Section 3: Fisheries Management

Stock enhancement as a major element of reservoir fisheries management

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ABSTRACT

For poor local communities throughout the riparian countries, reservoir fisheries are an important source of food and family income. The Management of River and Reservoir Fisheries (MRRF) and Aquaculture of Indigenous Mekong Fish Species (AIMS) components of the Mekong River Commission (MRC) Fisheries Programme play an important role in augmenting these natural resources by restocking them with species of fish indigenous to the Mekong. The stocking supports government policy to regenerate those species that have been lost and to increase the catch in this important ecosystem.

This paper reports the findings of a study carried out in northern Cambodia in November 2002 on the effects on local food supply and family income of stocking the Thmorda reservoir. Stocking is widely accepted by fishers as one of the most practical ways of strengthening community fisheries management and improving the livelihoods of local people. With the support of the Department of Fisheries (DoF), MRRF and AIMS, local inhabitants of the Thmorda reservoir formed community fishery (CF), drew up a reservoir-wide management plan that included restocking as a priority activity. The community then participated in restocking the reservoir with 21,500 fingerlings of native species (*Barbonymus gonionotus, Barbonymus altus, Pangasianodon hypophthalmus* and *Trichogaster pectoralis*) produced at Bati and Chrang Chamres, and monitoring the results of their activities.

During the seven months following restocking, the reintroduced fish grew five to six times faster than fish in pond-based aquaculture systems. Up to 30-40% of reintroduced *B. gonionotus* and *B. altus* were recaptured within seven months and had reached a total weight of about 1,180 kg, with an estimated value of about US$1,700.

Whilst these results are encouraging, the ecological effects of stocking on the reservoir and the socio-economic effects on people living in the area need to be investigated further .

KEY WORDS: Reservoir, stock enhancement, livelihood, CF participation

INTRODUCTION

Literature on Cambodia's inland fisheries makes frequent reference to the abundance of fish in the Tonle Sap and Mekong river systems, and to the expertise of the fishers who exploit these resources. Fish, together with rice, forms the stable diet of most Cambodians. Inland fisheries provide three quarters of the animal protein consumed by the population. In addition, fishing is a major source of income providing full or part-time employment for around two million people. Fishing is the principle livelihood for many rural families, who comprise almost 90% of the country's poor. Inland fisheries produce between 290,000 - 430,000 tonnes of fish each year; and the value of the landing is in the order US$150 to US$200 million (DoF 2002). The contribution of freshwater capture fisheries to national food security, and to the larger Cambodian economy, is probably higher than in any other country in Southeast Asia.

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Cambodia has a vast fresh water system that extends over nearly two million hectares. This system contains over 600 reservoirs, in addition to rivers lakes, flooded forest, grassland, rice fields, and swamps. Reservoir fisheries in this system are an important source of food and income for poor local communities.

Whilst these reservoirs may adversely affect existing fish habitats and stocks, they can also provide new environments well suited for fish aquaculture and fisheries. The government of Cambodia acknowledges the importance of reservoir fisheries and emphasises the need for appropriate management to promote and develop their existing use and to ensure the fisheries sustainability into the future.

The ecological issues relating to the reservoir fisheries draw increasing attention. These issues include, the consequences of over-fishing and the impacts of destructive practices such as, electro-fishing and fishing with homemade bombs, dynamite, and fine-mesh nets. Although Cambodian law prohibits these practices, they are still commonplace and cause great damage to fish populations and other aquatic fauna.

However, effective fisheries management, with the involvement of local communities, has been able to reduce the incidence of two of these illegal practices (bombs and dynamite) countrywide. This kind of cooperation, together with active stock enhancement, may pave the way for rehabilitation and preservation of the country's aquatic resources.

This paper documents the results of restocking the Thmorda reservoir, in northern Cambodia, with species of fish that were under threat of becoming extinct locally. The exercise, which required the cooperation of the local community and local fisheries authorities, shows that effective management can enhance food supplies and family incomes.

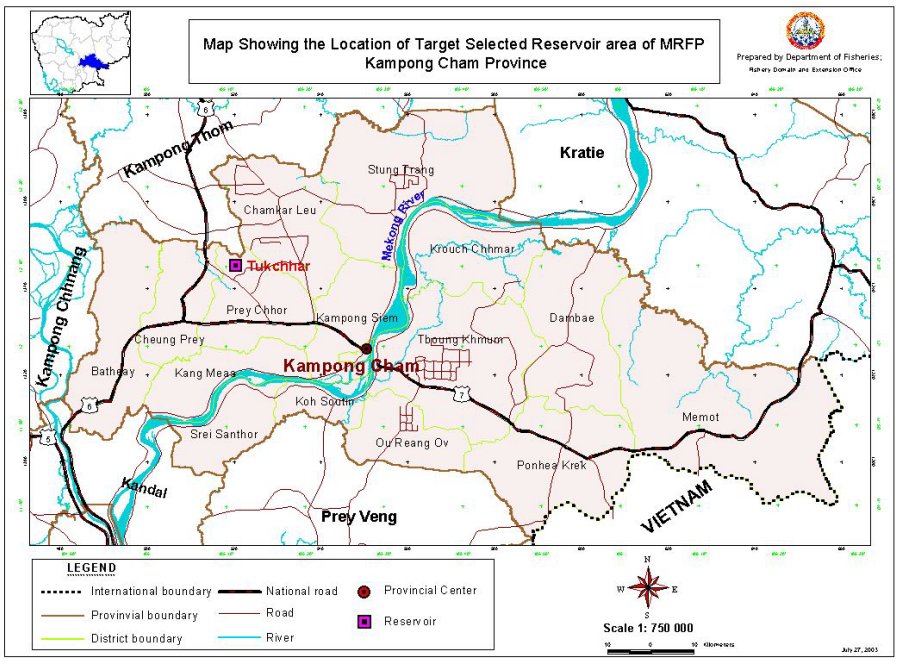

Figure 1. Location Map

THMORDA RESERVOIR

Characteristics and ecology

The Thmorda reservoir in Kampong Cham province of northern Cambodia is located 17 km from the provincial capital and 135 km north of Phnom Penh. Originally built during the Pol Pot era (1976 to 1977), the reservoir was refurbished in 1996 with the aid of a US$1,543,000 Royal Government Loan from the Asian Development Bank (ADB).

The designated area of the reservoir covers 200 ha, the surface area of water is approximately 70 ha and it has a maximum depth of four metres. With storage capacity of nearly 2.5 million m^3, the reservoir can provide enough water to irrigate 2,000 ha of rice fields. During the rainy season, the excess outflow from the reservoir flows into the Tonle Sap river via a canal. In the dry season, even though isolated from this outlet, the reservoir can still supply enough water for irrigation purposes.

Fishing activities

The four villages nearest to the reservoir house 749 families. While rice cultivation provides the main livelihood for the villagers, fishing accounts for about 30% of their income. About 15 families, who do not own a paddy field or garden, depend solely on fishing the reservoir for their living.

The Thmorda reservoir is rich in natural aquatic fauna including many species of fish and snails. Estimated fish production in 2001 and 2002 was between 13,000-15,000 kg. Most local fishers use small-scale fishing gear including cast nets, gillnets, seine, hooks, long lines, and spear guns and some collect snails by hand. Using this gear, fishers can expect to catch between 8-10 kg of fish per day during the rainy season and 2-3 kg per day during the dry season. The most common species in their catch are: *Hampala dispar, Pristolepis fasciata, Oxyeleotris marmorata, Channa striata, Clarias batrachus, Clarias macrocephalus, Notopterus notopterus, Henicorhynchus caudimaculatus, Anabas testudineus, Pseudabassis notatus, Mystus nemurus, Monopterus albus, Tilapia nilotica, Macrognathus siamensis,* and *Macrognathus maculates.*

The catch of some species has declined sharply over the past five years because of over-fishing and illegal fishing. These species include *Barbonymus gonionotus, Cyclocheilicthys repasson, Cyclocheilicthys armatus*, *Osteochilus hasseltii* and *Wallago attu.*

Despite the efforts of the community and local authorities to stop it, illegal fishing, usually electro fishing or fishing with very fine mesh nets, continues to be a problem.

Community fisheries management

Residents of the local four villages formed a community fishery (CF) and, with technical support from the Department of Fisheries (DoF) and financial assistance from the Management of River and River Fisheries component (MRRF), drew up a reservoir-wide management plan. The main aims of the plan

Figure 2. Fishing with cast net

Figure 3. Illegal practices, electro-fishing (left) and fine mesh nets (right)

Figure 4. Local people help re-stock the Thmorda reservoir

are to encourage sustainable management of the fisheries and to develop the resources of reservoir in a way that ensures security of food supplies and helps alleviate poverty. The villagers elected a committee that, together with the local authority and technical support from DoF, devised a plan to regulate internal fisheries. The chief of committee and the local authorities endorsed the regulations and distributed them to people living in and around the reservoir. Since the introduction of these regulations, illegal fishing has declined and fish stocks are recovering.

An example of stock enhancement as a major component of reservoir fisheries management

Why stock?

Re-stocking indigenous fish species also has high priority in the community fisheries' reservoir-wide management plan, the members saw as it another means to increase the catch and improve the livelihood of local people. They also see it as a very effective way of regenerating fish stocks depleted by over fishing and legal fishing. The Prime Minister of the Royal Government of Cambodia officially signed a sub-decree on 25th August 2002, and with immediate effect, declaring July 1st of every year National Fish Day.

METHODS

In support of this proclamation, the Thmorda reservoir was targeted as a site for restocking. The community fishery selected fish species that were in danger of becoming locally extinct to restock the reservoir (Table 1). These species, which include *B. gonionotus*, *Barbonymus altus, Pangasianodon hypophthalmus,* and *Trichigaster pectoralis,* are known to thrive in the type of habitats provided by the reservoir.

Table 1. *Number and weight of fish species restocked in the Thmorda reservoir*

Species	**N° of seeds stocked**	**Average weight (g)**
B. gonionotus	10,000	2.60
B. altus	10,000	1.60
P. hypophthalmus	1,000	1.30
T. pectoralis	500	2.50
Total	**21,500**	

Brood stock were collected from the Tonle Sap River and bred at the Chrang Chamres station. Fish seed from the station was transferred and stocked in the reservoir on 6th November 2002. A stocking ceremony, organised by the community fishery, and attended by local authorities, department and provincial fisheries officers, presented an opportunity to advise local people how to manage stocked fish and urge them to stop using prohibited fishing gear.

Monitoring and data collection

Regular monitoring began immediately after stocking and continues today. Forty local fishers, provided with special record sheets to ensure accuracy, give monthly accounts of the type of fishing equipment

they use and the number, species, weight, and market price of fish they catch. Every month a district facilitator collates these data. The data provide a record of the recapture of restocked fish.

At the same time, informal discussions with the community fishery and fishermen provide feed back on the progress of the fish stocking programme and promote information sharing. These discussions take in the yearly catch assessment in order to evaluate the catch since the formation of the community fishery and the restocking of the reservoir.

RESULTS

Restocking took place in November 2002. By May 2003, seven months after stocking, the average weight of recaptured specimens of *B. gonionotus* and *B. altus*, were 0.8 kg and 0.4 kg respectively. Figure 5 (opposite) gives the average daily growth rate of the re-introduced fish. Low stocking density and the high productivity of the reservoir probably contributed to growth rates significantly higher than those of the same fish reared in other culturing regimes. As an example, on average *B. gonionotus* gained 3.77 g per day, some five or six times that of the same species reared in a the pond-based culture system. The same is true for the growth rates of *B. altus*, *T. pectoralis* and *P. hypophthalmus,* even though only a small number of the last two species were recaptured.

The numbers of re-introduced fish recaptured reached a peak in December 2002 before decreasing sharply from January to May 2003 (Figure 6-opposite). By May, the proportions of recaptured re-introduced fish were *B. gonionotus* (30%)*, B. altus* (22%)*, T. pectoralis* (15%) and *P. hypophthalmus* (1%).

In contrast, the weight of recaptured re-introduced fish reached a peak in January 2003, remained at a high level through to March, and declined gradually in April and May (Table 2). *B, gonionotus* (72%) and *B. altus* (26%) account for the bulk of the 972.7 kg catch.

Yearly assessment records show that the fish catch increased from 15,000 kg in 2002 to 18,720 kg in 2003, a 20% increase since the formation of the community fishery and re-stocking the reservoir. Re-introduced fish, which accounted for up to 26% of this increase and for about 5.4% of the total 2003 catch, generated an income of about US$1,470.

Table 2. *Total weight (Kg) of stocked fish species recaptured by month*

Species	**Month (Nov 2002 – May 2003)**							
	Nov	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Total**
B. gonionotus	65.0	150.0	155.0	95.0	120.0	70.0	50.0	705,0
B. altus	25.0	50.0	55.0	40.0	50.0	20.0	18.0	258,0
T. pectoralis		1.8	0.5	0.3			4.5	7.1
P. hypophthalmus		0.6		2.0				2.6
Total weight	**90.0**	**202.4**	**210.5**	**137.3**	**170.0**	**90.0**	**72.5**	**972.7**

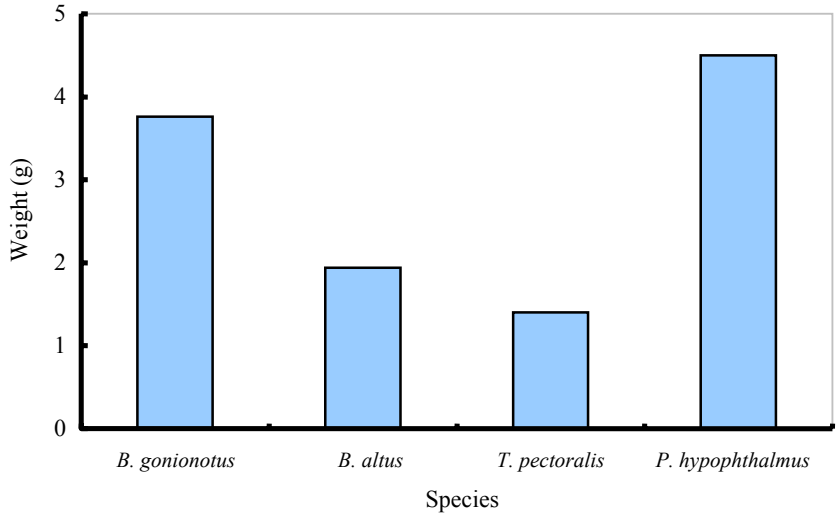

Figure 5. Average daily increase in weight of restocked fish

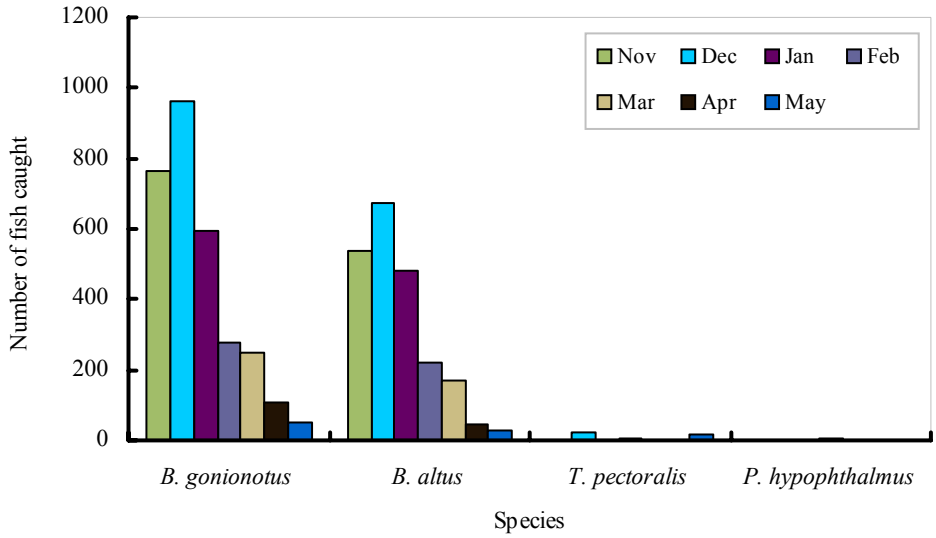

Figure 6. Number of restocked fish recaptured per month

Over 95% of the recaptured re-introduced fish were caught with either gillnets (80%) or cast nets (15%). In order to catch *B. gonionotus* the mesh size of gillnets size was increased monthly. The relationship between the weight of recaptured *B. gonionotus* and the effective mesh size of gillnets is given in Figure 7. Mesh size was increased from 4-5 cm to 9-10 cm in May 2003 when the average weight of this species reached about 800 g (from 2.6 g at stocking).

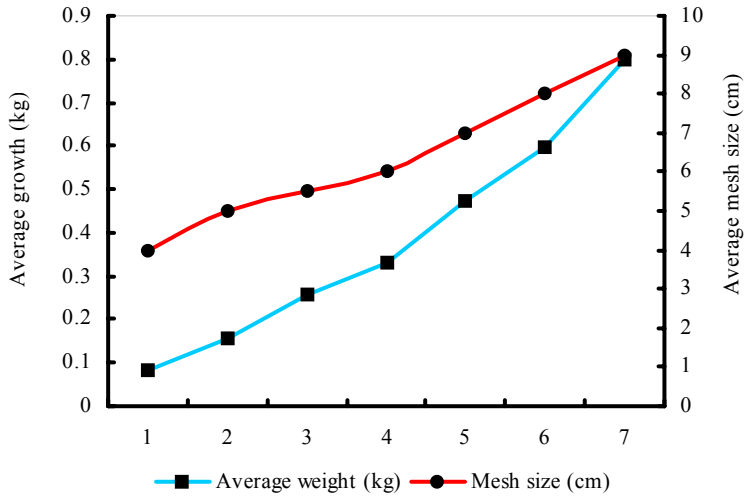

Figure 7. The relationship between weight of *B. gonionotus* and effective mesh size of gillnet mesh size

ATTITUDE OF THE FISHING COMMUNITY TO RESTOCKING

In general, the local villagers were pleased to take part in the restocking programme because the expected increase in their income and the security of their food supply would greatly improve the quality of their lives. The fishers sold about 60% of catch in their local market and kept the remainder for their own families.

Some fishers suggested the community fishery should bring in rules to regulate the mesh size of gillnets and introduce 'fishing seasons'. However, others complained that some fishers were unable to catch re-stocked fish because they could not afford to buy the appropriate fishing tackle.

CONCLUSIONS AND LESSONS LEARNED

Stocking is now widely accepted as one of the most practical and effective ways of improving the fish catch and preserving aquatic resources in reservoir fisheries.

Fish released into the Thmorda reservoir grew quickly and recapture rates were high, up to 30%. *B. gonionotus* and *B. altus* were particularly well suited to the reservoir environment and this factor should be borne in mind when fish species are selected for re-stocking.

Fishers were pleased to participate in restocking because they could see the potential benefits, i.e. more

food, increased income, and a better livelihood. Following the formation of the community fishery and restocking, the total catch increased by about 20% per year. Restocked fish accounted for about 26% of this increase. These realised a sales price of US$ 1,470.

The community fishery must now decide how it wants to control fish stocks and catches. It has two options:

1. The community fishery could regulate fishing activities by restricting mesh size and introducing fishing seasons. If these regulations are applied, the fish catch will increase and fish stocks will be recruited through natural reproduction, removing the need to stock the reservoir artificially. However, long-established fishing practices are difficult to change and these measures may meet some resistance.
2. The second option involves the community fishery nominating an individual to act as fish seed producer. This person could take on the responsibility of producing and stocking the reservoir with fingerlings. In this case, fishers who use the reservoir will pay the wages and costs of the nominated person.

We recommend prolonging the restocking of the Thmorda reservoir and extending the practice to other reservoirs in Cambodia. However, careful selection of the reintroduced species is essential, as they must be compatible with the ecology, productivity and physiology of the reservoir.

Future studies should include the social impact of restocking, constraints faced by fishers, and ecological change in reservoirs caused by this practice.

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Inland fisheries co-management: what next for Viet Nam?

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ABSTRACT

Natural resources co-management by local users, concerned local governments, and other stakeholders that pays particular attention to the role of the users in resource management has been strongly encouraged by many projects in Viet Nam in recent years. There are many reasons for this, although in general, various socio-economic and environmental problems make the need for resource management clear. However, users must accept the proposed management measures if they are to be legitimate and effective.

This paper focuses on the experiences of the Management of River and Reservoir Fisheries (MRRF) Viet Nam sub-component and makes recommendations to decision-makers on whether or not to promote fisheries co-management, to promote more systematically, and how to carry out this promotion. These recommendations are based on:

- an examination of the economics of co-management and other management systems at selected reservoirs,
- other less measurable but very important costs and benefits, which enter comparative economics equations with difficulty, and
- other lessons learned from efforts to establish co-management in six reservoirs in Dak Lak province, in the Central Highlands of Viet Nam.

In general, participation of fishers in the management of resources on which they depend should be promoted. However, there is great local variation in fishery resources and fishing communities and no single model will apply to all. Local, not just central government support is needed for any co-management effort to succeed and policy guidelines are needed to encourage local governments to support co-management. This should be combined with developing among local officials an increased awareness in the need for user participation.

Finally, the people who use these resources have very little money and limited free time. They usually cannot afford to invest the time and effort needed to achieve successful co-management. However, some modest compensation usually helps to encourage their participation.

KEY WORDS: Natural resources, reservoir, stakeholders, co-management

INTRODUCTION

Definition of co-management

The working definition of co-management used by the Management of River and Reservoir Fisheries (MRRF) sub-component in Viet Nam is:

> '…an increase in broad-based participation of the user community in managing the resource, which gets formal agreement.'

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This fitted the objectives of the component. However, participants at the First Regional Training Course in Inland Fisheries Co-Management in 2001 came up with the following alternative definition:

> 'A systematic process of participation by
>
> { affected resource user groups, concerned levels of government, and any other concerned agencies } in { Planning, making decisions about regulating and controlling, monitoring and evaluating and/or distributing }
>
> benefits from the use of a resource in a way which gets agreement, if possible formalised, from all concerned. It requires a sharing and definition of both the power and responsibility for managing the resource' (Cowling 2001).

Reasons for co-management

If a resource is sufficiently abundant to meet the needs of the community using it, there tends to be little perceived need to manage the use of the resource. When the resource becomes insufficient because of decreased abundance or increased needs of the community, the need to manage it becomes more widely appreciated.

We define as stakeholder as, 'any individual or group who depends on, or has control, over management of a resource'. Co-management by its very name means management by agreement between, or among, more than one stakeholder. This makes management more complicated, so why is it needed?

One fundamental point, and is it the key to successful co-management, is that fishers, the people who live by, and depend on these resources, are inevitably involved in managing them. They decide whether they will exploit the resource and how and when to exploit it. Fishers' knowledge of the resource is considerable. After all, it is their livelihood; they work with it daily, and have done so for many years and for many generations. No other stakeholder is so intimately involved with resource management and wise policy makers do not discount this intimate source of knowledge. The challenge for other stakeholders is to recognise this, and work with it.

So, when we ask, 'why co-management?' we are asking, 'why should all concerned stakeholders actively cooperate to manage the resource?'

Participants on the First Regional Training Course in Inland Fisheries Co-Management gave a long list of reasons, including:

- it is the cheapest way to manage resources (in the long run)
- sharing responsibilities should lead to better management since stakeholders can complement one

another (no single stakeholder can manage the fishery in a sustainable way)

- the government does not have the capacity, budget, or resources to manage it and needs the help of communities in monitoring, patrolling, and conservation
- reducing government responsibility for managing the resources (to a more manageable level). Communities are often capable of thinking and managing on their own
- strengthening local ownership (responsibility and problem-solving) and local empowerment. People who depend on the resource are involved in decision-making and enforcement. This should lead to better compliance, and more effective management
- helping solve shared social problems. Appropriate for management of common property
- supporting sustainable development if long-term and all concerned are involved in coming to agreements
- resolving conflicts and improves understanding between government officers and fishers. This improvement in communications should lead to more effective management
- increasing community understanding and consideration of the resource. Users learn how to solve problems on their own. Their knowledge is used and their thinking is stimulated
- organisation of local fishers and fishing activities strengthens the community
- more effective resource conservation if level of agreement is high
- user participation is needed to improve or restore resources
- optimal resource utilisation, with minimal disturbance to environment, society, and culture
- conflicts among users are reduced and benefits are shared more equitably leading to reduced gaps among resource users. If all concerned and affected groups participate, none should be seriously affected by management decisions
- hopefully, economic and income improvements
- hopefully, increased yields and size of caught fish
- in reservoirs, which are multipurpose, encourages discussion among all stakeholders
- peace
- fishers' knowledge of the resource is considerable. They are exposed to it over many years on a daily basis. This knowledge needs to be used in managing the fishery

- fishers normally live close to the resource and are in the best position to respond to emergencies if they are free to do so. They can usually adapt management to changing conditions or needs more promptly than agencies which are further-removed from the resource
- it is only fair to have a say in managing the resource on which one depends.

Most of these are reasons for promoting user participation. However, if users can be good managers, then why do other stakeholders need to be involved? The attendees gave following reasons:

- assurance that regulations confirm to government policies and the law of the land
- local resolution of conflicts between locals and outsiders
- co-ordination with other agencies and sectors
- complementation in surveillance and enforcement
- access to technical support and advice
- access to financial support

These are all good reasons why central and local government should promote co-management of fisheries, but how do these ventures work in practice? To answer this we will examine some existing co-managed fisheries located in Dak Lak Province in the Central Highlands of Viet Nam.

History of MRRF Viet Nam

MRRF association with Viet Nam began in August 1995. At this early stage its immediate objective was:

> 'Enhanced capacity of government fisheries agencies to plan and manage reservoir fisheries on a sustainable basis.'

However, as the project development plan makes clear, community based co-management was always the ultimate objective:

> 'Sustained high yields of fish achieved from reservoirs managed under local community agreement with government.'

The aims of Phase I were, therefore, to training project staff and relevant government agencies to conduct baseline biological and socio-economic surveys of selected reservoirs in the Central Highlands of Viet Nam.

The surveys brought to light important variations in the productivity of the reservoirs and their systems of fisheries management. Two of reservoirs were un-stocked and their fisheries managed ineffectively. The other reservoirs were stocked and their management better regulated and more effective. Groups of a few individuals contract two of the reservoirs from local administrative authorities, a cooperative runs

one, and an employee of the Dak Lak Aquatic Products Company (DAPCo) manages the forth. Only two of the four stocked reservoirs contained significant numbers of wild species.

The surveys also show that no two reservoirs are a like and, consequently, no single management model is applicable to all. At best, managers will be able work within set of broad guidelines tailoring them to match local circumstances and developing them as they gain experience.

Phase II began in March 2000. Its immediate objective was:

> 'To develop, implement and disseminate sustainable co-management models for optimal fish production in reservoirs.'

Three of the reservoirs studied in Phase I were dropped from Phase II. One reservoir, managed by a cooperative, was too small. Another, under the management of a provincial company, was already well run, even though the local fishing community did not partake in decision-making. In the instance of third reservoir we felt there was little prospect of establishing a venture under co-management. We selected three new reservoirs to replace the discarded ones.

The first steps towards establishing co-management ventures took place at Ea Soup in June 1998. Lak followed in January 1999 and the other four reservoirs very early in the Phase II.

At the outset, we informed the local authorities of MRRF's objectives. Having obtained their consent, we then held similar discussions with the appropriate representatives from local communes. Participatory rural appraisal-workshops usually followed these initial meetings. These workshops helped identify the principle stakeholders, bring to light potential problems and discuss possible solutions. The details the work programme were resolved once follow-up discussions with critical stakeholders, training courses, and workshops had taken place.

Following the initial workshops, we gave fishers at each reservoir a training course on environmental awareness. The number of courses depended on the size of the fishing community around the reservoir. These courses allowed participants to consider the need for managing the resource. Fishers realised that some existing fishing methods were not sustainable, but often saw no choice if they were to eat the next day. A common conclusion from every session was that the participants wanted their children to be able to fish. To achieve this needs management; and for the management to be successful, the fishing community had to be involved.

With the co-operation and approval of community and local authorities, informal groups of fishers organized themselves into formal bodies with their own by-laws and elected executive. MRRF staff helped facilitate this work. Generally, the objectives of the fishers-groups' aims were, assuring sustained fish production, providing mutual help to maintain and improving the living standards of the communities they represented. Facilitating work with concerned officials and other agencies was a third common objective.

To be able to mange the resource effectively, fishers developed regulations to control fishing practices; in many cases these included prohibiting non-sustainable fishing methods, especially use of electro-fishing. Penalties included fines and confiscation of gear. Consistent enforcement against violators of the regulators has been important. In practice, monitoring and enforcement has depended on the fishers' unions, often with some support from local police forces. Some fishers' groups have also stocked their reservoirs, as an additional way of increasing yield.

Table 1. *Reservoirs included in Phase II, showing management systems before and after MRRF involvement.*

Reservoir	Location (District)	Area (ha)	Fishing popn. 1996-2001 (families)	Management system before	Management system after
Ea Soup	Ea Soup	240	74	un-stocked/ open	stocked/union managed
Lak	Lak	658	325	un-stocked/ open	un-stocked/ union managed
Yang Re	Krong Bong	56	47	stocked/ contracted	stocked/ contracted
Krong Buk Ha	Krong Pac	120	30	un-stocked/ contracted	un-stocked/ contracted
Nam Nung	Krong No	52	69	stocked/ contracted	stocked/ contracted
Buon Tria	Lak	141	25	un-stocked/ open	stocked/ union managed

While managing the fisheries was the initial focus for the fishers' groups, the benefit from this was not sufficient to justify the time and money members invested in their organisation; assurance of mutual welfare quickly became an equally important objective. To address this concern all fishers groups received training in credit and savings management, and courses in livelihood alternatives to fishing were provided to most. The courses in credit and savings dealt with all aspects of management of very small-scale financing groups where members could deposit money for later use and borrow money conveniently, at modest interest rates. Most of the livelihood alternatives courses dealt with farming various crops, livestock husbandry, and aquaculture. These courses supported the objectives of the members by encouraging good management (financial and otherwise) and providing fishers with choices so that they could abandon unsustainable practices but still maintain their living standards.

Each month MRRF staff visit each fishers group to monitor their member's activities. During these visits, they attend group meetings, gave advice, and liaised with officials and other agencies as needed.

Finances

The lack of funds to carry out planned activities was one issue that arose in all fishers' group meetings. All the groups had plans to finance their activities through taxation and/or various sorts of contributions from the members; however, these sources alone were insufficient to meet costs. Stocking and patrolling are the two main activities that will help sustain optimal fish production, but these activities are expensive and, to put in place, need more financial contribution from the members and other organisations. The MRRF was not in a position to provide systematic financial assistance to the fishers'

groups, and not every group had the resources to do everything it deemed necessary. Neither the Ministry of Fisheries nor the Province of Dak Lak was in a position to help. In 2001 and 2002, the Australian Embassy provided VND 108,100,000 (about US$ 7,000) in assistance. This money was used mainly to purchase inputs for household economic activities supported by the credit and savings programs, fingerlings for stocking in Ea Soup and Buon Tria reservoirs, digging ponds in Nam Nung reservoir and patrolling and other union activities in Lak reservoir. Without this assistance, many fishers' groups would have failed.

The Ea Soup and Lak reservoir fishers' unions, who received support from the Vietnam Fisheries Association, are incorporated formally under provincial regulations. The Buon Tria reservoir group continued to manage its fisheries, but the membership is small and poor, and credit and savings activities did not work well. The Nam Nung reservoir group, while not yet managing its fishery, had a healthy credit and savings programme, and was in a position to manage other community activities, including the fishery, should local decision-makers decide favourably. The Krong Buk Ha reservoir group was progressing in this direction. At Yang Re reservoir, the level of organization declined. Most members, for who fishing was a secondary or tertiary activity, have not managed credit and savings activities efficiently.

Because of inadequate financing, fishers' groups at some locations were unable to participate fully in their fisheries co-management; in these instances, other stakeholders took more control.

The commune at Yang Re awarded a new contact through open tender, giving the contract to bidder who offered the highest price. This left little spare revenue for the new contractor to distribute to the fishing community. However, the contractor still allows poor fishers (mainly indigenous people) to fish in the reservoir with small nets and catch a small amount of fish for their own consumption.

The irrigation manager at Krong Buk Ha felt that any change to the existing fishery management system could lead to conflicts putting a very important dam at risk. The dam, manufactured from inflatable rubber, irrigated a large area, and the manager was concerned that conflicts could lead to sabotage. Ironically, he wanted to prohibit small-scale fishing at certain times and bring in outside fishers to harvest the reservoir. The manager agreed with MRRF's argument that participation by the community would probably reduce conflicts but did not put co-management into practice because he was afraid of the potential risks.

At Nam Nung, the contractor, despite repeated discussions with MRRF, did not agree to share management of the fishery with the local community.

Comparative economics and fishing pressure of co-managed and non-co-managed systems

In this section, we review some reservoir management systems that are already in place. We compare the costs and benefits of the system and comment on the impact the schemes have on fish stocks and the fishery. Unfortunately, the data that allow a more detailed comparison of the performance of individual

reservoir fisheries before and after the implementation of a given management scheme are not available.

The various types of reservoir management systems fall into three broad categories:

1. quasi-privatised, where an individual, or small group of individuals, invest in managing the fishery and decides the split of profit between themselves and the fishers

2. government managed, where a government agency regulates the fishery and taxes the fishers

3. co-managed, where the fishing community, and/or its elected representatives, invest in managing the fishery and apportion the share of profits among themselves, in cooperation with concerned local authorities and line agencies

However, before examining four cases in detail we can make some general comparisons between the benefits of the old and new systems. We have chosen two examples, Lak and Ea Soup. Before responsibility for management transferred to a fishers union both reservoirs operated under a system where the District collected taxes. Under this system, many fishers refused to pay taxes because they believed the fishery was under poor management. After transfer of management, however, most fishers willingly joined the scheme because they believed revenue from the taxes would support their own management activities as well as going to the district authorities. In the event, although the tax rate was higher in the old scheme, revenues received from taxes under the new system were twice as large (Table 2). Furthermore, the reduction in destructive practices is roughly four to six times greater under the new management scheme.

Table 2. *Comparison of the tax fee and fishing pressure during two management systems at Ea Soup and Lak reservoirs*

Reservoir	Management system	Tax fee (VND/month)	No. of registered fishers	Max. fishing fee (VND/year)	% of fishers using destructive gear
Lak	old (1997-2001)	35,000 for Kinh 15,000 for I.P	57	23,900,000	25
	new (2001-2003)	25,000 for Kinh 15,000 for I.P	218	53,760,000	6
Ea Soup	old (1980-1999)	10% of total catch	20	8,000,000	30
	new (2000-2003)	A = VND 30,000 B = VND 20,000 C = VND 10,000	20 20 35	16,200,000	5

Notes: The tax fees, A, B, and C account for differing types of gear and number of full and part-time fishers. Kihn are ethnic Vietnamese, IP indigenous people.

We will now examine four reservoirs in more detail, Ea Soup and Lak lake, which are co-managed, and Ho 31 and Ea Kao that are run under quasi-privatised management (Tables 3, 4, 5 and 6 - over page).

The quasi-privatised reservoirs, Ho 31 and Ea Kao achieved higher yield values per hectare because management had stocked them already. The situation at Ea Soup (Table 3) is particularity interesting

because the survey covers a period immediately following stocking. Most of the species restocked were declining before stocking and total yields continued to decline afterwards. However, subsequent data from Ea Soup recorded in 2003 suggests that production was stable but stocked species made up about 10% of its total income (about VND 50.4 million in 2002). Therefore, we suspect that stocking may be responsible for maintaining the yields and income of this fishery.

These trends reflect in the figures for profit per hectare, which is greater in small reservoirs than large reservoirs, and in stocked reservoirs than un-stocked reservoirs even under the same management system. Profit to management cost ratios are considerably higher in government managed and co-managed reservoirs because management costs are lower. Fishers assume management costs directly in un-privatised reservoirs. Net profits per fisher (their share of gross income minus their management costs) were higher in the privatised reservoirs and this was mainly because of stocking.

Also, the number of fishers in Ea Soup and Lak is considerably higher than in the quasi-privatised reservoirs so benefits are more widely but thinly distributed. Hence, the profit per fisher (co-operative member) in Ho 31 is actually lower for each of the 30 members than in Lak and Ea Soup. However, the contractor (a member of the co-operative) gets higher benefits. The profits of this reservoir under a contractor is much higher than it was under the old management system (from 1996-2000). The benefit contribution of the present contractor was 17 million as tax to Tan An co-operative, while annual profit from 1996 to 2000 was only about 11 million. This was because management and fingerling costs were relatively high and management methods were ineffective under the old scheme.

An employee of DAPCo manages Ea Kao reservoir. Thirty fishers operated in this reservoir and 12 people form the fishing team and patrolling group. The fishers pay these people 30% of the total value of the catch and the cost of their yearly insurance premiums. The benefit per fisher (including fishing and patrolling team) is relatively high but about 50% of net benefit goes to the contractor.

The current management systems at Ea Kao and Ho 31 have been very successful in terms of achieving high production and smooth co-operation with the local authorities. However, the managers decide how benefits are distributed, and as a result managers get greater proportion of the revenues (50%) than do the fishers.

The advantages of co-management, based on these data, appear to lie mainly in saved management costs and reduced use of destructive fishing methods. This is valid to some extent, but the whole question of cost and benefits of co-management is considerably more complicated than the simple numbers given here.

Finally, co-management of the water bodies as discussed here is a new activity and this analysis may therefore underestimate the benefits that could result from older, more established co-management systems.

Table 3. *Ea Soup: a medium-sized reservoir co-managed by the fishers union and restocked with fish*

Annual costs (2002)	**Amount (million VND)**
Meetings	12.3
Guarding	3.6
Communicating	1.1
Training	2.6
Stocking	12.0
Other	1.2
Total costs	32.8
Income (landed value 2002)	504.5
Profit to management group	471.7
Profit/ha.	2.0
Profit/cost ratio	14.8
Profit to fishers	471.7
Number of fishers	100.0
Profit/fisher	4.7

Table 4. *Lak lake: a lake co-managed by fishers union and not stocked*

Annual Costs (2002)	**Amount (million VND)**
Taxes	6.5
Meetings	17.1
Communicating	3.0
Guarding and boat maintenance	5.6
Allowance for collectors and board members	15.0
Training	5.5
Total costs	52.7
Income (landed value 1997-2001)	740.0
Profit to management group	687.3
Profit/ha.	1.0
Profit/cost ratio	13.0
Profit to fishers	687.3
Number of fishers	218.0
Profit/fisher	3.2

Table 5. *Ea Kao: a medium-sized reservoir managed by DAPCo. employees*

Annual Costs (2000-2002)	**Amount (million VND)**
Fingerlings	35.0
Insurance for team	12.0
Guards' wages	36.0
Taxes and fees	18.0
Repairs to gear	25.0
Total costs	126.0
Income (landed value 2000-2002) (ca.74% stocked)	475.0
Profit to management group	349.0
Profit/ha.	1.2
Profit/cost ratio	2.8
Profit to fishers	173.0
Number of fishers (including fishing and patrolling team)	42.0
Profit to contractor (1)	176.0
Profit/fisher (42 fishers)	4.1

Table 6. *Ho 31 a small reservoir managed by a co-operative member*

Annual Costs (2000-2002)	**Amount (million VND)**
Fingerlings	5.3
Taxes to tan and co-operative	17.0
Feeding	9.0
Fertiliser	0.6
Labour (fishing and patrolling)	9.2
Total costs	41.1
Income (landed value 2000-2002) (ca.99% stocked)	69.6
Profit to management group	28.5
Profit/ha.	5.4
Profit/cost ratio	0.7
Profit to co-operative members (30)	17.0
Profit to contractor (1)	28.5

Note: This reservoir was at the time stocked under ACIAR fund

OTHER PROBLEMS AND BENEFITS OF CO-MANAGEMENT

Problems

Co-management costs are low in financial terms partly because poor fishers assume them and the cost of their labour is very low. These people are poor and have little time to spare. This means that while they are willing to volunteer the time needed to help manage their fisheries, they are not always able to do so unless some modest compensation is available. Successful co-management depends on the active participation of the resource users. If they cannot afford to participate and invest the apparently modest costs needed, the effort will fail. Therefore, if public agencies wish to promote co-management, they need to be ready to devolve reasonable funding, as well as responsibility, to the users. In addition, participation in managing the resources does not always run smoothly and conflicts arise among users. At present, there are no effective, and timely, procedures in place with which to arbitrate and resolve these conflicts.

Benefits

All the fishers' groups have adopted additional objectives relating to mutual support for the welfare of the community and liaising with local agencies and authorities. They could clearly see that the benefits from managing the fishery alone might not be enough to justify the investment they need to make. Therefore, these groups have all established credit and savings activities and invited support from other agencies, notably those involved in training in alternative livelihoods.

Although the benefits from these activities are difficult to measure, they certainly exist. Nam Nung is a good case in point. Nhung (2002) points to additional, equally intangible benefits that may be of even greater importance; community groups that develop their management skills may be able to manage an increasing number of other different activities more competently and to the benefit of the community. This can increase the prosperity of the community, reduce the workload of over-worked officials, provide instructive examples for other communities and local governments, and ultimately lead to a stronger, more resilient society.

These benefits deserve serious consideration by decision makers responsible for determining the level of support and strong arguments can be made for co-management and community participation in resource management. However, decision-makers must also keep in mind the need for sufficient (and usually financially modest) support for the efforts of the community.

In fact even though co-management looks inexpensive (because fishers' labour is cheap), this does not mean that fishers can afford the investment. Since their participation in management is central, the whole process may fail unless financial assistance (or similar support) is sufficient to allow them to afford to invest their scare free time.

LESSONS LEARNED BY MRRF VIET NAM

In Viet Nam, co-management will not take place unless local authorities give it adequate support. The extent to which MRRF (Phase II) has been able to establish co-management has depended entirely on the attitudes of local stakeholders. In all cases but one (Nam Nung), it was local authorities who permitted, or prevented, the participation of the fishing community in managing the fishery.

It does not always follow that an initial agreement by critical stakeholders will result in the establishment of a co-management scheme. Some stakeholders can change their minds when the implications of devolving responsibility become clear.

The economic and social importance of the fishery may affect the local authorities' attitude to fisheries co-management; their willingness to sacrifice immediate revenue in favour of community participation and prosperity and past their experiences of managing fisheries may influence their position.

Resource users are very quick to understand the need for sustainable management and clearly see their role in this as crucial. They need training, facilitation, and time in order to achieve successful participation in resource management.

As we have said previously, users need some modest financial support, at least initially, if they are to make time available to participate in resource management.

We want to emphasise that it takes time to establish a successful co-management venture. Resource users have a limited amount of money, time, official contacts, and formal education. For co-management to become well-established prolonged, continuous communication and related support is essential.

Organising users to manage the resources on which they depend for their livelihood, in a sustainable manner, cannot be divorced from efforts to maintain and raise their standard of living. Most users exploit resources in an unsustainable way because they feel they have no choice. They are willing to control their efforts if other users do and if they can afford to do so.

Besides incentives, such as training in alternative livelihoods, discouraging violation of rules and regulations needs a system of penalties. Consistent enforcement of these penalties is essential. The wider community must understand and appreciate lenience in individual cases for the regulations to succeed.

Resource users can identify objectives around which they can organise themselves but the means of achieving these objectives need flexible and responsive planning. Poor economic circumstances force users to focus on short term, urgent issues, and unforeseeable, uncontrollable external factors can make more elaborate or longer-term plans inoperable.

The level of government directly involved with a given fishers' group should reflect the geographic area in which the fishery is important. In general the more local the crucial stakeholders, the faster and more

responsive the communication, and the more effective the management will be.

RECOMMENDATIONS

Participation of users in managing the resources on which they depend should be encouraged more actively by higher levels of government.

Since management of fisheries, or any other resource, carries implications for various sectors of the economy, and of society, this support should have the agreement of the Central Committee. Policies of particular ministries, while helpful and sometimes crucial, will be limited in their effectiveness without this support.

Encourage local governments to support resource co-management. Higher government levels may accomplish this in different ways such as, campaigns to promote awareness of the need for co-management, related training courses, and favourable publicity for local officials who conscientiously support co-management initiatives.

Public agencies that decide to promote co-management must be ready to support user groups with training, advice, liaison with other agencies and officials, and, at least initially, modest financing. They must be ready to invest the necessary effort and communication, and realise that successful establishment of a co-management mechanism takes a few years rather than a few months.

Efforts to establish co-management, if they are to succeed, must be combined and coordinated with efforts to maintain or improve the resource users' living standards.

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Participation in fisheries co-management in Kandal Province, Cambodia

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ABSTRACT

Policy reform of fisheries management provides a good opportunity for local users to participate in the running of fisheries and to achieve the goals of protection, conservation, development and sustainable use of this resource. Policy reform in Cambodia has led to the establishment of over 300 community fisheries (CF). This number includes 22 in Kandal province, 12 of which have received support from the Management of River and Reservoir Fisheries component (MRRF) since 2000. Establishing community management and development presents many challenges, especially where participation is concerned. Therefore, it is useful to study the factors that influence this aspect of fisheries co-management. This paper presents the results of such a study carried out in the MRRF target areas of Boeung Chunlen reservoir, Kandal province.

During interviews and discussions, more than 90% of CF members stated that they participated in CF activities, particularly those relating to elections. The legal entitlements that participation offered are a major motivating factor in promoting voluntary participation. Understanding attitudes, practices, beliefs and knowledge is also a key factor.

The interviewees also suggested a number of ways to improve the process of instituting and managing the CF. These form the basis of a number of recommendations concerning the way CF are setup in the future.

KEY WORDS: Community fisheries, community participation, Kandal, Cambodia

INTRODUCTION

Although rice is the staple food for most Cambodians, fish closely follows it in importance. Fish is traditionally the main source of animal protein, especially for the rural poor. The current population growth rate of 2.49% (Ministry of Planning 1998) means that there is a need to produce more fish and to increase access to fishing grounds. However, powerful leaseholders are progressively limiting access to fishing grounds and the number of unresolved conflicts between large-scale commercial fishers and small-scale subsistence fishers is on the increase.

The situation is becoming increasingly difficult for subsistence fishers who depend on natural resources for their livelihood. Furthermore, abuse of power, unequal distribution of benefits and denial of access to fishing grounds is leading to dissatisfaction and serious conflict amongst the thousands of inhabitants in the area around the Tonle Sap Great Lake and the Mekong river floodplain. Conflicts, such as those between owners of fishing lots and local fishers, drove the Government to reform the management of fisheries.

On 24th October 2000, during a visit to distribute emergency aid to flood victims in Siem Reap province, Prime Minister Samdach Hun Sen announced countrywide reforms to Cambodia's fisheries. The aims of

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the reforms were to provide more fishing grounds for subsistence fishing and to help alleviate poverty among rural farmers and fishing communities.

In line with this policy, the Government has closed about 56% of the area previously given over to fishing lots and allocated it to the establishment of community fisheries (CF). CF are formed by groups of people living in or near fishing grounds who, in order to relieve poverty and improve their standard of living, want to manage their fisheries in a way that optimises catches but is also sustainable (CF sub-decree 2003).

The policy gives local people an opportunity to participate actively in the co-management of natural fisheries resources in order to achieve the goals of protection, conservation, development and sustainable use of resources. Since introduction of the policy, local communities have established more than 300 CF. This number includes 22 CF in Kandal province, 12 of which have received support from the Management of River and Reservoir Fisheries component (MRRF) since 2000.

Establishing community management and development presents many challenges, especially where participation is concerned. Therefore, it is useful to study the factors that influence this aspect of fisheries co-management. This paper presents the results of such a study carried out in the MRRF target areas of Boeung Chunlen reservoir, Mok Campul, Kandal province (Figure 1).

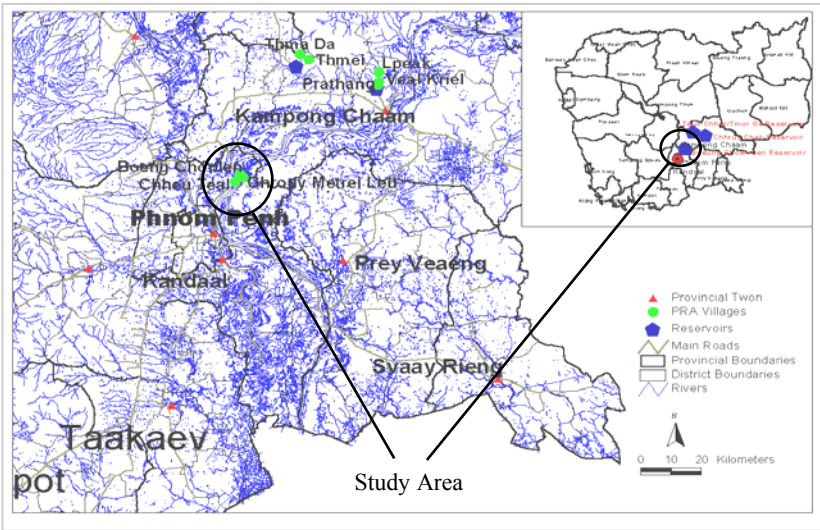

Figure 1. Location map.

METHODS

The CF Federation of Boeung Chunlen Reservoir is comprised of five CF from five villages and has a total membership of 477. Seventy-two of its members (34 female, 38 male), selected at random, participated in this study. Interviews of the participants used a standard questionnaire designed specifically for this study. Discussions in focus group helped to obtain general and supplementary information for later analysis and evaluation.

RESULTS AND DISCUSSION

Respondents' background

Ethnicity

The respondents included both people from both Cham (26%) and Khmer (74%) ethnic groups (see Figure 2). They live in the same communities and formed, and manage, the CF without any oblivious ethnic, or religious (the Cham are Muslims), discrimination or conflict.

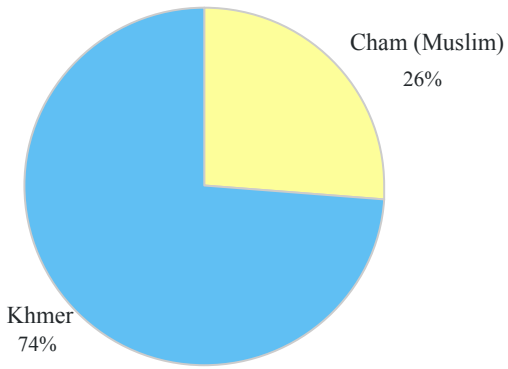

Figure 2. Ethnicity of respondents

Occupation

The primary occupations of the respondents were subsistence rice farming (48.6%), fishing (26.6%) and wage labour (6.9%).

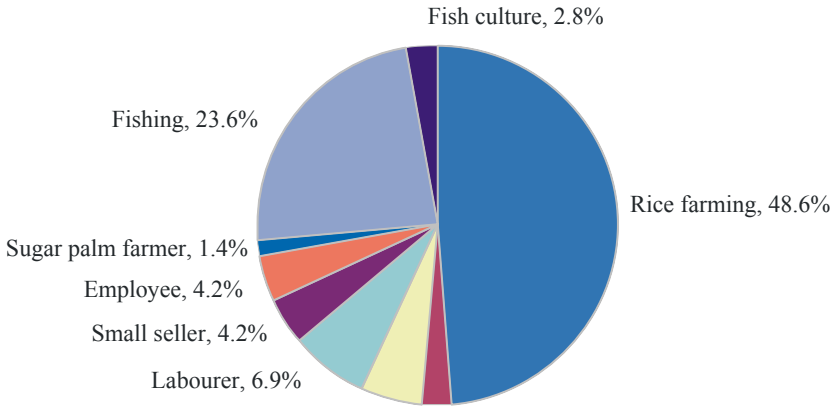

Figure 3. Primary occupation of respondents

However, fish are a very important element food in most villagers' diets and they provide additional source of income for some families. Many respondents gave fishing (40%) or fish culture (21%) as their main secondary occupation. Most villagers (over 87%), said they were engaged in fishing activity of some sort, usually when slack periods in rice cultivation permits.

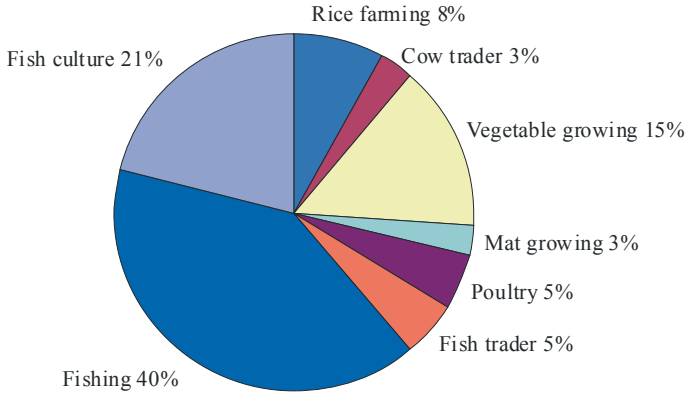

Figure 4. Secondary occupation of respondents

Participation in the CF process

Who participates?

There are two types of participant in the CF process: direct and indirect users. Direct users are members of the CF who fish for a living. These direct users are most closely involved in CF management and development. Indirect users include provincial fisheries officers, representatives of local authorities, local police officers and other related agencies.

Level of participation in the planning, management and implementation process

The survey shows that nearly all members of the CF (95.8%) are willing to participate in elections, probably because they do not wish to miss the opportunity of electing their own team leader onto the CF management team. The next most popular activity was drafting by-laws and regulations. CF members see the importance of these activities because they assign committee members roles, tasks, and responsibilities and establish rules and regulations for running the fishery.

The level of participation was very low in activities related to implementation (16.5%), planning (14.7%) and plan review (11.4%), as can be seen in Figure 6. This is probably because poorer CF members had to attend to their daily jobs in order to provide food for their families and had little time to spare. However, these people said that they were willing to support CF, abide by the rules and regulations, and report any illegal fishing activity.

Figure 5. People participating in drafting by-laws and regulations

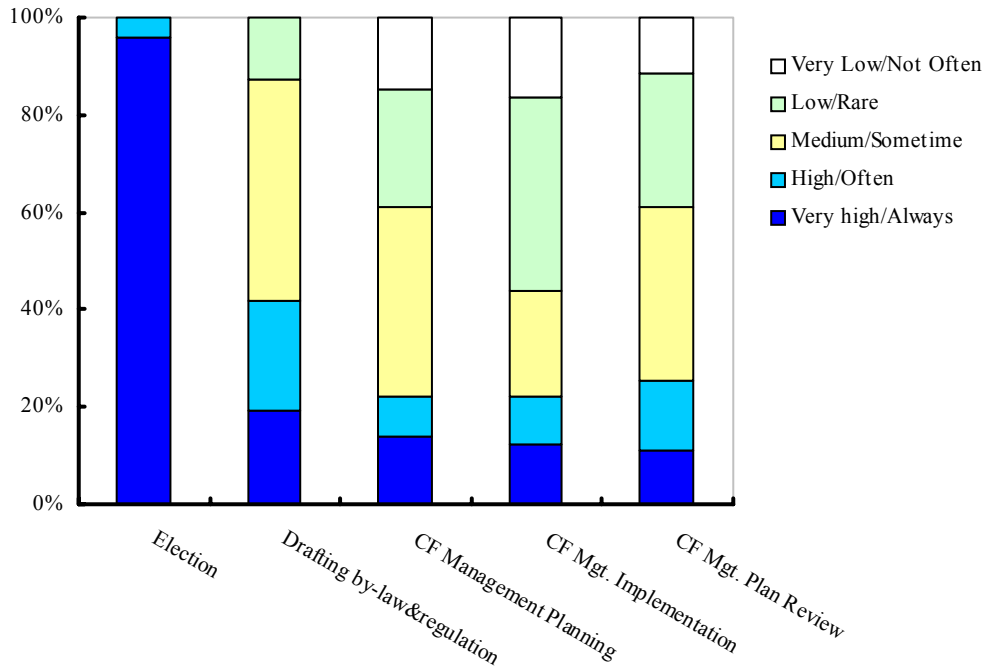

Figure 6. Participation in the CF planning, management and implementation process

Factors influencing participation

The factors that influenced local peoples participation in CF management and development included; national policy on fisheries management, people's knowledge and understanding of the importance and value of CF management, people's attitude/behaviour, and the perceived benefits of participating.

National policy on fisheries management

Almost all respondents (97.2%) said they were highly satisfied with the new national policy reform of fisheries management. They said that they are willing to support it because they believe it encourages user participation and is a better way of managing the natural fisheries resources, which they live close to and maintain.

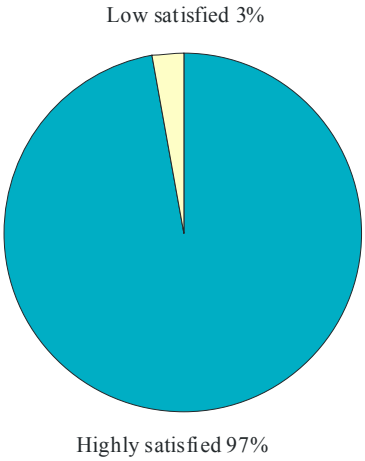

Figure 7. Level of satisfaction with national fisheries policy reform

Other reasons for satisfaction were:

- local users understood the value of their participation in natural resource conservation, protection, management and development
- it encourages co-operation and coordination amongst local users, stakeholders, and government
- no tax collection from middle-scale fishing
- illegal fishing is not permitted
- recently fish catch has increased in the study area and this has contributed to an increase in household income, food security, and poverty reduction
- the fisheries will be sustained for future generations

The very small proportion (2.8%) of participants dissatisfied with the national policy reform had largely misunderstood of the principles involved; some likened it to the idea of solidarity groups (*Krum Samaki*)

formed during the Pol Pot era. Therefore, there is still a need to raise awareness of the aims of CF among some stakeholders.

Knowledge and understanding of the importance and value of CF management

Willingness to participate often relates to an individuals' level of knowledge, awareness and understanding of the concepts, importance and value of CF management and development, especially the concept of fisheries co-management and development, and natural resource ownership.

Once people have a clear grasp of these aims, they expressed a willingness to participate and voluntarily support CF. Therefore, in the early stages of establishing a CF, the most important activities are, building trust and understanding, raising awareness, and disseminating information to all stakeholders in the new CF.

Attitudes

Attitudes are an important factor influencing levels of participation. The idea of working together in groups is much easier to promote in villages where people traditionally help each other and share responsibilities. Khmer people, especially in rural areas, tend to live and work together as a community. Therefore, villagers, including the 36% of the CF who are not active fishers, willingly participate in setting up and managing CF in order to develop their communities. They see a communal need to manage their resources in a sustainable way so that future supplies of food are secure, that their own standard of living will increase, and that future generations will benefit from the fishery.

Perceived benefits of participation

Almost half (40%) of all respondents said that they benefited from the CF within two years its establishment, (Table 1). The more than half (60%) of the respondents who claim to have seen no benefit were fishers who did not participate in CF activities and development or were not involved in fishing or active fishers.

Table 1. *Benefits received*

	Khmer		**Cham**		**Total**	
	Count	**%**	**Count**	**%**	**Count**	**%**
Yes	46	28.8	40	72.7	86	40.0
No	114	71.3	15	27.3	129	60.0
Total	**160**	**100**	**55**	**100**	**215**	**100**

Those who saw no benefit believed the fish catch had increased but that this mostly benefited those who fished on a regular basis. Many felt that the CF in their areas, some only launched only within the past two years, and had not developed in accordance with the needs of members because of lack of funds and capacity.

There are many activities involved in organising a CF that need to be carried out systematically (according to the CF management plan and with facilitation, help and guidance from technical agencies) in order to promote self sufficient and effective CF management in the future. All members of CF must receive a fair and proportional share of the benefits if the community as a whole is to increase its standard of living.

The respondents most intimately involved in the CF, active fishers, saw the principle benefits as:

- an increase in fish catch
- increased knowledge and awareness of the value and importance of local and other stakeholders participation in natural fisheries resource management and development
- increased understanding, co-operation and co-ordination both within and between villages; and an alternative livelihood strategy.

Most respondents (79.2%) felt that fish catch had increased since the formation of CF, especially since the establishment of fish conservation zones or fish sanctuaries and the clamp down on illegal fishing practices. This perception held across the community, regardless of the member's gender or ethnic group (see Table 2 and Figure 8).

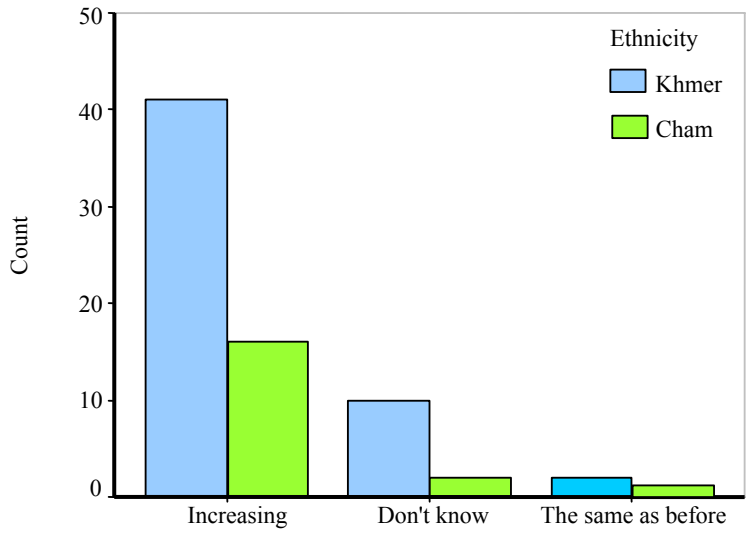

Figure 8. Ethnicity and perception of fish catch since the establishment of CF

Table 2. *Perception of the size of the fish catch since the establishment of CF*

	Male		Female		Total	
	Count	**%**	**Count**	**%**	**Count**	**%**
Increasing	32	84.2	25	73.5	57	79.2
Don't know	6	15.8	6	17.6	12	16.7
Same as before	0	0	3	8.8	3	4.2
Total	**38**	**100**	**34**	**100**	**72**	**100**

Effects of CF participation

Nearly all respondents (90.3%) said they experienced no negative effects from participating in CF activities (see Table 3) and, on the contrary, felt satisfied with the positive outcomes that they have seen. Only 9.7% respondents felt that their participation interfered with their daily work; most of these were committee members who spend most of their time on CF activities but do not receive any additional incentives or compensation.

Table 3. *Perception of negative effects of CF participation*

	Male		**Female**		**Total**	
	Count	**%**	**Count**	**%**	**Count**	**%**
Yes	4	10.5	3	8.8	7	9.7
No	34	89.5	31	91.2	65	90.3
Total	**38**	**100**	**34**	**100**	**72**	**100**

Members of the CF committee clearly need some form of additional incentives if they are to stay motivated. Providing training for alternative livelihoods or other activities that generate additional income may be one of the best incentives, especially if money generated from these activities helps to finance CF administrative work.

Problems and constrains

Although CF brings many benefits, they also face some problems and limitations. The following are some of the issues raised by respondents during focus group sessions:

- lack of resources to support the operation, participation, and implementation of CF management plans and administration
- a few illegal fishers still do not want to participate in the CF
- inadequate materials and incentives for CF committee members and patrol groups

CONCLUSIONS

This study has shown that at Beoung Chunlen reservoir CF were well organised with active participation and co-operation by members and other stakeholders.

The national legal framework and guidelines consider the needs of local people and present an opportunity for improving standards of living. Building trust, informing, and increasing awareness and knowledge of all stakeholders in the area, and especially in fishing villages, on the purpose of CF and fisheries co-management is one of the most important ways of promoting participation. It is important for facilitators to understand people's attitudes, practices and beliefs if facilitation activities are to be appropriate and capable of motivating people to participate actively in all CF activities.

Benefits are one of the most necessary factors in promoting high levels of active participation. Many members of the Beoung Chunlen reservoir CF are already enjoying the benefits that co-management brings. These benefits include an increase in fish catch in the area, raised awareness and understanding of the importance of fisheries resource management, and the creation of livelihood activities supported by MRRF. However, most of the membership preferred to receive immediate benefits because they were from rural communities and generally poor and short of food.

Only a few CF committee members, who were very poor and had to work daily to provide enough food for the household leaving them with little spare time, suffered negative effects of participation**.** Even so, these people were able to manage their time well by incorporating CF activities into their daily work routine.

Lack of resources for operating and running CF activities was the main problem identified by during the study.

RECOMMENDATIONS

During focus group discussions, the respondents identified the following list of recommendations:

1. Trust must be built and awareness and understanding of the purpose and concept of fisheries co-management raised if the level of participation is to be increased amongst users and other stakeholders.

2. External support is needed for facilitation activities and CF operation to run and develop CF and increase the level of participation.

3. High levels of co-operation and co-ordination between local authorities and technical agencies are needed to support CF management and development and generate higher levels of participation amongst CF members and local users.

4. The institutional set-up of CF should be reviewed regularly to ensure that benefits are equally distributed among all member of the community.

5. The creation of income-generating activities should be considered as a way of providing suitable incentives to increase the level of participation and benefit earning for suitable fisheries co-management.

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Hydrology, habitat and livelihoods on the floodplains of southern Lao PDR

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ABSTRACT

This paper examines the relationship between hydrology, floodplain habitat and livelihoods of people living in the catchment of the Xe Bang Hieng and Xe Kong rivers of southern Lao PDR. Healthy floodplain environments are a key factor in the food security of riverine communities as these habitats yield a rich fauna and flora on which the inhabitants' livelihoods depend. The hydrologic cycle plays a fundamental role in maintaining the health of the floodplain environment. The natural seasonal variation of flow, that includes periodic inundation of the floodplains, creates and supports a diverse range of habitats and ecological niches.

Rural people, who have lived in these environments for generations, and who are well attuned to making a livelihood on the floodplains, have adopted an impressive variety of artisenal fishing gear to target specific fish species or habitats through the changing seasons. Fish, snails, aquatic insects and plants, bamboo shoots and mushrooms are just some of the natural products, harvested from riverine environments, which form an essential part of the local diet. Therefore, healthy floodplain environments and rich biodiversity resulting from an unimpeded hydrological cycle are essential to the way of life of riverine communities in Lao PDR.

It is, however, a way of life that is under threat. As the countries of the Mekong Basin grow in population and develop their economies there is increasing competition and conflict over water resources. Demand for hydropower, irrigation, road networks, river navigation and flood mitigation are a growing challenge to the natural hydrologic cycle and the health of the floodplains. Considering the significant value of floodplain biodiversity to rural livelihoods, effective management of the hydrologic cycle and conservation of the floodplain environment will be necessary to support socio-economic development and environmental health.

KEY WORDS: Lao PDR, biodiversity, seasonally flooded habitats, rural livelihoods

INTRODUCTION

The expanding populations and growing economies of the countries within the Mekong River Basin are generating intense competition for the tremendous water resources of the region. In Lao PDR, the increasing demand on water resources means development plans must strike a balance between competing users that also protects the ecologically important habitats of the floodplains. These competing interests for water resources arise from fisheries, irrigated agriculture, hydropower and navigation. All of these sectors of the economy are important to the socio-economic development of the region.

The natural resources of capture fisheries, however, are a valuable common property and a significant component in the livelihoods of the rural poor. Regardless of age, gender or socio-economic status, capture fisheries and the collection of non-timber forest products (NTFP) are an important activity that

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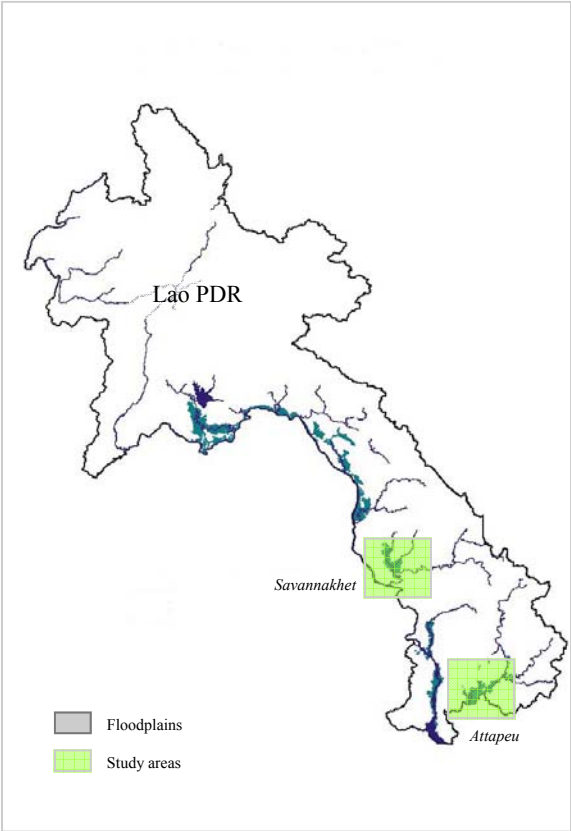


Figure 1. The extent of the floodplains of the Mekong and its major tributaries - Lao PDR

supports household food security and income. Fishing and NTFP collection are especially important to poor people who, if they do not have access to land, may not have other alternatives for food and employment. These people may not benefit directly from hydropower, irrigation and navigation improvement, but they do depend upon fish and NTFP for their livelihoods.

This paper describes one of the issues surrounding the use of these common property resources, the need for careful management of the floodplain environment and the hydrological factors that shape it. The paper illustrates this issue with reference to the extensive floodplains of Mekong and its tributaries in the southern provinces of Savannakhet and Attapeu (Figure 1) using data gathered through participatory assessments carried out by WWF, Living Aquatic Resources Research Centre (LARReC) and the provincial Livestock and Fisheries offices in both provinces.

Lao PDR is predominately a rural population with approximately 80% of people living in the countryside (UNDP 2001). The country is economically under-developed but is rich in aquatic resources from rivers, streams, floodplains and wetlands that provide necessary sustenance in times of rice shortage or crop failure. Rural people regularly collect NTFP for consumption in the home as a supplement to their staple diet of rice and livestock produce (Foppes and Khetphanh, 1997). Aquatic animals (fish, frogs, snails and insects) and plants have been important ingredients in the daily lives of Lao people for generations, providing a food source that is high in protein and rich in fat (Meusch *et al*. 2003).

As a result, the rural livelihoods in southern Lao PDR entwine closely with the seasonal rhythm of the river; the inhabitants' broad knowledge of ecology of their local environment means they are very adept at utilizing the natural resources of this dynamic ecosystem. Men, woman and children are all active in fishing and collecting NTFP, using a variety of gear types that target different fish species or habitat.

In southern Lao PDR, people value a healthy floodplain environment for the ecological role it plays in fish and NTFP production. The hydrologic regime of the river basin shapes this important environment. Alterations to river basin hydrology stemming from hydropower, irrigation development, and flood mitigation schemes potentially cut floodplains off from the mainstream river channel, severely affecting the floodplain environment, fish production and the livelihoods of people who rely upon these common property resources.

FLOODPLAIN ECOLOGY

Floodplains are an important feature of the landscape of southern Lao PDR. Characterized by rich biodiversity they are highly productive areas for agriculture and forestry. These lowland areas adjacent to rivers and streams are an integral component of a river basin and are a key element in the environmental health of a river.

The flow of rivers in southern Lao PDR fluctuates markedly between the wet and dry seasons (Table 1). This fluctuation serves to create critical habitat and food niches that support a diverse fauna and flora (Baran et al. 2001). During the period from August to November, when the flow is at its greatest, the river water inundates the floodplains and fish migrate into these flooded areas to feed and spawn (Baird and Phylavanh 1999).

Table 1. *Xe Bang Hienh and Xe Kong - mean monthly discharge (m^3/sec)*

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Xe Bang Hieng	44.9	24.0	31.2	18.4	111	131	182	194	885	309	377	194
Xe Kong	86.6	62.5	46.1	44.3	80.5	100	137	231	498	304	712	308

Note: Source: Lower Mekong Hydrological Yearbook: 1998. Mekong River Commission

The Mekong's abundant floodplain habitat is one of the key factors accounting for the river system's impressive fish productivity and diversity (Welcomme 1995) and conserving this habitat is essential not only to protect biodiversity but also to provide food security for many rural households. Floodplains are unquestionably the engine of high fish production and rich biodiversity, and serve an important ecological role for the entire river basin.

In southern Lao PDR, the floodplains of the Xe Kong and Xe Bang Hieng (Figure 2 - over page) are typical of the seasonal variation these environments display. The floodplain habitat of these rivers consists of seasonal and permanent wetlands, streams, forests, grasslands and rice paddies. High water levels during the rainy season serve to transport sediment and nutrients onto the floodplain, providing a

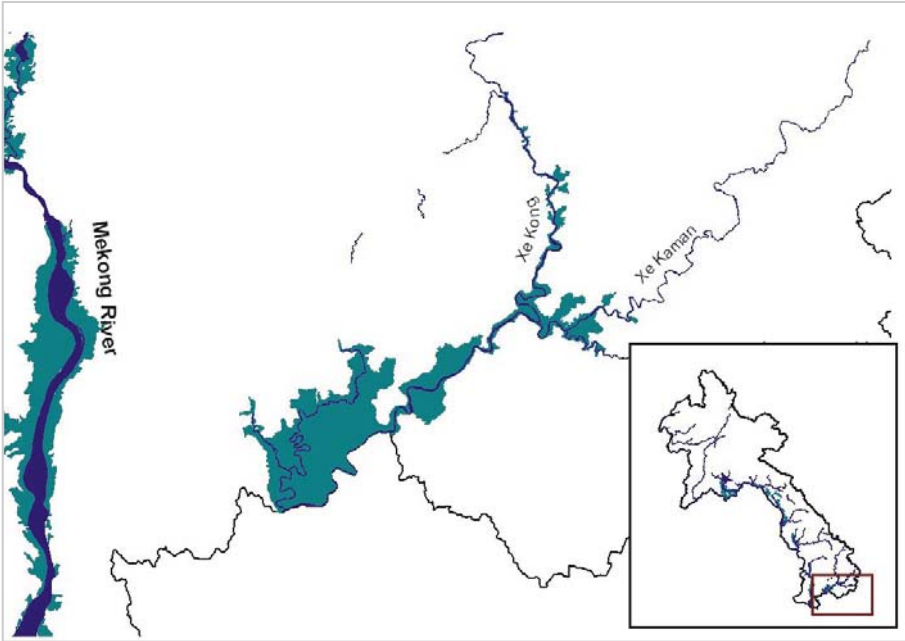


Figure 2. The floodplains of the Xe Kong and Xe Kaman river - Attapeu Province

food-rich environment for spawning fish as well as productive soil for the cultivation of rice and other cash crops. For the people living on floodplains the seasonal variations offer both inconvenience and opportunity. People rely on the rich biodiversity to provide food, income, medicine and construction materials, but seasonal floods can also damage infrastructure and hinder road transportation and livestock production.

Moreover, a healthy floodplain environment is beneficial to the entire river basin. Many fish species that spawn on the floodplain undergo long-distance seasonal migrations into the headwaters of the river system (Poulsen and Viravong 2001), suggesting that vigorous floodplain habitat has biological and socio-economic benefits for both upstream and downstream communities.

While floodplains represent a range of habitats, the type of habitat inundated by floodwaters has a direct effect on the production and diversity of fish and NTFP (Baran et al. 2001). Floodplain communities understand fully the relationship between quality floodplain habitat and high fish production and diversity and are willing to exert greater effort fishing in habitats like seasonally flooded forests than rice paddies or grasslands (Table 2).

Table 2. *Flooded habitats, effort invested and value of produce - Phouvong district, Attapeu province*

Flooded habitat	Effort per month (days)	Harvest rate (kg/day)	Market price (kip/kg)
Rice paddy	12	0.5	3,000
Flooded forest	22	3.0	6,000

The table shows how highly rural people value the high quality habitat of seasonally flooded forests for fish production. In this environment, they are not only able to catch more fish, but the species they catch fetch a higher price market.

This seasonally flooded forest environment is a complex ecosystem, rich in food resources and shelter for spawning fish and juveniles, and is an essential factor in the high fish production and diversity in the Mekong Basin (Baran et al. 2001).

THE ROLE OF THE HYDROLOGIC CYCLE

The seasonal flux of the Mekong is greater than that of any other large river in the world (Welcomme, 1979). The seasonal fluctuation in both the depth of the river and the velocity of its flow and the periodic inundation of its floodplains are key elements of the Mekong's natural hydrologic cycle. In southern Lao PDR, this flooding typically occurs during the wet season months of July to October, with the duration and timing of the flood varying from year to year. However to regard this natural phenomenon of seasonal floods solely as a threat to infrastructure, transportation and health is a mistake; rather it should be understood for the important role it plays in the environment of the river basin and the livelihoods of people who depend upon its abundant riverine natural resources.

Other hydrological factors such as water discharge, flood duration and timing, in addition to the quality of floodplain habitat, also play a role in determining fish production and supporting high biodiversity (Baran *et al.* 2001). Any development that affects the quality of floodplain habitat or alters the hydrologic cycle will have an impact on the production and diversity of fish and NTFP and the way of life of people who rely upon these natural resources.

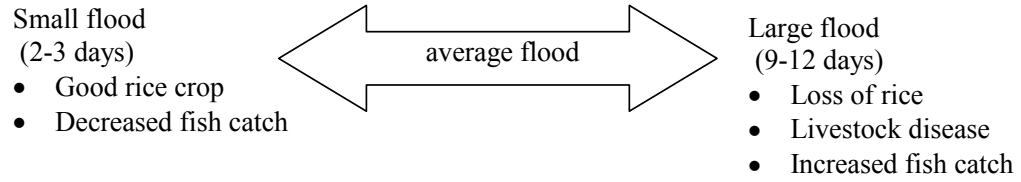
Threats to this natural cycle occur primarily from the development of infrastructure for irrigation, hydropower and flood mitigation. These types of infrastructure can alter the natural flow of a river, block long-distance fish migrations, and create reservoirs out of free flowing rivers. The cumulative impact of water resources infrastructure will lead to a dampening effect on peak flow as reservoirs holdback water during the rainy season (MRC 2003). This reduction of wet season discharge will lead to a shorter flood period that inundates a smaller area of the floodplain, thereby reducing the habitat available for fish to spawn and nurse in. The reduction, or loss, of seasonal flood events therefore is a threat to the floodplain environment that will lead to a decline in fish production and the aquatic biodiversity of the river basin.

LIVING WITH THE FLOOD

In addition to the benefits for fish production, the seasonal floods maintain the water table of the floodplain and carry sediments and nutrients onto these low-lying areas. For this reason, the people who live on the floodplains of southern Lao PDR recognize the benefits of seasonal floods to fisheries, agriculture and agro-forestry. However, they also recognize that large floods can damage infrastructure, interrupt transportation and lead to livestock disease and loss of rice crops. The box over page illustrates how people see the benefits of small to medium size floods to their overall livelihood, while recognising that large floods that may cause damage to rice crops can lead to higher fish production.

Local perception of seasonal floods

Small to average size floods are regarded as beneficial by flood plain communities. These communities have adopted livelihood strategies to cope with seasonal floods such as planting traditional varieties of flood 'tolerant' rice and utilising capture fisheries. Benefits from floods include high fish yield in the numerous rivers, streams, paddy fields, ponds and wetlands. Fish are an important food resource, high in protein and fat, thereby forming a vital component of rural food security.



Each flood is unique in terms of timing, water level, duration, and characteristics of the flooded habitat. The perception of flood benefits however may depend upon whether the person is a farmer or fisherman, land owner or landless, urban or rural, rich or poor. A good flood for fish production and capture fisheries may cause crop damage and interfere with road transportation. Rural development plans that invest in flood mitigation infrastructure in order to prevent seasonal floods altogether may benefit one sector of the economy at the expense of another.

However, from the perspective of rural villagers, many of who are dependant upon fish and NTFP for household income and food security, seasonal floods are a necessary event that supports fish production and agricultural productivity on the floodplain. These people understand 'living with the flood' is a balance between the ecological function of floodplain hydrology and the need for securing agricultural production. The development of floodplain areas and water resources infrastructure must attempt to balance the necessary role of seasonal flooding and river basin health and household economy. Promoting the concept of 'living with the flood' will improve our understanding of the benefits of floods and maintain these valuable ecosystems. Effective policy and planning will ensure that design of transportation and water resources infrastructure (roads and dams) minimises the impact on the hydrologic cycle of a river basin.

METHODOLOGY

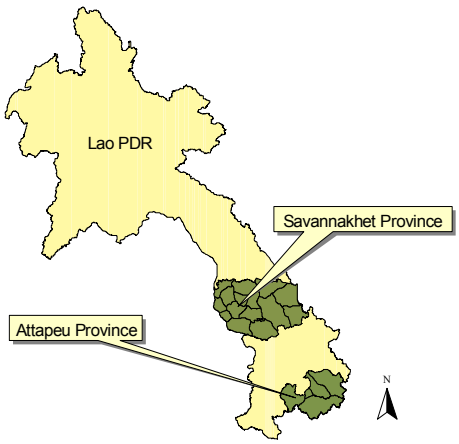
Planning for this study involved cooperation with the Lao National Mekong Committee, LARReC, Regional Development Coordination, and the Provincial Agriculture and Forestry Office and Livestock and Fisheries sections of Savannakhet and Attapeu provinces. The objective was to investigate the relationship between the hydrologic cycle, biodiversity, fish migrations and local livelihoods. To examine these themes in communities that experience different degrees of seasonal flooding this study included communities living on floodplains and in upper catchment areas.

Participatory Assessments

This study used participatory methods to analyse the local use of both habitat and biological diversity in the daily lives of rural communities. Participatory methods explore local knowledge of natural resources by inviting local communities to discuss their daily use and management. For this study, the participatory techniques used Participatory Rural Appraisal (PRA) methods to gain insight of local knowledge and encourage open discussion of the use of biodiversity. This involved asking key respondents to describe seasonal farming and capture fishery activities, compile lists of important fauna, flora and habitat as defined by local knowledge, and perform comparative ranking exercises where participants grade the importance of various types of NTFP and habitat relative to one another. Both women and men were included in the group of key informants and open-ended discussion was encouraged throughout the survey.

Site selection

The provinces of Attapeu and Savannakhet were chosen for the large flood plain areas from the Xe Kong and Xe Bang Hieng river systems respectively (see Annex 1 & 2). These rivers are two of the largest tributaries of the Mekong and serve an important ecological role in the capture fisheries of the Mekong Basin. While both rivers experience seasonal flooding during the rainy season, the size, timing and duration of floods will vary from year to year. Criteria used to select target villages were developed in cooperation with provincial and district authorities based on the socio-economic status of the village, propensity to flood and food self-sufficiency. This allowed for an analysis of the factors contributing to rural livelihoods in communities adapted to living with seasonal floods.



Attapeu province

The participatory assessments in Attapeu aimed to understand local perception of the impact and benefits of seasonal floods on biodiversity and their livelihoods. The survey included assessments in Sombpoi, Songkhon and Ta Ngao villages of Sanamxay district (Figure 3 over page). These villages located along the Xe Kong River suffer extensive seasonal flooding from the Xe Kong and Xe Pian river systems. The surveys, conducted at the household level, endeavoured to quantify household reliance on the system's rich biodiversity. On this extensive floodplain, fishing activities are not restricted to the Xe Kong, but extend across a mosaic of floodplain habitats.

Further participatory assessments, conducted in Phouvong district, examined the local perception of the quality of various floodplain habitats for capture fisheries. As an initial study into the quality of habitat, this survey compared two distinct types of floodplain habitat, rice paddies and flooded forests, to find out the value to livelihoods people attributed to each habitat with regard to capture fisheries.

Figure 3. Targeted districts - Attapeu province

The floodplain in Sanamxay and Phouvong districts possesses a complex ecosystem of both seasonal and permanently flooded habitat that is important to local communities for fishing and harvesting NTFP. Typically, the NTFP collected in flooded areas are fish, bamboo shoots and mushrooms, with some households collecting frogs, snails, rattan, grasses and various traditional medicine (Table 3)

Table 3. *Total quantity (kg/year) and habitat of important NTFP collected in Sombpoi village of Sanamxay district*

NTFP	Habitat	Average household collection (kg/yr)	% of surveyed household collecting this NTFP
Bamboo shoots	floodplain	238	100
Mushrooms	flood plain, evergreen forest, hills, dry forest	100	100
Fish	flood plain, rivers	704	88
Ke se resin	flood plain, dry forest	67	75
Frogs	flood plain, dry forest	27	63
Yang oil	flood plain, dry forest	158	63
Monitor lizard	flood plain, dry forest	25	50
Traditional medicines (*strychnos nux vomica*)	flood plain, dry forest	118	50
Turtle	flood plain	21	50
Snails	flood plain	49	38
Bong bark	flood plain	356	25
Traditional medicine	flood plain	29	25
Yang bong	flood plain, dry forest	463	25
Fruit	flood plain	40	13

Flooding in Sanamxay predominately occurs when the Xe Pian and Xe Kong rivers overtop their banks. Villagers generally see small to average size floods as beneficial and regard flooded soil to be more productive for growing rice. Large floods, that restrict transportation, bring livestock diseases and cause the loss of rice crops, are more of a problem. However, the local rice farmers in the villages surveyed see the benefits of the floods as a trade-off between rice and fish, where large flood years damage the rice crops but result in high fish yields and small floods produce good rice but less fish. Households with little or no access to paddy land put more effort in other activities such as capture fisheries and the collection of NTFP. These households place higher value on the benefits of flooding because consequences, such as increased fish production, are a more significant component of their livelihoods.

Savannakhet province

Surveys in Savannakhet sought to compare the importance of rich biodiversity and the hydrologic cycle to the livelihoods of communities in the upper catchment and on the floodplain. The participatory assessments in Savannakhet did not focus on the household level, but rather sought a broad overview of biodiversity and livelihoods across a wider geographical range of the river. In each village, a single group of key respondents ranked the relative importance of household food resources.

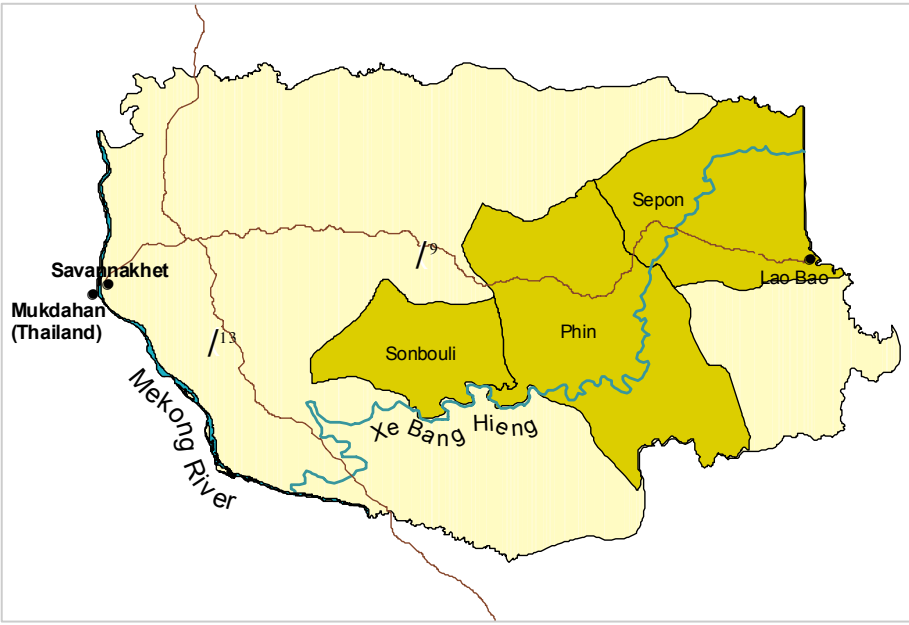


Figure 4. Targeted districts - Savannakhet province

Two field surveys collected data along the Xe Bang Hieng in the provincial districts of Sepon, Phin and Sonbouli. Sepon and Phin are located in the upper catchment where the low hills of the Annamite Mountains along the Lao-Vietnam border dominate the landscape. In these areas, the steeper gradient of the riverbanks limit the extent of seasonal floods. Conversely, in the lowland district of Sonbouli the large wet season flow in the Xe Bang Hieng causes large tributaries like the Xe Champhon and Xe Xang Xoy to back up and flood large areas (see Appendix 1). This extensive floodplain includes large forested areas, predominately bamboo and shrub forests, which, when seasonally inundated by floodwaters,

create important habitat for fish.

The first survey focused on the upper catchment area of Sepon and Phin Districts, and included participatory assessments in the villages of Kengkame, Na Huanam, Kengky, Vangkhot, Pai, Sawier, Pasiah and Nyang. The survey's objective was to determine the relative importance of capture fisheries and NTFP to the livelihoods of communities in localities subject to less severe seasonal flooding. This area does experience seasonal fluctuations in discharge, but steeper slopes limit the area of flooding. The habitats suitable for capture fisheries are therefore more restricted. Consequently, most fishing activity focuses on rivers and streams, where seasonal fish migrations triggered by hydrologic changes play a vital role in the local way of life. Because these fish migrate between the floodplains and the higher catchment, the way of life of communities living on this resource entwine intimately, even though they are geographically disconnected.

The floodplain villages of Dong Boun, Na Horlouang and Toum Nyae in the Sonbouli district were surveyed in a similar manner. Here, in contrast to the Attapeu villagers who can fish both the Xe Kong and its extensive floodplain, these communities, because of the high productivity wetlands and seasonally flooded forest habitat, invest more effort fishing on the floodplain. A single group of key respondents provided a general overview of how households value capture fisheries. The objective was to examine the relationship between seasonally flooded forests and capture fisheries and how these communities use these habitats to support their livelihoods. While floodplain communities often have access to rich aquatic resources, this study sought to highlight the importance of this diversity to livelihoods on both the floodplains and upper catchment communities and the pivotal role of an unhindered hydrologic cycle.

In each village, a group of key informants listed and then ranked the importance of floodplain habitats according to their contribution to household income and ease of catching fish. This list of aquatic habitats was grouped according to utilisation by gender. Each group then compiled a list of fish species regularly caught near their village and provided information about the habitat, migration and the importance of each species to villagers' livelihood.

LIVELIHOODS AND FLOODPLAIN BIODIVERSITY

The surveys in both provinces show how critical healthy floodplains are in shaping the environment and hence the way of life and the culture of rural people throughout southern Lao PDR. The high fish diversity and productivity of the floodplains provides an abundant food source for Lao people, accounting for the high rates of fish consumption in lowland communities of the Mekong Basin (see Table 3, also Baran and Baird, 2003; Singhanouvong and Phoutavong 2002).

For generations Lao households have consumed these riverine resources as the principle source of their protein and fat. Furthermore, these fish and NTFP resources are the 'natural capital' that rural villages rely on during periods of rice deficit or when crops fail. However, there is no similar source to rely upon during periods when fish and NTFP are limited (Meusch *et al.* 2003). The security of the food supply

and rural health therefore depends on the seasonal flooding and the vigour of floodplain habitat. Disruption of this seasonal flood pulse threatens the floodplain environment and livelihoods of the people who regularly consume fish and NTFP.

Table 4 gives a partial list of fish species regarded as important by people in three villages in the Sonbouli district of Savannakhet province. (Appendix 2 gives a complete list of fish species found near these villages.) This list, which uses local knowledge of capture fisheries rather than direct field sampling, shows just how important the diversity of habitat and aquatic organisms is to rural livelihoods.

Table 4. *List of important fish species from three villages in Sonbouli district*

Scientific name	Market price	Habitat
Belodontichthys dinema	18,000	River, deep pools
Channa spp.	8,000	River, pond, flooded area
Chitala ornata	8,000	River, pond, flooded area
Cyclocheilichthys enoplos	17,000	River, pond, flooded area
Cyprinus carpio	10,000	River, rapid, pond
Hypsibarbus malcolmi	8,000	River, flooded area
Kryptopterus cryptopterus	10,000	River, pond, flooded area
Micronema apogon	15,000	River, pond, flooded area
Morulius chrysophekadion	14,000	River, pond, flooded area
Mystus spp.	15,000	River, pond, flooded area
Notopterus notopterus	8,000	River, deep pool, flooded area
Pangasius macronema	10,000	River, pond, flooded area
Puntioplites falcifer	5,000	River, pond, flooded area
Thynnichthys thynnoides	6,000	River, pond, flooded area
Wallago attu	15,000	River, pond, flooded area

Table 5. *Factors determining the importance of fish species to local livelihoods*

Scientific Name	Fishing	Eating
Wallago attu	Difficult	Good taste
Micronema apogon	Difficult	Good taste
Belodontichthys dinema	Difficult	Good taste
Cyloscheilichthys enoplos	Difficult	Moderate
Kryptopterus cryptopterus	Moderate	Moderate
Mystus mysticetus	Difficult	Moderate
Hemibagrus filamentus	Moderate	Good taste
Chitala ornate	Easy	Moderate
Puntioplites falcifer	Easy	Good taste
Mystus mysticetus	Easy	Moderate
Pangasius macronema	Difficult	Good taste
Clarias batrachus	Easy	Good taste
Morulius chrysophekadion	Difficult	Good taste
Anabas testudineus	Easy	Good taste

A variety of factors influences the villager's perception of which fish species are important to their livelihoods (see Table 5). Fish are important for both subsistence and value their market value. Sold to traders, a large fish will provide household income, and is therefore valued for its potential to generate cash. Small fish, that are abundant and easy to catch, are valued for their regular contribution to food security. Other fish species are valued simply because of their good taste.

Strength in diversity

All the households interviewed for this study collect fish and NTFP from both permanent and seasonally flooded habitat. Permanently flooded habitat includes perennial rivers and streams, wetlands and natural ponds. Seasonally flooded habitat includes a wide range of habitat inundated by floodwaters for periods during the rainy season. This inundation may last as little as one week to several months. Examples of this habitat include the river banks and seasonal streams that are inundated as the rivers rise during the rainy season (May-October), wetlands and natural depressions on the floodplains that are inundated by floodwaters but dry out during the dry-season months, and forests on the floodplain that are flooded for varying periods of time each year. Rice fields also represent important aquatic habitat for collecting non-rice food items such as fish, frogs, molluscs and aquatic insects.

Each household relies on capture fisheries and NTFP for food and income to a different degree depending on factors such as age and gender of household members, number of individuals per household, the wealth of the family and their sufficiency of livestock and rice. While most community members are involved in the collection of fish and NTFP, the age, gender and wealth of an individual will determine the habitat they use, the gear type they employ and fish species they target. To fish in the main rivers often requires a considerable investment, in boats, motors and monofilament nets, while in habitats like flooded forests, wetlands and streams poorer people can use smaller-scale gear for collecting fish and other aquatic organisms such as frogs, snails and insects.

This diversity of habitat ensures a range of households have access to aquatic resources on a regular basis. Women and children may forage the wetland habitat nearby the village to collect plants, snails and fish for their families to eat. The men often fish the mainstream channels of the river where they can catch larger fish; they normally sell these to a trader to provide income for their household. As a rule, in rural villages the poorer the household the smaller the fish they will consume because they will sell large fish to markets in order generate some income.

Rice paddies are a multi-purpose resource utilised for both rice production and capture fisheries. Agricultural development that focuses on rice paddy production must also recognise the value of rice paddy fisheries in household food security. The loss of high quality habitat for capture fisheries, such as seasonally flooded forests and wetlands, for conversion into rice paddy may do little to strengthen food security. On the contrary, it may serve to undermine the considerable resources of food provided by healthy floodplain ecosystems.

FACTORS INFLUENCING USE OF AQUATIC RESOURCES

So far, this paper has explained how of the high biodiversity of wetland habitats support the way of life of rural communities throughout southern Lao PDR. However, how individual communities use and value these aquatic resources depends on a host of factors including their location in the basin and the hydrological regime (upper catchment or lowland floodplain), gender, household wealth and ethnicity.

Hydrological regime – upper catchment and lowland floodplains

The hydrology of the upper catchment differs in a number of significant ways from that of the lowland areas of the floodplain. In the headwaters of a river system the steeper gradient of the river banks restrict seasonal flooding, which creates different riverine habitat; as a result communities in different hydrological regimes place different emphasis on fishing.

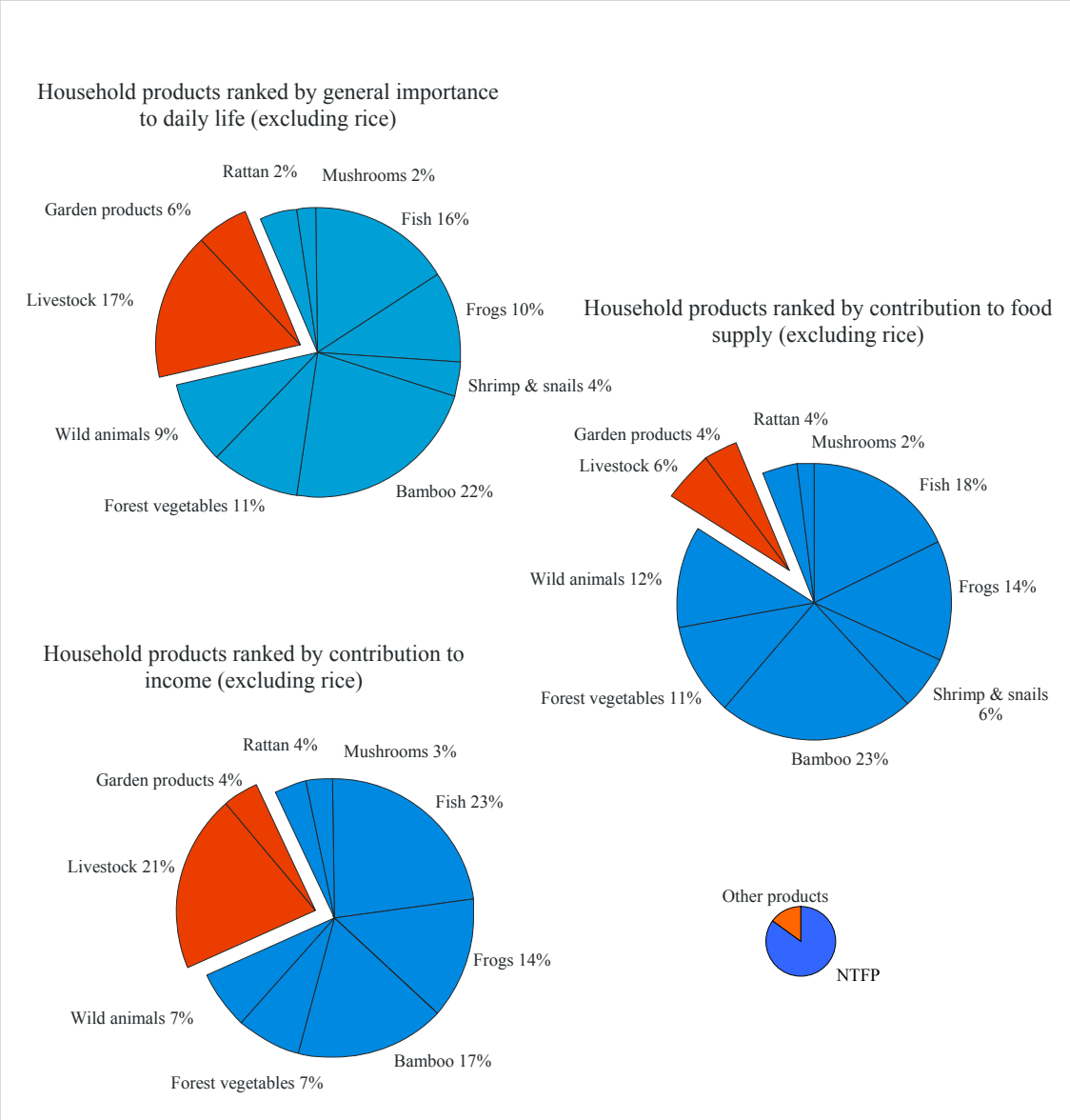


Figure 4. Ranked importance of household products in eight villages in Sepon and Phin districts, Savannakhet province

Despite a lack of floodplain habitat, fish represent a significant portion of the food and income of households in the upper catchment of a river. This lack of seasonally flooded habitat in the headwaters restricts the fishing effort to the mainstream river channels and streams. Seasonal fish migrations triggered by fluctuations in the flow remain a crucial part of the fishery. Many of the fish species that undergo these long distance migrations are dependant upon healthy floodplain habitat for spawning and feeding. In this way, the villages in the headwaters of the river to some extent rely on the same ecosystems and habitats as lowland villages from the floodplain. The hydrologic cycle is important to both maintaining critical floodplain habitat for fisheries as well as providing the environmental cue necessary to trigger seasonal fish migrations.

Table 5. *Water resources in three target villages in Sonbouli district*

	Dong Boun village	Na Horlouang village	Toum Nyae village
Perennial fishing habitat	Deep pools in river Tacham pond Tapone pond Kor swamp Xe champhone Xe Xang Xoy	Sim pond Huali wooden weir	Sim pond Xe Xang Xoy Deep pools in river
Seasonal fishing habitat	Khitha pond Khe pond Khone peung pond Khaman pond Kack het pond Edone pond Chakhe stream Lali stream	Khea pond Flood area Thomneung pond Thomleung pond	Pave pond Veun pond Sim channel Lamtheuck channel Channel small Chakhea channel

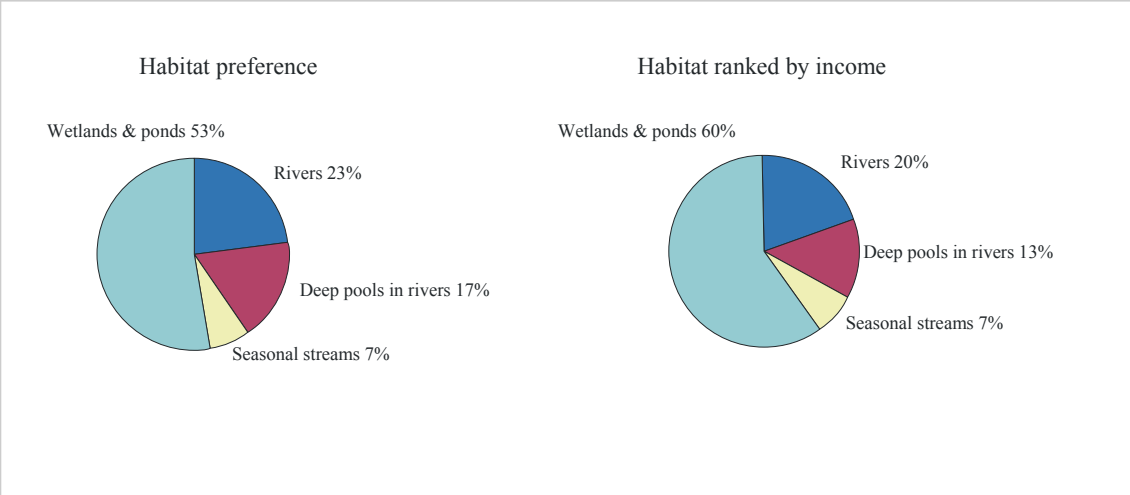


Figure 5. Preferred fishing location in Dong Boun village ranked according to habitat type

In lowland areas on the floodplain, there is more area of aquatic habitat available for fisheries. These communities are not limited to fishing mainstream rivers and streams, but have a range of floodplain habitat available (Table 5).

Table 6. *Usage of water bodies in Songkhon village, Sanamsai district*

Water Resource	Fishing Access	Purpose
Xe Pian	Year round	Income/subsistence
Xe Kong	Year round	Income/subsistence
Ta Ngao stream	Year round	Income/subsistence
Cheua stream	Rainy season	Subsistence
Ahlai stream	Year round	Subsistence
Talao stream	Year round	Subsistence
Rice paddy	Rainy season	Subsistence

Perennial and seasonal wetlands, streams, and flooded forests all offer important habitat for fisheries and livelihoods (Figure 5). These lowland communities are active participants in the fishery, targeting specific habitat for to provide subsistence or to generate income (Table 6).

Communities from the headwaters down to the floodplain regard the seasonal fluctuations in flow as positive factors in the fishery, creating seasonal habitat and triggering fish migrations. People will exert more fishing effort during the wet season months as the amount of habitat increases with the flood. Despite the larger area of habitat available, fishermen are able to catch more fish during wet season months as fish migrate across the floodplain, rice paddies, rivers and streams (Table 7).

Table 7. *Seasonal variation in capture fisheries habitat and average daily catch (kg) from three villages in Sanamsai district, Attapeu province*

Water resource	Fishing season	Dry season average daily catch (kg)	Wet season average daily catch (kg)
Xe Kong river	Year round	1.5	3.0
Seasonal stream	Rainy season		0.5
Rice paddy	Rainy season		0.4

Gender and Fisheries

Men and women will differ in their preference of habitat for capture fisheries (see Figure 6a and b over page). The gear type chosen by men compared with that used by women reflects this. Typically, the men will be fishing in the large rivers and ponds using boats and large-scale gear like monofilament gillnets. Women are responsible for many of the household duties other than fishing, and will often stay within close proximity of the village to collect fish and other NTFP using smaller gear. While this limits them in their choice of habitat, the contribution of wetland fish, molluscs, aquatic insects and plants to household food security is still significant.

Household Wealth

The wealth of the household may also determine how people value aquatic resources. To fish in the mainstream river channels often requires an investment in boats, motors, and monofilament gillnets. This may prevent some poorer households from fishing this habitat. Because fishing in wetlands and

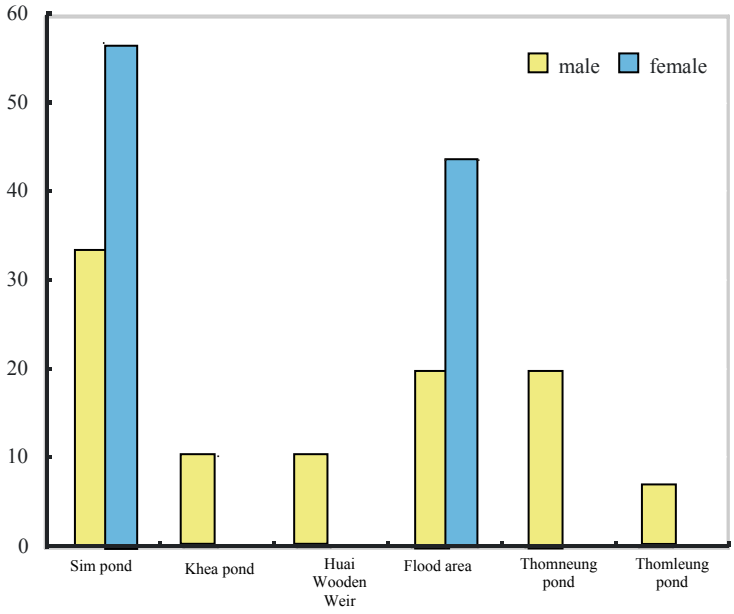


Figure 6a. Preferred fishing location in Na Horlouang village ranked by gender

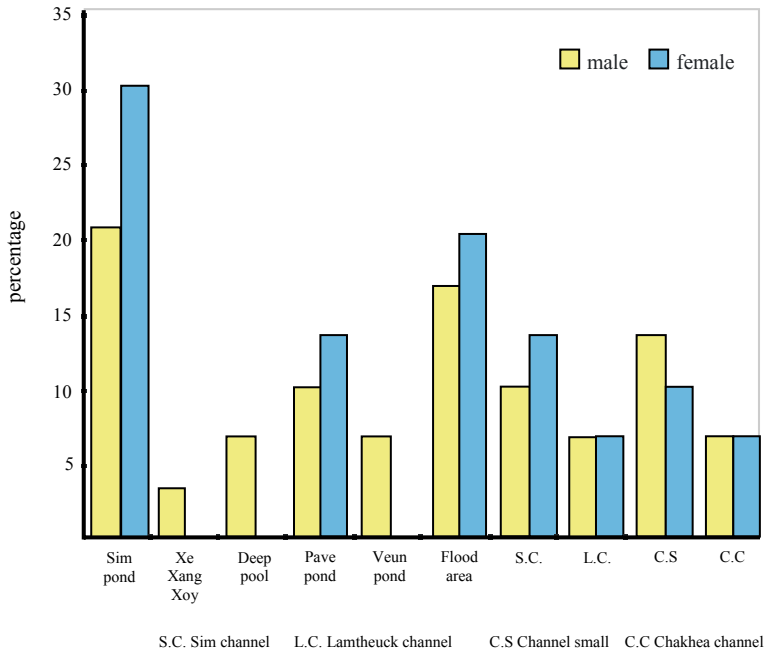


Figure 6b. Preferred fishing location Toum Nyae village ranked by gender

streams needs only inexpensive gear these habitats are available to all members of the community. To the poor and landless members of the village, a healthy fishery and floodplain environment is crucial to their household food security and income.

The type of fishing habitat may also determine the use of the fish and NTFP. Larger fish that are caught in the mainstream rivers are often sold to traders for income. Smaller fish as well as frogs, insects and wetland plants are often for consumption in the home. Rural communities will regard specific habitat as providing food for subsistence purposes or as opportunities to generate income (Table 6).

Ethnicity

Lao PDR's numerous ethnic groups may regard aquatic resources differently according to their own cultural values. The floodplains in upland areas are not extensive and ethnic groups living in these regions may not invest as much effort in fishing as do floodplain communities. However, despite having less of this habitat to fish in, upland villagers still rely on other aquatic animals such as fish and frogs to contribute a significant proportion of the protein in their diet (Figure 4).

In contrast, lowland ethnic groups living on the floodplains can access good fishing grounds and are quite skilled in capture fisheries. These communities exert greater effort on fishing and consume more fish (Table 8). Never the less many of the ethnic minorities living in these areas are very poor and are unable to buy the large-scale gear needed to fish in large rivers; poverty thus excludes some households from the fishery and they must rely instead on other NTFP.

Table 8. *Total quantity (kg/year) and habitat of important NTFP collected in Sombpoi village of Sanamxay district*

NTFP	Habitat	Average household collection (kg/yr)	% of surveyed household collecting this NTFP
Bamboo shoots	floodplain	238	100
Mushrooms	flood plain, evergreen forest, hills, dry forest	100	100
Fish	flood plain, rivers	704	88
Ke se resin	flood plain, dry forest	67	75
Frogs	flood plain, dry forest	27	63
Yang oil	flood plain, dry forest	158	63
Monitor lizard	flood plain, dry forest	25	50
Traditional medicines (*strychnos nux vomica*)	flood plain, dry forest	118	50
Turtle	flood plain	21	50
Snails	flood plain	49	38
Bong bark	flood plain	356	25
Traditional medicine	flood plain	29	25
Yang bong	flood plain, dry forest	463	25
Fruit	flood plain	40	13

Table 8 illustrates the importance of NTFP to households in Sombpoi village. This gives just a partial list of important NTFP collected by households showing the importance villagers consider items like fish, bamboo shoots, mushrooms and rattan to their way of life.

The target villages in Sanamsai district are on the floodplain of the Xe Kong, one of the largest tributaries of the Mekong and an important river system for capture fisheries. These villagers are active in the fishery, utilizing a multitude of gear in various habitats throughout the year, targeting a diverse range of aquatic organisms. Singhanouvong and Phoutavong (2002) estimate the average consumption of living aquatic resources per capita in the neighbouring Champassack province is currently 50 kg per anum. This is the average consumption across the entire province; lowland villages on the floodplain with access to an abundance of aquatic habitat are capable of harvesting a larger fish catch than average.

Floods and Capture Fisheries

The abundance of aquatic habitat on the floodplain supports a wealth of aquatic biodiversity targeted by local fishermen (see Appendix 2). Seasonal flooding plays an important role in generating and maintaining this biological diversity. This study, on the Xe Bang Hieng and Xe Kong rivers, shows the critical role of seasonal floods has on ecology of the floodplains and socio-economic benefits people living within the watershed derive from the diverse fauna and flora these habitats support.

The fishermen their families are fully attuned to the hydrologic cycle of these rivers. They can see that there are more fish in the wetlands and flooded forests than in the main river channels such as the Xe Xang Xoy and they know in years of large floods from the Xe Bang Hieng more fish migrate up the Xe Xang Xoy to the floodplains in their area. They understand the link between floods and capture fisheries. One fisherman explains, “if there is not a lot of water in the Xe Bang Hieng, there will not be fish here in our village.”

CONCLUSION

The study of the livelihoods of rural people in the wetlands of southern Lao PDR illustrates the close relationship between the hydrological cycle, the rich biodiversity of floodplain habitats and the way of life of the communities who depend on the abundance of fish and NTFP these habitats support.

However, it is a way of life that is increasingly under threat. Activities that originate outside of the influence of rural communities are challenging the riparian habitat that supports capture fisheries and NTFP production. Competition for the water resources of the Mekong Basin is putting this rich biodiversity at risk and thereby threatening the livelihoods of communities who rely on these natural resources. These threats stem from hydropower development, irrigated agriculture, flood mitigation and transportation infrastructure that may alter the hydrological cycle, as well as land conversion for agricultural development. Although development in these sectors of the economy is necessary to improve the living standards of rural people, these issues symbolise the growing conflict between urban

and rural areas, rich and poor, landowners and landless people. Rural development strategies must incorporate preservation of these ecosystems into their plans since it is these natural resources that play such a significant role in the culture and livelihoods of the very people whose standard of living these strategies aim to improve.

While clearly, there are many legitimate uses of the water resources of the Mekong Basin, development plans must find a balance between the competing demands of hydropower, irrigated agriculture, and flood mitigation and preserving the aquatic biodiversity essential to the livelihoods of the rural poor. Seasonal floods are a natural phenomenon that supports the high fish production and rich biodiversity of the Mekong Basin. An integrated approach to river basin management must understand the relationship between hydrology, biodiversity, and rural livelihoods.

ACKNOWLEDGEMENTS

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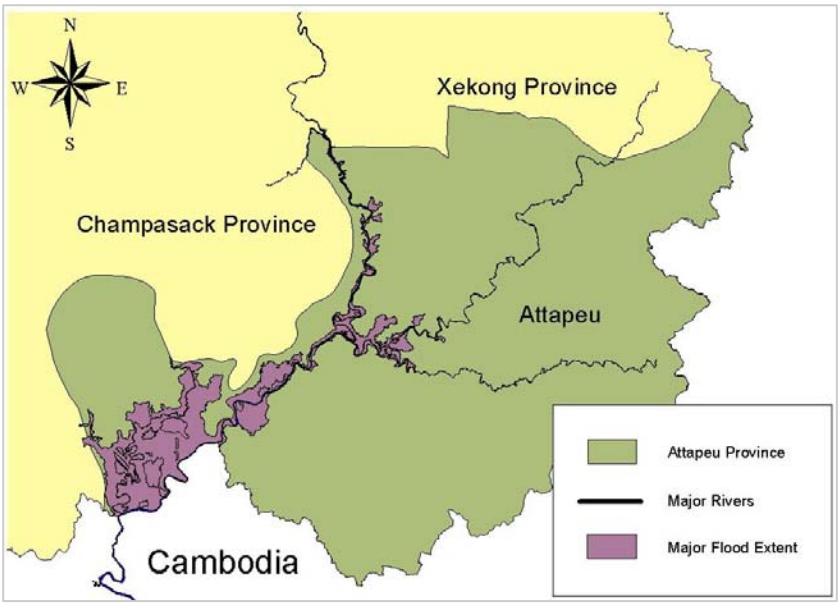
APPENDIX 1: Major flood extent, Attapeu province (Source: Mekong River Commission)



APPENDIX 2. List of fish species reported in three villages of Sonbouli district, Savannakhet province

Local name	Scientific name	Fishing season	Habitat
Pa kheng	*Anabas testudineus*	all year	Stay all area
Pa khea	*Bagarius yarrelli*	Sep-Nov	River
Pa vientfai	*Barbodes altus*	May-Jun	River
Pa khop	*Belodontichthys dinema*	Jul-Aug	River, deep pools
Pa khaman	*Catlocarpio siamensis*	Jul-Sep	River
Pa do	*Channa micropeltes*	all year	River, pond and flood
Pa khay	*Channa grandinosa*	all year	River, pond and flood
Pa khaotom	*Channa marulioides*	all year	Channel, weir
Pa khao tom	*Channa melasoma*	Apr-May	Stream, channel
Pa khor	*Channa striata*	all year	Stay all area
Pa tongdao	*Chitala ornata*	stay all area	Stay all area
Pa tasai	*Cirrhinus jullieni*	all year	River, pond, flood
Pa douck	*Clarias batrachus*	all year	River, pond
Pa chok	*Cyclocheilichthys enoplos*	Aug-Sep	River, pond, flood
Pa nai	*Cyprinus carpio*	all year	River, pond
Pa khealam	*Labiobarbus lineata*	all year	River, pond
Pa south	*Hampala dispar*	all year	River, pond, flood
Pa hoy	*Helicophagus waandersi*	Aug-Nov	River, pond and flood
Pa pak	*Hypsibarbus malcolmi*	all year	Stay all area
Pa pikkai	*Kryptopterus cryptopterus*	Sep-Oct	River, flood
Pa nang	*Micronema apogon*	Mar-May	River, pond, flood
Pa pia	*Morulius chrysophekadion*	Jun-Oct	River, pond, flood
Pa khayeng	*Mystus mysticetus*	all year	River, pond, flood
Pa koth	*Hemibagrus filamentus*	all year	River, pond, flood
Pa kheung	*Mystus wyckioides*	Sep-Nov	River, flood
Pa tong	*Notopterus notopterus*	all year	River, pond and flood
Pa seuam	*Ompok spp*	all year	River, pond, flood
Pa kapouck	*Osteochilus hasseltii*	all year	River, pond and flood
Pa nockkhao	*Osteochilus melanopleurus*	all year	River, pond
Pa bou	*Oxyeleotris marmorata*	all year	Stay all area
Payone	*Pangasius macronema*	Sep-Oct	River, pond and flood
Pa souay	*Pangasius bocourti*	Aug-Nov	River
Pa houakheng	*Poropuntius spp*	all year	River, pond, flood
Pa kar	*Pristolepis fasciata*	all year	Stay all area
Pa sakang	*Puntioplites falcifer*	all year	River, pond, flood
Pa koum	*Thynnichthys thynnoides*	all year	River, pond and flood
Pa nin	*Oreochromis nilotica*	Mar-Apr	River, pond
Pa salith	*Trichogaster pectoralis*	all year	Only pond
Pa khao	*Wallago attu*	Mar-June	River, pond, flood

ABSTRACT TITLES

A fish catch monitoring study using local fishers in Cambodia's rivers.
Chan Sokheng, Putrea Solyda, and Kent G. Hortle

Using local knowledge to inventory deep pools, an important habitat for river fish in Cambodia.
Chan Sokheng, Putrea Solyda, Sean Kin and Kent G. Hortle

Long-term monitoring of trends in catch of the *dai* fishery in the Tonle Sap River, Cambodia.
Hem Rady, Lieng Sopha, and Deap Loeung

A study of the fishery for a migratory species, Trey Kes (Kryptopterus apogon) in Stung Pursat, Tonle Sap Lake, Cambodia.
Phem Sea, Lieng Sopha, Sam Nuov and Kent G. Hortle

The *dai trey linh* fisheries in Tonle Touch River, Prey Veng Province.
Ngor Pengbun, Aun Sinath, Deap Leoung and Kent G. Hortle

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Ubolratana Suntornratana

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Anupong Sanitchon

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Kaing Khim and Prach Sokunth

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Yin Dara, Chuon Kim Chhea, Kaing Khin, Chap Piseth, Lieng Sareoun

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Thomas Augustinus, Wolf Hartmann, and Kesone Sayasane

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Sutee Sinunthorn, Wiratham Tongphan, Kanokporn Deeburee

Fishery status in public waters in Kanchanaburi Province, Thailand.
Amphorn Sakset

Status of using destructive gears in Lak lake, and Ea Soup and Buon Tria reservoirs.
Hoang Tuong Tien,Truong Ha Phuong,Phan Thuong Huy, and Nguyen Ngoc Vinh

Experiments on seed production and commercial culture of freshwater prawns (*Macrobrachium nippononense*).
Nguyen Quoc An, Phan Dinh Phuc,Le Thi Le Anh, Nguyen Thi Tu. Ly Ngoc Tuyen, Le Phuoc Binh

Artificial propagation of *Osteochilus melanopleura*.
Huynh Huu Ngai, Nguyen Minh Thanh, Pham Dinh Khoi, Thi Thanh Vinh, Dang Van Truong, Hoang Quang Bao, and Nguyen Thi Hong Van

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Thi Thanh Vinh, Nguyen Minh Thanh, Dang Van Truon, Hoang Quang Bao, Pham Dinh Khoi, and Nguyen Thi Hong Van

Biological characteristics, domestication and artificial propagation of beardless barb *(Cyclocheilichthys enoplos* Bleeker, 1850).
Pham Van Khanh, Dang Van Truong, Thi Thanh Vinh, Hoang Quang Bao, Nguyen Thi Hong Van, and Huynh Huu Ngai

Breeding of yellow mystus, *Hemibagrus filamentus* using brooders from Huai Luang Reservoir, Udornthani.

Decha Rodrarung, Noppanun Yoorong

A Study on the influence of characteristics of pond bottom and turbidity on yield of Lanchester's freshwater prawn.
Suriya Jongyotha, Wirat Jiwyam

Incubation of adhesive demersal eggs in plastic funnel.
Ratana Insiripong and Rungrudee Intachote

Rearing *Cirrhinus microlepis* (Sauvage, 1878) brood stock in earthen ponds.
Nongyao Manee, Aruna Maungmut and Prangthip Prasertwattana

Comparison of maturity of *Cirrhinus microlepis* brood stock from the wild and from hatchery condition.
Somboon, Phunsay Phitsanoukan, Voradet Duangboupha, Khunbualom Vonghachack and Vilath Mankhong

The comparison of growth performances of *Osphronemus exodon* with different stocking densities in cages.
Somboon, Khantheo Keodara and Nantha Phandavong

MRC Fisheries Programme language and communication coaching programme
Terry Clayton

Community-based natural resource management research project in Lower Mekong Basin, southern Champassack Province.
Thongchanh Sengsourivong

Dominant species in Cambodian commercial fisheries and the issue of names fishes.
Eric Baran and Chheng Phen

AGENDA

26 November 2003		
All	Registration	08:00 - 08:30
	Opening ceremony	
Chris Barlow	Welcome address	08:30 - 08:35
Governor Champassack	Opening remarks	08:35 - 08:40
	Poster presentations	
Mr. Wolf Hartmann	Introduction	08:40 - 08:45
All	Presentation of posters. Author(s) will be available to discuss (see appendix for titles)	08:45 - 10:00
	Coffee break	09:30 - 10:00
	Fisheries assessment Chairperson: Mr. Xaypladeth Choulamany, Director of LARReC, Lao PDR	
	Chairperson's introductory remarks	10:00 - 10:05
1 Troeun Roth	The yield of fish and other aquatic animals from rice fields in Battambang province, near the Tonle Sap Lake. Troeun Roth, Lieng Sopha, Sam Nuov and Kent G. Hortle	10:05 - 10:25
2 Apichart Termvidchakorn	Fish larvae of the Lower Songkham River Basin. Dr. Apichart Termvidchakorn	10:25 - 10:45
3 Vu Vi An	A fish catch monitoring study in the Mekong Delta, Viet Nam. Vu Vi An, Doan Van Tien and Kent G. Hortle	10:45 - 11:05
4 Khay Dany	Monitoring fish sales at Phnom Penh's retail markets. Dany Khay and Kent G. Hortle	11:05 - 11:25
5 Chea Tharith	Drift of fish juveniles and larvae and invertebrates over 24-hour periods in the Mekong River at Phnom Penh, Cambodia. Chea Tharith, Bun Racy, Em Samy, Thac Phanara and Kent G. Hortle	11:25 – 11:50
	Lunch	11:50 – 13:15
6 Wirathum Thongpun	Fish ecology and catch in the Songkhram River described by stationary trawl net fishery. Wirathum Thongpun, Siranee Ngoichansri, Boonsong Sricharoendham and Wirawan Rayan	13:15 - 13:35
7 Tiwarat Thalerngkieatleela	Taxonomy of freshwater prawn of *Kud Ting Yai*. Nong Khai province, northeast Thailand. Tiwarat Thalerngkieatleela	13:35 – 13:55
	Film: "Big fish - small fry: globalisation of Lake Victoria fisheries". Introduction by Mr. Wolf Hartmann, Component coordinator, MRRF	13:55 – 14:20
	Coffee break	14:20 – 14:40
	Mini workshop Introduction by Khamtanh Vatthanatham The MRC has initiated discussions with Danida regarding a second phase of the Fisheries Programme to begin after July 2005. In this mini-workshop, we would like counterpart staff to identify which issues they think should be covered in Phase 2. We expect country groups to work together to identify: major research and development topics to be addressed in FP Phase 2; and any personnel or administrative issues to be considered in planning a FP Phase 2	14:40 – 17:00
	Reception dinner at Pakse Hotel	19:00 – 22:00

AGENDA (cont.)

27 November 2003		
Group representative	Mini workshop group presentations	08:15 – 09:00
	Fisheries management Chairperson: Mr. Sam Nuov, Deputy Director, DoF, Cambodia	
8 Kanokporn Deeburee	'Women' are more than a group: women's participation in fisheries resources management, Thailand. Kanokporn Deeburee	09:00 - 09:20
9 Kesone Sayasane	Community and intra-household dynamics of food security in Lao PDR, Nam Houm reservoir, Lao PDR. Kesone Sayasane and Thomas Augustinus	09:20 - 09:40
10 Kaing Khim	Participation in fisheries co-management, Kampong Cham and Kandal Province, Cambodia. Kaing Khim; Prach Sokunthy; Soun Southea	09:40 - 10:10
	Coffee Break	10:10 - 10:30
11 Ouk Vibol	Stock enhancement as a major element of reservoir fisheries management. Ouk Vibol, Kaing Khim, Heng Samay, Lim Ngeth	10:30 - 10:50
12 Chanthone Photithay	Seasonally flooded habitat and non-timber forest products: supporting biodiversity and local livelihoods in Southern Lao PDR Roger Mollot,Chanthone Photithay	10:50 - 11:10
13 Malasri Khumsri	Possible causes of decreased catch in Nam Oon Reservoir, Thailand. Malasri Khumsri;Narongsak Sirichaipan**;** Wason Taruwan; Jaruk Nachaiperm	11:10 - 11:30
14 Phan Tuong Huy	Inland fisheries co-management: what next for Viet Nam? Truong Ha Phuong, John Sollows, Phan Tuong Huy	11:30 - 11:50
	Conclusion - Chairperson	11:50 - 11:55
	Lunch	11:55 - 13:20
	Aquaculture Chairperson: Mr. Naruepon Sukumasavin, DoF, Thailand	
15 Hor Chanlim	Comparison of the growth and total production of indigenous fish species using different stocking composition rates in grow-out polyculture system. Hor Chanlim, Ouk Vibol, Hang Savin and Lim Ngeth	13:20 - 13:40
16 Latsmy Phounevisouk	Survival, feeding and growth of juvenile Mekong prawn (*Macrobrachium* sp.) in aquariums, hapas and pond environments	13:40 - 14:00
17 Unnop Imsilp	Mobile hatchery: a new tool for fisheries extension. Unnop Imsilp, Sombut Singsee, Pin Polchai, Thanjai Assonjohn and Naruepon Sukumasavin	14:00 - 14:20
18 Somphouthone Phimmachack	A survey on aquatic animal health problems affecting small-scale aquaculture production and fisheries in Lao PDR. Somphouthone Phimmachack, Saleumphone Chanthavong	14:20 - 14:40
	Coffee break	14:40 - 15:00
	Aquaculture Chairperson: Dr. Nguyen Van Hao, Director of RIA.2, Viet Nam	
19 Chavalith Vidthayanon	Non-fish biodiversity as food security in Mekong Basinwide. Chavalith Vidthayanon, Apichart Termvidchakorn	15:00 - 15:20
20 Bounsong Vongvichit	Raising frog in cages using different feeds. Bounsong Vongvichit	15:20 - 15:40
21 Sombut Singsee	Effect of various types of hormone on induced ovulation of snail eater (*Pangasius conchophilus* Roberts & Vidthayanon, 1991). Sombut Singsee, Unnop Imsilp, Pin	15:40 - 16:00

AGENDA (cont.)

28th November 2003: Field Trip	
Field trip programme	Time
Departure from Pakse Hotel	08:15
Visit to KM 8 Fisheries Station and demonstration of AIMS activities	08:40 - 09:30
Visit to Khone Falls and lunch	11:30 - 13:00
Visit to Ban Hat Fisheries sub-centre, LARReC	13:30 - 15:00
Arrive Pakse Hotel	17:00