2b. Study on the option of land resources management and the empowerment for local community in the lowland swamp forest in Southeast Asia

（Abstract of the Final Report）

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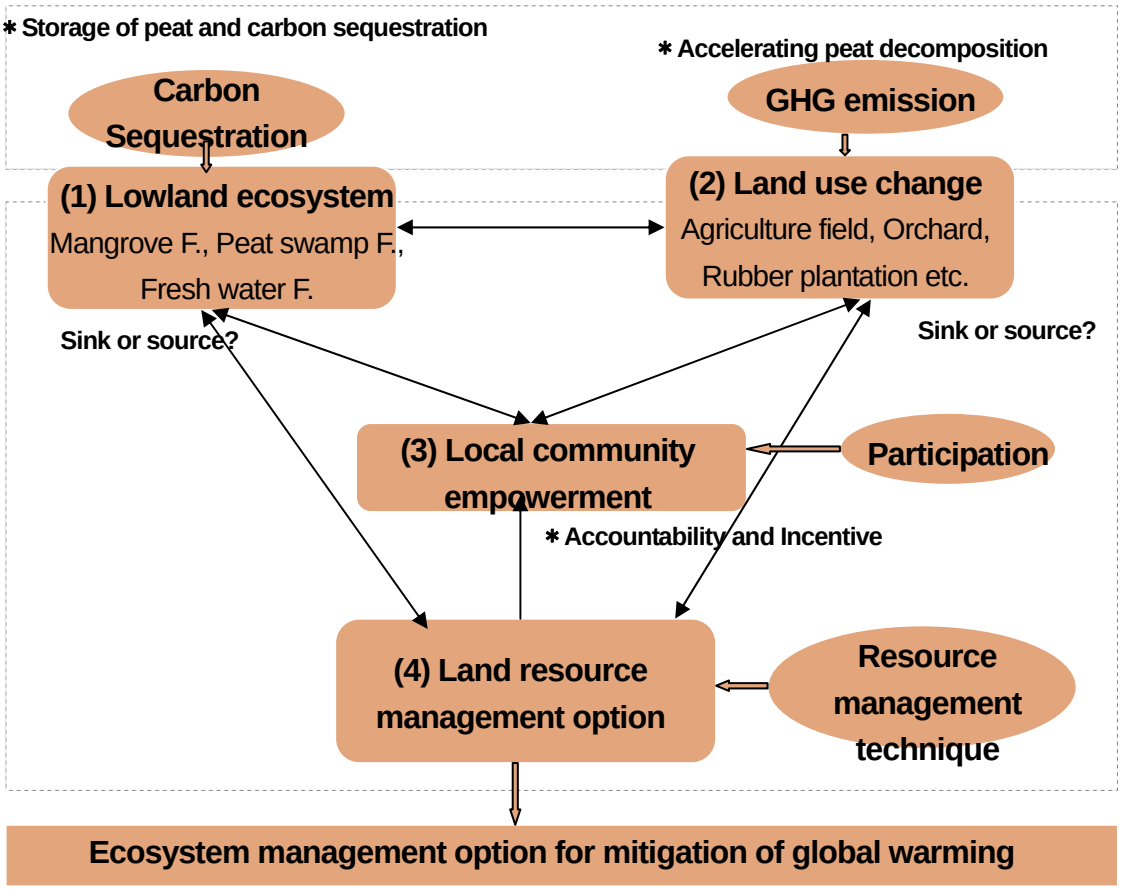
I. Overview

We have four sub-them from (1) to (4) (bellowed figure). Our final outputs are Ecosystem Management Option and Local Community Empowerment.



II. Scientific outcome

(1) Mangroves could accumulate carbon up to 282.2 tC/ha as the biomass in case of old growth while carbon fixation was highest in young stands as 5.5 tC/ha/yr. The carbon stock of riparian freshwater swamp forest differed by the period of water logged condition caused by annual flood so that nearly four times of difference was observed between very swampy low site and on drier terrace as 23 to 89 tC/ha even though the annual accumulation was equally small as ca. 1 tC/ha/yr in both site. Carbon stock of peat swamp forest was ca. 190 tC/ha at less nutrient-rich center site of peat dome. For belowground stored carbon in Iriomote, it was estimated to be about 200 tC/ha up to 1 m in depth. In Kosrae, it was estimated to be about 200 tC/ha up to 65 cm in depth and 2200 tC/ha up to 4 m in depth including mangrove peat overlain by freshwater swamp forest deposit. In the peat swamp on Sumatra, stored carbon up to 5 m in depth in the edge and up to 9.2 m in depth in the center were estimated to be about 2000 tC/ha and 2400 tC/ha, respectively. The belowground carbon accumulation rate was estimated to be 30 to 100 $g/m^2/yr$. Mangrove forests in Pohnpei were supported by mangrove peat and the belowground stored carbon were estimated to be 195 tC/ha for *Rhizophora stylosa* and *Sonneratia alba* forests, 585 tC/ha for *Rhizophora apiculata - Bruguiera gymnorrhiza - S. alba* forest and 1300 tC/ha for *R. apiculata - B. gymnorrhiza - Xylocarpus granatum* forest.

(2) We have also clarified that the secondary succession indicated its difficulties caused by loss of seed source and severe environment at peat land. Peat swamp forest also indicated that annual organic matter accumulation was 1.25 Ct/ha/yr. We have also estimated the accumulation of peat and organic matter 5.7 t/ha/yr. As the 50% of peat and organic matter annual decomposition rate, We have gotten the less than 0.26 Ct/ha/yr at Tuluk Meranti and 0.15 Ct/ha/yr under the conversion of land utilization from forest to coconut plantation.

(3) Local government is still supporting remained immigrants with several community empowering projects, which are turned out being failed, without admitting intentions and views of remained immigrants. These projects could be economically sustainable, once remained immigrants are properly involved. For the reasonable project planning, this study can contribute largely, by mediating local government and immigrant community.

In Lampung Province, the provincial forest department tries to establish a collaboration committee involving local authorities to cope with various problems derived from conflicts related to the border of forest and agricultural lands. On the other hand, local people who established farm lands in the forest area also try to establish a collaboration forum by combining farmers groups. Such trials indicate that there are two different directions; top-down and bottom-up organizing vectors. As a result of the joint research, it was observed that the presence of facilitators or mediators is indispensable in order to solve tensions and conflicts between the local government and local communities, as well as to empower the local people’s abilities to manage the problems. The research also revealed that mixed-farming consisting of various kinds of useful trees, which is practiced in the forest area, have provided a firm economic basis to the local people, and that they began to perceive that their farm lands may not be inferior to reforested lands with a single tree species in terms of environmental preservation. In order to confirm such perceptions of local people, more intensive surveys are planned to be conducted in collaboration with the Indonesian research group. Despite the dispute between the local government and local communities over the land management of “mixed gardens,” rather stable balance was kept between them as the negotiation between them developed. However, in spite of this stable condition,

Master Plan of National Forest Park prepared by the provincial forest office came to arouse a controversy. Immediately after the hearing, they began to strengthen their communication networks and to look for the occasions for publicizing their perceptions that the “mixed gardens” which were established by their agricultural activities play an important role not only in producing economic benefits but also in preserving the forest area and providing ecosystem services. It was expected that a model of collaboration with regard to the forest area management would be created between the local government and local communities, as was shown in the case of representation of Sumber Agung people as a participant to the National Assembly. As this indicates, it was concluded that the presence of facilitators or mediators is indispensable in order to reduce the tensions and conflicts, to empower the local community, and to create the collaboration between the local government and local communities.

(4) For renovation of wet rice cultivation: Our design for renovating the degraded wet rice cultivation produced remarkable increase of rice, that is, from 0 to 5.4 ton/ha in maximum case in abandoned fields, and from less than 1 ton/ha to 5.8 ton/ha in maximum case in rain-fed fields. The key for the success lied in (1) flushing of acid before transplanting and continuous inundation of water on the fields during the growing season, (2) application of lime to carry soil pH to around 4.5, (3) application of micro-nutrients, particularly foliage spraying of Fe-containing solution, as well as macro-nutrients. For collaboration of pilot project with provincial government: Based on our remarkable success, provincial government joined to our project from 2005, and laid pilot project of 100 ha. However, once the project changed to theirs, various problems appeared, such as delayed starting of rice cultivation, and non-approval of micro-nutrient fertilizers. Therefore, rice yield retreated to 2.4 to 3.9 ton/ha.

III. Contribution to policy of global environmental issues for decision makers

We expect to contribute to IPCC and other International conventions on the results of our research which are the data of carbon storage and accumulation at wetland forest ecosystem, peat decomposition rate after land use change and time of peat recovery by publication of scientific journals. We have also made the public information and extension through the presentations at several kinds of International conference.

It was expected that a model of collaboration with regard to the forest area management would be created between the local government and local communities, as was shown in the case of representation of Sumber Agung people as a participant to the National Assembly. The closer interaction between two parties, which was enhanced by the research team’s intervention, has developed the networking among farmers groups and strengthened their negotiation abilities. As this indicates, it was concluded that the presence of facilitators or mediators is indispensable in order to reduce the tensions and conflicts, to empower the local community, and to create the collaboration between the local government and local communities.

Collaboration of pilot project with provincial government: Based on our remarkable success, provincial government joined to our project from 2005, and laid pilot project of 100 ha. However, once the project changed to theirs, various problems appeared, such as delayed starting of rice cultivation, and non-approval of micro-nutrient fertilizers. Therefore, rice yield retreated to 2.4 to 3.9 ton/ha. This result has been caused by artificial mistake of provincial government.

1. Introduction

The Ramseur treaty on wetland conservation was concluded as an international treaty in 1971. Wetland forests in the tropics have, however, been experiencing drastic land-use transformations for easier access and utilization, which, together with tropical forest decline, has also been a focal point of global environmental issues. Southeast Asia in particular has a very wide area of wetlands in which mangrove, peat swamp and freshwater wetland forests are distributed in 22.2 million hectares. Such area of wetlands are increasing that were converted to agricultural farms or shrimp farming ponds, being subsequently abandoned due to productivity decline. Wetlands, stored with abundant organic matter, become a source of the greenhouse effect gases such as carbon dioxide and methane generated by decomposition of organic matter since such lands have not been properly utilized. Rehabilitation of degraded wetlands has, nevertheless, hardly been attempted. LULUCF (Land-Use, Land-Use Change and Forest) has been discussed as an agenda of IPCC since 2001. It is, therefore, urgently necessary to conduct research on land resource management option and local society empowerment for global-warming prevention in Southeast Asian wetlands.

In tropical wetlands, which most emit the greenhouse effect gases due to land use change, attempts have never been made to revitalize local society in favor of a land use which urges global-warming prevention (e.g., wetland forest rehabilitation). Land use landscape management in tropical wetland basin (e.g., mangrove, peat swamp, and freshwater wetland forests) has neither been conducted. Therefore, this research is to adequately develop multi-purpose land use for agriculture (wet rice, coconut, etc.), forestry, fishery (shrimps and crabs) and the like, taking into consideration of conservation of very fragile tropical wetland ecosystem, and to build a sustainable management system. It is also to explore the maintenance mechanism and carbon fixation function in freshwater wetland, peat swamp and mangrove forests and to elucidate the change in carbon storage in the process of land conversion from forest to others such as agricultural farms. In border region between forest area (*kawasan hutan*) and agricultural lands in Indonesia, conflicts over the right of land management of forest area arise between the local government and local people. In particular, in the age of decentralization after the fall of Suharto's regime, they have spread into all over the country and heated up. In order to seek for the solution, and also in order to understand the role of local people, the research was conducted in the provinces of South Sulawesi and Lampung by focusing on the implementation of social forestry program, taking the following assumption into consideration that the empowerment of local societies through the program may lead consequently to the establishment of effective measures for preventing global warming.

This will promote local society empowerment in favor of land use (wetland forest rehabilitation) that prevents global-warming (global environment conservation) and integrate the results into land use management option in wetlands, rehabilitation technique and social rehabilitation.

2. Research Objective

Forests such as those of freshwater wetlands, peat swamps and mangrove are the pristine vegetation of the tropical wetlands, where carbon fixation has been occurring since the ancient times and peculiar bio-species have created the ecosystem. Such forests have continuously been converted to other land uses, especially agricultural farms. The first objective of the research is to elucidate maintenance mechanism and carbon fixation function in freshwater wetland, peat swamp and mangrove forests. The second objective is to investigate the change of carbon storage, which has been brought about by land use conversion from

forest to agricultural farms and concomitant disappearance of peculiar bio-species. The third objective is to survey local society empowerment (revitalization) in favor of a land use that urges prevention of global warming (wetland forest rehabilitation). Based on research results from these three objectives, the fourth objective is to reflect the integration of land resource management option in wetlands, rehabilitation technique and social revitalization into regional administration. We set four main topics such as (1) Research on the maintenance mechanism and carbon fixation function in freshwater wetland, peat swamp and mangrove forests, (2) Determination of carbon storage change accompanying land use conversion from forest to agricultural farms and others, (3) Local society empowerment in favor of land use (wetland forest rehabilitation), which facilitates prevention of global warming (global environmental conservation), **(**4) Integration of land resource management option, rehabilitation technique and social revitalization. Then, taking into consideration a gap between global warming issues and local communities in terms of their practice and perception, the research dealing with the sub-theme 3 aimed at understanding various cases where the social and political interactions could be observed between local governments and communities by focusing on the implementation of social forestry programs in Indonesia, and in order to seek for the way for empowering the local communities, it aimed at analyzing the factors related to the establishment of appropriate resource management of farm lands reclaimed in the forest area.

3. Study Site and Methods

One of the study site is located Yasothon in Thailand. We carried out estimation of carbon storage and accumulation rate at the fresh water swam forest. We got the alommetry related with individual size and weight. We also carried out to classify the structure of fresh water swamp forest.

We have carried out the bowling for dating the peat and clarification of layers in Riau Province. Each core sample were analyzed their chemical properties and dating. We have also set the permanent plot of peat swamp forest (1 ha) at the center of peat swamp dome in Zamrud, Riau Province. This plot was analyzed its structure and DBH-H relation. Turuku Meranti and Tunbirahan were selected for estimation of peat decomposition. The study site are located at Zamrud, Tuluk Meranti and Tunbirahan, Riau Province and Parankararaya, Central Kalimantan Province, Indonesia. The peat swamp forest used to be converted into agriculture field such as paddy field, coconut plantation, lubber plantation, oil palm plantation and fast growing tree plantation etc.

We have studied local community empowerment in Central Kalimantan. The changes of their agricultural methods were monitored. We also studied agricultural activities for local community empowerment in Jambi Province, Indonesia. We have monitored on farm agriculture project. The research was conducted, in the same way as last year, jointly with an Indonesian research group in August, 2006 and January/February, 2007 in the surroundings of Gunung Butung in Lampung Province, where a social-forestry project was implemented by the government. Since a kind of tension or conflict was observed last year between the provincial forest office and local farmers groups over the land-use management of the forest area, fieldworks were carried out in order to follow up the negotiation processes between two parties, and obtain relevant information related to empowerment of local societies by participating in the meetings among farmers groups.

We have surveyed all of land use at coastal area of Jyambi, province, Indonesia. And we have monitored the examination of on farm paddy test caused by rehabilitation of salfic acidity damages.

4. Results and Discussion

(1) Research on the maintenance mechanism and carbon fixation function in freshwater wetland, peat swamp and mangrove forests

The swamp forest in the tropical Asia are playing important role in the prevention and mitigation of ongoing global warming with their wide extent and huge accumulation of carbon both as the aboveground biomass and belowground biomass as well as organic matter and peat. We tried to offer quantitative data of aboveground carbon stock of mangroves, riparian swamp forest and peat swamp forest in the SE Asia. Several study plots were established in the mangroves with different age and types including well developed old growth forests. All tree censuses were conducted repeatedly to determine the stand structure and growth. Mangroves could accumulate carbon up to 282.2 tonC/ha as the biomass in case of old growth while carbon fixation was highest in young stands as 5.5 tonC/ha/yr. The carbon stock of riparian freshwater swamp forest differed by the period of water logged condition caused by annual flood so that nearly four times of difference was observed between very swampy low site and on drier terrace as 23 to 89 tonC/ha even though the annual accumulation was equally small as ca. 1 tonC/ha/yr in both site. Carbon stock of peat swamp forest was ca. 190 tonC/ha at less nutrient-rich center site of peat dome.

Belowground stored carbon was examined for freshwater swamp forests on Iriomote Island, southwestern Japan and Kosrae Island, Micronesia, for peat swamp forest on Sumatra Island in Indonesia, for mangrove forest on Pohnpei Island, Micronesia and for mangrove reforested area in Vietnam. In Iriomote, it was estimated to be about 200 tC/ha up to 1 m in depth. In Kosrae, it was estimated to be about 200 tC/ha up to 65 cm in depth and 2200 tC/ha up to 4 m in depth including mangrove peat overlain by freshwater swamp forest deposit. In the peat swamp on Sumatra, the thickness of peat layer reached more than 4 m in the edge of peat dome and more than 9 m in the center. Stored carbon up to 5 m in depth in the edge and up to 9.2 m in depth in the center were estimated to be about 2000 tC/ha and 2400 tC/ha, respectively. The belowground carbon accumulation rate was estimated to be 30 to 100 $g/m^2/yr$. Stored carbon per unit volume of the peat layer formed under the center of peat dome was less than that of the edge, which was slightly less than that of mangrove peat. The formation of peat swamp forest was already started by 7000 cal BP. Subsequently, it expanded rapidly between 4000 and 2000 cal BP and nearly reached the present distribution area. As the peat swamp forest have been maintained in the wide area during the last 3000 years and formed 2 to 4 m thick of peat layer, the belowground can be evaluated to have played a significant role as the place for carbon sink as well as above ground. Mangrove forests in Pohnpei were supported by mangrove peat and the belowground stored carbon were estimated to be 195 tC/ha for *Rhizophora stylosa* and *Sonneratia alba* forests, 585 tC/ha for *Rhizophora apiculata* - *Bruguiera gymnorrhiza* - *S. alba* forest and 1300 tC/ha for *R. apiculata* - *B. gymnorrhiza* - *Xylocarpus granatum* forest. In the mangrove reforested area in Vietnam, the belowground carbon and nitrogen have decreased during the first four years after reforestation.

(2) Determination of carbon storage change accompanying land use conversion from forest to agricultural farms and others

The purpose of this study aims to clarify the characteristics of tropical peat swamp forest structure and vegetation recovery after peat swamp forest harvesting and estimate decomposition and accumulation rate of peat after conversion of peat land utilization. The study site are located at Zamrud, Tuluk Meranti and

Tunbirahan, Riau Province and Parankararaya, Central Kalimantan Province, Indonesia. The peat swamp forest used to be converted into agriculture field such as paddy field, coconut plantation, lubber plantation, oil palm plantation and fast growing tree plantation etc. After land use changes, surface temperature increased, moisture of peat became dry and mild acidic. Then the peat changed from fabric peat to mesic peat and to sapric peat. After changing, peat completely decomposed. We have also clarified that the secondary succession indicated its difficulties caused by loss of seed source and severe environment at peat land. Peat swamp forest also indicated that annual organic matter accumulation was 1.25 Ct/ha/yr. We have also estimated the accumulation of peat and organic matter 5.7 t/ha/yr. As the 50% of peat and organic matter annual decomposition rate, We have gotten the less than 0.26 Ct/ha/yr at Tuluk Meranti and 0.15 Ct/ha/yr under the conversion of land utilization from forest to Coconut plantation.

(3) Local society empowerment in favor of land use (wetland forest rehabilitation), which facilitates prevention of global warming (global environmental conservation)

In addition to cases in Sumatra yet studied, an immigrant community in Kalimantan peat swamp is studied for generalization of nature of “Frontier societies in swamp area” The investigated community, in this time, is located at the ex-project site, the project called Mega-project, which has been initiated and sponsored by central government in 1995, but then suspended in 1997, leaving vast deforested “agricultural” land behind. Most of immigrants has already left project site disappointedly. Initially planned modern paddy cultivation with high yield varieties was never realized. But those remained has somehow managed to survive, with a hope for stable income from allotted farm land by planting rubber tree, while engaging in illegal logging and/or gold mining in the time of former study in 2003, and in temporally works in nearby plantations in this time. Local government is still supporting remained immigrants with several community empowering projects, which are, unfortunately but naturally, turned out being failed, without admitting intentions and views of remained immigrants. As potentially high returns, in terms of carbon dioxide reduction, are expected from this area, proper environmental projects are urged to be enforced. These projects could be economically sustainable, once remained immigrants are properly involved. For the reasonable project planning, this study can contribute largely, by mediating local government and immigrant community.

The comparative surveys conducted in Sinjai district and other locations in South Sulawesi revealed that the economic benefit obtained from the rehabilitation program has been the most important concern of local people. Even though the villagers in Tongke-Tongke and Pangsa, who voluntarily began to plant seedling with an intention to reclaim fishponds after the plantation was established, succeeded in establishing the mangrove forests, the people in other villages did not have such intention and just followed the government instructions. In particular, the people in Pangasa succeeded in creating their own system for coexisting mangrove forests with fishponds, and this system was evaluated to be superior to those recommended by the government because of high profitability and risk avoidance. In Lampung Province, the provincial forest department tries to establish a collaboration committee involving local authorities to cope with various problems derived from conflicts related to the border of forest and agricultural lands. On the other hand, local people who established farm lands in the forest area also try to establish a collaboration forum by combining farmers groups. Such trials indicate that there are two different directions; top-down and bottom-up organizing vectors. As a result of the joint research, it was observed that the presence of facilitators or mediators is indispensable in order to

solve tensions and conflicts between the local government and local communities, as well as to empower the local people's abilities to manage the problems. The research also revealed that mixed-farming consisting of various kinds of useful trees, which is practiced in the forest area, have provided a firm economic basis to the local people, and that they began to perceive that their farm lands may not be inferior to reforested lands with a single tree species in terms of environmental preservation. In order to confirm such perceptions of local people, more intensive surveys are planned to be conducted in collaboration with the Indonesian research group. Despite the dispute between the local government and local communities over the land management of "mixed gardens," rather stable balance was kept between them as the negotiation between them developed. Also, it was observed in Sumber Agung and Talang Mulya that the presence of the farmers groups had succeeded in preventing the further penetration into the forest area, and that the production obtained from their reclaimed lands had been gradually increasing through the intensification of land-use management and the increase of the number of useful plants. However, in spite of this stable condition, Mater Plan of National Forest Park prepared by the provincial forest office came to arouse a controversy. Although the provincial forest office organized a public hearing, in which the farmers groups also participated, the plan seems to exacerbate their anxiety, because it might urge them to change the present land use if it would be implemented as it is. On the other hand, the official announcement of the plan seems to stimulate the rearrangement of the farmers groups' activities. Immediately after the hearing, they began to strengthen their communication networks and to look for the occasions for publicizing their perceptions that the "mixed gardens" which were established by their agricultural activities play an important role not only in producing economic benefits but also in preserving the forest area and providing ecosystem services. It was expected that a model of collaboration with regard to the forest area management would be created between the local government and local communities, as was shown in the case of representation of Sumber Agung people as a participant to the National Assembly. The closer interaction between two parties, which was enhanced by the research team's intervention, has developed the networking among farmers groups and strengthened their negotiation abilities. As this indicates, it was concluded that the presence of facilitators or mediators is indispensable in order to reduce the tensions and conflicts, to empower the local community, and to create the collaboration between the local government and local communities.

(4) Integration of land resource management option, rehabilitation technique and social revitalization

Assessment of government-sponsored reclamation on peat-acid sulfate soil environment: Present land use survey made it clear that the reclamation aim to develop tide-irrigated rice fields was confined to the area along major rivers and partly along the primary canals. Those lands far from major rivers and primary canals are occupied by scrub (37 %) covering the abandoned fields, and rain-fed rice fields of extremely low yielding (12 %). The others are coconut gardens and rubber gardens which are least managed. This kind of assessment on government-sponsored reclamation is the first ever made in Indonesia.

Mul-function of primary canals: Water quality survey of primary canals revealed unexpected fact that is contrary to the conventional surmise that sulfate acidity would be highest in the dry season. Actually, the fact is reversed, that is, release of sulfate water takes place in the rainy season. Furthermore, it was made clear that every primary canal is segmented into inlet section which is flushed with riverine water, vast midsection which is stagnant and extremely acid, and the other end which is intruded with salt water in the dry season.

Feasibility map of cropping land: Soil survey made it clear that cropping land irrigable with back-up tidal water stands primarily on riverine sediments, and that the inland terrain stands sapric peat-covered sulfidic sediments. It was made clear that unfavorable conditions of soil and primary canal water caused the occurrence of degraded fields which were abandoned or left merely as rain-fed. Relatively good stands of coconut trees and rubber exclusively rest on former sand ridges and on remaining peat.

Renovation of wet rice cultivation: Our design for renovating the degraded wet rice cultivation produced remarkable increase of rice, that is, from 0 to 5.4 ton/ha in maximum case in abandoned fields, and from less than 1 ton/ha to 5.8 ton/ha in maximum case in rain-fed fields. The key for the success lied in :(1) flushing of acid before transplanting and continuous inundation of water on the fields during the growing season, (2) application of lime to carry soil pH to around 4.5, (3) application of micro-nutrients, particularly foliage spraying of Fe-containing solution, as well as macro-nutrients.

Real cause of inhibition factor in peat-acid sulfate soil environment: The above-mentioned foliage spraying of Fe solution is contrary to a “common sense” that seeks the inhibition factor to toxic Fe level in acid sulfate soils. From the analysis of rice leaves, we found the Fe level ranged in 100 to 200 ppm which is not toxic, on the contrary high level of Al exceeding 300 ppm, particularly in the leaves showing chlorosis. Thus, it is reasonable to conclude that inhibition factor lies not in the toxic Fe level but in toxic level of Al in rice plants.

Collapse of clay minerals: Clay mineral specie present in the soil remain similar through the soil profile, but a remarkable decrease of smectite-vermiculite clay is clear and increase of mica-illite type is obvious in the rooting soil zone. This change indicates explicitly the collapse of 14 A clay minerals because of strong acidity and their change to 10 A clay minerals. It is a due surmise that a concurrent production of free Al sesquioxides is taking place.

Geochemical leaching process predominant in the reclaimed lands in peat-acid sulfate soil environment: There are two major agents to accelerate the leaching of elements out from this environment. One is tidal rivers and the other is tidal canals. So to speak, there are two powerful pumps to leach out elements. Tidal river pump lies between the tidal rivers and the canals, and its capacity is large. The tidal canal pump lies between tidal canals and reclaimed fields. Its capacity is small, but extensively working. These two pumps work for removal of toxic substances as well as for leaching of necessary nutrients. Among nutrients in the rhizosphere, critical elements for normal cropping are Fe and Al in this environment. Because of prevalent reducing conditions and strong acidity of soils, major part of free Fe which is originally at very low level is mobilized in movable forms, and easily lost by leaching. On the other hand, free Al is continuously provided because of acid attack on clay minerals. Deficiency of Fe and toxic level of Al in the plants cause strong stress and inhibit normal plant growth. Free Fe and Al are leached out from cropping fields to canals by tidal canal pump, show peculiar phenomenon of floccule coagulation and redissolution. Part of the coagules are precipitated on canal wall and bottom, oxidized into hard concretions in the dry season, and other part is transported out by tidal river pump, and lost. Major constituent of the floccules is Fe, with Al as subconstituent. Thus, the reclamation of this environment induces intensive leaching of free Fe. Free Al, which has a larger stock in the soil, is continuously provided through the collapse of clay minerals, and remains at toxic level. Unbalanced Fe deficiency and Al surplus make up a strong stress against normal crop growth. For renovation of crop performance, measures to increase free Fe are necessary, such as input of iron-rich material, red soil,

phosphate fertilizers, and slag.

Collaboration of pilot project with provincial government: Based on our remarkable success, provincial government joined to our project from 2005, and laid pilot project of 100 ha. However, once the project changed to theirs, various problems appeared, such as delayed starting of rice cultivation, and non-approval of micro-nutrient fertilizers. Therefore, rice yield retreated to 2.4 to 3.9 ton/ha. This result has been caused by artificial mistake of provincial government.

Planting of agarwood: Survival rate of planted agarwood tree is about 70 %, and original seedlings of 40 cm have now attained to grow up to 3.5 m. Good growth is observed on peat remaining soils and on the former sand ridges. As for the agarwood tree management, we hold a cooperative relation as yet with farmers agarwood association of Merangin district of Jambi. They employ an unique method for the management, that is, not following conventional method of whole cutting, instead collecting agarwood blocks from grown-up trees for several decades, just as collecting latex of rubber plantation. This method seems better way for re-greening.

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