

2.4 Local Perspective - NT2-HPP Proximal Impact Zones

Those districts most directly to be impacted by the construction and operation of the NT2-HPP would be: Nakai, Nyommalat, Mahaxay, Xe Bangfai, Nong Bok, Hinboun, and Bualapha Districts of Khammuan Province; Khamkeut, Viengthong and Pak Kading Districts of Bolikhamxay Province and Xaibouly District of Savannakhet Province.

Because the most tangible impacts of a trans-basin diversion water-storage reservoir project are on hydrology and rural landuse, the present status of landuse is described for each main drainage basin in the proximal impact zone (Theun-Kading, Hinboun, Xe Bangfai) with reference to the catchment main component tributary. The NT2-HPP impacts would add to the hydrological,

environmental, ecological and economic impacts. Already attributable to the ongoing Theun-Hinboun Hydropower Scheme operations in addition to the residual pre-project "background" impacts attributable to logging, warfare and the unsustainable landuse practices of the indigenous communities. Reasons for unsustainability may be illegal (e.g. cultivation of narcotic crops), environmental (e.g. arable farming on acidic, unprotected slopes, ecological (e.g. over-exploitation of wildlife or NTFPs) or economic (e.g. exploitive logging). Even without the advent of hydropower projects, ongoing background impacts are identified as potentially requiring remediation under the Nation Environmental and Poverty Alleviation Action Plans. Some remediation will call for proactive intervention in the form of land development (irrigation, terracing, plantation, etc.) and of capacity building for stable landuse management. Accordingly, before inventorying present landuse in each catchment, the component Landuse Management Units (LMU) are identified as a basis for planning said interventions.

An LMU is defined as a tract of land, in which all sites have a commonality of "ownership" and "prime purpose". In this context, therefore, an NBCA is a tract of land "owned" and managed by the State for the prime purpose of wildlife conservation; a road corridor is "owned" by the State for the "prime purpose" of transportation. An irrigation scheme is "owned" (operated and managed) by the beneficiary farmers for the "prime purpose" of subsistence and cash crop production. A single LMU may occupy a part of two or more adjacent catchments.

The next step required will be to measure each LMU (using the GIS maps available in the MRC Database, augmented by aerial photo interpretation) and to quantify the pertinent social, physical and financial parameters, such as population density, land capability, rehabilitation if required, etc. This will lay the foundation for costing, scheduling and budgeting the necessary development and remediation interventions and for attributing the pertinent costs to the relevant stakeholders, including, but not confined to hydropower scheme operators.

Because of internal commonality of purpose, for future local and regional planning, it would be both possible and desirable to quantify for each LMU, such parameters as hydrological discharge regime, sustainable carrying capacity and sustainable agricultural and forest productivity. This would in turn allow for quantification and prioritisation of the investments needed to ensure sustainable achievement of international, regional and local environmental and social goals as embodied in the MRC's Basin Development Plan and Natural Resource Allocation Optimisation Model. Decision Support Framework (DSF) and Resource Allocation Optimisation Model (RAOM).

The Irrigated Agricultural Development Project (ADP) will construct four irrigation schemes in Khammuan. Details of location and size of ADP-supported irrigation schemes in Khammuan Province are shown below.

Table 5: ADP Planned Irrigation Schemes in Khammuan Province

Scheme Designation	District	Status	Service Area (ha)
Phandeng	Nyommalat	Bidding	100
Naphoxay	Nyommalat	Design	80
Thathot	Nyommalat	Design	280
Nakosin	Thakhek	Bidding	70
Sangom	Thakhek	Bidding	280
Total Service Area			810

Serious consideration should be given to extending this or similar projects throughout the Xe Bangfai Basin with prior emphasis on upgrading all existing projects to a "flood-proof" standard, complete with raised and gated primary, secondary and tertiary distribution canals and drainage systems. Canals should be aquaducted over natural waterways and fish-ways provided wherever necessary. Diesel pumps should be converted to electric power, with due consideration to network connection discipline and switchboard protection to prevent extensive motor burnouts due to phase-out or voltage drop conditions.

Expansion of this or similar irrigation-upgrading loan projects throughout the Theun-Hinboun catchment and Hai/Hinboun Basins is also to be recommended to augment the irrigation upgrading activities undertaken by THPC. The cost of upgrading (sometimes in excess of \$3,000/ha), goes far beyond what hydropower developers upstream should be expected to bear alone.

Stream flow regimes in the Theun-Kading, Hinboun and Xe Bangfai Basins and those reaches of the Mekong downstream from Pak Kading would all be affected by the construction and operation of the NT2-HPP. Accumulated hydrological impacts upon the Nam Kading and Hinboun Basins and the Mekong mainstream levees and floodplains downstream of Pak Kading arise from the daily operation of the Theun-Hinboun Power Scheme. Further hydrological impacts will arise if the Theun-Hinboun power station is expanded, if the proposed Phou Hai Pumped Storage Hydropower Scheme is constructed, or if storage reservoirs are built on the Nam Nyuang or Nam Phao (Nam Theun 3 sites), or the lower Kading (Nam Theun 1 site). Construction of any of these reservoirs would flood some potentially irrigable land and create a need to cater for farmers who would be inundated by said reservoirs. Irrigation development in the reservoir catchments also has a role to play in providing productive sedentary alternatives to shifting cultivation. This watershed protection initiative would enhance reservoir longevity through reduced sedimentation.

The Theun-Kading River system would suffer reduced flows as a result of the inter-basin transfer of water caused by the NT2 project, while the Xe Bangfai would receive the additional water. Currently enhanced stream flow in the Hai-Hinboun Basin would be reduced in the dry season until such time that the water-regulating reservoir is installed in the Nam Nyuang or Nam Phao (Nam Theun 3 site).

Table II - 3 gives an overview of the existing irrigation schemes and potential for expanding wet and dry season irrigation in the various basins. The information is sourced from MRC's database on irrigation in the Lower Mekong Basin.

Table 6: Existing Irrigated Land Potential Increase in the NT2 affected Catchments

Catchment	Existing Irrigated Rice (ha)		Potential Increase (ha)	
	WS	DS	WS	DS
Xe Bangfai	22,720	16,004	14,140	9,375
Nam Hinboun ¹	6,040	4,496	5,200	3,345
Lower Nam Theun ²	445	445	196	196
Nam Nyuang ³	128	90	-	-
Nam Phao/Nam Kata ³	1,475	1,248	1,309	1,109
Pak Kading – Xe Bangfai, riverine, Lao	4,789	3,706	4,045	3,174
Pak Kading – Savannakhet, riverine, Thai	15,885	-	-	-
Total	51,482	25,989	24,890	17,199

WS = wet season, DS = dry season

¹ Includes the reach above the confluence Nam Hai–Nam Hinboun

² Road 8, south of Nam Nyuang

³ Tributaries of Nam Theun

In the Xe Bangfai basin, a 62% increase in irrigated area appears to be possible for the wet season and 58% in the dry season.

Because of the considerable past investment in flood control and irrigation civil works in the lower Xe Bangfai, the GoL has designated it as a priority area for agricultural development. Whether this is a wise or environmentally sound decision, is debatable. Civil works include flood control levee banks (only partially completed), flood impoundment reservoirs, sluice gates, flood gates, etc. Numerous diesel and electric pump sets have been installed, but with insufficient attention to the commandability or efficiency of the irrigation distribution network; drainage provision is inadequate. The lower Xe Bangfai is an important flood reticulation wetland for the Mekong River system and also an important fish hatchery. It would appear preferable to desist from attempts to exclude floods, but rather to build "flood-proof" irrigation systems (such as those installed along the lower Nam Ngum with funding from the European Union). These allow the floods in and can then provide pumped water in the cool-dry season for supplementary irrigation of recession rice followed by a fully irrigated dry season non-rice cash crop.

The NT2 Social Development Plan describes the categorisation of the proximal impact area into fifteen zones of "activities and/or impact"; these will be denoted in the following text as ZAI-1 through ZAI-15.

2.4.1 *Theun-Kading Basin (14,822 sq km)*

The Theun-Kading Basin has a total catchment area of approximately 15,000 sq km (MRC Database). It incorporates territory of both Khammuan and Bolikhamxay Provinces as well as a portion of Mork Mai District in Xieng Khuang Province. It extends from the Lao-Vietnam border to its outlet at Pak Kading on the Mekong mainstream.

Out of up to four potential hydropower dams are envisaged for the Theun-Kading Basin, only one, the Theun-Hinboun Hydropower Scheme diversion dam has been constructed so far. This dam has a total catchment of some 8,700 km², which would be truncated to 4,717 km² if and when the NT2-HPP dam (catchment area 4,025 km²) is constructed at the downstream margin of the Nakai Plateau.

The total catchment area upstream of the Nam Theun 1 dam site near Pak Kading is about 13,700 km². This would effectively truncate to about 4,800 km², i.e. that portion downstream of the Theun-Hinboun diversion dam, if and when a new regulating reservoir (previously referred to as the Nam Theun 3 site) is constructed in the Nam Theun catchment. The truncated Nam Theun 1 catchment would, however, still benefit from riparian releases and flood overflows from the Theun-Hinboun dam.

When it reaches Sop Nyuang (Nyuang/Theun confluence) in the Theun-Hinboun headpond, the Theun river changes name to the Kading River. In practical terms, however, it is more convenient to consider the Nam Theun extending downstream as far as the Theun-Hinboun dam at Keng Bit. The upper reach of the Nam Theun is sourced at the Vietnam border and extends to the Keng Mao Gorge. The mid-Nam Theun reach extending from Keng Mao Gorge to the proposed NT2-HPP dam site at Sop Hia, while the lower Nam Theun extends from Sop Hia to TH-HPP Headpond.

Most likely, all of the irrigation potential along the Nam Theun and its tributaries have been developed in the 20-year perspective. Along Lower Nam Theun the total wet season irrigated area may have reached approximately 650 ha while total irrigated area along Nam Phao/Nam Kata may have increased to around 2800 ha. Development of all remaining potential irrigable land along the Nam Hinboun will bring the total area up to around 11,000 ha

In the event that all foreseen hydropower schemes are installed, discharge at the Kading/Mekong confluence would equate to:

- the total runoff from the entire Theun-Kading catchment, less evaporation from the NT1 reservoir, less
 - 1) trans-basin diversions to the Hinboun Basin via the expanded Theun-Hinboun Power Station, less
 - 2) evaporation from the Theun-Hinboun dam headpon,
 - 3) less evaporation from the proposed Theun-Hinboun Extension Storage reservoir, less
 - 4) evaporation from the NT2 reservoir, less
 - 5) trans-basin diversion to the Xe Bangfai Basin through the NT2 Power Station.

In terms of foreseeable hydropower development, the Theun-Kading Basin may be sub-divided into the four component catchments described below:

Prospective NT2-HPP Catchment (4,013 sq km)

Damming the Nam Theun near Sop Hia would impound the runoff from the entirety of the mid-Nam Theun and upper-Nam Theun catchments. The dam would be fitted with a multi-level outlet, to ensure that dry season riparian release does not contain eutrophic water and to allow for a mixture of hypolimnion waters with flood overflows to minimise the downstream pollution risk. Presumably, the dam will not be fitted with a sediment-flushing sluice gate as this could have severe effects on sedimentation in the Theun-Hinboun headpond. Table II - 4 depicts the present situation of irrigation on the Nakai Plateau tract.

Table 7: Existing & Potential Increase of Irrigated Land in the Nakai Plateau and Nakai-Nam Theun NBCA

Catchment	Existing Irrigated Rice (ha)		Potential Increase (ha)	
	WS	DS	WS	DS
Nakai-Nam Theun NBCA	155	10		20
Nakai Plateau	270	100		15

NB: Irrigated areas pertaining to 5 villages in the Nam Kata are included under Nam Phao/Nam Kata in Table II - 3 'Existing Irrigated Land Potential Increase in the NT2 affected Catchments'

From the managerial viewpoint, the proposed Nam Theun 2 reservoir catchment can be sub-divided into three component tracts as follows:

The Nakai Plateau (640 sq km)

The Nakai Plateau constitutes a critical Buffer Zone for the adjacent Nakai-Nam Theun NBCA. Numerous socio-economic and landuse surveys have shown that, due to warfare, logging and high population growth, the residents of the Plateau are living in poverty and under frequent threat from floods, and are continuing to degrade the natural resource base through their slash and burn agricultural practices.

The component tracts of the Nakai Plateau are described in detail below:

Potential Storage Reservoir Tract (450 sq km)

This will occupy the low-lying portions of the Nakai Plateau and it will comprise two zones: the permanent inundation zone (82 sq km) and the drawdown zone or intermittent inundation zone (368 sq km).

If the NT2-HPP proceeds, all irrigation existing schemes, excepting that at Nongboua, will be submerged by the reservoir although some recession rice may be possible in the dry season providing that wind-tolerant varieties can be introduced. The NT2 Resettlement Action Plan (RAP) calls for the installation of 200 ha of civil works for year-round irrigation of orchards, gardens, livestock forage and some rice. Water could be sourced from chains of gully-stop dams on small side-streams and by pumping from the reservoir and/or the Nam On.

Apart from the limited irrigated areas that presently exist, upland shifting cultivation and semi-permanent cultivation dominate agricultural practices.

Permanent Inundation Zone - This currently houses some twenty rural villages who will need to be resettled, but because of flood risk and high soil porosity, they do not make irrigated paddy fields in this tract. However, they do make temporary bucket-irrigated gardens in the dry season on the lower riverbanks and sand bars, producing vegetables, maize, sweet potatoes, tobacco, etc.

Drawdown Zone - Paddy fields have been established on the heavier soils on parts of this tract, producing cool-dry season rice, irrigated from gully-stops and seepages. Yields are low due to poor soil fertility, frequent high winds at flowering time and possibly varietal unsuitability. Even if the hydropower dam is built, the better soils in this tract have some potential for irrigated crop production during low water stages (e.g. rice, sorghum, forage crops) but variety trials, demonstration and agricultural extension campaigns would be required to achieve this. The sandier soils in the drawdown zone however, could become unproductive due to wave action.

Settlements/Resettlement Tract (208 sq km)

This elongated tract occupies the western rim of the Nakai Plateau between the Full Supply Level of the proposed reservoir and the Phou Ark Escarpment. It encompasses three villages (Nakai Tai, Nakai Neua, Nongboua Kham), only part of whose lands will be inundated. This tract also contains the Nakai District headquarters at Oudomsouk, two sawmills, a chipboard mill, the Ban Phon Phan Pek industrial resettlement village, Ban Nongboua pilot resettlement village, the Theun-Duane pilot resettlement farms and a tract of logged over forest designated for the agro-forestry resettlement of about 1,000 families. These are currently located in 21 villages along the mid-Nam Theun and would be completely inundated by the reservoir.

Piped irrigation systems have been installed by NTPC at the Theun-Duane pilot resettlement farms, the Nakai Neua Livelihood Training Centre and the Ban Nongboua pilot resettlement village. At Theun-Duane and Nakai Neua the water is pumped by diesel power from gully-stop dams and an ox-bow lake respectively. At Nongboua (which is connected to the rural electricity grid) water is pumped electrically from a large gully-stop dam. Crops irrigated are vegetables, forage crops and fruit trees.

The tract has been excised from the Nakai Plateau Protected Forest and State Production Forests to be allocated to providing a livelihood for reservoir inundatees. It is comprised of the following landuse categories:

- Nakai District town and the associated industrial zone
- Slash and burn and sedentary farmland of Nakai District town residents
- Shifting cultivation fields and bush fallows of some potential inundatees
- The Oudomsouk industrial worker's village erected by BPKP
- Trial plantations of pine and fast-growing Acacias, established by BPKP
- Pilot Resettlement Village established by NTPC, together with associated irrigation dam and irrigated farmlands
- The Theun Duane Pilot Resettlement Farms, established by NTPC in 1996/1997
- Logged-over Pine and Dry Evergreen Forest, both in need of rehabilitation.
Note: While the boundaries of the resettlement tract have been delineated on a map attached to the Prime Minister's Decree, there is still some dispute and confusion at ground level between the Nakai and Nyommalat District boundaries and to the access rights to the remaining timber in this zone. Air photo interpretation of Native Ecotype in 1998, combined with consultative village territorial boundary mapping produced the resettlement area layout map, which is still displayed on the wall of the NTPC Meeting Room in Vientiane. Native ecotypes depicted are:
 - Upper Dry Evergreen Forest: Indicates soils with some clay content, reasonable depth and cation exchange capacity - chosen for shifting cultivation by the local communities and suitable for sedentary agriculture. Suitable for rehabilitation as sustained yield village production forest, or on slopes less than 25%, for "self-building" terraces for resettlers gardens and arable croplands. Suitable for irrigated paddy fields in flat areas. Based on 1,000 families to be resettled, it was calculated that there would be enough suitable land in the resettlement tract to support a farm model comprising

- 0.2 ha of irrigated paddy field (to grow irrigated rice initially, but later when farmers gain confidence, to be converted to irrigated livestock forage production).
- 0.5 ha of irrigated home lot, approximately half of which (depending on family size) to be allocated to vegetables and fruit for family subsistence; the remainder for irrigated supplementary forage for cattle and/or buffalo kept overnight in a roofed stall at the bottom of the garden, equipped with roofed bins for composting the animal manure for application to the crop lands. Chickens, ducks and pigs were also housed in the animal enclosure. When the bovine diet is supplemented daily by 5-10 kg per head of high-protein, sweet green grass or legume, then the animals are enabled to consume and digest larger amounts of poor quality roughage from under the pine forests and in the draw-down zone, and to gain weight every day of the year. Good nutrition is the first step to good livestock health and high fecundity.
- ha of farm forest adjacent to the village site. Trials and demonstrations were initiated for sustained yield silvicultural management, domestication of non-timber forest products and introduction of phosphate fertilised forage grasses and legumes under mature pine trees.
- Mixed Deciduous and Bush Fallow Ecotypes: Future landuse as above.
- Pine Forests Ecotype: This is an indicator of infertile, sandy, highly erodable soils with compacted podzolic horizons and it is not recommendable for agricultural landuse. Severe erosion has occurred wherever logging tracks are aligned up or downhill and have not been provided with drains or culverts. Such land is suitable for rehabilitation as Village Production Forest but should be based on a mixture of slow-growing native species and fast-growing *Acacia mangium*, and possibly Eucalypts. Some areas require salvage logging due to the risk of wind throw where canopy gaps are too wide.
- Dry Dipterocarp Forest: Indicates shallow, lateritic, degraded soils, not suitable for agriculture, but can be rehabilitated for firewood and pole production by fire-protecting and installing contour bunds between the trees at 1-metre vertical intervals on sloping lands.
- Grassland: Clear areas of grassland in the resettlement tract comprise poor sandy soils underlain at shallow depth by bedrock (otherwise they would have been forested) and are unsuitable for any landuse other than very light grazing.

Resettlement site surveys determined where each village territory intersects the resettlement tract. There is sufficient land - Dry Evergreen or Mixed Deciduous Forest Ecotype - to cater for the irrigated home lots, orchards/gardens and croplands of each resettled village plus 0.2 hectares per family of irrigable paddy fields. Such land is in short supply however and village community facilities should be erected on land originally supporting Pine or Dry Dipterocarp forests. Irrigation will need to be brought to the farmland, rather than the farmland being located on unsuitable soil just to be conveniently close to pumping facilities.

The Margules Pöyry Report proposed a forestland allocation and management system based on the nucleus estates and smallholder's model used for tree cropping in Malaysia and Indonesia. Each farm family would be allocated a 3-hectare block of farm forest within the territorial boundaries of each relocated village, plus a share of the nucleus forest estate, which would lie at the south-western end of the resettlement tract, external to the territories of relocated

villages. It was recommended that the whole forest enterprise would be managed under a concession agreement with a private sector forestry concessionaire registered with the Forest Stewardship Council. The concessionaire would provide the planting materials and the professional staff to give the necessary instruction and guidance to the forest farmers (resettlers) managing the farm forest plots. The concessionaire would provide the processing and marketing facilities and give employment opportunities to resettlers in the silvicultural operations of the nucleus estate forest.

Experience in China since 1980 indicates that it is essential for the resettlers (who have no history of tight community organisation) to have individual ownership of the trees on their allocated lands. History is full of bad experiences with communal ownership of land and resources - the 'haves' in the community usually take advantage of the 'have-nots'.

The Theun Duane Pilot Resettlement Farms site was selected in 1996, through collaboration between NTEC, District Government, Sop On village elders and EcoLao. Site selection was based on convenient access to pumpable water (in the Theun Duane oxbow lake), soil suitability and elevation above the full supply level of the proposed reservoir. Farm layout was based on a tentative livelihood model that took into account the following considerations:

- When upgrading of the roads serving the construction and operation of the power station intake and dam is completed, the resettlement site, which is in the narrowest part of Lao PDR, will only be some two to three hours by truck away from the Thai border or the Vietnam border.
- With respect to neighbouring countries, Lao PDR is at a comparative economic advantage in exporting timber and non-timber forest products and large livestock. On the other hand, it is at a comparative disadvantage in the export of arable crops, vegetables and small livestock and local demand could be easily satiated.
- Experience with other irrigation and hydropower reservoirs in Asia indicates that fish yields are low, due to water pollution, in the early years and when yields do recover, fish capture falls into the hands of commercial entrepreneurs and monopolists rather than those of local residents. In addition, the reservoir will have a wind run of some 60 kilometres; wave action would therefore be severe and dangerous for small fishing boats. The reservoir will be wide and shallow, and therefore not suitable for "close-to-home" fish-cage culture. This is not to say that, given adequate precautions and good management, reservoir fishery could not eventually become an important part of the family livelihood model (perhaps replacing irrigated agriculture). For the tentative livelihood model, aquaculture was restricted to rearing frogs and fish in chains of gully-stop ponds (small earth dams erected across intermittent streams near the tentative village sites). NTEC undertook to install and operate (for the period of the BOT period) electrically pumped water systems for domestic supply and irrigation for gardens, orchards, livestock forage and rice fields.
- With ongoing population growth in rural Southeast Asia, the continued husbandry of large herds of extensively grazed bovines is not a sustainable option, in either the resettlement area, or anywhere else. Southeast Asian grasslands are invariably the result of forest degradation and are poor in productive capability; they are usually burnt in the dry season, with resultant damage to the forest on their verges. Grazing animals under forests is detrimental to forest regrowth. Many of the buffalo herds on the Nakai Plateau do not belong to local residents but belong to the military or lowland

farmers in neighbouring districts. Experience shows that conversion to intensive cut-and-carry livestock husbandry systems is the only sustainable option. The tentative livelihood model therefore included provision for the irrigated plantation of Napier Grass and experimentation with ponded pastures to be planted in the reservoir drawdown zone. Three or four well-fed and well-medicated bovines per family can produce more income than ten or more extensively grazed large ruminants, which tend to lose weight and fertility in the dry season, due to poor forage quality. They are also prone to attack by tigers.

The monitoring system (labour inputs, crop yields, etc.) was designed in collaboration with an Agricultural Crops and Livestock Consultant hired by the World Bank. NTEC staff were trained in operation of the monitoring system and took responsibility for its execution. The original plan for the pilot resettlement farms called for relocation of ten volunteer families from Sop On Village to Theun Duane; only three families were installed before the Thai financial crisis caused NTEC to withdraw all but "caretaker" support to the activities at Theun Duane. Severe budgetary restrictions were imposed and plans to collaborate with the "Forages for Smallholders Project" (for trialling ponded pasture and introduction of other forages for under-forest and drawdown zone grazing) and the Lao-IRRI programme (for selecting and trialling wind-tolerant irrigated rice varieties) were shelved. In addition, plans for monitoring the labour requirements for silvicultural management of the farm forests were not approved. Training of villagers and collaboration with the schoolchildren at Nakai Neua was suspended. Irrigation water supply was limited to house garden requirements only so that demonstrations of irrigated forage production did not proceed.

It was not until early 2004 that further land was prepared to receive more families from Ban Sop On. Old lessons about the need for selecting suitable soils and developing terraces by the labour-intensive "self-build" method were forgotten. The terraces were installed mechanically and improperly levelled and will require considerable soil rehabilitation before they become productive. Monitoring the performance of only three families cannot be considered statistically relevant, but the findings are no less indicative. Salient findings are: although rice is the preferred staple, cassava is far more productive and is normally grown by the local communities, who also produce maize, sweet potato, taro and yams as supplementary staples. Establishing the houses on the home lots provides salutary advantages in labour efficiency. The home lots were weed-free at handover and have been maintained weed-free ever since. While the men are out working in the farms and forests, collecting livestock forage, firewood, etc., the women can much more combine cooking and childcare with tending the small livestock and gardens when the house lots are built on farm, rather than on a central village. The design of the pilot village did not take this consideration into account. Note: the more recently established Pilot Village is near Nakai District town, whereas the originally established pilot farms are located seven kilometres away in Sop On village territory.

There is plentiful family labour available to care for 0.2 ha of irrigated paddy field, 0.5 ha of irrigated orchard garden forage plot, 3 ha of farm forest and still undertake animal care and off-farm work. It is therefore recommendable to expand the size of the irrigated home plot to at least 0.75 ha.

In summary, the tentative livelihood model provided for the following:

- About half the family's rice needs of 0.2 ha of irrigated paddy (2 crops per year).

- All of the family's fruit and vegetable needs, plus some maize and sorghum for supplementing the diet of domestic pigs and poultry for domestic consumption, supplemented by fish - some caught in gully-stop ponds constructed across intermittent stream beds and, possibly from reservoir access canals dug from village boat landings to bring in water from the reservoir from at least average operating level.
- Large livestock fed on supplementary irrigated grass and grazed in the draw-down zone in the dry season and in the forest verges in the wet season - some consumed and some sold to the lowlands in exchange for rice, or for cash to buy rice, enough to meet production deficits.
- Legalised sale of timber from 3 ha per family of farm forest - capable of a sustained yield of 4.5 m³ of timber, netting an annual cash income of about US \$300 per family, after deduction of royalties in order to cover costs of medication, recreation and education; to make savings and to pay other governmental taxes. Farm forests, predominantly pine, were to be located close to the villages. In the case where these pine forests are under stocked (chiefly due to previous logging), they were to be enrichment planted with pines or other fast-growing species, or a mixture thereof, with the villagers financed by cash wages and/or food-for-work, sufficient to make up the forestry income per family to \$300 per annum.
- Firewood supplies from the Dry Dipterocarp component of the Community Forest and up to 1 m³ per annum of hardwood timber from the Dry Evergreen component of Community Forest for house and fence repairs, furniture, etc.

For statistical relevance, further development of the "original" model as described above would have required the addition of at least seven more families to the Theun Duane settlement. This did not transpire, due to a cost minimisation stance adopted by NTEC, due to the Southeast Asian economic crisis. When, several years later the refinement of the RAP commenced, there had been a change in personnel and activities concentrated on Nongboua Village rather than Theun Duane. One very important recommendation that has become evident is that, due to the thin soils in the resettlement tract, all soil-erosion control and land development works should be performed by hand labour as mechanical earth-moving exposes too much infertile and erodable subsoil.

The Nakai-Nam Theun NBCA (NNT NBCA - 3,363 sq km)

Damming the Nam Theun near Sop Hia would impound the runoff from the entirety of the mid-Nam Theun and upper-Nam Theun catchments.

The NNT NBCA encompasses the catchments of the Nam Xot, Nam Mon, upper Nam Theun, Nam Noy and Nam On tributaries of the Nam Theun. Population density is less than five persons per sq km and the whole tract has been gazetted for biodiversity conservation.

On the upper Nam Theun and its tributaries in the NNT NBCA, a number of small irrigation schemes have been constructed to serve the enclave villages (see Table II - 3 above). Possibilities for further expansion are severely limited by rough topography and deeply incised streambeds.

Route 8B from the bridge at Ban Thalung to Lak Xao follows more or less the northern boundary of the NBCA. A dry season only logging road (previously used mainly for NTFP extraction) extends from Lak Xao to Ban Navang, paralleling the Lao Vietnam border. Otherwise, access is by foot (3 days walk from villages near the border to the Nakai district town). Although constrained by cataracts, the main tributaries are navigable for at least some months of each year.

To cater for the construction traffic it will be necessary to upgrade, not only the road from Thakhek to Nakai via Mahaxay and Nyommalat, but also the logging trails between Nakai and the Sop Hia dam site and to construct a road from the dam site to the quarry in Bolikhamxai Province. These latter roads will cross the Protected Area Corridors between the Nakai-Nam Theun NBCA and the Khammuan Limestone and Nam Kading NBCAs. To minimise the impact on wildlife migration, it is recommendable to split these roads into two separate narrow single-lane thoroughfares with trees meeting overhead wherever possible. Wildlife Ranger Checkpoints should be located on roadsides at strategic points. Given that Routes 8, 9 and 12, joining the Mekong Valley to Vietnam, are now all being upgraded, it would be preferable from the wildlife conservation viewpoint, to disable rather than upgrade the logging route from Ban Thalang to Lak Xao. In 1998, the World Bank interceded with BPKP to cancel plans to extend a logging road to Ban Navang in the Upper Nam Xot sub-catchment. The Panel of Experts (POE) and the World Bank International Advisory Group (IAG) also subsequently strongly recommended that any access development in the Nakai-Nam Theun NBCA should be restricted to blasting gorges for easier small boat access and widening walking tracks to permit the passage of 2-wheel hand tractors and trailers, but not logging trucks.

Enclaved Village Territories.

There are several ethnic minority communities enclaved within the boundaries of the NBCA, practising hunting and gathering, and shifting cultivation, together with paddy field irrigation in those few riverine tracts of flat land scattered throughout this tract. There is some potential for enhanced dry season cropping by pumping, both for existing paddy fields and for terraces to be developed on sloping riverbanks above flood level. Local enclave residents constitute little threat to the integrity of the NBCA biodiversity when compared to the incursions of wildlife traders and hunters and gatherers from across the Lao-Vietnam border, where the population density is much higher and natural resource degradation much more advanced.

The enclaved communities in the NNT NBCA comprise thirteen villages in the upper Nam Noy, nine villages along the upper Nam Theun and nine along the upper Nam Xot. Since 2001, the Watershed Protection Management Authority (WPMA) has been coordinating the implementation of community development and wildlife protection activities funded from various sources, including the World Bank and the Government of Japan. Ongoing activities include the construction of schools, the training of formal and non-formal teachers, health and sanitation upgrading, wildlife-management awareness training and patrolling. Firearms have been confiscated and it is reported that a significant increase in wildlife population is observable.

There is kinship solidarity between ethnic minority villagers on both sides of the border however and reportedly, the awareness-raising activities supported by the WPMA have reduced cross-border incursions and helped restore wildlife population numbers on the Lao side of the border. Since 1996, the NT2-HPP Panel of Experts and the World Bank International Advisory Group have been conducting field excursions and making recommendations on linking the WMPA with biodiversity protection measures on the Vietnamese side of the border under the auspices of the Lao-Vietnam Border Coordination Committee, with the ultimate prospect of establishing the Annamite Ranges World Heritage under the auspices of UNESCO. Very little has happened in practice, apart from the establishment of the WPMA, which is still skeletal in nature, under-funded and definitely not equipped to address cross-border issues or the integrity of the chain of associated Protected Areas, gazetted or proposed, along the Annamite Range.

The Nam Theun 2 Concession Agreement made provision for allotting a budget of One million US Dollars per annum for supporting NBCA development and management, including irrigation upgrading. This is an estimate, thrown into the ring during concession negotiations; it does not appear to be based on any professional assessment of NBCA management needs, nor is it linked to the potential revenues from electricity sales. One to two percent of annual revenues is the generally accepted norm for financing the integrity of hydropower catchments and the long-term welfare of the residents. It is quite unlikely that NTPC could provide significant financial support for the Nakai-Nam Theun NBCA until at least financial closure and possibly, until the revenue stream commences. TH-HPP has been utilising water from the NNT-NBCA since 1998 and, whilst it pays taxes directly to the Khamkeut and Hinboun District governance, it does not make any direct contribution to upper catchment protection, land development or wildlife protection, except in those cases of families directly impacted by headpond flooding.

Truncated Theun-Hinboun HPP Catchment (4,717 sq km)

Particular attention is drawn to the rural community and land development activities of the Theun-Hinboun Power Company with over 300 families impacted by filling the diversion dam headpond. Although no involuntary resettlement is involved in Theun-Hinboun, the compensatory activities and the results thereof will have high relevance to the resettlement situation that will eventuate in the NT2 Project Areas on the Nakai Plateau.

Major tributaries of the Theun-Hinboun diversion headpond are the Nam Nyuang, Nam Phao/Kata, the lower Nam Theun, Nam Ngoy and the Nam Ao. There is a topographic limitation to further extension of flood-irrigated paddy field area. There is some opportunity, however, for the extension of garden/orchard irrigation on river levees as has been done by the THPC, to compensate loss of stream bank orchards and gardens from inundation by the headpond and the downstream discharge.

In the Nam Phao and Nam Nyuang catchments upstream of the headpond, the only agency giving attention to the socio-economic plight of the inhabitants of the catchment is the Wildlife Conservation Society (WCS). WCS is soon to commence a participatory wildlife management programme in some parts of the catchments as a means of raising buffer zone communities' incomes through sustainable wildlife harvests whilst helping to conserve the integrity of the Nam Kading, Khammuan Limestone and Nakai-Nam Theun NBCAs.

History shows that allowing swidden fallow periods to reduce and permanent cultivation to occur on steep slopes, without land development and soil conservation interventions, would result in irreversible degradation of the soil and the ecosystem, followed by abandonment of the land and unproductive, annually burnt grasslands. This situation is already evident in some highland areas designated as NBCAs and is causing weed infestation problems in sedentary farmlands around the Theun-Hinboun headpond.

Possibly, up to fifty percent of the potential area for irrigation expansion will have been utilised along the Nam Theun tributaries within 5 years, amounting to 600-700 ha.

Parts of this catchment are occupied by various NBCA Core Zones, but to date, apart from financing some signposting and nature trail mapping, neither THPC, nor any other agency is making any significant financial contribution to their protection and management. The Wildlife Conservation Society (WCS) will, however, be managing a five-year Wildlife Conservation Management Programme, funded by the Global Environmental Facility (GEF) through the

World Bank. Without however, parallel funding for agricultural sedentarisation and poverty alleviation, commencing with irrigation system development, across the Lao Vietnam border, then the effective protection and conservation of natural biodiversity in these sanctuaries cannot be expected. THPC has made significant progress with agricultural sedentarisation for the 300 families impacted by the headpond inundation zone as part of its environmental and social mitigation and compensation programme. It is not, however, likely to embark upon NTFP domestication or the incorporation of forestry into farm family cash flows, which would be necessary to guarantee sustainable livelihoods.

If the THPC proceeds with its proposed extension and expansion of generation capacity, it will require to find a suitable site for development for resettlement of the families who would be inundated by the new reservoir, preferably within the catchment, because of a shortage of suitable land elsewhere. According to ADB Operational Guidelines, an offset forest regeneration area should be delineated and protected, equivalent in area to each of the ecotypes to be flooded by the hydropower reservoir impoundment. As there is no scope for it within the proposed NT2 catchments, the Theun-Hinboun Catchment is the first choice for this "offset" forest. An offset reforestation area would presumably be required also to compensate for forest inundated by the Theun-Hinboun Extension Reservoir. This would also need to be located in the Theun-Hinboun Scheme catchment or the Nam Theun 1 Scheme catchment. Preferably, it would be combined with an agro-forestry sedentarisation programme, bringing current swidden bush fallows under reforestation with a mixture of fast-growing industrial species and slower growing natural species, with the local communities participating in management and a portion of the harvest. The constituent tracts of the TH-HPP catchment are described below:

Theun-Hinboun Hydropower Scheme Catchment (9,075 sq km)

The headpond of the Theun-Hinboun diversion dam is supplied by three major tributaries: the Nyuang, the Phao and the Theun. Downstream discharges into the Kading from the dam at Kengbit supply the totality of the runoff from the three constituent sub-catchments, less evaporation from the headpond, less diversions by tunnel to the Theun-Hinboun power station in the Hai-Hinboun Basin (up to 110 m³/s). If, and when, the planned power station expansion is installed, peak diversion discharge will increase to 220 m³/s. Engineering and economic feasibility investigations are in hand for siting a dam on the Nam Nyuang or Nam Phao for storing wet season runoff to augment dry season power generation. Some ten or more sites are undergoing comparative geological analysis. This enhanced cross season storage would augment THPC's dry season power generation capacity, as the existing headpond is only large enough for daily buffering. It would also help compensate for the considerably reduced discharge of the Nam Theun tributary if and when the NT2 hydropower scheme dam is constructed at Sop Hia. To enhance the water storage in the potential Nam Phao reservoir site, a diversion from the Nam Theun is under consideration. There are many rural villages in the Nyuang and Phao Valley catchments, but few along the lower Nam Theun. The residents are of Tai or Vietic ethnicity preferring riverside locations, but there are also some Hmong communities who prefer ridge-top locations. Navigability is restricted by cataracts in many reaches. Route 8 links the Mekong Valley with Vietnam, crossing the Nam Theun by bridge at Tha Bak; it proceeds through Lak Xao (the capital of Khamkeut District) en route to the border post at the Kaew Neua Pass. Route 8 is sealed and is currently being upgraded with grant assistance from the Swedish government. There are several branch roads into both the Nam Nyuang and Nam Phao catchments.

The Theun-Hinboun headpond inundated the temporary dry season streambed and lower bank gardens of several riverside villages. THPC has made compensation in rice for immediate loss of income, has supported the establishment of new bank-top pump-irrigated and rainfed gardens, orchards and rice fields. Apart from assistance with land development and titling, the company has supported the installation of potable water supplies, sanitary toilets, micro-finance revolving funds and enhanced livestock breeds, together with nutrition and veterinary services. Riverside bathing platforms and boat landings have been augmented. Road access and electricity supply have been upgraded hand-in-hand with local government. The Theun-Hinboun headpond is silting up quite rapidly. This will most likely be exacerbated by the “hungry” water erosion from the riverbanks downstream of the Nam Nyuang or Nam Phao regulating dams (previously known as Nam Theun 3) and the Nam Theun 2 dams. Regulation afforded by the Nam Nyuang or Nam Phao dams would help offset the loss of buffering capacity of the Theun-Hinboun headpond caused by damming the Nam Theun for the NT2 hydropower scheme.

Nam Phao Catchment

Mountainous Headwater Tracts. These encompass the gazetted and prospective NBCAs and PPAs that comprise the northeastern corner of the NNT NBCA and its northern extension (renamed Bolikhamxay Highlands NBCA). Many of the higher slopes have been degraded by pioneer shifting cultivation production of maize and opium poppy; the resulting unproductive grasslands are burnt annually, and require fire protection and forest regeneration.

Lands of slope < 5%. Most of these are already devoted mostly to some form of paddy field irrigation although there is considerable potential for upgrading. In the 1980s, BPKP mounted a resettlement programme by developing rice fields along the ex-Ho Chi Minh Trail, running towards Nakai and providing a pumped and piped irrigation system for the resettled Hmong ethnic group. The pumping system eventually failed and many more families migrated to slash and burn the steep forest further down the Nam Phao and up into the Nam Kata Valley, making frequent hunting and gathering forays into the nearby Nakai-Nam Theun NBCA, in which they were forbidden by the Khammuan provincial authorities to locate their residences.

Hilly and Mountainous Lands. Most of the remaining tall-growth forests have been logged to a greater or lesser extent. Much of the forest has been converted to cyclic re-occupance shifting cultivation. Once agriculture has been sedentarised (by irrigation development, terracing and pasture improvement), there is considerable potential for fast-growing orchard and industrial tree plantations (with community involvement), in this tract - particularly with respect to its proximity to National Highway Route 8 Corridor (Tha Bak to Lak Xao).

Lower Nam Theun Catchment

Wildlife Corridor A wildlife corridor crosses the Nam Theun just upstream of the proposed NT2-HPP dam site, joining the NNT NBCA and Khammuan Limestone (Phou Hin Poun) NBCA, allowing the migration of wildlife (including elephants) between the two.

Hilly & Mountainous Tracts Downstream of the NT2 dam site, the terrain is mainly steep and mountainous, consisting largely of MRC Watershed Class 2 land. There is virtually no irrigation and no commercial logging in these hilly and mountainous tracts due to the lack of settlements and steep, inhospitable topography.

Nam Ngoy Catchment

Hill Tracts

There has been little commercial logging because of the very steep topography but there has been considerable lumbering of valuable species such as Eaglewood and Ebony by the communities settled in the valley bottom. Hills near the villages are subjected to shifting cultivation of upland rice.

Settled Tracts

As the narrow valley bottoms have already been settled and used for paddy field irrigation, there is little potential to expand irrigation in this catchment.

Nam Kading NBCA

The southernmost portion of this NBCA extends to the Nam Hai and other, lesser Hinboun tributaries, such as the Nam Sanam and Nam Mahoy.

Nam Nyuang Catchment.

The Nam Chuan and Bolikhamxay Highlands NBCAs.

These NBCAs cover the high altitude western slopes of the Annamite Ranges. Parts have been degraded by opium cultivation and abandonment to annually burnt grasslands. Steep and eroding logging roads have been built into this area for the extraction of the valuable *Fokienia (Mai Long Leng)*, some of the trees being 300 years old.

Pha Khadoung Saola Management Area.

This tract comprises about 700 square kilometres and incorporates a predominantly forested area in the valley of the Nam Nyuang at an altitude between 450 m and 1,500 m (to incorporate the Saola's usual range of 500m to 1,000 m). It has been identified, but not as yet gazetted. The main objective is to provide a habitat for conserving the rare Saola antelope (bovid species, *Pseudoryx nghetinhensis*). The Saola (discovered only in 1992) is a very ancient species of spiral-horned bovid, whose diet is restricted to a very narrow range of plants found only alongside small streams in the moist evergreen rain forests of the Annamite Range in central Lao PDR and Vietnam.

Dependent upon the location chosen for the regulating reservoir for the Theun-Hinboun Hydropower Scheme extension, a smaller or larger portion of the proposed Saola Management Area may become inundated. In the application of Best Practices, rather than being an adverse impact, this inundation could lead the way to positive benefits, provided that THPC, or other, are prepared to devote funds and expertise to the proactive management of the biodiversity integrity of this tract.

Sedentary Agricultural Tracts.

Numerous village communities have developed sedentary gardens and some paddy fields along the narrow streamside tracts. Some could be developed for irrigation although pumping would be necessary due to the high riverbanks. High floods damage crops on this tract once every ten years or so.

Other Hilly Tracts.

Virtually no primary forest remains because of extensive shifting cultivation. Soils are quite good however and the area has high potential for fast-growing industrial tree crops production, recommendably on the nucleus estate and smallholders principle (see notes on the Mekong Minor Tributaries Tract and Nam Thon Catchment). As part of its environmental and social impact mitigation and compensation programme, THPC has installed piped, pumped irrigation systems

for orchards and gardens, in villages impacted by the headpond, together with sponsoring of soil-erosion protected rainfed agriculture on lands of slope less than 25%. This serves as a useful pattern and demonstration for future resettlement activities in the Theun-Kading Basin. An area at Ban Tha Si has been identified as having possibilities for resettlement from the proposed Theun-Hinboun Extension reservoir. It may also have capacity for development as a resettlement site for the proposed Nam Theun 1 Hydropower Scheme, but this requires further collaborative investigation.

Headpond Tract

As for "Other Hilly Tracts" above.

Nam Ao Catchment

Nam Kading NBCA.: Although the Nam Ao mainstream parallels the NBCA, its right bank tributaries drain from the high ridge that forms its eastern boundary.

Sedentary Agricultural Tracts.

The most significant of these tracts is around Ban Na Di, where considerable small stream irrigated paddy fields have been developed.

Extensive Agriculture Hill Tracts.

As for most other parts of the Theun-Hinboun catchment, little primary forest remains but considerable potential exists for fast-growing tree crop plantations. The Nam Ao River could be used for transport of logs to the Theun-Hinboun headpond, where they could be lifted out and loaded onto trucks, utilising the dam access road and Route 8.

Truncated Prospective Nam Theun 1 Hydropower Scheme Catchment (5,069 sq km)

A pre-feasibility study for this scheme was performed by the consultants, Electrowatt-Ekono, for a potential developer from Thailand some ten years ago, but was shelved partly as a result of the southeast Asian economic crisis. The feasibility study is now being revised by the same consultants hired by a Malaysian civil engineering and construction firm having potential financial support from the Malaysian Government. The various social, environmental and economic effects of alternative dam heights are being investigated, including a possibility of pumped storage of Mekong floodwaters. Current discharge at the dam site is the total runoff from the Nam Muan catchment, plus the runoff from that part of the Upper Kading catchment that lies downstream of the THPC diversion dam at Kengbit, plus the riparian release (5 m³/s), flood overflows and sediment-flushing discharges from said dam.

The catchment is occupied by about 60 villages and Viengthong, the district centre. This town is accessed from the dam site by a walking trail following the Kading, Muan and Ngom riverbanks (2 days walk). A dry weather only logging road, destined as National Route 1, links Viengthong with Meuang Mok in the North and with Tha Bak on National Route 8 to the South. The northern route fords the Nam Muan and the southern route crosses the Nam Nyuang branch of the Theun-Hinboun headpond by motorised ferry. The navigability of streams and rivers is impeded by numerous cataracts.

Along the Nam Kading, no significant irrigated areas are found and there is no significant potential for providing infrastructure to any land for irrigation. Most of the area along Nam Kading consists of forest of varying density and forest mosaic and shrub land. There is little agricultural activity apart from scattered patches of shifting cultivation

In the **5-year** Scenario, agriculture will still be dominated by shifting cultivation but the fallow period will have been narrowed down to 3-4 years in some areas while it will be nearing permanent cultivation in others.

Nam Muan Catchment

The Catchment comprises:

- Nam Chouan NBCA: Western slopes of the Annamite Ranges (see previous notes)
- Nam Kading NBCA: This comprises a large part of the catchment downstream of the Nam Nyuang confluence and the THPC diversion dam. Some of this NBCA would be flooded if the Nam Theun 1 Dam is built.
- Intensive sedentary agriculture tracts: Most of these are associated with the settlements in the main Nam Ngom and Nam Muan catchments. Some irrigated paddy fields have been developed along small tributaries.
- Shifting Cultivation Hill Tracts: The situation is similar to that in the Nam Nyuang catchment.

Lower Kading Mainstream Catchment

Extending from the Kading-Mekong confluence upstream some 35 km to the potential Nam Theun 1 dam site (located at the gorge where the Kading emerges from the hills onto the Mekong floodplain). Route 13 South, linking Vientiane with Pakxe crosses the Nam Kading within sight of its confluence with the Mekong. Otherwise, access within the catchment is by walking trail or by boat as far as the Nam Theun 1 dam site. Some previously riverside villages have recently moved to re-establish alongside the highway.

Only some limited existing irrigated areas with potential for expansion are found along the tributaries that join the Nam Kading close to its confluence with the Mekong. Small diversion weirs may be feasible for some of these, but most would require the installation of pumps.

To compensate for a lower dry season water table, the THPC has provided potable water systems to those 10 or so villages in the Lower Kading Catchment, which are situated on the riverbank.

Stream flow at the confluence comprises of the runoff from the entire Theun-Kading Basin less what is diverted into the Hinboun Basin through the Theun-Hinboun Power Station, less what is evaporated from the Theun-Hinboun headpond.

The component tracts of the Lower Kading Catchment include:

1) Nam Kading NBCA, 2) Nam Pang Catchment (including a military reserve), 3) Nam San Catchment, 4) Say Phou Ngou Provincial Protected Area, 5) Route 13 South Highway & Residential Corridor, 6) Sedentarised Flatlands, 7) Rolling Shifting Cultivation Lands.

Nam Theun 2 HPP Proximal Impact Zones

Many of the landuse practices in these tracts, especially in the hilly areas, are unsustainable, leading to soil erosion and ecological degradation. They risk becoming more so, as population continues to grow unrestricted, but without the appropriate poverty alleviation or land and community development measures being implemented. As a basis for planning the "Best Practices" restorative measures to be implemented following the MRC Basin Development Plan (BDP),

the various component tracts of each sub-basin are described under the headings according to the landuse management classification, which combines consideration of topography, land capability, population density, present landuse, conservation priorities, priorities for industrial and infrastructural development. Quantification is provided insofar as the available data permits but final quantification must await the refinement and augmentation of the data on hand.

In the late 1970's, the precursor of the Mekong River Commission identified the engineering possibilities of producing hydropower by trans-basin diversion with a reservoir on the Nakai Plateau. In 1985, the Snowy Mountains Engineering Corporation (SMEC) commenced geological and hydrological feasibility studies for what became known as the Nam Theun 2 Hydropower Project (Nam Theun 1 is a proposed site near Park Kading; the present Theun-Hinboun Scheme was known for a time as Nam Theun 1/2 and the proposed Nam Theun 3 dam site is on the head waters of the Nam Nyuang, north of Lak Xao). By the early 1990's, technical, preliminary engineering, hydrologic and economic feasibility studies had been completed and a Memorandum of Understanding signed between the Government of Lao PDR (GoL) and the Nam Theun Electricity Consortium (NTEC, now NTPC), headed by Transfield of Australia and incorporating Thai construction and finance companies and Électricité du France.

By the mid-1990's, NTEC had established offices in Vientiane and Thakhek, made a financial contribution towards the extension of the national electricity grid from Thakhek through Nyommalat and up the escarpment to Nakai District town, established a quarry and crusher between Nyommalat and Mahaxay and upgraded the road from Thakhek to Nakai. In 1994, NTEC hired TEAM Consultants from Thailand, who conducted a detailed census of families, livestock, building, orchards, etc. Of the twenty or so villages to be inundated by the Nam Theun 2 Reservoir; some alternative resettlement sites were also identified. By 1995, NTEC had been able to arrange financing and insurance for everything except Sovereign Risk (i.e., private sector protection against nationalisation). NTEC made application for Sovereign Risk coverage to the World Bank in 1995. A large multi-disciplinary World Bank mission was subsequently mounted, which pointed out to NTEC that the Project Action Plan was out of line with emerging World Bank Operational Procedures concerning project-affected people and the environment in many aspects. Particular concern was expressed about the following aspects:

- Lao PDR had no national resettlement policies and NTEC did not have cogent resettlement plan indicating how resettlers livelihood and welfare would be guaranteed after relocation,
- As per the Tropical Forest Action Plan (prepared in 1989 with Swedish Government support and with technical assistance from IUCN), the Forestry Department had declared the headwaters of the catchment of the Nam Theun as a National Biodiversity Conservation Area since the early 1990s. Much concern was expressed that logging of the potential reservoir inundation area was also extending into the NBCA forests. In fact, significant inroads had been made into these flatland forests, lying between the potential inundation area and the edge of the Phou Ark Escarpment.
- The potential impact on fisheries of damming the Nam Theun River had not been assessed, nor had the potential environmental and social impact of releasing large volumes of turbinated water through the trans-basin diversion into the valley of the Xe Bangfai River.

NTEC responded by taking the following actions:

- Contracted an NGO (CARE International) to conduct baseline socio-economic surveys of the potentially inundated communities.
- Contracted the Golden Valley Timber Company to review the resettlement site alternatives identified by TEAM Consultants and to draft tentative livelihood models for resettlers.
- Supported the establishment of a Resettlement Management Committee, comprising of officials from Khammuan Provincial and Nakai and Nyommalat District governments.
- Co-opted a senior Ministry of Agriculture and Forestry official to draft a Nam Theun Resettlement Policy as a component of a National Resettlement Policy.
- Contracted Dr. Maurice Kottelat to survey and record the fish biodiversity in the Theun Kading Basin.
- Contracted the Forestry Consultants, Margules, Groome, Pöyry to survey and install markers along the approximate perimeter of the proposed reservoir as a basis for confining logging to below the potential full-supply level.
- Provided a vehicle and per diem for a central government officer to regularly patrol the designated reservoir boundaries and apprehend any logs taken from above the potential waterline.
- Supported the Forestry Department in establishing checkpoints for monitoring log and wildlife traffic at Nakai District town and on the Nakai-Lak Xao road, where it crosses the border between Khammuan and Bolikhamxay Provinces.

2.4.2 *Nam Hinboun Basin*

Particular attention is drawn to both the social, economic and environmental impacts associated with the operation of the THPC Power Station, also to the mitigatory activities that have been implemented. In many respects, the impacts on the Hinboun Valley represent a microcosm of the impacts to be expected from trans-basin diversion of Nam Theun waters into the Xe Bangfai.

The Nam Hinboun basin, which also includes areas upstream of the confluence of Nam Hai and Nam Hinboun, has potential for 86% and 74% for wet and dry season irrigation area expansion respectively. However, due to regular flooding, irrigation schemes in the lower reaches of Nam Hai and Nam Hinboun are vulnerable to long periods of high water.

The daily fluctuating discharge of turbinated water from the powerhouse, inadequately regulated by a non-dredged surge pond, has led to severe erosion along the 14-km course of the Nam Hai through mass wastage and widening of the meander belt. The flooding of stream bank gardens without compensation for four years, led to compensatory increased illegal clearing of forest for shifting cultivation on steep slopes with a consequent increase in rainfall runoff and topsoil erosion.

Due to a restricting gorge and Mekong mainstream flood backup however, irrigated rice fields in the Hai-Hinboun Basin are subject to severe flooding two to three years out of ten. Flooding for three days does not harm the rice crop, provided that there is little current or sediment deposition. Flooding from three to seven days depresses the harvest yield and flooding for more than seven days kills the crop. To compensate, farmers keep "flood-proof" farm animals such as buffalo and ducks and harvest considerable quantities of fish, frogs and other aquatic animals from the flooded paddy fields.

If expansion of the THPC's generating capacity were accompanied by provision for gravity irrigation in the Hai-Hinboun Plain, this could have considerable socio-economic impact on the resident communities by relieving them of the necessity for paying the cost of pumping. This would have the knock-on effect of reducing use-pressure on the bio-genetic resources in the adjacent Khammuan Limestone and Nam Kading NBCAs and also:

- Increased stream flows and river levels in the Nam Hai and Nam Hinboun, with severe and fluctuating increase in the Nam Hai;
- Have negligible effects on the flood levels in either the Nam Hinboun or Nam Kading;
- Dilute the toxic mining wastes and sediments discharged into the lower Nam Hinboun from hydraulic mining in the Nam Pathen Valley;
- Impede navigation in the Nam Hai and mid-Hinboun due to trees and tree stumps being undermined by stream bank mass wastage in the Nam Hai and falling into the river.
- Similarly for the Nam Hinboun where deep pools have been filled with coarse sediment, water is discoloured by fine sediment eroded from the banks of the Hinboun and particularly from the Nam Hai. Enhanced fish catches have been observed in the Hai-Hinboun Basins, possibly due to turbinated water raising overall river volume with nutrient-rich sediments from the Nam Theun and its tributaries, mixed with suspended soil particles eroded from the banks of the Nam Hai.

Along the whole length of the Nam Hinboun, present irrigated areas amount to around 6,000 ha. Total potential for expansion is around 5,000 ha in the wet season; the economic viability of this however, requires deeper investigation due to low soil fertility and persistent flooding problems. The inefficient diesel pumping units presently installed would need to be replaced by electric motors and a substantial investment made in upgrading water supply canals and drainage networks. A possibility deserving of investigation is the supply of irrigation water by gravity from the THPC power station once this is expanded.

Along the Nam Hinboun, maybe up to fifty percent of the potential for expanded irrigation will be developed over the next 5 years. This will amount to around 2,000 to 3,000 ha. The foreseen developments in the agricultural sector are not expected to have any impact on the hydrological regime and flow patterns in the zone that will be significant compared to those caused by other sectors such as hydropower.

2.4.3 *Xe Bangfai Basin and Surrounding Districts*

The Xe Bangfai Basin has a total catchment area of 10,406 km² (MRC Database), extending from the Lao-Vietnam border in Khammuan Province to its confluence with the Mekong mainstream at the conjunction of Khammuan and Savannakhet Provinces. Since the early 1970's, considerable road, flood-protection and irrigation infrastructure has been installed. As its headwaters are at a relatively low altitude, no hydropower development is envisaged on the Xe Bangfai River, but it is destined to receive the turbinated discharges from the proposed NT2-HPP Power Station. In preparation for this eventuality, the lower half of the Basin has been classified into potential hydrological impact zones. These are described below before proceeding to classify the various tracts according to their landuse management characteristics.

Because a considerable portion of the Xe Bangfai headwater catchment lies in a limestone karst landscape with very little natural vegetative cover, flash floods

are a frequent occurrence during tropical depression events. There is no practical way to prevent this occurrence, but only mitigate its effects through wise choice of riverside building and farming sites.

The Xe Bangfai sub-catchment may be sub-divided into the following tracts:

Bangfai Headwaters (Bualapha District)

This incorporates the sub-catchment basins, Nam Phit and Nam Kathang/Nam Gnom. There are 23 villages containing 1,632 households and 12,722 persons. Population density is 38 persons per km². The Nam Phit traverses the Mahaxay Plain and will be modified to carry the turbinated water from the Power Station. The Nam Kathang traverses the Nyommalat Plain and will carry the drainage from the irrigation system to be augmented by a part of the turbinated waters. Xe Bangfai stream bank erosion will be severest in this zone. The 500kV and 115kV Transmission Lines will also traverse this tract.

Nyommalat District Reach

The 5-Year Scenario in these tracts will depend largely upon the answers to the queries raised below.

Reportedly, plans for the conversion of the Nam Phit Valley into the Discharge Canal for turbinated water from the NT2 Power Station in Nyommalat incorporate outlets for irrigating farmlands in both the Nyommalat and Mahaxay Plains en route to the discharge point on the Xe Bangfai. Whether or not this provision results in the expansion and intensification of irrigation in these tracts, depends upon several factors, including the following:

Will the planned outlets be at sufficiently high level to provide gravity command of irrigable lands, or will the water need to be pumped from the canal?

The present small irrigation systems in the Nyommalat and Mahaxay Plains are inefficient and inadequately infrastructured. Is it the intention to use NT2 compensation funds to rectify this situation? Or will this be incorporated into a loan or grant project?

Will the turbinated water be of acceptable quality for irrigation purposes?

Will the turbinated water discharge regime be sufficiently compatible with the regime of irrigation water requirements?

Effective use of available irrigation water requires not only "state of the art" civil works, but also competent rural institutions (the Interest Groups, Village Development Associations) to negotiate the necessary land acquisition for the irrigation civil works and to operate the system for equitable water distribution and to organise the maintenance and good working condition. Before commencing construction for upgrading, twelve months are required for establishing and training these rural institutions. Has this been provided for?

In the middle and lower Xe Bangfai some of the potential areas for irrigation expansion will have been developed while plans for upgrading and rehabilitation of existing schemes may have been realised by the provincial irrigation departments of Khammuan and Savannakhet. The World Bank funded Agriculture Development Project will have finished the construction of 3 new irrigation schemes comprising 460 ha in Nyommalat and 2 schemes in Thakhek District totalling 250 ha. It needs to be ascertained whether the projects in Nyommalat will be able to benefit from the NT2 turbinated waters, or are they entirely separate? Both government and external funding for rehabilitation of old schemes and additional irrigation development throughout the Xe Bangfai Basin will have been secured to a certain degree; in this respect, the prevailing acute

budgetary shortage, both for investment and for the payment of adequate remuneration for civil servants will not yet have been relieved under the 5-year Scenario. Hopefully, under the 20-year Scenario, revenues from the NT2 and other export-oriented hydropower projects will have relieved this situation. This would allow a "breathing space" to enable currently over-exploited production forests to recover their revenue-earning capacity. With respect to NT2 revenues, ADB is currently conducting a technical assistance support project for public expenditure planning.

The higher water levels in the Xe Bangfai during the dry season may have led to some limited energy savings in connection with pump irrigation, offsetting to some degree reduction of wet season rice cropping area due to higher wet season flood levels. The energy savings to be made however, by improving the conveyance and distribution efficiency of the irrigation networks (through civil works upgrading) would far outweigh any energy savings due to higher dry season water levels.

Xe Bangfai District Reach - Middle Impact Zone

The zone lies in the Xe Bangfai District of Khammuan Province and contains 12 villages, with 709 families and 3,900 persons; population density is 38 persons/km². This zone would be moderately affected by flood levels in the wet season and stream bank erosion due to NT2 power generation discharges. The zone extends from just below the Phu Soy Range until the start of the Xe Bangfai flood plain (Lower XBF). It also incorporates the lower Xe Noy sub-catchment.

Lower Xe Bangfai Reach

This reach is subject to annual inundation by Mekong floodwaters, in some places up to 3 metres deep. It extends from Route 13 South westwards to the banks of the Mekong River (Lower Xe Bangfai Impact Zone). This zone lies in the Districts of Xaibouly of Savannakhet Province and Nong Bok and Xe Bangfai Districts of Khammuan Province; there are 53 villages, containing 4,998 families with 27,489 persons (NT2HP Social Development Plan, Table 14-1). Population density is 76 persons per sq. km. Due to Xe Bangfai river levels being masked by the proximity of the Mekong, no negative impacts from NT2HP operation are foreseen.