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**Economic Viability of Mekong Region Dam Projects**

This report looks at selected proposed and completed dam projects in several Mekong Basin countries. Discussion of developmental effectiveness of the projects addresses the original economic rationale for the projects, and subsequent realized experiences. The selection of projects is significant and representative; most if not all of the projects had been chosen as a superior option from among contemporary dam alternatives by proponents, in its country, or in the case of the Pa Mong, for the Mekong mainstream.

### **Economic parameters of dams**

It will be helpful before taking up cases to say a brief word about economic parameters common to dam projects, with reference to Mekong regional conditions. All of the large dams of present relevance in the Mekong Region are wholly or largely justified by proponents on the basis of power production.<sup>1</sup> As a power producing alternative, hydropower is characterized by a high capital cost and a very low, usually nil, fuel cost. As an implication of this capital intensity, it is desirable that the site lend itself to a high utilization of the production capacity in order to pay for itself, that is, for the capital cost distributed over the unit cost to be minimized. Ideally the project will be suitable for supply of firm power, which earns a high tariff based on reliable availability, over many hours of the day, and throughout the year. Further, dam economics are favored if a long serviceable project life can be expected, not shortened by factors such as sedimentation.

Achieving economic (high) utilization rates generally requires a reservoir outflow which, as a function of streamflow volumes and interseasonal storage, is steady throughout the year. Southeast Asia experiences varied and highly seasonal rainfall. Some designers seek to compensate for the problem of pronounced dry seasons by specifying reservoirs of such size that they can store water throughout the year; this however imposes an even higher capital cost for a proportionally larger dam per production capacity.

The other, less common, approach to firm power is to install a run of the river power plant where streamflow is reliable throughout the year. The region's seasonal rainfall makes finding such a river very difficult.

Another characteristic of the region's rivers, linked to the seasonal rainfall, is that they carry large silt loads. Once the sediment flows into the relative stillness of a reservoir, a large portion of it is deposited. This occurs whether in the large reservoir designed for interseasonal storage or the smaller reservoir designed for daily storage. In both it can compromise service life by reducing storage capacity, and through secondary ways like scouring turbines.

Another consequence of the projects' inherent capital intensity is that they are "efficient" wealth transfer mechanisms. That is, if a project goes forward, very large amounts of capital are mobilized and transferred. Projects may also function to liquidate and centralize resource value.

### **Mekong mainstream**

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<sup>1</sup>The case of Pa Mong and past examination of irrigation justification will be discussed below.

The **Pa Mong** is a project proposed for the mainstream of the Mekong, and highlights issues associated with any retention or diversion of the primary flow. In 1963 the United States Bureau of Reclamation, an institution whose projects in the American west were often characterized by large scale diversion, began a feasibility study of the project, subsequently passed to other agencies. The site, relatively close to Vientiane, where the Mekong forms the Lao-Thai border, was chosen as a geologically optimal stretch of the mainstream for creating a dam and large impoundment, and for proximity to plains areas. The scheme, as submitted in 1970, called for a reservoir storage of two thirds of the mean river flow at the dam site (100 billion cubic meters), 4,800 MW of power production capacity, and diversion to irrigate 800,000 hectares, mostly in Northeast Thailand. The scheme would have displaced 250,000 people at its completion.<sup>1</sup>

A prominent justification given by American planners for the original project was food security. Project documents state, without demonstrating research support, that Asian populations were sure to increase dramatically, outstripping food production capabilities within as little as two decades. The Pa Mong was to transform and rescue the region via food production, and not only by irrigating huge areas of Thailand. Proponents claimed that the huge storage capacity of the reservoir would also allow increased dry season flows, and therefore cropping, in the Mekong Delta.

With the benefit of hindsight, the project clearly was not justifiable by the Malthusian hunger rationale. Thirty years later, and without the diversion, population growth is orderly, food security is good (localized exceptions notwithstanding), and Thailand is a food exporting country. Moreover, the project would have caused massive negative impacts on food security. The impacts of diversion on downstream areas including Ton Le Sap in Cambodia, and the Mekong Delta in Vietnam, were not well understood, nor even given much consideration at the time of initial conceptualization. Yet these two domains are the major food sources, in rice and fish, of the two countries, and are profoundly rich and varied habitats. Their unique, cyclical and highly seasonal conditions form highly specialized ecosystems which are home to an array of aquatic, bird, and other animal life.<sup>2</sup> In addition, a high proportion of the population in the region receives substantial protein from fish drawn from the Mekong and its tributaries; only now are researchers revealing the full complexity of the piscine ecosystem, and the importance of seasonal fish migration to and along the Mekong mainstream, which the dam would have interrupted.

Due to the implications just described, any retention or diversion of the Mekong mainstream would create political tension with the downstream countries.

Despite these factors, reasons to doubt Pa Mong's ability to supply least cost electricity, and the absence of demonstrated agricultural feasibility for irrigation of the designated lands, the project has been resurrected recurrently. In 1972, under World Bank sponsorship, the concept of a "Low

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<sup>1</sup>Low Pa Mong Dam Project Studies: Briefing Note on Findings (Bangkok: Mekong Secretariat, October 1991).

<sup>2</sup> Reductions in the amount of water acting to flush the Mekong delta could significantly alter its fertility. Potential impacts to the delta-sea-estuary economy from loss of streamflow include: 1) increases in estuarine salinity, 2) decreases in organic and inorganic matter, 3) increased detention times, 4) increased concentration of pollution, and 5) decreases in estuary fish populations. As cited in Herman van der Most, "Water Reservoirs: Sustainability and Soundness," in Economic and Social Commission for Asia and the Pacific, Towards an Environmentally Sound and Sustainable Development of Water Resources in Asia and the Pacific, (United Nations: New York, 1992), 86.

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Pa Mong" was unveiled, with a subsequent 1974 revision. By 1991 the scheme as designed would provide 2,700 MW of power and an initial irrigation development of 100,000 hectares in Northeast Thailand. An estimated 59,000 persons would be relocated, 21,000 in Laos and the remainder in Thailand.<sup>3</sup> In February of 1992 the Mekong Committee sought to press on with Pa Mong, submitting a \$2.7 billion version of the plan.<sup>4</sup>

## Thailand

Two projects in Thailand will be discussed, Nam Pong and Pak Mun.

The **Nam Pong**, which came online in 1966, incorporated some electrical generation, but had a major design function of diverting water for irrigation, one of the last major projects in the region to do so. The Mekong Committee undertook a study of the Nam Pong project in Northeastern Thailand in 1976. The Nam Pong Environmental Management Research Project encompassed the Ubolratana Dam and the Nong Wai-Nam Pong irrigation schemes, a combined project which had become operational in 1966. The scheme includes a modest hydropower plant and an irrigation capacity designed to ultimately serve 53,000 hectares. Project construction required resettlement; in 1976 approximately 14,000 persons resided in the resettlement villages.<sup>5</sup>

In an unexpected development, one of the greatest benefits of the Nam Pong project was found to be fish harvests from the lake. In 1966, 256 fishermen operated around the reservoir, while in 1978 some 45,000 people lived in a two-kilometer band around the lake, including about 4,000 fishermen, harvesting an average of 2,000 tons of fish per year for commercial sale, and another 400 tons for local consumption. From 52 species of fish found in the lake one year after impoundment, the number of species had risen to 77 in 1976 due to a program of stocking. The benefits to the lake fishermen are partially offset by losses to local river fishermen who formerly caught over 200 tons per year and now catch "practically nothing."<sup>6</sup> Some analysts have expressed doubts about the sustainability of the fishery due to watershed degradation and uncontrolled fishing.

Fisheries notwithstanding, Nam Pong outcomes with respect to the project objectives of agricultural improvement and electric production fell short. As a result of the irrigation: "In 1974 a World Bank review team found paddy yields of about 1.3 tons per hectare which were no better than paddy yields before the project was started. However, a study in 1978 indicated yields had increased over two tons per hectare."<sup>7</sup> As another measure of agricultural enhancement, nutrition

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<sup>3</sup>Ibid.

<sup>4</sup>Charles P. Wallace, "Regional Outlook; Is Asia Robbing Rural Poor to Power the Rich?; Vietnam's Hoa Binh Dam Displaced 50,000 and Wrecked Forests. Critics Ask Whether Hydroelectric Energy Is Worth It." Los Angeles Times, 18 February 1992, World Report p. 1.

<sup>5</sup>Samuel H. Johnson III, "The Effects of a Major Dam Construction: The Nam Pong Project in Thailand," in Too Rapid Rural Development: Perceptions and Perspectives from Southeast Asia, ed. Colin MacAndrews and Chia Lin Sien (Athens, OH: Ohio University Press, 1982), 172-207. It is suspected that some of the residents were opportunistic settlers in the resettlement villages who had not been displaced by the project.

<sup>6</sup>Ibid.

<sup>7</sup>SEATEC Consulting Engineers, Study of Environmental Impact of Nam Pong Project, pp. 2-1 to 2-11. As cited in Johnson.

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levels of children in the villages served by irrigation had not improved, while these villages experienced the greatest increase in parasites such as the liver fluke, which is transmitted by snails and fish.<sup>8</sup> Lands given to the resettled farmers who had formerly practiced rice cultivation in the now flooded valley are dry. Some began supplementing their incomes by harvesting wood from the forest to produce and sell charcoal, exacerbating watershed degradation.<sup>9</sup>

No provision for watershed protection was made in project planning or funding, but rather was ostensibly left to the government. In addition to the persons who were drawn to the lake area in order to fish, many families illegally settled adjacent to the lake in order to farm the lakeshore.

The **Pak Mun** dam, begun in 1991 with construction completed in 1994, is a power justified, run of the river system, utilizing a dam for daily storage to offer peaking power. It is the subject of a WCD case study, which focuses on the projected and actual hydropower benefits. The Pak Mun is presently the subject of an organized protest movement by affected persons focusing on claims of impoverishment, lack of resettlement, and provision of livelihood. Environmental impacts include the loss of aesthetic value of the river rapids, and surrounding areas, and damages to aquatic life.

The draft study finds “that the irregularity and unpredictability of the run-off of the Mun river result in a small amount of Dependable Power. The end result is that the Pak Mun Hydropower Project has an economic return lower than acceptable in Thailand.”<sup>10</sup>

## **Lao PDR**

For the Lao PDR, dam construction is a primary element of national economic strategy. Proponents claim that foreign earnings from hydropower export can break the cycle of chronic underdevelopment, substantially provide national GDP growth, fund the government, and finance national development. The countervailing view is that non-economic dam projects can only hurt the national economy, and that false hydro-hopes have distracted the nation from developing and pursuing a realistic, diversified, and appropriate course.

The **Nam Ngum** is a 150 MW producer of electricity, much of which is exported to Thailand. It was built with concessional bilateral aid, and is the country=s largest source of foreign revenue, without the need to make repayment for the dam. Recurring negotiations with the Thai utility, the sole purchaser, have kept the tariffs arbitrarily low. So while the economic return of the investment in Nam Ngum is questionable, the project functions for the Lao government to transform Japanese concessional aid into an annuity, and a foreign exchange denominated annuity at that.

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<sup>8</sup>Johnson, p. 192.

<sup>9</sup>Ibid, p. 182.

<sup>10</sup>Annez, Dr. Philippe The hydropower benefits of the Pak Mun Hydropower Dam and related aspects of the Mekong River Basin Thailand, Circulation Draft, 15 December, 1999.

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The **Nam Theun 2** has been cultivated as the most profitable, and a suitable first of many, of the possible large scale hydropower developments in the Lao PDR to be developed for export earnings. One of the reasons this project was chosen as very promising is the geology, which allows a reservoir to be formed in a naturally occurring upland basin, and high energy to be harnessed by draining the reservoir via a tunnel into a much lower adjacent watershed. The mechanism which has been pursued is construction and operation by a private entity in a variant of the BOT<sup>11</sup> model. The Lao government would participate in the 680 MW capacity project by buying a 25% equity share for \$100 million, money it would have borrowed from the World Bank. After 25 years, full project ownership would revert to the Lao government.

An economic study of the project was commissioned in 1997. The consultant report concluded that under the "most likely" scenarios, the economic internal rate of return for the project from a project ('global') perspective, and Lao government perspective, is not less than 16%, and the net present value of an initial \$100 million investment by the Lao government is more than \$345 million. It goes on to say "Sensitivity analysis of the model indicates that the net present value of the project remains positive under all but the most pessimistic of scenarios."

A review of the economic study, however, indicated a much higher risk and probability of substantially lower internal rate of return, and risk that the Lao government would earn less, or even lose money, on the project.<sup>12</sup> The review found a likelihood that tariff revenues would be 20 to 30 percent lower than assumed in the study, and that the risk of a construction cost overrun of at least 50 percent should be considered, whereas the study used 20 and 30 percent in differing calculations. The review also found a radically greater likelihood of hydrological shortfall, resulting in lower power production, and diminished project lifespan. Together, these factors presented a very real possibility of the project having a negative NPV, subjecting the GOL to loss of its total investment while incurring environmental, social, and opportunity costs. The review further found that the study had slashed the value of Land Opportunity Cost used in the calculation of Cost/Benefit from the \$311.4 million developed by its own experts to \$134.5 million in its final calculation.

Under the study's worst case scenario, which for reasons given above the review considers to fall far short of representing the worst case, in the first 30 years the Lao government loses \$69 million, while the project overall retains a positive net present value (and the BOT developers make money). The project's primary goal for the Lao PDR is to earn foreign revenue to boost GDP and finance national development. The possibility exists that the country would lose money on the project, in addition to the over \$300 million in lost land opportunity cost, and incur environmental and social damage.

## **Vietnam**

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<sup>11</sup>Build operate transfer, or BOOT: build own operate transfer.

<sup>12</sup>Wayne C. White, Review of Economic Impact Study: Nam Theun 2 Hydroelectric Project, September 5, 1997.

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Vietnam's primary objective in damming rivers is electrical generation to meet domestic needs and spur national economic development. About three-fifths of the country's total installed generating capacity is hydropower.<sup>13</sup>

While Vietnam has been able to attract finance to increase its capacity, its hydropower reliant strategy has left it with chronic dry season (May to August) supply shortages, is not a least cost supply option, and has tied up large amounts of capital that might have been productively invested elsewhere in the economy. By an institutional idiosyncrasy, hydropower appears less expensive to Electricity of Vietnam, because the utility does not pay for the construction costs, while it does pay the fuel costs of the less capital intensive, higher fuel cost, alternatives. In actuality, not only is the unit cost as high or higher, solving the problem of seasonal shortfalls would require a tremendous additional investment in back up plants, running on gas, diesel, or coal, which would then be used only intermittently.

The large investment and long construction time needed to install large hydropower plants also gives them a disadvantage due to the uncertainty of demand projections. One calculation states that variations from projections, for the Southern portion of the country alone, could result in \$3 billion worth of capacity being built and subsequently sitting idle, an amount equal to 10% of 1999 GDP. Combined cycle gas plants, in comparison to hydro, have 2 year rather than 10 year construction cycles, and half of the capital cost, thus could be implemented with far less risk from mis-projection of demand.

The **Hoa Binh** project, with capacity of 1,920 megawatts, was built with Soviet assistance.<sup>14</sup> Construction began in 1979 and the final turbine was completed in 1994. Built as it was under a socialist system, accounting is not available that would reveal the true construction cost. One estimate has been given as \$1.5 billion. Assuming, for sake of illustration, that the construction budget had been \$1 billion, and financed over the construction life at 12% interest for 15 years, the resulting cost at end of construction would be \$5.47 billion—this hypothetical should convey the magnitude of the range of what may have been the actual cost.

Hoa Binh production as a percentage of capacity has been constrained as a result of seasonal water scarcity and sedimentation. In 1998 it not only had a dry season output reduction, but came close to zero production capability, that is, reservoir level being below the turbine intake. "At Hoa Binh, sediment deposition into the reservoir is estimated to be about 42 million m<sup>3</sup> annually...upstream deforestation...threatens to increase sediment rates and reduce the useful life of the reservoir."<sup>15</sup> The turbines have already experienced abrasion damage from sediment.

Over 58,000 people were displaced to build the dam. Most of these were of ethnic minority groups including the Muong, Tay, White Thai, Black Thai, Hmong and Dao.

## Conclusions

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<sup>13</sup>This section draws heavily from Dapice, David and Brian Quinn *Overinvesting in Power: The Costs of Excess Capacity*, 1999, unpublished paper.

<sup>14</sup>This section is informed by field research done by Ms Ngan Nguyen.

<sup>15</sup>*Vietnam Energy Sector and Policy Review* June 18, 1993.

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A table summarizing the development effectiveness of the representative projects is given below.

As instruments of national development, do the referenced projects contribute to economic growth, and do they link equity and environmental sustenance with the growth? Many of the projects referenced do supply electricity, and electric availability can be an important precondition to sectoral economic growth, but none of the projects are demonstrably least cost providers of power. None of the completed projects discussed has achieved adequate watershed protection, each has experienced degradation. Each has experienced sedimentation far in excess of design projections. Of any of the projects which caused displacement of persons, there is a recurring deficiency to achieve international standards for restoration of livelihood, or consultation with affected persons. The representative projects examined do not provide examples of sustainable development.

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<b>Development effectiveness of selected Mekong Region dam projects</b>		
<i>project</i>	<i>primary development goal(s)</i>	<i>development impact</i>
<b>Mekong Mainstream</b>		
Pa Mong	Irrigation for food security, electricity	Irrigation need not in evidence, irrigation feasibility undemonstrated. Negative effects of impoundment and diversion profound and not mitigated by project satisfactorily or at all.
<b>Thailand</b>		
Nam Pong	Irrigation	Food security or nutritional enhancement negligible. Negative public health, environmental, and displacement effects.
Pak Mun	Electricity	Firm power supply targets not achieved, so financial returns underperform. Displaced persons and environmental costs.
<b>Lao PDR</b>		
Nam Ngum	Electricity for export	Funded with concessional assistance, exports cheap power to Thailand. Poor economic return, but converts aid into an annuity.
Nam Theun 2	Electricity for export	Real risks exist of country not earning from project. Environmental damage and some relocation.
<b>Vietnam</b>		
Hoa Binh	Electricity	Supply shortages seasonally. Cost compromised by construction delays and reduced service life. Displaced 58,000 people, environmental damage.

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