Key Issue: 12-Benefits due to Dam Function

Climate Zone:

As: Tropical Humid

Subject:

- Irrigation and Power Generation

Effects:

- Increase of rice cultivation and agriculture productivity
- Electricity supply serve peak demand
- Reduce flood damage
- Production of fresh water fish
- Increasing of Tourists

Project Name:	Bhumibol Dam	
Country:	Tak Province, Thailand (Asia)	

Implementing Party & Period

- Project:	Electricity Generating Authority of Thailand (EGAT)	
	1964 (Completion of construction) -	
- Good Practice:	Electricity Generating Authority of Thailand (EGAT)	
	1964	

Key Words:

Irrigation, Power Supply, Flood Control

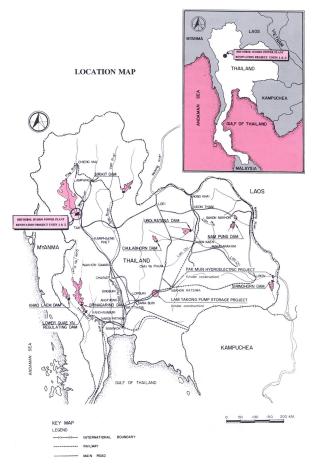
Abstract:

The Bhumibol Dam and Hydropower plant is the genesis of the large-scale multipurpose hydropower development in Thailand. This first and only concrete arch gravity dam in the country has for nearly four decades been creating electric power and irrigation profits, as well as many other benefits which have tremendously contributed to the country's continual development.

1. Outline of the Project

Bhumibol Dam, or originally known as Yanhee Hydroelectric Project, was first conceived in 1951 mainly to provide irrigation water supply to farmlands in the downstream Chao Phraya River and also to cope with the country's electric power supply shortage, The project which included the construction of a dam and a power plant to accommodate up to 8 generating units was approved by the Government in March 1951. Preliminary works were commenced in the following year. His Majesty the King Bhumibol graciously presided over the foundation stone laying ceremony on June 24, 1961. The dam and power plant was inaugurated by His Majesty the King on May 17, 1964 with the first two 70 MW generating units being placed into operation. Six additional units were installed and came on line on later years to cope with the country's rapid electricity demand growth.





 Installed Capacity
 Completion Year

 Units 1-2
 2 x 70 MW
 1964

 Units 3-6
 4 x 70 MW
 1967-1969

 Unit 7
 1 x 115 MW
 1982

 Unit 8
 1 x 171 MW
 1996

Figure 1: Location of Bhumibol project

1.1 Dam

Bhumibol Dam is a concrete arch gravity dam constructed across the Ping River, a tributary of the country's main lifeblood Chao Phraya River. The dam is 154 meters high, 486 meters long and 6 meters wide at its crest. Bhumibol Dam creates a large impounding area, capable of storing as much as 13,462 million cubic meters (MCM) of heavy runoff to prevent downstream flooding and provide the needed irrigation water supply for rice cultivation areas in the Central Plains and for other purposes all year round.

In effort to optimize the benefits of the available water supply, in 1991 a lower barrage was constructed across the Ping River, about 5.5 kilometers downstream of Bhumibol Dam, to create a lower pond for the operation of a new reversible pump turbine Bhumibol Unit 8. The concrete Lower Mae Ping Barrage is 8 meters high and 300 meters long and has a storage capacity of 5 million cubic meters.

1.2 Powerhouse

The hydroelectric plant situated at the dam base presently has a total installed capacity of 743.8 MW from its seven conventional hydropower generating units (Units 1-6 of 76.3 MW each and Unit 7 of 115 MW) and one reversible pump turbine unit of 171 MW. Bhumibol Unit 8 has double-fold functions, serving as a water pump during the off-peak hours to recapture water from the lower reservoir and pump it back up to the upper reservoir; and also operating as a generator to produce electricity during peak periods.

After over 25 years of service, Units 1-6 were renovated in 1992, 1993, 1996, 1997, 1999 and 2000 respectively. Each unit was subsequently up rated from 70 MW to 76.3 MW.

1.3 Transmission

The voltage of generated power from the power plant is stepped up at main transformers from 13.8 kV to the very high voltage of 230 kV for long-distance transmission on the transmission grid. Bhumibol power plant is connected with the country's grid network by four circuit lines linking the power plant switchyard and Nakhon Sawan substation, and one-circuit line linking the power plant switchyard and Bhumibol substation. Bhumibol dam is one among major power sources that supplies bulk energy to meet the growing needs of northern provinces as well as other parts of the country.

2. Features of the Project Area

The geographical features of the Ping basins are mainly rugged with high mountain ranges running in a north-south trend. These ranges extract much rainwater from the south-west monsoon which prevails during May-October. Since this region is located rather far from the sea and the topography is rugged, the difference in temperature during summer and winter seasons is rather high. In the Ping basin, the mean temperature in summer is within the range of $28-30^{\circ}$ C, while the value in winter varies between 20 and 25° C.

The amount of rainfall will differ from place to place. In the Ping basin, the average annual rainfall varies between 1,020 and 1,225 mm. September is the month with the highest rainfall.

The southern wind will prevail over the area most of the time, except in winter when the northern and the easterly winds prevail. In the beginning of the southwest monsoon period from April till May, the wind speed is high and becomes weaker in the rainy season and in winter. The maximum wind speed ever recorded is approximately 100 km/hr. Normally, the average wind speed is about 6 km/hr.

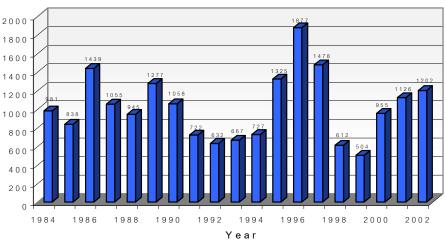
From the climatic data recorded at various stations in the Ping basins, it is found that are no distinguishable change in climatic conditions between the time prior to and after the construction of the dams. Only normal seasonal variations have been found because the reservoir areas is rather small when compared to the catchment areas as a whole. Therefore, it can be concluded that the Bhumibol dams do not have effects on regional climatic conditions. However, the reservoir impoundment does have some impact on the local climatic conditions, such as wind direction and relative humidity in the vicinity of the reservoirs.

3. Benefits

Historically, the two priorities for the development of Bhumibol Hydroelectric Project were irrigation and electricity generation. However, other major benefits, including flood control, fishery, navigation and tourism have been achieved through the course of the project development and operation. Bhumibol dam is the archetype of a successful multipurpose dam development in Thailand. For nearly four decades, it has unfailingly provided the faithful services which have vitally supported the rapid growth of the national economy and the improvement of the quality of life of the Thai people and will continue to provide the following multi-benefits for many more decades to come.

3.1 Electricity

With its ultimate capacity of 743.8 MW, Bhumibol dam is one of major power sources to help satisfy the country's peak demand and providing an average annual energy output of about 1,100 million kWh. The maximum electrical energy ever generated was 2197.5 million kWh in 1976. Regarding water use in power generation, it is found that the average rate of water use is 4.1 MCM/MWh.



Power Generatiom (million kWh)

Figure 2: Changes in power generation with lapse of years

3.2 Irrigation

In addition to power benefits, water from Bhumibol and Sirikit dams combined has turned the Central Plains areas into a major rice bowl for Thailand, irrigation about 10 million rai (an equivalent of 3.96 million acres) of rice planting areas in the downstream Ping and Chao Phraya river basins. Owing to adequate water supply from Bhumibol dam, rice cultivation in the Central Plains can be made twice a year.

Besides, the dam releases water through its generators for the purposes of water treatment and control of salinity in the downstream rivers caused by the influx of sea water into the rivers during the dry season.

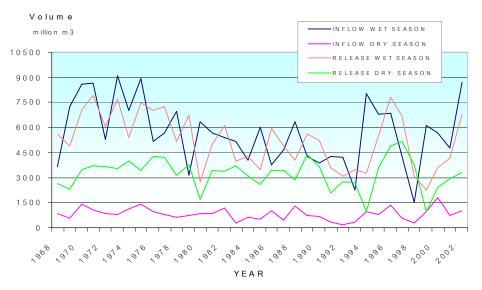


Figure 3: Water inflow and release, Year 1968-2002

3.3 Flood Control

As a storage dam, Bhumibol dam has successfully met both irrigation and flood control needs. Each year, the dam plays an important role in absorbing flood water during rainy season, thus helping prevent or reduce flood damage in downstream areas. During the peak inflow in August 2002, the record showed that the flood volume has reduced by amount of 3,000 MCM and on average amount of 2,050 MCM per year. The average flood duration reduction of about 12 days with a maximum reduction of 22 days were obtained.

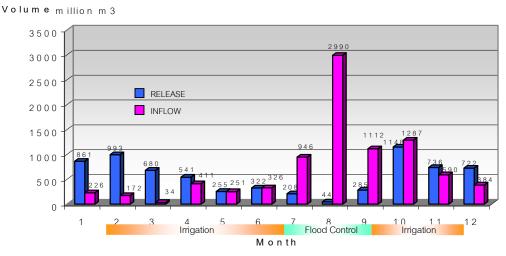


Figure 4: Irrigation and flood control in Year 2002

3.4 Fishery

Bhumibol reservoir has provided improved environments for fresh water fish breeding. Each year EGAT also releases over a million of fry into the reservoirs to increase fish population, enabling the local people to earn more income from fishery. Annually, about 800 tons of fish caught in this reservoir are supplied to the market



Figure 5: Fishery in Bhumibol reservoir

3.5 Tourism and Recreational Facilities

Located amidst the natural beauty, Bhumibol dam, with its comfortable amenities and recreational facilities, has become a major tourist attraction of Tak province with millions of people visiting the dam each year. This has significantly brought more jobs and income to the local people, and thus enhancing the community economy and well being.

Bhumibol dam is well equipped with a wide range of recreational resources for visitors. These include modern and comfortable accommodations, conference facilities, the Museum of the Royally-Initiated Water Resource Developments, recreational parks, a standard golf course, playground areas, picnic areas, swimming pools, jogging tracks, trails, and etc.

4. Effects of the Benefits

Bhumibol dam have been serviced the country for almost four decade. At the beginning of the project, the electrical energy generated from the Bhumibol dam in 1965 accounted for 73.66 % of the total system, but declined to 2 % in 2003. Even the power supply from this dam show not a significant number but the hydropower benefits still play an important role in the country because it is mainly supply during the peak demand. The effects of irrigation benefits are more important and sustainable. After the completion of Bhumibol dam, the downstream paddy lands in river basins have been developed to be irrigated paddy lands. In these areas, former irregular flood and drought have been eradicated. Double cropping has been practiced in the lands annually and the rice production of Thailand have become increasing acutely. The results obtained from the study effect of flood control reveal that the Bhumibol reservoir has played a noticeable role in flood protection at downstream flood prone area. They have provided a reduction of flood peak, flood volume and shortened flood durations. These have results in reduction of agricultural damages markedly. The socio-economic study show that the living and economic conditions of the people situated in the areas is satisfied. The annual household income is much better. They have been derived from double field crop, rice, government employment, trading, fishery and wage labour.

	DRY SEASON	WET SEASON	
Year	Irrigation Area	Irrigation Area	Remark
	(rai, rice-equivalent)	(rai, rice-equivalent)	
1978	2,118,600	\backslash	
1979	3,035,500		
1980	1,322,100		
1981	3,146,800		
1982	3,323,900		
1983	3,216,100		
1984	3,212,600		
1985	3,126,300		
1986	2,765,343		
1987	2,531,785		
1988	2,534,657		Before completion of
1989	2,769,481	Yearly Average	Bhumibol project
1990	2,920,000	\rangle 7.5 million	dry season cropping
1991	2,172,725	rai rice equivalent	Is impossible
1992	2,071,477		
1993	1,813,838		
1994	1,870,834		
1995	2,429,352		
1996	3,438,886		
1997	3,357,888		
1998	3,282,645		1 acres = 2.52 rai
1999	2,763,706		equivalent to 2.52
2000	3,889,064		
2001	4,492,314		
2002	3,977,920	/	

Table 2: Rice agriculture product in Chao Phraya irrigation area

5. Reasons for Success

- Good cooperation of the government Agencies who granted authorization to their officials to participate in the work of the project. These include the Royal Irrigation Department, Department of Mineral Resources, Land Development Department, The National Inland Fisheries Institute, The Tourism Authority of Thailand, University, as well as The National Social and Economic Development Board.
- The Evaluation overall benefits of the project, a conclusion can be made without debts that the Bhumibol Dam has rendered benefits to economy in various aspect.
- Regarding the impacts on the environment, the study reveals that the adverse environmental impacts caused by Bhumibol dam are insignificant.

6. Further Information

6.1 References

- 1) Chulalongkorn University, Social Research Institute: Post Impoundment Environmental Evaluation and Development Planning of The Bhumibol and Sirikit projects, September 1987
- Electricity Generating Authority of Thailand: Bhumibol Hydro Power Plant Renovation Project Unit 1&2, Completion Report, May 1994

6.2 Inquiries

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