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Content

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Recent change in rice cultivation technology in Bangladesh

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Abstract: This paper aims to report the scenario of recent changes in rice cultivation since 2000 in the village of Dakshin Chamuria, Tangail, Bangladesh. Particularly, the changes have occurred in the irrigated rice cultivation during dry season and it has been largely extended in the village. The new cropping system consists of a power tiller, a weeder, a new fertilizer application by Guti Shar (a table tennis type Urea fertilizer) and line transplantation. This change has been induced by the farmers themselves. The agricultural extension office has only introduced the newly developed Guti Shar. Others have been re-introduced and re-systematized by integration with Guti Shar to create the new rice cultivation technology as ZAICHI NO GIJUTSU (Locally Existing Technologies).
Key words: ZAICHI NO GIJUTSU, Guti shar application, Rice cultivation, recent changes, Power tiller, weeder, Bangladesh.

Introduction

1. Change of statistical figure of rice cultivation in Bangladesh: The modernization of rice cultivation by introducing new modern varieties or so-called HYV (High Yielding Varieties) and chemical fertilizers since 1960s has mostly realized food self-sufficiency in Bangladesh according to macro statistics figure of rice cultivation. Statistics of rice production, import, stock, export and food consumption requirement of Bangladesh appeared every year in the country wise FAO statistics from 1961 to 2003. From this report, it is clearly noticed that the amount of import has decreased relatively against that of export since1990. The amount of production, import, stock and export are respectively 25,100,000t, 450,000t, 1930,000t and 100t in 2000. The export was firstly recognized in the statistics since 1961. After 2000, 100t was exported in each year of 2001 and 2002. The amount of export did not appear in the statistics of 2003. However, it can be pointed out that the rice cultivation of Bangladesh has entered into a new stage.

The modernization of rice cultivation or "Green revolution" has started in Bangladesh since 1960s by extending HYVs in Aman, Aus in rainy season and Boro in dry season. It has been achieved at large extent by explosive spreading of Shallow Tube Well (STW) (Photograph 1) to lift ground water for irrigation in dry season from 1980s and 1990s. Statistical Year Book of 2003 shows increase in acreage and production from 50% to 63% and from 32% to 63 % respectively from 1987/88 to 2000/01. Total amount of rice production increased to10,000,000t for this period (Table 1). The modern rice cultivation using HYV is now an ordinary technology in the villages in Bangladesh. Recently the use of a local plough for land preparation has drastically decreased in 2004/05 as compared to 1994/95 in the village of Dakshin Chamura.

Table1. Recent changes of HYV use in rice cultivation in Bangladesh

Year	Cropped Area (1000 acre)			Production (1000 ton)		
	Local	HYV	Total	Local	HYV	Total
1987-88	17268	8239	25507	7779	7635	15414
1990-91	14420	11358	25893	6957	10895	17852
1995-96	11733	12835	24567	5454	12335	17688
2000-01	9821	16860	26681	5659	19427	25086
2005-06	7233	18785	26018	4316	22214	26530

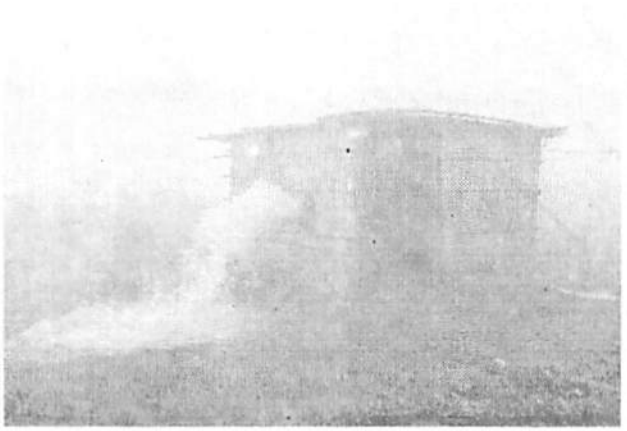
Source: BBS(2003). Statistical Year Book of Bangladesh 2001:138p, BBS(2010). Statistical Year Book of Bangaldesh 2009:131p

Table 2. Number of HHs to use Nangol (Local plough) for ploughing in Dakshin Chamuria village

Name of site (*Para*)	year		
	1994-95	1999-2000	2004-05
Dakshin (South)	32	17	2
Purbo (East)	09	03	3
Madho (Middle)	17	07	3
Uttar (North)	22	08	7

2. Change of rice cropping patterns in Bangladesh: In the village, namely Dakshin Chamuria, Khalihati Upozila, Tangail district where I have continuously visited since 1986, the cropping systems have changed in accordance with such a macro change. A set of new technologies consisting of three components; HYV, chemical fertilizer and irrigation pump, which have been introduced on the government's own initiative, has been brought into the village by the agricultural extension services and then irrigated rice cultivation in dry season with HYV has

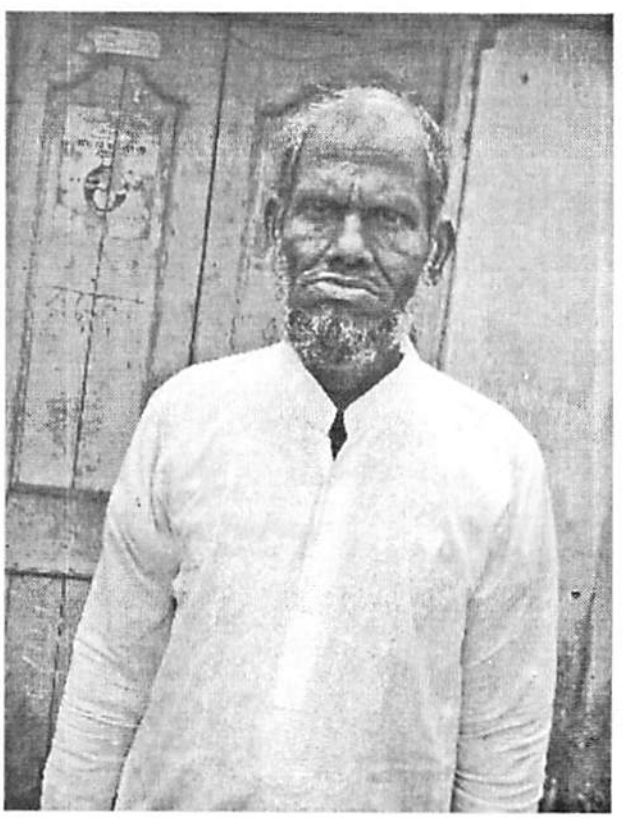
extended largely in the village from the second half of 1980s to the first half of 1990s. Before the first half of 1980s, the ordinary floodplain agriculture consisting of mixed sowing cultivation of Aus and Aman followed by rabi cropping of upland cultivation was predominant in the village. The villages have accordingly experienced drastic change in rice cropping patterns such as rapid decreasing of Aus cropping area due to competition in cropping patterns with new Boro season or HYV Boro season and rapid increasing of Transplanting Aman instead of Broadcasting Aman to avoid overlap of sowing time of Aman with maturing time of HYV Boro. However, the Japanese rice cultivation methodology particularly represented for line transplanting (Photograph 2) and a weeder or Japanese weeder (Photograph 3), which were strongly recommended by the government for the time of "Green revolution", have not come to stay in the village. The mainstream of rice cultivation technologies are to apply HYVs, chemical fertilizers and randomized transplanting methodology in "Traditional transplanting rice cultivation technology".



Photograph 1. Shallow Tubewell

Photograph 2. Line Transplanting

Photograph 3. Weeder



Photograph 4. Mr. Ajim Uddin

3. New technological innovation initiated by subjectivity of the villagers: However, the farmers have started to apply voluntarily line transplanting methodology and a weeder as their own technologies at large extent separately from the government encouragement after a border of the end of 1990s and 2000, when the positive "Green revolution" initiated by the government has achieved a major aim as "Food self-sufficiency". It should be mentioned that these technologies were not adopted by the farmers during the "Green revolution" period.
We could see the process that the farmers have subjectively adopted these technologies into their own technologies after fermentation period. It may be noticed that "time" needs to integrate their experience of using these technologies with the socio-economic condition.

Materials and Methods

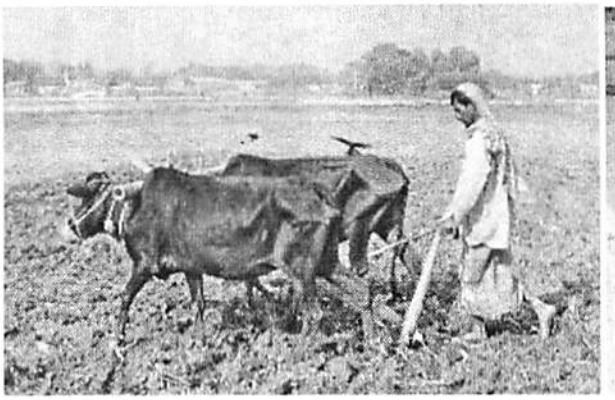
With the above mentioned issue and background, I have conducted the field work in the village of Dakshin Chamuria from January12 to 22, 2006 to record this technological change and the villagers' views on its background, when the farmers were busy in transplanting rice seedlings just after finishing land preparation for transplanting rice cultivation for dry season. Mainly, I have listen to Mr. Md. Ajim Uddin (56 yrs) (Photograph 4) about the change from 1994/95 to 2004/05 and also tried to listen to the farmers working in the rice fields for supplementary survey. This paper aims to report the result of my field study. The paper is the revised version of the paper originally presented in Japanese at the 99th conference of Japanese Tropical Agriculture Association held at Tsukuba International Conference hall, Japan on March 27, 2006 and published as the short paper in Japanese (Ando, 2006).

Results and Discussion

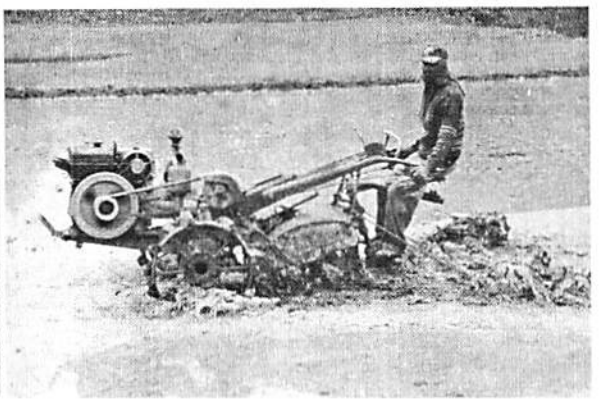
1. Land preparation for Rice cultivation of dry season in 1994/95: (1) Using local plough (Langol): in 1994/95, there were many people still to use the local plough namely Langol (Photograph 5) as well as a power tiller (Photograph 6). In the beginning of December when the farmers finished harvesting of Aman rice, they used to conduct tillage work for land preparation with a power tiller one time followed by one to two times ploughing by the local plough drawn by a pair of cows at the rice fileds during 15 to 20 days after harvesting Aman rice. Around January 15, the farmers start to irrigate the rice fileds by shallow tube well and then conduct Peka Chashi or ploughing by a pair of cows two times to make soil muddy. Just after Peka Chashi, the famers levelled the field with the local bamboo harrow locally called Chong or Moi (Photograph 7) two times. The leveling operation was done by the person standing on Chong two times and locally called Peka Moi. If the farmer found big soil lumps in the muddy field after the first time of Peka Moi, the second and third time of Peka Moi was done for finishing land preparation (Chashi). (2) Land preparation only by a power tiller: most farmers using a power tiller only for land preparation of Boro rice cultivation have increased since 1994/95. For example, the farmers applied a power tiller one time only between 15 and 20 days after the farmers harvested Aman rice from 25th to 30th of November. From the date of the first tillage nearly to the 15th of January, irrigations by shallow tube wells were done and then one time of Peka Chashi was done by a power tiller. One person stood on Chongo tied by rope with a power tiller and this Chongo was drawn by a power tiller for condcuting Peka Moi (Photograph 8) two times.

2. Land Preparation in 1999/2000: The ploughing with a local plough drawn by a pair of cows mostly has disappeared from Boro rice cultivation. Particularily, Peka Chashi by a local plough disappeared totally. The reason is that it takes three hours for ploughing per one bigha (1/3 arcre) with a local plough from 8:00 to 11:00 in the morning because of requirement of two to three times of ploughing, but only it needs 25 minutes for tillage per one bigha with a power tiller because of only one to two times of rotary tillage. Another advantage of rotary tillaging is that the soil lumps cannot be easly broken by a local plough. Particularily, it is worse in the case of Peka Chashi. Consequencely, leveling with a local harrow or Chongo is not well achieved after Peka Chashi with a local plough. Furthermore, there is tendency that apperance of weeds is more in the field of a local plough than in the field of a rotary tillage. Peka Chashi with a rotary tillage makes the rice field muddy well. Thus, irrigated water can be kept well in the rice field and naturally leveling becomes well and seedlings of Boro rice can root well in the soil quickly. A rotary tillage can till at depth of 7.5-10 cm (3 to 4 inches) but a local plough can do only at depth of 5-7.5cm (2 to 3 inches). The farmers can find the advantages of rotary tillage as the followings; speed of rooting is faster because of good muddy condition and deeper depth of muddy soil and also the farmers generally observe that the number of rice tiller (Powa) is much more in the rotary ploughed field than in the local ploughed field . The stem becomes thicker in the rotary ploughed fields than the local ploughed field. As a result, there is a tendency of higher yield in the rotary ploughed field. Four to five seedlings are transplanted for one rice stump. In case of BR29, there were 50 to 60(sometime 70) tillers at one rice stump. In case of the rice field of a rotary tillage, there were 30 to 40 tillers. Especially, the yield of the rice field applied a rotary tillage with a weeder and line transplanting was 18 to 20 mds (1md is nearly 40 kg) per one bigha (1/3 acre). In the rice field of a local plough, it takes two to three days to wait for transplanting because the soil can not easily become muddy well. In the rice field applied a local plough and randomized transplanting, the yeild per one bigha was 15 to 16 mds. Line transplanting made use of a weeder and Guti shar (a table tennis ball shaped Urea) possible (Photograph 9). One Guti Shar was buried in the center of square consisting of four rice stumps by line transplanting (Photograph 2). These technologies performed good for better yield in the field of a rotary tillage with line transplanting. Besides, use of Guti Shar reduced fertilizer application from two

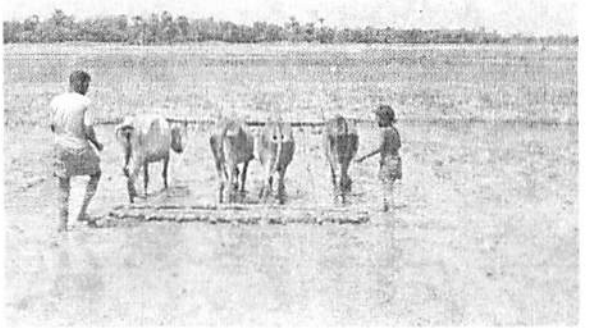
time (basal and additional applications) to one time(basal) and thus the amount of applied Urea decreased from 25 kg per bigha to 15 kg per bigha.



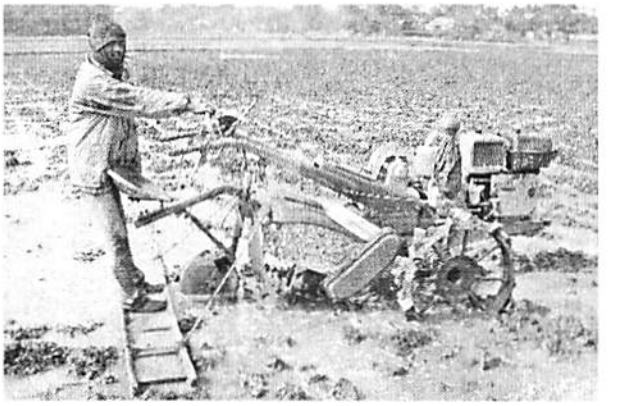
Photograph 5. Naggol (Local plough)



Photograph 6. Power Tiller (Rotary plough)



Photograph 7. Peka Moi with a pair of cows and Chongo or Moi



Photograph 8. Peka Moi with a Power Tiller and Chong or Moi

Photograph 9. Guti Shar

Conclusion

Table 2 indicates that the number of the farmer to use a local plough for land preparation drastically decreased in 2004/05 compare to 1994/95 in the village of Dakshin Chamura. Accordingly, it can be well understood that the farmers have re-built the HYV based rice cultivation in dry season through understanding an advantage of a rotary tillage and Guti Shar because of sandy soil of floodplain where the village of Dakshin Chamuria locates. The new rice cropping system is the sustainable and balanced technological systems consisting of the technical characteristics such as improvement in water retaining ability, reduction of amount of Urea application and number of weeding labor because of using Guti Shar and a weeder. Integration of each technology makes use of the characteristic of component technologies, which were already explained by the government officials etc. The farmers has integrated or localized the component technologies into a balanced technological system. This is "ZAICHI NO GIJUTSU" or locally existing technology as I have named. It can be concluded that the changes in rice cultivation for recent one decade is the process of integrating the "Green Revolution" component technologies ;HYVs, a power tiller, chemical fertilizer and line transplanting into "ZAICHI NO GJITSU" or locally existing technology with Guti Shar.

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Swidden farming and monsoon forests of mainland Southeast Asia- A patchwork of disturbance and succession

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1. Rain-Green Forest and Laurel Forest:

The greater part of continental Southeast Asia has a monsoon climate with a distinct dry season, and there is a wide distribution of monsoon forest, also known as "tropical seasonal forest." Compared with tropical rainforest, tree heights are lower, the layered structure is simpler, and leaves fall in the dry season, though only for a short period of time. Tropical seasonal forests are classified into three types according to the degree of dryness: (1) evergreen seasonal forest, (2) semi-deciduous seasonal forest, and (3) deciduous seasonal forest. There are no gigantic trees in an evergreen seasonal forest. Some tall trees lose their leaves in the semi-deciduous seasonal forest, as do almost all trees in deciduous seasonal forest. If the area is any drier than this it becomes savanna.

Aside from such seasonality in rainfall determined by latitude, there are also changes in rainfall that depend on altitude. High altitude areas have montane rainfall. Such an area develops a so-called "moss forest," i.e., an evergreen mountain forest composed of beech trees of the genus *Castanopsis* and evergreen oaks. These trees are covered by moss.

In the continental areas of Southeast Asia, the evergreen forest in upstream mountain land connects with laurel forests, while the evergreen forest in downstream lowland areas connects with tropical rain forests. Between them spread the monsoon forests, where leaves fall during the dry season and the scenery turns green all at once with the arrival of the rainy season. In May, the southwest monsoon brings rain from the Indian Ocean, which very rapidly turns the landscape in these areas to green. Because of the vivid impression this change creates on people, monsoon forest is also called "rain-green forest".

The "Thai cultural sphere" spreads from this monsoon forest zone to the laurel forest zone. This cultural sphere extends to six countries -- Vietnam, Laos, Thailand, Myanmar, India, and China -- straddling the great rivers that flow down from the Tibetan Plateau; the Mekong, the Salween, and the Brahmaputra, as well as their watersheds. In this region, the altitude of approximately 1,000m divides the landscape like a borderline, with mixed deciduous forest and dry *dipterocarp* forest spreading in the lower part, and evergreen montane forest in the upper part. The domain of the Thai cultural sphere overlaps with the transitional zone of rain-green forests and laurel forests.

In the continental areas of Southeast Asia, the most common type of swidden farming has been the one-year crop of upland rice in the rain-green forest zone. On the other hand, various types of crop rotation methods are observed in swidden farming performed in the laurel forest zone. Although the relations between the ethnic groups and their livelihood activities or their ways of making use of the environment are not fixed in any way, let us take a look at the general picture as it has been in the northern part of Myanmar, Thailand and Laos up till now.

In Laos, people are classified into three categories; *Lao Sung* (highland Lao), *Lao Theung* (midland Lao), and *Lao Lum* (lowland Lao). Although the actual habitation areas are intricately interwoven, simply stated, the highland Lao sustain their livelihoods by swidden farming (poppy farming in the past) in the evergreen montane forest zone, the hillside Lao by swidden cultivation of upland rice and the gathering of forest products in the mixed deciduous forest zone, and the lowland Lao by lowland rice cultivation in paddy fields in the flatlands.

As in Laos, the separation of mountain dweller habitation primarily by altitude was also clearly observed in northern Thailand until the 1960s. There have been different types of swidden farming, including the poppy fields of the Mong in evergreen montane forest, the swidden farming of the Karen, ranging from evergreen montane forest to mixed deciduous forest, and complementary swidden farming by lowland Thais. In terms of the period of crop planting and fallowing, three types of swidden farming have been noted; (1) short-term cultivation with long-term fallow, (2) short-term cultivation with short-term fallow, and (3) long-term cultivation followed by migration and abandonment.

The first category is the most common type of swidden farming in the continental areas of Southeast Asia, in which upland rice is cropped for one year followed by fallowing the field for nearly ten years. Since upland rice seed is sown by maintaining a certain distance between the seeds using dibbling sticks, the surface of the soil is not disturbed. Further, the secondary forest is fully restored during the fallow period by pioneer tree species and the regeneration of stumps through the sprouting of new branches. The second category is the early stage of the paddy field cultivation process or complementary swidden farming. Many of these fallow fields are bamboo forests. The third category is the swidden farming of the Mong, who live in the montane forest above 1,000m altitude. Until recent years, the Mong grew poppies (*Papaver somniferum)* and maize for a long period in one place, followed by abandonment and the clearing of new swiddens elsewhere. The Mong, who are highland dwellers, lived on maize originating from the new continent, and cultivating poppies. It would be reasonable to consider that this type of long-term cultivation is a technique of permanent cultivation originally introduced from China.

There are three types of agriculture in the mountain areas of northern Myanmar; monsoon *taungya*, grassland *taungya*, and irrigated hill terraces. A monsoon *taungya* is cultivated for one year only, and then fallowed for 12 to 15 years. In a grassland *taungya*, after practicing a crop

rotation of maize, buckwheat, millet, wheat and barley, the land becomes grassland fallow.

Leach has described this as follows; 'When *taungya* and hill terraces are both cultivated by the same community, as is often the case, the people concerned seem usually to regard *taungya* cultivation as the more rewarding. On the other hand, since terraces can be cultivated year after year with little or no fallow period, relatively dense local aggregates of population are possible. Hill terraces are thus usually found associated with unusually large communities on permanent sites. The real advantage of hill terrace systems seems to be military and political rather than economic.' (Leach 1954:28) This is a notable point in the comparison of swidden fields and paddy fields, and in my opinion is a viewpoint that leads to the notion of agricultural intensification which argues that intensification is achieved at the cost of labor productivity.

As commonly observed in above-mentioned northern areas of Myanmar, Thailand and Laos, swidden farming in the monsoon zone ends with a single year of cropping. All activities, including site selection, clearing, burning, sowing, weeding, control of agricultural damage by wild animals, and harvest are performed in one year. These peoples have repeated the process of "select, cut, burn, sow, raise, protect and reap" year after year, with the arrival of the dry and rainy seasons. Let us overview swidden farming in the rain-green forest, taking the example of a Karen village in the Bago Mountains and a Khmu village in northern Laos.

2. Karen Swidden Farming in the Bago Mountains:

In the Bago Mountains, located between Mandalay and Yangon in Myanmar, the Karen people practice swidden farming in mixed deciduous forests. Let us take a look at the content of their activities.

Select-Site Selection-: When the dry season comes, a field is selected for burning. They do not perform swidden farming within one kilometer of the area surrounding the village since this area contains water source forest and areas for collecting fuel wood. The people choose a "cold" area with black soil, avoiding ridges because the soil there is "hot." The people say places where *Bambusa tulda* (Indian timber bamboo) grows are suitable for swidden farming because these places are relatively flat and the soil is clayish.

When they find a place that seems suitable, they take a handful of soil back to their house, put it under their pillow and sleep. If they have a good dream, the place is satisfactory, and if they see a bad sign in a dream, they will seek another candidate site.

"Evil spirit, please go away. We are going to work in this place for food, to support my wife and children. May no mischief happen here. We will work to the last." These are the Karen words offered at the ritual of *Ta mawa hku.*

Cut-Clearing-: In December, the mountain area becomes much colder. The large leaves of teak trees become wet with the night dew, which drops like rain. The drops hit the parched leaves on the forest floor making a thudding sound. Clearing begins in the cold season, around mid-January. Clearing is a man's work. The men cut trees starting from the lower part of the slope, using a woodman's hatchet. Polymorph bamboo (*Bambusa polymorpha*) and Tinwa bamboo (*Cephalostachyum pergracile*) are bushy bamboos whose multiple stems stand as if bundled together. The Karen people cut them from the outside. They cut big trees at about two meters above the ground, not at ground level. They prop the cut bamboo stems against the tree like a ladder and cut the tree using the bamboo to stand on.

A newly-cleared swidden field will be left as it is to dry. Daytime temperatures become hotter after the Chinese New Year in February, and the hot season arrives in March. Generally in February the Karen make firebreaks of three meters in width around cleared fields in order to prevent the forest fires from invading the field. The people sweep away fallen leaves and sticks so that the forest fire cannot spread to the field from outside.

Burn-Burning-: The hottest season in the year is around the time of the Water Festival in April. The fields are burned at this time of the year. Burning starts from around 1 p.m., the hottest time of the day. The result of the burning greatly affects the crop. Two or three days after the burning, the people gather the residual vegetation and conduct a second burn, and then begin to build a temporary field hut in the field.

Sow-Sowing Seeds-: In May, a southwest monsoon wind brings rain and the parched land turns to green all at once. This is the period of the year when you can get a real sense of the meaning of the name "rain-green forest." With the arrival of the rainy season, the Karen strike holes in the soil with a dibbling stick and drop seeds into the holes. The dibbling stick is made of bamboo and has holes bored in it so that it makes a popping sound when the people strike the ground with it. It is a digging stick with a clapper.

The Karen raise three varieties of upland rice; non-glutinous early maturing variety, non-glutinous late maturing variety and glutinous medium maturing variety. Other than sesame, chili pepper and cotton, their main cash crops, they also grow millet, sorghum, maize, Job's tears, sugarcane, common beans, pigeon peas, cassava, konjac, cucumbers, melons, pumpkins, eggplants, okra, tomatoes, *Indigofera* spp., hibiscus, tobacco, bananas, as well as flowering plants such as feather cockscomb (*Celosia argentea*) for ornamental and ceremonial use.

Raise-Weeding-: Rains not only raise crops, but also grow thick weeds. Weeding begins just after sowing, and is carried out three times up to the end of September. Weeding is a hard work.

Protect-Agricultural Damage Caused by Wild Animals-: The Karen make a fence around the swidden field by September to prevent wild boars that eat upland rice and barking deer that eat chili peppers from entering the field. The swidden fields are surrounded with the bark of the tropical chestnut *(Sterculia villosa).*

Clappers are used to scare deer away. The rope for the clapper is also made from tropical chestnut *(Sterculia villosa, S. versicolor).*

Reap-Harvest-: The harvest of the early maturing rice begins in November, and the harvest of the late maturing

rice is completed in December. The grain is threshed at the field hut and stored in a rice granary. Feather cockscomb flowers bloom in the swidden fields around the time of the rice harvest, turning them into flower gardens.

Rest-Fallow-: Shortly after the fallow period has started, Eupatorium *(Eupatorium odoratum)* and *Thysanolaena maxima* begin to grow. The fallow land is covered by these grass in the first one or two years. Following these grass, bamboo species recover. Species such as polymorph bamboo and Indian timber bamboo are usually seen in fallow land. When you walk around in this kind of bamboo forest, all around the area you will see small piles of soil made by digging the surface. These are the work of the lesser bamboo rat, called *bwi* in Karen and *pwi* in Burmese. The soil they have dug out to make their nesting holes is piled up by the entrances. The lesser bamboo rat digs underground tunnels from the entrance and scrapes out soil at regular intervals. In this way, they breed in the nest holes in the ground, eating bamboo roots and bamboo shoots. There are also traces of digging by wild boars on the ground. The ground in the fallow areas, especially those of young fallows, looks as if it has been cultivated. The cultivation power of animals plays a significant role in the recovery of fertility in fallow land. Unlike the Japanese word *shinkan* ("the hushed silence of the forest"), fallow forest is in fact quite a lively world where animals are very active.

Regeneration of new branches begins from the stumps of trees such as *Xylia xylocarpa* (Burmese iron wood) which were cut well above the ground when clearing the field. The height of these trees exceeds that of bamboo after about ten years have passed after cutting. The quantity of biomass of trees recovers to a level roughly the same as that of bamboo. The secondary forest, where bamboo and trees are mixed in this way, is a suitable area for swidden farming because clearing is easy and the biomass burns well.

The transition of the vegetation that covers the land after swidden farming, from grass, to bamboo and then to trees, is the process of secondary succession. Swidden farming involves the troublesome work of weeding. Swidden fields require weeding at least three times in the first year. In the second year, as much as three times the amount of weeds will grow compared to first year. It therefore saves trouble and is more rational to allow secondary succession proceed and wait for the weeds to be defeated by the bamboo and trees covering the ground and darkening the forest floor instead of fighting a losing battle against weed infestation.

3. Khmu Swidden Farming of the Northern Laos:

The Khmu people produce upland rice in swidden fields below an altitude of around 1,000m. After a single crop in the first year, the field is kept fallow for six or more years. They produce upland rice for self-consumption and earn cash by producing and gathering forest products.

In the swidden fields of the Khmu people of northern Laos, Siam benzoin *(Styrax tonkinensis)*, a pioneer species, is the dominant species in fallow forests. Khmu people collect benzoin resin in the seventh and eighth year of fallowing, following which they clear the forest and carry out swidden farming in the ninth year.

Siam benzoin, a tree found in the mountain areas of northwestern Vietnam and northern Laos, provides benzoin resin, a raw material for perfumes and medicine. In particular, northern Laos has been known as a production area of Siamese benzoin since ancient times. Siam benzoin is a fast-growing, indigenous species and becomes the dominant species especially in a fallow forest after swidden farming. Benzoin resin has been produced in fallow land after swidden fields have been used to produce rice.

Here I would like to present the case of a village in Louang Phabang Province in northern Laos. Many of the secondary forests surrounding the village are fallow swidden fields consisting of Siam benzoin trees. The people clear the fields to be burned from the end of December to February, and burn the fields from the end of March to April. This burning breaks the dormancy of Siam benzoin seeds that have fallen to the ground during the previous autumn. When May comes, bringing the rain, the people sow upland rice seeds keeping a certain space between them. They also grow cassava, sesame, chili pepper, Job's tears, rattan, feather cockscomb and other plants in the swidden fields. At the time when the upland rice grows to around 30cm, Siam benzoin seedlings of about 5cm in height can be observed almost everywhere around the swidden field. Weeding is carried out three times. At the same time, the people carefully keep the seedlings. By the time the upland rice is harvested, the Siam benzoins have grown to about head height. The extraction of benzoin resin is conducted in the seventh and eighth years. The field is then cleared and swidden farming is carried out again in the ninth year.

Burning of the field facilitates germination, and Siam benzoins will grow as a pioneer species in fallow fields. They are felled after their resin is collected, and a new cycle of swidden farming begins. Here the combination of Siam benzoins and swidden farming is advantageous for two reasons: (1) the characteristics of the trees as a pioneer species, i.e., Siam benzoins are light demanding species, and their germination is facilitated by burning, and (2) regeneration is required because the resin can be extracted only for two years.

In northern Laos, cardamom and rattan as well as benzoin resin are gathered in the fallow lands after swidden farming. Lac and agarwood are also produced on fallow lands. The fields greatly contribute to the livelihood of swidden farmers as a "productive fallow."

4. Strength of Water and Fire:

In the rainy season, green paddy fields can be seen in intradeep basins. The rainy season from May until around October is the season for farm work. From November until around April is the dry season when the people carry out the clearing and burning of swidden fields. In the continental areas of Southeast Asia, paddy farming and swidden farming have been practiced to the rhythm of the monsoon climate in which rainy and dry seasons are repeated alternately. The "Thais," who cultivate paddy

fields, may sometimes perform complementary swidden farming in side valleys and the areas between mountain foothills and arable flat land. On the other hand, mountain dwellers sometimes cultivate paddy fields. In this sense, "Thais" and mountain dwellers form a continuum.

The Chinese character " " is a *kanji* unique to Japan, composed of " " (fire) and " " (field). While a paddy field (*suiden*, " ") is called a *ta* (" "), an upland field is made by burning away the vegetation on the ground and is called a *hatake* (" "). It is said that in ancient China, an area of land burned in order to carry out hunting by surrounding an area of forest was called " ," which later came to mean a swidden field.

In order to create the conditions necessary for crops to grow, people change the environment by borrowing the strength of water in paddy fields, or fire in upland fields.

In swidden farming, before cultivating upland rice, people burn the field to restore the conditions to those of an early stage of succession. During the fallow period, the recovery of secondary forest is left to the natural process of succession. When the forest has recovered, the fields are cleared and burnt again, and upland rice will be grown. This process of succession, taking ten or more years for each cycle, has been repeated in swidden farming.

A paddy field maintains the conditions of the early stage of hydrarch succession by inundation. In this way, the conditions of an early stage of succession are restored by the strength of fire in the case of swidden farming, and by water in the case of a paddy field.

There are four major types of succession process: (1) xeric succession, (2) hydrarch succession, (3) psammophytic succession and (4) halophytic succession,. Swidden farming falls into the first category, and paddy cultivation into the second category.

Swidden farming repeats the process of disturbance and succession in which forests are burned and then recover on the land formerly cultivated. Therefore, the forests where swidden farming is practiced are, unlike the case of monoculture plantation, not uniform, forming an uneven patchwork of swidden fields, young fallow land, old fallow land and deep forests. This uneven patchwork provides diverse habitats for animals, and this diversity has brought about the possibilities for various products.

5. Forest Products of Fallow Land:

People of the continental areas of Southeast Asia have been connected with the external world through the trade in forest products. These products have been gathered to port cities located along the rivers.

For example, among the exports of the ancient kingdom of Lan Xang, particularly important were gold, lac and benzoin resin. These forest products were transported across mountain passes carried on the backs of people, horses and oxen, shipped down rivers to port cities such as Ayutthaya, and then exported to Europe and beyond from the Coromandel Coast on the far side of the Indian Ocean. The products conserved well, and were therefore able to travel long distances, were easy to transport, and were lucrative. For centuries, people in northern Laos were self-sufficient practicing swidden farming, supplemented by cash income from forest products.

The mountain area of continental Southeast Asia that leads to Yunnan and Assam is also the origin of tea plants. In northern Thailand, northern Laos and the Shan State of Myanmar, people produce chewing tea, known as *miang* in Thai, and "lahpet" in Myanmarese. The people chew the tea leaves, which are fermented after steaming the raw leaves. In *miang* tea gardens, the tea plants are planted under the tall shade trees of the mountain forest. In these tea gardens, the gathering of firewood for steaming tea leaves was combined with grazing forest for the draft oxen used for shipping the chewing tea. Here the grazing inside the forests has prevented wildfires from invading the field areas in the dry season.

Kingdon-Ward, who conducted field study in the Mishmi Hills of Assam, in search of wild species, has written as follows; 'Camellia sinensis is a plant of the foothills, not of the plains. Is it not significant how its cultivation, even its very existence, seems to cling around places where the much-travelled Tai race is, or has been or could have been? The long road of their migrations is still bordered with tea-bushes. Will anyone claim that this is coincidence?' (Kingdon-Ward 1960:140)

Almost all of these tea gardens are developed in former swidden fields. We can consider that the planting of tea and agarwood imitates the last stage of secondary succession. The Thai cultural sphere, spreading from rain-green forests to the laurel forest zone, is a world where mountain ranges are decorated with a patchwork of disturbances and successions of swidden fields that produce various forest products.

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Ideal and reality of marine protected areas in Senegal

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Abstract: This paper focuses on the issue of the governance of Marine Protected Areas (MPAs) in a political context in which national and international authorities intervene in the traditional management operations of local communities. This analysis will draw on the social and historical backgrounds of the systems of land and marine tenure, usage, and management with particular reference to the Bamboung Community-based Marine Protected Area in Senegal. Multiple claims of legitimacy rely on the diverse accounts of history that give each group unique connections to social and legal systems. It also suggests that the legitimacy of each actor is undermined by ambiguities in the social and legal systems and by uncertain estimates of fish inventories. This situation presents a dilemma in which the promotion of resource management by non-local stakeholders exacerbates conflicts within the local population.
Key words: Marine Protected Areas, fishery, customary law, land tenure, Senegal

Introduction

Recently, the discussion about MPAs is active. There is no definition that agree on MPAs. However, the International Union for Conservation of Nature (IUCN) defines MPAs as "Any area of intertidal or subtidal terrain, together with its overlying waters and associated flora, fauna, historical and cultural features, which has been reserved by legislation or other effective means to protect part or all of enclosed environment (Kelleher 1999)." MPAs have developed for the conservation of ocean and littoral region exposed to the threat of destruction. By the end of 2006, 4435 MPAs exist in the world that account for 0.65% of oceanic area of the world (Wood et al., 2008). In the World Summit on Sustainable Development 2002 (or Earth Summit 2002), it was advocated to construct MPAs network based on scientific information by 2012. Thus the Senegalese government declared creation of 4 MPAs to attempt conservation of biodiversity and sustainable fishery on the 5th World Parks Congress (IUCN, 2003).

In the ocean, the zoning that sets the boundary is essential as well as the land. Especially, No-take Zone that prohibits all the collection activities is a principle (Weigel and Sarr 2002). Such a Western Europe and modern nature protection system has caused conflicts because it separates land from the local population or excludes natural resource users. Therefore, it is a few cases that MPAs have achieved a purpose of the conservation of biodiversity and the local life improvement (Jentoft et al., 2007).

In addition, as a peculiar problem to MPAs, fishes wander exceeding a border and a political boundary, and a boundary as clear as protected areas in the land cannot be set up. Fishes and men who capture them move exceeding the boundary, so it's impossible to control by the model fixed to a certain space (Dahou et al., 2003). The participatory approach project to make the local population excluded from the access to the resource positively participate in the naturalpositively participate in the natural resource management to avoid conflicts of protected areas and the local population is promoted in many parts of the world.

The democratization with structural adjustment programs that IMF and the World Bank recommended was promoted in Africa after the cold war was concluded, and one of its pillars was the decentralization. In Senegal, Local Autonomy Law was enacted in 1996, the empowerment from a central government to the local government was attempted, and it became possible for the rural community which is one of the local public entities to establish Nature Reserve.

Thus, the Bamboung Community-based Marine Protected Area (*Aire Marine Protégée Communautaire de Bamboung* : AMPB), the first MPAs in Senegal came to be founded in 2004.

We describe issues related to the governance of MPA in a political context where customary management by local communities is subject to top-down national and international intervention. We explore how context and interventions interact with the social and historical background of systems of land and marine tenure, usage, and management with particular attention to the AMPB in Senegal.

Study Areas

AMPB is located in the southeast 150km of capital Dakar in Senegal, and exists in the vast delta zone that is called *Saloum* Delta. This delta is a northern limit zone of the mangrove, and it is composed by innumerable reticulate branch that is called *bolon* and mangrove forests.

The area of AMPB is about 70km^2. The branch of the *Diombos River* that is called *Bamboung bolon* is thought to be fish's egg laying ground. Length is about 12 km, the width of a river is 500 meters from 50 meters, and depth is varied from 0 to 7 meters. 14 villages where about 16000 people reside is scattered in the surrounding (Fig.1). The villagers around the *bolon* are being composed by mainly two ethnic groups. One is *Serere Niominka* in the northern *Saloum* Delta, and the other is Soce in the southern part of delta near neighboring country Gambia. Though these two ethnic groups conflicted before, they came to have consideration as which the entire islands were the same by Islam's spreading and specializing in an economic activity of peanut cultivation (Pélissier 1966). Many of residents in the research zone depend on agriculture and fishery. The fishery is small-scale which is limited with the fisherman who owns the outboard machine. Generally, the fisherman fishes by gillnet or fishing rod on the small hand rowboat for one person or two people that is called *pagaie* (Photograph 1). It is said that the fisherman was engaged in cast net fishing in *Bamboung bolon* for tilapias and mullets before AMPB is founded. The woman gathers oysters and other shellfishes on *pagaie* or foot.

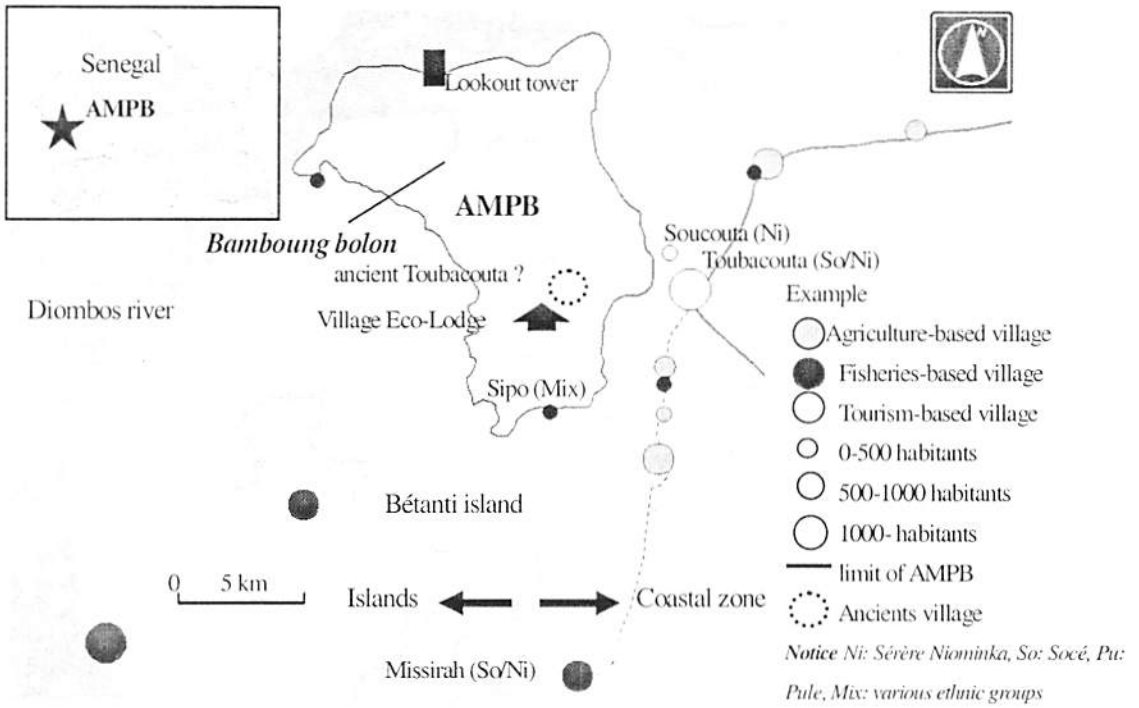


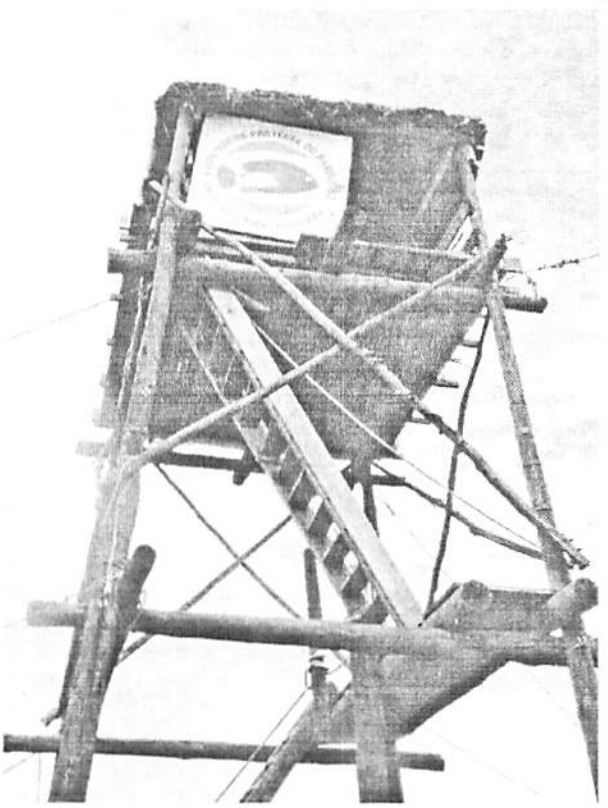
Fig.1 Location of AMPB and peripheral villages

Divergence of ideal from reality

The local community decided to create the AMPB using a participatory approach suggested by a local non-governmental organization (NGO). The *Oceanium*, an environmental protection NGO in Senegal, has been active in highlighting and educating residents about environmental problems since the 1990s, with a key focus on marine resources. In 2001 they started a marine resources management project with the express purpose of creating MPAs, which included the AMPB.

Photograph 1. Pagaie

The AMPB is co-managed by the state and the local population. Operational management is composed of two local citizen organizations. Decision making is carried out by a steering committee composed of representatives from all 14 villages. The watchdog committee conducts on-site monitoring activities, using volunteers to watch for poachers from a tower constructed in the mouth of *Bamboung bolon* (Photograph.2).



Photograph.2 Lookout tower

To compensate local residents for economic losses resulting from the fishing prohibition in *Bamboung bolon* starting in 2004, *Oceanium* constructed a sustainable tourism eco-lodge in one of the villages. Profits from the lodge are used for maintenance of the AMPB, to pay for patrols by residents, and to supplement the community budget for things like educational infrastructure. Through 2008 about 3 million CFA francs (about US$7000) have been brought into the local economy.

However, this seemingly idyllic protected area is threatened by lingering conflicts among the stakeholders. From the standpoint of economic livelihood, villagers had no choice about giving up fishing, both commercial and subsistence. Many villages had strongly depended on fishing in *Bamboung bolon*, and persons who gave up fishing and sold their boats have claimed that "AMPB killed the villagers". As well, there remains a level of dissatisfaction among the local populace with regard to how their values and opinions were addressed. *Oceanium* had screened an educational film in all the villages highlighting the issue of overfishing, particularly of juvenile fish stocks. Their message to the villagers was that they should now recognize the environmental and economic harm this could cause, and act in harmony with *Oceanium* to protect the resource. However, the local population raised objections to *Oceanium* on the basis that the overfishing activities depicted in the film did not occur in *Bamboung bolon*. Moreover, one ex-watch member indicated that the documents distributed at the AMPB proposal conference were too complex for village chiefs to understand. Even though the conference proceeded, the chiefs did not fully understand what was being proposed because the concept of "resource conservation" did not exist in the local language. Consequently, the local population's antipathy for the process and the AMPB remains because they feel that the opinions of vocal opponents to the plan were largely disregarded.

Legitimacy competitive of stakeholders

In MPAs, the stakeholder is diversified because of difficulty of dividing the space physically. There is nuance of time and spatial relations in various stakeholders, and their historical background is also different. Whose legitimacy is more appropriate in a local context? This chapter verifies the validity of each stakeholder's legitimacy by paying attention to the social and historical backgrounds of the systems of land and marine tenure, usage, and management with particular reference to the AMPB.

Ambiguity of property rights

A private property right as a Western Europe concept didn't exist in Senegal before the coming of Europeans as well as other African nations. The land and river were owned, used and managed under the common law traditional, and the *bolon* near the village belonged to ownership of the village (Pélissier, 1966).

After the French colonization, the land policy based on the concept of a private property right is promoted. The colonial government treated the land without name of owner and the uncultivated land for ten years or more, that is, "land that is no ownership from European's view" as public domain (Caverivière, 1986). The common law is disregarded, and the land use by the common law became under the control of the State.

The reorganization of the land system was starting with Senegalese independence in 1960. The President Senghor, who was a theoretical leader of African socialism, thought that the private property right was a product of capitalism. For him the capitalism meant the alienation of the human nature that changed the relation between the person and the person into the relation between the thing and the thing (Senghor 1976). In 1964 he divided Senegalese territory into three classes: national domain, private property and property of the state. The State temporarily owned 98% of land as national domain by this law (Caverivière, 1986). The State detains the national domain in order to assure their use and their rational enhancement, in accordance with the plans of development and to the programs of planning. In addition, the new government enacted national property law that provide "the navigable or buoyant rivers in the limits determined by the height of waters flowing to full sides before overflowing, as well as a zone of twenty-five meter large from these limits on every strand and on each of the sides of the islands" in 1976.

Either the colonial government, either new government after independence, traditional management was a trouble in management for the ruled side. Thus *bolon* was incorporated into the nation assuming that it was not possible to divide physically. The *bolon* was belonged to the local population, though it belongs to the nation by the law.

Logic that the local population has the property right of *bolon* is not simple. Different legitimacy is constructed by historical relations to *bolon* of each village. We see legitimacy of 3 villages where strength of relations with *bolon* is emphasized.

Toubacouta village avoided the colonization by France in the 19th century, and moved from the northern part of *Saloum* Delta to *Bétanti* Island. The village chief said that *Bamboung bolon* was the place for farming and fishery and the village located away from *bolon*. However, villagers migrated to the present place in the latter half of the 19th century because rice farm had become difficult due to the decrease of precipitation and the salt damage. The village chief insists that the *bolon* has not parted from the ownership of *Toubacouta* village because their ancestor was the first settling down in the *bolon*, and the descendant of clan who is owner of *Bamboung bolon* live in *Toubacouta* village.

Sipo villagers live most near the place of *Bamboung bolon* now. The ancestor in other villages migrated to the littoral zone in 1826 though they had settled down in the residence space of *Sipo* village. A *Bambara* family migrated from neighboring country Mali to the blank ground and *Sipo* village was built in 1921.

On the other hand, *Soucouta* village where the chairman of the steering committee lives takes leadership for management of AMPB. He haves high negotiating ability with the outside, and the village seizes the initiative about not only the committee but also the village lodge in AMPB.

From the viewpoint of historical relations, the claim of *Toubacouta* village is strong. However, from the viewpoint of present relations, there is a reason for *Soucouta* village in the point of taking the leadership of AMPB and *Sipo* village in the point of resident right. Legitimacy of the property right depends on where to put the time axis or where to put the standard of relations among actors who often are treated as the local population.

Conflicts concerning use among fisherman

The *bolon* to have belonged to the local society for the fisherman in local and the fishermen from the outside had to follow the customary law. Though only the *bolon* with deep depth was open for everyone to fish freely, the *bolon* near the village assumed the ownership of the village severely in *Saloum* Delta (Pélissier, 1966). Fishing was permitted under the owned village, and often the consideration of use, for instance, the dry fish was requested. Such customary law would have gone out of use in the age, and only a tacit rule of not using the *bolon* the period of rainy season remains now.

On the other hand, the consideration of the sea as the fishery for everyone strengthens, so general modern fisherman doesn't respect the rule of fishery has been traditionally allocated by each village (Chaboud and Charles-Dominiques, 1991).

The sphere of activity of fisherman has extended greatly by introducing a large-scale fishing boat, developing of refrigerating installation and organizing the fishery. Especially, the fisherman from outside invades in the *Saloum* Delta because of the high commercial value fish that brings the hefty profit such as groupers is abundant. Such invader doesn't often respect a local traditional custom, therefore the conflicts have occurred among local fisherman and invading fishermen who often ignore the prohibition of fishing period and use of fishing implement prohibiting.

Confusion over management

The co-management system between the State and rural community is adopted in AMPB. However, we cannot assert the State to be a consistent actor. Each ministry agency competes in interior of the State, so it's difficult their cooperation in local level. The Direction of Waters and Forests, Hunts and the Protection of Soils who has the authority of management of mangroves based on the Forest code, the Direction of National Park who engages in co-management of protected area conformed to memorandum of agreement with rural community and Direction of Fishing who limits and controls fishing method referring the Fish maritime code claim each competence.

We point out the problem of the layered structure of a different system of the law. Another national park is adjacent to the place where AMPB overlaps with conservation forest. Moreover, biosphere reserve is located like all covering them (Fig. 2). This layered structure of protected areas is a big pressure for local population. One fisherman appeals keenly "There is no guarantee that doesn't hang on to authorities picking up dying twig of mangrove in spite of admission of its collection. Whether in the forest or in the sea, our activities are almost prohibited, how should we live?"

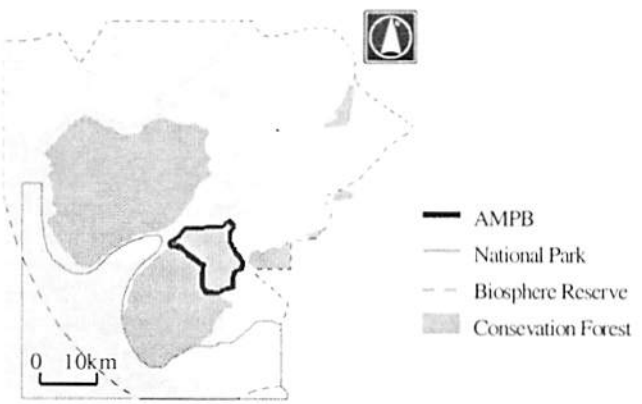


Fig.2 Protected Areas in Saloum Delta

MPAs contribute for sustainable development?

We cannot suppose that only a specific actor has validity about the legitimacy of the stakeholder over the MPAs. It might be necessary that grounds of the resource management policy are clear so that the stake holder may agree. Legitimacy in fisheries management will be determined due consideration of what is the most rational and reasonable for the user (Jentoft, 2000). We examine grounds of global legitimacy of AMPB, that is, biodiversity conservation, sustainable tourism and decentralization.

Incertitude of knowledge about the natural resource

The purpose of protected area is the conservation of biodiversity and sustainable local development. In almost cases, the zoning is executed on the assumption of "The natural resources decrease by local activities."

Océanium investigated, with the cooperation of research laboratories, the change in the number of fishes living after installation of AMPB. According to the result of investigation (Tito de Morais *et al.*, 2007), it's confirmed newly 23 kinds of fish like the shark and rays, and large-scale fishes that are object of invading fisherman has increased after prohibition of fishing. However, the number of medium fish that staple food for local

population such as mullet and tilapia decreases. Scientific knowledge cannot answer clearly a doubt of local fisherman that concentration of fisherman on other fisheries caused decrease of fish.

As well as mangrove resource in littoral zone, legitimacy of protected areas is disturbed by incertitude of knowledge about the natural resource. In *Saloum* Delta, the current established theory was that "the deforestation pressure has developed because of increasing demand for the live materials according to population increase and increasing smoked food kitchen range for herrings that Guinean merchant request (JICA 2008)." The management and the forestation have been executed under assumption of deforestation of mangrove. However, the study group of Paris University clarified that the area of mangrove forests decrease is recovering. They insisted that the key factor of changing mangrove vegetation is not man activity but dryness by decrease of precipitation (Ackermann *et al.*, 2006).

The preventive measures are justified because *bolon* is a spawning ground of the fish. However, the repeated discourse that "population increase applies pressure on resource" improve intervener's significance of existence at the same time as justifying his intervention (Fairhead and Leach 1996).

Incertitude of tourism

Tourism is an alternative activity for fishery? Tourism is important industry in the developing country as the means of the foreign currency acquisition. According to Senegalese Tourism Ministry, tourism is a foreign currency acquisition means to follow the fishery and the foreign currency revenue of about 220 million US dollars per year has been brought (Sarr, 2005).

However, tourism accompanies the risk caused by change of the world economy in the country that depends on the tourist from the developed country. In *Saloum* Delta, the number of tourists indicates strong seasonability. In addition, the occupancy ratio of accommodations in this area has greatly decreased from 49% in 1975 to 19% in 2000 by the accommodations construction rush in recent years (Sarr, 2005). The situation of employment in village eco-lodge is severe.

While tourism is highly influenced by the external factor that cannot be controlled by the local population, fishery is not only an economic activity from generation to generation but a local mental base. Tourism is insufficient as an alternative activity for fishery because it's impossible that all villages depend on tourism.

Insufficient decentralization

While the decentralization of the resource management was legally secured, rural community has a great obstacle, that is, the lack of management ability to assure autonomy in the resource management. If rural community hopes to create protected area, the elaboration of local action plan for the environment is demanded. However, the rural community has only one staff in general. It is extremely difficult to make the action plan at local level. Rural community has not only the difficulty of human resources but also lack of finance. With regard to the business to which the authority is transferred by Local Autonomy Law, the allocation of tax revenue from the central government to local agency has not been secured. Even if community protected area, all admission fee of protected area credits treasuries. After all, rural community will depend on the State even if it has an intention to autonomically manage the resources because rural community can request the technical service and the elaboration of the local maintenance plan to the State. Thus the empowerment to rural community in the resource management isn't pragmatic. The intention that the State doesn't part with authority is supposed to be concealed while admitting the autonomy of rural community in the co-management between the State and rural community.

Conclusion

This research demonstrated that multiple claims of legitimacy rely on the diverse accounts of history that give each group unique connections to social and legal systems. It also suggests that the legitimacy of each actor is undermined by ambiguities in the social and legal systems and by uncertain estimates of fish inventories.

Legitimacy is not an absolute norm, and should be reasonable and persuasive in the context of the society and the history (Suga, 2005).

However, legitimacy made from village level competes with legitimacy made in other villages and becomes weak in the place of discussion though it's persuadable in the unit of village referring the context of society and history. We cannot judge superiority or inferiority of each actor's legitimacy so that there is a small of consensus building.

If we try to arrive at the consensus building, the power of an external person who hangs out global legitimacy such as international organizations that have influence and fiscal resources will act greatly.

In this case, the involved problems of MPAs such as incertitude of knowledge about the natural resource have produced the competition of plural legitimacy due to lack of reasonable grounds, complexly intertwining with factors other than the original purpose of MPAs like ambiguities in the social and legal systems and decentralization.

MPAs have a dilemma in which the involvement of various stakeholders exacerbates conflicts. The global MPAs network might deprive the power of speech of people who are related to the resource while it promotes the participation of various stakeholders in the discussion.

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Resource utilization regarding acquisition of food material in rural Bangladesh

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Abstract: In rural Bangladesh, the problem of food deficiency and micronutrient deficiency is reported, but from where and how the foodstuff is actually provided has been little studied. This paper discusses how rural people interact with local resources and social networks for securing basic and everyday necessities: food. Food records were kept at six households under different economic conditions between March, 2006 and July, 2007. Everyday food (recipe names, foodstuff and its acquisition routes, who cooked, fuel and its acquisition routes, and those who ate) were recorded by household members. From the records, it was clear that many foodstuffs were self-supplied, which included gathering from local open-access commons such as fish from natural swamps, and wild vegetables from fallow fields. The natural swamps supplied an important source of protein to those who do not have enough production or monetary resources. Gifts from relatives and neighbors were also an important source of foodstuff for resource-poor households. Although local commons such as natural swamps are shrinking in size due to the increasing privatization of boro rice cultivation and commercial fish culture, they still play an important role, providing open access to everyone. In addition to increasing individual resources, attention to wild resources and preservation of local commons are also essential.

Key words: Rural Bangladesh, food acquisition, local resources, food recording

Introduction

Among 150 million people in Bangladesh, 70% live in rural areas. With high population density, landholding per person is less than 10 are, and more than 10% of the households own no farmland. With such limited production resources, food security and Nutrition survey conducted in 2008-2009 reports that about 25 % of households were under food insecurity, and that was more severe in rural areas. With recent rapid inflation of food price, more households are affected by food insufficiency (IPHN, UNICEF and WFP, 2009). Deficiency of micro nutrients such as Vitamin A is also is also major public heal problem (Bushamuka *et al.*, 2005). In order to cope with such problems, diversification of food intake is needed, and food aid including micronutrient supplements, kitchen gardening programs (Bushamuka *et al.*, 2005), health program and other various enlightening programs have been promoted. But how and where foodstuff is actually acquired has not been studied intensively.

It is difficult to come up with effective measures for improving food conditions without understanding how people interact with surrounding environments, and what kind of resources and access they have in order to acquire food. Recently, open access commons such as *beel*, or swamps, which used to be freely accessible for villagers, are becoming occupied and privatized half-illegally. In rural areas, they are converted into capital-intensive fish culture ponds. Quarrels between fish farms that encroaches upon natural *beel* and surrounding villagers are often reported in newspapers (e.g. the Chatla *beel* case in Ragpur, from the Daily Star, December 1, 2010). Commercialization and materialization of food production is drastic: mono-culture cropping of *boro* HYV rice has been spreading, and backyard chicken raising has been rapidly taken over by intensive cage raising of broilers. Rural people are losing interest in agriculture and leaving the rural areas. Under such drastically changing circumstances, rural households' strategies for securing everyday food are little understood.

In this paper, the everyday food managing of rural households throughout the year is analyzed, with the focus on their surrounding resources, social networking, and socio-economic backgrounds.

Materials and Methods

Research area: The research was conducted in Kazirshimla village in Trisal Thana, Mymensingh district. Kazirshimla village is located along the Dhaka-Mymensingh highway, and about 13km from the town of Mymensingh, located on the north end of the Modhpur tract. In 2005, the number of the total households was 362, and the total population was 1,908.

Sample households: Six households were selected as research subjects for their economic conditions and willingness to cooperate. Information of the six households is as shown on Table 1. With regards to landholding, family A was landless. Families C and E rented out all the farmland. Concerning regular cash income, the head of family D was permanently employed as a secretary to a judge. Family E operated a large-scale fish farm, and family F ran a pharmacy. The condition of the main residential building and possession of a freezer were regarded as the indicators of their economic condition. The houses of families A and B were made with earthen floor, and families C, E, and F owned freezers. In summary, families A and B were not rich in own resources, while families E and E were, especially for cash income. Families C, and D are positioned as middle among them.

Recording: Record keeping started in March, 2006. The eldest daughter/son of the household was assigned to record everyday food (the name of the dish and ingredients, the source of the foodstuff, who cooked, cooking time, how many people ate, the fuel and its source, and the amount of the foodstuff. It took the record keepers several weeks to become accustomed to the task, and the records from June, 2006 to July, 2007 were used for analysis.

Table 1. Economic condition of sample households

family	HH member male	HH member female	land holding□dec mal□ total	land holding□dec mal□ barı	land holding□dec mal□ tanks	land holding□dec mal□ farm land	operating land (dec mal□	livestock cows	livestock other	income source	Assets building	Assets freezer	recording days (2006.6-2007.7)
A family	7	1	98	26	7	65	117	none	goose	farming	eathern floor	none	409
B family	2	3	15	10	5	0	0	none		petty trade, cleaning woman	eathern floor	none	389
C family	2	2	325	19	6	300	0	none	none	get sharecrop harvest	cement floor	1	377
D family	3	6	118	12	6	100	100	none	none	secretary of judge	cement floor	none	389
E family	3	3	456	104	52	300	0	none	goats, chickens	get sharecrop harvest fish business□oasing 455dec mal ponds)	cement floor	1	392
F family	3	3	57	7	24	26	26	3		runs phermacy	cement floor	1	382

Results

Variety of foodstuff: shows the foodstuff used at each household. Vegetables had the most variety followed by fish. At each household, the number of items used was around 80. The variety did not necessarily correspond to the economic condition. Rather, it reflected the taste and lifestyle of each household. The only exception was the consumption of meat, sweets and sugars which indicated monetary spending, and therefore, the economic condition of the household.

Acquisition of foodstuff: show the consumption and acquisition of foodstuff by each household (left) and season (right), followed by categories of foodstuff. Seasonal category followed Bangladesh's six seasons: *Grismo kal* (summer:mid- April to mid- June) , *Borsa kal* (rainy season: mid- June to mid-August), *Shorot kal* (autumn: mid-August to mid-October), *Hemonto kal* (late autumn: mid- October to mid-December), *Sheet kal* (winter: mid-December to mid-February) and *Bosont kal* (spring: mid- February to mid-April). Axis Y shows the number of days when the particular item appeared on the table. Even when one item (e.g. rice) is consumed three times a day, it is counted as "one" appearance. When there are several items in one category, they are added (e.g. if one family consumes rice and flour on a same day, it is counted as two in the "cereal" category). The record keeping period included the fasting month (*Ramadan*) in *shorot kal* (autumn) and *hemonto kal* (late autumn), and *Eid* in *sheet kal* (winter), and their meals changed significantly during these two periods.

Acquisition of cereals and *dal* : Family E consumed flour every morning, and the number of its appearance days exceeded that of other families. Families B, C, E, and F cultivated rice, and family D got some share from their rented land. *Dal* (pulse) was not consumed so much except by family C who habitually ate *dal* almost every day. All the *dal* was purchased.

Acquisition of dairy: Consumption of milk and milk products differed among households, and it reflected their economic condition. Families A and B did not own a cow, and they could not afford to buying milk regularly (nowadays many people buy milk regularly from a neighbor with a cow). Family B sometimes purchased milk for the head of the household for its nutritional value. Only family E raised cows and self-supplied the dairy (*ghee*).

Acquisition of fish: Consumption of fish showed seasonal and household variation. The consumption of raw fish went up in the rainy season both for flood plain species and commercially cultured species. More fish were consumed by families D and E who owned fish culture ponds. All families cultured fish, but families A and B had access to jointly-owned ponds only, and the harvest share could not be expected very much. Instead of eating cultured fish, male members of family B frequently went to natural *beel* (swamp) on the edge of the village, and caught various natural floodplain fish. The *beel* is shrinking in size due to gradual privatization converting swamps into fish ponds and rice fields for *boro* cultivation as observed nationwide, but it still plays an important role of supplying a free source of protein to local people. A boy in family D also enjoyed catching fish from the *beel* although his family cultured fish. The head of family A could not fish at the *beel* because of physical weakness. Instead, he sometimes worked as a night watch at a commercial fish pond, and received some portion of the harvest (fish) as pay. Family A also got fish as gifts from family F (the heads of the two households are cousins) especially during the fasting season and *Eid*.

The appearance of dried fish was consistent throughout the year, but differed at each household. Because family A did not go fishing, their consumption of raw fish was not high but they ate dried fish instead. Families D and F liked dried fish, and cooked them often. Most of the dried fish were purchased, but some were processed by the household members themselves.

Acquisition of meat and eggs: Consumption of meat and eggs varied at each household. Family C consumed more

Table 2. Household wise carieties of foodstuff by categories

Category	Observed items/species	Number of observed items					
		A family	B family	C family	D family	E family	F family
Cereals		7	9	8	8	8	8
*Rice	*Chaul* (rice), *atop chaul* (non-perboiled rice), *gura* (flour) ,*khod* (broken rice)	4	3	3	3	3	3
*Wheat	*ata, moida*	1	2	2	2	2	1
*Others	*muri, chira*, noodle, bread, biscuit	2	4	3	3	3	4
Dal	(*musur dal, mas kurai, butto dal*).	1	1	1	1	1	1
Milk	milk, *ghee*(butter), *doi* (yoghurt)	1	1	1	1	1	2
Sugar	*gur* (Molasses), sugar, *khejur rosh* (juice of sugar palm), honey.	0	2	2	3	2	4
Fish							
*Raw fish	38 species	10	20	11	25	16	13
- Culture species	2 species (tilapia, pangas)	2	2	2	2	2	1
- Floodplain	14 species (*mola, taki, puti* etc.)	4	8	5	13	10	5
- Migrant	7 species (*rohi, murigel* etc.)	3	3	4	5	4	3
- Main river	4 species (Ilisa etc.)	1	1	0	2	0	2
- Unknown	11 species	0	6	0	3	0	2
*Semi fermented fish	*shutki, chepa*	2	2	2	2	2	2
Meat	chicken, chicken skin, beef, dried beef, cow brain, cow lever, beef Stomach and gut, goat, duck, pigeon, clane (wild)	3	3	7	9	8	6
Eggs	chicken, duck	2	1	1	1	1	1
Vegetables		40	38	35	47	36	38
*Fruits	5 species (eggplant, lady's finger, tomato etc)	4	3	3	3	3	3
*Fruits(climbing)	15 species (bottle gourd, country bean, wax gourd, bitter gourd etc)	11	14	10	11	11	12
*Leafy vegetables	19 species (amaranth, red amaranth, jute leaves, etc.)	15	12	14	17	14	14
*Leafy(climbing)	7 species (Indian spinach, bottle gourd leaves etc)	3	3	2	7	2	2
*Tuber + root	4 species (potato, radish, taro etc.)	3	3	3	4	3	3
*Tree	8 species (green papaya, jacktruit seed, green banana, banana flower etc.)	4	3	3	5	3	4
Fruits (domestic)	16 species	6	10	3	14	8	13
Total number		72	77	71	111	83	88
Unique item		sweet potato leaves	fish from *beel*	pigeon, regular intake of tea and biscuits	varieties, sweets	clane (wild)	ghee(self made), *Ilish* fish

meat than fish while other families ate fish more. During *Eid*, about half of the meat consumed was self-supplied in *shit kal* (winter). During the fasting and *Eid*, meat received as gifts also appeared on the table; family A got some share from family F.

Consumption of eggs depended on whether chicken or duck were raised at the household. Family B raised duck and was able to eat duck eggs which supplemented their protein intake.

Acquisition of vegetables: Most leafy vegetables were self-supplied, while tuber and root vegetables were mostly purchased. Consumption of fruit vegetables that usually grow in the fields increased in the dry season, while consumption of climbing vegetables which usually grow in homesteads was more consistent throughout the year. Fruit vegetables grown in the fields were more purchased than self-supplied, but family B kept a small vegetable garden in the field, and could get various harvest from there. About half of the climbing fruit vegetables were self-supplied, but family C grew no fruit vegetables because of lack of space in their homestead. Women are usually in charge of vegetable cultivation in homesteads,

but wife of household head of family C herself did not show any interest in planting vegetables in homestead since they were available in markets. It was common practice to bring fruits of homestead vegetables as gifts when visiting a relative's house, and all the households received gifts.

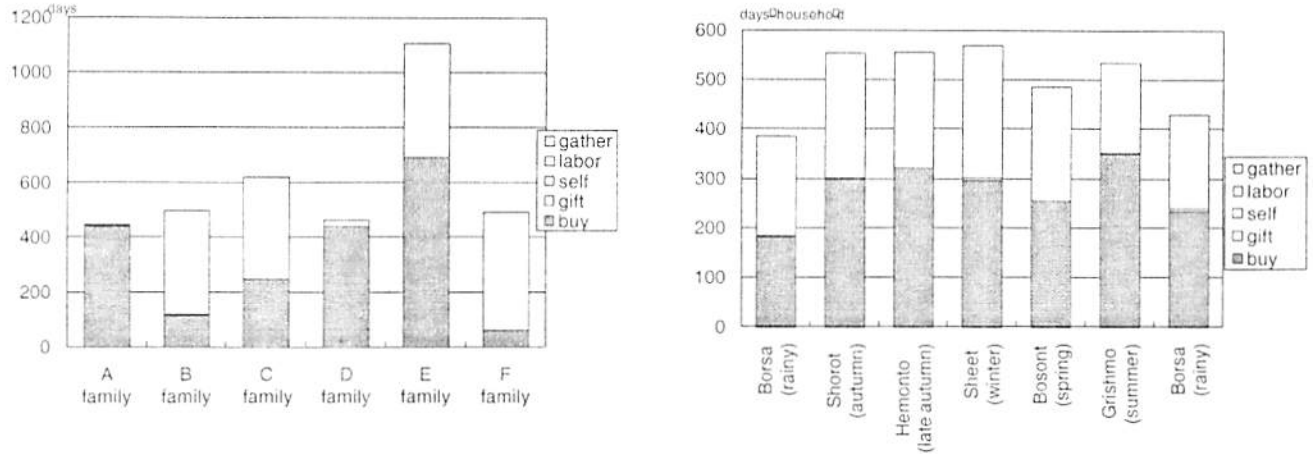


Fig. 1. Consumption and sources of cereals by household and season

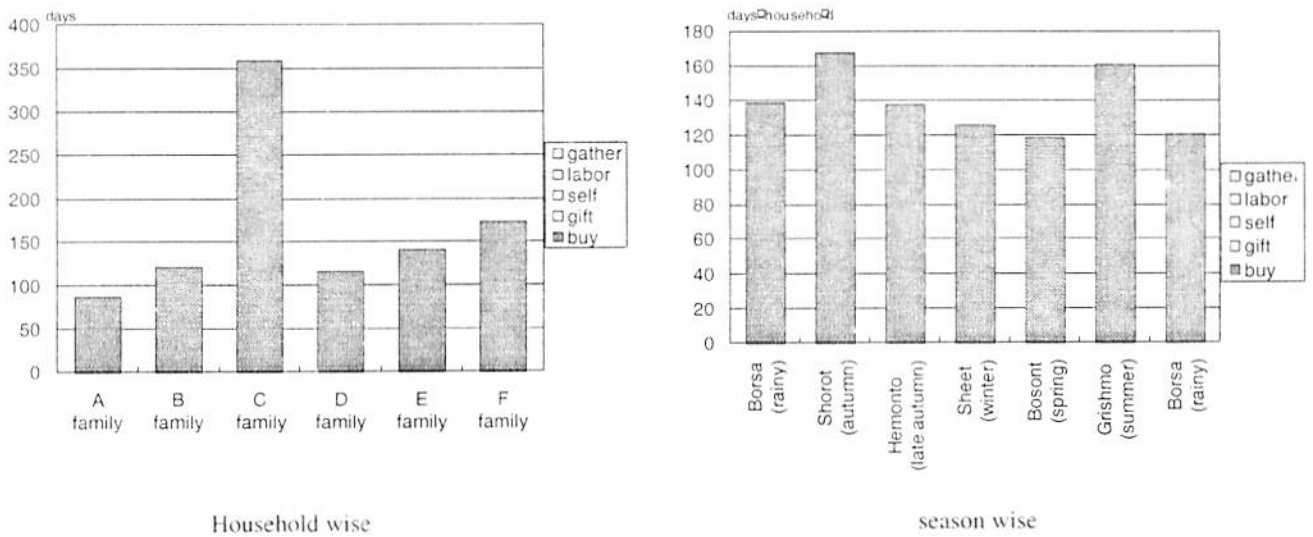


Fig. 2. Consumption and sources of *dal* by household and season

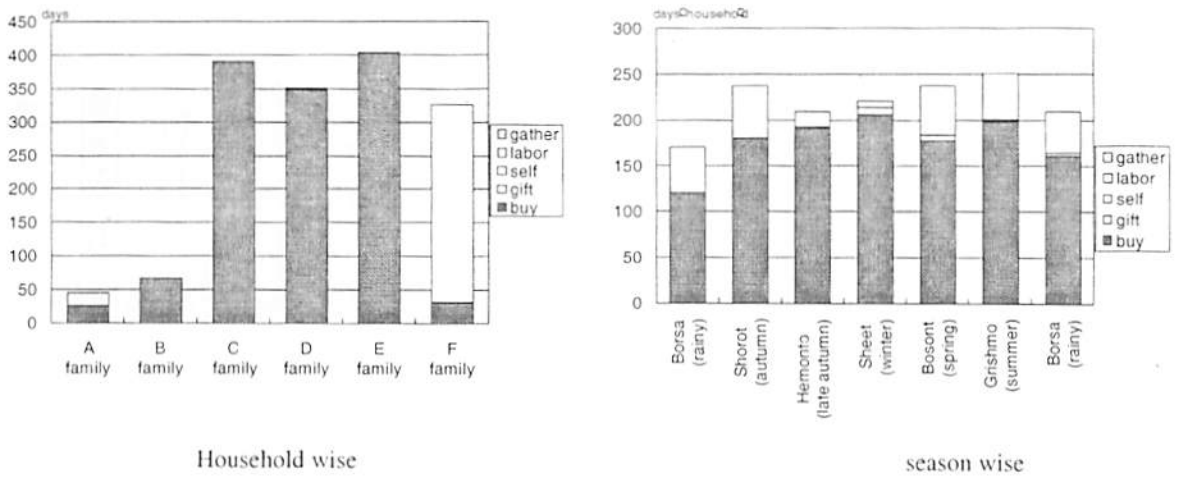
Among leafy vegetables, leaves of climbing vegetables are chiefly available in homestead. At the peak season of climbing vegetables (winter), the consumption increased supplementing vegetable intake of the family. Families B and D produced most of their own leafy vegetables. Family F started to grow climbing vegetables on the side of their fish pond because of the lack of space in their homestead. Sometimes wild vegetables were gathered, which did not necessarily reflect the family's economic condition since wild vegetables were regarded tasty and nutritious.

Among tuber and root vegetables, potatoes were consumed almost every day, but no household cultivated potatoes. Taros were usually grown in the homestead and consumed mainly in summer. Woody vegetables such as green papayas, seeds or young fruits of jackfruits, drumstick, and green bananas were also available on the homestead. Jackfruits seeds were consumed often during the harvest season.

Acquisition of fruits: The consumption of fruits also varied at each household and season. The consumption increased during the summer since it is the harvest season of major fruits, mangoes and jackfruits. During this period, the portion of fruits given as gifts also increased. Domestic fruits were acquired mainly from fruit trees on the homesteads, and so the amount varied by the size of homestead. Family A's homestead was small and enclosed, and produced a limited amount of fruits.

Although the homesteads of families D and F were not so large either, their homesteads faced open space and provided the families with seasonal delicacies to enjoy.

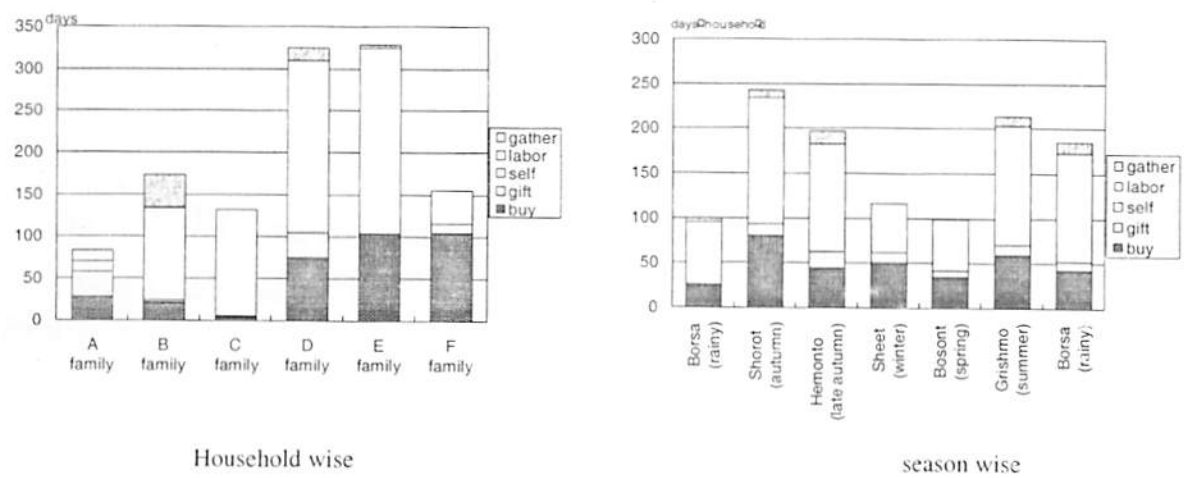
Among all foodstuffs, only cultured fish, leaves and fruits of climbing vegetables, and leafy vegetables were given as gifts from non-relative neighbors.



Household wise

season wise

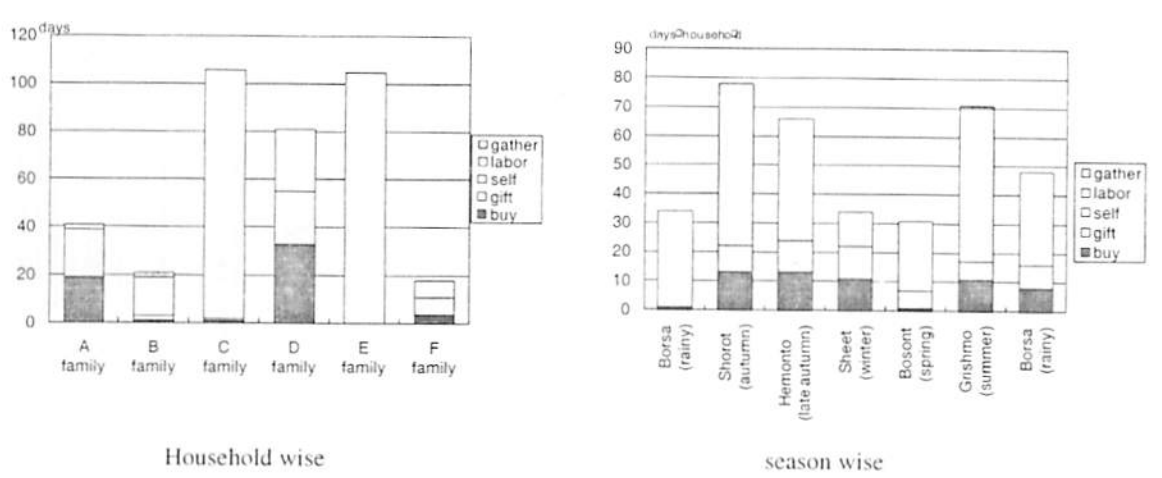
Fig. 3. Consumption and sources of milk and mik products by household and season



Household wise

season wise

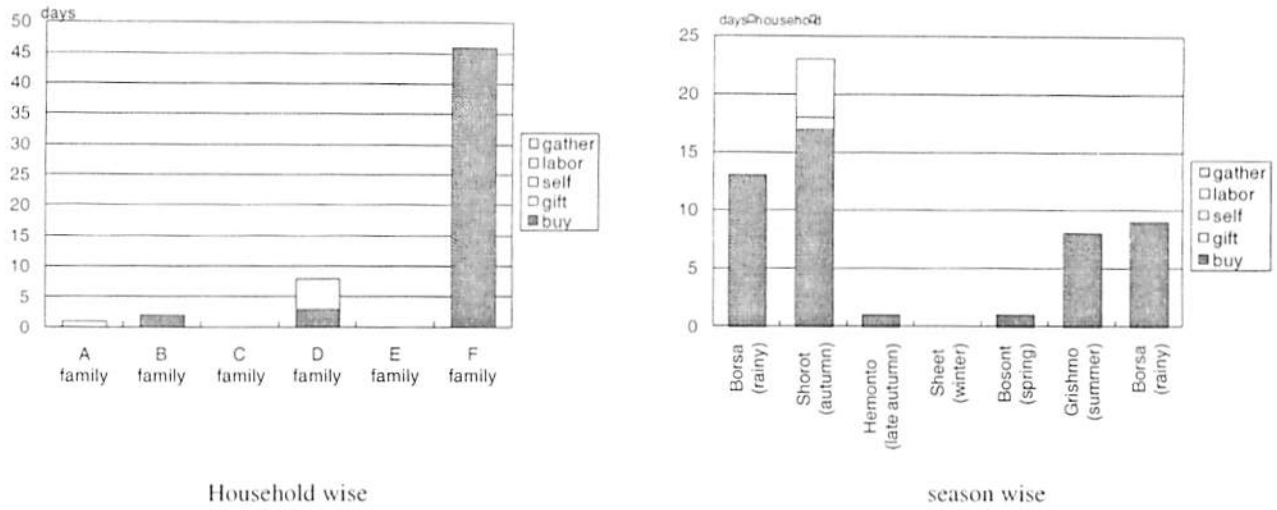
Fig. 4. Consumption and sources of fish (total) by household and season



Household wise

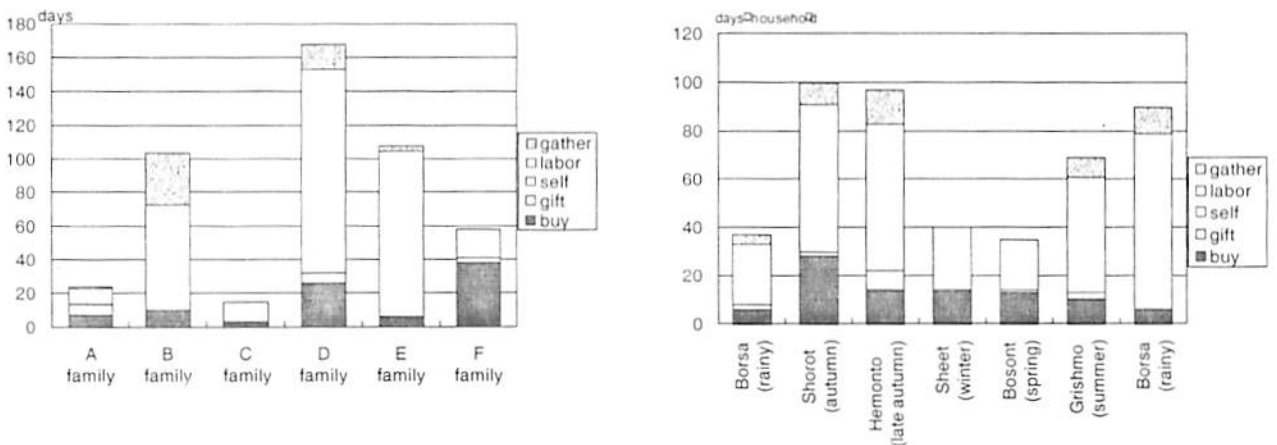
season wise

Fig. 5. Consumption and sources of cultured fish species by household and season



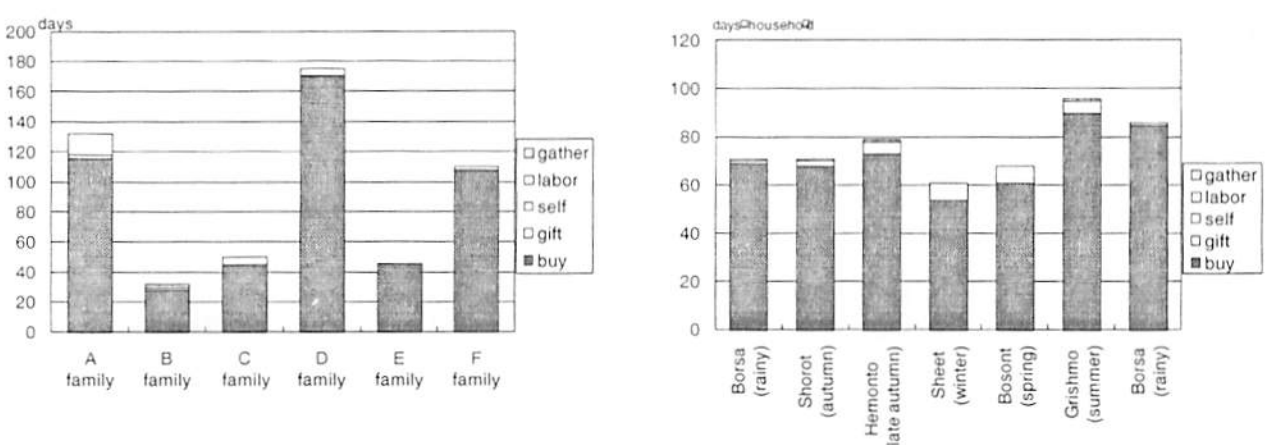
Household wise season wise

Fig. 6. Consumption and sources of main river fish species by household and season



Household wise season wise

Fig. 8. Consumption and sources of floodplain fish species by household and season



Household wise season wise

Fig. 8. Consumption and sources of semi-fermented (dried) fish by household and season

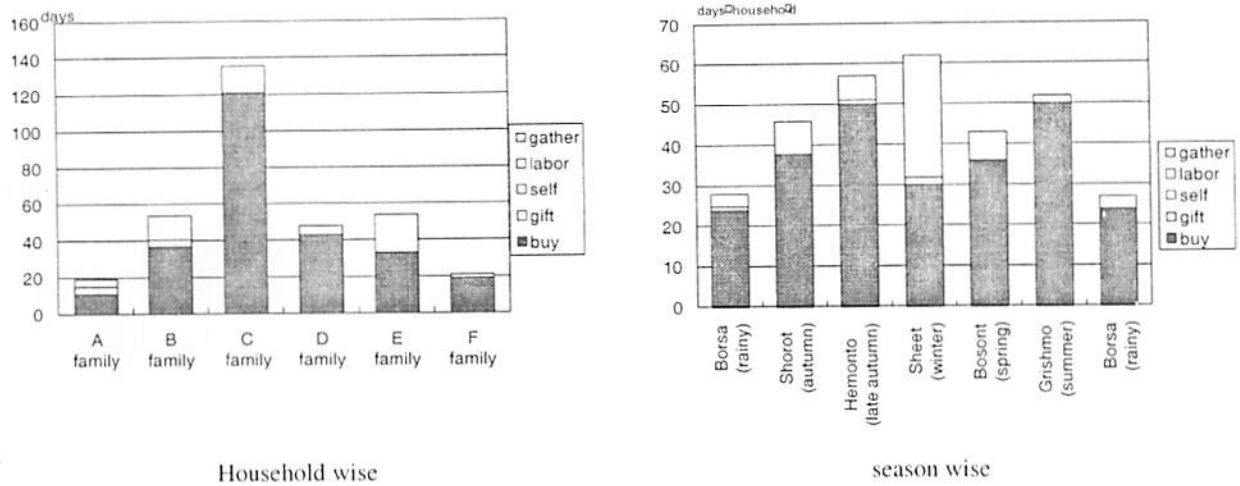


Fig. 9. Consumption and sources of meat by household and season

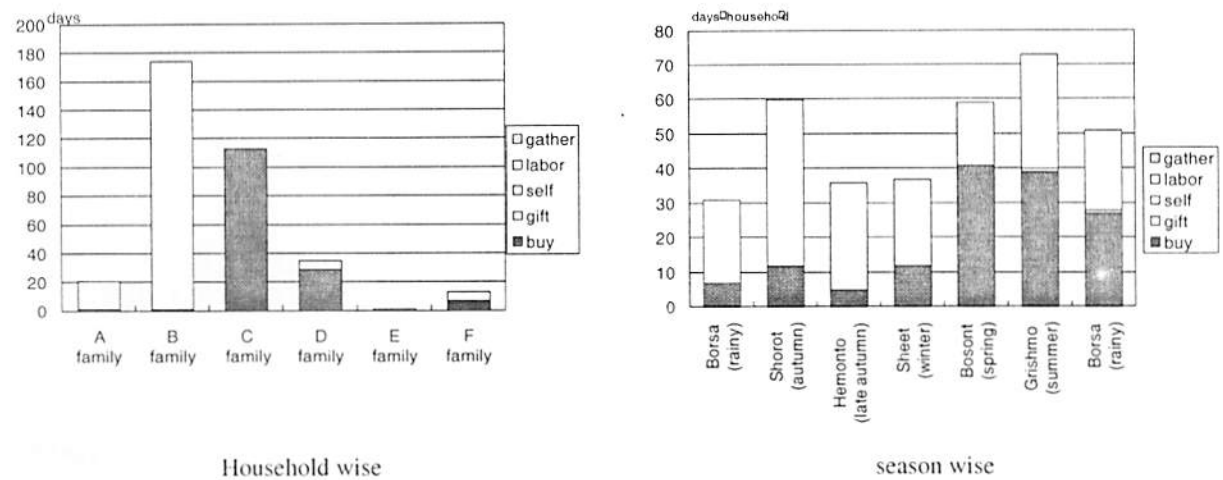


Fig. 10. Consumption and sources of eggs by household and season

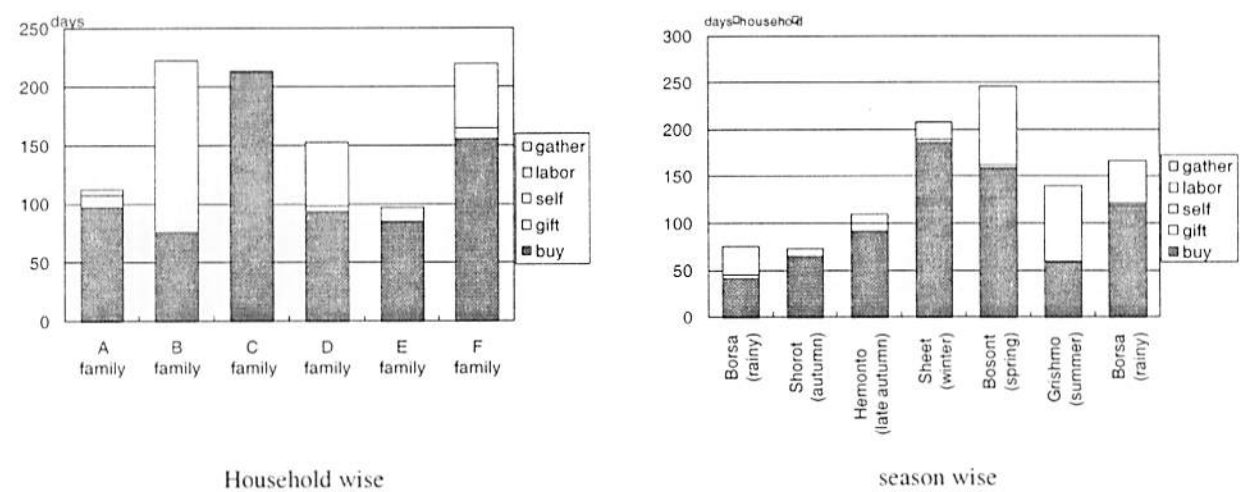


Fig. 11. Consumption and sources of fruit vegetables by household and season

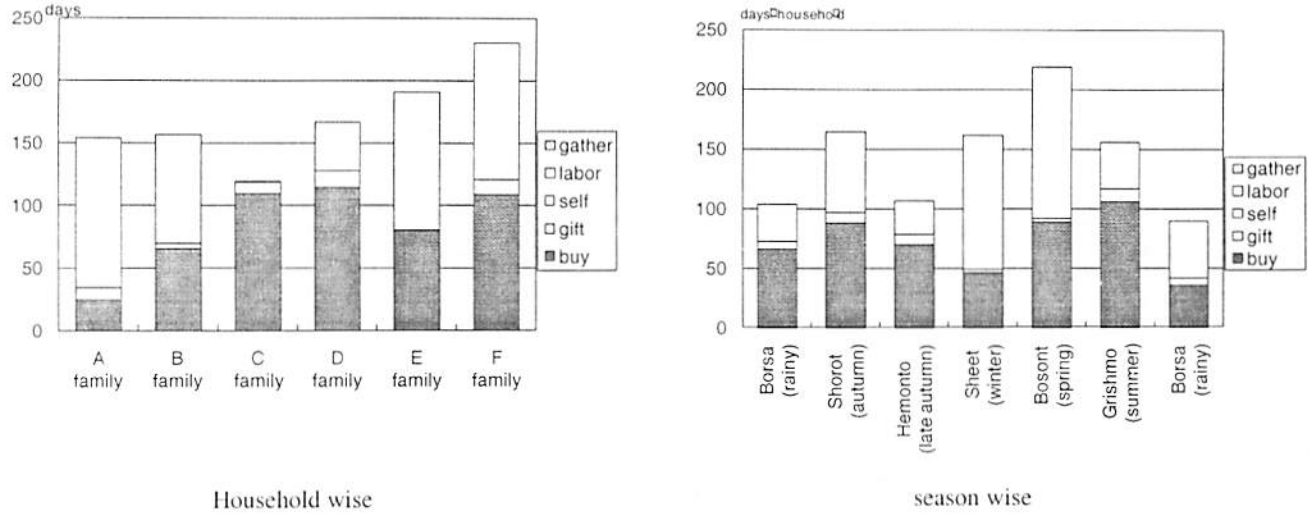


Fig. 12. Consumption and sources of climbing fruit vegetables by household and season

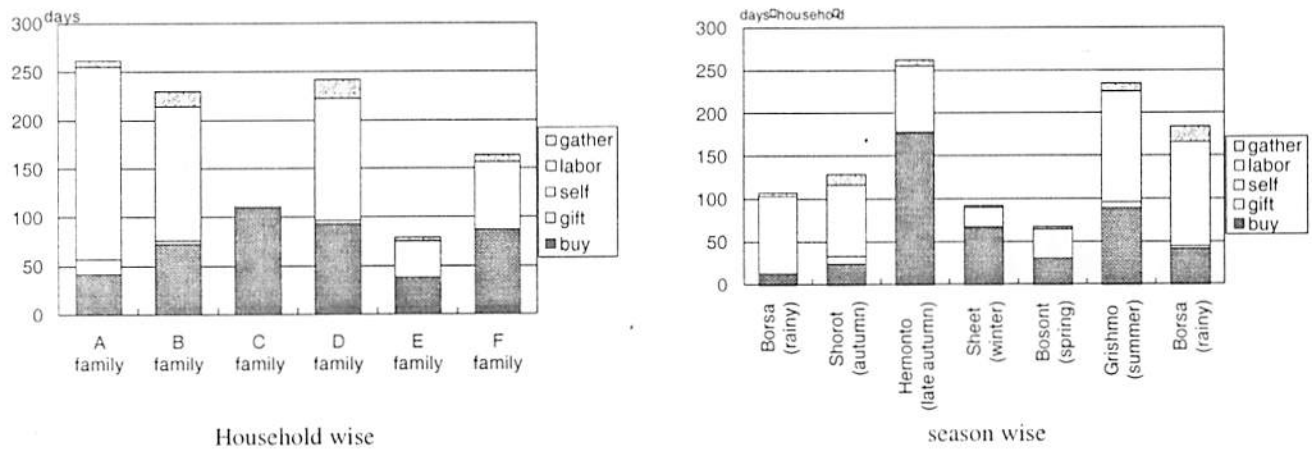


Fig. 13. Consumption and sources of leafy vegetables by household and season

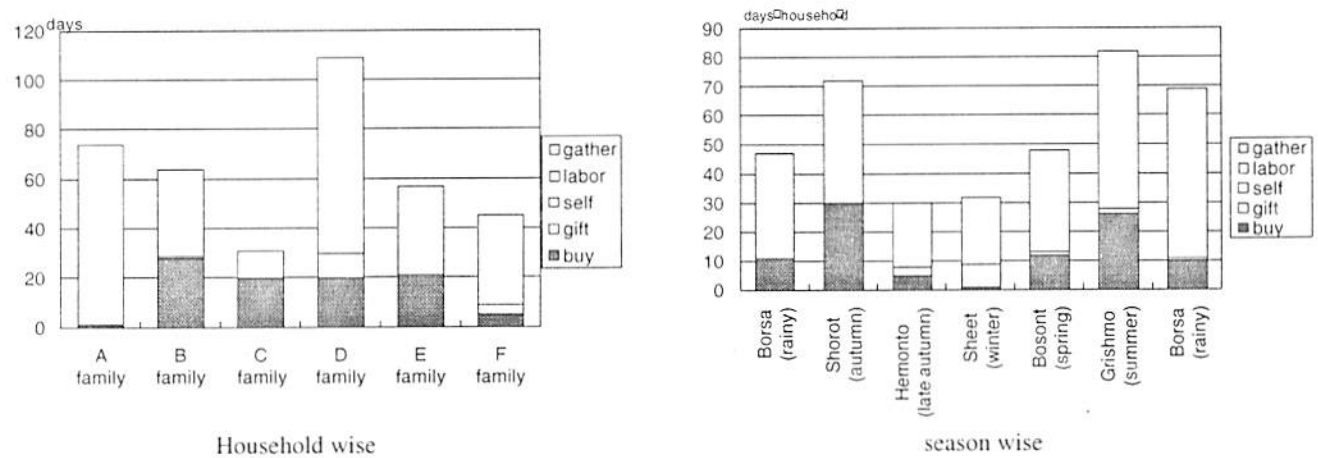
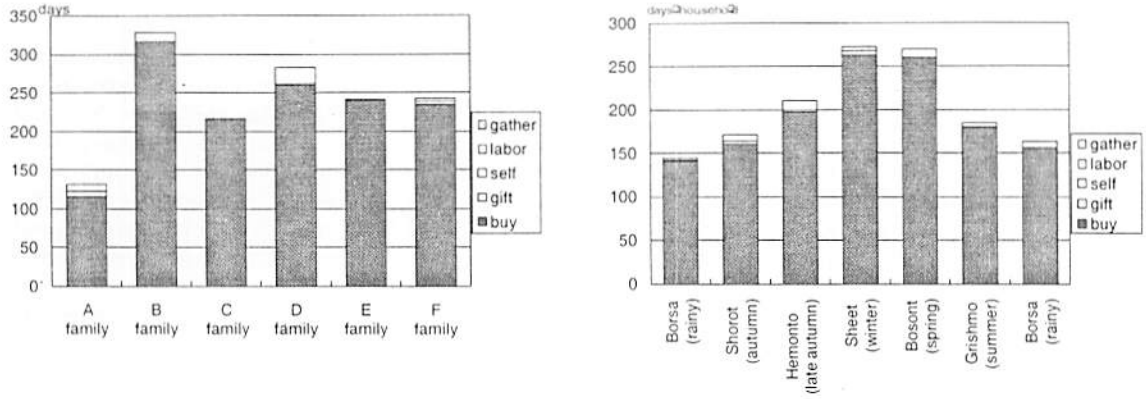
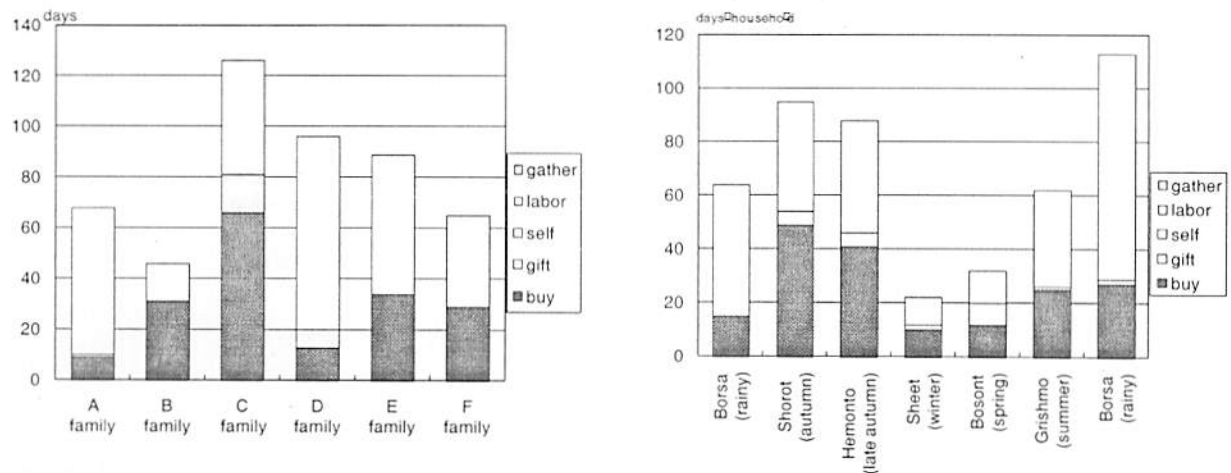


Fig. 14. Consumption and sources of climbing leafy vegetables by household and season



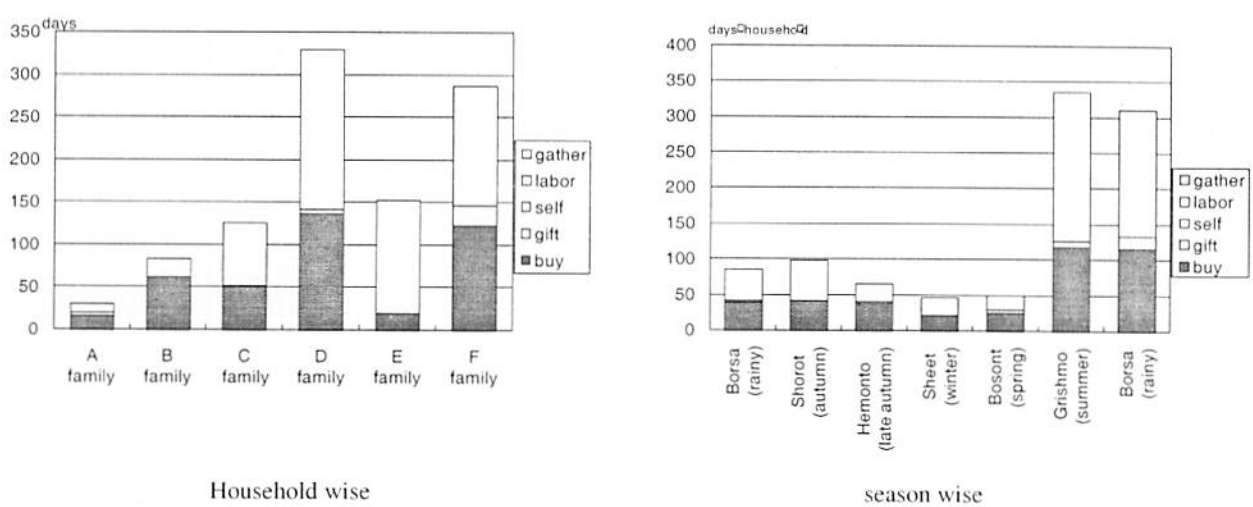
Household wise season wise

Fig. 15. Consumption and sources of tuber and root vegetables by household and season



Household wise season wise

Fig. 16. Consumption and sources of tree vegetables by household and season



Household wise season wise

Fig. 17. Consumption and sources of domestic fruits by household and season

Discussion

Seasonal changes: Fish, meat, eggs, milk were consumed as the important sources of protein, raw fish being the major item. In addition to cultured fish, wild fish were caught at natural *beel* (swamp). The supply of raw fish decreased in the dry season, and dried fish and meat were eaten instead. Eggs were also consumed rather than sold to supplement the diet. Milk was also a stable source of protein intake, but it became more common to purchase milk than to raise cows, which means regular cash disbursement. Homestead functioned as an important production base of vegetables when the vegetable supply from the fields was not enough especially during the rainy season. Climbing vegetables were usually grown in homesteads, but due to limited space, many of them were now being grown around the ponds created for commercial fish culture. Wild vegetables were also widely gathered for consumption.

Differences among households and their socio-economic implication: There were great variations among households which were explained in terms of the production conditions (including availability of labor force), economic constraints, and food preferences. Use of foodstuff was rationally influenced by the household production. Those who owned a fish pond or vegetable garden, raises cows and ducks, eat what they harvested. Though small in scale, family A family grew sweet potatoes (not for the root but for the vine as leafy vegetables), taros, and turmeric which supplemented their daily diet. Family labor force was another factor. Family B often enjoyed natural fish from *beel* (swamp) thanks to enough manpower they had (the household head and his boys were often available to go fishing). Family D also had a grown-up boy who could go fishing to *beel*.

Household members' taste also influenced on what they ate. Members of family D loved fruits, and grew various fruit trees on their homestead for seasonal delicacies. Wild fish and vegetables have unique tastes, and wild fish species require special recipes.

For families with not enough resources such as A and B, gathering wild foodstuff from local commons such as natural swamps and fallow fields was to secure necessary resources, and privatization of such open-access commons has negative impact on them.

Social networks also played an important role for foodstuff provision. Gift-giving extended to non-relatives, which indicates the existence of mutual support among neighbors. It should be noted that one of the few items given to neighbors was cultured fish. Commercial fish culture was expanding in the village, the occupancy rate of ponds to village area doubled between 1986 and 2005 (3.3% in 1986, and 5.6% in 2005). Commercial fish ponds created jobs for the villagers including petty ones such as night watch, for which fish was often given as pay. In the existing social context, commercial fish ponds operated by villagers seemed to distribute the profit to the villagers to some extent. However, privatization of local water body is causing problems nationwide as mentioned earlier. More detail and careful examination of their positive and negative impacts on the locality and environment is needed.

Food security of households was affected not only by individual factors such as production condition (space limitation of the homestead), labor force, cash income, and taste of the household members, but also by local factors such as local commons, changes in the local agricultural system, and social relations among relatives and neighbors. For the improvement of one's nutrition, broad and integrated consideration is required.

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Local management of forested wetlands in tropical Asia

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Sustainable management of forested wetlands was the main concern of session 3. Taking the cases in Samut Songkram Province, Yasothon Province and Chanthaburi Province of Thailand, how it was possible to reverse forested wetland degradation and how sustainable management emerged at those study sites will be discussed. In tropical Asia, forested wetlands can be divided into (1) floodplain forests, (2) swamp forests and (3) mangrove forests.

Floodplain forests (freshwater periodic swamp forests) are found in areas with periodically wet conditions. Extensive floodplain forests are thought to have once existed in the alluvial plains of Asia, but little remains of them today as most have been cleared away to make room for paddy fields. The tropical Asian landscapes of paddy fields have been transformed from what were originally floodplain forests. Only in select places such as the Kaing land of Myanmar is it still possible today to observe the prototypical use of floodplain forests in agriculture. Comparison with the Kaing land case helps in understanding local resource use in the Lam Se Bai, a tributary of the Chi River in Yasothon Province.

Peat swamp forests and freshwater swamp forests are found on permanently wet inland elevations. The presence of highly productive forests in the humid environment led to the deposition of peat on the ground surface. On the coasts of east Sumatra, Malaya and Borneo, peat swamp forest is most fully developed over marine alluvium. Large areas of freshwater swamp forests are to be found in Laos and Cambodia, and also offer interesting points of comparison with the case of Yasothon Province.

Mangrove forests are found in coastal areas and have acted as an important source of firewood, charcoal and tanning materials. In 1962, Pendleton reported as follows;

'Trees of the mangrove swamps have a variety of important uses. Tanning materials and red dyes are extracted from the bark of some mangroves. The wood is used as timber for marine purposes and for the manufacture of fishing structures in the Gulf, and a high-grade charcoal is made from it. Mangrove charcoal is especially prized for use in internally heated laundry irons, since the charcoal burns steadily and is not inclined to send off sparks as does other wood charcoal. It commands about twice the price of ordinary wood charcoal in the Bangkok market. Considerable quantities are exported.

Along the west side of the Peninsula, where mangrove fringes almost the entire coastline, the trees are cut and the bark is stripped during the off-agricultural season. Large brick charcoal kilns are worked here. These kilns are certainly of Chinese origin, and Chinese merchants control most of the trade. Mangrove firewood is used in tin mines and in the boilers of tin dredgers. The mangrove bark is taken in bundles by coastwise boats to Penang, Malaya; other craft ship charcoal in large open woven baskets to Penang and other coastal points.' (Pendleton 1962:222-223)

Thus mangroves were an important source of firewood and charcoal for local people's kitchens in the fuel-poor delta. The case of four villages in Yeesarn Sub-district, Samut Songkram Province provides a good example of the endogenous development of local mangrove forest management for charcoal-making. Aksornkoae et al. (1992) reported that the villages were established before 1932 and were declared legal in 1973 after the issuing of land ownership certificates. During 1943-1944, the Royal Forest Department surveyed this area to find that the plantations of *Rhizophera apiculata* had been established by local villagers. The government recognized this type of land use as agricultural land use and offered certificates of land ownership in 1955 and again in 1961 and 1973. At the present time, most of the land is privately owned.

An inventory estimated that the private mangrove (*Rhizophera apiculata*) plantation in Yeesarn Sub-district was about 2560 ha in 1987. It decreased to 1694 ha in 1990 due to conversion of mangrove plantation area into shrimp ponds. In 2006, there were 1315 ha of mangrove (*Rhizophera apiculata*) plantation and another 37 ha of natural mangrove forest. This total of 1352 ha of mangrove area constituted 22.2 % of the total area of Yeesarn Sub-district (Hassan 2006).

The case of Yeesarn Sub-district teaches us the dual function of privatization. Private ownership of mangrove forest ensured the sustainable production of charcoal from the *Rhizophera apiculata* plantation. At the same time, private ownership itself has no means of controlling strong economic incentives to convert mangrove areas to shrimp farming. Further studies will be done by Vipak Jintana and his research team.

Areas with mangrove forests have also acted as centers for salt production. In the old days, shrimp was a byproduct of salt pens. Since the late 1940s, when salt prices declined, local people began to engage in shrimp farming. In this early era, shrimp farms relied solely on natural larvae of *Peneaus merguiensis* and feed abundance. Stocking density of *Peneaus merguiensis* was less than 1/m2 at that time.

Penaeus monodon was originally harvested together with other shrimp species from traditional trapping-growing ponds. In Thailand, extensive and semi-intensive farms were commercially established in 1972 and 1974 respectively, after the first success in breeding *Penaeus monodon* at Phuket Fisheries Station in 1972. The stocking density of *Penaeus monodon* was 2-5/m2 in extensive and semi-intensive farms.

From the 1980s, an intensive shrimp farming system was introduced. It is believed that a viral disease outbreak caused the collapse of the shrimp exports from Taiwan to Japan in 1987-1988. This led Thailand, encouraged by extremely high prices in the Japanese market due to supply

shortages, to replace Taiwan as the world's leading producer of farm-raised *P. monodon* in 1988. High profitability of this activity fuelled a rapid spread of shrimp farming into mangrove forests along the Gulf of Thailand. In the 1990s, shrimp farming areas began to decline in number due to outbreaks of shrimp disease (FAO. 2006-2010).

Penaeus vannamei was introduced into Asia in the 1990s (Briggs et al. 2004). In the 2000s, commercial production of *Penaeus vannamei* overtook the production of P. *monodon* in China, Taiwan and Thailand due to a number of favorable factors. Thailand freely permits the commercial culture of *Penaeus vannamei*, but has official restrictions due to fears over importation of exotic diseases, and thus only SPF (Specific Pathogen Free) broodstock may be imported.

In the reviews of global production of farmed fish, Naylor et al. (2004) defined the stages of aquaculture as follows.

'Two key criteria, ownership of stock and deliberate intervention in the production cycle (husbandry), distinguish aquaculture from capture fisheries. Fish farming typically involves the enclosure of fish in a secure system under conditions in which they can thrive. Interventions in fish life cycles range from exclusion of predators and control of competitors (extensive aquaculture) to enhancement of food supply (semi-intensive) to the provision of all nutritional requirements (intensive). Intensification implies increasing the density of individuals, which requires greater use and management of inputs, greater generation of waste products and increased potential for the spread of pathogens.'

In Thailand nowadays, shrimp farming systems have diverged into two groups: 'natural systems' (i.e. extensive aquaculture) and 'developed systems' (i.e. intensive).

Aside from these types of shrimp farming, the Welu Wetland of Chantaburi has also attracted visitors through ecotourism based around its mangrove fireflies, a successful case of local mangrove management. Taking the case of Wele Wetland, Sommai Suppakun shows the importance of community participation for mangrove forest management in Mangrove Forest Resource Development Station No.2 (The Sorn, Chantaburi Province) of DMCR (Department of Marine and Coastal Resources). In contrast to the case of Yeesarn Sub-district (Samut Songkram Province), the whole area of Wele Wetland is national reserved forest, and the people living there have no land title at all.

The situation in Wele Wetland is common among the mangrove forests in Thailand. Sudtongkon and Webb (2008) noted the state management of mangrove forest and its failure as follows.

'In Thailand, mangrove forests are claimed and managed by the state (Aksornkoae 2004). The central government centralized and monopolized the control and management of natural resources together with the process of territorialization. Subsequently, mangroves were put under strict control by the state agencies, and settlement or forest utilization by local people in mangrove conservation zones is prohibited (Aksornkoae 2004). Early assessments of coastal management policy for Thailand failed to recognize the potential of communities in the process. State mangrove forest management can occur without the participation of local people, which not surprisingly has declined since the government claimed control and management of natural resources.'

If mangrove forests are owned and managed by the state, communities have limited or no rights of access. However, even under the 'exclusive' state management, coastal communities do access and manage mangrove forests. In their case study of mangrove forests under two management systems, i.e. state management and community management, Sudtongkon and Webb (2008) illustrate successful mangrove conservation and management in coastal villages in Trang Province, southern Thailand. They pointed out that 'the basis for the success in forest management was that the resource was necessary to local livelihoods and was becoming scarce; the communities enjoyed autonomous decision making and had a high degree of social capital; the forest and user groups were well defined and monitored; effective leadership was present in the villages to apply sanctions and resolve conflicts; and there was substantial assistance from an external non-governmental organization, which served as a bridge between the villages and the government' (Sudtongkon and Webb 2008).

Although the cases of Trang Province and Wele Wetland share many common features, we can find some differences. For example, 'resource scarcity' was not the driving force for the recent recovery of the mangrove forest and its conservation in Wele Wetland. After the collapse of the shrimp farming, caused by a viral disease outbreak in the 1990s, many villagers gave up shrimp farming, reduced their farm size and returned to extensive aquaculture. Those changes made room for reforestation in areas that had been disturbed by shrimp farming.

In the past several decades, mangrove forest areas have been rapidly destroyed and/or degraded in Thailand. Among the many reasons for this, land use conversion for aquaculture, agriculture and mining have been the main factors in recent years. In our research project, anthropogenic disturbances and local management of mangrove forests will be studied holistically and compared with other cases (e.g. Walters 2000, 2003, 2004, and 2005). Local uses of plant resources, including medicinal plants in mangrove and beach forests, will also be studied.

At study sites, field interviews and remote sensing methods will be used to analyze the past and present status of land cover and land use, analyze the natural environment, and investigate changes in these elements. We will begin our field research work on mapping land cover and land use changes using available aerial photographs, satellite images and geographical information system (GIS) data, combined with field observation and interviews documenting experiences from the local management of forested wetlands.

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Monsoon rainfall and rice cultivation in the Brahmaputra floodplain -A village study in Assam, India

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Abstract: Monsoon rainfall variations along with river water of the Brahmaputra have historically caused floods, and even droughts on rice cultivation in Assam. Assam state government tried to control water by engineering approach such as constructing embankments and irrigation canals, but the efforts have not always become successful. Therefore, an alternative approach should be considered to cope with changing hydrological environment in the Brahmaputra floodplain. This study examined rainfall variation, hydrological condition of the paddy fields and their influences on rice cultivation through intensive village survey. Field work was carried out in the study village in eastern Assam during June to November in 2009. It was found that water level of paddy fields in the study village was highly influenced by intra-seasonal variation of monsoon rainfall. Both rice cultivated area, transplant date and rice yield were affected by monsoon rainfall, but households who grow more local varieties and own both high land and low land were less affected by the drought. It can be concluded that farmers' indigenous knowledge is effective to some extent to mitigate the influence of rainfall variation on rice cultivation, and therefore, more studies are necessary to investigate the indigenous knowledge and traditional technologies of different ethnic groups in Assam.

Key words: Monsoon, rice cultivation, Brahmaputra, floodplain, Assam

Introduction

Northeast India is well known as one of the rainy places in monsoon Asia. In Meghalaya, there are wettest places on the earth, Cherrapunji (26,461 mm during August 1860 to July 1861) and Mawsinram (26,000 mm in 1985) (Murata *et al.*, 2007). Southwest monsoon comes from the Bay of Bengal during summer season and orography effect of Meghalaya plateau causes abundant rainfall in the region. Also in Assam, the amount of annual rainfall exceeds 3000 mm at many places of the state. Under humid environment with abundant monsoon rainfall and floodwater of the river Brahmaputra, rain-fed rice cultivation is traditionally conducted here. Monsoon rainfall shows variable characteristics on the scales of inter-annual and intra-seasonal. Inter-annual variation of monsoon rainfall means floods occur in abundant rainfall years and droughts occur in scarce rainfall years. Intra-seasonal variation means rainfall amount and rainfall period are irregular during rainy season, and not only floods but even droughts can occur during the season.

Floods are the biggest problem for rice cultivation in Assam, where about 2/3 of total population in Assam are engaged in agriculture directly or indirectly, and about 45 % of net state domestic products come from this sector (Daimari, 2008). About 10 % of total state area is affected by floods every year, and more than 50 % of state area was affected by floods in 1988 which was the worst in the twentieth century (Bora, 2003). As rice is grown in flood season and occupies about 70 % of the total crop area in Assam, floods influence on rice cultivation is not negligible.

Along with flood problems, droughts emerged to be another problem for rice cultivation in Assam recently. As most of the paddy fields in Assam are rain-fed and have no irrigation system, rainfall shortage during growing period can result to yield loss. In 2006, rice yield dropped largely (82 % of the previous year) all over Assam after poor rainfall during rainy season. Such a large scale drought was quite rare in Assam before, but drought damage on rice yield is increasing after 2000.

In order to control floods and droughts and make rice production stable, Assam state government has adopted engineering approach such as constructing of embankments or irrigation canals. These attempts, however, have not always succeeded, but flood affected area is rather increasing due to poor drainage and river bed rise (Agarwal and Narain, 1991). Irrigated area is still less than 5 % of total paddy fields in spite of efforts for expanding irrigation facilities. Therefore, it is necessary to adopt new approach for agricultural development to mitigate the influence of meteorological hazards on rice cultivation.

Keeping above points in mind, this study reveals the relationship between monsoon rainfall and rice cultivation in the Brahmaputra floodplain through intensive village survey, and consider new approach to cope with rainfall variation. Fieldwork was carried out in the study village from June to November in 2009.

Materials and Methods

Location of the study village: The study village (Rangpuriya Gaon) is in Lakhimpur district of eastern Assam, and located in northern bank of the Brahmaputra (Fig. 1). In the Brahmaputra valley, floods occur more frequently in northern bank than in southern bank (Bora 2003). Rainfall amount is higher in northern bank, and the tributaries from northern mountainous area have larger slope carrying more sediments. Gravel sediments from the Himalayas form sandy soil of northern bank. Flash floods tend to occur here after heavy rainfall.

Landform around the study village is created by numerous small and big rivers which come from mountains in Arunachal Pradesh (Fig. 2). The study village is located in the floodplains between the Subansiri and the Ranganadi, which consist of natural levee and back swamp. As the embankment was constructed along the right bank of the Subansiri, river water does not enter the village and water required for rice cultivation solely depends on rainfall.

Rice cropping system in the village: There are three kinds of rice in the village with different growing periods and ecological settings; Ahu rice (growing period is from March to June), Bao rice (March to December) and Sali

Fig. 1. Study area

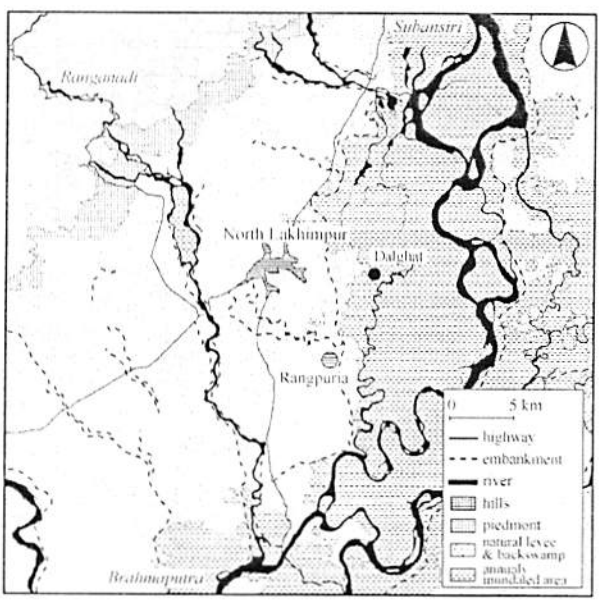

Fig. 2. Land classification around the study village
Source: 1:50000 topo-sheet published from Survey of India in 1971

rice (July to November). Ahu rice is broadcasted in cultivated paddy fields and grown in a drier condition with relatively less pre-monsoon rainfall. Bao rice is a deepwater rice or floating rice which is broadcasted in the lowest land in the village. Sali rice is first grown in seedbed and then transplanted in paddy field with the arrival of monsoon rainfall. Only local varieties are grown for Ahu rice and Bao rice, but for Sali rice, HYVs (High Yielding Variety) are grown along with local varieties.

In the village, back swamp and old river channels are used for paddy fields while natural levee are used for roads or homestead lands. The elevation of paddy fields is not flat but gently sloping and water can stay for a longer time in the lower part. Paddy fields are broadly classified into two categories by villages; low land (*Dha mati*) and high land (*Bam mati*). Low land is regarded as more suitable for rice cultivation with abundant water and fertile soil, but vulnerable to water inundation. High land is free from water inundation, but has risk of water shortage. Many households own both low land and high land to disperse the risk of floods and droughts and traditionally grow many local varieties to suit for different hydrological conditions from low land to high land (Asada, 2011).

Results and Discussion

Monsoon rainfall variation: Fig. 3 shows daily rainfall at North Lakhimpur which is located 10 km away from the study village. 30-year average data shows that normally pre-monsoon rainfall starts in March and it continues till May. Monsoon starts in late May, and ends in early October. Rainfall is little in the dry season from November to February.

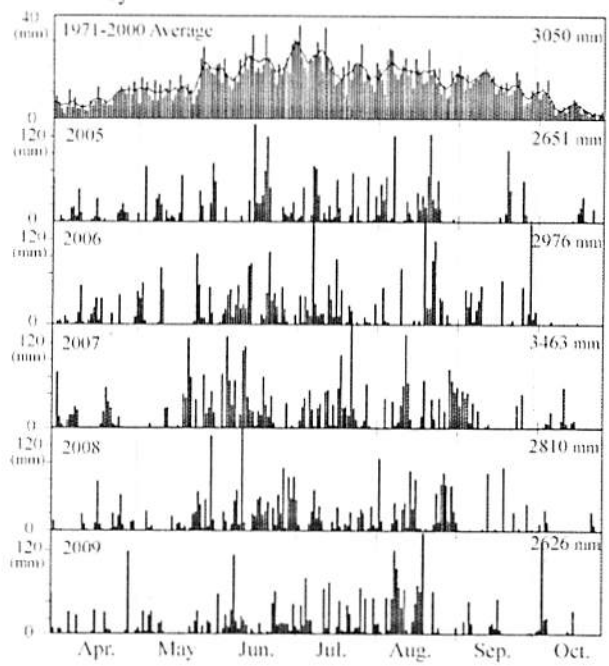

Fig. 3. Daily rainfall during rainy season at North Lakhimpur
Source: Indian Meteorological Department (IMD) at Guwahati

However, it does not rain continuously from the beginning to the end of monsoon season, and intra-seasonal variation of rainfall is very large in each year. Significant features of intra-seasonal variation are as follows. (1) Onset date of monsoon is not same, but varies by year. Monsoon started in mid-May in 2007 and 2008, but it started in mid-June in 2009. (2) Peak season of rainfall differs by years. Normally peak season of daily rainfall is from late June to late July, but it is mid-June and late August in 2005, late May to mid-June in 2007, late June in 2008, early to mid-August in 2009. (3) There exist both high rainfall period

and low rainfall period during monsoon season, which is called active-break cycle of monsoon rainfall. This phenomenon is caused by periodical change of convective activity of monsoon over the Bay of Bengal (Dhar and Nandargi, 2000). For example, active periods in 2007 were seen in late May to mid-June, early to mid-July, early August and early September with periodicity of 20 to 30 days.

Rainfall at North Lakhimpur in 2009 is first characterized as less rainfall in April and May and late onset of monsoon. In the active periods of early June and late June to early July, daily rainfall exceeded more than 10 mm, but after mid-July, rainfall again stopped. Peak season of daily rainfall was mid-August which was much later than normal years. After late August, no rainfall days again continued. Rainfall was little in the latter part of rainy season, and the total amount of rainfall from May to September was only 85 % of normal year.

Hydrological environment in the paddy field: Then, water level in the paddy fields was investigated in order to know how intra-seasonal variation of rainfall affects hydrological condition in paddy field (Fig. 4). From the field observation, it was found that low lands (IV) were inundated throughout the rainy season, and recorded highest water level of 80 cm in mid-August. In high lands (I), inundation started in late June, and did not exceed more than 10 cm. Water in high fields dried up when rainfall stopped in break period of monsoon.

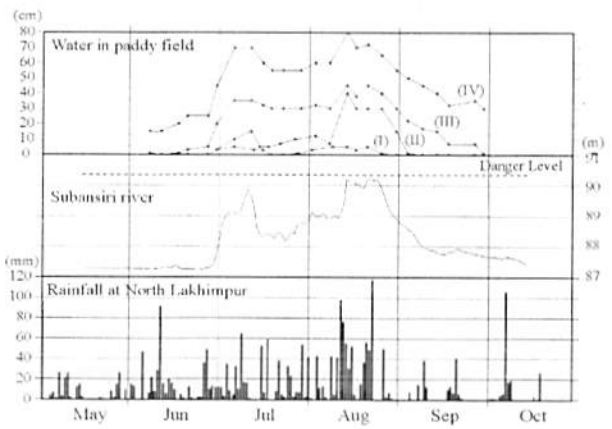

Fig. 4. Water level in paddy fields, water level of the Subansiri (at Dalghat) and daily rainfall (at North Lakhimpur) in 2009

Source: Field survey, Department of Water Resource Management, IMD

Note: Observation point (i)-(iv) are described in Fig. 5 (a).

Water level in paddy fields reached its peak twice in early July and mid-August. The peak timings almost coincide with the peak of water level in the Subansiri and active periods of monsoon rainfall. However, variation of water level in paddy fields does not fully correspond to rainfall variation. Monsoon rainfall became active in early June, but water level in paddy fields did not rise at the same period. Water level in the Subansiri also remained low in early June. Therefore, it can be said that along with rainfall variation, variation of underground water which is linked to river water variation determines the water level in paddy fields. In early period of rainy season, river water level remained low and water level in paddy fields did not rise even monsoon rainfall became active. Only when underground water level went near surface with the rise of river water level after July, rainfall could stay in paddy fields.

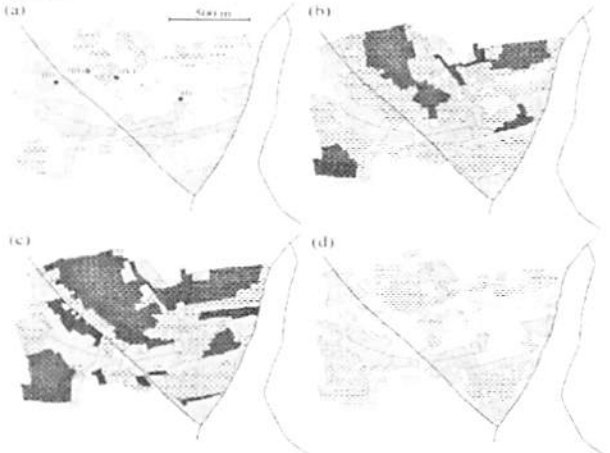

Fig. 5. Inundation area of paddy fields in the village (a) 25 Jun, (b) 15 Jul, (c) 5 Aug, (d) 15 Sep 2009.

Note: Dark color indicates higher water level

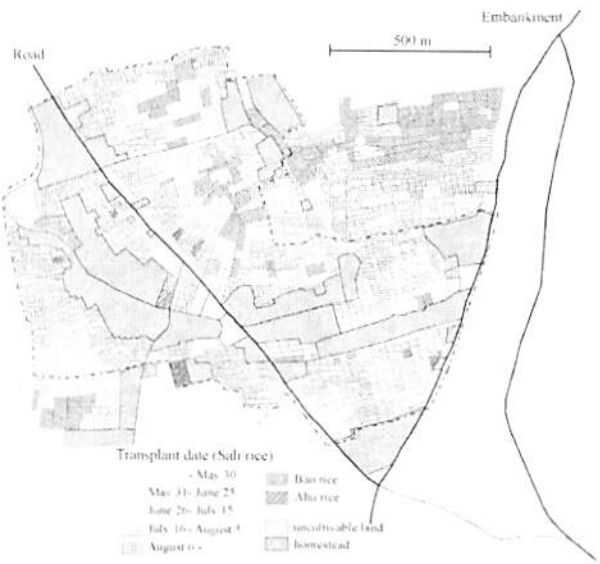

Fig. 6. Rice cultivated area and transplant date of Sali rice in 2009

Paddy fields in the village are divided by natural levee, and were first inundated by rain water in the lowest part of each paddy field (Fig. 5a). Only a part of low lands was inundated in late June. Water inundated in high lands after rainfall occurred, but soon dried up. Almost all paddy fields except for highest lands were inundated by mid-July (Fig. 5b). Water level did not exceed to ridge height in high lands, but water could move freely above ridges in low lands. At the peak period of water level in paddy

fields in early August, all lands were inundated except for roads, homestead lands and a few plots of high lands (Fig. 5c). Once monsoon entered break period and rainfall stopped, water level in paddy fields rapidly declined and water level became 0 cm in many parts of high lands (Fig. 5d). The soil texture of this area which is sandy with good drainage may contribute to rapid rise and drop of water level in paddy fields.

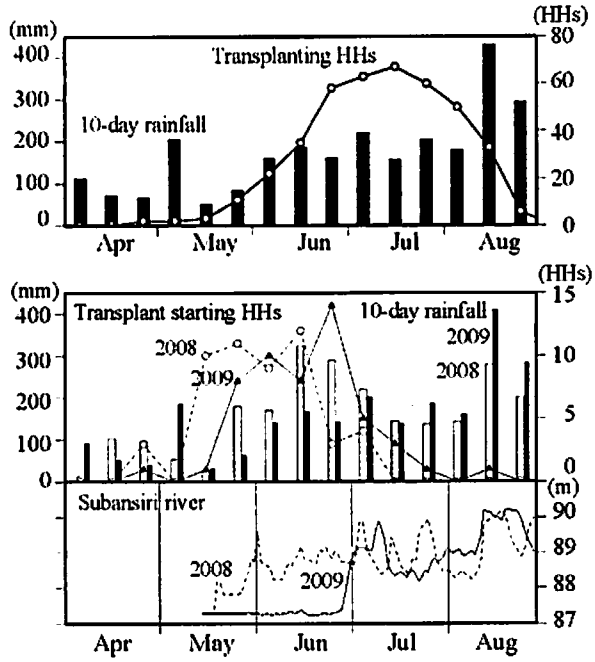

Fig. 7. Transplant date and rainfall (a) transplant date and pentad rainfall in 2009, (b) transplant starting date, pentad rainfall and water level of the Subansiri in 2008 and 2009.

Influence on rice cultivation: In this section, it was investigated that how variation of hydrological environment affected rice cultivation in the village. First, cultivated area of Ahu, Bao and Sali rice in 2009 was investigated to compare with inundation area in the paddy fields (Fig. 6). Bao rice is cultivated in 44 plots of the lowest part of paddy fields, and Ahu rice is cultivated in 17 plots of high lands near homestead land. Sali rice is transplanted in paddy fields from low lands to high lands, and the cultivated area (1280 plots) is much larger than Bao and Ahu rice. Sali rice is transplanted from lower lands in June to higher lands in August in accordance with water level rise. 14 plots of high lands were left untransplanted because of no inundation in these plots.

In 2009, one household started transplanting on 23rd April, but many households started late May when rainfall gradually increased (Fig. 7a). Most paddy fields were not inundated at this period, however, and only some households who own low lands could start transplanting. After late June when water level in paddy fields increased, number of households transplanting Sali rice increased and it reached peak in mid-July. It was just after water level in paddy fields reached its first peak. All transplanting operation had completed before 27th August. It took about four months from start to end transplanting in the village.

Starting date of transplanting in each household in 2008 was about 10 days earlier compared to 2009 (Fig. 7b). While many households started transplanting in late May in 2009, many households started in mid-May in 2008. Water level in the Subansiri started to rise in late May in 2008, although it remained low till late June in 2009. It is estimated that water level in paddy fields also increased earlier in 2008 than 2009 along with earlier rise of river water level. Peak of starting date of transplanting in 2008 was mid-June, and all households started transplanting by early July at latest.

Table 1. Number of rice varieties and yield in 2008 and 2009 (a) households classification by land area, (b) by land height

(a)

Land class		Average No. of variety in 2008				Average No. of variety in 2009				Yield (kg ha)		Yield change 2009/2008 (%)
Area (ha)	HHs	Sali (local)	Sali (HYV)	Ahu	Bao	Sali (local)	Sali (HYV)	Ahu	Bao	2008	2009	
0 - 0.5	23	2.8	1.1	0.0	0.2	2.6	2.1	0.1	0.1	3031	2804	95
0.5 - 1	40	3.4	1.7	0.2	0.3	3.3	2.4	0.1	0.3	2591	2674	106
1 - 1.5	12	2.4	2.3	0.1	0.3	3.2	2.4	0.1	0.4	2021	1927	95
1.5 - 2	5	5.0	2.6	0.8	0.0	4.0	2.2	0.0	0.0	2744	2287	91
2 -	3	5.0	1.7	0.0	0.3	5.7	3.3	0.0	0.3	3572	2896	83
Total	83	3.2	1.7	0.1	0.2	3.2	2.3	0.1	0.2	2658	2593	

(b)

Land class		Average No. of variety in 2008				Average No. of variety in 2009				Yield (kg ha)		Yield change 2009/2008 (%)
Height	HHs	Sali (local)	Sali (HYV)	Ahu	Bao	Sali (local)	Sali (HYV)	Ahu	Bao	2008	2009	
High	23	3.2	1.3	0.1	0.1	3.0	2.3	0.2	0.1	1970	1816	94
High-Low	27	3.6	1.8	0.2	0.3	3.8	2.8	0.1	0.3	2474	2423	98
Low	21	2.7	1.7	0.0	0.2	3.0	1.9	0.0	0.2	3043	3112	111

Table 2. Income source of selected households in 2008

Income source	Farmer with other job (N=10)			Full time farmer (N=10)		
	No. of HHs (%)	Average income (Rs.)	Percentage of total income (%)	No. of HHs (%)	Average income (Rs.)	Percentage of total income (%)
Paddy sell	6 (60)	4150	4	7 (70)	7229	31
Vegetable sell	6 (60)	4854	10	10 (100)	10370	35
Animal sell	8 (80)	4988	7	10 (100)	4262	20
Fish sell	0 (0)	0	0	3 (30)	3333	20
Animal products	5 (50)	2600	4	7 (70)	5729	16
Cottage work	2 (20)	2500	3	3 (30)	5833	15
Wage labour	0 (0)	0	0	1 (10)	2500	17
Business	5 (50)	37650	56	0 (0)	0	0
Salary	5 (50)	151200	93	0 (0)	0	0
Pension	3 (30)	88900	31	0 (0)	0	0
Other	1 (10)	7000	2	0 (0)	0	0
Total income		132288	100		26702	100
Income source per HH		4.1			4.1	

The rainfall amount was less and rainy days were irregular in 2009 compared to normal years. It can be supposed that not only transplanting date but also rice yield was also affected by rainfall scarcity. So, rice yield of each household in 2009 was investigated (Table 1a). All household classes show yield decrease in 2009 except for household class who own 0.5 – 1.0 ha land, which means land size is not necessarily important for mitigating influence of rainfall variation. Also number of HYVs grown in each household has no relation with yield change. When rice yield of each household was examined by classification of land height (Table 1b), rice yield in 2009 of households who own more low land increased while rice yield of households who own more high land decreased. In case of households who own both high land and low land, rice yield in 2009 was almost same with yield in 2008. It means that influence of rainfall variation is not same for all households in the village, but it depends on ecological conditions of paddy fields owned by each household. Therefore, many villagers traditionally own both high land and low land of paddy fields to avoid the risk of either floods or droughts.

Finally, income survey was conducted in 20 sample households in the village to know how farmers compensate rice yield loss in abnormal monsoon years (Table 2). It is revealed that 70 % of farm households and 60 % of households with other business sold rice, respectively. Many households sell rice but the ratio of income from selling rice in total income is not large; 31% in farm households and 4 % in households with other business. All households have income sources other than selling rice, and vegetable cropping is more important in terms of earning cash than rice cropping.

Conclusion

Rice cultivation in the study village is affected by intra-seasonal variation of monsoon rainfall in terms of cultivated area, transplanting date and yield. Along with rainfall, soil texture and topography of floodplain are also related with the rice cropping pattern as these factors determine water level in each plot of paddy fields. During 2009 monsoon season, not only rainfall amount was less but also onset of monsoon season was later than normal years which caused drought effect on rice yield. However, not all households were equally affected by rainfall variation, but households who own more high lands showed more drought effect, which means physical environment of paddy fields determined the extent of drought.

To cope with variation of hydrological environment in paddy fields, villagers have traditionally developed rice-based cropping system which includes landholding pattern and selection of various local varieties. Also their farming system combining rice cropping with vegetable cropping and livestock can mitigate influence of environmental hazards in terms of cash income. These are kinds of indigenous knowledge of environmental adaptive strategy and still effective in the study village.

Assam state government have tried to control water by engineering approach and almost ignored indigenous knowledge of local farmers. From this study, however, it was found that hydrological condition in paddy fields of the Brahmaputra floodplain is highly influenced by rainfall variation and farmers' indigenous knowledge is effective to a certain extent to mitigate the influence of rainfall variation on rice cultivation. More case studies should be carried to investigate indigenous knowledge and traditional technologies of different ethnic groups in Assam.

Acknowledgment: The author expresses sincere gratitude to Prof. A. K. Bhagabati, Gauhati University and Prof. K. Ando, Kyoto University for their support and guidance.

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Historical land development in Central and Eastern Himalayas

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Abstract: Environmental changes caused by human impacts in the Himalayas have caught the attention of conservationist, scientists, and administrators within the last 30 years. Particularly in Nepal, it has often been stated that deforestation (forest destruction by human impact) has accelerated during the latter half of 20th century because of population growth. In this study, dated charcoal and humus materials in soil, both of which are evidence of forest fires, and vegetation changes indicate past deforestation and agricultural land formation (paddy and dry fields) in the Eastern Himalayas. Around the Ziro, Lower Subansiri District, Arunachal Pradesh, North-East India, human impacts such as population growth and cultural changes, may have accelerated environmental and agricultural changes after *ca.* 2 ka BP. Relatively intense deforestation and agricultural land formation that occurred since *ca.* 1 ka BP were due to human impacts.

Key words: Buried humic soil layers, Hisitorical land development,, pollen analysis, radiocarbon age, Nepal, Arunachal Pradesh

Introduction

Environmental changes caused by human impact in the Himalayas have attracted the attention of conservationist, scientist, and administrators during the last 30 years. Particularly in Nepal, it has often been stated that deforestation (forest destruction by human impact) has been accelerated during the latter half of 20th century because of population growth. However, recent studies do not support above idea of deforestation and they claim that the area under forest has not changed significally during the past few decades (Ives and Messerli, 1989). Deforestation in Eastern Himalayan area is poorly understood except for that happened in the recent years, which is documented in historical records.

Soil studies are important ways for identifying the past environmental changes. Palaeosols such as buried soil, and charcoal fragments and fossil pollen in soil provide clear information on local palaeoenvironments. In the western and central Himalayas and Tibet, soil studies have been conducted to reconstruct the past environment. Caine *et al.* (1982) reported a podozonic paleosol near Namche Bazar (Nauje), eastern Nepal, which indicates mid-Holocene environmental changes. Saijo (1993) indicated evidence of forest fire in historical times in the Middle mountains, near Katmandu, central Nepal. Iwata (1994) observed many buried soil layers containing charcoal fragments in the south-eastern part of Tibet and eastern Nepal, and concluded that expansion of Tibet and immigration of Sherpa people caused this palaeosol formation. Saijo (1993) and Iwata (1994) emphasized that charcoal fragments in soil and buried humus layers are evidences of human factors contributing to forest destruction. Iwata *et al.* (1996), Miyamoto (1998) reported deforestation since the 3 ka yrs BP around the central Himalayas in Nepal.

In this paper, previous studies around the Nepal and India Himalayas areas are reviewed and datable charcoal and humus material in soil in Eastern Himalaya (Arunachal Pradesh) are reported at preliminary level.

Materials and Methods

Study area: The observation and sampling sites are situated in Ziro (Old Ziro) in Lower Subansiri district of Arunachal Pradesh, northeastern India (Fig.1) which is surrounded by mountains. The plain area of valley is utilized for wet rice cultivation. The slopes of adjacent hills in the vicinity of the wet rice-fields are used for rain fed agriculture which includes cultivation of maize, millet and variety of vegetables. This area is characterized by the cultivation of *Eleusine colacana* on the paddy field edge.

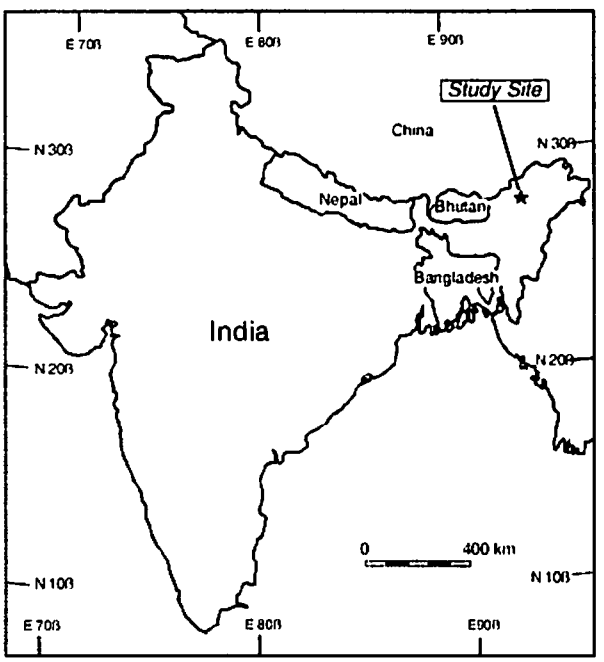

Fig. 1. The study site

Method: Soil profiles were observed at various exposures along paths and risers of the terraced fields and ridge of the paddy fields. Charcoal fragments and organic rich parts of soil were collected for radiocarbon (^{14}C) dating at

the exposed localities. Radiocarbon ages were obtained from charcoal fragments and humus soils taken from soil layers. From bulk humus soil, acid-insoluble humus mainly composed of humus acid and humin were extracted with the following physical and chemical analysis: Samples from which rootlets, worms, and gravels were removed, were boiled with 1N or 6N HCL for one hour in order to remove fresh organic materials. After the top clear solution was poured away, the residue (acid insoluble humus) was washed with distilled water. Measured ^{14}C ages calibrated using the calibration program OxCal ver. 3.10 (Bronk Ramsey, 2001).

Results and discussion

Buried humus soil layers, charcoal fragments and stump of paddy fields ridge (Fig. 2) show the columnar sections from which samples for radiocarbon dating were taken. This soil section represents

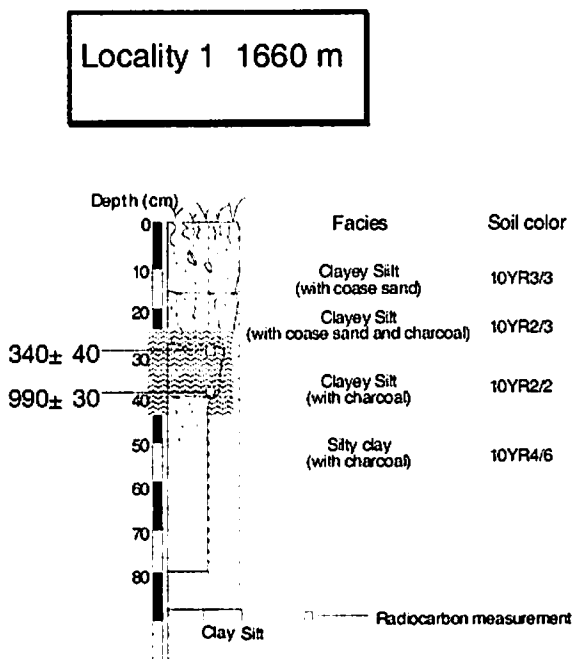

Fig. 2. Buried humic soil and radiocarbon age

typical site around Ziro area. In this area, relatively thin exposed layers (about less than 20 cm) were observed. Buried stump in paddy fields are distributed in many sites not only in Ziro area but in the surrounding areas also. Ridge of paddy fields built by human and buried stumps are detected under carbonized surface condition (Fig. 3). Stumps are suggesting not secondary sedimentation, because Ridges are repaired every year in dry season. However, the layer of detected stumps is not disturbed. The soil organics and buried stumps taken from buried humus soil layer and ridge of paddy field were dated: 340±40 (upper), 990±30 (lower), 2060±30 (stump).

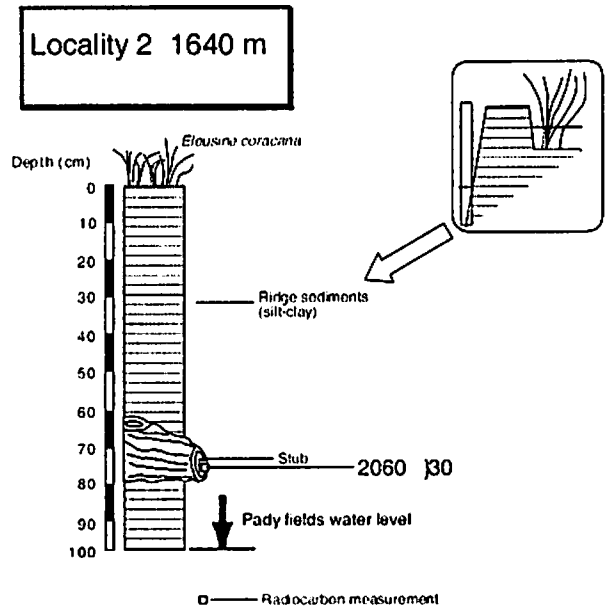

Fig. 3. Burried Stamp around Ziro.

It is reported that a fire appeared on many places from charcoal fragments being detected not only in buried humus layer but in the various horizons of the comparatively short dark-brown soil layer under the surface in Junbesi valley of the Nepal Himalayas (Iwata and Miyamoto, 1997). Moreover, the concentrating layer of the charcoal fragments is recognized even in the Arunachal Himalayas except for the buried humus layer which, indicates that a forest fire appeared in many places. The development by the bush fire of the forest aimed for pasturage was recognized after ca. 3700 y BP in the Nepal Himalayas (Miyamoto, 1998), but the buried humus layer of the Arunachal Himalayas indicates ca. 990 and ca. 340 y BP.

As for the eastern Himalayan (Arunachal Himalaya) area as well, this can be estimated that a similar development took place here also. As pointed out in the case of Nepal Himalayas, there is a possibility that a forest fire appeared in each age and area intermittently. There were a few forest fires which appeared naturally. But the possibility of the cause of the forest fire may be the human impact. So far the environment of Junbesi valley is concerned, it remains cloudy during monsoon (Tsuchiya, 1996). Equally, in the area which adjoins Arunachal has a high precipitation and occurrence of a forest fire due to the spontaneous combustion is difficult to accept.

The decrease in pollen and spore assemblages to the upper part from buried soil layer in Nepal area suggests a decreasing trend of forest cover from mainly in Quercus (Miyamoto, 1998; Fig. 4). This shows a tendency to be the same as that of the buried humus layer in Phaplu (2500 m) in eastern Nepal as reported by Iwata and Miyamoto (1996) and Iwata *et al.* (1996). Furthermore, the results obtained this time suggest that there was a definite change in vegetation in the formation process of the buried humus layer. Charcoal fragments are abundantly present in the buried humus layer, and the cause of this is the change in vegetation due to human impact.

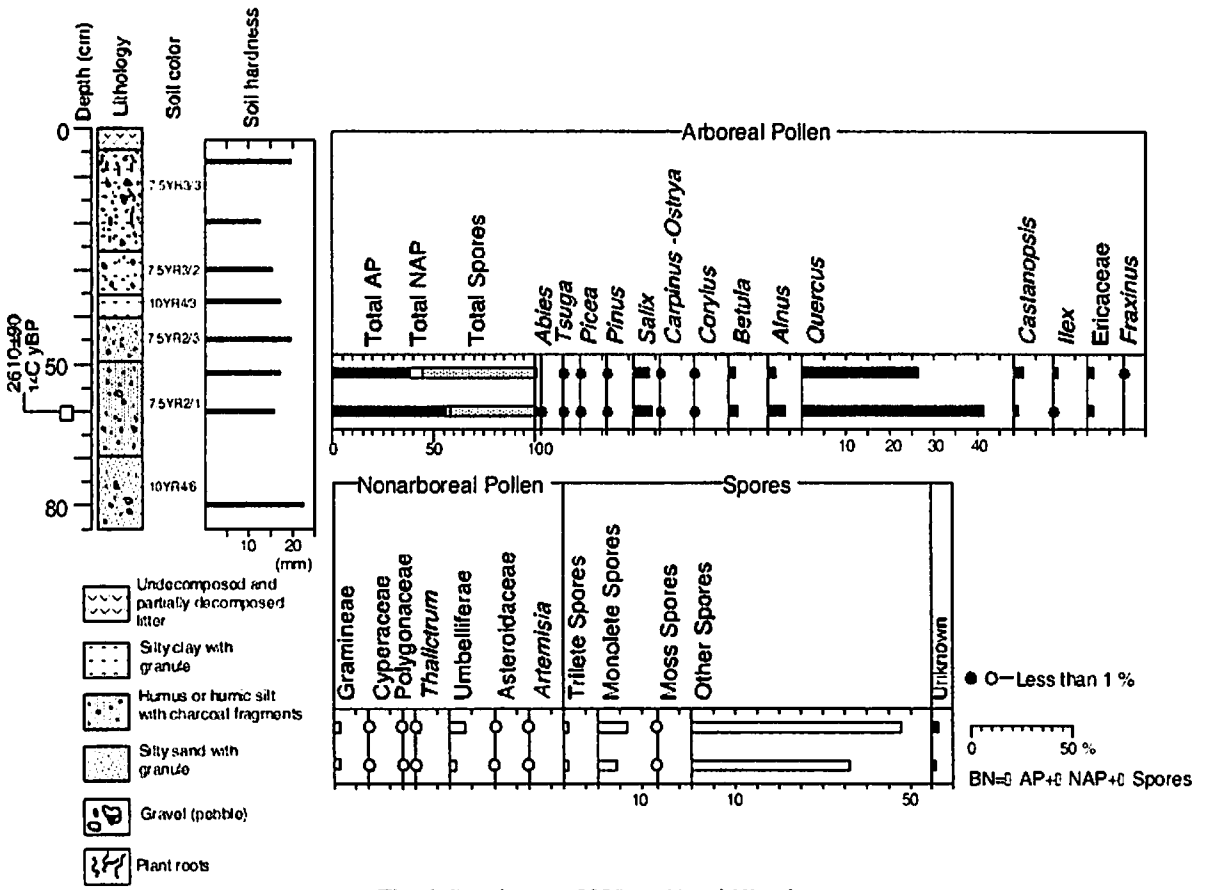

Fig. 4. Pangkarma (2920m), Nepal Himalaya

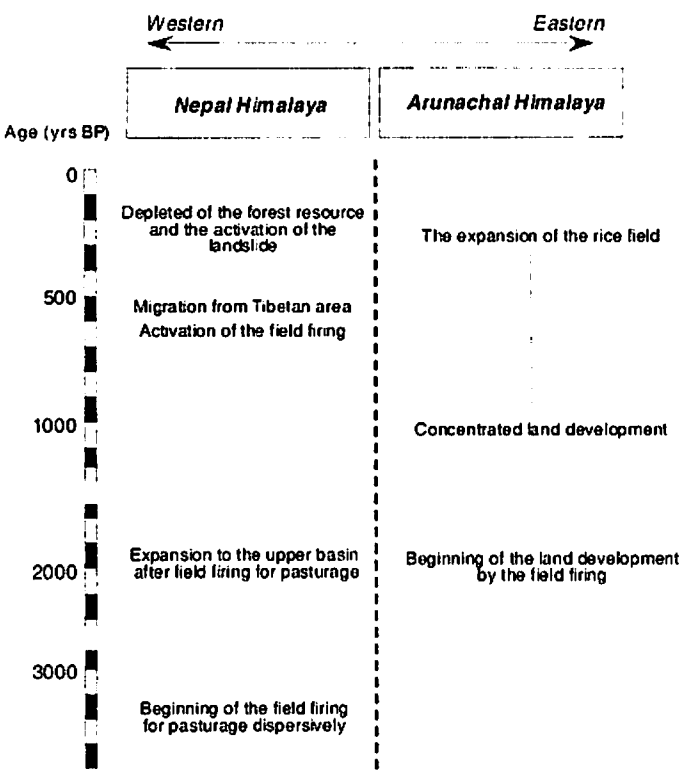

Fig. 5. Chronology of land development in Himalayas

On the other hand, buried stump under the rice field indicates occurred at ca. 2000 yrs BP, which is older than the buried humus layer. The oldest value of the buried humus layer was ca. 3700 yrs BP, and it was confirmed in a development period in Nepal Himalayas (Fig. 5). However, in Arunachal Himalayan area, where cereal cultivation is done, it can not be same as that of the Nepal area. As forest or bush fire was done in many areas, it can be estimated that some developmental activities in the early days were undertaken since ca. 2000 yrs BP in the present shifting cultivation field. We can estimate that the full-scale development concentrated at ca. 1000-340 years BP, the formation time of the buried humus soil layer. The migration of tribes may be a probable cause (Miyamoto, 1998) which is, however, not yet clear.

Conclusion

Dated charcoal and humus materials present in soil, are the evidences of forest fire, while vegetation changes indicate deforestation in the past and land development (paddy field) in Eastern Himalaya. Around Ziro, Arunachal Pradesh, North Eastern India, human factors such as population growth and cultural changes may have triggered an environmental and agricultural changes after ca. 2 ka BP. Relatively intense deforestation and land development since the ca. 1 ka BP was due to the human impact.

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Rainfall, flood and rice cultivation in Bangladesh

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Abstract: The long-term variation in rice production in Bangladesh was examined for the period from 1947 to 2008, and the impact of rainfall and recent severe floods was discussed. Although rice production is highly dependent on summer monsoon rainfall in India and other Asian monsoon countries, the relationship is poorly identified in Bangladesh. On the other hand, a clear relationship has been observed between severe floods and rice production. In general, there are three varieties of rice crop in Bangladesh, namely *Aus* in the early rainy season, *Aman* in the late rainy season, and *Boro* in the dry season. The cultivated area of *Aman* was almost constant throughout the study period, with some sharp drops in severe flood years. That of *Aus* slightly increased before the mid-1970s, and then began to decrease subsequently, decreasing more rapidly after the late 1980s until 2006. The yield of *Aus* tended to rise sharply in years following severe floods. That of *Boro* gradually increased after the mid-1960s, in particular after years of severe flooding. The yields of all varieties, especially *Boro*, consistently increased starting in the mid-1960s, due to the introduction of high-yielding varieties. Because yields also tended to increase after severe flooding, the total rice production rose sharply after years of severe floods. After the severe flood of 1998, the production of *Boro* exceeded that of *Aus* for the first time, and the difference in production between these two varieties has since increased. As such, rice production in Bangladesh has almost consistently increased in time, even with severe flood damage during rainy seasons.

Key words: Rice cultivation, flood, rainfall, HYV, irrigation.

Introduction

Bangladesh is a major rice-producing country, the 4th leading producer in the world in 2008 (FAO, 2009). It is expected that the world food supply will become scarce in the middle of this century as a result of a population explosion. However, rice production in Asia is still unstable and fluctuates yearly (Yoshino, 1998; Gadgil and Rupa Kumar, 2006). Most of the rice-producing countries in the world are located within the Asian monsoon region, and rice cultivation is largely influenced by monsoon climate. For instance, Parthasarathy *et al.* (1992) showed that food grain production in India is strongly influenced by the summer monsoon rainfall, where there is more production in years of abundant rainfall and vice versa. Krishna Kumar *et al.* (2004) confirmed this correlation with major crops including rice in India. A similar relationship was pointed out between rice yield and May–October rainfall in India and Thailand by Gadgil and Rupa Kumar (2006) and between rice production and annual rainfall in Bangladesh by Mowla (1976). However, Gadgil and Rupa Kumar (2006) reported that there is no discernable relationship between the year-to-year changes in rice yield and the change in seasonal rainfall during monsoon seasons across Bangladesh, due to the hydrological environment of rice cultivation in Bangladesh, which is very different from that of India.

In Bangladesh, rice is grown in the low-lying delta land formed by three major rivers: the Ganges, Brahmaputra, and Meghna. Severe floods often occur in these regions, causing extensive property damage. In 1974, 1987, 1988, 1998, 2004, and 2007, severe floods occurred in Bangladesh. The flood of 1998 was the worst one; it inundated 70% of the country and left approximately 1,000 people dead. Some studies have focused on flood damage to rice production (Murshid, 1989; Brammer, 1990; Paul and Rasid, 1993). However, these studies analyzed crop damage data, which only revealed the negative impacts of floods on agriculture. It is important to note that floods are not necessarily disasters for farmers because they can have positive effects by depositing fertile soil and water (Nakao, 1996). Indeed, Asada *et al.* (2005) showed that rice production in Bangladesh was higher after years of severe flood than that of previous years, suggesting that severe floods may increase long-term rice production. In addition, Asada and Matsumoto (2009) reported regionally variable effects of monsoon rainfall in the Ganges-Brahmaputra Basin.

This paper aims to further examine the trend in rice production in Bangladesh from 1947 to 2008 by updating the data utilized by Asada *et al.* (2005), and to reveal the relationship between monsoon rainfall/severe flooding and rice production. After 2000, severe floods occurred in two years, 2004 and 2007.

Materials and Methods

Rice cropping patterns in Bangladesh: In general, there are three varieties of rice crop in Bangladesh: *Aus*, *Aman*, and *Boro*. The growing period of each variety corresponds soundly with season. The climate in Bangladesh is characterized by a cool dry season, a hot summer season, and a rainy monsoon season. The dry season prevails from mid-October through February and less than 5% of annual rainfall occurs during this season. The hot pre-monsoon season lasts from March to May, which accounts for 15–20% of the annual rainfall. The rainy season starts in early June and ends in mid-October and 75–80% of the annual rainfall occurs during this season.

Aus is normally planted in April and harvested in July or August, before annual floods reach the peak stage. After that, *Aman* is planted in August, to correspond with the drop in floodwater, and is usually harvested in November or December. These are the two rainy season rice varieties. On the other hand, *Boro* is the dry season variety. It is normally planted in December and harvested in April or May.

High-yielding varieties (HYV) of each strain were developed for breed improvement and were introduced in the late 1960s after the Green Revolution (Islam and Taniguchi 2000). As the name implies, the yields of HYVs are much higher than those of the local varieties. However, they require a large water supply, fertilizer, and sufficient

care, as they are vulnerable to drought and harmful insects. These varieties cost more than local varieties, but their benefits are also much higher (Islam *et al.*, 2001).

Data used in this study: The agricultural data used in this study were taken from Hamid (1991) for the period from 1947 to 1967 and from the Yearbook of Agricultural Statistics of Bangladesh published in the Bangladesh Bureau of Statistics for the period from 1968 to 2008. These books contain information about rice production (in metric tons) and cultivated area (in hectares) of *Aus*, *Aman*, and *Boro*. For each variety, the data are split into the local and HYV strains. It should be noted that the statistical year of agricultural data does not always agree with the actual crop year. In these data books, the annual rice production data are based on the seeding period of each variety. For instance, the production of *Boro* in 2000 is that seeded and grown from November 2000 to April 2001. The annual rice production in 2000 indicates the sum total of the production of *Aus* and *Aman* harvested in 2000 and that of *Boro* harvested in 2001. The irrigated area data (in hectares) can also be obtained from the same yearbook. These data are available for each of the three varieties from 1969 to 2008.

As for the seasonal rainfall data, we utilized the total rainfall in the monsoon season (June to September) across Bangladesh from 1980 to 2008, averaged by seven major stations operated by the Bangladesh Meteorological Department (BMD: available at http://www.bmd.gov.bd/Monsoon_rain/Bgd_mon_rain.html).

Data on flood-affected areas during the monsoon season (FFWC, 2004), represented as the percentage of the total country, were taken from the Bangladesh Water Development Board (BWDB). These data are available from 1954 to 2008, excluding the years 1957–1959, 1979, 1981, and 1997. These years basically correspond to years with less flooding and the influence on rice cultivation was small.

Results and Discussion

Relationship between the year-to-year changes in *Aman* rice yield and rainfall: First, we investigated the relationship between the year-to-year changes in *Aman* rice yield and monsoon rainfall in the whole of Bangladesh from 1980 to 2008. The year-to-year changes were analyzed because simple yields have tended to increase mainly due to the increased use of HYV strains (Gadgil and Rupa Kumar 2006). Fig. 1 presents the time series of year-to-year changes in *Aman* rice yield and Bangladesh monsoon rainfall by BMD for the period 1980–2008. As shown in a scatter diagram in Fig. 2, there were no apparent relationships between these two variables.

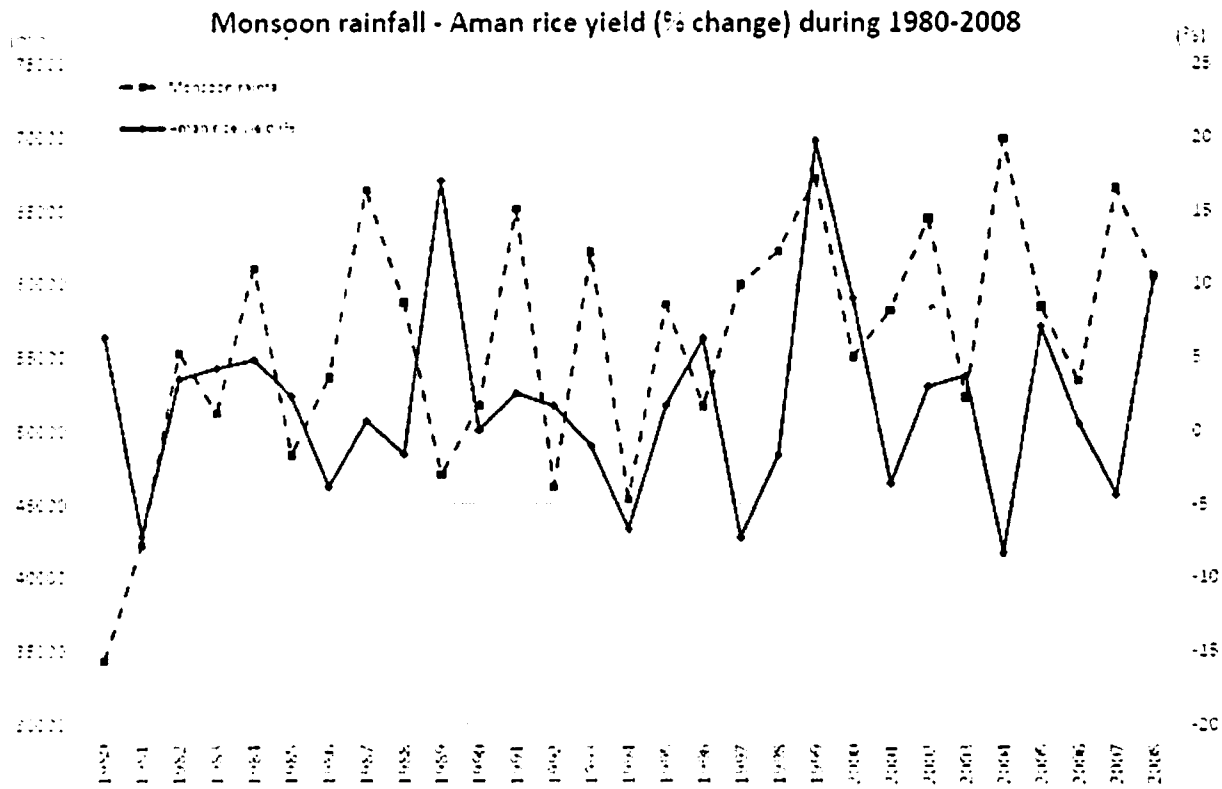

Fig. 1. The year-to-year changes in *Aman* rice yield and monsoon rainfall in the whole of Bangladesh for the period from 1980 to 2008.

Variation in the cultivated area: The inter-annual changes in cultivated area of each variety and total cultivated area are presented in Fig. 3. Total cultivated area gradually increased through the 1970s and remained relatively constant throughout the 1980s until 1998, which was a year of severe flooding. In 1999, total cultivated

area increased suddenly by 10%. A further increase was observed in 2008. Although the limited availability of arable land in Bangladesh is considered as a major impediment to agricultural development, and surpluses can only be produced by increasing either the yield or cropping intensity (Siddiqui and Suzuki, 1990), an increase in the dry season crop due to the development of irrigation enabled the expansion of the cultivated area.

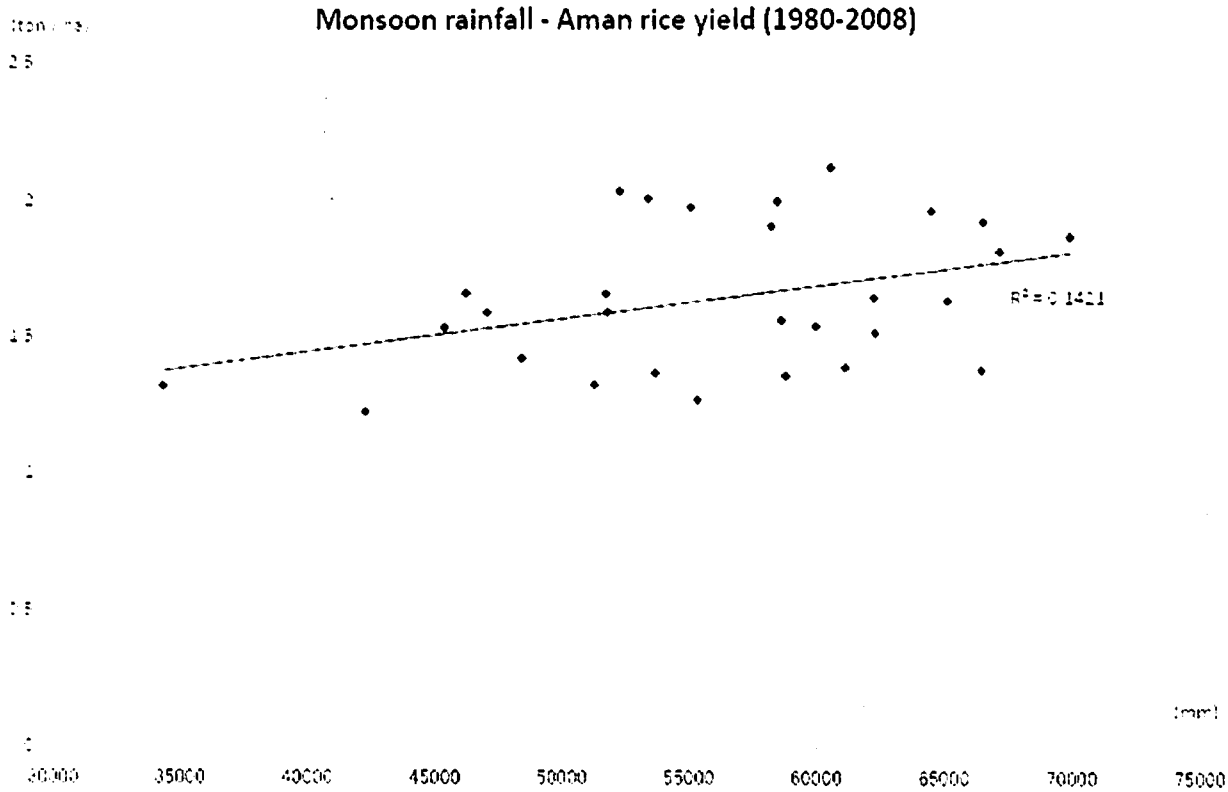

Fig. 2. Relationship between the year-to-year changes in *Aman* rice yield and monsoon (June to September) rainfall in the whole of Bangladesh for the period from 1980 to 2008.

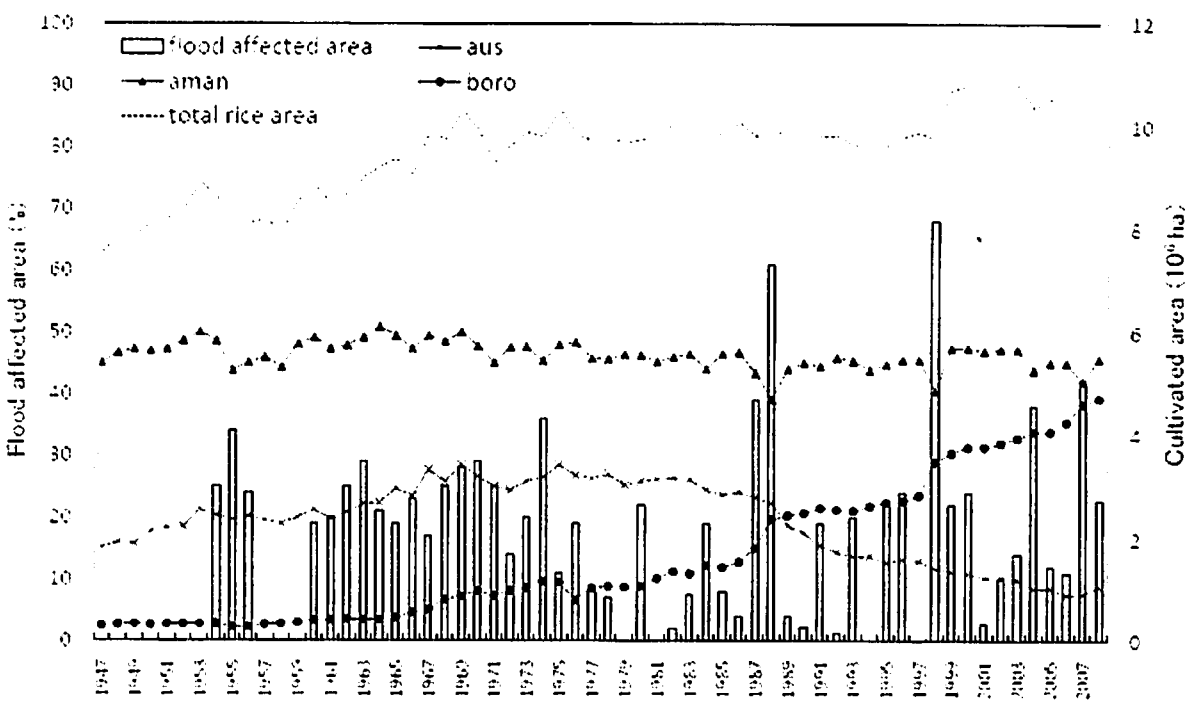

Fig. 3. The inter-annual variation in cultivated areas and flood-affected areas from 1947 to 2008.

The cultivated area of *Boro* rapidly increased in 1988 and 1998, and then slightly increased after the severe floods in these years. A similar rapid increase occurred after a severe flood in 2007. The cultivated area of *Boro* reached approximately 85% of that of *Aman* in 2008. Of course, the continuous increase in *Boro* cultivation was due to the constant expansion of irrigation (Fig. 4). In sharp contrast, the cultivated area of *Aus* has continually decreased since the mid-1980s. However, it appears to have hit bottom in 2006 and has gradually started to rebound. *Aman* cultivation tended to decrease during years of severe flood but then to recover to the previous-year level in the year following floods. It remained almost constant throughout the study period. The results obtained here are almost the same as those reported by Asada *et al.* (2005). It may be important to note that, since their report, the decrease in *Aus* cultivation seems to have stopped.

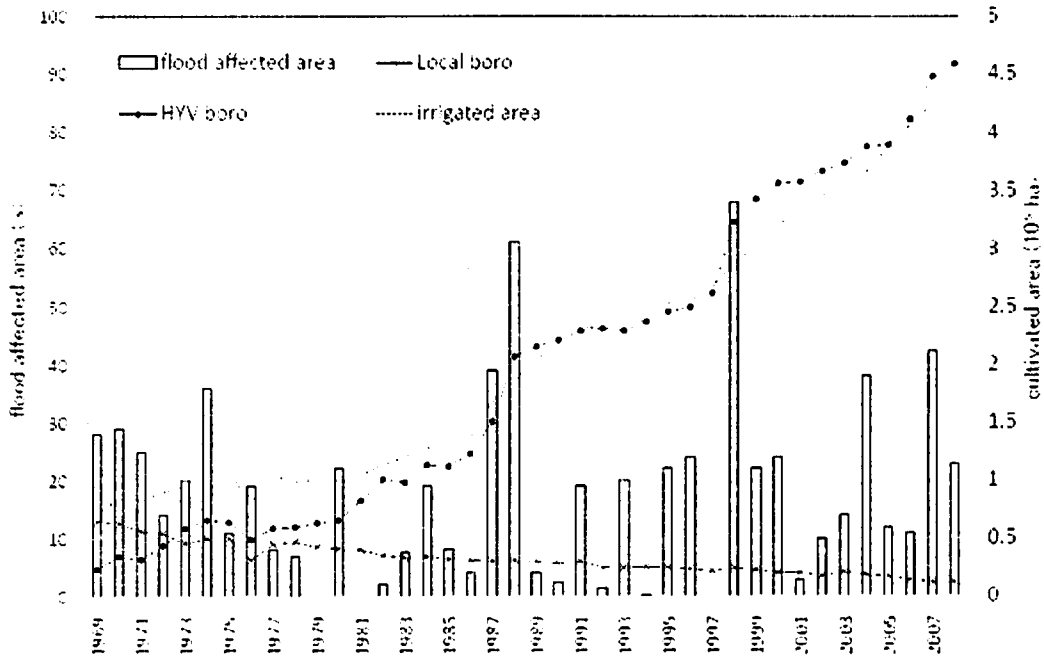

Fig. 4. Inter-annual changes in the cultivated area of HYV and local *Boro*, and in irrigated areas.

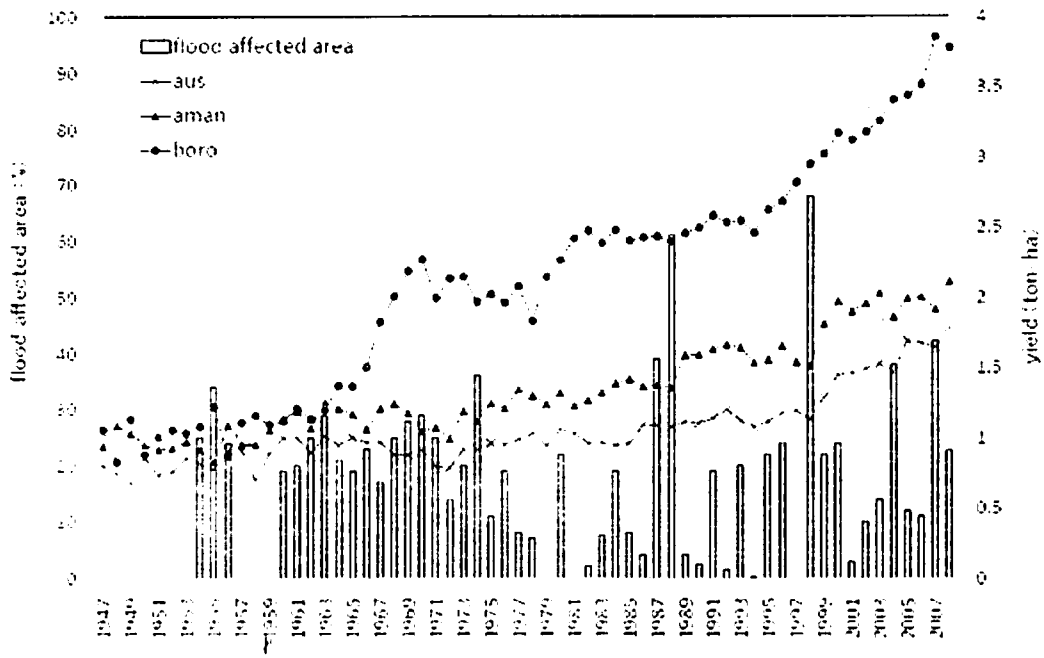

Fig. 5. As in Fig. 3, but inter-annual variation in rice yields.

Variation in yield: Fig. 5 shows the changes in yield for each rice variety. Before the introduction of the HYV strains prior to the mid-1960s, the yields of all three varieties were about the same (1 to 1.5 tons per hectare), although that of *Aus* was the lowest among the varieties. After the mid-1960s, the yield of *Boro* rapidly increased to 2–2.5 tons per hectare, while those of *Aman* and *Aus* remained about constant until the severe floods in 1988 and 1998, respectively. The *Boro* yield increased consistently after the mid-1990s and is currently at about 3.8 tons per hectare, nearly twice as much as the other varieties. In the years following the 1988 and 1998 floods, the yield of *Aman* rose significantly. However, after the severe flooding in 2004 and 2007, *Aman* yield dropped, and its recovery in the subsequent years was minimal compared to that observed after the 1988 and 1998 floods. Since 2000, *Aman* yield has remained constant at 2.0 tons per hectare. On the other hand, *Aus* yield increased after the severe floods in 1998, 2004, and 2007. After the report of Asada *et al.* (2005), *Boro* yield continued to increase until 2007, while *Aman* yield remained constant and *Aus* yield began to grow after the severe floods of 2004 and 2007.

Inter-annual variation in rice production: The variation in production is expressed by changes in both the cultivated area and the yield. Fig. 6 shows the changes in total rice production and changes in the production of each variety. The total production increased consistently throughout the study period and is now more than four times greater than it was 60 years ago (7 million tons in 1947 to 31 million tons in 2008). Among the three varieties, *Boro* increased the most, especially after the 1980s. As Asada *et al.* (2005) pointed out, total annual production increased most after the floods of 1988 and 1998. A similar trend can be found in the most recent severe flood of 2007, during and after which *Boro* production increased rapidly. The production of *Boro* first exceeded that of *Aman* in 1998, the most severe year of flooding in the last century, and it continued to increase subsequently. At present, *Boro* is the primary rice variety produced in Bangladesh. This is a unique characteristic among the rice-cultivating monsoon countries, where the major rice-growing period is normally during the summer monsoon season (Gadgil and Rupa Kumar, 2006). After 2007, its production was approximately 1.5 times as high as that of *Aman* and this tendency is not predicted to change in the future.

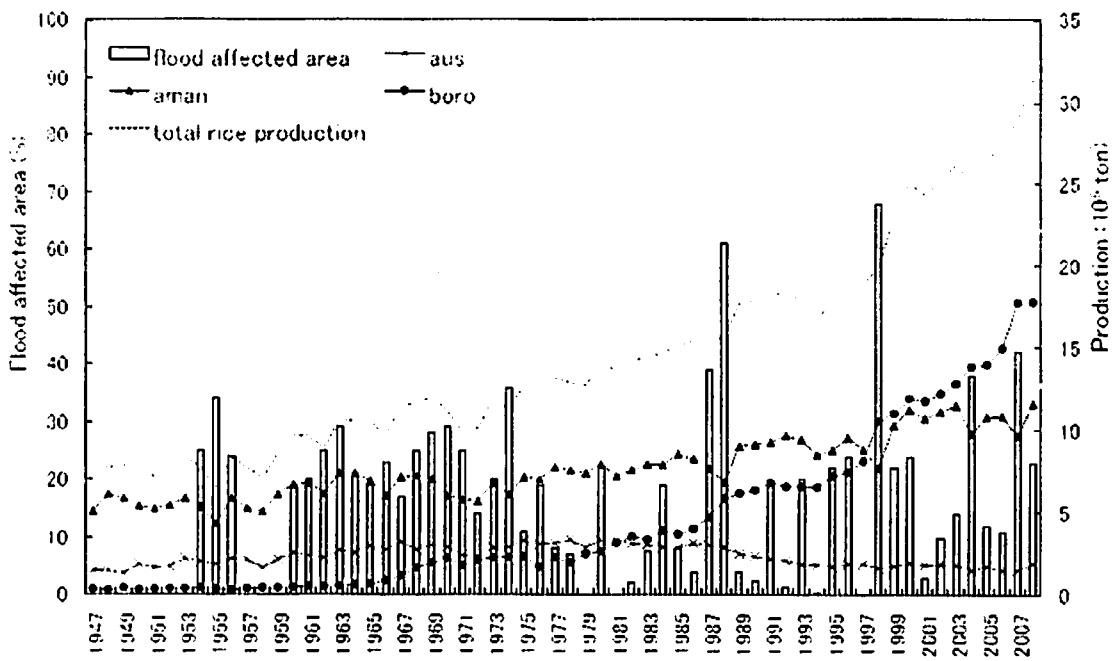

Fig. 6. As in Fig. 3, but inter-annual variation in rice production.

The production of *Aus* continued to decrease after the mid-1980s. *Aus* accounted for nearly 30% of the total rice production in 1970, but just 6% in 2008, while *Boro* accounted for 20% in 1970 and 57% in 2008. However, it seems that the decrease in *Aus* production stopped after 2004. *Aman* production also decreased during recent severe floods in 2004 and 2007. Although in the following years its production returned to previous levels, *Aman* production did not increase much after 1999.

Asada *et al.* (2005) showed that the annual total production remained constant during severe flooding years and rapidly increased in the year following severe flood. They also showed that the long-term increase in total rice production accelerated after severe floods, despite paddies incurring major damage in the short term.

Conclusion

This study updated the information on the long-term variation in rice production in Bangladesh and the

relationship between rice cultivation and the hydrological environment of Bangladesh provided by Asada *et al.* (2005).

Asada *et al.* (2005) proposed some hypotheses about rice production in the recent severe flood years in Bangladesh. During the severe flood years of 1988 and 1998, rainy season *Aman* production greatly decreased both in terms of cultivated area and yield, whereas dry season *Boro* production drastically increased in cultivated area at the same time. This expansion in *Boro* cultivation may be attributed to the utilization of the residual surface water of the floods and to the quick response of local farmers reported by Ando *et al.* (1990). It is also noticeable that the introduction of HYV strains became more pronounced after severe flood years for each of the three varieties, and that this also led to increased yields. The higher yields may also be attributed to fertile soil deposited by floodwater.

After 2000, two severe floods occurred in Bangladesh, in 2004 and 2007, although they were not as severe as those in 1988 and 1998. The responses of each variety to these floods were similar to the responses to previous floods, especially for *Boro*. The results obtained here confirm the validity of our former results. However, slight changes were also observed after 2000 in the cultivation area of *Aus* and in the yields of *Aus* and *Aman*. As such, Bangladesh agriculture has been continuously evolving even with severe flood damage during rainy seasons. The large increase in dry season rice production may help minimize the deleterious effects of flood on the total rice production of Bangladesh.

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Climate, climate change and diarrhoea in Bangladesh

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Abstract: Diarrhoea is one of the leading causes of mortality and morbidity in the world, predominantly affecting children in developing countries including Bangladesh. Many diarrhoeal diseases show clear seasonality suggesting that weather factors could play a role, either directly or as an indirect influence through other intermediate pathways. There is growing concern that climate change could increase the transmission of diarrhoeal diseases. This paper reviews firstly the burden of diarrhoea and secondly the effects of climate factors (rainfall, flood and temperature) on diarrhoeal diseases especially cholera in Bangladesh. There is evidence that the number of cholera cases increased with higher rainfall and lower rainfall in the weeks preceding the infections. High rainfall is likely to influence the growth, survival and proliferation of *V. cholerae* in the aquatic environment by a complex interaction with abiotic factors including other weather factors (e.g. temperature and sunlight), salinity and pH and phytoplankton and zooplankton in the aquatic environment. Low rainfall has been suggested to lead to reduced water availability for domestic use and increased concentration of enteric pathogens in raw water supplies. There is a clear evidence for an association of interannual variability of SST with interannual variation of cholera incidence. The short-term effect of ambient temperature on the number of cholera cases was also reported in Dhaka.
Key words: Climate, climate change, diarrhoea, mortality, Bangladesh

Introduction

Diarrhoea is one of the principal causes of mortality and morbidity especially in developing countries. Many diarrhoeal diseases show clear seasonality suggesting that weather factors could play a role, either directly or as an indirect influence through other intermediate pathways. Clarifying potential role of weather on transmission of diarrhoeal diseases could help to have deeper insight of the mechanisms of the seasonality, and therefore has the potential to improve disease control.

Global climate change is likely to have a significant impact on human health, with direct and indirect influences[1]. There is reasonable certainty that climate change will be associated with increases in average temperatures and the shifts in patterns of precipitation in future. Typically, rainfall is estimated to increase in high latitudes and some equatorial regions and decrease in many mid-latitude, subtropical, and semi-arid regions under IPCC's Special Report on Emissions Scenarios of patterns of changes for 2100[2]. Regional changes in precipitation characteristics (e.g., total amount, variability, and frequency of extremes) has been suggested to have the potential to affect frequency and intensity of floods in Bangladesh[3]. Quantitative estimates of weather effects on diarrhoeal transmission, which can be applied to estimate population attributable risk of climate exposure could also contribute to assess attributable burden of climate change.

Little is known about causes of deaths and illness in developing countries including Bangladesh, because they lack a systematic vital registration and national surveillance system and very few deaths are attended by a qualified physician. Longitudinal community-based studies have been conducted to estimate morbidity from diarrhoea in Matlab, rural Bangladesh (Table 1). It was estimated to have 5.6 episodes per year for children younger than 5 years and 7.0 episodes per year for children younger than one year for the period between 1978 and 1979[4-6]. Diarrhoea was the second most common illness following illnesses of the upper respiratory tract, with a peak prevalence in children 6–11 months of age[4]. Diarrhoea was also the most frequent reason for hospitalization of children aged 2–60 months[4]. Another study suggested 4.1 episodes per year for children younger than 5 years in 1978–1979[7]. The morbidity has little changed after 10 years (4.6 episodes per year in 1988–89)[8,9].

Table 1: Age-specific morbidity from diarrhoea in Matlab, Bangladesh

		Episodes of diarrhoea per person per year						
		Age group (months)		Age group (years)				
Authors	Period	0-5	6-11	1	2	3	4	0-4
Black et al.[4-6]	1978-79	----------7.0---------		6.0	5.5	4.5	4.5	5.6
Chen et al.[7]	1978-79	----------4.1----------						4.1
Huttly et al.[28]	1984-87	2.4	4.4	5.0	4.3			
Baqui et al.[8,9]	1988-89	----------4.6----------						4.6

Source: adapted from Bern.[29]

Mortality was estimated by active surveillance in Matlab for the period of 1966–1987.

Diarrhoeal death rate varied between 2.0 and 4.0 per 1,000 population except during the war and famine periods[10].

Diarrhoeal deaths rate was especially high in children aged 1–4 years: 10.4 per 1000 population in this age group in 1978–1979. On average, more than 20 percent of all deaths were related to diarrhoea and the relative

importance of diarrhoea as the cause of death did not diminish over time. Another study also showed similar figures of diarrhoeal mortality in Matlab[11]. The age specific mortality from diarrhoea in different period of years is shown in Table 2.

Table 2. Age-specific annual mortality from diarrhoea in Matlab, Bangladesh

Authors	Study characteristics		Diarrhoeal deaths per 1000 by age group (years)			Diarrhoeal deaths as percentage of total 0-4 year mortality
	Period	Population	<1	1-4	0-4	
Chen *et al.*[30]	1975-77	42,000	19.6	15.1	16	27
Shaikh *et al.*[10]	1978-87	28,000	5.7	10.4	9.5	
Fauveau *et al.*[11]	1986-87	1,897,000			8.6	24.5

Source: adapted from Bern.[29]

Diarrhoea in Bangladesh:

The aetiological agents of diarrhoea were suggested by case-control study of children under 5 years visiting ICDDR,B Dhaka hospital in 1993–1994[12]. The major pathogens associated with childhood diarrhoea were rotavirus, ETEC, enteropathogenic *E. coli* (EPEC), *Campylobacter jejuni*, *Shigella* spp., *V.cholerae* O1 and O139, *Aeromonas* spp., enterotoxigenic *Bacteroides fragilis* (ETBF), *Clostridium difficile*, and *Cryptosporidium parvum*. Infections with multiple pathogens were common. With a few exceptions, these findings are similar to those from other developing countries.

Persistent diarrhoea has been identified as the cause of a substantial proportion of diarrhoeal mortality in Bangladesh. A population-based surveillance among women in rural Bangladesh estimated 59 percent of deaths were due to persistent diarrhoea[13]. A case control study of children showed 49 percent of the diarrhoeal deaths were in children with malnutrition associated with persistent diarrhoea[14]. Risk factors of persistent diarrhoea in Bangladesh were blood in stool[15, 16], dehydration[15] and malnutrition[17].

The environmental risk factors of diarrhoea, especially for cholera, have been intensively investigated in rural Bangladesh. Cholera is primarily a waterborne disease and the occurrence of epidemics of cholera coincides with increased prevalence of the causative *V. cholerae* strain in the aquatic environment[18]. The incidental ingestion of copepods, which carry a high concentration of *V. cholerae*, can initiate an infection especially when communities rely on untreated environmental water sources for bathing, cooking, and drinking water[19].

Emch[20] reported high population density and large population in a *bari* (clusters of households), small household area, use of tube-wells with large number of households and use of latrines with multiple households were the risk factors for cholera. Not using tube-well for drinking and bathing, low tube-well density per person and small household area were the risk factors for non-cholera watery diarrhoea. Living in flood-controlled areas was also a risk factor for both types of diarrhoea without any plausible explanations offered. The spatial model of the selected risk factors (proximity to surface water, high population density and low educational status) found good correspondence between modelled risk areas and observed cholera morbidity and mortality[21]. Hughes *et al.*[22] found an increased risk of infection for families using contaminated surface water for drinking, cooking, washing or bathing. Khan *et al.*[23] reported higher attack rate of cholera in families with access to canal water than those with river water or tank water. Sommer and Woodward[24] reported that people living near the tube-wells had a lower incidence of cholera than those living distant from tube-wells.

Tube-well is a primary drinking water source for about 85 percent of Bangladeshi people[25] and has been installed in every village in rural areas. Tube-wells, however, have been only partly effective to prevent diarrhoea in Bangladesh[26]. High concentrations of faecal coliform and other bacterial indicators in tube-well water have been reported[25,27]. Inadequate environmental conditions of tube-wells such as short distance from latrines or sewage-contaminated ponds has been implicated[27]. Water contamination in storage containers in the house was also reported [25].

Effects of climate on diarrhoeal diseases: The direct evidence for a relationship between climate factors and diarrhoeal diseases will be reviewed in this section. Because of its abundance of epidemiological evidence, climate sensitivity and clinical importance, we much focus on cholera in this section.

Rainfall: Cholera dynamics in endemic regions show regular seasonal cycles. The annual bimodal distribution is observed in Bangladesh[31], while annual single peak can be seen in South America[32], India[33] and Pakistan[34]. The clear seasonality suggests that weather factors could play a role, either directly or as an indirect influence through other intermediate pathways. However, only little empirical evidence has been suggested.

Cockburn and Cassanos[35] proposed a hypothesis that ponds in Bangladesh were the main source of infection to the community. They hypothesised that if the pH in ponds were sufficiently elevated, *V. cholerae* could have advantage in survival to other bacteria. They showed a relationship between elevated pH and onset of cholera cases, which was also related to season, sunlight,

temperature, and rainfall. The driver of the temporal pH changes in their hypothesis was algae, which elevated the pH of the surrounding water by the sequestration of CO_2 during photosynthesis, with the greatest changes occurring under conditions with elevated temperatures, low turbidity, and sufficient light. According to their hypothesis, when high rain muddies and dilutes the pond water, the pH might not rise, and the *V. cholerae* would then lose its advantage in survival [35].

Pascual *et al.*[31] suggested that high rainfall during the monsoon season in Bangladesh could reduce cholera cases by diluting the concentration of *V. cholerae* in aquatic environments and also reducing salinity levels of surface water below the optimum requirements of the pathogen survival. This hypothesis was inferred from the observation of marked depression of cholera incidence during the monsoon season. The incidence of cholera is influenced by the primary transmission from an aquatic environmental reservoir in endemic regions[19], and a variety of physical and biological parameters are likely to influence the growth and survival of *V. cholerae* as a species in the environment[36]. In contrast, cholera reached peak during the monsoon season in the dryer areas in India. The effect of rainfall on seasonality of cholera may be dependent on the levels of average rainfall[31].

Lipp *et al.*[19] proposed a model of hierarchy in cholera consisting of abiotic factors, phytoplankton and aquatic plants, zooplankton and transmission to humans. *V. cholerae* increases growth rate in the aquatic environment at warm temperatures in combination with high-pH conditions and blooms of phytoplankton, aquatic plants or algae. The growth of phytoplankton and aquatic plants is influenced by sunlight, temperature and nutrients in aquatic environment, and in turn alter the dissolved O_2 and CO_2 content of the water and, therefore, the pH of the surrounding water. High phytoplankton production produce food for zooplanktons to which *V. cholerae* attach and protect it from the external environment and proliferate[19].

The predation of *V. cholerae* by phage has recently been reported to be a possible factor that influences seasonal epidemics of cholera in Bangladesh. Faruque *et al.*[37]suggested that epidemics would most likely begin in periods of low phage concentration (e.g after floods and the monsoon season) from the observation of the inverse correlation between the environmental concentration of vibriophages and the presence of susceptible *V. cholerae* strains in water[36, 37]. They also proposed that phages play their predominant role in ending cholera epidemics. This hypothesis may need to be confirmed by further observations in possible lags from weather events to phage concentration and the end of cholera epidemics.

Huq et al.[38] reported a time series analysis using clinical and various environmental data (water temperature, air temperature, water depths, rainfall, pH, salinity, water conductivity, dissolved O_2, count of bacteria and copepod counts in water samples, etc.) collected at biweekly intervals in four rural locations in Bangladesh for four years. They found a significant negative association of rainfall with cholera incidence in some locations with different lags (0–8 weeks). However, they did not control seasonal effects in the models and a linear relationship was assumed. Furthermore, so many environmental variables with various lags were examined by stepwise regression procedures without taking into account a priori decision of confounders and intermediates. This may cause biased estimates of the results[39].

Hashizume *et al.*[40] reported the weekly number of cholera cases increased by 14 % for a 10 millimetres increase above the threshold of 45 millimetres for the average rainfall over lags 0–8 weeks. Conversely, the number of cholera cases increased by 24 % for a 10 millimetres decrease below the same threshold of average rainfall over lags 0–16 weeks. River level partly explained the association between high rainfall and the number of cholera cases.

Low rainfall and drought have also been associated with increase in incidence of cholera. A time-series study in Dhaka reported the number of cholera cases increased by 24 % for a 10 millimetres decrease below the same threshold of average rainfall over lags 0–16 weeks[40]. Low rainfall was proposed to interrupt water supply and contributes to poor hygiene. This is particularly relevant where the rain water is collected for household uses. In such areas, hygienic and sanitary condition seem to be closely related with rainfall[41]. The multiple uses in a water body may increase during droughts and enhance the risk of contamination[19]. Increased concentration of pathogenic agents in raw water supplies is also suggested as possible routes of gastrointestinal infections[42]. Even where there is water treatment systems, falling water levels and reduced river flows during droughts increase the risk of cyanobacterial blooms, and also make water treatment less effective as levels of sediment and organic material increase[43].

Apart from the seasonality, cholera dynamics in endemic regions also show marked interannual variability. In the analysis of historical data of former British India, rainfall is associated with cholera's spatial distribution[31] Average annual cholera mortality in nine provinces of former British India was higher in provinces with higher annual rainfall.

Koelle *et al.*[44] reported environmental determinants of interannual cycles of cholera in rural Bangladesh taking into account intrinsic host immunity. The interannual variability showed a strong inverse relationship with monsoon rains and Brahmaputra river discharge at long periods (over 7 years) and positive correlations with flood extent in Bangladesh, sea surface temperatures (SSTs) in the Bay of Bengal, and the El Nino Southern Oscillation (ENSO) at shorter periods (less than 7 years). They suggested that understanding interannual cycles of cholera requires the combined analysis of both environmental and intrinsic factors.

Flood: Flood can be caused by high rainfall, tidal and wave extremes such as storm surge and tsunami, thawing of ice and structural failure such as dam-break flood and breaching of sea defences[45]. There is potential for increased transmission of diarrhoeal diseases during flood and post-flood conditions. In high-income countries, the risk of diarrhoea due to flood is considered to be low[46, 47], although a study in the UK reported an increase in risk of

gastroenteritis for flood exposed individuals[48]. A cohort study in the United States found that flooding house or yard was associated with increased risk of gastrointestinal illness[49]. Self-reported diarrhoea was used as an outcome measure in these studies.

In low-income countries, where water supply, sanitation system and causative agents of diarrhoea are likely to be different from those in high-income countries, post-flood increases in cholera[50], rotavirus diarrhoea[51,52], cryptosporidiosis[53] and non-specific diarrhoea[54-59] have been reported. However, most of these studies had methodological problems such as lack of pre-flood data, lack of comparison groups and potential recall bias. A recent study in diarrhoeal epidemic during floods in Dhaka provided good evidence for increase in diarrhoeal cases due to some pathogens[60]. During four consecutive flood-related epidemics in 1988, 1998 and 2004, the mean number of cases due to *V. cholerae*, *Shigella*, *Salmonella*, *E. hystolytica*, *Giardia lamblia* and rotavirus was increased compared with seasonally matched non-flood periods. *V. cholerae* played a primary role of flood-related epidemics, because it was the only pathogen of which proportion among pathogens increased during the flood compared with non-flood period. They also reported that the cases during the flood-related epidemics were older and of lower socioeconomic status than those in non-flood period.

Episode analysis of the 1998 flood revealed that, during the flood, the number of cholera and non-cholera diarrhoea cases was almost six and two times higher than expected, respectively[61]. In the post-flood period, the risk of non-cholera diarrhoea was significantly higher for those with lower educational level, living in a household with a non-concrete roof, drinking tube-well water (vs. tap water), using a distant water source and unsanitary toilets suggesting that low socio-economic groups and poor hygiene and sanitation groups were most vulnerable to flood-related diarrhoea. The risk for cholera was also significantly higher for those drinking tube-well water and those using unsanitary toilets. A time-series study using hospital surveillance data in Dhaka reported that the number of cholera cases increased by 137% for a 1 m increase of average river level over lags 0–4 weeks above the threshold of 4.0m after controlling for seasonal and between-year variations and rainfall[40].

Floods adversely affect water sources and supply systems as well as sewerage and waste disposal systems[62]. For example, the waste disposal system in Dhaka city was almost completely ineffective during the major flood in 1998[63]. A number of tube wells were covered by the floodwaters and were contaminated[64]. Many of the flood affected people became displaced and took refuge in temporary shelters[65]. Some of the shelters were extremely crowded with displaced people[65], and the deteriorated environmental conditions were observed in shelters and slums[66]. These observations implied that people's hygiene and sanitation level in the city were extremely disrupted, and the transmission of enteric pathogens was likely to have been increased during the flood.

Temperature: The relationship between temperature and cholera has in particular been studied in relation to ENSO. ENSO is a disruption of the ocean-atmosphere system in the tropical Pacific and can be seen in measurements of SST in the Equatorial Pacific Ocean[67]. It has been suggested that ENSO, a major source of interannual climate variability, causes the interannual variation of cholera incidence[68,69] particularly in areas of South America and the Bay of Bengal.

Interannual variability of cholera incidence between 1980 and 1998 in Dhaka, Bangladesh was positively associated with ENSO measured by SST anomaly in a region of the equatorial Pacific[70]. A consistent annual bimodal cycle of SST observed in Bay of Bengal was significantly associated with cholera outbreaks in 1992, 1994, and 1995 in Dhaka[71]. An analysis of historical data of Bengal (1981–1940) showed a significant positive correlation between spring cholera mortality in the coastal region and a monthly SST in the Bay of Bengal[72]. The positive association between cholera and ENSO is getting stronger in the last two decades compared to that in the last century[73]. The effects of ENSO and SSTs may be modified by the level of population immunity[44].

Apart from the effect of interannual variability of SSTs on the interannual variation of cholera incidence, effects of seasonal variability of water temperature and ambient temperature on seasonal variation of the number of cholera cases have been reported. A time-series study using hospital surveillance data in Dhaka reported that the number of cholera cases increased by 36.9 percent for a one degree increase of average temperature over lags 0–4 weeks below the cut-off of 28°C after controlling for seasonal and between-year variations and rainfall[40]. In rural Bangladesh, water temperature and ambient temperature were positively associated with the number of cholera cases in various places at various lags of weeks[39].

The possible mechanisms of the relationship between temperature and cholera incidence have been suggested. Warmer water temperatures are known to promote survival and reproduction of *V. cholerae* through their direct influence on the abundance and toxicity of *V. cholerae* in the aquatic environment, or indirect influence on pH elevations through the growth of aquatic plants or algae in combination with sunlight and rainfall, and on zooplanktons to which the pathogen attaches (hierarchical model for environmental cholera transmission)[19]. However, lag period of potential effect of temperature on cholera incidence is not clear. In addition, causal pathways need not be unique and other influences on cholera dynamics may be there.

Effects of non-climatic seasonal factors on diarrhea:

Not all seasonal variation of diarrhoea is a direct consequence of climatic effects. In particular, change of nutritional status could affect the incidence of diarrhoea seasonally. There is evidence for an increase in both gastroenteritis and malnutrition during the rainy season in some countries[74]. This may be associated with changes in patterns of food availability which is lower in the rainy season[75,76]. Higher opportunity costs of time for agricultural works which is busiest in the rainy season could abrupt weaning practices of women[74]. This could result in an increase of infant diarrhoea in the rainy season. Seasonal change of access to health care could also bias

the number of reported cases. Lower availability of cash income in the rainy season could lead to lower access to health care[77,78]. Poorer physical access to health care facilities due to flooding and submerged road, in the rainy season is also known[74].

These factors could result in biased estimate of effects of weather factors on diarrhoeal incidence if season is not controlled in analyses. For this reason, in this review the distinction of the relationships of diarrhoea with weather factors whether or not separated from other seasonal effects, were made clear as much as possible.

Conclusion

There is an evidence that the number of cholera cases increased with higher rainfall and lower rainfall in the weeks preceding the infections. High rainfall is likely to influence the growth, survival and proliferation of *V. cholerae* in the aquatic environment by a complex interaction with abiotic factors including other weather factors (e.g. temperature and sunlight), salinity and pH and phytoplankton and zooplankton in the aquatic environment. From the observation of reduction of cholera incidence during monsoon season in Bangladesh, high rainfall have been suggested to reduce cholera cases by dilution effect, by reducing salinity levels of water below the requirement of the pathogen survival. The role of vibriophages which prey on *V. cholerae* has also been suggested in the association of weather and seasonal epidemics. Low rainfall has been suggested to lead to reduced water availability for domestic use and increased concentration of enteric pathogens in raw water supplies. There is a clear evidence for an association of interannual variability of SST with interannual variation of cholera incidence. The short-term effect of ambient temperature on the number of cholera cases was also reported in Dhaka.

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Community mangrove forest management on the Andaman coast, Thailand

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Abstract: Mangrove forests support a variety of wildlife, including birds, fish, amphibians and mammals. These animals constitute an important resource for the population of the Andaman wetland and coastline areas, which local villagers both eat and sell throughout the year. Thus the Andaman coastal community depends on the fertility of the mangrove forests. Unfortunately, large areas of mangrove forests have been destroyed, which has resulted in a decrease in local marine life populations. As the livelihoods of many members of Andaman coastal communities have been put at risk by the destruction of mangrove forests, their rehabilitation is a matter of national interest. Mangrove community forests are comprised of forested areas around local communities in the Andaman coast. These forests are extremely important to the local economy and ecology. Local communities must work together to decide on the best way to manage these endangered forests sustainably. These communities are fighting to restore their mangrove forests with the help of the government, which plays an important role in the setting of appropriate policies and encouraging public participation. Also, the mass media can play a role by publicizing the efforts to save the mangrove forests for the people of Thailand.
Key Words: Community Mangrove Forest, Management, Andaman Coast.

Introduction

Thailand has mangrove forests distributed along approximately 2,600 km of river estuaries and coastline of the Gulf of Thailand and the Andaman Sea. Mangrove ecosystems in Thailand are divided into four regions according to the peninsular morphology and climate (Aksornkoae, 1998). Region 1lies along the eastern coastline in the Gulf of Thailand and includes the mangrove forests from Trat to Chon Buri provinces. The climate is described as tropical monsoon, but some parts of the mangrove forests in Chon Buri province are best described as tropical savanna. Region 2 lies in the inner Gulf of Thailand and includes the mangrove forests from Samut Prakan to Samut Songkhram provinces and is described as tropical savanna. Region 3 covers the east coast of the Gulf of Thailand and is located on the eastern side of Peninsular Thailand, from Chumphon province southwards to Narathiwat province. The total length of the coastline is around 932 km with a mangrove forest area 27,330 ha Region 4 is on the west or Andaman coast and is located on the western side of Peninsular Thailand, including Ranong province southwards to Satun province. The total length of the coastline is around 710 km with about 173,614 ha of mangroves. (Table 1).

There are 14 provinces in Peninsular Thailand, being Chumphon, Surat Thani, Nakhon Si Thammarat, Phatthalung, Songkhla, Pattani, Narathiwat, Yala, Ranong, Phangnga, Phuket, Krabi, Trang and Satun. In addition, Yala province has no coastline. Most provinces have mangrove forests (Table 1). Narathiwat, which is located in the lower part of the Gulf of Thailand, has no mangrove, though its coastline has a well developed swamp dominated by freshwater plants. Recently, Phatthalung has lost all of its mangrove forests. According to geographic and climatic factors, the mangrove forests of Peninsular Thailand can be divided into two regions (Kongsangchai, 1995). The area of mangrove forests by region until 2004 is shown in Table 1.

Mangrove area loss factors

The degradation of the mangrove forests on the Andaman coast in Thailand has had many negative effects on the ecology of the region, including increased temperature, salinity, turbidity and toxicity levels and soil erosion, and a decline in nutrient quantities. Accordingly, the local flora and fauna have been affected also. These alterations to the ecological equilibrium of the mangrove forests in coastal areas have had an inevitable effect on the local economies. Huge investments through public-private partnerships will be required to restore these forests, so that future generations may benefit from them. There are several activities that have in turn affected the destruction of mangrove forests.

1. Wood and charcoal production for local use: Mangrove forests are used directly by local inhabitants for firewood and charcoal for domestic and small industrial use. Throughout Peninsular Thailand, supplies of firewood and domestic fuel are decreasing, while at the same time the demand is rising rapidly. Population expansion had led to an increase in natural resource use. The deteriorating condition of the mangrove forests in Peninsular Thailand is due mainly to the over-exploitation of the forest for wood for charcoal. Large-scale forest exploitation occurs in the form of cutting of timber and wood for general use. Such exploitation may result in a gradual decrease in the mangrove area due to unsuccessful natural regeneration.

2. Mangrove concession: Since 1961, the Royal Forest Department (RFD) permitted logging in mangrove forests. A concession system allowed each concessionaire to log on an annual basis. From 1961 to 1969, a shelter wood system with a minimum girth size was practiced, with a rotation and felling cycle set at 10 y, with 10 annual coupes. Each year, one coupe was made available for extraction under a short-term (one year) permit. However, in 1968, the concession system was changed to long-term concessions of 15 y. In the first period (1968-1983), concessions were issued for 310 felling series (176,949 ha) along the coast of Thailand, of which 154,791 ha were in Peninsular Thailand. The second period of concessions was between 1986 and 2001, covering a total area of 143,961 ha (Table 2). A comparison between the first and second concession periods on the Peninsular shows that the area of concessions in the second period was 8% less than the first period, with 41,291 ha in Ranong. (Table 2 and 3).

This system was practiced until 1991, when it was ceased temporarily due to the adverse degradation of mangrove resources throughout the country. The conflict between destructive development and conservation put heavy pressure on the government to issue a number of

mitigation policies, including the cancellation of mangrove forest concessions throughout the country. In 1998, the cabinet announced that the concessionaires could continue charcoal production in their concession areas until the concessions expired. Since 2003, all concessions have expired and no new concessions had been issued. A further reason for increasing mangrove forest areas was derived from mangrove rehabilitation efforts, which will be addressed below (Pattanapongpaiboon, 2009).

Table 1. Mangrove forest area in Thailand until 2004 (ha)

Province	Year									
	Before 1961	1961	1975	1979	1986	1991	1993	1996	2002	2004
East Region										
Trat		12,900	10,600	9,840	8,818	7,750	7,668	7,534	9,613	9,201
Chanthaburi		15,400	26,100	24,064	14,507	2,450	4,072	3,893	12,393	11,794
Rayong		1,700	5,500	4,608	2,418	154	680	656	1,965	1,394
Chon Buri		-	3,800	3,312	1,498	150	92	92	780	722
Chachoengsao		-	3,000	2,320	740	367	536	483	1,676	1,250
Subtotal		30,000	49,000	44,144	27,981	10,871	13,048	12,658	26,428	24,360
Central Region										
Samut Prakan		-	600	1,040	103	-	312	297	1,110	1,466
Bangkok		-	-	-	-	-	200	198	662	406
Samut Sakhon		-	18,500	14,416	142	-	1,819	1,696	2,974	2,385
Samut Songkhram		-	8,200	7,648	49	336	2,068	2,070	2,364	2,258
Petchaburi		2,200	8,800	7,792	577	336	2,068	2,070	3,274	1,048
Prachuap Khiri Khan		1,100	400	336	145	70	40	43	500	433
Subtotal		3,300	36,500	31,232	1,016	742	6,507	6,374	10,884	7,997
Peninsular East Coast										
Chumphon		8,100	7,400	6,928	3,626	1,818	3,293	3,152	7,247	6,486
Surat Thani		25,600	3,700	5,808	4,284	2,204	3,164	3,134	7,517	5,202
Nakhon Si Thammarat		61,200	15,500	12,832	8,836	8,025	7,996	8,416	11,364	10,576
Phatthalung		1,400	1,900	1,632	105	60	128	141	112	327
Songkhla		1,300	5,900	5,184	965	229	548	623	3,506	1,023
Pattani		5,600	1,100	1,392	1,828	1,644	1,295	1,105	4,319	3,717
Peninsular West Coast										
Ranong		30,600	24,200	22,592	21,606	19,470	19,308	19,237	27,254	25,342
Phangnga		57,400	51,100	48,716	36,420	33,510	30,716	30,442	42,238	43,461
Phuket		4,500	3,100	2,848	1,935	1,554	1,548	1,512	1,896	1,695
Krabi		53,700	33,000	31,760	30,312	31,915	28,527	28,273	35,499	35,875
Trang		39,000	34,000	32,864	26,276	30,849	24,328	24,095	36,511	32,743
Satun		46,200	46,300	39,376	31,239	31,053	29,420	29,344	37,985	34,497
Subtotal		231,400	191,700	178,156	147,788	148,351	133,847	132,904	156,024	173,614
Total of Regions	372,448	367,900	312,700	287,308	196,428	173,944	169,827	168,507	227,399	233,300

Source : DMCR (2004); Havanond (1997); Jintana (1996).

3. Tin mining: Mining in mangrove forests occurs in the three provinces of Ranong, Phangnga and Phuket. Although mining accounts for only a small proportion of mangrove destruction, its impacts on the mangrove ecosystem are considerable. Mining requires clear felling of mangrove forests, followed by dredging operations that disturb the mangrove soil and introduce silt into the water, which is then transported to neighboring environments. Mining sediments affect directly the species composition, population numbers and forest structure (Snidwongs, 1982). The dominant effect of mining activities is deposition of sediment. Excessive sedimentation is detrimental to mangroves as it blocks the exchanges of water, nutrients and gases within the substrate and between the substrate and overlying water. Rehabilitation of mangrove forest is very difficult in abandoned tin-mining areas, due to the low survival rate and poor growth of seedlings that results.

4. Aquaculture: Many problems can be found in Peninsular Thailand that are typical of the rapid development of Peninsular shrimp aquaculture. The mangrove forests have been destroyed or surrounded with embankments to make shrimp ponds and after 2-3 y, production drops. After 5 y, most ponds are completely abandoned due to the effects of increasing acidity of the water caused by leaching from the mangrove soils, declining productivity, self-pollution and virus-disease problems. Diseases spread rapidly when the ponds are located close together.

In the early years of tiger prawn culture (1983-1986), pond culture using improved methods was very seldom practiced, due to shortage of fry. However, after 1986, aquaculture became very advanced in Thailand, because of: 1) the most favorable agro-climatic conditions; 2) soils with a high clay content, making them suitable for pond construction; 3) availability of wild brood stock; 4) extended experience in aquaculture; 5) good infrastructure and pond construction; 6) good support industries; and 7) the unique culture technique (Kongkeo, 1995). In 1990, the east coast of Peninsular Thailand had the largest area

of shrimp culture, with approximately 17,550 ha of shrimp farms. By 1994, the area of shrimp farms on the east coast had increased to 23,056 ha, which led to an expansion of shrimp culture on the west coast, with many sites in the Peninsular area (mostly mangroves) encroached upon for shrimp pond construction. In 1990, there were 2,950 ha of shrimp farms and this increased to 3,948 ha in 1993 (Plathong, 1998). Intensive shrimp farming produces both direct and indirect impacts on mangrove and other Peninsular ecosystems. Shrimp farming, including pond construction, requires an extensive area. Unfortunately, in many cases, mangrove forests are destroyed in exchange for pond space, which affects the essential breeding, feeding and nursing grounds for a variety of marine organisms. The destruction of mangrove forests which have served as sediment traps, results in an increase in the sediment load into the waters of the Peninsular.

Table 2. Concession mangrove forests (1968-2001)

Province	First period (1968-1983)		Second period (1986-2001)	
	Felling series	Area (ha)	Felling series	Area (ha)
Trat	3	7,425	2	1,712
Chanthaburi	4	12,159	-	-
Rayong	2	2,278	-	-
Ranong	27	23,675	19	17,616
Chumphon	4	7,111	-	-
Phangnga	109	39,995	70	25,914
Phuket	3	1,479	2	1,223
Krabi	76	31,034	73	33,410
Trang	44	22,575	44	27,941
Satun	37	28,466	37	35,393
Pattani	1	752	1	752
Total	310	176,949	248	143,961

Source: Havanond, (1997)

Table 3. Mangrove Forest Concessions in Ranong, Thailand (1986-2002)

Concession areas name	District	Area (ha)	Commenced (y)	Ended (y)
Klong Lam Liang	Kra buri	978	1986	2001
Klong Bang Yai	Kra buri	1,046	1986	2001
Klong La-un	Muang	1,046	1986	2001
Klong Set Kuad	Muang	616	1986	2001
Klong Lat Sang	Muang	876	1986	2001
Klong Porn-Rang	Muang	769	1986	2001
Klong La Ong	Muang	742	1986	2001
Klong Ko Sam	Muang	1,301	1986	2001
Klong Lao Non	Muang	1,477	1986	2001
Klong Lat Kapoe	Kra poe	1,012	1986	2001
Klong Kapoe (right)	Kra poe	754	1986	2001
Klong Kapoe (left)	Kra poe	721	1986	2001
Klong Koka_Chaklee	Kra poe	1,206	1986	2001
Klong Ko Kum	Muang	832	1986	2001
Klong Sai Khaow	Muang	1,005	1986	2001
Klong Muang Kluang	Kra poe	725	1986	2001
Klong Ko Jak	Muang	777	1987	2002
Klong Ko Jak	Muang	1,131	1987	2002
Ko Noo	Muang	602	1987	2002

Source: Royal Forest Department, RFD (Unpublished data referred to in Plathong, 1988)

5. Agriculture: Peninsular Thailand has very few agricultural areas located in former mangrove areas because of the acidity of the soil, which results in low productivity. However, some rice fields can be found in the mangrove areas of Satun province. In the provinces along the Andaman coast, such as Phangnga and Krabi, there are also palm tree, coconut and rubber plantations in mangrove areas. Converting mangroves into agricultural land involves digging narrow canals and piling up extracted soil to form bunds on one or both banks of the canal. The bunds generally prevent seawater intrusion. This may lead to extensive loss of mangrove areas and their productivity. In addition, the canals cause a change in the freshwater regimes of unreclaimed seaward mangroves and can have deleterious effects on the system.

6. Coastal development : Destruction of the mangrove forests and conversion of mangrove lands to domestic and industrial development is occurring in Thailand. The most common forms of conversion are housing and residential development and the development of tourist facilities on the Peninsular, including small port development. Urban development represents maximal density of human

settlement. Mangrove forest can be totally reclaimed for road construction and land modification. In addition, road construction through mangrove areas obstructs tidal and freshwater flows. Traditionally, mangrove areas have been regarded as wasteland, and much solid waste and garbage refuse has been dumped into mangrove ecosystems. Generally, channels and ports are constructed in response to needs for passageways and docking locations, and serve as routes for transporting marine catches to consumers and for tourism. Such works and associated dredging require specific expertise in selecting appropriate sites and construction and dredging processes. Prior to these processes, environmental impact assessments should be conducted to reduce any impacts from chemicals and contamination from materials used during the construction.

Community dependence on mangrove forests

Mangrove forests support a variety of wildlife, including birds, fish, amphibians and mammals. These animals constitute an important resource for the population of the Andaman wetland and coastline areas, especially shrimp, shellfish, crab and fish, which local villagers both eat and sell throughout the year. Thus the Andaman coastal community depends on the fertility of the mangrove forests.

Mangrove forests serve as breeding grounds for many aquatic animals. They play a vital role in the coastal ecology by acting as a buffer to sea winds and waves, while at the same time decreasing air and water pollution. Unfortunately, large areas of mangrove forests have been destroyed, which has resulted in a decrease in local marine life populations (IUCN, 2007). As the livelihoods of many members of Andaman coastal communities have been put at risk by the destruction of mangrove forests, their rehabilitation is a matter of national interest.

As mentioned above, mangrove forests are a significant natural resource for a variety of reasons:

1. Wood from mangrove trees is used for firewood and charcoal, as a building material, and in the distilling process to produce tannin, alcohol, acetic acid and tar.
2. Mangrove forests are used as fisheries for marine life, such as white thicket, *Cromileptes altivelis*, sea mullet and the Nuanjan sea fish. Of particular importance is their use as breeding grounds for many kinds of shellfish, including oysters, sea mussels and ark shells, as well as crustaceans, like the sea crab and horse crab, among others.
3. Mangrove forests help to preserve the coastline by decreasing water pollution and increasing the fertility of the land. They can also reduce the impact of waves and wind by absorbing the energy of waves, an especially important attribute during a tsunami.
4. Mangrove forests help prevent sediment and toxins from flowing into coastal areas.

Many local fishermen live in the mangrove forests scattered along the canals on the Thai Andaman peninsula. Most of these forests are under the management of the RFD. In recent years, the total area of mangrove forests in peninsular Thailand has declined considerably, from over 334,600 ha in 1961 to 200,944 ha in 2004 (Table 1). Within 43 years from 1961 to 2004, an area of over 185,125 ha of mangroves has disappeared in Peninsular Thailand (DMCR, 2004). The mangrove destruction currently underway in Thailand is due to the dual causes of over-exploitation by traditional users and activities related to unsustainable uses of mangroves.

Most of the mangrove forests around major areas of human population settlements have been destroyed or degraded. The major threats are conversion to aquaculture ponds, clear-felling for timber, charcoal and wood chip production for industry, urban development and other land uses. Recently, widespread urban development and over-exploitation of peninsular resources have been the factors most responsible for the degradation and destruction of mangrove ecosystems in the provinces of peninsular Thailand.

Mangrove community forest

Mangrove community forests are comprised of forested areas around local communities in the Andaman peninsula. These forests are extremely important to the local economy and ecology. Local communities must work together to decide on the best way to manage these endangered forests sustainably.

(1) Managing the community mangrove forests

Management of the mangrove forests by local villagers has to take into account the wide variety of uses for the forests, as, for instance, they function as fisheries and places for ceremony. Each mangrove community has a forest council responsible for the management of the local forest.

Mangrove forest councils are organizations set up by villagers who sit on a permanent village committee or *Tumbol* committee, *Tumbol* committees are comprised of elders in the community, along with Buddhist officials from local temples. These committees are responsible for protecting the forests through the development of legislation and regulations about their use, as well as penalties for violators. The *Tumbol* committees also determine how the resources of the forest are used for the benefit of the entire community. While there are inevitably disagreements on the best way to manage these resources, every member of the community realizes the importance of developing a plan for their conservation.

Examples of some of the regulations developed in the King of Naga *Tumbol*, in *Amphur* Suksamran, Ranong province are :

1. Prohibiting individuals from acquiring mangrove forest community areas.
2. Permission to cut down trees in forest wetland areas must be sought from the community forest committee.
3. If trees are cut down without permission from the community forest committee, punishment will be meted out according to the law.

2 (Case Study: Ban Bang Tip *Tumbol* Bang Van *Amphur* Kuraburi, Phangnga Province.

In 1996, the community of Ban Bang Tip developed their concept of mangrove forest resource management. In the beginning, the program encountered many problems. However, the community learned from these setbacks and work has continued to this day.

Some of the problems stemmed from disagreements about resource management of the sea, forests and rivers,

particularly regarding the use of chemicals. A return to natural ways and the use of herbs was advocated by fishermen and agriculturalists. Eventually, this community received the Global Green award for their successful conservation of a mangrove forest covering more than 960 ha with some 150 families contributing to this effort. This success came despite conflict between groups regarding differing opinions on how to best manage the community's resource (IUCN, 2007).

Discussion

Historically, Thailand's mangrove forests have covered vast areas and were extremely fertile; unfortunately, it has not taken much time for these forests to suffer a significant reduction in size. The primary culprits have been those involved in farming aquatic animals, salt farming, cultivation for agriculture and mining concessions, as well as the expanding human population. Currently, mangrove forests are found chiefly in six provinces on the Andaman coast. The east of Thailand only has a tiny patch of mangrove forest remaining. Communities along the Andaman coast have been co-operating to conserve and replenish the remaining mangrove forests, so that their children can benefit from this vital resource. This restoration effort is being undertaken through a partnership between the government and the private sector. The trend of community involvement in mangrove forest management in conjunction with experts in the field is a very encouraging one, and, despite the inevitable conflicts, this model is the best hope for their restoration.

Acknowledgements: The author extends appreciation to the staff of the Andaman Coastal Research Station for Development, Kasetsart University Research Development Institute (KURDI) for their help with this work. Special thanks go to all the staff of the Forestry and Forest Products Research Institute, Japan (FFPRI) along with the co-research team for contributing to the funding for the seminar. Finally, the author expresses gratitude to Dr Kurashima Takayuki, Dr Tabuchi Ryuichi and the Director of the FFPRI, for helping with the project in Ranong province, Thailand.

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Practical recognition about environment coping approach by NGO: A case of *Jhamna char* in Bangladesh

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Abstract: This paper aims to examine the methodology of how to collect local experience and knowledge to deal with the paradoxical issue of development and environmental preservation. The case study was conducted at *Jhamna char* in Bangladesh observing people's coping mechanism with their hush environment. The participants of the case study were mainly NGO workers but not only researchers. Because they have implemented similar activities on daily basis, their viewpoints showed practical notices about their environment coping. The role of the researchers on it was to establish system to organize their findings and to express them in words. It must be simple but clear method if you want to make it practical for their activities.
Key words: Environment coping approach, NGO, social software, *Jhamna char*, PLA, KJ method

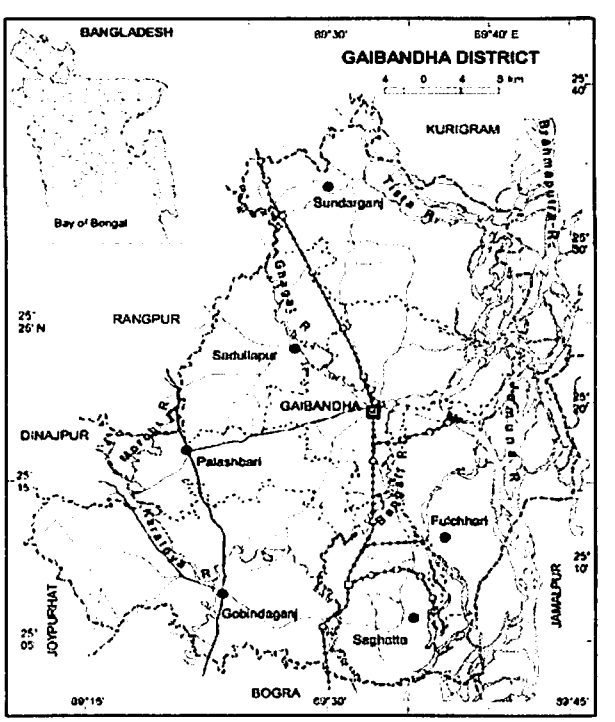
Introduction

Bangladesh has been discussed as one of the countries with the severe problems of poverty in the world. Like other developing countries, they have tried to address the problem caused by the pressure of overpopulation through excessive development of modern agriculture. However, as development approaches are progressed, new environmental problems have arisen, such as arsenic contamination of underground drinking water caused by expansion of rice cultivation using irrigation, or soil erosion from extensive deforestation. This kind of contemporary challenges of "attaining both development and environmental preservation" is not just a rhetoric, but a practical issue that affects the people's existence. People living in Bangladesh have faced a serious/urgent need to resolve this paradox. This project tries to find the countermeasures for this compatibility in Bangladesh, from the perspective of the local people or the expertise of NGOs who have worked with these problems at the grass-roots level. This paper will examine a methodology that collects their experiences and knowledge from local people and organizes them into a usable system. We call this approach/method "Social Software." The purpose of this project is to consider the balancing between environment and development, based on experiences of local people and NGOs. To begin with, we built the forum with local NGOs who have experience to work for environmental issues at the grass-roots level. 15 NGOs participated the first meeting and formed "Environment Coping Forum" with a researchers' team. The scale of the NGOs was varied from national NGOs working in several districts to, so called, local NGOs focusing on a village, but not including very big organization. The name of "Environment Coping Forum (ECF for short)" was decided by their agreement they achieved in their discussion of their development policy/trend.

Among 15 NGOs who compose ECF, five NGOs were chosen to conduct case studies as they have been working with typical environmental problems in Bangladesh such as; a flood plain of *Jhamna* river, the coastal encroachment at *Hatiya* Island, a scaled *hawar* (wetland), in *Kishoregang*, frequent flood and cyclone affected area in *Barisal*, and extensive deforestation in *Kagrachuri*. It was emphasized that the significance of the case studies should be neither to evaluate nor to give advice on them but to learn from their activities.

For the purpose of this project, PLA (Participatory Learning Action/Appraisal) could be used as a basis, whose aim is to learn from the local people, listening to the environment, and implementing projects with the people. Besides that approach, our aim is to define the methodology to collect their experience and knowledge and to put them into practical use. The findings of each member through PLA were analyzed by KJ method at the participatory workshop. A classification system is to use category cards for KJ method. The name of KJ method has come from the investor Kawakita Jiro, a Japanese Anthropologist. We conducted experiments with ECF members at their five working sites. This paper introduces the first case of *Jhamna char*.

Location: The first case study was held at SKS (*Samaj Kallyan Sangstha*) Foundation training center in *Gaibandha* from January 19th to 24th, 2008. A total of 24 people including ECF members and researchers team attended. *Gaibandha* is located on the western coast of *Jhamna* River (Brahmaputra River).



The water level fluctuation is huge such that even in areas that get flooded during the monsoon, people do farming during the dry season. Also, there are a number of *chars* (sandbars) and many people living there throughout the year. Needless to say, there is a huge variation in the change in people's lives, depending on the seasons. Furthermore, the fluctuation of flow channel caused by the yearly floods has been especially significant in the recent years, and it has become more difficult to acquire permanent land than before. People are forced to move their residences every few years, and they are not guaranteed land ownership.

SKS, who is in charge of hosting this case study, has been providing support to improve the quality of life for people living on the *char* or river-basin of *Jhamna* River since 1987. The SKS headquarter is located in *Gaibandha* and they are active in *Gaibandha*, *Rangpur*, and *Bogra*, all of these three districts face the *Jhamna* River.

The Procedure of Case Study: At first, the participants were split up into two groups, about 10 people each, and visited the field to observe SKS activities and the lifestyle at *char* and basin of the *Jhamna* River. They mainly visited areas receiving SKS support to improve quality of their life and farming, having women's *shomity* (community/group) activities, their medical programs, and informal education. The study focused on the following five points to learn: (1) What is SKS doing? (2) What services does SKS provide? (3) How do community people react? (4) How do community people cope with ongoing programs? (5) How does SKS staff cope with the people or their environment through providing programs?

SKS staffs joined the groups and introduced the activities. They investigated how the local people were making use of these activities, what and how things have changed before and after these activities. The participants also got a lecture on activities by SKS staffs. While their field study provided primary information based on their actual observation, the lecture gave secondary information as to include a hearing investigation from the staff view, which addressed the policy under which staffs carry out the activities or interacts with the local people.

In the second part, we extracted findings from the field study using the KJ method. All of the field study participants submitted three keywords that they noticed or felt important. Each key word should be written on a small card and the reason why they thought it important should be behind. Each person prioritized these words and presented them accordingly in front of other members. Then these words were categorized into "livelihood," "agriculture," "environment," "credit program," "hygiene," and "other." The characteristics of each category were then extracted in their ranked order. They were asked to write down the key words without notified about the categories mentioned above. When all the key words were submitted, they were classified into categories. Therefore the same person's first and second prioritized words may end up in the same category.

Priority issues' ranking: The chart shows the number of votes classifying feedbacks through the KJ method.

First priority: Many of the participants ranked "livelihood" as the first priority. In particular, it became apparent that with an encouragement from SKS, many of the local *char* and river-basin residents have valued livestock more than farming. It is because the flood could render farming impossible in monsoon season, but livestock could be managed year round. Also, during the change of seasons and at unexpected natural disaster, livestock (mainly cows) can be moved relatively easily. As "portable properties," tin structures were preferred over mud and brick walls in the construction of their houses. It could be disassembled, moved, and reused in the event of a flood.

Priority	Rank 1	Rank 2	Rank 3
Livelihood	11	4	4
Agriculture	7	4	2
Education	2	3	2
Health	1	5	6
Environment		4	5
Credit Program			1
Hygiene			1
Other		1	

Many participants also ranked their efforts in the agriculture as first priority. They pointed out their cultivation of pumpkins and *jambu* grass in sandy soil at *char* and the river-basin during the short dry season. Not only can *jambu* grass be used as livestock feed, but if the farmers dig up the roots before monsoon season, it can be replanted after the flood water recedes. These benefits make *jambu* grass suitable for their "seasonal nomadic lifestyle". Pumpkin cultivation was one of the farming technologies taught by SKS that allowed farming in the once unusable sandy soil. The cultivation has spread as pumpkins became a cash crop during the dry season. Also, other techniques were implemented, such as rotational cultivation of three types of crops in the same area, improved varieties with short cultivation period, and the development and provision of agriculture suitable for this particular region.

In both education and health categories, mobile schools and hospitals were suggested.

These prioritized points are specific approaches to improve quality of life that presupposes relocation of people due to the effects of flood.

Second priority: There are more variations in the second priority categories than the first. In points of livelihood, some approaches similar to those taken for the first priority have fulfilled the function of women's empowerment advocacy, and individual approaches have provided integrity to people's lives. They also mentioned about the continuity that allowed people to accept these approaches in agriculture, because it was not completely new to local people but an enhancement of the local technology.

Third priority: We could see more diversity on the categories in the third priority than in the second. It is keenly noticeable that the points stated in the third were about preservation of intrinsic local culture in both livelihood and agriculture. For example, while the use of improved rice seeds has been widespread, sustaining a millet farm is more suitable when considering the weather,

ease of farming, and laboring condition. SKS does not negate this, and they are highly valued for their position to promote diversity by bringing in new materials while respecting their local knowledge and technology. Similarly, in the field of education, they emphasized the connection between lifestyle and everyday items, such as a pen case, which was made out of local materials. It could be understood that this consideration for traditional culture (knowledge) is essential for development that takes into account their environment.

Integration: These findings could be integrated by stages. As stated above, specific approaches with a focus on livelihood and agriculture were prominent in the first priority. In the second priority, points were related to providing information and indirect effect caused by the specific approaches. It could be explained from the SKS policy that their activities should be based on local people's lifestyle and allow mutual relationships while maintaining their diversity. Furthermore, the third priority showed consideration to existing cultures and humanity in *char* area. In order to carry out the people-oriented (participatory) development, it must be crucial that they use a method that fits the local lifestyle and culture.

Coping with livelihood: As seen in the prioritization above, the coping mechanism in the livelihood category was determined to be the most important issue in this case study. The participants identified the following key points in the environmental problem: annual floods, fluctuation in the *char* and destruction of the river, destruction of riverbank due to unexpected cyclone, and labor problems of people losing their land during monsoon season. As an effort to improve quality of life based on these environments, the coping mechanism can be understood by the following activities: (1) Escape small flood damage by strengthening the home foundation, (2) Promote domestic farming in the dry season, (3) Promote livestock industry, (4) Promote improved furnace

As I mentioned above, their lives in this area vary largely between in monsoon season and in the dry season. In addition, the fluctuation of the river basin poses a risk of flooding to their land and farmland. The power of nature is immense, and people must make lifestyle improvements that meet the changes of the environment. People have learned through their experience that it is most prudent to make their lives sustainable.

There are some typical examples of people using/arranging SKS coping system on their own. For instance, SKS introduced improved furnaces that had the benefits of being portable and having high combustion efficiency (photo 1). They use charcoal made from cow dung instead of wooden fuel (photo 2). However, the women have used them in the traditional fixed furnace and invented "eclectic furnace" in which the fire does not burn out even when they left unattended (photo 3). Although the fuel consumption rate might go down a little, there is an added convenience for women to be able to do other work while the pot sits on the fire.

In another example, the portable storage boxes for flood can also be used during the dry season as a safety box when the women work out at others' houses. Also, informal education initiated by SKS became an example for people who started similar simplified community schools where they do not have any schools.

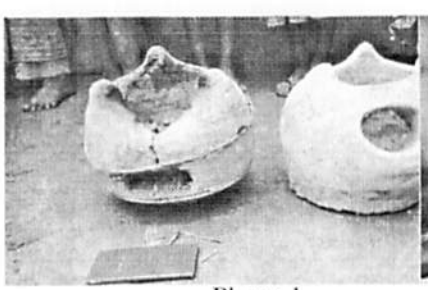


Photo 1

Photo 2

Photo 3

This kind of effort from local people shows subjective approach that incorporates SKS environmental coping mechanisms into their lives. The reason why this was possible might be because the SKS activities liberally incorporated not newly borrowed technology but the local existing life-technology. Coping mechanisms are truly the sight of SKS and people who are seeking development (improvement in quality of life) and mutually working together to improve the technology that allows their lives to adapt to the threat of nature.

Conclusion

This study introduced a methodology of how to collect experience and knowledge of local people through sharing practitioners' findings, using the KJ method and extracting the staged views of their activities. This method must be simple enough to make local people and practitioners understand. At the same time, two significant points made it possible; first, all participants of this case study were practitioners who have implemented the social development on a daily basis and have the intuitive viewpoint on those problems and on activities. Furthermore, we did not passively perform the case study on people's life at *char* area, but focused on dynamic activities of SKS. By conducting research based on their experiences and practices, we could discover the hidden coping mechanism and hopefully the way of recognition of local experience and knowledge, namely "Social Software," might be able to link them to their further practices.

This case study was not a criticism of the SKS activities, the slogan among the study team was "not a critique but an involvement". At first, for NGOs who are used to criticisms by researchers or aid agencies, it took time before they understood that this case study was not for evaluation. However, by scrutinizing the people's lives, and not just the SKS activities, we could elucidate connection and mutual effect between the lives of people and the SKS activities, or coexistence of environment and development. The practical recognition that overcomes and responds to the paradox could be shared under the ECF network and lead to further practices.

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Fisheries activities in floodplain of Mekong river basin

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Abstract: Floodplain in riparian swamps is important as feeding and breeding habitats as well as nursery ground for anadromous fishes inhabiting the Mekong river basin. We demonstrated in this study fisheries activities in the floodplain of the middle Lam Se Bai, which is one of the secondary branches of the Mekong river. Water level of the Mekong-Mun-Chi river basin was controlled by 22 dams in the northeastern Thailand, and the river flooded occasionally in the peak of the rainy season between August and October toward the floodplain. The maximum annual range of water level exceeded 18 m. The seasonal flooding was largely concerned with the life cycle of fishes and fisheries activities of local inhabitants. A lot of traditional fishing gears have been developed through generations of fisheries experience and knowledge. Local inhabitants operated 13 kinds of fishing gears, including unique indigenous branch stake trap "luan loub" and net trap "pon paan". The efficient use of these gears depended on understanding of fish behaviors, habitat and seasonal environmental conditions. A total of 45 fish species of 33 genera were treated at local markets. Thus, riparian swamps provided ecological services of abundant fisheries resources for local inhabitants in the Mekong river basin.

Key words: Fisheries, fishing gear, riparian floodplain, swamp, environment, Mekong river

Introduction

The Mekong is the world's 10th longest river which flows over 4,909 km^2 from the Tibet Plateau in China to its mouth in Vietnam through Myanmar, Laos, Thailand and Cambodia. Extremely high biodiversity and productivity in the Mekong river basin support the world's largest inland fisheries, in which the estimated annual production is 2.1 million tonnes and 2.1-3.8 billion US$ (Dugan *et al.* 2010). It is assumed that nearly a thousand of fish species inhabit the Mekong river basin (Dugan *et al.* 2010; Mekong Watch 2004). During the rainy season, a lot of fish species living in the trunk of the Mekong river migrate to the branches on certain stages of their life cycle (Paulsen *et al.* 2002). Thereby, floodplain in riparian swamps is important as feeding and breeding habitats as well as nursery ground for these anadromous fishes inhabiting the Mekong river basin.

However, as forests decreased drastically from 50 % by 20 % in the past half century in Thailand, the fish habitats in swamp forests decreased largely. Dam constructions alter river flows, disrupt the connectivity, change the environmental conditions, interrupt fish migrations, and reduce the feeding and breeding habitats. Other artificial impacts such as dike and levee construction, diversions, draining of wetlands, urbanization, navigation, pollution, overharvesting, introduction of exotic species as well as climate change also affect directly and indirectly the Mekong river ecosystem (Dugan *et al.* 2010; MRC 2007). As a results, biodiversity and productivity of the fisheries resources face the threat of decline in recent years (Mekong Watch 2004; MRC 2007; DOF 2008). Appropriate management and conservation of riparian swamp forests are required for utilizing sustainably the fisheries resources.

In this study we demonstrated fisheries activities in the floodplain of the middle Lam Se Bai, which is one of the branches of the Mekong river, as well as the biological diversity and the productivity of fisheries resources supported by riparian swamp forests.

Materials and Methods

Main study site was established on the floodplain of riparian swamps along the middle Lam Se Bai (15°35'23"N, 104°27'44"E) in Na Kae village, Kham Khuan Kaeo district, Yasothon province, northeastern Thailand (Fig. 1). The streams of the Lam Se Bai start from the northern hillside, flow toward southward and connect to the Mun river which is one of the main branches of the Mekong river. Therefore, the Lam Se Bai is a small secondary branches of the Mekong river basin.

We studied (1) aquatic organisms in riparian swamps, (2) fisheries activities in riparian swamps and (3) livelihood of fishermen from the biological, fisheries and social scientific standpoints, respectively (Fujioka *et al.* 2010). In this report, we demonstrated some indigenous fisheries activities related to fish behaviors, habitat and seasonal environmental conditions to reveal the relationships between riparian swamps and livelihoods of local inhabitants.

This study was done in collaboration and coordination among several Japanese and Thailand research institutes; that is, National Research Institute of Aquaculture, Japan (NRIA), National Research Institute of Fisheries Engineering, Japan (NRIFE), Forestry and Forest Products Research Institute, Japan (FFPRI), Japan International Research Center for Agricultural Sciences (JIRCAS), Faculty of Fisheries of Kasetsart University, Thailand (KU) and the Chulalongkorn University, Thailand (CU).

Results and Discussion

In the northeastern Thailand, water level of the Mekong river basin was controlled by 22 dams arranged along Mun river, Chi river, Lam Se Bai and some other branches. Some of them were indicated in Fig. 1. In our study site, Na Kae village, the water level was controlled by two small irrigation dams (or weir); that is, Lam Se Bai Dam (Fai Kon Khang Lam Se Bai) in the upper side and Pa Ao

Dam (Fai Pa Ao) in the lower side..

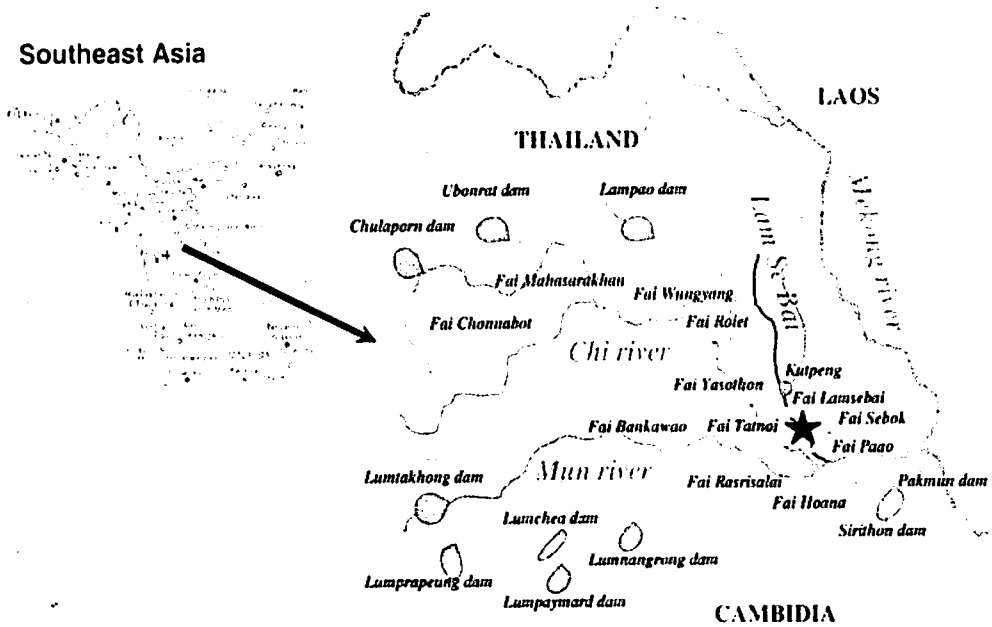

Fig. 1. Map of Southeast Asia and northeastern Thailand. Study site in Lam Se Bai was indicated as star.

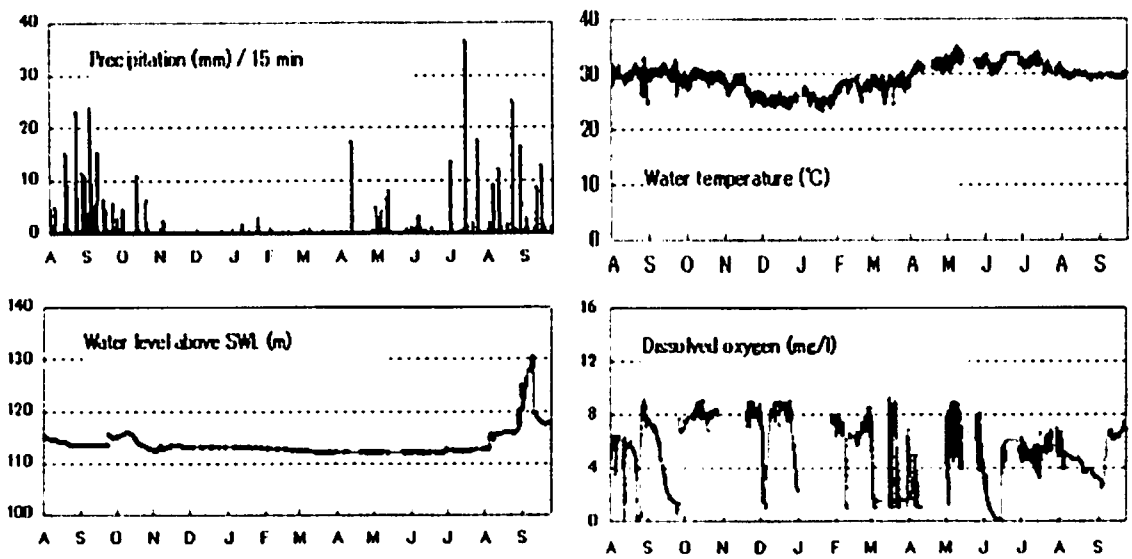

Fig. 2. Seasonal changes in water environments of the middle Lam Se Bai (left two) and the Chi river (right two). Original data were collected from August 2009 to September 2010 by Department of water resources, Thailand.

Seasonal changes in water environments of Lam Se Bai and Chi river were summarized on the basis of monitoring data from August 2009 to September 2010 collected by Department of Water Resources (Fig. 2). More than 92 % of precipitation was concentrated during the rainy season of six months between May and October. There was little rain during the dry season between December and April. Water temperature was fluctuated seasonally with the range of 23.1-34.8 °C, and the highest on May and the lowest on January.

Water level sometimes increased largely in the rainy season and the maximum annual range of water level exceeded approximately 18 m between 112.1 m and 130.4 m above sea water level (SWL). When water level of

upper dam (Lam Se Bai Dam) exceeded 118 m above sea water level, dam gates opened to avoid water flood in the upper areas. As a result, the riparian swamps around Na Kae village flooded occasionally in the peak of the rainy season between August and October (Fig. 3). Though water depth in the center of the river was less than only 1 m during the dry season in our study site (left of Fig. 3), it sometimes became nearly 10 m in the peak of the rainy season (right of Fig. 3).

Fig. 3. Riparian swamps and floodplain in Lam Se Bai survey site. Left: late dry season (April), center: early dry season (December), right: middle rainy season (September). Circles in the figures indicate the top of same pile.

Dissolved oxygen (DO) in the water fluctuated largely throughout the year. In the rainy season, water sometimes flooded from the river branches toward the swamp forests of floodplain. Since water stagnant near the riverside and in the floodplain, dissolved oxygen in water decreased largely near the bottom layer.

In the Mekong river basin, a lot of fish species living in the trunk of the mainstream migrated to the river branches during the rainy season for feeding, breeding and nursing (Paulsen *et al.* 2002). Among 850 fish species recorded from the Mekong river basin, 135 of which migrated within the river on certain stages of their life cycle (Dugan 2010). Thus, the seasonal flooding was largely concerned with the life cycle of fishes and fisheries activities by the inhabitants.

Approximately 3,600 inhabitants were living in eight communities ("mubaan") of Na Kae village, in which at least 55 inhabitants were associated closely with fisheries activities in Lam Se Bai (Table 1). A lot of traditional gears have been developed through generations of fisheries experience and knowledge of fish behaviors, habitats, and seasons. Fishermen in Na Kae village operated 13 different kinds of fishing gears by season and by target fishes; namely, gill net ("dan"), cast net ("hue"), trap fishing ("tun pra yon"), scoop net ("yoo"), branch stake trap ("gip", "luan loub"), net trap ("pon paan"), shrimp net trap, crap cage trap, and so on (Fujioka *et al.* in prep.).

Table 1. Population, number of households and number of fishermen in Na Kae village

No.	Village	Population	Households	fishermen
1	Na kae	520	126	
2	Plait	663	151	29
3	Na lue	1,018	196	
4	Noang toe	423	89	
5	Moang	324	71	15
6	Loaw trong	163	40	
7	Noang tug luk	198	51	
8	Plait	296	64	11
	Total	3,605	788	55

Especially, net trap "pon paan" and branch stake trap "luan loub" were the unique indigenous fishing gears in the floodplain of the middle Lam Se Bai. Some pictures and the schematic structures were shown in Fig. 4 and Fig. 5, respectively. The "pon paan" was a kind of net trap found in the center of the river stream (Fig. 4, upper three). Approximately 20 m long net was set between main gates which were made by wood piles to collect various fishes swimming in the middle and the lower layers of the river. The highest pile stands nearly 9 m high above the riverbed (circles in Fig. 3).

Whereas the "luan loub" was a kind of branch stake trap found in the floodplain. "Luan" means tree fence which was made by dried branches of "hualing" tree (1.4-1.8 m in length) align according to the terrain vertically to the river stream (Fig. 4, lower three). Density of dried branches was 34-46 (average 38) pieces per meter. Cylindrical shaped fish traps "loub" (1.3-1.6 m in length and 0.4-0.5 m in diameter) were put on the triangular opening (0.2-0.4 m in height and 0.2-0.25 m in width) near the base of the "luan". The gears were made predominantly from locally available materials, such as

tree, branches, ivy, bamboo, rocks and so on, but nylon net was also used to cover the outside of the fish trap. A lot of "luan loub" were densely arranged in the riparian floodplain in both sides of the middle Lam Se Bai, as shown in Fig. 6. A total of 19 "luan loub" were recognized within about 4 ha areas of our survey site. The horizontal distance of tree fence "luan" varied from 7.3 m to 91.7 m, in which 2-24 fish trap "loub" were arranged, and therefore every fish traps were set 1.8-6.4 m intervals each other.

As shown in Fig. 5, "pon paan" was a fishing gear which collected catadromous fishes going to downstream; on the other hand, "luan loub" was a fishing gear which collected anadromous fishes going to upstream against the mainstream of the river. Fishermen could collect effectively the descending fishes by means of "pon paan" because water stream in the center of river flowed strongly during the rainy season (Kuwahara *et al.* 2010). Likewise, they collected effectively fishes by means of "luan loub" because water current was extremely gentle and sometimes stopped or flowed backward in the bottom layer of floodplain (Kuwahara *et al.* 2010).

Every fishing gear belonged to the owners of Na Kae village, as shown in Fig. 6. Every fisherman had 1-9 "luan loub", and a total of approximately 200 "luan loub" were arranged along the middle Lam Se Bai. Whereas "pon paan" was operated collaboratively by several fishermen since it was a large equipment. A total of 26 "pon paan" were arranged in the middle Lam Se Bai. Fisheries by means of these fishing gears were restricted to three to five months between June and October when the water level increased. Local inhabitants in Na Kae village operated these fishing gears as a routine work during the flooded periods of rainy season. They collected fisheries products every day about 5-20 kg and 1-5 kg by means of "pon paan" and "luan loub", respectively.

In addition to the direct contribution of fisheries of villager's livelihoods, there were many additional economic benefits from engaging in fish processing and marketing. In the Mun river basin, commercial fisheries were developed and most of fisheries products were traded as fresh fish in local market or as processed products to brokers (MRC 2007). Whereas in Lam Se Bai, most fisheries were not the commercial but community-based activities because the fisheries production was not large and most aquatic habitats in the floodplain were difficult to introduce large fishing gears. Most fisheries products in Lam Se Bai were predominantly consumed by themselves in the village, and only a few products were distributed to the local market. A total of 45 fish species belonging to 33 genera and 14 families were collected by means of these fishing gears and/or treated at local fish markets. In these areas, species of cat fishes belonging to the families Notopteridae (*Chitala, Notopterus*), Bagridae (*Sperata, Hemibagrus*), Siluridae (*Belodontichthys, Micronema, Ompok, Kryptopterus, Wallago*) and Pangasiidae (*Helicophagus, Pangasius, Pangasianodon*), and various cyprinid carps (*Cyprinus, Barbonymus, Cirrhinus, Cyclocheilichthys, Hampala*, etc.) were dominant (Fujioka, unpublished). In addition to them, some famed freshwater fishes, such as *Clarias* spp. and *Oreochromis niloticus*, were sold frequently at local fish markets.

Thus, riparian swamps provided fundamental ecological services of abundant fisheries resources for local inhabitants living along the Mekong river basin. The efficient use of the indigenous fishing gears depended on understanding of fish behaviors, habitat and seasonal environmental conditions. As a results, fisheries by means of these gears were in harmony with the ecology of the river and presents little threat to wild fish stock; and as a results, they could utilize sustainably fisheries resources in this area. For local inhabitants, floodplain in riparian swamps was the place in which they could obtain natural resources supporting livelihoods through traditional routine fisheries activities and being the sacred site as well.

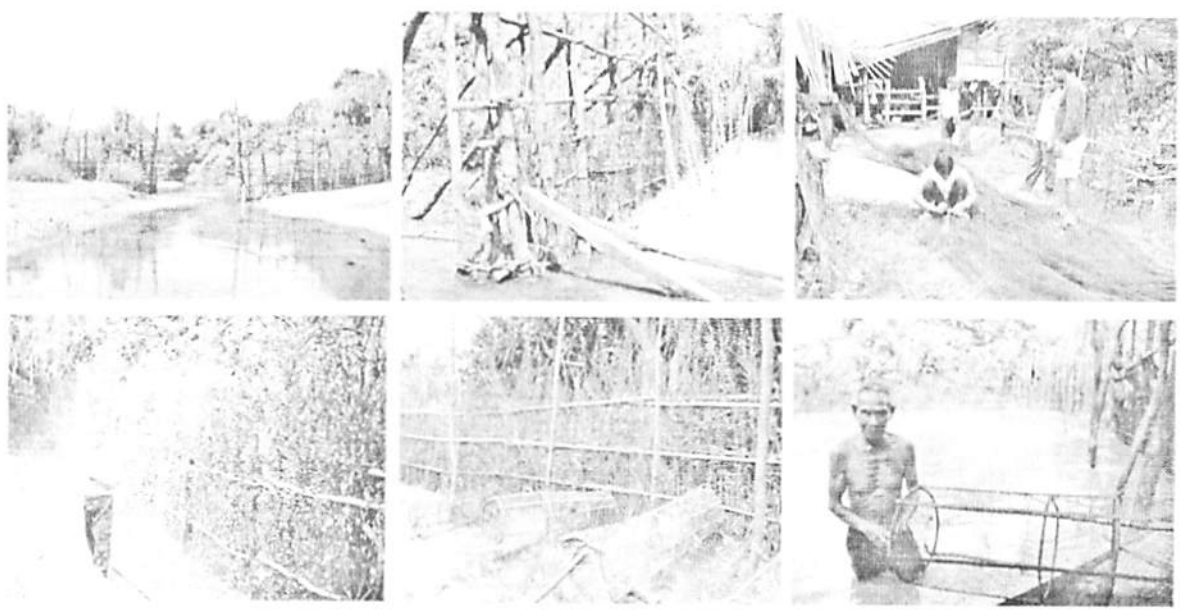

Fig. 4. Indigenous fishing gears found in riparian floodplain of middle Lam Se Bai, net trap "pon paan" (upper three) and branch stake trap "luan loub" (lower three).

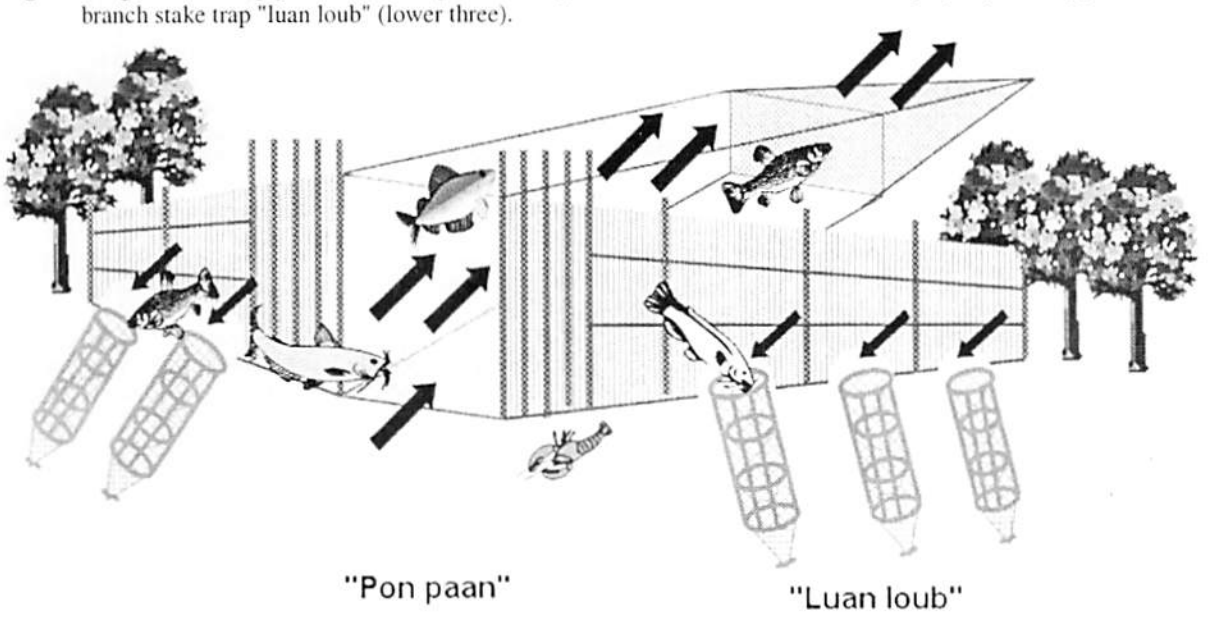

Fig. 5. Schematic structure of indigenous fishing gears, branch stake trap "luan loub" and net trap "pon paan". Arrows in the figure means the direction of water current.

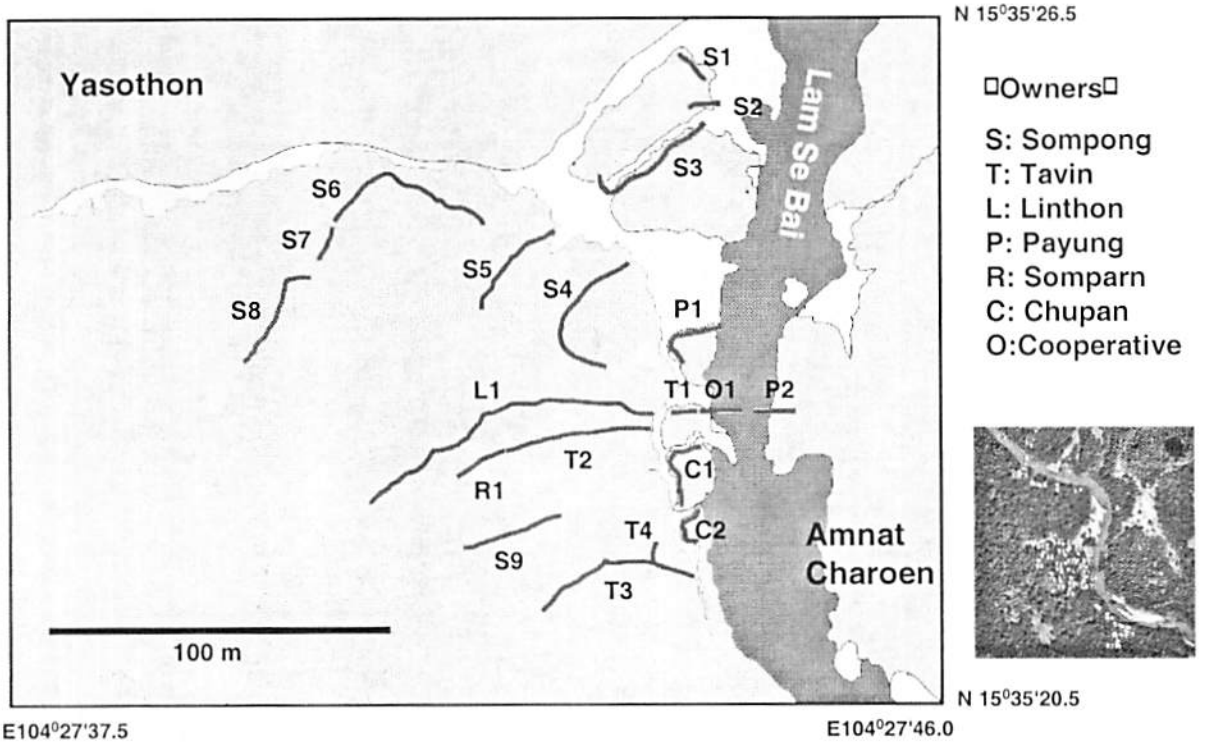

Fig. 6. Spatial arrangement of indigenous fishing gears, branch stake trap "luan loub" and net trap "pon paan" along Lam Se Bai. Every gear belongs to owner(s) (S, T, L, P, R, C, O).

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Traditional skills and knowledge inherited from Japanese swidden cultivation: Toward restoration of degraded *Satoyama* forests

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Abstract: In this study, we examined the potential of swidden cultivation as a form of environmentally sustainable agriculture in intermediate and mountainous areas of Japan. In 2010, almost 1000 m^2 of scrub forest dominated by bamboo (*Sasa* sp.) was slashed and burned for swidden cultivation in the town of Yogo, Shiga Prefecture. After burning, half of the swidden field was plowed with hoe, and then the entire field was sown with turnip (*Brassica rapa*) seed. The fire left a layer of ash on the soil surface, which may have supplied sufficient nutrients to the surface soil for successful cultivation of the turnip crop. By mixing the ash with organic matter in the surface soil, surface plowing appeared to be very important for creating suitable conditions for crop growth. Plowing also appeared to help prevent ash runoff. In addition, almost no weeds were observed during the turnip cropping period, probably because of the intensive burning. About 3 months after sowing, approximately 350 kg of turnips were harvested, without the use of any fertilizer, chemical pesticide, or herbicide; the success of the crop was attributed to effects of burning and plowing. Swidden cultivation still plays an important role in food production in mountainous areas of Japan, and contemporary swidden cultivation has potential as an environmentally sustainable form of agriculture.
Key words: Burning, plowing, environmentally sustainable agriculture

Introduction

Traditional livelihoods and agricultural landscapes in Japan have changed drastically since the mid-20th century, mainly due to rapid economic growth, introduction of chemical fertilizers and fossil fuels, urbanization, and depopulation of rural areas. *Satoyama*, a land use mosaic composed of woodlands, paddy fields, crop fields, grassland, and settlements, is a typical agricultural landscape in Japan (Ichikawa *et al.*, 2006). In the woodlands, called *Satoyama* forests, people felled trees for timber and charcoal, cut shrubs for firewood, and collected litter for compost. However, the *Satoyama* forest environment has changed dramatically since these activities were largely halted in the 1950s (Morimoto and Yoshida, 2005). Consequently, most *Satoyama* forests have been abandoned and their ecological functions have been degraded. Recently, there have been many attempts by community-based organizations to restore the ecological functions of *Satoyama* forests. However, these efforts are not sustainable in the long-term because most of these activities depend largely on volunteers and are no longer tied to human livelihood.

In the intermediate and mountainous areas of Japan, swidden cultivation was widely practiced in the past. Secondary forests that recovered during the fallow period of swidden cultivation were utilized for collection of firewood and litter and functioned similarly to *Satoyama* forests. As noted by Sasaki (1972), the total area of swidden fields in Japan decreased sharply during and after World War II, from 77,000 ha in 1936 to 10,000 ha in 1950. Although the total area of swidden fields decreased sharply, the decrease in the number of households engaged in swidden cultivation was rather gradual; around 110,000 households were estimated to be engaged in swidden cultivation in 1950 (Sasaki, 1972). In some areas of Japan (e.g., Tsuruoka in Yamagata Prefecture, Miyama in Fukui Prefecture, Yogo in Shiga Prefecture, Shiiba in Miyazaki Prefecture), local people still engage in traditional swidden cultivation.

The environmental heterogeneity of the *Satoyama* landscape, created by the mosaic of land use, is a key factor in the biodiversity of these areas (Katoh *et al.*, 2009). Abandonment of traditional land use thus poses a major threat to biodiversity conservation (Kadoya and Washitani, 2010). Secondary nature, such as *Satoyama* forests or fallow lands that are maintained by human interference, may be more difficult to preserve than virgin nature as it is deeply related to human lifestyles (Morimoto and Yoshida, 2005). Because swidden fields and fallow lands were important components in creating heterogeneity in the *Satoyama* landscape (Kamada and Nakagoshi, 1997), it is useful to examine the contemporary significance of swidden cultivation in crop production and environmental conservation. The goal of this study was to examine the skills and knowledge inherited from traditional swidden cultivation in the town of Yogo, Shiga Prefecture, to evaluate the potential of swidden cultivation as a form of environmentally sustainable agriculture in intermediate and mountainous areas of Japan. In this paper, we particularly focus on the effects of burning and plowing in swidden cultivation. In addition, because slash and burn practices in swidden cultivation stimulate the regeneration of various plants during fallow periods, abandoned *Satoyama* forests may be rejuvenated by this practice. The ultimate goal of our research activity is to use the skills and knowledge inherited from traditional swidden cultivation to establish a model for forest management and local revitalization in intermediate and mountainous area of Japan.

Materials and Methods

The study took place in Yogo, in the city of Nagahama, Shiga Prefecture, Japan. Villagers living in Yogo still conduct traditional swidden cultivation. In 2010, almost 1,000 m^2 of scrub forest dominated by bamboo (*Sasa* sp.) was slashed and burned for swidden cultivation. According to villagers, this kind of scrub forest is typical of the vegetation traditionally opened for swidden fields. More than 40 people including local villagers, researchers, nonprofit organization (NPO) staff members, and media

representatives participated in the burning. After burning, half of the swidden field was plowed with hoe, and half was not plowed, and then the entire field was immediately sown with turnip (*Brassica rapa*) seeds. Most of the seeds sown in this study are local variety of turnips in Yogo. Mature turnips were harvested about 3 month later. The dates of these agricultural practices are listed in Table 1.

Table 1. Date of agricultural practices in the swidden cultivation

Date	Agricultural practice
25 and 30 July 2010	Opening (slashing) the scrub forest dominated by bamboo
19 August 2010	Burning the opened scrub forest
19 August 2010	Plowing the swidden field
19 August 2010	Sowing turnip seeds
13 August 2010	Harvesting turnips

Fig. 1. Scrub forest dominated by bamboo (*Sasa* sp.).

Fig. 2. The study site, after opening the scrub forest.

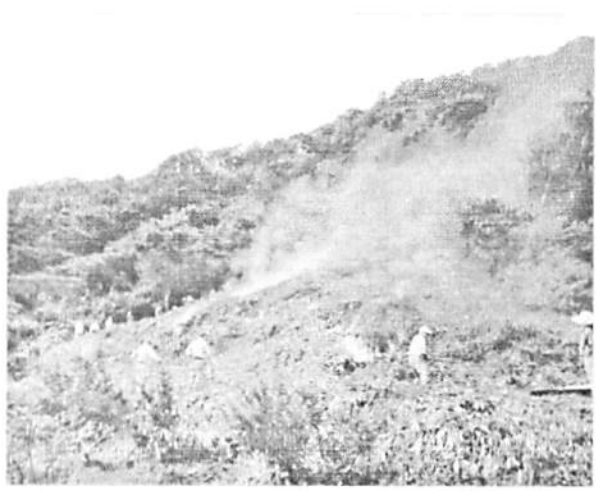

Fig. 3. Burning the study site.

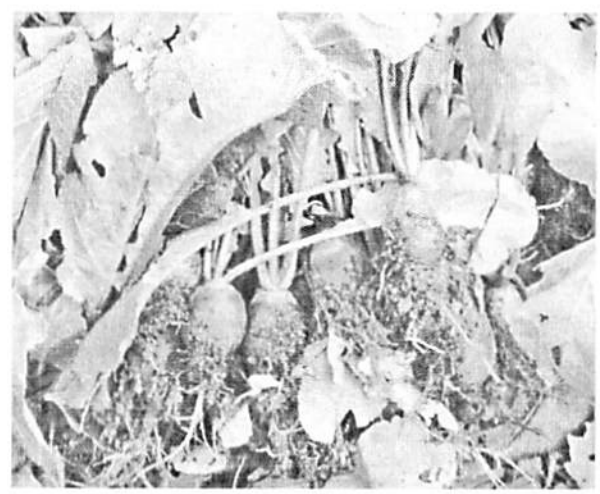

Fig. 4. Turnips harvested from the study site.

Results and Discussion

Effect of burning: The scrub forest was burned on 19 August. The fire intensity was quite high and almost all aboveground biomass burned completely. Many studies have reported that the slashing and burning of forests enriches soil nutrients due to the incorporation of ash from the burned biomass (Stromgaard, 1984; Andriesse and Schelhaas, 1987; Lessa *et al.*, 1996; Tanaka *et al.*, 2005). The burning of bamboo-dominated scrub forests has the particular advantage of supplying water-soluble K (Suzuki *et al.*, 2009) because bamboo accumulates more K than other base cations (Rao and Ramakrishnan, 1989; Shanmughavel and Francis, 1996a, 1996b; Mailly *et al.*, 1997), whereas tree-dominated forests accumulate more Ca (Kyuma and Pairintra, 1983). The burning left a layer of ash on the soil surface at our study site, suggesting that nutrients, especially water-soluble K, were supplied to the surface soil. In addition, slashing and burning enhances mineralization of organic N and P in soil by the "soil heating effect" (Stromgaard, 1984; Kyuma *et al.*, 1985). Thus, the intense burning observed at our study site may have enhanced the mineralization of these nutrients.

Field observations revealed an almost complete lack of weeds during the turnip cropping period, probably due to the intensive burning that occurred at the site. Fires of certain temperature and duration are known to be effective at killing buried weed seeds (Kato *et al.*, 1999). Furthermore, no pest damage was observed, whereas turnips grown in an adjacent upland field suffered from serious pest damage. It is also well known that sufficiently intense burning can prevent damage to crops from pests in swidden fields.

Effect of plowing: The swidden fields were plowed immediately after burning, as is commonly in Japanese swidden cultivation (Sasaki, 1972). In contrast, swidden fields in Southeast Asian countries are rarely plowed because plowing would lead to severe soil erosion in the rainy season.

In an interview survey conducted in Yogo, respondent indicated that surface plowing, by mixing the ash layer with organic matter in the surface soil, is very important to creating appropriate conditions for crop growth. Because the rainfall intensity after burning is generally not as high in Yogo as in Southeast Asian countries, plowing would not cause severe soil erosion. In fact, plowing the ash into the soil appears to aid in preventing ash runoff.

Field observations indicated that initial growth of turnips was much better in the plowed half of the field. In the unplowed half, seeds remained on the soil surface and seemed to dry up before germination. Summer 2010 was extremely hot in Japan, and almost no rain was observed after the sowing. The seeds covered by soil by plowing may have escaped desiccation.

The potential of Japanese swidden cultivation:

Approximately 350 kg of turnips were harvested in 2010 from our study field without the use of any fertilizers, chemical pesticides, or herbicides, probably owing to the beneficial effects of burning and plowing.

As mentioned in the Introduction, *Satoyama* forests have lost their biological resource production role because charcoal, firewood, and compost, which had been produced from *Satoyama* forest wood and litter, have been replaced by fossil fuels and chemical fertilizers. On the other hand, the role of swidden cultivation in food production has not been lost in mountainous areas of Japan. In particular, many varieties of turnips (*Brassica rapa*) are produced from swidden fields and are being sold at value-added prices. This suggests that contemporary swidden cultivation has high potential as a form of environmentally sustainable agriculture in intermediate and mountainous areas of Japan.

However, long-term monitoring of vegetation recovery after burning is necessary to determine the possibility of using swidden cultivation to restore degraded forests. Because our study site (scrub forest dominated by bamboo) was one of the typical of degraded forests in Japan, monitoring the vegetation recovery in this swidden field would be useful in evaluating the potential of using swidden cultivation to restore degraded *Satoyama* forests.

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Floral resources in a village environment of the Brahmaputra valley, Assam: inventory, use and conservation

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Abstract: Village environment is an integral part of a wider framework of rural landscape. The settlement sites along with the homesteads and the production territories around form a functionally linked system, where floral resources play an important role. Floral resources may be basically of two types: natural and planted. The livelihoods of the rural people are closely associated with these resources and, therefore, people are in some way or other concerned about their state of existence and conservation. This paper is an attempt to investigate the floral resources available in a village environment of the Brahmaputra floodplain, Assam. It tries to make an inventory of such resources and their utility and to explore the conservation efforts made by the natives for sustainability of these valuable resources. A systematic survey was conducted in the entire village with a purposively designed schedule to generate first hand data and information for the purpose.

Key words: Floral resources, Brahmaputra valley, Assam, conservation and village environment.

Introduction

The Brahmaputra valley in Assam covering a geographical area of 56,194 km^2 (72 percent of the state's total area) is richly endowed with diverse floral resources. The complex physiographic make-up, variable weather, soil and hydrological conditions have provided distinctive ecological settings for the luxuriant growth of different vegetations. The floral resources in village level environment in the valley, unlike the broader regional context, generally comprise wild and planted trees distributed in different micro-agroecological niches such as residential land, home garden, grazing land, small patches of forest, wetland and cropland. The traditional wisdom of tree growing in the villages of the valley in both natural and cultural lands has given rise to most diverse agro-forestry and ethno-forestry landscapes which have immense contribution to the local ecology and economy.

However, in course of time people started using village resources at a scale beyond the carrying capacity and sustainability, either because of internal constraints and pressure or external demands and interferences (Stadel, 2007). The change in farming system, especially after the introduction of modern farming practices under green revolution during 1960s altered not only the crops cultivated but also reduced the flow of various local natural resources (Yoshino, 2008). Moreover, rapid population growth in the state of Assam resulting mainly from immigration from the then East Pakistan, particularly during and after 1950s, and concomitant pressure on forest resources for food, fibre and fuel, and commercialization of floral products have caused degradation of the floral resources more particularly in the Brahmaputra valley of the state.

Although some studies on the resources of the valley have already appeared, detailed study covering all aspects of availability and use of natural resources in the villages of the valley has not been done so far. As a matter of fact, a holistic study of the resource base and utilization in the villages is very important for any kind of resource management and development planning. This paper is an attempt to study the availability, pattern of ownership and utilization of floral resources in a floodplain village called Muktapur in the district of Kamrup (Rural) of the Brahmaputra valley, Assam.

Materials and Methods

A comprehensive field work covering all the 408 households of the village was conducted through a purposively designed survey schedule during 2006-2008. The data / information regarding the availability, status, uses, ownership and management of floral resources generated through the household survey have been summarized and analysed. The information relating to the use and management of community resources are collected from the members of the *Chuburi* (hamlet) Development Committee and other groups and individuals. With the help of Participatory Rural Appraisal (PRA) and oral interviews conducted among some old and experienced farmers the distribution and utility of floral resources in the village has been studied. Personal field visit was made in the entire village to have an overall idea of the existing resource base within the village. The *dag* map collected from the Goreswar Revenue Office, Government of Assam is taken as the base map of the village. Modern tools and softwares such as GPS, ArcGIS 9.2 were also used to prepare the relevant map of the village.

Background of the Village: The name 'Muktapur' has historical significance. It stems form two local words: *Mukta-* meaning pearl and *pur-* meaning plethora. It is worth mentioning that up to 1990s, there were abundant natural resources in the village comprising extensive fertile agricultural lands, a variety of fish and aquatic vegetables and valuable trees. The Punai dead channel which is lying along the boundary of the village acted as the artery of life and living of the villagers as it provided sufficient amount of fish, water, vegetables and also fresh alluvium to the agricultural fields. There was a time, when the people of Muktapur could sustain their lives depending solely on the locally available resources. But, under the changed social and ecological situation, there has been sharp decline of these resources in the village.

Muktapur village is located in Goreswar Revenue Circle of Rangia Sub-division, Kamrup (rural) district, Assam (Fig. 1). The village lies within 26^{0}26′1″ N to 26^{0}25′6″ N latitude and 91^{0}43′14″ E to 91^{0}45′6″ E longitude. This is a

typical village inhabited by indigenous non-tribal Assamese people. It is located in the north bank floodplain of the Lower Brahmaputra, about 35 km from the Guwahati city and 40 km from the Bhutan Himalayan foothills. It is surrounded by some typical Assamese villages which together create an environment of mutual exchange and mobilization resources among them. Muktapur village with 408 households and a population of 2080 covers an area of 3.67 sq km (as on 2006). The population density is 567 persons per square kilometer. Out of the total working force of the village, nearly 80 per cent is directly related to agriculture. The literacy rate for the village as a whole is 84 per cent. The village consists of 11 *chuburis* (hamlets) inhabited by people belonging to different castes.

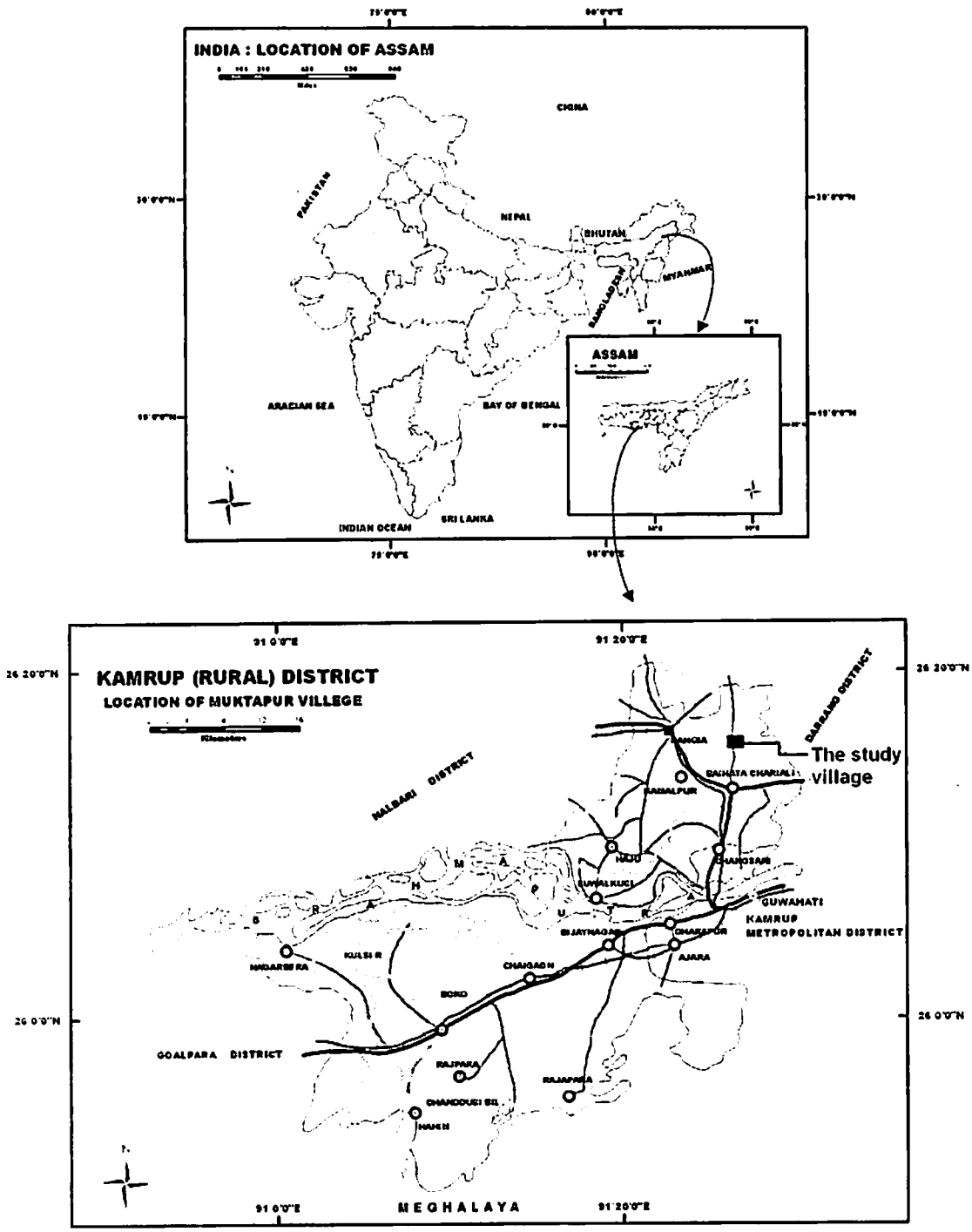


Fig. 1. Location of Muktapur village

Results and Discussion

Inventory of Village Floral Resources

The trees and other vegetation, aquatic resources and different types of crop lands form the principal resource base of the village (Table 1). Some of the trees available in the village are natural, others are planted by the people to meet their requirements. The village is also blessed with diversified aquatic flora and fauna. The people procure aquatic vegetables like *helochi* and *kalmou*, and fodder from the nearby wetlands.

Table 1. Floral resources available in the village environment

Type of trees			Name of the trees
Terrestrial vegetation	Natural	Wood, fruit and medicinal trees	*Moj, poma, ahat, jori, adimaru, kadom, simalu, siris, kata kuhi,* ,safed siris, *bogidhuli, loabandha, gomari,* mysore gum, *tangtangeli, tita chapa,* khair, *arjun, takou,* bamboo, cane, *kohimolla, bhoja,* pongam, bastard cedar, gol mohur, peacock flower, tamarind, mango, black berry, hog plum, leteku, bokoto plum, indian jujube, rose apple, banana tree, *ou ,kuji thekera, bar thekera,* indian curry leaf, *posotia, bhedelilota ,mesundari, manimuni, chamah ,kachu,* drum stick.
	Planted	Fruit and flower trees & Medicinal plants	Coconut tree, betel nut, betel pepper, amla, jack fruit, guava, olive tree, carambola, *bhomora,* litchi, indian almond, papaya, wood apple, *atlash, harphuli,* pumelo, *mausumbi,* orange tree, sour orange, indian medlar, pomegranate, *debadaru, sewali,* amaltas, *batal brash, palash, tagar, golap, champa, keteki, karabi ,patful, narjee ,tej pat, sirata, tita bahek, hiju, maha neem, jetuka, tulasi*
Aquatic vegetation	Flora (natural)	Vegetables and grasses	Swamp cabbage, *helochi, makuwa, kachu, padum, dalghah ,pani meteka*

Note: The local names of the trees are shown in italic form.

Floral resources in a village environment may be of various types depending upon the regional and local ecological conditions. Besides certain edible plants both aquatic and terrestrial, a large number of trees may be there serving various purposes. The main floral resources of the village comprise both naturally grown and planted trees. Interestingly, the assemblages of both natural and planted trees distributed in different categories of land in the village manifest a peculiar agro-forestry landscape with great potentiality to provide food, fodder, firewood, foliage, medicinal plants and building materials (Table 2). Tree-growing along with agriculture (agroforestry) as well as numerous vegetations in the cultural landscape (ethnoforestry) including the individual farms, watersheds and regional landscape can be integrated to take advantage of the services provided by adjacent natural, semi-natural or restored ecosystems (Pandey, 2007). The distribution of wood, fuel wood and fruit bearing trees and nut trees grown in the village under study is diverse and uneven (Table 3 & 4).

However, the number of wood trees by the side of the paddy fields is very negligible, accounting only for 1.27 percent of the total wood trees. Besides the wood trees, a large number of fruit- and nut-bearing trees are also there, especially in the homestead lands and home gardens accounting 7.63 percent and 90.54 percent respectively. It is noteworthy that like many other villages of the Brahmaputra floodplain, the people of Muktapur also traditionally grow a large number of coconut and betel nut trees in their home gardens and around the homesteads. In addition to these, fruit-bearing trees like mango, blackberry, jackfruit, olive, *kardoi,* litchi, *poniol, letuku,* etc are also grown in the village. The fruit-bearing trees are usually raised near the homesteads so that these can be protected from people and wild animals.

Areas of occurrence

As a substantial part of the village is under housing, infrastructural and agricultural uses, floral resources are limited to specific areas within the village (Fig. 2). The important areas of occurrence of these resources are as follows:

Residential lands (gharveti): The residential lands are in slightly higher lands accounting for 6.79 per cent of the village total area. Selected floras, like betel nut, betel leaf, coconut, neem, banana, bamboo etc are grown around the *gharbheti.* It is noteworthy that the plantation of betel nut and betel leaf in the front side of the homesteads traditionally is a peculiar feature encountered in the floodplain villages of the Brahmaputra valley. The trees grown around the homesteads not only protect the houses from the devastating wind (*bardoichila*) but also provide necessary floral products for various uses.

Homestead gardens (basti): The homestead gardens (Photographs 1 to 4) are endowed with highly diverse species providing edible plants and a variety of other products, such as firewood, medicinal plants, and some ornamentals species. These *bastis* are treated by the

villagers as 'productive units' from where they derive almost all necessary resources for their livelihood (Bhagabati and Das 1992). Economic plants such as coconut, betel nut, betel leaf, jackfruits, black berry, mango and citrus fruits like olive, orange, *rabab tenga, thekera tenga* etc. grown in the *bastis* are used for domestic consumption as also for cash. The perennial woody trees such as *moj, poma, teak, katakuhi, kohimallya*, etc. are used as fire-woods and construction materials.

Table 2. Number of selected trees and their utility

Local name of tree	Botanical name of trees	Number of trees in the village	Number of households possessing tree	Utility of the trees
Aam	*Mangifera indica*	1192	329	Fruit, wood, religious
Kalajam	*Syzygium curmini*	294	217	Fruit, wood
Kothal	*Artocarpus sp.*	672	235	Fruit, wood
Bel	*Aegle marmelos*	89	81	Fruit, religious
Bogori	*Ziziphus mauritiana*	82	77	Fruit, firewood
Teteli	*Tamarindus indica*	78	68	Fruit, firewood
Leteku	*Baccaurea raniflora*	60	58	Fruit
Narikal	*Cocos nucifera*	1,287	298	Cash crop, religious and cultural
Tamol	*Areca catechu*	4,672	376	Cash crop, cultural
Pan	*Piper betle*	1,821	381	Cash crop, religious and cultural
Dalim	*Punica granatum L.*	55	47	Fruits, medicinal
Bakul	*Mimusops elengi L.*	30	30	Religious, beautification
Kuji thekera	*Garcinia kydia Roxb*	37	33	Medicinal, wood
Jalphai	*Olea europia Linn*	22	19	Fruit, medicinal
Shilikha	*Terminalia cattapa L.*	24	20	Medicinal, religious
Kordoi	*Averrhoa carambola L.*	19	19	Fruits
Madhuri aam	*Psidium guajava L.*	237	219	Fruit, medicinal
Amlakhi	*Embilica officinalis*	67	65	Fruit, medicinal
Amara	*S. piñata (koem) kurz*	23	20	Fruit, medicinal, fire-wood
Ou	*Dillenia indica*	27	24	Medicinal, fruits
Ahat	*Ficus religiosa.*	12	8	Religious, shade
Jori	*Ficus hispida*	983	312	Firewood
Poma	*Cedrela toona*	456	284	Firewood, wood
Kadom	*Anthocephalus cadamba*	691	337	Firewood, wood
Simalu	*Bombax ceiba*	402	271	Wood, cotton
Moj	*Pithecellobium monadelphum*	980	330	Firewood
Arjun	*Terminalia arjuna*	18	0	Medicinal, religious, shade
Adimura	-	34	24	Religious, wood
Mahanim	*Azadirachta Indica*	337	289	Medicinal
Narasingha	*Murraya koenigii*	600	302	Medicinal
Posotia	*Vitex negudo*	182	174	Medicinal, tooth brash
Gomari	*Gemlina arborea*	897	219	Wood, leaves as fodder
Chegun	*Tectona grandis*	1,982	279	Wood
Khaira	*Acacia catechu*	145	80	Wood
Dimoru	*Ficus hirta*	140	110	Fodder, firewood
Takou	*Livistonia jankinsonia*	24	21	Roofing and *Japi* preparing
Banh	*Bambusa balcooa*	21,576	349	Construction materials, making tools and utensils, firewood, fencing, etc
Bet	*Calamus flagellum*	15,567	180	Construction materials, making tools and utensils

Crop lands (kheti mati): The crop lands, especially the paddy fields also contain a number of trees in their periphery which exhibit a unique agroforestry system in the village. Agro-forestry leads to a more diversified and sustainable rural production system than many treeless farming alternatives and provides increased social, economic and environmental benefits for land users at all level (Pandey, 2007). The plants in the paddy fields are seen along the dykes and approach roads which the farmers use as shade trees.

Grazing lands (bakari mati): These are slightly elevated lands kept specially for the growth of grasses. Because of higher surface level, the water retaining capacity of these lands is low. Used for the purpose of grazing these lands cover 3.77 per cent of the total village area. The trees for timber and firewood are seen to grow in the periphery of the grazing lands. Moreover, some shed trees also are grown in the grazing lands to provide shelter to the cattle during hot summer days.

Forest patches (Janghaltoli): These are some small natural patches of trees and undergrowths. *Janghaltolis* cover an insignificant proportion of area of the village. These are, however, rich in plant species and provide habitats for some lower order wild animals and birds.

These patches play a great role by providing fire woods, construction materials, medicinal plants, fruits, etc to the villagers.

Table 3. Distribution of wood and fire-wood trees in different land categories, 2006-2007

Chuburi	*Number of wood trees in each land categories*							
(hamlet)	Rl	Hg	Gl	Sb	Po	Kg	Ar	Wr
Auniati	97	76	218	18	106	1	0	3
Daibagna	76	153	7	49	28	0	0	0
Kalita	25	129	36	2	53	0	0	0
Veko	1	94	15	0	6	0	0	0
Brahman	15	251	70	0	36	0	0	2
Karariapara	19	134	83	0	9	2	13	2
Alikash	18	94	10	3	13	23	4	1
Satra	2	886	274	0	5	8	26	0
Gayatola	8	242	16	22	20	0	0	0
Bharali	12	248	29	15	11	0	0	0
Maranoipar	97	107	0	3	7	2	0	0
Muktapur	370	2414	758	112	294	36	43	8
village	(9.17)	(59.83)	(18.79)	(2.78)	(7.29)	(0.89)	(1.07)	(0.20)

Note: (i) Rl=Residential land, Hg=Home garden, Gl=Grazing land, Sb=Seedling bed, Po=Pond, Kg=Kitchen garden, Ar=Autumn rice field, Wr=Winter rice field. (ii) Trees include: Teak, gomari, titachopa, moj, kodom, khair, poma, sesu, jori, aahat, simalu, bogidhuli, radhachura, katakuhi, kohimalla, bhoja, korai, etc.

Table 4. Distribution of fruit and nut-bearing trees in different land categories, 2006-2007

Chuburi	Number of fruit and nut-bearing trees in each land category							
(hamlet)	Rl	Hg	Gl	Sb	Po	Kg	Ar	Rd
Auniati	623	2648	17	8	68	15	0	0
Daibagna	428	1435	0	19	28	5	4	5
Kalita	173	1707	0	1	11	0	0	0
Veko	32	1093	0	0	12	0	0	0
Brahman	222	2420	39	0	16	0	0	0
Karariapara	152	2361	83	0	8	0	4	35
Alikash	286	2270	15	0	61	0	0	32
Satra	214	7531	53	2	0	1	0	0
Gayatola	384	8365	23	29	31	6	3	0
Bharali	141	3069	7	6	35	0	1	0
Maranoipar	259	1676	0	0	3	0	1	0
Muktapur	2914	34575	237	65	173	27	13	72
village	(7.65)	(90.80)	(0.62)	(0.17)	(0.45)	(0.07)	(0.03)	(0.19)

Note: (i) Rl=Residential land, Hg=Home garden, Sb=Seedling bed, Po=Pond, Kg=Kitchen garden, Ar=Autumn rice field, Rd=Road side. (ii) Trees include: Mango, blackberry, jackfruits, guava, litchi, palm, coconut, betel nut, orange, papaya, olive, indian jujube, indian almond, mousumbi, carambola, tamarind, *thekera*, wood apple, pomegranate, pumelo,amla , *athiafal*, hog plum, bakoto plum, sour orange, rose apple

Wetlands (Khal-beel): The wetlands comprising natural *beels* and ponds (*khal*), dead channel (*mora nadi*), marshes (*pitoni*), water loggings (*hola*) and man-made ponds (*pukhuri*) make the aquatic vegetation in the village highly diverse in nature, occurrence and use.

On the banks of the man-made ponds, a variety of economic plants like coconut, betel nut, banana, bamboo are grown. On the other hand, the natural wetlands (*khal, beel, pitoni*) with saturated soil favour the growth of a large variety of herbaceous vegetation like rushes, reeds, sedges and grasses.

Road sides: The village landscape is criss-crossed by various roads from footpath to surfaced roads. People have a tradition of planting selected tree species for providing shades to human beings and domestic animals. Often, fruit-bearing and nut trees and also religious trees like coconut, betel nut, mango, black berry, wood apple, *harphuli, jori, ahat, arjun*, gol muhor, peacock flower are preferred for road side plantation.

Community ownership pattern

The Common Property Resources (CPRs) of the village such as small patches of forest, marshes, *beels*, public ponds, grasslands, *dongs* (irrigation channels), trees etc. play an important role in the sustenance and socio-economic upliftment of the rural people. The CPRs, which have traditionally constituted invaluable asset-base, provide both direct and indirect benefits to the local communities ranging from physical, mental, material,

cultural to spiritual (Mukherjee, 1997). As mentioned earlier, the village comprises 11 *chuburies* (hamlets) with their production territories coalescing within the broad landscape of a cluster of villages. Each *chuburi* has some common property resources, or sometimes 3 to 4 *chuburies* jointly have this type of resources. Usually the Chuburi Development Committee (CDC), which is there in each *chuburi*, is given ownership right to manage these common resources. In the case of resources belonging to 3-4 *chuburies*, a development committee is generally formed by the people of the *chuburies* to use such resources. The CDCs have been playing important role in managing the CPRs. The *chuburi* people have collective right for using such resources. However, the poor people of the *chuburies* are allowed to use these resources for their home consumption, but not for sell. These people usually collect fuel wood, dry branches, leaves, roots and fruits from the small green patches. Some of such patches are also used as community cremation site. The income generated from the CPRs is spent for common infrastructural development of the *chuburi* or the village.

The villagers depend on the forest patches mainly to acquire resources for domestic use, although a small portion is sold to earn cash (Table 5). Of the total population of the village, more than 75 percent directly use the community resources, especially the forest patches. Generally people collect fuel woods, fruits, roots, vegetables, building materials etc from the forest patches. Table reveals that 31 percent of the people go to the forest patches for firewood collection, 63 percent for fruits, roots, leaves and green vegetables, and 17 percent for collecting building materials. It is found that the forest resources, especially the fire woods, are sold by only 24 percent of the households, while fruits, roots, and vegetables are sold for cash by 7 percent of the households.

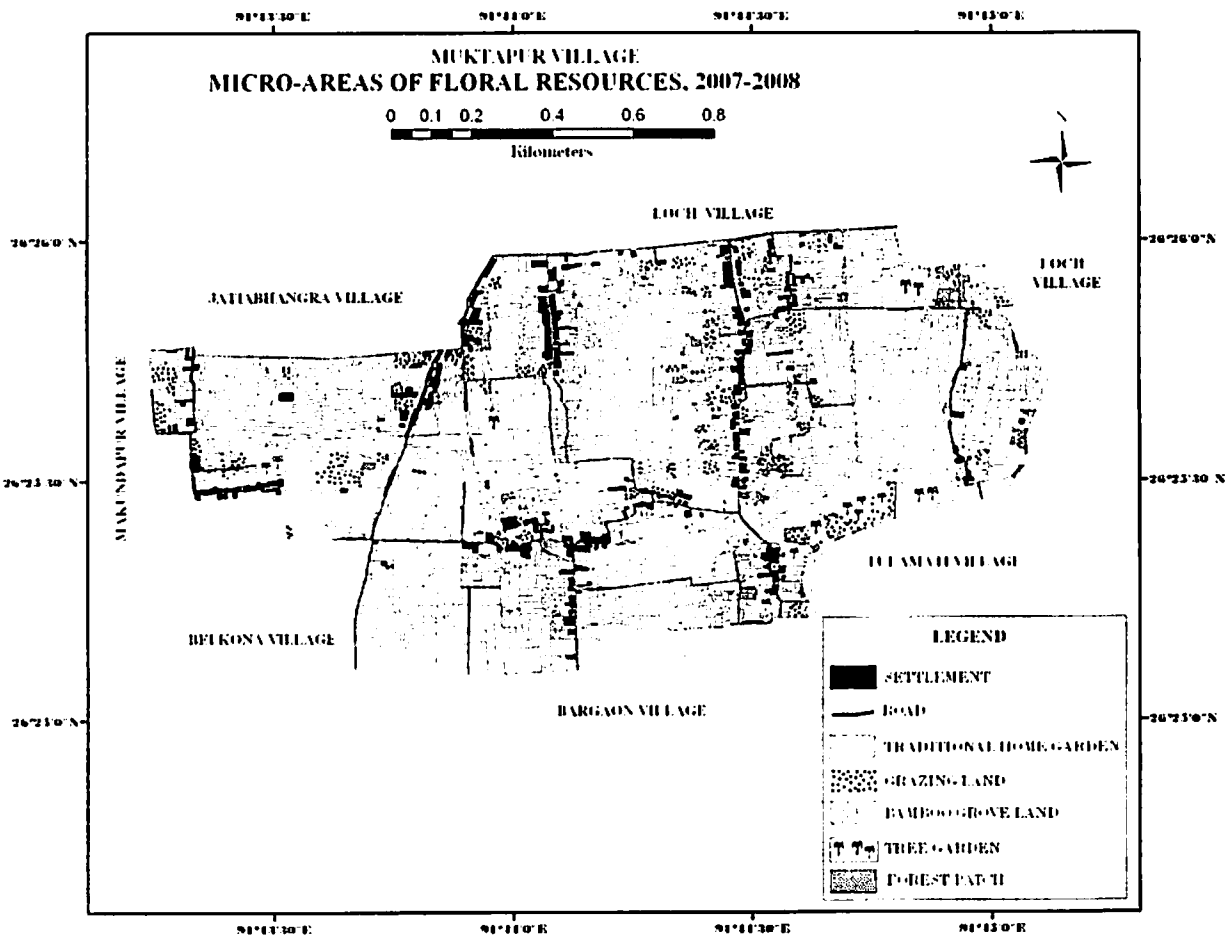


Fig 2. Distribution of floral resources in selected areas
Note: (i) Trees scattered in the agricultural fields and (ii) aquatic flora are not shown

Conservation efforts

While responding to the local environment for survival, the villagers spontaneously developed an understanding of the natural elements and their interrelation. As their life and living are closely linked with the environment, they can easily appreciate the invaluable support provided by nature. Thus the locals collectively play the role of a real custodian of the environmental elements that they have shared through generations. The feelings and perception that the people have developed about their environment help them to do something for conservation of natural resources. Thus, like other rural communities, the people

of Muktapur also have traditionally evolved some ideas and initiated actions towards conservation of their immediate environment. Interestingly, majority of the farmers, especially the small and marginal ones, still make use of the traditional practices, which proved to be effective and adaptive to their environment. For long, agriculture along with agro-forestry has been practiced on the basis of the availability and quality of land, water, and other organic elements as well as local seeds and indigenous knowledge that were nurtured traditionally in the area. Moreover, the households gardens, man-made ponds (*pukhuri*) and natural ponds (*khal*) that the villagers have been maintaining through generations are the store-houses of a large number of plants and animal species. The tradition and indigenous ethics of tree growing around farms and homes have significant conservation value and impact on the ecosystem and the economic and social well-being of the people (Pandey, 2007). These informal and unorganized but sincere efforts on the part of the people towards conservation of nature as well as indigenous culture are invaluable so far the continuity of local floral diversity is concerned.

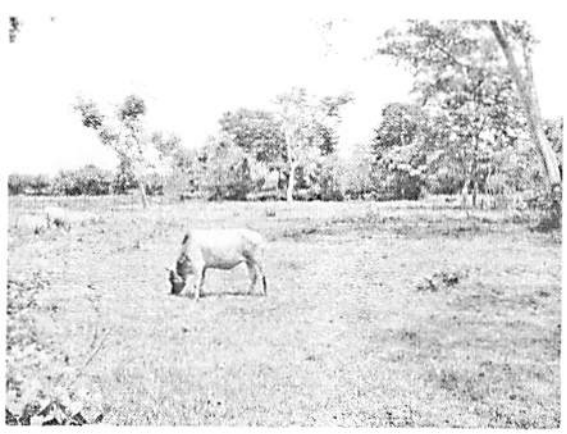
Table 5. Dependence on common property resources

Common resources	Type of use	No. of households involved	Purpose	
			For domestic use	For sell
Forest patches/ trees	Firewood	127 (31)	97 (76)	30 (24)
	Fruits/roots/ leaves/ vegetables	257 (63)	239 (93)	18 (7)
	Building materials	68 (17)	68 (100)	0 (0)

Note: Figures in the parentheses indicate the percentage to the total

Photograph 1. Trees on the man-made pond

Photograph 2. Forest patch



Photograph 3. Trees in grazing land

Photograph 4. Trees around homestead

There has been a growing consensus among the policy-makers, natural resource management practitioners, and academics towards the need of understanding the social dimensions of natural resource management (Dovers, 2003). One of the most important steps in this regard may be empowering the local communities for active

participation in the practices and processes of conservation and management of natural resources. Local communities, who have traditionally acquired good knowledge and understanding about their surroundings, are individually unique, often holistic, spatially specific (Broderick 2005) and socially constructive (Lane 1997) and can therefore contribute directly towards resource management strategies. The tradition of leaving portions of environment completely untouched (sacred groves), for example, has made possible the survival of some important tree species. The indigenous rural people in the floodplain of the Brahmaputra, who may be called 'ecosystem people', (Bhagabati 2007) have played the role of real custodian of the local resources mainly the flora, especially the fruit, medicinal and other edible plants.

Conclusion

The rural life and livelihoods basically evolve around the natural resources, particularly the floral ones that are available within the village and its neighbouring environment. The rural people, generally with limited needs and aspiration use these resources sustainably. However, the pattern of utilization of the natural resources in the study village, which continued to be sustainable till recently, has now lost its traditional character under the changing ecological and socio-economic situations. Most of the floral resources of the village have been exhausted and others are in vulnerable condition. Trees of different quality and usability are the most valuable assets of the rural people which they use for domestic purposes and also sell to fulfill certain urgent needs. The *bastis* and agricultural lands are getting increasingly fragmented to accommodate more people and diverse ownership. The common lands including the forest patches on the other hand are getting reduced in size and have lost their rich ecological character. The rural landscapes in the floodplains of the Brahmaputra have thus experienced remarkable change in the processes and patterns of floral resources use. There is, therefore, an urgent need to make the present generation of people aware of their immediate environment and its conservation and sustainable use.

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Dissemination of plants and technology for rural development in Bangladesh

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Abstract: Firstly, the authors are introducing such a case that a local farmer utilizes plants as environment friendly technology to protect the riverside. They suggest the researchers should make efforts to find such a local technology more intentionally to utilize in the field of rural development. Secondly, they are making report on another plant utilizing technology. In this case, the reason why newly introduced plant, or African *doncha*, which was used to prevent the water hyacinth invasion into the rice fields, could not be fixed in the village is analyzed. The result indicates the farmers select their choice in accordance with several environment conditions, namely natural, economical and timely. Thirdly, the authors describe the present situation of one of other new technologies, hand-weeder, which has disappeared once but reappeared later and is fixed in the village today. The reason why hand-weeder has appeared again is also discussed. The fact also suggests that the new technology can be acceptable for farmers when some condition would be set in right way like the case of African *doncha*. On the background of these discussions, at last, it is concluded that whether new technology can be accepted by the villagers or not is depending on the existence of moderate advanced farmers' group called *deka-deki* in the village.
Key words: Plant utilization, riverside erosion, local existing technology.

Introduction

People are actively utilizing many kinds of plant in the rural area of Bangladesh. The people of our target village (Fig.1) are also planting so many kinds of vegetation in their homesteads and all parts of those are used as food, fuel, medicine, timber and other utilities. We can understand easily the villagers are eagerly working on the introduction of useful plants to the village by seeing with homestead, including homestead garden, abounding in plants. Comparing farmland with homestead, only a few kinds of main crops are cultivated in the farmland but, in the homestead, more than 150 kinds of plant including 25 kinds of fruits and 33 kinds of vegetables are growing in the village (Yoshino, 1995). Not only males but also females are engaged in growing works in the homestead garden. The villagers might have fostered their feel familiar to plants through the experience of such plant utilization in the homestead rather than agriculture in cultivated land.

According to the villagers, the seeds of plants growing in homesteads are tend to have been provided by the neighbors and the relatives both in and outside the village, or sometimes seeds are gathered by the villagers themselves from the plants. On the other hand, plants growing on the roadside, the border of cultivated land and other open space, most of which are not edible for men, are tend to have been introduced by the villagers who found them outside of the village. Villagers might have brought the plants freely to the village as it looks to grow naturally on the roadside and other open space. It can be said that gathering the useful plants from the wild nature and/or other villages is the wisdom for their lives.

For example, *kaisha* (wild sugarcane: *Saccharum spontaneum L.*) was introduced to the village 10 years ago after the construction of embankment near the village (Photograph 1). One farmer who saw that *kaisha* was planted on the embankment in the neighboring village, he brought it to his village and it can be seen everywhere in the village nowadays. It is planted on the embankment, roadside, around the pond etc. to prevent the erosion and riverside to accumulate soil deposition. Moreover, it is also planted as the border and fence of farmland and used as roof material. Woody plant *dol-kolmi* (bush morning glory: *Ipomea crassicaulis*), which was introduced to the village 8 years ago and utilized in the same way of *kaisha*, especially for prevention of erosion and accumulation of soil deposition in the riverside, is also to be seen in the village everywhere at present (Photograph 2) (Uchida and Ando, 1998a).

Although it is only 8 to 10 years ago that *kaisha* and *dol-kolmi* were introduced to the village, both of the plants fit in with the landscape of the village at present as if they were indigenous plants from old days. High fixing ability of plants and villagers' eagerness for introducing new useful plants indicate that the plants can be accepted by the villagers easily and spontaneously if they can fulfill villagers' requirements. From this fact, we can think that the plants are possible to become one of valuable tools for rural development.

Materials and Methods

The study site Dakshin Chamuria village (hereinafter D village) is located on a small floodplain of the Lowhajon river, a tributery of the Jamuna river, about 9 km north-east of Tangail town (Fig. 1).

The Lowhajon river and rainfall bring rapid inundation to the village in July. The highest water level is 1 to 3 m in the flooded field during August and September, while homestead is not inundated. The flooded water quickly recedes into the Lowhajon river from late October. Most amount of annual 1,750 mm precipitation concentrates in the rainy season from June to October. The soils which are classified as Silmandi series are mainly silty loam and silty clay loam, with some scattered plots with sandy materials. Generally, topography of this area is flat and soil is sandy. The village has the total area of 184 ha with a population of 2,198 making 386 households, more than half of them are engaged in agriculture.

The field survey was done mainly under Joint Study on Rural Development Experiment (JSRDE) during 1992 to 1995 sponsored by the Japan International Cooperation Agency. In the survey field observations and interviews with farmers were conducted by the authors.

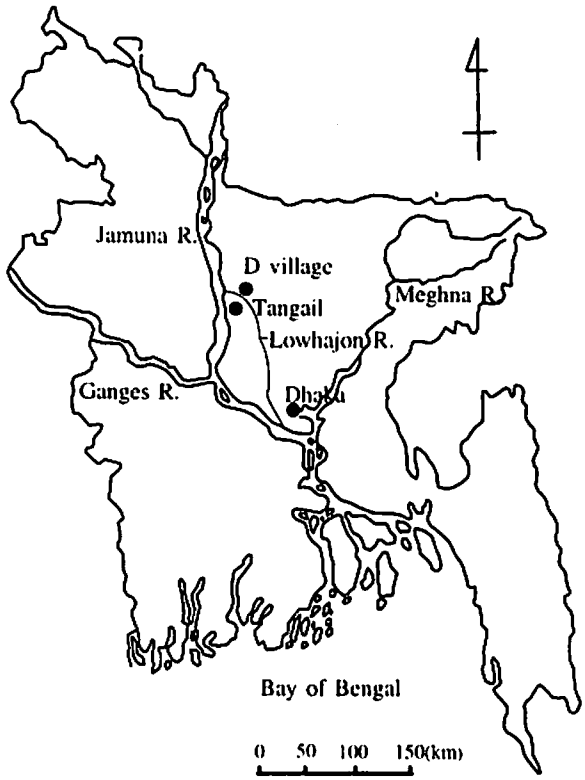


Fig.1. Location of Dakshin Chamuria (D) village

Results

Local Plant Utilizing the Technology to Protect Riverside: One farmer who lives on the riverside of upper Rowhajon river in Tangail district planted three kinds of vegetation on the ridge of riverbed. His purpose is protecting the riverside on which his homestead situated from water flow. He planted *dol-kolmi* on the lowest part of the riverside, *kaisha* on the medium elevating part and banana trees on the highest part of the ridge as shown in Fig.2 schematically (Uchida and Ando, 1996) (Photographs 3 and 4). He planted the vegetation in the dry season of 1994 in the aftermath of continuous two years' erosion by floods in the rainy seasons. The farmer who planted vegetation stated as follows:

"*Dol-kolmi* which has drifted ashore at the big flood of 1988 took root on char, or sand bar. I brought the cutting to plant near my house. As I have seen the cutting to root on the riverside on my way to the bazaar I planted the cutting of 45 cm on the riverside too. I am growing seedlings from the cutting in my homestead at present. *Dol-kolmi* can reduce velocity of water flow and also control waves. Sand and earth should deposit 90 cm thick annually if it would be planted in dense and the plant can stand even in deep water. I planted the cutting of *dol-kolmi* on riverside in 1989 at first and it grows thick over there with 3 m height at present. This plantation of *dol-kolmi* is protecting my homestead from the river erosion.

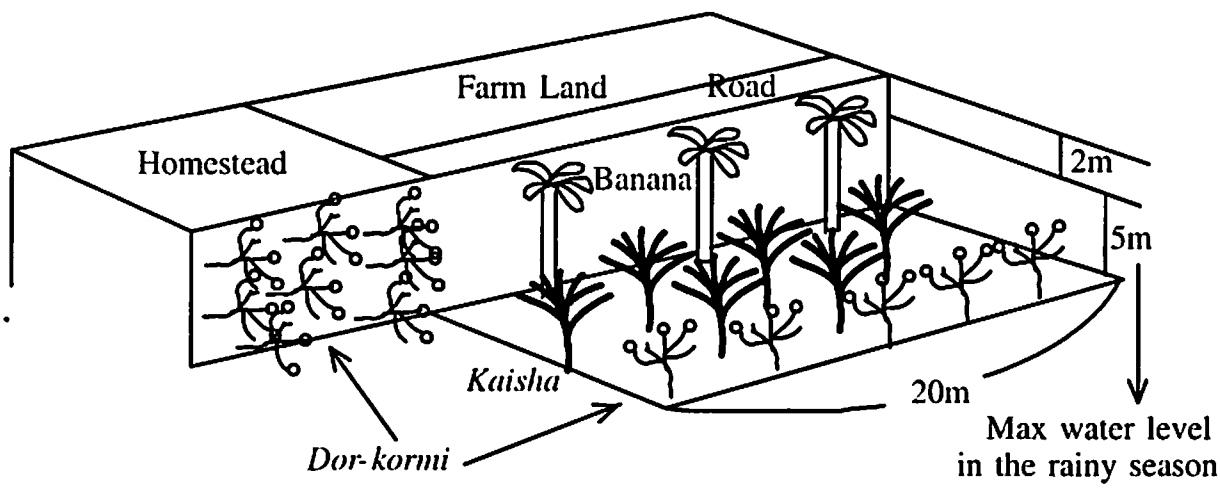
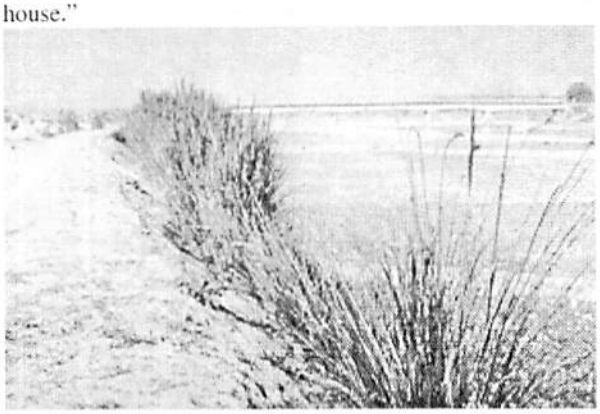


Fig.2. Planting against river erosion

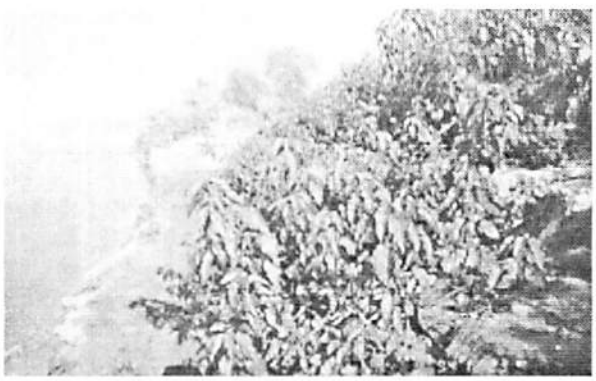
Planting *kaisha* on the riverside accelerates the deposition of sand and earth. Waves erode riverside when the engine boat passes by and continuous waves sometimes pull out *kaisha* from the ground. I planted *kaisha* around my house bringing from the *char* at first and I transplanted them to the riverside in November. A dozen stalks come from a root and it takes 10 to 15 days to root if there is enough rain and it takes one month in absence of rain. This weed grows about 2 m in a year. It can deposit 90 cm sediment if it could stay in water though the weed is pulled up sometimes by fast water flow. New stalks would come from the root in the following year after cutting old stalks at the point of 40 cm above the root if the root had not been buried in whole by sediment. It is only necessary to plant the root every four years if old stalks would be cut annually.

Banana trees are planted on the riverside to protect steep cliff and roadside from erosion and to promote sedimentation. The hard roots of about 3 m long stretch in all direction under the ground of 10 cm. The root is hardly

pulled out if once it rooted in the ground by waves and the tree can deposit sand 80 cm thick in a year. The local *bichikola* banana (similar to *Musa paradisiaca*) with hard stalks is usually planted on the riverside but I planted here other kinds of bananas too which have been around my house."



Photograph 1. Kaisha on the embankment



Photograph 2. Dol-kolmi on the riverside

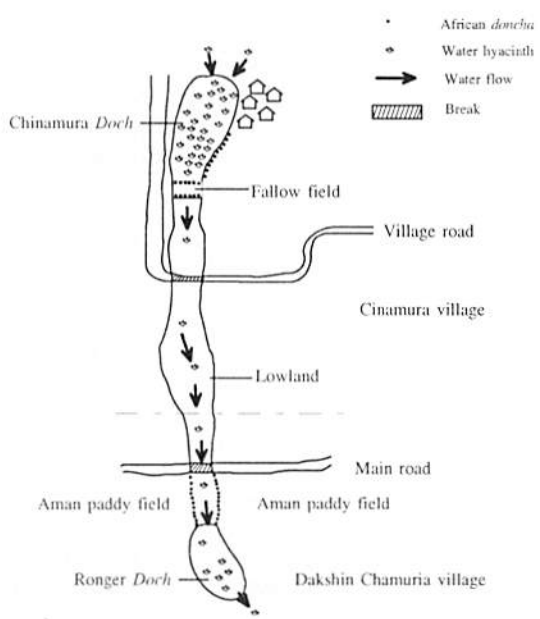
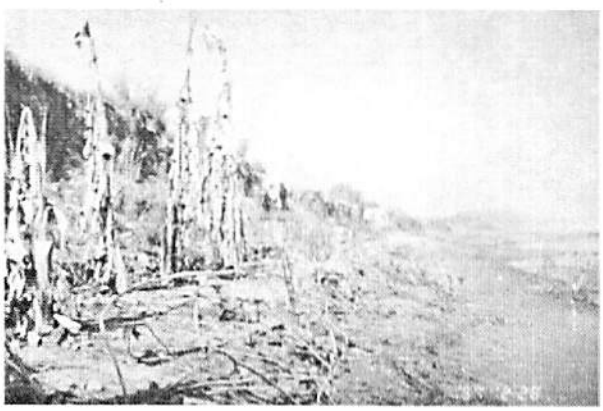


Fig.3. Water hyacinth control program

Photograph 3. Dol-kolmi & kaisha



Photograph 4. Dol-kolmi , kaisha & banana

It is clear that the efficiency of this kind of simple and small scale technology is less than so-called modern technology. But, at least, it is sure such kind of technology is suitable for a farmer who is not rich because of its inexpensiveness and sustainability. Moreover, this kind of technology can be said environment friendly technology, which can be substantiated individually. It is to be desired that the researchers are finding and collecting such local and/or indigenous technology more intentionally to utilize in the field of rural development. Such technology that is familiar to villagers can be

accepted easily by themselves and become an effective tool for rural development.

Water Hyacinth Control Program Using African *Doncha*: In Dakshin Chamura village, a lot of water hyacinth was flowing down from the upper Chinamura village and damaged deep water *aman* rice fields in the rainy season during the JSRDE acting period in the village. JSRDE decided to control those troublesome water hyacinth using newly introduced plant of African *doncha* (Photograph 5). African *doncha* (*sesbania rostrata*), an annual legume which grows up to a few meters, had been introduced to Bangladesh in 1986 by the professor of BAU (Bangladesh Agricultural University) from IRRI (International Rice Research Institute). The main difference from *deshi doncha* (*sesbania aculeata*), a local variety of *doncha* (*sesbania* spp.), is that the new kind of plant can be cultivated using seedlings (young plants and stem cuttings) under waterlogged conditions. Therefore, it can be cultivated at any time even during the rainy season if the seedlings are available. Rooting of African *doncha* occurs 2-3 days and leafing 5-6 days after planting of a stem cutting 50 cm high for normal cultivation and 1 m for deep waterlogged conditions, respectively.

Photograph 5. African Doncha

As shown in Fig.3, JSRDE implemented the program as follows (Uchida and Ando, 1998b). Firstly, at the beginning of the rainy season, the stem cuttings of African *doncha* were planted in the fallow field which was located just in front of water depression, or Chinamura *Doch* in the neighboring village from which water hyacinth flowed out. Secondly, the stem cuttings were also planted in the deep water rice growing area in two lines to guide water hyacinth into the other depression, or Ronger *Doch*, directly. Thirdly, at the same time, African *doncha* was also cultivated on the levees to prevent the invasion of water hyacinth to the deep water rice growing fields.

Photograph 6. Hand-weeder

This program was implemented in 1994 and 1995. But the efficiency of this program could not be substantiated. In the first year, the water hyacinth did not overflow from the upper depression, Chinamura *Doch*, because of unusual less flood and, on the contrary, in the second year, the large flood washed away the planted stem cuttings of African *doncha*. Nevertheless, at that time, we were sure the program is successful from the view point of introduction of a new plant. It was planted in the fields of 64 farmers and 80 farmers could not get the cutting in spite of their desire in 1994 and JSRDE could observe the villagers planted African *doncha* spontaneously not only in the second year but also in 1997.

But only five years later, nobody could see the African *doncha* in the village and in stead of it there were many *deshi doncha* in the same village. According to the villagers, *deshi doncha* was cultivated only in one plot in 1998 and 1999, and cultivated in 10 plots in the village in the year of 2000. On the contrary, Jute cultivation has decreased in the village. *Deshi doncha* is mainly used for fuel, *masa* (supporting terrace) for vegetable cultivation and Jute can be used only for starting the fire. Moreover, the price of *doncha* is higher than that of Jute. This can be thought as the reasons why *doncha* cultivation has increased and Jute cultivation has decreased.

According to the villagers, the reasons why African *doncha* was not acceptable for them are as follows. African *doncha* is unstable on the field and tend to fall down on the water, and its light weight and root spreading are also disadvantage in comparison to *deshi doncha*. Moreover, the hydrological condition surrounding the village has changed and water depth in the rainy season has decreased. So that, water hyacinth does not flow down from upper area any longer and usefulness of African

doncha has decreased for the villagers. This fact suggests that farmers select their choice in accordance with several environment conditions, namely natural, economical and timely.

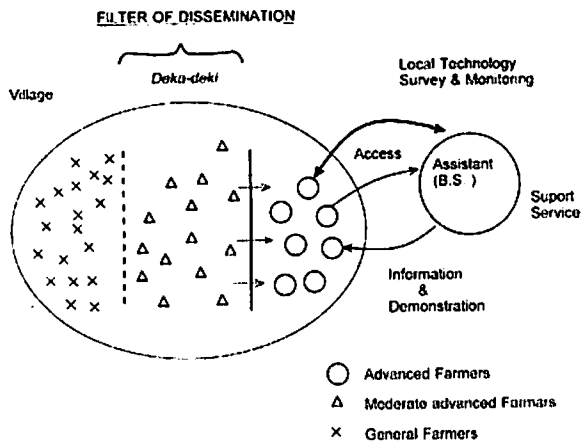


Fig.4. Dissemination of technology in the village

Re-Introduction of Hand-weeder: JSRDE also introduced the hand-weeder renting system with line transplanting method for *boro* rice of the dry season in the village (Photograph 6). During the program period there was only one hand-weeder of JSRDE's itself and no farmer had it. Moreover, very few farmers rent the weeder from JSRDE. Hand-weeder could not get popularity at that time. But six years later, number of hand-weeder owner has increased up to 9 and 69 farmers are renting the hand-weeder for their weeding work.

The reasons of this status quo, according to the farmers, are as follows. Firstly, the hand-weeder is available at the near bazaar at present but it was only available in Tangail city, center of the district (Fig.1), during the project period. Secondly, the price of the weeder is 150 Tk. now but it was 300 Tk. before (1 dollar was about 60 Tk. in 1995). Thirdly, the rental fee is cheaper at present. At last, most important reason should be that the *guti shar* (ball shaped fertilizer for paddy) was introduced after JSRDE gone by the block supervisor (BS) who engages in administrative service delivery for agricultural extension program.

In 1999, 75% of hand-weeder user is taking use of *guti shar* and only less than 50% of non-user is taking use of it as shown in Table 1. This figure indicates the relationship between the hand-weeder and *guti shar* in the dry season rice or *boro* rice fields of line transplanting. This fact also suggests that the new technology can be acceptable for farmers when some condition would be set in right way like the case of *doncha*.

Table 1. Relationship between hand-weeder and guti shar (in plots)

		guti shar	non-*guti shar*	Total
Weeder	own	13	6	19
	rent	25	7	32
sub total		38 (75%)	13 (25%)	51 (100%)
non-weeder		41 (47%)	46 (53%)	87 (100%)
Total		79	59	139

Only for line transplanting plots in 1999.

Discussion

In the case of the hand-weeder, new technology was not fixed at initial stage but about five years later fixed in the village. On the contrary, another new technology, African *doncha*, was not fixed although it looked to be accepted at initial stage, and consequently, the villagers chose old technology, *deshi doncha*. What is the reason of this queer phenomenon? When a new agricultural technology is introduced to the village by a field assistant, for example Block Superviser (BS), advanced farmers are willing to get it at first as shown in Fig. 4. In this stage, the technology is not fixed yet. In order to be fixed, the technology must pass through a kind of filter, namely, moderate advanced farmers at next stage. They don't jump to the new technology directly, sometimes even they pretend indifferent, but they are watching and hearing carefully advanced farmers and their plots to make sure whether the technology is useful for them or not. If they accepted the technology, it could be distributed even to the general villagers. Therefore, it is important their existence for dissemination system of agricultural new technology. They are conservative in a sense and called *deka-deki* (persons who are waiting and seeing how things go). It is *deka-deki* that both fixed hand-weeder and not fixed African *doncha* in the village. It can be said that *deka-deki* is playing key role in the dissemination of technology in the village. Consequently, it is needed that a sort of system to focus on them, consult with them and/or monitor their thoughts should be established for the dissemination of the new technology in rural development program.

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Forest structure and species composition of seasonal flood forest along the Se Buy River in Yasothon Province, Northeast Thailand

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Abstract: The structure and topography of seasonal flood forest, once inundated from August to October, was studied at the Se Buy river in Yasothon Province, Northeast Thailand. Tree census has been conducted since 2005. Five hundred and ninety three trees and climbers were recorded and 70 species were identified in the 30m × 150m plot. Stand density, total basal area and the mean diameter at breast height (DBH) were 1317.8 trees/ha, 23.61m^2/ha and 11.32cm, respectively. *Mallotus thorelii* (Euphorbiaceae), *Garcinia schomburgkiana* (Guttiferae), *Hymenocardia punctata* (Euphorbiaceae), *Dipterocarpus alatus* (Dipterocarpaceae) and *Vatica harmandiana* (Dipterocarpaceae) were abundant species in the plot. Riparian zone forest locating adjacent to the river was inundated for approximately 3 months, and consisted by small DBH trees of *M. thorelii*, *G. schomburgkiana* and *H. punctata*. Seasonal flooding might disturb the riparian zone frequently, and riparian zone forest consisted by pioneer species. Upper part of the plot, which was rarely flooded by special large flow, was mostly consisted by large DBH trees of *Irvingia malayana* (Irvingiaceae) and *Shorea roxburghii* (Dipterocarpaceae). Thus, elevation and flooding period would affect the species composition and consequently the dynamics of seasonal flood forest.

Key words: Seasonal flood forest, species composition, inundated period, Thailand.

Introduction

Swamp forests provide source of nutrients to terrestrial and aquatic organisms. Some studies have reported the importance of relationships between freshwater fish and seasonally inundated vegetation. In the tropics, fish - forest relationships in Amazon River Basin have been studied (Gottsberger, 1978; Kubitzki and Ziburski, 1994; Saint-Paul *et al.*, 2000). In Southeast Asia, many freshwater fish were known to feed on forest fruits and other seasonally flooded vegetation (Roberts, 1993; Baird, 2007). Thus, seasonal flood vegetation is important for terrestrial and aquatic ecosystem. A seasonal flood regime has a great impact on the vegetation. Inundation period might affect seed germination and seedling establishment. Litter amount might be also different in seasonal flood forest because flooding and drying out leads to change microbial activity in the soil (Neill, 1995).

A number of researches on forest vegetation have been conducted in Thailand since 1950's (Ogawa *et al.*, 1961, 1965; Royal Forest Department, 1962). Some of them studied the relationship between the local distribution of tree species and topography in major forest types (Bunyavejchewin *et al.*, 2003; Sri-Ngernyuang *et al.*, 2003). However, only few researches have been done in the seasonal flood forest in Thailand. In this study, pattern of tree distribution, and species composition were studied in a seasonally flood forest in Northeast Thailand.

Materials and methods

The studies were conducted at a seasonal flood forest along the Se Buy River in Nakae village, Khum Khuang Kaew District, Yasothon Province, Northeast Thailand (15°35' N, 104°27' E) (Fig. 1). The mean precipitation in Yasothon province is approximately 1600mm/y (Kono *et al.*, 1994). Rainy season occurs from May to October during the southwest monsoon, followed by dry season from November to April affected by the northeast monsoon. Forest type is typically Dry Dipterocarp Forest (DDF) and Mixed Dipterocarp Forest (MDF).

A research plot was established from river to inland. The size of the plot was 30m × 150m, and divided into 10m × 10m subplot. All trees having more than 4cm in DBH were mapped, tagged, identified, and measured. Topography of the plot was surveyed by surveying compass. The elevation increased with the distance from river line and the difference between the lowest and the highest ground height was approximately 8m (Fig. 2).

Water level logger (HOBO; U20-001) was set in the lowest level of the research plot to record the water level during flooded period. The measurement was conducted in 2007 and 2009.

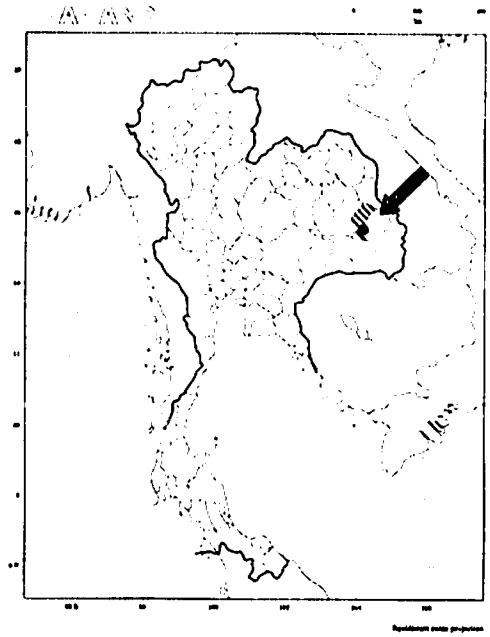

Fig. 1. Location of the study site

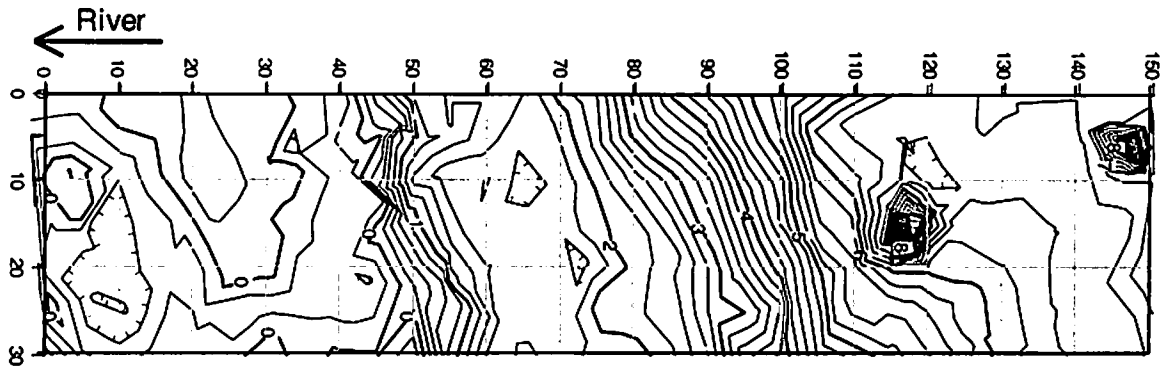

Fig. 2. Illustration of topography of the research plot

Results

Stand structure and species composition: Five hundred and ninety three trees and climbers were recorded in the plot. Within them, 70 species of 30 families were identified. Stand density, the mean DBH and total basal area were 1318 trees/ha, 11.3cm and 23.6m^2/ha, respectively (Table 1). *Mallotus thorelii* (Euphorbiaceae), *Garcinia schomburgkiana* (Guttiferae) and *Hymenocardia puncutata* (Euphorbiaceae) were abundant in this plot. These three species accounted for 35% of total tree number and 17% of total basal area. *Dipterocarpus alatus* (Dipterocarpaceae), *Syzygium* sp. (Myrtaceae) and *Irvingia malayana* (Irvingiaceae) showed high mean DBH and basal area. Basal area of these three species accounted for 45% of total basal area.

Table 1. Number of trees, density, basal area and mean DBH of the 15 common species in research plot.

Species	Family	Number of trees	Density [trees/ha]	Mean DBH [cm]	Basal Area [m^2/ha]
Mallotus thorelii	Euphorbiaceae	107	237.8	8.13	1.36
Garcinia schomburgkiana	Guttiferae	52	115.6	12.67	1.79
Hymenocardia punctata	Euphorbiaceae	50	111.1	9.01	0.78
Dipterocarpus alatus	Dipterocarpaceae	31	68.9	26.39	4.82
Vatica harmandiana	Dipterocarpaceae	28	62.2	10.91	0.69
Melodorum fruticosum	Annonaceae	19	42.2	12.36	0.67
Byttneria echinata	Sterculiaceae	18	40.0	7.22	0.18
Syzygium spp.	Myrtaceae	18	40.0	22.81	3.39
Melodorum siamensis	Annonaceae	17	37.8	6.10	0.12
Dalbergia foliaceae	Leguminosae-Papilionoideae	16	35.6	6.68	0.13
Barringtonia acutangula	Lecytidaceae	15	33.3	10.93	0.49
Irvingia malayana	Irvingiaceae	12	26.7	20.12	2.38
Terminalia cambodiana	Combretaceae	12	26.7	9.66	0.24
Shorea roxburghii	Dipterocarpaceae	11	24.4	25.04	1.27
Cinnamomum porrectum	Lauraceae	10	22.2	10.18	0.22
Other		177	393.3	9.76	5.07
Total		593	1317.8	11.32	23.61

The pattern of diameter distribution for all trees showed a reverse-J shaped (Fig. 3) That of the abundant tree species (*M. thorelii*, *G. schomburgkiana* and *H. puncutata*) also showed the reverse-J shaped pattern (Fig. 4). *Syzygium* sp. and *I. malayana* had a discontinuous diameter distribution with many small DBH trees. *Syzygium* sp. and *I. malayana* had the same distribution pattern to the abundant species. One of the abundant species in this plot, *D. alatus*, had different distribution pattern with less frequency of saplings.

Water level and flooded duration: Mean inundated days in 2007 and 2009 were in a range of 0-83 days (Table 2). It was obvious that number of inundated days decreased with increasing ground level. The highest water level was recorded at 6.2m in which means that the river flow came up to 6.2m of relative ground height. Then, approximately 70% of the plot area was inundated. The mean flooded

period at the highest (6.2m) and lowest point (0 - 0.1m) were 1.5 hours and 91days, respectively.

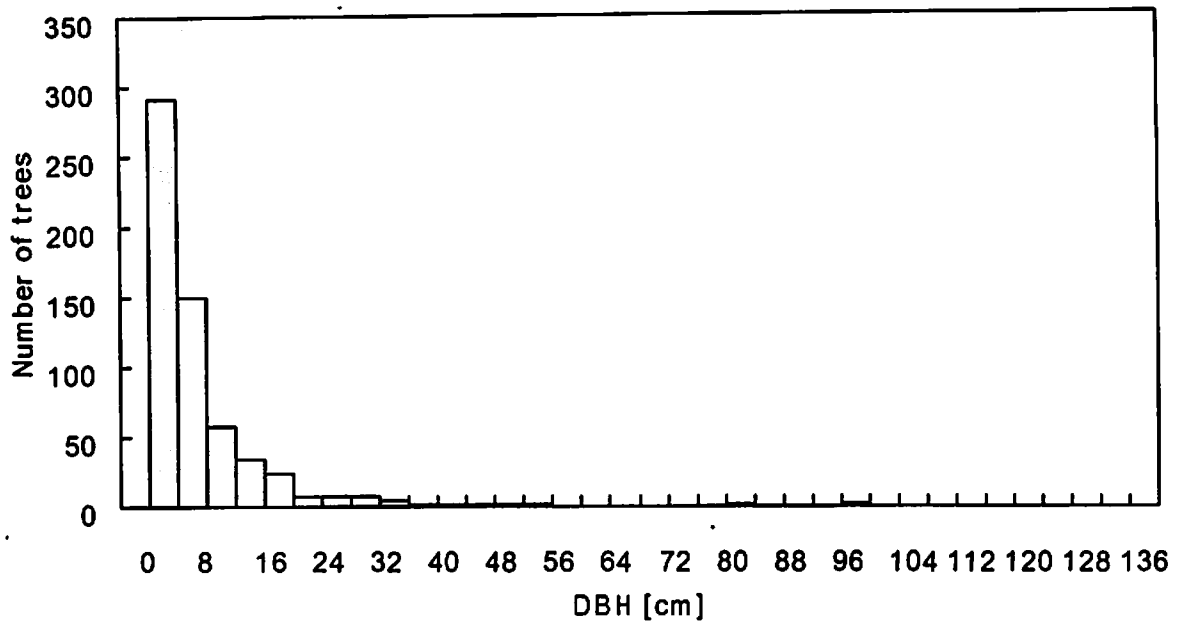

Fig. 3. Diameter distribution of all trees in the plot.

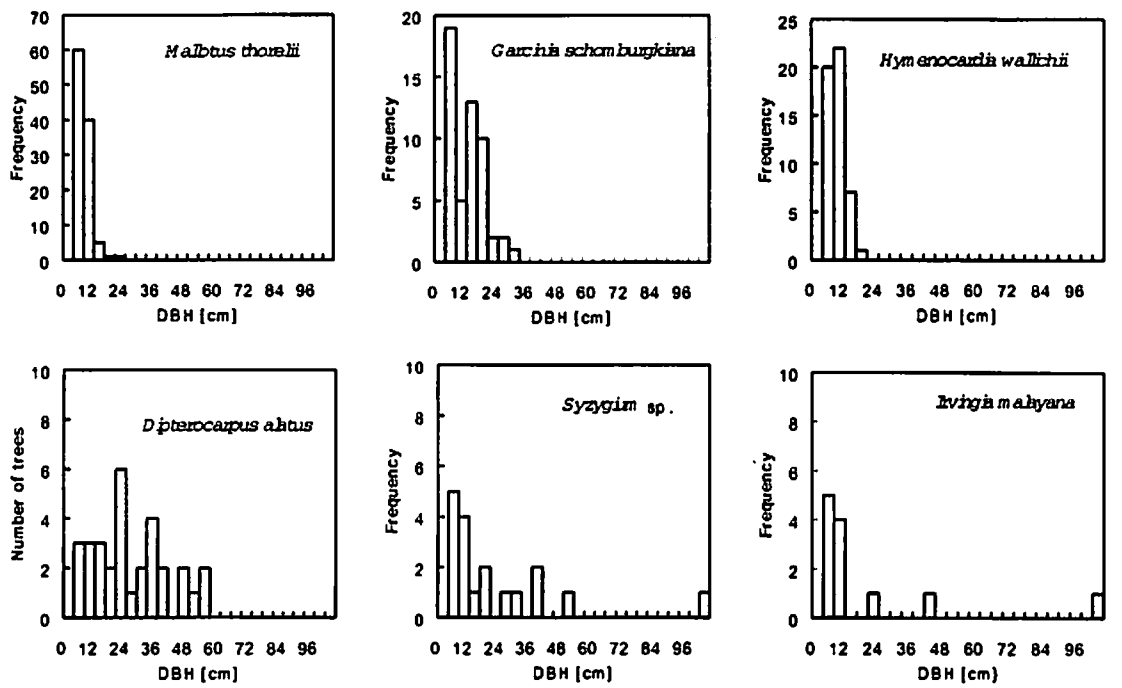

Fig. 4. Diameter distribution of six tree species in the plot.

Species composition and ground level: To compare the species composition and inundation period, we divided the plot into three zones based on ground level which were ranged from 0 to 3m (zone I), 3 to 6m (zone II) and more than 6m of ground level (zone III), respectively. Respectively for each of zones, the stand density was 1553, 1244 and 942 trees/ha, mean DBH was 9.48 ± 0.36, 15.00 ± 1.56 and 14.06 ± 1.05cm (Table 3). It was remarkable that the stand density decreased with increasing the ground level. The mean DBH of the trees in zone I was smaller than that of zone II and III. Zone I forest showed relatively high density with small DBH trees. On the contrary, zone III forest had low density with large-size trees.

Table 2. Mean inundated days at the each elevation in the plot

Relative Ground Level [m]	Inundated days
1	83
2	71
3	42
4	23
5	11
6	4
7	0

Table 3. Tree number, density and mean DBH among different ground level (mean±SE; ANOVA, $P<0.05$)

Relative Ground Level [m]	Area [m²]	Number of trees	Density [trees/ha]	Mean DBH [cm]
0-3	2401.3	373	1553.3	9.48 ± 0.36
3-6	739.9	92	1243.5	15.00 ± 1.56
6-	1358.8	128	942.0	14.06 ± 1.05
	4500.0	593		

The abundant species, *M. thorelii*, *G. schomburgkiana*, *H. punctata* and *Vatica harmandiana* (Dipterocarpaceae) generally distributed in the zone I (Table 4). Moreover, nine species of major 15 species distributed on this zone. In the zone II, *D. alatus*, *Syzysium* sp. and *Cinnamomum porrectum* (Lauraceae) were recorded as a major. For other species, *Hopea odorata* (Dipterocarpaceae) and *Faguraea fragrans* (Loganiaceae) were also found in this zone. In the zone III, *Melodorum fruticosum* (Annonaceae), *Shorea roxburghii* (Dipterocarpaceae) and *I. malayana* were occupied as major species, accompanying with *Anisoptera costata* (Dipterocarpaceae), *Dipterocarpus intricatus* (Dipterocarpaceae) and *Xylia xylocarpa* (Leguminosae - Mimosoideae).

Discussion

M. thorelii, *G. schomburgkiana* and *H. punctata* were abundant species in this seasonal flood forest. These three species frequently distribute with small DBH at the part having lower ground level of the forest. These three species are usually considered to be pioneer species in Thailand. According to Van Welzen and Chayamarit (2007), *M. thorelii* mainly distributes in the low altitude zone and *H. puncutata* distributes open shrub along a river and beach. Water level data showed that the lower zone of the plot was inundated for several months per year. The zone of lower ground level might be disturbed frequently by water flow from the river during flooded period. Therefore, pioneer species trees were dominant in the lower zone.

Table 4. Tree number of 15 major tree species distributed on the each elevation

Species	Family	Relative Ground Level [m]			
		0-3	3-6	6-	Total
Mallotus thorelii	Euphorbiaceae	103	4	0	107
Garcinia schomburgkiana	Guttiferae	50	2	0	52
Hymenocardia punctata	Euphorbiaceae	49	1	0	50
Vatica harmandiana	Dipterocarpaceae	25	3	0	28
Byttneria echinata	Sterculiaceae	18	0	0	18
Melodorum siamensis	Annonaceae	17	0	0	17
Dalbergia foliaceae	Leguminosae-Papilionoideae	15	1	0	16
Barringtonia acutangula	Lecytidaceae	15	0	0	15
Terminalia cambodiana	Combretaceae	11	1	0	12
Syzygium spp.	Myrtaceae	8	9	1	18
Dipterocarpus alatus	Dipterocarpaceae	1	13	17	31
Cinnamomum porrectum	Lauraceae	0	10	0	10
Irvingia malayana	Irvingiaceae	0	6	6	12
Melodorum fruticosum	Annonaceae	0	0	19	19
Shorea roxburghii	Dipterocarpaceae	0	0	11	11

In the zone II, *D. alatus*, *Syzysium* sp. and *C. porrectum* were usually recorded. For few numbers of species, *H. odorata* and *F. fragrans* were also recorded in zone II. These species are widespread in Thailand and can grow on wet site (Gardner *et al.*, 2007; Griffin and Parnell, 1997; Pooma and Newman, 2001). These species were recorded in short period inundated site in the plot. Although *D. alatus* distributed in short-inundated site, number of *D.*

alatus tree decreased with decreasing of ground level (Table 5). The saplings less than 10cm of DBH of *D. alatus* distributed only the zone inundated few days a year. It might be difficult to germinate and establish in inundated condition for *D. alatus*.

Table 5. Diameter distribution in each ground level on *Dipterocarpus alatus*

		Relative Ground Level [m]								
		0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	Total
DBH [cm]	4-10						2	1		3
	10-20				2	2		2	2	8
	20-30					1	2	2	3	8
	30-40			1	2	1		1	3	8
	40-50					1	1			2
	50-							1	1	2
	Total	0	0	1	4	5	5	7	9	31

D. alatus and *A. costata* were recorded in upper zone. These species distribute in lower part of valley in a dipterocarp forest (Pooma and Newman, 2001). *S. roxburghii* and and *X. xylocarpa* were recorded in upper zone in the plot. These species are widespread and common species in Dry Evergreen Forest (DEF), Mixed Deciduous Forest (MDF) and Dry Dipterocarp Forest (DDF) in Thailand (Nielsen, 1985; Pooma and Newman, 2001). D. intricatus distributes in open dry site (Pooma and Newman, 2001). Thus, upper zone forest was consisted by different habitat species.

From the present study, the tree species which consisted seasonally flood forest along the Se Bay River, distributed in the different ground level. Upper zone forest which has less impact of inundation was consisted by different habitat species having large size. On the contrary, the riparian zone forest which is commonly affected by the inundation during rainy season, consisted of pioneer species with small size. Short-inundated zone forest consisted by riparian species. These results indicate that elevation and flooding period would affect the species composition and the dynamics in seasonal flood forest. Fanshawe (1954) indicated the importance of variation in microtopography of the floodplain forests in determining the boundaries of plant population. The present study also showed the same results to other floodplain forests.

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Alternative rural development approach through reevaluation of traditional culture and knowledge in Laotian villages - Establishment of the Village cultural museum

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Abstract: : Existing rural development paradigm/ approaches, which aims at rapid achievement of economic affluence and modernization of life style, have improved or changed traditional life styles, farming methods and tools of life and occupations considering as already old and out dated. This might discourage people living in rural area and hurt their pride to live in the village. As a result, movement of rural people to the city and deterioration of environment, such as deforestation and farmland damage/loss may have been accelerated in rural areas. For grappling with these problems, an alternative rural development approach has been experimented through re-evaluating traditional culture and knowledge of people by installing village cultural museum in the Laotian villages. This is a report of progress of the project so far achieved.
Key words: Rural development, Laos, Japanese experience, Village cultural museum

Introduction

In the developing countries in Asia where large majority of population lives in rural areas, many rural development projects have been executed for sustainable development of the country. However, those existing rural development paradigm/ approaches, which aims at rapid achievement of economic affluence and modernization of life style, have improved or changed traditional life styles, farming methods and tools of life and occupations considering as already old and out dated. This might discourage people living in rural area and hurt their pride to live in the village. As a result, movement of rural people to the city and deterioration of environment, such as deforestation and farmland damage/loss were accelerated in rural areas.

In Laos, the village is exposed by the wave of sudden change by the rural development which accelerates modernization. Traditional culture and "intelligence and technology of the residents" developed in the community and succeeded generation to generation is neglected, and function of the community is weakened quickly too. Careless denial of knowledge and the experience of the community by the rural development projects, which weakens pride and reason for living of people and psychological unity, may obstruct sustainable rural development in Laos.

In Japan, many rural villages have faced critical situations of disintegration, and a few villages have already dismantled, because of drastic depopulation and aging of population in rural areas (Fig. 1) and widening of regional disparities in income and public services and so on between rural and urban areas. The past rural development policies in Japan did not try to learn or rather ignored clues of development from intelligence and technology of life of the peopfe who live there, and they were seriously considered and bound to economic affluence. We believe that the past development policies has caused serious problem in many rural areas in Japan. A few people living in the rural areas has already initiated alternative rural development approach by re-thinking and re-appreciation of spiritual resource of livelihood and life nurtured in the community over a long time. They have established Village Cultural Museum to conserve traditional culture through collecting and displaying traditional tools and cultural materials in their area, in expectation of recovering own identities and reactivating function of the community. Also Village cultural museum are utilized to promote eco tourism in the village.

On the basis of the Japanese experience, the Center for Southeast Asian Studies (CSEAS), Kyoto University in collaboration with Faculty of Agriculture, National University of Laos (hereafter FOA) and PADETC (Local NGO) have started a rural development project as practical area to study aiming to promote rural development through reactivating rural community by establishing village cultural museum with peoples' participation in Laos, supported by the Toyota Foundation from 2008. In this paper, the progress of this project will be highlighted.

Materials and Methods

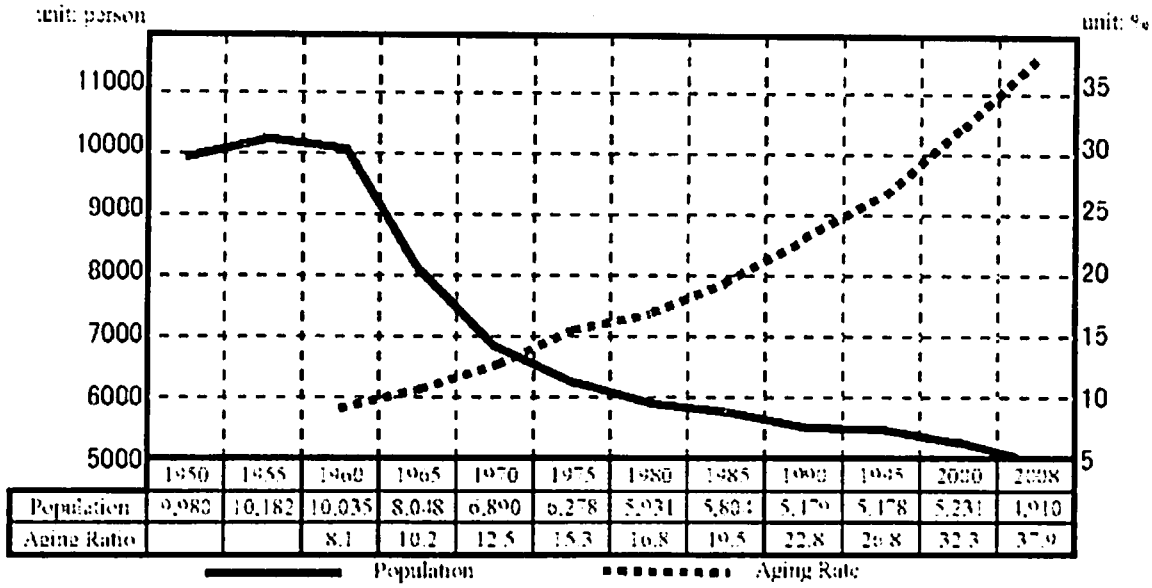
Study area: According to consultation with the FOA and the local authorities, three (3) villages, Dongbang, Thajampa and Raa-yao, are selected for project implemention (Fig. 2). Dongbang village and Thajampa village, Xaithany District, Vientiane Capital: These two villages are situated approximately 30 Km north east of Vientiane city and nearby the campus of FOA.

Dongbang village: South of the Nam Ngum River, it has about 150 households; most of all families are Lao ethnic and believe in Buddhism. Established more than 150 years before, most of open lands surrounding the village are farm land. Common facilities, such as village hall and meeting place are constructed by the government. Condition of village is better than other two villages.

Thajampa village: North river bank of Nam Ngum River, It has about 80 households and is a new village established in 1989. Many villagers believe in animism and there is no Buddhism temple in the village. Common facilities except a primary school are not constructed and less developed village in the area. Therefore, the district government is interested in development of the village.

Raa-yao village, Samakkhixai District, Attapu Province: Raa-yao situates at suburb of Samakkhixai town in southern Laos near border to Vietnam and Cambodia. Main ethnic group is *Oie* tribe of the Mon-Khmer family of languages. Many old instruments of livelihood are still seen in the village and villagers are producing traditional bamboo made handicrafts. Raa-yao has been selected as one of the cultural village of the Government's Cultural Village Project. The district government actively

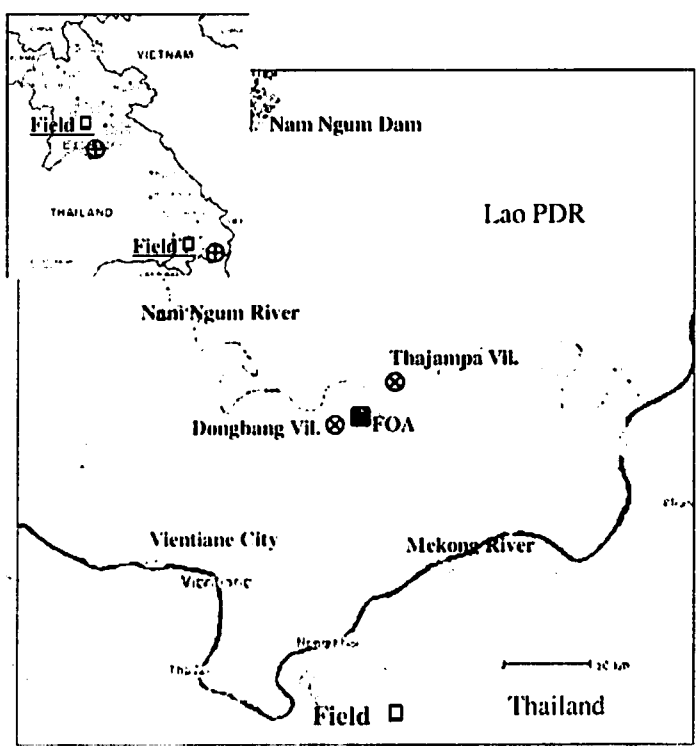
conserves traditional culture through collecting tools of livelihood and occupation in the area.



	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2008
Population	9,980	10,182	10,035	8,048	6,890	6,278	5,931	5,804	5,170	5,178	5,231	4,910
Aging Ratio			8.1	10.2	12.5	15.3	16.8	19.5	22.8	26.8	32.3	37.9

Source: Miyama Town Office

Fig.1. Change of Population and Aging Ratio of Miyama, Kyoto Prefecture



Field□
Central Laos
Xaithany District, Vientiane Capital
●**DongBang Village**
Old village established 150 years ago, Lao ethnic group, Government key village of development, infrastructural development by the government
●**Thajampa Village**
Establishe in 1989, Less developed, Black Thai tribe of Lao Linguistic Family
●FOA: Faculty of Agriculture, National University of Laos

Field □
Southern Laos
Samakkhixai District, Attapu Province
• **Raa-yao Village**
Oic Tribe of Mon-Khmer Linguistic Family, Traditional workmanship such as bamboo handicrafts and so on

Fig. 2. Project Implementing and Research Villages

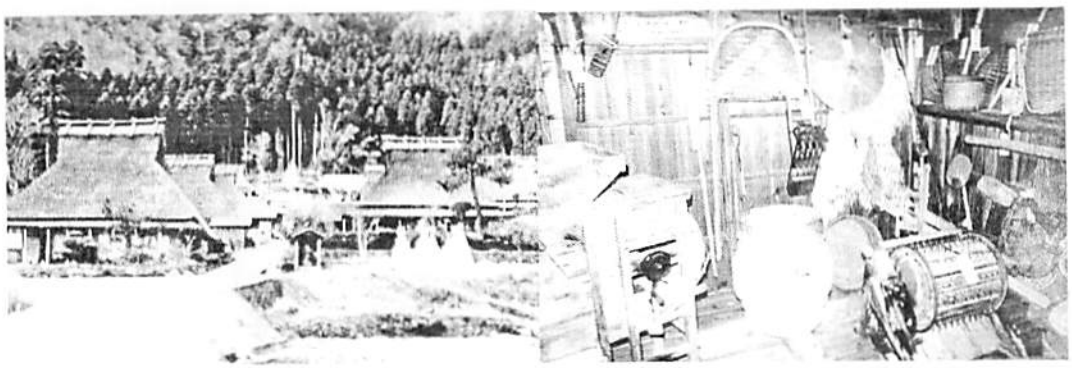


Fig. 3. Scene of Kita Hamlet in Miyama and Tools of Farming, collections of Thatched Roof Village Folklore Museum

Objectives and Methodology: Objectives of this study are to try to find out an alternative rural development approach, in which traditional culture and history of the village is highly respected and carefully considered by planner and practitioner of projects. For this objective, Action research method, in which both Japanese and Laotian researchers work together and participate in the process of establishing Village Cultural Museum with the villagers, is adopted as research method in this study. Following research topics and proposals are planned well ahead.

i) **Promotion of re-creation activity of culture**

The activities of NGO and villagers on re-considering and conserving traditional culture and wisdoms and skills of elder people are studied. Existing community programs of PADETC and activities of Lao Traditional Tools Farmers Museum of FOA have been reviewed.

Establishing village cultural museum by the villagers is promoted by utilizing experience and knowledge on the village cultural museum in Japan with partially financial assistance of the Toyota Foundation. Processes of activities are carefully documented and following results are expected at the end of the project.

- Compilation of village database compilation:

Traditional culture, instrument and skills of life and occupation (method of using), handing down both of folklores and public entertainment such as songs and dances and so on; the data is collected by participatory investigation of the villagers.

- Application of Japanese experiences and knowledge:

For utilization and management of village cultural museum, Japanese experiences and knowledge may be applicable.

- Exhibition program of livelihood.
- Village festivals/ events on traditional cultural and public entertainment.

ii) Network establishment and mitigation of social problems

The network among the Laotian and Japanese villagers, personnel of NGO/ NPO, local administration and universities is created for aiming to mitigate social problems such as local re-activation and planning development schemes.

- Study visit to rural area and exchange with villagers in Japan to learn problems in rural village and re-activation programs of participation of people utilizing village cultural museum in Japan.
- Advice and assistance to villagers to formulate village development plan and schemes by the network participant.
- Mutual study visit and exchange program by the villagers and the local authorities of the three Laotian villages to learn and advice each other and hold workshops focus on village history, traditional culture and village cultural museum.

Results and Discussion

The project is still going on, the each component is continuing. However, following actions have been executed by the project so far.

1) **Study visit to Japan by teachers of FOA, NUOL:**
2) With the purpose to make Laotian project participants to understand meaning and importance of conservation of traditional culture for rural reactivation through seeing and hearing present condition and problems from the Japanese villagers, three teachers of FOA, who take part in activities of Lao Traditional Tools Farmers Museum, have been sent to Japan in February and march 2009. They visited Kameoka Municipal Museum of Culture in Kameoka city, Chii Rural Promotion Bureau and Thatched Roof Village Folklore Museum of Miyama in Nantan city (Fig. 3) and so on.

Execution of sample survey for database compilation

Household survey by interview and questionnaire was done by teachers of FOA to grasp the feature of the village and collect information of the instruments available in the village which is displayed in the village cultural museum.

3) **Construction of village cultural museum**

Excluding Dongbang village where a village hall attached with a traditional cultural exhibition room has already built by the government, a village cultural museum has been constructed by villagers' participation both of planning and of financial contribution in each village, Thajampa and Raa-yao.

i) **Thajampa village**

In August 2009, the village officials including village headman held several meetings, and decided the building design of village cultural museum and estimated cost of construction. Then construction site was selected at an

adjacent plot to the primary schoolyard of the village. Instead of drawing plans, they provided a miniature model of the building made by timber, bamboo and papers. The project offered US 6,000 dollar as a part of construction cost, and the villagers owed shortage or rest of total construction cost. Schedule, supervision and management system and material arrangement of construction work are decided at the village officials' meetings. Construction work have been supervised and inspected by the teachers of FOA. Lumber were cut down from nearby forest with permission of the Xaithany district government. Collection of construction materials started in 2009 November, completion ceremony was held in June, 2010. Total construction cost was about US 7,550 dollar, in which the project provided US 6,000 dollar and the rest, approximately US 1,550 dollar including voluntary labor cost were contributed by Thajampa village.

At the beginning of construction, the 1st floor of the building were planned as the unofficial open meeting space, but it was finally attached in the wall and converted to an official meeting place of the village. It may be said that public facility demanded by the villagers was realized (Fig. 4).

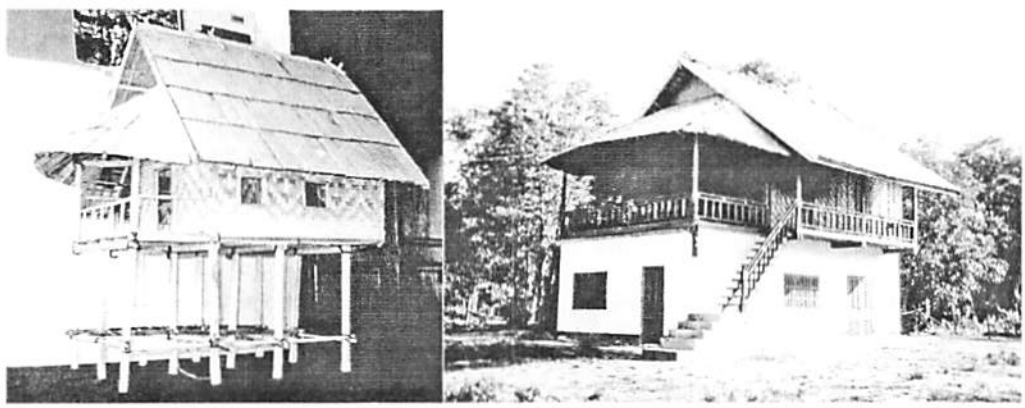


Fig. 4. Miniature Model and Thajampa Village Cultural Museum

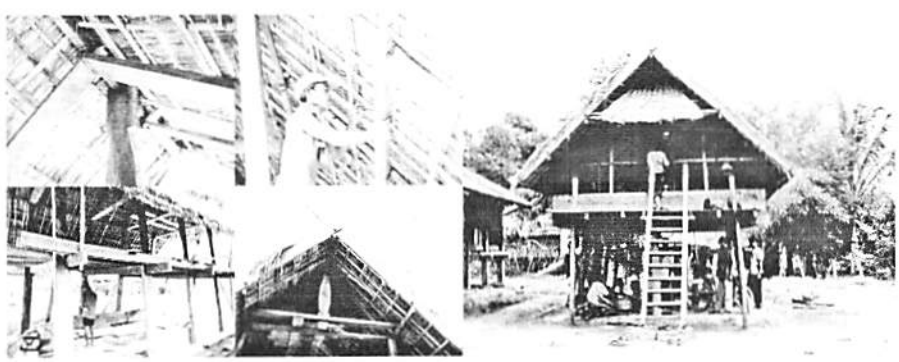


Fig. 5. Construction without nails and machineries, and Raa-yao Village Cultural Museum

ii) Raa-yao village

Villagers in Raa-yao asked an officer of District Irrigation Department to draw a plan of building and estimated the cost by them. In December 2009, the construction work started.

The lumber cut down from nearby forest in condition not using any machine like a chain saw by the permission of the local administration. To follow and practice traditional techniques of building construction, the nail and the like was not used and lumber were mortised each other or bound with ropes.

Leader of Women Association in the village and officers of the district government positively supported and assisted the establishment of the museum. Completion ceremony was held in July 2010 (Fig. 5).

In the village, the traditional techniques such as bamboo workmanship have positively been handed down to the generation and production of bamboo handicrafts is still the important work in the village. It is expected that the village cultural museum may attract sightseers and promote tourism and eco-tourism in the area in future.

Conclusion and Future Prospective

In two project villages, the village cultural museum was installed with the positive participation of the villagers. Through participation on the process of establishing the museum, the sentiment of self-confidence gradually grows among the villagers. There is some positive indication that

importance and necessity of conservation of the traditional culture and instruments by the villager itself has been gradually understood by the people concerned.

Examination of more effective application of the building has just started. For the cultural museum is quite new thing to the villagers, they are in the groping state towards an answer.

Future problem for the project is utilization of the museum and promotion of participation of the villagers, especially elders and children, to convey the traditional culture, wisdom and technology of the community to the next generation. We think that, for this purpose the experience of Japanese village cultural museum such as the Thatched Roof Village Folklore Museum in Miyama will be useful in Laos.

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developed countries. Therefore, international authorities and academics should be accountable for the diverse dimensions of REDD-plus and its impacts on a broad range of people, not just for the robust institutional design of the regime. However, while many existing reports and essays mention appropriate institutional design, few examine the likely outcomes, such as the consequences of building the normatjve forest-governance model into the REDD-plus operational framework.

This study clarifies the likely functions of normative forest-governance models in the emerging REDD-plus regime by reviewing, analyzing, and synthesizing the two categories of reports: those on the normative forest-governance model and those on the REDD-plus operational framework, together with concrete data on some Asian countries from the World Bank overall governance indicators. We first survey the normative forest-governance model and the dominant REDD-plus operational framework, then we unite the two and show the roles and functions of the model under the coming REDD-plus regime. Finally, we mention the more likely functions of the model and the grounds for such functions, i.e., the actual overall governance situations of some Asian countries and the difficulties of making improvements in a short period of time.

Materials and Methods

In this article, we determine the most likely functions of the normative forest-governance model under the coming REDD-plus regime by uniting the normative forest-governance model and the REDD-plus operational framework and examining data on overall governance. Principles for selecting the model and framework included that each be submitted by influential international bodies and be detailed enough for practical application. In addition, we utilized the World Bank's overall governance indicators, for two reasons. First, no such indicators limited to forest governance have been presented to date. Second, the indicators, which are the result of the long-term efforts of many organizations to improve governance situations, are informative in foreseeing the outcomes of forest-governance trials under the coming REDD-plus regime.

Normative forest-governance model and REDD-plus operational framework

The definition of forest governance, the trigger for model introduction, and the feature of a dominant normative forest-governance model: Several definitions of forest governance have been offered (Bodegom *et al.*, 2008); here we adopt those of the World Bank (2008) and the FAO and ITTO (2010), which are similar. According to these sources, forest-sector governance refers to the ways in which officials and institutions (both formal and informal) acquire and exercise authority in the management of the resources of the sector to sustain and improve the welfare and quality of life of those whose livelihoods depend on the sector. At the same time, they specify that good forest governance is characterized by predictable, open, and informed policymaking based on transparent processes, a bureaucracy imbued with a professional ethos, an executive arm of government that is accountable for its actions, and a strong civil society that participates in decisions related to sector management and in other public affairs; furthermore, all of these operate under the rule of law (World Bank, 2008; FAO and ITTO, 2010).

The World Bank, for example, already had a forest-governance model at the beginning of the 2000s (World Bank Group, 2001; Mayers *et al.*, 2002). This came about because a review by the World Bank's Operations Evaluation Department of the performance of the World Bank's 1991 Forest Strategy (Lete *et al.*, 2000) pointed out the failure of that strategy to address governance issues as a serious gap in the World Bank's work in forestry, and recommended that the World Bank help reduce illegal logging by actively promoting improved governance and the enforcement of laws and regulations, as poor laws and legislation and poor enforcement were fundamental to failures in the sector. As a result, the World Bank placed forest governance and illegal logging high on the agenda in its 2002 Forest Strategy (World Bank, 2008).

Currently, international bodies such as the World Bank, the World Resources Institute, Chatham House, etc., have several forest-governance indicators and models. In this article, we review the forest-governance model of the World Bank (2009a).

The normative forest-governance model presented by the World Bank (2009a) is outlined in Table 1. This model was devised to remedy the following shortfalls of the previous major initiatives on forest governance: a holistic approach to forest governance was missing; governance elements needed to be aligned to forest-sector development objectives; economic aspects of forest governance needed greater focus; actionable governance indicators needed to be highlighted; and overall governance indicators were needed to complement sector-specific indicators .

The outstanding characteristic of this comprehensive model of forest governance is that it has numerous elements that overlap with parts of the overall governance indicators of the World Bank. This becomes more evident when the model is compared with the indicators (Kaufmann, 1999) that the World Bank established more than a decade earlier. These indicators, comprising six building blocks and their components, have many elements with similarities to the normative forest-governance model of 2009, such as "voice and accountability", "graft (control of corruption)", and "rule of law" (Kaufmann, 1999; World Bank, 2007). It is apparent that the World Bank's 2009 forest-governance model was built in reference to the overall governance indicator of the World Bank.

Phased approach in REDD-plus operation and an elaborative framework: At present, the overriding operational framework of REDD-plus is a phased approach (La Vina, 2010; Hyakumura and Yokota, 2010; Knight *et al.*, 2010). This approach was introduced in 2009 in the Meridian Report (Angelsen *et al.*, 2009) and progressed through Forest Dialogue meetings in the same year (The Forest Dialogue, 2010). Moreover, it became an important point for key consensus at the Copenhagen UN meeting in December 2009 (La Vina, 2010). In this article,

we take up a model agreed upon at the Forest Dialogue meetings (The Forest Dialogue, 2010) to explain this approach.

Table 1. Forest governance model concepted by the team belonging to the World Bank

Transparency, Accountability, and Public Participation	Coherence of Forest Legislation and Rule of Law
Transparency in the forest sector	Quality of domestic forest legislation
Decentralization, devolution, and public participation in forest management	Quality of forest law enforcement
Accountability of forest officials to stakeholders	Quality of forest adjudication
Accountability within the forest agencies	Property rights recognized/honored/enforced
Stability of Forest Institutions and Conflict Management	Economic Efficiency, Equity, and Incentives
General stability of forest institutions	Maintenance of ecosystem integrity: sustainable forest use
Management of conflict over forest resources	Incentives for sustainable use and penalties for violations
Forest Administration Quality	Equitable allocation of forest benefits
Willingness to address forest sector issues	Market institutions
Capacity and effectiveness of forest agencies	Forest revenues and expenditures
Corruption control within the forest sector	
Forest monitoring and evaluation (M&E)	

Source: World Bank (2009a)

The distinctive feature of a phased approach, which is composed of three phases, is to proceed step by step toward the final phase, "Performance-based Payments," which is the ultimate goal of the framework (Table 2). Each phase has unique financial mechanisms, safeguards, and trigger/eligibility criteria for movement from one phase to the next, as well as outcomes. The Dialogue recommends that the eligibility of countries to shift phases should be based on triggers that are informed by a verification body so as to help steer and facilitate the process rather than block such shifts. Also, the Dialogue suggests that triggers would work like referenced indicators and would not constitute an obligation or a checklist (The Forest Dialogue, 2010).

Phase 1, the initial "Preparation and Readiness" phase, would involve the development of national-level REDD-plus strategies, including the identification and prioritization of key policies and institutional capacity-building measures for both state and non-state actors. In Phase 2, "Policies and Measures" would be put in place to allow the implementation of REDD-plus and, based on performance, to encourage scaled-up public-sector and private-sector investments in various areas such as institutional capacity, forest governance, land-tenure reform, sustainable forest management, the strengthening of conservation in protected areas, activities outside the forest sector, etc. In Phase 3, "Performance-based Payments," market mechanisms, such as the carbon market, and fund-based mechanisms would deliver performance-based payments based on third-party-verifiable emissions reductions and carbon-stock enhancements (The Forest Dialogue, 2010).

Roles and Functions of the Normative Forest-governance Model under the coming REDD-plus Regime

The term "forest governance" or "governance" appears directly in few elements in the REDD-plus operational framework (Table 2) as proposed by the Forest Dialogue (2010). Yet, based on our understanding of the definition and normative model of forest governance, the framework specifies the breadth of the range of components to which the concept relates.

In Phase 1 of Table 2, we consider that the following components are definitely associated with the forest-governance concept: "institutional development," "deployment of multi-stakeholder processes," "transparency," "participation and representation," "multi-stakeholder endorsement," and "development of plans for overcoming governance and policy gap." Correspondingly, most components of Phase 2, except those within the "finance mechanism," are related to the forest-governance concept, whereas the number of such components notably lessens in Phase 3 compared with the former two phases. In the REDD-plus operational framework (Table 2), the normative forest-governance model, such as that shown in Table 1, fulfills two roles. The model serves as a reference guide to be consulted when each fund- and credit-seeking government sets the specific content of components. For example, irrespective of whether each government can adopt any components on its own accord and actually implement them, in Phase 1, "Preparation and Readiness," many governments have to refere the normative forest-governance model for the design of "institutional de velopment." The other role is as a key criterion to be considered when third-party verification bodies judge whether to recommend to international authorities the phase transitions of targeted countries, in particular to Phase 3, "Performance-based Payments." As already motioned in the former section, the Forest Dialogue suggested that third-party verification bodies should help steer and facilitate the process rather than block countries. However, the verification bodies would not be able to avoid acting as blockades in cases where the institutional designs and performance levels of fund- and credit-seeking governments were inappropriate.

As a result of these roles, in a few years, the normative forest-governance model may be involved in aspects of the REDD-plus phased approach, either helping fund- and credit-seeking countries to attain a certain level of forest governance and gain access to the REDD-plus compliance market, or limiting access by blocking the transition to

Phase 3, "Performance-based Payments," by countries that have not attained a certain level.

Table 2. REDD-plus operational framework devised by the Forest Dialogue

	PHASE 1 Preparationand Readiness	PHASE 2 Policies and Measures	PHASE 3 Performance-based Payments
Outcomes	Development of national REDD+ strategy Assessment of drivers of deforestation Clarification of rights Institutional development Demonstration activities Deployment of multi-stakeholder process	Development of national portfolios Benefit-sharing and equitable distribution Development of institutional capacity, strengthening forest governance, and accomplishment of land-tenure reform	Third-party-verifiable emissions reductions and carbon-stock enhancements Equitable distribution mechanisms Social and environmental impact assessment
Safeguard	Transparency Participation and representation Particular attention to women and most vulnerable poor	Social and environmental audits Governance and legality audits Free, prior, and informed consent Installation of MRV system	Free, prior, and informed consent Social and environmental audits
Finance mechanism	Multilateral and bilateral grants Mechanisms such as FCPF and UN-REDD Voluntary carbon markets Public- and private-sector funding	The application of all possible finance tools within a portfolio framework Scale-up public- and private-sector investments Implementation of equitable distribution mechanisms	Compliance market Non-market compliance Underwriting risks Equitable distribution mechanisms
Triggers/ eligibility criteria	Multi-stakeholder endorsement Development of plan for overcoming governance and policy gaps	Adequate legal rights and tenure systems Endorsement of benefit distributions National capacity to perform third-party audits Proxy indicators	

Source: The Forest Dialogue (2010).

What is the more likely function of the normative forest-governance model under REDD-plus?

Of these contrasting functions, which will be more common or likely? The latter function, that is, limiting access by blocking the transition of problematic countries to Phase 3 or preventing countries with inferior forest governance from entering the REDD-plus compliance market, may become the more probable function of normative forest-governance models in the REDD-plus phased approach, at least in the short-term. We think this will be the case because of the actual current situation of overall governance in many countries and the difficulty of improving over a short period. Here we examine the circumstances of some Asian countries as examples.

Evaluated values of three components from the overall governance indicators of the World Bank, together with the forested area of countries, are listed in Table 3. These data are from 2009 and 2010, respectively. The targets are all countries in Southeast Asia and some democratic countries in East and South Asia. The components "voice and accountability," "rule of law," and "control of corruption" were chosen because they were very similar to some key components of the normative forest-governance model (Table 1). Many of the forested Southeast Asian countries listed in Table 3 had low marks based on the listed governance indicators. This suggests that such countries need varying degrees of improved governance if they intend to enter the REDD-plus compliance market. Table 4 lists the differences in country estimates from 1998 and 2009 for the same indicators listed in Table 3. These differences illustrate that the overall governance situations of many forested Southeast Asian countries, aside from Indonesia, have degraded over the past decade. As mentioned in the section "Normative forest-governance model and REDD-plus operational framework," the World Bank worked out overall governance indicators more than a decade ago and has tried to improve overall governance in many countries, including those of the Southeast Asian region. Many other agencies have also made similar attempts. For instance, between 1998 and 2009, the World Bank lent more than 6.352 billion US dollars to countries in the East Asia and Pacific region for the upgrading of "public-sector governance" and "rule of law" (calculated from World Bank, 2003; 2009b). Member countries of the Development Assistance Committee (DAC) and other multilateral agencies have assisted Southeast Asian countries by contributing official development assistance (ODA) funds totaling 661 million US dollars between 1998 and 2009 to improve "legal and judicial development," "strengthening of civil society," and "media and free flow of information" (calculated from

data in OECD QWIDS http://stats.oecd.org/qwids/; accessed on 9/11/2010). Nevertheless, the realities are shown in Table 4, where Indonesia, which underwent a political transformation at the end of the 1990s, is the exception.

The information presented in Table 4 is helpful in predicting the results of ongoing and future attempts at better forest governance by international organizations. In many cases, improvements in forest governance, as well as overall governance, are likely to be difficult to achieve in the short term.

Table 3. Governance scores (-2.5 to +2.5) in some Asian Countries with three dimensions

Voice & Accountability	Rule of Law	Control of Corruption	Forest Area (10^3 ha.)
Japan	+1.03	+1.31	+1.35	24,979
S. Korea	+0.69	+1.00	+0.52	6,222
India	+0.47	+0.05	-0.33	68,434
Indonesia	-0.05	-0.56	-0.71	94,432
Philippines	-0.12	-0.53	-0.71	7,665
Singapore	-0.40	+1.61	+2.26	2
Thailand	-0.40	-0.13	-0.23	18,972
Malaysia	-0.53	+0.55	+0.02	20,456
Brunei	-0.79	+0.79	+0.96	380
Cambodia	-0.88	-1.05	-1.18	10,094
Vietnam	-1.52	-0.43	-0.52	13,797
Laos	-1.71	-0.94	-1.14	15,751
Myanmar	-2.17	-1.52	-1.75	31,773

Source: http://info.worldbank.org/governance/wgi/sc_country.asp (9/11/2010 accessed), http://www.fao.org/forestry/fra/fra2010/en/ (9/11/2010 accessed

Table 4. The differences (1998-2009)* of governance scores in some Asian Countries with three dimensions of the World Bank's governance indicators

Accountability	Rule of Law	Control of Corruption
Japan	0.14	-0.09	0.2
S. Korea	0.07	0.19	0.25
India	0.15	-0.18	0.01
Indonesia	0.99	0.18	0.36
Philippines	-0.51	-0.48	-0.48
Singapore	-0.66	0.26	0.14
Thailand	-0.8	-0.64	-0.26
Malaysia	-0.32	0.09	-0.6
Brunei	-0.04	0.19	0.55
Cambodia	0	-0.07	-0.11
Vietnam	-0.16	-0.04	0.01
Laos	-0.68	-0.16	-0.73
Myanmar	-0.22	-0.18	-0.41

Source: http://info.worldbank.org/governance/wgi/sc_country.asp (9/11/2010 accessed).
*Minus values mean the worsening of overall governance during the period, whereas plus values indicate progre

Concluding remarks

Some reports have pointed out that REDD(-plus) may have some paradoxical relationships with governance. For instance, Sandbrook *et al.* (2010) warned that REDD interrupts the decentralization of forest management. The Forest Dialogue (2010) was concerned with the other paradoxical aspect, i.e., that it is unlikely that financial support will be available for REDD-plus in contexts where basic good governance is lacking, even though the need for REDD-plus is often most urgent in such places. Therefore the group proposed making upfront ODA-style funds available as an initial step (Phase 1), which could be used to improve governance (The Forest Dialogue, 2010). In this article, we also suggest a paradoxical aspect of REDD-plus related to governance, which is similar to the paradoxical aspect submitted in the Forest Dialogue (2010) but lies in a later stage, particularly under a dominant phased approach.

REDD-plus needs to pursue not only simple legitimacy, i.e., reducing carbon emissions, but also further legitimacy, i.e., democratic processes involving citizen participation in forest areas. This enlarged request for REDD-plus further enhances the value of the normative forest-governance model. If current situations and

transformation patterns of overall governance are examined, however, the difficulties that many developing countries have in attaining the level of forest governance called for under such a normative model, are apparent. Many nations require numerous years to achieve such levels, and some may find it impossible even after several decades. This means that many countries may receive support from ODA-style funds and the World Bank, but be unable to secure financing from the REDD-plus compliance market. In other words, the demands for funds from the ODA and the World Bank would increase; on the other hand, the volume of carbon credits would remain limited.

As was clearly shown by the World Bank (2006), some very large international agencies intend to heighten the efficiency of forest-governance improvements by linking forestry governance to overall governance. Moreover, various international bodies will further expand support for improvements once the REDD-plus mechanism is formally agreed upon in international negotiations. Surely, this will lead to better forest governance. Nevertheless, based on the results of efforts directed at overall governance during the past decade, we do not have an optimistic view of the ongoing and future forest-governance trials.

Currently, we have no concrete idea how the paradoxical aspect of the normative forest-governance model under the coming REDD-plus regime, as clarified here, needs to be handled. However, international authorities should retain the screening function fulfilled by the normative forest-governance model in the phased approach of the REDD-plus operational framework, even if this results in a lower number of forested developing countries entering the REDD-plus compliance market. To exclude this screening function would decrease the general confidence of investors and citizens of developed countries, as well as that of markets, in REDD-plus carbon credits. We think this would be detrimental to the progress and stability of the REDD-plus mechanism.

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Sundarbans: the largest contiguous mangrove forest of the world

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Abstract: The Sundarbans is the largest contiguous mangrove forest in the world located in the southern part of Bangladesh. The total area of the Sundarbans is 10000sq kilometers of which 60% lies in Bangladesh and the rest is in India. The Sundarbans supports an exceptional and the richest biodiversity of terrestrial, amphibious and marine, ranging from micro to macro flora and fauna. The Sundarbans is of outstanding importance for globally endangered cat species including the Royal Bengal Tiger, aquatic fresh water and marine species including Gangetic and Irawadi dolphins, estuarine crocodile and also critically endangered endemic river terrapin (*Batagur baska*). The Sundarbans is the only mangrove habitat in the world for *Panthera tigris tigris* species. The Sundarbans is the biggest delta, and back water and tidal phenomenon of the region provides diverse habitats for several hundreds of aquatic, terrestrial and amphibian species. The Sundarbans also provides sustainable livelihood for millions of people in the vicinity and act as a natural forest to protect the people from storms, cyclones, tidal surges, sea water seepage and intrusion.
Key Words: SRF (Sundarban Reserved Forest), WS (Wildlife Sanctuary), endangered, mangrove, terrestrial, amphibious, flora, fauna, world heritage, FD, SIDR

Introduction

The Sundarban Reserved Forest (SRF) is the single largest mangrove forest in the world. The SRF is a unique bioclimatic zone in a typical geographical situation in the coastal region of the Bay of Bengal. It is a landmark of ancient heritage of mythological and historical events.

Population growth and economic development have brought immense pressure on mangrove wealth and its system for firewood, timber, fishes, honey and thatching materials etc. About 3.5 million people directly or indirectly depends on the resources of Sundarban in a network of numerous small and big streams and creeks in the adverse bioclimatic of mangrove forests infested with fierce wild animals-tiger on land and crocodiles in water are struggling for survival and are in search of worthwhileness for their existence.

Nomenclature: Probably the name of the Sundarban is derived from the name of the principal tree species **Sundri** (***Heritiera fomes***). On the other hand people presumed that from the word **"Somundar"** (sea) and **"Ban"** (forest), first **"Samundarban"** and then the name **"Sundarban"** came into existence.

History: At the beginning of the eighteenth century, the forests were about double of the present size and were under the control of Zamindar (Land Lord). In 1828, British government first took the control over Sundarban management. In 1878 the Sundarban was declared as reserved forest and then was placed under the control of Forest Department (FD) in 1879.

Geographic Situation: The SRF is situated in the extreme south-west corner of Bangladesh between the river Baleshwar and Harinbhanga adjoining to the Bay of Bengal and it covers 6017 sq km including 3 wildlife sanctuaries (WS).

The SRF is situated at the southern part of Khulna, Bagerhat and Satkhira civil district lying in between latitude 21°39' & 22°30' north and longitude 89°01' & 89°52' east.

Topography: The forest floor rises 0.9m to 2.11m above mean sea level. The entire forest is inundated twice a day with the high tide.

Water: Salinity of the estuary varies seasonally. During monsoon, salinity decreases for heavy downpour in the upstream. Considering salinity, the forest area is divided into 3 (three) zones viz. Fresh water zone, Moderate salinity zone and Salinity zone.

Administrative setup: Since 2001, the whole Sundarbans is controlled under Khulna Circle and is divided into two divisions i.e. Sundarban West Forest Division (HQ at Khulna) and Sundarban East Forest Division (HQ at Bagerhat) (Table 1).

For proper management SRF is divided into 55 compartments. There are four Ranges (Satkhira, Khulna, Chandpai and Sarankhola), 17 Forest Revenue Stations and 72 Patrol posts/camps. A total of 1167 staffs are working in different categories.

Table 1. District and Range wise Area information of Sundarbans

Division	District	Thana	Range	HQ	Hectares	Compartments
Sundarban West Forest Division, Khulna	Khulna	Dakope	Khulna	Nalian	1,70,610	16 to 20, 32 to 40, 43 & 44
		Paikgachha				
		Koyra				
	Satkhira	Shyamnagar	Satkhira	Burigoalini	1,86,731	41, 42, 46, 47, 48, 49, 50a, 50b, 51a, 51b, 52, 53, 54 & 55
Sundarban East Forest Division, Bagerhat	Khulna	Dakope	Chandpai	Chandpai	13,686.85	29, 30, 31
	Bagerhat	Mongla	Chandpai	Chandpai	80,756.19	9, 10, 12A, 13, 14, 15, 21-27 (Part of 28)
		Morelganj	Chandpai	Chandpai	3,001.88	27 (Part)
		Sarankhola	Sarankhola	Sarankhola	1,45,599.40	1 to 8, 11, 12B, 24 & 45

Biodiversity in the Sundarbans

Flora: It has considerably high floral diversity and in total about 334 plant species, additionally 165 algae and 13 orchid species are also recorded. Among them Sundri (*Hertiera fomes*), Keora (*Sonneratia apetala*), Baen (*Avicennia officinalis*), Passur (*Xylocarpus mekongensis*), Kankra (*Bruguiera gymnorhiza*), Goran (*Ceriops decandra*), Golpata (*Nypa fruiticans*), Singra (*Cynometra ramiflora*), Bhola (*Hibiscus tiliaceae*), Hental (*Phoenix paludosa*), Khalshi (*Aegicerus corniculatum*), Gewa (*Excoecaria agallocha*) etc. are most important.

All the plant species in the SRF are indigenous. There is no endemic or exotic species and so far none is considered rare.

Fauna: There are more than 375 wildlife species which include 35 reptiles, 315 birds, 42 mammals. There are 291 (210 whitefish, 24 shrimps, 14 crabs and 43 molluscs) fish species exist in the SRF. The major wildlife in the SRF include the Royal Bengal Tiger (*Panthera tigris tigris*), spotted deer (*Axis axis*), wild boar (*Sus scorfa*), monkey (*Macaca mullata*), estuarine crocodile (*Crocodylus porosus*), python, turtle, dolphin, otter, jungle cat, fishing cat and a variety of bird species.

Fish Resources of the Sundarbans: The largest fishing ground in the Bay of Bengal is close to the Sundarbans. The Sundarban has a large area of water body which support huge amount of fisheries resources. More than 400 fish species have been recorded from the Sundarban and its adjoining coastal waters and 120 of these are regularly caught by commercial fishermen from the Sundarbans waters. There are about 53 species of pelagic fish belonging to 27 families, and 124 species of demersal fish belonging to 49 families. Besides these there are 24 species of shrimps belonging to 5 families.

The annual catch data of fisheries as compared to other zones suggests, southwest coastal Bangladesh produces the most amounts of fisheries among all. An estimated 160,000 people of Bangladesh are engaged in fishing activities. In only Sundarban, about 40000 fishing boats enter the forest for fishing purpose. In aquaculture sector, only three Sundarban adjoining districts Khulna, Satkhira and Bagerhat accumulate about 80 percent of the shrimp industry of Bangladesh. However to conserve mangrove ecosystem and maintain sustainable fisheries productivity, the FD has taken some initiatives: (1) Fishing activities is strictly prohibited within the three WS, (2)18 canals outside the WS are also prohibited for fishing throughout the year, (3) Collection of shrimp fry has already been banned in the SRF, (4) Harvesting of crabs is banned in the month of January and February.

The wildlife of SRF: Some important wildlife population of the SRF are: Tiger- 440, Deer-100000-150000, Monkey- 40000-50000, Wild boar-20000-25000, Crocodile - 150-200, Otter-20000-25000.

Tiger status and Study: In the SRF, there exist 440 tigers including 21 cubs (Tiger census 2004). So each tiger has a home range of 14.4 sq. km.

The home range of tigers in the SRF is about 14-16 sq km and compared to other habitat this is the smallest. Before this study in Bangladesh the smallest home range size was recorded in Nepal (about 25-30 sq. km) and largest from Russian far-east (over 400 sq km). This indicates that the SRF has a high overall density and indicate a stable and substantial tiger population.

Wildlife Sanctuary: As a part of conservation planning three wildlife sanctuaries have been declared in the SRF. They are: (i) Sundarban East Sanctuary (ii) Sundarban South Sanctuary & (iii) Sundarban West Sanctuary. These are situated in areas deemed to have wildlife management potential and as representative portions of natural areas in the three different biotypes which are free from timber extraction and other forms of harvesting and maintained as undisturbed breeding ground for wild animals and fishes. The total area of the sanctuaries is 1, 39,700ha which is meant for wildlife and nature conservation.

World Heritage Site: The Sundarbans provides a significant example of on-going ecological processes as it represent the process of delta formation and the subsequent colonization of the newly formed deltaic islands of mangrove community

The Sundarbans is one of the largest remaining areas of mangroves in the world, which supports an exceptional biodiversity with a wide range of flora and fauna of both terrestrial and marine aquatic environment including globally endangered cat species such as the Royal Bengal Tiger. The population of the Royal Bengal Tigers is more dense in the Sundarbans than any other habitat of tigers in the world.

On the basis of these criteria, the UNESCO World Heritage Committee declared Sundarbans as its 798th heritage site on the 6th December, 1997. The site includes three wildlife sanctuaries with an area of 139700ha.

Sundarbans as a Ramsar Site: The Sundarbans has been declared as a 560th Ramsar site in 1992 as it covers all criteria of wetland as well as Ramsar site. Contiguous with the Sundarban there is an additional 20 km wide marine zone with an area of 1603 sq km that is included in the Sundarbans.

Socio Economic Value of SRF: The local people around the SRF are mostly dependant on the Sundarban forests for such necessities of life as timber for boats, poles for house posts and rafters, Goran (*Ceriops decandra*) as fuel wood, Golpatta (*Nypa fruiticans*) leaf for roofing, grass for matting and fencing and also on other products including marine fishes, other brackish water fishes and dried fishes for their own consumption and business.

The most important aspect is protection of Mongla port and human habitation behind SRF from Cyclone due to the presence of this large, compact tract of mangrove forest of Sundarbans.

Honey Collection: There are many species of plants from where honey is collected by the bees. Honey collectors collect honey from the bee hives seasonally. They get permission from the FD at fixed revenue rate. Honey collection starts from 1st April and continues up to 15th June every year. About three thousand families are involved in honey and wax collection.

SIDR and Sundarbans:

According to the primary report of the FD 110,000ha area has been damaged in 18 compartments at Chandpai and Sarankhola Ranges during the cyclone SIDR. Many

international and local institutions like UNDP, UNESCO, SPARRSO, RIMS of FD etc reported the damage percentage ranges from 19 to 30 percent.

By the hit of the cyclone SIDR the eastern part of the SRF was submerged under 3.5 to 4.5 meter surge that caused severe damage to the flora and fauna. Trees were uprooted and died severely leaving the area barren. In some cases the trees were damaged as if they were burnt. The RIMS unit of the FD using satellite imagery identified that the trees of 2.47% area were fully damaged, 15.23% area were partially damaged and 4.47% area were less damaged.

During SIDR 23 deer & a tiger has been reported to die. All the fresh water tanks were flooded by tidal saline water leaving the wildlife in great trouble in search of drinking water for their survival. Many infrastructures of the FD have been damaged partially or fully. Wireless communication has been totally disrupted.

In order to cover the loss the government decided not to perform any sanitation harvesting. Rather all sort of extractions except fish and honey have been banned to help naturally rejuvenate the forest to its previous position.

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Perception of fish farmers on flood coping mechanisms in Dewanganj Upazila under Jamalpur district

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Abstract: The study focused on fish farmers' perception on flood coping mechanisms and the relationship between selected characteristics of fish farmers and their perception on flood coping mechanisms. At several villages in four *unions* of Dewanganj *upazila* under Jamalpur district, the data were collected from a sample of 70 fish farmers. Their perception on flood coping mechanisms were measured on five aspects of flood coping mechanisms such as pond management, harvesting and marketing, housing and shelter, means of livelihood and health and sanitation. Pearson's Product Moment Coefficient of Correlation (r) was computed to explore the above mentioned relationships. The findings were as follows: 92.9% of the fish farmers had the moderately favorable perception while 5.7% had the highly favorable perception and the rest 1.4% had the slightly favorable perception on flood coping mechanisms; The correlation test showed that annual family income, extension media contact, cosmopoliteness, training exposure and knowledge on flood coping mechanisms of fish farmers had significant positive relationships with their perception on flood coping mechanisms; but age, educational level, family size and farm size had no relationships with their perception on flood coping mechanisms.
Key words: Fish farmers, flood coping mechanisms, perception, flood prone area.

Introduction

Flood is more or less a recurring phenomenon in Bangladesh. Bangladesh is a land of many rivers, and heavy monsoon rains. Therefore, the country is subjected to inundation by overflow from the riverbanks due to drainage congestion, rainfall run-off and storm-tidal surges. Thirty five percent of the total land surface is flooded during the wet monsoon (Milliman *et al.*, 1989). The annual rainfall in Bangladesh varies from 1,200 mm in the west to over 5,000 mm in the east. The average annual rainfall is approximately 2,300 mm, of which 80% occurs during June to September. Runoff generated by the huge rainfall is carried out to Bangladesh by three major rivers namely the Ganges, the Brahmaputra and the Meghna. In addition to these three major rivers, there are 54 medium and small rivers which enter Bangladesh from India and Myanmar (Chowdhury, 1998).

Available documents revealed that over the last 50 years (1954-2004), Bangladesh has experienced at least 41 floods of different magnitude. Each year flood causes millions of dollars damage in Bangladesh. One fifth to one third of the country is flooded each year during June to October when nearly two thirds of the food grain (mainly rice) is produced. Crops, houses, market etc. go under water and people's sufferings know no bound. There are four categories of floods encountered by Bangladesh: (a) normal monsoon floods, over topping the riverbank of excess water, which submerge the adjoining areas; (b) floods due to on rush of rain water down the hill slopes over land and ultimately causing flooding up in the low lying areas; (c) flash floods in the eastern and northern rivers, with the sharp rise of river water within a matter of days only, followed by the sharp fall; (d) tidal surge because of tidal fluctuation and water level set-up due to cyclones in the coastal area. Of these four categories major river floods are of serious concern.

Flood makes people resourceless and very often in flood time it is seen that hundreds of hungry people are waiting for relief in flood affected areas. Consecutive floods at times (viz. 1987 and 1998 floods) drastically reduced the growth rate of Gross Domestics Product (GDP). The flood in 1998 was the longest lasting in the history of the country causing enormous damages to over two thirds of the country and continued for more then 75 days. Major losses were incurred in corps, livestock, poultry, fisheries and forestry (ITDG, 2001).

Bangladesh is the world leader in freshwater fish production with 4,016 kg/km^2 of water bodies and a per capita fish production of about 5.5 kg in the inland open-water system of Bangladesh. About 260 species of fresh water and brackish water fish and 475 marine water species (Hussain and Mazid, 2001), 24 species of freshwater prawn and 36 marine shrimp species (DoF, 2005) and 12 exotic cultivable fishes so far been introduced into Bangladesh with the aim of increasing fish production (Mazid *et al.*, 2002).

Fish is not only a food crop but also a cash crop. Fish is the major source of animal protein in the diet of people in Bangladesh contributing 63% of the total animal protein supply (DoF, 2007). It contributes 4.92% of the GDP and 6.0% foreign exchange earning (DoF, 2007). In the year of 2006-2007, the total fish production was 21.53 lakh metric tons (DoF, 2007). Bangladesh earned 3,702 core taka by exporting fish and fishery products in 2006-2007 (DoF, 2007). Approximately 1.4 million people are directly engaged in fishing, 11 million in part-time fishing and another 3 million in aquaculture activities. Thus, the fisheries resources offer excellent opportunities for the increased fish production that will effectively combat malnutrition and generate the additional employment. However, the regular flooding is one of the serious constraints to achieve the required fish production.

Due to regular floods, people of Bangladesh have traditionally developed different kinds of coping mechanisms to avoid or at least to decrease the loss due to floods. However, many people become perplexed what they will do during floods. Many of them are not well known about appropriate coping mechanisms. If they are trained on coping mechanisms their ability of coping with floods will be increased and sufferings during floods will be lessened many times (Ahmed, 2005).

To protect the loss from floods or flash floods, fish farmers take several precautionary measures such as netting around the pond dike, fencing, repairing and raising of pond embankment, fast growing fish species to minimize the production period, harvesting fish before

flood, transferring fish to the flood free pond etc. Due to lack of sufficient information fish farmers frequently fail to adopt these preventive measures against floods. Moreover, instead of some information relevant to the abovementioned precautionary measures fish farmers were not able to practice the preventive measures against floods due to lack of necessary perceptions on flood coping mechanisms. As perception is a mental process by which an individual become aware of the world around. It is a response, which in turns furnishes stimuli that elicit and steer further response. Though human perception is seen as an important factor for improving their livelihood, the government and NGOs are not trying to determine fish farmers' perception on flood coping mechanism. Though a number of studies are available on people's flood coping abilities in general (Anam, 1999; Nasreen, 1999; Ahren *et al.*, 2005; Khandker, 2007), no specific study was found on the perception of fish farmers on flood coping mechanisms. Keeping these issues in view, the study was conducted in a flood prone area of Jamalpur district.

Materials and Methods

Dewangonj upazila under Jamalpur district is situated near the river of Jamuna and the river old Brhmaputra crosses this upazila. The area was purposively selected as a suitable area for the study because this upazila comes under regular flood and the people were too much vulnerable to flood damages. Some villages in four unions namely Bahadurabad, Chikajani, Chukaibari and Char Aomkhaoa of Dewanganj upazila were purposively selected for the study. The selection was made on the basis of suggestions made by Upazila Fisheries Officer (UFO), Union parishad members and other relevant officials of Dewangonj upazila. Seventy fish farmers of the selected areas who used to become affected during floods. Due to limited number of fish farmers in the study areas the whole population sampling procedure was taken.

The perception of fish farmers on flood coping mechanisms was measured through getting opinion (by five-points Likert scale) about 20 statements in terms of five aspects for flood coping mechanisms, namely pond management, fish harvesting and marketing, housing and shelter, means of livelihoods, health and sanitation. A respondent was asked to explain how he/she takes necessary actions and measures during, before and after floods concerning the respective aspect. Then, the researcher made a judgment whether his/her overall perception on flood coping mechanisms in those aspects could be ascertained as good or not good. The researcher assigned the basic of answer of the situation by the respondents. The overall score of the respondents' perception on flood coping mechanisms was measured by adding the scores obtained in all five aspects of flood coping mechanisms. So, the overall flood coping mechanisms score can range from 0 (the lowest) to 80 (the highest).

A number of characteristics of the fish farmers were considered for the study such as age, educational level, family size, farm size, annual family income, extension media contact, cosmopoliteness, training exposure, knowledge on flood coping mechanisms. Data were collected through the pre-tested interview schedule by face-to-face interview procedure during the period from 05 September to 15 October, 2009.

Results and Discussion

Characteristics of fish farmers: The study areas were situated in a backward area and its infrastructural and communication facilities were poor. According to Table 1, the highest proportion (55.7%) of fish farmers belonged to the middle age, compared to 41.4% of the young age and 2.9% of the old age.

Table 1. Selected characteristic of fish farmers

Characteristics	Unit of measurement	Expected range	Observed range	Respondents Categories	Respondents % (N=70)	Mean	SD
Age	Year	unknown	24-61	Young (up to 35) Middle (36-50) Old (above 50)	41.4 55.7 2.9	37.23	6.912
Educational level	Year of schooling	unknown	0-12	Illiterate (0) can sign only (0.5) Primary (1-5) Secondary (6-10) Higher secondary (above 10)	7.1 7.1 19.8 53 13	6.71	3.926
Family size	Number	unknown	1-16	Small (below 4) Medium (5-6) Large (above 6)	15.7 31.4 52.9	7.18	2.956
Farm size	Hecture	unknown	0.240-2.540	Small farm (0.2-1.0) Medium (1.0-3.0) Large (above 3.0)	52.9 47.1 0	1.06	0.50
Annual Family income	'000' Tk	unknown	35-619	Low (up to 60) Medium (61-150) Medium high (151-250) High (above 250)	7.1 31.5 31.4 30	209.42	132.54
Extension media contact	Scale score	0-33	1-20	Low (below 11) Medium (11-20)	74.3 25.7	9.10	3.924
Cosmopoliteness	Scale score	0-21	0-13	Low (below 7) Medium(7-13)	95.7 4.3	3.69	2.624
Training exposure	Days	unknown	0-60	Short (below 5) Medium (5-16) Low (above 16)	34.3 45.7 20	10.31	10.655
Knowledge on flood coping mechanisms	Weight score	0-40	7-33	Low (below 13) Medium (14-26) High (above 26)	15.7 65.7 18.6	19.58	6.516

Only 7.1% of fish farmers were found illiterate, compared to 66 % of the secondary and above education. The majority (52.9%) of fish farmers had a large sized family with the average family size being 7.18 persons, compared to the national average of 4.9 (BBS, 2008). The majority (52.9%) of fish farmers were small farmers while 47.1% for the medium farmer. The average farm size of fish farmers was 1.062 hectares, which was slightly larger than the national average (0.81 ha). Less than half (31.5%) of fish farmers earned the medium annual family income, while 31.4% had medium high annual family income, 30% high annual family income and only 7.1% low annual family income.

Table 2. Distribution of fish farmers according to their overall perception scores (N =70)

Level of perception	Respondents (%)	Mean	SD
Slightly favorable (below 50)	1.4		
Moderately favorable (50-70)	92.9	63.4	5.647
Highly favorable (above70)	5.7		

Meanwhile, a significant proportion (74.3%) of fish farmers had low extension media contact while 25.7% medium extension media contact.

Table 3. Extent of perception of fish farmers towards flood coping mechanisms

Sl. No.	Statements	Mean
Pond management		
1.	Pond drying, liming and fertilization is more productive before fry release (+)	3.61 (0.519)
2.	Disease may have not any relevancy with the loss of fish production after flood (-)	3.13 (0.635)
3.	Fencing/netting is necessary practice to protect fish from escaping during flood (+)	3.40 (0.522)
4.	There is no relationship of fish production with or without exit of gases in the bottom layer of the pond after decrease the severity of flood (-)	3.04 (0.824)
Harvesting and marketing		
5.	Seasonal interference of middleman due to flood hampered achieving real market price of fish (+)	2.87 (0.867)
6.	There is no necessity to harvest and marketing of table size fish before flood occur (-)	3.13 (0.588)
7.	It is important to have harvesting equipments to catch of fish just after the flood occurrence (+)	3.17 (0.564)
8.	Buying of fish fry from the fingerling dealer just before flood is very useful (-)	3.31 (0.627)
Housing and shelter		
9.	There should be precaution about flood to protect house and homestead from flood (+)	3.30 (0.598)
10.	Protection of removable assets by transferring safety place to minimize the flood damage is not necessary (-)	2.93 (0.709)
11.	Necessary action should be taken when house moderately inundated by flood (+)	3.19 (0.546)
12.	There is no necessity to take any action when house is severely flooded you need to take shelter another suitable place (-)	3.19 (0.666)
Means of livelihood		
13.	Security of non-food essentials (e.g. clothing, shelter) is an important aspect of the fish farmer during flood occur (+)	3.04 (0.669)
14.	There is no possibility to earn huge money by selling of fish just before flood occur (-)	2.93 (0.644)
15.	It is important to ensure the security of fuel for cooking and other necessary commodities during flood (+)	3.17 (0.636)
16.	Saving money would not be very helpful for improving the livelihood of fish farmer during the time of flood (-)	3.13 (0.815)
Health and sanitation		
17.	Ensure pure drinking water and water for cooking can prevent water born disease (e.g. diarrhea) during flood (+)	3.21 (0.587)
18.	Use of toilet here and there may not create any health problem in the locality after flood (-)	3.31 (0.526)
19.	Restriction on taking bath and using water would be play a significant role in health and sanitation for the fish farmers during flood (+)	3.04 (0.550)
20.	It is not necessary to clean the household area immediately after drainage of flood water (-)	3.29 (0.764)

Notes: 1. Means were calculated on the basis of scores measured by a five-point Likert scale; and 2. The number in the parenthesis indicates Standard Deviation.

The majority of fish farmers (95.7%) had low cosmopoliteness as compared to 4.3% medium cosmopoliteness. The highest proportion (45.7%) of fish farmers had medium duration of training and 34.3% short training while 20% long training. It is said that training can enhance the level of knowledge and improve skills on various aspects of aquaculture technologies (Islam, 2004). As a result, more than half (65.7%) of fish farmers had medium knowledge, 15.7% low knowledge and 18.6% high knowledge on flood coping mechanisms. In general, the level of their knowledge was satisfactory.

Perception of fish farmers on flood coping mechanisms: The overall perception scores of fish farmers ranged from 44 to 76 with the average score of 63.4 and the standard deviation of 5.64. The distribution of the fish farmers according to their overall perception scores is shown in Table 2. Most of fish farmers (92.9%) had moderately favorable perception on flood coping mechanisms. However, 1.4% had slightly favorable perception and 5.7% had highly favorable perception on flood coping mechanisms.

The concrete perception (namely 20 statements) on flood coping mechanisms is shown in Table 3. Except No.5, 10 and 14 statements, of which the means were comparatively low (less than 3 with a high variance), the overall perceptions were favorable.

Relationship between selected characteristics of fish farmers and their perception on flood coping mechanisms: Relationships between selected characteristics of fish farmers and their perception on flood coping ability were ascertained by Pearson's Product Moment Coefficient of Correlation (r) (Table 4). Annual family income, extension media contact, cosmopoliteness, training exposure and knowledge on flood coping mechanisms were significantly (positive) correlated with their perception on flood coping mechanisms. However, age, educational level and farm size did not show the significant relationship with their perception on flood coping mechanisms.

Table 4. Relationships between the selected characteristics of the fish farmers and their perception on flood coping mechanisms (N=70)

Selected Characteristics	Correlation coefficient (r)
Age	0.026
Educational level	0.200
Family size	-0.066
Farm size	0.082
Annual family income	0.284*
Extension media contact	0.359**
Cosmopoliteness	0.309**
Training Exposure	0.354**
Knowledge on flood coping mechanisms	0.262*

**: significant at 1% level of probability (2 tailed test), *: significant at 5% level of probability (2 tailed test)

Conclusion

Findings of the study reveal that majority (92.9%) of the fish farmers in the study area had moderately favorable perception, while 5.7% of them had highly favorable perception towards flood coping mechanisms. This led to the conclusion that if majority of the fish farmers in a flood prone area do not have favourable perception on flood coping mechanisms their livelihoods will not be free from vulnerability. Moreover, annual family income, extension media contact, cosmopoliteness, training exposure, and knowledge on flood coping mechanisms of the fish farmers had significant positive relationships with their perception towards flood coping mechanisms. On the other hand, age, educational level, family size, and farm size of the fish farmers had no relationships with their perception towards flood coping mechanisms. Therefore, while undertaking any safety net programmes and livelihood improvement programmes for the fish farmers in the flood prone areas, these factors should be appropriately addressed by the concerned agencies.

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Community-based mangrove conservation: sustainable forest management in Yeesarn Samut Songkram province, central Thailand

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Abstract: A social survey was conducted in Yeesarn, Samut Songkram province, central Thailand for community-based mangrove conservation measure. A census on socio-economics and involvement of the local stakeholders was investigated. Interviews were made with 3 different target groups, consisting of 50 mangrove plantation owners; 8 charcoal kilns owners; and 12 charcoal producers who rent the use of kilns owned by others. In addition, direct observation and in-depth interview with 2 persons from each group were conducted. The investigation revealed that the majority of respondents were locals and inherited mangrove planting and charcoal production from their ancestors. Local wisdom in mangrove planting and charcoal production has been accumulated and passed on from generation to generation in the community. The average land holding of 9.28 ha per household was not sufficient for the mangrove wood production to run annual rotational harvesting and planting, which would bring them steady annual income. They, therefore, were necessary to engage in other income-generation activities. Furthermore, most of the mangrove wood producers stated that problems and obstacles in mangrove planting were at an acceptable and manageable level. However, the group of charcoal producers had much difficulty in wood harvesting labor shortage, especially among the group of smallholder charcoal producers who rented kilns. This problem could bring discouragement and possibly result in their giving up charcoal production in the near future. In terms of factors affecting mangrove plantation' sustainability, biophysical factors were found to be the most important. The physical conditions pertaining to soil and water tide were suitable for mangrove planting but were a constraint for growing other kinds of plants. Besides, most mangrove wood producers found it economically worthwhile to invest in mangrove planting. Although incomes from mangrove plantations were only a small part of total household income, it was regarded of family savings and was better than not using the land at all. On the other hand, mangrove wood producers had to earn enough income from selling wood or other occupations while waiting for the next rotation to be harvested, which took around 12-15 years. In addition, being have inheritor for mangrove planting from generation to generation has caused the occupation in mangrove planting remain in Yeesarn community ($p=0.004$).
Key words: community-based management, mangrove forest, *Rhizophora apiculata*, plantation

Introduction

The same other coastal zone in Thailand, mangrove forest of Samut Songkhram province disappeared rapidly after 1975 due to conversion of the mangroves to shrimp farming. However, many villagers in Yeesarn community still maintained their almost a century old local knowledge on mangrove conservation. They initiated mangrove *Rhizophora apiculata* plantations since 1907. That was the first time the mangrove trees ever been planted in the country. Wood productions had long been used mainly as construction materials and raw woods for charcoal making. The mangrove forest area of the province was recently estimated at about 2,456 ha (RFD 2000) including 1,352 ha *R. apiculata* plantations (Hassan 2006). The rests distributed along the coastal line of the province. The most fertile and thick mangroves along the coast occurred near the river mounts of Klongkhon (Fig. 1).

At present, even though the number of villagers who are willing to do mangrove plantation and charcoal production gradually decreased. There is someone who deliberately carries on this local inherited business. The mangrove forest management in Yeesarn has been proved villagers full measure in mangrove conservation. Current trends of clean development mechanism (CDM) and a sustainable economy promotion bring over our interest in the community-based mangrove forest conservation measure in this area.

The objective of our study was to investigate socio-economics conditions of local stakeholders involved in the mangrove conservation with emphasis on *R. apiculata* plantation for charcoal production. Factors affecting sustainable management of mangrove plantation at Yeesarn community were studied. Three major approaches under the sustainable development concept (Russell 2003) namely, economic viability, social just, and ecosystem equilibrium were applied.

Materials and Methods

The methods for this study consisted of structured interview and the RRA techniques' e.g. direct observation, in-depth interview, etc. The respondents were divided into 3 groups. The first was mangrove tree planter, the second was charcoal kiln owner, and the last group was the charcoal producer who rented the kilns from other person. A simple random sampling was used for the selection of 50 samples from the first group (Scott 1885). For the other groups, all were interviewed including 8 charcoal kiln owners and 12 charcoal producers by rental the other person's kiln. In addition, two respondents from each group were selected for in-depth interview. Data were analyzed and described with a simple statistics such as percentage and average values. Chi-square was calculated for testing the influence of the variables.

Results and Discussion

Socio-economic conditions

Socials: There was the male more than the female who were involved in mangrove plantation and charcoal production. Particularly for those who rented the kiln, less than one-fourth was the female. Most of them were born in Yeesarn community and only a few moved from adjacent areas. Owners of the mangrove plantation and charcoal kiln were rather old people, mostly over 60 years old, and inherited the business from their parents or relatives. For those the charcoal producers with rental kiln their ages were younger, mostly from 45-60 years old.

From the in-depth interview, we found that charcoal production from mangrove tree was an extremely hard and complicated job. There were so many management processes from wood material searching, wood harvesting, charcoal processing and marketing of the production (Box 1). Thus, most of them give up the job when they become the elder.

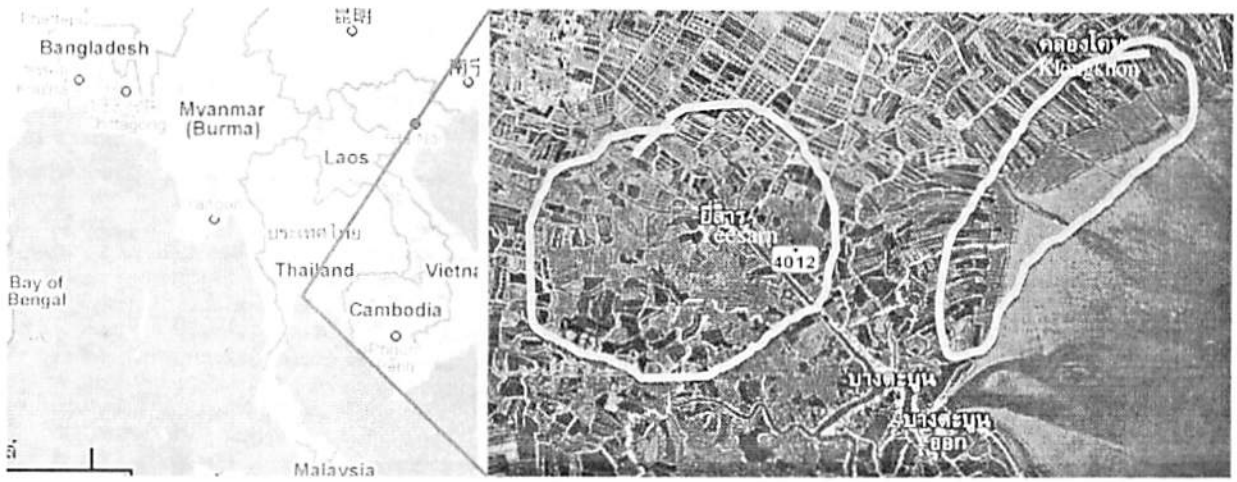

Fig. 1. Mangrove distribution in Samut Songkram province, central Thailand

Box 1. Management processes for mangrove charcoal production

Steps	Activities	Local knowledge base
1 Search wood source	Purchase aged-*Rhizophora* plantation	Forest inventory and valuation
2 Harvest wood product	Hire workers/boats to cut/carry wood	Logging and transportation
3 Combustion wood log	Charcoal kiln operation	Combustion process
4 Marketing of charcoal	Hire workers to pack and weight	Packaging and marketing

All of the owners of mangrove plantation finished primary school; nevertheless, learning by doing have brought about to become the professional manager in doing such a difficult business. Local wisdom in mangrove planting and charcoal production has been accumulated and passed on from generation to generation in the household and the community levels.

Economics: Both of mangrove plantation owners and charcoal producers gained their income from various sources. More than half of the plantation owner gained their income from mangrove plantation approximately one-third of their total income. Thus, only one-third of the plantation owners took it as the main occupation, whereas, the others conducted as for the minor or supplementary one. Important factors forced them to find other sources of income were size of land ownership and rotation of *R. apiculata* tree. The other jobs they simultaneously or sequentially worked such as charcoal production, aquaculture, employment, officer, merchant and other private jobs.

Costs for mangrove plantation consisted of *R. apiculata* viviparous seedlings (c 0.77 US$ per 100 hypocotyls) and hire worker (at a minimum wage of 5.43 US$ per man-day). Price of the plantation was depended on the wood production and the distance from charcoals' mill. Based on the recent value of *R. apiculata* plantation (1,250-2,083 US$ per ha) and the planting cost of about 350 US$ per ha, their annual income from commercial wood was about viable.

A half of the charcoal producer who owned the kilns also planted the mangrove trees as a main occupation. One-third of them produced charcoal as the main occupation, the others produced as a minor. Those who owned many kilns and could not manage to produce the charcoal; they hired some kilns to other producers. Some kiln owners even hired all their kilns.

All charcoal producers by the rental kilns stated that they produced charcoal as the main occupation. However, one-third gained income from this business only. A half gained two-third, and the rest gained a half of the total income. Some of them, therefore, generated income from other sources such as planting *R. apiculata*, hire worker, rental abandoned shrimp pond, and fishing. Most of them hired the charcoal kiln for a long time. Interestingly, the relationship between charcoal producers and owners of charcoal kiln was somehow dependent on each other. For instance, the kiln's owner advanced the charcoal producer investment cost, and the product must be sold to the kiln's owner.

The charcoal producers who owned both the kiln and the plantation generated sufficient income from charcoal production and hired some of the kilns. A rental fee of a

charcoal kiln was about 1,000-1,160 US$/year (about 10 combustion cycles). That included the cost for hired worker to look after the charcoal kiln as well. The production was about 7 ton charcoal per kiln per cycle. The annual income from one charcoal kiln was estimated at about 23,300 US$.

Land and land use: Land tenure of the respondents was on average 9.28 ha, but mostly less than 8 ha with only a few that hold more than 16 ha. A large area of the land was used for a traditional natural aquaculture. Many villagers sold their land to private company or wealthy person. Some charcoal producers intended to hire the land for planting a mangrove tree. Therefore, wood production can be sustained for the production of charcoal.

From Table 1 the less land tenure respondents, who hold less than 8 ha, perceived that they have not enough land to rotate the mangrove plantation. That caused their income insufficient for living. For those who hold the land from 8-16 ha, 16% mangrove planter and 37.5% charcoal producer perceived that the land was enough. Some explained that they planted mangrove tree for subsistence, some wanted to maintain their inherited mangrove plantation from their ancestors. In addition, site quality of the land was suitable for mangrove species but not for other terrestrial ones.

On the other hand, 8% of the planter indicated that 8-16 ha of land was not enough for mangrove plantation investment. First, the benefit from plantation will not be able to cover various expenses during waiting of wood production. Second, they have to support their children to go to school. Thus, they needed to do aquaculture traditionally to gain a faster income for living.

All the respondents who owned more than 16 ha perceived that it was a proper land size to manage mangrove plantation sustainable. This was supported by the informal interviewed when the most of the villagers in the study area agreed on the statement. Normally, it will take about 12-15 years to rotate the felling cycle of *R. apiculata* plantation. So, they can divide the land into a small patch of 1 ha for the annual planting area.

Table 1. Attitudes of the respondents on land size for investment mangrove *R. apiculata* plantation

Land size (ha)	Plantation owner (n=50)			Charcoal producer (N=20)					
				Kiln owner (N=8)			Kiln tenant (N=12)		
	Proper (%)	Improper (%)	Total (%)	Proper (%)	Improper (%)	Total (%)	Proper (%)	Improper (%)	Total (%)
<8	16.00	68.00	84.00	-	50.00	50.00	-	100.00	100.00
8-16	6.00	8.00	14.00	37.50	-	37.50	-	-	-
>16	2.00	-	2.00	12.50	-	12.50	-	-	-
all sizes	24.00	76.00	100.00	50.00	50.00	100.00	-	100.00	100.00

Problems on mangrove plantation and charcoal production

Apart from limitation of the land, there were some problems related to mangrove conservation in the study area. Lack of capital and labor, low production, market and price of wood, and stolen wood were among the problems. However, the plantation owners stated that the problems were not so serious and manageable. The small land holder (<8 ha) planted the *R. apiculata* trees instead of leave the land unused. The base of wood market, charcoal producer, was in the community. When the tree grew up, charcoal producer will contact the plantation owner for wood purchase. Afterward the buyer will be responsible for all logging and transporting costs. Clear felling in a specific area was used for logging. Wood billets length of 1.4 m were logged, debarked and transported by boat to the mill. Small canals were dug if necessary for wood transportation. Plantation owner usually leaves the felling site one or two year before reforestation. The fallow period was useful both for site and seedlings preparation; and also looking for planting workers. The small land holders renewed their forest by themselves. Plantation owners perceived their wood production was relatively decreasing. The attitude was confirmed by comparing the plantation yields estimated by Wechakit (1987) and by Hussan (2006). An average yield of 12-15 years old plantation that estimated by Wechakit (1987) was 193.86 cu m per ha. Whereas, the yield estimated by Hussan (2006) was only 112.5 cu m per ha. That means the yield decreased 41.94% within 19 years. Change of mangrove land use for aquaculture was attributed to be one of the major causes. Inundation of water tide to the planting site was obstructed by sedimentation of waste materials discharge from the aquaculture ponds. Planting areas were not inundated regularly by sea water. That led to slow growth rate of *R. apiculata* trees.

The charcoal producers had a moderate problem on the investment. Firstly, they need a lump sum for wood purchasing. In order to purchase the wood they have to pay in a unit area of plantation for instance 1,250-2,083 US$ per ha. Many charcoal producers, who hired the kiln, have to ask for the loan of the kiln owner. In that case, they must sell the charcoal products to owner of the kiln at a fixed price. The second problem was the lack of labor in mangrove tree logging. The few workers accepted this job because of so hard and dirty. They have to cut the tree into 1.4 m log, debarked, and transported to the mill. For a hundred of billets landed at the mill site they will get 3.33 US$. A team of ax-men usually composed of 2-3 workers with a boat and necessary equipment's for logging. In order to sustain raw materials for charcoal production, the producers had contracted with several teams of ax-men. They have to pay for labor costs not only on a fixed wage, but also some other incentives as well.

Factors affecting sustainability of mangrove forest plantation

Finding from the interview revealed that most of the mangrove plantation owners (86%) expressed their

willingness to continue their business. Based on sustainable development concept, we classified their possible incentives into 3 aspects namely economic, social and ecosystem. Forty-two per cent of them valued the ecosystem as the first priority important for mangrove plantation, whereas, 44% valued as the second priority. (Fig. 2) The area was suitable for mangroves, so-called species/site matching. The substrate was muddy with regularly inundated by sea water. It can enhance well growth of mangrove species without any additional input. Some stated that they lacked of alternatives for agriculture. Detail perception of plantation owners on the values of *R. apiculata* plantation is shown in Table 2.

Fig. 2. Perception of plantation owners on the values of *R. apiculata* plantation (left: value for the first priority; and right: value for the second priority).

Table 2. Detail perception of plantation owners on the values of R. apiculata plantation (n=43)

Application of the sustainable development concepts	Perceptions of the respondents (n=43)	
	First priority*	Second priority**
Economic viability	30.23	42.22
Satisfy the benefit/cost ratio	23.25	31.11
Enough income/saving while waiting for wood harvest	6.98	6.67
Indirect benefits from the plantation i.e. aqua-animals	-	4.44
Social just	27.91	35.56
Inherited occupation from ancestors	25.58	17.78
Support from state enterprise (CDM?)	2.33	-
Capability/skill to do the job		13.33
Close up with family, no need to migrate	-	4.44
Ecosystem equilibrium	41.86	22.22
Suitability of land use (soils and tidal water inundation)	39.53	22.22
A measure for mangrove conservation	2.33	-

* Each respondent answered 1 choise only

** Each respondent answered 1 choise or more

Remark: Applied sustainable development concept from Russell (2003)

There was some plantation owners (14%) wanted to give up the mangrove planting. Main reason was on the economics aspect. It took more than 10 years to get the benefit from mangrove plantation. They could not wait for that long time. Some wanted to change all their land use for shrimp farming so that they can gain income continuously. Some do not have successor. They wanted to sell their land if the price was satisfied. Some with a very small land wanted to build a new house for their children.

Table 3 showed the result of analysis of socio-economic conditions and decision making of the respondents on continuing mangrove plantation. Availability of successor was the only factor remarkable that influenced the decision. All of those who have the successor will continue their inherited mangrove plantation ($p < 0.01$).

Table 3. Analysis of socio-economics and decisions of the mangrove plantation owners

Socio-economic conditions of plantation owners	Decisions of plantation owners (n=50)		
	Continue (%)	Not continue (%)	Sig.
Sex			0.506
Male	50.00	10.00	
Female	36.00	4.00	
Age (year)			0.324
<45	2.00	2.00	
45-60	30.00	4.00	
> 60	54.00	8.00	
Education level			0.626
Primary school	72.00	12.00	
High school	4.00	-	
College	6.00	-	
University	4.00	2.00	
Purpose of planting			*0.183*
Main occupation	34.00	2.00	
Minor occupation	50.00	10.00	
Supplement occupation	2.00	2.00	
Land tenure (ha)			0.461
< 8	70.00	14.00	
8-16	14.00	-	
> 16	2.00	-	
Average for the continued group 9.8 ha			
Average for not continued group 5.9 ha			
Income gained from the plantation			0.530
Less than 1/3 of the total household income	50.00	12.00	
About 1/3 of the total household income	18.00	-	
About ½ of the total household income	6.00	-	
About 2/3 of the total household income	8.00	2.00	
100% of the total household income	4.00	-	
Availability of successor			0.004
Available	50.00	-	
Not available	36.00	14.00	

Conclusions

R. apiculata plantation in Yeesarn was a good example of community-based mangrove conservation in Thailand. The villagers practiced well to sustain their inherited local knowledge on wood and charcoal productions for nearly a century. From generation to generation they continuously improved skills and techniques within their households and the community. However, most of them were the elders and foresaw that their successors would be less in the near future.

Wood producers, the owner of *R. apiculata* plantation, were mostly the local people. Each owned the land approximately 9.28 ha. They were concerned about size of the land which was not proper to sustainably manage the timber forest product. Thus, they have to do mangrove plantation only for a minor or supplementary occupations. Problems related to mangrove tree planting was less and manageable.

Some charcoal producers, mostly in the middle-age, rented the use of the kilns from their neighbor to make the charcoal. Based on the community knowledge which had implemented continuously, they had no serious difficulty in carrying on this hard and complicated work. Both wood producers and charcoal makers were dependent on each other. A major problem concerning mangrove charcoal production was labor shortage. This problem strongly influenced the producers who rent the kilns from the others. They said that they may give up this business in future if the problem remains unsolved.

There were various factors influencing community-based mangrove forest conservation in Yeesarn. Sustainability of mangrove plantation was affected mainly by biophysical factors. The physical conditions pertaining to soil and water tide were suitable for mangrove planting but were not good for growing other terrestrial plants. Besides, most mangrove wood producers found it economically worthwhile to invest in *R. apiculata* planting. Although incomes from the plantations were only a small part of total household income, it was considered as family savings and was better than not using the land at all. On

the other hand, mangrove wood producers had to earn enough income from selling wood or other occupations while waiting for the next rotation to be harvested, which took around 12-15 years. In addition, being inheritor for mangrove planting from generation to generation the occupation in mangrove planting remained in Yeesarn community

Current information from an officer at the Yeesarn Tambol Administration Organization (personal communication) revealed that about 8,550 cu m of mangrove *R. apiculata* wood were used annually for charcoal production. Based on an average volume of the plantation, aged between 12-15 years, of 112.5 cu m per ha; approximately 76 ha of the plantation are needed in order to maintain wood supply for charcoal making. According to Hussan (2006), *R. apiculata* plantation in the area was estimated at 1,352 ha. So, the community-based mangrove forest management in Yeesarn shall be secured for wood utilization and charcoal production at least for 17 years more.

Acknowledgement: This research was supported by many people and institutions. First of all, we would like to thank for the financial support of the Graduate School of Asian and African Area Studies, Kyoto University and the Research Project E-092 by the Global Environment Research Fund, Ministry of the Environment, Japan. We also would like to thank the people of Yeesarn community for providing valuable information on their livelihood concerning the community-based mangrove ecosystem conservation. Thanks are given for master course and under graduate students from Department of Forest Management, Faculty of Forestry and the Sustainable Land Use and Natural Resource Management of Kasetsart University (KU-SLUSE) for their hard working in field data collection.

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Coping strategies with drought and agricultural development in dryzone, Myanmar

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Abstract: Myanmar is an agro-based country and its economy relies on agricultural production. Myanmar has a wide range of climatic conditions favoring the domestication of numerous crop species. The climate is mainly tropical but is sub-tropical in hilly regions. Rice occupies the majority of the crop sown areas (about 40%) and it is followed by pulses, oil seed crops, sugarcane, rubber and vegetables. Precipitation under monsoonal influence is becoming more and more erratic than ever before, and thus annual precipitation is very fluctuating. Under many uncertainties of climate change scenarios, farmers in dry zone areas have been traditionally practicing adaptation technologies to combat the harsh climate for several decades. To reduce the risk of crop failure, farmers follow the various cropping patterns, such as mix cropping, inter-cropping, double cropping, crop rotation, zero tillage, incomplete tillage, etc. In central dry zone, the rain-fed agricultural production highly relies on water supply from the large and small dams and tank irrigation for centuries. During the last decade, the onset of monsoon was later than usual and precipitation pattern changed, causing extreme weather phenomenon. The Ministry of Agriculture and Irrigation pays great attention on improving existing irrigation networks, construction and renovation of dams and reservoirs, establishing water pumping irrigation schemes from major rivers and exploring groundwater for increased irrigation. Meiktila plain electric-powered water pumping project and Meiktila-Thazi Groundwater Irrigation Project have recently been implemented. Some INGOs and NGOs are cooperating to provide facilities such as treadle pumps and water pumping engines for drinking water and irrigation in rural areas.
Key words: Coping strategies, drought, dryzone, Myanmar

Introduction

Myanmar is an agro-based country and its economy mainly relies on agricultural production. The population was estimated at 57.5 million in 2007-08, with a growth rate of 1.75 percent. About 70 percent of the total populations who reside in rural areas are principally engaged in agriculture, livestock and fishery sector for their livelihoods. Agricultural sector employs 61.2 percent of the total labor force and accounts for 35.6% of GDP and 13.3% of total export earnings. The major objective of the agriculture sector set up by the Ministry of Agriculture and Irrigation is 'to ensure national food security and generate surplus in rice and pulses production'. The goal of national food policy is the attainment of food security through self-sufficiency, price stabilization and the improvement of nutritional status. Since Myanmar has a wide range of climatic conditions, it favors the domestication of numerous crop species. Most regions of the country fall under the tropical climate, but hilly regions and plateaus are sub-tropical. Rice occupies the majority of the crop sown area (about 40%) and it is followed by pulses, oil seed crops, sugarcane, rubber and vegetables.

Agricultural impacts of climate change

Myanmar is geographically exposed to various hydro-meteorological hazards (Fig. 1). Its coastal regions are exposed to cyclones, tropical storms/storm surges, and tsunamis. Rainfall-induced flooding is a recurring phenomenon across the country. The country's hilly regions are also exposed to landslide risks. The whole country is at risk from earthquakes, droughts, and fires. Myanmar was severely hit by Cyclone Nargis in 2008 and Cyclone Giri in 2010, which highlighted the country's most vulnerability to natural disasters and urgent needs for the protection and adaption to the impacts of the natural hazards. Despite great technological advances in the second half of the 20th century, weather and climate are still key factors in determining agricultural productivity in most areas of the world. Agriculture is one of the most vulnerable sectors affected by climate change. Climate change related phenomena include unusual fluctuations in temperatures and rainfall patterns, as well as their associated impacts on water availability, pests, disease, and extreme weather events. They will substantially affect the potential of agricultural production.

Traditional adaptation strategies for climate change

Precipitation under monsoonal influence is becoming more and more erratic than ever before, and thus annual precipitation is very fluctuating. Under many uncertainties of climate change scenarios, farmers in Dry Zone areas have been traditionally practicing the adaptation technologies to combat the harsh climate for several decades. To reduce the risk of crop failure, farmers follow the mix cropping patterns under the single or double cropping (Fig. 2). The seeds of two or more crops are broadcast together in the same plot and harvested separately according to their duration. The risk-averse farmers ` concept is that they invest the least and they will collect whatever left in the field after the stresses.

Traditional water harvesting technologies in Central Myanmar, Dry Zone

- Frequent ploughing and harrowing while waiting for the sufficient rain
- Crop rotation
- Zero tillage or incomplete tillage for conservation of residual soil moisture: Post monsoon season black gram / chickpea after rice harvest
- Traditional water harvesting practice (e.g Land preparation is done at the pre-dawn darkness for timely seeding of peanut and sesame in Magwe Division)
- Broadcasting of sesame seeds before the rain comes (e.g in Kyaukpadaung Township)

National Adaptation Programs of Action (NAPA) in Agricultural Sector:

Since the agricultural sector is the backbone of Myanmar economy, the government has been exerting efforts on the agricultural development while trying to develop other sectors proportionally. To boost the agricultural production, new reservoirs and dams have been

a b

Fig. 1. (a) Rice plants harvested for cattle feed in Yamethin Township and (b) peanut plants suffering drought in Kyaukpantaung Township(b) in central Myanmar (Nov. 2009)

a b

Fig. 2. (a) Intercropping of peanut and sesame in Nyaung-u Township and (b) Crop rotation of black gram after rice in Pyinmana Township (harvested rice are sun-dried on the bund)

constructed throughout the country. At the same time, the existing reservoirs and dams are renovated. The life spans or usefulness of these reservoirs and dams totally depend on the forests growing in the watershed areas. Therefore, the effective watershed management is very essential in the country. Since watershed management is based on multi-disciplinary approach many line ministries and departments are cooperating to fulfill the various projects. Existing adaptation measures / coping options to drought are as follows:

- improved irrigation efficiency
- crop diversification
- drought resistant crops
- improved agronomic practices
- improvement in agricultural extension services
- effective pest and diseases control programs
- better storage facilities
- research and development on new drought-resistant crops (Agricultural University and Department of Agricultural Research)

Irrigation Facilities:

The dry zone has the characteristics of very low fertile soil, erratic rain fall and high land degradation. In central dry zone, the agricultural production highly relies on water supply from the large and small dams and tank irrigation for centuries (Fig. 3). During the last decade, the onset of monsoon was later than usual and precipitation pattern changed, causing extreme weather phenomenon. The Ministry of Agriculture and Irrigation (MOAI) pays great attention on improving existing irrigation networks, construction and renovation of dams and reservoirs, establishing water pumping irrigation schemes from major rivers and exploring groundwater for the increased irrigation (Fig. 4). Meiktila plain electric-powered water pumping project and Meiktila-Thazi Groundwater

Irrigation Project have recently been implemented. Some INGOs and NGOs are cooperating to provide facilities, such as treadle pumps and water-pumping engines for drinking water and irrigation in rural areas. The areas under irrigation have reached to approximately 30% of the total crop sown areas in 2009.

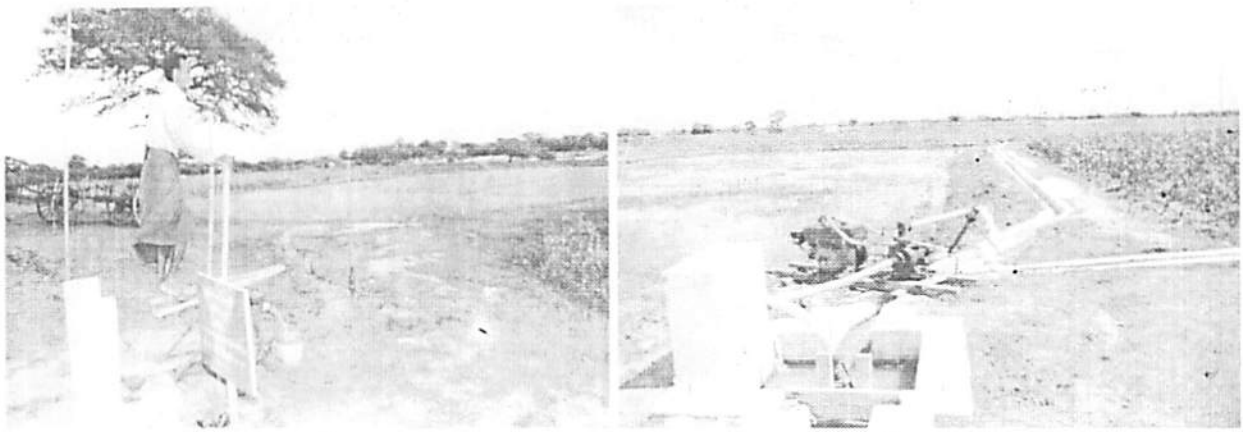

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Fig. 3. (a) Treadle-pumps and (b) shallow tube wells for ground water pumping in Thazi Township, Central Dry Zone, Myanmar

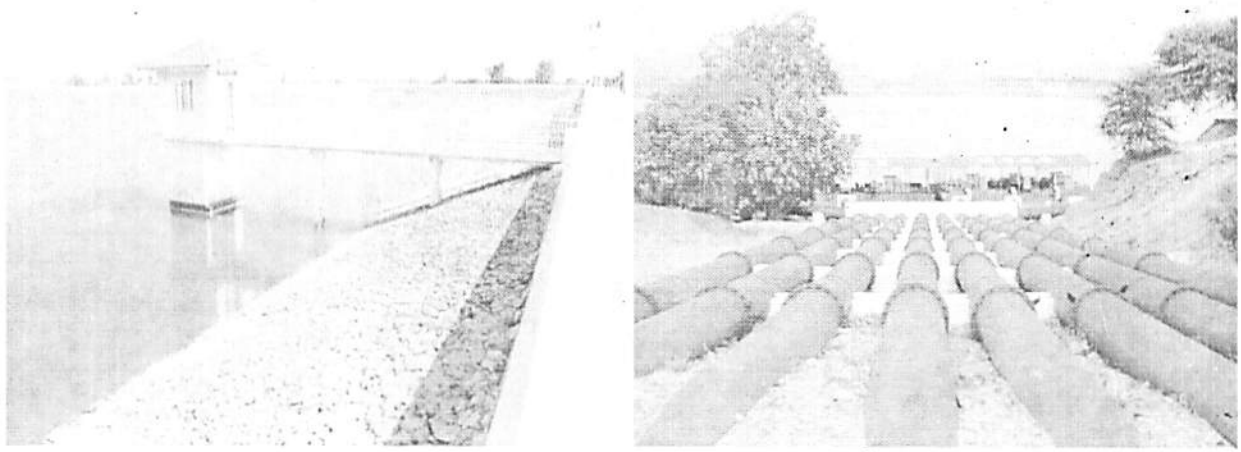

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Fig. 4. (a) Newly constructed dams, reservoirs and (b) water pumping projects from Ayeyarwady River

Climate change adaptation measures by the Water Resource Utilization Department, MOAI: Irrigation facilities installed in the last two decades were

- 228 dams
- 322 river water pumping stations
- 7974 underground water tapping stations
- 658 small rural dams

Regional and Rural Development Programs

The following Programs have been laid down by the government to uplift the living standard of the people.

(1) Border Area and National Races Development
(2) Development of 24 Special Zones (Greening Project)
(3) Rural Development (Agriculture-based)

Five Tasks for Rural Development Program

- To ensure smooth transport
- To supply sufficient irrigation water and safe water
- To promote education standard
- To provide better health care
- To expand agriculture and livestock breeding

Construction of Rural Roads and Bridges

- The Department of Development Affairs constructed the rural road (about 32,590 miles) and bridges (total 9,504) during the last 20 years. The Ministry of Construction also constructed 5,678 miles of rural road and 3,066 bridges.

Provision of Safe Drinking Water

The Department of Development Affairs prepared the 10 years plan (starting from 2000-01) for provision of safe

drinking water in the rural areas especially in Sagaing, Magway and Mandalay Division of the Dry Zone region. Moreover, the essential farmer support services should be provided for increasing crop production which will lead to the food security, poverty alleviation and rural development. In this regard, the following items are needed to be taken into account.

- Exploring the development opportunity for sustainable farm credit and financing system through public-private partnership,
- Development of sustainable agricultural production systems (which focus on the environmentally friendly farming systems),
- Strengthening existing technology generation, dissemination, and innovation system; opening channels for broader participation of private sectors, NGOs and INGO,
- Upgrading the role of various institutions, such as Agricultural University, and Department of Agricultural Research for research and development concerning with climate change.

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Pre-monsoon atmospheric condition in Bangladesh

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Abstract: Seasonal variation of vertical atmospheric structure over Bangladesh was analyzed by radiosondes in 2001 – 2007, and features in the pre-monsoon season were compared with that of other seasons. Calculation of meteorological parameters derived from the vertical structures of temperature and humidity explain why severe storms tend to occur in the pre-monsoon season.
Key words: severe storm, pre-monsoon, atmospheric condition

Introduction

Precipitation begins in the pre-monsoon season (March - May) over Bangladesh. These rainfalls usually occur locally and during shorter period compared with widespread and continuous rainfall in the monsoon season (June – September). Clouds in the pre-monsoon season produce not only rainfalls but also severe thunder and lightning, hailstones, strong wind gusts, and tornadoes. Consequently these clouds are recognized as severe storms, and locally called as *Kal-baishaki* over the Bengal Plain. They are also called *norwester* because these clouds tend to come from north-west direction.

Yamane et al. (2010a) extracted 2,325 severe storm events during 1990 - 2005 from newspapers published in Bangladesh and investigated their climatological features. The favorable meteorological conditions for the occurrences of these severe storms in the pre-monsoon season have been investigated by some researchers (Ramaswamy 1956; Weston 1972; Yamane and Hayashi 2006; Yamane et al 2010b).

The frequent occurrence of severe storms is one of specific characters in the pre-monsoon season, and rare in other seasons in Bangladesh. This paper discusses this reason by focusing the differences of vertical atmospheric conditions between winter, pre-monsoon, and monsoon seasons in Bangladesh.

Materials and Methods

We utilized radiosonde observations (Fig. 1) launched at 06 Bangladesh standard time in the morning during 2001 – 2007 in Dhaka observatory (90.38E, 23.77N) of Bangladesh Meteorological Department. Radiosondes are common meteorological equipments to measure vertical distribution of temperature, humidity, wind speed and wind direction. Observation frequency was done once per day for the most frequent periods, and once per week for the periods of the lowest frequency.

Results

Fig. 2 shows seasonal variations of vertical structures for temperature and relative humidity, zonal and meridional winds, respectively. The data is averaged by every week, and the x-axis represents number of weeks during 1 January – 31 December. Temperature decreases with height, and has a minimum with -70 to -80C at the tropopause around 16-17 km altitude. Temperature below 2 km has a minimum in January and increase since February, whereas temperature above 4 km increases in May. This difference implies time-lag between surface warming in the boundary layer near surface, and warming by latent heat release due to cloud formation in the upper atmosphere. Relative humidity below 2 km begins to increase in the end of March, whereas, the atmosphere over the whole troposphere becomes wet during June – October.

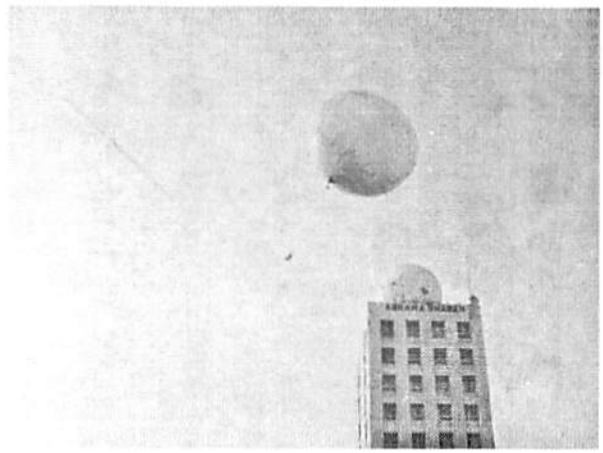

Fig. 1. Launch a radiosonde

For zonal wind, westerly component with the maximum of around 40 m/s at 10 km altitude is observed in the dry season (October – April), whereas, easterly component is observed with the maximum of around 30 m/s at 13 km altitude in the monsoon season. These strong winds correspond with subtropical jet stream in the dry season and part of anti-clockwise circulation of high pressure system over the Tibetan Plateau formed during the monsoon season.

For meridional wind, southerly wind component is dominant at the core of subtropical jet stream (10 km altitude) during the dry season, whereas northerly wind component is observed below 6 km altitude. The north-south circulation is, however, totally reversed in the monsoon season, that is, southerly wind is observed below 8 km and northerly wind is observed above that. One of the peculiar features in the pre-monsoon season is the appearance of southerly wind below 2 km under the continuous northerly wind above.

Fig. 3 shows vertical structure of temperature and humidity at 1st week (1-7 January), 15th week (9-15 April), and 30th week (23-29 July), respectively. These correspond

with thin solid, thick solid, and dash-dotted lines, respectively. Compared with winter and monsoon structures (1st and 30th weeks), temperature is warmer by around 10 degreeC in the monsoon season below 13 km altitude, and relative humidity is higher in the monsoon season except for near surface. Temperature in the pre-monsoon season is similar with that of monsoon season below 2 km altitude, whereas almost same as winter above 4 km altitude. Relative humidity in the pre-monsoon season becomes wet below 5 km altitude, though it is still very low when it is compared with monsoon season.

There is a method to estimate whether the deep clouds can develop or not. This method uses the vertical structures of temperature and humidity, and calculates a level of free convection (LFC), a level of neutral buoyancy (LNB), convective available potential energy (CAPE) and convective inhibition (CIN), etc. LFC is the level where the temperature in the cloud becomes higher than the environment at the same level.

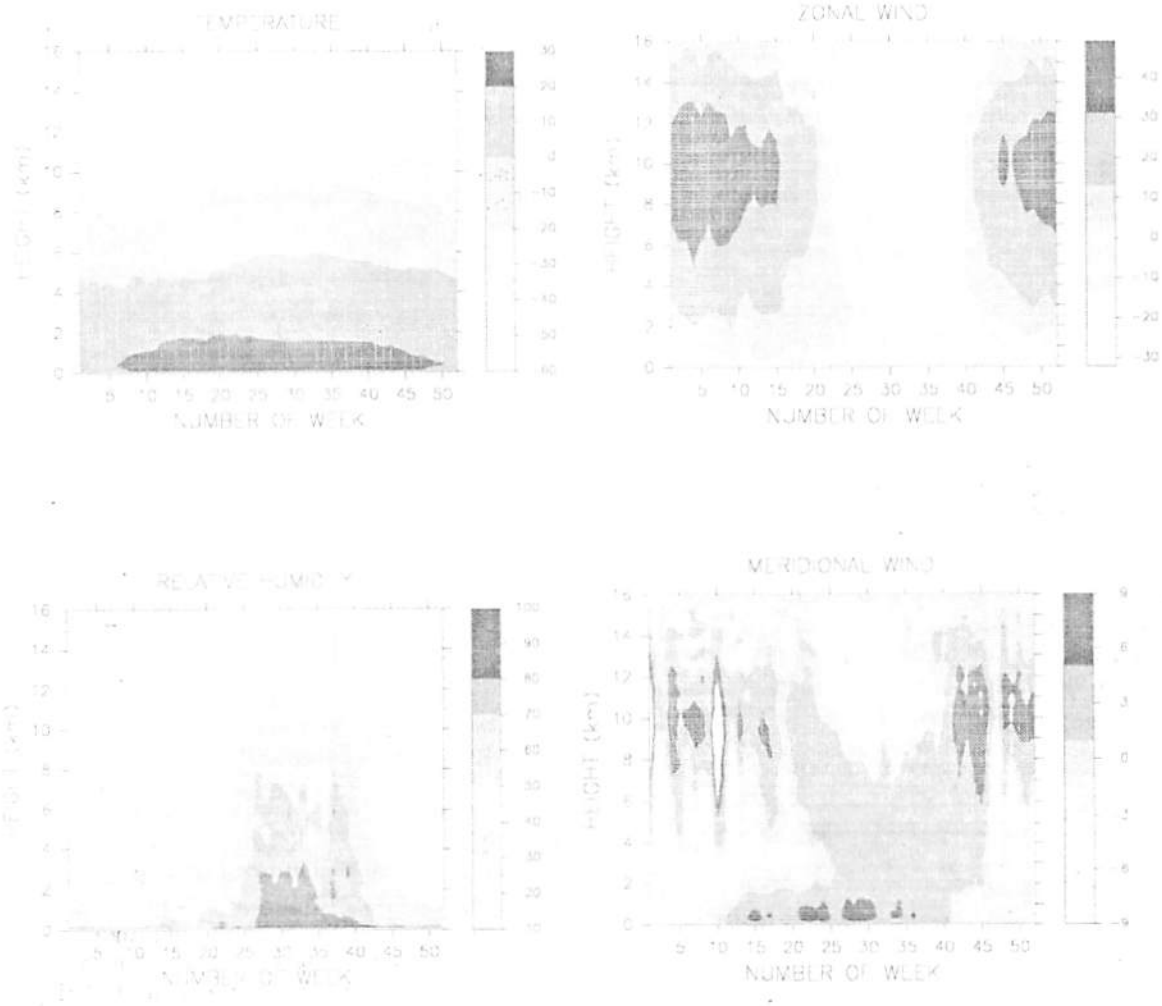

Fig 2. Seasonal variation of vertical structures up to 16 km altitude for temperature (unit: Celsius degree), relative humidity (%), zonal wind (m/s; positive is westerly wind) and meridional wind (m/s; positive is southerly wind)

In case the air is warmed by phase change from water vapor to liquid or ice particles and the air in the cloud becomes warmer than the environment, the air has buoyancy and cloud can develop and grow deeper. LNB is the level where the air loses the buoyancy and it is an indicator of cloud top height. CAPE is an indicator of the strength of the buoyancy energy of the air, whereas CIN is an indicator of the necessity energy in order the air to reach LFC. Fig. 4 shows a schematic figure for cloud development. Table 1 shows the calculation of these parameters for winter (1-7 January), pre-monsoon (9-15 April) and monsoon (23-29 July) seasons. There is no LFC in the winter season and it corresponds with the fact of rare developing clouds in the winter season. LFC in the

pre-monsoon season is higher than that of the monsoon season, whereas CAPE is larger in the pre-monsoon season. It implies that more energy is necessary to form deep clouds during the pre-monsoon season, but the clouds tend to become severe storms and have higher possibility to produce thunders, hails, strong winds or tornadoes in case that the air reaches LFC. Therefore, this result explains the higher occurrence of severe storms in the pre-monsoon season over Bangladesh.

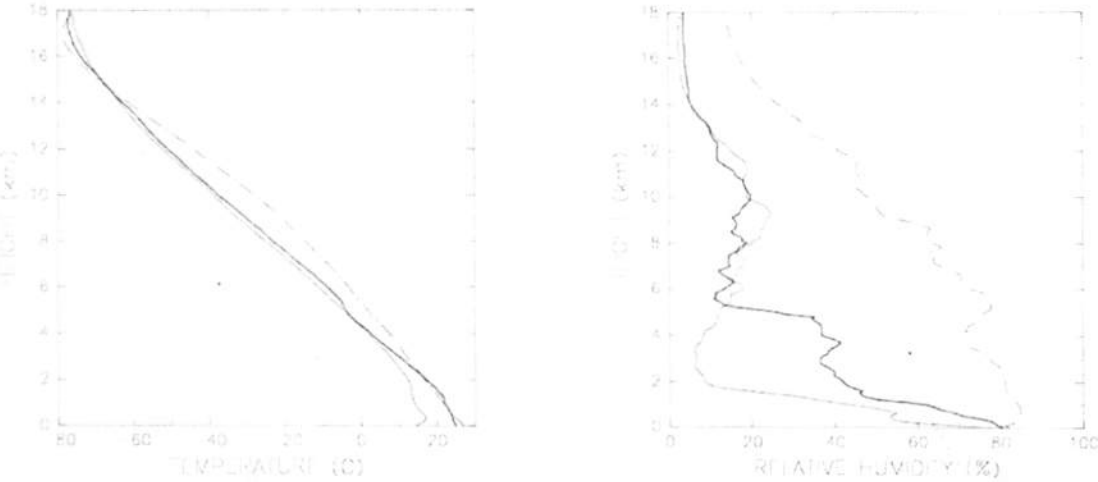

Fig. 3. Vertical structures of temperature and relative humidity at 1st week (1-7 January; thin solid lines), 15th week (9-15 April; thick solid lines), and 30th week (23-29 July; dash-dotted lines)

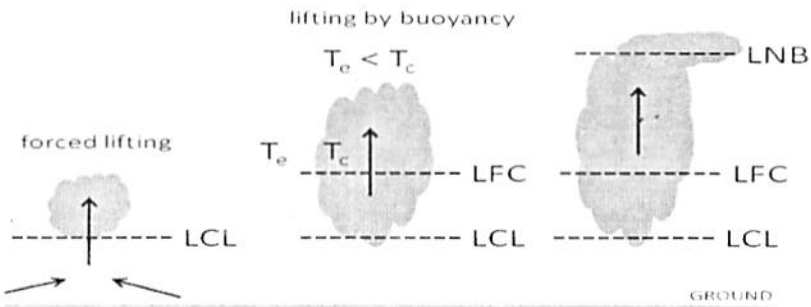

Fig. 4. Schematic figure of cloud in the three development stages

Table 1. Calculation of parameters for winter (1-7 January), pre-monsoon (9-15 April) and monsoon (23-29 July) seasons

	LFC	LNB	CIN	CAPE
1-7 January (1st week)	-	-	-	-
9-15 April (15th) week	3.1 km	11.3 km	264 J/K	909 J/K
23-29 July (30th week)	1.9 km	11.7 km	53 J/K	336 J/K

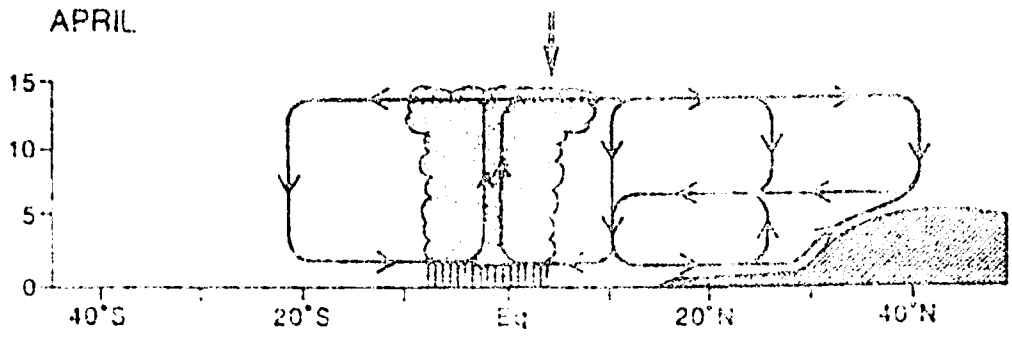

Fig. 5. North-south circulation along 90E based on Webster (1987) modified Barry and Chorley (2003). Same figure is adopted by Hofer and Messerli (2006)

Summary

This paper described the seasonal variations of vertical atmospheric structures over Bangladesh, compared the vertical atmospheric structures of winter, pre-monsoon and monsoon seasons, and revealed the reason why the severe storms (locally called *Kal-baishaki* or *norwesters*) tend to concentrate in the pre-monsoon season over Bangladesh. Figure 5 is a schematic meridional circulation in the pre-monsoon season along 90E by Webster (1987) and modified Barry and Chorley (2003). The observed vertical structure showed similar three layer structures over Dhaka (23N), that is, southerly wind observed below 2 km altitude, northerly wind in 2—6 km altitude and southerly wind above around 6km. However, the results of our paper reveal that we should take notice of the height range of northerly wind (2 - 6 km in our analysis) when we interpret Fig. 5. That is, the upward motion drawn in Fig. 5 over Dhaka should be confined below around 2km because the calculated LFC implies that deep clouds tend to grow frequently as like as monsoon season in case that the upward motion reached around 3 km, and it is not the real condition in the pre-monsoon season in Bangladesh.

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From the villages of *Lam* singers in Laos and Thailand: a case study of inheritance of indigenous knowledge in rural area

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Introduction, Background, Objective and Methodology

Last October, I have visited a village in Northeast Thailand where there are some *Lam* singers. An old *Lam* singer sang songs about wetland forest in his village and its preservation and development (Fig. 1, 2 and 3). His songs and the speech of former village head about livelihood and natural heritage of their village affected us deeply. But nowadays, it is very rare in Northeast Thailand that villagers sing traditional *Lam* songs to self-write lyrics and words, with crowded villagers listening to them. In reality, during my visit to some villages in Northeast Thailand, I was surprised by ongoing depopulation and decline of villager's dynamism and confidence.

On the other side, in rural Laos, depopulation has not been so serious at the moment. And *Lam* songs are sung on various occasions of daily life. In some area we can see some active efforts made for inheritance of *Lam* songs.

Recently in rural area in Thailand and Laos, villagers' values have been changing rapidly. Most of them have been putting much faith to modern science and technology instead of their indigenous knowledge, skill and their own culture.

In rapid change of social situations, I believe that *Lam* song and the acts of singing and listening them together will not only be an effective medium for inheritance of indigenous knowledge, but also be an important source of vitalities and unities of villages and identity as well as the pride of villagers.

This time I want to introduce my ongoing activities for promoting and inheriting of *Lam* song in Southern Laos.

Result and Discussion: What is *Lam* song?

In Southern Laos and Northeast Thailand, both belonging to the same "Lao cultural zone", traditional folk song is called *Lam*. Over the past few decades, the main trend of *Lam* song in Laos is *Lam Thongthin* (local folk song), which is unique to regions and each ethnic group. Among those local folk songs, there are many pieces named after a place or an ethnic group names such as *Lam Salawan*, *Lam Khonsawan* and *Lam Phuthai*. In Northeast Thailand the trend of *Lam* song is *Lam Kon*, *Lam Long*, *Lam Toei*, *Lam Sing* which are categorized by its melody lines.

Lam, or the traditional local folk song of Southern Laos and Northeast Thailand, may be said to be "story telling song" which consists of improvisational verses by adding up short poems which are similar to "waka" poem of Japan. And *khaen* (Lao mouth organ made by bamboo with free reeds) is the main instrument to accompany. While an ordinary song called *Pheng* in Lao has a fixed set of lyrics and music, *Lam* is more improvisational, which theme, as well as lyric may vary by singer or by time and occasion. *Lam* is themed around not only those love songs that lovers exchange but also much varied ones. Songs those singers sing will test wits, and are about folklore and legend, nature and history of the villages and region, domestic and international news, stories of singer's travels, and it could be even the petition to the local government officials or propaganda and enlightening messages. A skilled singer called *Moh-Lam* will have an attractive voice, and moreover, he/she will impromptu with meaningful lyrics endlessly by following the traditional pattern and rhyming.

It is said that the origin of *Lam* is chanting or recitation that is important part for a number of animistic rituals, or reading of Buddhist stories and folk tales written on palm leaf manuscripts (called *Bailan*). And the singing and playing styles have developed over the years. For example, multiple instruments for accompaniment were adopted, and a female singer who used to take quick-witted narrative part called *Kham Phanya*, also became a vocalist to sing to instruments.

Fig. 1. *Lam* singer singing about wetland and Sebai River around his village

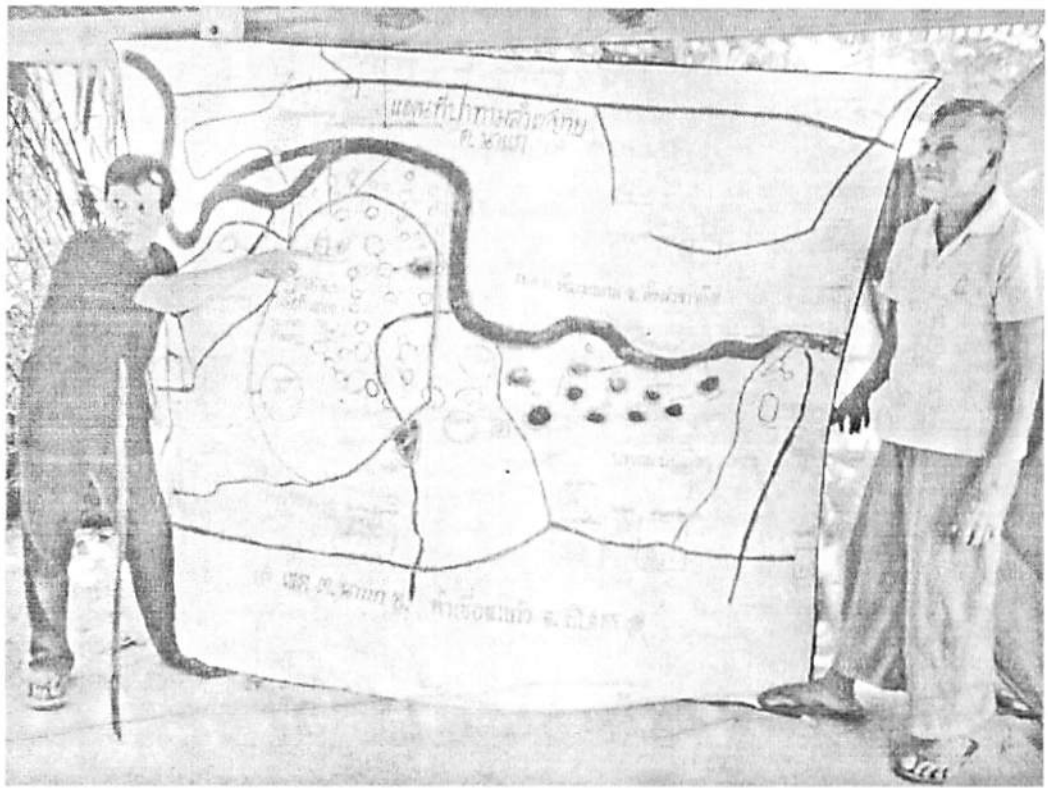

Fig 2. *Lam* singer explaining about wetland forest in his village (Northeast Thailand)

Fig. 3. All-night *Lam* performance at funeral ceremony

A brief report on the workshop

A two-day International Workshop on Contemporary Changes in Environment and Development was held at the Bangladesh Agricultural University (BAU) on 13 and 14 December 2010. The workshop was jointly organized by BAU and two projects of Kyoto University, Japan; one is "International Networking Project to Cope with Natural Hazards on the Periphery of Bengal Bay" and other is "Studies on the Conservation Measures of Swamp Forest through Sustainable use of Ecological Resources by Local Communities". These two research projects were basically financed by the Ministry of Education and Ministry of Environment, Government of Japan.

So far these projects have conducted two International Workshops, one in Thailand in December 2009 and other in Laos in February 2010. The present workshop was third of its kind being held at BAU. A good number of national and foreign participants attended the workshop including Japanese, Thai and Myanmar. Local participants were mainly from Bangladesh Agricultural University, Forest Department of Bangladesh and three NGOs. Professor Dr. M.A. Sattar Mondal, Vice-Chancellor of BAU attended the workshop as Chief Guest and inaugurated it. The inaugural session was presided over by Professor Dr. S.M. Altaf Hossain, Consultant, Livelihood Improvement of Farming Community in *Haor Area* through System Approach (LIFCHASA), Department of Agronomy, BAU. In the inaugural session Dr. TAKEDA Shinya and Dr. ANDO Kazuo both from Kyoto University, Japan presented the background of the workshop and Keynote speech, respectively. Vote of thanks was given by Dr. Hayashi Taiichi of Kyoto University, Japan. A total of 24 papers were presented in the workshop in four sessions. Participating members also visited Agricultural Museum of BAU at the end of the 4th session on day two. After completion of the workshop the participating members made a study tour from 16 to 18 December 2010 to the Sunderbans, the largest mangrove forest of the world and visited Kuakata on 19 and 20 December, 2010 to see people's coping measures with natural hazards in the coastal area and sea shores. All participatory members returned to Dhaka on 21 December and departed to their destination.

Dr. Muhammad Salim
Chief Organizer of the Workshop
and
Professor and Head of the Department of Agronomy
Bangladesh Agricultural University
Mymensingh-2202, Bangladesh

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Key Note Speech: Let us learn rural people and establish the academic and practical persons' international network to cope with problem of environment and development

Kazuo Ando
Center for Southeast Asian Studies, Kyoto University, Japan, E-mail: ando@cseas.kyoto-u.ac.jp

Assalam Alaikum , Namashikar, Mengalaba, Sawadee and Ohayou Gozaimasu, Thank you.

Chairperson: Prof. S. M. Altaf Hossain, Consultant, LIFCHASA

Chief Guest: Prof. M. A. Satter Mandal , Vice-Chancellor, BAU.

All the distinguished guests and participants

Ladies and Gentlemen,

First of all, I would like to express a heartfelt thankfulness to the authorities of the Bangladesh Agricultural University, Mymensingh to agree with us to hold "International Workshop on Contemporary Changes in Environment and Development ", which is jointly organized by BAU and Kyoto University and supported by two projects, namely Japan Society for Promoting Society(JSPS) "International Networking Project to Cope with Natural Hazards on the Periphery of Bengal Bay", headed by Ando, the other relevant projects of the CSEAS joint research programs and the "Research Project E-092 by Global Environment Research Fund, Ministry of the Environment, Japan Studies on the Conservation Measures of Swamp Forest through Sustainable Use of Ecological Resources by Local Communities" headed by Dr.Takeda, Postgraduate school of Asia and Africa Area Studies(ASAFAS), Kyoto University.

The project headed by Ando, so called the Bay of Bengal Kaken Project is consisted of seven major organizations, namely, Kyoto University Area Studies Group from Japan; Bangladesh Agricultural University, Environment Coping Forum NGO Group, BARD Group from Bangladesh; Yezin Agricultural University, Mandalay University from Myanmar; Guahati University from India; and the faculty of agriculture, the national university of Laos.PDR from Laos.The project headed by Dr.Takeda is consisted of several organizations from Japan, Thiland, Indonesia and except these two projects the other relevant organizations particularly NGOs and NPOs in Japan are tried to net-work for action and research related to Environment and Development.

For this workshop, we have especially invited Prof. .Bhagabati, Gauhati University, Professor Khin Lay Swe, Pro-rector, Yezin Agricultural University, Myanmar and other scholars from Thailand and Indonesia. Unfortunately, due to unavoidable problems, Prof. Bhagabati, India and Dr.Amuri, Indonesia cannot participate in the workshop. However, Prof. Khin from Myanmar, Dr. Sommai Suppakun and others from Thailand can attend the workshop and excursion to Sundarban and Kuakata. I should express my heartfelt thanks to the academic contributors to present the papers at the workshop from these mentioned countries, Japan and Bangladesh. Last but not the least, I must express my heartfelt thanks to the organizers and the student volunteers to prepare and manage the workshop and excursion for their laborious works and voluntary sprits.

The ladies and gentlemen, you surely have a question why such an international network is required between academicians, particularly University people and practical persons NGO or NPO through action and research? Most of the members of both the projects have experience to work in several countries, mainly in Myanmar, Assam, Thailand and Laos. The ladies and gentlemen, you can still remember the terrible disaster occurred in Myanmar by the cyclone Nargis 2008. In the same year, the cyclone Sidr attacked Bangladesh. The 130,000 people were killed due to Nargis, but the 4,300 people were victim due to Sidr. When I knew this figure, I asked myself, Why? Why did such a quite big difference occur in the number of the victims?

I have enjoyed my life in Bangladesh, particularly, in rural Bangladesh since 1978. I have started my life as a JOCV JICA Volunteer in Noakhali and one day I was a Ph.D. Student of department of Agronomy, Bangladesh Agricultural University since 1984. I have not received any official letter from the register of BAU noticing cancelation of my studentship in BAU. Therefore, my studentship surely still exists in BAU. Anyway, from 1978, I have worked as a Volunteer, Ph.D. student, JICA Expert and an academician with Bangladeshi people. On the basis of my limited experience, I could find very simple truth against my question that the Myanmar people did not get lessons from the Bangladesh people.

Ladies and Gentlemen, please do not mind my following state. Nearly 20 years back, Bangladeshi people themselves called Bangladesh a laboratory of Rural Development in the world and Bangladesh was much famous because of poverty and flood and cyclone disaster. However, for two decades, I myself have learned a lot from Bangladeshi people how to tackle such hard problems related to issues of environment and development. The contrast of the victim number is a good example for two decades' efforts of Bangladesh. The size or magnitude of Cycle and flood become bigger and bigger year by year, possibly due to the climate change. The high density population problem against limited resources has been unchanged. Such problems have been familiar to the Bangladeshi people since several decades ago. However, these newly appears in front of the other countries such as Myanmar. In the issues related to environment and development, at least the two decades' experiences of Bangladesh is the top most important lessons in the world, especially to the surrounding areas such as Assam, Myanmar facing the cyclone, flood and poverty, etc.
And also, we know limitation of the government networks. The government bureaucrat net work is sometime very tough to communicate each others. Therefore, I have proposed the project to establish the net-work by the academicians and practical persons among neighboring countries through the universities and NGOs by a hub of Kyoto University.
Our project to establish the network has just started last year after preparatory workshops; the first in Bangkok, September, 2009 and the second in Vientiane, February, 2010. We have implemented the participatory action research project with Environment Coping Forum consisting of 15 NGOs in Bangladesh and 8 NGOs in Nepal from 2007 to 2009 as well. On the basis of these experiences, we planted the third international workshop at BAU.

The real objective is to exchange participant's own experience related to the issues on contemporary changes in Environment and Development and share the experience and opinion so that we can establish the academic cum practical network among the neighboring countries. However, the foreign participants of the workshop, who are the first visitor to Bangladesh, are requested to find the hidden good potential of Bangladesh in the field of natural environmental conservation effort through Sundarban Excursion. Sundarban is the biggest mangrove and , so far I know, Sundarban's conservation program has leading role in the world because of its history and scale.

Bangladesh is not large country nearly 1/3 of Japan in national land acreage, but its uniqueness is remarkable in the world for monsoon of Bay of Bengal and Bengal delta. The dynamics of her nature made rich in agricultural production, culture and history but sometime cause the big disaster and overcrowding social problems. However, the people in Bangladesh, particularly, rural people have overcome these problems in collaboration with academicians and practical persons. The world must learn the experience of Bangladesh for good practices to find the keys to solution against such complicated problems of environment and development.

Ladies and Gentlemen, Bangladesh has responsibility to share her experience with the world. In this point of the view, I want to expect the role of academicians and practical persons, particularly, BAU teachers and students for leading agents in

Bangladesh, because Agriculture science is originally field science and has developed in collaboration with the rural people. I believe that the agriculturist is the good teacher to the rural people as well as the good student of the rural people. I believe that rural people's wisdom and experience is most important to cope with the problem of contemporary changes in Environment and Development in the world.

Thank you very much. Dannobad, Chezutinmare, Kopkunmakap Arigato Gozaimashita.

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International Workshop on Contemporary Changes in Environment and Development

Date: December 13-14th, 2010

Place: Conference room, Faculty of Agricultural Economics and Rural Sociology, Bangladesh Agricultural University, Mymensingh, Bangladesh

Program

FIRST DAY -December 13

Inaugural session

9:30-10:00	Registration
10:00-10:05	Taking seats by the Guests
10:05-10:10	Recitation from the Holly Quran
10:10-10:20	Welcome address by Professor. Dr. Muhammad Salim, Chief Organizer of the Workshop
10:20-10:30	Background of the Workshop by Dr. TAKEDA Shinya, Kyoto University, Japan
10:30-10:50	Keynote Speech by Dr. ANDO Kazuo, Kyoto University, Japan
10:50-11:00	Address by Chief Guest, Professor Dr. M.A. Sattar Mandal, Honorable Vice-chancellor, BAU
11:00-11:10	Address by Chairperson of the inaugural session, Professor Dr. S.M. Altaf Hossain, Consultant, LIFCHASA
11:10-11:15	Vote of Thanks by Dr. HAYASHI Taiichi, Kyoto University
11:15-11:30	*Tea Break*

SESSION 1: Agriculture and Rural Development part 1 (Chairperson: Dr. HAYASHI Taiichi)

11:30-11:50	Khin Lay Swe- "Coping Strategies with Drought and Agricultural Development in Dryzone, Myanmar"
11:50-12:10	YAJIMA Kichiji- "Alternative Rural Development Approach by Re-evaluating Rural Culture in Laos: Establishment of Village Cultural Museum"
12:10-12:30	MIYAMOTO Shinji- "Buried Humic Soil Layers and Agricultural Land Formation Process in the Himalayas"
12:30-14:00	*Lunch*
14:00-14:20	Imram Ahmed- "Sundarban: the largest contiguous mangrove forest of the world"
14:20-14:40	Nazmun Naher Kaisar Shampa- "Fingdings of Environment Coping Forum in Hatia, Nijhum Dwip and Barisal "
14:40-15:00	Zahirul Alam- "Land Use and Eco-friendly Livelihood of *Jhum* Population of Chittagong Hill Tracts"
15:00-15:20	Jahangir Alam- "Importance of Koroch Tree in protecting Soil Erosion in *Haor*"
15:20-15:40	Nityananda Deka- "Floral Resources in a village Environment of the Brahmaputra Valley, Assam: Inventory, Use and Conservation"
15:40-16:00	*Tea Break*
16:00-17:00	Visit to Agricultural Museum
19:00-21:00	Dinner Party

SECOND DAY - December 14

SESSION 2: Meteorology and Health (Chairperson: Prof. Dr. Muhammad Salim)

9:00-9:20 HAYASHI Taiichi- "Rainfall Process in the Notheastern Indian Subcontinent"

9:20-9:40 MATSUMOTO Jun-"Rainfall, floods and rice production in Bangladesh"

9:40-10:00 MURATA Fumie- "Premonsoon atmospheric condition in Bangladesh"

10:00-10:20 M.A. Baten- "Rice Paddy Flux Observation in Bengal Lowland: Carbon Budget in Double-Rice Cropping Paddy Filed in Northern Bangladesh"

10:20-10:40 *Tea Break*

SESSION 3: Conservation and Development of Swamp Forest (Chairperson: Dr. ANDO Kazuo)

10:40-11:00 TAKEDA Shinya- "Local Management of Forested Wetlands in Thailand"

11:00-11:20 FUJIOKA Yoshimi- "Fisheries Activities in Floodplain"

11:20-11:40 Vipak Jintana- "Community-based Mangrove Conservation: (1) Sustainable Forest Management in Yeesarn, Samut Songkram Province, Central Thailand"

11:40-12:00 Sommai Suppakun- "Managing Mangrove Forest Resources through Public Participation"

12:00-12:20 SEKINO Nobuyuki- "Marine Protected Areas as Imported Concept: Bamboung Community-Based Marine Protected Area in Senegal"

12:20-13:40 *Lunch*

13:40-14:00 KURASHIMA Takayuki-"Difficulties of prescriptive tropical forest governance models and their practical function in REDD+: A basis for framing better swamp forest management under the emerging paradigm"

14:00-14:20 MUSHIAKE Etsuo-"From the villages of Lam singers in Laos and Thailand -Some cases of inheritance of indigenous knowledge in rural area-"

SESSION 4: Agriculture and Rural Development part 2 (Chairperson: Dr. YAJIMA Kichiji)

14:20-14:40 ANDO Kazuo- "Recent Change in Rice Cultivation Technology in Bangladesh"

14:40-15:00 M. Jiaul Hoque-"Perception of Fish Farmers towards Flood Coping Mechanisms"

15:00-15:20 *Tea Break*

15:20-16:20 General Discussion

16:20-16:30 Closing Remarks by Professor Dr. G.M. Mujibar Rahman

EXCURSION

Dec. 15th Start from Mymensingh by Bus to Khulna via Dhaka

Dec. 16-18th Sundarban Tour, Stay at rented launch

Tour points: Kotka, Kochikhali and Harbaria - Hiking in the forest area to see wildlife and forest; Visit wildlife sanctuary; Trip through small creeks and canals by country boat to see the wildlife and close observation of the forest.

Dec. 19th Khulna to Kuakata by bus; Stay at Hotel

Dec. 20th Kuakata; (See *Rakhain* village, enjoy seeing sunrise and sunset from one sea point); Stay at Hotel

Dec. 21st Kuakata to Dhaka (Ando & Yajima: Dhaka to Tangail)

Dec. 22nd Dhaka to Bangkok (Ando & Yajima: Tangail to Dhaka and departure of most of the foreigners)

Journal of Agroforestry and Environment

(Published under the auspices of Agroforestry Society of Bangladesh)

NOTES FOR CONTRIBUTORS

- Article in the form of full-length papers or short communications must be of original research relating to basic or applied aspects viz. agroforestry, production, processing, genetics, physiology, storage, pathology, marketing, biotechnology, environment, germplasm etc.
- Submission of an article to the Journal implies that it is not under consideration for publication elsewhere.
- Manuscript preparation:
  a) a full-length paper should not ordinarily exceed 4,000 words. It should be typed double spaced within 12 pages (A4) including graphs, photographs and tables.
  b) A short communication should cover a maximum of 50 % space and words fixed for a full-length paper.
  c) There should be 2.5 cm margins all around the pages.
  d) Title followed by name (s) and address (s) of author (s) with key words should be given separately as a top sheet of the manuscript.
  e) The manuscript should be divided into the following sections: **Title, Abstract, Introduction, Materials and Methods, Results and Discussion, Acknowledgement** (if any), **References.**
  f) All heads should be placed centrally. The abstract should be limited within 200 words.
  g) Citation of references should conform to the following style-

Journal

Tombuison, H., Taklehaimanot, Z., Traore, A. and Olapade, E. 1995. Soil amelioration and root symbioses of *Parkia bialobosa* (Jacq.) Benth in West Africa. Agroforestry Systems 30 (1&2): 145-149.

Book

Tisdale, S.L. Nelson, W.L. and Beaten, J.D. 1982. Soil fertility and fertilizers. Macmillan Pub. Co., New York. pp 27-35. or p27.

Proceeding

Murphy, L.S. and Walsh, E.M. 1972. Correction of micronutrient deficiencies with fertilizers. *In:* Proc. Micronutrients in Agriculture. Mortvedt, J.J., Girdano, P.M. and Lindsay, W.L. (eds.). Soil. Sci. Soc. Amer., Inc., Wis., USA.

- The script should accompany a cash/draft (infavour of the Treasurer, Agroforestry Society of Bangladesh) of Tk. 300.00 only as handling charge.
- On acceptance of the paper, an amount of Tk. 1500.00 (for full-length paper) and Tk. 1000.00 (for short communication) only will be payable from the author (s) to the Treasurer of the society as printing charge.
- The first author must be an ordinary member for current session or life member of the society for publication of his/her paper.
- In case of foreign contribution, where the membership for the author (s) is not obligatory, an amount of US $ 25 only is payable for the author (s) should send two copies of the manuscript including the original to: Prof. Dr. M. Sultan Uddin Bhuiya, Chief Editor, Journal of Agroforestry and Environment, C/O Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh. E-mail : sultan@royalten.net or to: Prof. Dr. G. M. Mujibar Rahman, Associate Editor, Journal of Agroforestry and Environment, C/O Department of Agroforestry, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh. E-mail : gmmrbau@yahoo.com