3.3 PEOPLE & LIVELIHOODS

People of the Nam Ou Basin

Administration

The Nam Ou Basin is located within the boundaries of three provinces – Phongsaly, Oudomxay, and Luang Prabang – but not all of their areas fall within the hydrological boundaries of the Nam Ou Basin. There are 17 districts within the basin: seven in Phongsaly, six in Oudomxay, and four in Luang Prabang. All districts and nearly all villages in Phongsaly are in the Nam Ou Basin. The mainstream Nam Ou and territories within the 5-km corridor of the river lie within Phongsaly and Luang Prabang provinces; only tributaries of the Nam Ou are in Oudomxay Province.

Population

In 2015, the total population of the three provinces was **885,200**, with an estimated **404,094** people (45.7%) living within the watershed boundaries of the Nam Ou Basin (Table 5). About 96% of Phongsaly's population live in the basin, but only one-third of Oudomxay and Luang Prabang residents live in the basin. Compared to the other two provinces, Luang Prabang has the largest population but a majority of its residents live in urban areas. Over the last decade, population density has increased in all three provinces: Oudomxay recorded the biggest change with its population density rising from 17.3 persons/km^2 in 2005 to 20.0 persons/km^2 in 2015, while Phongsaly was the lowest (Figure 7).

Between 2005 and 2015, the population growth rate in the three provinces of the Nam Ou Basin has been uneven. Almost three-quarters of the people live in rural areas of the provinces; most of them engage in subsistence agricultural activities and depend heavily on natural resources for their livelihoods. A high percentage of the rural population does not have road access. In Phongsaly, for example, over 21% of the population live in rural areas without roads.

From the Agricultural Census (2011), over a quarter of farming households live within a 5-km corridor of the mainstream Nam Ou and the Nam Phak. Results of the 2016 household survey indicated that most households (around 96%) within 5 km of the Nam Ou are headed by men.

Table 5 **The Nam Ou Basin demographics (based on the availability of data from the Population and Housing Census 2015) – Phongsaly, Oudomxay, and Luang Prabang; number inside basin by district and total number outside the Nam Ou Basin.**

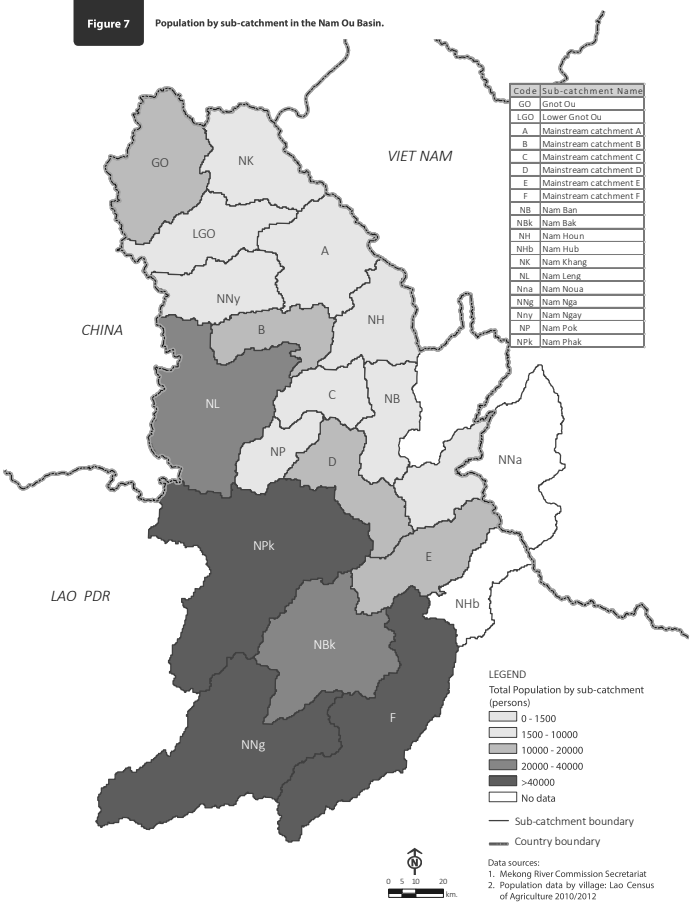
	Number of Households	Household Size	Total Population	Population Inside Basin (est.)[1]	% of Total Population
Phongsaly	33,800	5.1	171,400	163,858	95.6%
Oudomxay	55,200	5.4	295,800	101,459	34.3%
Luang Prabang	80,900	5.2	418,000	138,776	33.2%
Total	**169,900**	**5.2**	**885,200**	**404,094**	**45.7%**

[1] The number of population within the basin is estimated based on Data of the Agricultural Census 2010/11, however in terms of distribution.

Ethnic Groups/Ethnicity

The 2005 population census shows that residents of the Nam Ou Basin are ethnically diverse. In Phongsaly, the Akha account for the largest percentage of the provincial population (27%), followed by the Khmu (22%), and the Songsiri (18%). In Oudomxay, the Khmu is the largest (59%), followed by the Hmong (14%) and the Lue (around 10%). The Khmu makes up almost half (47%) of Luang Prabang Province's population, followed by the Lao ethnic group (29%) and the Hmong (16%).

Figure 7 **Population by sub-catchment in the Nam Ou Basin.**



Box 17

The Akha

The Akha originally settled in the area from Kuaichao and Yunnan, which are part of China today. Akha villages are usually situated on hillsides 600-1,000 masl and have 40 to 50 households per village. Their houses are made of materials from the forest such as bamboo and wood planks. Most Akha villages are located far from rivers. Qualitative information on the Akha suggests that they would be little affected by changes in water-resource availability in the Nam Ou Basin because they mainly practice upland agriculture with little reliance on fishing.

The Khmu

The Khmu are one of the oldest inhabitants in northern Lao PDR. Khmu villages are found near streams in lower mountainous areas, varying in size from 10 to 90 houses. The Khmu practice shifting cultivation, growing crops such as cassava, maize, peanuts, other vegetables, and tobacco. They raise buffalo, goats, pigs, and chickens; they also fish; hunt, catch rodents, and collect NTFP for cash and food. The Khmu are skilled at working with metal and weaving with bamboo and rattan, making baskets, fish traps, and other tools and utensils, which are sold or traded. Qualitative information on the Khmu suggests that they would be significantly affected by changes in Nam Ou water resources because of their reliance on fisheries and belief in the Hom Spirit.

The Lao ethnic group

The Lao ethnic group has been in Lao PDR for hundreds of years. They usually live in lowland areas near river/streams and have followed Theravada Buddhism for centuries. The Lao practice lowland paddy and upland agriculture, growing crops such as vegetables, tobacco, cotton, fruit, and cassava. They also raise buffalo, cattle, pigs, poultry, and dogs. Fish are an important source of food and income for the Lao who fish in rivers, streams, lakes, and other areas. They will be significantly affected by changes in Nam Ou water resources because lowland agriculture, including paddy and riverbank gardening, is highly dependent on water and they rely on fish as a food supply and income source.

The Singsily

The Singsily have lived in Lao PDR for centuries near streams in mountainous areas 600-1,000 masl. Singsily villages range from 20 to 100 households in size. They grow both dry and wet rice in upland/shifting cultivation areas, with glutinous rice being the most common; other crops include corn, cucumber, sugar cane, cabbage, lettuce, and some tobacco. Chicken, pigs, and buffalos are the livestock often raised. Singsily women are skillful in sewing clothes, while men can make simple tools such as knives, axes, machetes, and crossbows. They also weave baskets, fish traps, and storage baskets. Singsily households would be significantly affected by changes in Nam Ou water resources as their villages are located close to streams/rivers and they believe water spirits influence the results of harvests.

The Hmong

The Hmong migrated from the Tibetan region in China into Lao PDR in the mid-19th century. The Hmong practice mainly shifting cultivation, including rice and maize. They are skilled at animal husbandry, raising cattle, buffalos, horses (historically), goats, pigs, dogs, and chickens. Handicrafts form an important part of their livelihoods, including blacksmithing, baskets, jewelry, and embroidery. They fish only occasionally; as a result, changes in water resources in the Nam Ou Basin will affect them less as they mostly practice upland agriculture.

The Lue

The Lue originally came from China's Guangdong Province. Their villages are located at altitudes 150-400 masl near rivers/streams. They grow mostly glutinous rice as a staple food and other crops such as corn, tobacco, cotton, fruits, and vegetables. They raise buffalo, pigs, and poultry. They work with silver, weave baskets, and make sarongs, handbags, and other handicrafts. If there are changes in Nam Ou water resources, the Lue would be affected because of their dependence on rivers/streams for farming.

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Baseline vulnerability

Life expectancy is higher for women than men in all provinces of the Nam Ou Basin. Phongsaly has the highest life expectancy, followed by Luang Prabang, for both sexes despite having the lowest percentage of population with access to health services; only 5.3% of its population has access to a licensed pharmacy. More than half of the population in the three provinces have access to midwives and health volunteers.

Overall, less than 5% of the total sampled heads of households are females. Women aged between 15 and 49 in Phongsaly and Oudomxay give birth to nearly four children on average, while women in the same age group in Luang Prabang give birth to just over 3 children.

Literacy rates for women are lower than men in all three provinces. In Phongsaly, less than half of its population is literate, with a literacy rate of 53% for men and 34% for women; in Oudomxay, 73% of men and 40% of women are literate; the figures are 80% for men and 55% for women in Luang Prabang (National Statistics Center 2007).

A low percentage of the Nam Ou Basin's population has completed secondary education or higher. If people's livelihoods in these provinces are affected by changes in access to natural resources, less than 13% of Luang Prabang's population may be able to find better opportunities elsewhere and less than 7% in Phongsaly and 9% in Oudomxay can do so.

Water resources, such as fish, other aquatic animals and plants, and riverbank gardens, are an important part of people's nutrition in the Nam Ou Basin. A food security study found that wild meat and aquatic resources, especially wild fish, were the biggest source of animal protein in rural parts of the country (World Food Programme, 2007). The 2016 household survey within the 5-km corridor of the Nam Ou and the Nam Phak showed that the value of water resources, including irrigated rice, fish, and other aquatic animals, makes up 15-28% of the total monetary value of daily consumption. Changes in water resources will directly affect the nutrition of people in the basin. Fish have been the basis of subsistence livelihoods for rural people in the country and will remain important in the years to come.

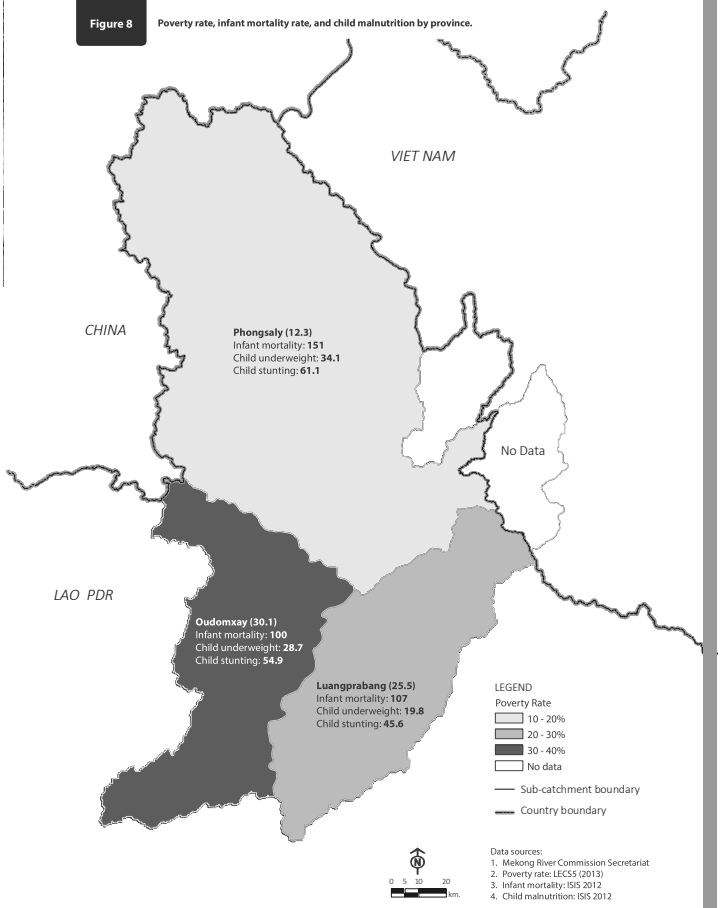
Dependency ratio is defined as the number of individuals aged below 15 or above 64, divided by the number of individuals aged 15 to 64, expressed as a percentage. The higher the dependency ratio, the more difficult it is for a household to adapt to changes that may be required by a decline in livelihood resources. Phongsaly and Oudomxay share the same, high dependency ratio of 0.8. This means that people in Oudomxay would be more vulnerable to negative changes because they are poorer and have more unproductive household members to feed compared to people in the other two provinces.

Poverty in rural areas is caused by factors such as limited opportunities for skill development, lack of investment in the area, a high dependence on rain-fed farming, the collection of NTFP, and fisheries, which are highly seasonal. Communities are therefore vulnerable to any changes in livelihoods or access to natural resources. Vulnerability in this context is not fixed, but highly dynamic. Poverty distribution in the Nam Ou Basin shows that the poorest province is not the remotest; Phongsaly, a mountainous province, has the highest percentage of population employed in the agricultural sector, but the other two provinces with larger urban centers – Meuang Xay and Luang Prabang – are in fact poorer (Figure 8).

More than half (53.9%), of the villages surveyed in Phongsaly had access to electricity. Although access is much higher in Oudomxay (74%) and Luang Prabang (71%), the electrification rate in these provinces is among the lowest in the country. However, LECS4 data indicate that the percentage of villages with electricity has increased between the LECS 2002/03 and 2007/08 surveys. In the northern provinces, including three in the Nam Ou Basin, access to electricity increased from 22% to 51% over this period.

The percentage of people living in villages with piped water supply is low in all three Nam Ou Basin provinces, ranging from under 15% in Phongsaly to just over 25% in Luang Prabang. Within the 5-km corridor in 2016, most households (93%) obtained water from piped water sources, often connected from small streams running from hills or mountains near the villages. Less than 7% of Phongsaly's population has access to markets, while the figures are 13% in Luang Prabang and 11% in Oudomxay.

Figure 8 Poverty rate, infant mortality rate, and child malnutrition by province.



Fisheries

Over 70% of the sampled households in the 5-km corridor indicated that they went fishing in the Nam Ou or one of its tributaries within a year before the survey. Over 90% of households in Zone 1 were engaged in fishing, and nearly 80% of households in Zones 2 and 3 did the same. Almost two-thirds (64.4%) of sampled households said they collected OAA; in Zone 1, over 90% of households collected OAA, and households headed by women noted that OAA collection was a more common activity for them compared to fishing.

The amount of fish and OAA captured increases as one moves from north to south along the Nam Ou; the total population also increases the further along downstream. The number of fishing households within the 15-km corridor of the Nam Ou Basin is higher in Phongsaly than Luang Prabang (Table 7).

Table 7 Number of fishing households in the Nam Ou Basin.

	0-5km	5-10km	10-15km	Total
Oudomxay			**1**	**1**
Nga			1	1
Phongsaly	**5,352**	**2,676**	**84**	**8,112**
Boun-tai	43	89	3	135
Gnot-ou	2,641	983	12	3,636
Khoa	704	263	12	979
Mai	249	261	18	528
Phongsaly	679	319	25	1,023
Samphan	1,036	761	13	1,810
Boun-neua			1	1
Luang Prabang	**5,340**	**1,341**	**47**	**6,728**
Nambak	465	686	32	1183
Ngoy	2,751	222	9	2982
Pak-ou	2,100	265	2	2367
Phonthong	24	168	4	196
Total	**10,692**	**4,017**	**132**	**14,841**

Importance of Nam Ou Water Resources to Local Livelihoods

Water resources play an important role in food consumption. Results of the 2016 Household Survey show that on average, 20.6% of the total food consumption value is derived from aquatic items, including irrigated rice, fish, and OAA. The share of consumption value from water resources can be as high as 28% in Zone 1; this does not include vegetables from riverbank gardens due to difficulties in separating sources of vegetables in the survey, and the results presented are therefore conservative. Overall contribution of water resources to cash income in villages in the basin is about 7% overall but much higher in specific zones (for example, over 24% in Zone 5 and 13% in Zone 3).

Changes in livelihood activities

Information obtained through FGD and household surveys conducted in 2016 suggests that fish catches have declined on the Nam Ou in recent years. In the eight villages selected for case studies, women and children who used to catch small fish and collect OAA and plants can no longer do so; this is the result of the hydropower developments and creation of reservoirs with steep slopes in the natural river.

Villagers said the number of fish species collected has also declined. For example, villagers of Ban Phoumeuang (near Nam Ou 6) identified 41 fish species that they used to catch in the Nam Ou; following their move to the new resettlement village of Ban Homsang, they report that they are only catching nine fish species in the reservoir, two of which are exotic – Tilapia (*Oreochromis niloticus*) and Common Carp (*Cyprinus carpio*). The experience of other areas of Lao PDR and Southeast Asia show that species diversity is reduced with the inundation of a reservoir; migratory fish species and rhithron resident species move away, allowing generalist and exotic species to take their place. If there is insufficient suitable habitat remaining, these species are likely to die out. It is, however, possible that the villagers of Ban Phoumeuang have not yet adapted to alternative fish-capture methods required in a deep, steep-sided reservoir.

In some of the case-study villages, villagers from Ban Pak Ou, Sop Kong, and Phou Meaung said they could no longer collect river weed following the construction of hydropower dams.

People in the Nam Ou Basin focus on upload rice as their main livelihood, and this has changed little over time. Only 68 of 1,500 households surveyed in 2016 reported a change in their livelihood activity in the last five years; many of them live in Zone 3, where hydropower developments have taken place.

A significant proportion of the people living along the Nam Ou and its main tributaries would be highly vulnerable to negative changes in water resources availability or access because of their reliance on fisheries and riverbank gardens. Overall, resilience capacity is low.

Livelihoods

Key Livelihood Activities of Nam Ou Basin Residents

Households in the three provinces of the Nam Ou Basin undertake different livelihood activities around the year, including paddy cultivation, upland cultivation of rice and other crops, fishing, collection of OAA and plants, riverbank gardening, raising livestock, hunting, collection of NTFP, and planting of industrial trees such as teak (Table 6). Households interviewed in 2016 said their most important livelihood activities include, but are not limited to, those pertaining to rice cultivation and livestock. Fishing is also important, particularly during the dry season and the onset of the wet season.

Close to 93% of the working-age population in Phongsaly is self-employed in owner-operated farms. In Oudomxay, the percentage is just 73.2%, while Luang Prabang was lowest (66.9%). This means Phongsaly would be most affected if significant changes occur in its farming systems or access to local resources.

Results of the 2016 Household Survey indicate that a substantial proportion of the working-age population in the 5-km corridor of the Nam Ou engage in rice cultivation in upland (45%) and paddy (26%) areas as their main livelihood activity. The high percentage of people undertaking upland rice cultivation as their main livelihood activity is partly because only 2.2% of the basin is flat and the rest of the area has steep slopes.

The 2016 survey results show that over 70% of all respondents said their household members went fishing within the past year. Fisheries are important to the local subsistence economy for many communities along the Nam Ou as fish can both be eaten and traded/sold. Several previous studies conducted in Lao PDR and the Lower Mekong Basin have clearly demonstrated that fish are a critical source of food and protein for local communities throughout the country. This is also true for residents of the Nam Ou Basin.

Table 6 Main livelihood activity of working-age population by zone in the Nam Ou Basin.

Livelihood	Zone				
	1	2	3	4	5
Not working	0.8%	2.3%	1.8%	1.2%	1.3%
Paddy	43.9%	0.2%	20.0%	21.2%	37.3%
Fishing	0.3%	0.6%	0.2%	0.3%	0.0%
Temporary worker	0.2%	0.7%	2.3%	3.6%	0.4%
Permanent employee	1.8%	1.4%	4.5%	8.0%	4.4%
Students/pupil	7.7%	10.9%	10.6%	10.3%	13.9%
Business/Trading	1.1%	2.5%	3.9%	7.4%	4.1%
Housewife	3.3%	1.1%	1.5%	1.3%	0.8%
Other	0.0%	1.9%	0.4%	0.4%	0.3%
Upland rice	37.9%	70.9%	46.5%	40.2%	35.2%
Other crops (not rice)	1.9%	6.6%	5.9%	4.4%	1.6%
Livestock	1.1%	0.7%	2.2%	1.5%	0.6%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Agriculture

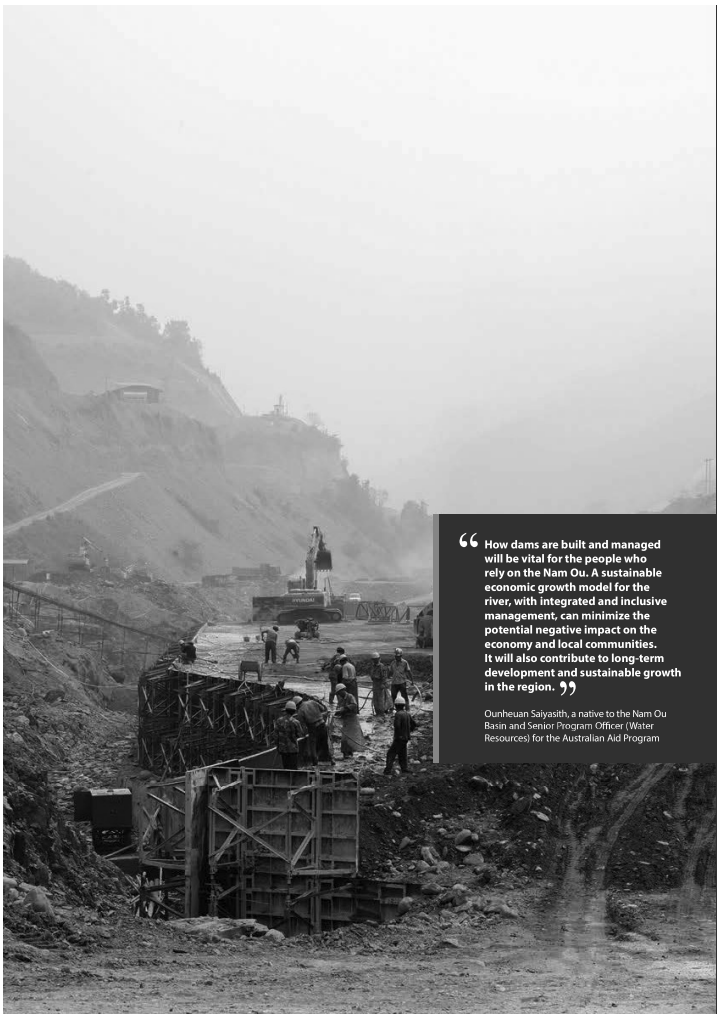
Only around 40% of villages within the 5-km corridor of the Nam Ou ranked upland rice as the most important livelihood activity, according to the 2016 Household Survey. Close to 30% of people living in the 5-km corridor do not have enough rice to eat throughout the year and experience shortages for about five months a year.

Few households in the Nam Ou Basin have land suitable for cultivation of dry-season paddy or second crops; only nine households out of 1,499 sampled said they grew a second rice crop (naxeng) in irrigated paddy within a year before the survey.

Non-rice crops grown by Nam Ou villages include: maize, starchy roots, peanut, soybean, vegetables, mung bean, tobacco, cotton, sugarcane, coffee, and tea. According to the Lao Statistical Bureau (2015a), productivity in Phongsaly is lowest among the three provinces for most crops, except for maize, sugarcane, and coffee. Riverbank gardens are an important source of household food and income in the Nam Ou Basin. One-third (33.2%) of the total sampled households along the 5-km corridor said they grew vegetables in riverbank gardens within a year before the survey.

Livestock

Livestock, especially buffalo and cows, are an important livelihood asset that enhances household capacity to withstand or recover from shock. Experience in Lao PDR shows that losing livestock has the most serious impact on long-term livelihoods and household security. The sale of livestock is an important source of funds when a disaster strikes or medical emergency arises. In rural areas of the country, the income from the sale of a buffalo can provide enough cash to buy rice for four to five household members for an entire year (World Food Programme, 2001). Livestock is therefore ranked by some villages for case studies as one of the most important livelihood activities.



> **“How dams are built and managed will be vital for the people who rely on the Nam Ou. A sustainable economic growth model for the river, with integrated and inclusive management, can minimize the potential negative impact on the economy and local communities. It will also contribute to long-term development and sustainable growth in the region.”**
>
> Ounheuan Saiyasith, a native to the Nam Ou Basin and Senior Program Officer (Water Resources) for the Australian Aid Program

4.0
WATER RESOURCE USE & MANAGEMENT CHALLENGES

Agriculture, Land use, Irrigation, & Livestock

The Nam Ou Basin has 112,409 ha of agricultural land and 34,249 ha of non-agricultural land, representing 4.6% and 1.4% of its total land area, respectively. The amount of agricultural land in each province increases with passage downstream, from 2.8% in Phongsaly to 6.2% in Oudomxay and 17.7% in Luang Prabang.

Cereal cultivation in the basin has been divided into four main crops: lowland rice, upland rice, sweetcorn, and Job's tears (Poaceae). In the wet season, there are nearly 19,000 ha of lowland paddy rice (rain-fed and irrigated), 29,000 ha of upland rice, 4,500 ha of sweet corn, and 1,000 ha of Job's tears. In the dry season, there are only 1,460 ha of irrigated rice and small areas of other cereals cultivated.

In recent years, there has been a marked expansion in crop production during the dry season, with a total of 4,621 ha being cultivated in Phongsaly in 2016. The main fruits cultivated in the basin are longan (368 ha), mangos (205 ha), custard apple (184 ha), and lychee (171 ha). Banana plantations have rapidly developed for export to the Chinese market, especially in Phongsaly and northern parts of Oudomxay; hillsides of banana plantations are becoming a characteristic feature of the agricultural landscape in some parts.

In 2010, there were 16,020 ha of rubber plantations in the river basin, of which 10,394 ha (65%) were in Phongsaly. Five districts in Phongsaly have similar areas of rubber plantations ranging from 1,300 to 2,700 ha, but Mai and Samphan Districts have much smaller areas of rubber. The 2010 Agricultural Census showed that 462 ha of tobacco was cultivated in the wet season, with 60% in Luang Prabang and 30% in Oudomxay.

Only 110 ha of coffee were cultivated as of 2010, with under 50% in Phongsaly and about 40% in Luang Prabang. However, recent (2016) newspaper articles have indicated that concession agreements with a Chinese company will develop up to 3,000 ha of coffee plantations in Phongsaly. The province has long been known as a tea-growing area: 1,227 out of 1,928 ha of tea planations were in Phongsaly District, according to data from the 2010 census. The total area of tea in the Nam Ou Basin is 2,026 ha, with Oudomxay and Luang Prabang having about 50 ha each.

According to the MRC Irrigation Database (2009), there are 178 existing irrigation schemes in the Nam Ou, of which 57 are fully operational, 98 are partially operational, and 14 are not operational. A total of nine schemes planned for construction between 2009 and 2016 have been included, of which eight are in the Nam Phak and one in the Nam Nga. These schemes provide irrigation for a total of 7,440 ha, including 3,416 ha during the dry season.

There are 492 planned irrigation schemes in the Nam Ou Basin covering a total of 20,031 ha with 5,675 ha for dry-season irrigation. The schemes will have an average size of 63.7 ha, with the smallest one at 30 ha and the biggest at 400 ha. Together, they will irrigate a total of 11,998 ha including 6,996 ha in the dry season throughout the Nam Ou Basin. These figures roughly double the 6,339 ha of total irrigated areas and 3,347 ha of dry-season areas presented in the MRC irrigation database (2009).

There are over 39,000 cattle, 37,000 buffalo, and 121,000 pigs in the Nam Ou Basin, with a smaller number of goats and sheep. The proportion of buffalo (18,000) to cattle (13,000) is higher in Phongsaly, but there are more cattle than buffalo in Oudomxay and Luang Prabang. Animal densities strongly correlate with human densities and are highest in areas with the most agricultural activities, especially in and around irrigation systems.

When these animal numbers are converted into Tropical Livestock Units (TLU) (1 cow=250 kg=1 TLU; 1 buffalo=2 TLU; 1 pig=0.2 TLU; 1 goat/sheep=0.1 TLU), there are 135,795 TLUs in the Nam Ou Basin with a density of 5.52 TLUs per square kilometer. This is much lower than the average for Southeast Asia, which has a density of 17.7 TLU per square kilometer (Peden, et al. 2007). Every year, some 1.276 million cubic meters are required as drinking water for the livestock to keep them alive without weight loss, and some 60.7 million cubic meters are required for fodder production (Peden, et al. 2007).

Aquaculture & Fisheries

In the Nam Ou Basin, there are 54,748 households participating in the capture fishery and 5,496 households engaged in aquaculture, usually fish ponds (Agricultural Census 2010). In Mai, Khoa, and Xai Districts, around 11 to 16% of households are engaged in aquaculture.

According to 2016 provincial data, there are 2,324 households engaged in aquaculture in Luang Prabang, roughly double the number of households recorded since 2009. Each household usually has one pond with an average size of 0.2 ha.

Most agricultural households also participate in the capture fishery. In Pak Ou, 66% of agricultural households engage in the capture fishery. In Nam Ou mainstream districts, over 90% of households are engaged in fishing, with the highest number in Gnot Ou (97%), Samphan (92%), and Khoa (99%); further downstream, the percentage of households engaged in fishing is lower (71% in Ngoy and 66% in Pak Ou). The districts furthest away from the Nam Ou mainstream have the lowest proportion of households going fishing, including Nam Bak (49%), Xai (52%), Phongsaly (57 %), and La (66%).

Assuming that each agricultural household goes fishing about three times a week, the total fish catch in the Nam Ou Basin is estimated at around 42,500 tons per year (ranging from 21,000-64,000 tons per year), of which 18,600 tons are caught in Phongsaly, 10,200 tons are captured in Oudomxay, and 13,600 tons are caught in Luang Prabang.

Energy Sector / Hydropower Development

The Nam Ou has one of the highest potential for hydropower development among the tributaries in the Lower Mekong Basin. Three of Sinohydro Corporation's seven hydropower plants – Nam Ou 2, 5, and 6 – have been constructed in the cascade on the Nam Ou mainstream. Before these were built, there were six small hydropower plants in the Nam Ou Basin:

- Nam Kor hydropower plant – 1.5 MW; built in 1996 on a tributary of the Nam Phak.
- Nam Ngay hydropower plant – 1.2 MW; built in 2002 but has now been submerged with the filling of the Nam Ou 6 reservoir.
- Nam Ou 9 – 454 kW; funded by the government of Japan and came into operation in 2013 on the Nam Ou above Gnot-Ou.
- Nam Boun – 110 kW in M. Boun Neua, Phongsaly; came into operation in 1997
- Nam Ngam – 110 kW in M. Mai, Phongsaly; funded by Japan's New Energy and Industrial Technology Development Organization in 2010; undergoing improvement
- Nam Mong – 70 kW in M. Nam Bak, Luang Prabang; operated by EDL.

There are two hydropower plants in Vietnam in the headwaters of the Nam Noua:

- Na Loi hydropower plant – 9.3 MW; completed in 2003 on the Pa Khoang Lake.
- Thac Bay hydropower plant – 2.4 MW; completed in 1984 and repaired and upgraded in 2002.

The total installed capacity of the Nam Ou cascade will be 1,272 MW, generating 5,044 gigawatt hours per year (Table 8). Each hydropower plant will operate for an average of 10.8 to 11.2 hours per day. The top dam in the cascade (Nam Ou 7) is the main regulating dam, storing water (1,060 Mm^3) during the wet season for release in the dry season. Nam Ou 6 and 5 have smaller regulating capacities of 246 Mm^3 and 142 Mm^3, respectively, while the lowest four dams (Nam Ou 1-4) have very little regulating or storage capacity and essentially act as run-of-river plants. They each have about 2 m draw-down, which enables them to balance daily power-generation schedules.

For most of the cascades, the reservoirs back up almost to the foot of the dam above, apart from the headwaters of the Nam Ou 2 reservoir to the Nam Ou 3 dam where there is about 30 km of free-flowing river, and the headwaters of the Nam Ou 3 reservoir to the Nam Ou 4 dam where there is 15 km of free-flowing river. Therefore, most of the mainstem Nam Ou will be transformed into a series of reservoirs through the construction of these projects.

A total of 64 villages have been affected by the three dams, with 804 households being resettled from 22 of these villages. Roughly 509 ha of land have been acquired for dam construction and 5,189 ha of land have been inundated.

Table 8 **Specifications for the 7 Sinohydro hydropower projects in the Nam Ou Basin.**

Nam Ou Hydropower Project	1	2	3	4	5	6	7	Total
Distance from Mekong (km)	18	53	112	171	215	283	327	392
Distance from d/s dam (km)	–	35	68	59	44	53	47	–
Reservoir length (km)	35.4	67.3	59.7	45.1	53.2	46.9	65.3[1]	373
Reservoir area (km^2)	9.6	15.7	13.3	9.4	17.2	17.0	38.2	120
Area of stream channel inundated (km^2)	7.1	13.5	8.6	4.2	4.1	3.5	5.4	46.4
Regulating storage capacity (Mm^3)	22	25	24	16	142	246	1,060	1,536
Installed capacity (MW)	180	120	210	132	240	180	210	1,272
Annual output GWh	710	448	826	519	977	726	838	5,044

[1] Reservoir length on the Nam Ou, main arm. The reservoir will also extend for 44.4 km along the Nam Khang (Sources: Sinohydro 2016, ESL 2010, CIA of Nam Ou cascade) Profile document source: 2 tables in Profile (Tables 6-22 & 6-23).

Other Industrial Sectors

Of all the river basins in Lao PDR, the Nam Ou Basin has among the lowest number of industries. In 2013, the Asian Development Bank Core Environment Program carried out a study of industrial pollution in the country (ADB Core Environment Program, 2013). Most of the industries are in Oudomxay, especially in Meuang Xai; industries in Luang Prabang Province are concentrated in the urban areas and not in the Nam Ou Basin.

Riverine sand and gravel dredging in the basin occurs in many locations. A total of 22 sand extraction licenses have been granted: 14 on the Nam Kor, four on the Nam Muan, three on the Nam Phak, and one on the Nam Ngao – together, they extract 13,823 tons of sand per day. Sand and gravel extraction is usually a dry-season activity, when the flows and river levels are lower and the sediment transport is reduced.

Artisanal gold mining occurs in many villages and is usually conducted by women and children. Impacts from these small local operations are likely minimal and restricted to small areas. However, in the middle sections of the river, there are large gold mining operations, which may significantly affect water quality and fisheries habitats (i.e., pools and riverbed).

Navigation & Tourism

River transport on the Nam Ou has historically been very important. Boats move people and goods up and down the full length of the mainstem, bringing them to villages and towns that would have been difficult to access by land. Most parts of the river are navigable, except in some areas where rapids restrict movements of smaller vessels, especially during the dry season. Boats can carry up to 2,000 kg of people and cargo when river conditions are ideal (and 500 kg per boat in the dry season). The connectivity of the river enabled trade and socialization between different villages and ethnic groups in the basin.

The construction of the Nam Ou dams 2, 5, and 6 has dislocated some of the boat routes. To address the issue, boat landings were built on the reservoirs above the dam wall. Villagers now have to portage around the dam sites, using local roads. To some extent, the reservoirs have made navigation easier and safer compared to the river, which was sometimes difficult to navigate, especially at low water levels. However, the dams are expected to pose significant and negative impacts on trade and overall vessel movement between communities.

Tourism is an important economic sector in the Nam Ou Basin, especially in the lower reaches of the river between Meuang Ngoy through Nong Khiaw to Pak Ou. These include the areas with dramatic limestone-karst landscape, caves, and river transport to the Mekong. In 2015, there were 13,541 domestic visitors and 38,863 foreign tourists visiting the Nam Ou according to data presented at the Luang Prabang provincial validation workshop. Tourism also depends on boat transport on the river, especially from Meuang Khoa to Nong Khiaw and Pak Ou. The construction of Nam Ou 3 and 4 within the main tourist area will likely have a significant impact on tourism.

Urban & Rural Water Supply

Urban areas in the Nam Ou Basin are relatively small. The largest is the provincial capital of Oudomxay, which has a population of around 25,000 people, followed by Phongsaly provincial capital. The district headquarters have smaller populations of under 5,000 people. Total urban water usage in the Nam Ou Basin, including Vietnam, is likely to be in the range of 12,000-19,000 m^3/day. In Vietnam, the town of Dien Bien Phu has an estimated population of 100,000 people, making it the largest urban area in the basin.

There are many rural water supply schemes. In M. Pak Ou, 50 villages are supplied with water, five of which come from springs and the rest from streams and rivers; a total of 27,634 people are served by these schemes. Eight schemes have problems with the water source drying up and not producing sufficient quantity, while the water is too hard for two of these schemes.