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EVAULATION OF THE ENVIRONMENTAL IMPACTS OF THE PAK MUN PROJECT IN THAILAND

By

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Abstract

This evaluation deals with the environmental impacts of the Pak Mun hydropower project in Thailand. Based on reports made by Thai authorities, meetings in Thailand and a site visit, the different impacts are evaluated according to the Environmental Impact Assessment made by the Norwegian Agency for Development Cooperation. The report concludes that there is uncertainty about some of the impacts and if financial support for the programme is given there should be close follow-up of environmental impacts, and that adequate funds are set aside to cope with them.

Subject Terms

Thailand
Hydropower
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EVALUATION OF THE ENVIRONMENTAL IMPACTS OF THE PAK MUN PROJECT IN THAILAND

Sverre Husebye, NVE, December 1990

CONTENTS

1.0 INTRODUCTION

The Pak Mun scheme is charcherized as a run-of-the-river type project associated to a low head hydro power plant. The Electricity Generating Authority of Thailand (EGAT) informed that Pak Mun is the firs run of river project in Thailand. The project is located in Ubon Ratchathani province in the North East near the Laotian border and Mekong river (Fig. 1). Installed capacity is estimated at 136 MW and the mean annual production is estimated at 280 GWh.

Electric Bureau (EB) has applied to the Norwegian Agency for Development Cooperation (NORAD) for financial support to be included in their bid for electromechanical components regarding the Pak Mun hydro power scheme in Thailand. The Norwegian Water Resources and Energy Administration (NVE) was requested by NORAD to give advice on the environmental impacts of the project.

This evaluation is based on information collected during a 5-day visit in Thailand in October 1990 and information given in reports (EGAT, 1984, 1989) published on the project.

During the visit in Thailand efforts were made to have meetings with both official and non-official institutions (Appendix 1) to get as broad a view as possible concerning the impacts of the project. To evaluate the Pak Mun project it was necessary to compare it with the general energy and environmental situation in Thailand.

Subjects of interest were to obtain a general view of the energy sources and situation in Thailand, the alternatives for meeting the future demand in electricity, and the environmental impacts of hydro power development in general; thereafter to obtain more specific information on the Pak Mun project and the different kinds of impact.

The official meetings included the EGAT, the National Environmental Board (NEB), United Nation organizations such as the Mekong Committee and the Economic and Social Commission for Asia and the Pacific (ESCAP) and finally the Royal Norwegian Embassy. Informal meetings with a well-known environmental journalist of the Thai newspaper "the Nation" and the Non Governmental Group (NGO) "Project for Ecological Recovery" (PFER) were arranged too.

Beside the meetings in Bangkok, a site visit to Ubon Ratchathani district was arranged by Thai Virawat Co., Ltd. The visit was guided by, and included meetings with, the local EGAT staff of engineers. The dam site and other locations of interest in the reservoir area were visited.

The Royal Norwegian Embassy in Bangkok and EB's representative for South East Asia (based in Kuala Lumpur) gave invaluable

assistance in helping to organize the meetings. A list of meetings and people met is given in Appendix 1.

2.0 CONCLUSIONS

Based on the information available (reports, meetings and site visit) an evaluation of the environmental impacts of the Pak Mun project concludes that, on certain conditions, there appears to be no major objections to NORAD giving EB financial support in their bid for electromechanical components.

The arguments for NORAD's support are first of all the small extent of the encroachments. Implementation of the scheme will affect a small area and a limited number of people. Environmental impacts of special importance have been studied in detail by Thai institutions and suggestions to handle the consequences have been made. The earlier plans have been changed and precautions will be taken to save areas of special interest to the local people and to reduce the number of people being relocated.

Neither NEB nor PFER pointed out any impact on the natural environment being in conflict with the project.

NEB and the Government of Thailand have approved the project, which therefore will be implemented.

Even if the implementation of this project will not itself solve Thailand's future energy problems, it may have positive effects on the energy situation in the north-eastern province. The value of renewable and non-polluting energy sources should not be underestimated in Thailand which have serious problems with air pollution. In this situation, it seems more favorable to implement the Pak Mun hydro power project than a comparable power plant using fossil fuels. The direct environmental impact of the Pak Mun project is perhaps greater, but the indirect and long term consequences seem to be less.

Socio-economic and socio-cultural impacts are the most important issues to be considered in the Pak Mun project. Mainly for these reasons there is some local resistance against the project.

Other negative impacts to be mentioned are potential future problems with water quality, and erosion. These matters seem not to be sufficiently taken care of in the project planning.

There appears to be neither institutions responsible nor financial liabilities to improve the situation in these fields if damage or negative effects occur.

As shown in this report, the project has some impacts which do not seem to be sufficiently elucidated. Therefore unexpected consequences may occur. As documented in general by the World Bank and pointed out by NEB and NGOs in Thailand, relocation

programmes may result in reduced standard of living for both the displaced people and the host population in the resettlement areas. These problems are usually linked to the destruction of the local infrastructure and often social security too. Perhaps the most important issue connected to the displacement is that more people have to survive on a reduced resource base. If development assistance does not increase the productivity of the remaining resource base, the carrying capacity of the relocation areas may quickly be exceeded.

A follow-up programme including financial support and a panel of independent experts therefore should be established in order to compensate for possible negative consequences to the local population. However, such a programme must be organized within Thailand in cooperation with local independent institutions. The point is not for NORAD to compensate all negative impacts, but to try to initiate and financially support such a programme. A suggestion might be to cooperate with the government appointed committees which shall follow up the consequences of the dam project.

In this way, a kind of "future security" for the local people can be established. This seems to be in accordance with NORAD's philosophy with regard to EIA (NORAD, 1988, 1990).

This report therefore concludes that NORAD may financially support EB in their bid for electromechanical components on the condition that a follow up programme including financial support is established.

3.0 ENERGY PRODUCTION AND ENVIRONMENT IN THAILAND

3.1 Energy situation

During the last years, there has been a tremendous growth in Thailand's economy. At the same time the increase in electricity demand has risen from the, by EGAT, forecasted 8 - 9 % each year to 15% (1988) and 19.5% (1989). The power reserve, which in 1986 was 50%, decreased to less than 5% in April and May 1990. The energy situation in Thailand today therefore is very difficult.

The energy sources for production of electricity in Thailand today are natural gas (38.6%), oil (27.7%), lignite (20.4%), hydro power (11.2%) and import from Malaysia and Laos (1.7%) (Ref. Royal Norwegian Embassy of Bangkok).

Utilization of alternative energy sources cannot solve the expected increase in electricity demand. Nuclear power seems not to be realistic in the near future because of the lack of national competence. Solar energy is not an alternative to cover the increase in domestic demand, as long as the price of the equipment is at today's high level. There is a potential

in energy saving which should be utilized. However, this alone is not enough to solve the energy situation in the years to come.

The importance of hydro power as a part of the total supply of electricity is expected to decrease from 11.2% today to 9.5% in 1995 and 6.8% at the beginning of the next decade. Hydro power therefore is not expected to cover the total increase in future demand.

However, in the years to come, EGAT wants to develop some hydro power resources as part of solving the immediate energy crises. Pak Mun is one of these projects.

3.2 Energy and environmental issues

Meetings with EGAT, ESCAP, NEB, Mekong Committee, the journalist from "the Nation" and PFER made it clear that there are different views and opinions about energy demand, production and environmental impacts.

Except for hydro power, the other economically feasible energy sources are non renewable. The alternatives are utilization of fossil fuels or import of electricity from Laos or Malaysia. The condition is that new hydro power schemes are implemented in these countries or along the Mekong river.

In Thailand there are two power plants using lignite. When these are fully developed, the yearly emissions of SO-2 and CO-2 will then constitute enormous quantities. The alternatives mentioned by the non-officials were energy saving, natural gas and thermal plants in areas with hot springs. It was stated by PFER that hydro power projects including reservoirs are not desireable in Thailand mainly because of the rural population patterns along the rivers and geographical conditions. Hydro power development in Laos is looked upon by the NGO as no alternative because of the impacts on the rain forests.

In addition the NGOs seemed very critical of the need to increase energy consumption. It was said that this development is based on the old fashioned way of thinking - " economic growth at any costs". At the same time they appeared to be more concerned about the direct and short term environmental impacts than the indirect and long term ones.

On the other hand EGAT gave the impression of dealing with the environmental impacts in a too easy way. Focusing too much on the positive sides and minimizing or "forgetting" the negative aspects were their main critics. From EGAT's point of view the important matter is to cover the electricity demand.

NEB has made an environmental impact assessment (EIA) covering the most important consequences of different kinds of encroachments. In this way they are supposed to evaluate both

direct and indirect effects of different kinds of projects. However, they are not a ministry and therefore appeared to be in a "weaker" position than for example EGAT.

ESCAP and the Mekong Secretariat stated the long term consequences of pollution and deforestation as the most important environmental problems in Thailand (and South-East Asia) today.

3.3 EGAT and NEB - environmental impact assessment (EIA)

EGAT which is organized under the Prime Minister's office with its own minister, is responsible for the national electricity supply. Planning, implementation and running of hydro power plants therefore are EGAT's responsibility.

NEB which coordinates the environmental issues, consists of members from different ministries and organizations (among others EGAT). The chairman is one of Thailand's three Vice-Prime Ministers. NEB is not connected to any ministry. The Office of Environmental Board (ONEB) is NEB's executive organization.

The client behind any project is responsible for working out an EIA (NEB, 1990) and paying the costs. NEB has a list of consulting firms which are approved to do EIAs. Finally, NEB approves the EIA made on the project. However, the client who has paid for the EIA owns the product and therefore has influence on the future use of it.

This system limits public information and control. Especially the NGOs criticize this. They claimed that EGAT does not release enough information. Other statements were: "Hard to get the information wanted, the public information normally favored the projects while the negative sides usually were minimized or not mentioned at all".

Thus, EGAT has a problem with public opinion and the local people affected by the hydro power projects, simply caused by lack of information and skepticism or mistrust of the information given. EGAT themselves also admitted some problems in this field.

3.4 Environment and the public

Even if The King of Thailand and the Prime Minister's office are concerned about environmental issues, there is local- and organized (NGO) resistance against hydro power projects in Thailand. Demonstrations in Bangkok and at the local level are common. The main problem seems to be mistrust of information given by EGAT and other officials combined with conflicting views on hydro power development. The most important environmental problems are related to resettlement of people, conservation of forests and threatened biological life.

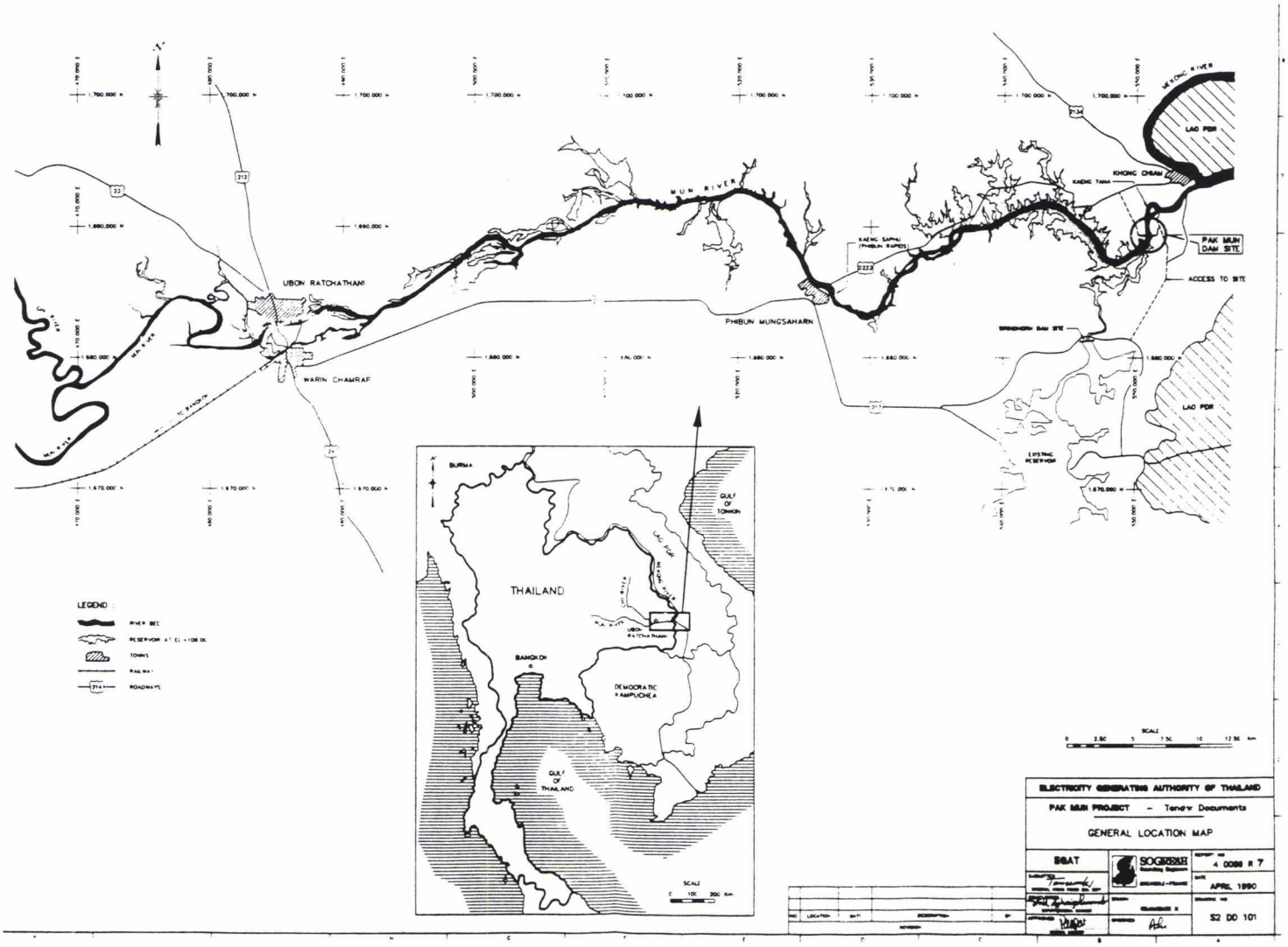

Fig. 1 Map showing the location of the Pak Mun project. The sketch of Mun river shows the reservoir at elevation 108 MSL.

4.0 THE PAK MUN PROJECT - A SHORT PRESENTATION

4.1 Geographical location

The Mun River is the largest and most important river of Thailand's north-eastern region. The Chi river drains the northern part of the region while the Mun river drains the western parts. Their confluence is about 10 km west of the city of Ubon Ratchathani. The catchment covers 117,000 km2, or about 70 % of the total area in the north-eastern region. The Pak Mun dam site is located 70 km east of Ubon Ratchathani at the Nam Mun River about 6 km upstream the confluence with the Mekong (Fig. 1).

The average flow is 737 m3/s and the 10 year flood is estimated to 5,400 m3/s. Other hydrological and technical details of the project are given in Appendix 2.

4.2 Technical data

Pak Mun project is the first run-of-river hydro power scheme in Thailand. It is a low head project with 4 horizontal axis Kaplan turbines and installed capacity of 136 MW divided on 4 horizontal axis Kaplan turbines. Each unit has a capacity of 34 MW. Generating head varies between 4.3 m and 15 m, with a nominal head of 11 m. Annual net energy production is estimated to 280 GWh (EGAT, 1990).

The dam is 17 m high and 300 m long. The spillway consists of 8 radial gates with a maximum capacity of 18,500 m3/s. This discharge is equal to the designed 1000 year flood. The reservoir capacity is 225 million m3 with a surface area of 60 km2 at normal high water elevation 108 MSL (MSL = meters above mean sea level). The reservoir will influence the Mun river about 70 km upstream, to Ubon Ratchathani city. The reservoir will occupy approximately 9 km2 (5,900 rai) of land areas suitable for agriculture, while 50 km2 (30,900 rai) have been classified as unsuitable (EGAT, 1984).

Pak Mun is planned as a multipurpose project including irrigation of 250 km2 (156,250 rai) farmland in the dry season and an estimated production of 1.3 millon kg fish/year in the reservoir.

4.3 Historical background

The Pak Mun project was suggested by the Mekong Committee (Ref. C. Lankester, Interim Mekong Committee). In 1967 the National Energy Authority (NEA) initiated a study of a multipurpose scheme including hydro power, irrigation and fishery. A feasibility report was made in 1970 and updated feasibility studies published in 1980. In May 1979 the project was trans ferred to EGAT, which now is responsible for the planning and

implementation of the project. Several reports have been made since then (Appendix 3).

In 1981, EGAT engaged TEAM Consulting Engineers CO. Ltd., to conduct a detailed Environmental and Ecological Investigation on the project, based on the water level of 113 m MSL and the dam site located at Kaeng Ta-Na. The results indicated that the impoundment of the Pak Mun reservoir would cause significant unfavorable socio-cultural effects on the existing inhabitants in the proposed reservoir area, as well as possible health threats due to snail-borne and water-borne diseases. In fact, approximately 4,000 households would have to be relocated due to the impoundment of the reservoir. NEB made their main comments on the socio-cultural and socio-economic problems, reduced water quality (sewage and salinity), danger of water-borne diseases and threat to tourism and local interests caused by inundation of some important rapids (Ref. O. Wongchumpit). Consequently, the project was temporarily shelved.

EGAT then ordered a new study to concentrate on the three issues: socio-economic conditions, resettlement planning and public health. The elevations of 108, 110 and 112 MSL were the bases of the study (EGAT, 1984).

In 1985 EGAT reviewed the project and determined to move the dam site approximately 2 km upstream, at Ban Hua Heo, Ampphoe Khong Chiam in Ubon Ratchathani Province. In the project description dated August 1990 (EGAT, 1989) the height of the dam is reduced to 17 m. The maximum retention level is 108 MSL in the wet season. In the dry season the retention level will be 105.5 MSL. In this way the number of resettlements was reduced to approximately 300 households and the rapids at Kaeng Ta-Na would not be flooded. These rapids are an important part of the National Park at Kaeng Ta-Na (established in 1983). The reduced retention level in the dry season, is to preserve the Phibun Rapids which are important both to the people in Phibun Mungsaharn city and for tourism.

4.4 Situation today

In May 1990 the project was approved for construction by the Government of Thailand. NEB has approved the project, even if they are uncertain about some environmental aspects. However, there is local and NGO resistance against the project.

Even if the Government of Thailand is concerned about environmental impacts of hydro power development (recently they temporarily stopped the controversial Kaeng Krung dam project), the Pak Mun project will be implemented (Ref. EGAT). Bid documents are already sent out.

Since the Pak Mun project is controversial, the Government in Thailand has established 2 committees to follow up the socio-economic and socio-cultural effects of the project (Ref. Royal Norwegian Embassy in Bangkok).

5.0 ENVIRONMENTAL IMPACTS OF THE PAK MUN PROJECT

5.1 Natural environment

None of the information available identifies severe impacts on the natural environment. The surrounding land is cultivated and there is no primary forest left. At Ba Hai site there is a rich forest reserve including wild life. Except for "one species of fish" mentioned in a newspaper article, nothing was found indicating threat to valuable plant or animal life.

However, the dam site is situated within the Kaeng Ta-Na National Park. The important rapids at Kaeng Ta-Na now are preserved. Only the upper parts will be affected by the construction of the tail race channel. None of the organizations or people met pointed this out to be a severe problem.

The forest in the vicinity of the dam site will be cut down and construction materials excavated. Enormous amount of soil will be lost due to the construction and by subsequent erosion (sheet wash during the rainy season). Good soil conservation practice during this period may reduce the effects on soil losses to an acceptale level.

5.2 Health

There is a danger of increased distribution of water-borne diseases. NEB and EGAT (1984) point out the danger of introduction of Schistosomiasis mekongi in the reservoir area as perhaps the most severe aspect. This disease is unfamiliar in the area. However, the T. aperta snail which is the intermediate host of S. mekongi, has been found on the rocks on the river bed in the Mun river, but not in ponds or rice fields.

The problem is accentuated due to the location of a Laotian refugee holding center located near the resettlement area of Muang district and at the edge of the reservoir. The disease is known to be endemic in southern Laos. If some of the refugees carry with them S. mekongi, this may be a potential health hazard to the people in northeast Thailand.

The chance of polluting the reservoir and then transmission of S. mekongi to the local T. aperta is stated as high. The survival and reproduction rate of T. aperta in the reservoir is another important problem.

Other diseases mentioned are Opisthorchiasis, Intestinal fluke infection, Dengue Hemorrhagic Fever and Malaria. In addition,

an increase in venereal diseases is expected because of all the workers entering the area during the construction period. Sexually transmitted diseases not existing in the area today, are expected to be introduced.

Water resources development projects usually improve the economic status of the family. However, a study in Khon Kaen area showed that prevalence of malnutrition is still high in the development area. Cases of malnutrition were seen more in the irrigation area than in other areas. A recent study has shown that lack of appropriate supplementary food, weaning pattern and infections were the major causes of malnutrition in preschool children of irrigation and resettlements areas (EGAT, 1984).

5.3 Resettlement

This is the most serious negative impact of the project. EGAT has made resettlement plans according to the proposals in their report (EGAT, 1984) including new housing, agriculture land, roads etc. Financial compensation will also be given.

However, NEB was skeptical despite their approval of the project. PFER and the journalist from "the Nation" were negative because of the bad experiences from other resettlement programmes connected to hydro power projects in Thailand. They gave examples of earlier resettlement projects which had failed.

Very often the soil in the vicinity of the rivers is quite fertile compared with that further away or in the uplands. The inundated areas therefore normally are more densely populated (Fig 2). Displacement of people to less fertile areas may therefore endanger the environment as more people and livestock have to survive on a reduced resource base. Unless the productivity of the resource base is increased, the carrying capacity of the area may be quickly exceeded (World Bank, 1989).

The people affected are poor farmers and quite often, the compensation given, changes their way of living for a short time. Buying of cars and other capital goods or alcohol instead of products for future agricultural use is common. After a while the families have less or nothing to support their new livelihood. Their social life changes. The old social infrastructure is destroyed. Reduced well-being and frustrations arise. Due to these aspects, the people often move back to the reservoir area or into the forests where new land then is cultivated. In other words, despite all the compensation and resettlement programmes, experience shows that people being moved usually achieve a reduced standard of living. This also causes an increased pressure on the forests and the natural resource base (Ref. PFER, A. D. Usher).

EGAT has calculated that a maximum of 300 families or approximately 1200 people have to be resettled from the Pak Mun reservoir area. These figures were confirmed by NEB. Therefore, there should be a follow-up programme with economic possibilities to help and ensure that both the displaced people and the host population maintain an equal standard of living also in the years to come. Fertile soil, water of acceptable quality, socio-economic and socio-cultural security should be the key words.

5.4 Water quality

NEB was concerned about the future water quality due to sewage water and effluent from the upstream area. In addition to the large city of Ubon Ratchathani there are several villages and industrial factories upstream of the reservoir.

Today the Mun river transports the effluent through the area. The question is how the future situation will be when the dam is constructed and areas with stagnant back water appear. Technical calculations show that the water will be renewed during a couple of days because of the small storage capacity in relation to the discharge. However, this is based on theoretical calculations and nature does not always work like a model. The hydrology and the morphology of the reservoir will be decisive in this process. A map of the reservoir (Fig. 1) shows large back water areas. The uncertainty is first of all related to how the process of renewing the water in these areas work.

Salinity may be a problem too. This will of course affect the irrigation part of the project. Department of Mineral Investigation (DMI) has located salt formations in the bedrock 30 meters below the surface in the reservoir area (Ref. O. Wongchumpit).

EGAT stated that problems with the water quality were insignificant. There will be future measurements of the water quality and plans have been made for cleaning the effluent if the situation becomes unacceptable. EGAT confirmed that evaporites containing salt minerals covered about 60 % of North-East Thailand.

5.5 Cultural environment

The temple of Wat Don That which is of great importance to the local people is situated on an island in the Mun river east of Kaeng Saphu. The site visit showed that the temple will not be affected by the highest regulated water level at 108 m MSL. During the highest peak flows the question is more uncertain, but EGAT gave assurances that flood warning and management of the gates at the dam will keep the temple safe.

6.0 DISCUSSION ON THE ENVIRONMENTAL IMPACTS

6.1 Natural environment

Erosion at the dam site may be reduced to an acceptable level by carefully managing the construction activities to minimize the possibilities for sheet erosion in the wet season. Construction materials should be excavated or borrowed from areas being inundated by the reservoir or from places with low agricultural potential. When constructing the tail race channel, both the Kaeng Ta Na rapids and National Park must be taken into consideration. No information available indicated serious threat to valuable plant or animal life.

The dam site is moved upstream of Kaeng Ta-Na. If the suggested management of the reservoir are followed, the rapids of Kaeng Ta-Na and the Phibun rapids will both be preserved.

A forest and wildlife protection unit has been suggested near Ba Hai. The main task should include control of forest and wildlife destruction, rehabilitation of the disturbed forest areas and reintroduction of suitable wildlife species (EGAT, 1984).

6.2 Flooding

The effects of peak flows and their effect on surrounding land above the 108 m level are uncertain. EGAT ensured that a flow warning system upstream and management of the dam would prevent the reservoir and surrounding land from flooding and inundation. The spillway capacity of 18,500 m3/s, management of the gates and lowering of the water level according to different discharges would solve this problem. Additional river protection work will prevent inundation in local areas and households. Between the dam and the confluence with the Mekong, flooding may cause problems in situations when the gates are fully opened.

6.3 Erosion

Information on erosion caused by daily regulation of the water level in the reservoir was hard to find. EGAT showed detailed sketches including river bank protection covering some areas. However, a detailed map of all the reservoir was not shown.

Another problem which may occur is degradation downstream of the dam caused by reduced sediment transport. Serious river bank erosion and flooding may also occur between the dam and the confluence with Mekong, especially if the gates have to be fully opened to reduce the water level in the reservoir. This may affect the village of Khong Chiam. However, these aspects were not mentioned as problems either in the reports or during the visit in Thailand.

6.4 Water quality

The danger of reduced water quality in the future is open to question. EGAT minimized this problem. Surveillance of the water quality and plans to improve the situation by cleaning the effluent were the argument.

Even if the water quality is measured in the years to come, this is no guarantee as long as there is no money or institutions responsible to improve the situation.

Pak Mun is planned to be a multipurpose project including irrigation of a larger area. The bedrock formations in the area include salt minerals, which may strongly reduce the value of the water for irrigation purposes. Reduced water quality will pull in the same direction. This may also affect the resettlement areas.

6.5 Health

There is a documented risk of increased danger for the occurrence of water-borne diseases. These problems seem to be well known and taken seriously in the project. In their report (EGAT, 1984), TEAM-CO discusses the different diseases and how to deal with them in a quite convincing way. If their suggestions are followed, these problems might be dealt with in an acceptable manner.

6.6 Cultural environment

According to the site visit and EGAT's explanations, there seems to be no threat to the temple Wat Don That east of Kaeng Saphu. This is situated some meters above the 108 m level and will therefore not be seriously affected.

6.7 Socio-economic and socio-cultural aspects

First of all, resettlement of people is a serious question for the one being affected. The socio-economic and socio-cultural effects were by different sources pointed out to be the main problems with the Pak Mun project.

The Kaeng Krung project in South Thailand was recently temporarily stopped by the Prime Ministers Office because of local resistance. There is local resistance against the Pak Mun project too.

Experiences from other hydro-power projects in Thailand show that relocation is difficult and several people have suffered a reduced standard of living. In addition, increased pressure on the forest reserves and returning to the reservoir areas seem to be the most common results (Ref. A. D. Usher, FPER).

Increased pressure on the remaining resource base resulting in the carrying capacity of the resettlement area being exceeded are well known effects of dam and reservoir projects (World Bank 1989). This will affect both the displaced people and the host population in relocation area. Therefore precautions have to be made to avoid this kind of development. There has to be a follow-up programme to give development assistance to increase the productivity of the resource base. This programme must include financial support and an organization responsible. Independent experts should be involved in the process of reviewing the situation during the preparation and implementation until a few years after the completion of the project.

7.0 EVALUATION

Pak Mun is the first run-of-river project in Thailand (Ref. EGAT). According to the reports made and the information submitted during the stay in Thailand, the encroachments must be characterized as limited compared with traditional schemes. Even so, the project is not without impacts on the environment. Some impacts are dealt with in an acceptable manner while there seem to be some uncertainty about other effects.

With reference to the EIA NORAD (1988, 1990), the most serious aspect of the project is stated in criterion 1, while criterion 6,7 and 8 are more uncertain (Appendix 4). Investigations and reports are made to cover most of the major environmental impacts.

However, there is some resistance from the local population and NGO's against the project. NEB and non-officials points out the socio-cultural and socio-economic conditions related to the resettlement of people as the most important issues. However, this project seems not to be comparable to Kaeng Krung scheme which was temporarily stopped by the government. The main difference appears to be the extent of the encroachments which also include the natural environment in the Kaeng Krung reservoir area.

Some of the resistance against Pak Mun is probably indirectly caused by EGAT themselves and their way of giving information. These are not believed to cover all aspects, and the negative effects are said to be under-estimated.

The impression given by EGAT's local staff and the reports (EGAT, 1984, 1989) indicate that the hydrological conditions in the reservoir area are seriously considered. On the basis of this information the rapids at Kaeng Ta-Na and Kaeng Saphu are preserved.

The suggested management of the gates during the wet season is seen in association with the discharge in the Mun river to

prevent undesirable inundation in the neighboring areas. In addition the river protection works described will pull in the same direction and reduce the danger of flooding (Fig. 3).

To some extent, the river protection works will reduce the danger of erosion along the reservoir. However, the impression is that the aspects of erosion and possible flooding, especially downstream the dam site, should have been given more attention.

Compensations in case of a future reduced water quality and/or saltination in the reservoir seem not to be sufficiently elucidated. In case of this, the irrigation part of the scheme has to be reconsidered too.

The resettlement problem which includes approximately 300 families should be paid special attention also after the completion of the project. Information given indicates that the Thai Government has established two committees to follow up the socio-economic and socio-cultural effects of the project. However, the value of such committees is dependent on the financial possibilities to amend disadvantages if they occur.

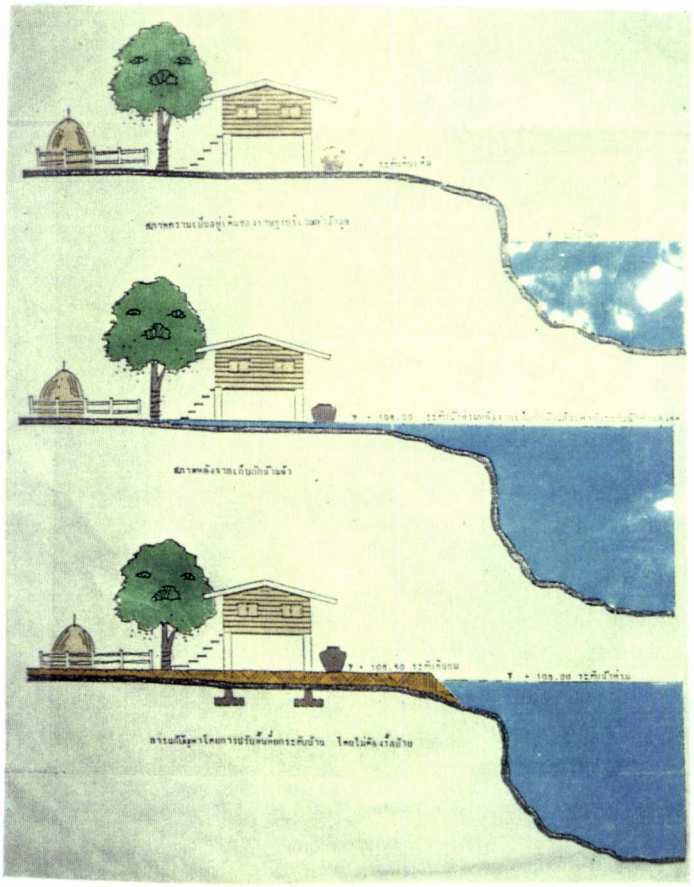

Fig. 2 Protection works to reduce the number of resettlements and danger of flooding.

Fig. 3 Example of rural settlement on the fertile banks of Mun river, which will be inundated in the area upstream the dam site.

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ABBREVIATIONS

The abbreviations used in the report are listed below:

DMI	Department of Mineral Investigation, Thailand
EB	Electric Bureau, Norway
EGAT	Electricity Generating Authority of Thailand
EIA	Environmental Impact Assessment
ESCAP	Economic and Social Commission for Asia and the Pacific
MSL	Meters above mean sea level
NEA	National Energy Authority, Thailand
NEB	National Environmental Board, Thailand
NGO	Non Governmental Organization
NORAD	Norwegian Agency for Development Cooperation
NVE	Norwegian Water Resources and Energy Administration
PFER	Project for Ecological Recovery
ONEB	Office of Environmental Board, Thailand

APPENDIX 1

LIST OF MEETINGS AND PEOPLE MET IN THAILAND, OCTOBER 18th - 23rd 1990

The Royal Norwegian Embassy in Bangkok

Johan Henrik Dahl;	Ambassador of Norway
Knut Langeland;	Second Secretary
Adirek Ratirattananont;	Marketing Consultant, Commercial Division

Economic and Social Commission for Asia and the Pacific (ESCAP), United Nations

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Kitti Kumpeera;	Division Chief, Ecology and Environment Division, Survey and Ecology Department, EGAT
Wanchai Naradej;	Assistant Manager, Power Utiliti es & Sales Division, Thai Virawat Co., LTD.

Travel from Bangkok to Ubon Ratchathani City to visit Pak Mun site

Wanchai Naradej (Thai Virawat) attended the study tour and meetings at Pak Mun site.

Meeting with the local EGAT administration and study tour to Pak Mun site and Mae Nam Mun River

Bhong Khamtee;	Assistant Project Engineer of Pak Mun Dam, EGAT
Paitoon Khumpibarn;	Securities Section, Pak Mun Project, EGAT, Ubon Province, Thailand
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Arammontry Sringarm;	C.E. Pak Mun Project (civil works), Ubon Ratchathani, EGAT
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People who have helped in giving informations and organizing meetings

The Royal Norwgian Embassy

Per Brekke;	Electric Bureau's (EB) representative in South East Asia, seated in Kuala Lumpur, Malaysia

Han Wongkomet; Managing Director, Thai Virawat Co.,

Ltd.

APPENDIX 2

SUMMARY OF PROJECT FEATURES

Location:

North Eastern region of Thailand, on the Nam Mun river, 70 km to the East of the city of Ubon Ratchathani, 6 km from the confluence with the Mekong, slightly upsteram from Ban Hua Heo.

Purpose:

Power, irrigation and fishery.

Hydrology.

Drainage area	117 000 km2
Average flow	737 m3/s
Average 10 - year flow	5 400 m3/s
Peak discharge, return period 2 years	2 750 m3/s
Peak discharge, return period 5 years	4 200 m3/s
Peak discharge, return period 10 years	5 900 m3/s
Peak discharge, return period 20 years	7 700 m3/s
Designed 100 - year flood	11 900 m3/s
Designed 1000 - year flow	18 500 m3/s

Natural inflow:

Month	Discharge (m3/s)	Month	Discharge (m3/s)
Jan	123.0	Jul	930.5
Feb	105.8	Aug	1 383.4
Mar	106.2	Sep	2 189.8
Apr	117.1	Oct	2 341.3
May	169.4	Nov	953.3
Jun	435.6	Dec	758.9

Reservoir:

Capacity at normal high water level	225 million m3
Active storage (for peak hours operation)	30 million m3
Average annual yearly inflow	24 000 million m3
Maximum retention level	108.0 MSL
Upstream water level, 1000 - year flow	110.4 MSL
Minimum operation level	107.5 MSL
Dry season retention level	105.5 MSL
Surface area at normal high water elevation	60 km2

Dam:

Type.....:	Roll - compacted concrete
Maximum heigth.....:	17 m
Crest elevation.....:	111 MSL
Crest length.....:	300 m
Crest width.....:	12 m
Fill volume.....:	104 000 m3
Upstream and downstream slopes:	1 : 1.75

Spillway:

Chute length.....:	217.5 m
Type of gate.....:	Radial (8 of)
Number of sluices.....:	8
Gate width (each).....:	22.5 m
Gate height.....:	14.74 m
Capacity.....:	18 500 m3/s
Upstream level.....:	108 MSL
Downstream level.....:	105 MSL
Crest elevation.....:	94 MSL

Channel:

Volume of excavation.....:	Between Ban Hua Heo site and Kaeng Ta Na site: 1 million m3

Powerhouse:

Type of turbine.....:	Horizontal axis Kaplan, double regulated unit
Number of turbines.....:	4
Runner diameter.....:	6.0 m
Turbine capacity.....:	34 MW
Installed capacity.....:	136 MW
Rated net head.....:	11.6 m
Minimum net head.....:	4.3 m
Maximum net head.....:	13.4 m
Minimum flow to be turbined...:	80 m3/s
Nominal unit discharge.....:	330 m3/s
Annual net energy.....:	280 GWh/year
Mean net peak power output....:	81 MW
Syncrhronous speed.....:	100 rpm
Frequency.....:	50 Hz
Transformers.....:	3 phases

Basic operation rules has been considered as follows:

January - May : * Upstream water level.....: 106 MSL
* Water release through 1 turbine: 100 m3/s (6 hours/day between 10 am and 4 pm)
* Peak energy production 6 pm to 10 pm

June - December: * Normal upstream water level....: 108 MSL
* Upstream water level if Mun river's inflow is greater than 2 000 m3/s.....: 107 MSL
* If the discharge is greater than 4 000 m3/s - open spillway and the river back to natural flow

Transmission lines

Power supply from Pak Mun dam will be transmitted to the Ubon Ratchathani Substation 2 (to be constructed), Ubon Ratchathani Substation 1 (Srisakesa Province) and the national grid.

From Pak Mun to Substation 2: 70 km - 115 kV double circuit.
From Substation 2 stringing one line of 115 kV.

APPENDIX 3

List of some report published in connection with the Pak Mun project. The reports reports available for this evaluation are marked (x).

1970 Feasibility study of the Pak Mun hydro-electric project, FSL 112 (NEA - SOFRELEC)

1980 "Up - dated Feasibility studies: Pak Mun Multipurpose Project", by SOGREAH Consulting Eng. (France) for Electricity Generating Authority of Thailand (EGAT), November 1980

1982 Environmental and Ecological Impact Assessment of Pak Mun project (EGAT - TEAM Consulting Eng. CO.)

1983 Review of the feasibility study taking account of the conclusions of the Environmental Studies and the creation of the Nature Park at Kaen Tana (EGAT - SOGREAH)

1984 (x) Final report, Selected Environmental and Ecological Investigation of Pak Mun Project, Volume I: Summary of Environmental and Ecological Impact Assessment, prepared by Team Consulting Eng. CO., Ltd. in association with Faculty of tropical medicine, Mahidol University, october 1984

1985 Pak Mun Multipurpose Development Project Feasibility Studies, Final Report (SOGREAH)

1986 Preliminary Framework on Pak Mun Water Control Project - Toward a New Concept (Mekong Secretariat)

1986 Pak Mun Water Control Project, - Northeast Thailand Project proposal - Mekong Secretariat

1989 (x) Pak Mun Project, Definite Study - Phase 2, Final Report, Volume I: Main Report, SOGREAH Consulting Eng., Grenoble France, September 1989

APPENDIX 4

Check lists for initial screening of projects - hydropower projects, from NORAD 1988.

This includes those projects which change the hydrologic regime in a watercourse by establishment of artificial dams, and by change in the flow or patterns of flow of water.

The project should be submitted to a more detailed assessment if it fulfils one or more of the criteria set out below, or if insufficiant information is available to answer "no" with a reasonable degree of certainty.

1. Flood areas which are of major significance for human settlement, agriculture, animal husbandry, or similiar?

2. Flood areas which support animal or plant life worthy protection or especially volnerable eco-system?

3. Flood areas which contain historic remains or landscape elements which are of importance to the local population?

4. Drain rivers or change the flow of water in such a way that it creates considerable changes for the environment and the utilization of natural resources?

5. Cause substantial changes in the flow of nutrient elements and fish production?

6. Create a risk for increased spread of water - borne diseases?

7. Change the way of life of the local population in such a way that it leads to considerabley increased pressure on the natural resource base?

8. Obstruct, or lead to substantial changes in the local populations exploitation or use of natural resources other than those directly affected by the project?

Fig. 2 Protection works to reduce the number of resettlements and danger of flooding.

Fig. 1 Map showing the location of the Pak Mun project. The sketch of Mun river shows the reservoir at elevation 108 MSL.

Fig. 3 Example of rural settlement on the fertile banks of Mun river, which will be inundated in the area upstream the dam site.

PUBLISHED IN THE SERIES

TAN 055-PHASE III.
Water Supply and Sanitation Development, Kigoma and Rukwa Regions Tanzania. 01-88
Hydrological investigations 1986-1989.
By Kjell Repp, Hydrological Department, NVE

Establishment of Hydrometric Stations within Quthing River Basin, Lesotho. 02-88
A Mission Report.
By Egil Skofteland, Division of Development Assistance, NVE.

Reorganization of the Technical Library at EDM. 03-88
A Mission Report.
By Trine Varkold, NVE

Small Hydro-Electric Power Development in the Northern Area, Pakistan. 04-88
A Mission Report.
By Fredrik Barth, Sverre Husebye and Torodd Jensen.

Seminar on Rural Electrification and Norwegian Development Assistance, 01-89
Holmen, March 14-15, 1989.

Small Hydro-Electric Power Development in the Northern Area, Pakistan. 02-89
Mission Report No. 2. Hydrology, Electro/Mechanical Equipment.
Torodd Jensen, Tore Knutsen, Oddmund Kristensen, Dan Lundquist, Einar Tesaker.

Hydrometric Stations within Quthing River, Lesotho. 01-90
Progress Report, 1989.
By Lars Evan Petterson, NVE.

Small Hydro-Electric Power Development in the Northern Area, Pakistan. 02-90
Mission Report No. 3.
By Torodd Jensen, NVE.

TAN 055-Water Supply and Sanitation Development, Kigoma Region, Tanzania. 03-90
Hydrological Investigations in Kigoma Region 1987-1988.
By F. Masanja, Ministry of Water, Tanzania, T. Herfjord, NVE and K. Repp, NVE.

Low Flow in Rukwa Region, Sumbawanga Area, Mpanda Area, Namanyere Area. 04-90
By Kjell Repp, NVE.

Fifth MAJI/NORAD Training Course for Hydrology Technicians. 16 October - 1 December 1989. 05-90
By J.M. Mihayo, MAJI and Bjarne Krokli, NVE.

Kigoma/Ujiji Urban Water Supply. Draft Report, November 1990. 01-91
By Torstein Herfjord, NVE and Mwesiga Lwakatare, MAJI.

Evaluation of the Environmental Impacts of the Pak Mun Project in Thailand.
By Sverre Husebye, NVE. January 1991. 02-91