A COST-BENEFIT ANALYSIS OF THE LAOS NAM THEUN TWO PROJECT

by

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Chapter 1

Introduction

Laos is one of the poorest countries in the world but is endowed with significant natural resources (see Table 1.1). The most abundant natural resource is water which offers significant potential for hydro-electric power development. Laos is situated almost completely within an area known as the Mekong River Basin and its water resources consist mainly of the Mekong's mainstream and its tributary streams. The "Mighty Mekong" is a sharp contrast to the underdeveloped socio-economic setting in the country. The main industries in the Laotian economy are the forest, garment, motorcycle and electricity industries (see Table 1.2). Electricity was the largest export item until 1992, when it was surpassed by assembled motorcycles and garments. Today, timber and wood products account for approximently 25 percent of the total value of exports.

The potential for export of hydro-electric power in Laos has barely been tapped. The Economist Magazine noted, in 1994, that only about one percent of the estimated 18,000 Mega Watt (MW) potential is being used for power generation. At present, the hydro-electricity for almost all of Laos is supplied by a single dam, Nam Ngum, located near Vientiane and constructed in the 1960s.

The promise of increased foreign exchange earnings from hydro-electric power development has prompted Laos to undertake an ambitious water development project on the Nakay Plateau of the Nam Theun River. The project - known as Nam Theun Two - involves

the construction of a large dam to harness hydro-electric power to be sold to Thailand. The NT2 dam project was identified in a 1989-91 United Nations Development Project Report and a World Bank funded feasibility study as the best option for hydropower development in Laos.

This paper will examine the economic costs and benefits of developing the Nam Theun River dam project and assess its economic, environmental and social impacts.

Chapter two provides an historical narrative on the evolution of the Lao People's Democratic Republic (PDR) and a short discussion of the current political system. This is followed by a discussion on the three stages of economic reforms that have been underway since 1979. These reforms consist mainly of structural adjustment programs developed by the World Band and International Monetary Fund.

Chapter three discusses the organizational framework for water development in Laos and provides a detailed discussion of the NT2 hydro-electric power project. Chapter four undertakes a cost-benefit analysis (CBA) of the NT2 dam project. The first part of chapter four introduces some basic theory of CBA and outlines the five methods that will be used in the subsequent analysis. The results of the CBA are presented and discussed in the main body of the chapter while all calculations are given in Appendix 4B and 4C.

Chapter five examines the economic, environmental and social impacts of the NT2 project and finally, chapter six draws some conclusions regarding the development of water resources in Laos.

Table 1.1 Country Profile Comparisons

	Laos	Thailand
Gross Domestic Product ($US)	1.7 billion	160 billion
Annual GDP Growth	7.0 percent	8.7 percent
Population	4.8 million	58.7 million
Urban Population	22 percent	20 percent
Population below the age of 15	45 percent	..
Population Density (people per square kilometer)	20	115
Total Land Area (square kilometers)	237,000	513,000
Life Expectancy at Birth	52 years	69 years
Infant Mortality Rate (per thousand live birth)	90	35
Illiteracy (% of population aged 15+)	43	6
GNP per capita ($US)	350	2,720
GNP per capita annual growth	4.6 percent	7.4 percent
Total Debt/GDP ($US)	121.0	42.5
Total Debt Service/Export ($US)	8.9	12.6
External Debt Per Capita ($US)	103	..
Bordering Countries	NorthWest: Myanmar (Burma) West: Thailand East: Vietnam North: China South: Cambodia	
Religion	Theravada Buddhism	
Climate	Subtropical	

Source: Trends in Developing Economies (1996): The World Bank.

Table 1.2 Sectoral Breakdown of GDP

Origins of GDP 1993	% of total	Principle Exports 1993	$US millions
Agriculture & Forestry	56.3	Timber and Wood Products	47
Industry (incl. construction)	15.8	Textiles and Garments	37
Services	27.9	Assembled Motorcycles	22
Total	**100**	Electricity	17
		Total incl. others	**203**
Main Destination of Exports 1994	% of total	Main Origin of Imports 1994	% of total
Thailand	20.8	Thailand	48.5
Japan	8.6	China	6.4
France	5.5	Japan	6.2
Germany	5.5	France	3..6
Netherlands	2.8	USA	1.7

Source: The Economist Intelligent Unit, Country Report on Laos, 4th Quarter 1995.

Chapter 2

The Political Economy of Laos

Historical Overview

The development of Laos began with the migration of the T'ai people from southern China to the Indochina peninsula between the sixth and thirteenth centuries A.D. A T'ai kingdom known as Nan Chao was established in the western part of the Chinese province, Yunnan. In the thirteenth century, Nan Chao was conquered by the Mongols resulting in large scale migration to the area known today as Laos.

In 1353, a Lao Prince named Fa Ngum founded the kingdom of Lan Xang by conquering most major regions of the country (see Table 2.1). Aided by the support of the Cambodian ruler, Fa Ngum was able to expand the kingdom of Lan Xang to cover the entire territory of Laos. For almost four centuries, Lan Xang constituted a kingdom in Indochina and represented a political state with clearly defined borders. The feudal monarchy ruled over a population composed of diverse ethnic groups, however, historians have identified the existence of a distinct Lao race and country.[1] The new state of Lan Xang was located in the centre of Indochina which left it vulnerable to attack from neighbouring countries such as Burma, Thailand and Vietnam.

In the early seventeenth century, the state of Lan Xang was weakened by constant internal struggles over succession to the throne. The struggles resulted in the division of the Lan Xang into three smaller kingdoms called Luang Prabang, Champassak and Vientiane.

This increased Laos' vulnerability to invasion and allowed Vietnam and Thailand to seize control over major regions of the country. Thailand eventually gained full control over all three individual states and reduced the king's role to that of a provincial governor.

Thailand's control over the country was short lived due to the growing influence of France in the mid 1800s. The French presence in Indochina began with a direct intervention in Vietnam in 1859. In 1886, France formalized its claim to Indochina by establishing a vice-consulate in Luang Prabang. The head of the vice-consulate, August Pavie, was instrumental in unifying the borders drawn by the three struggling kingdoms and, in 1900, established Vientiane as the centre of the government. This created a stability in Laos which lasted until World War II.

After the war, internal strife intensified. A two party system emerged, one adopting a western based capitalist ideology and the other following a communist ideology. The fight for political control brought the country near to civil war. In 1953, France granted Laos complete independence leading to new fighting between the two ideologues. The Royal Lao Government was backed by the United States while the Pathet Lao Communist Forces were backed by the former Soviet Union. International pressure for a solution to the dispute mounted as talks were held at the 1954 United Nations Conference in Geneva. The conference issued a declaration calling for a cease-fire and recommended that the Royal Lao Government assume rule over the country. [2]

The Geneva agreement had little binding effect on the two party struggle in Laos. After a coalition government in the late 1950s, fighting resumed throughout the 1960s and early 1970s. In February 1973, the two forces agreed to a cease-fire and later established a

new coalition government to maintain peace. Meanwhile, the communist party was successful in seizing control of the government in both Vietnam and Cambodia. On December 2, 1975, the communist forces also seized power in Laos by dismantling the monarchy and establishing themselves as the Lao People's Democratic Republic (PDR) (see Table 2.2).

The Current Political System

The Government of Laos is organized according to the three traditional branches of power; the Executive Branch, the Legislative Branch and the Judicial Branch. The Executive Branch is controlled by the president who is both head of state and commander in chief of the armed forces. In the Legislative Branch, policies are formulated in the National Assembly subject to approval of the president. The Judicial Branch is governed by a standing committee formed from the National Assembly (see Table 2.3).

The highest executive body in the government is the Council of Ministers. The chairman of this body appoints council members while the vice-chairman oversees responsibilities in all government departments operating within the council.

The key figure in the Laotian government is the president, Khamtai Siphandon. He is regarded (by political observers) as a transitional leader by uniting three important elements of the state; the political party, the military and the government hierarchy. Another key figure is the head of the State Committee for Planning and Cooperation (CPC), Khamphoui Keoboualapha. The role of the CPC includes setting economic and social development priorities, facilitating foreign investment and reviewing foreign aid dispursements. The CPC

has long been regarded (by political observers) as the government within the government and its head (Keoboulapha) as the economic chief of the country.

The Economy

In 1975, the People's Democratic Republic (backed by the former Soviet Union) introduced communist policies that eventually led to the collapse of the economy. Faced with a steadily declining economy combined with pressure from international creditors, the government introduced extensive economic reforms in 1979. The first stage of economic reform (1979-88) led to:

1) Removal of various restrictions on internal and external trade.

2) Devaluation of the national currency, the Kip.

3) Dramatic increase of official prices; especially for agricultural commodities.

4) Granting of operational autonomy to firms to permit them to determine production, investment, employment and wages.

5) Private sector activity was allowed in almost all sectors.[3]

This initial stage of reform was the beginning of a transition from the Marxist style, centrally planned economy, in favour of a free market system. Through its support of this first stage of economic reform, the Government of Laos began to transform itself into a mixed economy.

The Second Stage of Economic Reform began in 1989 and lasted until 1993. It included a Structural Adjustment Program (SAP) endorsed by the World Bank and the IMF. The SAP introduced the following economic reforms:

1) Promotion of private sector investment by privatizing state-owned enterprises.

2) Introduction of a legal framework for foreign direct investment.

3) Elimination of government bank borrowing and curtailment of credit to state enterprises.

4) Flexible management of the exchange rate.

5) Further liberalization of international trade.

6) Strict limits on the issue of new external debt.

7) A two tier banking system with a central bank and a commercial banking network.

8) Introduction of a new constitution (in 1991) as a basis for new business and regulatory laws.[4]

Domestic and international investors responded favourably to the economic reforms which led to robust growth in the small manufacturing sector and a recovery in agricultural production. Real GDP growth exceeded four percent in each year from 1990 to 1994 (see Table 2.4). The strong output growth combined with tight monetray policy (reduced government borrowing and credit restrictions) succeeded in reducing the inflation rate from 82 percent in 1989 to 6 percent in 1992.[5]

An increase in the exports of electricity, timber products and garments combined with a slowdown in the growth of imports (due to tight monetary policy) resulted in a considerable reduction in the current account deficit. Foreign reserves in the banking system increased sharply and the debt service ratio decreased from 20 percent to 15 percent during the period 1988-92.[6] Overall, the SAP was successful in bringing about a considerable degree of macroeconomic stabilization.

The third stage of economic reform, initiated in 1993, involved another structural adjustment program (SAP) which maintained many of the same goals and objectives of the previous one. The new reforms included:

1) Privatization of almost all state enterprises and reduction in the size of the civil service.

2) Introduction of regular treasury bill auctions in an attempt to install indirect monetary management.

3) Opening of new private sector banks.

4) Elimination of all remaining restrictions on international current account transactions.

5) Reduction in the number of tariff schedules by 50 percent.

6) Introduction of the Harmonized System for coding commodities.[7]

Macroeconomic performance following this stage of reform has once again been favourable. Real GDP growth was strong in both 1993 and 1994 (see Table 2.4) while inflation has remained stable at around 6 percent. The expansion in foreign trade continued as exports continued to grow around a huge influx of foreign direct investment.

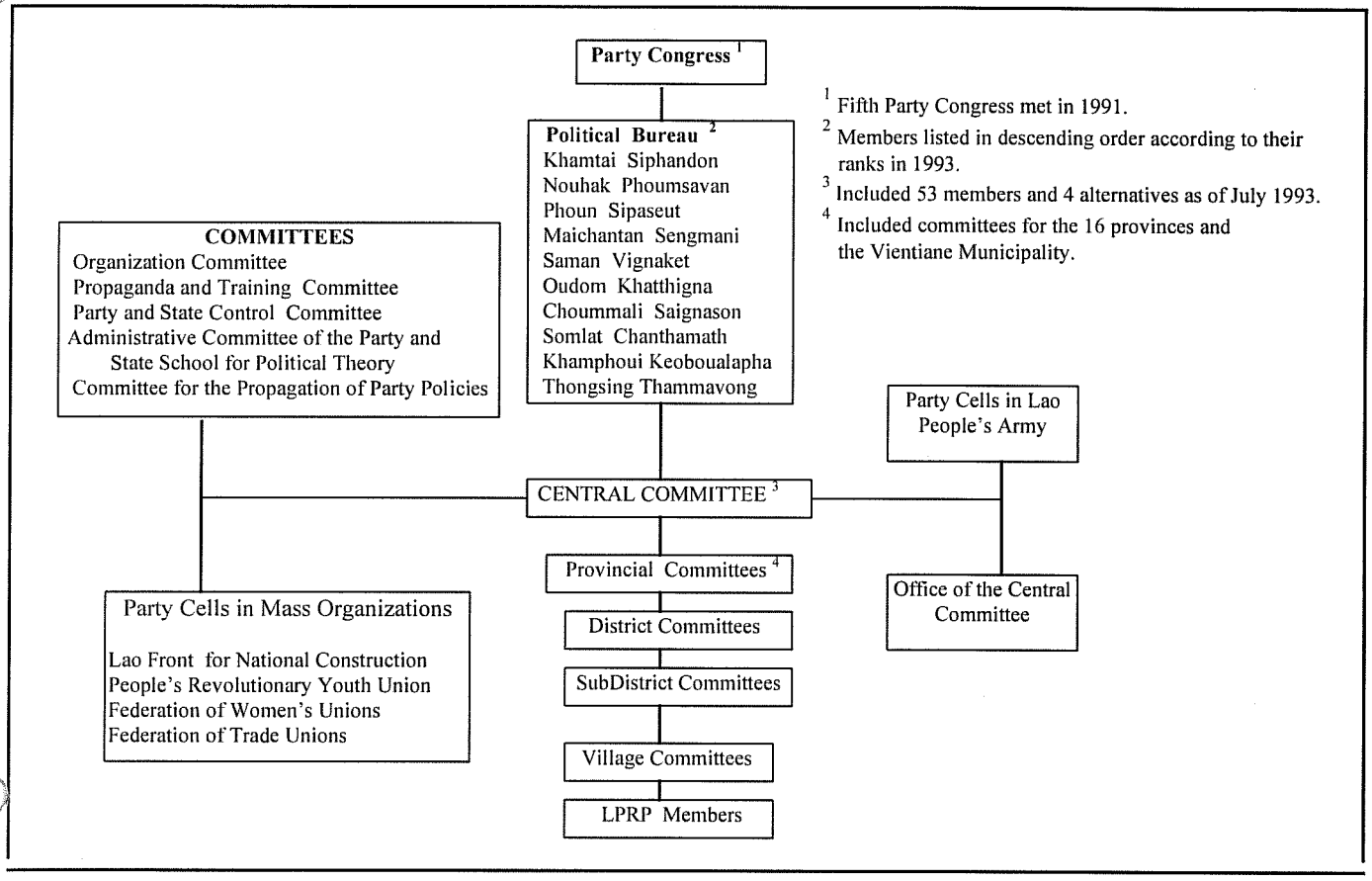
Although the series of macroeconomic reforms have been successful, Laos remains one of the poorest and least developed countries in the world. Despite its poverty, compared to other developing countries Laos is endowed with a rich and abundant supply of natural resources including untapped reserves of agricultural land, virgin forests, and a vast potential for hydroelectric power. One of the most important policy challenges facing the present government is to establish domestic resource mobilization - an essential element in the government's quest for economic development and future growth. This paper examines the feasibility of the government's attempt to harness the country's potential for hydroelectric power in the Nam Theun Two River Dam Project.

Table 2.1 Major Historical Events

1353	Laos was first unified by Fa Ngum, who captured Xieng Dong-Xieng Thong and brought several scattered fiefdoms together to form the powerful Kingdom of Lan Xang (Land of the Million Elephants). He was born in 1316 and died in 1374.
1376	First census taken of the population of Lan Xang during the accession of Sam Sen Thai. There were three hundred thousand people living in the Kingdom of Lan Xang.
1566	The construction of Wat That Luang by King Saya Setthathirat.
1633	King Souligna Vongsa succeeds to the throne. During his reign, the kingdom experienced more growth and prosperity than any other accession throughout history.
1690	The death of King Souligna Vongsa precipitated new succession disputes which lead to the division of Lan Xang. The Kingdom eventually divided into three small kingdoms; they were Vientiane, Luang Prabang, and Champassak.
1820	First Hmong migration into Laos.
1887	August Pavie arrived in Luang Prabang as France's first vice-consul.
1899	France unifies the administration of Vientiane, Luang Prabang, Champassak, and Xieng Khouang into one entity called Laos.
1907	Franco-Siamese (Thailand) treaty cedes three western-most provinces of Cambodia to France and adjusts the border between Siam and Laos.
1925	Franco-Siamese treaty. Agreements finalized all outstanding border questions and created a permanent Franco-Siamese High Commission of the Mekong (it is now called the Mekong River Commission).
1945	King Sisavang Vong proclaims independence of Laos under Japanese duress. Six months after, the Provisional Lao Issara National Assembly voted to depose King Sisavang Vong. The King was reinstated in 1946 as the King of Laos in return for royal legitimization of the provisional government's action.
1950	The Pathet Lao Resistance Party, headed by Prince Souphanouvong and Kaysone Phomvihane, received a majority vote from the First Congress of Representatives of the Free Laos Front and took government office.
1955	The formation of the Lao People's Party and Laos is admitted to the United Nations.
1959	The death of King Sisavang Vong and the succession of King Savang Vattana (the last King of Laos).
1975	Laos declares independence and proclaims Lao People's Democratic Republic (Lao PDR).
1986	Difficult transition and adjustment force the government to introduce new economic reform packages called The New Economic Mechanism (NEM). Its main purpose is to transform a central planned economy into a market-oriented economy.
1993	Laos applies for membership in the Association of South Eeast Asian Nations (ASEAN) and is expected to be a full member in 1997.

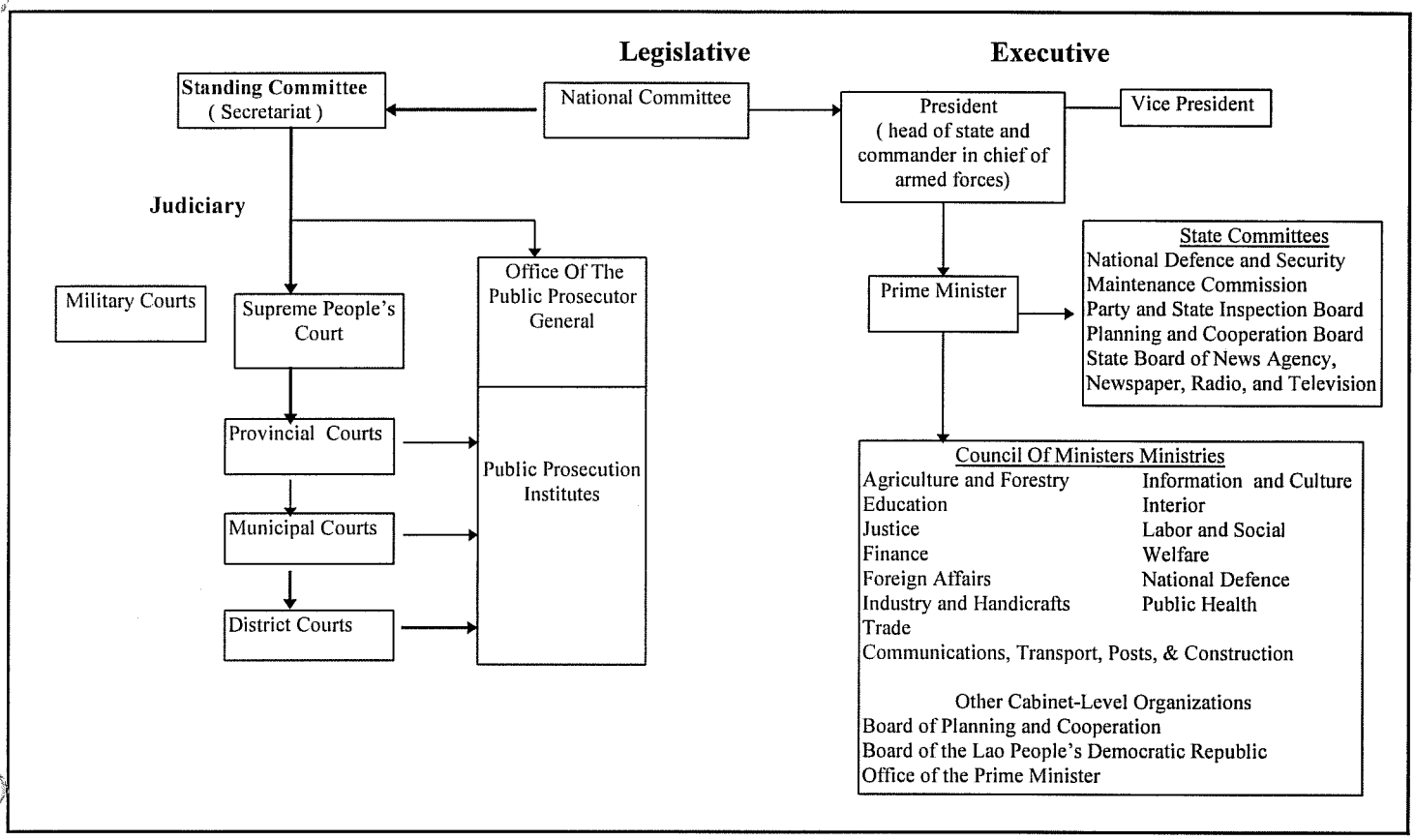
Source: Economic Intelligence Unit (1995), Maha Sila Viravong (1964), Geoffrey Gum (1990), Arthur Dommen (1985), and The Far East Economic Review (1994).

Table 2.2 Lao People's Democratic Republic Party Organizational Chart



Source: Savada (1995). *Laos: A Country Study.* Washington D.C. : United States Department of the Army, pp. 210 &230.

Table 2.3 The Political System



Source: Savada (1995). *Laos: A Country Study*. Washington D.C. : United States Department of the Army, pp. 210 &230.

Table 2.4: Key Economic Indicators

Economic Indicators	1990	1991	1992	1993	1994
GDP at current prices K bn	613	725	838	935	108
Real GDP growth %	5.9	4.0	7.0	5.2	8.4
Consumer price inflation %	35.9	3.3	9.8	7.3	6.7
Population $US(m)	4.2	4.2	4.3	4.4	4.5
Exports fob $US(m)	79	97	133	203	278
Imports c.i.f. $US(m)	185	210	244	392	486
Current account $US(m)	-84	-44	-41	-82	..
Reserves excl. gold $US(m)	61	55	81	151	..
Total external debt $US(m)	1768	1875	1917	1986	..
Debt-service ratio %	8.7	6.3	4.9	9.6	..
Exchange rate (avg.) K/$US	708	702	716	717	719

November 24, 1995. Kip 920 = $US 1

Source: The Economist Intelligent Unit, Country Report on Laos, 4th quarter 1995.

Notes

1. Arthur J. Dommen. *Laos: Keystone of Indochina*. p. 19.

2. --------. p.46.

3. International Monetary Fund. *The Lao People's Democratic Republic: Systemic Transformation and Adjustment*. Eds. Ichiro Otani and Chi Do Pham. pp.9-13.

4. --------. pp. 14-15.

5. --------.

6. --------.

7. --------. pp.16-19.

Chapter 3

The Nam Theun Two Hydropower Project

Despite the success of recent economic reforms, Laos still has serious health, education, and infrastructure problems including a very high infant mortality, low literacy rates and no road access nor electricity to many rural communities. A large majority of the population survives on various forms of agriculture with sixty percent of the population still operating as subsistence farmers.[1] Low income levels and geographical isolation (it is a landlocked country with a mountainous topography) combined with strong growth in other south-east Asian nations has left Laos searching for a new path toward economic development.

Water resources are the most important component of Laos' natural resource base (beside forest products) and their vast potential for hydropower is the country's most significant renewable resource. Laos is situated in an area known as the Mekong River Basin with abundant water resources stored in the Mekong's mainstream as well as in tributary streams. The Mekong is a rich resource in an area where people are still among the poorest in the world.[2] Given its natural endowment of water resources along the Mekong River, combined with high levels of monsoonal rain during the months of July and October, hydropower represents the most immediate development opportunity for Laos.

The primary organization in charge of water planning in Laos is the United Nations sponsored Mekong River Commission. The Commission received legal status in 1995

following a new agreement with the Laotian government. Prior to the 1995 agreement, an interim committee had existed from 1978 to 1995 with representatives from Laos, Cambodia, Thailand and Vietnam.[3] The new Mekong River Commission, however, is Laotian and does not require the consent of delegates from other south-east Asian nations in planning water development projects. It is responsible for the coordination, planning and development of water projects in the Mekong River Basin.

Sustainable development of Laos' water resources over the long term includes adequate policy planning. The national organizations responsible for water related policy matters are the following:

1) Electricité du Laos - Responsible for the construction of all electric power plants - including hydroelectricity - as well as the sale of electric power.

2) Ministry of Industry and Handicraft - In charge of matters related to industrialization.

3) Ministry of Post and Transport - Responsible for preparing and implementing legislation concerning water supply, drainage and navigation.

4) Water Supply Company - Duties include the design and construction of Laos' water supply system as well as the provision of water for domestic and industrial use in Vientiane.

5) Ministry of Public Health - Responsible for ensuring quality of drinking water and distributing water to mountainous regions.

6) Ministry of Agriculture and Forestry - Mandate includes issues related to fisheries in the Mekong and other rivers.[4]

The Lao Ministry of Industry and Handicrafts estimates the country's hydroelectric power potential at 18,000 megawatts (MW) of which about one percent is being used for

power generation.[5] Virtually all of the hydroelectric power in the country has been supplied by a single dam - Nam Ngum located near Vientiane and which was constructed in the 1960s. During the 1970s and 1980s, this dam project was the largest source of Laos' export earnings via hydropower sales to Thailand.

Compared to Laos, neighbouring Thailand is an economic superpower (see Table 1.1) experiencing rapid growth in electricity demand and struggling to meet that demand because all potential hydroelectric sites have already been utilized. Thailand's Electrical Authority, EGAT, is aggressively seeking reliable and sustainable power supplies from Laos. A ready nearby market combined with abundant water resources has prompted Laos to plan the construction of 23 dams for hydropower to be completed by the year 2010.[6] The most ambitious project is the Nam Theun Two reservoir dam.

The origin of the NT2 project dates back to 1984-85, when the South Mekong Economic Communittee (SMEC) carried out a pre-feasibility study of potential hydroelectric power projects in the Nam Theun Basin. In 1987-88, the Motor Columbus Consulting Firm undertook a study in which they ranked three major hydropower projects and recommended NT2 as the most desirable project. During the period 1989-91, the SMEC performed a feasibility study leading to a July 1991 United Nations Development Program (UNDP) donors meeting to discuss the NT2 project. In March 1993, a memorandum of understanding on NT2 was signed between the Government of Laos and the Thailand River Authority Network of SMEC (TRANSMEC).

The site for the NT2 reservoir is located in central Laos on the Nakay Plateau, 400 kilometres south-east of Vientiane and 50 kilometres north-west of Thakkhet (see Figure

3.1). The total area covers approximently 450 square kilometres. At the northern end of the site, a 50 metre high dam is planned for construction that will have the capacity to store 2.74 billion cubic metres of water. It is estimated that the water will cover 50 percent of the site's total area. A catch basin area is located east of the site. This catch basin area is estimated to receive approximently 2,200 millimetres of monsoonal rain between the months of July and October.

In order to reach the construction site, about 74 kilometres of existing road must be upgraded and 82 kilometres of new road must be built. Upon completion of the roads, the proposed 681 MW hydroelectric power station will be placed near the base of the site, adjacent to the reservoir, about 40 kilometres south-east of the dam wall. It is estimated that the water intake system can deliver about 210 cubic metres of reservoir water per second to the power station through two large tunnels. Each tunnel is 7 metres wide and 2.4 kilometres long.

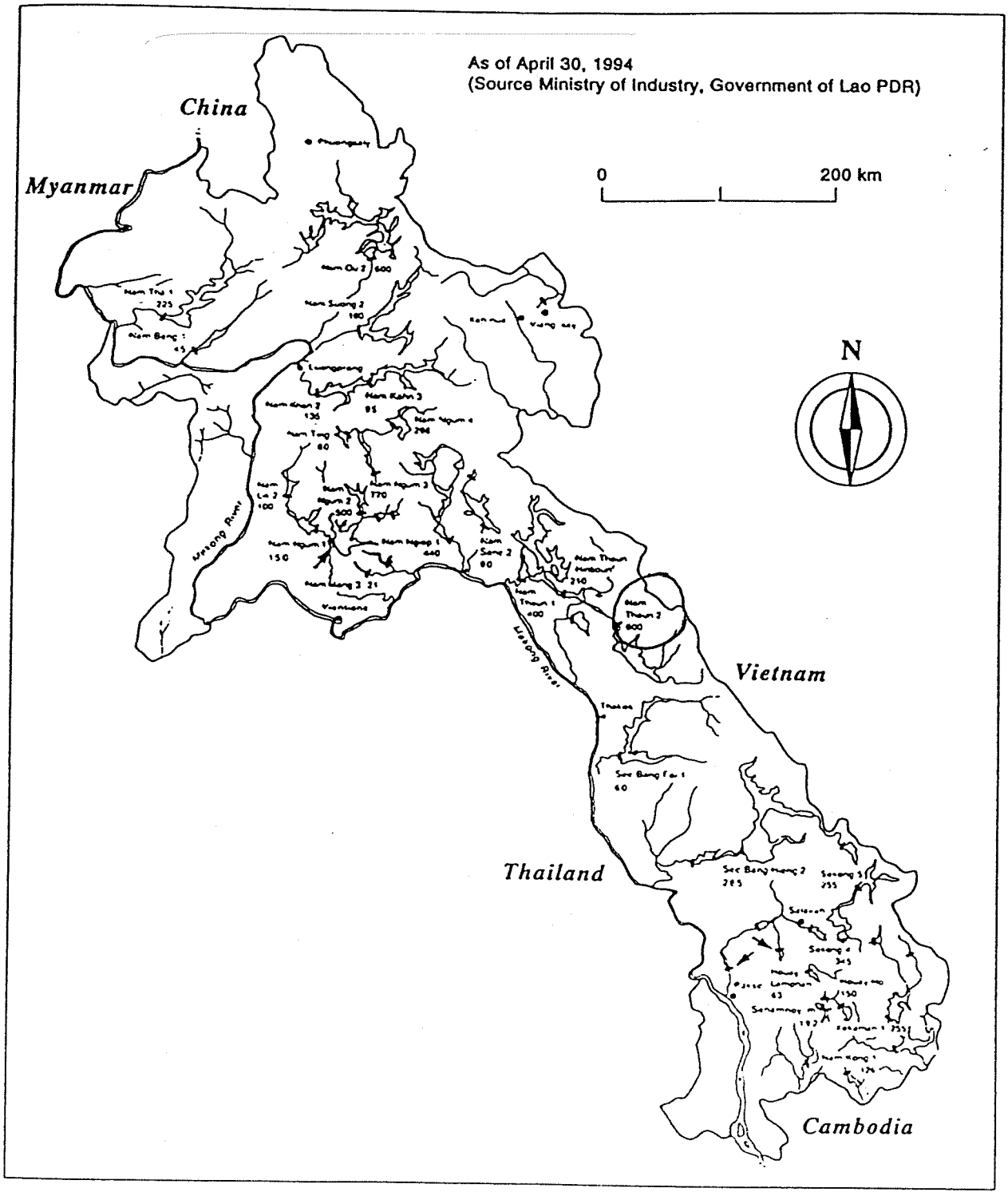
The water discharged from the power station will be released into a channel built with a weir which would regulate the discharge of water. The gradual discharge of water into the Nam Phit River and then into the Xe Bang Fai River would not cause problems to villagers living downstream.[7] The channel will divert 6 billion cubic metres of water from the Nam Theun to the Xe Bang Fai River System.

Two double circuit transmission lines, with a capacity of 230 Kilovolts (KV) and stretching 140 kilometres, will be used to transfer the electricity directly from the power station to the Thailand border. At the Thai border, near Savanakhet, the electricity will be metred and transferred to the Thai Power Authority.

The Government of Laos will own 25 percent of the project and be entitled to tax receipts, resource levies and dividend income. These income sources are expected to contribute $US 3 billion to the Government of Laos in the first 25 years of the project and an additional $US 400 million per annum thereafter for the life of the project.

It is estimated that land and about $US 5 million in financial compensation will be awarded to the approximately 4,000 people (900 families) that will be displaced due to flooding near the project site. The resettlement compensation income is equivalent to about $US 1,300 per person - an amount almost four times Laos' GDP per capita. A cost-benefit analysis of NT2 dam project is presented in chapter four while the environmental and social considerations of the dam are discussed in chapter five.

Figure 3.1 Map of Laos



Source: Jacobs, Jeffrey (1996).

Notes

1. Jeffrey Jacobs. "Planning For Change and Sustainability in Water Development in Lao PDR and the Mekong River Basin." p. 175.

2. M. Hiebert. "The Common Stream." Far Eastern Economic Review, 21 February, 1991. pp. 24-26.

3. Jacobs. p.180.

4. -------. pp. 180-81.

5. -------. p. 176, 179.

6. -------. p. 176.

7. Australian Feasibility Study of Nam Theun Two Project, 1989.

Chapter Four

Nam Theun Two: A Cost-Benefit Analysis

The World Bank has outlined a systematic step by step process for the successful completion of development projects which it funds. Each project undergoes various phases of analysis, from conception to monitoring of the project after its completion. The phases of the project cycle include:[1]

1) Identification - selection of projects that appear to be economically feasible.

2) Preparation - prefeasibility studies provide the background for later analysis.

3) Appraisal - A comprehensive review of the economic, environmental, institutional and engineering aspects of the project. Cost-Benefit Analysis is used at this stage of the project cycle and is the basis for deciding whether to invest in the project.

4) Negotiations and Financing - the borrower and the donors discuss the measures required for successful completion of the project.

5) Implementation and Supervision - carried out through periodic field visits by the donors and submission of progress reports from the borrower.

6) Evaluation - audits by an independent agency to ensure funds are used properly.

The appraisal stage is the most important phase of the cycle where a decision is made whether to invest money in the project or not. The decision to accept or reject a project is based on the results of a cost-benefit analysis (CBA).

CBA seeks to assess project costs and benefits using a common decision rule. Benefits are defined in terms of their socio-economic impact on society and in their improvements in human well being. Costs are defined in terms of project costs and also in terms of costs to society resulting from the development of a project. Where appropriate data and information is available, it is necessary to extend conventional cost-benefit analysis to include environmental and social considerations. However, it is often difficult to quantify non-market environmental and social costs and benefits. Despite its shortcomings, CBA is an economic tool that provides a consistent set of technical guidelines - derived from economic theory - to help an organization make a sound and rational decision.

Methods of Cost-Benefit Analysis

The most basic and widely used technique of CBA for project evaluation is the Net Present Value (NPV) method. The NPV is defined as the discounted value of all future streams of revenues and accumulated costs.[2] The mathematical notation is as follows:

$$NPV = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+r)^t} - C_0 ,$$

where B_t and C_t are the forecasted benefits and costs, r is the discount rate, n is the time horizon, and Co is the initial cost. The decision rule under this method is, when the NPV is greater than zero, then the project should be accepted. However, in most cases, the NPV must be significantly greater than zero before a decision is made to implement a project. If there is more than one potential project, the decision rule is to choose the project with the highest

NPV. If two projects have positive NPVs and project A has a higher NPV than project B then A will be chosen. If both projects have a negative NPV then both will be rejected.

Another method employed in undertaking CBA is the Internal Rate of Return (IRR) method. The IRR is the discount rate which reduces the NPV to zero. The decision rule under this method is that the project be accepted if and only if the IRR exceeds the required rate of return. If there are two or more projects under consideration the decision rule is to choose the project with the highest IRR provided that both exceed the required rate of return. This method is preferred by some analysts since it avoids a controversial decision on an appropriate discount rate. However, problems can occur if alternative projects have widely differing life spans so that the choice of an appropriate discount rate is crucial.

Another frequently used method is the Net Benefit-Cost Ratio (BCR). This method is also a derivative of the NPV method and its mathematical notation is:

$$BCR = \frac{\sum_{t=1}^{n} B_t / (1 + r)^t}{\sum_{t=1}^{n} C_t / (1 + r)^t + C_0}$$

The BCR is the ratio of the NPV and the discounted costs. The decision rule is to accept the project if the BCR is greater than one so that the discounted net benefits exceed or equal the discounted costs. However, in almost all projects there are costs that cannot be accounted for so that often a decision to implement a project is that the BCR be greater than one.

These three methods are the key elements of CBA and are the most widely used. The NPV method is the most popular. There are also two other supplementary methods that have been discussed in the CBA literature.

The discounted payback (DP) method is used to determine the length of time it takes for a project to recover all of its costs. The number of years (n) is determined by:

$$\sum_{t=1}^{n} \left[X_t / (1+r)^t \right] \geq C_0, \qquad \text{where } X_t \text{ is the cashflow and } C_0 \text{ is the initial costs.}$$

The discounted payback is the number of years it takes for a project to break even from its initial investment.

The final method is called the Wealth Maximizing Return (WMR). This method measures the percentage increase in real wealth of the project or the growth of the original investment during the project's lifespan. It is an alternative rate of returns, other than the IRR, and is defined as the compounded rate of return obtained on the original investment.[3] The WMR is calculated as follows:

$$WMR = \sqrt[n]{\frac{\sum_{t=1}^{n} \left[B_t (1 + BAAR)^{n-t} \right]}{C_0}} - 1 \qquad \text{where } B_t \text{ is the benefits \& } C_0 \text{ is the intial costs}$$

The WMR is then compared to the best interest rate available in the marketplace during a particular time period in question. The decision rule for the WMR method is to accept the project if the WMR exceeds the best available alternative rate (BAAR) and the BAAR is the same as the loan rate.

The five methods of undertaking CBA will all be used in the analysis of the NT2 dam project. Statistical data and information regarding the monetary aspects of the dam is readily available. However, information on the environmental and social aspects of the project is either hard to obtain or very difficult to quantify. As a result, the monetary aspects of the

project are covered in a quantitative CBA while the broader environmental and social concerns are dealt with qualitatively in chapter five.

CBA of The NT2 Project

The Government of Laos has considered two options regarding the construction of the NT2 project. The first option - which will be termed Project A - involves the construction of the dam in two phases. The first phase involves building a 300 MW power station with construction beginning in 1992 and ending in 1999 for a total of seven years. The second phase is to enlarge this station to its full operating capacity of 600 MW with construction beginning in 1999 and ending in the year 2005 for a total of 6 years. The total time required to complete the 600 MW power station under project A is 13 years.

The second option considered by the Government of Laos - which will be termed Project B - is to build the 600 MW power station in one phase beginning in 1992 and ending in the year 2000. Project organizers estimate that construction of this magnitude will take approximently eight years to complete (see Table 4A1, Appendix 4A). The Government of Laos actually chose this option. The construction began in 1992 and is due to finish in the year 2000.

The key assumptions underlying the CBA of each project are as follows:

1) The initial cost of the project is the discounted construction cost.

2) All costs and benefits are valued in 1992 $US.

3) The life of the project is 50 years.

4) The contingent and intangible costs associated with the project are assumed to be 10 percent of construction costs.

5) Annual operating costs of $US 8.3 million and annual logging loss of $US 9.2 million commence on the completion date of the project for a combined annual cost of $US 17.5 million. The logging loss represents the decline in the domestic energy consumptions of timber products. A 10 percent allowance (for contingent and intangible costs) is also applied to these costs. The total annual cost after completion of construction is $US 19.25 million.
6) The environmental and social costs are excluded from the calculations due to insufficient data and difficulties in using valuation techniques to quantify these measures.

The financial benefits of the NT2 project are estimated (by the Government of Laos) to be approximently $US 3 billion for the first 25 years of operation and $US 400 million per year thereafter for the remaining life of the project. The yearly distribution of the $US 3 billion is assumed to be in accordance with the two construction options (Project A and Project B) considered. The first phase of project A will have benefit streams totalling half of the annual distribution of $US 3 billion over six years and the second phase will have the full annual distribution of the benefits over the following 19 years. The total benefit streams for project A are $US 68.18 million for the first six years, $US 136.36 million for the next 19 years and $US 400 million thereafter for 25 years.[4] A projected total time period for the benefits of the project is 50 years.

For project B, the distribution of the $US 3 billion value is in the form of annual benefits of $US 120 million over 25 years and an annual benefit of $US 400 million for the next 25 years.[5] The total time period for the benefits is assumed to be 50 years.

The initial cost for the NT2 project is separated according to the two construction options considered. The initial cost of each project is the summation of the discounted

distributional costs. These costs are outlined in Tables 4A1 and 4A2 of Appendix 4A. Table 4A1 shows the annual breakdown of costs for both projects and Table 2 shows a detailed breakdown of the construction costs for project A.

An important consideration in discounting all costs and benefits is choosing a discount rate. If all costs occur in the early years of the project and benefits in later years, discounting reduces the chance the project will be implemented. To overcome the potential bias in the decision to implement the project, the CBA uses three different discount rates of 7 percent, 9 percent, and 11 percent for each method. All CBA calculations are shown in Appendix 4B.

The Results

The length of time needed to complete the 600 MW power station is the only difference in the calculations of project A and project B. Project A's results - using the five methods discussed earlier and three discount rates - are shown in Table 4.1. With a 7 percent discount rate, the results show a NPV of $US 824 million, an IRR of 14.65 percent, a BCR of 2.65, a discounted payback period of 6.06 years and a WMR of 12.46 percent when the BAAR equals 10 percent. The WMR is an excess return of 2.46 percent above the borrowing rate of 10 percent.

Table 4.1: Project A's Results

Discount Rate	NPV ($US millions)	IRR	BCR (PI)	Discounted Payback	WMR if BAAR = 10%	14%	18%
7%	**821.242**	**14.65 %**	**2.64**	**6.08 yrs.**	**12.46%**	**16.46%**	**20.48%**
9%	397.678		1.95	5.89 yrs.	11.72%	15.71%	19.84%
11%	177.454		1.50	5.55 yrs.	11.10%	15.07%	19.18%

The project has a positive NPV for each discount rate considered and a favourable internal rate of return. The BCR is above the required criteria of one and the WMR exceeds the BAAR. Project A's benefits are 265 percent greater than its costs and the time required to recover these costs is less than seven years. In terms of the five methods employed in the CBA, project A is an economically acceptable project.

The results for project B - shown in Table 4.2 - are similar to project A.

Table 4.2: Project B's Results

Discount Rate	NPV ($US millions)	IRR	BCR (PI)	Discounted Payback	WMR if BAAR = 10%	14%	18%
7%	**791.711**	**13.96 %**	**2.52**	**3.57 yrs.**	**12.26%**	**16.27%**	**20.28%**
9%	375.629		1.85	3.40 yrs.	11.51%	15.49%	19.72%
11%	157.749		1.41	3.24 yrs.	10.88%	14.84%	18.94%

The NPV is positive for each discount rate, the internal rate of return is favourable, the BCRs are all greater than one, the discounted payback period is short and the WMRs are all greater than the BAAR. With a NPV of $US 792 million and an IRR of 13.96 percent (under a 7 percent discount rate), project B is also an economically acceptable project.

A comparison of the results of the two projects show that project A has a higher NPV and a higher WMR for each discount rate considered. In addition, project A has a higher IRR and BCR. Project B has a shorter discounted payback period for each discount rate considered. This implies that project B is able to generate more benefits and recover its initial construction costs quicker than project A. This result is an intuitive one given that the construction period for project B is much shorter. Despite the advantages of project B, the most compelling factors in the CBA are the higher NPVs, the higher IRR and the higher

WMRs associated with project A. For most investors, these factors are valued more than the length of time required to recover an investment. In terms of investor preferences and, more importantly, in terms of the decision rule in CBA, project A is preferred to project B even though both are economically acceptable projects.

The results in Tables 4.1 and 4.2 show that the discount rate is inversely related to the NPV of the project. This relationship is shown in Figure 4.1.

Figure 4.1: The NPV and Discount Rate Relationship

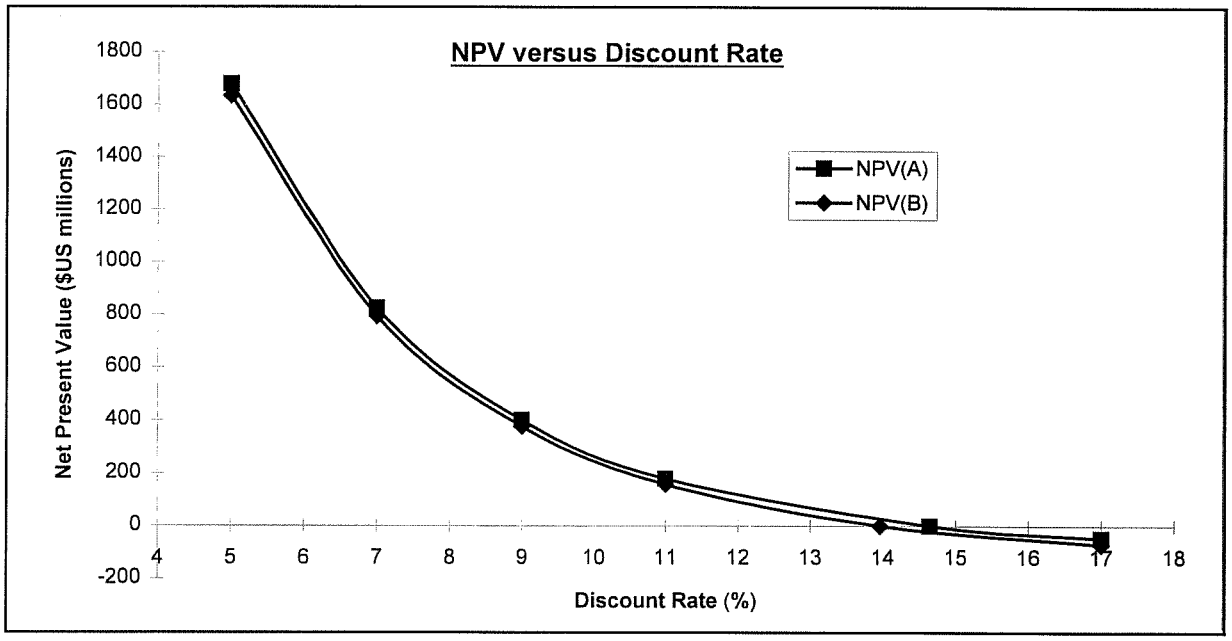


Figure 4.1 reveals that the NPVs of both projects are closely related over all discount rates and that the NPVs appear to be more sensitive to low discount rates. For every two discount rate intervals between 5 and 11 percent, the NPVs decrease by one half. This suggests that low discount rates have a greater impact on increasing the NPV of a project than high discount rates do on decreasing the NPV.

Sensitivity Analysis of The Results

The objective of a sensitivity analysis is to determine whether a project is still viable given that there are measurement errors and unforseen outcomes. The analysis proposes three scenarios with the calculations and results for each are given in Appendix 4C.

The first scenario assumes that after the dam project is completed, the annual operating and logging costs double while the initial construction costs remain unchanged. The results in Appendix 4C, Scenario 1, confirm that the NPVs and IRR of project A are acceptable and higher than that of project B. In short, project A still should be accepted.

The second scenario assumes that - other things being equal - the project experiences a 10 percent decrease in annual revenue after the dam project is completed. The results (Appendix 4C, Scenario 2) again confirm that project A is economically acceptable and preferred to project B. The impact of the 10 percent decline in revenue, under scenario 2, is larger than the impact of the doubling of annual operating and logging costs under scenario 1. This is because revenues are assumed to change by more than costs. Empirical studies have shown that, if costs and revenues are assumed to change (increase or decrease) by the same amount and revenues are greater than the costs, then the impact of the revenue change is greater than the impact of the cost change.

The final scenario assumes a combination of the doubling of annual costs and a 10 percent revenue reduction (both scenario 1 and scenario 2). The results again confirm that project A is economically viable and preferred to project B. With a NPV of over $US 500 million (under a 7 percent discount rate), the project could withstand even more negative impacts unforseen by project organizers.

The three scenarios presented in the sensitivity analysis suggest that the NT2 project is economically viable under a number of different scenarios. Chapter 5 will consider the environmental and social aspects of the project.

APPENDIX 4A: DETAILED COST COMPONENTS OF THE NT2 DAM PROJECT

Table 4A1: Yearly Cost Distribution (undiscounted)

Project A		Project B	
Phase I: Development of 300 MW		Phase I: Enlargement to 600MW in one stage	
Year	Costs ($US millions)	Year	Costs ($US millions)
1	10.2	1	13.0
2	14.2	2	17.0
3	46.3	3	63.0
4	88.9	4	133.5
5	122.2	5	178.5
6	41.7	6	61.9
7	14.7	7	23.5
		8	6.9
Total	**338.2**	**Total**	**497.3**
Phase II: Enlargement to 600MW			
8	3.6		
9	25.0		
10	61.9		
11	53.8		
12	14.4		
13	5.5		
Total	**164.2**		

Sources: The Australian Feasibility Study of NT2; Government of Lao P.D.R official cost estimates.

Table 4A2

DETAILED BREAKDOWN OF THE COST COMPONENTS FOR PROJECT A

Summary Of The Construction Cost Estimates

Capital Costs in Laos		**Other Capital Costs in Laos**	
Dam	25,625,780	Access roads in project area	10,980,000
Headwater channel	21,747,000	Road, Thakhet to Project	5,030,000
Intake structure	5,549,892	Reservoir clearing	500,000
Tunnel structure	36,580,390	Resettlement land resumption	4,310,000
Power station	10,633,681	Engineering	22,128,077
Switching station	250,140	Government Costs	6,631,823
Tailwater channel	1,713,140	Subtotal	49,579,900
Reregulating weir	2,783,682		
Downstream channel works	21,257,060	**Capital Costs in Thailand**	
Power station (and related)plant	79,13,0000	Transmission incl. Mekong	44,620,000
Subtotal	205,270,765	Crossing	
Total Capital Costs			299,470,665
Contingency civil works and others (15%)			26,358,100
Contingency electrical &mechanical plant (10%)			12,375,000
GRAND TOTAL			**338,203,765**

Items	**Unit**	**RateSUS**	**Quantity**	**Cost $US**
DAM (including spillway)- FSL 535, Dam crestEl 540				
Stripping of Abutments	m^3	2.0	13000	26,000
Excavation for RCC gravity structures				
- common	m^3	3.2	12000	38,400
- rippable	m^3	3.8	167000	634,600
- blastable	m^3	7.6	48000	364,800
Grouting - blanket	m	43	11200	481,600
Grouting - curtain	m	53	1700	90,100
Final preparation foundation surface	m^2	10	11200	112,000
RCC for spillway and abutment walls	m^3	65	128000	8,320,000
Concrete facing of RCC structures	m^3	81	23800	1,927,800
Conrete - for bridge/gate piers	m^3	150	3810	571,500
Bridge; 10*11m spans, 6m wide	m	1000	120	120,000
Spillway gates (10 off 7m high * 10m)	LS			5,430,000
Drainage holes into foundation	m	20	3100	62,000
River outlet trashrack structure	m^3	150	200	30,000
Outlet conduit -900mm dia. Cement lined	m	500	32	16,000
River outlet valves, stoplog	LS			520,000
Concrete - Outlet structures	m^3	150	120	18,000
Reinforcing steel	t	880	1780	1,566,400
Delivery and erection mechanical plant	LS			1,610,000
Minor items	%	10		1,276,920
Subtotal				23,216,120

DIVERSION WORKS				
Cofferdams - various	m^3	2	22000	44,000
Care and control of river	LS			500,000
Minor items	%	10		54,400
Subtotal				598,400
RESERVOIR RIM BUNDS				
Stripping	m^3	2	96000	192,000
Excavation for cutoff trench	m^3	3.2	31000	99,200
Homogeneous fill	m^3	4.6	249000	1,145,400
Sodding and grassing	m^2	5	42000	210,000
Minor items	%	10		164,660
Subtotal				1,811,260
TOTAL (dam and reservoir rim bunds)				**25,625,780**
HEADRACE CHANNEL (length 10.4km), invert EL 517.5 at start, width 40m				
Excavation - common	m^3	2.6	4860000	12,636,000
Excavation - rippable rock	m^3	3.8	948000	3,602,400
Excavation - blastable rock	m^3	7.6	316000	2,401,600
Slope protection - rockfilled mattresses	m^3	20	50000	1,000,000
Channel access road topcourse	m^3	10	13000	130,000
Minor items	%			1,977,000
TOTAL				**21,747,000**
INTAKE STRUCTURE				
Excavation - blastable rock	m^3	7.6	32700	248,520
Concrete - rock trap	m^3	130	530	68,900
Concrete - trashrack structure	m^3	150	770	115,500
Concrete - gate structure	m^3	150	14800	2,220,000
Concrete - retaining walls	m^3	130	480	62,400
Gates, bulkhead, trashracks, etc.	LS			1,710,000
Delivery and erection mechanical plant	LS			340,000
Reinforcing steel	t	880	530	466,400
Minor items	%	10		318,172
TOTAL				**5,549,892**
SWITCHING STATION				
Stripping	m^3	2.0	7000	14,000
Surface grading	m^3	4.0	10000	40,000
Topcourse	m^3	10	2100	21,000
Drainage - surface drains	m	40	500	20,000
Drainage - open channel drain	m	60	70	4,200
Concrete - tower foundations	m^3	130	580	75,400
Reinforcement		880	60	52,800
Minor items	%	10		22,740
TOTAL				**250,140**

Items	Unit	RateUS$	Quantity	Cost US$
TUNNEL (low and high pressure, and shaft) - length 3,610m + 200m start of 2nd tunnel				
Concrete - portal structure	m^3	130	160	20,800
Excavation in tunnel (incl. 5% o'break)	m^3	32	167000	5,344,000
Excavation in shaft (incl. 5% o'break)	m^3	100	15900	1,590,000
Support - steal rib	t	2200	140	308,000
Support - grouted bars (24mm)	No.	100	8200	820,000
Support - shotcrete (50 & 100mm)	m^3	180	1460	262,800
Lining - concrete	m^3	200	22200	4,440,000
Lining - steel (Wel-ten-60 grade)	t	4300	3760	16,168,000
Concrete backfill behind lining	m^3	170	17700	3,009,000
Grouting (nominal)	m	95	2000	190,000
Reinforcement mesh	t	900	50	45,000
SURGE SHAFT				
Excavation	m^3	100	8500	850,000
Support - grouted bars (24mm)	No.	100	850	85,000
Support - shotcrete (200mm)	m^3	170	640	108,800
Reinforcement mesh	t	900	15	135,00
Minor items	%	10		3,325,490
TOTAL				**36,580,390**
POWER STATION - surface alternative				
Excavation - common	m^3	2.6	240000	624,000
Excavation - rippable rock	m^3	3.8	76800	291,840
Excavation - blastable rock	m^3	7.6	48000	364,800
Slope protection - turfing	m^2	5	14160	70,800
Drainage works				
1/2 round berm drain	m	20	610	12,200
transverse cascade drain	m	40	240	9,600
buried 900mm	m	150	290	43,500
Backfill - free draining	m^3	6	10080	60,480
Subtotal - Excation+drainage+fill				1,477,220
Concrete - substructure	m^3	130	9000	1,170,000
Concrete - 2nd stage	m^3	120	1200	144,000
Concrete - intermediate structure	m^3	150	11100	1,665,000
Concrete - superstructure	m^3	180	1350	243,000
Reinforcing steel	t	880	2280	2,006,400
Subtotal - Concrete, rebar				5,228,400
Subtotal - Metalwork	%	15		784,260
Subtotal - Building construction (roofing, clading, lining, flooring, plumbing, etc.)	%	30		1,568,520
Subtotal - Water supply & sewage	LS			240,000
Subtotal - Station lift	LS			280,000
Subtotal - Ventilaton & aircon	LS			720,000
Minor items	%	5		335,281
TOTAL				**10,633,681**

RE-REGULATING WEIR				
Strippling	m^3	2.0	11000	22,000
Excavation				
- common	m^3	2.6	5500	14,300
- rippable	m^3	3.8	1400	5,320
Riprap	m^3	10	2400	24,000
Random fill	m^3	4	20200	80,800
Filter material	m^3	20	2600	52,000
Core material	m^3	5	12400	62,000
Sodding and grassing	m^2	5	2400	12,000
Grouting - blanket	m	43	1700	73,100
Grouting - curtain	m	53	0	0
Concrete for spillway	m^3	130	2240	291,200
Concrete for transition blocks	m^3	130	6670	867,100
Concrete for trash structure	m^3	150	200	30,000
Drainage holes from gallery	m	20	560	11,200
Reinforcing steel	t	880	120	105,600
Spillway Bridge; 2*15m spans, 6m wide	m	1000	20	20,000
Outlet gates (3 off 4m high * 4m wide)	LS			860,000
Minor items	%	10		253,062
TOTAL				**2,783,682**
TAILWATER CHANNEL				
Excavation - common	m^3	3.2	295000	944,000
Excavation - rippable rock	m^3	3.8	127000	482,600
Excavation - blastable rock	m^3	7.6	8000	60,800
Slope protection - rockfilled mattresses	m^3	20	3500	70,000
Minor items	%			1,557,400
TOTAL				**1,713,140**
DOWNSTREAM CHANNEL - widening and protection works				
Excavation - common	m^3	2.6	6030000	1,567,800
Concrete - drop structures	m^3	130	24100	3,133,000
Riprap - channel protection	m^3	20	10080	201,600
Bridge crossing	m	1000	312	312,000
Minor items	%			1,932,460
TOTAL				**21,257,060**
POWER STATION and related Plant (excludes water control plant)				
Turbinees and ancillary equipment	LS			23,260,000
Generators and ancillary equipment	LS			18,250,000
Mechanical auxillary	LS			8,300,000
Electrical auxillaries (switch stn.)	LS			5,610,000
Main transformers	LS			5,640,000
Switching station equipment	LS			4,750,000
Transmission line interconnection				
- 230 kV	LS			9,120,000
Substation - Thakhet	LS			3,150,000
Project 11 kV distribution lines	km			1,050,000
TOTAL				**79,130,000**

Sources: The Australian Feasibility Study of NT2; Government of Lao P.D.R official cost estimates.

APPENDIX 4 B: COST - BENEFIT ANALYSIS

The Calculations

DF = discount factor = $1 / (1+r)^n$

DFA = discount factor of an annuity = $\frac{1 - (1+r)^{-n}}{r}$

PROJECT A: The development of a 300 MW station with an anticipated gradual enlargement to a 600 MW station. The 300 MW station will take about 7 years to complete and a gradual enlargement to a 600 MW station would require another 6 years.

Net Present Value: Benefits - Costs

$$\mathbf{NPV} = [(68.18M * DFA_{r\%,\ 6yrs} + 136.36M * DFA_{r\%,\ 19\ yrs} * DF_{r\%,\ 6yrs} + 400M * DFA_{r\%,\ 25yrs} * DF_{r\%,\ 25yrs})$$

$$* DF_{r\%,\ 7yrs}] - [(10.2M * DF_{r\%,\ 1yr} + 14.2M * DF_{r\%,\ 2yrs} + 46.3M * DF_{r\%,\ 3yrs} + 88.9M * DF_{r\%,\ 4yrs} +$$

$$122.2M * DF_{r\%,\ 5yrs} + 41.7M * DF_{r\%,\ 6yrs} + 14.7M * DF_{r\%,\ 7yrs} + 3.6M * DF_{r\%,\ 8yrs} + 25M * DF_{r\%,\ 9yrs} +$$

$$61.9M * DF_{r\%,\ 10yrs} + 58.8M * DF_{r\%,\ 11yrs} + 14.4M * DF_{r\%,\ 12yrs} + 5.5M * DF_{r\%,\ 13yrs}) + (8.3M + 9.2M)$$

$$* 1.10 * DFA_{r\%,\ 50yrs} * DF_{r\%,\ 7yrs}]$$

$NPV_{@7\%}$ = (324.9827 + 939.1173 + 858.8657) * (1/ $(1.07)^7$) - (335.3912 + 165.4424)
= **$ 821.2423 M**

$NPV_{@9\%}$ = (305.85 + 727.7071 + 455.641) * (1/ $(1.09)^7$) - (301.5334 + 155.431)
= **$ 397.6781 M**

$NPV_{@11\%}$ = (288.4381 + 571.513 + 247.9634) * (1/ $(1.11)^7$) - (272.3484 + 83.8335)
= **$ 177.4544M**

$C_{0\ @7\%}$ = $335.3912 M $\quad \Sigma C_{t\ @7\%}$ = $165.4424 M

$C_{0\ @9\%}$ = $301.5334 M $\quad \Sigma C_{t\ @9\%}$ = $155.4310 M

$C_{0\ @11\%}$ = $272.3484 M $\quad \Sigma C_{t\ @11\%}$ = $83.8335 M

Internal Rate of Return

This is the discount rate that reduces the NPV to zero. The internal rate of return for *PROJECT A* is 14.65%. In other words, when *r* equals 14.65%, the benefits equal the costs and *NPV* becomes zero.

IRR = 14.65 %

Benefit-Cost Ratio

$BCR_{@r\%} = \Sigma$ Benfits (t) / Σ Costs (t)

$BCR_{@7\%} = 1322.0763 / 498.4582 = \mathbf{2.65}$

$BCR_{@9\%} = 814.6424 / 455.0270 = \mathbf{1.95}$

$BCR_{@11\%} = 533.6381 / 388.3793 = \mathbf{1.50}$

Discounted Payback

The initial cost is the discounted construction cost of the project. The initial cost of the project with a 7% discount rate is $US 333.0158 million. With this cost, the length of time it takes for the project to break-even is 6.06 yrs. It is calculated as follows:

$N_{@7\%}$: $333.0158 = 68.18M * DFA_{7\%, 6yrs} + 136.36M * DFA_{7\%, n\ yrs} * DF_{7\%, 6yrs}$
therefore, n = 6 yrs + 0.06 yrs = **6.08 yrs**

$N_{@9\%}$: $299.596 = 68.18M * DFA_{9\%, n\ yrs}$
therefore, n = **5.89 yrs**

$N_{@11\%}$: $270.262 = 68.18M * DFA_{11\%, n\ yrs}$
therefore, n = **5.55 yrs**

Wealth-Maximizing Returns

$$WMR_{@7\%, BAAR @ 10\%} = \left(\frac{1322.0763 * (1.10)^{57}}{335.3912} \right)^{1/58} - 1 = \mathbf{12.46\ \%}$$

$$WMR_{@9\%, BAAR @ 10\%} = \left(\frac{814.6424 * (1.10)^{57}}{301.5334} \right)^{1/58} - 1 = \mathbf{11.72\ \%}$$

$$WMR_{@11\%, BAAR @ 10\%} = \left(\frac{533.6363 * (1.10)^{57}}{272.3484} \right)^{1/58} - 1 = \mathbf{11.10\ \%}$$

PROJECT B: Development of a 600 MW station in one stage that requires approximately 8 years to complete.

Net Present Value: Benefits - Costs

$$\mathbf{NPV} = (120\,M * DFA_{r\%,\,25yrs} + 400M * DFA_{r\%,\,25yrs} * DF_{r\%,\,25yrs}) * DF_{r\%,\,8yrs} - [(13M * DF_{r\%,\,1yr} + 17M * DF_{r\%,\,2yrs} + 63M * DF_{r\%,\,3yrs} + 133.5M * DF_{r\%,\,4yrs} + 178.5M * DF_{r\%,\,5yrs} + 61.9M * DF_{r\%,\,6yrs} + 23.5M * DF_{r\%,\,7yrs} + 6.9M * DF_{r\%,\,8yrs}) + (8.3M + 9.2M) * 1.10 * DFA_{r\%,\,50yrs} * DF_{r\%,\,8yrs}]$$

$\mathbf{NPV}_{@7\%}$ = (1,398.43 M + 858.6652 M) * (0.58201) - (367.4368 M + 154.6191 M)
= **$ 791.7105 M**

$\mathbf{NPV}_{@9\%}$ = (1,178.71 M + 455.641 M) * (0.50187) - (338.6974 M + 105.9 M)
= **$ 375.6282 M**

$\mathbf{NPV}_{@11\%}$ = (1,010.61 M + 247.9634 M) * (0.43393) - (312.8533 M + 75.5256 M)
= **$ 157.7490M**

$C_{0\ @7\%}$ = $367.4368 M $\Sigma C_{t\ @7\%}$ = $154.6191 M

$C_{0\ @9\%}$ = $338.6974 M $\Sigma C_{t\ @9\%}$ = $105.900 M

$C_{0\ @11\%}$ = $312.8533 M $\Sigma C_{t\ @11\%}$ = $75.5256 M

Internal Rate of Return

Let *NPV = 0* and solve for *r* (the internal rate of return). The **IRR = 13.96%**. At this rate, the *NPV* equal zero and costs equal benefits.

Benefit-Cost Ratio

$\mathbf{BCR}_{@\,r\%}$ = $\Sigma B_t / \Sigma C_t$

$\mathbf{BCR}_{@7\%}$ = 1313.7664 / 522.0559 = **2.52**

$\mathbf{BCR}_{@9\%}$ = 820.226 / 444.5720 = **1.84**

$\mathbf{BCR}_{@11\%}$ = 546.1328 / 388.3793 = **1.41**

Discounted Payback

The initial costs are again assumed to be the discounted construction cost of the project. For example, the cost (with a discount rate of 7%) is $US 367.277 million. *N* years for each discount rate is calculated as follows:

$N_{@r\%}$: Costs = 120 M $DFA_{r\%,\ n\ yrs}$

$N_{@7\%}$: 367.2711 = 120 M $DFA_{7\%,\ n\ yrs}$ therefore, n = **3.57 yrs**

$N_{@9\%}$: 338.6972 = 120 M $DFA_{9\%,\ n\ yrs}$ therefore, n = **3.40 yrs**

$N_{@11\%}$: 312.8537 = 120 M $DFA_{11\%,\ n\ yrs}$ therefore, n = **3.24 yrs**

Wealth-Maximizing Returns

$$WMR_{@7\%,\ BAAR\ @\ 10\%} = \left(\frac{1313.7664 * (1.10)^{58-1}}{367.2711} \right)^{1/58} - 1 = \mathbf{12.26\ \%}$$

$$WMR_{@9\%,\ BAAR\ @\ 10\%} = \left(\frac{820.226 * (1.10)^{58-1}}{367.2711} \right)^{1/58} - 1 = \mathbf{11.51\ \%}$$

$$WMR_{@11\%,\ BAAR\ @\ 10\%} = \left(\frac{546.1328 * (1.10)^{58-1}}{367.2711} \right)^{1/58} - 1 = \mathbf{10.88\ \%}$$

APPENDIX 4C: COST - BENEFIT SENSITIVITY ANALYSIS

Scenario 1: Operation Costs and Logging Loss Double: 2 * (8.3 M + 9.2 M) * 1.10 = 38.5M

Project A:

Discount Rate	NPV ($US millions)	IRR	BCR	$\sum C_t + Co$ ($US millions)
7%	**655.800**	**12.86 %**	**1.98**	**330.885 + 335.391**
9%	282.247		1.53	230.862 + 301.533
11%	93.621		1.21	167.667 + 272.348

Project B:

Discount Rate	NPV ($US millions)	IRR	BCR	$\sum C_t + Co$ ($US millions)
7%	**637.092**	**12.54 %**	**1.94**	**309.238 + 367.436**
9%	269.278		1.49	211.800 + 338.697
11%	82.223		1.18	151.051 + 312.853

Scenario 2: A 10 percent reduction in benefits: Benefits for the first 25 years would be $2,700M and $360M thereafter per annum for the remaining life of the project.

Project A:

Discount Rate	NPV ($US millions)	IRR	BCR	$\sum C_t + Co$ ($US miilions)	Discounted Payback	WMR if BAAR = 10%	14%	18%
7%	**689.042**	**13.61 %**	**2.38**	**165.442 + 335.91**	**6.17 yrs**	12.24%	16.25%	20.26%
9%	316.218		1.76	115.431 + 301.533	6.23 yrs	11.52%	15.50%	19.48%
11%	124.093		1.35	83.834 + 272.348	6.11 yrs	10.90%	14.86%	18.82%

Project B:

Discount Rate	NPV ($US millions)	IRR	BCR	$\sum C_t + Co$ ($US millions)	Discounted Payback	WMR if BAAR = 10%	14%	18%
7%	**660.334**	**12.98 %**	**2.26**	**522.056**	**4.02 yrs**	**12.05%**	**16.06%**	**20.06%**
9%	293.606		1.66	444.572	3.85 yrs	11.30%	15.28%	19.26%
11%	103.136		1.27	388.379	3.68 yrs	10.68%	14.63%	18.58%

The distribution of benefits for both projects are calculated according to the assumption outlined in chapter four. All other things being equal, Project A's benefit distributions are as follows: $61.36M* for the first six years of operation with a 300 MW station, $US 122.727 million** for the next nineteen years of operation with a 600MW station, and $US 360 million, thereafter, for the life of the Project. Analogously, Project B's benefit distributions are $108M ($2,700/25) for the first twenty-five years and $360M for the next twenty-five years.

Project A (benefit distribution formula): $6x + 19y = \$US\ 2{,}700$ million, $x=0.5y$

** y = $US 122.727 million

* x = $US 61.36 million

Scenario 3: Combination of *Scenario 1* and *Scenario 2*.

The WMR and the DP values are the same as those derived in Scenario 2 by definition of WMR and DP.

Project A:

Discount Rate	NPV ($US millions)	IRR	BCR	$\sum C_t$ ($US millions)
7%	**523.599**	**11.82 %**	**1.79**	**663.901**
9%	200.787		1.38	530.458
11%	90.259		1.09	437.929

Project B:

Discount Rate	NPV (in $US million)	IRR	BCR (PI)	$\sum C_t + Co$ ($US millions)
7%	**505.715**	**11.53 %**	**1.75**	**676.677**
9%	187.706		1.34	550.472
11%	27.611		1.06	463.904

Notes

1. The phases of the project cycle are outlined in Mohan Munasinghe (ed). Environmental Economics and Natural Resource Development in Developing Countries. The World Bank, 1993. p.21.

2. There are many variables that can affect future revenues and costs such as general business cycle fluctuations, technological change, consumer preferences, depreciation of wages, price inflation, increased administration expenses and so on.

3. Richard Dively and Dwight Dively. *Benfit-Cost Analysis: In Theory and Practice*. pp. 204-205.

4. The benefits stream for Project A is derived as follows: (6x) + (19y) =$US 3 billion and x=0.5y . Therefore, y = $US 136.36 million and X =$US 68.18 million.

5. Yearly benefits: $US 3 billion / 25 years = $US 120 million.

6. NPV1 represents the NPV of Project A and NPV2 represents the NPV of Project B.

Chapter 5

Nam Theun Two: An Evaluation

Environmental Impact of NT2

The wilderness area adjacent to the 450 square kilometres of reservoir site is considered to be of international significance in terms of biodiversity and has been declared by the Government of Laos (GOL) as a National Biodiversity Conservation Area (NBCA). The area is located on the Nakay Plateau and shares a border with Vietnam.

Currently, the NBCA is suffering rapid deterioration because of forest degradation, extensive logging, illegal hunting, poaching, and livestock grazing. Dr. Alan Rabinowitz, Director of Asia Programs for the Wildlife Conservation Society (WCS) in New York visited the area in February 1996 and had the following comments:

> "Every area we have visited has been affected by varying levels of hunting, human settlement, livestock grazing, logging or some sort of forest degradation...Currently hunting pressures in the NBCA as a whole are extraordinarily severe... The steady decline of bird and mammal abundance is likely to continue unchecked, leading to species extinctions in the NBCA in the near future."[1]

The NBCA is a world class site for forests and wildlife. However, pressures on the area in recent decades, due to the lack of an organized policy framework for sustainable development have threatened its very existence. Dr. Rabinowitz suggests that the NT2 dam project will actually improve the condition of the area by providing much needed funding for protection and management.

> "My understanding of the agreement that has been reached between the NT2 Project Development Group and the World Bank is that, with initiation of the project, funds will be provided over at least the next 25 years for the proper protection and management of the NBCA. Without such funds, I and my colleagues see no hope for the long term survival of much of the wildlife that still exists in the NBCA as a whole."[2]

A significant factor in the Government of Laos' (GOL) decision to permit the location of the NT2 project adjacent to the NBCA was that the project would provide the focus and the funds for the development and implementation of a wildlife and catchment area management plan that would reverse the current destruction of the area and convert it into a model NBCA.

Any negative environmental impacts of NT2 can be greatly mitigated by drawing on the lessons from Laos' only other major hydropower dam project - the Nam Ngum project - constructed in the 1960s. The first phase of Nam Ngum was completed in 1971. Electricity subsequently flowed to Thailand with export earnings coming back to Laos. The forest area in the Nam Ngum reservoir area was not logged and shortly after the reservoir was filled, the forest vegetation began to decay creating a form of swampland. Fish populations in Nam Ngum soared with fish harvests steadily increasing between 1971 and 1983 after which they steadily declined. The flooding of the reservoir area around the NT2 dam is expected to provide additional habitat for fish.

One environmental concern associated with the NT2 project is the logging of the reservoir area and management of forests in the catchment area. Plans have been made to log the reservoir area prior to filling the NT2 reservoir so that this forest area is utilized. In terms of sustainable forest development, this is a negative environmental impact of NT2. However,

this impact has been mitigated by making use of a forest stand that would eventually decay after the reservoir is filled. In addition, the committed funds for the wildlife and catchment area management plan are designed to ensure that current deforestation practices in the catchment area and the NBCA are reversed.

Another environmental impact of NT2 is the downstream effects on the Nam Theun and Xe Bang Fai River Systems. Water discharged from the dam's power station will flow along a specially designed channel until it joins the Nam Phit and then the Se Bang Fai River. The net result of this channel will be that, each year, almost six billion cubic metres of water will be diverted from the Nam Theun to the Se Bang Fai River System. The Se Bang Fai flows near fertile areas with significant irrigation potential. There will be permanent changes to river flows and reduced water quality in the short term. Despite the initial degradation of water quality following the release of new water flows, plans have been made to do extensive clearing of the reservoir and to re-oxygenize discharged water in order to bring the water quality up to agreeable standards. If water quality does not meet agreeable standards, commitments have been made to provide alternative water supplies to villages and to compensate for fish kills. The permanent changes in river flows will have environmental costs associated with maintaining water quality but will also have environmental benefits in the form of enhanced irrigation potential.

Out of a total of approximently 600,000 hectares of land in Laos with irrigation potential, some 100,000 hectares lie within the Mekong flood plain near Vientiane. Irrigation development on these lands has been minimal. Although the possibility of large scale

irrigation in mountainous areas is limited, the mountain valleys and flood plains offer significant potential for rice production.

A final environmental impact identified by project organizers is the displacement of archaeological sites within the project area. This concern has been given much less attention than other environmental concerns for two reasons. First, there is a lack of evidence to support the claim that archaeological findings are buried beneath the project site. Thus any attempt to place a value on possible archaeological findings remains speculation. Second, the value of an archaeological site can only be measured by the "willingness to pay" to keep the site intact. One can only speculate as to the value of possible archaeological artifacts and if these findings do exist they will most likely remain buried beneath the project site.

Social Impact of NT2

The social impacts of NT2 would be most detrimental to residents living in the area of the project site. There are two main concerns. The first is the public health effects following the completion of the project. The outcome following the completion of the Nam Ngum dam may serve as a warning to NT2 organizers. The newly completed Nam Ngum dam and reservoir attracted many new settlers to the area who tried to take advantage of the new potential for agriculture. Rapid clearing of slopes surrounding the dam increased soil erosion considerably. It was estimated that sixteen tons of soil per hectare was washed away each year with most of it going into the reservoir[3] which is expected to become clogged with silt more quickly than anticipated. The result was that a lot of stagnant water built up in marginal areas surrounding the reservoir which has become a breeding ground for mosquitos and water-borne diseases. Dengue fever has become common and a local government official

noted that almost all children under the age of twelve have malaria.[4] Thus, the public health "costs" of the Nam Ngum project have been high. Health costs have been included in the NT2 project but they are minimal and do not reflect the health hazard that NT2 may impose. Careful monitoring must be carried out following the completion of the NT2 project to ensure similar health problems do not result.

The most visible and perhaps the most negative impact of the NT2 dam project is the displacement of approximently 4,000 people or around 900 families living in the area of the project site. Lessons from the Nam Ngum project indicate that relocation was handled badly. Sluiter (1992) noted in reference to relocation that:

> "The government helped move a number of people along the Nam Lik, a Nam Ngum tributary, by clearing forest and distributing corrugated iron roofing. Still, it was left to every family to build their house and prepare new fields. In time, these communities received electricity. People from other parts of the reservoir area were even worse off and had to build a new life without any support. At least three communities never received any compensation."[5]

NT2 project organizers, including the GOL and the World Bank, have all agreed to a resettlement process that includes a "compensation package." The package offers land and approximently $US 5 million to the 4,000 people displaced by the reservoir. The compensation income amounts to approximately $US 1,300 per person. Although this is a sizeable amount of money by Laotian standards, the new land awarded to displaced villagers will likely be without dwellings. Thus an initial cost must be borne by the displaced families to build new homes and prepare new crops. Thus, it is possible that each displaced family could spend their entire income compensation within a few months after relocation.

Project organizers have agreed that the resettlement process is to be conducted to a standard that will ensure that no family will be worse off and all will be better off. To meet this standard, it may be necessary to ensure that financial compensation to displaced villagers is increased to allow for the costs of new construction. The resettlement program should be monitored very carefully during the implementation and supervision phase of the NT2 project.

Economic Impact of NT2

The results of the cost-benefit analysis in chapter four suggests that the economic benefits of NT2 outweigh its economic costs. The GOL will receive a substantial benefit stream from its 25 percent ownership of the project. These revenue streams are expected to contribute $US 3 billion over the project's first 25 years of operation and an additional $US 400 million each year thereafter for the life of the project. Low unit costs of production will allow the project to pay significant taxes and royalties to the GOL. In addition, the project is expected to provide benefits in terms of over 1,500 short term jobs and 100 long term positions and will add approximately 20 percent to the GDP of Laos.

Laos has a very high infant mortality rate of 117 deaths per 1,000 live births.[6] Malaria and other life threatening diseases have reached the epidemic stage in many regions of the country. The health budget for the entire country is under $US 11 million annually and, as noted earlier, this amounts to less than $US 2.50 per person per year.[7] The overall literacy rate is only 50 percent and proper educational facilities are not available. In the NT2 project area only about 20 percent of the children attend school regularly.[8] There is no road access or electricity supply to many rural areas. One of the most important economic impacts of NT2

will be the generation of additional revenue for the improvement of health, education and basic infrastructure services.

The NT2 project's value in terms of improved local hospitals, disease prevention programs, improved educational facilities, construction of new roads and electricity connections are all positive economic impacts that are not included as part of the financial benefits of NT2.

A lack of export earnings in Laos is placing considerable pressure on the exchange rate leading to a devaluation and rising prices for imported goods. An important economic impact of the NT2 project is that it will increase hard currency income to Laos and therefore help to stabilize the exchange rate and the economy in general. The Nam Ngum hydropower project, with a total capacity of 150 MW, generated most of Laos' foreign exchange earnings for many years via hydropower sales to Thailand. It only lost its number one position as recently as 1992 when it was surpassed by timber products, garments and assembled motorcycles. The capacity of the NT2 project (600 MW) is four times larger than the Nam Ngum project and the hydro-electric power will become Laos' largest export item and generate considerable foreign exchange earnings for the country.

In 1992, the GOL chose to implement project B. This paper suggests that project A was preferable to project B on the basis of the CBA and on the basis of past lessons learned from the Nam Ngum dam. The government's decision suggests that reasons other than CBA may be important in the criterion considered by policy makers.

Extending the Analysis

This section incorporates the environmental and social costs into the CBA. These costs are estimates (from the Australian Feasibility Study) and are used to determine if NT2 will still remain a viable project. Under scenario 4 the following non market costs are considered:

Scenario 4

1. Each displaced family receives compensation income of $US 20,000 and $US 1,500 worth of land at the beginning of the project. This amounts to a total of $US 19.35 million.

2. River diversion costs are $US 25.5 million.

3. Anticipated interest and inflation costs during construction are $US 109 million and $US 149 million respectively.

4. Biodiversity protection costs are $US 3 million per year.

5. A 7 percent discount rate is applied.

Criteria	Project A	Project B
NPV@ 7%	$US 492.569 million	$US 464.664 million
IRR	9.61%	9.41%
BCR	1.59	1.55

Upon considerstion of these extra environmental and social costs, the CBA shows that the NT2 project is still viable. Project A is preferred to project B with a NPV of $US 492 million, an IRR of 9.61 percent and a BCR greater than one. A low IRR makes the project less attractive because if the IRR is lower than the discount rate then than the project will have a negative NPV. For axample, the project would be rejected under a sensitivity analysis

using an 11 percent dicount rate. The NPV under scenario four is approximently one half of its original value but may be a more accurate reflection of the actual value of the NT2 project. In terms of the distribution of benefits of benefits, the groups that stand to gain the most from NT2 are the local people, foreign investors and the Government of Laos. The local people who live in the area of the project site will receive considerable benefits such as health care, improved sanitation, food, education facilities and electricity. In addition, they will receive income compensation packages which, although small compared to western standards, are substantial according to Laotian standards.

Benefits will also accrue to foreign investors who will recover their investment within 7 years once the dam is fully operational and receive considerable returns thereafter. Foreign investment laws in Laos have specifically targeted the objectives of attracting private firms, transferring technology, creating employment, promoting exports and accessing foreign markets. Upon receiving returns from NT2, foreign investors have been encouraged to invest further in areas such as agribusiness, mining, energy, wood industries, tourism, light manufacturing and banking.

Upon the price negotiation for the sale of the electricity, the GOL should inlcude a clause that allow them to renegotiate the price setting of the contract after 20 years. A flexible price clause helps project participants adjust and account for unanticipated future costs of the project. NT2 should avoid the fixed price and rising costs as seen in the Churchill dam located on the Churchill River in Nitassinan (Labrador). With 23 more dams under way, the GOL should be aware of the environmental and social impact of large scale development. The lack of expertise and workers can lead to unsustainable development path in Laos.

The GOL as 25 percent owner of the NT2 project will receive benefits in the form of collection of tax receipts, resource levies and dividend income. The revenue collected by the government will be redistributed according to a set of objectives and social needs. The government has emphasized 8 objectives as priority items:

1. Food and grain production.

2. Commercial production.

3.Stabilization of slash and burn cultivation.

4. Rural development.

5. Infrastructure development (particularly roads and telecommunication improvements).

6. Human resource development.

7. Expansion of international cooperation.

8. Promotion of the services industry.

Special attention has been given to energy, infrastructure and human development programs. The potential for energy development has been identified as representing the most sustainable development opportunity for Laos providing a stable source of foreign exchange earnings. This potential has been greatly encouraged by the memorandum of understanding signed between the GOL and the Government of Thailand to increase the supply of electricity from 1,500 MW in the year 2000 to 3,000 MW by the year 2006. It is estimated that the energy sector accounts for 72 percent of the total contracted value of investment in Laos or about $US 5.1 billion. A reliable revenue stream from the NT2 project, combined with the government's strong committment to reform, will help lead Laos along a path toward sustainable development.

Notes

1. Open letter from Dr. Alan Rabinowitz, Director of Asia Programs for The Wildlife Conservation Society to Owen Lammars, Executive Director of The International Rivers Network. February 7, 1996.

2. -------.

3. Jeffrey Jacobs. "Planning For Change and Sustainability in Water Development in Lao PDR and The Mekong River Basin," 1996, p.181.

4. L. Sluiter. "The Mekong Currency Project for Ecological Recovery," 1992. It is also mentioned in Jacobs (1992), p. 182.

5. Sluiter (1992). It also appears in Jacobs (1996).

6. According to statistics provided by the Nam Theun Electric Company.

7. -------.

8. -------.

9. P. Handley. "Making Connections." *The Far East Economic Review*, November 4, 1993.

10. According to statistics provided by the Nam Theun Electric Company.

Chapter 6

Conclusions

The abundant water resources in Laos offer a vast potential for economic development. Hydro-electric power is the most significant, renewable and sustainable resource in the country with the most potential to generate foreign exchange earnings. The NT2 dam project was identified as the best project for hydro-electric power development in Laos in a 1989-91 United Nations Development Project Report and in a World Bank funded feasibility study. It has also been recommended by the South Mekong Economic Committee and a panel of experts appointed by the World Bank. Although the economic benefits of NT2 are sound, the GOL is well advised to consider a moderate pace in the economic development of its water resources. The country cannot afford to promote development policies that damage the environment or exclude the poor. Sustainable development of natural resources is not an event but a process that includes the ability of socio-economic systems to adapt to new conditions. Any long-term water development plan must be flexible enough to adapt to short-term changes in environmental and social conditions.

The CBA suggests that the economic impact of NT2 is positive. The hydropower generated from NT2 will become Laos' largest export item and will greatly increase foreign exchange earnings. The project has a capacity four times larger than Laos' only other major dam project - Nam Ngum. The economic earnings generated from NT2 have the potential to improve basic health, education and infrastructure services and may represent a first step

toward economic development of the Lao PDR. The contract to sell electricity to Thailand must contain a clause for revision of price setting in order to reflect future fluctuations in electricity prices, inflation and other changes in economic conditions. Caution should also be made for the vast and rapid development of electricity with approximately 23 dams under construction. Although there will be substantial amounts of foreign exchange earnings for the country, the large inflows of revenue ccould be used inefficiently and the lack of skill workers could lead to unsustainable energy development in Laos.

The environmental evaluation of the NT2 project suggests that measures have been taken to mitigate most of the negative impacts. The environmental consequences have been the subject of extensive study leading to the adoption of mitigation standards that are considered to be well in advance of those typically practised in Indochina. The World Bank has stated that it will not support the project unless these measures are adhered to. The Wildlife and Catchment Area Management Plan provides the organization and the funds to ensure that wildlife is protected in the NBCA. It will also ensure that the degradation of forests in the NBCA is reversed. Plans have been made to log the reservoir area prior to development. A failure to log this area would result in the eventual loss and decay of these forests after the reservoir is filled. Allowances have also been made for possible changes to aquatic life in the project area and downstream by a plan to improve the water quality following the release of water into the reservoir.

The social impacts of NT2 on communities in the area of the reservoir may have to be revisited by project organizers. The financial compensation offered to the 900 families displaced by the reservoir may be insufficient to cover the costs of building new homes and

developing new crops after resettlement has been completed. This requires monitoring during the implementation and supervision phase of the project cycle. This phase includes periodic field visits by donors such as the World Bank, and submission of progress reports.

The CBA reveals that - not only is the NT2 dam project economically feasible - but that the preferred construction option is to develop the project in two phases over a period of 13 years as opposed to one phase totalling 8 years. Some past lessons on water development in Laos have indicated that a moderate pace of water development is more desirable than a rapid pace in order to adequately address environmental and social impacts. It is difficult to incorporate these impacts into a development scheme that proceeds at a rapid pace. Although project A would have been preferable to project B (in terms of a development pace and the cost-benefit analysis results presented), project B was implemented by the GOL. Ambitious development projects that proceed at a rapid pace can accentuate the negative impacts including environmental degradation, reduce the benefits to local communities and may cause large cost overruns.[1] A slower pace of water development allows local communities to be included in the planning process and for greater flexibility in incorporating environmental and social changes.

It appears the NT2 project will be able to generate economic benefits for the country as a whole, mitigate negative environmental effects, and compensate those that will be adversely affected by the development. The NT2 project is a major step forward in the process of sustainable development in the Lao PDR.

Notes

1. Jeffrey Jacobs. "Planning For Change and Sustainability in Water Development in Lao PDR and the Mekong River Basin," 1996, p.178.

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Generally speaking, a cost-benefit analysis has three parts. First, all potential costs that will be incurred by implementing a proposed action must be identified. Second, one must record all anticipated benefits associated with the potential action. And finally, subtract all identified costs from the expected benefits to determine whether the positive benefits outweigh the negative costs. Identifying Costs.Â Make a list of all monetary costs that will be incurred upon implementation and throughout the life of the project. These include start-up fees, licenses, production materials, payroll expenses, user acceptance processes, training, and travel expenses, among others. Make a list of all non-monetary costs that are likely to be absorbed. Cost-benefit analysis (CBA) is a technique used to compare the total costs of a programme/project with its benefits, using a common metric (most commonly monetary units). This enables the calculation of the net cost or benefit associated with the programme. As a technique, it is used most often at the start of a programme or project when different options or courses of action are being appraised and compared, as an option for choosing the best approach. It can also be used, however, to evaluate the overall impact of a programme in quantifiable and monetised terms. CBA adds up the total costs o