

HighARCS Integrated Action Planning for the Phu Yen District study site, Son La Province, Vietnam

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**Title: HighARCS Integrated Action Planning for the Phu Yen District study site,
Son La Province, Vietnam**

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1. Introduction

General introduction

The Highland Aquatic Resources Conservation and Sustainable Development (HighARCS) project aims to analyse the status of highland aquatic resources at five sites including Son La in Northern Vietnam. The project aims to examine ecosystem services, livelihoods of poor people and biodiversity conservation issues of highland aquatic resources in order to produce action plans. An Integrated Action Plan (IAP) on livelihoods, conservation and policy issues was foreseen to be implemented among various stakeholders to enhance livelihoods, conserve aquatic biodiversity and encourage sustainable development.

Study sites in Vietnam were selected based on the following criteria: study sites must demonstrate typical characteristics of highland areas, not be situated on alluvial plains and be representative of the situation in northern and central Viet Nam. The areas selected were situated within the upper reaches of a watershed but still provide a home for many poor people. The three communities in each study site are situated along the watershed and have a high level of dependence on aquatic resources, ecosystem services and biodiversity in the watershed for livelihoods. The commitment of local people and authorities to engaging with the project and carrying out activities was also taken in to consideration.

Situation analysis and identification of management Issues

Vietnam is a country with a diverse topography, including tropical lowlands, hills and densely forested highlands (Wikipedia Contributors, 2010). Two-thirds of the total natural area is covered by hills and mountains, with a general downward slope from west to east (Viet Nam Environment Protection Agency, 2005). The country is divided into eight regions which include the Northwest, Northeast, Red River Delta, North Central Coast, South Central, Central Highlands, Southeastern and Mekong River Delta (Wikipedia Contributors, 2010). The four highland regions are Northeast region, Northwest region, North Central and Central Highlands which are indicated in Figure 1.



Figure 1. Vietnamese regions (Wikipedia Contributors, 2010)

Viet Nam has a tropical monsoon climate and the annual average temperature is above 20°C, average annual humidity is more than 80%, and rainfall averages 1500 mm per year (Vietnam Environment Protection Agency, 2005). Differences in climate between regions, especially in temperature and humidity range are strongly influenced by the biodiversity of each region.

Logistics of HighARCS study site selection

Based on the desk study about the values, livelihoods, conservation issues and wise-use options of highland aquatic resources in northern and central of Viet Nam, two provinces were selected for further study based on the overall framework of the HighARCS project; Son La is considered representative for northern areas of Viet Nam and Quang Tri representative for central areas of the country.

Son La Province



Figure 2. Son La map (source : www.sonla.gov.vn website)

Son La Province is located in the Northwest Region which is classified as a highland province with an average elevation of 600-700m above sea level. Son La city is 320km from the capital Hanoi. Son La has 14,055 km² of natural areas (www.sonla.gov.vn) and this is one of the three largest provinces in Vietnam, comprising 1 city and 10 Districts. There are two main river systems (Da River and Ma River) that flow through Son La which drain more than 97% of the regions area. The Da River runs for 527km through Vietnam of which 53km passes through Phu Yen District with a northwest-southeast orientation. The Ma River has a total length of 512km and a watershed area of 17,600km² located in Vietnam.

There is a rich and diverse aquatic fauna in the streams and rivers in Son La, especially in the watersheds of the Da River and Ma River (Van, 2005). On average, Son La has 1.2-1.8km of river and stream per km². There are 96 hydropower stations, 21 of these dams have a capacity exceeding 1000kW. Son La hydropower scheme is the biggest in Southeast Asia with a capacity of 3,600kW, and construction started on December 25, 2005. Aims for the Son La hydropower scheme were to

supply electricity, water for irrigation and contribute to socio-economic development in the Northwest Region. This project required 100,000 people to be displaced to Son La, Dien Bien and Lai Chau and this constituted the biggest involuntary resettlement in the modern history of Vietnam. Son La Province had the largest number of resettlement households in 8 Districts, 62 Communes and 237 sites for resettlement (including 3 standby sites) with a capacity to receive 13,100 households (Ha, 2008). Son La has a diversity of cultures from 12 ethnic groups, and the resettlement program has affected the livelihoods and culture of communities, especially of ethnic minority groups whose way of life was most closely related to the watershed. Phu Yen District is one of the poorest districts of Son La and was involved in the resettlement program. Phu Yen District was selected as a study site for the HighARCS project.

Phu Yen District has a total area of 1,236 km² ha covering 8.7% of Son La Province and is located in a mountainous area characterised by a complicated topography. In Phu Yen District, mountain areas which are characterised by steep slopes channelling most rivers and streams in a northwest to southeast direction dominate and the area has a high vulnerability to soil erosion with small-areas of cultivated land. There are 1200 rivers and streams belonging to 4 main river systems: Tac River, Sap River, Mua River and Khoang River, all of them flow to the Da River (53km of the Da River runs through the south of the district). Phu Yen District has dry and cold winters from October to April and hot, wet and rainy summers from April to September. In the rainy season, the rainfall fluctuates, with high average rainfall in June, July and August (80% rainfall for the year), accompanied by flooding and soil erosion (Phu Yen People's Committee, 2009).

Phu Yen is listed as a district affected by poverty with 14 of 27 towns and communes with more than 40% of households classified as poor, these communes are located along the Da River in highland areas. There are some fishing villages in Phu Yen District where people depend heavily on aquatic resources in the river. Many people in the selected communes in Tuong Tien and Tuong Ha go fishing on the Hoa Binh hydropower dam; fishing is the main income sources of many households. Figure 2 shows the location of the reservoir catchment within Viet Nam, which can be seen in more detail in the site map in Section 2 (Figure 3). Within Phu Yen, the reservoir covers 3,079ha and partly covers 9 of the 27 communes (Son La People's Committee 2006, Phu Yen People's Committee 2009).

requirement of water for electricity generation and for irrigation. At the start of the dry season (October) the reservoir increases in volume based on water storage by the hydropower dam for electricity generation, water levels can reach 25-30m in depth with high transparency (Oct to April). Figure 4 shows the reservoir/river at this level. These floodwaters inundate crop rice fields and much of the surrounding land. This extensive water body provides an important habitat for many fish searching for food and breeding areas. Thus, people living within this watershed are fishing on the river, and using the water for agricultural irrigation and home consumption. However, during the rainy season, the dam operators discharge large amounts of water lowering the level of the reservoir until it is only a stream, which occasionally dries up (May to Sept). The management of the dam for hydroelectric power is a major issue in this area, as it dictates the availability of aquatic resources for the livelihoods of local people.

At the site there are two major types of seasonal wildlife habitats (see Figure 4), namely:

River/reservoir habitats: during the storage water phase of the dam, the water level is high and the river/reservoir is wide. In the central section, water flow is slow and mudflats develop on the bottom. Close to the banks shallow waters are used to establish rice fields, and there are also some areas of gravel/rocky shores.

Stream habitats: occurs when the reservoir levels are lowered and creates a stream which has a strong flow the now dry areas are mud flats and crop land.

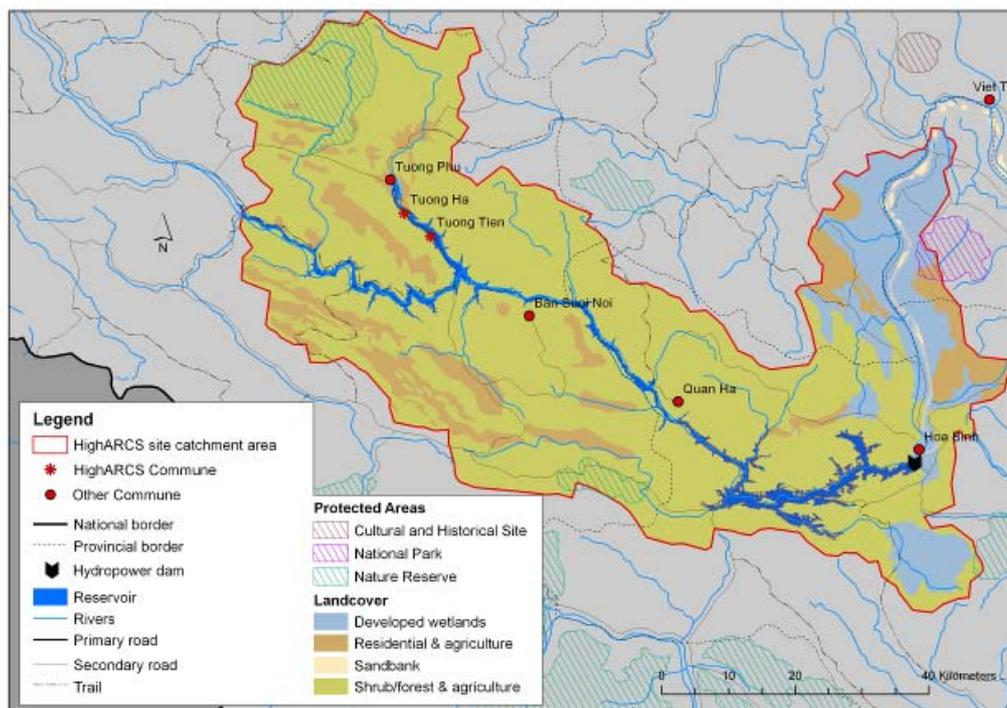


Figure 3. The HighARCS site and Phu Yen wider catchment area.

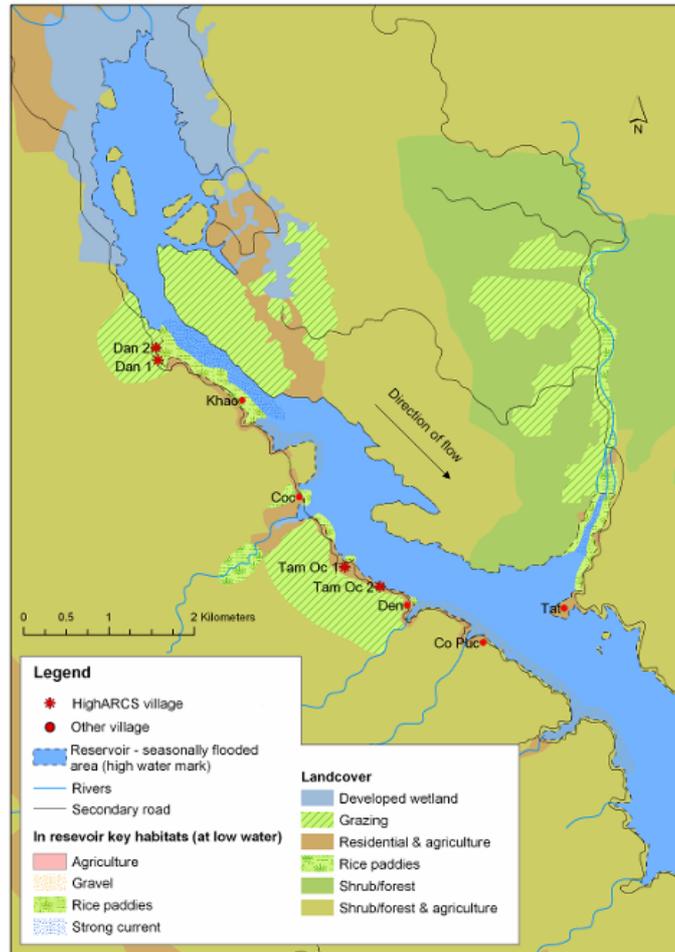


Figure 4. Map of HighARCS site villages and key habitats

Overall aims of the project at the site

Overall objectives for the HighARCS project include using interdisciplinary approaches to develop knowledge on the importance of aquatic resources in highland areas and formulate integrated conservation, livelihoods and policy action plans. With local communities of Phu Yen District in Son La Province (Northern Vietnam), the importance of aquatic resources in livelihoods of people in Tuong Tien and Tuong Ha communes, threats to biodiversity of fish species in reservoirs and the Da River and stakeholder perceptions have been assessed. Action planning was proposed for wise-use or sustainable utilisation of aquatic resources for the benefit of local people in a way that maintains the natural properties of the ecosystem in the reservoirs and the Da River (derived from the definition of wise-use of wetlands proposed at the 3rd Ramsar Conference of the Contracting Parties (COP3, 1987) Ramsar Convention Secretariat, 2010). Furthermore, Better Management Practices aimed at conserving biodiversity and sustaining ecosystem services will be formulated with potential users to promote uptake and enhanced policy formulation.

2. Assessment Methodology

Integrated assessment approach

The Integrated assessment process was developed at the Project Management Group (PMG) meeting in Hanoi (June 2010) in order to develop the most appropriate framework for planning in the HighARCS project. Following-up on the PMG meeting integrated activities for the HighARCS project were designed for data collection for WP3, WP4 and WP5. The integrated approach of HighARCS means action plans will no longer take three different formats of Conservation Action Plans, Livelihoods Action Plans as well as Policy Action Plans. Instead, at study sites, one Integrated Action Plan (Springate-Baginsky *et al.* 2008, IUCN 2008) is to be formulated addressing conservation, livelihoods and policy issues.

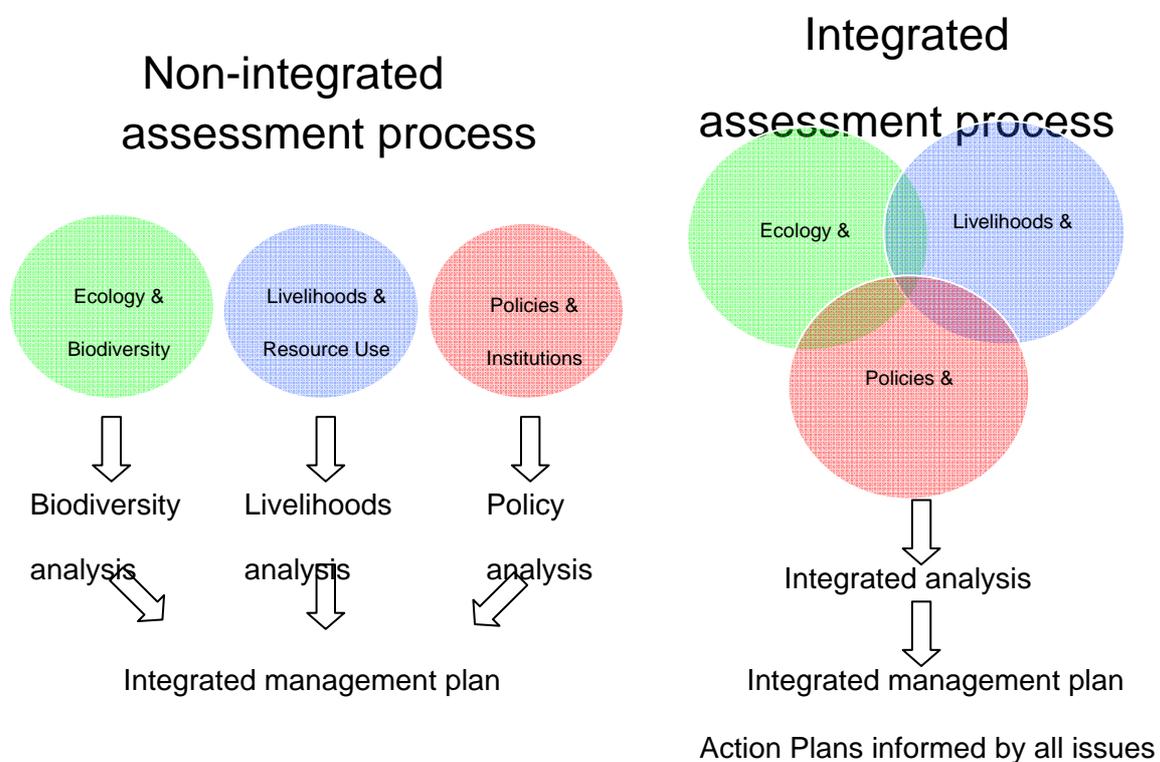


Figure 5. An integrated assessment and action planning approach of HighARCS (adapted from the IUCN Wetland Assessment Toolkit, 2009)

3. Overview of biodiversity and ecosystem service values (WP3)

There were 126 fish species identified that occur in the Da River (Bui The Anh *et al.*, 2009) which is in the larger catchment of the HighARCS site. Of these species, two are globally threatened (according to the IUCN Red List) *Sinilabeo tonkinensis* (assessed as Vulnerable (VU) under the name *Bangana*

tonkinensis and also assessed as VU in the Viet Nam national Red List) and *Pseudohemiculter dispar* (VU). Five species are also assessed as Near Threatened (NT) species (*Cirrhinus molitorella*, *Cyprinus multitaeniata*, *Onychostoma gerlachi*, *Bagarius yarrelli* and *Glyptothorax interspinalum*). Of these threatened and Near Threatened species three are important for livelihoods *Cirrhinus molitorella*, *Sinilabeo tonkinensis* and *Bagarius yarrelli*. In total there are 36 species of economic/livelihood importance in the Da River, three of which are globally threatened or Near Threatened (mentioned above), five are assessed as Vulnerable on the Viet Nam National Red List *Hemibagrus guttatus* (Data Deficient (DD) IUCN RedList), *Elopichthys bambusa* (DD IUCN RedList), *Semilabeo obscures* (Least Concern (LC) IUCN RedList), *Sinilabeo lemassoni* (DD under the name *Bangana lemassoni* on the IUCN RedList) and *Sinilabeo tonkinensis* (VU under the name *Bangana tonkinensis* on the IUCN RedList), and one, *Channa maculata* (LC on the IUCN RedList) is Endangered. Eight of the 126 species are not native to the catchment: *Oryzias latipes*, *Clarias gariepinus*, *Cobitis taenia*, *Carassius auratus*, *Cyprinus carpio*, *Oreochromis mossambicus*, *Oreochromis niloticus* and *Gambusia affinis*. Many of these species are known to have adverse ecological impacts when introduced (ISSG 2011).

Outputs of focus group discussions with local fishermen and market surveys showed that 18 fish species are harvested in the rivers, streams and wetlands around the study area in Tuong Tien and Tuong Ha communes. Most frequently caught fish species (Annex 1) include common carp Cá Chép (*Cyprinus carpio*), cá thiều (*Chanodichthys erythropterus*), tép dầu (*Pseudohemiculter dispar*), Cá Bò (*Pelteobagrus fulvidraco*), Cá Ngõ (*Culter flavipinnis*), Trắm cỏ (*Ctenopharyngodon idella*), mè trắng (*Hypophthalmichthys harmandi*), Cá Măng (*Elopichthys bambusa*), and Rô phi (*Oreochromis niloticus*). *Elopichthys bambusa* is Vulnerable on the Viet Nam National Red List, and *Pseudohemiculter dispar* is Vulnerable on both the Viet Nam National Red List and the IUCN RedList. There are reported declines since 1990 of three species *Channa striata*, *Clarias fuscus* and *Bagarius yarrelli*, and only *Bagarius yarrelli* is listed as nationally threatened (VU on the national Red List but NT on the IUCN RedList). Four species are known to have increased in numbers since 1990, these are *Cirrhinus mrigala*, *Squaliobarbus curriculus*, *Pseudohemiculter dispar*, and *Chanodichthys erythropterus*. One of these species *Pseudohemiculter dispar* is assessed as VU on the IUCN RedList while many other species have remained rare.

The main season for harvesting fish species from the reservoir in Tuong Tien and Tuong Ha communes is from September to April with a peak fishing season from February-March which corresponds to the high water levels (for the hydropower dam to store water) and low levels of turbidity. From May to August, the water level is often low, but flooding occurs due to high rainfall leading to high turbidity and there is little to no fishing undertaken. On average the water level is 3-4

meters, with the highest depth at 30 meters and the lowest at 20 centimetres. In general, fishing activities are undertaken in all months of the year.

Human action to capture and exploit freshwater ecosystem services can result in negative impacts upon biodiversity. The threats to freshwater biodiversity at the site were identified (between April 2010-July 2011) using focus group discussions including the drawing of maps and through RIA1 researcher site visits and while collating information for other work packages in particular the stakeholder Delphi for WP5 (Nguyen et al., 2011). Issues evaluated using the stakeholder Delphi method included (1) evaluation and remarks from stakeholders about the status of aquatic resources in the study site (exploitation; use; biological diversity; problems and threats), policy, regulation (government and village level), organization and implementation of aquatic resource conservation (2) suggestions of policy, implementation measures, organization. The stakeholders included managers, policy makers, researchers and people exploiting and using aquatic resources in the study site. Stakeholder groups involved in the stakeholder Delphi at the HighARCS site in the north included: stakeholders dependent on highland aquatic resources and stakeholders managing or regulating highland aquatic resources.

Stakeholder dependent on highland aquatic resources are:

- +Fishing group - livelihoods of this group depend mainly on aquatic resource and aquatic resources are seriously affected by unsuitable fishing;
- + Market group - fishing people often sell to 2 or 3 intermediate traders who live locally or travel from elsewhere; fishing people can also sell fish at local markets themselves.

At the Phu Yen site, the main threats identified are overfishing and the use of destructive fishing methods, agricultural pollution, deforestation and changing water levels caused by hydropower dam operation. Other threats including climate change and the harsh climate leading to heavy storms and flooding were also mentioned during discussions with focus groups and stakeholders.

Overharvesting and destructive fishing methods

Based on the results of research (stakeholder Delphi approach) for WP5, just under 70% of villagers replying described the status and condition of aquatic resources as either 'seriously declining' or 'declining' (Nguyen et al., 2011). From our survey during field work in 2010, the use of fine nets and small mesh sizes had resulted in the harvesting of many fingerlings that do not have the chance to reproduce, which has resulted in the decline of many fish populations. Focus group members indicated that some illegal fishing such as using explosives or electricity to fish still happens, even though all fishermen understand that these methods are illegal. Many fishermen also do not adhere

to fishing regulations that regulate the harvestable species, minimum size of individuals allowed to be caught, fishing grounds or seasons and instead just try to catch as much fish as possible, especially the commercially valuable species.

Water pollution and sedimentation

Based on the results of the stakeholder Delphi assessment, 91% of respondents indicated erosion and water turbidity, and 25% mentioned agricultural pollution as significant threats facing aquatic biodiversity at the site (Nguyen et al., 2011). Figure 6 shows that the entire upper catchment of the river/reservoir in which the communes are situated is being used for agriculture (maize and soybeans) within a mosaic of shrub and forest, although some removal of natural vegetation has taken place in these hilly areas. In addition the clearance of natural vegetation has occurred in the less hilly areas (light red on the map) to provide land for more intensive agriculture. These agricultural areas are using increasing amounts of fertilizers and pesticides that are washing into the rivers and polluting the water, also exposed soils (due to deforestation) are being washed away into the rivers (especially during high rainfall and floods) leading to increased sediment.

Dams

In Phu Yen District, Tuong Ha and Tuong Tien Communes are located on the reservoir of the Hoa Binh hydropower plant. Management of the dam, as it controls the level of water at the communes, dictates the availability of many of the aquatic resources to the communities as where there is little water, there are few fish. According to the fishermen at the focus group discussions, fish quantity and the number of species have greatly reduced since the hydropower dam was constructed. The construction of the dam, changing flow regimes and increased sedimentation have destroyed fish breeding grounds and blocked fish migrations. Also during floods and when the hydropower dam discharges water, the sediment load increases turning the water turbid which has resulted in massive fish kills in the Van Yen area.

From Delphi research, about 93% participants (n = 41) recommended that aquatic resources in Son La can be improved and only 7% of participants (n = 3) were not sure that there could be improvements. Other ideas indicated that if the water level in Son La hydropower reservoir can be stable then fisheries resources will be enhanced and livelihoods of local people will develop (Nguyen et al., 2011). The main difficulty and threatens to aquatic resources in Son La are rocks, erosion and sediment (91% of participants, n = 40). Every year heavy rains erode soil and rocks away from the mountains causing sediment in the river flow. Such muddy conditions cause fish kills. There were also additional comments that in 2009, during heavy rains and floods, fish were killed in the Hoa Binh hydropower reservoir.

Commenting on methods and activities to implement Better Management Practices for aquatic resources, regarding institutional organization, business and management, many people suggested establishing a board of management of fisheries resources or building a cooperative management body. Around a third of participants (29.5%) (n = 13) commented that management of fisheries resources should be coordinated for either the entire Hoa Binh hydropower scheme or by cooperatives managing fisheries resources in areas associated with their commune. Others commented that it would be necessary to implement management regimes at the commune level (18.2%, n = 8) or under 2-3 lake areas governed by common fisheries management regimes (15.9 %, n = 7). In addition, according to the Master Plan of Social Economic Development from 2009-2020 of Phu Yen Peoples Committee four small hydropower stations are planned (each with capacity of 8-15MW) in Phu Yen District; (Suoi Sap 1, Suoi Sap 2, Suoi Sap 3 and Muong Lang) (Phu Yen People's Committee, 2009).

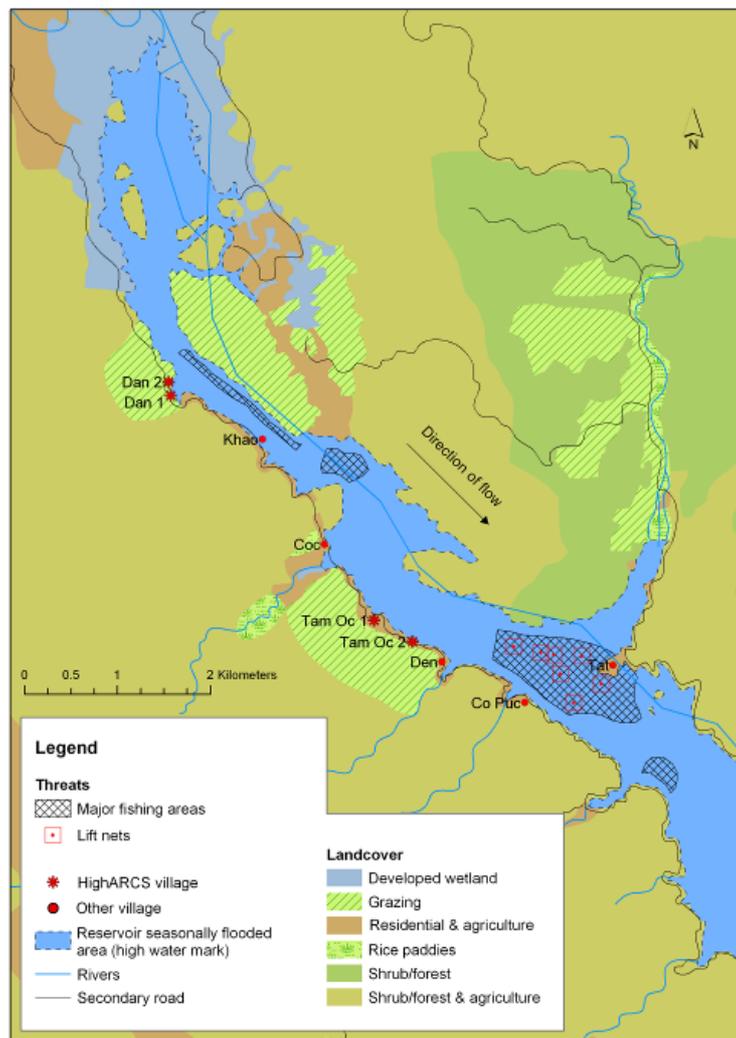


Figure 5. Map showing the major fishing grounds used by the fisherman in the area

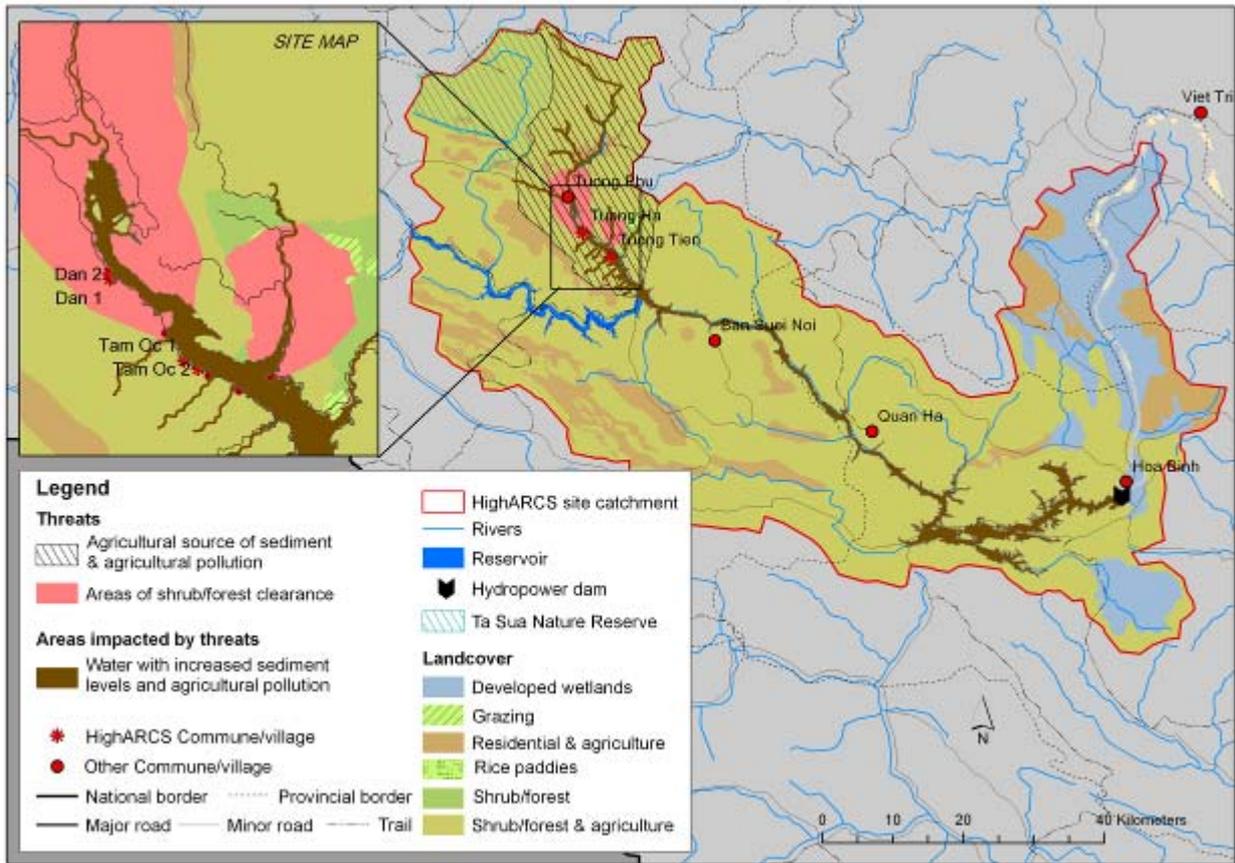


Figure 6. Deforestation and agricultural pollution impacting the Phu Yen site.

Ecosystem services discussion and maps

Some of the ecosystem services have been mapped and this showed at a watershed and site scale the areas generating the services and the areas receiving (or benefiting) from the services (Figure 7). This information is based on the results of the analysis in this Work Package, field observations by RIA1 staff and formal and informal discussions with the various stakeholder groups. The maps are based on those produced for the site and catchment maps with the ecosystem service generating and benefiting areas overlaid. Ecosystem services were discussed and drawn by RIA1 staff and IUCN during the mapping workshop held on 23-24 August, 2011 at the South China Agricultural University, Guangzhou, China. Results were digitised using GIS software by IUCN. The maps allow geographic areas of importance for the continuation of services to be identified and the wider benefits of the services to be visualised. They also informed the IAP to identify potential actions needed to protect the services and also indicators to monitor the quality or continued delivery of the services.

Fish and shrimp harvesting

Fish and shrimps for commercial and subsistence use are ranked relatively highly by all groups of respondents, but in particular by Group 3 (village group). The annual report from Phu Yen District shows that the total fisheries product was estimated at 156 tons with a value of 2.29 billion VND (~83,500 Euros at current exchange rates) in 2000, 323 tons worth 3.55 billion (~129,500 Euros) VND in 2005, and 306 tons worth 3.98 billion (~145,000 Euros) VND in 2007 (Phu Yen Peoples Committee 2009). According to the annual report of Tuong Ha and Tuong Tien People's Committee, the total yield of fishing was 46 tons in 2009 in Tuong Ha commune and 14 tons in Tuong Tien (Tuong Ha People Committee 2010; Tuong Tien Peoples Committee 2010). On average fishermen catch between 3-10kg of fish per day including common species such as prawns, common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys harmandi*) and mud carp (*Labeo rohita*) and a mix of small native fish. Local people confirmed that their daily income coming from fishing on the river was important (Nguyen *et al* 2010). Fish are the main protein source for local people within the site villages, and they also help save family expenses on other foods. As market networks are underdeveloped in the rural, remote and isolated mountain regions (The Socialist Republic of Vietnam 2003) people spend a long time (up to a day) travelling to market to purchase food, goods and exchange commodities (Thuan 2005). Therefore, local people also save time that would otherwise be spent travelling to buy food.

Potential indicators:

- Regular fish market surveys, identifying species composition, harvesting locations and catch levels.
- Annual social surveys of fishermen to identify their perception of trends in quantity and quality of fish.
- Monitoring of official fish harvesting statistics reported by Phu Yen Local Peoples Committee

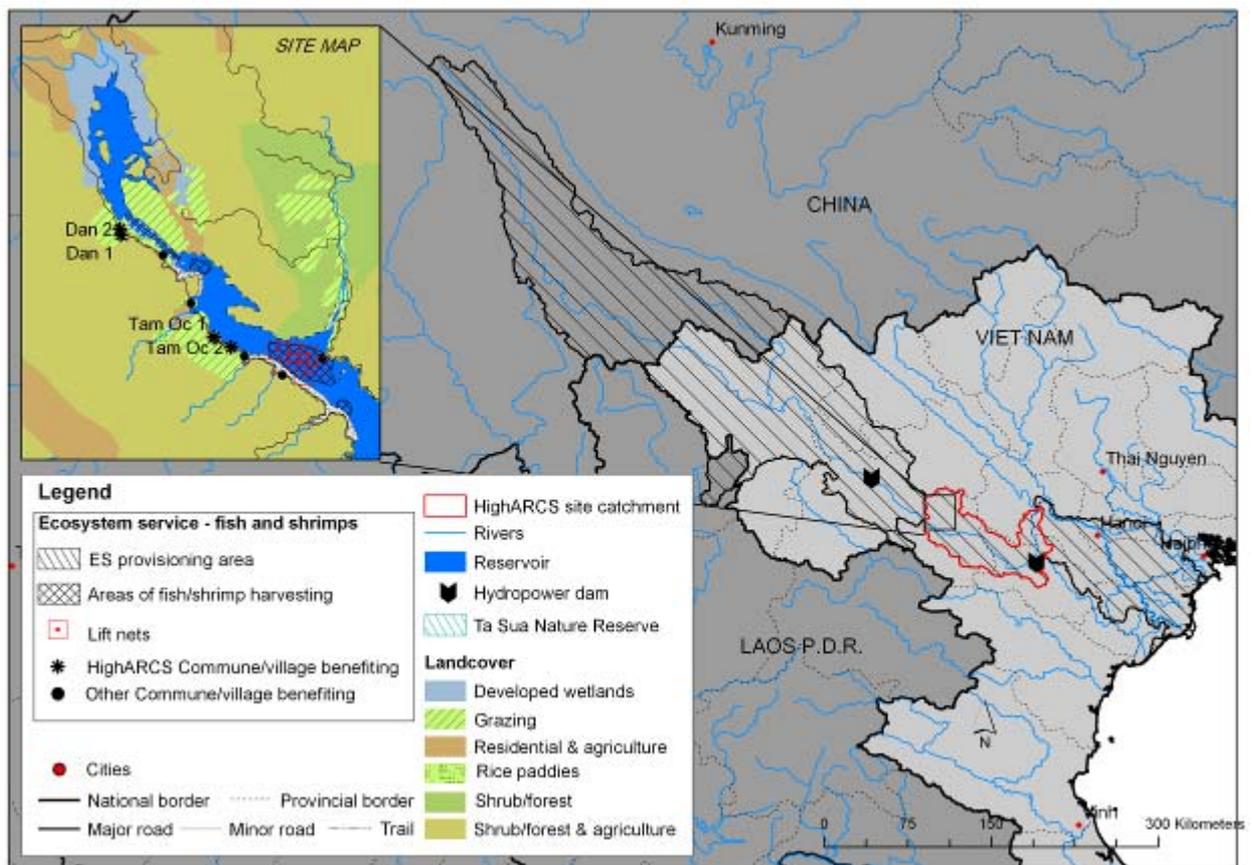


Figure 7: Areas supporting ecosystem services provisioning fish and shrimp

Water provision and water purification

Water supplies for human use and livestock are also rated as important services. The local communities rely on water from the reservoir/river when the water levels are high, but during the rainy season they also harvest water from mountain streams, which in some cases is piped to the villages. Water for crop irrigation is generally seen as less important as many of the local people farm in mountain areas where crops are generally rain-fed and water from the river is only needed to farm one crop of rice. Potential indicators should be identified through the process of IAP implementation in consultation with stakeholders.

Water transportation

Water transportation plays an important role in the daily activities of local people. During the flood season, people use boats to cross the river and carry their agricultural products from mountain areas to the villages. During the dry season, or when the water levels are low people have to spend more time walking cross the river carrying goods by hand.

Potential indicators:

- annual social surveys to identify the how often boats can be used to transport goods and people across the river
- monitoring of water levels in the reservoir (use of official statistics).

Hydropower

Total installed capacity of Hoa Binh hydropower is 1920 MW (Hirsch et al. 1992) and the study area makes an important contribution (through water storage) regarding the operation of this hydropower scheme. However, it is difficult to calculate its actual contributed proportion.

Potential indicators: the annual power output of the Hoa Binh hydropower station (and the potential of new dams being built along the Da River in Phu Yen).

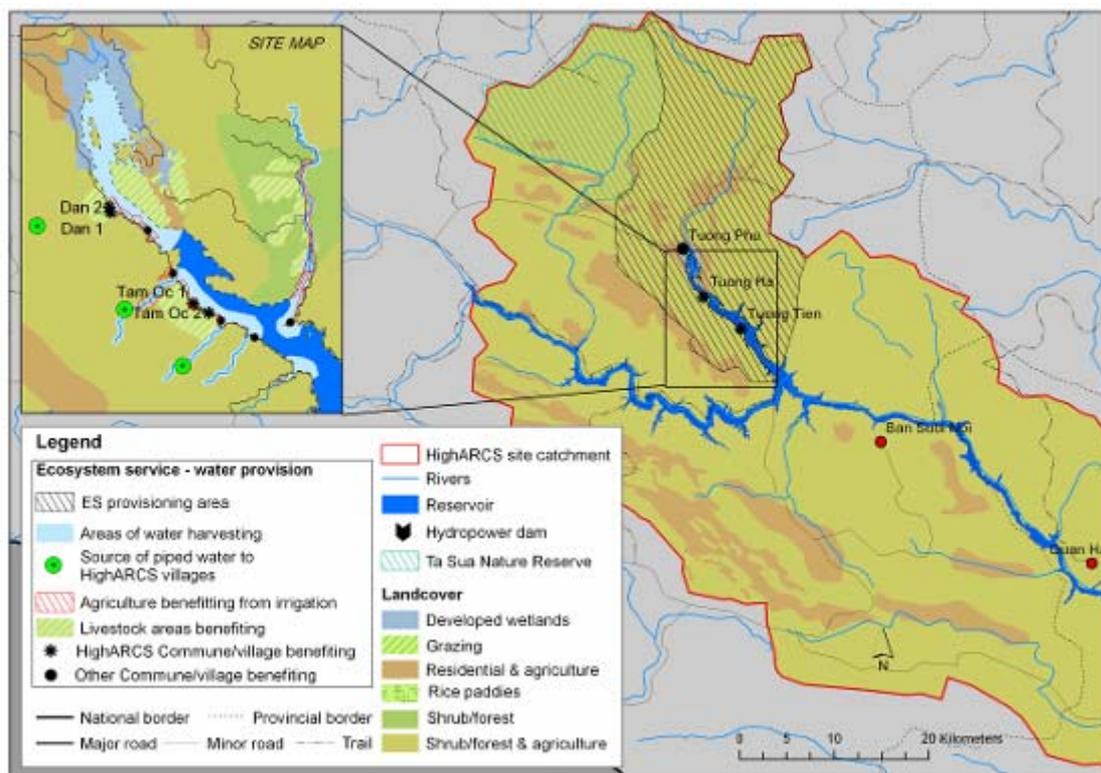


Figure 8: Areas supporting the ecosystem service of water provision

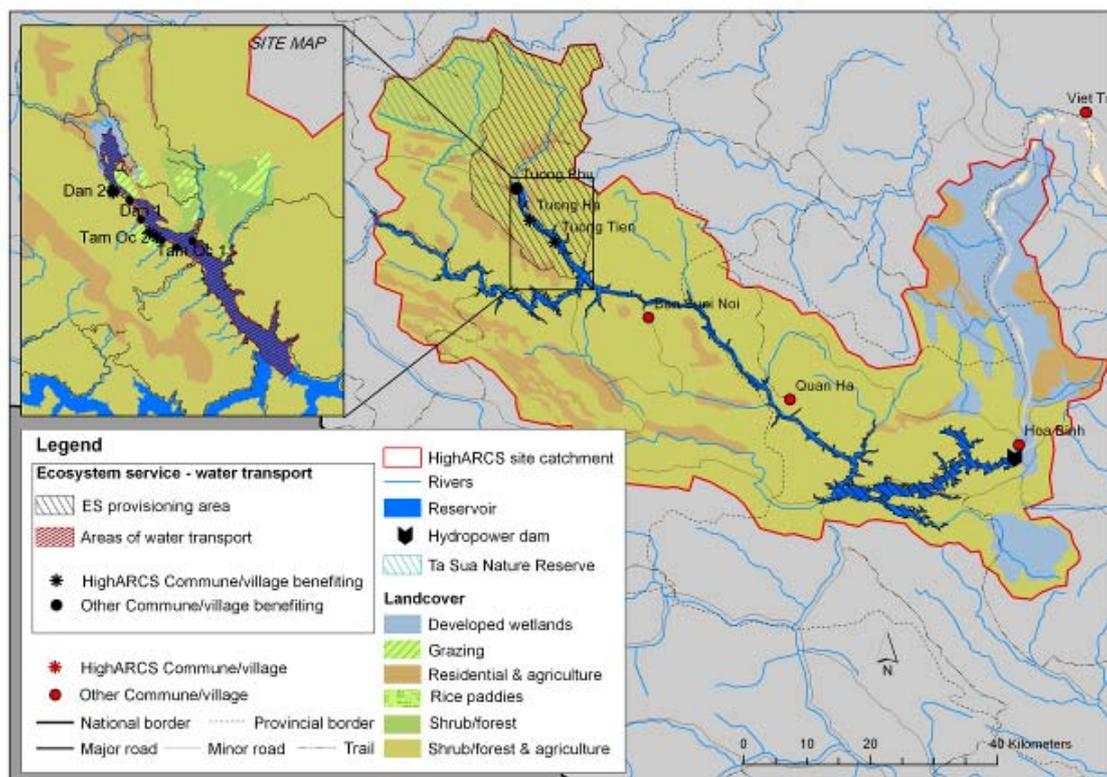


Figure 9: Ecosystem service of water transport areas

Climate regulation

In terms of local climate regulation the role of the rivers/reservoir is unclear. Through the focus group discussions, local people indicated that the climate seems to be more harsh and there are more ‘Laos’s winds’ (hot and dry wind blowing from Lao) since the hydropower dam was created in 1994. However this may be due to the changing wider climate or the moving of the settlement position (the villages moved further up the hills/catchment when the reservoir was formed). It is necessary to monitoring the local climatic parameters to evaluate this regulating service.

Potential indicators: Monitoring at the temperature, wind and rainfall at the site

Flood control

The natural vegetation in the catchment still provides some degree of flood protection to the communities at the site, however flooding still occurs at the site and the continued loss of vegetation in the catchment will only increase the severity of flood events. Flooding at the site needs to be better understood, as the water levels at the site are dependent upon rainfall and the reservoir levels controlled by dam operations. The dam operators do communicate when water levels are going to rise or fall to local authorities which then inform local people.

Potential indicators:

- Monitoring of water levels in the reservoir (use of official statistics)

- Annual social surveys to identify number of flood events at the site

Habitat for economic species, maintenance of genetic resources of valuable fish species and biodiversity protection

These services were rated with high importance by all groups (apart from biodiversity protection by Group 3 – villagers). Son La People Committee (2009) indicated that the fish fauna in Son La Province is diverse with 162 identified fish species, of those 126 are found in the Da River (Bui The Anh, 2011) and many of them are economically important and endemic species (Annex 1). In terms of biodiversity protection, although many native species survive in the reservoir it is an artificial habitat and construction of the dam and subsequent reservoir will have changed and destroyed many natural habitats causing many species (particularly those that require flowing water, or plants that cannot survive the large changes in water levels, and migratory species that cannot pass the dam) to be extirpated from the area.

Potential indicators:

- Regular fish market surveys, identifying species composition, harvesting locations and catch levels.
- Annual social surveys of fishermen to identify their perception of trends in quantity and quality of fish.
- Monitoring of official fish harvesting statistics reported by Phu Yen Local Peoples Committee

Tourism and other cultural services

Cultural services including educational value, research value, spiritual, aesthetics, recreation and tourism have proved difficult to define in this study. They were scored with relatively low value (apart from education), especially for recreation and tourism. However, Phu Yen District is an important economic development area in the Northwest region and it is not too far from Ha Noi the capital. Consequently there is potential for the development of tourism in this area in the future.

Potential indicators: Use of official government statistics to monitor the number of tourist visits every year in Phu Yen

4. Overview of livelihoods (WP4)

Historical change in livelihoods

Son La has a complex history, with relative historical isolation from the state structures of the lowlands, while also being influenced by indigenous forms of economic and political organisation. Decollectivisation coincided with what is perhaps an even more significant shock to the livelihoods of Tuong Ha and Tuong Tien, the construction of the Hoa Binh dam downstream. Between 1986 and 1989 households were compelled to move to slightly higher ground to make way for a new reservoir which would flood the valley (Table 1). A large portion of the most fertile rice land was lost under the water permanently for most residents, and seasonally for some of the residents of Tuong Ha,

who could plant just one rice harvest. While aquatic resources in earlier periods were primarily valued as a source of water for irrigation and household use, and as a location for small-scale fishing activities, they now played a far more significant role in people’s lives as communities were compelled to adapt their livelihoods following the loss of their paddy lands.

Fishing activities in the new reservoir were promoted and supported through the governments Project 747, although this was by no means straightforward for households who were not traditionally large-scale fisher people. Kinh fishers from the lowlands were the first to benefit from the new reservoir. They would migrate seasonally and set up temporary floating homes in shallow sections of the reservoir for a few months a year, and would fish with large fixed ‘lift nets’ and with seine nets from small boats. They continue to reside here, and over the years their fishing skills were gradually transferred to local people, whose livelihood strategies today include a diversity of aquatic and non-aquatic dependent activities.

Table 1. Timeline of villages

Year	Events
1986 – 1989	Move to higher place because of construction of Hoa Binh dam
1990 – 1991	No wetland cultivation because of high water level
1995	Project 747 supports planting forest and equipment for fishing and aquaculture
1996	Having electric system. Animal disease because of new higher living place
1997	CARE project supports construction of water tank, training technical planting trees and breeding livestock, cattle.
1999	Started constructing road No 114 (provincial road) that was finished in 2009
2002	Storm destroyed ten roofs on houses
2005	Number of lift nets increase but hand nets decrease
2007	Flooding caused muddy water and many fish and shrimp died. Yield decreased
2008	Successful soybean crop due to new seed and area of soybean much increase
2009	Unsuccessful corn crop due to the damage of rats

(In focus group from 14/4/2010 – 23/10/2010 in Tuong Ha and Tuong Tien commune)

Wealth ranking

Patterns of resource use today and livelihood strategies vary considerably within the study communities. In order to gauge these differences it is first necessary to identify the livelihood

resources or 'assets' available to different groups of households. The first step in this process entailed a wealth ranking exercise (see Table 2).

Table 2. Characteristics of household according to well-being ranking of study villages

Villages	Worse-off households	Medium households	Better-off households
Dã 1	<ul style="list-style-type: none"> - Low level income, -More dependent people (children ,old person), -Family members with illness - New household, - Lack of capital, -Obligated to take loan with high interest - Involvement only in agriculture and fishing, 	<ul style="list-style-type: none"> -Normal income, -Some inheritance of capital from parents. -No access to bank loan -Some land 	<ul style="list-style-type: none"> Stable income -Subsidy from government (200,000 - 600,000 VND/ month, -Access to pension, -Capital investment, -Higher education for children , -Head of village or commune -Involvement in business or trading -Enough food for whole year
Dã 2	<ul style="list-style-type: none"> -Lack of labour, having many dependent people (children) -Family members with illness -Not enough food all the year. -No motorbike -Limited access to loans -Lack of land 	NO DATA	<ul style="list-style-type: none"> -Stable income, -Only two children, -Happy family, -Enough food for whole year -Motorbike -Higher education for children -Large land holdings
Tầm Ốc 1	<ul style="list-style-type: none"> -Income lower than 200.000 VND/month/person -Lack labour -Two small children and old person -Poor health -New divided HH from poor 	<ul style="list-style-type: none"> -Income from 300,000 to 400,000/person/month No ill people -No access to bank loan 	<ul style="list-style-type: none"> -Income more than 400,000/person/month -Inheritance of capital from parents - Stable income -Access to subsidy or pension -Children studying at university - Involvement in business

	Households -Lack of capital, -Obligated to take loan with high interest -Little land	- Hard working	
Tầm Ốc 2	-Many people in the family, -New households, many small children -Lack of valuable asset, -Poor health -Limited knowledge.	-Works hard but lack capital. -Good health, knowledge -Good labour management	-Access to, subsidy -Inheritance of capital from parents Access to household labour (4-5 main labourers), - Knowledge of integrated agriculture, -Fishing with animal husbandry -More than 10 cattle -Hard working
Tật	-Ineffective use of capital -Less labour and many small children -Many children and old people, -poor health, -Newly started household , -Limited knowledge. -All husband and wife have no education	-Having many children at school -Main occupation is agriculture - Good agricultural productivity	-High income - Inherit capital from parents - Access to pension/ allowance - Access to loan to invest in plantation forest and animal husbandry -Hard working -Few dependent people -Children have higher education and stable job -Government job

‘Worse-off’ households are those that lack land or capital to invest and have limited education. Without adequate holdings of wet rice land, households often must cultivate cash crops such as corn and cassava on the fragile upper slopes or carry out small scale fishing to generate cash to purchase rice in the market. Even holdings of land on the upper slopes are sometimes marginal. Given the lack of opportunities to generate a surplus in this context there are fewer opportunities to diversify their livelihoods through entry into trade and other occupations. Another cause of poverty is demographic. Households classified as ‘poor’ often have a large number of dependent family members such as young children or elders, which means there is a shortage of food or income

relative to the amount of productive labour in the household. Poor health can also increase the numbers of dependent family members and can incur additional expenses. Such households usually have a small house with more limited space to live, with day to day food insecurity and no valuable assets such as motorbikes. They are often dependent upon loans from the bank or private lenders, often at high interest rates.

'Medium' wealth households have larger holdings of wet rice land and can usually meet their subsistence needs through agriculture and fishing. They also are not constrained by large numbers of dependent family members or illness. However, most households in this category lack significant savings and there is limited capital investment to expand the household asset base.

'Better-off' households have a lot of land and cattle which assures them year-round livelihood security and allows them to generate a surplus product which when sold can be used to accumulate wealth. Profits are sometimes invested in more advanced agricultural inputs and machinery, or are diverted into other activities such as aquaculture. This explains the higher average investment over the last year of 3,519,000 VND on agriculture, livestock and aquaculture inputs by 'better-off' households as compared to the 2,283,000 invested by 'medium' households and 1,736,000 spent by poor households. Furthermore, the survey showed that 7 sampled 'rich' households owned high value machinery such as threshing and husking machines, while only three 'medium' and one 'poor' household had made such investments. The consumption pattern of households reflects these wealth differences. According to 'better-off' households, they spend considerably more on building and maintaining their homes than their medium and 'worse-off' counterparts. They also have more electrical equipment such as televisions and refrigerators and spend more money on gas to cook.

Children in the 'better-off' category have a better education, family sizes are reportedly smaller, and the general health of the household is better. Although educational expenditure per person was reportedly higher for richer households larger family sizes amongst poorer households may be why average educational expenditure over the last year remains the same for all wealth categories.

In order to understand the basis for wealth differences, a first step is to examine each livelihood resource, and examine who has access to them. Natural resources include wetlands, hills, fields, forests and water surfaces. In the research areas, there is more than 200ha of water surface. The reservoir is by far the most important aquatic resource in the study site. The watershed belonging to the Hoa Binh hydropower dam has a high potential for fishing and aquaculture (The Social-Economic Report for Tuong Ha Commune in 2009; The Social-Economic Report for Tuong Tien Commune in 2009). The reservoir is effectively 'common property', in that any household with appropriate fishing equipment can utilise its resources. Aside from this, there are some small artificial ponds which are privately owned and built by households for aquaculture. There are also several smaller streams which are sources of aquatic produce such as molluscs.

Marshy wetlands were traditionally used for wet rice cultivation, although since 1994, the water level in this area has increased due to the storage of water in the Hoa Binh hydropower dams and they are underwater. Before resettlement, all the villages had a large area of wet fields but now most of it is under water, so local people are lacking wet land for rice cultivation especially in Tầm Ốc 1 and Tầm Ốc 2 village, where each household previously had 2ha wetland area which was distributed by the village leader. However the yield of agricultural products harvested in these areas depends on natural conditions and water level. The annual rice production is about 5.6 – 6.6 ton/ha

(Tuong Ha People Committee, 2009; Tuong Tien People Committee, 2009). Furthermore, wet rice holdings are not equally distributed. Wealthy households have larger holdings of wet rice land than their poorer counterparts, explaining their stronger livelihoods. Households classified as ‘poor’ and ‘medium’ own on average 533 and 430m² of wet rice land respectively, while ‘rich’ households own 904m².

Hill land and dry fields are the main land for agriculture activities in the study site. Cultivation in dry fields includes dry rice (*Oryza sativa*), corn (*Ostrinia nubilalis*), cassava (*Manihot esculenta*), soybean (*Glycine max*) and dong giềng (*Canna edulis*). Techniques of cultivation are different between villages, depending on the natural conditions and habit of local people. In general, the quality of land is decreasing due to soil erosion, deforestation and unsustainable farming techniques.

Regarding forest resources, there are two kinds: natural forest and cultivated forest. Natural forests are listed as national assets that are entrusted to local communities for protection. Beside natural forest, each household has also been given two hectares of hill land to plant and manage. On these kind of land, local people are growing forest tree such as Keo (*Acacia mangium*), Luồng (*Dendrocalamus membranaceus munro*) and Tểch (*Tectona grandis*).

Aquatic resource use

Livelihoods depend on a combination of both aquatic and non-aquatic resource based activities. Agriculture is the predominant livelihood activity in Tat, Dan 1 and Dan 2 villages, while both fishing and agriculture provide the main income in Tam Oc 1 and Tam Oc 2.

Aquatic resources in Hoa Binh reservoir today play an important role in the livelihoods of respondents in each of the three villages. A diverse range of fish are caught, as is displayed Table 3. Households in Tam Oc are most dependent upon aquatic resources, primarily because this village had lost the most wet rice lands due to the reservoir, obliging households to diversify their livelihoods.

Table 3. Species of fish caught locally

Local name	English name	Latin name	Harvest seasonal
Cá Chép	Common carp	<i>Cyprinus caprio</i> (Linnaeus, 1958)	July to August next year
Cá rô phi	Tilapia	<i>Oreochromis mossabicus</i> (Peters) <i>O. niloticus</i> (Linnaeus, 1758) <i>O. aureus</i> (Steindachmer, 1864)	All year
Tôm sông	Shrimp		September - April next year
Cá tạp	Trash fish		From January to July
Cá Mè trắng	Silver carp	<i>Hypophthalmichthys</i> Bleeker, 1860	July - August next year
Cá Trắm cỏ	Grass carp	<i>Ctenopharyngodon idellus</i> (Cuvier & Valenciennes 1844)	July - September

Cá Trôi	Mud carp	<i>Cirrhinus molitorella</i> (Cuvier & Valenciennes 1844)	July - September
Cá Ngõo		<i>Ancherythroculter daovantieni</i> Banrarescu, 1967	September - February next year
Cá Bò		<i>Pelteobagrus fulvidraco</i> (Richardson) <i>P. tonkinensis</i> Hao, 2001 <i>P. intermedius</i> (Nichols & Pope)	October - December
Cá Lăng		<i>Hemibagrus guttatus</i> (Lacepede, 1803)	October - December
Cá Măng	Milk fish	<i>Elopichthys bambusa</i> (Richardson, 1844)	All the year

Local people use a number of different tools for fishing such as lift nets, traps, hand nets and cover nets. Some methods have been forbidden, although the fishers still use these techniques secretly on some occasions, such as the use of explosives or electricity. According to the survey, the total yield of fishing was 46 tons in 2009 in Tuong Ha Commune and 14 tons in Tuong Tien. The fishing method includes lift nets, boat fishing and small scale fishing (line fishing and using trap). Among 94 households interviewed, 54 households (57.4%) were involved in fishing, with 5 households using boats with an engine and 55 using small boats and 32 households used lift nets.

Many people use traps to catch shrimp. They go out very early in the morning (4-5am) to lay the traps, and then return in the evening to collect them. This is mostly done closer to the village. A household who used 1000 traps (cost for one trap was 2600 VND) could earn 1.5 to 1.7 million VND per fishing month per person. However the season is only about six to seven months (from late September to the following March). Traps can also be used to catch very small fish. Often these 'trash fish' sell for about 8000VND per kilogram and they can catch up to 10kg per day. Boat fishing often involves long distance travel on larger boats with motors. This is practiced mostly by Kinh fishers, and one or two households in each village. The common species collected include shrimp, common carp, silver carp, mud carp and "trash fish". Fishermen said that the quantities of fish are decreasing due to overfishing and soil erosion which has worsened water turbidity and promoted accumulation of mud.

In the five villages surveyed, Tầm Ốc 1 and Tầm Ốc 2 villages have a higher rate of households involved in fishing with the proportion of 94.4% and 78.4% respectively; followed by Dã 2 (47.8%), Tật (34.8%) and Dã 1 (32.6%). In Tầm Ốc 1 and Tam Oc 2 village, people spent most of the time fishing because they lack wet rice land, while the upland field soil quality is poor and crops are frequently damaged by rats. The proportion of poor and medium households involved in fishing is higher than for better-off households, suggesting that they are more dependent upon aquatic resources, perhaps due to their limited ownership of land and other productive assets. There are more than 60% of medium and poor households engaged in fishing as compared to just 50% of the wealthy households. The reason is perhaps the fact that better-off households have more land and higher income from animal husbandry than their poorer counterparts, and therefore spend more time engaged in agricultural activities. Within the household, men participated in fishing more than women (Table 4) and the men usually go out to fish in the afternoon and return in the morning the

next day. In some households the husband goes fishing for a few months and their wives stay at home to take care of her children and work in the field.

Aquaculture

Another livelihood activity which depends upon aquatic resources is fish culture. The large surface area of the reservoir and the availability of bamboo to make cages suggest there is a good potential for cage culture development. From 1990 to 1991, the government supported a policy on cage culture development in Hoa Binh reservoir but it was not successful because of fish disease and water fluctuation. At the same time, the complicated topography of the mountains limited the potential for pond culture. Each village has 3 or 4 ponds with an area of 70 to 100 m². Pond culture is normally carried out by some wealthier households who can afford the investment, although productivity is generally low. For example, one 'better-off' household was raising tilapia in a pond. Some was sold and the rest was kept for the family. The common culture species include tilapia, common carp, grass carp, mud carp, catfish and silver carp which are highly adaptable species that can survive on available food waste such as cassava and banana leaves and grass. All households wish to participate in cage culture because despite its limitations, it is one way to supplement their income in the context of soil erosion and climate change.

Gender and age

In terms of aquatic resource dependent activities, both women and men are involved in fishing near the village, using shrimp traps, lift nets and small boats. It is primarily women who are involved in fishing from smaller streams near to the villages, which is compatible with their work responsibilities in the home and existing gender ideologies. It is however, considered dangerous for women to travel out onto the distant shores on the larger boats. Occasionally they do participate, but only with their husbands, and this is normally due to labour shortages. When husbands go fishing it is normally overnight and they return in the early morning. This allows them to travel quite far, often as far as Moc Chau, the next district, where the fish stocks are more plentiful. By staying the night the nets can be left out, and it saves them the fuel which would be used if they had to return to the village and then come back to collect the nets in the morning. The tendency for men to migrate to other provinces both on a temporary and permanent basis has increased women's role in many aquatic dependent activities. We heard of some women who had been learning fishing and shrimp catching techniques from their husbands who were now migrating outside.

Table 4. Household activities ranking by women group in Tầm Ốc 1 village

Activities	Men	Women	Boys	Girls
Fishing	++++	++	+	+
Sowing crop and planting	+++	+++	+	+
Transplanting rice	0	++++	0	+

Ploughing fields	++++	0	0	0
Gardening	++	++	+	+
Going to market to buy product	++	++++	+	+
Selling product	+++	+++	0	0
Tidy up house	++	+++	++	++
Repairing house	+++	+	0	0
Cleaning the house	+	++	++	++
Collecting wood	+	+++	++	++

Level: +++ : Very involved; ++ : Moderately involved; + : Least involved; 0 : Not involved

Aside from gender divisions, there are significant differences in labour responsibility according to age. Boys usually play a more important role in fishing activities. Young boys who do line fishing derive their fishing knowledge from their fathers and elder siblings. They also enjoy watching older men fishing. Boys usually go to the reservoir to catch fish by boat, hand net or trap. Girls' fishing activities are normally restricted to catching snails or small fish near the river's edge. Any money which is earned by boys or girls through fishing is normally given to their parents to buy rice and cover family expenses. Some children wish to keep a little money for themselves such as to buy new clothes, notebooks, or shoes. Girls aspired to buy clothes, shoes and books while boys wanted to buy bicycles, mobile phones and balls to play. However, sources of personal income were generally low and children generally felt a responsibility to give all their catch to their parents.

While girls play a limited role in fishing, they play a more important role in agricultural activities, and the maps they produced for the focus groups showed much more detail for the different agricultural environments when compared to those produced by boys. Girls also make a significant contribution to household reproductive activities such as washing clothes, cooking, washing bowls, collecting wood or working in the garden. Boys however, play a more marginal role in these activities.

The activities which boys 'enjoy' most include fishing, swimming, catching snakes, trapping birds in the field, and studying, whereas activities boys least enjoy include washing clothes, washing bowls, working in the fields, collecting wood and cooking. The girls said that the activities which they most enjoy as include catching snails, cleaning the house and planting vegetables. Activities they least enjoy include preparing food for pigs, working on the fields, collecting wood and taking care of buffalo. Some actually noted catching snail as a 'least enjoyable' activity.

Education is really valued by both boys and girls, and they feel that their parents allow them to focus on this when they get older and work less. When they were younger they were expected to contribute significantly to household labour, but when they are in high school, they are allowed to

focus on their studies during free time. Girls for example, noted how when they were younger (up to age 12) they used to go out to collect snails from the smaller streams with their friends. However, now they no longer have time.

5. Overview of institutions, policy and conflict (WP5)

In the local governments view aquaculture and fisheries are important livelihood activities for local people hence these activities are encouraged and promoted. Aquaculture activities and outputs are planned to be doubled and tripled within the next 5 to 10 years and with introduction of new species this is expected to impact the biodiversity and natural resources conservation. Present fishing practices are unsustainable and illegal and regulations and penalties are not enforced.

Aquatic catch and markets in Phu Yen District, Son La Province

Research carried out in two communes Tuong Ha and Tuong Tien (Phu Yen District, Son La Province) showed that fish is the main aquatic market product and fish are being traded in a well defined network (Figure 10).

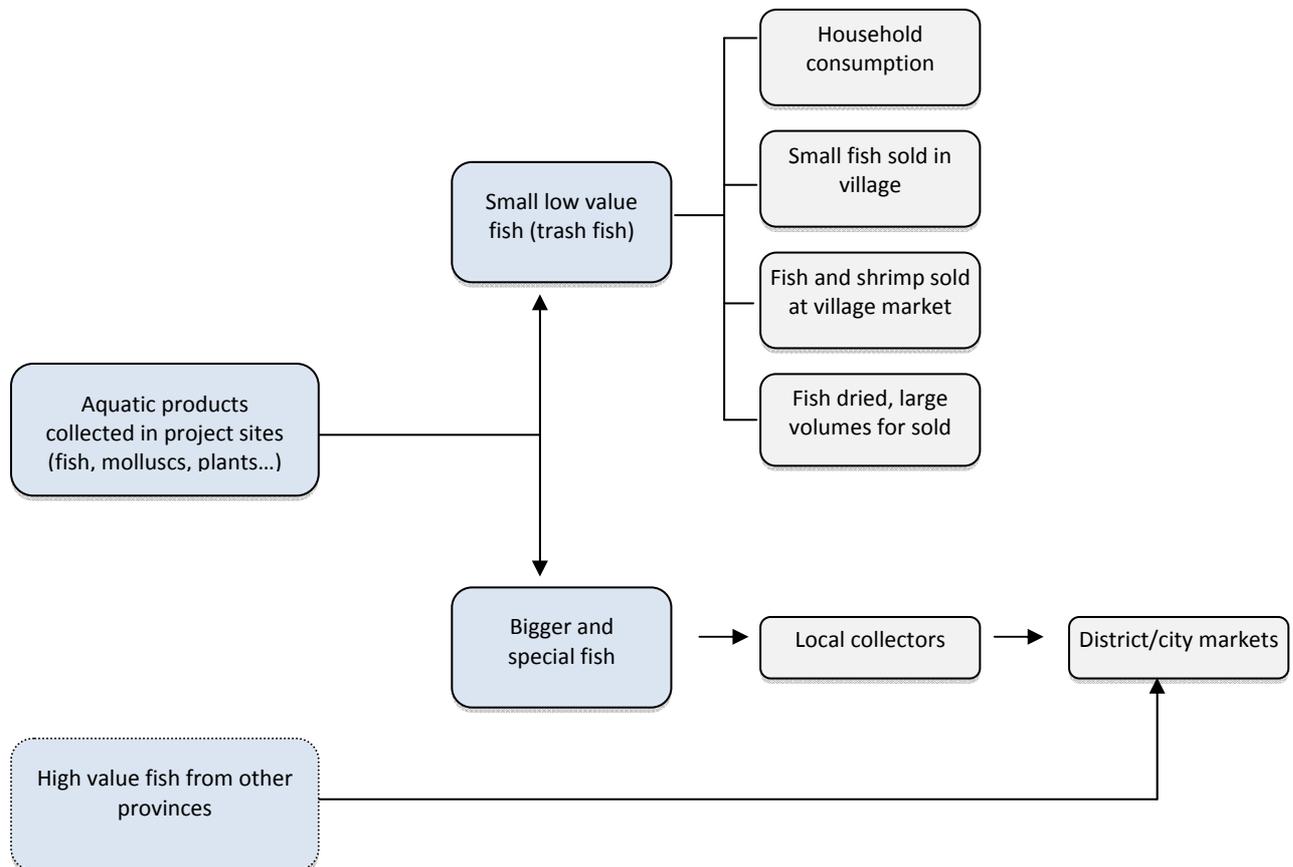


Figure 10: Fish market chain in Phu Yen District

Fish collected are divided into big, high value fish and small, low value fish (trash fish¹). Normally, the big fish and special fish are sold to local collectors who will bring them to the city markets or restaurant. Trash fish with higher volume are dried for sale, used for pigs as well as used for household consumption. Sometimes, the small fish are transported by bike to sell in the village. Fish and shrimp are also sold at the local market, which opens three times a month. This market is more important for ethnic minorities' living at the top of the mountain such as Hmong people who often take a day to go to the market to buy fish and other products such as salt, sugar candies, seeds and oil for lighting (field trip in Tuong Ha).

There are estimated to be one or two fish and shrimp collectors in the commune who collect shrimp in the village in the morning (5-7 am) and afternoon (5-7 pm) on a daily basis. Intermediate traders then buy all the fish and shrimp for further distribution to cities such as Hanoi, Hai Phong and Hai Duong for sale. It was estimated that three trucks are used for the distribution of fish collected around watersheds in Phu Yen District and neighbouring areas which equates to about 10 tonnes of aquatic products being traded per day. In Phu Yen, restaurants often order fish, shrimp and snails from traders collected from streams (Restaurant interview, Sep 2010). There are 8-9 fish retailers in Phu Yen District markets, of which four sell river fish, including two people from Phu Tho Province who both catch and sell fish directly. Because, the price of wild caught big fish is a lot more expensive than cultured fish, wild fish are sold in markets in the cities, while cultured fish are brought from other provinces to supply in Son La. With such an exchange of fish it is difficult to ascertain figures of the real catch of fish in the areas. And no authority controls the trade in fish.

Stakeholders related to highland aquatic conservation

Stakeholders involved in biodiversity and conservation of highland aquatic resources include:

- Fishers: those people have livelihoods heavily dependent on fisheries resources, part or their total income related to fishing.
- Traders: wholesalers, middleman or small traders in fish and aquatic product.
- Consumers: consumers who use aquatic product as daily food or restaurants who cook aquatic product.
- Managers: staff from the central to local agencies who are involved in agriculture, fisheries and environmental management.
- Researchers: researchers who participate in the study of fisheries resources and have knowledge in aquatic resources in mountainous areas.
- Non-governmental organizations: active in the field of aquatic resource conservation, environmental managers and hydroelectric managements.

¹ The term 'trash fish', although used widely locally, is indicative of the low monetary value associated with some species and size classes and greater awareness is needed concerning the broader benefits of maintaining and enhancing aquatic biodiversity to sustain stocks and flows of ecosystem services supporting broader social-economic development

There are many development pressures on and threats to aquatic resources in Son La Province, including hydropower development, gold and mineral mining, agricultural cultivation, industrial activities and deforestation. And according to a Government official in Phu Yen District (Interview, September 2010) it is challenging to balance economic development and aquatic conservation, and to ensure poverty reduction, food security and sustainable use of aquatic resources. The key finding with regard to pressures, threats and conflicting interests are presented in the following sections.

Conflicting interests in hydropower generation and aquatic resources conservation

In Phu Yen District, Tuong Ha and Tuong Tien Communes are located on the reservoir of Hoa Binh hydropower scheme with the capacity of 1,920MW and Son La hydropower with the capacity of 2400MW. In addition, according to the master plan 2009-2020 there will be four more small hydropower schemes (Suoi Sap 1, Suoi Sap 2, Suoi Sap 3 and Muong Lang) with the capacity of 8-15 MW in Phu Yen District (Phu Yen People Committee 2009). The fishers in Phu Yen, Son La said that fish production is greatly reduced since hydropower stations were constructed; the construction of dams destroyed breeding ground, fish could not migrate to breeding areas, sediment load covered the living areas for fish, there are too many people involved in fishing and many of them use destructive fishing equipment (although banned) such as mine, electric and small mesh nets (General notes from Tuong Ha and Tuong Tien observation interviews, 11/4-22/4) the construction of hydroelectric power leads to migration and resettlement, the population growth leads to excessive exploitation of natural resources, changing habitats, changing the natural living areas to make room for the activities of human life. However, a local authority said “if we manage the hydropower well, the aquatic resources will not be affected” (Interview, Sep, 2010).

There is an environmental impact assessment before the construction of hydropower schemes, but there is no research on the changes in aquatic resources after (Key informant interview, Jan, 2010). However, the construction of hydropower leads to changes in land use; water filling up rice fields leading to the cessation of rice cultivation which forces people to cut down trees to create new planting areas. People in these areas use old cultivation techniques so productivity is low and poverty high which emphasizes deforestation and destructive fishing; finally, the environment has been continuously destroyed. It is evident that the development of hydropower and poverty are the most important factors explaining declining biodiversity in Phu Yen. This shows that there are many conflicting interests between the hydropower development plans and biodiversity conservation.

Conflicting interests between mineral exploiting and biodiversity conservation

In Phu Yen District, policies are being developed to attract investment from investors and companies that wish to come and exploit and process minerals such as copper ore (Cu), lead ore (Pb) and nickel. In the master plan, it is proposed to set up two factories to process copper ore in Gia Phu Commune and lead-zinc processing in Muong Coi Commune and build ore exploiting stations in Da Do and Suoi Bau Communes. Furthermore, plans include building an NKP fertilizer factory in Gia Phu to use the by-products from ore factories (Phu Yen People Committee, 2009). Based on this, exploitation of mineral resources could have a devastating impact on the environment and reduce biodiversity. It is clear that the master plan for mineral exploiting in Phu Yen is in conflict with biodiversity conservation.

Conflicting interests between agriculture and biodiversity conservation

In Phu Yen, it is apparent that agriculture production (rice farming, soybean farming and tea cultivation) use chemicals and pesticides that can be discharged into the environment and cause water pollution. Many people said they were actively cultivating higher slopes and using plant protection agents, notably pesticides. Given problems with erosion and the prevailing climate it is likely that rain will wash such chemicals into rivers and lakes and create negative impacts (Focus group at Tuong Ha, Oct 2010). However, in the master plan of Phu Yen District in the period 2009-2020, a change in emphasis for agricultural development is encouraged, focusing on intensive farming, limiting farming on highly sloping land, increase long-term industry trees (tea and rubber trees) and increasing livestock numbers. In addition, distribution of forest land to households and community management of these holdings is included with an aim of having 17,455ha of forest in 2020 with forest cover at about 60% (Phu Yen People Committee 2009). Following this master plan, livestock proportion will be more prominent in the agricultural sector, thus waste and chemical use will increase and negative effects on the environmental and biodiversity can be foreseen.

Conflicting interests between fisheries and aquatic conservation

Fisheries and unsustainable aquaculture have led to negative impacts on natural resources conservation in Phu Yen District. The Master Plan of Phu Yen District for 2009-2020 encourages aquaculture, especially cage culture and fisheries in Da Reservoir. It is estimated that the total area suitable for aquaculture would be 159ha in 2020 with average production of 1.5-2 tonne ha⁻¹ under aquaculture. The main culture species are mud carp, common carp, silver carp, tilapia, frog and turtle. Following this policy, cage culture and aquaculture with introduced species will create an impact on environment and native species in this area. In addition, people living in Son La Province face very difficult circumstances; rice field loss due to flooding and the replacement of hydropower dams and low yields of maize and cassava due to soil erosion. Therefore fishing is one of the main livelihood activities. Recently, illegal fishing with inappropriate net sizes and electric equipment has led to decreasing aquatic resources. If policies encouraging fishing on the Da Reservoir are carried out when illegal fishing is still an issue, aquatic resources and biodiversity will be reduced rapidly.

Local authorities believe that propaganda promoting fishing laws and awareness-raising for aquatic conservation are important for biodiversity conservation. However, fishing within the boundaries of the law does not provide the people with enough fish to ensure survival so they are still pushed into illegal fishing. If fishing is strictly banned people will lose their job and livelihood so there is no easy solution for this issue (Interview, 9/2010). Thus, it is important to educate people about the role of biodiversity in the livelihoods of local people in the long term and create alternative jobs for local people instead of promoting dependence on fishing.

Conflicting interests in factory development and environmental protection

According to the Master Plan for development of Phu Yen District for 2009-2020, there will be four industrial zones in Gia Phu, Huy Thuong, Huy Ha and Muong Coi Communes. Consequently, there will be many factories built such as tunnel brick factories, ceramic factories, textile and agriculture product processing factories (Phu Yen People Committee 2009). If all these factories are built and do not strictly comply with environmental regulations then there will be a significant risk from water pollution. Recently, some processing facilities in Phu Yen District discharged waste to the river and affected the lives of local people. However, at the district level, there is not enough equipment for

water quality checks or reports that could lead to penalties for the factories. Therefore, it is very difficult to prevent and stop the discharge of factory waste (Interview, 9/2010).

6. Synthesis chapter

Problems from WP 3

Soil erosion is a major problem owing to cultivation on sloping fields, poorly suited to agricultural production. Aquatic resources are declining as fishing tools and methods for exploiting fish stocks are unsustainable, with over fishing and use of small size nets, mining, electricity and lift nets being widespread. Water resources are polluted by soil erosion (resulting in turbid rivers and causing fish kills) and petrol from boats on the river.

Major aquatic habitats in the HighARCS site in Phu Yen are predominantly artificial, with the reservoir levels dictated by the management of the Hoa Binh hydroelectric dam which was constructed in 1989 (communities were relocated up the catchment to allow for the reservoir). The construction of the dam on the Da River is likely to have had major impacts upon the native biodiversity, particularly those not adapted to lacustrine conditions, requiring migrations to complete their lifecycles or not able to survive large changes in water levels. The exact impacts (which species no longer occur at the site) are unknown, though many native species still occur there providing an important resource to the local communities. Based on a collaborative project between Research Institute for Aquaculture No1 and the Ministry of Agriculture and Rural Development called *Assessment of Inland Fisheries in Son La Province 2008-09* 126 species of fish are known to occur in the Da River (Bui The Anh *et al.* 2009). Of these, 8 species are non-native, many of which are known to have negative impacts upon native species and habitat quality.

Key threats to biodiversity and ecosystem services at the site are overfishing and the use of destructive fishing methods, agricultural pollution, deforestation, and the changing water levels caused by hydropower dam operation. All the threats apart from overharvesting are driven by factors outside of scope of community control, with land use changes upstream and dam control impacting the biodiversity and ecosystem services at the site.

Ecosystem service prioritisation work has shown that different stakeholder groups value the services differently. The regulating services were valued the highest by the Provincial and District level governance (group 1) and the Commune level governance (Group 2), in particular wetland water storage during dry season, habitat provision for economic species, flood control and the maintenance of genetic diversity of valuable fish species. Whereas the villagers (group 3) also value the provisioning services, especially fishes for commercial and subsistence use as highly as the regulating services. Many of the highly prioritised ecosystem services are dependent upon the reservoir (an artificial environment) and the dam management providing suitable levels of water for harvesting of fish and water.

Problems from WP4

Major problems elicited during livelihoods focused research and assessment activities include:

- Lack of wet land for rice cultivation in Tam Oc 1 and 2 villages
- Hard climatic conditions

- Low agriculture productivity so that there is a lack of food for four to six months (January to June)
- Lack of water for drinking, domestic use and cultivation in Tat Village; cultivation mainly depend on rain water
- Animal diseases
- No addition occupation to earn extra income
- Lack of capital to invest in animal husbandry and fishing
- Irregular water level change in the reservoir

Potential mitigation measures to compensate for these problems identified during focus groups with community members are summarized in Table 5 whilst solutions favoured by government officials include agricultural cultivation along river banks and cage culture in reservoirs.

Table 5 Problems and suggestion solution from focus groups

Problems	Suggestion solutions
Lack of water for drinking and domestic use	Increasing level of forest covering that keep ground water so people could make well to collect water for domestic use. In addition, building and maintaining water tank to store rain water in rainy season.
Degradation of soil and soil erosion	Planting the suitable plants in high slope that prevents erosion and increase benefit. Setting steps field, planting soybean and increasing the level of forest covering.
Damage crop by rats	Commune and schools is encouraging people to trap and catching rats Each household should have at least one cat.
Lack of technique in planting and animal husbandry	Communes organize annual training courses on planting, animal husbandry and aquaculture to improve knowledge for local people. Establishing groups in sharing experience of breed and plant in village.
Lack of capital	Government support and making good condition for loan with low interest
Degradation of aquatic resources	Improving people's knowledge about sustainable fishing. Strictly forbidden in using destructive fishing methods such as bomb, poisonous, explosive and electric equipments. Fishing households should join into a group or fishing union and making fishing regulation. All villagers need to understand and make agreement on it regulation as village's regulation. Need the good cooperation between communes, villages leader and police and army in carrying out the village's regular
Animal diseases	The agricultural staffs in commune combine with village organizing annual training course and injecting vaccine for cattle and livestock to prevent disease
No addition occupation	Find and establishing the suitable addition occupation such as make broom, handicraft ...in order to increase household's income

(In focus group from 14/4/2010 – 23/10/2010 in Tuong Ha and Tuong Tien commune)

Problems from WP5

Major issues identified concerning policies, institutions and processes included:

- Limited awareness of local people and staff on aquatic conservation
- Fishery law is issued in 2003 but local people cannot access it

- Due to a preoccupation with making a living people are not engaging in aquatic resources conservation
- Lack of staff for aquatic conservation with only one aquaculture staff at district level and none at commune level
- Lack of access preserve natural resources and fishery law
- Lack of a detailed guide on how to conserve natural resources
- Limited collaboration between stakeholders at different levels
- Allowing people outside community come to caught fish but don't manage their tools and methods, makes conflict between them with local people
- Limited progress in devising workable solutions for decentralization of management based on allocation of responsibility for selected surface water areas

The following key recommendations related to policies, institutions, and implementation in practice, should be considered when developing the action plans for sustained provision of ecosystem services, in view of improved resource use, tackling user conflicts and conserving aquatic resources:

- **Integration of biodiversity conservation into development plans:** it is recommended that biodiversity issues and targets are more fully integrated into the People's Committees at Provincial, District, and Commune levels to ensure a more integrated approach to development and conservation and to enable budget allocation for conservation.
- **Addressing the issue of overlapping institutional mandates:** it is recommended that functions and tasks for aquatic resource conservation should be clarified and the detailed responsibilities at sub-national levels developed. Moreover, the provinces should develop a shared database where all documents and data are uploaded and easy to use for any employee from any department working in the field of natural resources. This database would also help in new policy making, making it easier to ensure coordination and that all policies aimed at controlling biological resources are active and taken into account when making new policies.
- **Enhancing management and technical capacity of technical units at all sub-national levels:** by clarification of the management areas (as mentioned above), and by building management and technical capacity for staff and creating full time positions in all departments, districts and communes is essential in order to implement existing and future policies properly.
- **Strengthening enforcement of regulations:** it is recommend to 1) develop detailed guidelines for provinces, districts, and communes, and 2) to enhance the human resources for implementing the laws and regulations. This could be done with security teams for better and stricter management of destructive fishing. Binding funds for supervision would bring more attention to control and implementation of regulations, which is essential in assuring implementation and compliance to the laws and regulations.
- **Enhancing community participation for improved management and use of aquatic resources:** To address the challenge with lack of staff capacity for aquatic resource management, we recommend decentralization in management of aquatic resources and encouraging local people to participate in the management of aquatic resources and build regulation in villages to protect aquatic resources. This should also include the mobilisation

of a budget specifically for enhancing local people’s knowledge about fish stocks and aquatic environment issues.

- **Balancing poverty reduction/alternative livelihood creation and aquatic resource conservation:** to address the issue of it is recommended that ‘green’ jobs are created ie. by starting environmental initiatives like green energy businesses or payments for protecting the environment when making a living.
- **Improving wastewater monitoring in Phu Yen District:** the problem of illegally discharged waste needs more attention. Having someone assigned specifically for control and supervision of water quality would be an improvement on its own. However, there is insufficient equipment for water quality control, which complicates the report making necessary for catching and fining the polluters.
- **Addressing the negative impacts of mining:** the development plans for mineral exploiting in Phu Yen is a conflicting interest to biodiversity conservation as exploitation has devastating effects on the environment. Mineral exploitation should be minimized in areas with vulnerable natural resources and regulations to reduce its impact on the environment should not only be strengthened but also communicated and enforced.

7. Action Planning Process and Methodology

Objectives

- Enhanced biodiversity
- Stronger livelihoods
- Stronger management of institutions

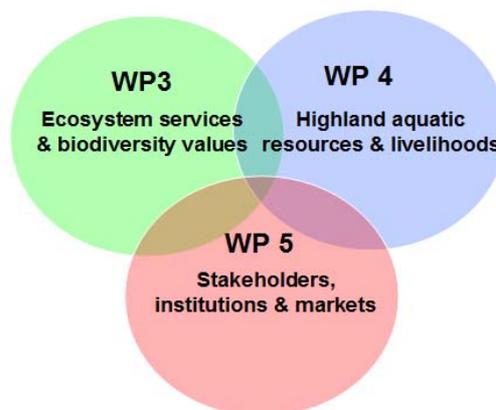


Figure 11. Methodology and approach: integrated activities of WP3, WP4 and WP5

Step to implement proposals included stakeholder meeting discussions (SOS meeting), revised IAP, finalized IAP, implementation, monitoring and evaluation.

Initial action plan

An outline for the IAP for the Phu Yen site is presented in Table 6. Suggestions for district government included training actions:

- Cage culture training - this was something mentioned by respondents during interviews.
- Farmers without paddy lands in particular, could be provided with training in fishing techniques, particularly shrimp fishing which is carried out close to the village, and is the domain of both men and women.
- Fish pond culture training, particularly amongst the H'mong community in higher areas. There were already several ponds in the village above Tuong Tien. Although not 'dependent' on aquatic resources, they are probably the poorest and most marginalized community in the field site and should perhaps be more central to the HighARCS action planning agenda. They are also responsible for management of large parts of the upper watershed, and poor soil quality and run-off here affects reservoir water quality and the livelihoods of the study villages in the valley.

More ambitious ideas centred on:

- Poor soil and extensive erosion were raised as problems by respondents. This is perhaps one of the most significant problems in Son La, and is responsible for declining agricultural yields as well as soil run-off and increased water turbidity. Some respondents suggested they needed support in planting trees to protect the hillsides from erosion. Sustainable afforestation or forest regeneration schemes may be appropriate, (although not monoculture). More research is necessary in this area. These could be community managed. Evidence from other parts of Asia suggests that community managed forests generally are better conserved than state managed forests whereby it is difficult to enforce regulations. Again, both the H'mong community higher in the watershed and the Muong and Thai communities in the valleys would need to be involved. We would however need to think of ways that income could also be generated by forests, as afforestation would involve giving up agricultural land, the yields of which are very low anyway.

- In Tuong Tien, water problems were one of the most significant issues raised. We could look at possibilities for water harvesting or introduction of a piped water supply. This would be expensive and logistically challenging, requiring the input from technical experts, but it is at least something we can discuss with the local government as a possible intervention. However, it would not relate directly to proposed actions to improve conservation or promote wise-use and it would be necessary to see how this could help alleviate pressure on local aquatic resources.

The implications for policy and practice of the current study lend strong support to addressing the problems of local people, in particular the inclusion of degradation of aquatic resources and lack of technique in fishing and aquaculture. It has demonstrated that the critical importance of aquatic resources in livelihoods and economic terms. It has documented the importance of implementing fisheries regulations. The on-going local-level planning process offers a key opportunity to make operational current national policies of decentralized and participatory environmental management.

When discussing the implications of formulating action plans the main considerations are; implications to who or what, when and why? In theory, no action has the most positive impact on livelihoods. It is very important to engage policy makers, authorities and communities to link alternative livelihood options, income generating activities with awareness raising and conservation. It is also necessary to facilitate the participation of men, women, boys and girls. The action should aim to target specific groups such as children, fishers, communities and local authorities.

For the children: A contest about understanding of law/regulation in fisheries and conservation of biodiversity and aquatic resources might be carried out. The contestants are students at primary and secondary school (from 9-15 years old/ grade 3-9) in the district. The form of contest might be poster presentation within class, oral presentation for some excellent candidates or written paper.

For fishers: A technique training on cage and pond culture and fishing regulations could be carried out. In addition, integrated pond culture could be practiced. In this model, the impact of different types of culture on income could be tested.

For communities and awareness rising: A broad poster could be put in public areas such as commune's office and village leader's house. The contents should convey in pictures the rules relating to conservation of aquatic resources and fishing. Another option is a simple HighARCS notebook or calendar (including simple and practical fishing regulations and HighARCS findings) could be given freely to household involved in the project and to local officers. The dissemination of posters/calendar could be carried out with a set questionnaire administered at the beginning of

poster hanging and then after 6 or 12 months to see how much awareness has improved by age, gender and among different stakeholders.

For local authorities: Some suggestions and recommendation for integrated livelihoods diversification and income generation for sustainable development will be communicated to different levels of authorities. For example, suggestions about improvement of policy and mechanism, management strengthening. The agreement in fishing regulation is also suggested to put in village's conventions and it might be one of criteria for family culture. Evaluation would also be carried out after a year with an open questionnaire to see if something had changed their concerns or improved their action plan.

Table 6. Outline Integrated Action Plan for Son La

Rank	PROBLEM	SOLUTIONS	ACTION PLANS
1	Soil erosion causes muddy river	Development of policy and legal framework	- Planting forest and strengthening forest management
2	Over-fishing and indiscriminate fishing methods (use of poison and electricity, light net, small size of the nets), uncontrolled fishing	Development of policy and legal framework	- Detailed and suitable regulation in aquatic conservation. - Master plan in breeding ground and fishing areas
		Enforcement	- Clear punishment regulation for destructive fishing - Better and stricter management of destructive fishing
		Training capacity	- Train commune/village staff and local people in fishing regulations - Training in sustainable fishing
		Local management in aquatic resources	- Setting up an aquatic resources management group in commune - Decentralization in aquatic resources management - Build village regulation in aquatic resources

		Awareness raising	- Awareness raising in aquatic resources conservation
3	Not enough document, policy and regulation in aquatic conservation (commune and local people)	Training capacity	- Train commune/village staff and local people in fishing regulations
4	Not clear collaboration regulation from province to commune and between organizations	Development of policy and legal framework	- Making detailed plans and policy for implementation in each department and level
5	Waste (domestic, small factory)	Enforcement	- Clear punishment regulation for discharge waste - Better and stricter management of waste from factory
6	Migratory fishers	Development of policy and legal framework	- Better and stricter management of destructive fishing - Setting up aquatic resources management groups in communes
7	Hard climate condition, low agriculture productivity	Training capacity	- Training on cage culture to diversify livelihood - Setting model in aquaculture - Training on culture in high slope land and husbandry
8	No budget for aquatic conservation (district, commune level)	Development of policy and legal framework	- Setting-up project to evaluate aquatic resources
9	Irregular water level change and turbid water due to hydropower	Development of policy and legal framework	- Hydropower companies should be notified of changing rules regarding water level management of hydropower dam
10	Weak controlling and inspection of aquatic resources and ineffective punishment	Local management in aquatic resources	- Setting-up aquatic resources management groups in communes - Should have 1 staff at commune for aquatic resources management - Build village regulation in aquatic resources

Revised Integrated Action Plan:

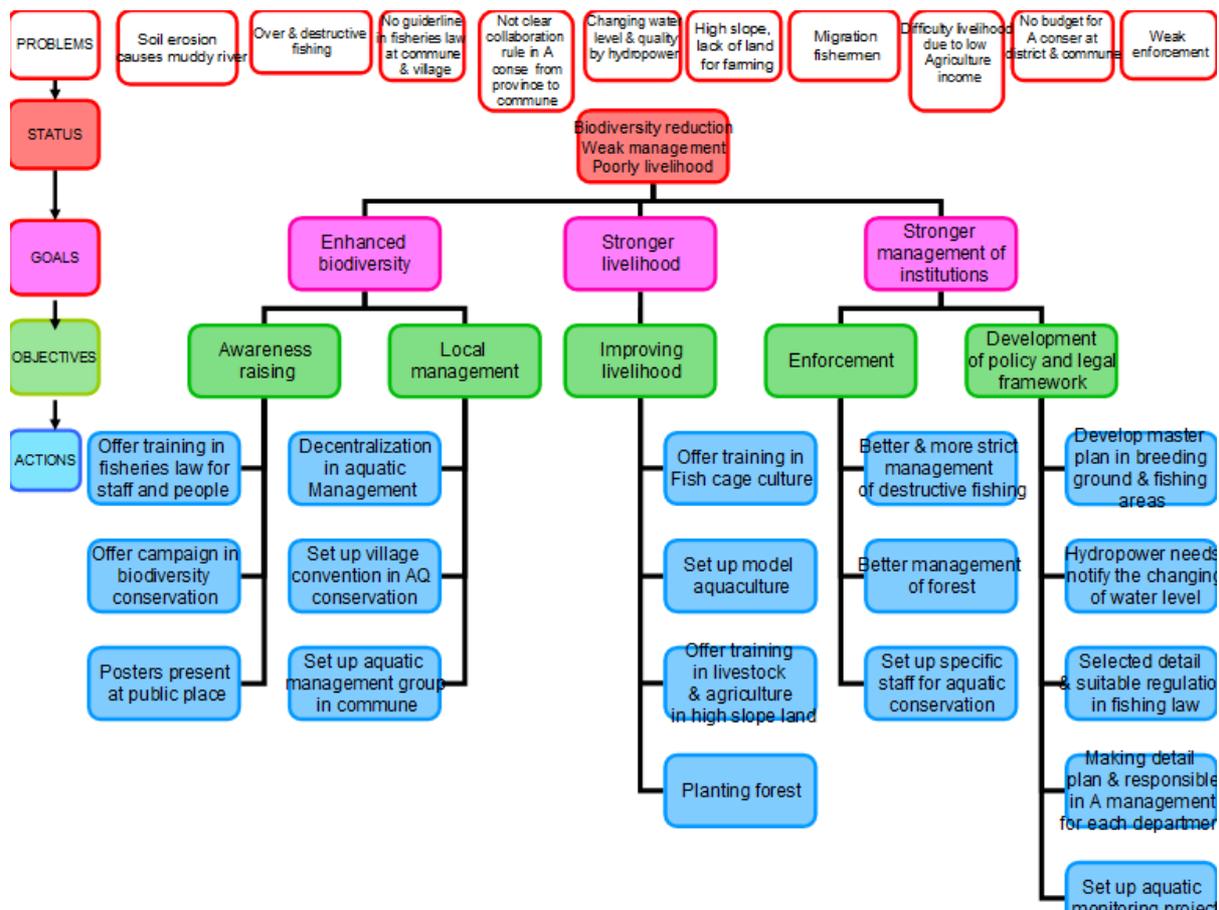


Figure 12. Integrated Action Plan for HighARCS Son La

8. Management proposals

Concerning proposed actions to address management issues at the site they need to be feasible, achievable with the resources available and acceptable to and supported by stakeholders.

Furthermore, actions and monitoring should both be sustainable beyond the HighARCS project.

Following an initial formulation of action plans in early 2011 the Integrated Action Plan (IAP) was refined based on HighARCS project outputs related to conservation, livelihood and policy and presented at the project management group meeting in China (Table 7). Specified objectives for the IAP were: enhance biodiversity of aquatic resources; improve livelihoods and living conditions; stronger management and institutions. Furthermore, the effectiveness of IAP implementation should be considered with regards the prioritization and focus of HighARCS, scale of pilots and possible funding, agreed timing and responsibilities, including who do what and by when, how will this be carried out and how will it be monitored and evaluated.

Table 7. Integrated Action Plan for Phu Yen study site, Son La Province

Objective	Activities	Indicators (monitoring)	Main responsible agency	Monitoring and Evaluation
Awareness raising	Training in fisheries law and environment protection in general for staff and local people	2 trainings for 2 communes	RIA1 and Tuong Ha and Tuong Tien communes	A set questionnaire will carried out at the beginning and after 6 or 12 months; assessment how much awareness improved by age, gender and different stakeholder groups Participatory assessment
	Communication tools: campaign in biodiversity conservation; HighARCS calendar; poster presentation at public places	1 contest for school children (poster/oral/presentation/written) 1 poster at commune station Conferences, festival, field trip	RIA1 and Tuong Ha and Tuong Tien communes	
	Poster presentation in public places	2 posters at commune office for 2 communes	RIA1 and Tuong Ha and Tuong Tien communes	
	Publication	Articles/news of HighARCS will be posted on Quang Tri website, TV, radio program by local language	RIA1, FIN	
Local management for better conservation of aquatic resources	Decentralization in aquatic management and environmental protection	Setup management group Quantities of fish collected	Commune People Committee & village	Group of management people Performance of its assessed after 6 or 12 months
	Set-up village convention in aquatic conservation and environmental protection	3 conventions for 3 communities	RIA1, villages, commune, district people committee	3 conventions for 3 communes Participatory assessment of its affect
Improve livelihoods and living conditions	Training in cage culture	Training course	RIA1, Phu Yen district's People Committee; communes	Numbers of training and participants
	Building aquaculture model	Set up model	RIA1, Phu Yen district's People Committee; communes	Success of model
	Training livestock and agriculture in slope land of mountain	Training course	Phu Yen district's People Committee; communes	Numbers of training and participants
	Planting forest	Training; support seed	Phu Yen district's People	Numbers of training and

			Committee; communes	participants
Development of policy and legal framework	Clear punishment and regulation for illegal fishing	Detailed regulations	Province; district; commune	Detail regulation
	Develop master plan in breeding ground and fishing areas	Survey and estimate on reservoir and up stream	RIA1 and provinces and district levels	Finding breed ground and fishing area
	Hydropower needs to notify local communities of the changing of water level	Give note before opening the dam to local people	Province; hydropower factories	Stableness of water level in reservoir; local people can culture fish in cage and agriculture cultivation
	Selected detail and suitable regulation in fishing law	Detailed regulations	Provinces and district levels	Detail regular
	Make detail plan and note responsibility for management in each department	Detailed regulations	Provinces and district levels	Detail regular
Enforcement	Better management and stricter punishment in illegal fishing tools	Punishment; More staff monitoring	Village commune district	Number of species conserve Illegal fishing tool reduced
	Better management of forests	More staff; punishment	Village commune district	Areas of forest increase; prevention of cutting and burning forest
	Set up specific staff for fish conservation	More staff monitoring	Village commune district	Knowledge of staff about aquatic conservation; Practices of conservation improve

9. Annexes

Annex 1. Fish species harvested in Tuong Ha and Tuong Tien communes, identified through focus group discussions.

The IUCN Red List categories are EX – Extinct; EW Extinct in the Wild; CR – Critically Endangered; EN – Endangered; VU – Vulnerable; NT – Near Threatened; LC – Least Concern; DD – Data Deficient. The categories CR, EN and VU are classed as the ‘threatened’ categories. ‘*’ indicates a draft Red List assessment, that still needs to be peer reviewed.

Vietnamese name	Binomial	Viet Nam National Red List	IUCN Red List	Collected before 1990?	Collected now?	Fishing season	Fishing ground
Cá Thiểu	<i>Chanodichthys erythropterus</i>		LC	No	Many	Jul-Aug	Tuong Ha commune
Tép đầu	<i>Pseudohemiculter dispar</i>		VU	No	Many	Jul-Aug	Tuong Ha commune
Lươn đồng	<i>Monopterus albus</i>		LC	Rare	Rare		Rice fields
Cá Trê	<i>Clarias fuscus</i>		LC*	Rare	No		
Cá quả	<i>Channa striata</i>		LC	Rare	Rarer		
Cá chày mắt đỏ	<i>Squaliobarbus curriculus</i>		LC	No	Many		
Trôi trắng	<i>Cirrhinus mrigala</i>		LC	Rare	More than before		Tuong Ha commune
Trắm đen	<i>Mylopharyngodon piceus</i>		DD	Rare	Rare		
Cá Chiên	<i>Bagarius yarrelli</i>	VU	NT	Rare	No	Aug-Sep	Tac stream
Chạch bùn	<i>Misgurnus anguillicaudatus</i>		LC	Rare	Rare		
Cá chép	<i>Cyprinus carpio</i>		Introduced		Common species	Any time of year whenever water is high	Along the river
Rô phi	<i>Oreochromis niloticus</i>		Introduced				
Mè trắng	<i>Hypophthalmichthys harmandi</i>		DD				
Trắm cỏ	<i>Ctenopharyngodon idella</i>		DD				
Cá Trôi	<i>Labeo rohita</i>		LC				
Cá ngão	<i>Culter flavipinnis</i>		DD (as <i>Chanodichthys</i>)				
Cá Bò	<i>Pelteobagrus fulvidraco</i>		LC (as <i>Tachysurus</i>)				
Cá măng	<i>Elopichthys bambusa</i>	VU	DD				