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Ex-post Monitoring of Completed ODA Loan Project
"Rehabilitation of the Tenom Pangi Hydropower Project"

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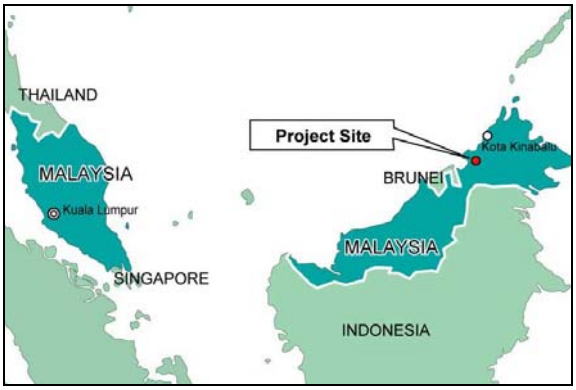
Field Survey: September, 2009

1. Project Description



Map of the project area

Water intake gate of
the Tenom Pangi Hydropower Station

1.1 Project Objective

The objective of this project is to secure the stable supply of electricity by rehabilitating the Tenom Pangi Hydropower Station damaged by flooding in the State of Sabah, thereby contributing to the growth of local economy.

1.2 Outline of the Loan Agreement

Approved Amount/ Disbursed Amount	543 million yen / 299 million yen
Loan Agreement Signing Date/ Final Disbursement Date	May 1992 / September 1999
Ex-post Evaluation	FY 2003
Executing Agency	Sabah Electricity Sdn. Bhd. (SESB)
Main Consultant	Japanese companies, etc.

1.3 Background of Ex-post Monitoring

The Tenom Pangi Hydropower Station is a conduit type hydropower plant on the Padas River with a maximum capacity of 66MW. It was constructed with assistance of Japanese ODA loans. The power station started operation in 1984 but torrential downpours in 1988 damaged the water intake gate (the trash boom and vertical gate) and resulted in unstable operations. This

project implemented civil works to prevent accidents which could cause outages as well as the repair of damaged facilities. Ex-post evaluation confirmed the recovery of power generation but it also revealed that the rehabilitated facilities had been damaged again. Among the facilities repaired by this project, the trash boom, the strainer / sand separator, and the river flow rate forecasting system were seriously damaged. The trash boom lost its floats and could not trap trash at the water intake gate only a few weeks after its completion. The strainer / sand separator also started malfunctioning a few weeks after completion, requiring the switch to an older system. The river flow forecasting system also did not function and suffered from sand clogging at meters. Some parts were stolen. Since this damage was expected to cause outages at the time of the ex-post evaluation, the sustainability of project benefit was in doubt. Therefore, this project was selected for ex-post monitoring and each criterion reviewed with the findings from the field survey and other research activities. The conclusion was then drawn.

2. Monitoring Results

2.1 Effectiveness (Impact)

Power generation of the Tenom Pangi Hydropower Station increased after the ex-post evaluation and remained at a high level (above 500GWh in FY2007 and FY2008). Although power generation decreased due to the repair of the generators in FY2009, it is expected that it will recover as repair works are completed at the end of FY2009. The trash boom is still damaged at the time of the ex-post monitoring but this damage only marginally affects the operation of the power station.

2.1.1 Quantitative Effects

(1) Electricity generation and maximum output of Tenom Pangi Hydropower Station

The rehabilitation works which this project implemented ended in 1998. Following this, the average annual electric generation from 1999 to 2002 reached 423GWh.[1] After the ex-post evaluation, annual electric generation stood from 400 GWh to 510GWh between 2003 and 2007 and the average climbed to 466GWh (see Table 1 and Figure 1). Furthermore, annual electric generation recorded a new high in 2007. A considerable decrease in the annual electricity generation for FY2009 was due to the replacement of hydropower parts and the emergency repairs of the Generation Unit III. Repairs were completed in August 2009 and, thus, electricity generation is expected to recover. At the time of the ex-post monitoring, the damage to the trash boom still remains and flooding may cause further damage around the water intake gate. As the damage to the trash boom does not result in a reduction in electricity generation, its influence on daily operations is considered relatively marginal (further details on the damage to the trash boom can be seen in “2.2.2 Current Status of Operation and Maintenance”).

[1] Based on the ex-post evaluation report, “Malaysia: Rehabilitation of the Tenom Pangi Hydropower Project”

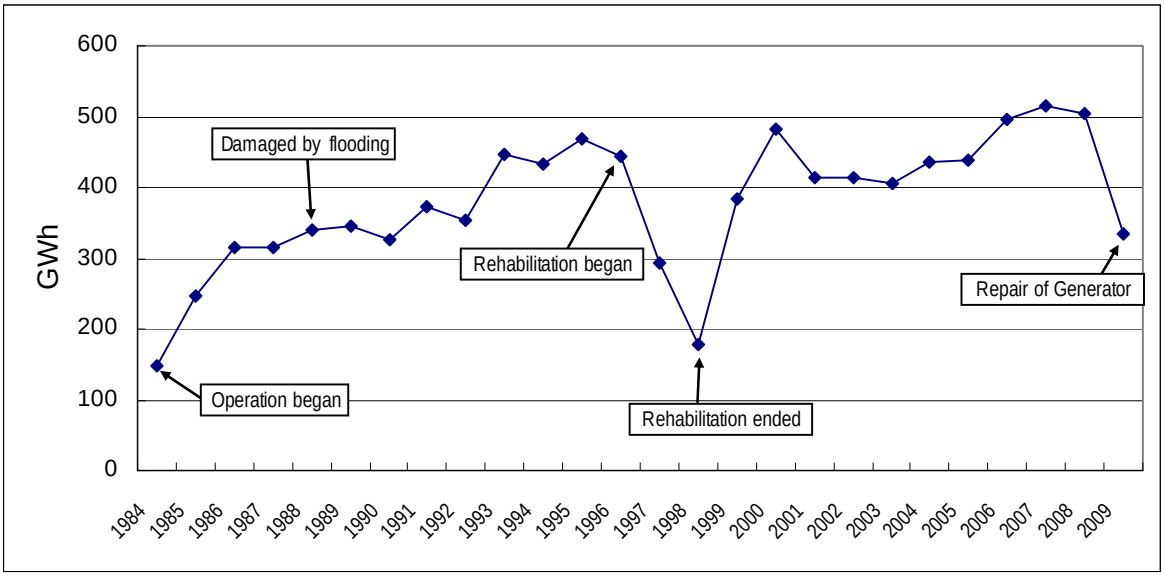
Table 1: Annual electricity generation of Tenom Pangi Hydropower Station

Unit: GWh

Fiscal Year[2]	2002	2003	2004	2005
Electricity Generation	414.6	405.94	435.17	438.63

Fiscal Year	2006	2007	2008	2009
Electricity Generation	496.40	514.07	505.33	334.30

Source：SESB

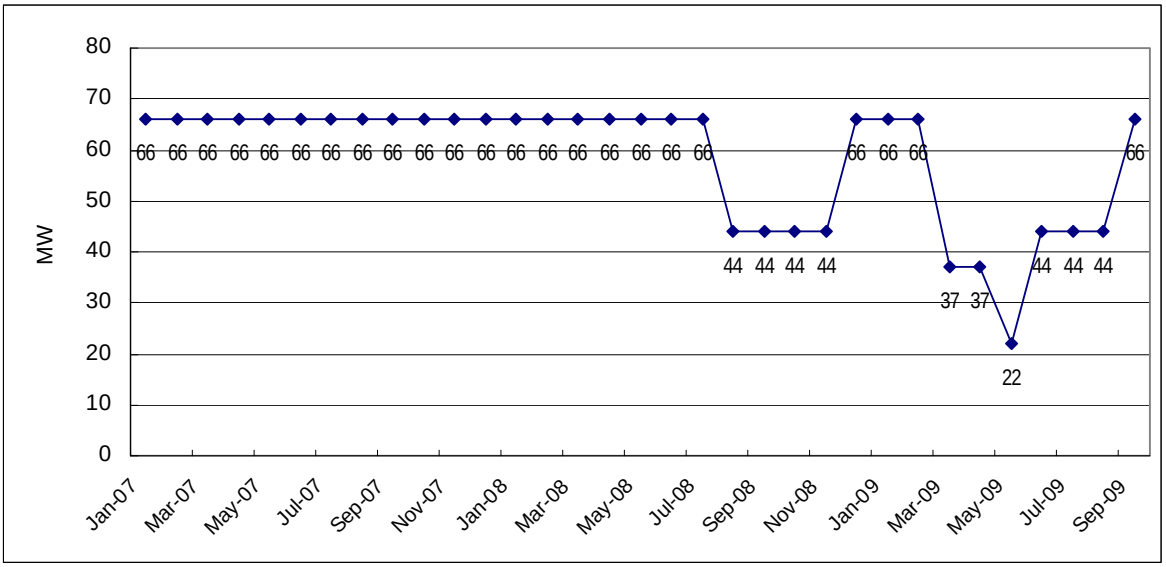


Source: SESB

Figure 1: Annual electricity generation of Tenom Pangi Hydropower Station

The maximum capacity of the Tenom Pangi Hydropower Station is 66MW (22MW×3 units). As mentioned earlier, however, maximum capacity started to decrease in August 2007 due to the replacement of hydropower parts and emergency repairs on the Generation Unit III (see Figure 2). After completion of the repairs, the maximum capacity recovered to 66MW after September 2009.

[2] In Table 1 and Table 2, SESB's fiscal year is from August to September.



Source: SESB

Figure 2: Maximum capacity of Tenom Pangi Hydropower Station

(2) Outage hours for the Tenom Pangi Hydropower Station

The outage hours for the Tenom Pangi Hydropower Station during the last three years (total hours of the three generators) is shown in Table 2. The large increase in unplanned outages in FY2008 was due to the emergency repairs on the Generator Unit III. Unplanned outages are expected to decrease after the completion of repair work on the Generator Unit III.

Table 2: Outage hours for the Tenom Pangi Hydropower Station

Unit: hour

Fiscal Year	2007	2008	2009
Unplanned	85.73	263.26	2177.50
Planned	174.41	281.75	882.47
Total	260.14	545.01	3059.97

Source: SESB

(3) Financial Internal Rate of Return (FIRR)

The FIRR of this rehabilitation project is reviewed in accordance with the FIRR calculation method at the time of the ex-post evaluation. The FIRR reaches 12.1%, a rate which is higher than the 9.2 % at the time of the ex-post evaluation. The actual incremental electricity generation after the completion of this rehabilitation project surpasses the estimation made at the time of the ex-post evaluation. The increase in incremental electricity generation contributes to the higher return of the FIRR. The recalculation of the FIRR is based on:

Cost : investment, opportunity costs during project implementation, and O&M costs[3]
Benefit : incremental sales of electricity (incremental electric generation[4] × sales price[5])
Project life : 50 years after the completion of the power plant (until 2033)

2.1.2 Impact

(1) Contribution to the local economy

After the ex-post evaluation, the GDP of the state of Sabah has been growing at 5% per annum and the population at 2% per annum (see Table 3). In tandem with the economic and population growth, electricity consumption has recorded a high level of growth. Electricity generation by the Tenom Pangi Power Station accounted for 12% of that of Sabah in 2008, which accounted for 15% at the time of the ex-post evaluation. In light of its share in the electric supply in Sabah, the Tenom Pangi Hydropower Station remains a major source at the time of the ex-post monitoring and plays a vital role in sustaining the growth of the local economy.

Table 3: GDP, Population and Electricity Consumption in the State of Sabah

	Ex-post Evaluation	Ex-post Monitoring	Rate of Increase / Year
GDP (Prices in year 2000, million RM)[6]	21,702	26,563	5.18%
Population (thousand)[7]	2,603.5	3,219.2	2.69%
Electricity consumption (GWh)[8]	2,118.1	3,384.7	8.13%

Source: Department of Statistics Malaysia, SESB

(2) Supply and demand in the State of Sabah

- Electricity statistics

In the State of Sabah, the supply and demand in electricity is tighter now than at the time of the ex-post evaluation. The Tenom Pangi Hydropower Station shoulders a critical burden for the supply of electricity. A significant growth in electric demand contributes to this tighter supply and demand, though both generation capacity and electric generation have increased in Sabah (see Table 4). The Ninth Five-year Plan aims to ensure 20% of power generation for SESB from coal-fired power plants. However, there are strong concerns regarding the negative impact on the environment, which has resulted in a slow switching to coal-fired power plants, and which

[3] Investment, opportunity cost during project implementation, and O&M costs are based on data at the time of ex-post evaluation. O&M cost is estimated at 2% of accumulated investment costs.

[4] Incremental electricity generation is based on actual data for 2003-2009 and the average for 2003-2009 after 2010.

[5] Electric prices have not been revised since the time of the ex-post of evaluation. For this reason, the sales price is based on the CPI-adjusted sales price at the time of the ex-post evaluation.

[6] The figure at the time of the ex-post evaluation is based on actual data for 2002. The figure at the time of the ex-post monitoring is based on preliminary data for 2006.

[7] The figure at the time of the ex-post monitoring is based on the population census of 2000. The figure at the time of the ex-post monitoring is the estimated data for 2008.

[8] The figure at the time of the ex-post evaluation is based on actual data for 2002. The figure at the time of the ex-post monitoring is based on the actual data for 2008.

in turn is one of the reasons behind the tighter supply and demand.

Table 4: Supply and demand of electricity in the State of Sabah[9]

	At the time of Ex-post Evaluation	At the time of Ex-post Monitoring
Units generated per annum (GWh)	2,736.4	4,176.3
Units consumed per annum (GWh)	2,118.1	3,384.7
Unit generated/Units consumed	129.2%	123.4%
Installed capacity (MW)	768	959
Peak demand (MW)	447.0	646.9
Generation Capacity/Peak Demand	171.8%	148.3%

Source: Department of Statistics Malaysia, SESB

- Questionnaire survey and non-structured interviews with consumers

In order to assess the demand and supply of electricity, a questionnaire survey and non-structured interviews with 15 manufacturing plants in Kota Kinabalu, the state capital of Sabah, were conducted.[10] For comparable information, an identical survey and interviews were carried out at 5 plants in the Kota Kinabalu Industrial Park (KKIP) which has a preferential supply of electricity. The questionnaire survey and non-structured interviews proved that the demand and supply of electricity was tight.

Photo 1: Questionnaire survey with consumers

Among the manufacturers in Kota Kinabalu, more than a half of the respondents chose "Unstable" or "A little unstable" to describe the electricity supply. Similarly, a majority selected "More unstable" regarding the stability of the electric supply compared with 5 years ago (see Table 5 and Table 6).

Table 5: Current status of the energy supply

	Very unstable	Unstable	A little Unstable	Stable
Kota Kinabalu City	0	5	8	1
KKIP	0	0	1	4

[9] The figure at the time of the ex-post evaluation is based on actual data for 2002. The figure at the time of the ex-post monitoring is based actual data for 2008.

[10] The questionnaire survey and non-structured interviews were conducted at Kelomnong, Inanam,and Penampang in early September 2009.

Table 6: Status of the energy supply compared with 5 years ago

	More Stable	Unchanged	More Unstable	Do Not Know
Kota Kinabalu	1	5	7	2
KKIP	2	1	1	1

Non- structured interviews revealed that an insufficient supply of electricity caused rotating blackouts in some areas in Kota Kinabalu. The tight supply and demand is not the sole reason for blackouts as accidents on distribution lines are also blackout cause. Interviewees explained the negative effects of blackouts as followed: blackouts jeopardize the quality of products, often waste work-in-progress products, prevent employees from working. Many manufacturing plants in Kota Kinabalu own back-up generators but some plants do not, due to insufficient capacity and additional costs. On the other hand, there is no plant with a back-up generator in KKIP.

(3) Environmental and social impacts

As the project scope is mainly the rehabilitation of damaged facilities, land acquisition and resettlements were not carried out. During the site visit, significant changes in the environment after the ex-post evaluation were not observed.

2.2 Sustainability

After the ex-post evaluation, there has been no significant change in the structural aspects of operation and maintenance (O&M). As for the technical aspects, technological capability is maintained by periodic training and has reached a satisfactory level by technological transfer. Regarding the financial aspects of O&M, a review of the financial statements of Tenaga Nasional Berhad (TNB), the parent company of SESB, shows that TNB's profitability and financial stability improved between the ex-post evaluation (2003) and the ex-post monitoring (2008). The ex-post evaluation pointed out damages in the trash boom, the strainer / sand separator, and the river flow forecasting system. The executing agency properly coped with the damages excepting in one case at the trash boom. The current status of O&M shows improvement.

2.2.1 Operation and Maintenance Agency

2.2.1.1 Structural Aspects of Operation and Maintenance

SESB is responsible for the O&M of the Tenom Pangi Hydropower Station. SESB is a vertically integrated electric supplier and conducts generation, transmission, and distribution activities. In the operational units of SESB, the Division of Generation is in charge of the O&M of the power station. After the ex-post evaluation, the state-owned electric company TNB has continued to be a controlling shareholder of SESB and owns 80% of the total shares outstanding. SESB is included in the consolidated financial statements of TNB.

2.2.1.2 Technical Aspects of Operation and Maintenance

At the time of the ex-post monitoring, 98 employees were working at the Tenom Pangi Hydropower Station. Out of these, 75 employees were engaged in the O&M of the power station. At the time of ex-post evaluation, considering the technological transfer during the project implementation of this project, the technological level was evaluated to be satisfactory. At the time of the ex-post monitoring, SESB maintained technical capability at the power station by periodic training. For employees at the power station, SESB currently conducts internal training on the operation of power plants (7 courses) twice a year. While routine maintenance (inspection on a daily, weekly, and monthly basis) and periodic maintenance (twice a year) are conducted by power plant staff, overhauls (once every 10 years) and emergency repairs (whenever necessary) are outsourced to a contractor (TNB REMACO). Spare parts are available but it takes time to obtain them.

2.2.1.3 Financial Aspects of Operation and Maintenance

Since the financial statements of SESB are not disclosed to the public, financial stability is analyzed from the financial statements of the parent company TNB (see Table 7).[11] The Return on Assets (ROA) fluctuates year by year but Interest Payment/EBIT suggests that TNB has enough profit to satisfy interest payments.[12] As the Debt-to-Equity Ratio is stable and the Current Ratio has remained at 1.5, it can be concluded that TNB is financially stable. Compared with financial ratios at the time of the ex-post evaluation, the ROA shows a better profitability and the Interest Payment/EBIT and the Debt-to-Equity Ratio suggests an improvement in financial stability at the time of the ex-post monitoring. Although the executing agency SESB has not revised electricity prices since 1986, the solid financial stability of TNB guarantees that the financial status of SESB has only a very marginal influence on the sustainability of this project.

Table 7: Financial Ratios of TNB

Fiscal Year	2003	2004	2005	2006	2007	2008
Interest Payment/EBIT	0.44	0.48	0.47	0.37	0.21	0.27
ROA	1.77%	1.28%	2.02%	3.32%	6.01%	3.72%
Current Ratio	0.92	1.73	1.22	1.41	1.51	1.68
Debt to Equity Ratio	3.27	3.26	2.92	2.33	1.81	1.71

Source: TNB

2.2.2 Current Status of Operation and Maintenance

This project implemented 1) the rehabilitation of the hydropower station, 2) the rehabilitation of civil works, and 3) the establishment of the river flow forecasting system. The

[11] The financial ratios are calculated on the financial data from the annual reports from FY2003 to FY2008 (consolidated basis). All of the annual reports are publicly disclosed.

[12] EBIT: Earning before Interest Payment and Tax

ex-post evaluation pointed out that, out of the facilities repaired and improved by this project, the trash boom, the strainer / sand separator, and the river flow forecasting system had been damaged. The executing agency conducted repair works on these facilities. Except for the trash boom, these facilities are now in a better condition. The current status of these facilities is as follows:

(1) Trash boom

At the time of ex-post evaluation, the facility to trap trash was broken as the floats of the trash boom had been washed away. In 2004 (after the ex-post evaluation), a structure for catching trash was constructed in front of the water intake gate (see photo 2).[13] After half year from the completion of construction, however, damage occurred again. At the time of the ex-post monitoring, no facility to prevent the clogging of trash had been installed at the water intake gate (see photo 3).

Photo 2: Water intake gate after the ex-post evaluation

Photo 3: Water intake gate at the time of the ex-post monitoring

As counter measures, the executing agency is currently:

1) Expanding meshes in the trash grills installed in the water intake gate so that clogging of trash does not occur
2) Raking trash in the settling basin placed between the water intake gate and the water tunnel. Trash screens are placed in the settling basin. Raking machines are currently in use.
3) Stopping the power plant, opening the diversion gate, and washing way trash, when a great quantity of trash appears.

The lack of a facility to catch trash causes the danger of clogging and damage to the water intake gate. In the case of 3), furthermore, a switch to a high cost power source such as a diesel

[13] SESB conducted the comparison analysis between the period in which the structure was installed and the same period of the previous year. The electric outage derived from the action 3) on the next page is reduced by approximately 40% from 4177MWh to 1766 MWh.

generator or natural gas-fired generator is required in order to cope with the insufficient supply of electricity. For this reason, the executing agency plans to redesign and install the trash boom with an improvement in materials and movable parts.

(2) Strainer / Sand separator

The Tenom Pangi Hydropower Station separates sand from river water and produces cooling water. The water is used for cooling the bearings in the generators. At the time of the ex-post evaluation, the strainer / sand separator was not used because of malfunction. A new system was installed after the ex-post evaluation and the cooling system was updated. As sand clogging is less than at the time of the ex-post evaluation, cleaning of the cooling system does not hinder operation.

Photo 4: Sand Separator

(3) River flow forecasting system

Although this project created gauging stations at three locations (Kemabong, Ansip, and Biah) in the upper Padas River, these gauging stations were not functioning at the time of the ex-post evaluation. After the ex-post evaluation, SESB reestablished three gauging stations working together with the Irrigation and Drainage Department of Sabah State. At the time of the ex-post monitoring, flooding had damaged and one station disabling its function while other two stations continued to send data to the power station. The gauging stations are unmanned and the equipment in the stations is extremely prone to theft. For tighter security, SESB cooperates with the government which owns a facility nearby and their staffs inspect the gauging stations more frequently than before.

Amongst other civil works which had been rehabilitated by this project, several gabion walls collapsed due to landslides. However, access roads to the power plants were well-maintained after the landslides, thus the traffic within the power station was not negatively affected. Other facilities and equipment have sustained no serious damage and the operation of the power station is not otherwise hindered.

3. Conclusion, Lessons Learned and Recommendations

3.1 Conclusion

The trash boom in front of the water intake gate was still damaged at the time of the ex-post evaluation but power generation had recovered and a negative effect on the operation of the power station was not confirmed. The supply and demand of electricity in the State of Sabah

is tighter than at the time of ex-post evaluation. The Tenom Pangi Hydropower Station plays a crucial role in power supply. The damaged facilities, except the trash boom, are now in a better condition. As the executing agency took appropriate remedial action for the problems raised by the ex-post evalution, this project is still significant at the time of the ex-post monitoring.

3.2 Lessons Learned

None

3.3 Recommendations

(1) Monitoring of repair work on the trash boom (for SESB)

The ex-post monitoring revealed that the trash boom had not been set up and, for this reason, trash had gathered nearby the water intake gate. The executing agency SESB plans to review the design and reconstruct the trash boom. However, the trash boom has broken three times (before project implementation, after project implementation and after the ex-post evaluation) and this trouble is in danger of developing into damage of the water intake gate, a similar accident which occurred in 1988. As trash clogging at the water intake gate is unavoidable due to the design of the power station, it is recommended that the executing agency continues to monitor both trash clogging and its effects on the operation of the power plant and remove trash periodically.

Comparison of the Original and Actual Scope

Item	Original	Actual
Project Outputs:		as planned
Trash control		
1) Trash boom	1 set	
2) Movable protection rack	1 set	
3) Strainer/Sand Separator	1 set	
4) Differential pressure detecting system	1 set	
Rehabilitation of civil works		
1) Front footholds of side walls/ apron foot protectors	1 set	
2) Gabion wall	1 set	
3) Slope protection on access roads	1 set	
Update of river flow forecasting system		
1) River flow forecasting system	1 set	
Consulting service	Intern'l : 20.90 M/M Local : 25.50 M/M	Intern'l : 21.24 M/M Local : 25.70 M/M
Project Period:		
Loan Agreement	May 1992	same as the left
Selection of consultant	January 1993～March 1993	January 1995
Preparation of tender documents	April 1993～May 1993	April 1995
Tender	June 1993～July 1993	
Evaluation and Approval of Bids	August 1993～September 1993	June 1996
Signing of contract	October 1993	
Construction works		
1) Trash control	July 1994～November 1994	September 1996～January 1998
2) Rehabilitation of civil works	July 1994～December 1994	September 1996～January 1998
3) River flow forecasting system	July 1994～October 1994	September 1996～July 1997
Project Cost:		
Foreign currency	482 million yen	N/A
Local currency	243 million yen	N/A
Total	725 million yen	485 million yen
Japanese ODA loan portion	543 million yen	299 million yen
Exchange rate	RM 1=JPY46.6 (1994)	N/A