E-3 Research on the rehabilitation in the landscape level of degraded tropical forest

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1. Introduction

Tropical forests are decreasing at the rate of 16.9 million hectares per year due mainly to clearing for agriculture and shifting cultivation. Moreover, timber harvesting results in more than 5 million hectares of tropical forest becoming secondary forests every year without any adequate management. The decrease and degradation of the tropical forests affect not only the production of timber but also global environments. Natural disasters such as flooding, erosion, landslides, and desertification are increasing due in part to the degradation or loss of tropical forest. Many environmental changes are initiated by forest harvesting including site degradation, reduced water supply, soil loss, and greenhouse gas emission. Selective and clear cutting, and burning are major causes of land degradation, though forest harvesting becomes a trigger to other forms of land utilisation. What is needed at present time is the assessment of harvesting impacts, which significantly influence rehabilitation methods. The harvesting impacts to ecosystems vary with time and methods of logging, timber transporting methods, logged tree species, soil characteristics, topographies, local rainfall patterns, and others. Therefore, the impacts in relation to logging and timber transportation measures must be assessed in a range of conditions with long term monitoring. In the Asia Pacific region, a growth in population and rapid economic expansion in the region has resulted an escalation in demand for wood products. Increased supply of wood from plantation forests has the potential to reduce pressure on natural forest resources as well as contributing to environmental care and economic advancement for landholders in the tropics. Where short-rotation plantations are developed there will be changes in nutrient storage and cycling processes due to factors such as harvesting wood, changed organic matter quality, fertilisation, erosion, leaching etc., and modified patterns of organic matter turnover. All of these factors can affect on storage and supply of soil nutrients for tree growth and consequently the sustainability of plantation systems. Opportunities exist to manipulate soil organic matter through silvicultural practices. The challenge for us is to provide the scientific information that enables managers to devise silvicultural systems, which enhance soil properties important to

sustainable production and minimise deleterious effects associated with short rotation tree crops. These practices must not only be technically feasible and economically viable but also socially acceptable.

The needs of the socio-economics and research on the disappearance and degradation of tropical forests for global environment are international issues such as the global warming prevention measure, sustainable forest management, biodiversity conservation, desertification prevention etc. And they are closely connected with a series of international treaties which are discussed in COP6 (Kyoto Protocol), the Montreal Process (Criteria and Indicators), ITTO2000 (sustainable forest management), etc. The exertion with many healthy forest functions, such as mitigation on global warming, biodiversity maintenance, etc. which tropical forest has, is made important, about sustainable forest management, by the U.N. Forest Forum (UNFF), the criteria and indicators are set up and a plan called monitoring, assessment, reporting to it is examined. However, although the deliberations about the great influence which disappearance and degradation of tropical forests has on global environment are progressing, examination of the rehabilitation of the tropical forest, which went to degrade is not carried out.

2. Research Objectives

In order to rehabilitate the tropical forest, which went to degrade, and the fragmentized forest region, the rehabilitation technology in the landscape level of these ecosystems needs to be developed. What is performed as research for this is as follows; (1) development of the rehabilitation technology of degraded forest, such as a logged-over forest, a secondary forest, and degraded shrub forest, and evaluation of biodiversity, (2) rehabilitation of the degraded land and the rubber plantation etc, and the clarification of the secondary wood trees characteristic, (3) evaluation of the catalytic effect introduced by the natural forest corridor to the early tree of growth artificial plantation, and development of the site management method. Moreover, (4) while performing research on land resources management planned decision on the landscape level by evaluation and local community participation of a forest rehabilitation management option of the socioeconomic adaptation possibility, (5) in order to perform existing exchange of network information and synthesis of a project, international network construction is performed with a database, the rehabilitation technology for the environmental conservation of an area is unified, and the purpose is attained.

Focal points

(1) Site classification of secondary vegetation, which should be rehabilitated by clarifying the understory revegetation pattern and direction of secondary succession.

(2) Introduction of natural forest corridor to a plantation former site, bare land, etc.

(3) The influence of the rehabilitated forest on the local socioeconomic is evaluated, and the rehabilitated forest is expanded.

(4) The biodiversity of various secondary forests becomes clear and the management method of a secondary forest is established.

(5) It has an analysis result in connection with rehabilitation, and is an international network.
(6) Database and publication of data such as recovery of forest resources, recovery of an environmental conservation function, recovery of biodiversity, etc.
(7) Integration of rehabilitation technology is performed and a homepage explains the rehabilitation technical options, which will be adapted for the region.
(8) Local community participation in rehabilitation of degraded tropical forest.
(9) The meaning of rehabilitation of degraded tropical forest is understood as conservation of a forest environmental function and biodiversity, and is reflected in the Global Environmental Policy.

3. Results and Discussion

Sub theme 1: Development of the rehabilitation technology of degraded forest, such as a logged-over forest, a secondary forest, and degraded shrub forest, and evaluation of biodiversity

1-1 Development of rehabilitation technology, and evaluation of biodiversity

The physiological characteristics of secondary forests and the change of insect fauna as an indicator of biodiversity are examined in Indonesia. The survival rate of *Macaranga gigantea* seedlings is generally low, and other plants such as ferns frequently prevent the progress of secondary succession. Thus, shoots from stumps, rather than seedlings will be effective in the rapid progress of secondary succession after disturbance. The ontogenetic changes in leaf physiology and morphology were found in *M. gigantea*. Cerambycid beetles fauna in Sebulu Experimental Forest of East Kalimantan was examined. The bibliographies of cerambycid beetles occurring in Kalimantan were made and also cerambycid specimens were gathered for good identification. Traps using *Artocarpus* shoots showed good performance in the sampling of cerambycid beetles. We could identify indicator species among cerambycid beetles for natural dipterocarp forest and degraded forests.

In 2004, the purposes of this section are to examine the dynamics of tree populations, to clarify the eco-physiological properties of pioneers and dipterocarps, and to establish the management system to recover the degraded forestland. In addition, we evaluate the recovery of biodiversity after forest fire using indicator horn beetles. Pioneer trees are effective for relatively quick reforestation in degraded tropical forests. We examined the leaf gas exchange and nitrogen use of the seedlings, saplings, shoots from the stumps, and adults of *Macaranga gigantea*, a typical pioneer tree in South-east Asia, and examined water use in the saplings transferred from shade to sun conditions of two pioneer tree species (*Macaranga* and *Trema*) and four late successional *Shorea* species. From the seedling to the sapling stages of *Macaranga*, the amount of nitrogen increased within the plant body, and the nitrogen use within the leaves changed. Following the shade-to-sun transfer, root water permeability decreased for all species. The decrease was larger in the pioneers than the late successional trees, and the pioneers developed larger root systems.

The increase in reserved resource and the change of root system are important limiting factors from the seedling to the sapling stages. The remained adult trees or stumps after deforestation will be important for supplying of the large amount of seeds. The large plasticity in pioneers will favor large gaps, but be not favor small gaps that re-closing and re-opening cyclically occurs. The species-specific gap size will be needed to effectively accelerate reforestation with high species-diversity, following the development of canopy of pioneer trees. After 29 years from clear cutting, about 48% of biomass recovered at secondary forest in a lowland dipterocarp forest in Pasoh F.R., Peninsular Malaysia. It will take more than 40 years to reach the original amount of biomass as a primary forest. An effective method to collect horn beetles were established, and samples and references for inventory of horn beetles in east Kalimantan was set up. There were indicative beetles to characterize a primary and degraded forest after fire.

1-2 Evaluation of the forest water supply function of a logged-over forest

The following findings were obtained from hydrological observations conducted at Bukit Tarek Experimental Watershed (BTEW) and Pasoh Forest Reserve (PAFR) in Peninsular Malaysia. Annual (365 days) ET for a 3-yr period ranged from 1243 to 1605 mm (mean=1425 mm) when calculated using the shifting water budget method. ET estimated by the short-time period water-budget method that accounts for changes in soil water storage ranged from 2.7 to 4.9 mm d^{-1}(mean=3.8 mm d^{-1}) for a 2-yr period. Potential evapotranspiration, estimated by Penman equation, is lower than ET estimated by SPWB-S method. The mean ratio ET/EP is 1.38. Mean percentages of various hydrological inputs compared against total rainfall measured in the open areas (1) were: (2) at road center without coverage of ferns (97.1%), (3) at the edge of fern protrusion (134.0%), (4) under ferns (79.2%), and (5) above the fern canopy (107.7%). The seven plots (10m x 20m) were established along the each stream at 50m intervals in C1 (control) and C3 (disturb). The census at riparian in C1 counted 536 individuals in 40 families and 144 species. In disturbed riparian zone in C3, 371 individuals were recorded in 30 families and 91 species. The total soil depth show more than 6 m at 14 point in 6ha plot in PAFR.

In 2004, the restoration of tropical forests lost once is not easy. Therefore, the rehabilitation technology in the tropical forests needs to be developed at area of the disappearance and degradation of tropical forests. Knowledge of the water conservation function in tropical forests is useful information to develop rehabilitation technology. Then, the objectives of this study are; 1) to clarify the water conservation function of tropical forests, 2) to evaluate the forest water supply function of a logged-over forest. The following findings were obtained from hydrological and metrological observations at Pasoh Forest Reserve (PAFR) and Bukit Tarek Experimental Watershed (BTEW) in this study; 1) Spatial distribution of surface soil moisture was affected by topography at 50-ha plot in PAFR. 2) Soil depth at 6-ha plot in PAFR was measured at 38 points. The soil depth showed 6 m over at 14 points in the plot. This result implies that deep soil plays a role in storage of rain water into the soil. 3) Annual evapotranspiration (ET) ranged from 1,243 to

1,605 mm (mean: 1,425 mm, SD: 70.8) using the shifting water budget method. The starting date is an important factor to estimate annual ET because surface water storage is not constant throughout a year. 4) The base flow discharge depended on geology. The ratio of plentiful runoff to scanty runoff and the recession constant at BTEW was similar to the results underlain by sedimentary rock in Japan. In addition, it is suggested that the function of water recharge on watersheds underlain by granite rock was superior to that at BTEW which underlain by sedimentary rock. 5) Wood biomass and biodiversity of tree species composition decreased after disturbance such as selective forest cut at buffer zone along the stream. 6) Volume of sediment, wood, and detritus in logged stream without buffer zone were greater compared to other channels: control and logged stream with buffer zone. 7) The spatial distribution of throughfall was caused by fern along 3-y after abandonment logging road, and by big trees (DBH≧20cm) and understory vegetation (e.g. bertam; rattan) along 41-y after abandonment logging road.

Sub theme 2: Development of the location management method about natural forest corridor introduction of a plantation, a degraded grassy place, etc.

2-1 Species selection, installation and growth analysis of natural forest corridor

In order to rehabilitate the deeply degraded land, it is important to develop the plantation technique from physiological aspect. To estimate the soundness and fitness of planted seedlings, we measured net photosynthetic rate (*A*), stomatal conductance (*G*w), water use efficiency (WUE), and osmotic potential at fully turgidity (Ψo_{sat}) on 24 species. Nine tree species whose fruits were edible for animals and birds were selected using the data of *A*, *G*w, WUE, and Ψo_{sat} from the nursery of University Putra Malaysia (UPM). And, we planted these in deeply degraded land at Ayer Hitam Forest Reserve (AHFR) on late of October, 2003. To investigate the adaptive capacity to strong light after planting, we examined photosynthetic properties in relation to photoinhibition for sun-leaves of 6 tree species, which are *Bouea macrophylla* (*Bm*), *Callerya atropurpurea* (*Ca*), *Canarium pilosum* (*Cp*), *Cynometra cauliflora* (*Cc*), *Morinda citrifolia* (*Mc*) and *Syzysuim* sp.(*Ssp*). The degree of chronic photoinhibition indicated by a decrease in pre-dawn F_v/F_m was well associated with an accumulation of excessive excitation energy in PSII indicated by the decrease in photochemical quenching (qP). Among species, *Ca* and *Mc* showed lower degrees of photoinhibition with higher qP. As higher electron transport rate (ETR) was observed with higher qP whereas there was no significant relationship between thermal dissipation (indicated by a decrease in F_v'/F_m') and qP, energy dissipation via electron transport was suggested to be more important to keep qP high and to prevent photoinhibition. Higher ETR in *Ca* appears to result from the higher area-based leaf N while that in *Mc* might be achieved by the higher stomatal conductance. From the result of growth analysis, *Mc* showed relatively good growth performance among planted species during 3 months after planting. Soil physical properties of the erosion/sedimentation monitoring points set up in the buffer zone of the C2 basin of the Bukit Tarek Forest Hydrology Experiment Watershed (BTEW) of Forest Research Institute of Malaysia

(FRIM). Soil physical environment at the sedimentation area were similar with that at the non-disturbed area. Setting up of the buffer zone proved to improve the physical conditions of the soil at the sedimentation area.

In 2004, Osmotic potential were studied for 36 tropical tree species in order to clear the adaptability to drought at Peninsula Malaysia. And hardening examination was done to examine plasticity of osmotic potential for 11 tropical tree spices. Osmotic potentials of tropical tree spices were high (low ability of water suction) in comparison with temperate tree spices. We found some spices that osmotic potentials don't lower (not change to high ability of water suction) by hardening treatment. From these results, it became clear that most of tropical tree spices are not suitable for open site planting. Since October 2003, we experimentally planted 9 tree species whose fruits are edible for animals and birds at degraded area in AHFR. Ecophysiological characteristics (photosynthesis, water use, chlorophyll fluorescence and so on) and the tree height were measured continuously. The species which showed lower degree of photoinhibition could have high performance of tree growth. Tree growth and the photosynthetic property of non-drought tolerant species showed low performance during drought period. Thus, ecophysiological characteristics reflected the growth and survival rate of planted trees. In order to examine soil degradation due to forest felling operation, erosion/ sedimentation of soil particle and physical and chemical properties of surface soil were monitored at the felling catchment in the BTEW of FRIM. Topographic and soil condition regulated the amount of erosion / sedimentation of soil particles, and the canopy openness of the monitoring points did not specific relationship with the amount in the buffer zone with close forest canopy. Bulk density and organic carbon contents of surface soil did not change after forest felling except on the ridge of the gentle slope where the surface soil was striped by construction of logging road. Changes in organic carbon density of the surface soil after the felling were varied by site. Eventually area of the degraded soil within the felling catchment due to the felling was estimated to be limited such as the ridge of the gentle slope. Relationship among soil accumulation/erosion rate, microtopography, and vegetation coverage at the soil movement monitoring points in the buffer zone. The maximum soil accumulation/erosion rate was observed at the point located within gully topography which connected with skid trails and/or cut over lands those were the source of soil movement. On the other hand, the soil movement seldom occurred at the point covered by dense understory vegetation though it located next to a skid trail. Fallen tress in the zone proved to trap soil movement effectively.

2-2 Development of the afforestation technology in the degraded land

The objectives of this study are 1) to clarify the responses of trees to various environmental stresses, and 2) to develop reforestation techniques in degraded lands using the stress-response characteristics of trees to be clarified in the present research. The target sites of this study are the problem soils in peat swamp area in Southeast Asia. We have established experimental plantation sites on theses problem soils in Narathiwat Province,

Thailand. We intend to select stress resistant tree species in these experimental sites, and to clarify the stress tolerant mechanisms of the selected resistant species in our laboratory. As a goal, we show reforestation techniques in degraded lands by a low input manner through the improvement of nursing and plantation methods using the stress-response mechanisms of trees. Fundamental studies and field researches have been done to get better knowledge for reforestation of degraded soils at tropical peat swamp area and surroundings. Experimental plantings at degraded sandy soils revealed: 1) large size pots bring better survival of dipterocarp seedlings planted at sandy soils, 2) some dipterocarp species showed better survival when they exposed to full sunlight at nursery 3 months before planting. Experiments on responses of tropical tree species against rhizosphere stresses revealed: 1) gene expression of high affinity phosphate transporters in roots of four tropical leguminous tree species were induced by low phosphate conditions, 2) a kind of Al exclusion mechanism was suggested to exist in tolerant species (*Melaleuca cajuputi*, *Eucalyptus camaldulensis*), 3) a kind of Al tolerance mechanism was suggested to exist in *M. cajuputi* to prevent strong binding of aluminium to root apex, 4) initially reduced photosynthesis under low oxygen conditions was recovered in rather short time and transportation of phosotynthate to roots was increased in tolerant *M. cajuputi*, 5) sucrose cleavage enzymes in roots of *M. cajuputi* did not reduce their activities and transportation of photosynthate to roots were maintained under oxygen shortage in rhizosphere.

In 2004, the purposes are to clarify the responses of trees to various environmental stresses and to develop reforestation techniques in degraded lands using the stress-response characteristics of trees to be clarified in the present research. The target sites of this project are on problem soils in peat swamp area in Southeast Asia. We have established experimental plantation sites on these problem soils in Narathiwat Province, Thailand. We intend to select stress tolerant tree species in these experimental sites, and to clarify the stress tolerant mechanisms of the selected tolerant species in our laboratory. As a goal, we show reforestation techniques in degraded lands by a low input manner through the improvement of nursing and plantation methods based on the stress-response mechanisms of trees. Fundamental studies and field researches have been done to get better knowledge for reforestation on degraded soils in tropical peat swamp area and surroundings. Experimental plantings at degraded sandy soils revealed: (1) large size pots bring better survival of dipterocarp seedlings planted at sandy soils, (2) some dipterocarp species showed better survival when they were exposed to full sunlight at nursery 3 months before planting. Experiments on responses of tropical tree species against rhizosphere stresses revealed: (1) gene expression of high affinity phosphate transporters in roots of four tropical leguminous tree species were induced by low phosphate conditions, (2) a kind of aluminium exclusion mechanism was suggested in tolerant species (*M. cajuputi*, *E. camaldulensis*), (3) a kind of aluminium tolerance mechanism that prevents strong binding of aluminium to root apex was suggested in *M. cajuputi*, (4) initially reduced photosynthesis under low oxygen conditions was recovered in rather short time and transportation of photosynthates to roots was increased in flood-tolerant *M. cajuputi*, (5)

sucrose cleavage enzymes in roots of *M. cajuputi* did not reduce their activities and transportation of photosynthate to roots was maintained under oxygen shortage in rhizosphere, (6) *Acacia flavescens* and *A. crassicarpa* showed heat tolerance, and *A. auriculiformis* and *A. mangium* were seemed to have some defense mechanisms to photoinhibition under high temperature.

2-3 Planning of the landscape level of afforestation using multiple tree species

The growth data of plantation trials in East Kalimantan, Indonesia were collected. Eight tree species had been planted in 1998 in the Sebulu Experimental Forest, East Kalimantan Indonesia. About 4.8 years after planting, biomass of each organ (leaves, branches, stems and root system) of 3-4 trees was measured. From allometric relationships between dbh^2 and biomass of each organ, total biomass of each plantation was estimated. For indigenous species, *Shorea gratissima*, *Dryobalanops lanceolata* and *Peronema canescens* plantation, total biomass estimated 1.45tDw ha^{-1}, 1.68tDw ha^{-1} and 9.89tDw ha^{-1}, respectively. *On the* other hands, *Shorea roxburghii*, *Tabebuia impetiginosa* and *cf. Albizia* sp. estimated 12.0 tDw ha^{-1}, 38.6 tDw ha^{-1} and 192.5 tDw ha^{-1}, respectively.

In 2004, the results suggested that the difficulties to propose reforestation projects in this region. Meanwhile, the profitable plan was derived from mixed planting with several species and suggested an economical advantages of the mixed planting rather than mono-cultured plantations. Moreover, the economical profits could be compatible with ecological profits such as species diversities in practices of forest managements. From these results, it is necessary to find out indigenous species that have few impacts on the environments and could satisfy the ecological demands for the establishment of feasible reforestation projects. In this study, our efforts were focused on seeking new species those have potentials for the planting. Wood qualities of some pioneer and indigenous species in Sebulu region (e.g. *Octomeles sumatrana*, *Anthocephalus chinensis* and *Dillenia excelsa*) were investigated. It was clarified that the veneer of three sample species could be used as core and center core of plywood and wood qualities of *D. excelsa* was appropriate for face, back and core of plywood. The result suggested that these indigenous fast growing species could contribute to profitability of a forest plantation and rehabilitation of degraded forest.

Sub theme 3: Research on the land resources control program by evaluation and citizens' participation in municipal affairs of the socioeconomic adaptation possibility of a forest rehabilitation management option

3-1 Evaluation of the socioeconomic adaptation possibility

In our research group, firstly, we summarized the rehabilitation activities from the conceptual view. And secondly, we focused on four tree planting promotion activities held in Lao P.D.R. and Thailand, and extracted characteristics of each promotion project from socio-economical aspects. Those promotion programs improve the profit rate of tree planting thorough soft loans, subsidies, and providing some implements or seedlings for tree planting. But management system should not be neglected for getting the stable and

constant success. The subsidy strategies encouraged the local peoples' participation in tree planting, but the efficiency was not always high because participants did not lose much in case of failure. Lastly, we mentioned land enclosure problems that could be caused by tree plantation. Tree planting activities need much time and much initial cost, so in some cases those activities affect the flexibility of land use. At the sample village located in the northern part of Lao P.D.R., supposed that all of the tree plantation areas are utilized for shifting cultivation, it can lengthen the fallow period by almost a year.

In 2004, there are still sufficient forest resources, to stop the lawless encroachment could also be called as a kind of rehabilitation program in the region. The land and forest allocation program is an example in Lao P.D.R. Through this activity, the utilization category of forests are defined and the protected or conservation forests are saved from encroachment. Forest village program by Royal Forest Department is an example in Thailand. The program intended to get people in the forests out from forests. The program provided the agricultural lands and also some job opportunity as the labor of rehabilitation site. On the other hand, in the region where there is a little forest, lands are usually changed into agricultural lands and also changed into private lands. So to make land owners participate in the rehabilitation program, the profitability is concerned. To improve the profitability, some economical incentives are essential. But it is hard for the local people to choose forest plantation which need long term and much initial invests. And in some cases, it caused the accumulation of lands to the capitalists and caused another land conflicts.

3-2 Land resources control program construction by local community participation in municipal affairs

This research objective is to clarify the "Land and forest resource management program through participation of local communities on the forest rehabilitation project site" and the guideline for making the program. The condition of "Participation" and "Participatory Forest Management (PFM)" (in 2002) and the characteristic of "Participation" on "the forest rehabilitation project site" (in 2003) were studied. Field surveys on the autonomous forest management in village B in Indonesia (in 2002) and on the rehabilitation program of West Kutai district government in Indonesia (in 2003) were carried out. Ideally "PFM" is that the local community "Independently" participates in "All the processes" of various forest management activities and has "Decision right". Its final goal is development of the ability for the local community to manage the forest resources sustainable. B villagers have managed the customary forest land and timber harvesting legally or illegally. In West Kutai Forest Office's rehabilitation program, uplift of indigenous people's welfare is one of important objectives. Combination of "Social Unit" and "Landscape", that is to start rehabilitation in land managed by a social unit under participation, is one of practical approaches for "Participation" on "the forest rehabilitation project site."

In 2004, the intensity of participation in the rehabilitation project site is limited because projects are mostly introduced by not locals but outside project promoters. Combination of "Social Unit" and "Landscape", that is to start rehabilitation in land managed by a social

unit under participation, is one of practical approaches. The "Program" is needed to define, clear or promote "Role and right/duty" of all actors, "Total land/forest management plan", "Sustainable motivation/free will", "Autonomic and transparent management" of participants organization including conflict management system, "Ownership or responsibility" of participant to project, "Capacity building", "Good relation" among all actors and so on. The process of making the program includes "survey", "initiation", "planning", "implementation" and "Monitoring and Evaluation" stages. The "Program" is needed to be modified and improved in repeating the process. In the process, the followings issues are important, "Locals participation/initiative" in "whole process", "Professionally-guided participatory approach" or "Endogenous bottom-up approach", "Behavior and attitude" that project promoter must follow as one of the "Three pillar" of Chambers, "Capacity building" for participant to repeat the process by themselves, "Role" of all actors and so on.

Sub theme 4: Synthesis of the rehabilitation technology for the environmental conservation of religion

4-1 Research on the network of tropical forest rehabilitation technology, and database construction

4-2 Research on the network of tropical ecosystem rehabilitation technology

This research was to specify how conscious people are of the significance of rehabilitating degraded tropical forests and how they view forests in their own area and the tropics. The data of 670 persons was collected through the questionnaires in five survey locations in Japan. The results showed that there are three different views: (1) forests are far outside their daily milieu (high school students), (2) forests are inside their daily milieu but the distance is far (science school, parents, the Ministry of the Environment), and (3) forests are inside their daily milieu (Shinshu University). The response percentage of 'agreement' concerning the rehabilitation of degraded forest surpassed 80 % in every survey, showing by and large people's support. There were opinions of 'leaving degraded forests for natural recovery', avoiding active human intervention and 'financial difficulty', making the rehabilitation activity difficult and leading, even if implemented, to a waste of budget. There was also an opinion that the regulation of development should be prioritized. We need, thus, take account of the order of priorities for each measurement. We had also visited 160 families to collect information about the rehabilitation of degraded tropical forest through the questionnaires in Thong Pha Phum, Kanchanaburi, Thailand where Forest Industry Organization is carrying out the plantation widely for the rehabilitation degraded land. Results of this information were discussed with comparison between Japanese and Thai people. Japanese people consider the forest as some feelings of amenity such as comfortable, clean and seasonality. But Thai people consider the forest functions such as water storage, shading and climate mitigation. Further results will be discussed on Indonesia and Malaysia. For extension and publicity of the research, we constructed the

homepage (Japanese and English versions) within the Forestry and Forest Products Research Institute server to provide information to the people in the research sites as well as those in other places with the aim of giving them opportunities to recognize the value of forests. For the purpose of extending knowledge about forests and tropical forests and enlightenment, we conducted lectures eight times in Japan, Thailand and Malaysia and introduced the existing research results, the rehabilitation of degraded forests, and the present condition of forests in Japan and the world.

In 2004, there are many local community living with the forests in the world where are degraded rapidly and threatened their routine lives in tropics especially. Moreover, people who are living in urban area also recognize the global environment problem related to the degraded forest. Therefore, we tried to clarify differences of the forest recognizing between Thai and Japanese, and between local community and urban citizen by the interview for the rehabilitation of tropical degraded forests. Aims of our studies (1) to clarify understandings of the forest by local community for the participation, socioeconomic adaptability and land resources management, (2) to compare differences of understandings between Japanese and Thai and (3) to discuss the significance of the rehabilitation of degraded tropical forest. We had carried out the interview at Bangkok, Kancahnaburi, Thong Pha Phoon and villages near TPP in Thailand, and Iida city, Takao, Tsukuba, Mishima city and Tokyo in Japan. We have made the simple interview format which is consisted of selection questions among 40 answers and free answers to what is the important of existing forest, how do you think to rehabilitate degraded forests and which is better between plantation and natural forest. Meanwhile, one of the final results through the project, we have arrived the compartment model which will be he initiated to response option of rehabilitation techniques. For the synthesis of rehabilitation techniques, the response option by Compartment Model was constructed. Controlling factors consist of landscape level, trade-off, and cyclic term which drive the direction and evaluate the adaptive set of rehabilitation techniques. And controlling factors play the important roles as the driving the compartment dynamics and feedback system. We have selected parameters which are decided results of each sub-theme. In this time, we selected as parameters of rehabilitation techniques and parameter of socioeconomic. Parameters of rehabilitation techniques are selected (1) site evaluation and classification, (2) rehabilitation techniques, (3) evaluation of landscape level rehabilitation, (4) selection of planting tree species, (5) natural forest corridor, (6) silviculture of degraded land, (7) mixed plantation. Parameters of socioeconomic are consisted of (8) local community participation, (9) socioeconomic adaptability, (10) land resources management, (11) synthesis of rehabilitation techniques, and networking.

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