UNDERSTANDING LIVELIHOODS DEPENDENT ON INLAND FISHERIES IN BANGLADESH AND SOUTHEAST ASIA

(DFID/FMSP Project R8118)

COUNTRY STATUS REPORT LAO PDR

Prepared by

KAI LORENZEN
IMPERIAL COLLEGE, LONDON

XAYPLADETH CHOULAMANY
LIVING AQUATIC RESOURCES RESEARCH CENTRE, LAOS

&

PARVIN SULTANA
WORLDFISH CENTER

March 2003

TABLE OF CONTENTS

1. Socio-economic Context

1.1 Introduction

Lao PDR has a population of about 5.1 million, approximately 77% of whom live in rural areas and 40% live below the Word Bank poverty line (World Bank 2000). After steady GDP growth during the early 1990's, the Lao PDR's economy faltered in the wake of the East Asian financial crisis, which led to increased levels of poverty. Annual per capita GDP was estimated at US$ 400 in 1997 but as US$ 280 in 1999, which is considerably below the World Bank's average for Low-income countries of US$ 410 (1999 figure), and considerably worse than the Bank's figure of US$ 1,000 for East Asia and the Pacific. Meanwhile per capita income in rural areas of Lao PDR is believed to be considerably lower than the national average (US$ 150 – 200).

1.2 Characteristics of poverty and livelihoods in Lao PDR

On a number of social indicators Lao PDR also does more poorly than the World Bank's indices for other Low-income countries, and significantly worse than the Bank's indices for East Asia and Pacific countries. Gross primary education enrolment compares well (at 112% of school age population) with that of Low-income countries (96%) and East Asia and Pacific (at 119%). However, there is still a primary education enrolment gap between males (123%) and females (101%), and an illiteracy rate of 53% among the population aged 15+ as compared with 39% for Low-income countries and 15% for East Asia and Pacific. Life expectancy at birth (at 54 years) and infant mortality (at 96 deaths per 1000 live births) are worse than that for Low-income countries (at 60 years and 77 per 1000), and markedly worse than that for East Asia and Pacific (at 60 years and 35 per 1000). Similarly the proportion of the population with access to a safe water source (39%) is also poorer than Low-income countries (64%) and Asia and Pacific (84%) (World Bank 2000).[1]

The armed struggle against French and later American forces for three decades after World War II left Lao PDR as one of the poorest countries in the world. However, after the accession of the Lao People's Revolutionary Party in 1975 and particularly after 1986 there has been a gradual social and economic improvement and an increasing opening up of the country to the world. 1986 saw the Lao government enact the New Economic Mechanism (NEM) which began a process of decentralising decision-making to the provinces, decontrolling prices, eliminating state subsidies, unified the exchange rate, began a process of privatisation of state enterprises and introduced a number of other macro-economic and institutional reforms. As Rigg (1997) notes the reform process proceeded rapidly because 'the constraints on the reform programme have…not been so much those linked to the tensions of transition from a command to a market-based system, but rather those connected with underdevelopment, pure and simple.' Thus infrastructural and other constraints have led to uneven development (both spatially and socially) in the wake of the reform programme, with different groups 'winning' or 'losing' in the development process (see Rigg 1997). Nevertheless, the overall impact of the reform programme on the national economy has been impressive. Between 1979 and 1989 average annual growth of GDP was 2.9%. However from 1989 to 1999 growth has been 6.3% annually on average, and one of the main development targets for the Government of

[1] There are considerable regional differences in all social indicators within the country, with the rural and particular mid- and upland areas performing more poorly. For example in 1989 the infant mortality rate in the capital, Vientiane, was 50 per 1000 live births, but in some mountain districts was as high as 299 per 1000 (WHO 1989:4).

Lao PDR is to continue this growth. However, a key challenge for the government, as Datt and Wang recognise (2001) is promoting economic growth while keeping inequality in check.

As Rigg (1997) notes, after decades of being an economic backwater Lao PDR is seeking to make up lost time and join other East Asian 'miracle' economies. Having been a landlocked, isolated, 'timeless' corner of Asia, Lao PDR is undergoing rapid and deep economic reform and is being incorporated into regional and international economies. In particular Lao PDR has significant natural resources, such as forestry, which have for the most part been exhausted elsewhere, an abundant supply of cheap labour, and opportunities for the production of hydropower for export to its industrialising neighbours Thailand and Vietnam. The NEM reform programme has led to significant investment in the country by Thai (and Chinese) entrepreneurs, which is helping to grow the economy, though it is also increasing strains in the Laotian social and economic fabric.

Presently agriculture (within which the fisheries sector is subsumed) is the main economic sector, contributing more than half of GDP (52.6% in 1998), but its overall importance has declined (from 60.6% in 1989%), while its average annual growth rate of 4.6% between 1989 and 1998 compares unfavourably with industry's 12.2% annual growth rate over the same period. Industry has expanded since 1986 and accounted for 17.5 percent of the GDP in 1995 (22% in 1998). Growing exports are the driving force behind economic growth with wood products contributing US$ 115m and manufactures US$ 80m to total exports of US$ 337m in 1998. The agricultural sector by contrast contributed only US$ 8m (World Bank 2000). For the future, the export of hydropower is expected to be a major source of foreign exchange earnings. However, there are serious environmental and social issues linked to the exploitation of timber resources (with deforestation proceeding at a quite alarming rate (see below), together with soil loss, siltation, and loss of biodiversity, and pressure on tribal peoples to change traditional land use practices), and hydro-power development (with dams likely to displace whole communities and impact on river flow regimes and potentially wild fisheries) (Rigg and Jerndal 1996).

A World Bank study using data from the Lao Expenditure and Consumption Surveys (LECS) conducted in 1992-3 and 1997-8 (Datt and Wang 2001) notes that 'Rural poverty rates are 2-3 times higher than urban poverty rates, and poverty in Laos is overwhelmingly rural, with the rural poor accounting for more than 90% of all poor.' Datt and Wang (2001) also note that there exist significant variations in levels of poverty across regions, with living standards being highest in the Central region (and containing the capital Vientiane), with the South and the North having significantly lower living standards. The North has about 38% of the poor but 32% of the population, the South has about 22% of the poor and about the same proportion of the population, while the Central region has 38% of the poor but 45% of the population. Within the three regions there are also significant differences between provinces in their level of poverty (see Datt and Wang 2001: Table 5), which has important implications for geographical targeting.

Datt and Wang (2001) also indicate the relationship between poverty and the characteristics of socio-economic groups, which provide some insight into the potential causes of poverty. Thus households with an illiterate head are disproportionately poorer than those who can read and write in Lao. The severity of poverty for the illiterate group is more than double that of the literate group. Interestingly, female-headed households (which make up only about 5% of the total population) are less poor than their male counterparts – the incidence of poverty amongst the two groups being 30% and 37% respectively. However, Haylor et al

(1997) suggest that families headed by single women are the most vulnerable in such a labour-constrained farming system. Meanwhile poverty levels tend to decline with the age of the household head, but the differences are not large (Datt and Wang 2001: Table 6).

Laos is arguably the last country in South-East Asia, which can be said to be truly 'agrarian: agriculture and forestry account for about 60% of GDP, and employ over 85% of the labour force (Rigg and Jerndal 1996). The Lao PDR economy is predominantly farm-based, with the largest part of the labour force consisting of farmers (60% of the 90% of the population in households with economically active heads) (Datt and Wang:Table 7). Other self-employed account for about 13%, paid employees for another 13%, while employers account for less than 1%. The depth and severity of poverty are highest among farmer households (with farm households accounting for more than two-thirds of national poverty). Poverty levels are below average for non-farm self-employed households, lower still for paid employees and lowest of all for the employer group. Given this data, it is clear that natural resources are of considerable importance to a major proportion of the population, and including the poor, but the data also indicate that as natural resources are currently utilised they are unlikely to be the basis for lifting poor people out of poverty.

Datt and Wang (2001) also consider how far the characteristics of the poor differ from the nonpoor while categorising the poor into the 'very poor' (or ultra poor) whose per capita consumption is below the food poverty line, and the 'moderately poor' whose per capita consumption falls between the food and the total poverty lines. On this definition, the very poor make up about 17% of the total population, while the moderately poor account for about 20%. Poor households are more likely to have an illiterate head, and tend to be larger and to have a higher dependency ratio than nonpoor households. Poor and nonpoor also differ notably in their economic activity status over the year (see Table 9). In general poor households depend on farming as their main source of livelihood and have fewer nonfarm opportunities as compared with non-poor households. (Table 9 shows that the poors greater dependence on farm activities holds for other working age household members as well as for the household head.) While Datt and Wang do not say so, the data indicate that the diversification of household livelihood strategies beyond the farm are likely to be of most significance in lifting Lao households out of poverty – particularly as the differences between poor and nonpoor in access to dry and irrigated land is not very large (reflecting the preponderance of small farm holdings and limited levels of irrigation in the country (Table 10). However, increased investment in and commercialisation of the farming sector (and including enhanced rice-field fish production where it is suitable, see Haylor et al 1997, and discussion below) would make a significant difference to the living standards of a majority of the poor.

Access to community-level infrastructure (roads, irrigation, transport, markets) and services (health and education) are important complements to household-level assets in generating incomes and enhancing livelihoods (Datt and Wang 2001:Table 12). Infrastructure in Lao PDR is underdeveloped, particularly in the upland and highland areas, with about half the population living in areas unreachable during the rainy season, while more than two-third are not linked to an electricity network and about half not having access to a safe water supply. Additionally poor households are concentrated in areas where infrastructure is more underdeveloped. Anecdotal evidence from Haylor et al's (1997) wealth ranking exercises suggest that Lao themselves rank as rich those who have proximity to an urban centre and have the opportunity for salaried work there.

Geographically there is considerable topographic variation throughout the country, from floodplain to high mountain (80% of the country is mountainous and around only 3% is cultivated), with different livelihood strategies being stratified by land type and altitude. A major determinant of poverty is the degree of self-sufficiency in rice production and a primary indicator of wealth is livestock ownership. Lack of land and a shortage of cash for investing in land improvements are major causes of rural poverty. In addition, location and infrastructural links affect access to markets and imported products. Villages close to forested areas have access to a wide range of local foods, production-enhancing inputs and grazing, which villages in dry or deforested areas do not have. Additionally, long-established villages with developed land-water and institutional infrastructure contrast with newer ones reclaiming dry forest areas and bunding rice fields, or moving close to main traffic routes (Haylor et al 1997).

To this can be added the fact that the spatial incidence of poverty has ethnic, and land use connections. Lao PDR has an extremely varied ethnic composition with over 68 distinct groups. However, while it is rather simplistic to put it so (see Trankell 1993, Rigg 1997). These diverse peoples are often put into three categories, the Lao Lum (Lowland Lao), Lao Theung (Upland Lao), and Lao Sun (Mountain Lao) - the latter two groupings (which contain a number of different tribal groups such as Hmong, Akha, Lahu and others) being referred to in government literature as 'ethnic minorities'. Government is dominated by Lao Lum.The latter two groupings are in general poorer than Lowland Lao, have fewer material possessions, have less access to good farm-land and most commonly practice swidden agriculture rather than wet rice cultivation coupled with gathering in the forest. (Meusch 1996, Roder et al 1995, Haylor et al 1997)

The Central region is predominantly low-lying, with reasonable infrastructure and opportunities, and has benefited from the NEM reform programme. The population here is predominantly Lao Lum. The North and South with significantly lower living standards, infrastructure and services, consists primarily of uplands and highland, with a population comprised primarily of Lao Theung and Lao Sun ‘tribal’ groups together with poorer Lao Lum who have moved into the uplands in search of land. The NEM reform programme has so far produced only moderate benefits for Lao Theung, and insignificant benefits for Lao Lum (see Rigg 1997).,

In terms of food security there are also disparities between regions. While Lao PDR is self-sufficient in rice, the North has a rice deficit, while the South has a surplus (Lao PDR 1996b). The World Food Programme (1999) sees access to food in Laos as ‘constrained by scarce off-farm opportunities, lack of access to services and markets and limited irrigation schemes.’ IFAD sees households in remote uplands areas as being most vulnerable to food shortages, particularly those practicing short-cycle shifting rotations and with marginal lowland paddy holdings. IFAD also sees increasing household rice production as the most effective way of achieving food security (IFAD 2002).

In sum it can be argued that poverty and its multiple facets in Lao PDR are primarily the result of underdevelopment (see Rigg 1997). The government’s policies under the NEM reform programme are designed to address this. However, in the shift from an overwhelmingly subsistence economy to one integrated into regional and global economies, the government runs the risk of promoting uneven development and increasing the vulnerability of many of its poorest citizens. Thus it can be argued that the government’s drive to modernise the economy through granting concessions to large-scale commercial logging enterprises and developing large-scale hydopower infrastructure, together with its antithetical approach to traditional swidden

agriculture, has contributed to a reduction in the livelihood opportunities of the poorer sections of Lao society rather than to an increase in them (see below). That is poverty is – at least partially –'policy induced'.

1.3 Local structures and livelihoods

Rural Laotian villages generally have a strongly integrated social structure, with village elders being respected and community members having a well-defined sense of mutual responsibility. Villages in Lao PDR can be characterized as self-sustaining communities relatively unconnected with larger political and social units, while Lowland Lao rural communities traditionally had very limited social and economic stratification. Moreover, shared understandings and the social expectations of neighbors circumscribe the actions and decisions of villagers. High levels of cooperation and mutual dependence between villagers are characteristic of rural communities (Ireson, 1995, 1996).

There are some worries, however, that since the NEM reform programme is accentuating inequalities within communities, this could threaten village support networks and communal solidarity (Trankell 1993 in Rigg 1997, Baird 1999). There is a tradition of committee decision-making and, where there is irrigation infrastructure, water use groups for managing water allocations. On external measures, wealth differences between families are not pronounced and most people would be classified as poor, but Haylor et al (1997) did find in their Savannakhet study that when using local wealth ranking indices - which classified families into poor, middle and rich - there were differences between families and between villages. In some villages, 'poor people' - those with very little land and who regularly produce less than they need to eat - made up between 50% and 60% of the total village population. In other villages they constituted a minority. In Haylor et al's sample villages, 'middle people' - those who usually have enough to eat but who may have difficult years, who have some but not extensive land holdings, some livestock, but no business - constituted between 30% and 64% of the population. Villages with higher proportions of middle and 'rich families' - the latter being those that are never hungry, who have plenty of land and significantly some kind of business - were those with proximity to main roads and markets (Haylor et al 1997).

The household is an important decision-making body since land is managed by the family and not by the community. Both Ireson (1992) and Haylor et al (1997) note that women's status in Lao PDR is relatively high and that husbands and wives shared the decision -making for the household. Both studies note that in many villages there were more women than men -due to the war and not to out-migration for work - and that there were a small number of female-headed households. However, the studies do not indicate what the wealth statuses of these households were. Women and men tend to have different sources of income.

Haylor et al (1997) state that livelihoods in Lao PDR are based on four components: food production systems, the collection of wild food resources, other income generating activities, and other essential activities. Rice production dominates Laotian agriculture, although many other components of the rain-fed rice field ecosystem are harvested (e.g. many species of fish, frog, insect vegetables etc.). Rice production is central to most farming systems in Laos, and accounts for more than 80% of cropland. It is important to note that 97% of rice production is rain-fed (of which about 25% is upland rice), with the remaining 3% being irrigated lowland rice. However, national policy has focused on rain-fed lowland rice production and the expansion of irrigation in order to achieve national food security (Lao PDR 1996a,

1996b). By contrast there has been a policy for long term reduced rice production - including swidden rice cropping - in the highlands in order to improve environmental and hill-slope stability. The role of swidden agriculture in forest destruction is a highly sensitive issue with the government maintaining that shifting cultivators are the main source of forest loss and outstripping commercial logging, though others suggest that different upland peoples manage the forest resource in different ways and their impacts vary accordingly (Rigg and Jerndal 1996).

Both men and women work on the household farm and make decisions regarding it jointly, but men are primarily responsible for rice field preparation and for hunting for larger wild animals, while women are responsible for family care, garden crops, the raising of small stock, the transplanting, weeding, harvesting and threshing of rice, and for foraging in the forest (Ireson 1992, Schenk-Sandbergen and Choulamany-Khamphoui 1995). Women are the principle foragers for plants, animals and other wild foods for supplementing the households' staple rice and farm animal production. Wild food dependence decreases with greater population density and proximity to urban centres, which offer alternative sources of food and income generating opportunities. A great diversity of plants and animals, including aquatic resources, are collected, but Haylor et al (1997) suggest that such resources are declining. This not surprising given the rate at which forest cover is being depleted by commercial logging and by farmer encroachment. (It is estimated that 70 000 hectares of dense forest and 200 000 hectares of less dense forest are depleted each year, while a government projection is that by the year 2000 Lao PDR will have lost 44% of its forest cover in fifty years.) Forest and wild resource use is also related to ethnic group, with Upland Lao being more dependent on wild food resources, since upland households usually have an annual rice deficit and are forced to supplement their food requirements through forest gathering or food purchases (Meusch 1996; Ireson 1992, Schenk-Sandbergen and Choulamany-Khamphoui 1996). Ireson's (1992) study showed that an indicator of poverty is dependence upon wild resources, respondents noting that 'only the poor are always dependent.' As Thompson and Baden (1993) note 'This loss of forest has serious consequences for women as it forces them to travel greater distances to collect wood and other essential forest products. Deforestation has particularly adverse effects on women in the Highland areas where household survival depends almost solely upon forest food and medicinal plants (Ireson 1991: 23).'

2. The Ecology and Biodiversity of Living Aquatic Resources

Fish species diversity in the Mekong basin is currently estimated at 1,200 species. In addition, the Mekong fish fauna, as in other large rivers, is probably characterized by a high degree of within-species diversity. This, in part, is brought about by the zoogeographic history of the region, whereby different sections of the basin have been isolated and re-united over time. The dynamic nature of floodplain ecosystems also drives fish to migrate over short and long distances, contributing to both genetic mixing and isolation of populations. Although only a fraction of migratory species have been studied, in only modest detail to date, a high proportion of these are thought to have distinct populations within the Mekong basin (Coates *et al.* 2001, and Table 1).

Fisheries ecology of the Mekong River Basin is intimately linked to, and influenced by, the morphological and hydrological characteristics of the basin. The main driving force responsible for the fisheries productivity of the Mekong and other floodplain river systems is the pulsing of the river flow, which produces periodic inundations upon the floodplain or aquatic/terrestrial transition zone (ATTZ). The bulk of this

production is derived directly or indirectly within the ATTZ itself, which is periodically replenished with inorganic nutrients derived from water and sediments transported from the main channel. These promote primary production from phytoplankton, grasses and higher plants. The ephemeral conditions also produce 'dynamic edge effects' or moving littoral zones where decomposition of organic material is promoted thereby releasing nutrients back into the floodplain (Junk et al, 1989). This rapid increase in primary production and area available for colonization by aquatic organisms supports a diverse community of highly productive fauna. Fish exploit this surge in production, feeding upon the abundant food resources to grow rapidly. The floodplain also provides sheltered spawning grounds and refuges amongst submerged vegetation for the young and juvenile stages. Various dry season waterbodies, replenished with water from the flood pulse, also provide important dry season refuges for floodplain resident species of fish (Welcome, 1985). By contrast, conditions in the main channel are less favourable for primary and secondary production. Most species of fish that permanently occupy the main channel tend to be predators of fish and aquatic invertebrates, which depend to a great extent directly or indirectly on the primary production of the floodplains. The main channel is used mainly as a migration route for gaining access to feeding and spawning grounds upon the floodplain or as a refuge during the dry season.

It is vital that this system of flood-pulses (and thereby the Mekong riverine fisheries) is maintained in the light of hydraulic engineering proposals for the basin such as major hydroelectric dams which have been criticised outside Lao PDR on various grounds (Ryder 1996).

3. Exploitation of Fisheries

The most significant aspect of biodiversity in the Mekong is not its extent but how clearly it is linked to, indeed inseparable from, the socio-economic value of the fishery. Fish is an important component of the diet, and until recently almost all fish were caught in the wild both in rivers but most frequently in rice fields (Meusch 1996). Wild fish are more highly prized for their taste than cultured species. The diversity of the environment, the fishery resource, and its accessibility, promote a high degree of diversity in exploitation. Participation in fishing is almost ubiquitous among rural households (over 80% in southern Laos, Lorenzen et al. 2000).

Virtually all-aquatic habitats are heavily fished, from large rivers including the Mekong mainstream to paddies and roadside ditches. While much fisheries research and management attention has focused on the Mekong mainstream, it is important to remember that nationally, the bulk of the fish catch is obtained from smaller water bodies. The important waters for capture fisheries are the Mekong River and its tributaries, reservoirs, lakes and wetlands, the majority of which are located on the floodplains of Lowland Lao. Rice fields are also important for capture fisheries – particularly for the many non-fish aquatic species exploited by Lao.

Haylor et al (1997) note that the rice field wild fishery is open and unregulated and neither catch nor the fish taken by the farming family are normally quantified and, since some farmers use aggregating techniques and fish density is far from uniform, harvest rates for wild fish per unit area can be misleading. However, they suggest that production may be around 10kg/ha. While this does not compare with the production from 'extensive', 'semi-intensive', and 'intensive' fish culture in rice fields (from 30kg/ha for 'extensive' up to 500kg/ha for intensive)(Haylor et al 1997:Table 4.8), it does not require any labour input beyond harvesting, nor any further input costs. It is also far less risky, which is an important consideration for cash-strapped poor farmers.

There is considerable seasonal variation in aquatic resources use patterns in Lao PDR. Noraseng et al (1999) show changes in resource use in terms of both income and nutrition. Fish are consumed more in October and May while the least amount of fish is consumed in February and September. Income from aquatic products is greatest during the months of July and December-January. This closely follows the annual flooding cycle with most fish available on the rising and the falling flood in July and October respectively. The large amount of fish consumed in May and October is probably associated with the harvesting of rice-field fisheries and dry season back-swamps.

Seasonality in fish caches is driven mostly by hydrological and ecological cycles. Peak catches are obtained during the periods of up-migration of fish from perennial waterbodies to seasonal wetlands including paddies, and during down-migration. Harvesting during these periods involves mostly traps and other passive gear set across migration paths. This method of harvesting is highly efficient, bringing in a substantial share of the annual household catch while interfering little with concurrent agricultural activities (paddy land preparation and transplanting).

Even though there is a marked seasonality in catches, fishing activities are carried out at a high level of effort throughout the year. During the dry season when agricultural labour demand is low and food security most at risk, perennial waterbodies are subject to extreme fishing pressure. It is not unusual for rural people (particularly men) to travel for 10-20 km to fish in perennial water bodies.

4. Biological Status of Fisheries

4.1 Existing status

The biological level of fisheries exploitation is generally very high, although there is a great deal of local variation (driven largely by population density relative to the extent of local water resources). The fishery is inherently multi-species and multi-gear, exploiting virtually all fish species as well as various invertebrates.

Relationships between catch and effort in Lao PDR lake and floodplain fisheries (Garaway 1999; Lorenzen et al 2002) show the asymptotic pattern typical of aggregated catch-effort relationships in multi-species fisheries (Welcomme 2001), where a constant level of catch is maintained over a wide range of high effort levels. The constant catch is likely, however, to mask a change in species composition from larger and higher value species to smaller, low value species with increasing effort.

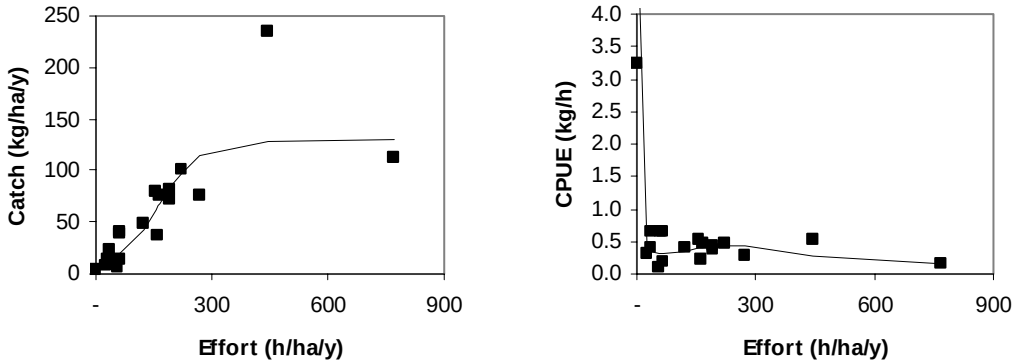

Fig. 1. Relationship between fishing effort, catch and catch per unit of effort in relation to maximum flooded area in the lowlands of Savannakhet province, Lao PDR (Lorenzen et al. 2002).

Natural fish stocks may be declining due to a range of unfavourable human-induced disturbances including deforestation in the upland, water pollution and dam construction (Phonvisay 1994). According to Cavas (1994) riverine fisheries have declined by up to 20%, while Phonvisay (1994) suggests production in lakes and reservoirs declined by about 60% between 1980 and 1994. However, there are no convincing data to support the widespread assumption of an overall decline. While it is likely that catches per fisher have declined as result of increasing exploitation pressure, it is likely that overall catches have been maintained or increased. Apart from overexploitation, potential threats to the diversity and/or productivity of fisheries include

- Water resources development for irrigation and hydropower, and
- Intentional or inadvertent release of exotic species

To date, Lao PDR aquatic ecosystems are less modified than those in most other countries of the region. However, a range of regional and national development issues pose a number of challenges for both farming and fish production. These include a series of hydroelectricity generation dams on tributaries of the Mekong which would change the character of the river's flood pulse, and could have negative impacts on fish which leave the river to spawn on the submerged floodplain (and rice fields) during and after the monsoon rains. Considerable deforestation in the highland areas also has implications for flooding patterns, erosion, water pollution and siltation, which in turn may negatively impact the fisheries (see Phonvisay 1994)

4.2 Threats: Hydropower development

If Lao PDR is to increase foreign exchange earnings quickly, then hydropower is an obvious option, and one that the Lao PDR government has opted for enthusiastically. From 1993 the Lao PDR has had agreements with Thailand to supply electricity (1,500 megawatts by 2000) from hydroelectric power development. There have been various concerns and campaigns related to resettlement, deforestation and environmental changes that are predicted if proposals for 60 dams in Lao PDR are implemented. For example, Usher (1996) has considered the politico-economic factors influencing the evaluation of the impacts of the Nam Theun Hinboun hydropower project, which led NORAD to conclude that no people's land or homes would be flooded and no serious environmental impacts were expected. A range of parties disputed this conclusion. For example, Skoglund, a Swede working for the Mekong committee, suggested that there would be a considerable impact on the fisheries, and that 'this is not just an environmental issue. It's a livelihoods issue, especially for poor people. To destroy that resource is just not acceptable.' As Usher

(1996) points out, the official argument goes that 'some have to suffer for the benefit of the majority. However, with the dams being built or planned in Lao PDR today, the 'costs' will all be borne in Lao PDR by the environment and rural peoples, while the 'benefits' will be exported to Thailand. Apart from cash, Lao PDR will not gain 'development' in any conventional sense, while it is extremely doubtful that the affected communities and environments will derive any direct developmental benefits at all from the economic returns.

The main concerns regarding fish are that the migrations and complex biology of riverine fishes associated with flood pulses discussed earlier will be disrupted, and with them not only the fishery in Lao PDR (including locally important subsistence fisheries in the upland areas – see later) but also that in Cambodia.

4.3 Irrigation development

Irrigation development is proceeding rapidly, based mostly on small to medium scale schemes. The fisheries impacts of such schemes have been evaluated in a recent DFID project (Lorenzen et al. 2000).

Weir irrigation schemes were associated with a 40% (90%CI [5%, 67%]) reduction in household fish catches from a non-impacted mean of 30 kg/household/year. This difference reflects a change in fishing effort as well as in resources abundance. Dam irrigation schemes were associated with no significant overall effect on household catches in villages in the vicinity of the newly created reservoir. However, catches from floodplain areas declined significantly by 58% (90%CI [2%, 90%]) from a non-impacted average of 78 kg/household/year. This was largely but not fully compensated by increased catches from the reservoir. Again, differences reflect a change in fishing effort as well as in resources abundance. The relatively moderate net impacts even of significant modifications by dams are likely to reflect the fact that a large share of capture fisheries production in agricultural areas is derived from rain fed paddies, and these have not so far been modified significantly even in irrigated areas. Net impacts may be spatially differentiated, and overall negative impacts may occur downstream of the dam where the reservoir is less accessible. Pump irrigation schemes abstracting from major rivers had no significant effect on catches from the irrigated areas. None of the irrigation schemes had significant effects on fish species diversity. Measured effects on species richness were as follows: weirs –3% (90%CI [-30%, +16%]), dams +8% (90%CI [-22%, + 30%]); pumps (irrigated area) –13 (90%CI [-31%, +4%]).

The development of individual, small-to-medium scale irrigation schemes is associated with moderate, but significant negative impacts on local aquatic resources. However, these resources can remain productive and diverse and add substantial value to the use of water in irrigation. Proliferation of small-to-medium scale irrigation schemes may lead to cumulative impacts in excess of those established here.

Interestingly, given government (and international concerns) about the reduction of forest areas in Lao PDR through conversion of dry forest to wet-rice land, there is evidence that the building of micro-dams and other alterations to local watersheds, can enhance wild fisheries (Haylor et al 1997:34, and Table 4.8). However, given the fact that the majority of rice produced in Lao is upland rain fed rather than irrigated rice, the opportunities for mitigating forest loss through enhancing wild fisheries may be limited. Haylor et al's (1997) categorisation of paddy agro-ecosystems suitable for fish production (wild and cultured) suggests that, due to the failure of many systems

to hold water during the dry season, the opportunities for intensification of fish production given the constraints of predation, disease, flooding, drought and theft, are quite limited (see Box 7 and Figure 5.1 – Figure 5.3).

Again, both in these new locations for wild fish and in older areas of irrigated rice, the gain for wild fisheries may be temporary unless other factors intervene. Due to a variety of pressures, the direction of change is from forest to rice field. Where the latter are irrigated, there may be a tendency towards intensification of fish production, but there is little evidence for this in Lao PDR. Intensive cultivation of high yielding rice varieties is largely incompatible with any form of fisheries production, due to low water levels and high agrochemical use. Thus while Haylor et al (1997) note that in one of their study villages, a newly established one, 'wild fish availability from the dry forest area (10km from the nearest permanent river) is low but appears to be increasing as the result of micro-watershed development around the village', Meusch (1996) notes that in one of his study villages, an older established village, farmers reported a decrease in wild fish availability over the past two decades from paddies and other water sources.

Again, the pressure on wild fish in rice-fields is likely to increase as farming systems are adapted to 'semi-intensive' and 'intensive' cultured fish production, since farmers are likely to erect perimeter netting to protect their investment by excluding wild piscivorous fish which predate on stocked fish – particularly while they are still young (Haylor et al 1997). There may well remain wild fish 'sanctuary' rice fields scattered among netted fields stocked with cultured fish. Farmers consulted by Haylor et al (1997) suggested that while rich and middle-ranked people have more land which is better suited to intensive fish production, not all of them would be interested in this strategy because they were more attracted to business which was less risky. However, such 'sanctuaries', being open-access, are likely to be under considerable pressure from opportunist fishers, since the owners of netted and stocked rice-fields will deny them access to these.

4.4 Exotic species

Several exotic species of tilapia (*Oreochromis mossambicus* and *O. niloticus*), carps (*Cyprinus carpio, Hypophthalimichtys molitrix, Aristichthys nobilis, Labeo rohita*, and *Cirrhinus mrigala*), and the African catfish (*Clarias gariepinus*) have been widely introduced throughout Laos for aquaculture and fisheries enhancement. Of these, *O. mossambicus, O. nilotoicus, C. carpio* and *C. gariepinus* have developed self-sustaining populations in the wild.

Impacts of tilapia and carp stocking on the diversity and abundance of wild fish stocks in small waterbodies have been analysed by Lorenzen et al (1998) and Arthur (unpublished), Neither studies found evidence of any negative effects of the stocked exotics on native species assemblages. This suggests that the exotic species currently used in Lao PDR aquaculture pose at best moderate risks to biodiversity. (Although fishers in the PRAs expressed some concerns over impacts of cultured fishes conducted for the present study).

This floodplain system with its complex natural fisheries linked with and complementing agriculture, plus enhancements to both agriculture (irrigation) and fisheries provides an extended value chain - a resource system of immense value to rural livelihoods. Equally, however, the trend in environmental changes (e.g. hydro-electric dams, agricultural intensification and irrigation), leading towards both a reduction in productive capacity and a simplification of the ecosystem components, is

likely to seriously undermine aquatic resource biodiversity. Given the widespread dependence of poor people on these resources, as shown in the PRAs under this study and other studies such as Lorenzen et al. (2000), the socio-economic value of the resources is high. Thus current development trends and policies within and outside the country pose a threat to those whose livelihoods are dependent on these resources – and in particular pose a threat to the consumptive needs of the rural poor.

4.5 Within channel – deep pools

Within the main river channels, certain sections are better suited as dry season fish habitats than others. In particular, deeper sections of the river are used by a large number of species during this period of the year. These deep sections are often referred to as deep pools, a term that is increasingly being used in the context of fisheries ecology of the Mekong Basin (Anders, 2001)

The importance of these deep pools is already recognised by local fisher communities who sometimes impose harvest restrictions upon them (Baird 1999), and there have been local initiatives to develop and expand such networks. This means that dry season fish habitat in the riverine system is critical and any changes that would reduce these pools or intensify fishing effort arelikely have an impact beyond the locality and affecting the whole of the fishery.

4.6 Proposed solutions/mitigation

Recommendations by fisheries experts for dealing with threats to the bio-diversity of the Mekong river system are:

1. In relation to managing the potential impact of infrastructural development on aquatic resources (e.g. dams, weirs and particularly large structures associated with hydroelectricity generation), the significance of aquatic resources - particularly fisheries - to the country as a whole, to poor people and local communities, and to neighbouring countries, needs to be better reflected in EIAs, social impact assessments, benefit-cost analyses, and policy decisions and basin level negotiations. [see Mekong River Commisssion, Lohmann 1991]

2. Land use change in rice based farming systems is potentially the largest single threat tofisheries production. Development of intensive rice farming practices that maintain as much aquatic resource productivity as possible is a key challenge (e.g. Nguyen Khoa et al 2003).

3. In relation to managing the potential impacts of exotic species, and strains and/or varieties of native species, the only documented successful approach is that of developing and implementing an appropriate, effective and practical code of practice (Coates 1995b).

Such guidelines should be based on consideration of the potential impacts of introductions/transfers at the genetic level, that is, upon genetic diversity (Bartley and Coates 1995, Bartley *et al.* 1996). It is essential, however, that such codes be developed with the participation of the relevant stakeholders, at regional and local levels, as appropriate, and are workable (Bartley *et al.* 1995). However, it is unlikely that any naturalization that have occurred so far can be reversed.

5. The Importance of the Fisheries

5.1. Nationally

While the agricultural sector is gradually declining in importance to the national economy, it still contributes over half of total GDP value (US$ 25b in 1998). However, the economy of Lao PDR is one of the least developed in the world; with production primarily oriented to the subsistence needs of the rural population (still 77% of the population in 1999, although down from 90% in 1989) – the majority of who are dependent on the exploitation of natural resources (World Bank 2000).

While no separate fisheries statistics are available, the gross value of fisheries output is put at around US$ 48m with a contribution to GDP of about 4% by commercial fisheries and another 2% by subsistence fisheries. An estimated 225,000 people are formally employed in an industry producing 40,000 ton live weight p.a. for direct human consumption within the country (FAO 1999). Current fish production is estimated at 73,135 tons, of which aquaculture is estimated to total 43,100 tons (Phonvisay, 2002) (see Table 1).

However, due to a lack of comprehensive data on fish catch and consumption this is more of a guesstimate, which may not reflect the size and importance of this resource (see also Coates 2002). Actual catch could be substantially higher. In particular, unregistered catches from rice fields and wetlands for subsistence needs may be of a considerable size. There is no data at all on the catch and consumption of other aquatic animals (frogs, snails, snakes, and turtles) which is believed to be of substantial magnitude (Phonvisay 2002).

Almost the entirety of aquatic resource production is consumed in country, with little or no fish exports, although a considerable amount of catch from the Mekong river may be landed in Thailand where market prices are higher (FAO 1999).

Table 1. Production Based on Type of Water Resources

Description of the fisheries	Type of water resources	Area in (ha)	Productivity (kg/ha/year)	Total production (tons/year)	% of total catch
Capture fisheries	Mekong and tributaries	254 150	70	17 790	25
	Reservoirs (stocked)	57 025	60	3 421	4
	Irrigation and small reservoir (natural and stocked)	34 460	150	5 169	7.40
	Swamps and wetlands	95 686	30[a]	2 870	4
	Total:			30 035	
Aquaculture	Fish pond	10 300	1 000		15
	Rice- fish	3 050	150		0.60
	Rain fed rice and irrigated	477 176	50		34
	Natural pools & irrigation weirs	12 934	573		10
	Total:			43 100	
Grand Total		946 631		73 135	100

(Data sources DLF, 2001)

[a] This appears to be a substantial underestimate and implies an average landholding of about 3 ha per household in the floodplains based on household catch data from Lorenzen 2000)

5.2 Importance to livelihoods

While the fisheries do not appear to make a large contribution to GDP, aquatic resources are nevertheless of great importance in the livelihoods and diets of the majority of Lao – both in the lowlands and uplands (see later). Fish play an important role in the economy and diet of the people, particularly those living in the rural areas. For these people, fish and other aquatic animals such as frogs, snails, snakes and turtles are an easily accessible and inexpensive source of food, which may not be replaced easily with other food items of the same nutritional and other qualities. According to sample surveys in 1995 the annual per capita fish consumption of rural and urban dwellers was 10 and 8 kg respectively. These figures indicate that a minimum of 30 percent of the total animal protein intake comes from aquatic resources. FAO (1999) notes that:

> *proper estimates of per caput consumption cannot be established; fish consumption as a percentage of total animal protein consumption can vary from only 10% among hill tribes to 90% among the population in Lower Lao. The average estimate for 1997 was 8.5kg of fish consumption per caput, out of a total of 20kg of animal protein. These figures certainly ignore the contribution of non-fish aquatic products which are gathered and consumed in large quantities during the monsoon season and can form a significant part of rural diets.*[2]

However, a recent fisheries survey in Luang Prabang Province carried out by the Living Aquatic Resources Research Center (LARReC) in cooperation with the MRC Fisheries Programme, Assessment of Mekong Fisheries Component (AMFC), concluded that the average yearly per capita consumption of all fish and aquatic products is estimated to be 29 kg per person per year, with fresh fish accounting for between 16 and 22 kg. Fish and aquatic animals account for 43 % of the total animal product consumption, but for between 55% and 59% of the total animal intake if standard conversion is applied in order to correct for differences in protein content of various foods. Similarly for the southern lowlands Baird (pers comm.) estimates fish consumption is more likely to be 60kg/person/year. Baird et al (1998a) note that in their study area (Khong province) approximately 78% of the animal protein consumed annually consist of fish products.

The survey in Luang Prabang also reported that a large number of households living in mountainous areas of Lao PDR are dependent on fishing and the collection of aquatic species for subsistence needs. Fishing and collection is ranked overall as the third most important activity after rice farming and livestock rearing. In general, in rural Lao PDR the economy is largely subsistence-based and fishing, in common with many other activities, does not appear to be of primary importance for income generation.

[2] All species are taken and utilised by Lao – including crabs, shrimp, fish, snails, frogs and insects. This can confuse fisheries statistics where data collection often emphasises fish while ignoring the significant contribution of other species.

Example of livelihoods assessment related to aquatic resources in uplands:

Though a mountainous region, Luang Prabang Province is rich in aquatic resources with 1,053 km of riverbanks to major rivers, 7284 km length of medium rivers, and 17,722 km of small rivers and streams (according to GIS analysis of stream data provided by Watershed Classification Project, MRC). There are few floodplain areas but rice fields are habitats for fish and aquatic animals that are extensively exploited.

72 % of all the households in all the surveyed villages are engaged in fishing and collection of aquatic animals which is the third most important economic activity after rice farming and livestock rearing. In general, in rural Lao the economy is largely non-monetary and fishing, in common with most activities, does not appear to be important for income. Two surveyed villages in Luang Prabang (7.5% of the total households) have professional (commercial) fishermen and in those 10% of the households get their main income from fishery related activities.

Overall, 83% of the households report that they fish and collect aquatic animals and in these households, on average, 41% of the household members, of whom 20% are children, are actively involved. A large variety of gears are used. The most important fishing grounds (habitats) are rivers and streams of varying sizes followed by rice fields. April and May are the most important fishing months followed by March and June, July. However, fishing activities are reported throughout the year.
In this area aquaculture is not as important as capture fisheries. Only 2% of households ranked it at all as important for food, and only 0.5% household for income. The average yearly production per household from aquaculture ponds was the same as the average catch of the much larger number of households fishing in rivers.

Community-based management systems for living aquatic resources are widespread. 52% of the villages report that they have some form of local management system for their resources. These include conservation zones and restrictions on seasons, gears and fishing certain species. These often apply to migratory species and relate to specific spawning sites. Some of these fish stocks are very likely trans-boundary in nature, that is, they migrate to and from different countries. However, the current management activities appear to relate only to fishing effort and access.

Most of the fish and aquatic animals caught are consumed in the household of the fisher. However, a sizeable amount is given away to other households or villages, sold or used in barter-trade.

The average yearly per capita consumption of all fish and aquatic animal products is estimated to be 29 kg per person per year, with fresh fish accounting for between 16 and 22 kg (at 95% confidence level). Fish and aquatic animals account for 43% of the total animal product consumption, but for between 55% to 59% of the total animal protein intake if standard conversion rates are applied in order to correct for differences in protein content of various foods. These figures correspond well to comparable survey data.

The estimated total production of Luang Prabang Province is between 10,000 – 15,000 Tons per year, of which about half is fish and aquatic animals that are processed, primarily being dried, after catch.

The survey also confirms the findings of the recent Agricultural Census, 1998/99 and the Lao Expenditure and Consumption Survey, (1997/98) that fishing and collection of aquatic animals is very important for subsistence and is integrated with all aspects of people's livelihood strategies. According to the Agricultural Census 35,100 households, or 56%, of the total 62,546 households in the province are engaged in capture fisheries.

Again the recent Agricultural Census of 1998/99, and the Lao PDR Expenditure and Consumption Survey of 1997/98, indicated that fishing and collection of aquatic animals is very important for subsistence and is integrated with all aspects of people's livelihood strategies (Lao PDR 1999)] According to the Agricultural Census more than half the population is engaged in capture fisheries in one way or another. It has been shown that there is a significant correlation between catches and consumption at the household level but that reported catch figures are consistently lower than figures for consumption of fresh fish. This indicates that the yearly catch figures for the households are probably systematically under reported.

A survey in the lowland areas of Savannakhet province (Lorenzen 2000) found that participation in natural aquatic resource use was near universal, with 82% of

households fishing during the survey period. On average, households caught 60 kg of fish per year. The relative importance of aquatic resource use to households can be assessed by comparing the value of the fish catch to other household income (in cash and in kind). The value of fish in local markets ranges from 0.5 US$/kg for small "trash" fish to 1.5-2.5 US$/kg for larger fish. Household catches consist of about one third of "small" and two thirds of "large" fish, and the average value can therefore be estimated to be about 1.5 US$/kg.

Baird *et al.,* (1998b) note that in their study area – the Kong district of southern Lao PDR where the overwhelming majority of the population practice subsistence or semi-subsistence paddy rice agriculture as their primary occupation but who have also traditionally relied heavily on the aquatic wealth of the Mekong River and its tributaries- approximately 94% of families participated in wild-capture fisheries for food in 1996, and 56% generated income from selling wild-caught fish. The average annual catch for a family was about 355 kg, of which 249 kg was consumed (Baird *et al.,* 1998a). Fishing was not only the main source of animal protein in Khong, but was also the largest source of cash income (Baird *et al.,* 1998a).

Table 2 provides an indicative estimate of average household income, including the contribution of fish catches. This suggests that in an average household, aquatic resource use accounts for about 20% of gross income.

Table 2. Contribution of aquatic resource use to gross household income in the lowland areas of Savannakhet province (Lorenzen et al. 2000)

	Physical unit	Value	Proportion
Paddy rice (subsistence)	1.5 t/ha, average area 1 ha, market value 0.1 US$/kg	150	34%
Fish catch (subsistence)	60 kg/year, market value 1.5 US$/kg	90	21%
Cash income	From sale of surplus produce, employment and other activities (survey estimate)	195	45%
Total		435	100%

Lorenzen et al (2002) analysed survey data to identify key socio-economic determinants of effort and catch. Household size was by far the most important determinant of fishing effort and catch. Ownership of assets such as a tractor, a shop or a motorbike had a significant but moderate negative effect on fishing effort, reducing effort in an average household by 35%. The effect of asset ownership on catch was also negative, but not significant. This suggests that asset-owning households reduce their involvement primarily in fishing activities that provide low returns to effort. Interestingly, there was no significant effect of cash income on fishing effort or catch. Overall these results suggest that aquatic resource use is only weakly related to socio-economic status, although it is clearly most important to the poorer households in both absolute and relative terms.

Thus, in conclusion, while overall fisheries statistics are not available, it is clear that aquatic resources are of considerable importance to the rural poor, and perhaps particularly to those in Lowland Lao PDR, where the greater proportion of the population live and where the greatest opportunity for aquatic resource exploitation exists.

5.3. Trends

It is also important to note that the pressures bearing on the fisheries have changed. Traditionally, Fishing was conducted almost entirely for subsistence purposes, with the exception of a small amount of barter trade for certain high quality preserved fish like *"som pa eun"* and *"pa chao"* (Baird *et al.* 1998a). However, the NEM reform programme, the increased availability of new technology (such as mono-filament gill-nets, motorized boats and ice-coolers), and particularly the opening up of market-links to the provincial capital and to Thailand, have led to a shift from subsistence to commercial fishing. As noted above, a significant number of Lao PDR households, particularly Lowland Lao PDR is close to the Mekong and its tributaries now depend on fish sales for a considerable proportion of their income. As Baird (1999) notes, in southern Lao PDR 'changes were occurring rapidly, and while most villagers were becoming aware of the over harvesting problems facing their fisheries, only limited action had been taken to reverse the perceived downward trend in aquatic animal populations.'

However, while Lao PDR inland fisheries have been faced with dramatic changes in fishing and fish marketing practices which have resulted in apparent declines in fish and other aquatic resource stocks due to over harvesting and destructive resource-use patterns, experience in some locations (e.g.Khong) suggest that common property regimes do not always just break down when faced with crisis. In the case of Khong, many villages have responded by strengthening their management systems to ensure that aquatic resources are managed more sustainably (Baird 1999). Whether the experience of Kong is replicable elsewhere in Lao PDR, particularly where wet-rice field enhancement and 'privatization' of the resources they contain is proceeding, remains uncertain.

5.4. The importance of the fisheries to women

While there is a gender division of labour, this not absolutely fixed. Certainly both sexes are involved in the agricultural sector (where women composed 60% of the labour force in the agricultural sector in 1989 (UNESCO 1989), and both sexes fish and gather aquatic resources (see Thompson and Baden 1993:5-6). However, women face a number of constraints, which deny them access to the means to optimise their labour productivity (e.g. the burden of housework, insufficient agricultural skills-training by extension services, lack of access to credit, lack of research and technology development appropriate to their activities), even though these have increased since the introduction of NEM in 1986 (see Ireson 1989).

Schenk-Sandbergen and Choulamany-Khamphoui's (1995) study indicates that changes in agriculture, land legislation and the administration of irrigation could have potentially serious effects on the role and position of women. Increased mechanisation using power tillers and tractors, together with the use of chemical inputs and credit, is tending to reinforce the position of men. Others (Koninck 1992, Trankell 1993, Ireson 1992) suggest that mechanisation is leading to a 'feminisation' of agriculture by reducing the agricultural workload of men and giving them, but not women, the opportunity to for work outside agriculture (Rigg 1997). (However, from a household perspective, this trend is likely to increase households' livelihood strategies, access to income streams as well as goods and services, and reduce vulnerability). Where government is supporting irrigation projects, the water users organisations that have to be established to manage the schemes are invariably dominated by men, in contrast to traditional irrigation schemes in which men and women had equivalent status and roles. Again women as gatherers of forest

products were finding it increasingly difficult to maintain this activity in diminishing forest areas.

Haylor et al (1997) suggest that rice-field fish production can in particular support the livelihoods of women, and particularly female-headed households. They note that the main reasons women give for not taking to aquaculture have to do with the heavy labour involved in the early stages and reluctance to fish in deep water, while female heads of household emphasised the labour constraint and their unwillingness to risk time or money in a new venture. The authors suggest that fish-in-rice can avoid both of these constraints, but whether women will take it up remains to be seen. There is also the danger, and some evidence, that as the resource becomes more valuable men seek to establish control over the resource.

6. Institutions and management

Institutional arrangements for aquatic resources management in Lao PDR have been studied in detail by Garaway (1999), and only a brief overview is given here.

Formal responsibility for aquatic resources management in Lao PDR rests with the Livestock and Fisheries Department under the Ministry of Agriculture and Forestry. (The situation is somewhat unclear for protected areas, for which the Department of Forestry has overall responsibility).

In practice there is little active management of natural aquatic resources by the Department of Livestock and Fisheries. Although there are regulations, for example banning the use of destructive fishing gear and the capture of fish during the spawning season, these cannot realistically be enforced by the government. This should not be taken to imply that destructive fishing is rampant. Rather, fishing is often regulated by local customary rules.

Community-based management systems for living aquatic resources are generally wide spread throughout the country. Villagers do practice some form of indigenous management of their resources (see for example Baird 1999). These include conservation zones and restrictions on seasons, gear, the blocking of migration routes, and the catching of certain species. In keeping with its policy to devolve management responsibility, the right of communities to manage these resources is recognised by the government, and community management initiatives are encouraged and supported. Baird (1999) for example, notes that in Khong ‘no attempts were made to establish new levels of bureaucracy at the village level, although certain villages have established their own informal or ad hoc working groups to deal with particular issues. Regulation implementation and enforcement is left up to the community.’ Interestingly, there also appears to be an association between villages, which have done an outstanding job with implementing their aquatic resource management plans, and relatively remote villages with a high level of community spirit and solidarity. It appears that activities and conditions that increase solidarity at the village level also indirectly benefit community-based natural resource management (Baird 1999).

However, as a consequence of the difficulties in sustaining such initiatives when several villages are involved, active management is largely restricted to small areas and individual water bodies. Interestingly, however, Baird (1999) notes that in Khong over the last five years ‘there have been no major conflicts between villages with regards to village boundaries as they relate to aquatic resources. In fact, villagers appear to have a clear sense of aquatic resource territoriality.’

However, while community management initiatives can be highly effective in regulating aquatic resource use locally, they are less effective in dealing with pressures on resources that arise outside the local area, such as cumulative effects of irrigation development. This should constitute an important area for government intervention and management, but at present it receives little attention.

Involvement of the Livestock and Fisheries Department in aquatic resources management is primarily focused on aquaculture and culture-enhanced fisheries. Natural aquatic resource issues are becoming increasingly integrated with aquaculture development. This is evident in tendencies such as the development of native species for aquaculture, or the development of rice-fish culture technology with explicit consideration of wild as well as cultured stocks.

A good example of progress in management approaches in the Mekong is afforded by the relatively successful application of the use of local ecological knowledge in research and policy formulation. This has led not only to cost-effective means of obtaining information but also a much greater general recognition of the value, extent and relevance of the local knowledge of natural resources held by rural communities. This includes not only knowledge regarding livelihood-related information, but of natural history and biodiversity in a more general sense. Although these approaches have yet to lead to actual improved management, they are certainly making a significant contribution to management information. Additionally, and perhaps more importantly, the approach is also laying better foundations for the participation of resource users in future resource co-management systems.

An important point to note is that while in principle all land is owned by the state, in practice because usufruct rights are hereditary, rice fields are individually owned. Haylor et al (1997) report that in their study area common land in villages was limited to that containing temple, cemetery and school, while forest tenure was variable with the grazing in some areas being split between the families of the village, while elsewhere it was open-access. In the latter areas Haylor et al (1997) report that if the forest (the resources of which have no clearly defined property rights attached to them) is converted into rice fields it becomes private property. However,even on private property wild resources are common property – for example anyone can catch wild fish in a private rice field. However, if a field is stocked with fish, the owner will deny access to the resource, while those who dig them on their land own ponds. Given the potential for enhanced rice field fish production being adopted on an extensive scale by lowland farmers, there is a danger that poor people will progressively lose access to what were previously common pool resources, while fishing pressure on those resources, which have not been privatised, may become unsustainable (see below).

The diversity of wild fish species (snake-head, catfish, eels and the like), and the common occurrence of small wild non-fish species (small shrimp, frogs, snails) that form an important source of additional nutrition for farm households, is a feature of the livelihoods of poor people in Lao PDR. This small species catch does not have a high market value and may not usually be sold, being kept for home consumption. Yet if there is a shift to widespread cultured fish production, the future abundance and availability of these aquatic resources to the poor is also in question, given that farmers may seek to ‘clean’ their rice fields of these to enhance cultured fish production.

7. Aquaculture development

While aquaculture development has been a major focus of national and international fisheries development efforts in Lao PDR, the overall importance of aquaculture to fisheries production and the livelihoods of the poor have remained limited. In a survey in Savannakhet province, only six percent of households considered themselves fish farmers, cultivating ponds of an average area of 0.12ha. Production from aquaculture was estimated to contribute 2-10% to total fish catches in the study area, with the bulk of fish production being based on capture fisheries (Lorenzen et al. 2000).

7.1 Socio-economic correlates of aquaculture adoption

When comparing socio-economic indicators between adopters and non-adopters of aquaculture, it is clear that adopters score much higher on virtually all indicators, with significant differences in rice index, cash income, shop and motorcycle ownership. Given the FAO estimate of productivity and survey estimates of average pond size, adopters would on average gain 102 kg of fish, with a cash value of US$ 153 per year. However, given that most adopters farmed fish for their own consumption (only 8% sold any farmed fish), and that the average value of farmed fish is less than the difference in cash income between the groups, it is unlikely that status differences are primarily the result of aquaculture adoption. Rather, it is likely households that are already better off more readily adopt aquaculture.

Table 3. Average socio-economic indicators for non-fish farmers and fish farmers in villages with several fish farmers. Values in bold are significantly different between the groups (Lorenzen et al 2002).

	Non-fish farmers	Fish farmers
Household members	6.0	6.3
Rice index (see Table 1)	**0.21**	**0.30**
Cash income (US$/year)	**124**	**375**
No. of buffaloes	1.46	1.73
No. of cattle	1.96	3.52
Tractor ownership	9%	17%
Shop ownerships	**4%**	**8%**
Bicycles ownership	84%	100%
Motorcycle ownership	**16%**	**32%**

The distribution of average income in the adopting and non-adopting groups is shown in Fig. 2). Although households of above-average cash income are disproportionately represented among the fish farmers, adoption is not restricted to such households. However, only about 20% of adopters fall in the below-average income category. This also suggests that, while aquaculture may contribute 10% to household fish production (and consumption) overall, this share is much lower (about 2%) in households of below-average income.

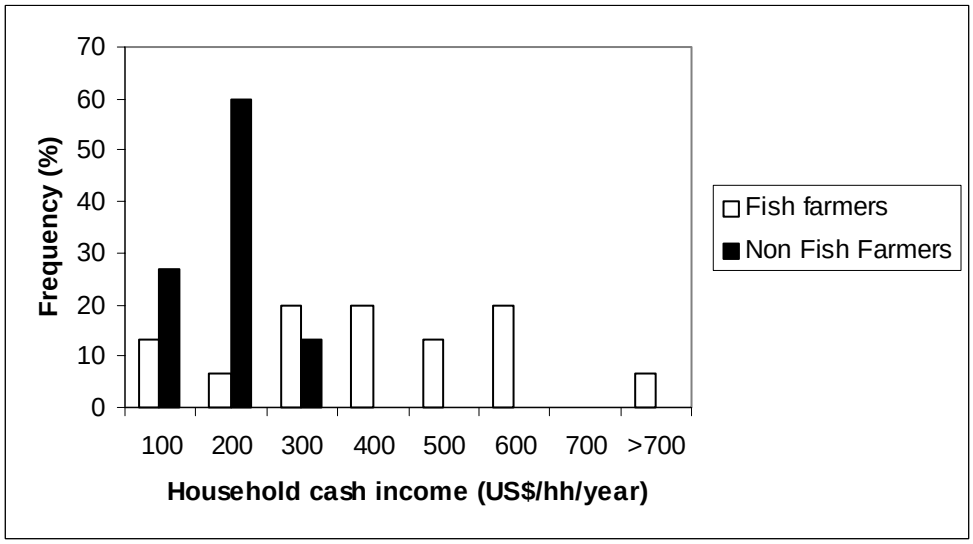

Fig. 2. Distribution of average income of non-fish farmers and fish farmers in Savannakhet province (Lorenzen et al. 2000).

7.2. Impacts of aquaculture development on capture fisheries and livelihoods

Aquaculture ponds currently account for 0.4% of wet, and 1.0% of dry season aquatic habitat. Hence at present, habitat modifications for aquaculture are insignificant. This may change in the future should aquaculture adoption increase significantly. As an extreme example, if all households were to set aside 0.1 ha for a fish pond (or one in ten households converted their paddy holding into 1 ha of fishponds), aquaculture ponds would account for 7% of wet, and 20% of dry season habitat. Access restrictions to paddies and waterbodies within them are likely to accompany aquaculture development, but this is unlikely to restrict natural aquatic resource use significantly.

The effects of aquaculture adoption on household fishing are marginal. Adopting households reduce total (pond and open water) fishing effort significantly by about 31%, and increase total catch slightly by 17%, leading to a large effective increase of CPUE by 105%. Hence adopters gain primarily in labour use efficiency rather than total quantity of fish produced (and consumed). Adopters reduce fishing effort in open waters significantly by 36%, while maintaining catches almost unchanged and again gaining in labour efficiency. This suggests that adopters become more selective in their open water fishing, concentrating on activities that provide good returns to labour and harvesting from their pond at other times. Overall, however, adopters do not significantly reduce their harvest of wild fish.

There are good opportunities for production increases in aquaculture provided that national expertise and funds become available for adapting known technologies to Lao conditions and for supporting interested fish farmers in adopting the new technologies.

This aquaculture potential could be achieved through improvements in production systems in existing ponds and expansion of pond area; integrating aquaculture into farming systems practiced in different ecosystems; extensive and semi extensive cage culture of fish in reservoirs and rivers; enhanced fisheries or culture based capture fisheries in community managed bodies.

There are a diversity of fish species cultured in Lao PDR including tilapia, exotic carps (Indian carp, Chinese carp and Common carp) and a few indigenous barbs (*Barbodes gonionotus* and other *Barbodes* species).

Small-scale aquaculture tends to be combined with farming. Not surprisingly, given the substitution between capture fishery and aquaculture noted above, small-scale aquaculture is best developed in areas away from the main fishery and major floodplains.

Rice-fish "culture", a very significant resource (Meusch 1996 Haylor 1997), is based upon the recruitment of wild fish and small aquatic animal stocks to rice areas, which they treat as natural floodplains (which historically they are). Rice farmers have complex traditional methods for managing this fishery with elaborate systems for allowing recruitment and continuous cropping, primarily through trapping. Only more recently is rice field aquaculture production being enhanced through stocking., However, due to the subsequent loss of production area, some farmers are still reluctant to cut channels or construct refuges in these fields as recommended by the conventional rice-fish culture technical documents.. IRRI and FAO have been researching and trialing the culture of fish in rice fields in Lao since 1993 with mixed results (see also Haylor et al 1997:21-23).

It should also be noted that currently 97% of rice land in Lao PDR is rain-fed rather than irrigated (Haylor et al 1997). As the authors point out, resource systems are diverse and conditions erratic (particularly the timing and intensity of rainfall). In consequence farming systems are continually adapted by their operators who tend to be risk averse and rarely adopt pre-packaged 'complete solutions' by outsiders.

There are still several technical issues to be addressed in improving and expanding small-scale aquaculture:

a) identification of agro-ecological zones and appropriate aqua culture systems;
b) development of aqua culture techniques for indigenous species;
c) development of fish seed production systems appropriate for Lao PDR .
d) development of extension approaches which can address the needs of poor families and
which take account of the diverse agroecosystems, which they manage.

The main problem with fish seed production in Lao PDR is the limitation of brood stock supply. In some areas brood stock cannot be kept throughout the year due to lack of a continuous water supply, while the supply of quality new brood stock is a problem throughout Laos. Although fisheries stations are facing constraints cited above, fish seed production has increased significantly from 4,49 millions in 1990 to 185 millions in year 2001. However, this still does not meet the demand requirement expected at about 500 millions throughout the country due to the large increase in irrigated land over the past few years and the expansion in rice-fish production. Aquaculture by rural small holders can contribute to rural households' income and nutritional needs, even if the total volume of fish produced is surpassed by natural fisheries and fisheries in reservoirs and small village level waterbodies.

While the impact of rice-fish intensification on wild fish stocks is uncertain, the likely impacts on livelihoods and poverty is perhaps clearer. Haylor et al (1997) note that rice-fish culture is a technology which is only applicable on lowland rice-fields. In their study area (Savannaket) it is wealthier lowland Lao PDR who own such land and are more likely to be in a position to try out the technology. Upland Lao PDR, who are in general poorer, by contrast farm dry rice in swidden systems, and their opportunities

for adopting the technology are negligible. Thus support to this sector cannot be justified on grounds of its targeting the poorest members of Lao PDR society, though it may perhaps be justified on grounds of boosting national GDP which in turn may support diversification into non-farm enterprises in which the poor may find employment. An additional worry, mentioned by Haylor et al (1997), is that if owners of rice fields suitable for fish production were to fence off their fields (converting access from open to private), this would deny the poorest a source of fish. The authors suggest that in mitigation, fish production could increase its availability in the village by reducing the price for fish (cultured fish being cheaper than wild fish), and potentially provide employment to those who have insufficient land. However, this seems unlikely since the evidence is that, being small-scale, farm enterprises most usually utilise family and not non-family labour (see Datt and Wang 2001), whilest the poorest adopt expenditure-saving strategies such as open-access fishing in rice-fields precisely because they allocate what little money they have to livelihood strategies which require money. Meanwhile the continuing conversion of forest to farmland is reducing the availability of the resources of the former to that group (the poor) who are most dependent on them. As Rigg and Jerndal (1996) say 'The losers in this rapid exploitation [of the forest] are the poorest farmers and the hill groups who are entirely dependent on the land and the forest.' A likely impact of such intensification in fish production and deforestation is thus a potential increase in interstitial poverty in lowland agro-ecological areas based on irrigated rice-fish production.

One conclusion of the above analysis is that a focus on intensifying lowland farming systems is highly likely to increase the gap between richer and poorer members of Lao PDR society by favouring already better endowed regions (such as the central region) over less well endowed regions (such as the north and south), and similarly within regions where there is a mix of lowland irrigated- and upland dry-rice farming systems. It may also potentially lead to an increase in interstitial poverty in lowland areas with irrigated-rice farming systems as intensification in these leads to extensive privatisation of common pool resources. Lastly, a policy based on such intensification fails to address the problems of poverty in the uplands of Lao PDR and the threat to the dry forests from increased human activity.

8. Strategies and Development Framework

The Department of Livestock and Fisheries has developed four major priority areas for fisheries as follow:

1st priority area:	Aquaculture and floodplain management
2 nd priority area:	Reservoir management
3 rd priority area:	Aquatic resources identification, assessment research and management
4 th priority area:	Post harvest fisheries technologies and regulation

Aquaculture and Flood Plain Management:
This includes:

- Aquaculture development
- Wetland management and protection
- Brood stock development and seed production

- Technology development and dissemination
- Fish disease prevention and social impact related to fish disease

Reservoir Management
This includes:
- Pre impound assessment (EIA/SIA/GIA)
- Appropriate mitigation measures (Bio environmental and socioeconomic)
- Participatory management (Co-management)

Living Aquatic Resources Research, Assessment and Management
This includes:
- Inventory of indigenous living aquatic resources
- Habitat, migration, life cycle of important species
- Limnology of important species for the culture of indigenous species
- Environment and social assessment
- Community awareness, empowerment and participatory management

Post Harvest Technology and Regulations
These include:
- Improvement of traditional fish product
- Development of fish processing and marketing
- Development of post harvest loss technologies
- Development of aquatic resources regulations and implementation through community based and bottom up approaches

9. Issues concerning statistical Information on the Fisheries

In Lao PDR the fishery statistics system is a part of the agricultural statistical system, which is derived from different statistical agencies whose primary functions are generation, processing, analysis and dissemination of official statistics. Government agencies of different institutional levels, which are involved in the generation of fisheries statistics include:

- the National Statistics Center under the Committee for Planning and Cooperation
- the Division of Statistics under the Planning Department, Ministry of Agriculture and Forestry (MAF)
- the Department of Livestock and Fisheries
- the Living Aquatic Resources Research Center (LARReC)
- the Provincial Livestock and Fisheries Office
- the District Livestock and Fisheries Office

Existing information relevant to the fisheries are:

- the Lao PDR Expenditure and Consumption Survey, 1992/1993 (LECS I)
- the Lao PDR Expenditure and Consumption Survey, 1997/1998 (LECS II)
- the Agriculture Census 1998/1999
- Foreign trade statistics
- Consumer Price of Fish Index
- Compilation of GDP
- Fisheries Survey in Luangprabang Province, LARReC/MRC, 1999

- Meat and Fish Consumption in Xiengkhouang Province, 1997
- Baseline Survey in 5 Provinces on Aquaculture Development, FAO,1998
- Vientiane Municipality Fish Market Survey, LARReC, 2000
- Fish Marketing Study in Champassack Province, LARReC, 2001
- CPUE Data Collection in Khong District, LARReC, 2002

Constraints in generating appropriate fisheries information are:

- lack of guidelines and incentives to enumerators to produce reliable data,
- data generated are not used in an efficient manner, and
- limited human resources capacity and know how on data collection and gathering.

Because of the lack of reliable information, aquatic resources are under evaluated by policy makers. This raises the question as to the sustainability or not of aquatic resources that are being exploited, since changes in water and government may promote land use in ignorance of the significance of associated losses in aquatic resources to livelihoods of the poor.

References

Baird, I.G. 1999 The Co-management of Mekong river inland aquatic resources in southern Lao PDR. CESVI, Pakse, Lao PDR.

Baird, I.G., V. Inthaphaisy, B. Phylavanh and P. Kisouvannalath 1998a. A Rapid Fisheries Survey in Khong District, Champasak Province, Southern Lao PDR, Unpublished technical report prepared for the Environmental Protection and Community Development in Siphandone Wetland Project, CESVI, Pakse, Lao PDR, 31 pp.

Baird, I.G., P. Kisouvannalath, V. Inthaphaisy, B. Phylavanh 1998b. The Potential for Ecological Classification as a Tool for Establishing and Monitoring Fish Conservation Zones in the Mekong River, Unpublished technical report prepared for the Environmental Protection and Community Development in Siphandone Wetland Project, CESVI, Pakse, Lao PDR, 28 pp.Cavas , I., 1984 Sectoral report: Inland fisheries. Prepared for FAO/UNDP Country Programming Mission to LAO PDR (LAO/84/006)

Committee for Planning and Cooperation 1995 *Basic statistics about the socio-economic development in Lao PDR.* National Statistics Office, Vientiane, Laos.

Claridge, G.F., Sorangkhoun, T., and Baird, I.G. 1997 *Community fisheries in Lao PDR: a survey of techniques and issues.* IUCN: Vientiane, Lao PDR.

Cunningham, P.D. 1998 Extending a co-management network to save the Mekong's giants, Mekong fish catch and culture, Mekong River Commission. **3** (3) pp6-7.

Datt, G., and Wang, L., *Poverty in Lao PDR: 1992/3-1997/8*. World Bank, Wahington D.C.

Dugeon, D., 1992 Endangered ecosystems: a review of the conservation status of tropical Asian rivers. *Hydrobiologia* **248** pp.167-191.

FAO 1999 Fishery Country Profile:The Lao People's Democratic Republic. FAO Fisheries Department, FAO: Rome. (also at http://www.fao.org/fi/fcp/FICP_LAO_E.asp).

Garaway, C., 1995 Women in fisheries and aquaculture development in Lao PDR. Mimeo MRAG, Imperial College:London.

Garaway, C.J. 1999. Small waterbody fisheries and the potential for community-led emhancement: case studies in Lao PDR. PhD Thesis, Imperial College, London.

Garaway, C., Lorenzen, K. & Chamsingh, B. (2001) Developing fisheries enhancements in small waterbodies: lessons from Lao PDR and Northeast Thailand. In: *Reservoir and Culture-Based Fisheries: Biology and Management*. Edited by S.S. de Silva. ACIAR Proceedings 98. Canberra: ACIAR. pp. 227-234.

Garaway, C.J., Arthur, R. & Lorenzen, K. (2002) Adaptive learning approaches to fisheries enhancements. Final Technical Report to the DFID Fisheries Management Science Programme. MRAG Ltd. 54 pp.

Hakangard, Agneta, 1990, ,Women in shifting cultivation: Luang Prabang province, Lao P.D.R *Development Studies Unit Report* No **18**, Department of Social Anthropology, Stockholm University, Stockholm.

Haylor G., Lawrence, A., and Meusch, E., 1997 *Identification of technical, social and economic constraints to the rearing of fish in rice fields in Lao PDR.* project report 3 volumes for DFID NRSP project R6380CB. DFID: London.

Ireson, W.R., 1992 Peasant farmers and community norms: agricultural labour exchange in Laos. *Journal of Peasant Studies.* 19 (2*).*

Ireson, R. 1995. Village Irrigation in Laos: Traditional Patterns of Common Property Resource Management, *Society and Natural Resources*, 8:541-558.

Ireson, R. 1996. Invisible Walls: Village Identity and the Maintenance of Cooperation in Laos, *Journal of Southeast Asian Studies*, 27(2):219-244.

Lao PDR 1996a *Statement by the government of Lao PDR at the World Food Summit, Rome 13-17 Nov. 1996.* Vientiane,: Govt. of Lao PDR.

Lao PDR 1996b *Country paper on food security. Presentation to the World Food Summit, Rome 13-17 Nov. 1996.* Vientiane,: Govt. of Lao PDR.

Lao PDR 1999 *The Households of Lao PDR: social and economic indicators, Lao expenditure and consumption survey and social indicator survey (1997/98 (LECS 2)* Vientiane: State Planning Committee, National Statistics Centre.

Lohmann, L., 1991 Engineers move in on the Mekong. *New Scientist* **13** July pp 44-47.

Lorenzen, K., Garaway, C.J., Chamsingh, B. & Warren, T.J. (1998) Effects of access restrictions and stocking on small water body fisheries in Laos. *Journal of Fish Biology* **53** (Supplement 1) 345-357.

Lorenzen, K., Nguyen Khoa, S., Garaway, C.J., Arthur, R.I., Chamsingh, B., Litdamlong, D., Siebert, D. & Innes-Taylor, N. (2000) Impacts of irrigation and aquaculture development on small-scale aquatic resources. Final report to the DFID Environment Research Programme.

Lorenzen, K., Smith, L., Burton, M., Nguyen Khoa, S., & Garaway, C. (2002a) *Guidance Manual on the Assessment and Management of Irrigation Development Impacts on Fisheries*. (Consultation document, to be formally published end 2002)

Lorenzen, K., Almeida, O.T., Garaway, C. & Nguyen Khoa, S. (2002b) Aggregated catch and fishing effort in multi-species fisheries: conservation may reduce returns to effort.(Unpublished manuscript).

Lorenzen, K., Smith, L., Nguyen Khoa, S., Burton, M., Garaway, C.J. (2002) Management of irrigation development impacts on fisheries. Final Technical Report to the DFID Knowledge and Research in Engineering Sectors Programme.

Nguyen Khoa, S., Lorenzen, K., Garaway, C.J., Chamsingh, B. (2003) Impacts of irrigation development on capture fisheries in rice-based farming systems of southern Laos. Paper presented at the Second International Large Rivers Symposium

Meusch, E.N., 1996 *Participatory assessment of rice field fisheries in Atsphangtong district, Savannakhet province, Lao PDR.* MSc Thesis, Auburn, Alabama.

Rigg, J. and Jerndal, R., 1996 Plenty in the context of scarcity: Forest amanagement in Laos. (in Parnwell, M.J.G. and Bryant, R.L., (Eds.) 1996 *Environmental*

change in South-East Asia: People, politics and sustainable development. London:Routledge).

Rigg, J., 1997 Uneven development and the (re-)engagement of Laos. (in Dixon, C., and Smith, D.W., (Eds) 1997 *Uneven development in South East Asia*. Ashgate: Aldershot, U.K.

Roder, W., Keoboualapha, B., and Manivanh, V., 1995 Teak, fruit trees and other perennials used by hill farmers of northern Laos. *Agroforestry Systems*. 29: 47-60.

Ryder, G. 1996. *The political ecology of hydropower development in the Lao People's Democratic Republic*. Probe International. www.probeinternational.org/pi/documents/mekong/grreport.

Phonvisay, S., 1994 *Inland fisheries development policies and strategies in the Lao PDR with special emphasis on the Mekong Basin*. Director General of the Department of Livestock and Veterinary Services. Ministry of Agriculture and Forestry.

Schenk-Sandbergen, L., and Choulamany-Khamphoui, O., 1995 *Women in rice fields and*

offices: Irrigation in Laos: Gender specific case-studies in four villages. Heiloo: Empowerment.Thompson, S., and Baden, S., 1993 Women and development in Laos. *BRIDGE (development-gender) Report* No.9. IDS: Brighton, UK.

UNDP latest edition *World Development Report*. New York: OUP.

Usher, A.D. 1996 The race for power in Laos: the Nordic connections. (in Parnwell, M.J.G. and Bryant, R.L., (Eds.) 1996 *Environmental change in South-East Asia: People, politics and sustainable development.* London:Routledge).

Welcomme, R.L. (2001) (ed.) *Inland Fisheries: Ecology and Management.*. Oxford: Blackwell Science.

World Food Programme 1999 World Food Programme: Laos PDF – an overview. Vientiane: WFP.

World Bank 2000 Lao People's Democratic Republic (in *The World Bank Participation Sourcebook.* World Bank:Washington. (also on the internet).

Unpublished reports and web sites of: MRC, IUCN, FAO, World Bank, Asian Development

Bank, UNDP, UNCEF.