

Submerged Weir Technology by Local Community as a Sustainable Solution for Water Management in the Lower Songkram River Basin, Thailand

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The Lower Songkram River Basin, Thailand is one among many areas of the world under the tropical monsoon climate that are facing the water shortage problem during the dry season. The Thai government has been trying to solve the problems but due to the limitation of the budgets, the problem is still remained and so far it is going to become more serious due to the change of climate and the human activities. Since the villagers in remote areas could not wait for the budget of the government as they had to survive, they then collected or contributed their money, labor and indigenous knowledge and constructed the so-called "submerged weir" made by the clay, across the sub-tributary of the Songkram River in order to provide water for their irrigated agriculture as well as for a fishing ground in the dry season. In the rainy season, the water level is over two meters above the submerged weir which enables fish to migrate from the two main rivers, the Mekong and the Songkram into the seasonal floodplains. Because this submerged weir was constructed with their own resources, the people have been paying attention in taking good care of the dike and so it is still working until nowadays. This submerged weir can conserve wetland ecosystem for their sustainable use for the whole year round. Communities exhibit a high degree of dependency on wetland resources for their livelihoods such as fish capturing and processing, wetland products harvesting including agriculture and livestock grazing. From the studies it becomes to a conclusion that if proper technology is applied and if the full participation of the local villagers is achieved, the sustainable solution for water management will be possible. In addition to our studies, it can suggest that due to the early than usual of the decrease of water level in the dry season which is consistent with the development and operation of big dams in the upper Mekong Basin, constructions of small submerged weirs in sub-tributaries are recommended in order to maintain water level and extend flooding periods on the seasonal floodplains.

Keywords: Submerged weir, Lower Songkram River Basin

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1. Introduction

The Songkram River has the second largest catchment of any basin in the northeast Thailand after the Mun-Chi Basin, with a catchment area of 12,700 square kilometers and a total length of 420 kilometers. It enters the Mekong River in Tha Utaen District in Nakhon Phanom Province (Fig.1). The whole basin is divided into upper and lower basin due to the different of the

geographical features. In the lower reaches, stretching up to 200 kilometers, with a gentle gradient about 1:30,000, from the mouth of the river, there is a seasonally flooded forest where annual floods cover an area of approximately 500,000 - 600,000 Rais (1Rai = 0.16 ha.) for three or four months during the rainy season.

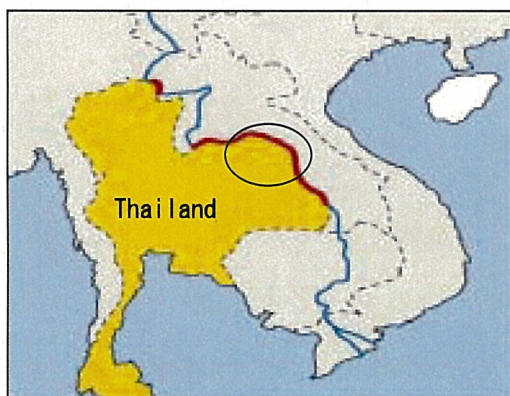


Fig. 1. The study area with many ponds and floodplains in the Lower Songkram River Basin

The Lower Songkram River Basin receives floods derived from upstream runoff and backflow from the Mekong River. These ecosystems support a wealth of biodiversity and natural resources, e.g. the Giant Mekong Catfish (*Pangasianodon gigas*) and other many kinds of fish, that subject to dramatic seasonal changes of floods and recession. Communities located along the Songkram floodplain exhibit a high degree of dependency on wetland resources for their livelihoods.

According to the interviews made to local people

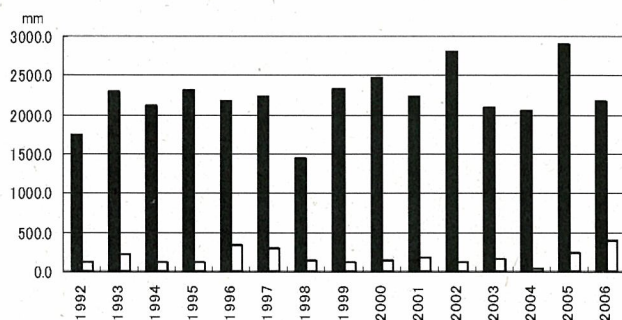
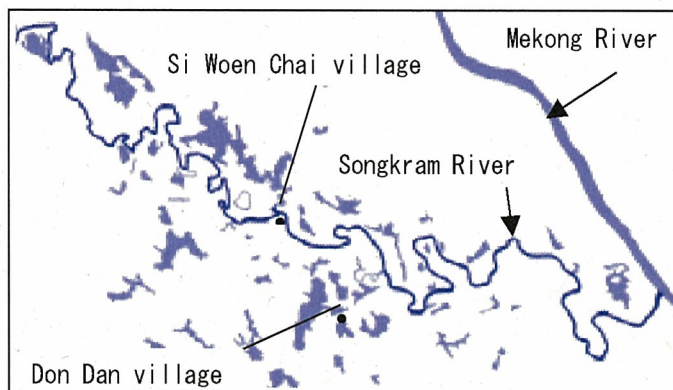


Fig.2. Precipitation from 1992-2006 at Nakon Phanom Station along the Mekong River

■ rainy season □ dry season



living along the Songkram River, it was found that the major incomes and subsistence of them are from fisheries. People in this area cannot grow rice in the rainy season on floodplains because of flooding which sometimes rises the water level up to 10 - 12 meters but in the dry season water flows backward to the Mekong

River so the floodplains usually dry out which make people cannot do either fishery or rice planting.

Therefore, they trade fish for rice from people outside the villages. This paper aims to share the information studied during 2003-2007 of the ecology, livelihoods and traditional technology at Si Woen Chai and Don Dan villages in the Lower Songkram River Basin where people have been dealing with their water problems for sustainable uses, under newly condition of construction of big dams at upper stream in China.

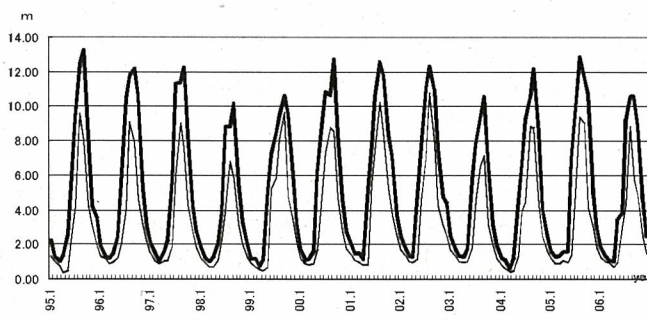


Fig.3. Water levels of the Mekong River, typically vary 10-12 meters in height difference between the dry and the rainy seasons (1995-2005).

— Maximum water level — minimum water level

2. Methods

The field survey based study was carried out during 2003-2007 to obtain data on wetland ecology, resources utilization in 8 selected villages and water management by field observations, interviews made to some key informants including monks together with satellite images analysis and GIS applications in the Lower Songkram River Basin, Nakhon Phanom province, Thailand.

3. Ecology of the Lower Songkram River Basin

Along most of its lower reaches, the river meanders pass through an extensive floodplain at an altitude of between 145-160 m.a.s.l. and a gentle gradient of about 1:30,000. The village researchers found that the complex wetland ecosystems of the Lower Songkram River Basin is comprised of 28 different wetland habitat types, e.g. the main river channel, pools, river sand bar, tributary streams, seasonally flooded forests, swamps, ponds, depressions channels and ox-bow lakes. The main upland forests are dry dipterocarp forest and semi-evergreen forests. There are some seasonally flooded forest which is composed of many plant species such as *Barringtonia acutangula*, *Syzygium cinereum*, *S. cumini*, *S. gratum*, *Elaeocarpus hygrophilus*, *Lagerstroemia spireana*, *L. macrocarpa*, *Fagraea fragrans*, *Strebus taxloides* and *Bambusa arundinacea*, *Phyllanthus collinsae*, *P. taxodiifolius*, *Maytenus mekongensis*, *Morinda talmyi*, *Memecylon pauciflorum* bush.

Due to the various habitats, it contains valuable natural resources including 191 species of plants (Sangkamethawee, W. 1997), 183 species of fish, and 87 species (in the entire Songkram River Basin) of birds (Blake, D. and Pitakthepsombut, R, 2006).

For example, main aquatic plants, *Rhinchospora racemosa*, *Nymphoides indicum*, *N. cristatum*, *N. gratum*, *Nelumbo nucifera*, *Trapa incisa*, *Nelumbo*

nucifera, *Ceratopteris thalictoides*, *Eleocharis dulcis* are found in this area.

4. Water Level and Fluctuation

The Lower Songkram River Basin encompasses a broad range of wetland habitats associated with the functional floodplain ecosystem that link to the Mekong Basin. The fluctuation of water level in the Mekong River will affect wetland ecosystems in the Songkram River Basin. Especially in 2004 it was notable that the rainy season finished abruptly in mid September at least a month earlier than a normal period and the water level was only 0.42 m high in the dry season while the precipitation is not different from another year (Fig.2, Fig.3).

This result caused water levels to fall rapidly in the Songkram River and the floodplain. Such unusual water fluctuations are consistent with the development and operation of dams in the Upper Mekong Basin. When the wetland ecosystem is affected by the unusual water fluctuations, migration pattern of fish may also be affected.



Fig.4. Landscape of wetlands in different seasons at Pak Un village (Songkram River tributary).
(a); landscape in the rainy season, Sep. 2005.
(b); landscape in the dry season, Apr. 2006.

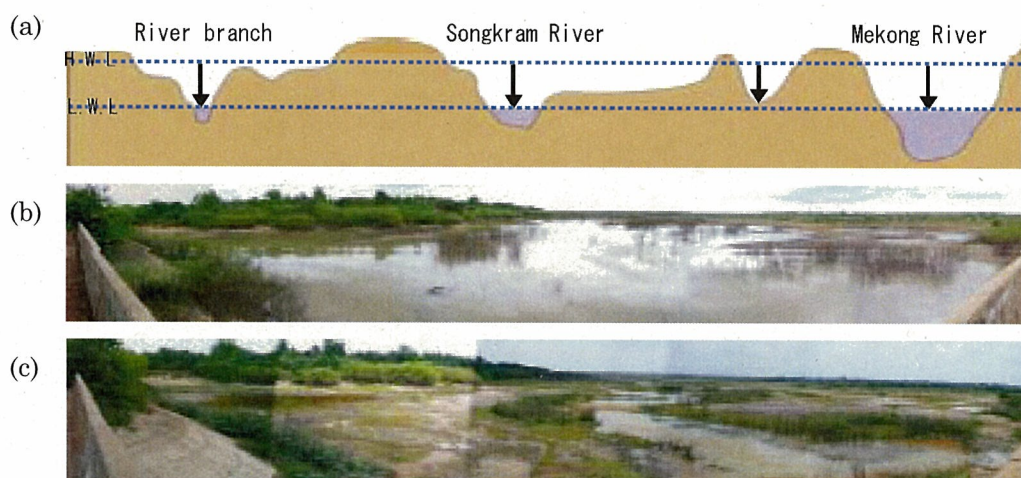


Fig.5. (a) shows the fluctuation of water level in the Songkram River that linked to the Mekong River. Due to the draw down of the water level, landscape of wetlands change from (b) to (c)

This in turn may cause the reduction of the wetland products and the changes of the wetland ecosystems. In addition, from the study, due to early water level decrease in the dry season, construction of small submerged weir in sub-tributaries were recommended to balance the water level and to extend the flooding periods that will help the local people to survive and live with harmony throughout the whole year.

5. Livelihoods

The rural population of the Lower Songkram River Basin is largely dependent on natural resources for their livelihoods. According to the interviews made to the local people in the eight villages (Si Woen Chai, Sam Phong, Dong Nong Bua, Kha, Pak Yam, Tha Rae, Tha Kon, and Tha Ruar) located next to the Songkram River, it was found that the major incomes and subsistences of them were from fisheries (Fig. 6).

Depending on the season and the hydrological conditions, fishing tends to be the highly seasonal activity, peaking during periods of fish migrations, both up and down the streams (Mekong – Songkram – Floodplain – Songkram-Mekong). The most productive fishery comes

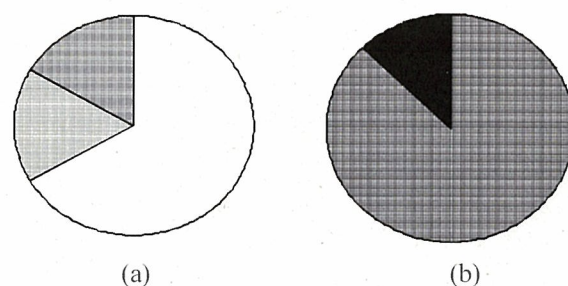


Fig.6. Major income of local people in the Lower Songkram Basin area (Homchuen, S., Sasaki, Y. and Kamata, K. 2007)

(a): Major income in the dry season

(b): Major income in the rainy season

- Migrant ▨ Only fishery
- ▩ Fishery and rice Farming ■ Only rice farming
- ▧ Fishery and gathering bamboo

(September-October). Besides fish, many other types of living aquatic organisms are also harvested from the wetlands. These include timbers, firewood, bamboo shoots, mushrooms, vegetables, mollusks, shrimps, crabs, turtles, frogs, snakes, birds, and insects.

From the study it was found that a large part of the local economy is likely to be derived from wetland products, especially fish and mainly in the rainy season.

Because in the dry season the wetland cannot keep much water, so fishery is not the main source of their incomes.

Villagers exhibit a high rate of out-migration for labor both to nearby big cities and Bangkok or even abroad. Most farming in this region is characterized by rain fed system (Fig. 7) with relatively small area being used for irrigated agriculture in the dry season. Too much water in the rainy season and lack of water in the dry season were major problems in this area.



Fig.7. Rain fed rice farming system on floodplain (in the rainy season, August 2005)

6. Water Management by the submerged weir technology

The Lower Songkram River Basin is one among the areas as well as in many parts of the world under a tropical monsoon climate were facing the water shortage during the dry season .

The Thai government has been trying to solve the problems but due to the limitation of the budgets, the problem is still remained and so far it is going to become more serious due to the change of climate and the human activities. Since the villagers in remote areas could not wait for the budget from the government as they had to survive, then they contributed their money and constructed the submerged weir to provide water in the dry season for irrigated agriculture and fishing ground and the best examples of the two villages were discussed as the following:

6.1 Case of Si Woen Chai village

Si Woen Chai village located in Tambon Sampong, Sri Songkram District, Nakon Phanom Province is one among of good example villages that the villagers has been dealing with their water problem by using the local technology, the **submerged weir** technology.

They collected and contributed their own money (about 300,000 Baht, 1US\$=35 Baht) and labor and with the indigenous knowledge under leadership of Buddhist priest in Sri Wichai temple. They have been able to construct the so-call "submerged weir" across the sub-tributary of the Songkram River in order to provide water for their irrigated agriculture as well as for a fishing ground in the dry season (Fig.8, 9).

This clay **submerged weir** was built in 1987 with a size of about 8.0, 250.0 meters in height and length respectively, and with 6.0 meters wide on the top covered with laterites and 30.0 meters wide on the bottom of the submerged weir, respectively.

To prevent the erosion and damage of the submerged weir, they also planted the native plants such as *Bambusa arundinacea*, *Hymenocardia wallivhii*, *Vetiveria zizanioides*, *Combretum trifoliatum*, *Phyllanthus collinsae* and *Lagerstroemia spireana*.

After constructed weir, done maintenance only one time.

In the rainy season, the water level is over 2 meters above the submerged weir which enables fish to migrate from the two main rivers, the Mekong and the Songkram into the seasonal floodplains.

Because this weir was constructed with their own resources, the people have been paying attention in taking good care of the weir. The weir lasted only one year because the soil was not firmly pressed after that it was repaired and it has been working until now which is about 20 years. This submerged weir can conserve

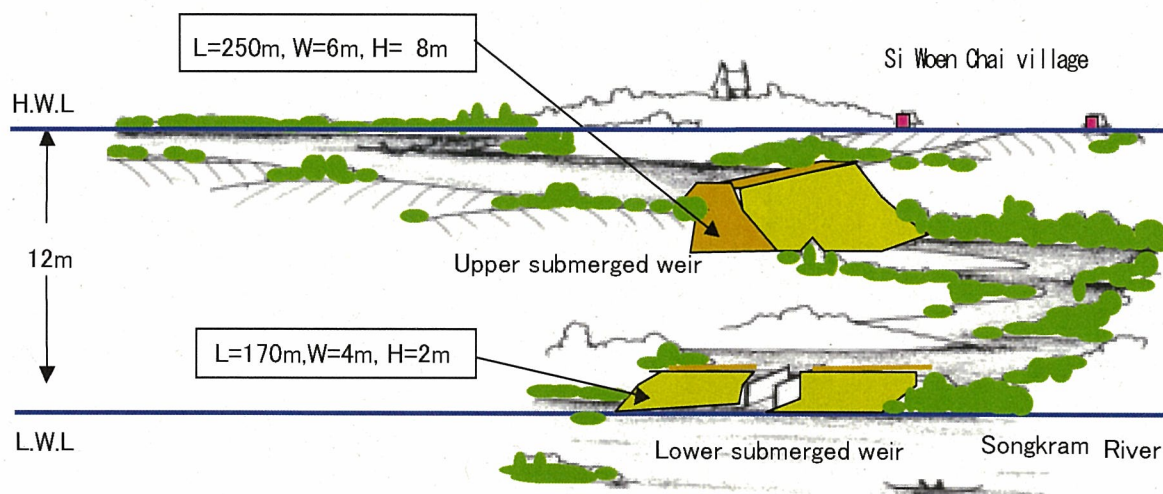


Fig.8. Diagram of the lower and the upper small submerged weir functions in the high and the low water levels in Si Woen Chai village.

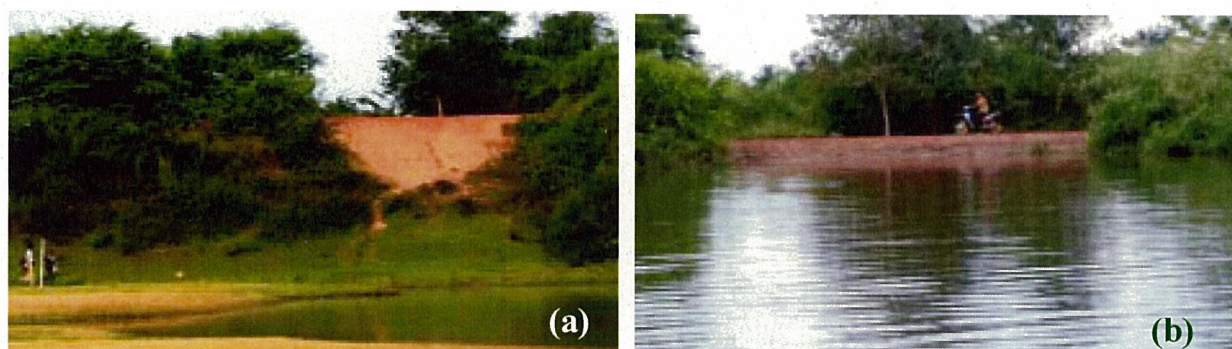


Fig.9. The upper small submerged weir in the dry and the rainy season (2007 April) and the reservoir, which can keep water of about 6 meters in depth. (a): in the day season .(b): in the rainy season (Aug.2007).

wetland ecosystem for their sustainable use for the whole year round. In the rainy season, the local people can do their fishing while in the dry season this submerged weir can keep enough water for the whole village including two communities (which consists of 275 households with

a population of 836) to grow rice which is sufficient for their own consumption and for sale.

At the same time this reservoir also served as a fishing ground in the dry season because it can keep water up to 6 meters in depth. Since the people then can

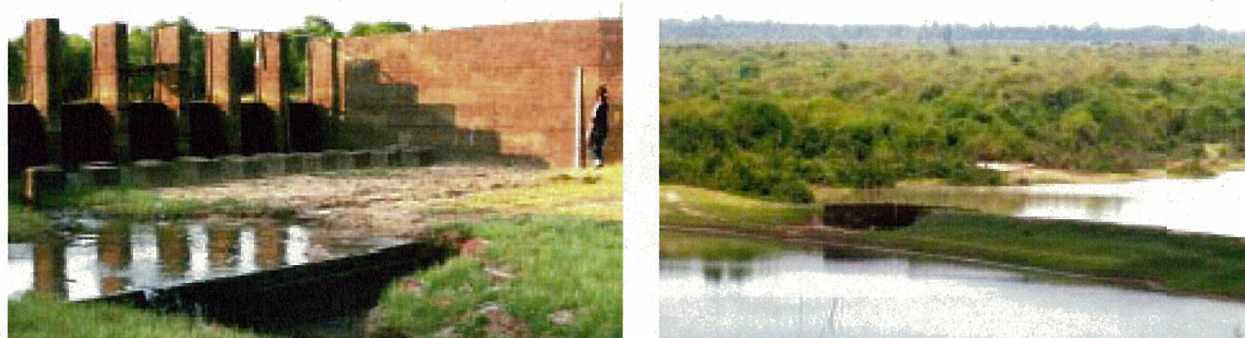


Fig.10. The lower submerged weir constructed by the government technology (two meters above water level in Songkram River)

now live with harmony, nobody will need to migrate for work to the big cities and so the whole family can live together happily. After that, the second facility, the lower **submerged weir**, was built in 2005 by government support with a size of about 4.0, 2.0, 170.0 meters in wide, height and length respectively. This **weir** worked only to keep water for fishing and for fish banks (Fig.10). The lower **submerged weir** is under water of over 5 m depth in the rainy season.

Water level of Mekong river over 9 m in rainy seasons, this **submerged weir** will cover water, if water level of Mekong river over 11 m in maximum, this **submerged weir** will cover 2 m depth in this time many fish traveling into the Lower Songkram River Basin from Mekong River.

6.2 Case of Don Dan village

Don Dan village located also in Sri Songkram District, Nakorn Pranom Province, the older and traditional solution which was the same as Satoyama system in Japan was applied to it for landuse management.

The population of this village was 820 (about 275 households). This village has a natural wetland called Nong Chai Wan which located in the floodplain. In the rainy season the wetland was flooding but in the dry season the water almost flow out to the main river, the Songkram River. So the water was not sufficient for irrigated agriculture in the dry season. Then local people then set up the small mud **submerged weir** about 150 cm high by government support in 1986 and in the same time near by the village they conserve community forest to provide natural resources for their livelihoods.

Therefore, after a small **submerged weir** has been constructed, the villagers has been able to grow rice both in the rainy and dry seasons. Until today, this village has an areas about 600-700 rai as paddy fields for growing

rice in the dry season.

Nong Chai Wan pond can keep fish bank, irrigated agriculture, water supply, fishing, cattle raising, boat racing, birds conservation and firewoods, vegetables and fish harvesting. Because the population of the village was small, a **submerged weir** of only 50 cm high has been built 21 years ago and it still working as being able to keep sufficient water for the whole village until today and in the same time can be used as a path (road) for transportation. Beside this, the villagers have conserved the natural condition and therefore a good environment (forest, water, agriculture) for the sustainable life is possible.

The villagers have volunteered to take care and look after of their **submerged weir** as well as their community forest by setting up some regulations as the details below and in following Fig.11-12:

1) Community forest

Community forest is a place used for firewood collection, religion ceremony, timber, cattle raising, etc. There are some regulations as follows

- (1) Cutting trees are not allowed. Offenders will be fined 500 and 5000 Baht for a small and a big tree respectively.
- (2) Only dead trees are allowed to collect.
- (3) Honey is not allowed to collect.
- (4) Outsiders are not allowed to collect honey and ant larvae.
- (5) Witnesses will get 50% reward of the fined money.



Fig.11 Regulation sign for community forest

2) Fish bank

Now, Lower Songkram River Basin has a problem of decrease fish mass by the around conditions changed, so then villagers and Thai government try to keep fish resources, set up fish bank area.

Government has now plan to set 26 spots of fishbank where will be decided informations with fisherman to use simple GPS navigation systems.

There are regulations in controlling the size of the net, equipments and fishing methods as follows:

- (1) Small sizes of nets are not allowed to be used
- (2) Electric shock is not allowed
- (3) Bird hunting is prohibited
- (4) Catching aquatic fauna in the conserved area or in the fish bank is not allowed.
- (5) Burning litter in the reservoir is not allowed.
- (6) Outsiders are not allowed to collect the reeds.
- (7) Baby fish catching is not allowed.



Fig.12 Regulation sign for the fish bank

3) Village committee systems

Each village also has its own voluntary system committees, which is composed of 19 persons for controlling and planning the villager's life and for managing the community forests and fish bank.

Those committee's mainly job is to control the community forest, fish banks, co-op, eco-tourisms management, conservation of the wild birds (i.e. the water ducks), irrigation, and water supply.

Don Dan village is one of the typical case of

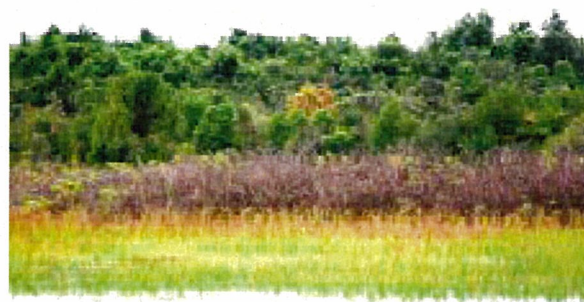


Fig.13 Swamp forest in Nong Chai Wan



Fig.14 The small submerged weir in Don Dan village

Satoyama system in Thailand. The local people kept forests, natural wetlands, ponds and rice fields together as a complex ecosystem. Therefore, the people did both the conservation nature and the utilization of natural resources, e.g. fire woods, timbers, some vegetables from the forest including growing rice in the fields, and raising water buffalos, cattles, chickens and fishing. Some dominant species in the natural swamp forest are *Mitragena diversifolia*, *Elaeocarpus hygrophilus*, *Nepenthes mirabilis*, *Nymphoides cristatum*, *N. indicum*, *N. gratum*, *Nelumbo nucifera*, *Utricularia aurea*, *Marsilea crenata*, *Salvinia molesta*, *Polygonum odoratum* and *Scirpus grossus* and these plants could be served as foods and shelters for the fish bank.

6.3 Land use distribution

After the submerged weir were constructed, more area in Si Woen Chai and Don Dan villages could be

used as rice fields because residents around the submerged weir have got enough water in the dry season.

At the beginning the government provided each family about 4 rai of land along the river for rice growing.

At present, the rice fields have been expanded up to 10-15 rai for each family. So the local people has been able to grow rice for subsistence and for sale. The people can do fishing both in the rainy season and the dry season. The village committees could also give licenses

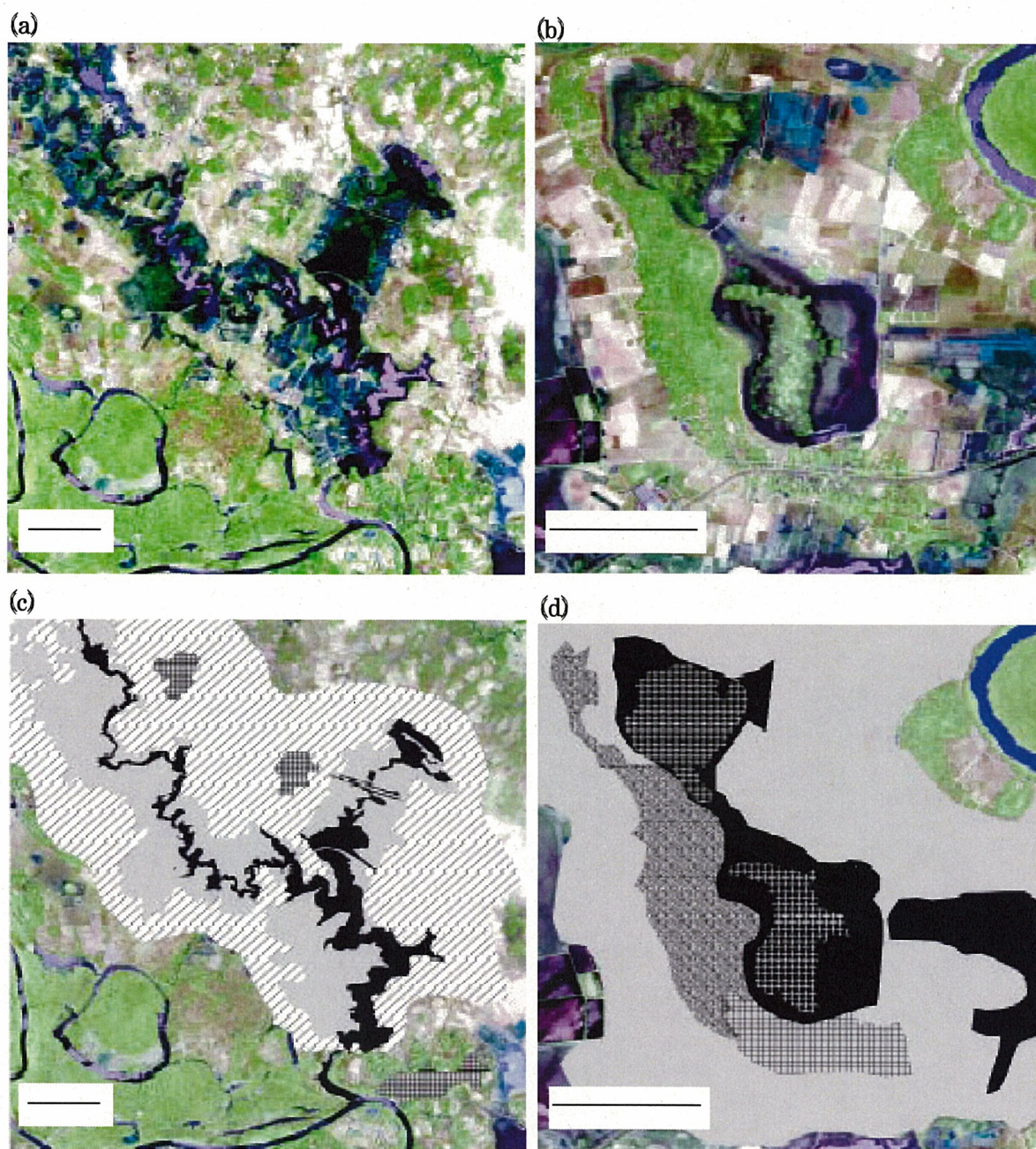


Fig.15. Satellite image and land use around sink dike in Si Woen Chai village and traditional types with community forest in Don Dan village. A horizontal bar indicates a scale of 1 km. (a): Satellite image around Si Woen Chai village (b): Satellite image around Don Dan village (c): Land use around Si Woen Chai village (d): Land use around Don Dan village

to the outsiders for fishing, they in turn get pay from doing these works for the whole village.

The upper area of Si Woen Chai submerged weir, Don Toei village including 9 communities, Moo Mon village including 6 communities and Natom village, which consists of 430 households and with a population of 3000, have got benefits from this submerged weir as well. They can use 4-15 rai of lands as paddy field, for each family in the dry season, because the weir created a big water body. According to our calculation, the weir creates 4.07 k m² water body and there are 10.4 k m² of paddy field.

In addition, if the irrigation is applied, they can have 21.2 k m² of paddy fields (Table.1 and Fig.15).

In Don Dan village, one traditional system called a community forest could help to maintain the water in the dry season. It consists of many inundated trees in water body. It does not only help in keeping water but also helps to maintain the good natural environment.

The village has 0.96 k m² of swamp forests, 1.17 k m² of forests, 1.89 k m² of water body, and 7.98 k m² of paddy field (Table.1 and Fig.15). The villagers get enough water and natural products that serve their needs.

As such traditional technology, King of Thailand introduce one method for keep of small water in mountain area, which set up small check dike by the stone and woods for the materials. The system works fire break and to keep the forest ecosystem, small wild insects, plants and animals can live.

7. Conclusions

The Songkram River's lower reaches and floodplains are considered by the Thai government to be a wetland site of international importance (OEPP, 2002) because of the high value of livelihood services and ecological functions of the wetlands can offer local communities.

While there are no doubts that the Lower Songkram River Basin is a significant and unique wetland area, the nature and the change in the wetlands composition in recent years are not appreciated.

The continued prosperity of these wetland resource-dependent communities can be seriously threatened from within and outside the local communities.

There is a strong evidence to show that there has been a very rapid conversion of forested land and natural wetlands being replaced by agriculture (sugar cane, cassava, eucalyptus and rubber tree plantation). In addition, the wetland ecosystems are also deteriorating from other human activities especially the big dams construction on the upper Mekong Basin in China as well as the impacts from the change of climate.

However, the study in Si Woen Chai and Don Dan villages indicated that if a proper, low cost but high efficiency and practical technology, was applied as well as if the full participation of the local villagers is achieved, a sustainable solution for water management would be possible and this would increase not only the people's economy but also the safe of the wetland ecosystems. This implementation needs to be applied urgently before there are no more wetlands left.

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