Aquaculture Survey of Six Reservoirs in Lao PDR

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No.	Name	Institution	Nam Ngum 1	Nam Mang 3	Nam Houm	Nam Souang	Houay Siet	Houay Peung
1	Mr Thongkhoun Khonglaliane	NADC	✓	✓	✓	✓	✓	✓
2	Mr Seangmany Phaphiboun	NADC	✓	✓	✓	✓	✓	✓
3	Mr Keosy Moungkhounkeha	NADC	✓	✓	✓	✓	✓	✓
4	Mr Hongvilaiy	NADC	✓	✓	✓	✓	✓	✓
5	Mr Vilasiay	NADC	✓	✓	✓	✓	✓	✓
6	Mr Jinda	NADC	✓	✓	✓	✓	✓	✓
7	Ms Soudsada	DAFO of Naxaythong			✓	✓		
8	Mr Vansy	DAFO of Vangvieng	✓					
9	Mr Bounyou	DAFO of Keooudom	✓					
10	Mr Khomsamone	DAFO of Toulakhom	✓	✓				
11	Ms Janthajon	DAFO of Hom	✓					
12	Ms Amkeo Janthavongsouk	PAFO of Paksan					✓	✓
13	Ms Noukhy	DAFO of Paksan					✓	✓
14	Mr Thongmy*	Chief of Community Fishery at Nam Houm			✓			

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Glossary

DAFO	District Agriculture and Forestry Office of the DLF
DLF	Dept of Livestock and Fisheries
Eutrophic	Having a high content of nutrients which can support a high productivity of plants such as algae or macrophytes. Eutrophic waters may become oxygen-enriched as a result of photosynthesis during the day; and oxygen-depleted at night as a result of respiration and decomposition of plants.
Houay	*A small river or stream*
IMC	Interim Mekong Committee - short name for the predecessor of the MRC, the Interim Committee for Coordination of Investigations of the Lower Mekong Basin, which included Lao PDR, Thailand and Vietnam
LARReC	Living Aquatic Resources Research Center
Mesotrophic	Having a moderate content of nutrients which can support a moderate productivity of algae or higher plants; intermediate between eutrophic and oligotrophic
MAF	Ministry of Agriculture and Forestry of Lao PDR
MRC	Mekong River Commission
NADC	National Aquaculture Development Center at Nam Souang Reservoir
Nam	*Water or river*
Nong	*A small lake*
NUOL	National University of Laos
Oligotrophic	Having a low content of nutrients which can support a low productivity of algae or higher plants. Such waters are typically clear and well oxygenated.
Polyculture	Growing several compatible species together; fish polyculture aims to fully utilise all available niches and all types of natural food available in the pond.
PAFO	Provincial Agriculture and Forestry Office of the DL
Pak	*River junction*

Summary

Many dams are being built in Lao PDR for hydropower and irrigation. Dams generally cause negative effects on river fisheries, but they also provide opportunities for increased fisheries and aquaculture production in reservoirs, as well as for aquaculture downstream, in or near rivers or irrigation canals, where reservoirs may provide a year-round supply of relatively clean water. This study aimed to describe the main commercial aquaculture systems associated with six selected reservoirs in Lao PDR, and to obtain data on production and value from aquaculture. While the study shows that there are various issues to be addressed by agencies responsible for aquaculture, the main intention is that the agencies and developers who are responsible for dams and reservoirs will take aquaculture into account in their planning and management.

Aquaculture is a developing industry in Lao PDR, with total production in the country now officially estimated at over 100,000 tonnes per year. About 20 species of fish are commonly cultured, with Nile tilapia, silver barb, and Indian and Chinese carps dominating production. The main systems that have developed near or downstream of the studied reservoirs are (1) pond culture of fish, typically polyculture (i.e. several fish species), (2) pond fish polyculture of fish integrated with chicken or pig farming, mainly near irrigation canals (3) cage farming of fish – mainly Nile tilapia - in rivers or reservoirs, 4) cove culture, in which part of a reservoir is fenced-off and stocked with fish as a polyculture. Fish are also grown in rice-fields or floodplain lakes.

The main study results are summarised in Table 12, which shows that the studied reservoirs conservatively support about 173 commercial aquaculture farms which produce about 10,700 tonnes of fish per year worth around US$19.6 million at first sale. All farms are family businesses, which directly employ about 500 people, as well as supporting suppliers and those who sell their fish through markets, stores and restaurants. Private households also grow fish, which would add a small amount to the total estimate.

Production of Nile tilapia in cages, mainly in the Nam Ngum River (which is regulated by dams) is carried out by about 25% of the farms, but supplies more than 90% of the quantity and value of all of the estimated aquaculture fish production, and is now an extremely important industry for supplying food fish in Vientiane and nearby centres. Near Vientiane, there are now about nine times as many tilapia cages in the Nam Ngum River as in the Mekong River, reflecting the more favourable conditions for fish farming provided by regulation of this large Mekong tributary.

Pond fish polyculture of fish integrated with chicken or pig farming is also an important and growing industry. Fish production is secondary to the main outputs from these farms, but is nevertheless significant at about 800 tonnes of fish per year worth about US$1 million; production of eggs, chickens and fish is much greater, showing the importance of water supply for meat production. Growing fish in ponds enriched with animal wastes adds little to farm costs and is a way of capturing nutrients that would otherwise be lost. The additional value from fish can mean that a farm makes a profit, and fish also provide some insurance against fluctuating prices for livestock, poultry and eggs. The farms also provide some benefit to downstream users, as their ponds drain to irrigation canals, which transport waste nutrients to farmland.

While aquaculture is a growing industry, particularly associated with reservoirs, it is facing various challenges: 1) lack of technical and business capacity of farmers, 2) poor disease management, 3) competition among farmers, including with immigrants, 4) limited availability and the need to import large quantities of fish fry and feed, 5) possible impacts of wastes on other uses of downstream rivers (in the case of cage farming), 6) water quality problems caused by hydropower dams upstream during commissioning and operations and 7) unreliable supply of water from irrigation dams.

The study also indicates that commercial aquaculture has limited viability where reservoirs are remote from urban centres, because costs are higher and wild fish can supply local demand. The relative merits of capture versus culture fisheries should be considered case-by-case and management efforts applied where most appropriate.

By highlighting the scale and value of aquaculture, it is hoped that this study will improve the support for aquaculture in Lao PDR, and also influence the planning and management of dam and reservoir projects.

Specifically, maintenance and operation of irrigation systems should be improved so they provide irrigation water when needed, and also provide water for fish farmers, particularly at the hottest and driest time of year, the end of the dry season. At present, many irrigation reservoirs and associated systems are not functioning well. Integrated chicken-fish and pig-fish farms downstream of irrigation reservoirs could provide significant revenue and might be re-considered as the primary users of water from some reservoirs, based on their value and potential to support maintenance of infrastructure. Currently, irrigation reservoirs are the responsibility of the Dept of Irrigation, but management of some selected reservoirs could readily be transferred to the Dept of Livestock and Fisheries, as both departments are within the Ministry of Agriculture and Forestry.

Hydropower dam commissioning procedures need to be improved to reduce the impacts of 'bad water' which may affect fish farmers downstream, which has been a problem for cage fish farmers in the Nam Ngum River. Hydropower operation also needs to take into account downstream users, particularly regarding water quality, as well as flow variation caused by hydro-peaking, which should be mitigated according to license conditions and advised to farmers downstream.

1. Introduction

1.1. Background

This study was carried out as part of the MK19 project: 'Fisheries and Aquaculture Production in Reservoirs in Lao PDR', under the Challenge Program for Water and Food (CPWF), which aimed to reduce poverty and foster development by optimizing the use of water in reservoirs.

The MK19 project's overall aim was to provide better information on reservoir fisheries and aquaculture so that reservoirs could be planned and managed to provide a broader range of benefits, particularly to the rural people living nearby. In particular, the project aimed to study the tangible benefits of reservoirs, especially in terms of production and value of fish, as well as obtaining other information relevant to management.

The MK19 project staff carried out four activities at six reservoirs to collect data as follows.

1 A survey of fisheries and aquaculture stakeholders using a PRA approach, to collect general background information on fisheries and marketing (by DLF).

2 A survey of markets and marketing fish from reservoir fisheries and aquaculture (by DLF and LARReC) to estimate quantities and value of fish traded and to understand market chains.

3 **A survey of aquaculture types and interviews with aquaculturists to get basic information on aquaculture systems and production (by DLF - this report).**

4 A household survey of catches and consumption which aimed to estimate the quantity and value of fish catches and aquaculture production from reservoirs (by NUOL).

5 A survey of the lower Nam Ngum River to investigate reported fish kills and their possible causes, as well as a survey of water quality and general conditions at the reservoirs, to determine their suitability for fisheries and aquaculture.

This report covers the third activity. It is based on field activities during 2013, as well as reviews of relevant information.

1.2. Aquaculture in Lao PDR

Aquaculture is a government priority for rural development in Lao PDR, where it has received increasing aid-funded support over recent decades since the first efforts to establish hatcheries and introduce fish in the 1950s (Singh, 1990; Choulamany, 2004; Funge-Smith, 1999a; Funge-Smith, 1999b; Phonvisay, 2011; LARREC, 2011). Increased production of fish from aquaculture is widely promoted as a way of improving rural incomes and food production (Funge-Smith, 1999a; Funge-Smith, 1999b). Despite government and donor support, aquaculture is not a very prominent rural activity in Lao PDR because of technical constraints, the time and cost involved, and because most rural people can catch fish and other aquatic animals in rivers, streams, floodplains, rice-fields and other wetlands (Phonvisay 2011). However, aside from income or food production, one of the major benefits of small-scale aquaculture is improved food security because seasonal deficits in supply of wild fish can be filled by fish produced by a household, especially during the dry season; moreover owning an aquaculture pond can confer status and provide other social benefits (Bush, 2007). Aquaculture is now generally proposed in Lao PDR as one way to compensate for a perceived decline in wild fish, which is usually attributed to overfishing and destructive fishing practices as well as habitat alteration and the impacts of water resources development. As more dams are built for

hydropower and irrigation, negative impacts on wild capture fisheries can be expected to increase, but at the same time new reservoirs and the availability of year-round water can potentially support increased aquaculture production, a secondary benefit which should be taken into account in evaluating and managing the effects of new dams.

While there are various technical impediments to aquaculture development (see Choulamany 2004), Lao PDR is increasingly benefiting from its proximity to Thailand, where inland aquaculture is a major industry for which suppliers reliably provide the necessary inputs: fry of fast-growing high-yield fish (especially Nile tilapia and silver barb), cheap mass-produced feeds, medicine, materials (e.g. netting) and machinery (e.g. pumps and freezers). There are several functioning hatcheries in Lao PDR, but many are in poor condition and cannot supply the demand for fry (LARREC, 2011), so many farmers now purchase fry and feed and other necessary inputs direct from Thailand.

Common aquaculture systems in Lao PDR are as follows.

- Pond culture of fish is the most common culture practice in Lao PDR, primarily for household or local consumption. Many households maintain one or more small ponds which are stocked with fish fingerlings; practices vary between extensive culture (no inputs with fish relying on the natural food in the pond) to semi-intensive where the ponds are fertilised (usually with manures) and fish are usually fed with locally available feeds such as rice bran and termites. Intensive fish culture (control of the pond environment and all inputs to achieve high and predictable yields) is uncommon in Lao PDR. Formulated feeds and fingerlings (fry) are becoming more readily available near major centres. Roadside or peri-urban borrow-pits (i.e. holes from which earth or rock have been removed for construction material) are often converted to fish ponds. Ponds are also often constructed adjacent to reservoirs, sometimes encroaching into a reservoir, and fish ponds are also commonly found downstream of reservoirs near irrigation canals or outflowing rivers from where water can be drawn. Pond polyculture of fish involves stocking ponds are stocked with several compatible species, the aim being to totally utilise all available niches and all types of natural food available in the pond.

- Integrated livestock or poultry with polyculture of fish utilises the wastes from farm animals to fertilise ponds where fish are grown, and is well-developed in neighbouring countries. Despite some promotion by development agencies in the 1980s, integrated polyculture is not widely practised by Lao smallholders, but is now developing rapidly near Vientiane, in particular downstream of Nam Houm and Nam Souang Reservoirs. Such integrated farming depends upon year-round water supply, which is readily available downstream or adjacent to reservoirs.

- Cage culture (floating cages) is becoming common in reservoirs or rivers. The first cage culture in Lao PDR was in Nam Houm and Nam Souang Reservoirs for Chinese carps (trialled in 1988) as well as snakeheads in Nam Ngum Reservoir, but since 2000 there has been a major expansion of cage-farming of Nile tilapia; first along the Mekong River, and more recently along the Nam Ngum River, which now supports most of the tilapia farming in the country. The Nam Ngum River has some advantages over the Mekong because of its low sediment concentrations and relatively stable water levels (a result of regulation by Nam Ngum 1 Reservoir).

- Cove culture involves fencing off a cove (i.e. an arm) of a reservoir and stocking it with fish and is a form of extensive fish culture. This practice removes a section of the reservoir from common access, but at the same time clarifies ownership of the stocked fish and allows the

owner(s) to protect those fish until harvest. Fenced coves can provide a large expanse of clean water at low cost, and seasonal drawdown of the reservoir concentrates the fish near the fence where they can be easily netted.

- Ricefields can be modified to provide fish refuge habitat and stocked with fry which are fed supplementary feed, so-called 'rice-fish culture', which is distinct from the natural production of wild fish and other aquatic animals from paddies.

- Natural floodplain lakes and very small irrigation reservoirs are often stocked with fish; this form of extensive aquaculture is usually promoted as part of community-based fisheries (e.g. Saphakdy et al., 2009).

Figure 1. Some fish species commonly grown together in polyculture
Common carp and silver barb (left) and mrigal (upper right) and Nile tilapia (lower right), photos taken at markets

As shown in Table 1, there are 20 fish species that are now commonly cultured in Lao PDR. Some of these are also cross-bred to produce faster-growing and hardier hybrids (e.g. Pangasiid catfishes). Together they provide a broad suite of species suitable for various environments and systems. Most are herbivorous or omnivorous fishes, which can efficiently convert natural or artificial foods to edible fish flesh. Some carnivorous species are useful in culture as a means to upgrade low-value trash fish or other protein-rich waste to high-value fish. When aquaculture was being developed in Lao PDR, culture techniques for Mekong fishes were not known, so exotic species were introduced, with ten species commonly cultured. Of these, Nile tilapia dominates production in Lao PDR as elsewhere in the region (Hortle et al., 2011). Recent research on Mekong basin fishes has provided the know-how to culture local species, with ten indigenous species now able to be produced, and of these, silver barb is now one of the most-cultured fish in Lao PDR (Anonymous, 2011).

Table 1. Fish species commonly cultured in Lao PDR

Species	English name	Lao name	Origin	Family	Maximum Length (cm)	Feeding habit
Oreochromis niloticus	Nile tilapia	Pa nin	Africa	Cichlidae	46	Herbivorous
Cyprinus carpio carpio	Common carp	Pa nai	China	Cyprinidae	120	Omnivorous
Clarias gariepinus	African catfish	Pa duk phan	Africa	Clariidae	150	Omnivorous
Ctenopharyngodon idella	Grass carp	Pa kin ya	China	Cyprinidae	150	Omnivorous
Hypophthalmichthys nobilis	Bighead carp	Pa hua nyai	China, temperate	Cyprinidae	100	Omnivorous
Hypophthalmichthys molitrix	Silver carp	Pa ketlaep	Europe & Asia, subtropical	Cyprinidae	100	Herbi/Omnivorous
Cirrhinus cirrhosus	Mrigal carp	Pa mrigal, Pa nuan chan	India	Cyprinidae	115	Omnivorous
Catla catla	Catla	Pa catla	Indian SC	Cyprinidae	182	Omnivorous
Labeo rohita	Rohu	Pa rohu	Indian SC	Cyprinidae	80	Herbivorous
Carassius auratus	Goldfish		Central Asia, China, Japan	Cyprinidae	30	Omnivorous
Barbonymus gonionotus	Silver barb	Pa pak	Mekong Basin	Cyprinidae	33	Omnivorous
Channa micropeltes	Giant snakehead	Pa doh	Mekong Basin	Channidae	100	Carnivorous
Channa striata	Striped snakehead	Pa koh	Mekong Basin	Channidae	90	Carnivorous
Chitala ornata	Clown Featherback	Pa tong dao	Mekong Basin	Notopteridae	115	Carnivorous
Cirrhinus microlepis	Small-scaled carp	Pa phon	Mekong Basin	Cyprinidae	65	Omnivorous
Osteochilus melanopleurus	Barred carp	Pa nok khao	Mekong Basin	Cyprinidae	40	Herbivorous
Pangasianodon gigas	Giant catfish	Pa beuk	Mekong Basin	Pangasiidae	300	Herbi/omnivorous
Pangasianodon hypophthalmus	Sutchi catfish	Pa souay kheow	Mekong Basin	Pangasiidae	150	Omnivorous
Pangasius bocourti	Bocourt's catfish	Pa houa mouam	Mekong Basin	Pangasiidae	100	Omnivorous
Catlocarpio siamensis	Giant barb	Pa kahe	Mekong Basin	Cyprinidae	300	Omni/herbivorous

Indian SC = subcontinent, India and neighbouring countries. Maximum length from Fishbase all converted to Total Length (TL)

The total production from aquaculture in Lao PDR was reported officially as about 55,000 tonnes per year in 2007, based on estimates of areas under culture and crude assumptions of yield per unit area (Phonvisay, 2011 -Table 1). Of this total estimated production, about 60% was from ponds, 21% from cages, 16% from stocking of natural lakes and 3% from rice-fish culture. An 'official' estimate from the FAO (www.faostat.org) is that aquaculture production in Lao PDR in 2007 was 63,200 tonnes, rising to 102,000 tonnes by 2012. These national figures are of unknown accuracy as there are no reports available which explain how they were calculated, and a significant component of the production appears to actually be wild fish from rain-fed rice-fields (see Souvannaphanh et al., 2003). There is however no doubt that aquaculture has been growing significantly, as can be seen by field observations of ponds and fish cages in many places, and also by general observations of fish in markets, where cultured species - especially Nile tilapia - are often the dominant fish nowadays. There is however limited up-to-date quantitative information on aquaculture production based on fieldwork, and no clear information on the relationship between reservoirs and aquaculture, which is required for any assessment of the overall effects of dam projects on fisheries and aquaculture.

Figure 2. Typical street market sales of fresh fish from polyculture
Silver barb (foreground) Nile tilapia (centre) and pangasiid catfish (right rear)

1.3. Objectives

The survey reported here set out to answer some key questions regarding the main aquaculture systems which are associated with reservoirs and to attempt to quantify benefits and understand issues and problems faced by farmers. The survey can also be used to guide design of further studies to better understand the relationship between dams and aquaculture and to recommend appropriate management approaches.

The survey only covered aquaculture which is directly dependent on water from reservoirs and it focused on commercial aquaculture operations; i.e. those which produced fish for sale as well as household consumption. As such, it did not cover small home ponds which produce fish for household use; these are widespread, and while many are rain-fed, some are linked to irrigation systems. Thus, to some extent, the survey underestimates the overall benefit of reservoirs in supporting aquaculture systems. Another MK19 study (No. 4) included questions on aquaculture as part of a household survey at each reservoir, complementing this study's results.

2. Methods

2.1. Project reservoirs

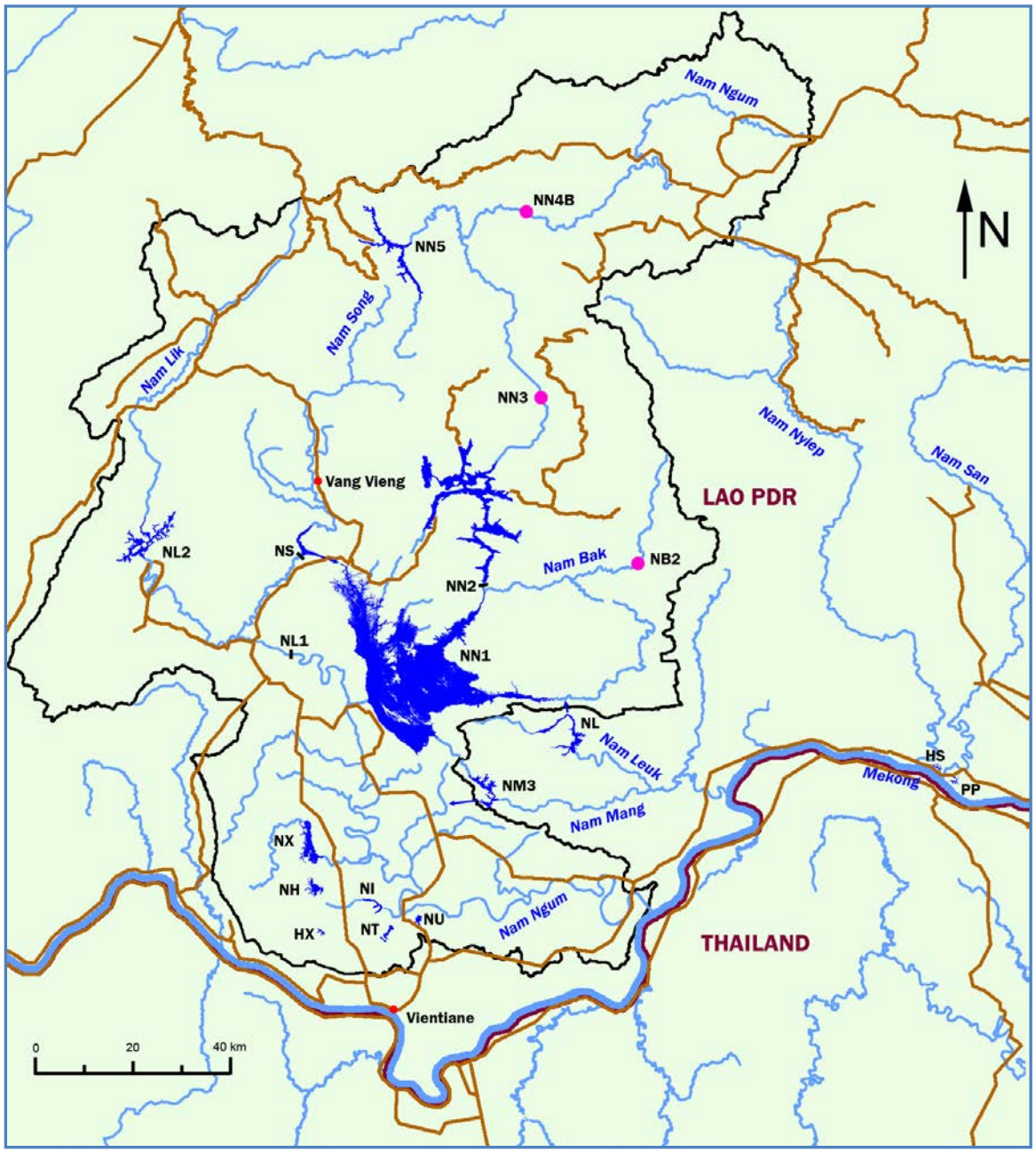

Figure 3. The main rivers, dams and reservoirs near Vientiane, Lao PDR
Some dams are under construction or planned ●. The Nam Ngum catchment is outlined in black. The six surveyed reservoirs are coded as shown in Table 2.

Aquaculture operations were surveyed around six reservoirs which were selected to cover a broad range of sizes and types of reservoirs as found in Lao PDR. Reservoirs were also selected to be close to Vientiane because of time and cost constraints, so they may not be entirely representative of those in other parts of the country. The locations of the six reservoirs together with other existing and proposed reservoirs in the provinces around Vientiane are shown in Figure 1, with some basic information in Table 2 and,. More detailed information is provided in the results and also in separate reports prepared under the MK19 Project.

Table 2 Dams and reservoirs near Vientiane as shown on Figure 1

The six surveyed reservoirs are highlighted. Areas were calculated by digital planimetry for this project.

Code	Dam	Commissioned	Main Purpose	Surface area at Full Supply Level (km^2)
NH	Nam Houm	1981	Irrigation	8.8
NX	Nam Souang	1981	Irrigation	15
NN1	Nam Ngum 1	1971	Hydropower	460
NM3	Nam Mang 3	2004	Hydropower	11
PP	Houay Peung	1990	Irrigation	3.9
HS	Houay Siet	1987	Irrigation	1.7
HX	Houay Xone	nd	Irrigation	0.4
NB2	Nam Bak 2	planned	Hydropower	4.9
NI	Nong Niau	nd	Irrigation	0.5
NL	Nam Leuk Diversion	2000	Hydropower	17.2
NL1	Nam Lik 2	2010	Hydropower	24.4
NL2	Nam Lik 1	2011	Hydropower	22.3
NN2	Nam Ngum 2	2010	Hydropower	122.2
NN3	Nam Ngum 3	2018	Hydropower	25.6
NN4b	Nam Ngum 4b	planned	Hydropower	0.2
NN5	Nam Ngum 5	2014	Hydropower	14.6
NS	Nam Song Diversion	2011	Hydropower	1.3
NT	Nong Taleuk	1990s	Irrigation	1.5
NU	Nong Seuam	1990s	Irrigation	1.6

2.2. Field surveys

Before beginning the survey, the NADC team designed a questionnaire and presented it during an inception meeting for comment and suggestion from participants from different organisations including DLF, LARReC, NUOL, PAFO and DAFO, the intention being to make the questionnaire suitable and easy to use with farmers.

The questionnaire covered background information, type of aquaculture system, fish species, sources of fish seed (fry) and supplies, size of facilities, stocking density, production, use of supplemental feeds and chemicals, occurrence of diseases, details of other animals used in integrated culture farms, and typical costs and income for the farms.

After finalising the survey form, the team contacted the District Agriculture and Forestry Office (DAFO) which is responsible for fisheries and aquaculture in the district(s) around each reservoir to request that they assign staff to coordinate between the survey team and aquaculture farmers.

Field surveys were carried out from August to October 2013. The DAFO staff contacted the heads of villages at or near reservoirs wherever there were commercial aquaculture activities; i.e. farms where people produced enough fish to sell some. For the field survey, DAFO and NADC chose representative villages where people were practicing aquaculture.

The number of aquaculture farmers interviewed was intended to be proportional to the number in each village, but also depended upon the owners being present at the farm during the survey. The team interviewed 49 fish farmers in 14 villages, within 6 districts in 2 provinces and Vientiane Capital, as summarised in Table 3. Other information was obtained by general field observation and other data sources. District officers also provided information on the total number of aquaculture farms of different types. Most of the interviews were with integrated polyculture farmers, with lesser numbers of cage and pond farmers, and relatively few with cove farmers (Table 4).

Table 3. Number of interviews at each reservoir by administrative units

Province	District	Village	Nam Ngum	Nam Mang 3	Nam Houm	Nam Souang	Houay Siet	Pak Peung	TOTAL
Vientiane	Keo Oudom	Don Say Oudom	3						**3**
	Phonehong	Sivilai				1			**1**
	Thoulakhom	Keun Kang	2						**2**
		Nam Yam		1					**1**
	Vang Vieng	Houay Xai	3						**3**
		Nam Phat	1						**1**
	Total		9	1		1			**11**
Vientiane Capital	Naxaithong	Houay Nam Yen			4				**4**
		Nathon			11				**11**
		Phonthong				3			**3**
		Phosy				4			**4**
		Phoxai				8			**8**
		Songpheuay			4				**4**
		Tham				3			**3**
	Total				19	18			**37**
Bolikhamsai	Paksan	Pak Peung					*	1	**1**
TOTAL			**9**	**1**	**19**	**19**	**0***	**1**	**49**

Note: see individual reservoir maps which show villages.

** At Houay Siet there were no aquaculture operations evident.*

Table 4. Summary of interviews by farm type at each reservoir

Culture type	Nam Houm	Nam Souang	Nam Ngum 1	Nam Mang 3	Houay Peung	Houay Siet	Total
Cage culture of fish	3		5				8
Cove culture of fish			4				4
Ponds - polyculture of fish integrated with chicken or pigs	16	12		1			29
Ponds - fish polyculture		7			1		8
Grand Total	**19**	**19**	**9**	**1**	**1**	**0***	**49**

** Note: at Houay Siet there were no aquaculture operations evident.*

Some farmers who were considered representative of the different aquaculture systems were also interviewed in more detail about details of the economics of their operations. Figures in Kip were converted at the rate of US$1 = 8000 Kip.

3. Results

Background information on each reservoir is presented, followed by summaries of the results of field surveys. The results of questionnaires were tabulated and are presented in full in Annex 1.

3.1. Nam Houm and Nam Souang Reservoirs

Background information

Nam Houm and Nam Souang Dams are about 30 km and 35 km north of Vientiane respectively (Figure 3-5) on small tributaries of the Nam Ngum River. They are medium-sized dams built to support irrigation of rice. They are long and relatively low earth-fill dams, as is typical of lowland irrigation storages in the Mekong basin. They are still the two largest irrigation storages in Lao PDR (excluding multi-purpose dams). Like many irrigation dams in the region, they appear to have been built primarily for food security and rural development, being funded by donors with very limited economic justification (IMC, 1984). The dams were built from 1979 to 1980 and their spillways, gates and a small part of the irrigation system were built from 1981 to 1982, all funded by a loan from OPEC and a grant from Japan with administrative support from the Interim Mekong Committee (IMC, 1984; IMC, 1988). It was several years before the irrigation infrastructure was completed downstream of each reservoir, paid for mainly by further aid. The irrigation systems are run by the District office of the Dept of Irrigation. The head-works and canals are in poor condition, with vandalism of infrastructure a significant problem (MAF, 2008); the situation is so bad that for example in 2013 Nam Houm Reservoir did not fill completely because the main gate was leaking. Most families that own rice-fields near the reservoirs continue to grow wet-season rain-fed rice, a traditional practice that provides food mainly for their own household consumption and does not traditionally require any formal irrigation by large-scale diversions from storages. The reservoirs now supplement rain-fed wet season rice irrigation, and one significant benefit is security of supply to the early wet-season rice nurseries (i.e. where seedlings are grown). For dry-season irrigation, stored water is released from their reservoirs, which consequently 'draw-down' each year, exposing a large draw-down zone, which becomes common grazing land for cattle. While some dry-season (irrigated) rice is grown, officials interviewed at both sites explained that it is difficult to collect revenue from farmers for irrigation water, which leads to limited funds for maintenance, which affects reliability of supply, which in turn dissuades farmers from depending upon the system or paying for water.

The catchments of both dams are still largely forested, although there has been some recent clearing for plantations, and rice is grown in some places. Because of erosion and runoff of domestic wastes and fertiliser from agriculture, nutrient levels are probably adequate to support abundant plankton growth; the water is at times turbid due to inflows from partly cleared tributaries, shoreline erosion and wind-induced re-suspension of sediment. Water quality is generally good (MK19 No. 5 report) and overall it is likely the two reservoirs are mesotrophic and ideal for producing wild capture fish and for aquaculture.

Capture fisheries are important at both reservoirs, based on wild and stocked fish. Estimates of production are quite variable and are discussed further in separate MK19 reports. Aquaculture in floating cages began at Nam Houm and Nam Souang after a project by FAO/UNDP demonstrated viability in 1988. Cage farming was carried out by a private operator, who stocked bighead carp, silver carp, common carp, grass carp and rohu; there are 140 cages evident in 2008 Google Earth images of Nam Houm. Catla were introduced later; they command a good price, were popular with farmers and appear to be a superior fish for that cage culture (Figure 6). Nam Houm appears to be particularly rich in plankton, as caged Catla can grow to about 1 kg in 9 months without being fed; plankton is particularly abundant in the late dry season (March to May) (Boualaphan et al., 2010).

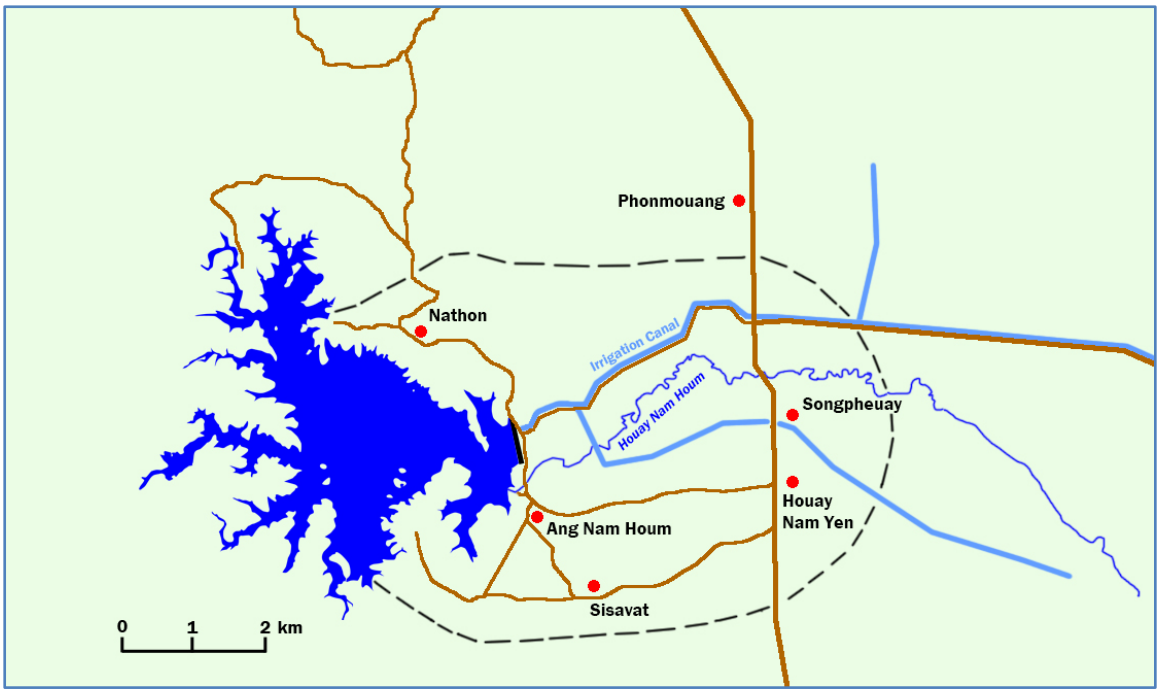

Figure 4. Nam Houm Reservoir, showing villages and the coverage of the field survey of aquaculture farms (dotted line)

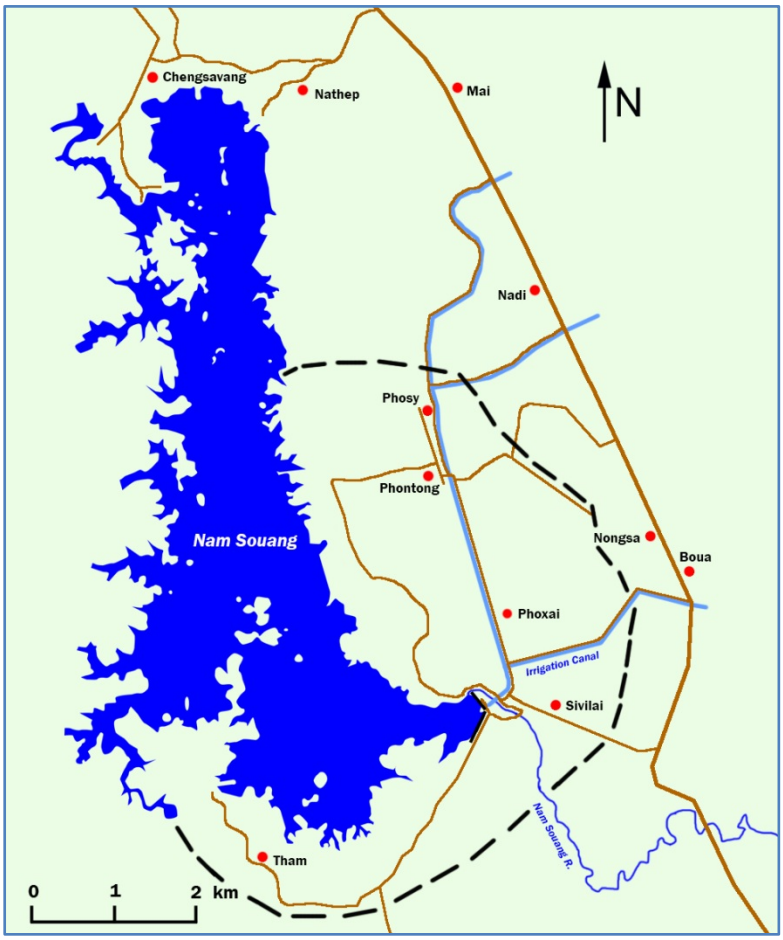

Figure 5. Nam Souang Reservoir, showing villages and the coverage of the field survey of aquaculture farms (dotted line)

Cage farming collapsed in Nam Souang in about 2005; one ongoing problem was that puffer fish (Figure 7) bit through the netting on the cages, presumably while they were feeding on detritus and periphyton (algae) which grows on the netting.

Figure 6. *Catla catla*, an Indian carp, used in stocking of fish cages
Photo by Vannida Boualaphan, LARREC Officer

Figure 7. *Monotrete turgidus,* a puffer fish which is common in some Lao reservoirs
This fish causes problems for cage farmers when it bites through netting; it is common in Nam Souang Reservoir

With the population in and around Vientiane increasing and becoming urbanised, the demand for meat is rising, so there are opportunities to use the stored water which are more profitable than irrigated rice-farming, as is evident from the recent rapid expansion of farms for chickens or pigs, many of which are integrated with fish, especially near these two reservoirs (Figures 8 & 9). These farming systems were not envisaged during dam project planning or evaluation, which assumed the reservoirs would only be used to support rice irrigation; in this case additional unforeseen benefits have arisen. The presence of the reservoirs has allowed many local people to improve their income through commercial integrated farms. However, as in the lower Nam Ngum River (see below), there have been some problems because immigrants with capital and knowhow are well-equipped to take advantage of the economic opportunities offered by year-round water supply downstream of reservoirs (see Annex 3). For these two reservoirs to provide a full range of benefits for the Lao people living nearby there should be a reappraisal of the factors which inhibit development of viable businesses. Donor and agency attention has been directed to technical inputs, such as supply of fry

and training in aquaculture. But existing and potential growers also need training in basic business skills, financing arrangements at competitive rates of interest, foreign language training, and assistance for connecting with aquaculture suppliers in Thailand, Vietnam and China, as well as access to credit, surety over land and water tenure and so on.

Figure 8. New fish-chicken farm downstream of Nam Souang Reservoir, May 2013

Figure 9. Many new ponds for integrated culture are being dug next to irrigation canals
Downstream of Nam Souang Reservoir, May 2013, new pond on the left

Survey results from Nam Houm Reservoir

Large quantities of fish are farmed to supply markets in Vientiane city and elsewhere. In the reservoir there is still some cage farming and one cove farm, but the majority of fish farms are in ponds downstream of the reservoir, supplied with water by irrigation canals. All are family farms, with some of the larger farms hiring additional labour. The main systems are described below.

Cage farms in Nam Houm Reservoir

In Nam Houm Reservoir in 2013 there were three cage farms, growing polycultures of Nile tilapia, and carps: silver carp, big head carp, catla, rohu and mrigal. The farms are made of bamboo cages which are 4 x 5 x 2.5 m, with netting to confine the fish (Figure 10). The oldest of these farms has been in operation since 1996. Two farms are family businesses and the other is run by the army. Operators of these three farms were interviewed (Annex 1) and basic parameters are summarised in Table 5. The farmers do not feed the fish, which eat only natural food, especially plankton. The farmers harvest fish after 6-8 months so manage one harvest per year. They produce in total about

3.45 tonnes of fish per harvest at a first-sale value of about US$4,209. (Kip=8000). In general, cage farming is declining or stable in this reservoir.

Table 5. Basic parameters of three fish cage farms in Nam Houm Reservoir in 2013

Farm No.	No. of cages	Total area (m^2)	Total Production (tonnes)	Yield per harvest (t/ha)	Weight of fish at harvest (kg)	Number of fish per harvest	Mean product price (Kip/kg)	Total Value (Kip)
1	20	400	1.2	30.0	1.0	1,200	8,000	9,600,000
2	30	600	1.8	30.0	1.0	1,800	10,250	18,450,000
3	10	160	0.45	28.1	1.5	300	12,500	5,625,000
Total	60	1,160	**3.45**	29.7	1.05	3,300	9,630	33,675,000

A simple analysis (Annex 2, Case Study No. 1) shows that farmers appear to make a very good return (71%) on their costs, because certain other inputs such as bamboo for the cages can be obtained free locally. However if the family's time was accounted for the operations might be considered less economical, which could explain why cage farming in the reservoir is declining, compared to an estimate in 2003 of 22.5 tonnes (Phonvisay, 2006). Overall the nett income per farm is on average $938 per year.

These three farms buy all fingerlings locally. Among management issues they reported that caged fish often die in November-December each year. This would be consistent with seasonal overturn of this stratified water-body (see MK19 report), which brings deoxygenated water to the surface. A possible solution would be to plan the production cycle to harvest stock just prior to the seasonal overturn, or to oxygenate or aerate around the cages at this time.

Figure 10. Fish cages at Nam Houm made from bamboo, lined with netting

Cove fish polyculture farm in Nam Houm Reservoir

In Nam Houm Reservoir there is one large cove culture operation near the dam wall (Figure 11), managed by the army, but little specific information was obtained. It covers an area of about 10 hectares and fish are stocked but not fed. It is reportedly not operating now, but based on the

figures for Nam Ngum cove culture below, it could have produced about 3.3 tonnes of fish per harvest.

Figure 11. Nam Houm cove fish polyculture farm at low water levels

Integrated chicken-fish culture at Nam Houm Reservoir

Figure 12. Integrated chicken-fish farms downstream of Nam Houm Reservoir

Figure 13. Integrated chicken-fish farm on the downstream side of Nam Houm Dam wall

Figure 14. Hens in integrated chicken-fish polyculture farm

Downstream of Nam Houm Reservoir there are 48 integrated chicken-fish polyculture farms associated with irrigation canals (Figures 12-14). Operators of 16 farms were interviewed (see Annex 1 for detailed results). These are all family businesses and the oldest began in 1995; half of the operations have begun since 2007 and more farms are being developed. These farms all grow chickens in sheds over their ponds, in which they grow Nile tilapia, carp species (silver carp, common carp and mrigal) and one farmer also grew *Pangasius* catfish.

Table 6. Summary statistics for fish production for each harvest (6 months) at 16 integrated chicken-fish polyculture farms downstream of Nam Houm Reservoir in 2013

Statistic	Total area (ha)	Production per harvest (t)	Mean fish weight	Number of fish per harvest	Yield per harvest (t/ha)	Mean product price (Kip/kg)	Total Value (Kip)
Min	0.14	1.00	100	5,000	2.7	7,000	21,333,333
Max	5.00	80.00	500	320,000	44.6	12,000	446,428,571
Mean	1.12	9.98	192	48,497	10.2	9,031	96,372,375
Total	**17.9**	**159.7**	**206**	**775,951**	**8.9**	**9,655**	**1,541,958,006**

Note: means in total row are weighted

The ponds are highly eutrophic and are much more productive for fish (yield per hectare) that at pig-fish farms (Table 9), as chicken manure is a more concentrated and rich fertiliser than pig manure. As summarised in Table 6, total production from the 16 surveyed farms was estimated at 159.7 tonnes of fish per harvest. Because there were 48 farms in the survey area their total production at first-sale was approximately 480 tonnes of fish per harvest. As they conservatively harvest fish twice per 18 months, their annual fish production was about 639 tonnes worth 6,168 million kip or US$770,932 (Table 7).

The total production and value of the 48 integrated polyculture farms downstream of Nam Houm was estimated based on the first-sale sale quantities and value of the eggs, chickens and fish (Annex 2), and assuming that the 16 surveyed farms were representative of all 48 farms. Table 7 shows that about 79% of the value of total production was from sale of eggs, about 11% was from fish and about 10% was from sale of ex-layer hens.

Table 7. Estimated total annual production from 48 integrated chicken-fish polyculture farms downstream of Nam Houm Reservoir in 2013

Product	Quantity & units	Price	Value (000 Kip)	Value (US$)
Hens sold annualised (96.4% survival)	109,318 hens/year	50,000 Kip/hen	5,465,880	683,235
Eggs sold annualised (15 months producing in 18 months, 90% of hens, annualised)	53,866,247 eggs/year	Kip833 Kip/egg	44,870,584	5,608,823
Fish sold (annualised) (2 harvests in 18 months)	638.8 tonnes/year	Kip9655 Kip/kg	6,167,678	770,932
Total			**56,504,141**	**7,063,018**

A simple assessment of the economics of polyculture (Annex 2, Case Study No. 2) (ignoring pond construction costs) shows that net profit is about 21.1% of total income, which if applied across 48 farms is $31,048 per farm (note that this excludes the cost of investment in ponds).

If converted to weight at 1 kg per chicken and 60 grams per egg, the production of chickens is 109 tonnes per year, and the production of eggs is 3,232 tonnes per year or about 5 times the weight of the fish. Not surprisingly, most of the profit derives from the sale of eggs, and fish farming can be seen as a useful supplement to the main farming activity.

These farmers all buy fish fingerlings from Thailand as there is inadequate or irregular supply locally. They use little or no chemicals in their fish farming operations. They have highly variable fish stocking and survival rates (Annex 1), so there is considerable potential to improve their operations through proper training. They report that each year in May-June fish some fish die in the ponds, apparently because at that time there is inadequate water supply, a result of the poor condition of the irrigation system and reduced storage in the reservoir (as mentioned above).

Integrated pig-fish polyculture at Nam Houm Reservoir

There are 7 pig-fish polyculture farms fed by irrigation canals downstream of Nam Houm Reservoir. These were not surveyed, but they are of similar size to those at Nam Souang as discussed below, for which the survey data were used for estimating production and value.

Survey results from Nam Souang Reservoir

Like Nam Houm, Nam Souang is an important reservoir for farmed fish to supply to markets in Vientiane and elsewhere. The main farms near this reservoir are integrated pond fish polyculture with pigs or chickens, as well as pond fish polyculture, all supported by water from irrigation canals.

The culture cycle is 6-8 months during which the farmers use no supplemental feed and on average farmers harvest fish twice in 18 months.

Nineteen farmers were interviewed and the results were adjusted to estimate total production from the reservoir according to the ratios shown in Table 8.

Table 8. Nam Souang - number of farmers interviewed compared with the total number of each type at the reservoir

Culture type	No. interviewed	Total at Nam Souang	Ratio
Integrated fish & pigs*	8	8	1
Integrated fish & chickens	4	7	1.75
Pond polyculture – fish only**	7	26	3.71
Total	**19**	**48**	

** One farm also kept 10 chickens*

*** One pond was for sportfishing, yield was estimated based on area*

Integrated fish and pig culture at Nam Souang Reservoir

In this type of farming, pigs are grown in sheds built around ponds. The pigs are grown for about 3 months, when they can reach 90 kg and are sold to middlemen principally for sale in Vientiane. Pig prices have fluctuated over several years and there are various problems confronting pig growers (see articles in Annex 4).

Table 9. Summary statistics for fish production for each harvest (6-8 months) at 8 integrated fish-pig farms downstream of Nam Souang Reservoir in 2013

Statistic	Total area (ha)	Total Production (t)	Mean fish weight (g)	Number of fish per harvest	Yield per harvest (t/ha)	Mean product price (Kip/kg)	Total Value (000 Kip)
Min	0.160	0.12	167	240	0.8	10,000	1,200,000
Max	2.528	5.00	500	17,778	5.0	11,000	50,000,000
Mean	0.921	2.15	328	7,358	2.3	10,275	21,910,555
Total	**7.368**	**17.24**	**293**	**58,866**	**2.3**	**10,169**	**175,284,440**

Note: means in total row are weighted

Fish are harvested progressively over a period of 6-12 months after stocking, and there is one harvest per year. The annual fish harvest from the 8 farms in the survey area is about 17.2 tonnes per year, worth about 175 million kip or US$21,911 (Table 10). By comparison, the total weight of pigs harvested (at 90 kg/pig) is about 83 tonnes, i.e. about five times the weight of the fish.

The total production and value of the 8 integrated pig-fish farms downstream of Nam Souang was estimated based on the first-sale sale quantities and value of the pigs and fish (Annex 2).

Table 10. Estimated total annual production from 8 integrated fish-pig polyculture farms downstream of Nam Souang Reservoir in 2013

Product	Quantity & units	Price	Value (Kip)	Value (US$)
Pigs	922 pigs/year	1,710,000 Kip/pig	1,576,620,000	197,078
Fish	17.2 tonnes/year	10,169 Kip/kg	175,284,440	21,911
Total			1,751,904,440	218,988

A simple assessment of the economics of integrated pig-fish culture (Annex 2, No. 3) shows that the farms were not meeting their operating costs in 2013, with income being about 5% less than costs, excluding the cost of ponds. Low prices for pigs were the result of severe competition from more efficient large-scale growers, including in Thailand (see the series of reports in Annex 4). Most of the farms' income derives from the sale of pigs, but there is very little extra cost in growing fish (because they are not fed), so fish farming is a valuable supplement to the main farming activity.

Integrated fish and chicken culture at Nam Souang Reservoir

Figure 15. Integrated chicken-fish polyculture farm downstream of Nam Souang Dam

Table 11. Summary statistics for fish production for each harvest (6 months) from 4 integrated chicken-fish polyculture farms downstream of Nam Souang Reservoir in 2013

Statistic	Total area (ha)	Total Production (t/harvest)	Mean fish weight (g)	Number of fish per harvest	Yield per hectare (t/ha)	Mean product price (Kip/kg)	Total Value (000 Kip)
Min	1.0	4.00	250	16,000	2.0	10,000	48,000,000
Max	7.0	20.00	500	60,000	4.8	12,000	200,000,000
Mean	3.6	12.64	361	33,555	3.9	11,000	131,731,480
Total	**14.280**	**50.6**	**377**	**134,219**	**3.5**	**10,414**	**526,925,920**

Note: means in total row are weighted

As summarised in Table 11, total fish production from the 4 surveyed farms at Nam Souang was estimated at 50.6 tonnes per harvest or 12.64 tonnes per farm on average. Because there were 7 such farms in the survey area which conservatively harvest fish twice per 18 months, their total annual fish production is estimated as 12.64 x 7 x 1.333, which is 118 tonnes worth about 1,229 million kip or US$153,693 (Table 12).

As at Nam Houm, these farms derive most (85%) of their income from sale of eggs and ex-layer hens, with fish farming a way to increase their profits at little extra cost.

Table 12. Estimated total production from 7 integrated chicken-fish farms downstream of Nam Souang Reservoir in 2013

Product	Quantity & units	Price	Value (Kip)	Value (US$)
Hens sold annualised (96.4% survival)	18,444 hens/year	50,000 Kip/hen	922,200,00	115,275
Eggs sold annualised (15 months producing in 18 months, 90% of hens, annualised)	7,856,625 eggs/year	Kip833 Kip/egg	6,544,568,625	818,071
Fish sold (annualised) (2 harvests)	118 tonnes/year	Kip10,414 Kip/kg	1,229,546	153,693
Total			**9,311,009,345**	**1,163,876**

If converted to weight at 1 kg per chicken and 60 grams per egg, the production of chickens is 18.4 tonnes per year, and the production of eggs is 471 tonnes per year. As at Nam Houm, most of the profit derives from the sale of eggs, and fish farming can be seen as a useful supplement to the main farming activity.

Assuming similar economics to farmers at Nam Houm (Annex 2, Case Study No.2), these farmers' nett income would be on average 21.1% of total income or $32,766 per farm.

Pond fish-only polyculture at Nam Souang Reservoir

There are 26 farmers who practice fish-only polyculture downstream of Nam Houm Reservoir, and 7 of the farmers were surveyed. Three farmers import their fingerlings from Thailand. They grow tilapia, silver barb, common carp and silver carp, which are usually fed for about one month, after which they feed only on natural food in the ponds, especially plankton. They are harvested after about 8 months at a relatively small size (Table 13).

Table 13. Summary statistics for fish production for each harvest (8 months) from 7 fish-only polyculture farms downstream of Nam Souang Reservoir in 2013

Statistic	Total area (ha)	Total Production (t)	Mean fish weight (g)	Number of fish per harvest	Yield per hectare (t/ha)	Mean product price (Kip/kg)	Total Value (000 Kip)
Min	0.16	0.20	167	800	0.3	9,000	2,310,800
Max	3.90	1.00	250	5,000	1.4	15,000	11,000,000
Mean	1.49	0.53	203	2,674	0.6	11,457	5,991,473
Total	**10.4**	**3.7**	**197**	**18,719**	**0.4**	**11,350**	**41,940,312**

Total production and value from fish-only polyculture ponds at Nam Souang can be estimated by assuming the 7 sampled farmers are representative of all 26 farms, and they harvest two times in 18 months. Total production is therefore about 0.53 x 26 x 1.333, which is 18.3 tonnes worth about 208 million kip or US$25,957, or $998 per farm. These farms are relatively low-key and unproductive (mean yield 0.4 t/ha) compared with integrated polyculture ponds, because the farmers typically feed fish for the first month only. The famers over-stock with fingerlings, most of which die, and there is low survival rate to harvest of 3-11% of fingerlings.

As shown in Annex 2, Case Study No. 4, the production per farm and yield per hectare are low, but the farmers can make a good return on their limited operating costs (59%), or as a proportion of gross income (37.1%), because they only pay to feed the fish for the first month. On average these farms make a nett income of $370 per farm per year. This does not including pond construction costs, which may be nil or very low if the ponds are borrow pits. There is considerable scope to

increase the returns from such ponds by supplementary feeding and optimising stocking rates. It seems likely that over time more of these farmers could convert to integrated culture as demand increases.

Pond fish-only culture of African catfish at Nam Souang Reservoir

African catfish are grown in ponds near Nadi village (Figure 5) which are supplied with water from irrigation canals from Nam Souang Reservoir. The ponds cover about 2 ha and produce 200,000 fish per harvest; with 2 harvests per year at 200 grams per fish the production is likely to be about 80 tonnes per year. This farm was not surveyed and the information reported is from the PAFO office.

3.2. Nam Ngum 1

Background information

Figure 16 Nam Ngum 1 Reservoir, showing villages and the coverage of the field survey of aquaculture farms (dotted line).

Nam Ngum 1, about 90 km north of Vientiane, is Lao's largest reservoir and a striking feature of the landscape in Vientiane Province; it was formed by a gravity concrete dam built across the Ngum River over four years (1967-1971) during the civil war. Nam Ngum 1 has been from many aspects a successful multi-purpose project (Koizumi, 2006), although not without some negative impacts. In terms of basic economics, for a relatively small expenditure, a very large reservoir was created which has supplied year-round water to generate electricity for export to Thailand and for domestic consumption.

Runoff from the dam's catchment is around 310 m^3/s, and additional water is now diverted into its reservoir from two adjacent catchments by the Nam Song Dam (built in 1994-5) and the Nam Leuk Dam (1997-2000) which added 58 m^3/s and 15 m^3/s to mean discharge respectively and significantly increased power generation (Koizumi, 2006); mean discharge is now about 383 m^3/s. Below the dam's power station, all water is discharged to the Nam Ngum River, one of the Mekong's largest tributaries. Storage of water in the wet season and release for power generation provides a constant base flow of water to the river, where there are 42 large pumping stations with a total capacity of 48 m^3/s, which support extensive irrigation of rice and vegetables on the Vientiane Plain (Lacombe et al., 2014).Nam Ngum 1 Reservoir supports a large fishery for wild fish, for which the yield was estimated at 1,470 tonnes in 1982 and 6,833 tonnes in 1998, based on quantitative surveys (Mattson et al., 2001). The 1998 estimate equates to a yield per unit area from the reservoir of about 145 kg/ha, which is relatively high for a large reservoir (Mattson et al., 2001).

'Official' figures by government staff are much lower; e.g. those quoted by Koizumi (2006) and Bernacsek (1997); those figures are from partial surveys of landing sites and as such they are incomplete and grossly underestimate total fisheries production. About 55 species of fish are caught regularly in the reservoir, and of these a small pelagic planktivorous cyprinid *Clupeichthys aesarnensis* (*pa keo*) now dominates catches.

Given its large size, there is considerable scope for aquaculture in Nam Ngum 1 Reservoir and for cage culture downstream in the large volume of relatively clean water which flows from the powerhouse year-round to the Nam Ngum River downstream. However, aquaculture development has been limited by costs, competition with locally available and cheap wild-caught fish, relatively modest demand (as the population is low), and poor infrastructure for processing, storage and transport of fish.

The availability of excess *pa keo* – *Clupeichthys aesarnensis* a relatively low-value small pelagic cyprinid fish – led to the development of cage culture in the reservoir in the 1990s. Like most cyprinids, *pa keo* are delicate fish that die quickly following capture and spoil rapidly, so most are sold as dried fish. Feeding *pa keo* to snakeheads (*Channa micropeltes* and *Channa striata*), efficiently converts them to a high-value fish that can be transported long distances alive with little water. Hambry (2002) discussed the very favourable economics of snakehead farming in 2001, and the survey reported here updates his figures. In 1999 there were reportedly 21 households that owned 126 cages, which as well as snakeheads also grew some tilapia and silver barb. In 2001, 20 tonnes of snakehead were reportedly harvested from the reservoir (AQIP, 2003). Most cages were made from locally sourced bamboo, with some cages made from wood frames and netting. While aquaculture at this location was viable economically, it was dependent on the capture fishery and produced relatively small quantities of fish.

Compared with the reservoir, the lower Nam Ngum River (i.e. downstream of the dam) is superior for aquaculture in several respects: (1) water flow through cages, (2) proximity to required inputs, (3) proximity to markets, (4) adjacent to roads and other infrastructure. The main species grown in cages in the lower Nam Ngum River is Nile tilapia. Farming of caged tilapia developed in Thailand in the 1990s, and the technology was transferred to Lao PDR across the Mekong, where cage farming began in the late 1990s and gradually expanded. Hambry (2002) provided an overview of the economics of cage-farming tilapia along the Mekong in 2001, which indicated it was less profitable than snakehead farming in the Nam Ngum Reservoir because of the cost of feed and the lower sale prices of tilapia. Over the last five years, cage culture along the Mekong near Vientiane has declined, whereas cage culture has increased greatly along the Nam Ngum River, which provides better conditions for farming because the Nam Ngum 1 Reservoir regulates river flow and traps sediment. Based on observations and interviews with farmers along both rivers, the relative advantages of

farming in the lower Nam Ngum River compared with the Mekong near Vientiane can be summarised as follows.

1. Water levels fluctuate less in the Nam Ngum than in the Mekong, resulting in less time and cost for moving cages. If there were no dams, the Nam Ngum River would fluctuate even more than the Mekong, with floods each wet season and with low water levels each dry season making cage culture difficult or impossible.

2. In the lower Nam Ngum River, because of trapping in reservoirs, there are relatively few large drifting logs and other debris which can damage cages, compared with the Mekong in which a large amount of organic debris is swept down the river in the early flood each year.

3. Water quality: suspended sediment concentrations in the lower Nam Ngum River are less than in the Mekong, where tilapia are reported to die at the beginning of each wet season when suspended sediment concentrations increase (interviews of Mekong farmers by Kent Hortle and Suchart Ingthamjitr, 2010). The precise cause of mortality is not known, but tilapia are intolerant of high sediment concentrations, or may be affected by pesticides which are swept into the river with agricultural runoff from the first wet-season rains (note that pesticide contamination is an increasing problem for Mekong fish (Phanwichien et al., 2010). Farmers along the Mekong are forced to harvest all their tilapia through April and early May each year and also raise their cages to reduce flood damage. Tilapia cannot be grown for several months during the wet season. However, low oxygen concentrations are a problem at times in the lower Nam Ngum River close to the dam, and recently there have been water problems which are likely attributable to dam construction upstream of the reservoir (see separate MK19 report).

Notwithstanding these favourable attributes of the Nam Ngum River for farming of tilapia in cages, farmers have lost fish because of poor water quality and fish diseases, which have been exacerbated by poor farming practices (see separate MK19 report). Moreover, most of the Lao people who have recently taken up tilapia farming have no relevant experience or training, and they face severe competition with Chinese farmers who have moved into the area in recent years. As discussed in a series of articles in the Vientiane Times (Annex 3), there have been ongoing complaints from Lao fish farmers that they cannot compete with 'illegal' Chinese migrants, who have experience of running an aquaculture business and can produce fish more efficiently and cheaply. In this case, people who had permits to run businesses at a Chinese market were using Lao people as a front for their operations (since this field survey, in 2014 the illegal farmers were fined and they are now working under a company – Long Ngum JV - which has obtained a concession to farm along 16 km of the Nam Ngum River downstream from Thangon). The situation with licensing and regulating the farms is often not clear; some farmers may evade tax because they are not registered; based on interviews with district officials, the number of farms is significantly underestimated (Table 9). Licensing and taxing the farms provides revenue that the government can use to support their development and enforce pollution control, but governance need improvement, as evidenced by the lengthy time taken for district officials to get "illegal" farmers to comply with their lawful directives to register and pay fees etc. (Annex 3). In summary, the potential benefits for local people of commercial aquaculture in regulated rivers are not being fully realised because of the lack of experience and training, which is exacerbated by competition with outsiders.

The catchment of Nam Ngum 1 is largely forested and until recently there was little development upstream, so the reservoir water quality has been generally good – clear and with low conductivity and nutrient levels. However, stratification in the reservoir leads to low oxygen concentrations at depth, and release of this deeper water causes the river downstream to be at times low in oxygen

content, which can cause stress to fish in cages. In recent years there have also reportedly been inflows of “bad water”, from the newly constructed Nam Ngum 2 Reservoir, which have apparently led to death of fish in cages (see MK19 Report No. 5).

Survey results from Nam Ngum 1 Reservoir

Cage farming of snakeheads in Nam Ngum 1 Reservoir

At Don Sai Oudom Village there are 10 cage farms for snakeheads; all are of a similar size and use a similar system based on stocking of wooden cages (see discussion above) and it appears these are now the only cages for snakeheads in the reservoir. The team interviewed 3 cage farmers. They collect wild fingerlings of giant snakehead *Channa micropeltes* and also some striped snakehead *Channa striata* in the reservoir, and they also buy some fingerlings. They stock the fingerlings in small wood and bamboo cages (about 1 x 2 m x 2 m deep), about 1,000 fish per cage. They feed the snakeheads with small fish (*pa keo*) caught in the reservoir as well as other trash fish and waste from processing. They grow the fish from June for 9-12 months then sell fish at 500 grams or larger. They produce on average about 1 tonne of fish per farm, which is sold at 30,000 Kip/kg, so their average income is about 30 million kip/year. From the 20 farms in Nam Ngum Reservoir the production is therefore about 20 tonnes of snakeheads worth 600 million kip, or US$75,000 per year.

Figure 17. Cage farming of snakeheads in Nam Ngum 1 Reservoir

A simple analysis of one farmer (Annex 2, No. 5) shows that the operation is very profitable; about 89% of gross income is profit, because there are very few costs, with most fingerlings and feed caught by the fisherman himself at no cost. The farm is basically a way to upgrade the value of some excess fish to easily transportable high-value fish.

Cove farming in Nam Ngum 1 Reservoir

The northern shores of Nam Ngum 1 Reservoir are suitable for cove farming where small tributaries enter, whereas the other sides are generally too steep or remote. There are 7 cove culture farmers in Vang Vieng District and our team interviewed 4 of them. These farmers use fine nylon netting to fence-off an arm of the reservoir during the dry season when water levels are low. They stock the cove at the start of the next wet season with locally produced fingerlings of Nile tilapia, silver carp, common carp, big head carp, rohu, mrigal, Pangasiids, silver barb and giant gouramy *Osphronemus gouramy* (Pa men). The fenced-off coves are up to 17 m in depth and are 1.7 - 3 ha in area. They harvest during the next dry season when the fish are concentrated in a small area of residual water. They produce on average 800 kg of fish per harvest from an average area of 2.425 ha, so their average yield is low at 330 kg/ha, however they do not need to buy food or other inputs as the fish eat natural food. The culture cycle takes 6-8 months. Total production is estimated at 5.6 t/yr, which is worth 56.72 million kip, or US$7,090 per year.

Based on Case Study No. 6 in Annex 2, cove farming appears to provide a good return of 39% of operating costs, because feeding is not required.

Diversion of extra water from Nam Song and Nam Leuk into Nam Ngum 1 reservoir has reduced the extent of drawdown of water each dry season, which has made cage farming less viable because harvesting of fish is more difficult (i.e. the coves retain water all year).

Figure 18. Cove farm at Nam Ngum 1

Pond farming of African catfish at Nam Ngum 1

Recently some farmers have begun growing African hybrid catfish near Houay Pa Mom at high density in four large ponds, and some people are also growing these fish under small pig stys in the reservoir. The pond growers are all Chinese immigrants so could not be interviewed in detail, but it is likely that they are producing at least 10 tonnes of fish per year given the high fish densities observed; further information is needed on this type of operation.

Figure 19. Growing African catfish in ponds near Nam Ngum 1.
Fish are stocked at high densities, and the water quality is poor

Cage farming of tilapia in Nam Ngum 1 Reservoir

A large tilapia farm has recently been set up where the Nam Song Diversion enters Nam Ngum 1 Reservoir. The farm benefits from a good through-flow of water as well as relatively stable water levels. There were no farmers present to provide information on this farm, but with about 60 cages it probably produces about 360 tonnes of tilapia per year (see discussion below for Nam Ngum River cages).

In addition to this farm, there are eight small farms with a total of 50 cages at Ban Sengsavang, in the Nam Ngum Reservoir near the dam wall, supplying fish to floating restaurants. These probably produce about 300 tonnes of fish per year in total. There is also a small operation at Ban Sengsavang growing red-tailed catfish (*Hemibagrus wyckioides*) - a high-value Mekong species - in 10 cages; no production figures were obtained but a conservative estimate is 2 tonnes per year.

Figure 20. Cage culture of tilapia at Houay Pamom
This farm is where the Nam Song diversion inflow meets Nam Ngum 1 Reservoir

Tilapia culture in the lower Nam Ngum River

Official information on tilapia farms in the lower Nam Ngum River (from Thalat to the Mekong junction) was obtained from district officials and is summarised in Table 9. In Google Earth (GE) images for the lower Nam Ngum River, all dated 11 Jan 2014, rafts are visible and cages can be

counted easily (Figure 25). Overall, the GE images show 59 rafts with 2,814 cages, 86% more than were registered with district officials in 2013. All of the additional cages are in the section of the river downstream of Thangon, which is relatively inaccessible by road. The possible errors in this comparison are: (1) some cages visible on Google Earth would not have been operational, and (2) the images are about six months more recent than the survey period, so there may have been an increase in that time. However, for three sections of the river the GE images underestimate the number of cages, overall the ratio seems conservative to indicate the underestimate in the official figures. Anecdotally, the number of cages is increasing in the Thangon section, and declining further upstream where there have been water quality and disease problems, and the GE images appear to reflect that trend – see also Table 10 below.

Figure 21. Google Earth view of tilapia farms near Thangon, looking upstream
The rafts and cages can be easily counted

Table 14. Estimated no. of tilapia farms and no. of cages in the lower Nam Ngum River

Location	Information from District, July 2013		Google Earth (GE) 11-Jan-2014		Ratio of cages in GE to District information
	No. of farms	No. of cages	No. of rafts	No. of cages	
Thalat	7	118	7	82	**69%**
Keun Kang	3	92	3	88	**96%**
Thangon	23	1,246	48	2,596	**208%**
Napok	1	54	1	48	**89%**
TOTAL	**34**	**1,510**	**59**	**2,814**	**186%**

Note: some cages would be non-operational; see Table 10.

Figure 22 Tilapia farms along the Nam Ngum River, Keun Kang (left) and Thangon (right)

Our team inspected from the reach of the lower Nam Ngum from Thalat down to Keun Kang village (about 13 km downstream of Thoulakhom); in that reach there are 10 cage farmers. In this study only two farmers were interviewed because other owners were unavailable and because 7 other farmers were interviewed in a separate MK19 activity. Nile tilapia are farmed in floating steel cages about 4 x 6 x 2.5 m lined with nylon netting. A farm comprises a raft of such cages bolted and welded together, held up by floating drums, and may comprise from 6 to 120 cages (Table 9). Cages may be added or removed from a farm as the owner wishes. Each raft can be up to 4 cages wide, aligned lengthwise with the flow of the water. The entire raft rises and falls with the river, and may be towed up or downstream as needed to avoid shallow water or fast currents. In each cage farmers stock 4-5000 fingerlings which are imported from Thailand. The fish are fed imported pellet feed and grow quickly; after 4-5 months they are harvested at 670-1500 grams (average 1 kg).

Production is quite variable as there have been problems with water quality and diseases in this upper section of the river (Thalat to Keun Kang), as revealed during a separate MK19 survey (No. 5), where more information is to be presented. Along the entire lower Nam Ngum River, based on data from MK19 Study No. 5, operating cages each produce 2-4.5 tonnes of fish per harvest, twice per year, so a cage produces 4-9 tonnes per year; a reasonable estimate is about 6 tonnes per cage per year on average. If applied to the official number of operating cages, the total production estimate is 6 tonnes x 1,510 cages or 9,060 tonnes per year, worth 135 billion kip or about US$17 million at 15,000 kip/kg.

The return on investment of tilapia cage farming is about 14% per year, but the total profit per farm can be relatively high because of the large quantities of fish that can be farmed in comparison to other systems (Annex 2, Case Study No. 7).

As shown in Table 9 there were estimated to be about 2,814 cages in 59 rafts in the lower Nam Ngum River, so the possible total annual production (assuming all cages produce 6 t/year) is about 16,884 tonnes of whole fish. There is some uncertainty about production figures because the number of farms sampled was a small percentage of all farms, and some farms were new, so their production might be low, therefore total production could be between the two estimates (i.e. 9-16,000 tonnes of fish).

Figure 23. Keun Kang Village, a tilapia of 1.5 kg at 5 months old, and tilapia in cages

After this MK19 study, in 2014 DLF surveyed all tilapia farms in Vientiane Capital. That survey found there were 34 farms along the lower Nam Ngum River, consistent with Table 9, and 21 farms along the Mekong (Table 10). However there were about nine times as many operational cages in farms along the Nam Ngum River compared with the Mekong. Moreover only half of all cages along the Mekong were being used, compared with 83% of those along the Nam Ngum, suggesting an ongoing reduction in cage farming along the Mekong compared with an increase along the Nam Ngum.

Table 15. Tilapia farms (numbers) recorded in Vientiane Capital in June 2014, DLF survey

Nam Ngum River	Registered farms	24
	Unregistered farms	10
Mekong River	Registered farms	21
	Unregistered farms	
Total	**Registered farms**	**45**
	Unregistered farms	**10**

Table 16. Number of tilapia cages recorded in Vientiane Capital in June 2014, DLF survey

Nam Ngum River	Total cages	2,650
	Operational cages	2,208
Mekong River	Total cages	486
	Operational cages	242
Total	**Total cages**	**3,136**
	Operational cages	**2,450**

3.3. Nam Mang 3

Background information

Nam Mang 3 is a medium-sized dam built from 2002 to 2005 primarily to provide water for hydropower, but most of its discharge is diverted directly to a new 2000-ha irrigation system on the Nam Ngum plain. The project has been an economic success, with its construction loan fully repaid by electricity sales within the first 7 years of operations (EDL data supplied during site visit). The reservoir was formed in the headwaters of the Nam Mang River by a roller-compacted concrete (RCC) dam, as well as a second relatively low earth-fill 'saddle' dam which blocks a small valley to the west. The reservoir is relatively elevated with a small discharge, but with a high head due to diversion south-west down a steep slope. Rainfall is relatively high and less seasonal than in most parts of Lao because of exposure to two monsoons (southeast and northwest) which is a significant factor in the project's economic success; although relatively small, the reservoir can supply water year-round.

About 166 households were moved from the reservoir area; of these 81 households moved to lowland resettlement areas at and south of New Khou Khouay Village. The population near the reservoir is now concentrated at the southeast end of the reservoir in three villages. There is as yet no aquaculture in the reservoir, and only one farmer operating downstream near Nam Nyam village. There is considerable potential to increase fisheries yield from the reservoir by stocking and also to initiate aquaculture (cage or cove farming) to provide improved livelihoods for the people near the reservoir. However, the people who continue to live close to the reservoir are mainly Lao Soung (high-elevation people, primarily Hmong group), who traditionally are swidden (shifting) agriculturalists and hunters, with no experience of fish culture. Moreover the main access roads to their village and the reservoir are in poor condition and impassable during wet periods. For the benefits of the reservoir to be fully realised, basic infrastructure would need to be improved, together with supplies of equipment, feed and fingerlings. As the capture fishery in the reservoir is not fully utilised at present (see MK19 PRA report), in the short-term it is likely that the best way to increase fish production would be to stock the reservoir and to support local people to improve their fishing, processing and marketing skills, and business and management ability.

The catchment of Nam Mang 3 is largely forested, so the water is clear and has low conductivity and is low in nutrients (EDL data); at 760 m ASL it can be classified as a mid-elevation, cool and oligotrophic reservoir, which probably has relatively low to moderate potential for fish production. However, production of some cool-water species may be particularly viable and should be further investigated.

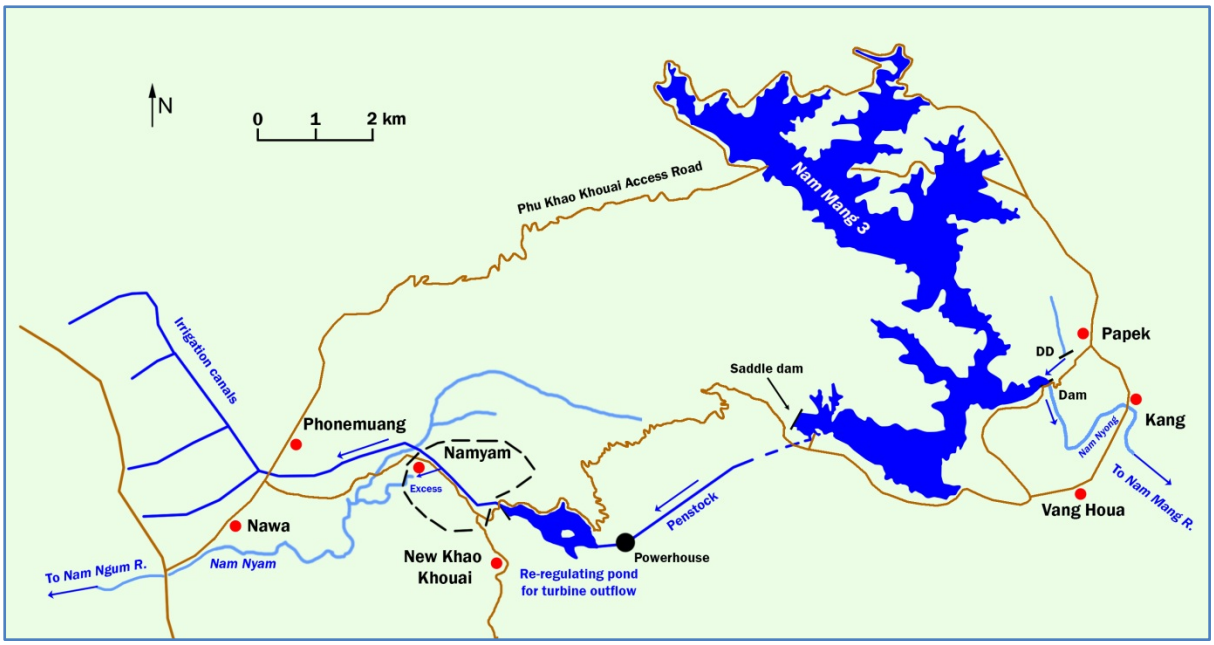

Figure 24. Nam Mang 3 Reservoir, showing villages
The aquaculture farms are in the vicinity of the dotted line

Figure 25. Overflow from the re-regulating pond downstream of Nam Mang 3 powerhouse

Survey results from Nam Mang 3 Reservoir

There is no aquaculture in or adjacent to Nam Mang 3 Reservoir, but the irrigation canals and excess water flowing to the small stream of Nam Nyam offer opportunities for expansion of pond aquaculture. There are five integrated pig-fish farmers operating, but only one was available for interview.

Downstream near the irrigation canal in Nam Yam village there is one aquaculture farmer Mr Jongjer, who was a core-farmer of the AQIP project in 2002-201. He can produce 500,000 fingerlings per year in a small hatchery. He has a large family of 13 to assist with farming. He grows tilapia, silver carp and common carp in 2.3 ha of ponds, producing about 1 tonne per cycle (6-8 months), and he also produces also 15 pigs per cycle. Assuming two crops in 18 months the total fish production from his polyculture about 1.33 tonnes per year and from all five farms is about 6.7 t/year.

Figure 26. Integrated fish-pig farmer at Nam Mang 3, small hatchery in centre

3.4. Houay Siet

Background information

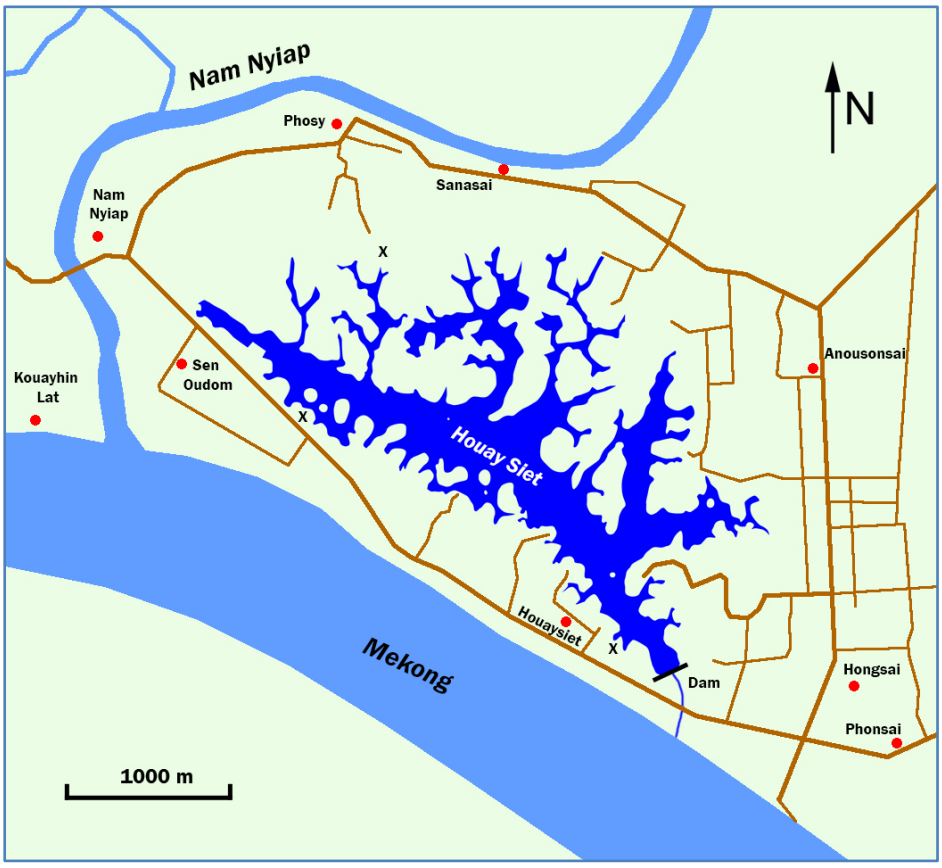

Figure 27. Houay Siet Reservoir, showing nearby villages

Houay Siet is a small reservoir west of Paksan, just north of the main Highway 13 south, which runs parallel to the Mekong. The reservoir was formed in 1985 by damming a small Mekong tributary with a simple earthen dam which has a fixed spillway. The project was reportedly funded by JICA with the intention of providing irrigation water, but it has never been used for that purpose and none of the additional infrastructure for off-take or distribution of water was ever built as required. There is some low-key tourism at lakeside restaurants on the south side of the reservoir, and plans for a golf course, but the reservoir remains unused apart from some domestic water and for fisheries. As well as the lack of a designated use for its water, the reservoir is unusual because its

water level is stable year-round, which has allowed extensive growth of aquatic plants (macrophytes) in many areas. Aquatic vegetation is to some extent beneficial for fisheries by providing spawning substrate for some species, shelter for fry and habitat for aquatic invertebrates and growth of periphyton. On the other hand, because of the lack of annual drawdown, a nutrient-rich sludge of detritus and sediment has accumulated on the reservoir's bed, the bottom waters are anoxic (separate MK19 report) and the production of plankton would be limited due to lack of nutrients and blocking of light by macrophytes. The reservoir is probably 'out of balance' for optimal fish production, which requires regular recycling of nutrients from bottom sediments, and adequate but not excessive shelter by macrophytes or other structure (a rule-of-thumb in extensive aquaculture is for up to 25% coverage of fish ponds, for example).

Next to the spillway there is a simple pool-and-weir fishway, probably the first fishway in Lao, but it is a poor design which is unlikely to pass many fish.

Figure 28. Spillway at Houay Siet Dam, with simple pool fishway on the right

Figure 29. Duck farm at Houay Siet Reservoir

Survey results for Houay Siet Reservoir

There is little aquaculture development near this reservoir, although there are some small ponds in Sen Oudom and Hongsai villages which are fed by rainwater, so are not dependent on the reservoir; it was unclear whether these were being stocked. There is no cage or other aquaculture in the reservoir. However, there is a farm for ducks on the south side of the reservoir near Sen Oudom. It is worth noting that duck farming has some distinct advantages over growing fish:

(1) Ownership is clear and poultry can be herded and housed for security each night, unlike fish, for which there is a risk of escape or theft.
(2) Ducks eat a wide variety of animal and vegetable materials which can supplement pellet feed.
(3) Duck farmers receive ongoing income from eggs, which can be shipped easily and require no refrigeration.
(4) Ducks can be transported and marketed alive without issues of spoilage.
(5) Ducks are not affected by poor water quality or anoxic conditions, which could be a problem for fish farming in this reservoir which has a small catchment and relatively limited water movement.

Duck farming is however perceived negatively by many others who depend upon wetlands, because domestic ducks are preferentially carnivorous, eating fish fry and invertebrates if available, and therefore may affect the capture fishery.

3.5. Houay Peung Reservoir

Background information

Houay Peung Reservoir (or Nong Peung or Pak Peung Reservoir) is a small reservoir south of Paksan and south of the main Highway 13 which runs parallel to the Mekong. It is a modified floodplain wetland, and as such is typical of many similar small reservoirs within the floodplain of the Mekong or its larger tributaries. The reservoir is within a natural floodplain depression, in which there are two large permanent lakes. Formerly the depression filled in the wet season with rainwater and inflows from small streams, as well as backed-up water from the Mekong, and then most of the water drained naturally to the Mekong as water levels fell, leaving the two permanent lakes.

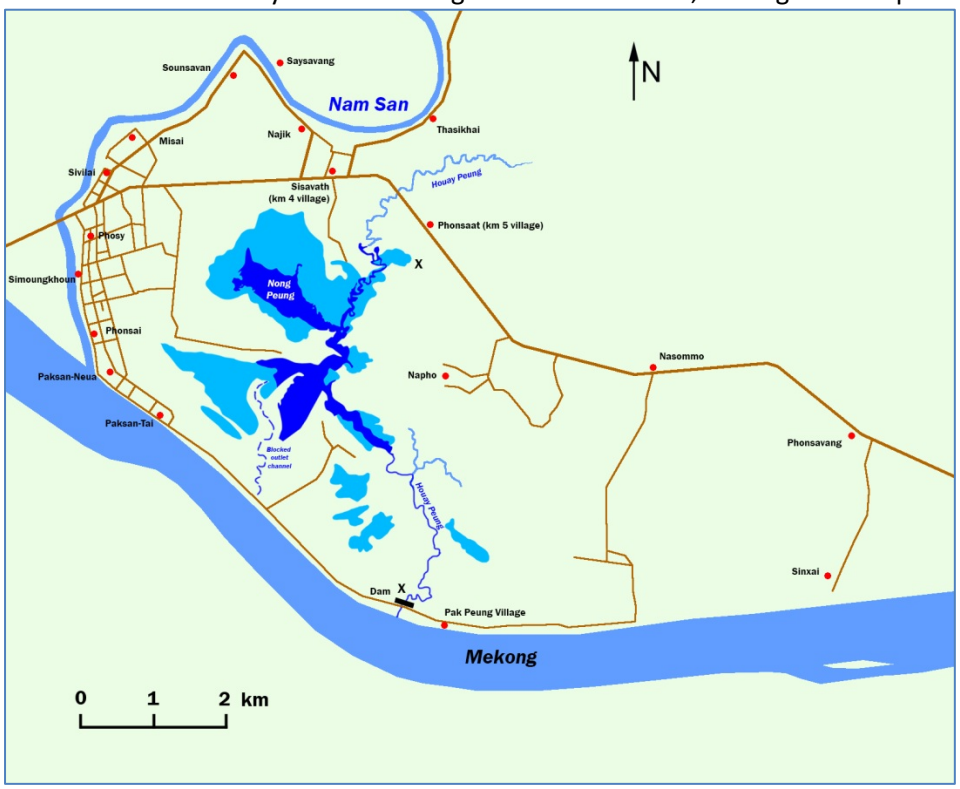

Figure 30. Houay Peung Reservoir, showing nearby villages

The levels of the reservoir are now artificially regulated by a road levee parallel to and about 30-70 metres from the Mekong which acts as a dam, and two water-gates installed at Pak Peung under the

levee which act as regulators. The road along the natural Mekong levee was built-up and fitted with culverts and floodgates in the 1980s and outflows from the lake were blocked under Japanese funding to support irrigation. The aim of damming floodplain lakes in this way is to (1) maintain high water levels to allow gravity diversion to adjacent parts of the floodplain via canals, (2) regulate the rate of water level fall so that recession rice can be grown within the reservoir's boundary in the dry season, (3) store some water which can be pumped to irrigate the dry-season rice as required (4) prevent the inflow of Mekong water as water levels rise in the early wet season, so that the dry season rice crop can be harvested. While the reservoir has always been perceived to be quite productive for fisheries, the water-gates are impassable for most of the year to upstream-migrating fish, so many formerly common Mekong species are rare or absent from the wetland and local fishers believe that catches have declined as a result. The reservoir was the target for extensive stocking under the MRC Management of Reservoir Fisheries Project (2000-2005), and a modern fishway has recently been installed (Baumgartner et al., 2012); both these measures may have improved catches from the reservoir.

Survey results for Houay Peung Reservoir

There is very limited aquaculture development in or near this reservoir, probably because many fish can be caught from the reservoir, other floodplain wetlands or from the Mekong River. Commercial aquaculture in this locality would be less viable than growing fish closer to Vientiane or other large towns or in Thailand. There are however 5 small-scale farmers who grow African hybrid walking catfish in small ponds about 1.1 km west of the Pak Peung water-gates. They import all feed (450 Baht/bag and fingerlings (100 Baht/fish); from Thailand. Their ponds are about 16 x 10 x 1.5 m deep. They are stocked with 20,000 fingerlings per pond, where the fish are fed intensively. These fish are very tolerant of crowding and poor water quality; only one farmer was interviewed (Annex 2) and he said that from a pond 160 m^2 in area he produced 1.4 tonnes of fish per harvest, a yield of 88 tonnes per hectare, which is high but within reported ranges for this species. Assuming similar production per farmer, in this area the total production of this species is probably about 7 tonnes per harvest. Fish are harvested at about 200 grams after about 6 months, so there can be two harvests per year (ponds can be filled by water from the irrigation canal). Therefore, the total harvest at this location of African hybrid walking catfish could be 14 tonnes per year, worth approximately $21,000. The study team observed that water quality in some ponds was very bad (the water was black and smelly) and there were many small dead catfish, so there is a need to improve culture practices including allowing for adequate turnover of water.

There is also some small-scale duck farming south of the reservoir, as at Houay Siet Reservoir (see discussion above).

Figure 31. Pak Peung Village - ponds for growing African hybrid walking catfish

4. Discussion and conclusions

This survey focused on documenting the main aquaculture systems and estimating production quantity and value. Table 10 summarises the key data presented in Section 3 to derive an overall conservative estimate for aquaculture production and value associated with the six reservoirs of 10,749 tonnes of fish worth $19.6 million, which is a significant component of the estimated entire annual aquaculture production from Lao PDR of about 100,000 tonnes per year.

Table 17. Estimated annual aquaculture production and value at the reservoirs in 2013

Reservoir	System	No. of farms	Mean prodn per farm per year (tonnes)	Total prodn (tonnes/ year)	Mean fish price weighted (US$/kg)	Total Value (US$)
Nam Houm - Reservoir	Cage fish polyculture	3	1.15	3.45	$1.20	$4,140
	Cove fish polyculture	1	Not producing			
Nam Houm Res.- downstream near irrigation canals	Chicken-fish polyculture	48	13.3	638.8	$1.21	$770,932
	Pig-fish polyculture	7	2.15	15.05	$1.27	$19,114
Nam Souang Res.- downstream near irrigation canals	Pig-fish polyculture	8	2.15	17.2	$1.27	$21,911
	Chicken-fish polyculture	7	16.85	117.95	$1.30	$153,693
	Pond fish polyculture	26	0.7	18.3	$1.42	$25,957
	Ponds - African catfish	1	200	100	$1.50	$150,000
Nam Ngum 1 - Reservoir	Cage fish -snakeheads	10	1	10	$3.75	$37,500
	Cage fish - tilapia	110 cages (9 farms)	6 t/cage	660	$1.88	$1,240,800
	Cage fish - red-tailed catfish	10 cages (1 farm)	0.2 t/cage	2	$5.00	$10,000
	Cove fish polyculture	7	0.8	5.6	$1.27	$7,090
	Ponds- African catfish	1	80	10	$1.50	$120,000
Nam Ngum 1 - downstream on Nam Ngum River	Cage tilapia culture - official farms	1510 cages (34 farms)	6 t/cage	9,060	$1.88	$17,032,800
Nam Mang 3 - downstream	Pig - fish polyculture near irrigation canal'	5	1.33	6.65	$1.25	$8,313
Houay Siet	No farms dependent on reservoir water					
Pak Peung	Pond farming African catfish	5	2.8	14	$1.50	$21,000
Total		**173 farms**		**10,749**	**$1.83**	**$19,623,249**

Note: fish prices and value are at 1st sale (farm or market)

Cage-cultured tilapia dominate the total production estimate, supplying about 91% of the weight and 94% of the total value (1st sale price) as a conservative estimate, based on the official number of farms and cages; however only 25% of fish farmers are tilapia cage farmers. Nile tilapia now are by far the most important fish sold in Vientiane and nearby centres, where the increasing dominance of tilapia in urban fish supply can be readily observed in markets and restaurants. If all cages on the lower Nam Ngum River were producing Nile tilapia, the dominance of tilapia would be even higher, at about 97% of the weight and 98% of the value of all aquaculture fish; a recent (2014) DLF survey suggests that the number of farms and cages continues to increase along the Nam Ngum River.

Pond fish polyculture of fish integrated with chicken or pig farming is also an important and growing industry. Fish production is secondary to the main outputs from these farms, but is nevertheless significant at about 800 tonnes of fish per year worth about US$1 million. While not the main subject of this report, the total production of eggs, chickens and pigs is far more significant than fish production from integrated farms, which further highlights the importance of water supply in supporting commercial-scale meat production. Growing fish in ponds enriched with animal wastes adds little to farm costs and is a way of capturing nutrients that would otherwise be lost. The additional value from pond-grown fish can mean that a farm makes a profit, and fish also provide some insurance against fluctuating prices for livestock, poultry and eggs. The farms may also provide some benefit to downstream users, as their ponds drain to irrigation canals, which transport any waste nutrients to farmland.

All of the aquaculture farms associated with the reservoirs are family businesses, which directly employ about 500 people, as well as suppliers and those who trade their products through markets, stores and restaurants.

While the benefits of commercial aquaculture in meeting growing urban demands for fish are obvious, discussions with farmers, as well as information in Annexes 3 and 4, have highlighted some of the problems they face. These can be broadly grouped as arising within or outside the sector. Problems related to aquaculture itself include 1) lack of technical and business capacity of farmers, evidenced by variable stocking and survival rates, which result in suboptimal returns, 2) poor disease management as is common in Lao PDR (Phimmachak and Chanthavong, 2005), 3) competition among farmers and particularly with immigrants, which drives down the price of fish, 4) limited availability of fish fry and feed, which are being imported in large quantities, which raises costs, and 5) possible impacts on other users and the environment, especially from tilapia cage farms which discharge all wastes to their host river; there may be a need to limit the number of these farms based upon the assimilative capacity of the river. Taken together these issues present a considerable challenge, which needs to be addressed if fish farmers and others in Lao PDR are to fully realise the benefits from this expanding industry.

Issues ‘outside the sector’ arise largely because much aquaculture in Lao PDR is now dependent upon (or at least greatly benefits from) the year-round availability of water from hydropower or irrigation reservoirs. However, low oxygen levels for much of the year in the Nam Ngum River are caused by discharge of water from the deep layers of the reservoir (the hypolimnion) where oxygen is depleted; while this problem is usually mitigated in design of new dams, it needs to be addressed at the Nam Ngum 1 Dam for the Nam Ngum River to be suitable along its length for fish culture, and also to support many wild fish species. Fish kills were also reported in farms at Thangon and Keun Kang villages in 2012, coinciding with releases of ‘bad water’ from the newly filled Nam Ngum 2 reservoir, which indicates a need for better mitigation of dam commissioning impacts. In more general terms, fish farming downstream of hydropower dams requires stable water levels and mitigation of any rapid changes caused by hydro-peaking.

The study has shown that irrigation dams and their distribution systems are essential for supporting integrated fish-pig or fish-chicken culture. However, maintenance and operation of irrigation systems needs to be improved so they can reliably provide irrigation water when needed, as well as supporting fish farmers, who particularly require water at the hottest and driest time of year, the end of the dry season. Integrated chicken-fish and pig-fish farms could provide significant revenue and might be re-considered as the primary users of water from some reservoirs, based on their value and potential to support maintenance of infrastructure. Currently, irrigation reservoirs are the responsibility of the Dept of Irrigation, but management of some selected reservoirs could readily be

transferred to the Dept of Livestock and Fisheries, as both departments are within the Ministry of Agriculture and Forestry.

The study found that commercial scale aquaculture is developing rapidly near Vientiane, but it is noteworthy that there was no commercial scale aquaculture at Houay Siet and only one very minor operation near Houay Peung Reservoir. In Nam Ngum Reservoir itself, commercial aquaculture is quite limited compared to wild fish production. The study indicates that aquaculture has limited viability at reservoirs which are remote from urban centres, because costs are higher and wild fish are probably sufficiently abundant to make most aquaculture uncompetitive for meeting local demand. More detailed economic studies are needed to guide allocation of government resources to aquaculture development or toward management of capture fisheries in different areas of Lao PDR. The relative merits of capture versus culture fisheries should be considered case-by-case and management efforts applied where most appropriate.

By highlighting the scale and value of aquaculture, it is hoped that this study will improve the support for aquaculture development and management in Lao PDR, and also influence the management of dam and reservoir projects to optimise their benefits to multiple users.

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Annex 1

Data from field interviews

Data are available as an Excel file from the senior author.

Annex 2

Some simple case studies of the economics of fish farming in 2013

The case studies are of selected farmers interviewed in detail during the field work.

Please note:

1. These case studies do not take into account some capital costs, such as for constructing ponds and also some of the minor inputs. They show the main operating costs and income.

2. The cost of pond construction near Vientiane in 2013 was about 10-12,000 kip/m^3 of soil moved, with prices varying depending upon soil conditions and slope. In some cases, pond costs might be low or negligible where farmers have used ex-borrow pits from road or other construction.

3. The interviews were carried out in Aug-Sep 2013; the prices of inputs and products vary widely, so they may not apply now. See Annexes 3 and 4.

Case study No. 1: Simple economic analysis of cage fish polyculture in Nam Houm Reservoir.

Mr Sybounheuang
Farmer No. 11 in Annex 1.

Mr Sybounheuang lives in Nathon Village; he is 44 years old and started integrated farming in 1997. His family has 3 people; they all help with the farm and he employs no labour. His farm has 30 cages which he stocks at 300 fish per cage. He buys fingerlings for 500 kip per fish at a size of about 4-5 cm. He grows fish for 10 -12 months; they reach 1-2 kg each and are sold middlemen at 10,000 kip/kg; he produces 60 kg of fish per cage, or 1,800 kg total each year. Taking into account his basic costs and income he makes a profit of about 71.4% of his costs. However this does not take into account the labour cost of his family nor some other inputs such as bamboo which can be obtained from the forests locally for free.

Table A1. Simple economic analysis for cage fish polyculture in Nam Houm Reservoir

1 Costs					
No.	**Item**	**Price**	**Number**	**Total cost/12 month cycle**	**Percentage**
I. Costs					
1	Fingerlings	500 kip/fish	9,000 fish	4,500,000	42.9%
2	Netting for cages	200,000 kip/year	30 cages	6,000,000	57.1%
Total Costs per 12-month cycle				10,500,000	100.0%
II. Income					
No.	**Item**	**Price**	**Number**	**Total income/12 month cycle**	**Percentage**
1	Fish sales	10,000 kip/kg	1,800 kg	18,000,000	100.0%
Total Income per 12-month cycle				18,000,000	100.0%
III. Nett income = II-I				**7,500,000**	
Nett income as a percentage of gross income				**41.7%**	
Nett income as a percentage of costs				**71.4%**	

Case study No. 2: Simple economic analysis of integrated chicken - fish polyculture downstream of Nam Houm Reservoir

Mr Bounthy
Farmer No. 18 in Annex 3.

Mr Bounthy lives in Houay Nam Yen village. His farm is located down-stream of Nam Houm Reservoir beside an irrigation canal. He was born in 1976 and started integrated farming in 2011. His family has 5 people. His farm has one fish pond which is 0.8 ha in area. He constructed a chicken shed above the pond where he stocks 2,000 chickens (hens) per cycle of 18 months. He has 2 workers to take care of the farm, including feeding chickens twice/day, at a rate of 110 g/chicken/day. After three months, 90% of the chickens will be laying eggs. In the pond he stocks 550,000 fingerlings per cycle of 5 fish species: tilapia, silver carp, common carp, silver barb and mrigal. He buys 2-cm long fingerlings from Thailand at 60 kip/fish and one cycle takes 6 months, producing 5 tonnes of fish per cycle. He stated that his selling price for fish was 7000 kip/kg which would result in only a 6% profit on the cost of fingerlings. However, the average first-sale fish price for 15 other similar farmers was 9167 Kip/kg, kg would give a profit from fish sales of 39% more than the price of fingerlings; which is probably more representative. Overall, about 90% of his stated costs were related to chicken farming which provided 93% of the income from the farm, of which 85% was from the sale of eggs. At a more representative fish price (9164 kip/kg) the income from fish would increase to 16% of the total. Hence fish polyculture is a useful supplement to the main business of chicken farming, however with three crops per year, some supplemental feeding and improved management its contribution could be increased greatly.

Table A2. Simple economic analysis for chicken-fish culture downstream of Nam Houm Reservoir.

1. Costs					
No.	**Item**	**Price**	**Number**	**Total cost/18 month cycle**	**Percentage**
1	Chickens	50,000 kip/hen	2,000 hens	100,000,000	15.3%
2	Chicken feed	3,666 kip/kg	220 kg/day	441,569,700	67.6%
3	Worker	950,000 kip/month	2	34,200,000	5.2%
4	Chicken house	7,500,000 kip/year		11,250,000	1.7%
5	Electricity	35,000 kip/month		630,000	0.1%
6	Fingerlings	60 kip/fish	550,000 x 2 cycles	66,000,000	10.1%
Total Costs per 18-month cycle				653,649,700	100.0%
II. Income					
No.	**Item**	**Price**	**Number**	**Total income/18 month cycle**	**Percentage**
1	Eggs sales	833 kip/egg	1,800 eggs/day for 15 months	684,101,250	85.3%
2	Chickens sales	25,000 kip/hen	1,928 hen	48,200,000	6.0%
3	Fish sales	7000 kip/kg	5,000 kg x 2 times	70,000,000	8.7%
Total Income per 18-month cycle				802,301,250	100.0%
III. Nett income = II-I				**148,651,550**	
Nett income as a percentage of gross income				**18.5%**	
Nett income as a percentage of costs				**22.7%**	

Note: assumes two cycles of fish per 18 months; 3 cycles is possible.

Case study No. 3: Simple economic analysis of integrated pig-fish polyculture downstream of Nam Souang Reservoir

Mr Bounlouang
Farmer No. 38 in Annex 1.

Mr Bounlouang is 58 years old and began polyculture in 2011. His family has 6 people and his farm has 3 fish ponds with a total area of 2.53 ha. He built pig sheds close to the ponds and stocks 200 pigs at a time. He and other family members take care of the farm, feeding the pigs two times per day, with total feeding of 720 kg/day. He grows pigs for about 3-5 months until they are about 90 kg each and sells at 19,000 kip/kg; he produces two crops of pigs per year. In the pond he stocks 100,000 fingerlings of Nile tilapia and silver barb. He imports fingerlings from Thailand @ 150 kip/fish, at a size about 2-5 cm, and he produces one fish cycle per year with fish sold at about 225 grams each. Most of his costs (98%) and most of his income (92%) are from pigs.

Currently (2013) his operation appears to be losing money, with operating costs higher than income; if pond construction costs were taken into account, the farm would be very uneconomic. Pig and pork prices have fluctuated widely in recent years and are mainly what determine whether his farm makes money. By May 2014, pig prices in Vientiane had risen to 22-23,000 kip/kg, despite which pig farmers were still reported to be struggling (Vientiane Times article, 6 May 2014). At that rate his profit would have increased to about 15% of his input costs, which is probably still marginal if capital costs were accounted for.

Fish polyculture is a useful supplement to the main business of pig farming, but with only one fish crop per year it is likely that he could greatly improve his production with supplemental feeding and improved management.

Table A3. Simple economic analysis for pig-fish culture downstream of Nam Souang Reservoir

No.	Item	Price	Number	Total cost/12-months	Percentage
I. Costs					
1	Fingerlings	150 kip/fish	100,000 fish	15,000,000	1.9%
2	Pigs	500,000 kip/pig	400 pigs	200,000,000	25.4%
3	Pig feed	4,333 kip/kg	720 kg/day for 182 days	567,796,320	72.2%
4	Pig house	555,555 kip/month	6 months	3,333,330	0.4%
Total Costs per 18-month cycle				786,129,650	100.0%
II. Income					
No.	**Item**	**Price**	**Number**	**Total income/cycle**	**Percentage**
1	Pig sales	1,710,000 kip/pig	400 pigs	684,000,000	91.9%
2	Fish sales	15,000 kip/kg	4,000 kg	60,000,000	8.1%
Total Income per 18-month cycle				744,000,000	100.0%
III. Nett income = II-I				-42,129,650	
Nett income as a percentage of gross income				-5.66%	
Nett income as a percentage of costs				-5.36%	

Case study 4: Simple economic analysis of pond fish-only polyculture in Nam Souang Reservoir

Mr Kuoey, Farmer No. 30 in Annex 1.

Mr Kuoey farms fish in 3 ponds of total area 6,400 m^2 downstream of Nam Souang Reservoir. He started integrated farming in 20011. His family has 5 people and they all help to take care of the farm. He stocks 40,000 fingerlings of 3 species: Nile tilapia, silver carp and silver barb. He buys fingerlings from Nam Souang Aquaculture Development Center, at 100 kip/fish. Fish are fed only for the first month after stocking at 4 kg/day using commercial feed (120,000 kip/bag), and grows them for 8 months until they are about 250 g on average. He sells fish to people in the village at 15,000 kip/kg and his total production is 500 kg/year.

Table A4. Simple economic analysis for fish-only polyculture farm downstream of Nam Souang Reservoir

No.	Item	Price	Number	Total cost/cycle (Kip)	Percentage
I. Costs					
1	Fingerlings	100 kip/fish	40,000 fish	4,000,000	84.7%
2	Feed	120,000 kip per 20 kg bag	6 bags	720,000	15.3%
Total costs per 18-month cycle				4,720,000	100.0%
II. Income					
No.	**Item**	**Price**	**Number**	**Total income/cycle (Kip)**	**Percentage**
1	Fish sales	15,000 kip/kg	500 kg	7,500,000	100%
Total Income per 18-month cycle				7,500,000	100%
III. Nett income = II-I				**2,780,000**	
Nett income as a percentage of gross income				**37.1%**	
Nett income as a percentage of costs				**58.9%**	

Case study 5. Simple economic analysis of snakehead cage culture system in Nam Ngum Reservoir

Mr Sysongkram
Farmer No. 46 in Annex 1.

Mr Sysongkram is a fisherman who also cultures snakeheads in cages near Don Sai Oudom village, in the north of Nam Ngum Reservoir. He is 46 years old and he started cage culture in 2000. His family has 5 members (3 female); the family takes care of the fish. His farm has 2 net cages, where he stocks 1,000 fish/cage. He collects juvenile fish about 4-5 cm from the wild (about 800 per year), and also buys some from other villagers (about 1,200 per year). He goes fishing every day, which has various costs including fuel at 50,000 kip/day. Feeding snakeheads is basically a supplement to the family's main business of fishing. They feed the snakeheads on average about 5 kg/day/cage; most of which is trash fish (mainly pa keo) and about 1 kg/day is trash fish which he buys from others in the village for 7,000 kip/kg. He grows the snakeheads for 10 -12 months when they can reach get 1-2 kg/fish. He sells the fish to tourists and middlemen.

Table A5. Simple economic analysis for snakehead cage culture in Nam Ngum Reservoir

I. Costs					
No.	**Item**	**Price/unit**	**Number**	**Cost/cycle**	**Percentage**
1	Fingerlings	1,000 kip/fish	1,200 fish	1,200,000	29.6%
2	Netting for cages	150,000 kip/year	2 cages	300,000	7.4%
3	Feed (trash fish bought from others)	7,000 kip/kg	365 kg	2,555,000	63.0%
Total costs per 12-month cycle				**4,055,000**	**100.0%**
II. Income					
No.	**Item**	**Price/unit**	**Number**	**Cost/cycle**	**Percentage**
1	Sales of fish	30,000 kip/kg	1,200 kg	36,000,000	100.0%
Total income per 12-month cycle				36,000,000	100.0%
III. Nett income = II-I				**31,945,000**	
Nett income as a percentage of gross income				88.7%	
Nett income as a percentage of costs				787.8%	

One-year cycle, does not include fingerlings or trash fish for feed that the farmer caught himself.

The economics of this operation are extremely favourable because there is no cost for the fingerlings and feed that the fisherman can catch himself. The farm is basically a way to upgrade the value of some excess fish to easily transportable high-value fish.

Case study 6: Simple economic analysis of cove fish polyculture system in Nam Ngum Reservoir

Mr Khamsavai
Farmer No. 46 in Annex 1.

Mr Khamsavai farms fish in a cove in Houay Xai Village, on the northern side of Nam Ngum Reservoir. He is 41 and he started cove culture in 2003; his family member has 6 persons (5 female) who help to take care of the farm. The enclosed area is 3 ha; he releases 29,000 fingerlings per crop of 5 species: common carp , mrigal, Chinese carp , silver carp, and Catla. He buys fingerlings from Thailand at 200 kip/fish and he grows the fish for 8 months; they grow to a size of up to 2 kg/fish and total production is 1,200 kg per year. He sells fish to middleman at 12,000 kip/kg,

Table A6 Simple economic analysis of fish polyculture in Nam Ngum Reservoir

I. Costs					
No.	**Item**	**Price/unit**	**Number**	**Cost/cycle**	**Percentage**
1	Fingerling	200 kip/fish	29,000 fish	3,800,000	43.2%
2	Fence	5,000,000 kip/year	1 cove	5,000,000	56.8%
Total costs per 12-month cycle				**8,800,000**	100.0%
II. Income					
1	Sales of fish	12,000 kip/kg	1,200 kg	14,400,000	100.0%
Total income per 12-month cycle				14,400,000	100.0%
III. Nett income = II-I				**5,600,000**	
Nett income as a percentage of gross income				38.9%	
Nett income as a percentage of costs				63.6%	

Case study 7: Simple economic analysis of mono-sex tilapia cage culture system,

Mr Noualahou
Farmer No. 43 in Annex 1.

Mr Noualahou farms mono-sex Nile tilapia in cages in Keun Kang village, Thoulakhom District, Vientiane province. His farm is about 28 km down-stream of Nam Ngum Reservoir (13 km downstream of Thoulakhom) on the east bank of the Nam River. He is 44 years old and started integrated farming in 2005. His family has 8 members (6 female); some of whom help him to take care of the farm. He has 60 cages, where he stocks about 5000 fish/cage. He imports tilapia fingerlings (2-5 cm long) from Thailand at 150 kip/fish. He feeds fish two times/day, total feed is 7,200 kg/day. He grows fish for 3-5 months and he harvests 4,500 fish per cage at an average weight of about 1kg/fish at harvest. He produces 2 harvests per year and sells most fish to middleman at 16-18,000 kip/kg and sells some locally at 17,000 kip/kg.

Table A7. Simple economic analysis for mono-sex tilapia cage culture in lower Nam Ngum River

I. Costs					
No.	**Item**	**Price/unit**	**Number**	**Cost/cycle**	**Percentage**
1	Fingerlings	175 kip/fish	300,000 fish	52,500,000	1.4%
2	Nets and cages	3,000,000 kip/cage	60 cage	180,000,000	4.8%
3	Floats for cages	7,500,000 kip/cycle	1	7,500,000	0.2%
4	Fish feed	7,375 kip/kg	480,000 kg	3,540,000,000	93.7%
Total costs per 6-month cycle				3,780,000,000	100.0%
II. Income					
No.	**Item**	**Price/unit**	**Number**	**Cost/cycle**	**Percentage**
1	Sales of fish	16,000 kip/kg	270,000 kg	4,320,000,000	100.0%
Total income per 12-month cycle				4,320,000,000	100.0%
III. Nett income = II-I				540,000,000	
Nett income as a percentage of gross income				12.5%	
Nett income as a percentage of costs				14.3%	

Mr Noualahou's tilapia farm at Keun Kang village
Image date 1-Jan-2014

Annex 3

Articles from Vientiane Times on tilapia farming along the Nam Ngum River

In chronological order

Foreign group conducting fishy business

Vientiane Times, 7 Sep 2009

The Xaythany District Fish Breeding Group in Vientiane is facing market competition from a foreign group operating a fish breeding business, using licenses obtained by Lao farmers.

The foreign group are operating a business of 557 fish cages on the Nam Ngum River. “They do not join our group or the Vientiane Fish Breeding Association,” said Xaythany district fish breeding group chief, Mr Oudom Phongpaseuth, on Wednesday.

District Governor, Mr Bounthong Phommachanh said, “We are trying to inform them to register with the relevant authorities for a license.”

District officials have collected information on the case to submit to the Vientiane Mayor. “We want to get a statement from the Mayor on how to resolve the issue,” Mr Bounthong said. The district has been trying to find a solution to the problem for more than a year.

The group is operating its business using licenses obtained by Lao farmers who are no longer running fish breeding operations. “According to the law they must have their own licences because they are foreign investors,” Mr Bounthong said

Mr Oudom said the foreign operated business commenced in 2006 and started supplying to local markets in 2007 at lower prices than other competitors. The group sells their fish for around 1,000 kip less per kilogram than the Xaythany district fish breeding group who sell their produce for about 16,000 to 18,000 kip per kg.

“They sometimes sell for only 7,000 to 8,000 kip per kg,” Mr Oudom said. “We can't match those prices because fish feed and other costs are high.”

By offering cheaper prices the foreign group has snatched traders away from the local group. Traders now often only purchase the district group's fish when the foreign operated group runs out, according to Mr Oudom.

The Xaythany fish breeding group has reduced its production. It used to breed about 3,500 to 4,000 fish per cage. “Now we breed only 2,500 to 3,000 fish in each cage,” Mr Oudom said.

Currently the group has only 17 members after some left the businesses. “We had over 20 members in the years from 2003 to 2007,” he said.

Fish farmers import fingerlings for breeding because they cannot be breed locally.

The group supplies 165 traders in 28 markets, restaurants, guesthouses and hotels in Vientiane and other provinces of Xieng Khuang, Luang Prabang, Xayaboury and Huaphan throughout the year.

The group cooperates with other similar groups in each district of Vientiane to ensure demand is met.

Vientiane has four fish breeding groups - Xaythany, Sisattanak, Hadxaifong and Sikhottabong - with a total of more than 1,530 fish cages, according to the association.

Nam Ngum fish catches dwindle

Vientiane Times, *27 March 2012*

The daily fish catch from the Nam Ngum river in Thoulakhom district, Vientiane province, has been steadily dwindling in recent years, and this is evident when you visit the riverside Keun market.

Most of the fish on sale at the market these days are small, and there are fewer species than there used to be. However, market traders are philosophical about the fact and are happy they at least have some produce to sell. “Nevertheless, while the fish on sale in Keun market are small they have become a more popular dish for many local families,” fish trader Saengdouane Phetkhamsing, said on Saturday.

She told Vientiane Times that each day from 2 to 3:30 pm she goes to nearby villages to buy fish from local fishermen and then takes them to the market to sell at around 4pm. She sells the fish for 5,000 kip per portion. She said the fish catch in that area has become noticeably smaller in recent years, and sometimes she struggles to source fish to sell at the market because the fishermen have had a bad day.

A customer at the market, Mr Khamphan Onta, 66, of Chaeng village in Thoulakhom district, said he always buys fresh fish at Keun market at about 5pm, after the local fish traders have brought in the day's catch. He said he wasn't too keen on fish when he was young, but now that he's older he has to eat it because he has trouble chewing pork, beef and other meats.

“If I eat meat, I don't chew it because it hurts my teeth. I get constipated when I eat meat, and don't have any bowel movements for about four or five days. Also, if I eat meat I don't sleep well. If I eat fish, I sleep well.”

“When I was a kid, my parents told me that eating lots of fish was good for the brain but I didn't want to eat it because I hated the bones and I was afraid they would stick in my throat,” he said. Things have changed. Now, his daughter gives him 5,000 kip every day to buy fresh fish at the market.

In Laos, fish is commonly eaten either grilled or in soups, as a delicious and healthy alternative to meat.

A former fisherman in Chaeng village, Mr Khamheuang Saengsavanh, said he stopped fishing in the Nam Ngum river almost two years ago because he couldn't catch enough fish to sell at the market.

He said he now breeds tilapia in the river, and the fish sells well in local markets as it is difficult to catch in the wild. “I can say that almost all the fish in the Nam Ngum River at Chaeng village have been caught by local fishermen,” he observed.

About 10 fish breeders now grow tilapia for sale along the Nam Ngum in Chaeng village and others nearby.

Mr Khanheuang said he has 16 fish cages and is now in the process of building another three cages so he will have fish to sell year round.

Tilapias are fetching about 14,000 kip per kilogramme from the suppliers and at the market one kilogram sells for up to 18,000 kip.

A typical net produces about 2 tonnes of fish every four months. Mr Khanheuang has 16 fish nets on the river, and every four months he sells four nets of fish.

Vientiane to tackle illegal foreign-run fish farms

Vientiane Times, 12 Feb 2013

Vientiane authorities will take steps to regulate the nine illegal fish farms run by Chinese in Xaythany district following a visit to the district by the committee responsible for the oversight of foreigners in the capital. Chinese were reportedly operating 13 fish farms in the district, but only four farm operators can produce legal documents, Deputy Director of the Vientiane Labour and Social Welfare Department, Mr Naenthong Leumaisone, told the *Vientiane Times* yesterday.

Nine other farms have been reported as being run by the Chinese, who are using licences that carry the names of Lao people.

Mr Naenthong said many of these Chinese did not attend the meeting with the committee last week as requested to present their business documents.

Deputy Mayor of Vientiane Mr Saithong Keoduangdy, who chaired the meeting, asked the district authorities to decide how they will persuade the Chinese fish farmers to present their operating documents by February 28.

“Those who refuse to show us the documents relating to their operations will have their businesses seized beginning on March 1,” Mr Naenthong said, citing the instruction issued by Mr Saithong.

The Chinese fish farmers are required to have the proper documents in their own names in order to carry out their business.

According to the regulations, foreigners found operating businesses such as wholesale or retail shops, tailor shops and livestock farms without a business licence can apply for legal documents if the value of their business amounts to at least one billion kip.

Those whose business value is less than one billion kip but not less than 250 million kip will be given a two-year period in which to grow their business to one billion kip, after which they can apply for legal documents. Those failing to fulfill the requirement will not be allowed to remain in Laos.

Some of those operating fish farms in Xaythany district initially entered Laos for other purposes, such as working at the Sang Chieng Chinese shopping centre or on various development projects. Mr Saithong asked district officials to ensure that they return to their original places of work.

The Deputy Mayor suggested that the district authorities recheck reports that some Lao people, after being paid by the Chinese, have bought large plots of land to be used as fish farms. If they find this to be true, he asked the authorities to pursue the matter.

Officials warned Lao people who have given fish farm licences to foreigners not to do this because it is illegal. District officials were instructed to look into the matter and resolve it.

Vientiane is launching a pilot scheme to regulate illegal foreign workers and traders in line with government instructions.

More than 6,400 foreigners - mostly from neighbouring Vietnam and China - have been reported as living in the capital. Of these, only 1,624 have work permits, while the rest are working and running businesses illegally.

According to the regulations, foreigners working in Laos without a work permit and other necessary documents will be allowed to obtain legal documents if their workplace or employer can certify them and facilitate the procedures required to obtain the correct paperwork.

Foreigners presently working as hawkers, nail cutters, beauticians, scrap metal collectors or vegetable and seafood vendors in markets or doing other informal work will be sent back to their country of origin.

Officials miss deadline to legalise foreign-run fish farms

Vientiane Times, 4 March 2013

Xaythany district officials said they were unable to complete the legalisation of nine unauthorised fish farms run by Chinese after having been told to finish the work by February 28.

Vice Mayor of Vientiane Mr Saithong Keoduangdy asked the officials to legalise the nine farms by that date when he visited the district early last month to give guidance on regulating illegal foreign workers in the district.

Mr Saithong also told officials that illegal fish farm operators who failed to present their business documents by that date would have their businesses seized starting March 1.

His instruction came after the government had given the illegal fish farmers a grace period within which to legalise their operations, but they had failed to do so.

Deputy Governor of Xaythany district, Ms Khamphay Latsamy, admitted that there had been complications in the legalisation process, and more time was required.

“We can't finish by the deadline. We told the fish farm operators to come to us with their business documents, but they arrived on February 25 so we didn't have enough time to complete the paperwork,” she said.

“Also, the procedures are complicated. The operators said that when they approached one office, they were told to go to another office first, which made them confused.”

District officials on Wednesday submitted a document to the Mayor of Vientiane requesting further guidance on the issue.

Chinese nationals were reportedly operating 13 fish farms in the district, but only four could produce legal documents. Many of the illegal operators were reportedly using licences bearing the names of Lao people.

Vientiane is launching a pilot scheme to regulate illegal foreign workers to comply with the government's instructions on the issue.

Numerous illegal foreign workers, mostly from China and Vietnam, have entered Laos as tourists or legal workers on development projects but failed to return home after these projects ended and their visas became invalid. Instead, they sought employment illegally, while others set up illegal businesses.

There are more than 6,400 foreigners in Vientiane alone - mostly from Vietnam and China. Of these, only 1,624 have work permits, while the rest are working or running businesses illegally.

According to regulations introduced by the government to regulate the issue, foreigners found operating businesses such as wholesale or retail shops, tailor shops and livestock farms without a business licence can apply for legal documents if the value of their business amounts to at least one billion kip.

Those whose business value is less than one billion kip but not less than 250 million kip will be given a two-year period in which to grow their business to the required level, after which they can apply for legal documents. Those who fail will not be allowed to remain in Laos.

In addition, foreigners working in Laos without a work permit and other necessary documents will be allowed to obtain legal documents if their workplace or employer can certify them and facilitate the procedures required to obtain the correct paperwork.

Foreigners presently working as hawkers, nail cutters, beauticians, scrap metal collectors or vegetable and seafood vendors in markets or doing other informal work will be sent back to their country of origin.

Xaythany resets deadline to legalise foreign-run fish farms

Vientiane Times, 16 May 2013

Authorities in Xaythany district, Vientiane, have reset the deadline requiring Chinese expatriates to acquire documents to legalise the nine fish farms they are operating illegally in the district to June 15, a senior official has said.

The date was pushed back after the farm operators failed to meet the original deadline of February 28.

There are 13 fish farms being operated by Chinese nationals in the district, but the operators of the other four already have legal documents, district Deputy Governor Ms Khamphay Latsamy told the *Vientiane Times* .

District officials have issued initial documents to the nine farm operators to facilitate the further paperwork processes necessary to legalise their farms with the relevant departments in Vientiane before the new deadline of June 15.

“The operators will also be required to pay business tax dating back to the start of their operations,” Ms Khamphay said. Once their paperwork is complete, the operators need to obtain membership in the district's Fish Farm Association.

If they are planning to raise fish for export, they must draw up plans with the association to ensure they work within the regulations. These allow foreigners to produce up to 49 percent of the total export volume, while 51 percent is retained for Lao farmers.

Ms Khamphay said the main reason the Chinese operators failed to meet the previous deadline was due to the complications they faced in the procedures to legalise their businesses.

Vice Mayor of Vientiane Mr Saithong Keoduangdy yesterday toured the district following his visit a few months ago to give guidance on how to regulate the issue there.

Vientiane is launching a pilot scheme to regulate illegal foreign workers, who come mostly from China and Vietnam. Many of them entered Laos as visitors and legal workers but did not return after their visas expired. Instead they sought illegal employment and started illegal businesses.

It was reported recently that in Vientiane alone there are more than 6,400 foreigners but only 1,624 have work permits, while the rest are working and running businesses illegally.

The government plans to introduce the scheme to regulate illegal foreign workers in other provinces at later dates after launching it in Vientiane.

According to policies introduced by the government to regulate the issue, foreigners found operating businesses such as wholesale or retail shops, tailoring shops and livestock farms without a business licence can apply for legal documents if the value of their business amou nts to at least one billion kip. Those whose business value is less than one billion kip but not less than 250 million kip will be given a two-year period in which to grow their business to one billion kip, after which they can apply for legal documents. Those who fail will not be a llowed to stay in the country.

In addition, foreigners working in Laos without a work permit and other necessary documents will be allowed to obtain legal documents if their workplace or employer can certify them and facilitate the procedures required to obtain the correct paperwork.

Foreigners presently working as hawkers, nail cutters, beauticians, scrap metal collectors or vegetable and seafood vendors in markets or doing other informal work will be sent back to their country of origin.

Lao fish breeders struggle to stay afloat

Vientiane Times, 6 June 2013

Fish farm breeders (sic) in Vientiane are struggling to run their businesses due to several factors, leading some to leave the industry and explore other opportunities.

The first issue is unstable prices because of poor management and lack of coordination from the relevant sectors, the Lao Fish Farm Breeding Association Vice President, Mr Nhay Keomanyvong told Vientiane Times on Tuesday.

The price of tilapia at fish farm gates during Lao New Year (Pi Mai Lao) was around 18,000 kip a kg but from May onwards, the cost fell to 16,000 kip, he explained, which puts pressure on revenues.

At the same time, capital costs are increasing as in general most fingerlings and fish food needs to be imported from neighbouring countries.

Thirdly, farmers are hamstrung by high interest payments after taking out loans from the banks, Mr Nhay said.

Each year, farmers are also struggling with variable weather, particularly flooding and drought, causing the rivers to become muddy or water levels to fall.

Many fish die from a lack of oxygen when heavy rains cause muddy waters, or during periods of low water levels and high temperatures.

In the last few years, many fish farms in Vientiane who operate along the Mekong River were affected by flooding, so breeders are consequently raising less fish during the rainy season due to the risk, he explained.

“Normally, I release 3,000-4,000 fishes per net but this rainy season I am breeding only 2,500 fish in each net,” Mr Nhay said.

Another major problem for Lao breeders is cut throat competition from illegal foreign farms, especially in Vientiane.

For the past five years, Lao fish farmers have been forced to sell their fish for the same price as the Chinese operators, otherwise they would lose customers. Prices would rise when competition dropped off and then would fall when fish production soared.

The Chinese fish farmers can sell their fish for any price they chose because they have sufficient capital and can buy feed and fingerlings from China cheaply, Mr Nhay complained.

Some fish farms that run business along the Mekong River in Hadxaifong district, Vientiane have simply stopped breeding after running at a loss for several years.

To ensure Lao fish farmers can continue to stay in business, Mr Nhay called on the relevant government departments to put more effort into solving the problems they are facing.

The association is currently able to produce 18-22 tonnes of fish a day for supply to Vientiane markets, which exceeds local demand.

Farmed fish prices rise as operators struggle to stay afloat

Vientiane Times, 14 August 2013

The cost of tilapia farmed on the Mekong River in Vientiane has risen now that many farmers have packed in their operations because of the rising river level and muddy water.

After weeks of heavy rainfall the river has become fast-flowing and turbid, making fish farming problematic.

A few months ago, farmed fish sold for about 16,000 kip per kg but this month was selling for up to 19,000 kip, Vientiane fish farmer Mr Nhay told *Vientiane Times* yesterday.

Traders are continuing to bring fish to sell at markets for about 20,000-22,000 kip per kg so they can make a profit.

To cut costs and reduce the number of fish deaths, during the rainy season Mr Nhay is keeping fewer fish in his netted cages.

“Normally, I keep 3,000-4,000 fish in one net but this rainy season I am keeping only 2,500 fish in each net,” he said.

He is still raising fish because he must have something to sell to sustain his family and to repay the interest on his bank loan.

Some of the fingerlings he bought have died but most are still alive, he added. However, he remains fearful of the impact of flooding caused by storms.

Many fish farms along the Nam Ngum and Mekong rivers stopped operations several months ago because they could not compete with illegally operated foreign-run farms in Vientiane, said the President of the Lao Fish Farm Association, Mr Kenchan Thailavan.

This problem has been eating into the profits of Lao fish farmers for several years but the government has not been able to put a stop to it, he added.

Xaythany district authorities in Vientiane have said that illegally-operated fish farms run by the Chinese on the Nam Ngum River can legalise their operations if they first sell all their fish stocks.

The operators were given from March 15 to June 15 to complete the process but they continue to operate along the same lines as previously.

There are nine fish farms that were operating illegally before Government Resolution No. 3 on foreigners working and trading in Laos came into effect in March 2011. The Resolution states that these farms must sell their fish and use only 30 nets if they want to stay in business.

Fish farms that have set up illegally since the Resolution came into effect are required to sell all their stocks and re-register.

Xaythany district, in cooperation with the sectors responsible, is encouraging unauthorised fish farms to sign an agreement that they will comply with this order.

Thirteen fish farms were found to be operating in the district, but only four were able to produce the requisite legal documents.

Foreign fish farmers allowed to register their businesses

Vientiane Times, 23 July 2014

Vientiane authorities are planning to legalise foreign owned fish farms as part of efforts to generate revenue for the capital.

Officials announced last week that foreigners who operate fish farms should request a business operation licence from the authorities as soon as possible.

According to policies introduced by the government to regulate the issue, foreigners found operating businesses such as wholesale or retail shops, tailoring shops and livestock farms without a business license can apply for legal documents if the value of their business amounts to at least one billion kip.

The government plans to use the business licences which are granted as a reference to collect tax from the fish farmers in question, which are currently not paying any tax to the government.

Those whose business value is less than one billion kip but not less than 250 million kip will be given a two-year period in which to grow their business or they can form a cooperative to reach the one billion kip, after which they can apply for legal documents. Those who fail to do this will not be allowed to stay in the country.

The announcement came after the discovery that there are 13 fish farms being operated by Chinese nationals in the Xaythany district but only four operators currently have legal documents.

It was reported recently that in Vientiane alone there are more than 6,400 foreigners but only 1,624 have work permits, while the rest are working and running businesses illegally.

Authorities also showed that operating businesses illegally can lead to the government losing millions of kip in revenue collection which could be used for funding development.

The authorities explained that by allowing foreign owned fish farms to operate legally it would simplify the tax collection process and increase revenue while encouraging growth in the fish trade which would create a sufficient supply for the local market.

One member of the audience for the announcement suggested that while allowing the foreigners to legalise their businesses might mean that market prices could come down to benefit consumers there was a danger this could have a damaging effect on local fish farmers over a long period.

Lao fish farmers concerned about foreign competition

Vientiane Times, 25 July 2014

Lao fish farm breeders are concerned about the stiff competition they will face from foreign fish farm operators after the government moved recently to legalise some unauthorised foreign fish farms.

Vientiane authorities recently announced that they would move to formalise the illegal fish breeding operations of some Chinese fish farmers on the Nam Ngum River on the outskirts of Vientiane.

The government said foreigners who are operating fish farms in Vientiane should submit the relevant documents to obtain proper business operation licenses as soon as possible.

The move comes as all sectors of industry and agriculture are now open to foreign investment, aiming to generate more revenue and integrate with the Asean Economic Community by next year. However Lao fish farm breeders are worried that the promotion of foreign investment in the industry will create too much competition in the local market, causing the numbers of fish to overflow and prices to crash.

Head of the Lao Fish Farmers' Group, Mr Kenchanh Thailavan said the issue is that oversupply will force the prices farmers receive for their fish to fall significantly, thereby putting extra pressure on local breeders.

Almost all Lao fish farms in Vientiane have borrowed money from the bank to establish their operations, he explained, and they have to make high interest repayments each year.

In contrast, some foreign operators have access to other sources of capital and can afford to lower their prices temporarily to force competitors out of the market only to raise them again.

Mr Kengchanh asked who will be responsible if a number of Lao fish breeding operations collapse. He acknowledged that foreign investment promotion is a good policy for the country but stressed that the government should create measures in management and allocate a quota of farms for breeding to prevent an overflow of fish.

Normally Vientiane requires somewhere between 1,300-1,500 nets to produce fish for people's consumption but currently there are over 3,300 nets in the surrounding area, Mr Kenchanh said. Many Lao fish farm breeders cannot compete with foreign breeders as they have invested large amounts of capital and lack knowledge on efficient breeding and marketing techniques.

Consequently, most Lao farmers have to import fingerlings and fish feed from neighbouring countries which adds to the cost of their operations.

Amid stiff competition and a lack of good management, Mr Kenchanh believes that in the years ahead many Lao fish farmers may go out of business and there will no longer be a fish farmers' association any more.

“Our group currently comprises around 51 members including the farmers in Borikhamxay and Vientiane provinces,” he said, “but at the moment we have fears for its future.”

He stressed that for the group to survive it will require closer collaboration and cooperation among the group members in order to share new techniques and achieve economies of scale.

However despite farmers' concerns the demand for fish in the market is still high as many people are eating more fish after limiting their beef consumption following a sharp rise in price.

The price of captive bred tilapia at the farm gate has currently fallen to between 12,000-15,000 kip a kg due to market oversupply.

Foreign fish farms provide healthy competition

Vientiane Times, 11 August 2014

A senior economist has expressed his support of Vientiane authorities' decision in allowing foreign investors to invest in fish farms.

The National University of Laos' Economic and Business Management Faculty's Research Division Director Assoc Prof. Dr Phouphet Kyophilavong said this would provide healthy competition and allow Lao fish breeders to improve their capacity.

Dr Phouphet told *Vientiane Times* last week that the government was promoting foreign investment, so the country needs to place suitable limits on it.

This policy is put in place to promote Laos' integration into the Asean Economic Community next year.

Through opening up the country to foreign investors and businessmen, it would push Lao operators to develop their businesses further and prepare themselves for overseas competition.

The quality of the products would also improve and this would be a benefit to their consumers as they could buy goods at a cheaper price, Dr Phouphet said. However, he urged the government to provide Lao breeders with support on technical breeding, marketing and receiving loans.

He said some businesses may collapse if they did not have a good management plan drawn up or if they did not improve their capacity.

Lao fish breeders have been struggling with competition from foreign farmers operating illegally in the past few years due to the poor management of local authorities.

Local fish farmers said they could not compete with foreign breeders as they had invested larger amounts of capital but lacked knowledge on efficient breeding and marketing techniques.

Most Lao farmers had to import fingerlings and fish feed from neighbouring countries, which also added to the cost of their operations.

Amid stiff competition and a lack of good management, Vientiane Fish Farm Breeding Group said that in the years ahead many Lao fish farmers may go out of business.

Foreign breeders have more access to funding, fingerlings and fish feed, as well as good marketing experience.

In the past, many fish breeders had to stop their business operation due to the owners' financial issues and poor marketing management.

However, some fish farms are still thriving and operating their businesses.

Most of them are raising fish along Nam Ngum and Mekong Rivers, according to the Vientiane Fish Farm Breeding Group.

Fish farm production is currently supplying a surplus of about 20 tonnes per day to the Vientiane market.

Fish farmers lose out as prices tumble

Vientiane Times 3 September 2014

Fish farmers keeping cages of tilapia in Vientiane have seen their profits dwindle as the sale price of fish sinks to its lowest level in years amid increasing competion from foreign fish farmers.

The growing presence of Chinese fish farmers on the Nam Ngum River has led many Lao fish breeders to give up the business, as the Chinese traders have more funds to finance their operations. Fish are now selling at the farms for just 11,000-12,000 kip per kg, but the cost of raising the fish is about 15,000 kip per kg, Xaythany district model farmer Ms Khankeo Pravongviengkham told *Vientiane Times* recently.

This year, the price of fish is down about 1,000 kip per kg compared to the same time last year, she added. In addition to the increasing number of Chinese fish farmers, the cost of fingerlings and fish feed has risen, she said.

The few Lao-owned fish farms still operating this business have strong financial backing and sufficient funds to tide them over. Lao fish farmers suffer from a number of disadvantages compared to their foreign competitors.

They cannot compete with foreign breeders because they have to use their own savings as investment capital, while the Chinese can borrow money from banks. They are also poorly informed about efficient fish farming methods and marketing techniques.

Most Lao fish farmers have to import fingerlings and fish feed from neighbouring countries, which adds to the cost of their operations. Initially, the fish farm group in Vientiane comprised more than 200 members but there are now just 50 farmers in the group.

Ms Khankeo said Lao fish farmers cannot compete with the Chinese because they sell the fish at lower prices and so attract far more customers. Naturally, most Lao consumers will buy from the farm that is offering the lowest price. “Sometimes we have to sell our stock at a loss when the fish are fully grown,” she said.

Ms Khankeo suggested the government should set a fixed price for all farms, whether Lao or foreign-owned. She proposed that the lowest price should be set at 15,000 kip per kg and the highest at 18,000 kip, but realised this would not be possible because of market forces and the nature of competition.

It is government policy to encourage foreign investment in economic development in Laos, so business operators should learn how to make their products competitive in the marketplace, she added.

Annex 4

Articles from Vientiane Times on pig farming and price fluctuations

Arranged in chronological order

Vientiane to set fixed pig, pork prices

Vientiane Times, January 3, 2012

Vientiane Industry and Commerce Department is planning to set fixed prices for live pigs and pork to prevent traders taking advantage of consumers.

Under the proposed price structure, farmers would sell live pigs for 15,500 kip to 16,500 kip per kg, which would enable slaughterhouses to make a profit of 20,000 kip when they sell the meat. Market vendors would be required to sell pork for a maximum of 28,000 kip per kg, department official Mr Noumun Phothisane said.

This price structure would benefit everyone involved in the trade, including farmers and market vendors, he said.

The department is directing Industry and Commerce Offices in Vientiane's nine districts to collect information on live pig and pork prices as a basis for discussions with farmers and businesses, he added.

“After each party has agreed to this measure we will sign a memorandum of understanding after which the department will announce the implementation of the regulation,” he said. Anyone found to be infringing the regulation will be fined in accordance with the seriousness of the case.

Breeders and others involved in the business will be required to register. If they fail to do so, the department won't permit them to engage in market trade.

With the rapid rise in the demand for pork in recent years, the numbers of pig breeders has increased, but some have not registered, Mr Noumun said.

Over time, the price of pork at markets has risen continuously and the industry and commerce sector was unable to regulate the situation. In the meantime, the sale price of pigs at farms dropped because of increasing competition from illegal producers.

Many pig farms closed as they were unable to make a profit and were unable to source any funding to continue their business, according to the Vientiane Pig Farm Association.

Foreign pig breeders are operating farms illegally in Vientiane, the association said, and ndependently set prices, which skewed the market and cut profits.

Mr Noumun believes the proposed price structure will effectively regulate pig and pork prices, but it will require the cooperation of various government agencies and the private sector. Implementation of the regulation may be difficult at first, but it will ultimately benefit the commerce sector and consumers, he added.

Pigs currently sell for 15,000 kip to 16,000 kip per kg at the farm,while pork in the market sells for 36,000 kip to 38,000 kip per kg.

The Vientiane market requires about 400 pigs per day but at present there is an oversupply.

Pig farming back on the rise

Vientiane Times, 18 Sept 2013

Members of the Vientiane Pig Farm Breeding Group are considering increasing their stock numbers to supply a growing demand for pork across the country.

As beef and buffalo meat prices peaked in Vientiane and all over Laos earlier this year, many consumers shifted to eating pork and fish.

Vientiane Pig Farm Breeding Group Head, Mr Neuang Sombounkhan, said as a result, the price of pigs and pork had risen.

Buying a pig at the farm now costs about 21,000-22,000 kip per kg, while pork at the market is worth 37,000-38,000 kip per kg. Mr Neuang said if prices remained stable at such high levels, pig breeders would be able to make their businesses sustainable.

The group is currently calling on the government to consider providing funding for growth in the Lao pig farm sector.

More than 7,000 pigs are owned between the 80-odd member group, a long way short of its peak in 2008 and 2009 when more than 200 pig farms were part of the collective.

A blue ear disease outbreak, competition from illegal foreign pig breeders and high interest rates put a number of farmers out of business and forced others to reduce their pig numbers.

But according to Mr Neuang, some former-members are looking to return to pig farming.

He said if breeders could not meet the continued high demand in the market, pig and pork prices would see further increases.

The number of pigs sold for consumption in Vientiane sat at about 300 per day a few months back, but has now risen to about 500 per day. The demand has also forced farmers to sell animals weighing between 50 and 60kg, rather than the more standard 70 to 80kg.

Mr Neuang said the government had ordered local authorities in Naxaithong district to put a stop to illegal foreign pig farming in the area, removing one more worry for the Lao group.

He said boosting production in the pig breeding group would also help the country's farmers prepare for Asean Economic Community integration in 2015.

The cost of beef remains high in Vientiane at around 65,000-70,000 kip per kg, while fish costs 19,000-20,000 kip per kg.

Pig breeder ‘bringing home the bacon'

Vientiane Times, 2 May 2014

Many Lao pig farmers are facing bankruptcy hampered by the high cost of capital for investment as well as a lack of technical breeding expertise.

Despite farmers having sufficient land to breed pigs they have limited funding to buy piglets, animal feed and vaccines to successfully operate their businesses.

Some farmers are generating enough income for their families but are struggling with high interest rates charged for loans from the banks and competition from overseas pork producers.

One successful pig breeder who is bucking the negative trend in Pakngum district, Vientiane province, Mr Cheu-va Saytong, told *Vientiane Times* during a visit to his farm last week that his family earns around 300 million kip income a year from breeding pigs.

He started with just 50 pigs in 2007 but has now expanded to breed 1,800 pigs, and employs his cousin, uncle and son's families in the care of the pigs.

Charoen Pokphand (CP) Lao Company has provided piglets, feed, technical advice, vaccines and marketing know-how, while Mr Cheu-va Saytong has supplied the labour and facilities for pig breeding.

He initially borrowed 500 million kip from the bank to establish the farm for development and he managed to repay the entire loan by 2011.

He said he put the success of his pig farm down to paying close attention to breeding techniques especially having clean pigsties, providing good quality feed and vaccinations as well as trying to seek traditional treatments when pigs got sick from seasonal disease and outbreaks.

His farm currently has one pig shed that comprises eight pigsties with 400 breeding pigs inside. In this ‘standard house' he has invested around 300 million kip in capital buying equipment and installing new systems.

The innovations include a water vapour system and closing off the standard house from the rest of the farm but with flow through ventilation. This enables the management of the temperature inside and prevents disease from the outside. This model facility is the first and only one thus far of his six houses, and he plans to eventually convert the other five.

Pigs bred in the standard shed grow larger and are better quality compared to those of the same age raised by the normal methods.

For normal pigs sold he receives 900 kip per kg from the company while for those from the standard shed the price is 1,300 kip per kg. For these better quality pigs he has also been able to sell large job lots to the company and received around 100 million kip over four months.

He would like to install more standard pigsty systems providing he can reinvest enough money from the business or there are good lending policies from the banks to help.

Many pig breeders in the district are still struggling to generate sufficient profits from their businesses with a lack of new breeding techniques and providing correct feeding as part of the problem.

Pig farmers still struggling despite price rises

Vientiane Times, 6 May 2014

Vientiane pig farmers are still struggling to make large profits despite pork prices rising in Vientiane markets, a pig farm owner has said.

The price of pig meat sold directly from farms has risen from 19,000 kip per kg a few months ago to 22,000-23,000 kip per kg now. It has reached as high as 24,000-25,000 kip per kg at some farms, Vientiane pig breeder Mr Neuang Sombounkhan told *Vientiane Times* yesterday.

The price at the slaughterhouse rose from 25,000 kip to more than 30,000 kip, while at the market it rose from 40,000 kip to 43,000 kip per kg of pork.

However the margin for market vendors is not that great as they purchase the entire butchered pig from the slaughterhouse, including the bone, offal and head, for the same price. They then have to separate and grade the meat before selling it at different prices.

Mr Neuang said if the farm price stayed between 22,000 and 23,000 kip per kg then pig breeders could manage their farms smoothly.

But farmers would have trouble staying afloat if the price dropped to 18,000 to 19,000 kip per kg, he said. The costs of pig farming are high, with farmers needing to pay for piglets, animal feed and labour.

Mr Neuang said traders who buy pigs from the farm to kill at the slaughterhouse and then sell to pork vendors at the market always made a profit.

These middlemen now collect 5,000 kip for every kilogram of pig they buy and then sell on, an increase on the 3,000 kip they earned in 2012, by charging higher fees for service, slaughter and transportation.

Mr Neuang said high demand and low supply had caused the price rise. Over 500 pigs are needed every day to meet the demand of markets in Vientiane.

However local pig producers, including the 40 odd Lao Pig Farmer's Association farms as well as the CP operations, have recently only been able to supply around 300 or more. Some pig breeders have been forced to sell their young pigs to bolster their incomes, Mr Neuang said.

Many local pig farmers are struggling despite the high prices because they import pretty much all their inputs, including, piglets, vaccinations and feed from neighbouring Thailand and are also saddled with debt after borrowing to build their pig sties.

The number of people regularly eating pork has risen, while beef consumption has been lower as a result of high prices and the low supply of meat.

The government has set the price for pigs at 18,000-20,500 kip per kg at the farm, 22,500-25,000 kip per kg at the slaughterhouse and 37,000 kip per kg at the markets, but the prices have proved difficult to control.

Less cattle and buffalo have been killed recently as farmers have limited land on which to raise the livestock. Pork prices in neighbouring countries, especially Thailand, have also risen.