Nepal

Kulekhani Disaster Prevention Project

Report Date: March, 2002

Field Survey: August, 2001

1. Project Summary and Japan's ODA loan

Site Map：Kulekhani in Nepal

Site Photo：Sabo dam on the Kani River

1.1 Background

In response to the rapid growth of power demand in central Nepal, plans were made in the early 1980s to build Kulekhani power stations No. 1 & 2, with assistance from the Japanese government. Both power stations were important components of Nepal's power system, with projected installed capacity of 60MW and 32 MW, respectively.

After the completion of Kulekhani No.1 and during the construction stage of Kulekhani power station No.2, torrential rains in 1984 and 1986 triggered slope failures, collapses and land slides around the project area. Roads and bridges were damaged, houses were washed away and people were killed. The rainfall, floods and landslides not only seriously affected the project facilities, they threatened the future safe operation of the Kulekhani power stations. Urgent remedial measures were taken to cope with the damage. It was necessary, however, to take further measures to protect against heavy rainfall in the future.

1.2 Objectives

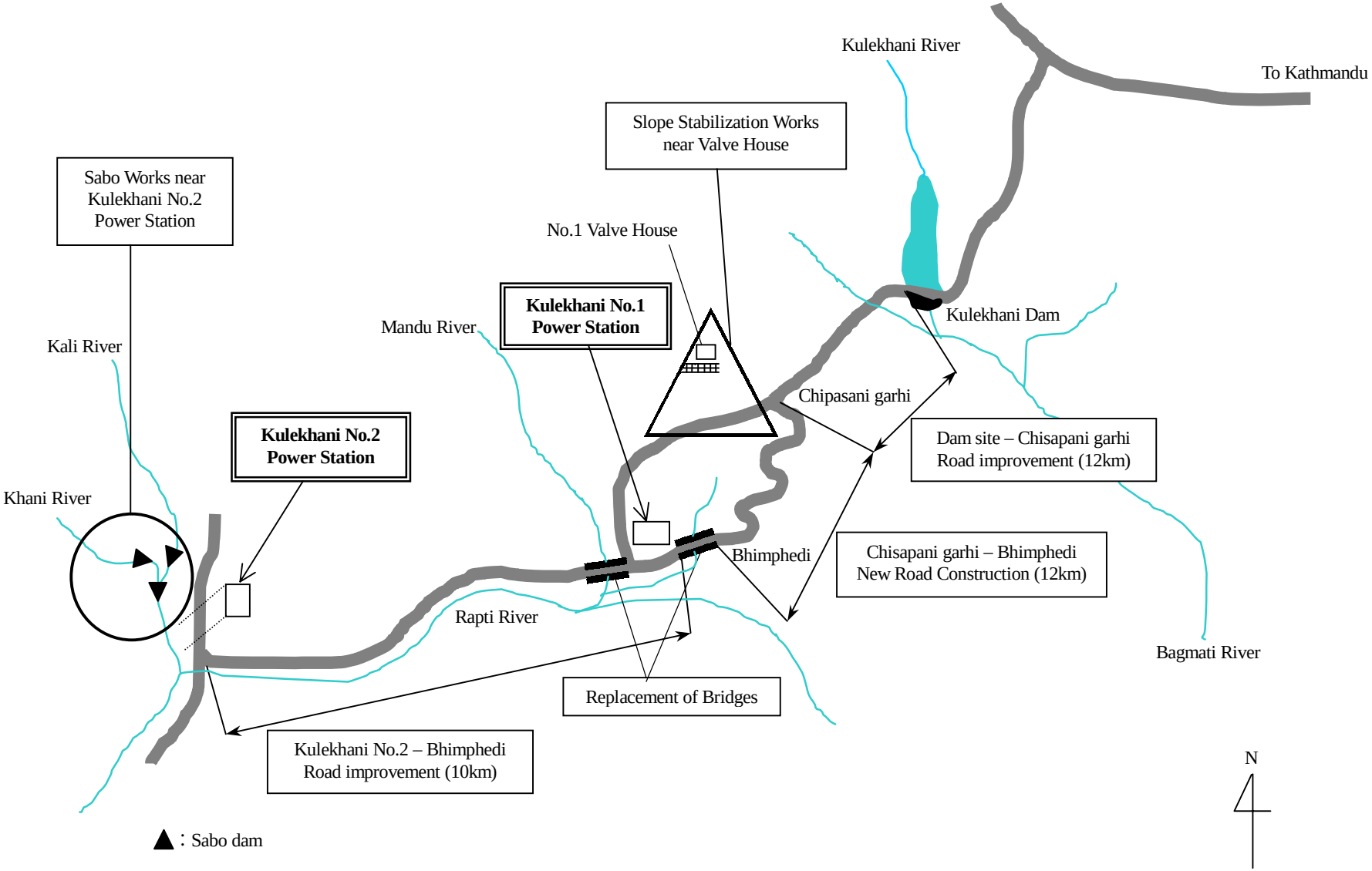
To construct disaster prevention facilities that would ensure the smooth and efficient operation of Kulekhani power stations No. 1 and No.2.

1.3 Project Scope

-Urgent prevention works near valve house of Kulekhani. No.1 Power Station (Urgent Works)
-Purchase of Construction equipment
-Sabo works near Kulekhani No.2 power station
-Slope stabilization works near Valve House
-Improvement of the project road and erosion control of collapsed areas along roads between Kulekhani dam site and Kulekhani No.2 power station (Rehabilitation of the project road)

Location map of project site is shown on page 2.

Location Map of Project Site



1.4 Borrower/Executing Agency

His Majesty's Government of Nepal /Nepal Electricity Authority (NEA)

1.5 Outline of Loan Agreement

Loan Amount Loan Disbursed Amount	2,710 million yen 2,630 million yen
Exchange of Notes Loan Agreement	August 1990 October 1990
Terms and Conditions Interest Rate Repayment Period (Grace Period) Procurement	 1.0 % p.a. 30 years (10 years) General untied
Final Disbursement Date	November 1995

2. Analysis and Evaluation

2.1 Relevance

Given the disaster-prone environment of the project site and the actual damage from the rains in 1984 and 1986, this project was an urgent priority. Even during project implementation, weather conditions caused further damage. It is clear that if this project had not been implemented, the damage would have been worse.

Kulekhani power station continues to play a vital role in the power system in Nepal, currently contributing about 30% of power generation in terms of installed capacity. The smooth and efficient operation of the station is still highly required.

2.2 Efficiency

2.2.1 Project Scope

The project scope had to be revised due to the damage caused by flooding in 1993, during project implementation. At the time, rainfall of up to 80mm per hour, and 540mm over a 24-hour period, was recorded. The penstock line, head pond, and power station generator were seriously damaged, and power generation had to be halted. Under the circumstances, Japan extended emergency grant aid for the overhaul of the generator. Once priority was given to normalizing power generation, restoration of the penstock and some restoration work on Mandu head pond were added to the project scope, and the plans for road improvement were cancelled. Additional engineering services were also conducted for complete restoration of the dam and for further strengthening disaster prevention measures. The damaged facilities were crucial for power generation; therefore, these revisions are considered necessary and appropriate.

2.2.2 Implementation Period

Project completion required an additional two years, mainly because of the disaster mentioned in Project Scope. The flooding in 1993 blocked the access road, completely isolating the project site. According to NEA, it took only one month only to restore the access road, using the heavy construction equipment available at the project site. It took 104 working days to restart power generation. It seems

that all efforts were made to restore power generation as soon as possible and to implement the rest of the work with minimum delay. The executing agency reported that the performance of the consultant and the contractor was prompt and very good. Considering the difficulties caused by the disaster, it can be said that performance was good in terms of the efforts to try to follow the period as scheduled and to take countermeasures for minimizing delay.

2.2.3 Project Cost

The total project cost is 2,730 million yen, while the planned was 2,991 million yen. The difference between planned and actual cost is due to several intertwined factors: the revised project scope, keen competition in tender, and exchange rate fluctuation. The changes in project scope are due to the emergency work discussed above. The damage was so enormous that some portion such as overhaul of generator was conducted by Japan's grant aid (748 million Yen) and some road improvement portions were cancelled to utilize the fund for emergency work. Kulekhani Disaster Prevention Project (II) implemented those portions that were cancelled in this project. The construction costs were lower than estimated because of keen competition. In addition, the Nepalese Rupee-Yen exchange rate varied widely, from NRs.2.48 to NRs.5.99 during the project period and this affected the project cost.

2.3. Effectiveness

2.3.1 Effect of Project Facilities

All facilities constructed under the project have been functioning adequately through to the present. Although canalization of the river channel in front of the power station, which was carried out as part of the project, was completely buried due to the flood in 1993, some other works that had been completed before the disaster proved their protective capacity. For example, sabo works, consisting of a check dam and canalization near Kulekhani power station No.2 (KL-2) prevented the clogging at the KL-2 tailrace. The dyke retained the debris and prevented it from accumulating in front of the KL-2 Power station, thus avoiding the aggravation of river in front of the tailrace area. Slope stabilization works near the valve house also proved their effectiveness during 1993 flood, when the penstock line was washed away and the whole area of valve house was shaking. The anchoring and shortcrete work prevented the area from collapse. Without these facilities, the damage would have been worse.

Following this project, reinforcement work on the structures and additional works cancelled in this project were carried out under the Kulekhani Disaster Prevention Project (II). From completion year 1995 to the present, there were no natural disasters on the scale of the 1993 floods. The rainfall record from 1995 to the present shows that the project area occasionally had some heavy rain, over 100mm[1]; however, the durability of the project facilities has proved their effectiveness.

Operation of KL No. 1 & 2 were not affected by natural disasters after project completion (Year 1995). **Table 1** shows the operation status of KL No. 1 & 2. After 1995, annual power generation has been maintained at a high level. According to executing agency, dips in the availability factor and annual power generation were caused by general maintenance or overhaul of the facility. The executing agency also explained that there was no record of forced outage hours due to disaster. Thus, the project contributed

[1] This figure is on daily basis, measured in executing agency's own way. According to executing agency, from their experience, they have noted that as the rainfall reaches at this level, the slope around the vicinity starts collapsing in road side. Such slope collapse may sometimes trigger the landslide. Thus, as the rainfall reaches towards this level, they make people to take necessary precautionary action to avoid the damage.

to the stability of power generation in KL No.1 & 2.

Table 1: Operation Indicators of Kulekhani Power Stations No. 1 & 2

Item			1993	1994	1995 Completion Year	1996	1997	1998	1999	2000
Availability Factor (Unit: %)	KL-1	Unit No. 1	Approx. 65	56.20	80.55	75.68	58.55	87.58	100.00	86.20
		Unit No. 2	Approx. 65	54.65	75.85	75.33	62.93	83.55	96.56	73.97
	KL-2	Unit No. 1	Approx. 65	Approx. 80	99.88	99.83	99.86	99.68	99.88	97.23
		Unit No. 2	Approx. 65	Approx. 80	99.88	99.92	99.97	99.81	99.48	99.57
Forced Outage Hours (Unit: hr)	KL-1	Unit No. 1	N/A	N/A	N/A	N/A	N/A	4:99	1:32	9:91
		Unit No. 2	N/A	N/A	N/A	N/A	N/A	4:99	2:06	5:3
	KL-2	Unit No. 1	N/A	N/A	10:17	14:22	11:26	27:22	10:31	241:56
		Unit No. 2	N/A	N/A	9:58	6:44	1:49	15:48	45:22	37:23
Annual Power Generation (Unit: Gwh)	Total Kulekhani Power Station		112.3	160.2	189.6	245.9	180.2	291.6	372.5	254.6

Source: Nepal Electricity Authority (NEA)

Note: Fiscal Year.

Availability factor indicator for 1993& 1994 was estimation by executing agency.

2.3.2 Recalculation of Economic Internal Rate of Return (E.I.R.R.)

For the appraisal, EIRR was calculated as 21.7%, based on the assumptions below.

Project life: 15 years

Benefit: Estimated Loss of revenue from Kulekhani No.1 and No.2 for one year without this project

Cost: Project Cost + Operation & Maintenance cost for the project and Kulekhani No.1 and No.2 Stations

. The result of re-calculation at the time of evaluation, based on the same assumptions as those made at appraisal, was 23.5%. The investment cost increased, due to the inclusion of Japan's grant aid, while the revenue of Kulekhani No.1 and No.2 appeared to have risen mainly because of increased in the electricity tariff. Thus, the recalculated EIRR was a nearly 2 % higher.

2.4 Impact

2.4.1 Contribution to stability of the power supply

Since the project was completed in 1995, no forced outage due to disaster has been recorded. The safety of the Kulekhani power stations has increased, and as a result the project has contributed to the stability of the power supply in Nepal. In Nepal, there has been a nationwide peak demand gap of about 40-50MW annually in recent years (Year 1998-2000). The Kulekhani power stations contribute nearly 30 % of the total installed capacity and 10-15% of the total power supply in Nepal (refer to **Table 2**).

Table 2: Status of Kulekhani Power Stations in Total Power Sector in Nepal

	Unit	1991	1995	1996	1997	1998	1999	2000
1.Total Installed Capacity								
(Nepal)	MW	288	288	288	300	319	319	319
(KL P/S)	MW	92	92	92	92	92	92	92
Share of KL to Total		31.9%	31.9%	31.9%	30.7%	28.8%	28.8%	28.8%
2.Electric Supply								
(Nepal)	GWh	906	1,117	1,262	1,369	1,373	1,475	1,701
(KL P/S)	GWh	132	108	110	168	122	196	250
Share of KL to Total	%	14.6%	9.7%	8.7%	12.3%	8.9%	13.3%	14.7%

Source: Nepal Electricity Authority (NEA)

Note: KL P/S = Kulekhani Power Stations (No.1 & 2).

Fiscal year in Nepal

2.4.2 Other indirect impact (Social and Environmental aspect)

The slope protection and sabo works carried out as part of the project definitely contributed to forest conservation. In addition, anchoring work around the valve house is preventing landslides around its location, further contributing to forest conservation. Conservation of river banks was also an indirect benefit of the infrastructure constructed under the project. The project infrastructure is also thought to have contributed to improved feelings of security for Workers at the power station and residents in the lower area of the river, as it protects their livelihood and farmland from flood damage.

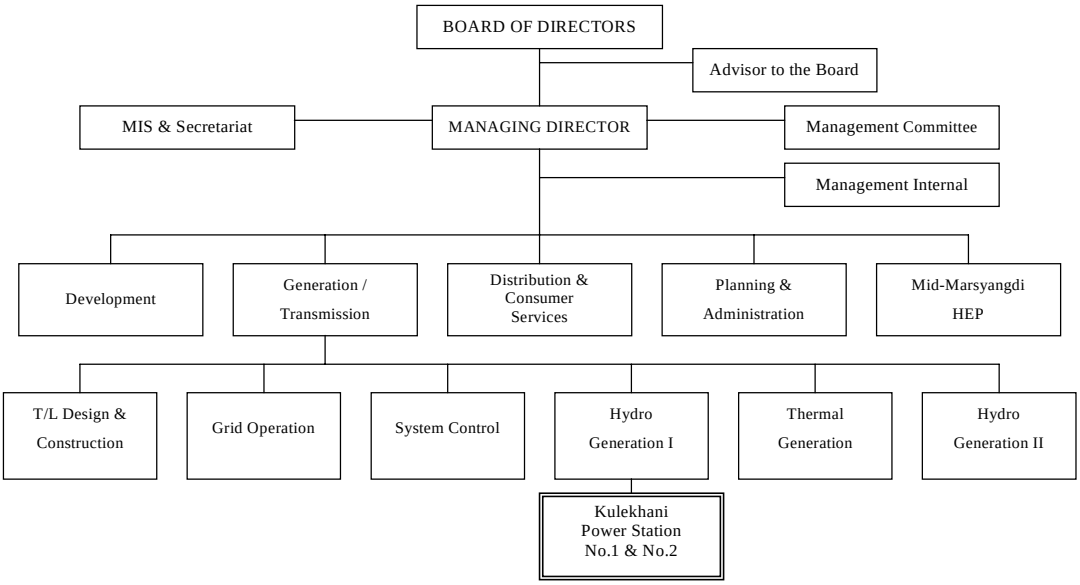
Improvements made to the road between Bhimphedi and Kulekhani No.2 Power station resulted in an increase in the number of vehicles using the road. Prior to the project, only 2 buses used the road daily, whereas now there are a total of 6. Impact was also observed in the amount of time saved; whereas it used to take 4 hours to travel this road, it now takes one hour. During the rainy season, people often could not use the road, however, after the road improvements, they can use it year round. It has become more convenient for villagers living near the road, approximately 20,000 people, to utilize it to go out of village.

Land was acquired for access road construction with compensation and according to executing agency, there was neither relocation nor resettlement of residents under this project.

2.5 Sustainability

The project facilities are managed by the civil section of Kulekhani No.1 & No.2 power station. Personnel in the civil section monitor the facilities every day and report to the Design/Civil section of NEA's Main Office in Katmandu, which is in charge of overall monitoring. The main office staff also examine the facilities in the project site at least once a year, before the rainy season starts.

Figure 1. Organization Chart of Nepal Electricity Authority (NEA)



The project facilities do not require much maintenance work. Some portions, such as the Mandu head pond, were reinforced by Kulekhani Disaster Prevention Project Phase II; therefore, the current system appears to be adequate for managing the project facilities.

O & M of the facilities should not pose a financial burden, unless natural disaster seriously damages project facilities in the future. According to NEA, some works, such as the penstock line and Mandu head pond, which were restored underground, do not require a maintenance budget. The financial records of NEA indicate that all O &M costs are covered by revenue.

In sum, the project is considered sustainable since there is no damage in the facilities currently and their operation & maintenance do not pose a burden in terms of cost and personnel. This conclusion, however, should be reconsidered with the results of the work implemented by Kulekhani Disaster Prevention Project II.

Comparison of Original and Actual Scope

Item	Plan	Actual
(1) Project Scope		
1. Urgent prevention works near Valve house of Kulekhani No.1 P/S		Same as planned
2. Purchase of Construction Equipment	1 Bulldozer w/ripper 4 vehicles	Same as planned
3. Construction work	-Sabo Work near Kulekhani No.2 P/S	Same as planned. Canalization of the river channel was not however completed, because it was buried due to the 1993 flood.
	-Slope stabilization works near Valve house	Same as planned
	-Improvement of the project road	New construction the road between Chisapani garhi and Bhimphedi and Improvement of the road between Kulekhani dam site and Chisapani garhi were cancelled
4. Consulting Service	560.7M/M	640M/M
(2) Implementation Schedule	1990-1993	1990-1995
(3) Project Cost		
Foreign currency	2,424 million yen	2,430 million yen
Local currency	567 million yen	300 million yen
Total	2,991 million yen	2,730 million yen
ODA Loan Portion	2,710 million yen	2,630 million yen
Exchange Rate	1 NRs = 5.1 yen (As of December 1989)	1NRs = 1.69 yen (As of June 1995)