

7 PREDICTIONS OF CUMULATIVE IMPACTS

7.1 Introduction

7.1.1 *Perspectives*

In this chapter the possible impacts predicted to be found in the different impact zones (as defined in the previous chapter), are presented. The potential impacts described are the cumulative impacts. As mentioned initially, this is the **combined impact of the NT2 Project and other projects and development trends envisaged in the 5-year and the 20-year perspective.**

It has been decided to define the base date for the scenarios to be the year for NT2 construction start, which is envisaged to be 2005. Thus the 5-years perspective will be at the time of commissioning i.e. **2010**, and the long-term horizon to be 20 years after assumed construction start, i.e. **2025**.

7.1.2 *Prediction of Trends, Impacts and Scenarios*

The CIA bases its assessment on plans for development or trends observed in the relevant sectors. A problem is that some sectors do not have specific development plans. Some sectors might have plans but there are no implementation mechanisms connected to the plans and thus the plans cannot be recognised to be realistic. Hydropower can be considered as a well-planned development sector. Even here we see that reality diverts from the original staged development plans or that the development plans are frequently revised. Other sectors are totally “out of control”. Several developments are mostly dependent on outside forces, which are impossible to predict, for instance global or regional economic development, advances in health science, etc. In this perspective the impacts of specific planned projects will be totally swamped by the large-scale developments. This is in particular the case when trying to predict the 20-year scenario.

7.1.3 *Responsibility*

It is important to realise that it is sometimes difficult to identify which part of the assumed impacts can be attributed to the NT2 Project, what are caused by other development projects, and what is a result of the general trends in economy and social development. By no means should the predicted cumulative impacts be interpreted as the potential results of the Nam Theun 2 Hydropower Project alone.

7.2 Nakai Plateau

7.2.1 *Introduction*

In the construction period and shortly afterwards the social and environmental impacts on the Plateau will be totally dominated by the impacts of the establishment of the reservoir, the resettlement and other construction and support activities. A number of fundamental changes will occur and most of the impacts can be considered as “project specific impacts”. The cumulative impacts will be minor and difficult to distinguish from the project specific impacts. In the 20-year perspective a more settled situation is assumed, where some of the project induced developments and cumulative impacts are likely to be more prominent.

In the following section some of the basic “project specific impacts” are described as background or as a perspective for the discussion of the “cumulative impacts”. It is, however, not the purpose of this report to give a comprehensive picture of the impacts of the NT2 project. For completeness and details we refer to the studies mentioned in Chapter 4.

7.2.2 *Impact Predictions*

Hydrology and Vulnerability to Flooding

The new “lake” that has replaced the Nam Theun will dominate the plateau. The lake level will be controlled by the operation of the NT2 power station and the release of water from the Nakai dam. These project impacts are described in detail in the EAMP (NTPC 2003). Neither in the short-term nor in the long-term perspective are any upstream hydropower or larger irrigation schemes planned that might influence the hydrology of this area.

Water Quality and Water Supply

The water quality in the reservoir will, as described in the EAMP (NTPC 2003), undergo changes in the years after inundation. In the first years (end of **5-year** period) the reservoir will be rich in nutrients (eutrophic) and organic materials causing alga growth in the upper layers and development of an anoxic (oxygen depleted) deep layer.

In the **5-year** perspective most of the resettlement villages and villages situated along the rim of the reservoir, including Oudomsouk, will have started to utilize the reservoir as its main water source. Water will in general be made potable by boiling, but a certain percentage of the population will probably continue to drink untreated water. Due to the high groundwater level, it will be easy to construct shallow wells and this will supplement the piped water schemes.

Potential water quality problems that might impair its uses as drinking water and for irrigation of vegetables will for the most part be linked to bacterial contamination in the streams and in shallow, closed parts of the reservoir. Contamination in terms of pesticide residues in the water will in general not be an issue due to the size of the reservoir and the limited scale of intensive agriculture.

In the **20-year** perspective the release of nutrients from the reservoir deep layers will be reduced and the lake be dominated by the less nutrient rich water from the tributaries. The reservoir will move into a more oligothrophic status. This change might be counteracted by the discharge of wastewater from the increased population on the Plateau and the increase of fertiliser intensive agriculture in resettlement areas.

An increase in tourist and recreational facilities will require further development of the water and sanitation system. This development will also enable some of the villages to link up and improve the quality of their water and sanitation systems. It is not assumed that polluting industries or other activities will develop on a scale that can jeopardise the water quality requirements for fish production or water supply.

Fisheries and Aquatic Biodiversity

At the end of the **5-year** period the reservoir will be filled up and the river ecosystems replaced by a lake ecosystem. The basis for a higher fish production is likely to have been created and the basis for new fisheries established. The

likely species composition and production potential is currently being studied as part of the NT2 Environmental Management Plan. This fisheries development will however, be in its infancy at this time as the reservoir has just been filled. The fish populations will not be properly developed and there are likely to be many physical obstacles creating difficult fishing conditions.

In the **20-year** perspective the systems will be settled, both ecologically and institutionally. This involves a conversion of a flowing (lotic) ecosystem into a static (lacustrine) system. This may negatively affect some species that require flowing water to complete their life cycles. Other species, however, will have no problem in adapting to the new “reservoir” conditions and will likely proliferate and dominate the species composition. These will include a number of small carp (Cyprinid) species and also fish belonging to the labyrinthine species group. If good stocks of fish develop significant fishery will be made possible. There might be pressure from outside fishing entrepreneurs to establish businesses. It is questionable if the SEMFOP intention to give priority to local small-scale fishing can hinder this development. Large-scale fisheries run the risks of overexploitation with reduced long term economic benefits and consequently further marginalisation of local fishermen.

Industrialised facilities for fish processing is not envisaged on the Plateau. However, simpler village based units for drying and smoking will most likely emerge and give employment opportunities for the local population.

The effect that the reservoir will have on prawns, frogs, crabs, snakes and other aquatic animals, that also form part of the diet of the Lao rural population, is uncertain. Irrigated land during the dry-season months may favour the production of “non-fish”.

Terrestrial biodiversity

The most important area for terrestrial biodiversity in the Nakai Plateau is the wildlife corridor between Nakai-Nam Theun NBCA and Phou Hin Poun NBCA.

In the **5-year** perspective, the 450 km² reservoir will have been established and destroyed the terrestrial ecosystems and the biodiversity values found here. The reservoir drawdown zone will appear as a barren boggy area. Improvement of roads, other construction activities and increased human population, will lead to a further encroachment of the ecosystems on the Nakai Plateau. Some hunting for subsistence and trade, and some illegal logging might still take place, brought about by improved access and influx of people. However, the availability of valuable products that can be harvested will have been significantly reduced except for on the outskirt areas of the plateau. In addition the implementation of the community forest plan will probably contribute to more sustainable use of the forest resources.

In the **20-year** perspective, following the improved road network, better trade opportunities and a general increase in tourism, it is likely that the Nakai plateau, with its link to the Nakai-Nam Theun NBCA, will develop into a centre for eco-tourism. The eco-tourism will generate money for the local communities, and will also be an incentive for increased protection of the natural values in the area. The village forestry programme will have helped restore some of the forest land. It will not have returned to its original tree species composition but might still be able to provide habitats for a variety of bird and mammal species. The reservoir drawdown zone will become more established with vegetation that survives periodic inundation.

Agriculture and Forestry

Agriculture and forestry will in the **5-year** perspective be dominated by resettlement activities and the efforts to establish sustainable livelihoods under the RAP. The optional livelihood models that will be offered to the resettlers will still be in the process of being adapted to individual choice and preference. Irrigated rice, vegetable production, perennial crops, agroforestry, village forestry, domestication of NTFPs and livestock will be important components in the livelihood models. Only a part of the resettlers will be able to adopt and practice irrigated rice.

The remaining forested areas on the south-western side of the plateau will have started to be utilized by the resettlers as a source of cash income. Village forestry associations will be under formation and training and the forest restoration activities will have started.

In the **20-year** perspective a range of farming systems will have been established incorporating irrigated rice and cash crops, livestock, agroforestry, village forestry and cultivation of domesticated NTFPs. A certain percentage of the households will produce rice enough for their own consumption while others will rely on sale of vegetables, livestock and NTFPs. The market for vegetables and commercial crops will have expanded beyond the Plateau and the district centre to the urban areas like Thakek and Savannakhet. The marketed crops will consist of a mix of temperate region vegetables (cabbage and carrots) and fruits. Livestock, where fodder production and stall-feeding is increasingly replacing free ranging, will constitute an important part of cash incomes for a considerable part of the resettler households.

Village forestry will be dominant on the Plateau and harvesting of timber will be predominantly done according to long-term plans. The forest will be restored to the degree that income can be provided from collection of non-timber-forest-products (NTFPs) and selective timber harvest.

Urban Development and Population Growth

In the **5-year** perspective, most of the expansion of Oudomsouk will be driven by the establishment of the workers' camps and the associated influx of camp followers. Some immigrants will possibly settle in a haphazard way, while others will settle into areas that are served by an expanded water supply and drainage/sewage system. By 2010 the population will possibly number 3,500 to 4,000 people, dependant on the level of still ongoing construction activities. This represents an increase of 84 to 110% in relation to the 2003 population figure.

In the **20-year perspective** it can be expected that the population in the Oudomsouk will develop more slowly. With a population growth around 3% incorporating natural population growth and in-migration the population will be around 5,400 by 2025. This represents an increase of more than 180% compared to number of inhabitants in 2003. However, with a stronger in-migration of people from the Nakai-Nam Theun NBCA and development of ecotourism and commercial fisheries the population may be somewhat higher.

Health

The description of the present status and possible developments of the health situation on the Plateau is covered in detail in several project specific assessment studies. It is difficult to distinguish between aspects strictly being a result of the NT2 Project and what is a result of a combination of development factors, which are the main focus of this study.

In the **5-year** perspective the NT2 Project will dominate the development picture. In addition to the project specific impacts the project will initiate new migration patterns for people in the surrounding areas, in particular from the Xe Bangfai Basin and from communities in the NBCA.

Many migrant workers will experience an improvement in the standard of nutrition compared to in their home villages. They may also be less exposed to certain communicable diseases and conditions, and will have better access to emergency and/or routine health care.

The Nakai district centre, as well as ad hoc settlements that may spring up near the campsites, may potentially become major focal points for the transmission of HIV/AIDS and other STIs. Rapidly changing socio-economic conditions and behavioural practices at these sites, amongst young men and women, increase the risk. Knowledge and understanding of the causes and means of preventing STIs is likely to remain low amongst many at risk individuals unless preventive interventions are successfully and rigorously carried out

As a result of construction activities and the influx of workers and other migrants in and around the Nakai Plateau, the frequency and severity of vehicular accidents will increase.

The Project related health programme will keep in check many of the most negative health effects.

In the **20-year** perspective Nakai district may have changed dramatically. Although the size of the district centre may have increased only moderately since construction, new developments and programmes initiated by the NT2 Project are assumed to have significantly improved the health conditions on the Plateau. Malaria cases and dengue fever may be rare events. The improvement in public water supply systems and the use of latrines will reduce the number of illness caused by water or food-borne diseases.

Changing diets and lifestyles, will have altered the picture of morbidity and mortality. Communicable diseases like tuberculosis may have become relatively less important compared to non-communicable diseases associated with chronic ailments, aging, and new behavioural patterns. Diabetes, circulatory diseases and heart ailments, cancers and psychological problems will emerge as problems. Many health workers at dispensaries and hospitals, however, may not have been re-trained to deal with these emerging health issues.

The high level of vehicular accidents is not expected to have declined. A recent study on the newly complete Route 9 in Savannakhet Province predicts an increase in vehicular accident by about 100%, based on forecasts for the first 5 months after the upgrading of the road (Benefit Monitoring Report, 2004). Although the traffic volume will be considerably less along the upgraded Route 8B and new access roads, a doubling of the number of accidents is considered a realistic estimate due to the dramatic increase in the number of vehicles of all types and sizes on the roads.

Services Capacity

In the **5-year** perspective the Nakai district services will have received considerable support in terms of staffing, training and financial resources. District services will thus be far better prepared and equipped for the task of assisting development of livelihoods and offering basic health care and other services to the resettlement population and the rest of the inhabitants in the district. However, it must

be expected that there will still be shortcomings in terms of health outreach services and hospital and health centre facilities. Education facilities in the resettlement villages will largely be in place but difficulties will be faced in connection with recruitment of qualified teachers. Agriculture and forestry extension services will have received considerable reinforcement but are likely to still be struggling to cope with the task of assisting resettlers to establish viable livelihoods.

20 years ahead, district services will have reached a sort of equilibrium considerably below the activity and capacity level that was common during the time they received specific project support. Some of the service provisions have been taken over by private providers especially in the health sector. In general service capacity and provision are likely to be below the demands from a growing population.

Ethnic Minorities

Except for the new arrivals in Oudomsouk town, the newly established district capital of Nakai, almost all of the inhabitants on the Nakai Plateau are ethnic minorities as defined in the EMDP (Dec 2003). However, there is a clear trend towards integration and assimilation of the groups on the Plateau into mainstream Lao culture. With the arrival of educated and more resourceful lowland Lao during the construction period (**5-year** perspective) and the already noticeable increase of majority groups in the district capital, the ratio of ethnic minorities in relation to lowland Lao and related groups is likely to change. At present the ratio is approximately 1:5 in favour of the minorities with the lowland groups mostly located in the district capital and in small numbers along the existing roads. It is likely that this ratio will have changed to 1:3 due to influx of outsiders. Due to the changes outlined in the proposed livelihood systems, education improvements (in the Lao language), newly established Buddhist monasteries and the existing mix of culture, the so-called 'melting pot of the Plateau', a local Lao culture will develop consisting of Lao language and cultural characteristics. The project is likely to further hasten this process of integration.

In the **20-year** perspective the communities on the Nakai Plateau will likely be fully integrated into the mainstream Lao culture and nation state. This implies that the Nakai culture will be a Lao culture (Buddhism, Lao language and Lao government institutions) without many of the common characteristics of Ethnic Minorities, such as reliance on natural resources, unique cultural traits, languages and institutions. Inter-marriage between groups is likely to increase and present ethnic identities (Bo, Brou, Sek and Vietic) are likely to be further blurred or even forgotten. It is also likely that people will start to define themselves as *Lao Loum* (lowlanders or dominant group) or as Tai Nakai (Tai-Lao group of the Nakai region) as is already the trend among some residents of Nakai.

Poverty Alleviation

There should be considerable improvement on the Nakai Plateau with regard to the levels of poverty. Given the fact that the resettlers were recorded as being below the Lao poverty level in terms of annual household income of less than 700 USD (462-449 USD), serious rice deficiency, unstable livestock populations and dwindling natural resources as well as very limited social services (EMDP 2003), it is expected that in the **5-year** perspective the rural population of the Nakai Plateau will experience a considerable improvement in the living standards. This can be summarised as:

⚡ Increased food security (but still reliant on rice supplements)

- ⌘ Improved health and education services
- ⌘ Improved market access for vegetables and other agricultural products
- ⌘ Improved transportation, communications (market access) and electricity
- ⌘ Training programmes (community forestry management) and skills development support (agricultural extension)
- ⌘ Employment for some during the construction period

In many large infrastructure developments, it is common that more resourceful and educated groups can more easily benefit from socio-economic change and rapid integration into market-oriented economies. In the **5-year** perspective social disparity may increase due to the differences in economic resources (livestock), available labour, education levels and degree of social support and network. There are, however, measures to deal with disadvantaged and vulnerable households in the RAP since it is acknowledged that household's adaptation to the new livelihood systems will vary in terms of economic performance. Existing differences will manifest themselves over time and the fact that these communities will become fully integrated into the mainstream economy could exaggerate social disparity to some extent. However, it should be noted that there should be a significant overall decrease in the incidence of poverty.

The expected growth of the service sector and government jobs in Nakai District town (Oudomsouk) will concentrate capital in this town, creating an economic gap between the rural communities and new urban development. It is expected that most of the government positions and service sector will be dominated by lowland Lao outsiders with more education and financial resources to develop businesses. This process has already started and is likely to accelerate during construction.

Gender relations are likely to change due to increased urbanisation, the influence of lowland values and differences in livelihood systems. In rural communities, there was a division of labour but most tasks were shared, with women and men partaking in making of goods and the production of food. However, men dominated formal decision-making, politics and working outside the village. In the **5-year** perspective, it is expected that men will benefit more directly from development initiatives since it is likely more men will work as wage labourers. However, women should also benefit from aspects of the livelihood model since they are often responsible for buying and selling at local markets. Improved services, water supply and other planned improvements are likely to save women considerable time in the domestic sphere, allowing more time for income-generating activities. In the urban setting of Nakai, modern, lowland Lao values are likely to become the norm, and this might lead to increased male dominance since men are likely to become the main or only contributor to the household economy, decreasing the influence women have on decision-making.

In the **20-year** perspective, it is likely that social disparity between household within communities, between villages and urban areas (Nakai town) and between men and women will increase unless direct interventions are introduced to counter these trends, such as specific programmes directed towards rural areas, gender empowerment measures, quotas or positive discrimination. The performance of the education systems and the quality of education at the primary level and general economic development will determine to a large extent how social disparity develops. It is expected that the Nakai Plateau, in general, will not have a 'significant' poverty gap due to the expected improvements in the RAP.

7.2.3 Summary of Impacts

Table 24: Summary of the most Important Cumulative Impacts on the Nakai Plateau

| Nakai Plateau | |
|--|--|
| 5-year scenario | 20-year scenario |
| <p>The impacts will be dominated by NT2 project activities. Some additional impacts are however, envisaged due to improved access and activities “following” the construction work and temporary population increase.</p> <p>The most important impacts will be increased pressure on wildlife, increased risk for STIs including HIV/AIDS and increasing frequency and severity of vehicular accidents.</p> | <p>The situation will have stabilised but will have changed significantly compared to the initial situation. Communication both north and south will be radically improved and the reservoir will have attracted new activities like commercial fisheries and tourism. It is assumed that:</p> <ul style="list-style-type: none"> ≠ Sanitation and water supply will be improved. ≠ The Odomsouk population will possibly have increased with more than 180% in relation to number of inhabitants before the start of construction activities. ≠ Commercial fisheries will be established. ≠ The health conditions will be improved with reduced incidence of malaria and food and water borne diseases, and there will be a shift from communicable towards non-communicable diseases. ≠ Health and education services will be struggling to keep up with demand due to population increase. ≠ There will be increased employment in service sector including tourism. ≠ There will be increased cultural integration on the Plateau with blurring of ethnic borders and loss of identity. |

7.3 Nakai-Nam Theun NBCA

7.3.1 Introduction

The Nakai-Nam Theun NBCA can be considered as part of the NT2 project area. The planned reservoir forms a part of the NBCAs western border. Nakai-Nam Theun NBCA is ranked as the most important NBCA in the whole of Lao PDR (Robichaud et al. 2001), and is probably one of the most important protected areas in the whole of Southeast Asia. The protection of the biodiversity values of NBCA has been the focus of earlier studies, in particular the Social and Environment Management Framework and Operation Plan (SEMFOP), which specifies a programme for sustainable management.

7.3.2 Impact Predictions

Hydrology, Water Quality and Water Supply

The only potential changes in hydrology and water quality of the rivers inside the NBCA might be caused by increased deforestation and expansion of the practise of swidden agriculture. This potential development might lead to increased sediment content in the rivers. Such development is supposed to be efficiently counteracted by the SEMFOP initiative.

For people living close to the reservoir the water supply situation will be improved both in the **5-year** and in the **20-year** perspective.

Fisheries and aquatic biodiversity

The NT2 project will not have any direct impact on the rivers and streams in the NBCA. The potential impacts will be caused by downstream changes. It is not foreseen that that other projects and developments will have an impact on the fisheries and aquatic biodiversity in the NBCA.

In the **5-year** perspective the important change will be the establishment of the reservoir and the Nakai dam. It is likely that this will have an impact on the up-stream migration of fish from Nam Theun to the tributaries in the NBCA. In the first years after commissioning of NT2 the downstream fish populations will be in a pioneer stage, establishing new production patterns which are difficult to predict.

In the **20-year** perspective the ecological situation will be more settled. However, still the impact on upstream fish biodiversity and fisheries opportunities are uncertain. Much will depend on whether the reservoir fish population becomes dominated by small pelagic species confined to the reservoir or by larger species using the tributaries in the NBCA for breeding.

Terrestrial biodiversity

In the **5-year** perspective, the commencement of operation of the NT2 Project will provide the environmental authorities with annual funds of US\$ 1 million for management and protection of the Nakai-Nam Theun NBCA. The SEMFOP initiative will provide a unique opportunity for development of sustainable management practices and better protection of terrestrial biodiversity in the area. The Nakai-Nam Theun NBCA will end up having a more advanced control and management system than any other Lao PDR NBCA. Thus, both in the **5-year** and in the **20-year** perspective the situation for primary forests and the unique fauna inside the NBCA will be better than without the project.

The most serious threat to the biodiversity values of the NBCA comes from planned development in Vietnam. The Ho Chi Ming Highway (National Highway No.2) will run along the border opening up previously relatively inaccessible areas for settlement and economic exploitation. It will cut through the Vu Quang National Nature Reserve and also significantly increase the access to Nakai-Nam Theun NBCA. The impact will be felt in the **5-year** perspective and, due to the assumed new settlements “following” the road, further intensified in the **20-year** perspective.

In the **20-year** perspective some eco-tourism might be developed in the NBCA. The disturbance to terrestrial biodiversity will increase marginally, but on the positive side it means increased opportunities for the local people to generate money and improve their livelihoods from sustainable activities.

Agriculture and Forestry

Both in the **5-year** and in the **20-year** perspective the development will be controlled by the SEMFOP programme. The pressure on forest and land resources in the NBCA is also likely to decrease due to migration of people from the NBCA to the Plateau. The main potential threat to the principle of sustainable use of forest resources and sustainable agricultural practises will be influx of people and illegal logging originating from the Vietnam side of the border.

Urban Development and Population Growth

From communities in the NBCA some, mostly younger people, may move to the Plateau in search of employment during the construction period. For those who cannot successfully find employment there, some may seek work further afield; in one of the nearby district towns, or in the establishments related to the development in the Savannakhet Economic Zone or East-West Corridor, or in Thailand. Also people from the resettlement villages might participate in such out-migration triggered by the activities and improved transportation opportunities between the Plateau and the surrounding areas. It is not predicted that this will occur on a significant scale

Both in the **5-year** and in the **20-year** perspective it is estimated that the natural population growth rates, which are presently above the average for the country (3.79-6.25% recorded in the EMDP for the SEMFOP), will be offset by out-migration. Thus, it is predicted that out-migration to the Plateau for work and in search of better services and markets may lead to population growth rates for the NBCA of about only 2-3%. Large-scale out-migration is not envisaged due to attachment to traditional territories, relative abundance of resources and initiatives under the SEMFOP to improve existing agricultural practices.

Health and Education

Health and education facilities in the NBCA are lacking for the most part. Reliance on traditional medical practices and irregular visits from health workers characterise the situation. There are few properly functioning schools, a serious shortage of teachers and high level of illiteracy. In the **5-year** perspective, the health and education interventions outlined in the SEMFOP will be fundamental in supporting a weak government system in this remote area. It is predicted that there will be some improvements by 2010, including more regular visits by trained personnel, improved availability of medicines and possible reduction of malaria and nutritional problems. It is also expected that some of the existing schools may be restored or improved, better equipment made available and the presence of teachers more regular. In the **20-year** perspective, further improvements are envisaged, including immunisation coverage, improved hygiene and nutrition, established health centres and functioning village schools. However, the standards of health and education services will not be the same as on the Nakai Plateau and this may be one of the attractions for out-migration.

Ethnic Minorities

In the **5-year** perspective the situation for the ethnic minorities of the NBCA will differ from the Nakai Plateau since these groups are less integrated and will not experience directly the influx of lowland culture. However, many groups may attempt to find work, to increase economic interaction and even to relocate to the Plateau during the construction period. This is likely to lead to some integration but not to the same extent as with the Plateau communities. The livelihood development schemes outlined in the SEMFOP may act to slow down this process and counter to some extent the temptation to migrate to the Plateau.

For the **20-year** perspective there will be increased contact with the Nakai Plateau, both economically and culturally, the relative isolation of the various ethnic minorities in the NBCA will no longer be a reality, at least not to the same extent as before. Government institutions and services will expose groups to lowland cultural traditions. It is likely that many households may choose to leave this area for the better standards of the Nakai Plateau. Most ethnic minorities have relations to those residing on the Plateau. It is likely that the natural population in-

crease in the NBCA will result in considerable out-migration. Labour migration, both seasonal and to urban areas for longer periods, may become common among some groups. Those remaining will integrate culturally with Lao replacing many of the ethnic languages and local beliefs being modified by Lao customs, traditions and Buddhism. Small Vietic groups are unlikely to retain their ethnic identities and will probably be integrated into larger ethnic groups like the Brou or adopt Lao identities.

Poverty Alleviation

Some improvement is anticipated in terms of poverty alleviation for the NBCA during the **5-year** perspective but significant development will require more time, given the participatory approach to be taken in planning, implementation and monitoring and the logistical challenges presented. In the **20-year** perspective, these improvements should be moderate to significant, given the fact that the rates of poverty are higher in this region and interventions are likely to have a positive impact. These can be summed up as:

- ⌘ Increased food security (development of paddy and improved swidden cultivation techniques).
- ⌘ Improved health and education services locally and better access to hospitals and secondary schools in Nakai town.
- ⌘ Improved market access by boat to Nakai town markets.
- ⌘ Training programmes, skills development, agricultural extension and possible sources of employment in conservation and tourism.

7.3.3 Summary of Impacts

Table 25: Summary of the most Important Cumulative Impacts in Nakai-Nam Theun NBCA

| Nakai-Nam Theun NBCA | |
|---|--|
| 5-year scenario | 20-year scenario |
| <ul style="list-style-type: none"> €# Migration of fish from the Nam Theun affected by the establishment of the reservoir. €# Better protection of biodiversity and forest resources through SEMFOP while at the same time threats to biodiversity will come from extractive activities and hunting linked to developments on the Vietnamese side of the border including road building and increased population. €# Improved social service delivery in terms of availability of medicines, possible reductions of malaria and nutritional problems, improved access to education. €# Some integration of ethnic minorities and adoption of elements from dominant lowland Lao culture but not to the same extent as with the Plateau communities. €# Some improvement in terms of poverty alleviation. | <ul style="list-style-type: none"> €# Effect on fish biodiversity and production will depend on whether the development of reservoir fish population become dominated by small pelagic species confined to the reservoir or by larger species using the tributaries in the NBCA for breeding. €# Increased threat to biodiversity through population increases on the Vietnamese side of the border leading to increased exploitation of the NBCA. €# Further improvements in social services including immunisation coverage, hygiene and nutrition, health centres and functioning village schools. €# Natural population increase will result in considerable out-migration and labour migration to urban areas for shorter or longer periods. €# The process of integration with the lowland Lao culture will have proceeded further and led to assimilation of small Vietic groups. €# Significant reduction of poverty in terms of food security, better market access and employment opportunities. |

7.4 Xe Bangfai Basin and Surrounding Districts

7.4.1 Introduction

In this zone the impacts from the NT2 Project can in broad terms be divided in two types:

- €# Impacts generated by the construction activities, which will be most prominent in the middle part of the basin in the Gnommalath and Mahaxai districts. In particular Gnommalath, where large construction works will take place and labour camps be established, will experience many of the same impacts as found the Nakai plateau.
- €# Impacts related to the hydrological changes caused by the transfer of water from the Nam Theun Basin into the Xe Bangfai. This impact will create a new and permanent change in water flow regime and will be felt all the way down to the confluence with Mekong.

Compared to the Nakai plateau zone the assumed cumulative impacts in the Xe Bangfai Basin will to a much larger degree be influenced by development in other sectors than hydropower.

7.4.2 *Impact Predictions*

Hydrology and Vulnerability to Flooding

In terms of hydrology, the main impact in Xe Bangfai is the discharge from NT2 just upstream Mahaxai. No further development of hydropower is expected in the **5-year** or **20 year** perspective that will affect Xe Bangfai, with the exception of the Lower Xe Bangfai, which is subject to backwater from Mekong and will thus be impacted by future changes in water flow in the mainstream Mekong. The plans for irrigation developments in the Gnommalath district and in the lower Xe Bangfai are not supposed to result in significant changes in water flow in the river in the **5-year** or in the **20-year** perspective.

In the pre-NT2 baseline situation, the mean discharge in Xe Bangfai at Mahaxai varies from a minimum of 12 m³/s in March/April to a maximum of almost 800 m³/s in August. In extreme years, however, the annual maximum can vary from 270 to 1900 m³/s, as a monthly average. Furthermore, the instantaneous discharges may be much higher than the quoted monthly averages.

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At the time of the present study, information was not available about power agreements, which will stipulate the NT2 power production. Hence the exact magnitude of the NT2 diversion was not finally determined. It is however determined that full turbine capacity (330 m³/s) will be run 16 hours a day, while the operation for the remaining 8 hours may be from 0 to 100 % capacity. One day a week, Sunday, there will be no diversion. Thus, the average diversion will be between $6/7 \times (16 \times 330 + 8 \times 0) / 24 = 190 \text{ m}^3/\text{s}$ and $6/7 \times (330) = 280 \text{ m}^3/\text{s}$. It is these two alternatives, that will be considered in the following, while the real situation can be expected to be somewhere in between.

As monthly averages, the diversion will have a constant magnitude throughout most of the year, although in the case $Q=280 \text{ m}^3/\text{s}$, the diversion will decrease at the end of the dry season, because the reservoir is reaching the bottom. The largest *relative* diversion will occur in March (relative to the XBF flow), because the natural flow in Xe Bangfai is very small at that time. On the average, the flow in Xe Bangfai at Mahaxai will become 12-15 times larger in March than pre-NT2 flow.

During the flood period, the diversion will amount to a smaller proportion of the discharge in the Xe Bangfai. In August, NT2 increases the flow by 24-35 % in an average year.

Impacts from NT2 on flood risks in the Lower Xe Bangfai is an issue for the ongoing study by SMEC, which is planned to be submitted by July 2004. The hydraulic dynamics of the lower and middle Xe Bangfai is very complex, partly due to significant backwater effects from Mekong, partly because of a complex system of floodplain/paddies and numerous tributaries with small flood control structures (gates, etc). Without the results of that study, it is extremely difficult to assess the flood impact in the Lower Xe Bangfai in a situation with high water levels in Xe Bangfai and Mekong.

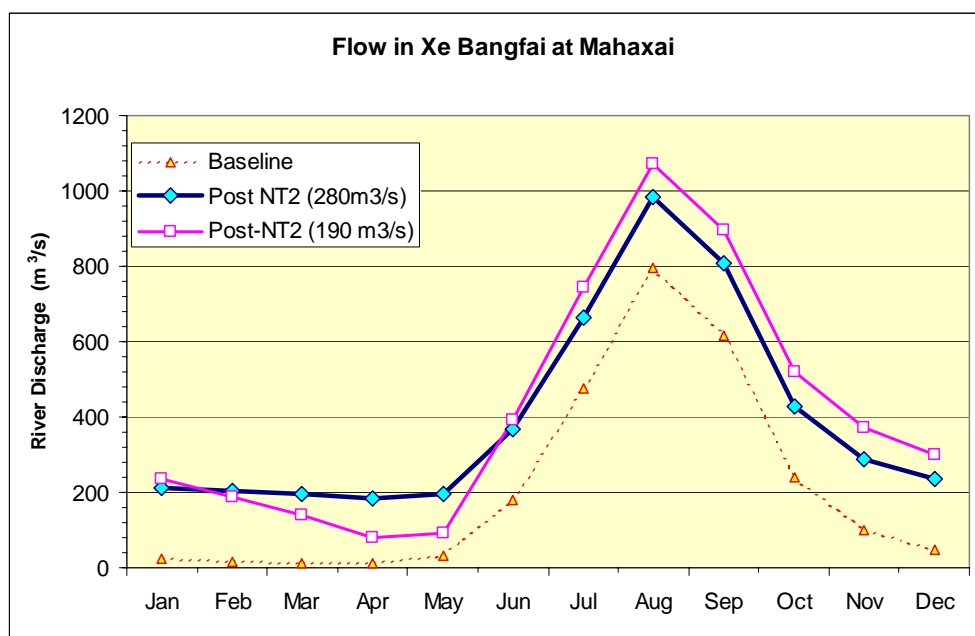


Figure 1: Annual Variation in Monthly Mean Flow in Xe Bangfai Pre- and Post-NT2 (two options for NT2 power production).

In situations with more moderate water levels, i.e. when Xe Bangfai remains within its banks, the impact of NT2 on water levels in the middle Xe Bangfai (Mahaxai) can be assessed approximately. Based on the Mahaxai rating curve (MRC Yearbook), the average NT2 diversion in March (when the relative change is largest), will induce a *water level increase of 3.4 m*.

During the flood season of an average year, NT2 will increase the natural flow from 800 m³/s to 1080 m³/s. The corresponding *water level increase is 1.3 m*. The bankfull discharge is found at 2200-2300 m³/s.

If no special flood-protection measures are taken, an addition of 280 m³/s to flood discharges will change the flood frequency regime so that for example a natural 5-year flood (2490 m³/s) will become a 2 year flood, i.e. the same flood level will occur on average every 2 years instead of every 5 years. In the project specifications it is prescribed that the NT2 diversion will stop when Xe Bangfai approaches bankfull stage.

In the lower Xe Bangfai (downstream Bridge 13), the hydraulic conditions are greatly influenced by backwater from the Mekong, and consequently also the flooding vulnerability. It has therefore been claimed that the increased risk to flooding in Xe Bangfai in general will be counterbalanced by a corresponding discharge reduction in the Mekong, and thus consequently a reduced backwater into Xe Bangfai.

Calculations done by the developer estimate the energy saving potential in connection with pump irrigation for different water levels. A raised dry season water level of around 1 m will lead to a reduction in average electricity consumption by 11% while 2 m will give an average power saving of 16%. These figure represent

averages for different pumping systems (pontoon and fixed bank installations) with a static head varying from 13 to 20 m.

Water Quality and Water Supply

The most important water quality issues identified in the NT2 impact assessments are the problem of low oxygen content in the power plant discharge water. Some local erosion by slumping of riverbanks in Xe Bangfai due to the increased flow is also envisaged. However, the riverbanks are expected to adjust to the higher flow (and rate of change) and stabilise after some years.

In the **5-year** perspective these issues might cause some problems to the use of the water for water supply. It is assumed that the labour camps will not increase the discharge of untreated wastewater as proper treatment is supposed to be in place. However, the wastewater discharges caused by the uncontrolled influx of camp followers and the general population increase in Gnommalath and Mahaxai, caused by developments along the East West Corridor, might add significant volumes of wastewater to the rivers. This might add to the problems of oxygen depletion. In addition there will be increased microbiological contamination. This microbiological contamination of the recipient will be counteracted by much higher water flow and recipient capacity in the low season. So the total picture of the water meeting microbiological standards for drinking purposes will not be much reduced. In the downstream town of Nongbok safe drinking water will be provided by a water supply system by that time.

In the **20-year** perspective the problem of oxygen depletion of the discharged water will have been reduced, as most of the organic materials in the reservoir will be digested. The wastewater volumes from Mahaxai and Gnommalath will have increased substantially as a result of the population increase and potential industrial development in the area. It is assumed however, that organised water supply, sewage collection and wastewater treatment has been established by that time, and thus that negative health impacts are not likely to occur. In addition the increased flow induced by NT2 will be beneficial as it increases the recipient capacity of the river.

The agriculture development and more intensive production methods, in particular in the lower part of Xe Bangfai Basin, will have led to increased use of fertilisers and pesticides. This will most likely lead to local problems with eutrophication and heightened levels of pesticides in drainage water and fish. This might cause problems for local surface water sources and shallow wells.

Fisheries and Aquatic Biodiversity

The impacts on fisheries in the middle and lower Xe Bangfai will be dominated by the direct impacts caused by the NT2 hydropower project. Other developments causing significant changes in water flow are not envisaged in the 5-year and 20-year perspective. The only developments that might contribute to cumulative impacts on fish production and aquatic biodiversity are increased pollution from agriculture, industry and urban areas. In addition population increase and demand for food might increase the price of fish and consequently induce over-fishing.

At this stage the predictions on changes in fish stocks and fisheries are difficult to give. Too little is known about the present situation in the fisheries, fish biodiversity and on the detailed hydrological changes caused by NT2 in the lower Xe Bangfai. These issues are presently under investigation and will be reported in separate studies. The most important question is how the migration of different

fish species will be influenced by the hydrological changes, and how the increased dry season flow will change upstream spawning habitats. Many species of fish rely on the annual production of filamentous algae that develop on hard and soft substrates during the dry-season months, when light can penetrate the relatively clear, shallow waters. This provides the “food fuel” for the fish to build up reproductive products (eggs and sperm), and also provides the necessary energy to enable fish to undertake migrations.

In the **5-year** perspective the NT2 project will have just started operation. In the first years significant erosion and turbidity problems along the length of the river are foreseen. In the initial stage also the oxygen content of Xe Bangfai might also be reduced for some distance downstream the point where the channel discharges into Xe Bangfai. These factors combined with the rise in water level will reduce the algae growth and bottom fauna in the river and consequently a reduction in fish production is likely to occur. Spawning grounds for some species might also be negatively impacted. Some traditional fishing gear will become useless, as it will not be able to be used in the new high flow situation.

In the **20-year** perspective the water quality situation caused by NT2 will stabilize. The basic assumption is that biodiversity and the production of many species might be reduced. The algae growth and thus the food supply for many fish species will still be reduced compared with the natural condition but probably more important the increased dry season flow in Xe Bangfai is likely to cause migratory disorientation. Initially, this may appear to be a positive impact, because more fish may be caught out-of-season, but in the long term it is likely to result in reduced fish production. This is based on the fact that most Mekong species are adapted to, and react to, specific flow situations for their migration and spawning cycles.

The increased flow and the assumed expansion of dry season irrigation in the basin might, however, increase the capacity for flood plain and “back swamps” fish production.

It is not foreseen that larger scale aquaculture will have developed to compensate for the loss of river fisheries.

Terrestrial Biodiversity

The areas of particular concern from a terrestrial biodiversity point of view are the upper parts of the Xe Bangfai catchment (Hin Nam No NBCA), the area west of the Nakai Plateau (Phou Hin Poun NBCA). Phou Hin Poun to a large extent belongs to the Nam Hinboun catchment. The lower part of Xe Bangfai catchment is of little interest from a biodiversity point of view as most of the land is converted into agriculture.

In the **5-year** perspective, there will be additional pressure on the natural resources and biodiversity caused by the combination of influx of people for the NT2 Project and improved road conditions locally and to Vietnam. In the Nakai-Nam Theun NBCA this pressure might be efficiently counteracted by the improved management and control systems established. The other NBCAs, however, will not have the same protection and control of illegal activities. There is therefore a risk that increased protection of NNT NBCA will change the pattern of illegal logging and hunting, from NNT NBCA to other, less controlled areas. Of special concern is the development in Phou Hin Poun NBCA where a road is under construction from Gnommalath into the protected area. It is facilitating eco-

tourism development, but it might also unintentionally open up the area for logging and uncontrolled activities.

In the **20-year** perspective, the pressure on terrestrial biodiversity will continue to increase due to a general population growth and an increased movement of people and goods through the transport corridors (mainly route no. 9). The possible construction of a cement factory in Mahaxai, less than 10 km from Phou Hin Poun NBCA, will affect the local environment due to emissions of dust and gas, but is not likely to represent a major problem to the Phou Hin Poun NBCA itself.

However, it is assumed that political recognition of environmental values has increased in this period, and that legal and institutional system for control and management of the protected areas will have been improved. If not, habitat destruction and illegal hunting will most certainly have taken its toll on the biodiversity and NBCAs in this region.

Agriculture and Forestry

In the **5-year** perspective agriculture in Gnommalath and Mahaxai districts will be more geared towards producing for the growing local and outside market. The World Bank financed rural livelihood development project focusing on Gnommalath, Mahaxai and Xe Bangfai districts will have supported this shift towards commercialisation. The improved road connections to Thakhek and Vietnam will have expanded the markets for agricultural produce, a factor that adds to the market demand created by the NT2 Project. Together with the increased commercialisation of agriculture, an intensification of the production technology will take place leading to an agricultural production based more on purchased inputs such as chemical fertilizers and pesticides. There will be a considerable increase in the number of 2-wheel tractors that are used to carry products to the local market places. However, only some of the farmers may have chosen to utilize the opportunities for cash crop production and a majority will probably still depend on rain-fed and irrigated rice for household consumption, and sale of production surpluses to generate cash. Local demand and the improved access to wider markets may have raised the farm-gate price of rice to some degree.

The irrigated area will probably to some degree be expanded but the potential offered by the NT2 for the additional water for irrigation development on the Gnommalath Plain and further downstream will not have been fully realised yet.

In the middle and lower Xe Bangfai some of the potential areas for irrigation will have been developed while plans for upgrading and rehabilitation of existing schemes may have been developed by the provincial irrigation departments of Khammouan and Savannakhet. The World Bank funded Agriculture Development Project will have finished the construction of 3 new irrigation schemes comprising 460 ha in Gnommalath and 2 schemes in Thakek District with a total of 250 ha. Both government and external funding for rehabilitation of old schemes and additional irrigation development in the area will have been secured to a certain degree. 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.

In the forestry sector the supply needs of the existing wood processing industry will have put the existing production forest areas in Khammouane Province of approximately 120,000 ha under increased pressure. The forest resources in the Phou Hin Phoun will also have come under pressure. In areas degraded by commercial logging, the local population will probably carry out non-mechanised logging on a smaller scale. However, the SUFORD Project will have started to

make an impact on local logging practices in the 2 production forest areas where villagers will be starting to adopt more sustainable timber harvesting and management practices. Commercial forest plantation areas with involvement of villagers will also have started to expand.

In the **20 year** perspective agriculture will have been further commercialised with production of crops for an expanded market. The range of cultivated crops will have been diversified and different types of fruits crops will have complemented vegetables as cash crops. The local markets for agricultural products will be Thakhek and Nongbok, which will have seen a substantial growth in their populations. However, the neighbouring areas in Vietnam and Thailand plus more remote domestic markets such as Savannakhet and Vientiane should also be developing. In spite of the development of cash cropping, production of rain-fed and irrigated rice will still be the main agricultural activity in this zone providing the mainstay for the majority of the farmers.

It must be expected that much of the potential area for irrigation will have been developed through the assistance of external funding while many of the existing irrigation schemes will have been rehabilitated and upgraded. Perhaps an estimated half of the dry and wet season potential for expanding irrigation perhaps will have been developed. This amounts to around 7,000 and 5,000 ha for the wet and the dry season area respectively. Irrigated dry season cropping will also have diversified to include crops like maize, soybeans, groundnuts and a number of vegetables crops.

Village forestry is likely to be the dominating utilization and management system within the designated production forest areas. At the same time forest plantation for industrial purposes will have expanded and become an important part of the total forest output in the zone.

Urban Development and Population Growth

In the **5-year** perspective Gnommalath will experience a sharp rise in population caused by the NT2 Project while Mahaxai will grow mainly because of the construction and operation of the planned cement factory located in the district. In addition they will also experience the impacts of being located on Route 12 and 8B. The urban areas will probably expand rapidly and only partly in a planned and orderly manner as the district plans for expanded settlements are unlikely to be implemented fully. For both these urban areas at least a doubling of the population is likely. This would bring the number of urban residents up to 4,000 both in Gnommalath and Mahaxai by 2010.

Thakhek will have its own momentum of growth, which the trade and local economic growth generated by the NT2 Project will be contributing to, offsetting partly or fully the effect of the declining timber industry. With a continued high growth rate of 3.5% Thakhek's urban population will reach around 48,000 in 2010. This represents an increase of 46%. Thakhek already has an Urban Development Administrative Authority (UDDA) that will continue to provide services and address the problems of rapid urbanisation.

Water supply, sanitation and garbage collection services will most likely be poorly developed. Individual households are likely to rely on pumping or fetching water from the nearby streams and rivers, or on shallow wells which will necessitate boiling of the drinking water. Each household will, to a certain extent, have built their own latrine or own septic tank. However, water pollution may also arise from

sewage water from toilets and kitchens being released directly into nearby rivers and streams, and from surface runoff from the urban area itself.

In the **20-year** perspective the district centres of Mahaxai and Gnommalath may continue to experience a substantial growth. A growth rate of 3%, which appears to be likely in the future, will bring their urban populations up to more than 6,000 by 2025. This represents a more than 200% increase over the present population size. It can be expected that by that time wastewater treatment, water supply and waste collection services have to some degree been established.

Thakhek will, with a continued growth rate of 3.5%, have reached a population of around 80,000 by 2025. This represents a growth of 142%.

Health

In the **5-year** perspective the health impacts will be related to the change in water flow and water quality caused by the start of NT2 operations, and to traffic accidents and increased exposure to HIV/AIDS and other STIs caused by NT2 activities and a number of other developments going on in the area.

The expected increase in sediments in the river water and the low oxygen content in the discharge water may reduce the quality of potable water used for drinking, bathing, and other household purposes, causing gastro-intestinal illnesses as well as skin problems. The changes in water levels, in and around riparian communities, may influence the prevalence and incidence of rodent and vector-borne diseases. This concern is most relevant for dengue. The promotion of an additional dry season rice crop, aided by planned irrigation schemes, might also help dengue fever to proliferate.

Gnommalath and Mahaxai lie not far from the junction of Route 8B and Route 12 that will have been improved by the NT2 Project. This will put the district centre within two hours travelling time of both the Thai and the Vietnamese border, linking it to cross border trade as well as possible international trafficking activities.

The cement factory complex near Mahaxai might at this stage have become a major local environmental health and traffic safety issue. The main problems will be dust from the processing and increased transport of limestone and products.

Increased traffic, population increase and crowded living conditions may lead to a number of health impacts. Vehicular accidents may increase substantially, there may be an introduction or re-introduction of potentially dangerous vector-borne diseases, and finally, a serious STI and HIV/AIDS situation may develop propelled by an increase in commercial sex services, increased migration, mobility and risk behavioural practices.

The Public Health Action Plan that will be implemented in connection with the NT2 Project will address these issues through a number of targeted measures, helping to prevent and limit the foreseen negative health aspects.

In addition, there are plans to build a new spacious district hospital just outside the Gnommalath district centre. This facility will serve as an inter-district facility, supporting the health care delivery network in both Nakai and Mahaxai districts. This development will have obvious positive health implications for the NT2 Project intervention area.

In the **20-year** perspective some of the health problems that were witnessed during the early years after the completion of the hydropower project, will no longer be significant. The assumed problems related to drinking water quality caused by sediment load and oxygen depletion will have decreased. After some years of operation the situation will return to normal due to natural processes and stabilisation. The assumed general economic development in the region will lead to better sanitation, health services and improved awareness in health issues. Water-borne illnesses and intestinal parasitic infestations are likely to have practically disappeared. Malaria might no longer be a problem in this region and although dengue fever might continue to break out some years, the mortality will go down.

STIs and HIV/AIDS will most likely still remain a problem particularly in the larger towns and district centres but it is assumed that better treatment may have been found and a number of private clinics and pharmacies that specialize in syndromic treatment and counselling services will have been established. However, the incidence of HIV/AIDS and STIs will remain high, due to the large number of transients passing through Gnommalath and Mahaxai. Vehicular accidents and deaths due to increased traffic will increase and will maybe become the leading cause of morbidity and mortality.

In Mahaxai District dust pollution, from transport and cement production might be a major health concern, causing increased number of respiratory illnesses

The middle and lower Xe Bangfai area will remain an agricultural production area for domestic markets in the nearby provincial centres. It is likely that local farmers will substantially increase their use of pesticides and herbicides to stimulate food production. In the end this might jeopardise the marketing of the products. The users will be at the highest risk and “unexplained” mortalities from kidney and liver failures in farming communities might be seen.

Services Capacity

5 years into the NT2 construction phase the capacity of key district service including agriculture education and health will have been strengthened through training and staffing increases in connection with implementation of the Social Development Plan and the Resettlement Action Plan. Nakai and Gnomalath are the districts that will benefit the most from this support due the fact that Nakai is the focus area for resettlement activities and that project installations are located in Gnommalath district. However, staff and capacity increases in Nakai and Gnommalath may come at the cost of less available staff in surrounding districts and beyond, created by transfers and secondments to meet the demands at Nakai.

In the **20 year** perspective the capacity of district services will in general increase in parallel with the growing economic capability of the districts brought about by local economic growth and increased tax incomes. In Gnommalath the population will enjoy better health and education services due to the inter-district hospital establishment and the permanent presence of a considerable number of staff attached to the hydropower plant that will bring extra resources to the district.

Ethnic Minorities

The SDP identifies a number of ethnic minorities in the Xe Bangfai area. These minorities, unlike those on the Nakai Plateau, share a common livelihood system with the Lao, Phou Thay and other *Lao Loum* groups in this area. There are

some differences in terms of cultural practices and degree of urbanisation, but in terms of socio-economic status the Brou or Makong of the Nam Phit and Xe Bangfai, as well as other Kautic (Mon-Khmer) groups in adjacent districts, are similar in terms of socio-economic development. Given the fact that all groups should benefit from potential development of irrigation, improved infrastructure and services, it is likely that economic integration will not be at the price of social and cultural assimilation in the **5-year** perspective. Most Brou and other minorities will remain bilingual and retain local traditions to a large extent in rural areas.

In the **20-year** perspective, the ethnic minorities in the downstream districts are likely to retain their identity to some extent in rural areas although a gradual integration into the mainstream economy and culture will occur. This is due to the fact that there are large clusters of Brou in Gnommalath and Mahaxai Districts unlike the mix of ethnic groups on the Plateau and small isolated groups in the NBCA. Lowland Lao will dominate towns and urban areas and minority households residing at these locations will probably lose their identities and merge with the local Lao groups to some extent. Buddhism may replace or subsume many of the non-Buddhist or animist traditions in the area, a process that has been ongoing for at least a century. Since virtually all education, official interaction and business is in Lao, the Brou language will remain predominant only in the domestic setting and in villages where the Brou are a majority.

Poverty Alleviation

There should be considerable improvement in the Districts of the downstream areas with regard to the levels of poverty. Average household incomes recorded in the EMDP (2003) were 664 USD, varying from 842 to 508 USD. This means that the majority of households are below the Lao poverty level of 700 USD and suffer from rice deficiency and insufficient sources of income (livestock, wages, etc.). Social services are better than on the Plateau but mortality rates and the quality of services are far from adequate. It is predicted that in the **5-year** perspective the rural population of this region will experience a moderate improvement in standards of living, primarily due to project activities. This can be summarised as:

- ⌘ Increased food security (improved irrigation systems and expansion).
- ⌘ Improved health and education services (Regional Health Plan).
- ⌘ Increased demand for agricultural products, livestock and wage labour.
- ⌘ Improved transportation (road upgrading), communications and electricity supplies.
- ⌘ Training programmes and skills development support.
- ⌘ Employment for some during the construction period.

Rapid socio-economic change may accentuate existing social disparity in the region. Households and communities that already have advantages in terms of available resources, productive land and irrigation systems, access to markets and higher levels of education are likely to be able to take advantage of opportunities that arise from project activities and indirect impacts. Many outsiders that move into the area seeking economic benefits are likely to have greater skills, more financial resources and education than the local population. For both the **5-year** and **20-year** perspective it is predicted that there is likely to be a growing gap between households, between rural and urban populations and possibly between men and women as the primarily agriculturally based economy diversifies

and becomes more market-oriented and more services activities increase. However, as with the Nakai Plateau, the incidence of poverty is likely to decrease and the 'poverty gap' is not predicted to be significant due to project mitigation and opportunities for socio-economic development in the area.

7.4.3 Summary of Impacts

Table 26: Summary of the most Important Cumulative Impacts in Xe Bangfai Basin

| Xe Bangfai Basin and Surrounding Districts | |
|--|--|
| 5-year scenario | 20-year scenario |
| <p>The impacts of the NT2 operation will have started to be felt. In addition, the new Road 12 will have significant impacts. The cumulative impacts are likely to be:</p> <ul style="list-style-type: none"> ☞ Increase in untreated wastewater due to population increase around Gnommalath and Mahaxai may add to the oxygen depletion problems caused by the reservoir and make the water less fit for consumption and fish production. ☞ Higher pressure on biodiversity in terms of hunting and logging due to influx of people and improved access to the area. Improved management and enforcement efforts in the Nakai Nam Theun NBCA might increase the pressure on other NBCAs. ☞ There will be commercialisation and intensification of agriculture in Mahaxai and Gnommalath, but the irrigated rice area will yet only be moderately expanded. ☞ Logging in undisturbed forest and other areas will increase. ☞ Gnommalath and Mahaxai urban areas will expand considerably, possibly experiencing a doubling of the population while ad hoc planning will characterises the expansion of settlements. ☞ STI and HIV/AIDS prevalence will have increased and vehicular accidents will have become more common. ☞ The capacity of the various district services will have been strengthened considerably due to NT2 Project support. | <p>No new large-scale hydrological changes are foreseen, but the transport corridors and accompanying urbanisation will be a significant development in relation to cumulative impacts. In summary the impacts are likely to be:</p> <ul style="list-style-type: none"> ☞ The oxygen depletion problem will be reduced due to less organic matter in the reservoir and better wastewater treatment. ☞ Agriculture developmet will cause local eutrophication problems. Hightened levels of pesticides in drainage water and consequently in fish, might be experienced. ☞ Change in flow regime may have lowered biodiversity and fish production due to disturbed spawning cycles. On the other hand increased flooding may have increased flood plain and "back swamps" production of fish. ☞ There will be better sanitation, health services and improved awareness on health issues. Water-borne illnesses and intestinal parasitic infestations will have been substantially reduced as will mortality caused by malaria and dengue fever. ☞ The District centres of Mahaxai and Gnommalath will have grown substantially, possibly with more than 200% while the population of Thakhek may have increased with more than 140%. The service sector including tourism will grow and the cement industry in Mahaxai will have expanded and created more employment. ☞ Some assimilation of ethnic minority groups in urban areas will have occurred, but cultural identity will to a larger extent be retained in rural areas. |

7.5 Nam Theun, Nam Kading and Nam Hinboun Basins and Surrounding Districts

7.5.1 Introduction

In this zone the impacts from the NT2 project will primarily be impacts related to the hydrological changes caused by the transfer of water away from the Nam Theun, which today is providing water to the Theun-Hinboun hydropower project. In the cumulative impact perspective the changes caused by the NT2 will be combined with the assumed impacts caused by the planed Theun-Hinboun Extension project, which is assumed to be implemented in the same period.

7.5.2 Impact Predictions

Hydrology and Vulnerability to Flooding

In the Nam Theun/Nam Kading/Nam Hinboun river system, the relevant planned hydropower projects include the NT2 and Theun-Hinboun Extension (including the Nam Theun 3 reservoir). Both projects are envisaged to be in operation by **2010**.

In the following section, the predictions for the **5-year** perspective are carried out for two alternatives; the impacts of NT2; and for NT2 together with Theun-Hinboun Extension. The impacts are compared to the baseline, which includes the hydrological regime imposed by the existing Theun-Hinboun operation.

Apart from occasional spilling during floods, only 2 m³/s will be released into Nam Theun downstream the NT2 dam. As tributaries join Nam Theun downstream, the discharge increases. Figure 2 below shows the pre- and post-NT2 discharge into the Theun-Hinboun head pond. Of the local runoff between NT2 dam and TH head pond, more than 50% is inflow from Nam Gnouang, a large tributary joining Nam Theun immediately upstream of the Theun-Hinboun head pond.

The reduction of the inflow to the Theun-Hinboun head pond due to NT2 will on average be approximately 55%. The energy generation at Theun-Hinboun will be affected to a lesser degree because a larger proportion of the flow diverted at NT2 is floodwater, which is spilled over the Theun-Hinboun dam also in the pre-NT2 situation. As a total, the turbined water volume at Theun-Hinboun will be reduced by 20%, but up to 60 % in dry season months.

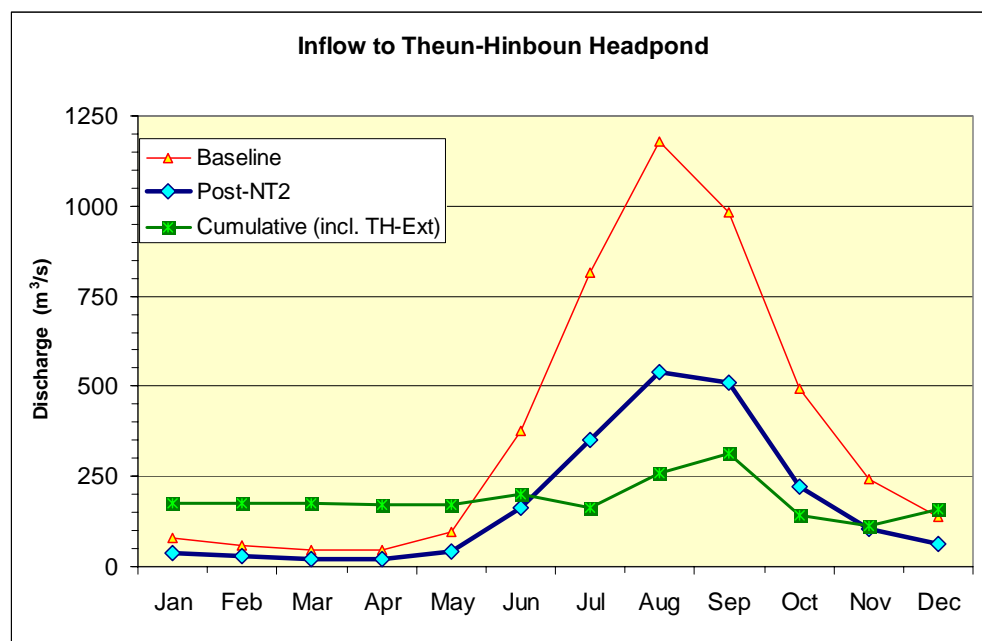


Figure 2: Cumulative Impact of Discharge into Theun-Hinboun Headpond.

The reduction of energy generation at Theun-Hinboun due to NT2 is one of the incentives to plan for Theun-Hinboun Extension, which includes an increase in installed capacity and the erection of a dam on Nam Gnouang. The dam will regulate the runoff from this tributary to counter-balance the loss of water from the Nam Theun, so that the total inflow to Theun-Hinboun head pond becomes

as constant as possible (Figure 2). This will enable Theun-Hinboun to increase power generation significantly.

In Nam Kading downstream Theun-Hinboun dam, the impact from **NT2 alone** is a reduction of the discharge in the flood season June-October. The average reduction in August will be from 1880 to 1240 m³/s or 35% at Pakkading (Figure 3). The period with spills over THB dam will be reduced from an average 245 days per year to 190 days per year. As a result of NT2, THB will be able to divert all the inflow in the dry season, so only the minimum release of 5 m³/s will be discharged into Nam Kading.

Including also the Theun-Hinboun Extension, the *cumulative impact* will be that a larger part of the water that enters the Theun-Hinboun headpond will be diverted into Nam Hinboun, thereby further reducing the spills into the Nam Kading. As shown on Figure 3, the cumulative reduction of discharges in Nam Kading in August is from 1880 m³/s (baseline) to 960 m³/s or 50%.

In Nam Hinboun the impacts from the NT2 alone will be a reduced flow, due to a reduced inflow to Theun-Hinboun headpond. As shown on Figure 4, the flow reduction is most significant in the dry season. It should be remembered that the baseline situation is not the natural flow, but includes the existing operation of Theun-Hinboun.

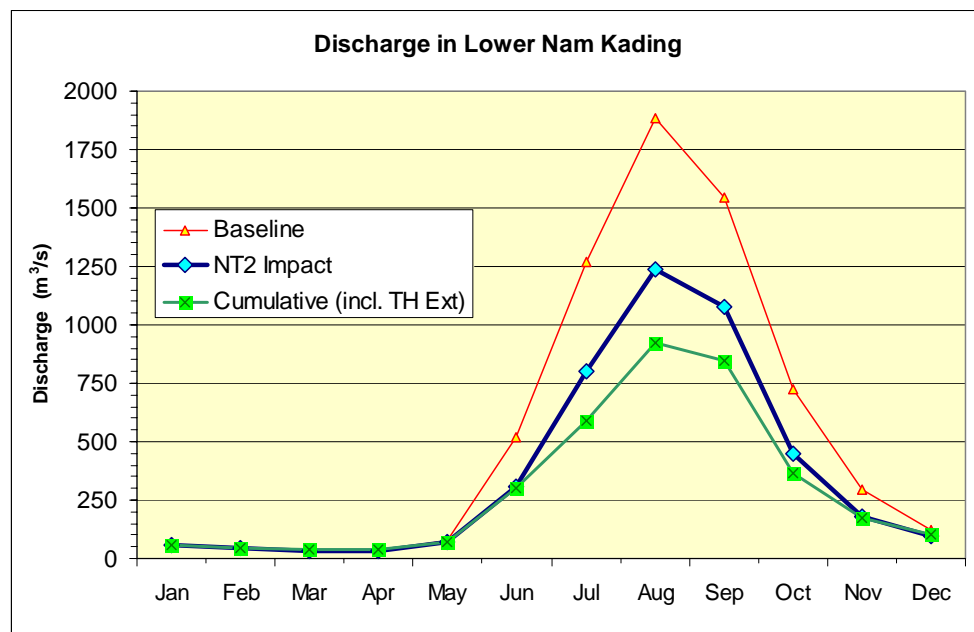


Figure 3: Reduction of Flow at Pakkading (downstream Theun-Hinboun dam).

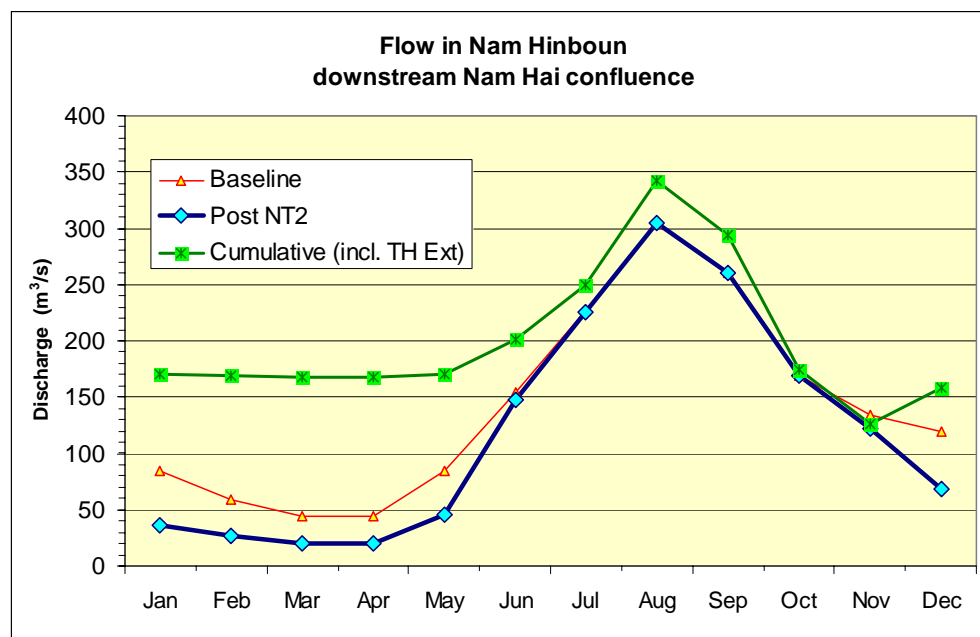


Figure 4: Changes in Flow in Nam Hinboun.

With the Theun-Hinboun Extension implemented, the cumulative impact will be a moderate flow increase in the wet season and a large increase in the dry season. This is due to Theun-Hinboun Extension's operation rule, which is to counterbalance the flow variations in Nam Theun as much as possible. As a result, the cumulative impacts will increase the wet season flow by around 12%, while the dry season flow is increased by 300% to 170 m³/s.

Impacts of **NT2 alone** on the water quality of downstream of the Nakai dam are studied in the ongoing Riparian Release Project.

In the **5-year** perspective it is assumed that both the NT2 and the Theun-Hinboun Extension are in operation and thus the water flow regime will be significantly changed in Nam Kading and in Nam Hai/Nam Hinboun compared to the isolated impacts of NT2 (see above).

The release of only minimum flow downstream of the Nakai dam will reduce the recipient capacity of the river. In addition the first year after commissioning the water released from the Nakai reservoir will have low oxygen content, due to organic materials in the reservoir. The water will be oxygenated as it flows in the rapids downstream and the water quality will be partly restored by the release of water from Nam Phao.

The district centre of Lax Xao will have been provided with a water supply system. Piped water supply will result in increased discharges of wastewater, which in this case will be into the Nam Phao. The population of Lax Xao is predicted to reach 17,500 in this period. Assuming a production of 3g tot P and 12 tot N per person per day, and that 50% of this reaches the river (a high estimate), the impact in river water concentration in the low flow season (5 m³/s) will be 61.2 µg/l tot P and 245 µg/l tot N. This is a distinct elevation from the level of round 10-15 µg/l tot P and 100-200 µg/l tot N found in the upper tributaries of Nam Thun. However, based on the average flow situation (40 m³/s) the contribution is rela-

tively smaller. The nutrient load and the microbiological contamination will first of all create a local problems in the near downstream areas. Its influence on lower Nam Theun water quality will most likely be marginal.

The influence for Nam Kata mining activities on downstream water quality is a potential serious problem.

In the Nam Hinboun the recipient capacity to dilute the heavy metals and iron contained in the discharges from Nam Pathen, will increase significantly in the dry season when the Nam Hinboun flow volumes will be 2-3 times what it is today (see *Figure 4*). However, lacking monitoring of metal concentrations and loads from Nam Pathen makes it impossible to assess the impact in more precisely.

In the **20-year** perspective the basic water quality conditions will not be changed. The only relevant development foreseen is increased wastewater generation from the expanding Lax Xao town. It is assumed, however, that a sewerage and wastewater treatment system will have been installed by that time, efficiently reducing nutrients, organic mater and pathogens in the wastewater. Local water pollution problems will still be experienced in the recipients downstream the town, but the situation in the Nam Phao is likely to have stabilised before its confluence with Nam Theun.

Fisheries and Aquatic Biodiversity

When in operation the NT2 dam will release 2 m³/s (+) below the dam into the Nam Theun. About 10 km downstream the reduced flow will be partly alleviated by the inflow of Nam Phao (average flow about 60 m³/s). The Theun-Hinboun head pond is located approximately 60 km further downstream. The other significant tributary Nam Gnouang discharges just upstream of the head pond. The specific impacts of the proposed water release from the Nakai dam are presently being studied in the "Riparian Release Study".

The present operation of the Theun-Hinboun power plant has resulted in a significant reduction in water flow in the Nam Kading. The riparian flow is set at 5 m³/s. In the wet season, however, is additional water overtopping the dam and released downstream into the Nam Kading. Interviews with fishermen and villagers in the areas of the lower Nam Kading near to the Mekong confluence in 1998 and 1999, most of the people considered that low fish catches during that period were attributable to a reduction in dry-season / early wet-season flows caused by the Theun-Hinboun dam (Warren 1999). In the head pond reach the establishment of a "reservoir" fishery seems to have compensated for the original river fisheries. A change in species composition has been observed.

In the Nam Hai and Nam Hinboun the operation of the Theun-Hinboun is reported to have had negative impact on fisheries, primarily because of erosion problems and high turbidity. Other impacts are more difficult to assess. Increased flow seems to have changed migration pattern, reducing some fisheries and increased others. However, the long-term impact of these changes is still unclear.

With the **NT2** project in operation the period of flood overspill will be significantly reduced, and the existing problems for fisheries and fish migration further downstream Nam Kading increased. NT2 operation will also lead to a decrease in inflow to the TH head pond. The reduced flow will further reduce the riverine fea-

tures of the pond and strengthen its “lake” characteristics. This might also cause changes in species composition.

In Nam Hai and Nam Kading the operation of NT2 will reduce the dry season flow (partly back to the pre Theun Hinboun situation).

In the **5-year** perspective both the NT2 and Theun-Hinboun Extension project, will likely be in operation. This TH Extension project will further reduce wet season flow in the Nam Kading. The detailed hydrological impacts of NT2 and Theun-Hinboun Extension on the flow in Nam Kading and in Nam Hinboun were presented in the hydrology section above.

Reductions in wet season flow volume will have a negative effect on fisheries in Nam Kading. During the dry-season period, more water will be available from the NT3 than at present, but this will be diverted into the Nam Hinboun Basin. It is not assumed that the storage water will be used to increase the present environmental flow releases of 5 m³/s into Nam Kading. The reduction in flood periods and consequently the water overtopping the weir will affect fish migratory behaviour to some extent below the dam and will probably make any ascent by migratory fish (not very significant at present) past the Theun-Hinboun dam impossible.

The impacts to fisheries in the Nam Hai/Nam Hinboun might be increased after NT3 is built as the flows will increase during the dry-season period, which will further increase the bank erosion and sediment load. The storage of water in NT3 will result in lower oxygen content in the water and lower temperature in the water transferred to this basin, and thus have an impact on fisheries and aquatic life.

No additional hydropower development or other larger project that might change the hydrology of the rivers and thus the fisheries is expected in the **20-year** perspective. An additional aspect that might cause negative impacts to the fisheries and aquatic biodiversity is, however, the mining activities on the lower tributaries to Nam Hinboun. If the activity is expanded and or the mines are closed down without proper clean-up or pollution control, the discharges of heavy metals will be of serious concern.

Terrestrial Biodiversity

The most important areas in this impact zone are Phou Hin Poun NBCA, Nam Kading NBCA and the Nam Chat/Nam Pan Provincial Conservation Forest. In addition, the Nam Theun-Phou Hin Poun Corridor straddles the border between this impact zone and NNT NBCA in the south. Parts of the Nam Gnouang catchment, including the dam site of the proposed NT3 reservoir is proposed as the “Pha Kadoung Saola Management Area” IUCN, 2000.

The area along the Mekong river (west of Nam Kading and Phou Hin Poun NBCAs) and the central eastern part the catchment, from Lak Xao through the central parts of Viangthong District, have been subject to years of intensive logging and conversion of forest into agricultural land. In these areas, only fragments of primary forest remain.

In the **5-year** perspective, it is expected additional pressure on the natural resources and biodiversity caused by the combination of population growth and unsustainable forest and land management. In particular, improved road conditions locally and to Vietnam (Route 8A) might facilitate increased trans-border

trade in wildlife and timber, and thereby also increase the pressure on the NBCAs further away from the border. The establishment of the NT3 reservoir (part of Theun-Hinboun Extension project) will inundate large tracts of forests hosting a population of the endangered Saola.

In the **20-year** perspective, the pressure on terrestrial biodiversity will continue to increase due to a general population growth and an increased movement of people and goods through the transport corridors. As previously mentioned, Nam Kading NBCA, Phou Hin Poun NBCA and Nam Chat/Nam Pan Provincial Conservation Forest are unlikely to receive the same protection and control of illegal activities as Nakai-Nam Theun NBCA. Hence, there is a certain risk that the pattern of illegal logging and hunting, will shift from Nakai Nam Theun NBCA to the other, less protected NBCAs in this region.

Agriculture and Forestry

On the upper Nam Theun there are some limited irrigated areas upstream the point where Route 8 crosses the Nam Theun. Presently irrigated areas on this reach cover only around 445 ha while the potential for expansion has been estimated to 196 ha. Along the tributaries to Nam Theun comprising Nam Nyuang, Nam Phao and Nam Kata there are some larger irrigated areas with an identified potential for expansion amounting to around 1,300 ha. Apart from the limited irrigated areas that presently exist upland shifting cultivation and semi-permanent cultivation dominate agricultural practices.

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

In the **5-year** perspective 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. This will reduce soil fertility and yields seriously as the intensification of land-use will probably not have been accompanied by proper and adapted production technologies and increased inputs in terms of manure and fertilizer. Possibly up to 50% of the potential area for irrigation expansion will have been utilised along the Lower Nam Theun and its tributaries, and along Nam Hinboun. For Nam Theun itself it will only mean an additional 100 ha while for the tributaries of Nam Phao and Nam Kata it will increase wet season irrigated area with 600-700 ha. Similarly, along the Nam Hinboun a 50% expansion of wet season irrigated areas of the potential for expanded irrigation will add 2,000 to 3,000 ha. The foreseen developments in the agricultural sector are not expected to have any impact the on hydrological regime and flow patterns in the zone that will significantly to effects caused by other sectors such as hydropower.

In the **20-year** perspective a considerable part of what today is shifting cultivation areas will have come under permanent cultivation, while yields will still be quite low because of the lack of sufficient inputs and application of appropriate technology. Most likely all of the irrigation potential along the Nam Theun and its tributaries and along Nam Hinboun will have been developed. 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. The intensification of land-use and development of the irrigation potential in the zone are not expected to contribute significantly to cumulative effects on the hydrological regime caused by other development sectors.

Urban Development and Population Growth

The only proper urban centre in this zone is Lak Xao. According to the Lao Urban Databook (ADB 2003) it has a population of 12,744. The growth rate in the past years has been estimated to be around 2.7% (Norconsult, 2003) Being the only urban area in the south-eastern part of Boulykhamxay and a focal point for trade and transport services with established warehouses, Lak Xao is also expected to grow at a relatively high rate also in the future. The main driving force behind the urban expansion will be the improvement of Route 8 and the transport and trade associated with regional economic integration, in particular the Lao and Vietnamese economies. It is not foreseen that the NT2 development will be a major factor behind the growth of Lak Xao in the future. The reason for this is the distances between the major centres of NT2 project activity, the nearest being the damsite situated some 20 km from Lak Xao while the distance to the intake structure and the power station is 50-60 km. In addition to this comes the fact that the main supply routes for the NT2 Project will be Route 12 and Route 8B. These are being upgraded by the Project but it is uncertain whether the section of Route 8B between the dam site and Lak Xao will be substantially improved.

Assuming an annual growth rate of 3% in both the **5-year** and **20-year** perspective the population of Lak Xao will increase from around 12,800 in 2003 to 17,000 - 18,000 in 2010. This represents an increase of more than 33%. With the same continued growth rate of 3% the population of Lak Xao will reach 27,000-28,000 in 2025, an increase of more than 110%.

The growth of Lak Xao will most likely be a mix of planned and unplanned developments with settlements springing up on the periphery of town which will not be included in the expansion of water supply and sewer systems.

Health

In the **5-year** perspective the direct, as well as cumulative, health impacts in this zone are expected to be minimal. A work camp will be established for construction of the dam site and Road 8B north to its junction with 8A near Lak Xao. This work camp, and possible ad hoc camp follower settlements that may spring up here, are dealt with in the project specific impact assessments. As there are no established villages or settlements close to this site, significant health impacts are not expected except for those faced by the labour force and the camp followers. Further downstream in the Nam Theun, Nam Kading and Nam Hinboun Basins and surrounding districts no cumulative health impacts are foreseen. It is expected that the specific health interventions in connection with the NT2 project will limit and keep the spread of HIV/AIDS in check in the workers camp area.

In the **20-year** perspective other developments than NT2 will dominate. Route 8B from the damsite to Lak Xao may have been improved to support a higher traffic volume. Traffic will increase substantially which may lead to an increase in vehicular accidents and in roadside establishments. Increased traffic will also entail an increased risk for the spread of HIV/AIDS.

Ethnic Minorities

The ethnic population of Khamkeut District of Bolikhamxai, including the town of Lak Xao, is very mixed. The majority residing in this district belong to the broad category of *lao loum* or lowland groups, including various Tai sub-groups. There are also populations of Hmong, Mon-Khmer (Brou) and smaller groups, including Vietic (Maleng) along the areas bordering the NBCA. Like other districts in and adjacent to the NT2 project, there is likely to be increased integration in terms of social, economic and cultural development. A particular concern for this region are the small vulnerable Vietic groups who are more susceptible to assimilation due to their small population numbers, relative isolation, reliance on natural resources and lack of understanding of market forces. Their future is uncertain at a time of rapid socio-economic change.

Another issue is the swidden practices of the Hmong adjacent to the NBCA and the potential threat to biodiversity. In the **5-year** perspective, the most likely situation will consist of the gradual integration of groups into the mainstream economy being sped up slightly by NT2 project-related activities, population influx, increased urbanisation, consolidation of smaller groups into larger village administrative units, improved infrastructure and growth in the service sector. A study of migration and population change along Route 8 conducted as part of this study reveals the following trends (Table 27):

Table 27: Population and Migration along Route 8 (1995-2003)

| Unit | 1995 | 2003 |
|---------------------------|------|------|
| Abandoned village | - | 28 |
| New Administrative Units | - | 27 |
| Size: 0 - 50 households | 45 | 2 |
| Size: 50 - 100 households | 10 | 14 |
| Size: < 100 households | 8 | 29 |

Almost all small Vietic groups are now resettled in larger villages or part of new administrative units

In the **20-year** perspective, it is likely that smaller ethnic groups in or near Lak Xao, including some Vietic populations, will become more assimilated and may lose their ethnic identity to a large extent. Groups related to Lao, such as Phou Thay and Tai sub-groups, are likely to become fully assimilated in urban areas, but in rural areas cultural differences will continue to some extent. Buddhism will replace some local beliefs and the Lao language will gain ground, leaving local languages and dialects only the domestic sphere for expression. Among cultural traditions and language are likely to continue despite changes in the socio-economic condition due to the fact that Hmong clan structure is strong and there is a large network of Hmong groups within Lao PDR and abroad.

Poverty Alleviation

NT2 mitigation will not directly effect this area except for the relocation of Tai villagers from Sop Hia village on the Nakai Plateau to a new location to the south-east of Lak Xao. In terms of poverty, some of the highest incidents in the country

were recorded in Bolikhamxai. The town of Lak Xao is probably an exception and likely to experience growth and development due to the planned upgrading of Route 8.

It is likely that social disparity may increase due to a lack of available land for agriculture and continued population influx. This area will not benefit directly from extensive mitigation or infrastructure improvement initiated by the NT2 project. Households having primarily subsistence-oriented economies will continue to struggle to make ends meet. Differences between income levels and standards of living between rural and urban areas may continue to increase, although rural areas may also benefit from some of the improvements in infrastructure and greater availability of services and employment opportunities. Gender relations in urban areas may change in that men will become the main or primary earner unlike the complementary socio-economic situations for men and women in rural areas.

7.5.3 Summary of Impacts

Table 28: Summary of the most Important Cumulative Impacts in Nam Theun, Nam Kading and Nam Hinboun Basins and Surrounding District

| Nam Theun, Nam Kading and Nam Hinboun Basins and Surrounding Districts | |
|---|--|
| 5-year scenario | 20-year scenario |
| <p>Nam Kading and Nam Hinboun will experience the combined impacts of the NT2 and the Theun-Hinboun Extension projects, in addition to the developments caused by the improvement of the Route 8 corridor, and increase in cross-border trade and population movement. The predicted impacts are:</p> <ul style="list-style-type: none"> ∄# In Nam Kading downstream Theun-Hinboun dam, the impact from NT2 will reduce the discharge in the flood season. Adding Theun-Hinboun Extension, the cumulative impact will be that a larger part of the flood spills over Theun-Hinboun dams will be diverted into the Nam Hinboun, thereby further reducing the spills into the Nam Kading. ∄# The reduction in flood periods will affect fish migratory behaviour and will probably make any ascent by migratory fish (not very significant at present) past the Theun-Hinboun dam impossible. ∄# There will be increased threats to biodiversity due to population increase and increased trans-border traffic. However, the WCS wildlife conservation project will tend to counteract the negative development trend. ∄# The remaining and limited forested areas will be increasingly encroached upon but participatory village forestry will have been introduced. ∄# Irrigated areas and irrigation schemes will increase along Nam Hinboun. ∄# Lak Xao will increase to a population of 17,000 – 18,000, representing a growth of more than 33% in relation to present number of inhabitants.. Part of the growth will be due to in-migration. | <p>No additional hydropower expansion is planned in the basin. The development will be dominated by the increase in transport related activities and impacts and developments on the Plateau. The main impacts will be:</p> <ul style="list-style-type: none"> ∄# Nam Kading NBCA, Phou Hin Poun NBCA and Nam Chat/Nam Pan Provincial Conservation Forest are likely to experience an increased pressure of cultivation, logging and hunting as a result of improved protection of Nakai-Nam Theun NBCA. ∄# The rural urban migration trend will be reinforced and the size of Lak Xao will have grown to 27,000 –28,000, an increase of more than 110% over todays population ∄# It is likely that smaller ethnic groups in or near Lak Xao, including some Vietic populations, will be fully assimilated and will lose their ethnic identity. ∄# Hmong cultural traditions and language are likely to continue despite changes in the socio-economic conditions in the area. |

| | |
|---|--|
| <p># Gradual integration of ethnic groups into the main-stream economy will speed up slightly due to NT2 project-related activities, population influx, increased urbanisation, improved infrastructure and growth in the service sector.</p> <p># The vulnerable Vietic groups will be under particular pressure of integration.</p> | |
|---|--|

7.6 Mekong River Basin

7.6.1 Introduction

The downstream impacts in the Mekong River Basin are all a consequence of changes in hydrology. The changes caused by the Nam Theun 2 Project are here added to other activities in the basin that have an influence on water flow and water quality, in particular other hydropower projects and development of irrigation. In the sections below the impact analyses contain discussions of the downstream impacts of **NT2 alone** in addition to the **5-year** and the **20-year** combined development perspectives.

7.6.2 Impact Predictions

Hydrology and Vulnerability to Flooding

The hydrological regime of the Mekong in the period 1925-2000 is characterised by a gradual decrease of annual flows. The reason for this trend is not clear, but it has been argued that the main reason would be the expansion of the area under swidden cultivation in this period. Assuming that this trend will continue, the discharges in the Middle and Lower Mekong are projected to be 8% lower in the period 2005-2025 compared to the reference period. Therefore the hydrological simulations in this study have used a (1950-2000) baseline reduced by 8% as input to the models. For details see Annex 2.

Floods are a chronic event in the Lower Mekong Basin. Floods result in loss of life and property, damage to agriculture and rural infrastructure. At the same time flooding of the Mekong floodplains and Cambodia' Great Lake positively impact biodiversity and fish production, and in addition the floods provide sediments that are important for soil fertility. Severe floods were experienced in Cambodia and Vietnam in 2000 and 2001. In Cambodia 347 people lost their life in 2000 and 62 in 2001. In Vietnam the death toll was more than 500 in 2000 and 230 in 2001. The total physical damage was in 2000 calculated to be USD 161 million in Cambodia and USD 285 millions in the Vietnamese delta.

The flow situation in the Mekong Delta is strongly influenced by tidal movements. Due to quite large tidal amplitude (up to 3 m), sea water is "pumped" quite far upstream through the Mekong branches. The tidal movements are visible on water level records as far upstream as Phnom Penh during the dry season, although seawater itself does not intrude so far. Seawater intrusion is a significant environmental problem in the Delta and has increased due to the general decrease in the Mekong runoff. Saltwater intrusion is particularly a problem for the use of river water for irrigation in the Delta.

Regulation by hydropower is beneficial in this context because it increases the dry season flow and therefore reduces saltwater intrusion. The hydraulic model includes results concerning seawater intrusion. It should, however, be noted that

the Delta is described in a rather simplified way in the model, and the results should be considered as indicative only.

Impacts due to **NT2 project** alone will cause no flow change in the Mekong at Pakkading (confluence with Nam Kading) in the dry season. Theun-Hinboun will be releasing only the minimum 5 m³/s into Nam Kading both with and without the NT2. In the heaviest flood season, NT2 will reduce the spills over the Theun-Hinboun dam by approximately 650 m³/s as an average for the month of August. In the Mekong it is in July that the proportion of the change is largest because of different flood timings in the two rivers. The *average* wet season flow reduction in the Mekong downstream Pakkading is 4% in July. In 10% of all years, the July flow reduction will be *less than 2%* and in other 10 % of all years the reduction will be *larger than 7%*.

Downstream Pakhinboun, where the Theun-Hinboun diversion returns to the Mekong, the impact in the flood season is about the same proportion as upstream Pakhinboun, a 4% reduction on the average. In the dry season however, there is a flow reduction which was not seen upstream Pakhinboun (Figure 6). The reason for this dry season flow reduction is that pre-NT2, the Theun-Hinboun diversion returns to the Mekong at Pakhinboun. Due to the NT2, the flow diverted into Nam Hinboun by Theun-Hinboun is reduced by approximately 25 m³/s in April, or 1.7% of the Mekong April discharge. This amount of water is thus “moved” from Nam Hinboun to Xe Bangfai by NT2.

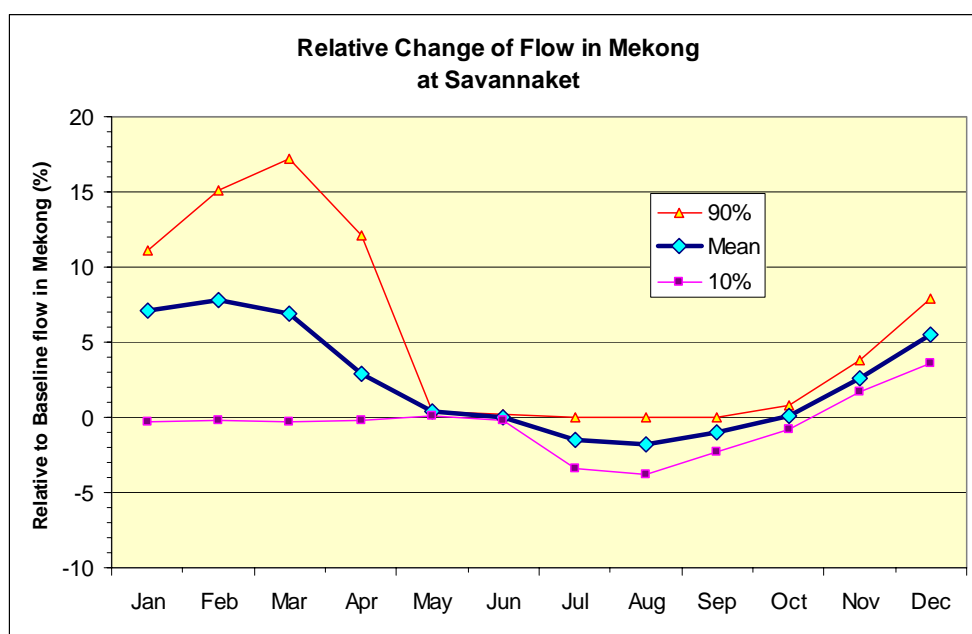


Figure 5: NT2 Impact on Mekong Discharges at Savannakhet

In terms of water levels in Mekong this translates to a reduction in the dry season of about 2 cm between Pakhinboun and the confluence with Xe Bangfai. In the wet season the reduction will be in the range 23-29 cm, with the larger value at Pakkading and the smaller at the Xe Bangfai confluence. For comparison water levels naturally vary in the range 7.5-11 m for the flood season when the 80% most frequent years are considered. For the dry season (April), the natural range of variation is 0.6 m.

Between Pakhinboun and Xe Bangfai outlet both the dry season reduction and wet season reduction of water levels are marginal compared to the normal Mekong flow. The need for additional pumping cost for dry season irrigation and water supply will not be measurable. A slight reduction in wet season flooding and reduced backwater effect in tributaries might be seen on the Thai and Lao PDR side of this Mekong reach. The combined impact on the water flow changes on the Xe Bangfai floodplain will be addressed in the ongoing Xe Bangfai Downstream Study.

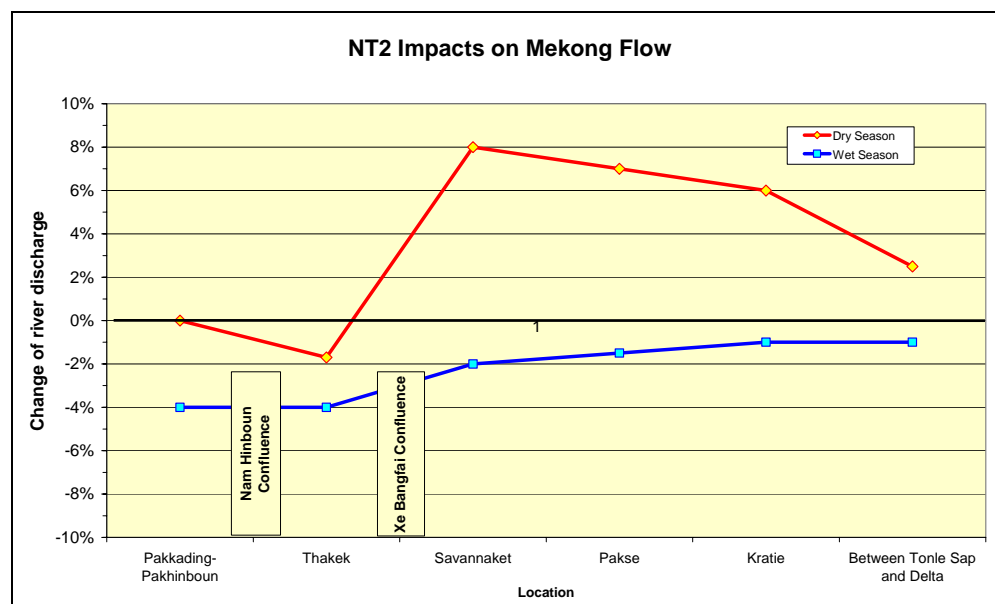


Figure 6: Summary of NT2 Impacts on the Mekong, as relative flow changes.

Figure 6 summarises the impacts of NT2 along Mekong. At Pakse and Kratie, the flow modifications are identical to those reported for Savannakhet, but as a *proportion* of the flow they are slightly smaller, due to the increased Mekong flow as one moves downstream.

The Mekong river section with the largest relative impact from NT2 in the dry season is the section around Savannakhet with 8% increase of the dry season flow: from 1790 to 1930 m³/s. According to the rating curve for Mukhdahan gauging station this corresponds to an increased dry season water level (gauge) of 8 cm.

The impacts on the Great Lake system were simulated with a hydrodynamic river model, described in Annex 2. In the wet season, the Mekong water level at Phnom Penh is reduced by 3 cm. The reduction causes a reduced inflow to the Great Lake of 100 m³/s, or 2% of the baseline average inflow. As a result, the simulations show that the Lake level will be reduced by 3 cm, out of a total rise of 7-8 m. This reduction should be seen in relation to the natural variation from year to year. In 80% of all years the natural year-to-year variation of the annual maximum level will vary within a range of 2.6 m.

In the dry season, the lake level will be increased due to the regulation by NT2. The lowest Lake level, which occurs in April, is at elevation 0.9 m masl on the average. This water level will be increased by 2 cm on the average.

The 3 cm reduced flood water level of the Great Lake corresponds to a reduction of the inundated area of approximately 40 km^2 . At elevation 7-8 m, the Lake circumference is approximately 530 km. Thus, an average reduction of the Lake area of 40 km^2 can be visualized as a “band” roughly 75 m wide along the entire lakeshore. This “band” will of course not be located the same place every year, as the maximum water level varies greatly from one year to another. It should be noted that this band width is meant for illustration only; in reality the Lake shore is extremely irregular and characterized by insections and many small islands. The real Lake circumference is therefore significantly longer and the “band width” smaller.

The reduced wet season flow, which is calculated to about 8 cm at Phnom Penh will have a positive but insignificant impact on reducing the risk of flood damages.

The impact on saltwater intrusion is assessed by inspecting the gauging station Tan Chau close to the Cambodia/Vietnam border. At this location, negative discharges are experienced 9.5% of the time (of the entire year) as *baseline*. Discharges are negative when the water current is going upstream due to high tide. In a **post-NT2** situation, the dry season discharge will increase so that negative discharges occur 9.4% of the time. Thus it appears that the effect is beneficial but insignificant in terms of salt intrusion.

The **5-year** perspective of upstream hydropower development will result in the dry season Mekong discharge downstream Pakkading will increase by approximately $800 \text{ m}^3/\text{s}$, or 58%. Floods will be reduced by approximately 17%, as monthly averages. For flood peaks, the reduction will be larger.

The increase of the Mekong dry season flow varies slightly (between 70% and 55% increase) as one moves downstream, depending on local inflow and whether they are regulated or not. Down to Kratie, the picture remains largely the same.

In Tonle Sap River the dry season discharge will be reduced by 7%, as the only place in the Mekong system where the discharge is reduced in the dry season due to regulation. The reason for the reduction is 1) less water is filled into Great Lake during the preceding flood season and 2) the increased water level in the Mekong reduces the pressure gradient out of Great Lake. In the Mekong downstream of Phnom Penh, the increase of the Mekong dry season flow will be 35%, i.e. considerably less than upstream of Phnom Penh. The reason for the big difference compared to Kratie and further upstream is that downstream Phnom Penh a part of the increased dry season flow is compensated by the reduced outflow from Great Lake as mentioned above.

In the flood season, floods are reduced by between 15% and 10% between Pakkading and Kratie. Generally the flood reduction diminishes when one moves downstream, due to local inflows without large seasonal regulation.

The Great Lake responds to the reduced floods in the Mekong by lowering the highest water level from 7.64 masl as a baseline to 7.42 masl in September/October, i.e. a reduction of about 22 cm on the average. Correspondingly, the lowest water level of the Lake will be increased by 25 cm to 1.14 masl. The

reduction of the Lake flood levels corresponds to a reduction of the *maximum Lake area* of approximately 355 km².

At Phnom Penh, the flood levels will be reduced by about 25 cm, which will have a positive impact on reducing the risk of flood damage.

In the Delta, the impact of increased dry season flow is a reduction of seawater intrusion. The period with negative discharges (water flowing upstream due to high tide and low flow) at Tan Chau is reduced to 8.4% of the year from 9.5% in the baseline. This corresponds to a reduction of approximately 12%.

The **20-year** perspective includes substantial planned development of hydropower, of which the largest concentration is in Yunnan, but it is substantial also in Nam Ngum and Se Kong/Xe San basins. The hydropower development plans, which are the basis for the calculations below, are described in Chapter 5.2. Development of irrigation is also taken into consideration.

The *potentially* most significant impact from irrigation is expansion of areas for dry season irrigation, which will reduce the dry season runoff. Wet season irrigation will not affect the water balance, because the areas converted to irrigation would have had a similar water consumption in the wet season also before paddies were established.

It was found that even in the most ambitious development case, the increased water consumption due to dry season irrigation was marginal; in the order 30-40 m³/s for the entire Lower Mekong upstream of Kratie. Consequently, the cumulative impacts described below can in practice be entirely ascribed to hydropower.

Due to hydropower development up to 2025 the dry season Mekong discharge downstream Pakkading will be increased by approximately 1750 m³/s, or 125%. Floods are reduced by approximately 20%, as monthly averages. For flood peaks, the reduction will be larger.

As illustrated in Figure 7 below, the relative increase of the Mekong dry season flow varies slightly (between 135% and 120%) as one move downstream, according to local inflow and whether they are regulated or not. Down to Kratie, the picture remains largely the same.

In Tonle Sap River the dry season discharge is reduced by 15%, as the only place in the Mekong system where the discharge is reduced in the dry season. The reason for the reduction is 1) less water is filled into the Great Lake during the preceding flood season and 2) the increased water level in the Mekong reduces the pressure gradient out of Great Lake. In the Mekong downstream Phnom Penh, the increase of the Mekong dry season flow is 85%, i.e. considerably less than upstream Phnom Penh. The flow increase here is smaller because a part of the increased dry season flow is compensated by the reduced outflow from the Great Lake as mentioned above.

In the flood season, floods in the Mekong are reduced from between 25 and 15% (considering average monthly flows). Generally the flood reduction diminishes when one moves downstream, due to local inflows without large seasonal regulation.

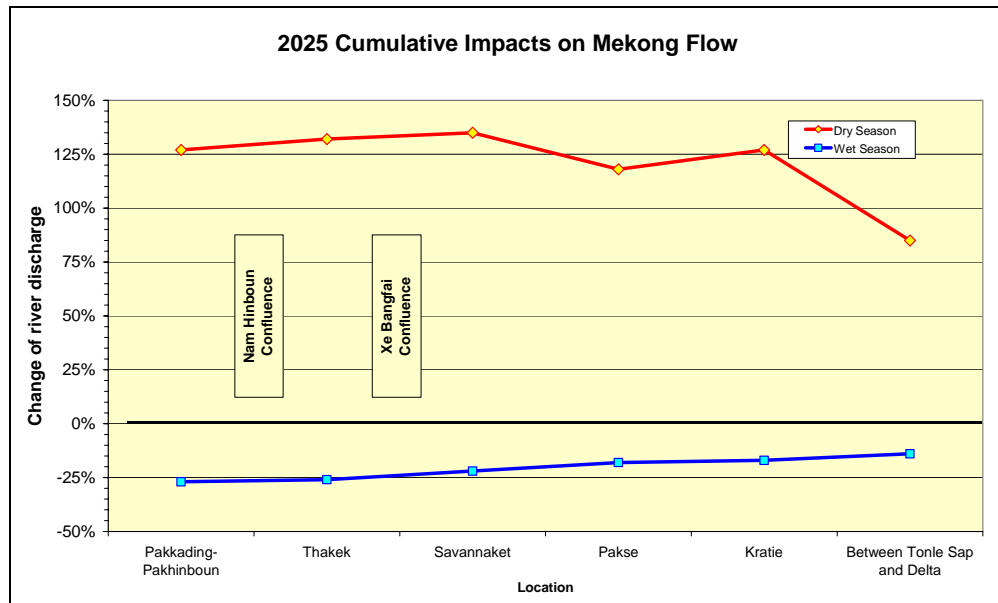


Figure 7: Summary of Cumulative Impacts on the Mekong, as relative flow changes.

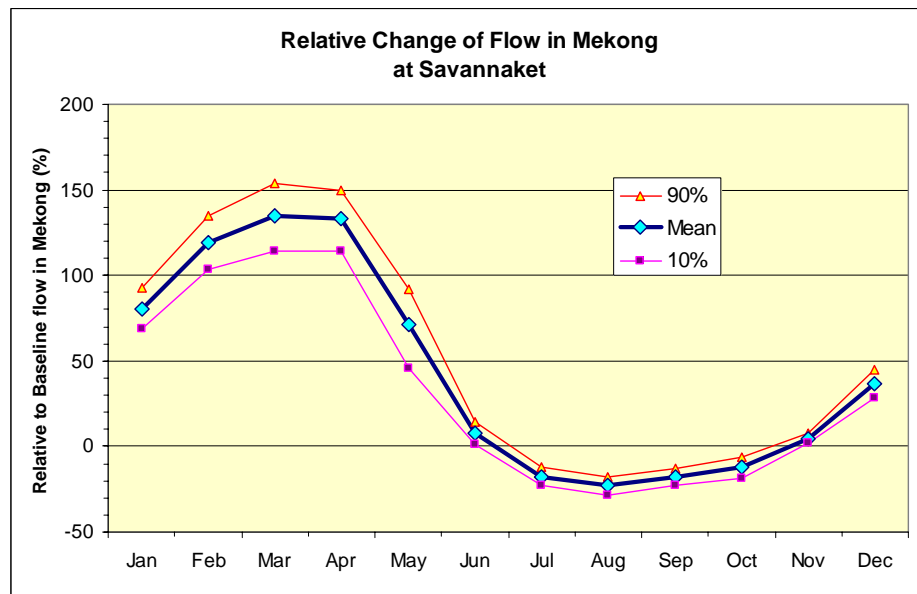


Figure 8: Cumulative Impacts 2025 on Mekong Monthly Flow at Savannaket.

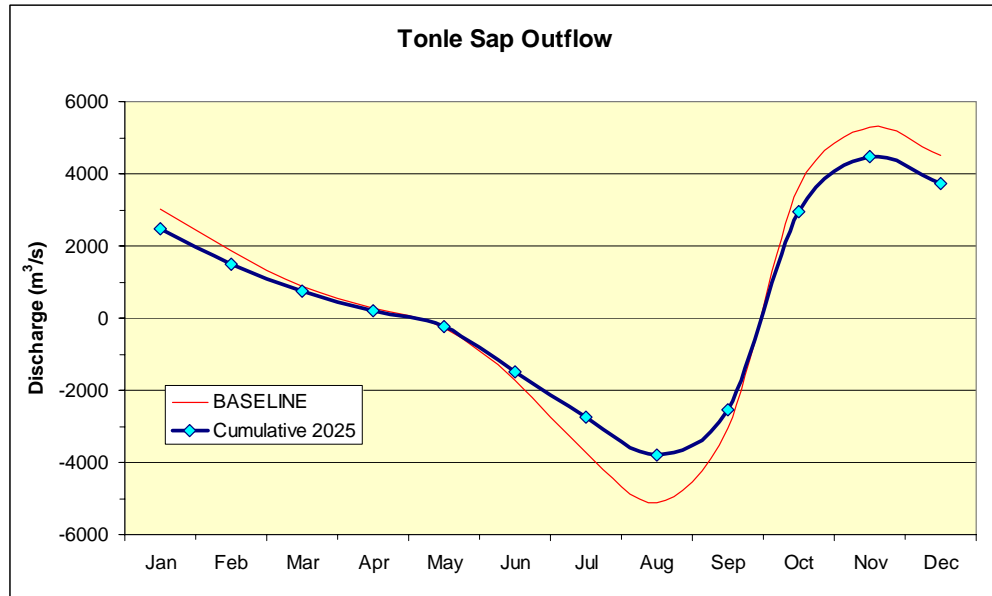


Figure 9: Cumulative Impacts 2025 on flow in Tonle Sap. Positive Flow is from the Lake to Mekong, Negative Flow is from Mekong to the Lake.

The impact on Mekong water levels has been assessed by inspecting the Mukhdahan/Savannakhet rating curve. The 135% increase of the dry season discharge (as seen on Figure 7) corresponds to a water level increase of 1.2 m. During floods, the discharges are reduced by around 20%. In an average year, this means from 19,200 m³/s to 15,000 m³/s in August. The corresponding reduction of water level is 1.6 m.

The Great Lake responds to the reduced floods in the Mekong by lowering the highest water level from 7.64 masl as baseline to 7.1 masl in September/October, i.e. a reduction of 54 cm on the average. Correspondingly, the lowest water level of the Lake will be increased by 63 cm to 1.52 masl in the dry season.

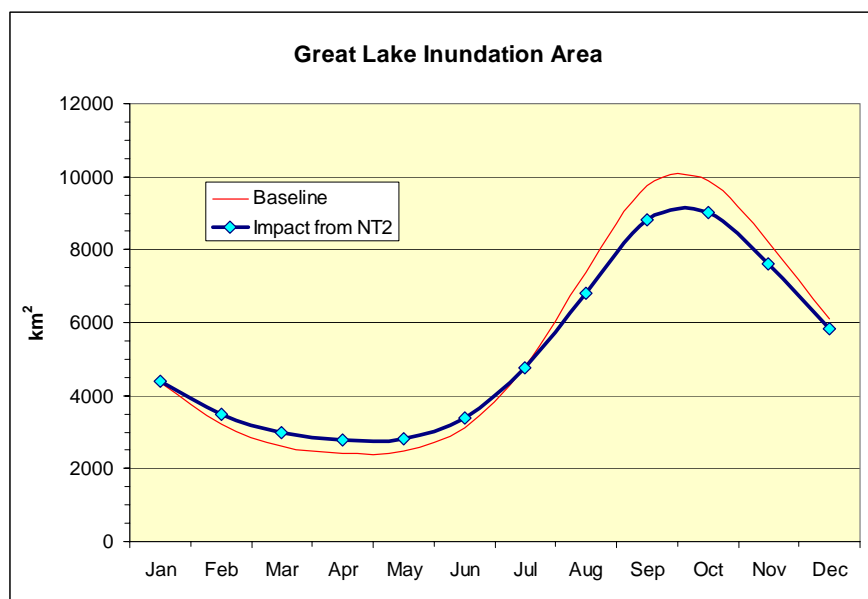


Figure 10: Cumulative Impacts 2025 on Great Lake Inundated Area.

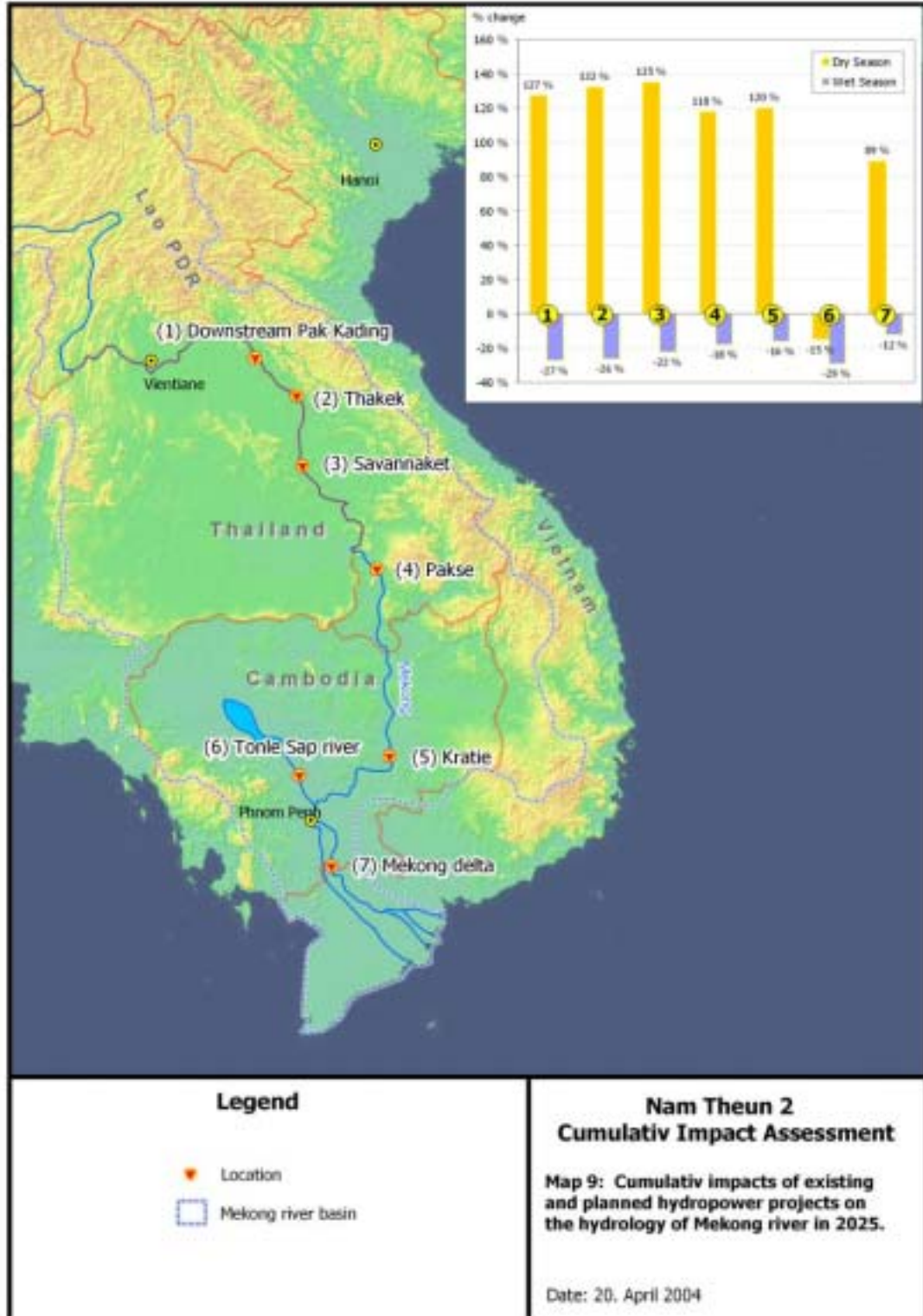
The Lake area at maximum flood level will be reduced by approx. 865 km² to 9030 km². The Lake circumference is approximately 530 km, so the area that will not be inundated by the Lake can be viewed as a 1.6 km wide “band” around the lakeshore (Figure 10). In the real situation the non-inundated area will be different from year to year, according to the annual peak flood level, and besides the area will be very irregular as the shape of the lakeshore with numerous small islands.

The reduced wet season flow, corresponding to a reduction in level of about 60 cm at Phnom Penh, will have a significant positive impact on reducing the risk of flood damages.

The Delta will experience a significant reduction of seawater intrusion in the dry season due to the upstream hydropower development. The period with negative discharges (water flowing upstream due to high tide and low flow) at Tan Chau will be reduced to 6.1% of time from 9.5% in the baseline. This corresponds to a reduction of approximately 36%.

Table 29: Summary of Cumulative Impacts on Mekong flow at Selected Locations.

| Location | 2010 | | 2025 | |
|---|------------|------------|------------|------------|
| | Dry Season | Wet Season | Dry Season | Wet Season |
| Mekong at Pakkading | +58% | -15% | +127% | -25% |
| Savannakhet | +70% | -10% | +135% | -20% |
| Mekong at Phnom Penh (after Tonle Sap confluence) | +36% | -6% | +70% | -13% |



Sediments

There are reports that the present sediment transport in the Mekong is about to exceed or has already exceeded its sediment carrying capacity. This is in agreement with the fact that a number of irrigation water intakes along the Mekong have problems with sedimentation.

Most large rivers may be divided into an upper erosion zone, a transportation zone of alternating erosion and sedimentation and a lower sedimentation zone, typically river plains and deltas. In lower Mekong this is the case, the transportation capacity is exceeded and the level of the riverbed is gradually increasing.

Sedimentation transport is affected by two parallel developments working in opposite directions - intensive agriculture and deforestation increases the erosion and sediment load to Mekong whereas the building of reservoirs might trap sediments. At the moment the first process seems to be the strongest and the sediment transport in Mekong is increasing. It is reported an increased sediment load of about 50 % at Pakse between the 60s and 1992 (Harden and Sundborg, 1992). The main reason has been increased deforestation and cultivation in the catchment.

In one respect there is reason to assume that sediment transport will continue to increase. Development of large reservoirs will, however, give the opposite effect, partly by trapping sediments, partly by reducing flood magnitudes.

Fisheries research concludes that nutrient rich sediment deposited in the Great Lake during floods has a positive impact on the fish production (van Zalinge et al., 2003). It is however, uncertain how much nutrients are brought in by Mekong and how much is from local runoff.

The construction of the **NT2 reservoir** will cause a negligible reduction in downstream sediment load. Only a very small amount of sediments will be trapped in the NT2 reservoir since the catchment is well forested and the inflow water is very clean. The "clean" NT2 discharge water might cause increased erosion of the riverbanks of Xe Bangfai, and it is predicted that the total sediment transport will increase in particular in the first years of operation before the river system has been stabilised. This issue is studied in more detail in the ongoing Xe Bangfai Hydrology Study.

It is difficult to predict which of the factors determining sediment loads are the "strongest" in the future. It is possible that the successive construction of dams will delay the sedimentation in the Lower Mekong for some decades. In the long run however, there is reason to believe that the deposits will raise the water level and thus cause more frequent and larger inundations. An annual sediment "inflow" to the lower Mekong could be calculated by estimating the land use pattern at present, in **2010 and 2025**, and by using different erosion rates for different land use. For simplicity it could be assumed a 100% trapping efficiency of sediments upstream of hydropower projects with seasonal storage. Although deforestation is taking place at a high rate, much of the undisturbed forest left is upstream of existing or planned hydropower reservoirs. One result could be that the sediment load to Mekong might be at the highest at present when there are relatively few hydropower reservoirs and the deforestation rate is still high.

Fisheries and Aquatic Biodiversity

The impacts on fisheries and aquatic biodiversity in the mainstream Mekong and Great Lake will for the isolated NT2 impacts and for the 5-year and the 20-year perspectives primarily be a result of the changes in hydrology and the secondary impacts resulting from this (sediment transport, flooded river plains etc.). The development plans and trends do not indicate that basin wide pollution problems will be an important factor in this time perspective.

The hydrological changes in the Mekong, percentage wise, are less dramatic than the flow changes the Nam Kading, Nam Hinboun and Xe Bangfai. It is important to be aware, however, that the extremely important fisheries in the lower Mekong (i.e. the Great Lake and the floodplains in Cambodia) are determined by the flooding of the plains and in particular the lowland forest habitats. The inundated land is rich in nutrients and serves as spawning or feeding grounds for fry and juveniles. A lot of fish is caught on the plains but large amounts follow the receding water back into the Mekong. Without this inundation the Cambodian fisheries would only be reduced compared with today. The average fish production in the Great Lake is according to the latest estimates 235,000 tonnes per year (MRC December 2002).

There seems to be a positive relationship between the magnitude of the annual flood-pulse and the fish production in the Great Lake. For the bag-net fishery in the Great Lake River that connects the Great Lake to the Mekong, the "dry" year catch can be close to half of the catch in a "wet" year

Thus the Mekong fish have adapted themselves to the annual flood-pulse, and have an intimate relationship with it. In the lower Mekong floodplains and the Great Lake the relation to water flow has roughly be described as "the higher the wet season flood, the more fish". Several studies have discussed the relationship between annual variations in Great Lake flood level and the fish catch (Baran et al, 2001, Lieng & van Zalinge, 2002). The studies indicate a strong positive correlation between floods and fish production. Baseline data on fish catch are, however, uncertain and a number of other ecological factors in addition the flood levels, are in play. Thus, the present knowledge does not allow for determination of a definite production figure pr. flooded area. The most productive fish breeding areas on the floodplains and around the Great Lake are reported to be shrub and forest-covered wetlands. These vegetation types are under pressure of being converted into agricultural land, which are less suited as breeding grounds and might contribute to increased pollution problems.

For most of the fish species found in the Cambodian and Vietnamese parts of the catchment, migrations take place within Mekong and its tributaries downstream Khone falls. Some species are able to "climb" Khone falls but the majority of species are blocked at this site. Changes in water flow and water quality in Nam Kading and in Xe Bangfai are therefore not likely to have any significant impact on fisheries in downstream countries.

The hydrological impacts of **Nam Theun 2 alone** are shown in Figure 6. Between Pakhinboun and the mouth of Xe Bangfai there will be a slight reduction in water flow both in the wet and in the dry season. In theory this might be negative for the concentrations of fish that are adapted to survive the dry season in deeper pools of the river. However, the water level reduction will be marginal and no significant impact is foreseen. The potential negative impact will, in the 5-year perspective be more than compensated by planned upstream hydropower developments, which will increase the dry season flow.

For the downstream fisheries the reduction in peak wet season flow is the most important factor. The hydrological calculations have indicated that NT2 will cause a reduction in Great Lake average maximum flood level of about 1%, compared to an annual variation in maximum level of about 2,5–3 m, and thus cause an insignificant reduction in fish production potential.

With all the upstream hydropower projects included in the **5-year perspective**, and the predicted hydrological changes (Table 29) the potential stress to of fish surviving in pools in the Mekong mainstream Pakkading and the outlet of Xe Bangfai will be removed.

The reduced maximum flow will, however, result in an average reduction in the Great Lake maximum annual water level of about 22 cm and thus cause a small negative impact on fish production potential.

In the **20-year perspective** further upstream hydropower development will have resulted in that the average low-flow level have been significantly increased and the wet season flow significantly reduced in the Mekong (Table 29). The changes might have reached levels where they will have negative impacts on the migration and spawning cycles of several fish species. The knowledge of fish biology does not allow, however, for any precise prediction of such impacts on commercially important or endangered aquatic species.

In the Great Lake the reduced maximum flow will result in an average annual reduction in maximum Lake level of about 54 cm, compared to an annual variation in maximum level of about 2,5–3 m, and thus cause a significant reduction in fish production potential.

It is not likely that either the **NT2 alone**, or the **5-year perspective** will cause any significant negative impacts on the aquatic biodiversity in the Mekong zone. There might be small changes in distribution of some species but there is no indication that the species composition will be changed or that vulnerable species will be endangered.

In the **20-year perspective**, however, the situation is more uncertain. The combined impact of the planned projects will cause fundamental changes in the ecology of the Mekong. It is, thus, likely that some species will have their habitat destroyed or their life cycles interrupted. Special concern is related to the plans for building a hydropower plant on the Mekong mainstream in Cambodia (Sambor) and the utilisation of a part of the Mekong at Khone fall (Thakho) in Lao PDR. Both projects have the potential to negatively impact some of the unique and highly endangered aquatic species found in Mekong.

Wetlands

Several wetlands might be impacted by changes in hydrology and sediment transport in the Mekong. The most important of these are the Siphandon Wetlands in Lao PDR upstream of Khone falls and the Ramsar site Stung Treng Wetlands in Cambodia downstream of the falls. These wetlands are passageways for migrating fish and are critical habitats for many fish species, waterfowl and other wetland fauna and flora. The ecological functions and their dependencies of hydrological factors and fluctuations are complex and little understood. Thus in this assessment the assumption has been made that changes in the natural flow conditions will have an overall negative impacts on the present ecological functions and biodiversity.

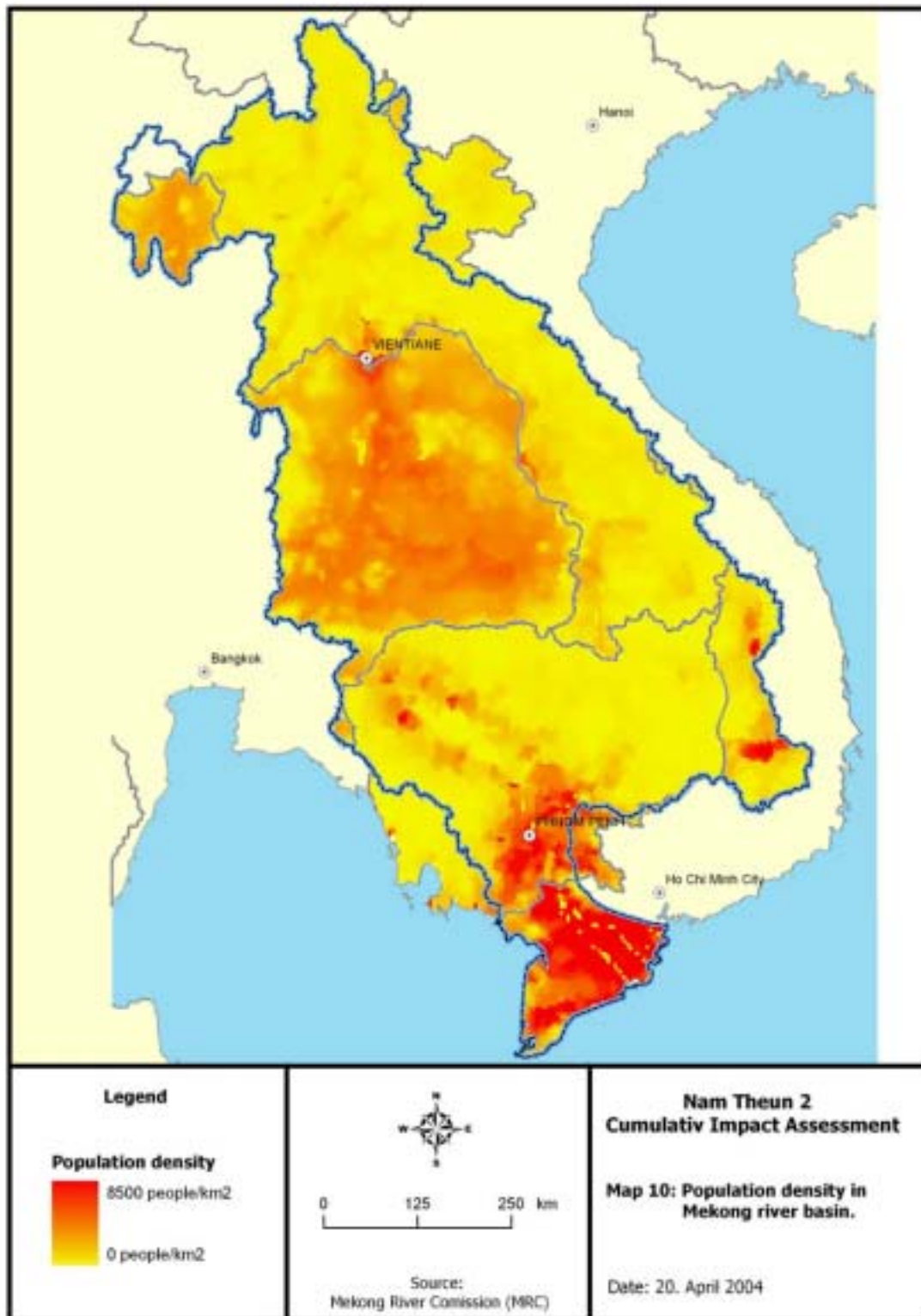
Similar to impact on fish and fish biodiversity, it is likely that the impact on wetlands of **NT2 alone** will be insignificant, and the impacts on wetland will be small in the **5-year** perspective. In the **20-year** perspective, however, more significant negative impacts might be envisaged.

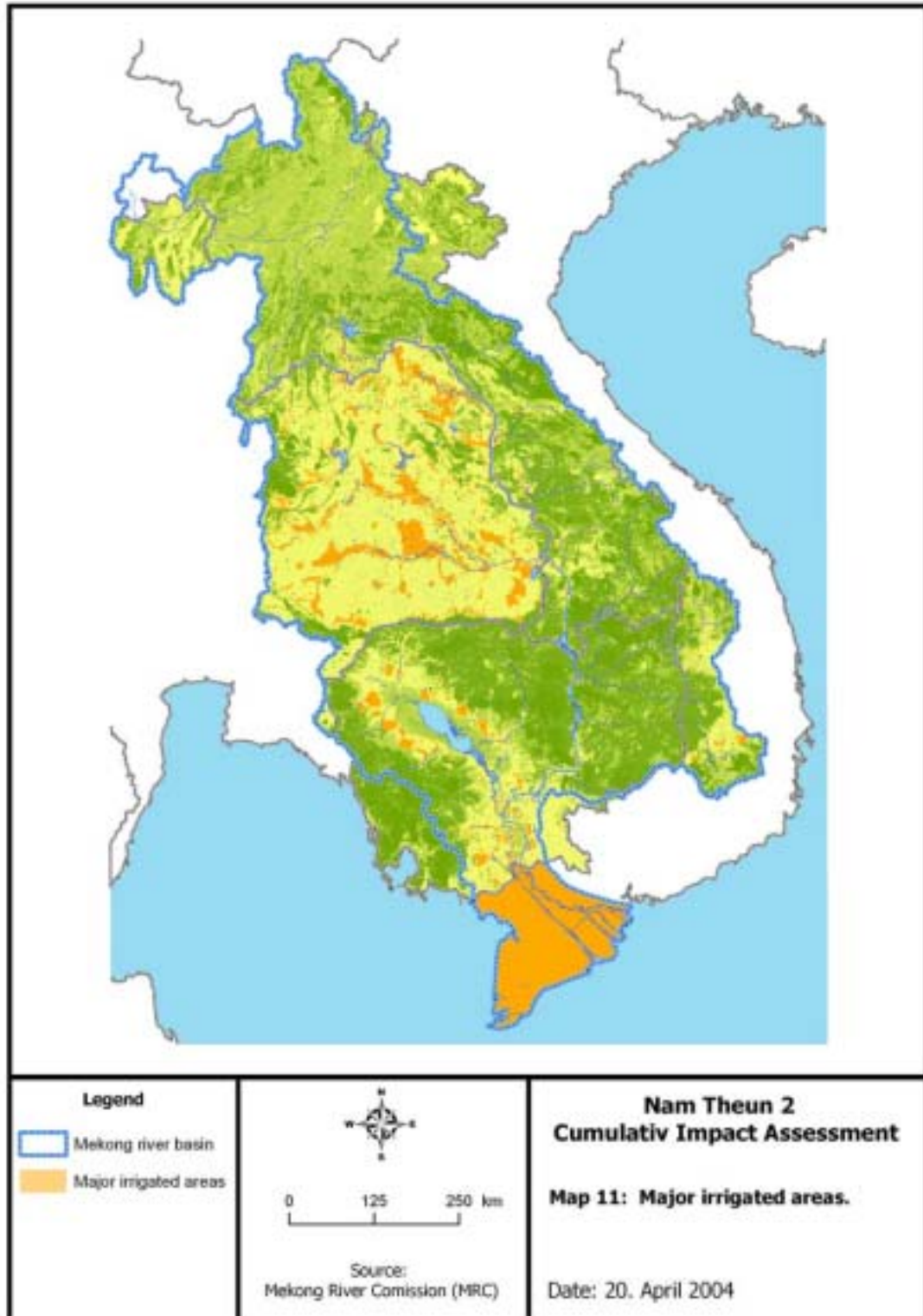
Agriculture

Agriculture in the Lower Mekong Basin is expected to develop rapidly as increasing population's lead to the expansion of agricultural lands and intensified cultivation practices. It is first and foremost Cambodia and Lao PDR that possesses land that can be reclaimed for agricultural production land, while Northeast Thailand and the Mekong Delta have little additional land suitable for cultivation. Development plans for the Delta, however, include increased production and diversification of crops.

The most important water management issues in the Delta area are water shortage and saltwater intrusion in the dry season. These two elements are threatening the agricultural production in the area.

During the early part and end of the dry season the flow in the mainstream Mekong is sufficient to meet the water requirements for irrigation. In the mid part, however (March to May) the highest demand for irrigation water coincides with the minimum Mekong flow.





During the dry season the salt marine water moves upstream along the rivers and channels in the Mekong Delta. The highest salinity is usually observed in April. Currently about 1.7 million ha of the total Vietnamese delta area of about 4 million, is affected by saltwater intrusion. This affects irrigation and domestic water supply and sets a limit to further development of irrigation systems.

As mentioned under the hydrology section, the **NT2** will slightly increase the dry season flow and thus have a beneficial but marginal impact on the water availability for irrigation and reducing salt-water intrusions.

The Pak Kading-Xe Bangfai reach of the Mekong presently has some irrigated areas estimated to be around 4,800 ha in the wet season and 3,700 ha in the dry season. These consist of irrigation schemes that draw water directly from the Mekong and from small tributaries influenced by the flow level in Mekong. The potential for expansion of irrigated areas has been estimated to almost a doubling for both the wet and dry season irrigation. The potential effects on irrigation schemes due to changes in water level are expected to be insignificant in this reach. During the dry season only a 0 to 2 cm lowering of the flow level is foreseen while during the wet season a 23 to 29 cm change is expected.

In the **5-year** perspective the period with negative discharges (water flowing upstream due to high tide and low flow) at Tan Chau will be reduced to 8.4% of the time from 9.5% in the baseline. The positive effect on more water available for irrigation will increase accordingly.

In the **20-year** perspective the Delta will experience a significant reduction of seawater intrusion in the dry season due to the upstream hydropower development. The period with negative discharges at Tan Chau will be reduced to 6.1% of time from 9.5% in the baseline. The positive effect on more water available for irrigation will increase accordingly.

Health

In the **5-year** perspective it is not expected that there will be immediate or cumulative impacts originating in the NT2 Project intervention area that will affect the health situation of people in the Mekong River Basin. Even an increase in the use of pesticides and herbicides, which might cause local health problems in selected communities or sections, will not have any significant impact on humans and aquatic life in the Mekong River Basin at large.

In the **20-year** perspective, however, the combined hydrological changes might reach levels where they might have an impact on water related diseases and on the nutrition situation through its impact on fish production. Reduced flood levels might be negative for fish production but on the other hand, will most likely cause a reduction in the frequency of several water borne diseases.

7.6.3 *Summary of Impacts*

The impacts of **NT2, alone**, on downstream Mekong conditions are as follows:

- €# Between Pakhinbound and Xe Bangfai outlet there will be a reduction in both dry season (about 2 cm) and wet season (23 –29 cm) water level. The increased pumping cost for dry season irrigation will not be measurable. The reduced wet season level will have a positive impact by reduce flooding of the flood prone and highly developed agricultural land on the Thai side of the river.

- €# At the Tonle Sap River confluence, the Mekong water levels may be increased by about 2-3 cm in the dry season and reduced by around 3 cm during floods
- €# The Great Lake responds to the Mekong changes by lowering the maximum water level by between 3 cm compared to an annual variation in maximum level of about 2,5–3 m.
- €# The construction of the NT2 reservoir will cause only minimal retention of sediments and thus not have any significant impact on Mekong sediment balance.
- €# The changes in flow pattern will have an insignificant negative impact on floodplain and Tonle Sap fisheries as this is favoured by high wet season water levels.
- €# The changes in flow pattern will have an insignificant positive impact by damping damaging flood incidents and by increasing dry season water level that will support irrigation and reduce salt intrusion in the Mekong Delta.

Table 30: Summary of the most Important Cumulative Impacts in Mekong River Basin

| Mekong River Basin (Includes the impacts of planned hydropower developments in all GMS countries) | |
|--|--|
| 5-year scenario | 20-year scenario |
| <p>The dominant factor will be some additional development of hydropower in Yunnan and Lao PDR. The impacts and are calculated to be:</p> <ul style="list-style-type: none"> €# Dry season discharge at Savannakhet may increase by 70% corresponding to a water level increase of 65 cm. During floods, the discharges may be reduced by around 10% corresponding to a reduction of water levels by 85 cm. €# At Kratie the average annual maximum flow will be reduced from the present baseline of 35,250 m³/s to 33,565 m³/s (5%). €# At the Tonle Sap River confluence (Phnom Penh) the water level will be reduced by about 25 cm during floods and increased by about 28 cm in the dry season. The Great Lake responds to the Mekong changes by lowering the average annual maximum level of the lake by 22 cm, compared to an annual variation in maximum level of about 2,5 – 3 m. €# The changes in flow pattern will have a small negative impact on floodplain and Great Lake fisheries as these are favoured by high wet season water levels. €# The changes in flow pattern will, however, have a small positive impact by damping damaging flood incidents and by the increased dry season water level that will support irrigation and reduce salt intrusion in Mekong Delta. | <p>The dominant factor will be further development of hydropower in Yunnan and Lao PDR. The impacts and are calculated to be:</p> <ul style="list-style-type: none"> €# Dry season discharge at Savannakhet may increase by 135% corresponding to a water level increase of 1.2 m. During floods, the discharges may be reduced by around 20% corresponding to a reduction of water levels by 1.6 m. €# At Kratie the average annual maximum flow will be reduced from the present baseline of 35,250 m³/s to 31,020 m³/s (12%). €# At the Tonle Sap River confluence (Phnom Penh) the water level will be reduced by about 60 cm during floods and increased by about 70 cm in the dry season. The Great Lake responds to the Mekong changes by lowering the average annual maximum level of the lake by 54 cm, compared to an annual variation in maximum level of about 2,5 – 3 m. €# The changes in flow pattern will have a significant negative impact on floodplain and Great Lake fisheries as these are favoured by high wet season water levels. €# The changes in flow pattern will, however, have a significant positive impact by damping damaging flood incidents and by the increased dry season water level that will support irrigation and reduce salt intrusion in Mekong Delta. |

Table 31: Estimated Staff Needs of NT2 in Relation to Available District Staff

| District | Existing staff | RMU need | WMPA need | Total NT2 need | NT2 need in % of total available staff |
|------------|----------------|----------|-----------|----------------|--|
| Khamkeut | 147 | 22 | 15 | 37 | 25% |
| Gnommalath | 191 | 28 | | 28 | 15% |
| Mahaxai | 84 | 26 | | 26 | 31% |
| Nakai | 37 | 90 | 72 | 162 | 438% |
| NongBok | 64 | 13 | | 13 | 20% |
| XeBangfai | 19 | 21 | | 21 | 111% |
| Xaibouly | 72 | 18 | | 18 | 25% |

Source: ADB Capacity Building Assistance Project – Phase I

STEAs, together with their provincial offices (STEOs), and the Social and Environmental Management Division (SEMD) of the Department of Electricity, MIH, will play a crucial safeguard and monitoring role in connection with the implementation of the NT2 Project and other hydropower projects in the future. The number of staff and staff qualifications are summarised below.

Table 32: Staffing and Qualification Level of Provincial and Central Agencies

| Agency | Total Staff | Education Level | |
|---------------------------------|-------------|-----------------|---------|
| | | University | College |
| STEAs - Dep. of Environment | 19 | 17 | 2 |
| EIA Division | 5 | | |
| SIA Division | 2 | | |
| STEO - Bolikhamxai | 6 | | |
| STEO - Khammouane | 14 | 9 | 5 |
| STEO - Savannakhet | 6 | 1 | 5 |
| SEMD – Dep. of Electricity, MIH | 5 | 5 | |

STEAs: Provincial Science, Technology and Environment Office
SEMD: Social and Environmental Management Division

Both the EIA/SIA Divisions of STEAs and the SEMD have been recently established and are presently being built up and trained. In relation to mandates and responsibilities their staffing is relatively limited as is also their funds for equipment, training and travel.

The provincial STEOs, which will be crucial for monitoring and follow up of environmental and social plans in connection with development projects in their province, are also in the process of being built up. Khammouane is the province with the highest number of STEO staff.

Challenges

The implementation of the NT2 will pose challenges to the government and mass organisations on all levels. The most pressing challenge in the short run will be the lack of technical staff to carry out all the assigned tasks in connection with the NT2 environmental and social programmes. As the district where the resettlement takes place, Nakai will face the biggest challenges.

The additional human resource demands created by the NT2 Project will most likely result in a situation where less attention and personnel resources are available for other important tasks and obligations, for instance in connection with other development projects in the area. The planned cement factory in Mahaxai District is an example of such a project that will have to compete with NT2 for district staff resources. In addition to Mahaxai, Gnommalat is the district that probably will be most affected by the “tying-up” of human resources by the NT2.

Recommendations

Given the challenges noted above there is a clear need to plan ahead how to meet staffing and training needs in connection with the implementation of the NT2 Project as well as other development projects the area. Planning should include:

- ⌘ a more detailed account of the type and number of staff that will be needed;
- ⌘ an assessment of sources of recruitment and recruitment procedures;
- ⌘ identification of technical skills that cannot be filled by district and provincial staff;
- ⌘ an outline of funding sources for the government and estimated budget requirements for the different types of resettlement and development activities.

The issue of funding of resettlement and development activities is crucial and should be resolved as quickly as possible. It will be necessary to review and explore external funding options either as a grant or a loan as scarcity of resources on the part of the GoL is likely to be an obstacle to action. With regard to funding of capacity building and training, donor agencies should be identified and enlisted as soon as possible.

To meet the challenges of properly following up the NT2 and other projects in the area, STEA and SEMD should be strengthened through targeted training and operational support. Given the budget situation of the Government, international donor funding should be sought for the training component. Funding for recurrent operational costs should as a principle be furnished by the Government but to secure that the training is put into practice, a more time limited budget support for travel and administrative costs by development agencies should be considered.

8.2.2 *Integrated Planning*

Existing Situation

Today planning in the Lao Government system is done on a sectoral basis with limited coordination and harmonisation of goals. Coordination is to some degree taking place at province level but is mostly concerned with the budgetary aspects of sectoral plans, not their physical, social and environmental dimensions and implications. Sectoral plans thus tend to be regarded as fulfilling a quantified goal or a service function and not as contributions to an overall development goal. This situation has its background in the tendency to define development in terms of availability of particular services such as road access, access to clean water and houses with electricity etc.

Integrated planning will offer better opportunities to direct resources to the sector where they have the best overall development effect and to avoid unnecessary negative environmental and social impacts.

Over the past years the government system has been going through a process of decentralisation where power and responsibilities are devolved to the province and district levels of government. This includes responsibilities for both strategic and operational planning with strategic planning being done at province level while operational planning is left more to the districts.

Another feature of the current planning situation is the involvement of the private sector. After the market reforms that were introduced from the middle of the 1980s, the private sector has come to play an increasingly important role in planning and determining the development of some sectors. The industrial sector is possibly the sector that has been most influenced by market forces and private investments, while the hydropower has increasingly also seen private sector involvement.

Challenges

There is a need for a more harmonised and integrated development planning process to reduce conflicting planning goals and facilitate resource allocation to each sector according to their importance and contribution to the agreed overall development goals.

With regard to the decentralisation process the challenge is to harmonise and reconcile the need for integrated planning with the process of imparting power to the province and district levels to act independently. The built-in conflicts of decentralisation and integrated planning can be expected to increase and become a challenge in the future as the decentralisation process takes more hold.

Finally, private sector involvement in a number of sectors is most probably going to increase in thus giving market forces more roles in determining future developments. This will reduce the role of government and weaken the position of integrated development planning as various government institutions have practiced it.

Recommendations

With the increased private sector participation in development, GoL's role as a regulator and strategic planner becomes more important. Through strengthening of important planning institutions the Government should seek to promote an integrated development planning framework within which the private sector can be invited to participate.

Institutions that should be considered for strengthening include the 4 agencies under the Prime Ministers office with special responsibilities in integrated planning. These are the Rural Development Committee, the State Planning Committee, the Land Allocation Committee and the Science, Technology and Environment Agency. At provincial level the focus should be on the Provincial State Planning Committee, the Department of Planning and Cooperation, the Provincial Rural Development Committee and the Rural Development Office, while at district level the District Planning Office should be strengthened

In addition to focusing on integrated planning through training and capacity building there is a need to clarify the roles and responsibilities of all the possible ac-

tors. As decentralisation proceeds it would appear most important to strengthen the integrated planning capacity function at province level.

In the future efforts to strengthen integrated planning and environmental and social assessment should constitute a main focus. STEA as the key environmental safeguard agency should be given the responsibility for training other planning institutions in environmental and social safeguard principles and also be given a role in screening and evaluating government development frameworks and plans.

8.2.3 *Management of other NBCAs*

Existing Situation

As mentioned several times in Chapter 7, there is a danger that the improved management regime planned for Nakai-Nam Theun NBCA (SEMFOP) might cause an increased pressure on the values in the other NBCAs in the region. Some initiatives are however underway.

The Wildlife Conservation Society (WCS) are planning to start a 5-year project in Bolikhamxai Province, co-financed by GEF. Provided that the project plans are approved by GEF, this might bring biodiversity conservation in this region an important step forward. The Nam Kading NBCA, Phou Hin Poun NBCA and Nam Chat/Nam Pan PCF will benefit from this project. This project could counteract the otherwise negative trend with regard to biodiversity conservation in this region, at least within the protected areas.

Challenges

The future challenge will be to mobilise resources for the development of management plans and establishing of control apparatus for the protected areas in the region, in particular for the Hin Namno, Phou Hin Poun and Nam Kading NBCAs.

Several plans have been tabled for extension of existing NBCAs and establishing new conservation areas. It will be necessary to assess this in the light of the capacity of the existing management system and the danger of spreading limited resources too thin.

Recommendations

Programmes should be established to increase the competence and capacity of the administrative staff for nature conservation.

A comprehensive and balanced plan for the establishment of new protected areas and NBCAs should be prepared for the Lao PDR. The plan needs to prioritise the areas in question in order to find a realistic level of protection in balance with other users of the areas and in balance with the enforcement and inspection capacity at hand.

In terms of funding the establishment of the Nakai-Nam Theun NBCA and the financing of its management by the Developer through the WMPA sets an important precedence for future funding of NBCA. The possibility of establishing a fund for management and protection of all NBCAs in the country should be considered. One of the main sources for the fund could come from a concession fee levied on all future hydropower development projects in the country, both private and public. The experience with WMPA and its funding from the NT2 Project should therefore be studied and evaluated closely.

8.2.4 *Environmental Assessment*

Existing Situation

The main environmental legislation in Lao PDR is the Environmental Protection Law of 1999, further elaborated by an implementation decree in 2002. A general frame “Regulation on Environmental Assessment in Lao PDR” was issued in 2000.

According to the Environmental Protection Law and the Regulation all line Ministries are required to prepare environmental assessment guidelines for their activities and operations. Only the Department of Electricity of MIH and the Department of Roads of MCTCP have so far responded to this requirement. Both these Departments have now developed their own environmental regulations and set up environmental divisions. These regulations and standards appear to be broadly consistent with state of the art international guidelines and safeguard principles.

Challenges

Implementation of existing environmental regulations and guidelines will to a large extent depend on the resources available in STEA and the environmental divisions in the sector ministries.

The fact that the EIA regulations and guidelines have not yet been developed for a number of project categories where EIA is legally required, is a problem for a balanced assessment of different development initiatives.

Presently the Social and Environmental Division of the Department of Electricity employs only 5 people that have to follow up and implement a relatively demanding and comprehensive set of regulations and guidelines. The Ministry of Transport, Department of Roads, Social and Environmental Division (SED), has seven full-time staff to oversee and monitor social and environmental aspects of roads in the whole country. STEA's Environmental and Social Assessment Division presently consist only of 7 staff.

Thus, there are several problems linked to the assessment of environmental and social impacts of development projects:

- ⌘ Lack of regulatory framework for EIA content and processes for several important project categories (forestry, agriculture, industry, mining, etc); and
- ⌘ insufficient capacity and competence in managing and controlling the EIA preparation and in implementation of its recommendation in MIH and MCTPC and the total lack of such capacity in the other Ministries.

In today's situation there is a risk that some project categories (roads and hydro-power) get a lot of attention but with limited follow up and that for other, sometimes equally important projects, no assessments are made at all.

A relevant example is the cement factory planned to be built in Mahaxai. Possibly due to lack of specific sector environmental assessment guidelines it appears that an EIA for the project has not been carried out. It is unclear what kind of environmental assessment, if any, will be demanded by the authorities.

Recommendations

STEAs should again encourage the sector Ministries and support their efforts in developing sector specific regulations and guidelines for project categories under their responsibility.

With regard to assessing cumulative effects in the NT2 Project Area an EIA study should be carried out for the planned cement factory planned at Mahaxai.

In addition to preparing guidelines for project specific EIAs there is also a need to take a more strategic view of each sector. By developing “Strategic Impact Assessments” for the most relevant development sectors a better basis for planning and political decision making can be achieved. The Strategic Impact Assessments would provide an up-front broad outline of anticipated impacts of the most important potential projects in the sector and facilitate comparison and prioritisation.

Technical assistance and training should be provided in Environmental Impact Assessment procedure and techniques in existing and new “Environmental Units / Divisions” in the sector ministries.

8.2.5 *Cross-border Cooperation*

Existing Situation

The development in the areas influenced by NT2 are also determined by the development on the Vietnamese side of the border. This influence is already being experienced today and will be further strengthened by improvements to the trans-border road connections and the development of road plans in Vietnam. This development is in particular critical for the future for the Nakai-Nam Theun NBCA and the other NBCAs in the border area and along road 8 and road 12.

Some initiatives for cooperation between the conservation authorities and relevant NGOs in Lao PDR and Vietnam have been taken but seems still to be on an informal level.

Challenges

The future of the protection of biodiversity values of the NBCAs and the establishment of sustainable management systems for these areas is to a great extent dependent on a strong commitment of authorities on both sides of the border to plan and control the activities in the NBCAs. Without the involvement of the Vietnam side the NBCAs in this region run the danger of being seriously degraded.

Recommendations

Bilateral arrangements – preferably legally binding – should be established between Lao PDR and Vietnam for planning, management and control of Nature Protection Areas in the mountain range border. International NGOs active in both countries can facilitate such arrangements but the final responsibility has to be placed on the governmental level.

Joint principles of management and protection needs to be developed and included in operational management plans. The arrangements should in particular focus on curbing illegal logging, hunting and wildlife trade.

8.2.6 *Mekong Basin Planning*

Existing Situation

The Mekong River Commission is the main regional instrument for water related planning in the Lower Mekong Basin. The 1995 Agreement on the Co-operation for the Sustainable Development of the Mekong River provides a legal framework for co-operation that commits the four signatory countries to; “sustainable development, utilisation, conservation and management of the Mekong River Basin for social and economic development” (preamble of the Agreement). Several tasks and objectives mentioned in the agreements are relevant for addressing problems related to cumulative impacts in the Lower Mekong Basin:

- ⌘ Sustainable development, utilisation, management and conservation of water and related resources of the Mekong River Basin, including irrigation, hydropower, navigation, flood control, fisheries, timber floating, recreation and tourism.
- ⌘ Joint and/or basin-wide development projects and basin programmes through the formulation of a Basin Development Plan.

The implementation of the elements of the Agreement is facilitated by the MRC through providing a forum for exchange of information and through overall planning and research activities. The project specific planning and implementation is the responsibility of the relevant authorities in the member countries.

The Joint Committee of MRC in 1998 approved several principles relevant for hydropower development. This included the principle that information should be exchanged among the MRC member states as well as the GMS countries; and that state of the art assessment of cumulative environmental impacts and socio-economic aspects should be carried out by MRC in order to promote the most effective use of the natural resources in the Lower Mekong Basin.

An important factor determining the future water regime in the Mekong is the plans for hydropower projects in Yunnan. From the 5-year scenario and the 20-year scenario it is seen that this development will have significant impact on downstream water use and ecology. The People’s Republic of China is at present not a member of MRC and thus not bound to the principles of the Mekong agreement.

Challenges

The main challenge of the MRC is to fill the role of an institution for real case co-ordination between the countries and safeguarding a sustainable use of the water resources in the basin. For hydropower development the initiative has now been taken over by the national authorities and private investors, leaving MRC as a forum for information exchange at a late stage in the process.

It is to be hoped that the results of the Water Utilisation Programme and the Basin Development Plan will provide a basis for more proactive actions in relation to larger development project in the Basin.

Recommendations

Given the fact that neither the People’s Republic of China (Yunnan) nor Myanmar are members of the MRC efforts should be made to strengthen mutual information exchange and cooperation with these upper-basin countries. The strength-

ened cooperation should be done both through a stronger integration of especially Yunnan in the MRC work as well as through the Greater Mekong Sub-region Initiative.

The legal mechanisms of the Mekong Agreement should be strengthened in order to make the Commission an efficient forum for implementation of the principles of fair and equitable use of water resources in the Basin and for solving conflict between the countries.

MRC should be given an active role in managing processes of water related Cumulative Impact Assessments and Strategic Impact Assessments in the region.

8.3 Best Practice Scenario

8.3.1 Introduction

In Chapter 7 the 5-year and 20-year scenarios are indicated for each impact zone. The scenarios are based on the assumption that the proposed safeguard plans and initiatives proposed in connection with the NT2 project are implemented and working according to the intentions. The planned interventions represent, in many respects, much more advanced and comprehensive compensation and mitigation measures than normally found for a hydropower project in the region, and can thus be seen as examples of “best practise”.

In this CIA, however, the “best practise scenario” is based on the implementation of recommendations and initiatives that come **in addition to the NT2 safeguard activities**. Most of these recommendations are related to potential impacts outside the main NT2 project area and to sector developments and projects other than NT2.

8.3.2 “Best Practise Scenario”

Table 33 summarises the recommended mitigation and compensatory activities and initiatives described in section 8.2 and assessments of their impacts in the 5-year and 20-year perspective. The impacts identified in Chapter 7, combined or modified by the assumed results of the recommendations will constitute the “Best Practise Scenarios”.

Table 33: Summary of Best Practise Actions and Scenarios

| Action | 5-year impact | 20-year impact |
|---|--|---|
| Establish a plan for staffing and training needs in connection with NT2 and other projects in the area. | Resettlement and livelihood restoration and development appropriately carried out. | Maintenance of adequate livelihoods in the resettlement villages. |

| | | |
|---|---|--|
| Provide training and equip STEA and SEMD with resources needed for monitoring and follow up of NT2 and other projects. | Better quality assurance of the NT2 resettlement social development and resettlement process. | Environmental assessment and safeguarding established as a procedure in connection with development projects |
| Strengthen the role of Government as regulator through capacity building and establishment of a development framework. | A more balanced development process and a clearer role for the private sector in the development process. | Better government control of the development process. |
| Strengthen integrated planning institutions at all levels of government through focusing on environmental assessment, capacity building and clarification of roles. | A more balanced development taking into consideration overall development goals and more efficient resource allocation between sectors. | A more effective and sustainable use of available natural and financial resources. |
| Establish programmes to increase the competence and capacity of the administrative staff for nature conservation. | Gradually improve the control of activities in the NBCAs. | Lessen the pressure otherwise induced by the focus on Nakai –Nam Theun NBCA. |
| Develop a comprehensive and balanced plan for the establishment of new protected areas and NBCAs | Improved institutionalization of conservation efforts. | Might substantially improve the protection of NBCAs. Allow for a more efficient use of resources for protection of biodiversity. |
| Explore the possibilities for setting up a fund for NBCA management with contribution from larger development projects (e.g. hydropower development). | Improved protection of NBCA surrounding the Nakai-Nam Theun NBCA. | More resources for management of NBCAs countrywide. |
| Develop EIA regulations and Environmental and Social Units / Divisions in all relevant ministries. | Secure that impact assessments are made for all project categories. | Better control of development activities and provide for balanced assessment of development projects. |
| Carry out an EIA for the Mahaxai cement factory. | Better overview of cumulative effects and a better basis for planning of mitigation activities. | Less long terms and lingering environmental and social effects. |
| Develop Strategic Impact Assessments for the most important and relevant sectors. | Improved basis for planning and prioritization of development projects. | More balanced development with less negative environmental and social ramifications. |
| Increase the EIA competence and capacity in all sectors both in Central administration and in the Provinces. | More professional handling and control of the EIA processes. | Efficient implementation of mitigation and compensation measures related to development projects. |
| Establish bilateral legal arrangements between Lao PDR and Vietnam for planning, management and control of Nature Protection Areas. | Provide the basis for better control and protection of Nature Protection Areas. | Significantly improved control of illegal practises and trade in timber and wildlife. |