

## **ASIA LINK PROJECT**

*“New Educational Tools for Sustainable Management of Peatland in the Humid Tropics” (PEATWISE)*

**History of the Development of Tropical Peatland in Central Kalimantan,  
Indonesia**

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## PREFACE

This report as a general history of the peatland utilization in Central Kalimantan. Beside to complete of PhD thesis, this report also to complete a modul of Human Dimension in Asia Link Project : "***New Educational Tools for Sustainable Management of Peatland in the Humid Tropics (PEATWISE)***", through the collaboration research between Wageningen University, Leicester University, UNIMAS and Palangka Raya University. Important to explain that the local knowledge which is related with the peatland utilization will give understanding for local people widely, because the environments damages by exploitation of peatland for agriculture unsuccessful yet, because the Indonesia Government has neglected the local knowledge.

The real profile of the Government mistaken has showed through the opened of peatswamp forest about one million hectares for agriculture and transmigration. The movement of people from Java to Central Kalimantan as transmigrant in reality has just movement of poorness to the new area. We do not know where is the transmigrant settlement successful to manage their land, because many of them move to other job as illegal activities.

This report will give warning for the Government how to wise use of tropical peatland that must be consider on peat characteristics, human culture and marketable. The existing of peatland condition in Central Kalimantan will be arise of disaster, if the Government does not rehabilitate based on major cause factor, that is hydrological status was changed.

Palangka Raya, December 2006

Suwido H. Limin

## 1. INTRODUCTION

The province of Central Kalimantan, Indonesia, with an area of approximately 153,564 km<sup>2</sup>, contains at least 2,651,724 ha (or around 17.3%) of peatland. Based on geographical location and the influence of tidal movement, peatland can be grouped into two types: **inland peat** (not influenced by sea water), and **coastal peat** (mainly influenced by sea water). Inland peat is not only typified by thick peat of up to 17 meters thick, but also by poor vegetative growth that results from the decomposition status of this type of peat, which is either fibric or hemic. In addition, the subsoil beneath the inland peat is mainly quartz sand and granite, making it a very poor nutrient soil. In contrast, coastal peat is shallow (25 – 100 cm) and gives rise to highly fertile soil owing to the natural enrichment by sea water sediment. At maturity this peat is usually sapric or hemic. However, as the subsoil is predominately marine, the subsoil is very acidic (less than pH 4.0) identifying it as acid sulfate or potential acid sulfate.

Peat swamp forest is not only important as the habitat for flora and fauna of high economic value and rarity, but it is also a major global carbon store. If vegetation on the peat layer is destroyed by canal construction, the ecosystem will change accordingly, and at the same time decomposition of peat by microorganisms will increase, leading to a loss of CO<sub>2</sub> to the atmosphere.

Historically, the Government of Indonesia has executed development programs, often without taking into account undeniable facts and past experiences. Every sector makes different plans, carries out their own programs in disintegrated ways, and underestimates the importance of research findings. The successful experience in managing peat in Sumatra was assumed to be a successful method and applicable to Central Kalimantan. However, the transmigrated farmers in Bereng Bengkel (now known as Kalampangan) have only been able to successfully manage the area surrounding their houses (0.25 ha); their farmlands have not been productive. The government has not identified the factors that caused the failure of the transmigration program in Bereng Bengkel.

The opening of peatland for agriculture in both upstream and coastal areas has always been by trial and error. Limin *et al.* (2000) and Limin (2005) mentioned that the

Government policy should have included the traditional size-limited canals (*“handel”*). However, the Mega Rice Project policy neglected the knowledge of local people who understand that the key to successful rice cultivation is appropriate water management. Presidential Decree 32/1990, which declared that peatland with thickness less than 3 meters could be used for agriculture and more than 3 meters should be conserved, was a major factor leading to the degradation of peatland in Indonesia. In the planning process of the development program, the Government never involved the researchers who made recommendations based upon the results of hard work and comprehensive research. Limin (1999) stated that the utilization of peatland in Central Kalimantan has been unsuccessful, because the government policy to convert peatland area for agriculture never considered the carrying capacity, land ecosystem, culture, local knowledge and marketability of the crops.

The utilization of peatland based on Presidential Decree 32/1990 is a threat to the existence of peat, because it was formulated without research findings. According to Limin (2004a and 2005), proper utilization of peatland is not only determined by peat thickness, but also by the nature of the material underneath the peat layer, along with the hydrological status. Even if peat thickness is less than 50 cm, if the materials underneath the peat layer are sand, granite, or acid sulfate soil, it will be impossible to achieve sustainable agriculture, especially of food crops. In peat areas with underlying acid sulfate soil, namely, Basarang, Palingkau, Tamban, Mintin, Kuala Pembuang and Tabak Kanilan in Central Kalimantan, rice production is very limited.

For wise use of tropical peatland in Central Kalimantan, the Government should learn from the Dayak people’s traditional ways, which are based on understanding the carrying capacity of the land. For example, in contrast to the present when timber has major economic value, before 1960, the condition of natural resources was always in balance. Before this last decade, the Dayak people only exploited the forest for their own subsistence rice fields (*“ladang”*) and cut trees in limited amounts for house construction and other facilities. As a consequence of local people’s attitude and approach, the natural environment provided human needs for living in plenty. Unfortunately, this situation has changed very fast following the forest exploitation and transmigration and plantation projects that are now the main programs promoted by the Government to increase community welfare. This increase in the rate of environmental damage in Central

Kalimantan has not just been caused by local people (*Dayakness*), since about 80% of the people involved in illegal activities are newcomers, mostly transmigrants and illegal migrants (Limin, 2004b).

In this paper, traditional peatland management techniques are described, because these techniques are essential for sustainable peatland use and rehabilitation of disturbed peatland. Data for this paper were obtained from field observations in a long-term field survey.

## 2. TRADITIONAL PROCEDURE AND STAGES ESTABLISHING RICE FIELD (“LADANG”)

The opening of forest area for rice field (“*ladang*”) is always determined by considering of the season, especially the flooding level and the length of the dry season. The farmers must follow several rules based on experience gained by their parents and ancestors. Generally, the procedures for establishing rice field (“*ladang*”) by Dayak people are as follows.

**Season estimation:** Based on nature’s signs the Dayak farmers estimate when the following are likely to occur (1) short dry season, (2) long dry season, (3) no flood and (4) big flood. Knowing this they can use two criteria to choose a field’s location, namely, (i) low land (“*petak pematang*” or “*petak bahu danum*”), if a long dry season is predicted, and (ii) hill area (“*petak bukit*”), if a short dry season and big flood are predicted.

Several natural signs that indicate the type of season likely to occur in the following year include: 1) Moon and star positions when these are forthcoming, 2) Roots of trees (mangrove tree) and mushrooms e.g. “*kulat danum*” which grow near or beside the river, and 3) Behavior of certain animals, e.g. “*rihun*” (*Hexagenia bilineata*, Say), ants i.e. “*semut gatal*” or “*sansaman*” (*Dolichoderus bituberculatus* Mayr), and birds i.e. elang (*Spizaetus nanus*).

**Choice of location:** Farmers must discuss among themselves to determine the location, because at least two families should be neighbors in one place to establish their rice field (“*ladang*”). This strategy must be conducted, because the main constraint to rice production will be pests, e.g. pig, deer, monkey, rat and bird. To confirm the choice of location there is an important natural sign of luck for growing called “*nantuani dahi*ang”.

The farmers can know the success of their rice field (“*ladang*”) management by: 1) their dream before and after visiting the location and 2) the sound of an eagle when they leave and arrive at the location. Land fertility can be determined by the color of the top layer of soil by dig of soil use the knife (“*maneheb petak*”). If the topsoil is black (fertile) for around 10 – 20 cm, they can use the area for rice field (“*ladang*”). Vegetation type is another indicator of soil fertility, e.g., “*kalapapa*” (*Euodia* sp), and “*kalanduyung*” (*Mallotus* sp).

**Land clearing and land preparation:** Land clearing and land preparation can be divided into four stages. Shrubs or small trees should be cut down, so burning will be clean. Tree branches and twigs should be chopped and used as biomass.

In the burning stage, the farmers like to burn all of the biomass (grass, leaves, branches and twigs), except for large timber. Success of the burning stage determines the success of rice production. Using traditional burning methods, the fire does not spread outside of their rice fields (“*ladang*”). To make sure of this they have to make a transect along the border of the rice field (“*ladang*”) and many people join in the burning activities. Generally, all of the biomass is never totally burnt. Therefore, the farmers must collect the residual biomass material (“*mangakal*”) and put in a pile (“*pehun*”). This heap of biomass is disposed of by local burning (“*mamehun*”).

**Planting (“*manugal*”) and land management:** The Dayak people always plant rice directly by seed, especially in dry areas. Seeds are planted in holes made by sticks from small timber 5 – 7 cm in diameter. The holes must be closed with soil or ash after the seed is put inside.

Intensive weeding activity is carried out commonly in the second and third year of the rice field (“*ladang*”). In the first year, weeding is not necessary, especially for rice field (“*ladang*”) just prepared from primary forest. Populations of weeds in the first growing year are very limited owing to the burnt quality of rice field (“*ladang*”). In the second year, populations of weeds become very high and grow fast, because the burnt quality is low, since there is limited biomass material available. Therefore, after the first or second year, farmers usually abandon the rice field (“*ladang*”), and they move to a new area.

Traditionally, pest and disease protection involves the use of an extract of “tuba” and “saing”, applied using a bamboo sprayer. “Tuba” (*Vatica albiramis*) and “saing” are local names of plants from which a paralyzing drug is obtained.

**Harvesting:** Generally, harvest activities are conducted in three stages. First, in the young rice harvest stage (“*nyumput parei*”) Dayak people make “*behas maru*” and “*kenta*” (looks like chips) from young rice. The maturity of rice grain in this stage is less than 10%, as indicated by its green color. The amount of rice harvested for “*behas maru*” is very limited, and provides enough for food for one or two days.

Next, full harvest is carried out if all rice grains on 50% of the stalks are mature, indicated by their yellow color. Finally, the remaining harvest (“*mamata*”) is carried out, because some of the rice had not matured when the full harvest was conducted. This activity also includes rice produced by new shoots.

**Post-harvest:** All of the rice harvested is put in one place close to the roof. The drying process is carried out every day by opening the roof, only closing it when it rains and at night. The rice grains are dry enough when they are easily released from the ear-stalks, and release process namely “*mengirik*”. Before the rice is placed in the rice barn (“*lumbung*”) the drying process should be carried out until the grains become firm, and unhulled paddy is separated from the ear-stalks using a huller (“*kipas*”) and winnowing basket (“*penampi*”). The rice barn can be constructed by people in the rice field (“*ladang*”) or in their house in the village.

**Celebration festival for blessing harvest:** The last activity in the rice field (“*ladang*”) system is the celebration festival for blessing the harvest (“*pakanan batu*”). This party signifies the people’s appreciation of the blessing of the Lord, support of the land and functioning of equipment. The name of the celebration comes from “*batu*”, a rock for sharpening the knives (“*parang*”), and “*beliung*” and “*gentu*”, equipment used for making the rice fields (“*ladang*”) since the beginning.

The celebration festival is held after finishing all the activities for managing the rice field (“*ladang*”). The Dayak people say many thanks to the Lord, nature (land and water) and their ancestors. They believe that successful management of the rice field (“*ladang*”) must involve the three components above.

**Utilization of former rice fields (“ladang”):** Usually the Dayak people use former rice fields (“ladang”) for growing other annual commodities, e.g. rubber, rattan, and fruits such as cempedak (*Artocarpus chempeden*), durian (*Durio zibethinus*), and rambutan (*Nephelium* sp). Planting the appropriate annual commodity depends on future plans for the area. If the farmers want to open an area for rice field (“ladang”) after several years, other crops are restricted to certain places or planted in wide rows. The purpose of planting with wide rows is to leave space to grow rice between the rows of plants. However, if they will not use the area as a rice field (“ladang”) in the future, the population of crops must be full. Through this system, many Dayak people have plantation gardens (rubber, rattan, fruits) that were established by their grandfathers and even earlier. This system is a strategy to maintain the carrying capacity of the land and to claim land ownership.

The re-opening of former rice fields (“ladang”) does not take place after a fixed period of time; rather, rice fields are re-opened only after there is sufficient density of vegetation to produce enough biomass for fertilizer when burned.

### 3. TRADITIONAL UTILIZATION OF PEATLAND

**History and technology development:** Dayak people have never used deep peat for agriculture; they have only utilized shallow peat (“*petak luwau*”) near the riverbanks, where there is a preponderance of mineral soil. Therefore, the Dayak people, whose livelihood depends on shifting cultivation and especially upland rice, have concentrated their settlements in upstream areas of Central Kalimantan. For example, along the Kahayan and Rungan rivers, the Dayaks live mostly in the foothills of the mountains where the rivers and landscape are unaffected by tides. The total number of villages every 100 km along the Kahayan riverbank, counted from the mouth of the Kahayan river is as follows: 0 – 100 km (18), 100 – 200 km (8), 200 – 300 km (43), 300 – 400 km (64), 400 – 500 km (26) and > 500 km (10).

Consequently, the utilization of peatland for agriculture has been very limited, historically. Unfortunately, the Government of the Republic of Indonesia (GORI) wrongly interpreted the reasons for local people’s success in managing their farmlands with the “*handel*” system. GORI tried to apply it to much larger areas drained and irrigated by

means of over-sized canals. The history of development of the canal system by GORI in coastal areas can be summarized as follows: 1) “*Handel*” system (traditional way), 2) “*Anjir*” (1880 - 1936 by Dutch Colonials), 3) “Polder” system (1950 by Schophyus/Dutch Expert), 4) “*Garpu*” (fork) (UGM)/ “*Sisir*” (comb) system (IPB and ITB) (1969 -1982), 5) “*Kolam*” (pond) system (1980’s), and 6) Giant canal system (1996, Mega Rice Project).

**Local knowledge of peat utilization:** The utilization of peatland by Dayak people is limited to shallow peat. Shallow peat used for growing rice by local people in upstream areas is called “*petak luwau*”, while in coastal areas it is referred to as “*lahan pasang surut*”.

The characteristics of shallow peat in upstream (“*petak luwau*”) are as follows: 1) Peat thickness: 20 - 50 cm, 2) Decomposition condition: hemic to sapric, 3) Bottom material: clay, 4) Location: near river banks or between two hills, 5) Previous vegetation: dominated by grass, 6) Water supply: rainfall and river flood and 7) Soil condition after planting: muddy. Rice fields in “*petak luwau*” were managed by local people as follows: (1) Clearing land in the first year by cutting small trees and grass. After the first year for growing rice, all of the field becomes covered by the grasses, one of them is very sharp and itchy with local name is “*garigit*”, teki (*Cyperus rotundus*) and “*kumpai*” (*Ortoxylum ridicum*), (2) burning when the biomass is totally dry, (3) removing the biomass left and re-burning at specific places or places along the border between other farmers to keep water available, (4) not tilling, since it is sufficient to cut grass and burn, (5) planting rice plants grown in a nursery for 2 -3 months rather than seeds, (6) marking the border between farmers by digging small and shallow canals to either drain water from the field or collect water if necessary, (7) getting water needed for irrigating the rice field from the river without a connecting canal from the river to the field, since the water needed comes from river flood water, (8) using the same planting schedule as the rice field in the “*ladang*” system, i.e. October to March, and (9) these areas are unaffected by sea water tidal fluctuation. According to the farmers with experience of “*petak luwau*”, rice production depends on the hydrological conditions. If, in the generative growth phase, the rice field is not flooded for a long time, rice yield will be high. Productivity of the local variety is 1.75 - 3.00 t/ha (Limin, 1994) and for the superior variety, 2.4 - 5.6 t/ha (Noor, 2001).

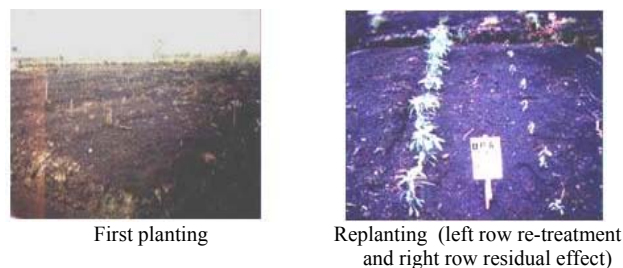
**Shallow peat in coastal areas (“*lahan pasang surut*”):** The utilization of peatland was popular using the “*handel*” system. “*Handel*” is a small canal excavated from a big river to the interior or dome area of a coastal peatland. The size of canal was limited to a width of 2 - 3 m, depth 0.5 - 1.0 m, and length 1000 -2000 m. The characteristics of this land area are as follows: (1) it is influenced by sea water tidal movement pushing river water into the rice field and flooding it every day, (2) the rice field is located up to 2000 m from the river bank, (3) the maximum peat thickness is 1.0 - 2.0 m, (4) the material underlying the peat is clay, (5) the decomposition status is mostly sapric, (6) nutrients are provided constantly by the twice daily tidal movements, and (7) the soil condition after planting becomes muddy. Productivity of the local rice variety is 1.90 - 4.00 t/ha from one source and 2.0 - 2.8 t/ha from another, while the superior variety yields 3.4 - 5.5 t/ha (Noor, 2001).

**Canal technology:** Establishment of the canal system in coastal areas by the GORI is linked to the settlement of transmigration people. An area of the Basarang Canal, called “*Anjir Basarang*”, still produces rice at a high level (around 4 to 5 t/ha), and many Dayak people from upstream areas moved to this area to make rice fields there. The farmers are still making “*handel*” along the “*Anjir Basarang*”. Extending the “*handel*” into a big canal (“*Polder*”, “*Garpu*”, “*Sisir*” and “*Kolam*”) system for the new transmigration settlement has led to a significant decrease in rice production. After that decrease, the Dayak people returned to their villages.

#### 4. RECENT UTILIZATION OF PEATLAND

The most recent development project established by the GORI was the Mega Rice Project (MRP), which involved the construction of a giant system of canals. This project totally destroyed more than one million hectares of wetland, mostly peatland in Central Kalimantan. The total length of canals completed by the middle of 1999 was 4,473.46 km. This consisted of 187.00 km of main primary canals, 958.18 km of primary canals, and 913.28 km of secondary canals, 900 km of tertiary canals and 1,515 km quaternary canals (Ad Hoc Team, 2006).

**High input and detrimental of environments:** An experiment for monitoring the residual effect of chicken manure (21 t/ha), dolomite (4 t/ha) and phosphate (180 kg P<sub>2</sub>O<sub>5</sub>/ha), showed that the fertilizers could support growth of sweet corn (rotation 1), chili (rotation 2), corn (rotation 3), but the productivity of plants always decreased in the next rotation. The chili planted in rotation 4 totally died (Figure 2.1). Therefore, the residual effect of these fertilizers can only support land productivity until corn rotation 3, or 22 months.



**Figure 1. Growth of chili in rotation 4 in inland peat, Kalampangan**

Growing some commodities in inland peat, especially in Kalampangan village, depends on ash. Total ash use by farmers in Kalampangan is shown in Table 2.1.

**Table 1. Average of ash for growing five commodities in Kalampangan village**

Commodity	Dosage of Ash (ton/ha/planting) <sup>1</sup>	
	Mean	Confidence
Jagung/Corn ( <i>Zea mays</i> )	16,09	[(9,99 - 22,19)]
Sawi/Mustard green ( <i>Brassica juncea</i> )	18,17	[(10,84 - 25,50)]
Bayam/Amaranth ( <i>Amaranthus sp</i> )	93,72	[(13,26 - 174,19)]
Kangkung/Swamp cabbage ( <i>Ipomoea batatas</i> )	43,18	[(7,5 - 93,89)]
Seledri/Celery ( <i>Apium graveolens</i> )	117,29	[(31,15 - 203,43)]

<sup>1)</sup> Source: Jentha (2003)

**Present field conditions:** Extension of the traditional “*handel*” system by the GORI has not benefited those farmers who were already successfully growing rice. Since the government has extended the area for agriculture and transmigration, the hydrological status of the land has changed, altering the peatland ecosystem in coastal areas. Therefore,

rice yield decreased tremendously in several areas, in places where some fruits and rubber are grown, productivity is also very low (Figures 2.2 and 2.3).



**Figure 2. Pineapple, zalacca and rubber were replace of rice field as a rice barn before**



**Figure 3. Alang-alang (*Imperata cylindrica*) growing well in Kalampangan village**

**Compatibility with carrying capacity:** Rice planted in areas where irrigation is provided by the fluctuation in river water levels (directly and indirectly influenced by sea water) will grow well (Figure 2.4). Generally, these areas are never far from the nearest river.



**Figure 4. Rice field in Kuala Kapuas (Kapuas river) and in Pulang Pisau (Kahayan river)**

Cultivation of inland peat with a layer of peat less than 100 cm, introduces many constraints to the growth and yield of rice, causing very low yields, especially if the underlying mineral material is sand or granite.

**Incompatible with carrying capacity:** Several crops, although they may grow in deep peat, have a low yield and their period of production is shorter (Figures 2.5, 2.6, 2.7 and 2.8). They will grow well only when supplied with a high input of lime and fertilizers.

**Wise use of native species:** The native species, e.g. ramin (*Gonystylus bancanus* Kurz), grow well in areas unaffected directly by the large drainage canals (Figure 2.9).



- Notes :**
- *Kalampangan village is of the new name for the transmigration unit Bereng Bengkel*
  - *Established 1979/1980; 500 families*
  - *Rubber planted:*
    - *Peat thickness: 2 – 3 m*
    - *Bottom layer : sand and granite*
    - *Planting in 1987*
    - *After 12 years old the Dbh  $\geq$  40 cm only 11%.*

**Figure 5. Rubber trees in Kalampangan village**



- Notes :**
- *Peat thickness : 80 -100 cm*
  - *Bottom layer : sand and granite*

**Figure 6. Rambutan (*Nephelium*) after 10 years growing, located 13 km north of Palangka Raya**



## 5. CRITERIA OF PEAT UTILIZATION

Based on reality in the field and peat characteristics, the utilization of peatland should be determined not only by peat thickness, but also by the nature of the mineral material underlying the bottom peat layer and the hydrological conditions (Table 2.2).

**Table 2. Criteria concept for utilization of peatland in Central Kalimantan**

No.	Depth of peat (cm)	Underlying mineral material	Hydrology	Recommendation
1.	≤ 50	1.1. Mineral/clay	1.1. Full support	1.1. Rice/Corn, etc. & fish in “ <i>beje</i> ” system
		1.2. Sand/granite	1.2. Full support and/or unsupported	1.2. Conservation
2.	50 – 100	2.1. Mineral/clay	2.1. Full support	2.1. Rice, Corn, and Plantation commodity
		2.2. Sand/granite	2.2. Full support and/or unsupported	2.2. Conservation
3.	100 - 200	3.1. Mineral/clay	3.1. Full support	3.1. Plantation commodity
		3.2. Sand/granite	3.2. Full support and/or unsupported	3.2. Conservation
4.	> 200	4.1. Mineral soil or granite	4.1. Full support	4.1. Conservation

**Note :** This criteria had been expressed previously by Limin in Government meeting in the BAPPEDA office in 1994.  
Source : Limin *et al.* (2000); Limin (2004c)

## 6. DISCUSSION

Several factors caused the failure of peat utilization in Indonesia, in particular, the Government’s misinforming Presidential Decrees (KEPPRES) contributed to the failure. According to Presidential Decree (KEPPRES 32/1990) (Noor, 2001), land with peat of more than 3 meters thick must be conserved, while that less than 3 meters can be used for agriculture and tree plantations. This decree was not formulated based on research findings. Limin *et al.* (1999) and Limin (2004c) stated that the utilization of peatland should not only be determined by peat thickness, but other factors must be considered as well. These include the nature of the material at the bottom of the peat layer, hydrology of the area, the background of farmers, culture of the communities, and marketability.

The Government should have reconsidered the suitability of the “*sisir*” (comb) and “*garpu*” (fork) systems following the decreasing rice production after both were implemented. In reality, the Government never investigated sustainable peat management systems, such as “*handel*” and “*anjir*”, but continued to excavate giant canals in the Mega Rice Project (MRP). Furthermore, the Government did not implement the Presidential Decree (32/1990) correctly, because many of the canals in the MRP were constructed across the deepest peat areas (i.e. >3 m thick) or domes, which consist of peat about 8 to 10 meters thick, especially in the inland peat areas. The negative impact of peatland utilization was significant after the opening and mismanagement of the MRP’s one million hectares of peat swamp. In addition, those canals brought about two extreme conditions: extended drought and flooding. Then, these two conditions will be possible and supported the exchange of vegetation in the next future. In 1997, one year after the MRP began, the biggest fire disaster ever on peatland in Indonesia occurred in the MRP area and its surroundings (Page *et al.*, 2002). The extensive fires lasted for almost two months and they produced thick smoke locally and a noxious haze that blanketed the Southeast Asia region affecting the environment, economy and human health. Limin *et al.* (2003) and the Ad Hoc Team (2006) stated that the main cause of the failure of the MRP was the excessively large dimensions of the canals. The canals, which were established for irrigating the rice fields, could not function due to the lack of water from the upper stream of the Kahayan, Kapuas, and Barito Rivers. Therefore, instead of serving as tools for irrigating the rice fields, those canals have been effectively used for illegal logging activities, surely threatening the region’s environmental sustainability. Therefore, to restore this area, priority must be given to the recovery of the hydrological status of the peatland landscape by blocking canals in the dome areas.

As a consequence of the over-sized canals, the ecosystems of the area were altered, very negatively impacting the local people’s livelihood. Limin *et al.* (2003) stated that rice production in coastal areas (“*pasang surut*”) decreased drastically owing to the hydrology status changes caused by canal establishment in MRP areas, such as Basarang, Palingkau, Mintin, Tamban in Central Kalimantan. Limin (1994) reported that after the Public Work Development established the big canals the hydrological status drastically changed in both

Tabak Kanilan village in Barito upstream and Goha village in Kahayan upstream, greatly decreasing the rice production in these two shallow peat (“*petak luwau*”) areas.

Over-drainage of peatland, especially of inland peat, accelerates subsidence. Limin *et al.* (2000) stated the rate of soil surface subsidence has also been significant, ranging from 1.0 – 3.0 cm per year, and it is very much dependent on the local hydrological conditions. Based on the results of measurements in the field, it was found that within a period of 18 years, the peat surface subsidence has reached 36 cm. Limin (1998) discovered that water soil had been drastically decreased due to drainage systems. This, in turn, had resulted in a great change in temperature and humidity on the upper peat layer.

Limin *et al.* (2003) suggested that the Palingkau, Basarang, Mintin, Tamban and other areas managed by “*handel*” and “*anjir*” systems are suitable for rice production in Central Kalimantan. The local knowledge about the utilization of peat for agriculture has been understood and fully considered by the local people. Limin *et al.* (2003) stated that the Dayak people understand that peat with more than 50 cm depth (for both inland and coastal areas) is not feasible for agriculture. This knowledge is indicated by the distribution of Dayak villages along the Kahayan riverbank. They have chosen the upstream areas, because their main activities are making rice fields, mainly “*ladang*” in the mineral soil, but also in shallow peat (“*petak luwau*”).

The utilization of peatland for agriculture, especially deep peat (more than 1 meter), requires high-energy input and is risky; the Government must consider both of these factors. Based on the experimental research findings of Limin (1998) for growing chili and corn in thick inland peat in the Kalamangan area with the application of lime, phosphate and chicken manure, it was determined that the residual effect of these supplements was only effective for three planting rotations (22 months), after which yields decreases. After 22 months of applying these ameliorants, the residual effect was gone and all plants became yellow in the fourth planting period. In other words, the plants could only grow and become productive with a high input of lime and fertilizer. Whereas, Jentha (2003) calculated total of ash per planting for growing corn (*Zea mays*) averaged 16.1 t/ha, mustard green (*Brassica juncea*) 18.2 t/ha, Amaranth (*Amaranthus sp.*) 93.7 t/ha, swamp cabbage (*Ipomoea batatas*) 43.2 t/ha, and celery (*Apium graveolen*) 117 t/ha. Limin *et al.* (2000) reported that rice cultivation is very difficult in thick peat areas. Coconut never

grows well outside the house yard. Although rubber trees grows in areas with thick peat, ranging from about 2.75 – 3.00 m, in this observation, we reached a dbh ranging from 11.0 – 54.0 cm in 12 years, and only 11% of the rubber tree population had a dbh of  $\geq 40$  cm, which is necessary for tapping. Their tree trunks appeared very rough and stiff (Figure 1).

## 7. CONCLUSION

Dayak people have always taken the carrying capacity of the land into full consideration when opening the forest for growing rice (*ladang*). The Dayak use natural signs to decide the location of rice fields and they manage them with local knowledge. Upstream, the Dayak people use only shallow peat (*petak luwau*) near the riverbanks. In coastal areas, they use the *handel* system, which depends upon the hydrological behavior of twice daily tidal movement. The recent decrease in rice production by the over intensive canalization system resulted from the government's ignorance of the success of local people in implementing their local knowledge. The giant canals constructed as part of the Indonesian Central Government's Mega Rice Project to utilize peatland for agriculture were failures when compared with traditional canals in Central Kalimantan, namely, the *handel* and *anjir*.

Presidential Decree 32/1990 declared that peatland with peat thickness less than 3 meters could be used for agriculture, while that with more than 3 meters should be conserved. Then, in 1996, the Mega Rice Project (MRP) in Central Kalimantan was established. However, rather than only considering the thickness of the peat layer to determine peatland utilization, land users should also consider information on the chemical properties of the bottom peat layer, hydrological status, local knowledge, culture of communities and marketability of proposed crops. Unfortunately, neglecting these factors when cultivating tropical peatland, especially deep peat in inland areas and also coastal peat, gives rise to unproductive land (*lahan tidur*). Peatland degraded by unsuitable agriculture must be restored using native tree species to achieve ecosystem stabilization. Thus, Presidential Decree 32/1990, which was formulated without first carrying out research, was a major factor leading to the failure of peatland utilization in Indonesia; it must be reformulated using knowledge of peatland's carrying capacity.