

CRITICAL EVALUATION OF THE NAM LEUK DAM ENVIRONMENTAL IMPACT ASSESSMENT

PURPOSE

This case study critically evaluates the environmental impact assessment (EIA) which was completed for the Nam Leuk hydropower dam in Lao PDR. Emphasis is placed on the role of EIA, if properly done, in helping to identify and minimize environmental impacts of economically-important projects in developing countries. Particular attention is given to the assessment of ecological impacts, including EIA scoping, selection of valued environmental components (VECs), and mitigation and monitoring measures, and socio-economic impacts.

ETP1 COURSE TOPIC COVERAGE:

- ▶ ENVIRONMENTAL IMPACT ASSESSMENT (EIA) PROCEDURES
- ▶ ENVIRONMENTAL MONITORING
- ▶ ENVIRONMENTAL SCIENCE IN THE MRB
- ▶ CHALLENGES IN APPLYING EIA IN THE MRB
- ▶ CUMULATIVE EFFECTS ASSESSMENT (CEA)
- ▶ SOCIO-ECONOMIC IMPACT ASSESSMENT (SIA)
- ▶ ENVIRONMENTAL ECONOMICS

ISSUES

Specific issues highlighted by this case study are:

1. The need for EIA's to comprehensively examine all potential environmental impacts of a proposed project to ensure that appropriate mitigative measures are identified and implemented
2. The fundamental role of baseline and follow-up monitoring programs as part of EIA in identifying potential environmental impacts and in providing feedback on the actual magnitude of impacts to inform future EIA for similar projects, respectively
3. Clarification of the role of EIA in informing decision making concerning major, economically important projects in developing countries (i.e., why do an EIA if the project will proceed anyway?)

LEARNING OBJECTIVES

On completion of this case study, participants will be able to:

1. Provide example of each of the VECs identified for the Nam Leuk dam project as listed in the following table

BIOLOGICAL	PHYSICAL	SOCIO-ECONOMIC
Forest	Surface Water	Socio-Economic
Terrestrial Ecology	Ground Water	Public Health
Riverine Ecology	Air Quality	Farming & Aquaculture
Fisheries	Soil	Resettlement
Wildlife	Climate	Archeological/Historical
	Noise	Land use
	Erosion	
	Land quality	

2. Characterize potential impacts of the Nam Leuk project and the likely magnitude of these impacts
3. Discuss the concept significant environmental issues (SEI) and explain what is meant by significance and how to distinguish between no effects, insignificant effects, and significant effects
4. Identify available mitigative measures and evaluate their expected effectiveness in avoiding or minimizing project impacts
5. Explain the role of monitoring as part of an EIA and distinguish between different types of monitoring programs
6. Outline the objectives of socio-economic analysis as part of the project review process and list both the negative and positive economic aspects of the Nam Leuk project
7. Suggest improvements to the cost-benefit analysis completed as part of the Nam Leuk EIA

PROJECT SUMMARY

Introduction and Background

The Nam Leuk hydropower development project (hereafter referred to as the Nam Leuk dam project) is located in Vientiane province approximately 80 km northeast of Vientiane by road. The project area encompasses the sub-districts of Phonsavanh and Long Xan of the Muang Hom district. The 45 m high Nam Leuk dam is situated on the Nam Leuk River, a tributary of the Nam Mang River. The dam will create a 12.8 km² reservoir to store water and divert water to the Nam Ngum reservoir through a 60 megawatt power station located on the Nam Xan River, a tributary of the Mekong River.

The Nam Leuk dam has long been recognized as an technically and economically promising project, taking advantage of its proximity and location in relation to the Nam Ngum basin. At its closest point, the Nam Leuk River is only 3.5 km from the Nam Xan River, but significantly is 180 m higher. The Nam Luek dam will divert most of the flow (i.e., a minimum flow will be maintained in the river) from the upper reaches of the Nam Leuk River and one small tributary, the Nam Poun, to the Nam Ngum reservoir for the generation of electricity . Energy will be generated

first at a new power station located on the left bank of the Nam Xan River, about 2 km upstream from where it joins the Nam Ngum reservoir, and as second time at the existing Nam Ngum power station.

Electricité du Laos (EDL) first commissioned a detailed design for the Nam Leuk dam project in 1993. The French consultant SOGREAH Engineering was selected by EDL in accordance with the procedures outlined in the Asian Development Bank's (ADB) consultant selection guidelines. Importantly, SOGREAH's report was intended to identify only major types of impacts expected if the project proceeded, without proposing a detailed mitigation plan. Following completion of the detailed design phase, additional technical options for the project were considered which raised concerns about potentially significant environmental impacts. Consequently, ADB requested that EDL carry out additional environmental studies in order to update the information and to provide an EIA report in accordance with accepted international standards. ADB stipulated that EDL re-assess and document major environment impacts by: (i) gathering additional information to obtain a more accurate picture of the physical, biological and human environment and of anticipated potential impacts; and (ii) proposing measures to cancel, minimize or compensate for any impacts. The new EIA work was expected to meet the requirements of ADB and be in accordance with the environmental policies of the Lao PDR government.

Predicted Impacts to Natural Resources

Aspects of the natural environments considered as part of the Nam Leuk dam EIA included fisheries, hydrology and aquatic ecology, and wildlife. Predicted impacts to these components from dam construction and operation are detailed in the following sections.

Fisheries

As part of the EIA, the expected ability of fish species found in the upper Nam Leuk River to adapt and develop in the new reservoir environment was assessed. Fish species were identified upstream from the dam site on the basis of their feeding status, their known habitat preference and their presence in the Nam Ngum reservoir as commercial species. Of the ten species collected during the fish survey upstream the dam site, six species were found to already be present in the Nam Ngum reservoir. Three of the remaining four species were expected to be lost from the Nam Leuk after inundation. Fish species collected in the Nam Leuk above the dam site are listed below with species expected to be lost identified by an asterisk.

SCIENTIFIC NAME	COMMON NAME
<i>Channa gachua</i>	Pa Kho Kang
<i>Channa micropeltes</i>	Pa Do
<i>Channa marulius</i>	Pa Kho Na
<i>Clarias batrachus</i>	Pa Douk Eu
<i>Clarias macrocephalus</i>	Pa Douk Oui
<i>Ctennogobius Ocellatus</i>	Pa Bou*
<i>Osteochilus vittatus</i>	Pa Khing
<i>Puntius binotatus</i>	Pa Sieuhuangen*
<i>Hampala macrolepidota</i>	Pa Chard*
<i>H. dispar</i>	Pa Soud

Impacts to migratory fish as a result of the Nam Leuk dam were also predicted. Available information indicated that fish migration does occur in the lower Nam Leuk with large fish migrating from the Mekong River mainstream at least as far upstream as Tad Leuk to spawn in June. Migratory species present in the Nam Mung basin which could potentially be impacted include: *Amblyrhynchichthys truncatus*; *Barbodes altus*; *Cirrhinus prosemion*; *Crossocheilus reticulatus*; *C. siamensis*; *Henicorrhynchus linaetus*; *H. siamensis*; *Labeo yunnanensis*; *Labriobarbus leptocheila*; *Labocheilos*; *Gyrinocheilus aymonieri*; and *Kryptopterus apogon*.

The upper Nam Leuk above the Tad Leuk waterfall was characterized as offering only limited spawning opportunities for migratory fish species. Although some fish species are reported to be able to move upstream past the Tad Leuk waterfall during high flow periods, the waterfall is thought to act as a barrier for most migratory species in the Nam Leuk River. For this reason, implementation of the dam 20 km upstream of the waterfall is considered unlikely to affect migration and the development of economically-valuable downstream species.

Hydrology and Aquatic Ecology

The Nam Ngum River joins the Nam Mang River, which is a tributary of the Mekong River. Approximately 4 km downstream from Tad Leuk, the Nam Leuk receives the discharge of a main tributary, the Nam Gngang, which drains a 328 km² catchment area. Discharge rates in the Nam Leuk system are influenced by the geology of watershed and the rainfall pattern. River discharges are highly variable with rapid discharges occurring immediately following rainfall events during the wet season and very low discharges occurring during the dry season when most of the tributaries and the upper Nam Leuk River stop flowing. Flooding in the Nam Leuk and Nam Poun is common in the wet season and may occur during the dry season as a result of sporadic heavy rains.

The basin of the Nam Leuk is a large sedimentary plateau covered with a fairly dense tropical forest. Water in the river is of good quality and was characterized as having generally low mineralization during both wet and dry seasons.

Plankton and benthic fauna were sampled for quantitative assessment and identification. Benthos were determined to be generally poor in the Nam Leuk

River as a result of high current velocity causing seasonal scouring of bottom sediments in the wet season and drying out of the river substrates during the summer months.

Wildlife

The approximately 13 km² area which will be inundated as a result of the Nam Leuk dam project is situated within the Phou Khao Khouay (PKK) protected area. This protected area is one of eighteen legally designated National Biodiversity Conservation Areas (NBCA) in Laos which cover a total area of approximately 28,264 km² (10,6% of country's area).

Predicted impacts to wildlife in the PKK protected area include impacts occurring during the construction and long-term impacts during the operational phase of the Nam Leuk dam project. Construction phase impacts will be the most severe resulting in permanent loss of wildlife habitat and disturbance of breeding sites. Operational phase impacts will result from easier access to area leading to increased hunting and poaching pressure.

The EIA determined that clearance of forest and plant cover followed by inundated of the reservoir would disturb many of the large animals and cause them to move out of the area. It was anticipated that some slow moving animals would be drowned when the inundation occurred. The PKK has a diverse large mammal population although densities are low, probably as a result of hunting. Of about 25 mammal species confirmed during a survey completed as part of the EIA, few species which are consider key for conservation purposes were recorded. Animals observed in the PKK include small cats, the Asian elephant, gaur, gibbons, bears, langurs, otter and deer. Species observed or are expected to occur in the project area are the Sun and Asiatic black bears, the Slow loris, Clouded leopard and Sampar deer.

Additional forest and plant cover will be lost due to extensive upgrading and construction of access roads and installation of a transmission line. In total, 74.1 km of existing roads will be upgraded and 9 km of new road will be built resulting in an estimated land loss of 79 ha. The proposed corridor for the transmission line will closely follow the existing Muang Hom road along which forested areas have already been seriously affected by illegal logging, clearing and hunting. Total forest land lost due to installation of the transmission line is estimated at 140 ha.

Although bird species are more mobile, there were concerns about the loss of riverine habitat utilized by some specialized species. Loss of habitat provided by the forest canopy and vegetation cleared prior to inundation was also identified as a concern. A total of 157 species of birds were found in PPK including twelve key species. During the survey undertaken as part of the EIA, many of the species previously identified in the PKK were absent or recorded at very low densities. Key species recorded during the survey are listed in the following table. Of these twelve key species, only three were observed in the vicinity of the project area – the Malayan Night heron, the Jerdon's Baza and the Javan Frogmouth.

COMMON NAME	SCIENTIFIC NAME	STATUS ¹
Malayan Night Heron	<i>Gorsachina melanolophus</i>	NT
Jerdon's Baza	<i>Aviceda jerdoni</i>	NT
Fish Eagle	<i>Ichthyophaga</i> sp	NT
Siamese Fireback	<i>Lophura diardi</i>	T
Grey Peacock Pheasant	<i>Polyplectron bicalcaratum</i>	AR
Coral-billed Ground Cuckoo	<i>Carpococcyx renauldi</i>	NT
Javan Frogmouth	<i>Batrachostomus javensis</i>	NT
Crested Kingfisher	<i>Mgacelerle lugubris</i>	AR
Pale-headed Woodpecker	<i>Gecimulus grantia</i>	AR
Red-collared Woodpecker	<i>Picus rabicri</i>	T
Rufous-throated Fulvetta	<i>Alcippe rufogularis</i>	NT
Pin-tailed Parrotfinch	<i>Erythrura prasina</i>	AR

¹ NT = globally nearly-threatened, T = globally threatened, AR = at risk in Thailand

In addition to impacts to wildlife and birds as a result of habitat loss, predicted increases in hunting pressure is of concern; hunting is expected to increase immediately during the construction phase due to the influx of workers staying at labour camps on the construction site. Ease of access to the PKK during the operational phase will encourage more hunting in the area. Wild animals are no longer plentiful in the area, but hunting is still widespread. Birds are hunted year-round while hunting for mammals generally occurs in the autumn. Monkeys are commonly hunted in the rainy season. The most common game is wild pigs. Another game animal is the wild cat.

Further loss of habitat in the PKK as a result of forest fires was also identified as a concern. Unintentional setting of fires in the Nam Leuk area by hunters and poachers is a serious threat during the dry season given the potential for extensive damage to forest vegetation and negative consequences for terrestrial wildlife.

Socio-Economic Analysis

Local Community Characterization

A field survey was completed in 1995 to gather socio-economic data for the project area. The survey covered villages which would be impacted directly or indirectly by the project: B. Nam Leuk, B. Keng San, B. Thamdin and B. Nong Mouang. These four villages have a population of 1,172 people comprising 181 households. The survey, carried out with the participation of the Lao Women's Union, involved social participatory appraisal in which the local people were interviewed about major social and economic issues at the community level and about their perception of the future after implementation of the Nam Leuk dam project.

Results of the survey showed that the rural economy relies predominantly on rice production which constitutes the staple food. Cropping patterns differ between the lowland and upland, with both areas being planted with paddy, maize and beans but in different proportions as paddy dominates in the lowland. In addition to field crops, most households maintain some fruit trees (e.g., mango, banana, jackfruit

and quava) either in the house yard or along the Nam Xan near paddy fields. The main source of income for these families comes from the sale of agricultural products. Consequently, land tenure is a major socio-economic parameter.

Livestock such as buffalo cattle, pig, goat and poultry were present in all households.

Most of the farmers fish seasonally and only 4 households of the 40 interviewed reported fishing on a daily basis. Approximately 40% fish on average once a week and another 50%, 2 to 3 times a week. Fishing represents a major source of protein for households and has become a supplementary source of income. Fishing gear observed in households included gillnets, cast nets, bamboo traps, hand nets, fishing rods, spear guns, and scoop nets. During the dry season, fishing occurs mostly in downstream areas on the Nam Leuk and in the Nam Mang. During the rainy season, fishing shifts to the paddy fields to avoid strong river currents. The peak fishing season is from May to June when the river discharge increases and fish move into the Nam Leuk from the Nam Mang

Predicted Impacts to Local Communities

The major impacts to local communities examined by the EIA were destruction of cultivated areas, potential loss of fishing opportunities and impacts to houses and other built structures.

Loss of cultivated areas along the right bank of the Ban Keng San will occur to accommodate the operator's village and contractor installations resulting in the permanent destruction of 9 ha of paddy fields and the temporary loss of use for at least three years of about 16.5 ha. An additional 1.5 ha of paddy field will be permanently affected by construction of the power station. On the left bank of the Nam Xan, where approximately 60% of the land is currently under paddy development, 20 to 40 ha will be utilized for production of sand and gravel. Small paddy fields covering less than 1.5 ha scattered along the Nam Leuk, in the upper reach of the reservoir area, cultivated by villagers from Ban Nam Leuk will also be affected by the reservoir impoundment. The transmission line to Pak Xan crosses over 57 km of paddy fields in the Mekong plain resulting in the permanent loss of cultivated area of about 0.5 ha (i.e., calculated as an estimated 240 towers each requiring a foundation area of 20 m²).

Existing land uses in the area which are predicted to be affected by the Nam Leuk dam project are summarized in the following table.

LAND USE	AREA AFFECTED (HA)		
	PERMANENT	TEMPORARY	TOTAL
Forest cover	1,519.6	3.5	1,523.1 ¹
Paddy fields ²	12.5	36.5	49
Built-up areas	-	-	0

¹ Including 140 ha of right-of-way for a transmission line

² Based on estimates prepared for the original project design; the actual land area affected could be less

No impacts to the rainy season fishery were predicted as a result of dam construction and operation. Reduction of flow rates in the river during the rainy season is expected to reduce fish populations in the Nam Leuk but is not expected to affect local fishing activity in the paddy fields. Flow rates will not be affected during the dry season so the fishing conditions are expected to remain unchanged.

The Nam Leuk dam project will not result in any resettlement. No house is affected either within the reservoir area or along the Nam Xan. Only a few 'rice-huts' will need temporary relocation in the future borrow area on the left bank of the Nam Xan.

Cost-Benefit Analysis of the Nam Leuk Dam Project

The Nam Leuk dam was determined to be the most acceptable hydropower development project, as compared to other potential projects in Laos, based on a comparison of all major factors such as generating power for domestic versus foreign consumption, environmental and social impacts, stage of preparation, and total capital costs. A summary profile of the Nam Leuk dam is provided below.

NAME OF PROJECT	NAM LEUK
Installed Capacity	60 MW
Average Annual Generation	245 GWh
Annual Plant Factor	47%
Total Capital Cost	US\$85 million
Unit Capital Cost	1.417 S/KW
Unit Generation Cost	5.3 C/kWh
Funding Source	Public
Reservoir Area	12 km ²
People Resettled	None

The estimated cost to construct the Nam Leuk dam project is US\$118.7 million of which 81% will be foreign content and 19% will be local content. A cost-benefit analysis was completed for the project to determine whether it was economically viable. Summary calculations are shown in the following table.

LINE ITEM/YEAR	1996	1997	1998	1999	2000	2001
Capital Cost Generation million \$	0.00	12.51	25.30	39.15	8.56	
T&D million \$			1.12	7.16	0.93	
O&M million \$				1.05	1.05	1.05
Generation GWh				220.4	22.4	220.4
Losses GWh				4.4	4.4	4.4
Export Sales GWh				209.6	208.3	206.8
Benefits million \$				8.84	8.79	8.73
Add Nam Ngum million \$				1.5	1.50	1.5
Local Sales GWh				5.8	7.0	8.4
Losses GWh				0.58	0.70	0.84
Benefits million \$				0.41	0.49	0.58
Div. & Gen. Benefits million \$				0.81	0.87	0.94
Total Cost million \$	0.00	12.51	26.41	46.31	10.54	1.05
Total Benefits million \$	0.00	0.00	0.00	0.00	11.56	11.64
Net Fund Flow million \$	0.00	-12.51	-26.41	-46.31	1.02	10.59

Assumptions used in completing these calculations were:

1. The project's annual average power generation of 215 GWh (245 GWh including production at Nam Ngum power station) is expected to meet the local demand in the Paksane grid
2. The project's energy surplus will be exported to the Electricity Generation Authority of Thailand (EGAT)
3. The economic life of the project is 40 years and will have no residual value at the end of the period
4. Exports to Thailand both in economic and financial terms are valued at an average rate of \$ 0.045/KWh
5. As regards to the economic benefit in the domestic market, it has been valued in terms of resource savings and consumer surplus

SITE VISIT METHODOLOGY

Course participants will visit the Nam Leuk dam in Vientiane province to view the finished project and collect additional information through observation, interviews and review of supplementary documents to complete their assessment of the EIA prepared for the project. Participants will have an opportunity to discuss various aspects of the project and EIA with environmental manager and engineers,

government officials and community representatives. The expected duration of the case study site visit is two days. Travel to the project location will take approximately 2-3 hours in each direction from Vientiane so overnight accommodation will be provided on site.

Participants will be organized into small groups for the visit with each group being assigned a specific topic and focus for their investigations summarized in the following table.

TOPIC	FOCUS
Fisheries	Baseline conditions Environmental receptors at risk Impact assessment Mitigation measures Follow-up monitoring
Terrestrial Ecology	Baseline conditions Environmental receptors at risk Impact assessment Mitigation measures Follow-up monitoring
Social-Economic	Impacts to agriculture Impacts to fishery Economic benefits Compensation and mitigation measures Community support for project
Cost-Benefit Analysis	Economic benefits Direct costs Non-monetary costs Export sales Project justification

On completion of the site visit, the small groups will be asked to present their findings to the class with emphasis on the practical lessons learned by course participants which reinforce EIA theory taught in the course.

TAKE HOME MESSAGES

Anticipated lessons learned by course participants in completing the case study and site visit might include:

1. Clear EIA screening criteria and assessment guidelines are necessary to ensure that all projects which are likely to cause environmental impacts are subject to environmental assessment.
2. Environmental assessments completed for large projects in developing countries are increasingly subject to close scrutiny by the environmental community and donor bodies. As such, EIA practitioners must ensure that generally-accepted EIA procedures are followed and that findings and conclusions are scientifically defensible.
3. Cost-benefit analysis should attempt to consider all costs and benefits associated with a proposed project including the non-monetary costs of

predicted project impacts to the natural environment. Failure to include both monetary and non-monetary costs reduces the usefulness of cost-benefit analysis in support of decision making.

4. Follow-up monitoring is essential to validate impact predictions and to assess the effectiveness of mitigation measures. Completion of a comprehensive baseline monitoring program as part of an EIA will provide the necessary benchmarks to evaluate the magnitude of actual versus predicted impacts and the need for additional mitigative measures.

REFERENCE READING

ADB. 1993. Dams and Reservoirs/Hydropower. Environmental Guidelines for Selected Industrial and Power Development Projects. Asian Development Bank. pp. 17-28.

EDL. No date. Nam Leuk Hydropower Project. Electricite du Laos. Lao People's Democratic Republic.

SOGREAH Engineering. 1996. Nam Leuk Hydropower Development Project Environmental Impact Assessment.

STEA. 2000. National Environmental Action Plan for Lao PDR. Science, Technology and Environment Agency.