Chapter 10

Selection and Evaluation of Promising Projects

Chapter 10 Selection and Evaluation of Promising Projects

As described in Chapter 8, development of storage-type hydroelectric power generation is absolutely necessary for overcoming the current power shortage in the dry season and for meeting an increase in power demand in the future. In 2009, the NEA made out a long list of 65 potential storage-type hydroelectric power projects for the Study. In this chapter, these potential projects were evaluated from technical, economical, and environmental aspects, and promising projects that are candidate projects of the power development plan in Chapter 8 were selected.

10.1 Selection of Promising Storage-type Projects

10.1.1 Projects examined in the Study

The projects examined in the Study are 65 projects in the long list of potential sites of storage-type hydroelectric power projects that was prepared by the NEA in December 2009 (see Appendix-1), and two projects, the Bagmati Multipurpose Project (C-19) and the Nisti-Panah Project (W-27), that were added by the NEA's request at the start of the Study, in January 2012. These 67 potential projects are shown in Table 10.1.1-1.

Table 10.1.1-1 Projects in the Long List

Eastern River Basin			Central River Basin			Western River Basin		
No.	Project Name	Capacity (MW)	No.	Project Name	Capacity (MW)	No.	Project Name	Capacity (MW)
E-01	Dudh Koshi	300.0	C-01	Kaligandaki-Modi	816.4	W-01	Barbung Khola	122.9
E-02	Dudh Koshi-2	456.6	C-02	Lower Badigad	380.3	W-02	Chera-1	148.7
E-03	Dudh Koshi-3	1,048.6	C-03	Lower Daraudi	120.2	W-03	Chera-2	104.3
E-04	Dudh Koshi-4	1,603.0	C-04	Seti-Trisuli	128.0	W-04	Humla-Karnali	467.1
E-05	Khimti	128.1	C-05	Upper Daraudi	111.4	W-05	Lower Jhimruk	142.5
E-06	Kokhajor-1	111.5	C-06	Kaligandaki-2	660.0	W-06	Madi	199.8
E-07	Likhu-1	91.2	C-07	Budhi Gandaki	600.0	W-07	Mugu Karnali	3,843.8
E-08	Mulghat	2,647.7	C-08	Andhi Khola	180.0	W-08	Sani Bhari-1	763.5
E-09	Piluwa-2	107.3	C-09	Langrang Khola	218.0	W-09	Sani Bhari-2	646.9
E-10	Rosi-2	106.5	C-10	Uttar Ganga	300.0	W-10	Sharada-2	96.8
E-11	Sankhuwa-1	176.0	C-11	Madi-Ishaneshor	86.0	W-11	Thuli Gad-2	119.7
E-12	Tama Koshi-3	330.0	C-12	Kali Gandaki No.1	1,500.0	W-12	Tila-1	617.2
E-13	Tamor No.1	696.0	C-13	Marsyangdi	510.0	W-13	Tila-3	481.9
E-14	Tamor (Terahathum)	380.0	C-14	Seti (Gandaki)	230.0	W-14	Thuli Gad	120.0
E-15	Sun Koshi No.1	1,357.0	C-15	Dev Ghat	150.0	W-15	LR-1	98.0
E-16	Sun Koshi No.2	1,110.0	C-16	Bhomichok	200.0	W-16	BR-3B	801.0
E-17	Sun Koshi No.3	536.0	C-17	Trishulganga	1,500.0	W-17	BR-4	667.0
E-18	Sun Koshi No.3	432.0	C-18	Ridi Khola	97.0	W-18	Surkhet	600.0
E-19	Sun Koshi No.3	190.0	C-19	Bagmati MP *	140.0	W-19	Lakarpata	1,200.0
E-20	Indrawati	91.2				W-20	Bhanakot	810.0
E-21	Kankai	90.0				W-21	Thapna	500.0
						W-22	SR-6	642.0
						W-23	Nalsyagu Gad	400.0
						W-24	Sarada Babai	75.0
						W-25	Naumure (W. Rapti)	245.0
						W-26	Lohare Khola	67.0
						W-27	Nisti-Panah *	90.4

*: Added in January 2012.

10.1.2 Selection Procedure of Promising Projects

Promising projects were selected by the following procedure.

Step-1: Selection of Projects that are subjected to the Evaluation
In the above-mentioned 67 potential projects, there were some projects that were not appropriate for objects of evaluation in the Study. In Step-1, these inappropriate projects were excluded from the potential projects, and the projects to be evaluated in the Study (hereinafter referred to as the candidate projects) were selected.

Step-2: Evaluation of Candidate Projects
Evaluation of the candidate projects selected in Step-1 was conducted. Specifically, scores of all candidate projects were calculated based on the evaluation items and the criteria described in 10.1.4.1 and the weight of evaluation items described in 10.1.4.2, then they were ranked by their score.

Step-3: Selection of Promising Projects
Projects that are promising as the projects to be listed in the master plan of hydroelectric power development in Nepal were selected, taking into consideration the location of each project, overlapping with other projects to which a construction license or a survey license had already been issued.

10.1.3 Selection of Projects that are subjected to the Evaluation (The First Step)

Some projects in Table 10.1.1-1 were deemed inappropriate as candidates of evaluation in the Study. These projects were excluded and the projects to be evaluated in the Study were selected.

(1) Exclusion of Projects of which Detailed Design or Feasibility Study is in Progress or in Planning

Since the above-mentioned long list was prepared in 2009, more than two years had passed at the start of the Study. In May 2012, when this exclusion was conducted, one project in the long list had already proceeded to the detailed design stage, and feasibility study or pre-feasibility study was planned by the NEA for some projects. Since detailed design is conducted on the premises of the implementation of the project, and feasibility studies and pre-feasibility studies are more detailed studies than this master plan study, the implementation of evaluation on these projects in the Study were deemed as not useful, and these projects were excluded from the projects to be evaluated in the Study. However, these projects were taken into consideration in the Master Plan that was prepared in the final stage of this study. Regarding the Nalsyau Gad project, of which a feasibility study was being carried out at the time, this project was evaluated in the Study since the interim report had already been prepared, and it was available to the Study Team.

<u>Project in Detailed Design Stage</u>

Budhi Gandaki (C-07: 600 MW)

Projects in which FS or Pre-FS is in progress

Tamor (Terahathum) (E-14: 380 MW)
Kaligandaki-2 (C-06: 660 MW)
Bagmati Multipurpose (C-19: 140 MW)
Nisti-Panah (W-27: 90.4 MW)

These excluded projects are shown in the column A of Table 10.1.3-1.

(2) Exclusion of Projects that overlap with Other Projects

The locations of the following projects are about the same with other projects. Since it is difficult to implement both projects, the following projects were excluded.

Tamor No. 1 (E-13: 696 MW)

Tamor No. 1 was excluded and E-14: Tamor (Terahathum) (380 MW) was adopted because the study of the Tamor (Terahathum) project was conducted later than Tamor No. 1.

Sun Koshi No. 3 (E-18: 432 MW) and E-19: Sun Koshi No. 3 (190 MW)

These two projects were excluded and E-17: Sun Koshi No. 3 (536 MW) was adopted because this alternative is the optimum development plan in the "Master Plan Study on the Koshi River Water Resources Development" (March 1985, JICA).

Seti (Gandaki) (C-14: 230 MW)

This project was excluded because its location overlaps with the Upper Seti project that is now in the detailed design stage.

Thuli Gad (W-14: 120 MW)

Thuli Gad was excluded and W-11: Thuli Gad -2 (119.7 MW) was adopted because the study of the Thuli Gad -2 project was conducted later than Thuli Gad.

LR-1 (W-15: 98 MW)

LR-1 was excluded and W-26: Lohare Khola (67 MW) was adopted because the study of the Lohare Khola project was conducted later than LR-1.

These excluded projects are shown in the column B of Table 10.1.3-1.

(3) Exclusion of Projects that is not appropriate as exclusion for Storage-type Hydroelectric Power Projects for Domestic Supply in Nepal

From the viewpoints of installed capacity, dam height, project cost, regulating capacity of reservoir[1], number of submerging households, etc., projects that were deemed inappropriate as a storage-type hydroelectric power project in Nepal were excluded.

It should be noted that the projects that were excluded by this screening might be worth

[1] Regulating capacity of reservoir (%) = (Effective storage volume of reservoir) / (Annual inflow) × 100

studying from the viewpoints of power exports, multi-purpose development, etc.

Installed Capacity

In general, large electric power plants are economically efficient, but they have a large impact on the power system if an accident or trouble happens. The objects of this study are storage-type hydroelectric power plants for domestic supply that are connected to the Integrated Nepal Power System (INPS). Taking into consideration that the total installed capacity of Nepal at the end of FY2010/11 was about 700 MW and that the power demand in FY2027/28 forecasted by the NEA is about 3,700 MW, the adequate size (installed capacity) of one power plant seemed to be several hundred megawatts. In this study, projects whose installed capacity is more than 1,000 MW were excluded. The projects excluded are as follows (see the column C of Table 10.1.3-1).

Dudh Koshi-3 (E-03: 1,048.6 MW)

Dudh Koshi-4 (E-04: 1,603 MW)

Mulghat (E-08: 2,647.7 MW)

Sun Koshi No. 1 (E-15: 1,357 MW)

Sun Koshi No. 2 (E-16: 1,110 MW)

Kali Gandaki No. 1 (C-12: 1,500 MW)

Trishulganga (C-17: 1,500 MW)

Mugu Karnali (W-07: 3,843.8 MW)

Lakarpata (W-19 1,200 MW)

Dam Height

The highest dam in the world as of January 2012 was the Nurek dam in Tajikistan, and its dam height is 300 m. Since there are technical difficulties in construction of a dam higher than the world's highest dam, problems such as a long construction period because of large dam volume are expected, and projects with a dam higher than 300 m were excluded from the projects to be evaluated in the next stage of this study. The projects excluded are as follows (see the column D of Table 10.1.3-1).

Dudh Koshi-3 (E-03: 357 m)

Dudh Koshi-4 (E-04: 425 m)

Mugu Karnali (W-07: 694 m)

Sani Bhari-1 (W-08: 417 m)

Sani Bhari-2 (W-09: 330 m)

Tila-3 (W-13: 338 m)

Project Cost

The fiscal scale of Nepal is small, and implementation of projects requiring a very large project cost in the near future was deemed difficult. Since the national budget in FY2009/10 was about

US$ 4.5 billion and the current project costs are higher than those at the time point of cost estimation, projects whose project cost is more than US$ 2 billion were excluded from the projects to be evaluated in the next stage of this study. The projects excluded are as follows (see the column E of Table 10.1.3-1).

Dudh Koshi-3 (E-03: US$ 2.26 billion)

Dudh Koshi-4 (E-04: US$ 2.87 billion)

Mulghat (E-08: US$ 2.37 billion)

Mugu Karnali (W-07: US$ 4.78 billion)

Regulating Capacity of Reservoir

Projects whose regulating capacity of reservoir is less than 5% were excluded, taking into consideration that the main role of projects in the Study is seasonal regulation of river flow, that is to store excess river flow in the rainy season and to discharge the stored water in the dry season. The projects excluded are as follows (see the column F of Table 10.1.3-1).

Khimti (E-05: 2.91%)

Likhu-1 (E-07: 2.87%)

Sun Koshi No. 1 (E-15: 0.19%)

Seti-Trisuli (C-04: 2.56%)

Dev Ghat (C-15: 0.32%)

Bhomichok (C-16: 0.07%)

Humla-Karnali (W-04: 2.73%)

Tila-3 (W-13: 2.13%)

Number of Submerging Households

Since a large number of relocation of households has a serious impact on the social environment of the project area, careful judgment is required for implementing such projects. A small number of relocation of households is preferable, but taking into consideration that the development of hydroelectric power generation in Nepal is the one and only means for resolving power shedding to achieve economic growth and to enhance people's living standards, the threshold value in the Study was determined to be 5,000 households. The projects excluded are as follows (see the column G of Table 10.1.3-1).

Kankai (E-21: 11,700)

Kaligandaki-2 (C-06: 7,000)

Marsyangdi (C-13: 5,170)

BR-3B: (W-16: 9,270)

Surkhet (W-18: 6,600)

Lakarpata (W-19: 20,400)

National Park and Protected Areas[2]

Projects that located in the areas stipulated in the "National Parks and Wildlife Conservation Act, 2029" were excluded. The projects excluded are as follows (see the column H of Table 10.1.3-1).

Sankhuwa-1 (E-11: Makalu-Barun Conservation Area)

Langtang Khola (C-09: Langtang National Park)

Uttar Ganga (C-10: Dhorpatan Hunting Reserve)

World Heritage Sites

Projects that were located in world heritage sites were to be excluded. However, there was no project in Table 10.1.3-1 that was located in a world heritage site.

(4) Selected Candidate Projects

As the result of exclusion described in the above, 31 projects that are shown in Table 10.1.3-1 with "✓" are selected as the candidate projects. The locations of these projects are shown in Figure 10.1.3-1.

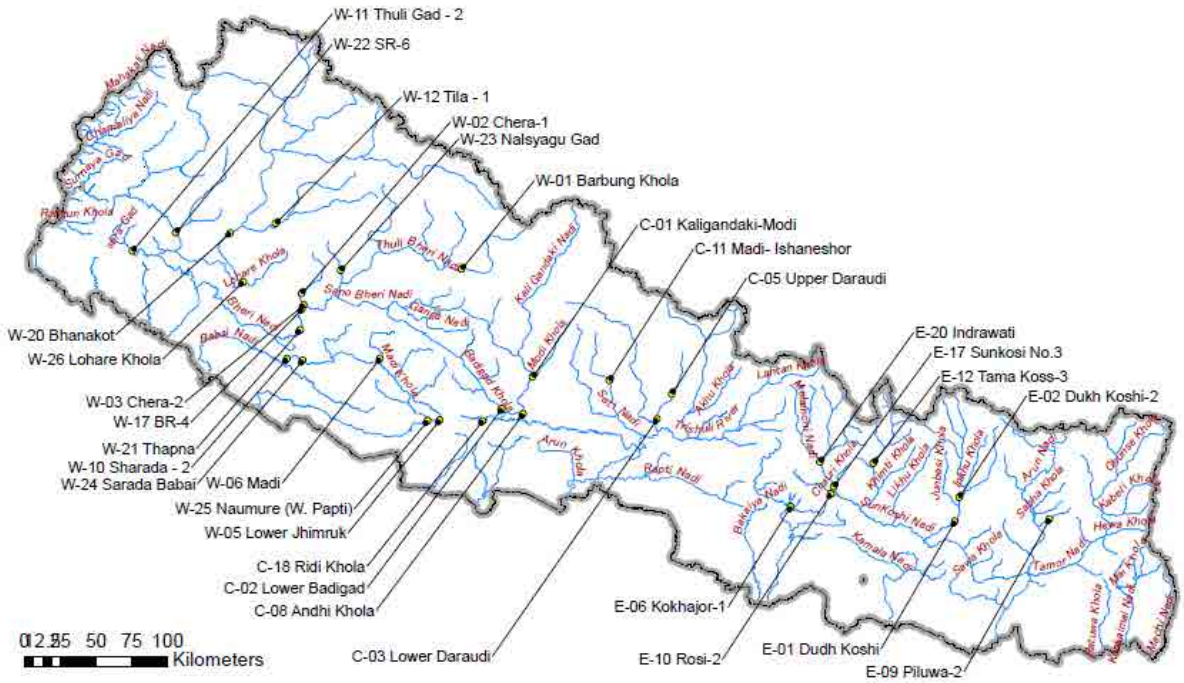


Figure 10.1.3-1 Location of Candidate Projects

[2] JICA Guidelines for Environmental and Social Considerations (April 2004) stipulates as follows: "Projects must, in principle, be undertaken outside protected areas that are specifically designated by laws or ordinances of the governments for conservation of nature or cultural heritage."

Table 10.1.3-1 Selection of Candidate Projects

No.	Project Name	Selected Candidate Project	Excluded from Object of Evaluation							
			A	B	C	D	E	F	G	H
			DD, FS or Pre FS Stage	Overlap with Other Project	Installed Capacity > 1,000MW	Dam Height > 300m	Project Cost > US$2,000M	Regulating Capability Factor < 5%	Submerging Houses > 5,000	National Parks and Wildlife Conservation Act
E-01	Dudh Koshi	✓								
E-02	Dudh Koshi-2	✓**						*3.50*		
E-03	Dudh Koshi-3				1,048.6	357.0	2,264.3			
E-04	Dudh Koshi-4				1,603.0	425.0	2,872.6			
E-05	Khimti							2.91		
E-06	Kokhajor-1	✓								
E-07	Likhu-1							2.87		
E-08	Mulghat				2,647.7		2,368.1			
E-09	Piluwa-2	✓								
E-10	Rosi-2	✓								
E-11	Sankhuwa-1									Conservation Area
E-12	Tama Koshi-3	✓								
E-13	Tamor No.1			with E-14						
E-14	Tamor (Terahathum)		Pre FS							
E-15	Sun Koshi No.1				1,357.0			0.19		
E-16	Sun Koshi No.2				1,110.0					
E-17	Sun Koshi No.3 (536 MW)	✓								
E-18	Sun Koshi No.3 (432 MW)			with E-17						
E-19	Sun Koshi No.3 (190 MW)			with E-17						
E-20	Indrawati	✓								
E-21	Kankai								11,700	
C-01	Kaligandaki-Modi	✓								
C-02	Lower Badigad	✓								
C-03	Lower Daraudi	✓								
C-04	Seti-Trisuli							2.56		
C-05	Upper Daraudi	✓								
C-06	Kaligandaki-2		FS						7,000	
C-07	Budhi Gandaki		DD							
C-08	Andhi Khola	✓								
C-09	Langrang Khola									National Park
C-10	Uttar Ganga									Hunting Reserve
C-11	Madi-Ishaneshor	✓							.	
C-12	Kali Gandaki No.1				1,500.0					
C-13	Marsyangdi								5,170	
C-14	Seti (Gandaki)			with Upper Seti						
C-15	Dev Ghat							0.32		
C-16	Bhomichok							0.07		
C-17	Trishulganga				1,500.0					
C-18	Ridi Khola	✓								
C-19	Bagmati MP *		FS							
W-01	Barbung Khola	✓**						*2.75*		
W-02	Chera-1	✓								
W-03	Chera-2	✓								
W-04	Humla-Karnali							2.73		
W-05	Lower Jhimruk	✓								
W-06	Madi	✓								
W-07	Mugu Karnali				3,843.8	694.0	4,868.1			
W-08	Sani Bhari-1					417.0				
W-09	Sani Bhari-2					330.0				
W-10	Sharada-2	✓								
W-11	Thuli Gad-2	✓								
W-12	Tila-1	✓								
W-13	Tila-3					338.0		2.13		
W-14	Thuli Gad			with W-11						
W-15	LR-1			with W-26						
W-16	BR-3B								9,270	
W-17	BR-4	✓								
W-18	Surkhet								6,600	
W-19	Lakarpata				1,200.0				20,400	
W-20	Bhanakot	✓								
W-21	Thapna	✓								
W-22	SR-6	✓								
W-23	Nalsyagu Gad	✓								
W-24	Sarada Babai	✓								
W-25	Naumure (W. Rapti)	✓								
W-26	Lohare Khola	✓								
W-27	Nisti-Panah *		Pre FS							

* : Added in January 2012

** : These projects are not excluded from the objects of evaluation because of a request by the NEA.

10.1.4 Evaluation of Candidate Projects (The Second Step)

Multi Criteria Analysis (MCA) was adopted for evaluation of the candidate projects in the second stage.

Traditionally, evaluation of electric power projects has mainly been conducted by a cost-benefit analysis. In this analysis, the project efficiency is evaluated by comparing all effects of a project that are measured by monetary value to the project cost. However, since it is difficult to measure all effects by monetary value, this method is not suitable for evaluation of projects for which evaluation of these kinds of effects is important.

Regarding the MCA method, all effects of a project are measured by an individual measuring method and the measured values are standardized and evaluated. Then the evaluation results of all effects are aggregated in some way, and the whole effect of the project is evaluated. This method has been used for SEA of land utilization planning, highway planning, water supply planning, power development planning, etc.[3] In the studies conducted by JICA, this method is used in the "Project for Master Plan Study on Hydropower Development in the Republic of Uganda (2011)," "Project for the Master Plan Study of Hydropower Development in Indonesia (2011)," etc.

10.1.4.1 Evaluation Items and Evaluation Criteria

The candidate projects selected in "10.1.3 Selection of Projects that are subjected to the Evaluation" were given a score by evaluating the items described below. The weight of each evaluation item is described in "10.1.4.2 Weighting of Evaluation Items."

Technical and Economical Conditions

- Hydrological Conditions
  - Reliability of flow data, risk of a glacier lake outburst flood (GLOF), sedimentation.
- Geological Conditions
  - Geological conditions of the project site, natural hazards (earthquakes), seismicity.
- Lead Time to Implementation of the Project
  - Length of access roads, difficulty level of funding, and reliability of the development plan (current stage of study).
- Benefit by Project
  - Unit generation cost, installed capacity, annual energy production, and energy production in the dry season.

Impact on the Environment

- Impact on the Natural Environment
  - Impact on forest, impact on protected areas, impact on fishes, and impact on

[3] Ministry of Environment of Japan, Effective SEA and Examples (in Japanese), 2003

conservation species.

- Impact on the Social Environment
  - Impact on the locality by construction of transmission lines, impact on households, impact on agriculture, impact on ethnic minorities, and impact on tourism.

(1) Hydrology

Regarding hydrology, the items evaluated were "Reliability of Flow Data," "Risk of GLOF," and "Sedimentation."

1) Reliability of Flow Data

Flow data is one of the most important basic data items for planning of an hydroelectric power project.

As mentioned in Chapter 2.2.6, NEA has estimated the flow of the project by two kinds of methods. In the case that there is a gauging station near the project site, the flow of the project is estimated by using the gauged flow data. In the case that there is no gauging station near the project site, the flow of the project is estimated by Regional Analysis. Regional Analysis is a method to estimate the flow using correlation equations, which were derived by the correlation among flow, catchment area and precipitation intensity based on the flow data and precipitation data gauged at gauging stations and meteorological observatories in the entire country.

In this study the flow data at 75 gauging stations in which the gauging period was more than 10 years were adopted considering reliability of flow data. The flow data used for electric energy calculation was for the latest ten years.

Figure 10.1.4.1-1 shows the location of gauging stations adopted and Table 10.1.4.1-1 shows the specifications of these gauging stations.

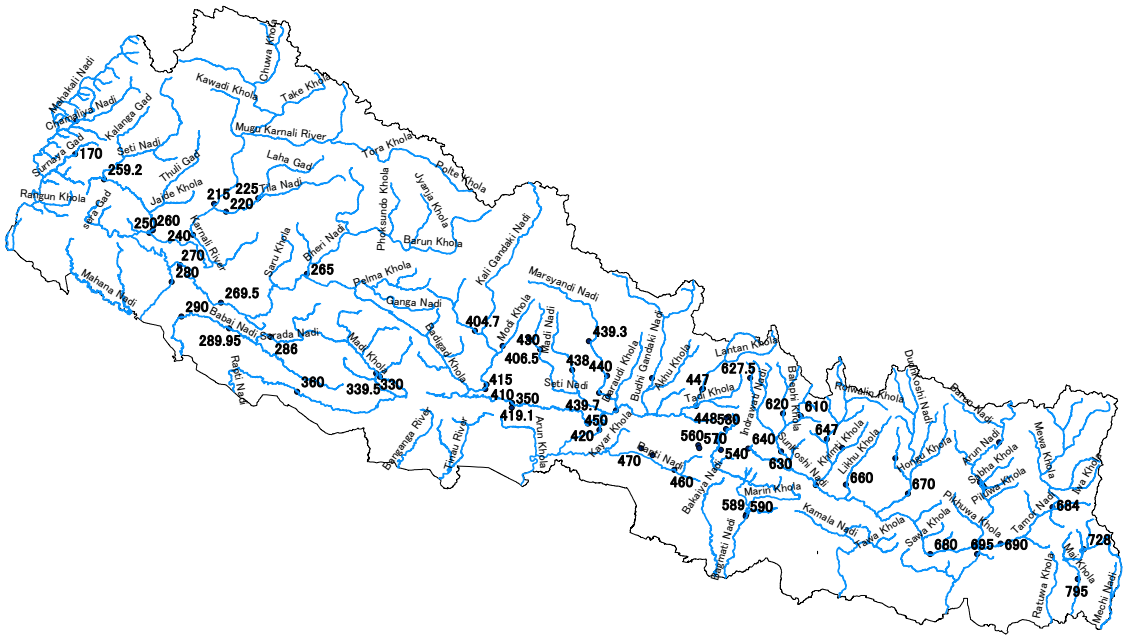


Figure 10.1.4.1-1 Location of Gauging Stations Selected for Energy Calculation

Table 10.1.4.1-1 List of Gauging Stations Selected for Energy Calculation (1/2)

No.	GS No.	Name of River	Location	Latitude N	Longitude E	Elevation (m)	Drainage Area (km^2)	Gauging Period		
								From	To	Period
1	120	Chamelia	Nayalbadi	29 40 20	80 33 30	685	1,150	1965	2006	42
2	170	Sumayagad	Patan	29 27 30	80 33 23	1,110	188	1966	1987	22
3	215	Karnali	Lalighat	29 09 32	81 35 28	590	15,200	1977	2006	30
4	220	Tilanadi	Nagma	29 06 26	81 40 49	1,935	1,870	1973	2006	34
5	225	Sinjhakhola	Diware	29 12 00	81 55 00	1,943	824	1967	2006	40
6	240	Karnali	Asaraghat	28 57 10	81 26 30	629	19,260	1962	2006	45
7	250	Karnali	Benighat	28 57 40	81 07 10	320	21,240	1963	2006	44
8	259.2	Seti	Gopaghat	29 18 00	80 46 30	756	4,420	1986	2006	21
9	260	Seti	Bangga	28 58 40	81 08 40	328	7,460	1963	2006	44
10	265	Thulo Bheri	Rimna	28 42 47	82 17 00	550	6,720	1977	2006	30
11	269.5	Bheri	Sanaijighat	28 31 02	81 39 25	500	12,200	1992	2006	15
12	270	Bheri	Jamu	28 45 20	81 21 00	246	12,290	1963	2006	44
13	280	Karnali	Chisapani	28 38 40	81 17 30	191	42,890	1962	2006	45
14	286	Saradakhola	Daradhunga	28 17 58	82 01 30	579	816	1972	2006	35
15	289.95	Babai	Chepang	28 21 04	81 43 14	325	2,557	1990	2006	17
16	290	Babai	Bargadha	28 25 20	81 22 10	192	3,000	1967	1987	21
17	330	Marikhola	Nayagaon	28 04 20	82 48 00	536	1,938	1965	2006	42
18	339.5	Jhimrukkhola	Chernata	28 03 00	82 49 40	762	683	1971	1995	25
19	350	Rapti	Bagasotigaon	27 51 12	83 47 34	381	3,380	1976	2006	31
20	360	Rapti	Jalkundi	27 56 50	82 13 30	218	5,150	1964	2006	43
21	404.7	Mayagdi Khola	Mangalghat	28 21 10	83 31 16	914	1,112	1976	2006	31
22	406.5	Modikhola	Nayapul	28 15 15	83 43 27	701	601	1976	2006	31
23	410	Kali Gandaki	Setibeni	28 00 14	83 36 31	546	6,630	1964	1995	32
24	415	Adhikhola	Andhimuhan	27 58 28	83 35 58	543	476	1964	1991	28
25	419.1	Kali Gandaki	Ansing	27 53 05	83 47 42	351	10,020	1996	2006	11
26	420	Kali Gandaki	Kotagaun	27 45 00	84 20 50	198	11,400	1964	2006	43
27	428	Mardikhola	Lahachowk	28 18 02	83 55 06	915	160	1974	1995	22
28	430	Seti	Phoolbari	28 14 00	84 00 00	830	582	1964	1984	21
29	438	Madi	Shisaghat	28 06 00	84 14 00	457	858	1975	2006	32
30	439.3	Khudikhola	Khudibazar	28 17 12	84 21 27	990	151	1983	1995	13
31	439.7	Marshyandi	Bimalnagar	27 57 00	84 25 48	354	3,774	1987	2006	20
32	439.8	Marshyandi	Goplingghat	27 55 35	84 29 42	320	3,850	1974	1986	13
33	440	Chepekhola	Gharmbesi	28 03 41	84 29 23	442	308	1964	2006	43
34	445	Burhi Gandaki	Arughat	28 02 37	84 48 59	485	4,270	1964	2006	43
35	446.8	Phalankhukhola	Brtrawati	27 58 25	85 11 15	630	162	1971	1995	25
36	447	Trishuli	Betrawati	27 58 08	85 11 00	600	4,110	1977	2006	30
37	448	Tadi	Belkot	27 51 35	85 08 18	475	653	1969	2006	38
38	449.91	Trishuli	Kalikhola	27 50 08	84 33 12	220	16,760	1994	2006	13
39	450	Narayani	Devghat	27 42 30	84 25 50	180	31,100	1963	2006	44
40	460	Rapti	Rajaiya	27 26 50	84 58 26	332	579	1963	2006	44
41	465	Manaharikhola	Manahari	27 32 37	84 49 03	305	427	1964	2006	43
42	470	Lotharkhola	Lothar	27 35 14	84 44 07	336	169	1964	2004	41
43	505	Bagmati	Sundarijal	27 46 49	85 25 36	1,600	17	1963	2006	44
44	530	Bagmati	Gaurighat	27 42 35	85 21 10	1,300	68	1991	2006	16
45	536.2	Bishnumati	Budhanilkantha	27 46 54	85 21 25	1,454	4	1969	1985	17
46	540	Nakhukhola	Tika Bhairab	27 34 30	85 18 50	1,400	43	1963	1980	18
47	550	Bagmati	Chovar	27 39 40	85 17 50	1,280	585	1963	1980	18
48	550.05	Bagmati	Khokana	27 37 44	85 17 41	1,250	658	1992	2006	15
49	560	Thadokhola	Darkot-Markhu	27 36 20	85 09 00	1,830	14	1964	1976	13
50	570	Kulekhanikhola	Kulekhani	27 35 10	85 09 30	1,480	126	1963	1977	15

Table 10.1.4.1-1 List of Gauging Stations Selected for Energy Calculation (2/2)

No.	GS No.	Name of River	Location	Latitude N	Longitude E	Elevation (m)	Drainage Area (km^2)	Gauging Period		
								From	To	Period
51	589	Bagmati	Padharadoven	27 09 06	85 29 30	180	2,700	1979	2006	28
52	590	Bagmati	Karmaiya	27 08 22	85 29 22	177	2,720	1965	1979	15
53	600.1	Arun	Uwagaun	27 35 21	87 20 22	1,294	26,750	1985	2006	22
54	602	Sabayakhola	Tumilingtar	27 18 36	87 12 45	305	375	1974	2006	33
55	602.5	Hinwakhola	Pipaltar	27 17 45	87 13 30	300	110	1974	2006	33
56	604.5	Arun	Turkighat	27 20 00	87 11 30	414	28,200	1975	2006	32
57	606	Arun	Simle	26 55 42	87 09 16	152	30,380	1986	2006	21
58	610	Bhotekosi	Barbise	27 47 18	85 53 55	840	2,410	1965	2006	42
59	620	Balephi	Jalbire	27 48 20	85 46 10	793	629	1964	2006	43
60	627.5	Melamchi	Helambu	28 02 21	85 32 07	2,134	84	1990	2006	17
61	630	Sunkosi	Pachuwarghat	27 33 30	85 45 10	602	4,920	1964	2006	43
62	640	Rosikhola	Panauti	27 34 50	85 30 50	1,480	87	1964	1987	24
63	647	Tamakosi	Busti	27 38 05	86 05 12	849	2,753	1971	2006	36
64	650	Khimtikhola	Rasnalu	27 34 30	86 11 50	1,120	313	1964	2006	43
65	652	Sunkosi	Khurkot	27 20 11	86 00 01	455	10,000	1968	2006	39
66	660	Likhu	Sangutar	27 20 10	86 13 10	543	823	1964	2006	43
67	668.5	Solukhola	Salme	27 30 03	86 34 52	1,800	246	1987	2006	20
68	670	Dudhakosi	Rabuwabazar	27 16 14	86 40 02	460	4,100	1964	2006	43
69	680	Sunkosi	Kampughat	26 52 28	86 49 10	200	17,600	1966	1985	20
70	681	Sunkosi	Hampchuwar	26 55 15	87 08 45	150	18,700	1991	2006	16
71	684	Tamur	Majhitar	27 09 30	87 42 45	533	4,050	1996	2006	11
72	690	Tamur	Mulghat	26 55 50	87 19 45	276	5,640	1965	2006	42
73	695	Saptakosi	Chatara	26 52 00	87 09 30	140	54,100	1977	2006	30
74	728	Maikhola	Rajdwali	26 52 45	87 55 45	609	377	1983	2006	24
75	795	Kankai	Mainachuli	26 41 12	87 52 44	125	1,148	1972	2006	35

Source: Stream flow summary (1962-2006), October 2008, DHM

As mentioned in Chapter 2.2.6, the NEA has calculated the monthly flow data by Regional Analysis using the flow data before 1990 and the Monsoon Wetness Isolines based on precipitation before 1984. In this study, the Study Team revised the calculation formula for monthly flow as follows, using the flow data before 2006 and precipitation before 2010. Figure 10.1.4.1-2 shows Monsoon Wetness Index Isolines revised based on the monthly average precipitation data before 2010.

January: $Q = 0.0249 \times A^{0.8847}$

February: $Q = 0.0203 \times A^{0.892}$

March: $Q = 0.0178 \times A^{0.9039}$

April: $Q = 0.0163 \times A^{0.9345}$

May: $Q = 0.0188 \times A^{0.9748}$

June: $Q = 0.01682 \times A^{0.23219} \times MWI^{0.521437}$

July: $Q = 0.00256 \times A^{0.892982} \times MWI^{0.62385}$

August: $Q = 0.005817 \times A^{0.889299} \times MWI^{0.541055}$

September: $Q = 0.004677 \times A^{0.877219} \times MWI^{0.535014}$

October: $Q = 0.00304A \times {}^{0.863316} \times MWI^{0.497909}$

November: $Q = 0.001422 \times A^{0.873818} \times MWI^{0.491577}$

December: $Q = 0.000995 \times A^{0.88672} \times MWI^{0.470822}$

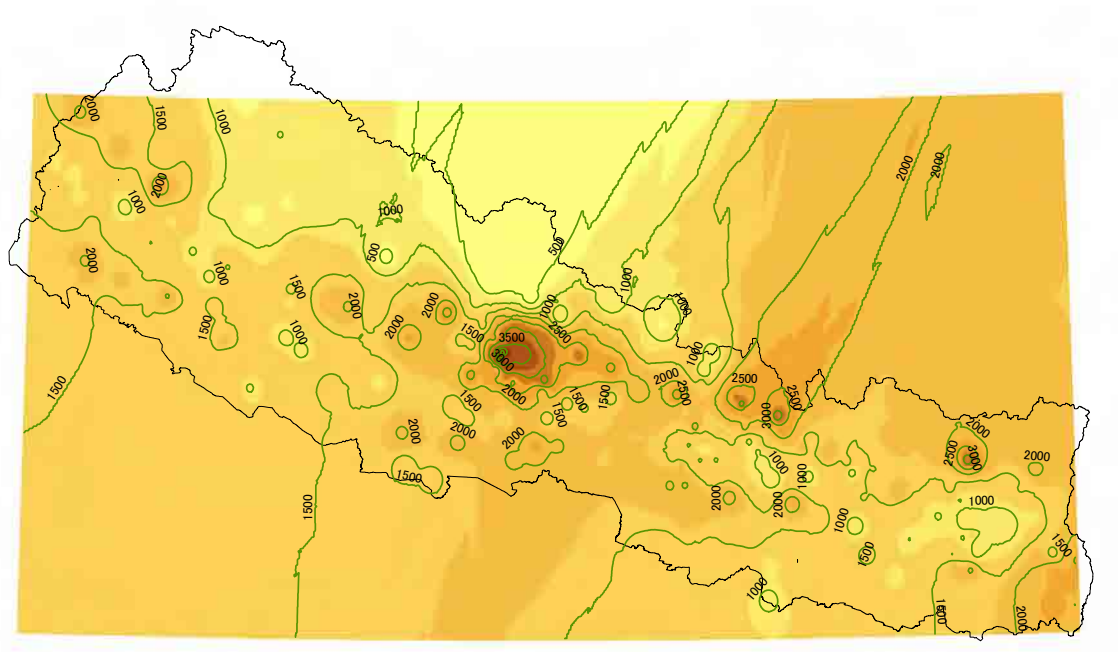


Figure 10.1.4.1-2 Monsoon Wetness Index Isolines

The gauged flow data is more reliable than the calculated flow data. Therefore, the Study Team decided the criterion for the reliability of flow data to evaluate the potential projects by the estimation measures of flow data as in Table 10.1.4.1-2.

The project in which the flow data was gauged for 10 years is considered as Low Risk. Its score is 100.

The project in which the flow data was gauged for 10 years but has some missing data is considered as Medium Risk. Its score is calculated by the following formula.

Medium Risk Score = 100 × Number of existing data / (12 months × 10 years)

The project in which the flow data is calculated by a calculation formula derived from the flow data gauged in the all gauging stations of Nepal is considered as High Risk. Its score is 0.

Table 10.1.4.1-2 Evaluation Criterion for Reliability of Flow Data

Flow Data	Estimated by the formula derived from the flow data gauged in the all gauging stations in Nepal	Gauged at the site but there are some missing data items	Gauged at the site for 10 years
Score	0	100 × Number of existing data items / (12 months × 10 years)	100

2) Risk of a GLOF

When a glacial lake outburst flood (GLOF) occurs in the upstream basin of the project site, a GLOF may damage the hydropower stations.

As shown in Table 2.4.2-2, according to the report by the ICIMOD, 21 potentially critical glacial lakes in Nepal are identified.

Therefore, the Study Team decided the evaluation criterion for risk of a GLOF to evaluate the potential projects by the number of potentially critical glacial lakes upstream of the project site as in Table 10.1.4.1-3.

The project where there is no potentially critical glacial lake upstream basin is considered as No Risk. Its score is 100.

The project where there is at least a potentially critical glacial lake upstream basin is considered as Risky. The 21 potentially critical glacial lakes are categorized into I, II, III. The project where the potentially critical glacial lake is category III is considered as Low Risk. Its score is 40. The project where the potentially critical glacial lake is category II is considered as Medium Risk. Its score is 20. The project where the potentially critical glacial lake is category I is considered as High Risk. Its score is 0.

Table 10.1.4.1-3 Evaluation Criterion for Risk of a GLOF

Number of glacial lakes identified as "potentially critical" by the ICIMOD located along the upper reaches of the dam	None	One or more		
		Low risk	Medium risk	High risk
Score	100	40	20	0

3) Sedimentation

Sediment phenomena progresses and reduces effective storage capacity between FSL and MOL. In this stage, the reservoir storage effect to regulate river water is reduced, and consequently the power plant cannot generate energy as expected at the planning stage. In the case the sediment reaches to the intake and the level reaches the intake sill, the power plant faces a problem to stop generation because of intrusion of sediment to the waterway.

Life of reservoir is an index to show the sediment impact to a reservoir. It means how many years the reservoir becomes full through sediment yield. The life of a reservoir is equal to the storage of a reservoir divided by the mean annual sediment yield.

Since the expected life of a power plant is 50 years, the life of reservoir is required to be more than 50 years. The project in which the life of reservoir is less than 50 years is considered as High Risk. Its score is 0. The life of a reservoir of a Low Risk project is decided to be 100 years. Its score is 100. The life of a reservoir in the Medium Risk project is more than 50 years and less than 100 years. The score is calculated by proration. Table 10.1.4.1-4 shows the evaluation criterion for sedimentation.

If the sediment yield of a project is estimated, the sediment yield was adopted. However, unless the sediment yield of a project is estimated, the sediment yield was calculated using the specific sediment yield of three areas of Nepal, such as the eastern area, the central area and the western area.

Table 10.1.4.1-4 Evaluation Criterion for Sedimentation

Life of Reservoir	Less than 50 years	50 years - 100 years	More than 100 years
Score	0	Linear interpolation	100

(2) Geology

This section describes the evaluation criteria for geology.

As discussed already, Nepal has numerous large active faults. Naturally, earthquakes occur very frequently. Earth conditions including geology vary from one area to another quite rapidly. Storage hydropower has a 30-50 years structure, so extreme care should be taken to items such as Geology, Tectonic Faults, or Seismicity, in site selection, as well as in design. Therefore these geological evaluation criteria have been studied.

In the study, each criterion is defined as “Geological conditions of the site,” “Natural hazards (earthquakes)” and “Seismicity.” Each criterion is valued from “1” to “5” depending on each site condition. And thus the “weighted percentage” determined by the Study Team is multiplied onto each “value,” giving the final total “geological evaluation point.”

Each criterion is determined based on the actual project sites conditions concerning these 3 categories, thus the most appropriate “threshold” for each criterion is defined from the actual dataset of the projects. The sites were selected for the long listed project sites proposed by the Counterpart for this Study.

The actual geologic and seismic dataset analyzed for all the sites are presented in Table 10.1.4.1-5.

Table 10.1.4.1-5 Geologic and Seismic Dataset for Each Project Site (5-1)

No.	Name	Geological Map (50,000 or 250,000)							Previous Studies (Desk studies by NEA, pre-FS, FS)					Mining - operating mine	Seismicity		
		Formation	Area	Age	Rock Type	Large Tectonic Thrust	Faults	Land slides	Faults	Seismicity	Dam	Powerhouse	Reservoir		Area	Acceleration	Epicenter
															area	mgal	distance to M>4 (km)
E-01	Dudh Koshi	Seti formation	LH (Lesser Himalaya)	Upper Precambrian-Late Paleozoic	Metasediment, phyllite and quartzite with minor conglomerate.	MCT 26km NW, MBT 32km SW	Dudh Kosi fault. ENE-WSW crossing dam axis, resrvoir along river bed.	moderate	Dudh Koshi fault run NE-SW, in tunnel with wide shear zone but not considered active fault (associated with anticline). 2km from damsite. These 2 faults cross tunnel.		Quartzite and phyllite.On right bank quartzite and phyllie contact has no signs of fault or shear zone. This contact also has no sign of shear at upstream at confluence with Thotne khola, but the contact shows strongly faulted feature in 900m downstream.	UG. Mica schist predominant. Medium-high in strengnth.	Rim mainly consists of phyllites, considered impervious.		LH (Lesser Himalaya)	240	10km, M4-5, NE
E-02	Dukh Koshi-2	Seti formation	LH	Upper Precambrian-Late Paleozoic	Metasediment, phyllite and quartzite with minor conglomerate.	MCT 28km NW, MBT 28km SW	Dudh Kosi fault 2km to SE on left bank	moderate	Local fault crosses tunnel MBT 46km south	high	Augen gneiss	Phyllite and quartzite with alluvial deposit	Augen gneiss, phyllite, quartzite,with alluvials		LH	260	4km, M4-5, E
E-03	Dukh Koshi-3	Ulleri formation on Left abutment, Seti formation on right abutment	LH	Ulleri); Upper Precambrian- Late Paleozoic Seti); ditto.	Ulleri); Schists. Augen gneiss. Intrusions of granite noted. Seti); ditto.	MCT 20km NW, MBT 50km SW. One thrust EW crosses damsite in 800m. (across river bed) thus 0km.	Fault crossing dam axis & reservoir along river bed.. A fault crossing river 800m upstream.	moderate	Local fault 9km south, MBT 65km south	moderate	Phyllite and quartzite	Quartzite with alluvial deposits	Phyllite and quartzite, with alluvial deposits		LH	330	8km, M4-5, N
E-04	Dukh Koshi-4	Seti formation	LH	Upper Precambrian-Late Paleozoic	Metasediment. Phyllite and quartzite with minor conglomerate.	MCT 10km N, MBT 55km SW	A fault lies in 1.5km on leftbank	moderate	2 local faults 3, 6km south, MBT 60km south	moderate - high	Phyllite and quartzite	Augen gneiss with alluvial deposits	Phyllite, quartzite, and augen gneiss		LH	350	4km, M4-5, W
E-05	Khimti	Ulleri formation, of Pokhara sub group, Midland group	LH	Upper preCambrian	Schists, augen gneiss,	MCT 6km NE	A minor fault 3km upstream crossing river	moderate	MBT 35km south	moderate	Schist, quartzite,and augen gneiss	Quartzite and schist	Schist, quartzite amd augen gneiss		LH	300	7km, M4-5, NE
E-06	Kokhajor-1	Upper middle Siwaliks formation	Siwaliks	Middle Miocene-lower Pleistocene	Sandstone, mudstone with siltstone, sandstone predominant.	MBT 2.5km north.	none	moderate	MBT 2km north	high	Sandstone with conglomerate	Sandstone with conglomerate	Sandstone with conglomerate		Siwaliks	140	26km, NNE, M4-5
E-07	Likhu-1	Galyang formation, Lakharpata subgroup, midland group	LH	Larte Paleozoic	Shales with limestone, calcerous slates, dolomitic limestones,	MCT 750m downstream	none	moderate	MBT 4km south, Near to Aunkoshi fault	moderate	Phyllite and quartzite	Limestone with terrace deposit.	Phyllite, quartzite, and limestone		LH	190	23km, M4-5, SW
E-08	Mulghat	Seti formation	LH	Upper Precambrian-Late Paleozoic	Metasediment, phyllite and quartzite with minor conglomerate.	MBT 12km, south	One fault parallel to river, crosses dam axis	moderate	MBT 16km south	moderate	Greenish grey phyllite and quartzite	Phyllite and quartzite	Greenish grey phyllite and quartzite with conglomerate	YES	LH	140	3km, M4-5, W
E-09	Piluwa-2	Seti formation, of Pokara sub-group, Midland group.	LH	Upper preCambrian	Phyllite, Quartzite with minor conglomerate layer	MBT, 43km south	1km on left bank	moderate	MCT 3km south	high	Quartzite, phyllite, augen gneiss	Quartzite, phyllite, augen gneiss	Quartzite, phyllite, augen gneiss and schist		LH	200	12km, NW, M5-6
E-10	Rosi-2	Malekhu Limestone.	LH	Paleozoic	Limestone with dolomite	Mahabharat thrust (MT) crosses damsite, runs along river in reservoir. Reservoir in limestone, MBT 12km south	none	none	MBT 17km south	moderate - high	Phyllite and quartzite	Phyllite and quartzite covered with terrace deposits	Phyllite and quartzite covered with terrace deposits		LH	180	27km, NW, M4-5
E-11	Sankhuwa-1	Sarung KH formation, of Kathmandu group, Midland group	LH	Late Paleozoic	Quartz biotite schists, occasionally interbedded with quartzites.	MCT 6km north, MBT >50km south.	A thrust 250m downstream	moderate	MCT 3km north	high	Biotite schist with quartzite	Biotite schist with quartzite	Biotite schist and quartzite		LH	250	5km, M4-5, seismicity active
E-12	Tama Koshi-3	Ulleri formation, of Pokhara sub group, Midland group	LH	Upper preCambrian	Schists, augen Gneiss,	MBT>50km south, MCT 1.5km upstream	A thrust, (maybe MCT) 1.5km upstream crossing reservoir.	moderate	2 faults and 1 synclinal axis across tunnel		Cambrian gneiss, OB 10m at mountain slope, 20m at riverbed. No fault in dam. V shape valley. Natural soil erosion & mass wasting is limited in watershed./ 1 old landslide on left bank downstream. Left bank should be studied for height and stability.	UG. sound blocky to massive gneiss, no fault.	Augen geneiss. Watershed condition good except 1 new landslide on the downstream of intake.		LH	340	14km M5-6, seismicity active
E-13	Tamor No.1	Seti formation, of Pokara sub-group, Midland group.	LH	Upper preCambrian	Phyllite, quartzite with minor conglomerate layer	MBT, 20km south	A thrust crossing reservoir 5km upstream.	moderate	none		Precambiran Telio Khola F. of phyllite, quartzite, Landslide in rightbank during excavation high.				LH	150	16km, M4-5, SW
E-14	Tamor (Terahathum)	Sarung KH formation, of Kathmandu group, Midland group	LH	Late Paleozoic	Quartz biotite schists, occasionally interbedded with quartzites.	MBT 30km south	A thrust immediate downstream crossing river, 500m	moderate							LH	170	22km, M4-5, SW

Note: Compiled and modified from various sources.

Table 10.1.4.1-5 Geologic and Seismic Dataset for Each Project Site (5-2)

E-15	Sun koshi No.1	Sarung KH formation, of Kathmandu group, Midland group	LH	Late Paleozoic	Quartz biotite schists, occasionally interbedded with quartzites.	MBT 9km SW	none	moderate			Cambrian, Bhimphedi F. (biotite schist). Alluvial deposit 26m thick.. Right bank steep, left bank gentle slope. No fault.				LH	190	6km, M4-5, S
E-16	Sun koshi No.2	Twaa Khola formation, of Kathmandu group, Midland group	LH	Late Paleozoic	Biotite quartz schists, with intercalation of quartzite, amphibolites.	MBT 12km, south	A fault parallel to MBT 1km downstream.	moderate			Syncline to S along axis, granite intrusion, Cambrian Bhimphedi Towakhola F. biotite schist. riverbed 29m thick. CH at 19-22m at drillings of banks. No geological problem. extermeley attractive.				LH	190	26km, NNE, M4-5
E-17	Sun koshi No.3, Kosi MP (Multipurpose)	Kunchha formation, Lower Nawakot group	LH	PreCambrian	Phyllites, metasandstones, gritstones	MBT 16km south	none	moderate	Small fault crosses dam axis, thrust 5km W.		Precambrian Kuncha F. of sandstone. right bank steep, left bank steep cliff. Riverbed max 40m.				LH	190	28km, M4-5, NW
E-18	Sun koshi No.3, Kosi MP	Kunchha formation, Lower Nawakot group	LH	PreCambrian	Phyllites, metasandstones, gritstones	MBT 16km south	none	moderate							LH	190	28km, M4-5, NW
E-19	Sun koshi No.3	Ranimatta formation, Midland group,	LH	Uppe preCambrian-Late Paleozoic	Phyllite gritstone with conglomerate, and quartzite	MBT 22km south	A fault along river in reservoir in 2km	moderate							LH	225	25km, M4-5, NW
E-20	Indrawati	Ranimatta formation, Midland group,	LH	Upper preCambrian-Late Paleozoic	Phyllite gritstone wth conglomerate,and quartzite	MCT 15km north, MBT 30km south	A fault crosses damsite along river	moderate	MBT 10km south, MCT 16km north. Sun koshi fault 3km south.		Lesser Himalaya, m-l grade metamorphics. The area is in Ranimatta formation of phyllite. Banks stable. Right bank more gentle with deposit 10-15m thick, left bank steeper. Soft-medium hard phyllite. River deposits 15-20m thick.	Surface PH. OB <10m but 15-20m away from slope. No geological hazards expected.	Mainly phyllite with some quartzite. No major instabilities including faults, landslides. Phyllites expected impervious that water tightness expected.	YES, but minor affects	LH	225	14km, M4-5, W
E-21	Kankai	Upper middle Siwalik, Siwalik group	Siwaliks	Middle Miocene-Upper Pleistocene	Sandstones, pebby sandstones with siltstones, mudstones.	MBT 13km north	A fault parallel to MBT 7km upstream.	moderate	Major fault with breccia runs in left abutment.		Alternation of sandstone, shale and siltstone of middle-upper Siwaliks formation. In plio-pleistocene. Soft and weathered easily. Shale predominant on left bank, sandstone predominant on right bank. Riverbed thick 17-19m. Talus on left bank. Banks rather steep 40deg.				Siwaliks	130	18km, M5-6, N
C-01	Kaligandaki-Modi	Thick Alluvium, Kunchha formation (right), Kuushma Quartzite (left)	LH	PreCambrian	Phyllite, phyllitic quartzite (right), quartzite (left)	MCT 25km south, MBT 50km south	none	moderate	MCT 15km south	moderate	Conglomerate	Conglomerate	Phyllite quartzite conglomerate		LH	200	23km, M4-5, N
C-02	Lower Badigad	Bennnighat Slate, Upper Nuwakot group	LH	PreCambrian	Slate, carboneceous slate with limestone and quartzite	MBT 25km south	Some faults in reservoir, 3.5km	moderate	Badigad fault passes through project area. MCT 20km north	moderate-high	Limestone and slate	Limestone	Limestone, dolomite, slate,and phyllite		LH	170	30km, M4-5, N
C-03	Lower Daraudi	Ranimatta formation, Midland group,	LH	Upper preCambrian-Late Paleozoic	Phyllite gritstone with conglomerate, and quartzite	MBT 17km south	none	moderate	MBT 20km south	moderate	Phyllite	Phyllite	Phyllite, quartzite and gritty phyllite		LH	250	24km, M4-5, E
C-04	Seti-Trisuli (FS)	Benighat Slates, of Nawakot group	LH	Upper Paleozoic	Shales, phyllites, carboneceous slates	MBT 7km south	A fault parallel to river crosses dam axis,	moderate	No major geological hazards.		Dandagaon phyllites of Lesser Himalaya. Damsite comprises slaty phyllite, quartzite, int. limestone. Banks are m. strong to strong calcerous phyllite and quartzite. River runs along anticline axis. Fair-good rock mass.	Surface PH. quartzite, phyllite, dolomite of Nourpul formation, LH. Alluvials 15-20m thick. Fair.	Covered by alluvial-colluvials. Rare outcrops with weathered and calecerous rocks. Potential mass movements, kalstic phenomena. Major faults cross.		LH	190	27km, M5-6, NE
C-05	Upper Daraudi	Ranimatta formation, Midland group,	LH	Upper preCambrian-Late Paleozoic	Phyllite gritstone with conglomerate, and quartzite	MCT 8km north	A fault immediately upstream crossing river, 500m	moderate	MCT 12km north	moderate	Phyllite and quartzite	Phyllite	Phyllite and mica quartzite		LH	300	28km, M5-6, NE
C-06	Kaligandaki-2	Lower Nourpul formation, Nawakot group	LH	Upper Paleozoic	Quartzite, with phyllite intercalation	MBT, 2.9km south	Some parallel faults to MBT crossing river close at damsite, at 800m upsttream, and 500m downstream.	moderate	MBT 8km south		Nuwakot complex of late cambrian-Paleozoic. Phyllite, intercallation of quartzite and phyllte.	Surface PH. Basement on intercalation of phyllite and quartzite. Riverbed thick as 2-10m near PH.	Phyllite, slate, quartzite. Number of faults pass. Biggest is Kaligandaki fault		LH	180	16km, M4-5, N
C-07	Budhi Gandaki	Sangram formation, or sequences of Midland group	LH	Upper preCambrian-Late Paleozoic	Shales intercallatd with limestone, quartzite or quartzite, calcerous quartzite	MBT 18km south	Some parallel faults crossing river close at damsite100m.	moderate			Late Cambrian, phyllite.				LH	270	13km, M5-6, N

Note: Compiled and modified from various sources.

Table 10.1.4.1-5 Geologic and Seismic Dataset for Each Project Site (5-3)

C-08	Andhi Khola	Benighat Slates, of Nawakot group	LH	Upper Paleozoic	Shales, phyllites, carboneceous slates	MBT 25km south	none	moderate	MCT 70km N, MBT 20km S. Andhikhola F.(active F) is 500m downstream of confluence with Kaligandaki and Andhikhola river.		Late Cambrian-early Paleozoic, metamorphics/ predominantly phyllite of Andhikhola slates member. Right bank steep with thin OB. Left bank steep with thick terrace >100m on top. No faults. River deposit 1-5m. Phyllite medium strong to strong. Fair to good.	Semi-UG. Phllyte. Terrace 45m thick.			LH	200	40km, M4-5, NE
C-09	Langrang Khola	Himal Group,	HH (Higher Himalaya)	PreCambrian	Biotite gneiss	MCT 10km east	Unknown as map does not cover the areaa	moderate	Traversed by MCT		Relocated 20km upstream with a higher dam. Fresh to slightly weathered gneiss with fair RQD.	U/G PH recommended as rock is good. Quartzite and garnetifferous mica schist with fair RMR			HH (Higher Himalaya)	250	16km, M5-6, SW
C-10	Uttar Ganga	Lakharpata formation, of Midlandgroup	LH	Late Paleozoic	Limestone, dolomitic limestone (quartzite, shales)	MCT 22km N	none	moderate	Surrounded by MCT but considered inactive. MBT 50km south, Phalebas thrust anticipated but not confirmed.		Lesser Himalaya. Metasedimentary rocks, of Dhorpatan phyllite zone. Dominantly calcarerous, of phyllites-schists-quartzite-limestone. No karstic features but needs investigation. Dam site river channel in line with Uttara Ganga anticline. Banks steep.	Surface PH/ extension of Bari Gad Fault may cross PH. Limestone, phyllite. Slope steep, Colluvials 20-30m.	Phyllite, calcerous rocks. Covered by glacial deposits to cause potential massmovement. Uttara Ganga anticline may affect water tightness. No instabilities.		LH	400	4 events <5km, 2km closest. M4-5, 5-6, seisimicity large
C-11	Madi- Ishaneshor	Kunchha formation, of Nawakot group	LH	Upper Cambrian-Precambrian	Phyllite, phyllitic quartzite, quartztic phyllite,	MCT 10km north	One lineament just downstream, 250m.	moderate	MBT 50km south, MCT 30km north		Lesser Himalaya, Kunchha formation of Nawakot complex, metasedimentary rocks. Medium hard phylllitic quartzite. Considered Fair. River bed at channel 5-10m thick.	3 surface PH options. Quartzite-phyllite. Riverbed 10m->30m. Slopes are stable.	Quartzite-phyllite. Considered impervious. No landslides, no karstic conditions. No major faults, considered water tight.		LH	400	5km, M4-5, SE, seisimicisty rather large
C-12	Kali Gandaki No.1	Benighat slate, of Upper Nuwakot group,	LH	preCambrian	Slate, carboneceous slate with limestone, quartzite bands	MBT 25km south	1 fault crossing river 500m upsream.	moderate			Upper Proterozoic-Cambrian dolomitic limestone, phyllite, slate, chert, etc. Low-interm. thick terrace widely spread. 16m max. Limestone upstream & at right bank. Phyllite in left bank. Limestone not weathered but solution cavities in limestone. 200m shear zone along dam axis. Some instabilities on steep leftbank.	Low level alluvial terrace, considerable instabilites along hillside above PH.	Limestone upstream of damsite. Phyllite at confluence with Andhi Kola. Faults zone 100m at confluence.		LH	170	40km, M4-5, NW
C-13	Marsyangdi	Ranimatta formation, Midland group,	LH	Upper preCambrian-Late Paleozoic	Phyllite gritstone wth conglomerate, and quartzite	MCT 37km north, MBT 11km south	A fault 1km on left bank	moderate							LH	220	25km, M5-6, NE
C-14	Seti (Gandaki)	Kunchha formation, of Nawakot group,	LH	Upper preCambrian-Cambrian	Phyllite, phyllitic quartzite, quartztic phyllite,	MCT 20km north	none	moderate	MBT 8km to south	moderate	Slate	Slate and limestone	Slate, limestone, phyllite and quartzite		LH	400	3km, M4-5, SE
C-15	Dev Ghat	Middle Siwalik, of Siwalik group	Siwaliks	Neogene	Sandstones, with shale and siltstone	MBT 6km south	Some faults parallel to MBT, 3km upstream, 200m downstreamm, etc.	moderate			Old metamorphic rocks with banks 45deg slopes				LH	160	39km, M4-5, N
C-16	Bhomichok	Ranimatta formation, Midland group,	LH	Upper preCambrian-Late Paleozoic	Phyllite gritstone with conglomerate, and quartzite	MBT 14km south	A fault along river in reservoir, a fault 1km on right bank	moderate			Midland metasediment of metamorphic rocks of sandstone, slate, quartzite, siliceous mica schist, green schist, graphite chlorite quartz schist, mica gneiss, granitic gneiss of late Cambrian. Banks form 35-45deg. River deposits 1-5m.				LH	240	17km, M5-6, NE
C-17	Trishulganga	Ranimatta formation, Midland group,	LH	Upper preCambrian-Late Paleozoic	Phyllite gritstone with conglomerate, and quartzite	MBT 12km south	2 faults with 1.2km upstream, 500m downstream, crossing river	moderate			Late preCambrian metamorphic rock of sandstone, slate, quartzite, schist, gneiss. Alluvials thin. Abutments relatively steep. Good for damsite.				LH	210	20km, M4-5, NE
C-18	Ridi Khola	Dhading dolomite, of Upper Nuwakot group	LH	PreCambrian	Dolomite, silicious dolomite	MBT, 11km south	none	high	A thrust fault runs parallel to river		Both banks stable. Riverbed 16-20m. Left bank consisted of fractured rocks with loose rocks hanging over. Right bank is stable dolomite.	Initial surface PH was not suitable as a big landslide immediate upstream. Changed location to 100m upstream with with rocky slope recommended. UG at fresh - slightly weathered limestone.	Dolomite and phyllite with slaty phyllite. Major landslides, rock flow, debris flow slump areas not anticipated.		LH	180	30km, M4-5, NW

Note: Compiled and modified from various sources.

Table 10.1.4.1-5 Geologic and Seismic Dataset for Each Project Site (5-4)

C-19	Bagmati Multiporpose	Middle Siwaliks	Siwaliks	Upper preCambrian - Late Paleozoic	Sandstone, with clays, conglomerates	MCT 19km north	A fault 1km leftbank	moderate							Siwaliks	110	33km, M4-5, S
W-01	Barbung Khola	Himal group (1,000,000 scale map only available)	HH	preCambrian	Gneiss?	MCT 20km east	none?	moderate	MCT 25km south	moderate		Gneiss	Gneiss and schist		HH	200	24km, M4-5, E
W-02	Chera-1	Kushma formation, of Lakharpata subgroup, Midland group	LH	Upper Cambrian-late Paleozoic	Quartzites intercalated with phyllites.	MBT 30km SW	A fault 2km upstream	moderate	MBT 30km south	moderate	Quartzite	Quartzite covered by alluvial deposits	Phyllite, quartzite and slate		LH	250	10km, M4-5, NE
W-03	Chera-2	Ranimatta formation, of Lakharpata sub-group, Midland group	LH	Upper Cambrian-late Paleozoic	Phyllites, phyllitic quartzite, metasandstones, conglomerate beds	MBT 27km SW	A fault immeadiate upstream 500m	moderate	MBT 20km south	moderate	Phyllite and quartzite	Quartzite covered by alluvial deposits	Phyllite, quartzite and slate		LH	200	10km, M4-5, NE
W-04	Humla-Karnali	Himal group (1,000,000 scale map only available)	HH	preCambrian	Biotite gneiss, mica schists, augen gneiss, micaceous quaurtzites.	MCT very close, 1km south	unknown	moderate	MCT 10km south	low-moderate	Schist and gneiss	Quartzite	Gneiss, schist and quartzite		HH	250	7km, M4-5, N, frequent seismicity
W-05	Lower Jhimruk	Syanga formation, of Pokhara subgroup, Midland group	LH	Upper preCambrian	Quartzite, quartztic limestone, with shales and calcareous quartztic beds etc.	MBT immediate close to damsite. 2km south	none	moderate	MBT 3km south	moderate-high	Quartzite	Limestone covered by alluvium	Limestone, shale, quartzite and schist		LH	150	34km, M4-5, NE
W-06	Madi	Ranimatta formation, of Dailekh group, Midland group	LH	PreCambrian	Shales, shaly phyllite, quartzite with carbonate beds.	MBT 25km, south	A fault 1km upstream crossing river	moderate	MBT 25km south	moderate-high	Phyllite	Phyllite	Phyllite, limestone and quartzite		LH	160	35km, M4-5, NE
W-07	Mugu Karnali	Nawakot group, Jaljala group (1,000,000 scale map only available)	LH	PreCambrian	Marine sediments; Lower parts clastic (phyllites, sandstones,quartzites, calcareous sandstones)	MCT 23km NE	unknown	moderate	MCT 10km north	moderate	Phyllite and schist	Schist	Phyllite, schist, dolomite, limestone		LH	350	0km, M4-5, very much frequent seismicity
W-08	Sani Bhari - 1	Lakharpata formation, of Midlandgroup	LH	Late Paleozoic	Limestone, dolomitic limestone, (quartzite, shales)	MCT 46km, north	none	moderate	MBT 75km south Ranimatta thrust 35km south	moderate	Limestone	Dolomite	Phyllite, limestone, dolomite and quartzite		LH	200	16km, M5-6, W
W-09	Sani Bhari - 2	Lakharpata formation, of Midlandgroup	LH	Late Paleozoic	Limestone, dolomitic limestone, with intercalation of shales.	MBT 46km south	A fault 2km upstream crossing river	moderate	MBT 55km south	moderate	Limestone	Dolomite	Phyllite, limestone, dolomite		LH	170	3km, M5-6, E
W-10	Sharada - 2	Lower middle Siwaliks	Siwaliks	Middle Miocene-lower Pleistocene	Sandstone, interbedded with siltstone, mudstone	MBT, 6km south	A fault in 2km upstream crossing river	moderate	MBT 3km north	moderate-high	Sandstone and conglomerate	Conglomerate and claystone	Sandstone, mudstone, siltstone		Siwaliks	120	30km, M4-5, N
W-11	Thuli Gad - 2	Middle Siwaliks	Siwaliks	Middle Miocene-Pleistocene	Sandstone, interbedded with shales, conglomerates, mudstones.	MBT, 3km north	Some faults in 1-2km	moderate	Thuligad active fault across dam axis	high	Sandstone and shale	Sandstone and alluvial deposits	Quartzite, dolomite shale, and limestone		Siwaliks	220	very close, 1km, M4-5
W-12	Tila - 1	Kalikot formation, Dadeldhura group, Jaljara group	LH	preCambrian	Schists, quartzite, carbonates, augen gneiss, crystalline limestone	MBT 50km south	unknown/none?	moderate	MBT 50km south Reanimatta thrust 25km south	moderate	Gneiss	Gneiss	Gneiss, granite and pegmatite		LH	330	6km, M4-5, SE
W-13	Tila - 3	Kalikot formation, Dadeldhura group, Jaljara group	LH	preCambrian	Schists, quartzite, carbonates, augen gneiss, crystalline limestone	MBT 36km south	A fault crossing river in 4km downstream	moderate	MBT 45km south, Ranimata thrust 10km north	moderate	Schist and gneiss	Schist	Gneiss, limestone, schist		LH	350	18km, M4-5, SW
W-14	Thuli Gad	Middle Siwaliks	Siwaliks	Middle Miocene-Pleistocene	Sandstone, interbedded with shales, conglomerates, mudstones.	MBT, 3km north	Some faults in 1-2km	moderate	MBT across dam site	very high	Sandstone, dolomite and limestone	Sandstone and alluvial deposits	Sandstone, mudstone, dolomitic limestone		Siwaliks	220	very close, 1km, M4-5
W-15	LR-1	Ranimatta formation, of Lakharpata sub-group, Midland group	LH	Upper Cambrian-late Paleozoic	Phyllites, phyllitic quartzite, metasandstones, conglomerate beds	MBT 18km south	A low angle thrust crosses both banks of reservoir (location of a thrust not neccessarily accurate) 500m	moderate			2 dam axes/ Midland group metasediment of phyllite. MCT crosses both abutments paralell to river at boundary of phyllite and gneiss above. Axis2 is not favorable as MCT crosses dam abutment. And MCT crosses above axis1 dam abutment. Axis1left bank covered with thick mudflow deposit and terrace. Mudflow younger than terrace deposit. Active landslides observed. Rightbank steep with phyllite. Axis2 right abutment steep and considered good. Axis 1 fair. Axis2 poor-fair	Surface PH.	Active landslide. Thick mudflow on left bank upstream/ MCT caused erosion.		LH	300	10km, M4-5, N

Note: Compiled and modified from various sources.

Table 10.1.4.1-5 Geologic and Seismic Dataset for Each Project Site (5-5)

W-16	BR-3B	Kushma formation and Ulleri formation, of Dailekh subgroup, Midland group	LH	Upper Cambrian-late Paleozoic	Quartzite intercalated with phyllite, augen gneiss, schists.	MBT 5km, south	A fault along river at dam axis	mode rate							LH	140	14km, M4-5, N
W-17	BR-4	Ranimatta formation, of Lakharpata sub-group, Midland group	LH	Upper Cambrian-late Paleozoic	Phyllites, phyllitic quartzite, metasandstones, conglomerate beds	MBT 25km, south	A fault immeadiate upstream. 0m	mode rate							LH	200	10km, M4-5, S
W-18	Surkhet	Middle Siwaliks, of Siwalik group	Siwaliks	Mid-Miocene Pleistocene	Sandstone interbedded with clay, shales, conglomerates, mudstone.	MBT 2km south	None, but expected parallel to MBT.	mode rate							Siwaliks	180	20km, M4-5, NE
W-19	Lakarpata	Lower Siwaliks, Siwalik group	Siwaliks	Mid-Miocene Pleistocene	Sandstone interbedded with shales, clays, conglomerates.	MBT 1km south	None, but expected parallel to MBT.	mode rate			Hard sandstone and siltstone. Good for dam construction/ Hard and fresh sandstone				Siwaliks	180	25km, M4-5, NE
W-20	Bhanakot	Ranimatta formation, of Lakharpata sub-group, Midland group	LH	Upper Cambrian-late Paleozoic	Phyllites, phyllitic quartzite, metasandstones, conglomerate beds	MBT 30km south	A fault 1km upstream, crossing river	mode rate							LH	350	12km, M4-5, NW
W-21	Thapna	Ranimatta formation, of Lakharpata sub-group, Midland group	LH	Upper Cambrian-late Paleozoic	Phyllites, phyllitic quartzite, metasandstones, conglomerate beds	MBT 20km south	A fault 3km upstream, crossing river	mode rate							LH	160	8km, M4-5, NW
W-22	SR-6	Ranimatta formation, of Lakharpata sub-group, Midland group	LH	Upper Cambrian-late Paleozoic	Phyllites, phyllitic quartzite, metasandstones, conglomerate beds	MBT 15km south	A fault 500m downstream, crossing river	mode rate							LH	320	4km, M4-5, E
W-23	Nalsyagu Gad	Swat formation, Surkhet group,	LH	Cretaceous	Carboneceous shales with limestrones and quartzes.	MBT 60km south	A fault very close at left bank. 0km	mode rate	A thrust 9km upstream. Nalsyagu fault parallel to river, on rightbank. MBT 50km, MCT 75km.	moderate	Lesser Himalaya, Paleozoic. Damsite major geology is dolomite with frequent shale intercalation. Dolomite m. strong. On Right bank, N fault runs parallel to river. (FS geological conditions found better, containing siliceous limestones predominantly, providing firm foundation)	Paleozoic, partially metamorphics of Proterozoic. Sandstone, shale but terrace and alluvials thick. N fault crosses 500m downstream.	Dolomite, shale, quartzite. Left bank steeper, right bank gentle. Number of landslides. No geological hazards from photos, but a thrust crosses reservoir. Potential leakgage.		LH	200	some M4-5 <10km, closest 7km, NW
W-24	Sarada Babai	Lower Siwaliks, Siwalik group	Siwaliks	Mid-Miocene lower Pleistocene	Sandstone interbedded with mudstone, shale, siltstone, marl.	MBT very close 0km, crossing dam site, along river	Some parallel faults with MBT	mode rate	MBT 300m north from damsite on right bank		"Dam design influenced by MBT but not significant" Sandstone, siltstone, mudstone. OB: <10m at riverchannel. Alternating beds of sandstone, thinly siltstone and mudstone. Right bank crushed, fractured and disturbed due to MBT.	Conglomerate bed, alluvium >30m, founded on conglomerate bed of >30m.	Sandstone, siltstone, mudstone slate, quartzite, dolomite, dolomitic quartzite expected. MBT crosses reservoir.		Siwaliks	130	30km, M4-5, N
W-25	Naumure (W. Rapti)	Middle Siwaliks, of Siwalik group	Siwaliks	Mid-Miocene-Pleistocene	Sandstone interbedded with clay, shales, conglomerates, mudstone.	MBT 1km north	none	mode rate	MBT and 2 parallel faults pass reservoir. Paleozoic Metasedimentary rocks north, Siwaliks south of MBT.		Middle Siwaliks sedimentary rocks of sandstone, shale, conglomerate, mudstone etc. Damsite mainly sandstone with mudstone, shales. Sandstone is thick medium strong. No major faults observed but many shear zones are seen in mudstone and siltstone beds. Weathering to sound rock is 10-40m.	Mostly of weaker rocks as mudstone, shale, siltstone, and less sandstone.	MBT and 2 parallel faults pass reservoir Paleozoic metasedimentary rocks north, Siwaliks south of MBT.		Siwaliks	130	40km, M4-5, NE
W-26	Lohare Khola (Lohore Khola)	Ranimatta formation, of Lakharpata sub-group, Midland group	LH	Upper Cambrian-late Paleozoic	Phyllites, phyllitic quartzite, metasandstones, conglomerate beds	MBT 9km SW	none	mode rate			Left bank very steep. V shape valley. Phyllitic rock.	UG recommended due to deep creek and steep slope.	Flood deposit, terrace deposit. Colluvials, and metasediment of phyllite, quartzite, gneiss. MCT passes across reservoir requiring water tightness study.		LH	260	13km, M4-5, NE
W-27	Nisti-Panah	Benighat Slate	LH	PreCambrian	Slate with limestone and quartzite band	MBT, 35km SW	none	mode rate			Option1/Phyllites with quartz veins. Option2/Phyllites, quartzitic phyllites. Option3/similar to option 2 (presumably)	Option1/ terrace deposits. Option2/slate.			LH	240	13km, M4-5, NW

Note: Compiled and modified from various sources.

1) Evaluation Criterion for Site Geology

As discussed in Chapter 3.2.1, when considering the global and regional geological features of hydroelectric power development areas, it is advisable and a natural procedure to consider typical representing geological characteristics of each "sub-division" of geological features such as age, rock type, or physical properties.

The NEA, in the past, also applied similar methodology and provided "qualitative" geological points (score) to each candidate project. The methodology the NEA applied is shown in Table 10.1.4.1-6.

Table 10.1.4.1-6 Evaluation Criterion for Geology applied by the NEA

Summary of Regional Geology

Units	Sub-Units	Lithology	Rock Condition	Boundary	Age
Higher Himalaya	Tibetan Tethys	Fossiliferous sedimentary rocks (Limestone, Shale, Sandstone etc,)	Good to Excellent	MCT	Precambrian to Neogene
	Himalayan Gneiss	High-grade metamorphic rocks (Granite, Gneiss, Schist etc.)			
Lesser Himalaya	Crystalline zone	Metamorphosed sedimentary and crystalline rocks. (such as Quartzite, Schist, Granite, Gneiss etc.)	Fair to Good	MBT	Precambrian to Permian
	Midland Group	Low-grade metamorphic rocks (Phyllite, Slate Quartzite etc)			
Siwaliks	Upper Siwalik	Conglomerates	Poor to Fair	HFF	Tertiary
	Middle Siwalik	Sandstone, Siltstone, Mudstone & Clay			
	Lower Siwalik	Sandstone, Shale & Pseudo Conglomerates			
Terai Plains	Quaternary Deposit	Alluvium Gravels, Boulders, Sand, Clay etc.	Poor		Recent

Source: Update and Review of Identification and Feasibility Study of Storage Project, phase 1 Coarse Screening and Ranking Study, Main Report (July 2002)

In principle, the evaluation by the NEA divided the geological condition of each site inclusively into 3 categories, after collection of basic information and being based on regional geological maps.

- High Himalaya, High Himalaya metamorphic Zone: good-excellent
- Lesser Himalaya: good-fair
- Siwaliks: poor-fair

This criterion by the NEA is broadly true and understandable as a whole, however a little rough. The Study Team has considered it is necessary to re-evaluate this taking into consideration

more detailed data such as "rock types" and "ages" of each site both of which compose specific site geology.

After collecting various geological data on all candidate sites, the Study Team has come to apply "matrix" evaluation criterion for "Geological conditions of the site" shown below, after discussion with the NEA. Both parties discussed this based on the actual geologic and seismic dataset of all of the project sites (Table 10.1.4.1-5). In other words, this criterion matrix is the outcome after it has been "tuned" so that the both parties have agreed upon it.

For instance, there is a case where the criterion was revised after the discussion. Initially "limestone" was put in an inferior "point" as it was generally interpreted as one of the problematic rocks. However, it has been suggested that a certain limestone in Nepal is less problematic when it is "Siliceous dolomite- limestone." The evaluation matrix has been revised accordingly.

The details of the Evaluation Criterion on Site Geology are described as below.

a) Criterion of "Age" and "Rock type"

Based on the concept above, The "Matrix" on Table 10.1.4.1-7 has been proposed and applied.

The idea is to represent the general feature of the site geology by the combination (Matrix) of "Age" and "Rock type" thus representing the qualitative evaluation scores (ranks) for each site in terms of, from the perspective of the the "general geologic features."

b) Modification (Subtraction of points) by "Landslides" or "Mines in operations"

i) Landslides

As landslides in reservoir or dam axes, they have a negative impact from safety points of view, in addition to maybe bringing potential increases of development cost. The comparative and relative "screening" on landslides considering their scales, as well as their activities must be conducted. Risks by landslides when noted will be valued as a subtraction of "20 points."

ii) Mines in Operations

The impact of natural resource developments nearby on the potential planning (planned) sites of hydropower is not geological issues, but rather, they have much more impact on the political aspects of the Nepalese government's capabilities of coordination between two contradicting parties.

Naturally, the individual elements of such mining activities for all potential sites must be considered to evaluate any impact from such activities. However, in this study, the conditions of having mining activities or development plans nearby is classified as equally "disadvantageous" and it is valued as a subtraction of "20 points."

Thus, the modification is:

i) Frequent landslides; subtract 20 points from the a) value

ii) Mines in operations etc.; subtract 20 point from the a) value

Based on this criterion, the Study Team processed the actual geology and seismic dataset for all candidate sites (Table 10.1.4.1-5) and determined the "Evaluation Criterion for Site Geology (i.e. Geological conditions of the site)."

The results are shown in Table 10.1.4.1-7.

Table 10.1.4.1-7 Evaluation Criterion for Site Geology

Age	Precambrian, Cambrian	Paleozoic	Mesozoic	Tertiary	Quaternary
Class	1	2	3	4	5
Rock	igneous	Cristaline (incl. quartzite, hornfels)	Metasediment (incl. metasandstone, phyllite)	sediment	limestone
Class	1	2	3	4	5

Matrix (Age, Rock)	(1,1), (1,2), (2,1)	(1,3), (2,2)	(2,3)	(1,4), (1,5), (2,4), (2,5), (3,1), (3,2), (3,3), (3,4)	(3,5), (4,1), (4,2), (4,3)	(4,4), (4,5), (5,1), (5,2), (5,3), (5,4), (5,5)
Score*1)	100	80	70	60	40	20

*1): In case of frequent landslides, subtract "20 points" from the Score.
In case of mines in operation etc., subtract "20 points" from the Score.

2) Evaluation Criterion for Natural Hazards (Earthquakes)

Considering the situation of seismicity and earthquake risks, it has been discussed and proposed to apply the Evaluation Criteria for that. It has been discussed to apply "Large Thrusts and faults" and "Seismicity (Earthquakes)."

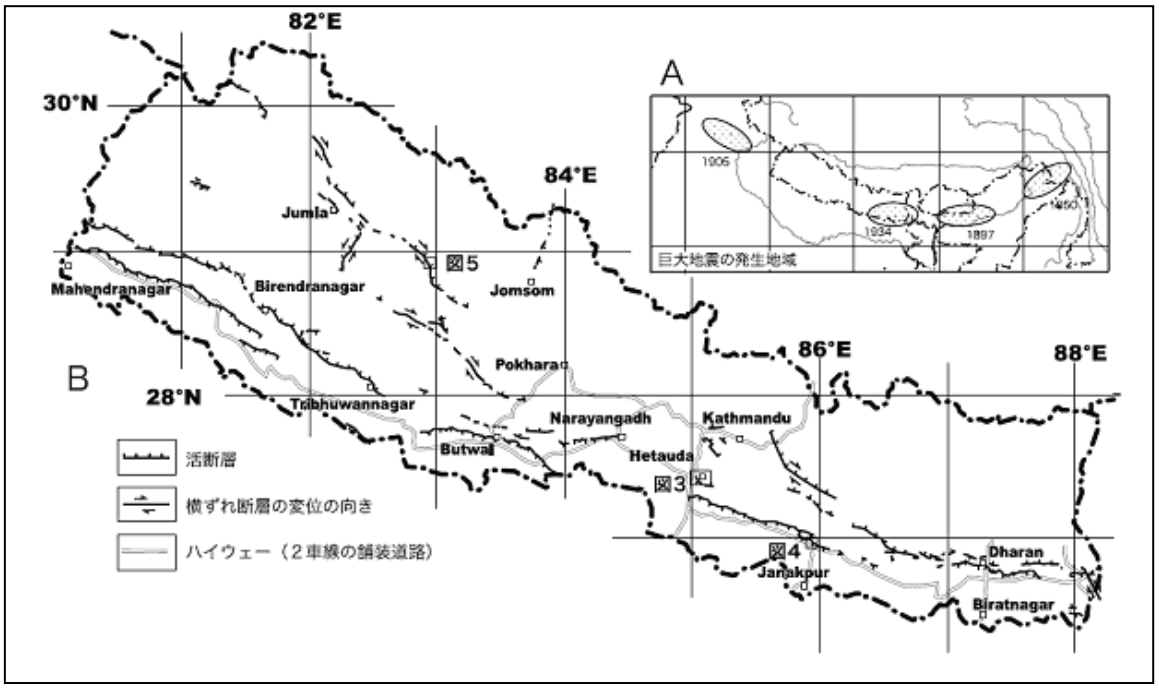
First, the "Large thrusts and faults" criterion is considered. This evaluation is composed of 2 factors, such as "proximity to large tectonic thrusts" and "closeness to other faults," and the evaluation is named after "Evaluation Criterion for Natural Hazards (Earthquakes)."

"Large tectonic thrusts" develop in Nepal as Himalayan Frontal Thrust (HFT), Main Boundary Thrust (MBT) or Main Central Thrust (MCT) of E-W directions in parallel to the Himalaya range. Both MBT and MCT accompany 150 m to 100 m wide "disturbed zones." It is noted that earthquake faults are not always revealed by seismic activities. However, it is also acknowledged that seismic activity is large with frequent earthquakes in the past, thus such earthquakes are likely to cause serious damage to construction structures once surface faulting occurs. In any case, it is accepted that the faults themselves are considered as weak and thus not suitable for foundation. Considering these points, criterion such as "proximity to tectonic thrusts" is one of the useful measures to screen candidate projects.

The tectonic movements have shifted their main tectonic thrusting formation from north to south, therefore at present MBT can be more active, causing large earthquakes over M8 compared to MCT, which was once active in the earlier stages of the Himalayan orogenic

movement. This indicates MCT and MBT are at present not equal in their effects. However, in considering the purpose of the "screening" projects, the closeness to such tectonic thrusts (or accompanying faults) was decided to be evaluated equally.

It is also necessary to collect and evaluate the risks of such faults other than large tectonic thrusts in general. Figure 10.1.4.1-3 shows the example of such a fault map.



Source: Detailed mapping on active faults in developing regions and their significance: A case study of Nepal, 2005.

Figure 10.1.4.1-3 Example of Active Faults in Nepal

However, after collection of such data, it was found there were no such compiled data like "Active Faults of Japan" in Nepal, although Nepal has suffered many earthquakes and has many faults even now. Thus, it is concluded that evaluation of "activeness" for such faults are not to be conducted, but that the "closeness to those faults" are to be used.

The evaluation value for "Natural Hazards (Earthquakes)" is determined as a sum of points for "proximity to tectonic thrusts" and the points for "closeness to other faults" shown below.

As an agreed methodology, the "threshold" used for the proximity to tectonic thrusts (in Table 10.1.4.1-8) is decided from the distribution of actual data from the actual geologic and seismic dataset for all the project sites (Figure 10.1.4.1-4). The "Threshold" used for closeness to other faults shown in Table 10.4.1-9 is decided through the discussions with NEA.

Table 10.1.4.1-8 Evaluation Criterion for Proximity to Large Tectonic Thrusts

Distance	Score
> 12.8 km	5
< 12.8 km	3
< 3.2 km	1
< 1.6 km	0

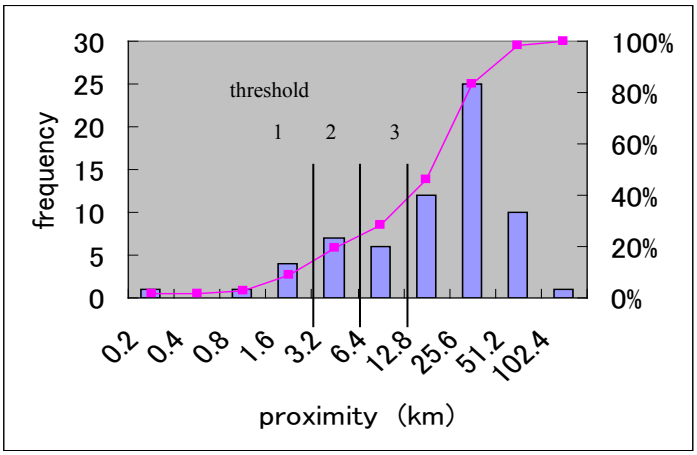


Figure 10.1.4.1-4 Actual Distribution of Proximity to Large Tectonic Thrusts for all project sites

Table 10.1.4.1-9 Closeness to Other Faults

Distance	Score
> 1 km	0
< 1 km	-1
< 100 km	-2

Based on this criterion, the Study Team processed the actual geology and seismic dataset for all candidate sites (Table 10.1.4.1-5) and determined the "Evaluation Criterion for Natural Hazard (Earthquakes)," i.e., the criterion on the proximity and closeness to large tectonic thrusts and faults.

The result is shown in Table 10.1.4.1-10.

Table 10.1.4.1-10 Evaluation Criterion for Natural Hazards (Earthquakes)

Distance to large tectonic thrusts	> 12.8 km	12.8 km > > 3.2 km	3.2 km > > 1.6 km	1.6 km >
Score*1)	100	60	20	0

*1): In case of the closeness to other faults < 1 km, subtract 20. In case of the closeness < 100 m, subtract 40.

3) Evaluation Criterion for Seismicity (frequency, scale)

The "Seismic hazard map" was prepared in Nepal as a reference for evaluation of seismic activities (Figure 3.3.3-1). This map indicates the horizontal acceleration (cm/sec^2), thereby

seismic activities of each potential site are to be "screened" by putting the relative "threshold" into such acceleration values from the view of the "design horizontal seismic coefficient."

The Himalayas are the place for the collision of the Indian subcontinent and the Eurasian continent, thus inducing frequent earthquakes such as thrust type earthquakes. Table 3.3.2-1 and Table 3.3.2-2 show earthquake records in and around Nepal.

Most of the earthquakes have occurred in Lesser Himalaya, the area between MCT and MBT, and many in western Nepal. It may be better to differentiate the impact of MCT, MBT, HFT in terms of each seismic risk. But as we see, an M7.5 occurred in 1916 near MCT, so we decide that all these thrusts may be better treated equally risky for seismic risks.

It should be noted that the NEA study in the past just simply ruled that a regional area such as the Lesser Himalaya has a "same single" higher seismic risk than other areas such as the Higher Himalaya.

However, when looking at the hazard map, there are differences in risk values even in the same Lesser Himalaya area, thus the NEA's grouping is not sufficient enough to represent such localities.

Therefore, in this study we determined the "seismicity risk" based on the "Matrix" shown in Table 10.1.4.1-11. This is the combination of a "regional area" and "acceleration value" shown in the hazard map.

The Study Team also decides that the points by the table will be subtracted by 1 point if any earthquake of M>4 occurs within a 10 km distance from the site, which is considered the caution level in Nepal in general.

As agreed, the "threshold" of Table 10.1.4.1-11 was determined after the evaluation of the actual distribution of the data in the actual geologic and seismic dataset for all the project sites (Figure 10.1.4.1-5).

Table 10.1.4.1-11 Evaluation Criterion for Seismicity - Matrix

Area	Higher Himalaya (Tibetan-Techys Zone)	Metamorphic zone (Higher Himalaya Crystalline)	Lesser Himalaya	Siwaliks (Sub-Himalaya)	Terai Zone
Class	1	1	2	3	3
Acceleration	> 240 gal	240 gal > > 180 gal	180 gal >		
Class	1	2	3		

Matrix (Area, Acceleration)	(3,3)	(1,3)	(2,3), (3,2)	(1,2)	(1,1), (2,1), (2,2), (3,1)
Score*1)	100	80	60	40	20

*1): In case of closeness to epicenters greater than M4 < 10 km, subtract 20.

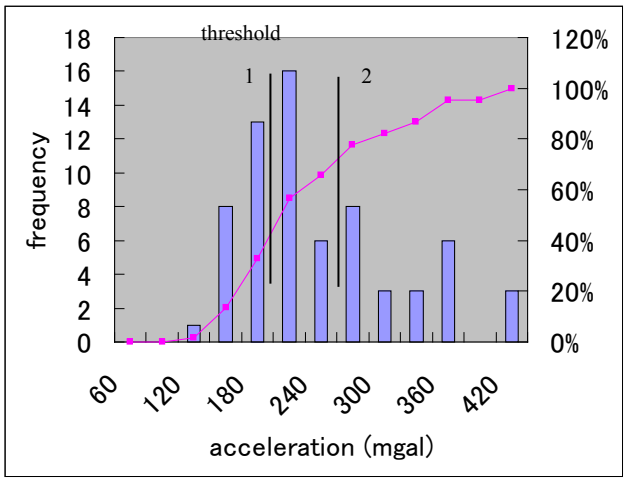
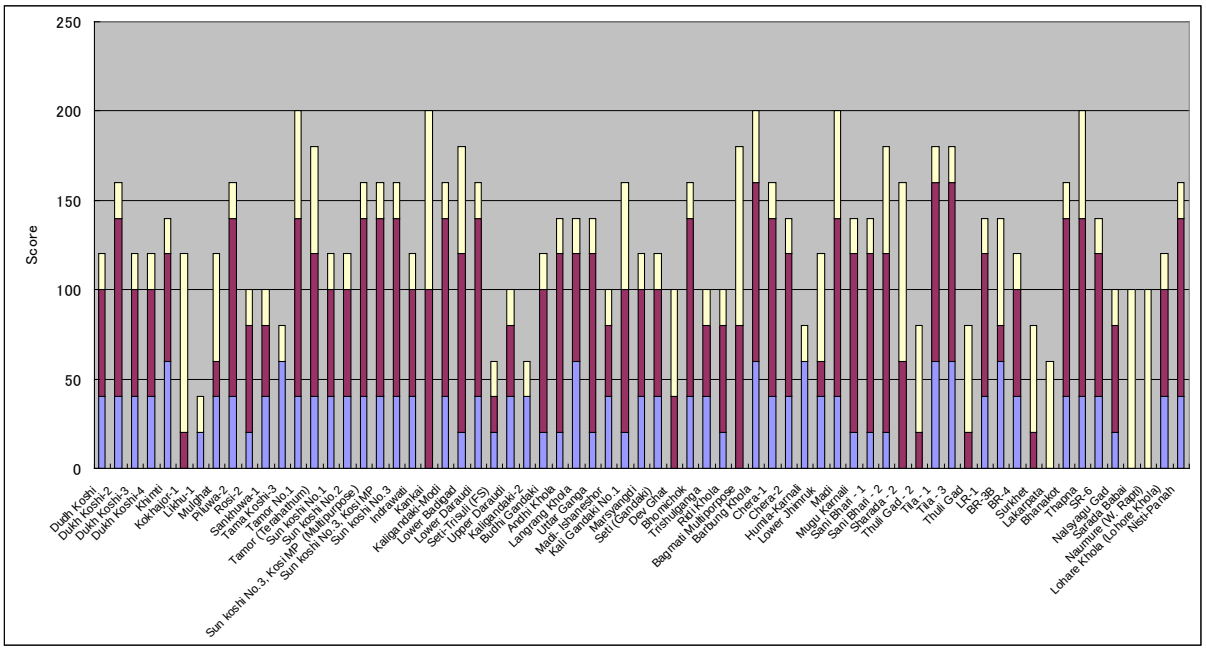


Figure 10.1.4.1-5 Actual Distribution of Acceleration for All Project Sites

All the outcome and results using these three criteria are compiled in Figure 10.1.4.1-6.



Note: Based on the simple summation of all three criteria with equal weight.

Figure 10.1.4.1-6 Geology Evaluation Outcome from All Three Criteria for All Project Sites

The discussion with the NEA has concluded that the results above, in general, bear no problems. However, we found several issues to be solved, so it is advisable to note such issues as below for the next stage.

- Incompleteness of geological maps
- Unavailability of aerophotographs (Lack of landslide data)

It is also noted that each "weighted percentage" for "Site Geology," "Natural Hazards (Earthquakes)" and "Seismicity" is defined by the Study Team as discussed later. This is

basically rooted upon the stakeholders, the NEA, etc. But the weighted ratio is the present evaluation value and is fundamentally to be revised from time, to time referring to the various changing circumstances in the future, so that such a ratio needs to be re-evaluated when required.

Incompleteness of geological maps

Figure 10.1.4.1-7 shows the available geological maps in Nepal for a 1:50,000 scale (as of June 1, 2012). As clearly shown only 30 sheets are available for a 1:50,000 scale, which is usually required in this kind of study. Only 1:1,000,000 or 1:250,000 maps cover all of the land. In particular the eastern and the western areas lack geological maps with a 1:50,000 scale.

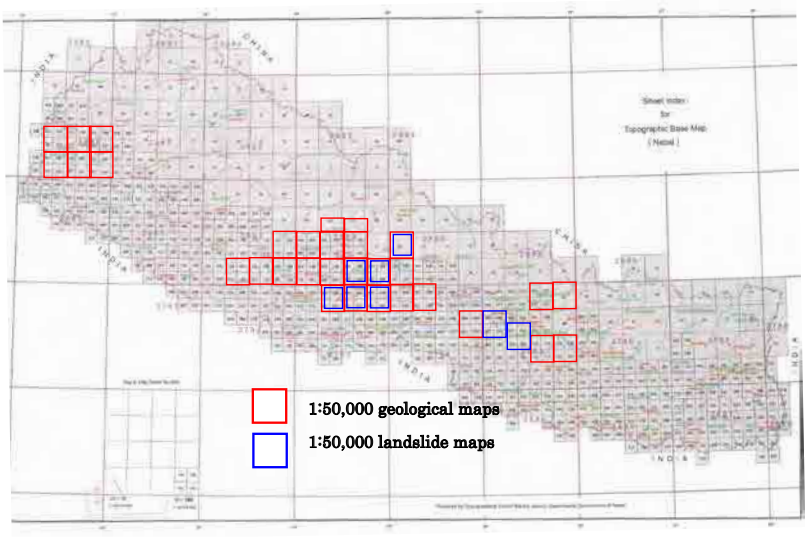


Figure 10.1.4.1-7 Availability of Geological Maps in Nepal

The Study Team collected the previous study reports (pre-FS, FS, or other desk studies). However, it was revealed that pre-FS level geological studies sometimes did not conduct drillings or field survey, rather only aerophoto interpretation was carried out for their analysis, without confirmation of the actual geology. Therefore, the possibility is that the actual geology differs from the described geology in the existing materials. The confirmation of geology by visiting those sites is necessary.

Lack of landslide data

As shown in Figure 10.1.4.1-7, there are only 8 sheets of "land slides" in Nepal. In conjunction with the unavailability of geological maps for 1:50,000 scales, the data for collapses, landslides and other geological features are prepared far below a sufficient level. The actual analysis in each prospective area one by one is necessary.

It is well worth noting that the Department of Survey does not have any material. It is also unable to publish that material in time due to "load shedding."

(3) Lead Time

1) Length of Access Roads

The length of access roads to be newly built for a project could influence its construction period significantly. The length of access roads for each project was extracted from the existing study. In case that no information was found in the study, the length from a major road to a project site was measured on a topographical map. All the data were compared relatively. Evaluation points were prorated between 100 points set as the minimum length of 0 km and 0 points set as the maximum length of 65 km. (See Table 10.1.4.1-12)

Table 10.1.4.1-12 Evaluation Criterion for Length of Access Roads

Length of access road (km)	0 (Min.)	0 - 65	65 (Max.)
Score (points)	100	Linear interpolation	0

2) Difficulty level of financing

In general, the larger a project is required, the higher the cost is as well as a longer construction period. It takes a longer time for financing for such projects. Therefore, the difficulty level of financing could be estimated with the cost of each project. The cost of each project estimated in the existing study at various points in time was adjusted to the present cost in consideration to price escalation, and compared relatively. Evaluation points were allocated between 100 points set as the minimum project cost of 173.8 million USD and 0 points set as the maximum project cost of 1,728.8 million USD in quadratic interpolation in consultation with the NEA. (See Table 10.1.4.1-13)

Table 10.1.4.1-13 Evaluation Criterion for Difficulty Level of Financing

Project Cost (MUS$)	173.8 (Min.)	173.8 - 1,728.8	1,728.8 (Max.)
Score (points)	100	Quadratic interpolation	0

3) Reliability of the Development Plan

In general, the more advanced study level a project has, the higher reliability the project has. Therefore, the reliability of the development plan was to be evaluated with the study level of each project. The portions of study levels of 65 potential projects in the long list provided by the NEA are as shown in Table 10.1.4.1-14.

Table 10.1.4.1-14 Study Level of Candidate Projects on the Long List

Study Level	Number of Projects
Desk Study	54
Pre Feasibility Study	4
Feasibility Study	7

The difference about the geological information in each above-mentioned study level is classified in the long list as follows:

- Desk Study: Based on regional maps and other relevant information without a site visit
- Prefeasibility Study: Geological mapping with site visit
- Feasibility Study: with a drilling and seismic and construction material survey

With reference to the classification of study levels in the long list, all projects were classified into 6 categories depending on the study level, considering all the collected information related to the studies for the projects. (Table 10.1.4.1-15)

Table 10.1.4.1-15 Classification of Study Level for Evaluation of Reliability

Study Level	Application
FS completed	Feasibility Study has completed.
FS on going*	Feasibility Study is ongoing.
Pre-FS	Pre Feasibility Study has completed.
Preliminary Study	Additional investigations such as site reconnaissance, etc. have been conducted after a desk study.
Desk Study	Desk study has been conducted.
Desk Study (few data)	A small amount of data is available even though a desk study has been conducted.

* Only the Nalsyau Gad Project is on this study level. See Clause 10.1.3 (1).

In general, a Feasibility Study is conducted to objectively determine the viability of the project from the standpoint of the technical, economic, financial, and social and natural environment. A Feasibility Study report is used for the nations' policy makers to determine whether to implement the project. It is also used for international financial institutions to examine and determine the viability of the project. A Pre-Feasibility Study is classified as a Feasibility Study, of which accuracy is beyond the required level to achieve the above-mentioned purpose. The Desk Study is defined as a study conducted on available topographical maps without a site survey. Further, a study for which additional surveys such as site reconnaissance, etc. were conducted after Desk Study prior to conducting the Pre Feasibility Study is defined as a Preliminary Study.

Evaluation points were prorated between 100 points set as the highest study level of FS completed and 0 points set as the lowest study level of the Desk study (a small amount of data) depending on study levels as shown in Table 10.1.4.1-16.

Table 10.1.4.1-16 Evaluation Criterion for Reliability of Development Plan

Study Level	FS completed	FS on going	Pre-FS	Preliminary Study	Desk Study	Desk Study (few data)
Score	100	80	60	40	20	0

As mentioned in 10.1.3 (1), the projects for which feasibility study or pre-feasibility study were conducted at the time of this study were excluded from the evaluation.

(4) Benefit by Project

1) Unit Generation Cost

A unit generation cost is one of the important indices of economic efficiency of a project, and the smaller the unit cost is, the smaller an investment is required to yield the same benefit. Since the unit generation cost in this chapter is used as the index of relative economic efficiency of the project, the following simplified calculation formula was used.

Unit generation cost (US cent/kWh) = Project cost / Annual energy production (kWh) × expense rate

The project with the smallest unit generation cost was scored with 100 points, the project with the largest unit generation cost was scored with 0 points, and other projects were scored with points obtained by linear interpolation with the unit generation cost. (See Table 10.1.4.1-17)

Table 10.1.4.1-17 Evaluation Criterion for Unit Generation Cost

Unit Generation Cost (US cent/kWh)	2.21 (Minimum)	2.21 - 20.42	20.42 (Maximum)
Score	100	Linear interpolation	0

Note: Unit Generation Cost = Project Cost / Annual Energy Production × 10%

2) Installed Capacity

The maximum system load on January 28, 2011, the day of the maximum load in FY2010/11, was 946.1 MW. However, the total installed capacity, including diesel plants was 705.6 MW, and the real supply capacity was 510.1 MW, including imports from India. According to the demand forecast by the Study Team, the maximum demand in FY2030/31 will be 3,071 MW, and it will increase by several percent in FY2031/32[4], the last year of the study range of this study. Under these circumstances, projects with a large installed capacity should receive a high evaluation because they contribute to the reduction of load shedding much more than small-scale projects.

On the other hand, it takes time to the implementation of a project, since large-scale projects require large costs in general, and financing of these projects is associated with difficulty.

Though the suitable development scale of promising project was expected to be 100 MW to 300 MW in the scope of work of this study, the evaluation score of installed capacity was determined as shown in Table 10.1.4.1-18, taking the above-mentioned aspects into consideration.

[4] The demand forecast in FY2031/32 had not been calculated when evaluation of installed capacity was carried out.

Table 10.1.4.1-18 Evaluation Criterion for Installed Capacity

Installed Capacity (MW)	0	0 - 100	100 - 300	300 - 1,000	More than 1,000
Score	0	Linear interpolation	100	Linear interpolation	0

Note: Projects more than 1,000 MW have already been excluded in Section 10.1.3 in this chapter.

3) Annual Energy Production

In the same manner as installed capacity, annual energy production also indicates a project scale. The annual energy production of each project is described in the existing report of each project. However, since calculation conditions may be different project by project, the Study Team calculated the annual energy productions of all candidate projects with the same calculation conditions.

In general, projects with a large energy production are more preferable than those with a smaller energy production. On the other hand, these projects have a tendency of having a large installed capacity, and in some cases this may be contradictory to the evaluation of the installed capacity described in the above. To avoid this contradiction, the score was determined so it is linearly proportionate to annual energy production until 2,000 GWh and a constant value, and it as a perfect score for more than 2,000 GWh. (See Table 10.1.4.1-19)

Table 10.1.4.1-19 Evaluation Criterion for Annual Energy Production

Annual Energy Production (GWh)	0	0 - 2,000	More than 2,000
Score	0	Linear interpolation	100

Note: “2,000 GWh” is about 1.5 times of the average of annual energy production of all candidate projects.

4) Energy Production in Dry Season

One of the important roles of a storage-type hydroelectric power project is energy production in the dry season. In the same manner as the above-mentioned evaluation of annual energy production, the score was determined so it is linearly proportionate to energy production until 850 GWh, and has a perfect score for more than that. (See Table 10.1.4.1-20)

Table 10.1.4.1-20 Evaluation Criterion for Energy Production in the Dry Season

Energy Production in Dry Season (GWh)	0	0 - 850	More than 850
Score	0	Linear interpolation	100

Note: “850 GWh” is about 1.5 times of the average of energy production in the dry season of the all projects.

(5) Impact on Natural Environment

1) Impact on Forest Areas

Impact on the forest areas is evaluated by the size of the affected forest area per unit output.

Evaluation points are given by the value obtained by the following calculation (forest area inside of reservoir area / energy production of power plant), 0 points for the maximum value (11.24 ha/MW), 100 points for the minimum value (0.10 ha/MW) and between them, the evaluation points are given by proportional distribution. In case many small projects are developed, the total lost forest area may be larger than the lost forest area by one project with a large project area. Therefore, the affected area per unit output is used for evaluation in order to minimize the total lost forest area to meet the demand. (See Table 10.1.4.1-21)

Table 10.1.4.1-21 Evaluation Criterion for Impact on the Forest Area

Inundated Forest Area (ha/MW)	0.10 (Min)	0.10 - 11.24	11.24 (Max)
Score	100	Linear interpolation	0

2) Impact on Protected Areas

The impact on protected areas is evaluated by the direct or indirect impact of reservoir areas for the six protected areas described in Table 10.1.4.1-22. Downstream of reservoir areas, according to the operation of reservoirs, the flow rate may be increased in the dry season and reduced during the rainy season. To account for this effect, one point is given for each category if the World Heritage Site, National Park including its buffer zone, Wildlife Reserve, Ramsar Convention or Key Biodiversity Area[5] is located downstream of the reservoir area. If the Key Biodiversity Area or one part of this area is located in the reservoir area, it counts as 2 points. The total score of each project is the sum of the points of each category, the highest score is 3 and the lowest score is 0. Regarding these scores, the evaluation points are given for each project, 0 evaluation points for a score of 3, 100 evaluation points for a score of 0, and between them, the evaluation points are given by proportional distribution. (See Table 10.1.4.1-23)

Table 10.1.4.1-22 Points for the Impact on Protected Areas

Category	Description	Point
a) World Heritage	Indirect impact (located downstream of the reservoir)	1
b) National Park	- ditto -	1
c) Ditto (Buffer zone)	- ditto -	1
d) Wildlife Reserve	- ditto -	1
e) Ramsar Convention	- ditto -	1
f) Key Biodiversity Area	Direct impact (located in the reservoir area)	2

Note: Candidate projects which have direct impact on a) to e) have been already excluded.

[5] Key biodiversity areas are places of international importance for the conservation of biodiversity through protected areas and other governance mechanisms. They are identified nationally using simple, standard criteria, based on their importance in maintaining species populations. As the building blocks for designing the ecosystem approach and maintaining effective ecological networks, key biodiversity areas are the starting point for conservation planning at the landscape level. Governments, intergovernmental organizations, NGOs, the private sector, and other stakeholders can use key biodiversity areas as a tool for identifying national networks of internationally important sites for conservation. (Source: IUCN)

Table 10.1.4.1-23 Evaluation Criterion for the Impact on Protected Areas

Total Point	0	0 - 3	3
Score	100	Linear interpolation	0

3) Impact on Fishes

The impact on fishes is evaluated by the impact to the water system where the following 18 species in Table 10.1.4.1-24 nominated in the IUCN Red List are living. The number of inhabitant fish of each water system corresponds to the score of projects located in its water system, the highest score is 10 and the lowest score is 0. Regarding these scores, the evaluation points are given for each project, 0 evaluation points for a score of 0, 100 evaluation points for a score of 10, and between them, the evaluation points are given by proportional distribution. (See Table 10.1.4.1-25)

Table 10.1.4.1-24 List of Fishes used in the Evaluation

Scientific Name	English Name	Criteria	Lake and River system[6, 7]
Schizothorax nepalensis	Snow Trout	CR	Rara lake
Schizothorax raraensis	Rara Snowtrout	CR	Rara lake
Himantura fluviatilis	Ganges Stingray	EN	
Clarias magur	Wagur	EN	Kosi, Gandaki, Karnali, Mahakali,
Tor putitora Putitor	Mahseer	EN	Kosi, Gandaki, Karnali, Mahakali,
Cyprinion semiplotum	Assamese Kingfish	VU	Kosi, Gandaki, Karnali, Mahakali, and their feeder streams
Puntius chelynoides	Dark mahseer	VU	
Schizothorax richardsonii	Snow Trout	VU	Kosi, Gandaki, Karnali, Mahakali, and their feeder streams
Carcharhinus leucas	Bull Shark	NT	
Ailia coila	Gangetic ailia	NT	
Bagarius bagarius		NT	Kosi, Gandaki, Karnali, Mahakali, and their feeder streams
Bagarius yarrelli		NT	Kosi, Gandaki, Karnali, Mahakali, and their feeder streams
Chitala chitala		NT	Kosi, Gandaki, Karnali, Mahakali, and their feeder streams
Labeo pangusia	Pangusia labeo	NT	Kosi, Gandaki, Karnali, Mahakali, and their feeder streams
Neolissochilus hexagonolepis	Katli	NT	Kosi, Gandaki, Karnali, Mahakali, and their feeder streams
Schistura devdevi		NT	
Tor tor	Mahseer	NT	Kosi, Gandaki, Karnali, Mahakali, Also in Phewa lake, Begnas lake
Wallago attu		NT	Kosi, Gandaki, Karnali, Mahakali,

Note: CR = Critically endangered , EN = Endangered, VU = Vulnerable, NT = Near threatened

Table 10.1.4.1-25 Evaluation Criterion for Impact on Fishes

Precious fish (species)	0 (Min)	0 - 10	10 (Max)
Score	100	Linear interpolation	0

[6] Cold water fisheries in trans-Himalayan countries (FAO, 2002)

[7] Coldwater Fish and Fisheries in Nepal (Jiwan Shrestha)

4) Impact on Conservation Species

The impact on conservation species is evaluated by the impact to the seven rare land species shown in Table 10.1.4.1-26 for which the distribution map is available. If there is an overlap in the distribution of rare species and the reservoir area, a point of five levels is given by the habitat density. The total score of each project is the sum of the scores of each of the seven species, the highest score is 18 and the lowest score is 7. Regarding these scores, the evaluation points are given for each project, 0 evaluation points for the highest score of 18, 100 evaluation points for the lowest score of 7, and between them, the evaluation points are given by proportional distribution. (See Table 10.1.4.1-27)

Table 10.1.4.1-26 List of Species and Points for Impact on Conservation Species

Conservation species	Point				
Panthera tigris (EN)	No habitat	Habitat			
	0	5			
Lutra Lutra (NT)	No habitat	Habitat			
	0	5			
Macaca assamensis (NT)	No habitat	Habitat			
	0	5			
Panthera pardus (NT)	No habitat	(Low) ← Habitat density → (High)			
	0	1	2	4	5
Melursus ursinus (VU)	No habitat	(Low) ← Habitat density → (High)			
	0	1	2	5	
Neofelis nebulosa (VU)	No habitat	Habitat			
	0	5			
Ursus thibetanus (VU)	No habitat	(Low) ← Habitat density → (High)			
	0	1	2	4	5

Note: EN = Endangered, VU = Vulnerable, NT = Near threatened.
Presence Code: 1 = The species is known or thought very likely to occur presently in the area, usually encompassing current or recent (post 1980) localities where a suitable habitat at appropriate altitudes (or depths) remains.
2 = The species' presence is considered probable, either based on extrapolations of known records, or realistic inferences (e.g., based on distribution of a suitable habitat at appropriate altitudes and proximity to areas where it is known or thought very likely to remain Extant). 'Probably Extant' ranges often extend beyond areas where the species is Extant, or may fall between them.
3 = The species may possibly occur, and should be searched for, but there are no known records and less than a probable occurrence. 'Possibly Extant' ranges often extend beyond areas where the species is Extant or Probably Extant, or may fall between them.
4 = The species was formerly known or thought very likely to occur in the area, but it is most likely now extirpated from the area because habitat loss/other threats are thought likely to have extirpated the species and/or owing to a lack of records in the last 30 years.
5 = The species was formerly known or thought very likely to occur in the area, but there have been no records in the last 30 years and it is almost certain that the species no longer occurs, and/or habitat loss/other threats have almost certainly extirpated the species.
6 = The species was formerly known or thought very likely to occur in the area but it is no longer known whether it still occurs (usually because there have been no recent surveys).
(Source: IUCN 2012. *IUCN Red List of Threatened Species. Version 2012.1.*)

Table 10.1.4.1-27 Evaluation Criterion for Conservation Species

Total Points of Habitat Density	7 (Min.)	7 - 18	18 (Max.)
Score	100	Linear interpolation	0

(6) Impact on the Social Environment

1) Impact of Construction for Transmission Lines to the Social Environment

As for the impact to the social environment by construction of new transmission line, longer transmission line has a lot of influence on the scenery, acquisition of right of way and surrounding residents. Therefore, evaluation points were prorated between 100 points set as a length of 30 km or less and 0 points set as a length of 100 km or more. (See Table 10.1.4.1-28)

Table 10.1.4.1-28 Evaluation Criterion for Impact of Construction for Transmission Lines to the Social Environment

Length of Transmission Line (km)	Less than 30	30 - 100	More than 100
Score	100	Linear interpolation	0

Note: Length to the nearest 400 kV substation

2) Impact on Households

The impact on households is evaluated by the number of buildings located in reservoir area on the map. The number of buildings on the map is different from the actual number of buildings. Also, in some cases, the numbers of buildings indicated in the report are not the same as the number on the map. However, in order to have a same evaluation level, only the number of buildings on the map is used for the impact evaluation. The maximum number is 3,175 and the minimum number is 0. Regarding these numbers, the evaluation points are given for each project, 0 evaluation points for the maximum number of 3,175, 100 evaluation points for the minimum number of 0, and between them, the evaluation points are given by proportional distribution. (See Table 10.1.4.1-29)

Table 10.1.4.1-29 Evaluation Criterion for Impact on Household

Number of building	0 (Min.)	0 - 3,175	3,175 (Max.)
Score	100	Linear interpolation	0

3) Impact on Agricultural Land

The impact on agricultural land is evaluated by the agricultural land area per unit output (Agricultural land area inside of a reservoir area (according to the map) / energy production of power plant). With this calculation, the maximum value is 9.05 ha/MW and the minimum value is 0.15 ha/MW. Regarding these values, the evaluation points are given for each project, 0 evaluation points for 9.05 ha/MW, 100 evaluation points for 0.15 ha/MW, and between them, the evaluation points are given by proportional distribution. The reason for using the area per

unit output is the same as the evaluation of the impact on forest area. (Table 10.1.4.1-30)

Table 10.1.4.1-30 Evaluation Criterion for Impact on Agricultural Land

Inundated agricultural land (ha/MW)	0.15 (Min)	0.15 - 9.05	9.05 (Max)
Score	100	Linear interpolation	0

4) Impact on Ethnic Minorities

The impact on ethnic minorities is evaluated by the number of affected ethnic minorities. For this evaluation, the ethnic minorities are determined by the 84 caste groups with less than 200,000 people in the population census in 2001. The number of ethnic minorities is the sum of the number of the relevant ethnic minorities extracted from the VDC statistics, and this is counted by each reservoir area. The maximum number is 26 ethnic groups and the minimum number is 0. Regarding these numbers, the evaluation points are given for each project, 0 evaluation points for 26 ethnic groups, 100 evaluation points for 0 and between them, the evaluation points are given by proportional distribution. (See Table 10.1.4.1-31)

Table 10.1.4.1-31 Evaluation Criterion for Impact on Ethnic Minority

Number of minor ethnic group	0 (Min.)	0 - 26	26 (Max.)
Score	100	Linear interpolation	0

Note: Number of ethnic group living in the VDCs in the reservoir area.

5) Impact on Tourism

The impact on tourism is evaluated by the impact to the tourist area frequented by foreign tourists as well as trekking routes and the impact to temples, mosques and churches in the reservoir area. Most projects do not affect tourist areas. Therefore, the projects affecting tourist areas are evaluated with 0 points and the others are evaluated with 100 points. (See Table 10.1.4.1-32)

Table 10.1.4.1-32 Evaluation Criterion for Impact on Tourism

Number of trekking routes and religious assets in the reservoir area	0 (Min.)	0 - 10	10 (Max.)
Score	100	Linear interpolation	0

10.1.4.2 Weighting of Evaluation Items

The evaluation items described in Section 10.1.4.1 above were weighted depending on the importance in the objective of the Study, that is “development of storage-type hydroelectric power projects in Nepal.” Scores of each evaluation item were multiplied by the weight of such evaluation item, and the total of weighted scores of all evaluation items is the evaluation score of the project in question.

The Study Team prepared a draft of weighting taking into consideration the weighting used in other projects[8] in the past, and then it was modified after discussion with the NEA. The Study Team proposed the modified draft of weighting to the first stakeholders meeting and invited comment on it from participants. The final weighting shown in Table 10.1.4.2-1 to Table 10.1.4.2-4 were determined by reference to useful comments obtained from stakeholders.

The basic ideas for deciding weights of evaluation items are as follows.

- The same weight is attached to the technical and economical conditions and the impact on environment.
- In the technical and economical conditions, importance is placed on the effectiveness of the project.
- In the impact on the environment, the same weight is attached to the impact on natural environment and the impact on the social environment. Regarding the weight of evaluation items in the category of impact on the environment, "Impact on forest," "Impact on protected area," "Impact on conservation species," and "Impact on household" are given larger weights than other evaluation items.[9]

[8] Project for Master Plan Study on Hydropower Development in the Republic of Uganda, 2009, JICA
The Master Plan Study of Hydropower Development in Cambodia, 2009, JICA
Update and Review of Identification and Feasibility Study of Storage Project, 2002, NEA

[9] In this study, the weights of impact on households are 6.25% and 5.1% of the total for the second stage and the third stage of evaluation of the base case, respectively. This study put equivalent or more importance on impact on households when compared with similar studies by JICA in the past. In the above-mentioned "Project for Master Plan Study on Hydropower Development in the Republic of Uganda," the weight of impact of resettlement was 4%, and in "The Master Plan Study of Hydropower Development in Cambodia," 8% were given to the impact on living from viewpoints of resettlement, the possibility of power supply to neighboring households (within a 40 km radius), and the effect of flood protection.

Table 10.1.4.2-1 Weight of Evaluation Item (Base Case)

Category	%	Subcategory	%	Evaluation Item	%	Point
Technical and Economical Conditions	50	Hydrological Conditions	25	Reliability of flow data	25	3.13
				Risk of a GLOF	40	5.00
				Sedimentation	35	4.37
		Geological Conditions	25	Seismicity	30	3.75
				Geological conditions of the site	40	5.00
				Natural hazard (earthquake)	30	3.75
		Lead Time	20	Length of access roads	25	2.50
				Difficulty level of funding	35	3.50
				Reliability of development plan	40	4.00
		Effectiveness of the Project	30	Unit generation cost	25	3.75
				Installed capacity	20	3.00
				Annual energy production	20	3.00
				Energy production in the dry season	35	5.25
Impact on the Environment	50	Impact on the Natural Environment	50	Impact on forests	25	6.25
				Impact on protected areas	30	7.50
				Impact on fishes	20	5.00
				Impact on conservation species	25	6.25
		Impact on the Social Environment	50	Impact on locality by construction of transmission line	20	5.00
				Impact on household	25	6.25
				Impact on agriculture	20	5.00
				Impact on ethnic minorities	20	5.00
				Impact on tourism	15	3.75
				Total		100

In the first stakeholder meeting held in February 2012, an attendee from Madhesi Jana Adhikar Forum, Nepal (Madhesi People's Rights Forum, Nepal: a political party) made a comment that the technical and economical conditions were more important than the impact on environment when the power condition of Nepal was considered[10]. Taking these comments into consideration, two other cases of weighting were prepared, Case 1 that put more importance on the technical and economical conditions (60%) and Case 2 that put more importance on the impact on environment (60%), and effects of difference in weighting on evaluation result were studied. (See Table 10.1.4.2-2 and Table 10.1.4.2-3)

[10] See "Appendix-3: Strategic Environment Assessment Report, 12.1 The 1st Stakeholders Meeting"

Table 10.1.4.2-2 Weight of Evaluation Items (Case 1)

Category	%	Subcategory	%	Evaluation Item	%	Point
Technical and Economical Conditions	60	Hydrological Conditions	25	Reliability of flow data	25	3.75
				Risk of a GLOF	40	6.00
				Sedimentation	35	5.25
		Geological Conditions	25	Seismicity	30	4.50
				Geological conditions of the site	40	6.00
				Natural hazard (earthquake)	30	4.50
		Lead Time	20	Length of access roads	25	3.00
				Difficulty level of funding	35	4.20
				Reliability of development plan	40	4.80
		Effectiveness of the Project	30	Unit generation cost	25	4.50
				Installed capacity	20	3.60
				Annual energy production	20	3.60
				Energy production in the dry season	35	6.30
Impact on the Environment	40	Impact on the Natural Environment	50	Impact on forests	25	5.00
				Impact on protected areas	30	6.00
				Impact on fishes	20	4.00
				Impact on conservation species	25	5.00
		Impact on the Social Environment	50	Impact on locality by construction of transmission line	20	4.00
				Impact on households	25	5.00
				Impact on agriculture	20	4.00
				Impact on ethnic minorities	20	4.00
				Impact on tourism	15	3.00
				Total		100

Table 10.1.4.2-3 Weight of Evaluation Items (Case 2)

Category	%	Subcategory	%	Evaluation Item	%	Point
Technical and Economical Conditions	40	Hydrological Conditions	25	Reliability of flow data	25	2.50
				Risk of a GLOF	40	4.00
				Sedimentation	35	3.50
		Geological Conditions	25	Seismicity	30	3.00
				Geological conditions of the site	40	4.00
				Natural hazard (earthquake)	30	3.00
		Lead Time	20	Length of access roads	25	2.00
				Difficulty level of funding	35	2.80
				Reliability of development plan	40	3.20
		Effectiveness of the Project	30	Unit generation cost	25	3.00
				Installed capacity	20	2.40
				Annual energy production	20	2.40
				Energy production in the dry season	35	4.20
Impact on the Environment	60	Impact on the Natural Environment	50	Impact on forests	25	7.50
				Impact on protected areas	30	9.00
				Impact on fishes	20	6.00
				Impact on conservation species	25	7.50
		Impact on the Social Environment	50	Impact on locality by construction of transmission line	20	6.00
				Impact on households	25	7.50
				Impact on agriculture	20	6.00
				Impact on ethnic minorities	20	6.00
				Impact on tourism	15	4.50
				Total		100

10.1.4.3 Result of the Evaluation

The 31 candidate projects selected in Section 10.1.3 were evaluated by the evaluation method described in Section 10.1.4.1, then the evaluation scores of each evaluation item were weighted with the weight described in Section 10.1.4.2 and summed up, and the evaluation scores of each candidate project were obtained. Numerical values or information of each evaluation item was obtained from existing project reports, topographical and geological maps, and other literature.

Table 10.1.4.3-1 shows the evaluation score and ranking of candidate projects, Table 10.1.4.3-2 shows the ranking of each case, and Table 10.1.4.3-3 to Table 10.1.4.3-5 and Figure 10.1.4.3-1 show the detail of evaluation results. In addition, Table 10.1.4.3-6 to Table 10.1.4.3-8 show the details of the impact on protected areas, the impact on conservation species, and the impact on tourism, respectively.

Table 10.1.4.3-1 Evaluation Score and Ranking

No.	Project Name	P (MW)	Base Case		Case 1		Case 2	
			Score	Ranking	Score	Ranking	Score	Ranking
E-01	Dudh Koshi	300.0	65	6	65	5	65	9
E-02	Dukh Koshi-2	456.6	62	12	61	17	63	12
E-06	Kokhajor-1	111.5	62	13	60	20	64	10
E-09	Piluwa-2	107.3	59	21	57	25	60	19
E-10	Rosi-2	106.5	60	20	58	21	61	17
E-12	Tama Koss-3	287.0	63	10	63	13	63	13
E-17	Sunkosi No.3	536.0	63	11	64	8	62	15
E-20	Indrawati	91.2	58	23	58	24	58	24
C-01	Kaligandaki-Modi	816.4	57	25	58	23	56	25
C-02	Lower Badigad	380.3	62	14	63	14	62	16
C-03	Lower Daraudi	120.2	50	30	52	29	49	31
C-05	Upper Daraudi	111.4	53	27	51	30	54	27
C-08	Andhi Khola	180.0	62	15	64	9	61	18
C-11	Madi- Ishaneshor	86.0	61	17	62	15	59	21
C-18	Ridi Khola	97.0	53	28	53	28	53	28
W-01	Barbung Khola	122.9	61	18	60	19	63	14
W-02	Chera-1	148.7	65	7	64	7	66	4
W-03	Chera-2	104.3	62	16	61	16	63	11
W-05	Lower Jhimruk	142.5	71	2	69	2	73	2
W-06	Madi	199.8	76	1	73	1	78	1
W-10	Sharada-2	96.8	64	9	63	12	65	7
W-11	Thuli Gad-2	119.7	59	22	58	22	60	20
W-12	Tila-1	617.2	66	4	65	6	66	5
W-17	BR-4	667.0	51	29	53	27	49	30
W-20	Bhanakot	810.0	66	5	66	4	65	8
W-21	Thapna	500.0	61	19	64	10	58	23
W-22	SR-6	642.0	58	24	61	18	56	26
W-23	Nalsyagu Gad	400.0	68	3	67	3	70	3
W-24	Sarada Babai	75.0	57	26	55	26	59	22
W-25	Naumure (W. Rapti)	245.0	65	8	64	11	66	6
W-26	Lohare Khola	67.0	50	31	51	31	49	29

E: Eastern River Basin, C: Central River Basin, W: Western River Basin.

Base Case: Technical point 50%, Environmental point 50%
Case 1: Technical point 60%, Environmental point 40%
Case 2: Technical point 40%, Environmental point 60%

Table 10.1.4.3-2 Evaluation Score and Ranking of Each Case

Base Case

Technical point : 50%, Environmental point : 50%

No.	Project Name	P (MW)	Score	Ranking
W-06	Madi	199.8	76	1
W-05	Lower Jhimruk	142.5	71	2
W-23	Nalsyagu Gad	400.0	68	3
W-12	Tila - 1	617.2	66	4
W-20	Bhanakot	810.0	66	5
E-01	Dudh Koshi	300.0	65	6
W-02	Chera-1	148.7	65	7
W-25	Naumure (W. Rapti)	245.0	65	8
W-10	Sharada - 2	96.8	64	9
E-12	Tama Koss-3	287.0	63	10
E-17	Sunkosi No.3	536.0	63	11
E-02	Dukh Koshi-2	456.6	62	12
E-06	Kokhajor-1	111.5	62	13
C-02	Lower Badigad	380.3	62	14
C-08	Andhi Khola	180.0	62	15
W-03	Chera-2	104.3	62	16
C-11	Madi- Ishaneshor	86.0	61	17
W-01	Barbung Khola	122.9	61	18
W-21	Thapna	500.0	61	19
E-10	Rosi-2	106.5	60	20
E-09	Piluwa-2	107.3	59	21
W-11	Thuli Gad - 2	119.7	59	22
E-20	Indrawati	91.2	58	23
W-22	SR-6	642.0	58	24
C-01	Kaligandaki-Modi	816.4	57	25
W-24	Sarada Babai	75.0	57	26
C-05	Upper Daraudi	111.4	53	27
C-18	Ridi Khola	97.0	53	28
W-17	BR-4	667.0	51	29
C-03	Lower Daraudi	120.2	50	30
W-26	Lohare Khola	67.0	50	31

Case-1

Technical point : 60%, Environmental point : 40%

No.	Project Name	P (MW)	Score	Ranking
W-06	Madi	199.8	73	1
W-05	Lower Jhimruk	142.5	69	2
W-23	Nalsyagu Gad	400.0	67	3
W-20	Bhanakot	810.0	66	4
E-01	Dudh Koshi	300.0	65	5
W-12	Tila - 1	617.2	65	6
W-02	Chera-1	148.7	64	7
E-17	Sunkosi No.3	536.0	64	8
C-08	Andhi Khola	180.0	64	9
W-21	Thapna	500.0	64	10
W-25	Naumure (W. Rapti)	245.0	64	11
W-10	Sharada - 2	96.8	63	12
E-12	Tama Koss-3	287.0	63	13
C-02	Lower Badigad	380.3	63	14
C-11	Madi- Ishaneshor	86.0	62	15
W-03	Chera-2	104.3	61	16
E-02	Dukh Koshi-2	456.6	61	17
W-22	SR-6	642.0	61	18
W-01	Barbung Khola	122.9	60	19
E-06	Kokhajor-1	111.5	60	20
E-10	Rosi-2	106.5	58	21
W-11	Thuli Gad - 2	119.7	58	22
C-01	Kaligandaki-Modi	816.4	58	23
E-20	Indrawati	91.2	58	24
E-09	Piluwa-2	107.3	57	25
W-24	Sarada Babai	75.0	55	26
W-17	BR-4	667.0	53	27
C-18	Ridi Khola	97.0	53	28
C-03	Lower Daraudi	120.2	52	29
C-05	Upper Daraudi	111.4	51	30
W-26	Lohare Khola	67.0	51	31

Case-2

Technical point : 40%, Environmental point : 60%

No.	Project Name	P (MW)	Score	Ranking
W-06	Madi	199.8	78	1
W-05	Lower Jhimruk	142.5	73	2
W-23	Nalsyagu Gad	400.0	70	3
W-02	Chera-1	148.7	66	4
W-12	Tila - 1	617.2	66	5
W-25	Naumure (W. Rapti)	245.0	66	6
W-10	Sharada - 2	96.8	65	7
W-20	Bhanakot	810.0	65	8
E-01	Dudh Koshi	300.0	65	9
E-06	Kokhajor-1	111.5	64	10
W-03	Chera-2	104.3	63	11
E-02	Dukh Koshi-2	456.6	63	12
E-12	Tama Koss-3	287.0	63	13
W-01	Barbung Khola	122.9	63	14
E-17	Sunkosi No.3	536.0	62	15
C-02	Lower Badigad	380.3	62	16
E-10	Rosi-2	106.5	61	17
C-08	Andhi Khola	180.0	61	18
E-09	Piluwa-2	107.3	60	19
W-11	Thuli Gad - 2	119.7	60	20
C-11	Madi- Ishaneshor	86.0	59	21
W-24	Sarada Babai	75.0	59	22
W-21	Thapna	500.0	58	23
E-20	Indrawati	91.2	58	24
C-01	Kaligandaki-Modi	816.4	56	25
W-22	SR-6	642.0	56	26
C-05	Upper Daraudi	111.4	54	27
C-18	Ridi Khola	97.0	53	28
W-26	Lohare Khola	67.0	49	29
W-17	BR-4	667.0	49	30
C-03	Lower Daraudi	120.2	49	31

E: Eastern River Basin, C: Central River Basin, W: Western River Basin.

Table 10.1.4.3-3 (1) Evaluation Score and Ranking of the Base Case (1/3)

Category		Technical and Economical Conditions																							
Subcategory		Hydrological Conditions									Geological Conditions (See Table 10.1.4.1-5)						Lead Time								
Evaluation Item		Reliability of Flow Data			Risk of GLOF			Sedimentation			Seismicity		Geological Condition of Site		Natural Hazard (Earthquake)		Length of Access Road			Difficulty Level of Financing			Reliability of Development Plan		
Weight (%)			3.13			5.00			4.37			3.75		5.00		3.75			2.50			3.50			4.00	
No.	Project Name	Calculation Method	Score	Weighted Score	Risk	Score	Weighted Score	Life Time of Reservoir	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Length (km)	Score	Weighted Score	2012 Project Cost (MUSD)	Score	Weighted Score	Study Level	Score	Weighted Score
W-06	Madi	RH	0.0	0.00	None	100	5.00	202.0	100.0	4.37	60	2.25	40	2.00	100	3.75	15.0	76.9	1.92	394.5	85.8	3.00	DS	20	0.80
W-05	Lower Jhimruk	GS330*As/Ag	100.0	3.13	None	100	5.00	146.9	100.0	4.37	60	2.25	40	2.00	20	0.75	18.0	72.3	1.81	312.4	91.1	3.19	DS	20	0.80
W-23	Nalsyagu Gad	RH	0.0	0.00	None	100	5.00	149.5	100.0	4.37	20	0.75	20	1.00	60	2.25	30.0	53.8	1.35	607.5	72.1	2.52	FS ongoing	80	3.20
W-12	Tila - 1	GS225*As/Ag	100.0	3.13	None	100	5.00	65.5	31.1	1.36	20	0.75	60	3.00	100	3.75	56.0	13.8	0.35	1163.8	36.3	1.27	DS	20	0.80
W-20	Bhanakot	GS240*As/Ag	100.0	3.13	None	100	5.00	144.3	100.0	4.37	20	0.75	40	2.00	100	3.75	1.0	98.5	2.46	1728.8	0.0	0.00	DS few data	0	0.00
E-01	Dudh Koshi	GS670	100.0	3.13	High	0	0.00	145.4	100.0	4.37	20	0.75	40	2.00	60	2.25	65.0	0.0	0.00	830.8	57.7	2.02	FS	100	4.00
W-02	Chera-1	RH	0.0	0.00	None	100	5.00	119.3	100.0	4.37	20	0.75	40	2.00	100	3.75	5.5	91.5	2.29	332.2	89.8	3.14	DS	20	0.80
W-25	Naumure (W. Rapti)	RH	0.0	0.00	None	100	5.00	191.5	100.0	4.37	100	3.75	0	0.00	0	0.00	34.0	47.7	1.19	594.5	72.9	2.55	Pre FS	60	2.40
W-10	Sharada - 2	RH	0.0	0.00	None	100	5.00	140.2	100.0	4.37	100	3.75	0	0.00	60	2.25	5.0	92.3	2.31	173.8	100.0	3.50	DS	20	0.80
E-12	Tama Koss-3	GS647	87.5	2.74	None	100	5.00	133.9	100.0	4.37	20	0.75	60	3.00	0	0.00	13.0	80.0	2.00	515.6	78.0	2.73	DS few data	0	0.00
E-17	Sunkosi No.3	GS630*As/Ag	100.0	3.13	None	100	5.00	100.5	100.0	4.37	20	0.75	40	2.00	100	3.75	20.0	69.2	1.73	1147.0	37.4	1.31	DS	20	0.80
E-02	Dukh Koshi-2	GS670*As/Ag	100.0	3.13	High	0	0.00	77.3	54.7	2.39	20	0.75	40	2.00	100	3.75	35.0	46.2	1.15	979.7	48.2	1.69	DS	20	0.80
E-06	Kokhajor-1	RH	0.0	0.00	None	100	5.00	353.8	100.0	4.37	100	3.75	0	0.00	20	0.75	22.0	66.2	1.65	324.0	90.3	3.16	DS	20	0.80
C-02	Lower Badigad	RH	0.0	0.00	None	100	5.00	165.6	100.0	4.37	60	2.25	20	1.00	100	3.75	0.0	100.0	2.50	672.8	67.9	2.38	DS	20	0.80
C-08	Andhi Khola	GS415*As/Ag	100.0	3.13	None	100	5.00	280.5	100.0	4.37	20	0.75	20	1.00	100	3.75	8.0	87.7	2.19	450.3	82.2	2.88	FS	100	4.00
W-03	Chera-2	RH	0.0	0.00	None	100	5.00	111.3	100.0	4.37	20	0.75	40	2.00	80	3.00	2.5	96.2	2.40	283.5	92.9	3.25	DS	20	0.80
C-11	Madi- Ishaneshor	GS438*As/Ag	98.3	3.08	None	100	5.00	160.9	100.0	4.37	20	0.75	40	2.00	40	1.50	3.0	95.4	2.38	190.3	98.9	3.46	FS	100	4.00
W-01	Barbung Khola	RH	0.0	0.00	None	100	5.00	52.1	4.1	0.18	40	1.50	60	3.00	100	3.75	60.0	7.7	0.19	184.7	99.3	3.48	DS	20	0.80
W-21	Thapna	GS269.5*As/Ag	100.0	3.13	None	100	5.00	204.9	100.0	4.37	60	2.25	40	2.00	100	3.75	1.0	98.5	2.46	1484.2	15.7	0.55	DS few data	0	0.00
E-10	Rosi-2	RH	0.0	0.00	None	100	5.00	149.8	100.0	4.37	20	0.75	20	1.00	60	2.25	15.0	76.9	1.92	326.9	90.2	3.16	DS	20	0.80
E-09	Piluwa-2	RH	0.0	0.00	None	100	5.00	363.5	100.0	4.37	20	0.75	40	2.00	100	3.75	40.0	38.5	0.96	275.4	93.5	3.27	DS	20	0.80
W-11	Thuli Gad - 2	RH	0.0	0.00	None	100	5.00	126.9	100.0	4.37	60	2.25	0	0.00	20	0.75	10.0	84.6	2.12	221.3	96.9	3.39	DS	20	0.80
E-20	Indrawati	RH	0.0	0.00	None	100	5.00	208.6	100.0	4.37	20	0.75	40	2.00	60	2.25	2.3	96.5	2.41	360.4	88.0	3.08	Pre FS	60	2.40
W-22	SR-6	GS260*As/Ag	98.3	3.08	None	100	5.00	186.8	100.0	4.37	20	0.75	40	2.00	80	3.00	17.0	73.8	1.85	1212.7	33.2	1.16	DS	20	0.80
C-01	Kaligandaki-Modi	RH	0.0	0.00	Low	40	2.00	177.0	100.0	4.37	20	0.75	40	2.00	100	3.75	0.0	100.0	2.50	768.4	61.8	2.16	DS	20	0.80
W-24	Sarada Babai	GS286	100.0	3.13	None	100	5.00	72.6	45.2	1.97	100	3.75	0	0.00	0	0.00	32.0	50.8	1.27	259.1	94.5	3.31	DS	20	0.80
C-05	Upper Daraudi	RH	0.0	0.00	None	100	5.00	317.3	100.0	4.37	20	0.75	40	2.00	40	1.50	15.0	76.9	1.92	444.5	82.6	2.89	DS	20	0.80
C-18	Ridi Khola	RH	0.0	0.00	None	100	5.00	252.1	100.0	4.37	20	0.75	20	1.00	60	2.25	6.0	90.8	2.27	383.3	86.5	3.03	Preliminary	40	1.60
W-17	BR-4	RH	0.0	0.00	None	100	5.00	197.1	100.0	4.37	20	0.75	40	2.00	60	2.25	1.0	98.5	2.46	1369.6	23.1	0.81	DS	20	0.80
C-03	Lower Daraudi	RH	0.0	0.00	None	100	5.00	289.1	100.0	4.37	20	0.75	40	2.00	100	3.75	0.0	100.0	2.50	198.4	98.4	3.44	DS	20	0.80
W-26	Lohare Khola	RH	0.0	0.00	None	100	5.00	155.0	100.0	4.37	20	0.75	40	2.00	60	2.25	5.0	92.3	2.31	218.9	97.1	3.40	Pre FS	60	2.40

Table 10.1.4.3-3 (2) Evaluation Score and Ranking of the Base Case (2/3)

Category		Technical and Economical Conditions (Cont.)												Impact on Environment											
Subcategory		Effectiveness of Project												Impact on Natural Environment											
Evaluation Item		Unit Generation Cost			Installed Capacity			Annual Energy Production			Energy Production in Dry Season			Impact on Forest				Impact on Protected Area (See Table 10.1.4.3-6)			Impact on Fishes			Impact on Conservation Species (See Table 10.1.4.3-7)		
Weight (%)				3.75			3.00			3.00			5.25				6.25				7.50			5.00			6.25
No.	Project Name	(USc/kWh)	Score	Weighted Score	(MW)	Score	Weighted Score	(GWh)	Score	Weighted Score	(GWh)	Score	Weighted Score	Inundated Forest Area (ha)	Forest Area / Installed Capacity (ha / MW)	Score	Weighted Score	Total Point	Score	Weighted Score	Numbers of Species	Score	Weighted Score	Total Point	Score	Weighted Score
W-06	Madi	6.14	75.6	2.84	199.8	100.0	3.00	642.9	32.1	0.96	256.43	32.1	1.69	214	1.07	91.3	5.71	1	66.7	5.00	0	100.0	5.00	7.0	100.0	6.25
W-05	Lower Jhimruk	6.85	71.8	2.69	142.5	100.0	3.00	456.3	22.8	0.68	163.37	20.4	1.07	196	1.38	88.6	5.54	1	66.7	5.00	0	100.0	5.00	13.0	45.5	2.84
W-23	Nalsyagu Gad	4.73	83.2	3.12	400.0	85.7	2.57	1285.5	64.3	1.93	462.90	57.9	3.04	41	0.10	100.0	6.25	1	66.7	5.00	10	0.0	0.00	14.0	36.4	2.27
W-12	Tila - 1	4.79	82.9	3.11	617.2	54.7	1.64	2428.7	100.0	3.00	642.86	80.4	4.22	237	0.38	97.5	6.09	1	66.7	5.00	10	0.0	0.00	14.0	36.4	2.27
W-20	Bhanakot	2.45	95.4	3.58	810.0	27.1	0.81	7042.2	100.0	3.00	4089.34	100.0	5.25	1,484	1.83	84.5	5.28	1	66.7	5.00	10	0.0	0.00	11.0	63.6	3.98
E-01	Dudh Koshi	4.46	84.6	3.17	300.0	100.0	3.00	1864.6	93.2	2.80	821.33	100.0	5.25	382	1.27	89.5	5.59	2	33.3	2.50	7	30.0	1.50	17.0	9.1	0.57
W-02	Chera-1	5.95	76.6	2.87	148.7	100.0	3.00	557.8	27.9	0.84	166.17	20.8	1.09	157	1.06	91.4	5.71	1	66.7	5.00	10	0.0	0.00	12.0	54.5	3.41
W-25	Naumure (W. Rapti)	5.10	81.2	3.05	245.0	100.0	3.00	1165.1	58.3	1.75	425.17	53.1	2.79	908	3.71	67.6	4.23	1	66.7	5.00	0	100.0	5.00	13.0	45.5	2.84
W-10	Sharada - 2	3.81	88.1	3.30	96.8	96.8	2.90	455.6	22.8	0.68	159.57	19.9	1.04	268	2.77	76.1	4.75	3	0	0.00	10	0.0	0.00	8.0	90.9	5.68
E-12	Tama Koss-3	3.89	87.7	3.29	287.0	100.0	3.00	1325.3	66.3	1.99	468.77	58.6	3.08	227	0.79	93.8	5.86	2	33.3	2.50	7	30.0	1.50	17.0	9.1	0.57
E-17	Sunkosi No.3	6.29	74.8	2.81	536.0	66.3	1.99	1824.8	91.2	2.74	461.90	57.7	3.03	519	0.97	92.2	5.76	2	33.3	2.50	7	30.0	1.50	17.0	9.1	0.57
E-02	Dukh Koshi-2	4.40	84.9	3.18	456.6	77.6	2.33	2225.5	100.0	3.00	617.48	77.2	4.05	209	0.46	96.8	6.05	2	33.3	2.50	7	30.0	1.50	17.0	9.1	0.57
E-06	Kokhajor-1	11.97	44.4	1.67	111.5	100.0	3.00	270.7	13.5	0.41	124.11	15.5	0.81	546	4.90	56.9	3.56	0	100	7.50	3	70.0	3.50	17.0	9.1	0.57
C-02	Lower Badigad	4.97	81.9	3.07	380.3	88.5	2.66	1354.4	67.7	2.03	486.81	60.9	3.20	376	0.99	92.0	5.75	3	0	0.00	10	0.0	0.00	13.0	45.5	2.84
C-08	Andhi Khola	6.96	71.2	2.67	180.0	100.0	3.00	646.9	32.3	0.97	207.10	25.9	1.36	254	1.41	88.2	5.52	3	0	0.00	10	0.0	0.00	18.0	0.0	0.00
W-03	Chera-2	7.04	70.8	2.66	104.3	100.0	3.00	402.6	20.1	0.60	117.68	14.7	0.77	351	3.37	70.7	4.42	1	66.7	5.00	10	0.0	0.00	13.0	45.5	2.84
C-11	Madi- Ishaneshor	4.84	82.6	3.10	86.0	86.0	2.58	393.3	19.7	0.59	103.52	12.9	0.68	154	1.79	84.8	5.30	3	0	0.00	10	0.0	0.00	17.0	9.1	0.57
W-01	Barbung Khola	2.70	94.1	3.53	122.9	100.0	3.00	683.5	34.2	1.03	227.09	28.4	1.49	20	0.16	99.5	6.22	1	66.7	5.00	10	0.0	0.00	16.0	18.2	1.14
W-21	Thapna	4.30	85.5	3.21	500.0	71.4	2.14	3450.5	100.0	3.00	1894.43	100.0	5.25	2,094	4.19	63.3	3.96	1	66.7	5.00	10	0.0	0.00	13.0	45.5	2.84
E-10	Rosi-2	9.79	56.1	2.10	106.5	100.0	3.00	334.1	16.7	0.50	117.75	14.7	0.77	50	0.47	96.7	6.04	2	33.3	2.50	7	30.0	1.50	17.0	9.1	0.57
E-09	Piluwa-2	18.01	12.0	0.45	107.3	100.0	3.00	152.9	7.6	0.23	82.96	10.4	0.55	51	0.48	96.7	6.04	2	33.3	2.50	7	30.0	1.50	17.0	9.1	0.57
W-11	Thuli Gad - 2	4.31	85.4	3.20	119.7	100.0	3.00	513.5	25.7	0.77	157.86	19.7	1.03	170	1.42	88.2	5.51	1	66.7	5.00	10	0.0	0.00	18.0	0.0	0.00
E-20	Indrawati	9.39	58.2	2.18	91.2	91.2	2.74	384.0	19.2	0.58	116.00	14.5	0.76	103	1.13	90.8	5.67	2	33.3	2.50	7	30.0	1.50	17.0	9.1	0.57
W-22	SR-6	3.69	88.7	3.33	642.0	51.1	1.53	3284.1	100.0	3.00	1425.50	100.0	5.25	1,929	3.00	73.9	4.62	1	66.7	5.00	10	0.0	0.00	17.0	9.1	0.57
C-01	Kaligandaki-Modi	2.21	96.7	3.63	816.4	26.2	0.79	3477.4	100.0	3.00	709.28	88.7	4.66	177	0.22	99.0	6.19	3	0	0.00	10	0.0	0.00	11.0	63.6	3.98
W-24	Sarada Babai	12.83	39.8	1.49	75.0	75.0	2.25	202.0	10.1	0.30	92.64	11.6	0.61	258	3.44	70.0	4.38	3	0	0.00	0	100.0	5.00	12.0	54.5	3.41
C-05	Upper Daraudi	20.42	-0.9	-0.03	111.4	100.0	3.00	217.7	10.9	0.33	116.72	14.6	0.77	140	1.26	89.6	5.60	3	0	0.00	10	0.0	0.00	17.0	9.1	0.57
C-18	Ridi Khola	15.01	28.1	1.05	97.0	97.0	2.91	255.3	12.8	0.38	133.65	16.7	0.88	410	4.23	63.0	3.94	3	0	0.00	10	0.0	0.00	13.0	45.5	2.84
W-17	BR-4	4.13	86.4	3.24	667.0	47.6	1.43	3315.3	100.0	3.00	1479.84	100.0	5.25	3,548	5.32	53.2	3.32	1	66.7	5.00	10	0.0	0.00	13.0	45.5	2.84
C-03	Lower Daraudi	7.88	66.3	2.49	120.2	100.0	3.00	251.7	12.6	0.38	126.81	15.9	0.83	324	2.70	76.7	4.79	3	0	0.00	10	0.0	0.00	17.0	9.1	0.57
W-26	Lohare Khola	7.48	68.4	2.57	67.0	67.0	2.01	292.7	14.6	0.44	100.92	12.6	0.66	753	11.24	0.0	0.00	1	66.7	5.00	10	0.0	0.00	12.0	54.5	3.41

Table 10.1.4.3-3 (3) Evaluation Score and Ranking of the Base Case (3/3)

Category		Impact on Environment (Cont.)																	
Subcategory		Impact on Social Environment																	
Evaluation Item		Impact on Locality by Construction of Transmission Line			Impact on Household			Impact on Agriculture				Impact on Ethnic Minority			Impact on Tourism (See Table 10.1.4.3-8)				
Weight (%)				5.00			6.25				5.00			5.00			3.75		100
No.	Project Name	Length (km)	Score	Weighted Score	Number of Inundated Household	Score	Weighted Score	Inundated Firm Land (ha)	Firm Land / Installed Capacity (ha / MW)	Score	Weighted Score	Number of ethnic minority groups	Score	Weighted Score	Number of Religious Asset and Trekking Route	Score	Weighted Score	Total Score	
W-06	Madi	43	81.4	4.07	162	94.9	5.93	266	1.33	86.8	4.34	5	80.8	4.04	0	100.0	3.75	75.67	76
W-05	Lower Jhimruk	54	65.7	3.29	186	94.1	5.88	210	1.47	85.2	4.26	3	88.5	4.42	0	100.0	3.75	70.72	71
W-23	Nalsyagu Gad	31	98.6	4.93	90	97.2	6.07	126	0.32	98.2	4.91	5	80.8	4.04	0	100.0	3.75	68.32	68
W-12	Tila - 1	86	20.0	1.00	44	98.6	6.16	208	0.34	97.9	4.90	0	100.0	5.00	0	100.0	3.75	65.55	66
W-20	Bhanakot	110	0.0	0.00	361	88.6	5.54	1,078	1.33	86.8	4.34	5	80.8	4.04	1	90.0	3.38	65.66	66
E-01	Dudh Koshi	21	100.0	5.00	52	98.4	6.15	418	1.39	86.1	4.30	8	69.2	3.46	1	90.0	3.38	65.19	65
W-02	Chera-1	51	70.0	3.50	75	97.6	6.10	97	0.65	94.4	4.72	10	61.5	3.08	0	100.0	3.75	65.17	65
W-25	Naumure (W. Rapti)	68	45.7	2.29	615	80.6	5.04	613	2.50	73.6	3.68	9	65.4	3.27	1	90.0	3.38	64.58	65
W-10	Sharada - 2	23	100.0	5.00	154	95.1	5.95	142	1.47	85.2	4.26	0	100.0	5.00	0	100.0	3.75	64.29	64
E-12	Tama Koss-3	21	100.0	5.00	56	98.2	6.14	136	0.47	96.4	4.82	18	30.8	1.54	1	90.0	3.38	63.26	63
E-17	Sunkosi No.3	27	100.0	5.00	343	89.2	5.57	978	1.82	81.2	4.06	11	57.7	2.88	5	50.0	1.88	63.13	63
E-02	Dukh Koshi-2	15	100.0	5.00	71	97.8	6.11	225	0.49	96.2	4.81	7	73.1	3.65	0	100.0	3.75	62.16	62
E-06	Kokhajor-1	51	70.0	3.50	102	96.8	6.05	130	1.17	88.6	4.43	8	69.2	3.46	0	100.0	3.75	61.69	62
C-02	Lower Badigad	36	91.4	4.57	366	88.5	5.53	671	1.76	81.9	4.10	11	57.7	2.88	0	100.0	3.75	62.43	62
C-08	Andhi Khola	38	88.6	4.43	97	96.9	6.06	158	0.88	91.9	4.59	9	65.4	3.27	1	90.0	3.38	62.32	62
W-03	Chera-2	49	72.9	3.65	114	96.4	6.03	144	1.38	86.2	4.31	6	76.9	3.85	0	100.0	3.75	62.45	62
C-11	Madi- Ishaneshor	10	100.0	5.00	89	97.2	6.07	264	3.07	67.2	3.36	6	76.9	3.85	2	80.0	3.00	60.64	61
W-01	Barbung Khola	67	47.1	2.36	0	100.0	6.25	19	0.15	100.0	5.00	2	92.3	4.62	0	100.0	3.75	61.29	61
W-21	Thapna	56	62.9	3.15	1,495	52.9	3.31	2,646	5.29	42.3	2.11	11	57.7	2.88	8	20.0	0.75	61.11	61
E-10	Rosi-2	32	97.1	4.86	125	96.1	6.00	151	1.42	85.8	4.29	2	92.3	4.62	0	100.0	3.75	59.75	60
E-09	Piluwa-2	5	100.0	5.00	13	99.6	6.22	49	0.46	96.6	4.83	8	69.2	3.46	1	90.0	3.38	58.63	59
W-11	Thuli Gad - 2	42	82.9	4.15	108	96.6	6.04	159	1.33	86.8	4.34	3	88.5	4.42	2	80.0	3.00	59.14	59
E-20	Indrawati	15	100.0	5.00	179	94.4	5.90	521	5.71	37.5	1.88	11	57.7	2.88	1	90.0	3.38	57.80	58
W-22	SR-6	25	100.0	5.00	1,291	59.3	3.71	1,431	2.23	76.7	3.83	26	0.0	0.00	9	10.0	0.38	58.23	58
C-01	Kaligandaki-Modi	11	100.0	5.00	436	86.3	5.39	549	0.67	94.2	4.71	19	26.9	1.35	10	0.0	0.00	57.03	57
W-24	Sarada Babai	32	97.1	4.86	359	88.7	5.54	369	4.92	46.4	2.32	3	88.5	4.42	2	80.0	3.00	56.81	57
C-05	Upper Daraudi	18	100.0	5.00	72	97.7	6.11	174	1.56	84.2	4.21	5	80.8	4.04	0	100.0	3.75	52.58	53
C-18	Ridi Khola	35	92.9	4.65	51	98.4	6.15	429	4.42	52.0	2.60	7	73.1	3.65	0	100.0	3.75	53.07	53
W-17	BR-4	51	70.0	3.50	3,175	0.0	0.00	3,565	5.34	41.7	2.08	13	50.0	2.50	9	10.0	0.38	50.98	51
C-03	Lower Daraudi	9	100.0	5.00	677	78.7	4.92	1,088	9.05	0.0	0.00	14	46.2	2.31	1	90.0	3.38	50.28	50
W-26	Lohare Khola	92	11.4	0.57	243	92.3	5.77	422	6.30	30.9	1.55	9	65.4	3.27	4	60.0	2.25	49.98	50

Table 10.1.4.3-4 (1) Evaluation Score and Ranking of Case 1 (1/3)

Category		Technical and Economical Conditions																							
Subcategory		Hydrological Conditions									Geological Conditions (See Table 10.1.4.1-5)						Lead Time								
Evaluation Item		Reliability of Flow Data			Risk of GLOF			Sedimentation			Seismicity		Geological Condition of Site		Natural Hazard (Earthquake)		Length of Access Road			Difficulty Level of Financing			Reliability of Development Plan		
Weight (%)				3.75			6.00			5.25		4.50		6.00		4.50			3.00			4.20			4.80
No.	Project Name	Calculation Method	Score	Weighted Score	Risk	Score	Weighted Score	Life Time of Reservoir	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Length (km)	Score	Weighted Score	2012 Project Cost (MUSD)	Score	Weighted Score	Study Level	Score	Weighted Score
W-06	Madi	RH	0.0	0.00	None	100	6.00	202.0	100.0	5.25	60	2.70	40	2.40	100	4.50	15.0	76.9	2.31	394.5	85.8	3.60	DS	20	0.96
W-05	Lower Jhimruk	GS330*As/Ag	100.0	3.75	None	100	6.00	146.9	100.0	5.25	60	2.70	40	2.40	20	0.90	18.0	72.3	2.17	312.4	91.1	3.83	DS	20	0.96
W-23	Nalsyagu Gad	RH	0.0	0.00	None	100	6.00	149.5	100.0	5.25	20	0.90	20	1.20	60	2.70	30.0	53.8	1.62	607.5	72.1	3.03	FS ongoing	80	3.84
W-20	Bhanakot	GS240*As/Ag	100.0	3.75	None	100	6.00	144.3	100.0	5.25	20	0.90	40	2.40	100	4.50	1.0	98.5	2.95	1728.8	0.0	0.00	DS few data	0	0.00
E-01	Dudh Koshi	GS670	100.0	3.75	High	0	0.00	145.4	100.0	5.25	20	0.90	40	2.40	60	2.70	65.0	0.0	0.00	830.8	57.7	2.43	FS	100	4.80
W-12	Tila - 1	GS225*As/Ag	100.0	3.75	None	100	6.00	65.5	31.1	1.63	20	0.90	60	3.60	100	4.50	56.0	13.8	0.42	1163.8	36.3	1.53	DS	20	0.96
W-02	Chera-1	RH	0.0	0.00	None	100	6.00	119.3	100.0	5.25	20	0.90	40	2.40	100	4.50	5.5	91.5	2.75	332.2	89.8	3.77	DS	20	0.96
E-17	Sunkosi No.3	GS630*As/Ag	100.0	3.75	None	100	6.00	100.5	100.0	5.25	20	0.90	40	2.40	100	4.50	20.0	69.2	2.08	1147.0	37.4	1.57	DS	20	0.96
C-08	Andhi Khola	GS415*As/Ag	100.0	3.75	None	100	6.00	280.5	100.0	5.25	20	0.90	20	1.20	100	4.50	8.0	87.7	2.63	450.3	82.2	3.45	FS	100	4.80
W-21	Thapna	GS269.5*As/Ag	100.0	3.75	None	100	6.00	204.9	100.0	5.25	60	2.70	40	2.40	100	4.50	1.0	98.5	2.95	1484.2	15.7	0.66	DS few data	0	0.00
W-25	Naumure (W. Rapti)	RH	0.0	0.00	None	100	6.00	191.5	100.0	5.25	100	4.50	0	0.00	0	0.00	34.0	47.7	1.43	594.5	72.9	3.06	Pre FS	60	2.88
W-10	Sharada - 2	RH	0.0	0.00	None	100	6.00	140.2	100.0	5.25	100	4.50	0	0.00	60	2.70	5.0	92.3	2.77	173.8	100.0	4.20	DS	20	0.96
E-12	Tama Koss-3	GS647	87.5	3.28	None	100	6.00	133.9	100.0	5.25	20	0.90	60	3.60	0	0.00	13.0	80.0	2.40	515.6	78.0	3.28	DS few data	0	0.00
C-02	Lower Badigad	RH	0.0	0.00	None	100	6.00	165.6	100.0	5.25	60	2.70	20	1.20	100	4.50	0.0	100.0	3.00	672.8	67.9	2.85	DS	20	0.96
C-11	Madi- Ishaneshor	GS438*As/Ag	98.3	3.69	None	100	6.00	160.9	100.0	5.25	20	0.90	40	2.40	40	1.80	3.0	95.4	2.86	190.3	98.9	4.16	FS	100	4.80
W-03	Chera-2	RH	0.0	0.00	None	100	6.00	111.3	100.0	5.25	20	0.90	40	2.40	80	3.60	2.5	96.2	2.88	283.5	92.9	3.90	DS	20	0.96
E-02	Dukh Koshi-2	GS670*As/Ag	100.0	3.75	High	0	0.00	77.3	54.7	2.87	20	0.90	40	2.40	100	4.50	35.0	46.2	1.38	979.7	48.2	2.02	DS	20	0.96
W-22	SR-6	GS260*As/Ag	98.3	3.69	None	100	6.00	186.8	100.0	5.25	20	0.90	40	2.40	80	3.60	17.0	73.8	2.22	1212.7	33.2	1.39	DS	20	0.96
W-01	Barbung Khola	RH	0.0	0.00	None	100	6.00	52.1	4.1	0.22	40	1.80	60	3.60	100	4.50	60.0	7.7	0.23	184.7	99.3	4.17	DS	20	0.96
E-06	Kokhajor-1	RH	0.0	0.00	None	100	6.00	353.8	100.0	5.25	100	4.50	0	0.00	20	0.90	22.0	66.2	1.98	324.0	90.3	3.79	DS	20	0.96
E-10	Rosi-2	RH	0.0	0.00	None	100	6.00	149.8	100.0	5.25	20	0.90	20	1.20	60	2.70	15.0	76.9	2.31	326.9	90.2	3.79	DS	20	0.96
W-11	Thuli Gad - 2	RH	0.0	0.00	None	100	6.00	126.9	100.0	5.25	60	2.70	0	0.00	20	0.90	10.0	84.6	2.54	221.3	96.9	4.07	DS	20	0.96
C-01	Kaligandaki-Modi	RH	0.0	0.00	Low	40	2.40	177.0	100.0	5.25	20	0.90	40	2.40	100	4.50	0.0	100.0	3.00	768.4	61.8	2.59	DS	20	0.96
E-20	Indrawati	RH	0.0	0.00	None	100	6.00	208.6	100.0	5.25	20	0.90	40	2.40	60	2.70	2.3	96.5	2.89	360.4	88.0	3.70	Pre FS	60	2.88
E-09	Piluwa-2	RH	0.0	0.00	None	100	6.00	363.5	100.0	5.25	20	0.90	40	2.40	100	4.50	40.0	38.5	1.15	275.4	93.5	3.93	DS	20	0.96
W-24	Sarada Babai	GS286	100.0	3.75	None	100	6.00	72.6	45.2	2.37	100	4.50	0	0.00	0	0.00	32.0	50.8	1.52	259.1	94.5	3.97	DS	20	0.96
W-17	BR-4	RH	0.0	0.00	None	100	6.00	197.1	100.0	5.25	20	0.90	40	2.40	60	2.70	1.0	98.5	2.95	1369.6	23.1	0.97	DS	20	0.96
C-18	Ridi Khola	RH	0.0	0.00	None	100	6.00	252.1	100.0	5.25	20	0.90	20	1.20	60	2.70	6.0	90.8	2.72	383.3	86.5	3.63	Preliminary	40	1.92
C-03	Lower Daraudi	RH	0.0	0.00	None	100	6.00	289.1	100.0	5.25	20	0.90	40	2.40	100	4.50	0.0	100.0	3.00	198.4	98.4	4.13	DS	20	0.96
C-05	Upper Daraudi	RH	0.0	0.00	None	100	6.00	317.3	100.0	5.25	20	0.90	40	2.40	40	1.80	15.0	76.9	2.31	444.5	82.6	3.47	DS	20	0.96
W-26	Lohare Khola	RH	0.0	0.00	None	100	6.00	155.0	100.0	5.25	20	0.90	40	2.40	60	2.70	5.0	92.3	2.77	218.9	97.1	4.08	Pre FS	60	2.88

Table 10.1.4.3-4 (2) Evaluation Score and Ranking of Case 1 (2/3)

Category		Technical and Economical Conditions (Cont.)												Impact on Environment											
Subcategory		Effectiveness of Project												Impact on Natural Environment											
Evaluation Item		Unit Generation Cost			Installed Capacity			Annual Energy Production			Energy Production in Dry Season			Impact on Forest				Impact on Protected Area (See Table 10.1.4.3-6)			Impact on Fishes			Impact on Conservation Species (See Table 10.1.4.3-7)		
Weight (%)				4.50			3.60			3.60			6.30				5.00			6.00			4.00			5.00
No.	Project Name	(USc/kWh)	Score	Weighted Score	(MW)	Score	Weighted Score	(GWh)	Score	Weighted Score	(GWh)	Score	Weighted Score	Inundated Forest Area (ha)	Forest Area / Installed Capacity (ha / MW)	Score	Weighted Score	Total Point	Score	Weighted Score	Numbers of Species	Score	Weighted Score	Total Point	Score	Weighted Score
W-06	Madi	6.14	75.6	3.40	199.8	100.0	3.60	642.9	32.1	1.16	256.43	32.1	2.02	214	1.07	91.3	4.57	1	66.7	4.00	0	100.0	4.00	7.0	100.0	5.00
W-05	Lower Jhimruk	6.85	71.8	3.23	142.5	100.0	3.60	456.3	22.8	0.82	163.37	20.4	1.29	196	1.38	88.6	4.43	1	66.7	4.00	0	100.0	4.00	13.0	45.5	2.27
W-23	Nalsyagu Gad	4.73	83.2	3.74	400.0	85.7	3.09	1285.5	64.3	2.31	462.90	57.9	3.65	41	0.10	100.0	5.00	1	66.7	4.00	10	0.0	0.00	14.0	36.4	1.82
W-20	Bhanakot	2.45	95.4	4.29	810.0	27.1	0.98	7042.2	100.0	3.60	4089.34	100.0	6.30	1,484	1.83	84.5	4.22	1	66.7	4.00	10	0.0	0.00	11.0	63.6	3.18
E-01	Dudh Koshi	4.46	84.6	3.81	300.0	100.0	3.60	1864.6	93.2	3.36	821.33	100.0	6.30	382	1.27	89.5	4.47	2	33.3	2.00	7	30.0	1.20	17.0	9.1	0.45
W-12	Tila - 1	4.79	82.9	3.73	617.2	54.7	1.97	2428.7	100.0	3.60	642.86	80.4	5.07	237	0.38	97.5	4.87	1	66.7	4.00	10	0.0	0.00	14.0	36.4	1.82
W-02	Chera-1	5.95	76.6	3.45	148.7	100.0	3.60	557.8	27.9	1.00	166.17	20.8	1.31	157	1.06	91.4	4.57	1	66.7	4.00	10	0.0	0.00	12.0	54.5	2.73
E-17	Sunkosi No.3	6.29	74.8	3.37	536.0	66.3	2.39	1824.8	91.2	3.28	461.90	57.7	3.64	519	0.97	92.2	4.61	2	33.3	2.00	7	30.0	1.20	17.0	9.1	0.45
C-08	Andhi Khola	6.96	71.2	3.20	180.0	100.0	3.60	646.9	32.3	1.16	207.10	25.9	1.63	254	1.41	88.2	4.41	3	0	0.00	10	0.0	0.00	18.0	0.0	0.00
W-21	Thapna	4.30	85.5	3.85	500.0	71.4	2.57	3450.5	100.0	3.60	1894.43	100.0	6.30	2,094	4.19	63.3	3.17	1	66.7	4.00	10	0.0	0.00	13.0	45.5	2.27
W-25	Naumure (W. Rapti)	5.10	81.2	3.65	245.0	100.0	3.60	1165.1	58.3	2.10	425.17	53.1	3.35	908	3.71	67.6	3.38	1	66.7	4.00	0	100.0	4.00	13.0	45.5	2.27
W-10	Sharada - 2	3.81	88.1	3.96	96.8	96.8	3.48	455.6	22.8	0.82	159.57	19.9	1.25	268	2.77	76.1	3.80	3	0	0.00	10	0.0	0.00	8.0	90.9	4.55
E-12	Tama Koss-3	3.89	87.7	3.95	287.0	100.0	3.60	1325.3	66.3	2.39	468.77	58.6	3.69	227	0.79	93.8	4.69	2	33.3	2.00	7	30.0	1.20	17.0	9.1	0.45
C-02	Lower Badigad	4.97	81.9	3.69	380.3	88.5	3.19	1354.4	67.7	2.44	486.81	60.9	3.84	376	0.99	92.0	4.60	3	0	0.00	10	0.0	0.00	13.0	45.5	2.27
C-11	Madi- Ishaneshor	4.84	82.6	3.72	86.0	86.0	3.10	393.3	19.7	0.71	103.52	12.9	0.81	154	1.79	84.8	4.24	3	0	0.00	10	0.0	0.00	17.0	9.1	0.45
W-03	Chera-2	7.04	70.8	3.19	104.3	100.0	3.60	402.6	20.1	0.72	117.68	14.7	0.93	351	3.37	70.7	3.54	1	66.7	4.00	10	0.0	0.00	13.0	45.5	2.27
E-02	Dukh Koshi-2	4.40	84.9	3.82	456.6	77.6	2.79	2225.5	100.0	3.60	617.48	77.2	4.86	209	0.46	96.8	4.84	2	33.3	2.00	7	30.0	1.20	17.0	9.1	0.45
W-22	SR-6	3.69	88.7	3.99	642.0	51.1	1.84	3284.1	100.0	3.60	1425.50	100.0	6.30	1,929	3.00	73.9	3.70	1	66.7	4.00	10	0.0	0.00	17.0	9.1	0.45
W-01	Barbung Khola	2.70	94.1	4.23	122.9	100.0	3.60	683.5	34.2	1.23	227.09	28.4	1.79	20	0.16	99.5	4.97	1	66.7	4.00	10	0.0	0.00	16.0	18.2	0.91
E-06	Kokhajor-1	11.97	44.4	2.00	111.5	100.0	3.60	270.7	13.5	0.49	124.11	15.5	0.98	546	4.90	56.9	2.85	0	100	6.00	3	70.0	2.80	17.0	9.1	0.45
E-10	Rosi-2	9.79	56.1	2.52	106.5	100.0	3.60	334.1	16.7	0.60	117.75	14.7	0.93	50	0.47	96.7	4.84	2	33.3	2.00	7	30.0	1.20	17.0	9.1	0.45
W-11	Thuli Gad - 2	4.31	85.4	3.84	119.7	100.0	3.60	513.5	25.7	0.93	157.86	19.7	1.24	170	1.42	88.2	4.41	1	66.7	4.00	10	0.0	0.00	18.0	0.0	0.00
C-01	Kaligandaki-Modi	2.21	96.7	4.35	816.4	26.2	0.94	3477.4	100.0	3.60	709.28	88.7	5.59	177	0.22	99.0	4.95	3	0	0.00	10	0.0	0.00	11.0	63.6	3.18
E-20	Indrawati	9.39	58.2	2.62	91.2	91.2	3.28	384.0	19.2	0.69	116.00	14.5	0.91	103	1.13	90.8	4.54	2	33.3	2.00	7	30.0	1.20	17.0	9.1	0.45
E-09	Piluwa-2	18.01	12.0	0.54	107.3	100.0	3.60	152.9	7.6	0.27	82.96	10.4	0.66	51	0.48	96.7	4.83	2	33.3	2.00	7	30.0	1.20	17.0	9.1	0.45
W-24	Sarada Babai	12.83	39.8	1.79	75.0	75.0	2.70	202.0	10.1	0.36	92.64	11.6	0.73	258	3.44	70.0	3.50	3	0	0.00	0	100.0	4.00	12.0	54.5	2.73
W-17	BR-4	4.13	86.4	3.89	667.0	47.6	1.71	3315.3	100.0	3.60	1479.84	100.0	6.30	3,548	5.32	53.2	2.66	1	66.7	4.00	10	0.0	0.00	13.0	45.5	2.27
C-18	Ridi Khola	15.01	28.1	1.26	97.0	97.0	3.49	255.3	12.8	0.46	133.65	16.7	1.05	410	4.23	63.0	3.15	3	0	0.00	10	0.0	0.00	13.0	45.5	2.27
C-03	Lower Daraudi	7.88	66.3	2.98	120.2	100.0	3.60	251.7	12.6	0.45	126.81	15.9	1.00	324	2.70	76.7	3.84	3	0	0.00	10	0.0	0.00	17.0	9.1	0.45
C-05	Upper Daraudi	20.42	-0.9	-0.04	111.4	100.0	3.60	217.7	10.9	0.39	116.72	14.6	0.92	140	1.26	89.6	4.48	3	0	0.00	10	0.0	0.00	17.0	9.1	0.45
W-26	Lohare Khola	7.48	68.4	3.08	67.0	67.0	2.41	292.7	14.6	0.53	100.92	12.6	0.79	753	11.24	0.0	0.00	1	66.7	4.00	10	0.0	0.00	12.0	54.5	2.73

Table 10.1.4.3-4 (3) Evaluation Score and Ranking of Case 1 (3/3)

Category		Impact on Environment (Cont.)																	
Subcategory		Impact on Social Environment																	
Evaluation Item		Impact on Locality by Construction of Transmission Line			Impact on Household			Impact on Agriculture				Impact on Ethnic Minority			Impact on Tourism (See Table 10.1.4.3-8)				
Weight (%)				4.00			5.00				4.00			4.00			3.00		100
No.	Project Name	Length (km)	Score	Weighted Score	Number of Inundated Household	Score	Weighted Score	Inundated Firm Land (ha)	Firm Land / Installed Capacity (ha / MW)	Score	Weighted Score	Number of ethnic minority groups	Score	Weighted Score	Number of Religious Asset and Trekking Route	Score	Weighted Score	Total Score	
W-06	Madi	43	81.4	3.26	162	94.9	4.74	266	1.33	86.8	3.47	5	80.8	3.23	0	100.0	3.00	73.17	73
W-05	Lower Jhimruk	54	65.7	2.63	186	94.1	4.71	210	1.47	85.2	3.41	3	88.5	3.54	0	100.0	3.00	68.89	69
W-23	Nalsyagu Gad	31	98.6	3.94	90	97.2	4.86	126	0.32	98.2	3.93	5	80.8	3.23	0	100.0	3.00	67.11	67
W-20	Bhanakot	110	0.0	0.00	361	88.6	4.43	1,078	1.33	86.8	3.47	5	80.8	3.23	1	90.0	2.70	66.15	66
E-01	Dudh Koshi	21	100.0	4.00	52	98.4	4.92	418	1.39	86.1	3.44	8	69.2	2.77	1	90.0	2.70	65.25	65
W-12	Tila - 1	86	20.0	0.80	44	98.6	4.93	208	0.34	97.9	3.92	0	100.0	4.00	0	100.0	3.00	65.00	65
W-02	Chera-1	51	70.0	2.80	75	97.6	4.88	97	0.65	94.4	3.78	10	61.5	2.46	0	100.0	3.00	64.11	64
E-17	Sunkosi No.3	27	100.0	4.00	343	89.2	4.46	978	1.82	81.2	3.25	11	57.7	2.31	5	50.0	1.50	63.87	64
C-08	Andhi Khola	38	88.6	3.54	97	96.9	4.85	158	0.88	91.9	3.67	9	65.4	2.62	1	90.0	2.70	63.86	64
W-21	Thapna	56	62.9	2.52	1,495	52.9	2.65	2,646	5.29	42.3	1.69	11	57.7	2.31	8	20.0	0.60	63.74	64
W-25	Naumure (W. Rapti)	68	45.7	1.83	615	80.6	4.03	613	2.50	73.6	2.94	9	65.4	2.62	1	90.0	2.70	63.59	64
W-10	Sharada - 2	23	100.0	4.00	154	95.1	4.76	142	1.47	85.2	3.41	0	100.0	4.00	0	100.0	3.00	63.41	63
E-12	Tama Koss-3	21	100.0	4.00	56	98.2	4.91	136	0.47	96.4	3.86	18	30.8	1.23	1	90.0	2.70	63.38	63
C-02	Lower Badigad	36	91.4	3.66	366	88.5	4.42	671	1.76	81.9	3.28	11	57.7	2.31	0	100.0	3.00	63.16	63
C-11	Madi- Ishaneshor	10	100.0	4.00	89	97.2	4.86	264	3.07	67.2	2.69	6	76.9	3.08	2	80.0	2.40	61.92	62
W-03	Chera-2	49	72.9	2.92	114	96.4	4.82	144	1.38	86.2	3.45	6	76.9	3.08	0	100.0	3.00	61.41	61
E-02	Dukh Koshi-2	15	100.0	4.00	71	97.8	4.89	225	0.49	96.2	3.85	7	73.1	2.92	0	100.0	3.00	61.00	61
W-22	SR-6	25	100.0	4.00	1,291	59.3	2.97	1,431	2.23	76.7	3.07	26	0.0	0.00	9	10.0	0.30	60.63	61
W-01	Barbung Khola	67	47.1	1.88	0	100.0	5.00	19	0.15	100.0	4.00	2	92.3	3.69	0	100.0	3.00	59.78	60
E-06	Kokhajor-1	51	70.0	2.80	102	96.8	4.84	130	1.17	88.6	3.55	8	69.2	2.77	0	100.0	3.00	59.51	60
E-10	Rosi-2	32	97.1	3.88	125	96.1	4.80	151	1.42	85.8	3.43	2	92.3	3.69	0	100.0	3.00	58.05	58
W-11	Thuli Gad - 2	42	82.9	3.32	108	96.6	4.83	159	1.33	86.8	3.47	3	88.5	3.54	2	80.0	2.40	58.00	58
C-01	Kaligandaki-Modi	11	100.0	4.00	436	86.3	4.31	549	0.67	94.2	3.77	19	26.9	1.08	10	0.0	0.00	57.77	58
E-20	Indrawati	15	100.0	4.00	179	94.4	4.72	521	5.71	37.5	1.50	11	57.7	2.31	1	90.0	2.70	57.64	58
E-09	Piluwa-2	5	100.0	4.00	13	99.6	4.98	49	0.46	96.6	3.86	8	69.2	2.77	1	90.0	2.70	56.95	57
W-24	Sarada Babai	32	97.1	3.88	359	88.7	4.43	369	4.92	46.4	1.86	3	88.5	3.54	2	80.0	2.40	54.99	55
W-17	BR-4	51	70.0	2.80	3,175	0.0	0.00	3,565	5.34	41.7	1.67	13	50.0	2.00	9	10.0	0.30	53.33	53
C-18	Ridi Khola	35	92.9	3.72	51	98.4	4.92	429	4.42	52.0	2.08	7	73.1	2.92	0	100.0	3.00	52.64	53
C-03	Lower Daraudi	9	100.0	4.00	677	78.7	3.93	1,088	9.05	0.0	0.00	14	46.2	1.85	1	90.0	2.70	51.94	52
C-05	Upper Daraudi	18	100.0	4.00	72	97.7	4.89	174	1.56	84.2	3.37	5	80.8	3.23	0	100.0	3.00	51.38	51
W-26	Lohare Khola	92	11.4	0.46	243	92.3	4.62	422	6.30	30.9	1.24	9	65.4	2.62	4	60.0	1.80	51.26	51

Table 10.1.4.3-5 (1) Evaluation Score and Ranking of Case 2 (1/3)

Category		Technical and Economical Conditions																						
Subcategory		Hydrological Conditions									Geological Conditions (See Table 10.1.4.1-5)						Lead Time							
Evaluation Item		Reliability of Flow Data			Risk of GLOF			Sedimentation			Seismicity		Geological Condition of Site		Natural Hazard (Earthquake)		Length of Access Road			Difficulty Level of Financing			Reliability of Development Plan		
Weight (%)			2.50			4.00			3.50			3.00		4.00		3.00		2.00			2.80			3.20	
No.	Project Name	Calculation Method	Score	Weighted Score	Risk	Score	Weighted Score	Life Time of Reservoir	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Length (km)	Score	Weighted Score	2012 Project Cost (MUSD)	Score	Weighted Score	Study Level	Score	Weighted Score
W-06	Madi	RH	0.0	0.00	None	100	4.00	202.0	100.0	3.50	60	1.80	40	1.60	100	3.00	15.0	76.9	1.54	394.5	85.8	2.40	DS	20	0.64
W-05	Lower Jhimruk	GS330*As/Ag	100.0	2.50	None	100	4.00	146.9	100.0	3.50	60	1.80	40	1.60	20	0.60	18.0	72.3	1.45	312.4	91.1	2.55	DS	20	0.64
W-23	Nalsyagu Gad	RH	0.0	0.00	None	100	4.00	149.5	100.0	3.50	20	0.60	20	0.80	60	1.80	30.0	53.8	1.08	607.5	72.1	2.02	FS ongoing	80	2.56
W-02	Chera-1	RH	0.0	0.00	None	100	4.00	119.3	100.0	3.50	20	0.60	40	1.60	100	3.00	5.5	91.5	1.83	332.2	89.8	2.51	DS	20	0.64
W-12	Tila - 1	GS225*As/Ag	100.0	2.50	None	100	4.00	65.5	31.1	1.09	20	0.60	60	2.40	100	3.00	56.0	13.8	0.28	1163.8	36.3	1.02	DS	20	0.64
W-25	Naumure (W. Rapti)	RH	0.0	0.00	None	100	4.00	191.5	100.0	3.50	100	3.00	0	0.00	0	0.00	34.0	47.7	0.95	594.5	72.9	2.04	Pre FS	60	1.92
W-10	Sharada - 2	RH	0.0	0.00	None	100	4.00	140.2	100.0	3.50	100	3.00	0	0.00	60	1.80	5.0	92.3	1.85	173.8	100.0	2.80	DS	20	0.64
W-20	Bhanakot	GS240*As/Ag	100.0	2.50	None	100	4.00	144.3	100.0	3.50	20	0.60	40	1.60	100	3.00	1.0	98.5	1.97	1728.8	0.0	0.00	DS few data	0	0.00
E-01	Dudh Koshi	GS670	100.0	2.50	High	0	0.00	145.4	100.0	3.50	20	0.60	40	1.60	60	1.80	65.0	0.0	0.00	830.8	57.7	1.62	FS	100	3.20
E-06	Kokhajor-1	RH	0.0	0.00	None	100	4.00	353.8	100.0	3.50	100	3.00	0	0.00	20	0.60	22.0	66.2	1.32	324.0	90.3	2.53	DS	20	0.64
W-03	Chera-2	RH	0.0	0.00	None	100	4.00	111.3	100.0	3.50	20	0.60	40	1.60	80	2.40	2.5	96.2	1.92	283.5	92.9	2.60	DS	20	0.64
E-02	Dukh Koshi-2	GS670*As/Ag	100.0	2.50	High	0	0.00	77.3	54.7	1.91	20	0.60	40	1.60	100	3.00	35.0	46.2	0.92	979.7	48.2	1.35	DS	20	0.64
E-12	Tama Koss-3	GS647	87.5	2.19	None	100	4.00	133.9	100.0	3.50	20	0.60	60	2.40	0	0.00	13.0	80.0	1.60	515.6	78.0	2.18	DS few data	0	0.00
W-01	Barbung Khola	RH	0.0	0.00	None	100	4.00	52.1	4.1	0.14	40	1.20	60	2.40	100	3.00	60.0	7.7	0.15	184.7	99.3	2.78	DS	20	0.64
E-17	Sunkosi No.3	GS630*As/Ag	100.0	2.50	None	100	4.00	100.5	100.0	3.50	20	0.60	40	1.60	100	3.00	20.0	69.2	1.38	1147.0	37.4	1.05	DS	20	0.64
C-02	Lower Badigad	RH	0.0	0.00	None	100	4.00	165.6	100.0	3.50	60	1.80	20	0.80	100	3.00	0.0	100.0	2.00	672.8	67.9	1.90	DS	20	0.64
E-10	Rosi-2	RH	0.0	0.00	None	100	4.00	149.8	100.0	3.50	20	0.60	20	0.80	60	1.80	15.0	76.9	1.54	326.9	90.2	2.52	DS	20	0.64
C-08	Andhi Khola	GS415*As/Ag	100.0	2.50	None	100	4.00	280.5	100.0	3.50	20	0.60	20	0.80	100	3.00	8.0	87.7	1.75	450.3	82.2	2.30	FS	100	3.20
E-09	Piluwa-2	RH	0.0	0.00	None	100	4.00	363.5	100.0	3.50	20	0.60	40	1.60	100	3.00	40.0	38.5	0.77	275.4	93.5	2.62	DS	20	0.64
W-11	Thuli Gad - 2	RH	0.0	0.00	None	100	4.00	126.9	100.0	3.50	60	1.80	0	0.00	20	0.60	10.0	84.6	1.69	221.3	96.9	2.71	DS	20	0.64
C-11	Madi- Ishaneshor	GS438*As/Ag	98.3	2.46	None	100	4.00	160.9	100.0	3.50	20	0.60	40	1.60	40	1.20	3.0	95.4	1.91	190.3	98.9	2.77	FS	100	3.20
W-24	Sarada Babai	GS286	100.0	2.50	None	100	4.00	72.6	45.2	1.58	100	3.00	0	0.00	0	0.00	32.0	50.8	1.02	259.1	94.5	2.65	DS	20	0.64
W-21	Thapna	GS269.5*As/Ag	100.0	2.50	None	100	4.00	204.9	100.0	3.50	60	1.80	40	1.60	100	3.00	1.0	98.5	1.97	1484.2	15.7	0.44	DS few data	0	0.00
E-20	Indrawati	RH	0.0	0.00	None	100	4.00	208.6	100.0	3.50	20	0.60	40	1.60	60	1.80	2.3	96.5	1.93	360.4	88.0	2.46	Pre FS	60	1.92
C-01	Kaligandaki-Modi	RH	0.0	0.00	Low	40	1.60	177.0	100.0	3.50	20	0.60	40	1.60	100	3.00	0.0	100.0	2.00	768.4	61.8	1.73	DS	20	0.64
W-22	SR-6	GS260*As/Ag	98.3	2.46	None	100	4.00	186.8	100.0	3.50	20	0.60	40	1.60	80	2.40	17.0	73.8	1.48	1212.7	33.2	0.93	DS	20	0.64
C-05	Upper Daraudi	RH	0.0	0.00	None	100	4.00	317.3	100.0	3.50	20	0.60	40	1.60	40	1.20	15.0	76.9	1.54	444.5	82.6	2.31	DS	20	0.64
C-18	Ridi Khola	RH	0.0	0.00	None	100	4.00	252.1	100.0	3.50	20	0.60	20	0.80	60	1.80	6.0	90.8	1.82	383.3	86.5	2.42	Preliminary	40	1.28
W-26	Lohare Khola	RH	0.0	0.00	None	100	4.00	155.0	100.0	3.50	20	0.60	40	1.60	60	1.80	5.0	92.3	1.85	218.9	97.1	2.72	Pre FS	60	1.92
W-17	BR-4	RH	0.0	0.00	None	100	4.00	197.1	100.0	3.50	20	0.60	40	1.60	60	1.80	1.0	98.5	1.97	1369.6	23.1	0.65	DS	20	0.64
C-03	Lower Daraudi	RH	0.0	0.00	None	100	4.00	289.1	100.0	3.50	20	0.60	40	1.60	100	3.00	0.0	100.0	2.00	198.4	98.4	2.76	DS	20	0.64

Table 10.1.4.3-5 (2) Evaluation Score and Ranking of Case 2 (2/3)

Category		Technical and Economical Conditions (Cont.)												Impact on Environment											
Subcategory		Effectiveness of Project												Impact on Natural Environment											
Evaluation Item		Unit Generation Cost			Installed Capacity			Annual Energy Production			Energy Production in Dry Season			Impact on Forest				Impact on Protected Area (See Table 10.1.4.3-6)			Impact on Fishes			Impact on Conservation Species (See Table 10.1.4.3-7)		
Weight (%)				3.00			2.40			2.40			4.20				7.50				9.00			6.00			7.50
No.	Project Name	(USc/kWh)	Score	Weighted Score	(MW)	Score	Weighted Score	(GWh)	Score	Weighted Score	(GWh)	Score	Weighted Score	Inundated Forest Area (ha)	Forest Area / Installed Capacity (ha / MW)	Score	Weighted Score	Total Point	Score	Weighted Score	Numbers of Species	Score	Weighted Score	Total Point	Score	Weighted Score
W-06	Madi	6.14	75.6	2.27	199.8	100.0	2.40	642.9	32.1	0.77	256.43	32.1	1.35	214	1.07	91.3	6.85	1	66.7	6.00	0	100.0	6.00	7.0	100.0	7.50
W-05	Lower Jhimruk	6.85	71.8	2.15	142.5	100.0	2.40	456.3	22.8	0.55	163.37	20.4	0.86	196	1.38	88.6	6.64	1	66.7	6.00	0	100.0	6.00	13.0	45.5	3.41
W-23	Nalsyagu Gad	4.73	83.2	2.50	400.0	85.7	2.06	1285.5	64.3	1.54	462.90	57.9	2.43	41	0.10	100.0	7.50	1	66.7	6.00	10	0.0	0.00	14.0	36.4	2.73
W-02	Chera-1	5.95	76.6	2.30	148.7	100.0	2.40	557.8	27.9	0.67	166.17	20.8	0.87	157	1.06	91.4	6.86	1	66.7	6.00	10	0.0	0.00	12.0	54.5	4.09
W-12	Tila - 1	4.79	82.9	2.49	617.2	54.7	1.31	2428.7	100.0	2.40	642.86	80.4	3.38	237	0.38	97.5	7.31	1	66.7	6.00	10	0.0	0.00	14.0	36.4	2.73
W-25	Naumure (W. Rapti)	5.10	81.2	2.44	245.0	100.0	2.40	1165.1	58.3	1.40	425.17	53.1	2.23	908	3.71	67.6	5.07	1	66.7	6.00	0	100.0	6.00	13.0	45.5	3.41
W-10	Sharada - 2	3.81	88.1	2.64	96.8	96.8	2.32	455.6	22.8	0.55	159.57	19.9	0.84	268	2.77	76.1	5.70	3	0	0.00	10	0.0	0.00	8.0	90.9	6.82
W-20	Bhanakot	2.45	95.4	2.86	810.0	27.1	0.65	7042.2	100.0	2.40	4089.34	100.0	4.20	1,484	1.83	84.5	6.34	1	66.7	6.00	10	0.0	0.00	11.0	63.6	4.77
E-01	Dudh Koshi	4.46	84.6	2.54	300.0	100.0	2.40	1864.6	93.2	2.24	821.33	100.0	4.20	382	1.27	89.5	6.71	2	33.3	3.00	7	30.0	1.80	17.0	9.1	0.68
E-06	Kokhajor-1	11.97	44.4	1.33	111.5	100.0	2.40	270.7	13.5	0.32	124.11	15.5	0.65	546	4.90	56.9	4.27	0	100	9.00	3	70.0	4.20	17.0	9.1	0.68
W-03	Chera-2	7.04	70.8	2.12	104.3	100.0	2.40	402.6	20.1	0.48	117.68	14.7	0.62	351	3.37	70.7	5.30	1	66.7	6.00	10	0.0	0.00	13.0	45.5	3.41
E-02	Dukh Koshi-2	4.40	84.9	2.55	456.6	77.6	1.86	2225.5	100.0	2.40	617.48	77.2	3.24	209	0.46	96.8	7.26	2	33.3	3.00	7	30.0	1.80	17.0	9.1	0.68
E-12	Tama Koss-3	3.89	87.7	2.63	287.0	100.0	2.40	1325.3	66.3	1.59	468.77	58.6	2.46	227	0.79	93.8	7.04	2	33.3	3.00	7	30.0	1.80	17.0	9.1	0.68
W-01	Barbung Khola	2.70	94.1	2.82	122.9	100.0	2.40	683.5	34.2	0.82	227.09	28.4	1.19	20	0.16	99.5	7.46	1	66.7	6.00	10	0.0	0.00	16.0	18.2	1.36
E-17	Sunkosi No.3	6.29	74.8	2.24	536.0	66.3	1.59	1824.8	91.2	2.19	461.90	57.7	2.42	519	0.97	92.2	6.92	2	33.3	3.00	7	30.0	1.80	17.0	9.1	0.68
C-02	Lower Badigad	4.97	81.9	2.46	380.3	88.5	2.12	1354.4	67.7	1.62	486.81	60.9	2.56	376	0.99	92.0	6.90	3	0	0.00	10	0.0	0.00	13.0	45.5	3.41
E-10	Rosi-2	9.79	56.1	1.68	106.5	100.0	2.40	334.1	16.7	0.40	117.75	14.7	0.62	50	0.47	96.7	7.25	2	33.3	3.00	7	30.0	1.80	17.0	9.1	0.68
C-08	Andhi Khola	6.96	71.2	2.14	180.0	100.0	2.40	646.9	32.3	0.78	207.10	25.9	1.09	254	1.41	88.2	6.62	3	0	0.00	10	0.0	0.00	18.0	0.0	0.00
E-09	Piluwa-2	18.01	12.0	0.36	107.3	100.0	2.40	152.9	7.6	0.18	82.96	10.4	0.44	51	0.48	96.7	7.25	2	33.3	3.00	7	30.0	1.80	17.0	9.1	0.68
W-11	Thuli Gad - 2	4.31	85.4	2.56	119.7	100.0	2.40	513.5	25.7	0.62	157.86	19.7	0.83	170	1.42	88.2	6.61	1	66.7	6.00	10	0.0	0.00	18.0	0.0	0.00
C-11	Madi- Ishaneshor	4.84	82.6	2.48	86.0	86.0	2.06	393.3	19.7	0.47	103.52	12.9	0.54	154	1.79	84.8	6.36	3	0	0.00	10	0.0	0.00	17.0	9.1	0.68
W-24	Sarada Babai	12.83	39.8	1.19	75.0	75.0	1.80	202.0	10.1	0.24	92.64	11.6	0.49	258	3.44	70.0	5.25	3	0	0.00	0	100.0	6.00	12.0	54.5	4.09
W-21	Thapna	4.30	85.5	2.57	500.0	71.4	1.71	3450.5	100.0	2.40	1894.43	100.0	4.20	2,094	4.19	63.3	4.75	1	66.7	6.00	10	0.0	0.00	13.0	45.5	3.41
E-20	Indrawati	9.39	58.2	1.75	91.2	91.2	2.19	384.0	19.2	0.46	116.00	14.5	0.61	103	1.13	90.8	6.81	2	33.3	3.00	7	30.0	1.80	17.0	9.1	0.68
C-01	Kaligandaki-Modi	2.21	96.7	2.90	816.4	26.2	0.63	3477.4	100.0	2.40	709.28	88.7	3.73	177	0.22	99.0	7.42	3	0	0.00	10	0.0	0.00	11.0	63.6	4.77
W-22	SR-6	3.69	88.7	2.66	642.0	51.1	1.23	3284.1	100.0	2.40	1425.50	100.0	4.20	1,929	3.00	73.9	5.55	1	66.7	6.00	10	0.0	0.00	17.0	9.1	0.68
C-05	Upper Daraudi	20.42	-0.9	-0.03	111.4	100.0	2.40	217.7	10.9	0.26	116.72	14.6	0.61	140	1.26	89.6	6.72	3	0	0.00	10	0.0	0.00	17.0	9.1	0.68
C-18	Ridi Khola	15.01	28.1	0.84	97.0	97.0	2.33	255.3	12.8	0.31	133.65	16.7	0.70	410	4.23	63.0	4.72	3	0	0.00	10	0.0	0.00	13.0	45.5	3.41
W-26	Lohare Khola	7.48	68.4	2.05	67.0	67.0	1.61	292.7	14.6	0.35	100.92	12.6	0.53	753	11.24	0.0	0.00	1	66.7	6.00	10	0.0	0.00	12.0	54.5	4.09
W-17	BR-4	4.13	86.4	2.59	667.0	47.6	1.14	3315.3	100.0	2.40	1479.84	100.0	4.20	3,548	5.32	53.2	3.99	1	66.7	6.00	10	0.0	0.00	13.0	45.5	3.41
C-03	Lower Daraudi	7.88	66.3	1.99	120.2	100.0	2.40	251.7	12.6	0.30	126.81	15.9	0.67	324	2.70	76.7	5.75	3	0	0.00	10	0.0	0.00	17.0	9.1	0.68

Table 10.1.4.3-5 (3) Evaluation Score and Ranking of Case 2 (3/3)

Category		Impact on Environment (Cont.)																	
Subcategory		Impact on Social Environment																	
Evaluation Item		Impact on Locality by Construction of Transmission Line			Impact on Household			Impact on Agriculture				Impact on Ethnic Minority			Impact on Tourism (See Table 10.1.4.3-8)				
Weight (%)				6.00			7.50				6.00			6.00			4.50		100
No.	Project Name	Length (km)	Score	Weighted Score	Number of Inundated Household	Score	Weighted Score	Inundated Firm Land (ha)	Firm Land / Installed Capacity (ha / MW)	Score	Weighted Score	Number of ethnic minority groups	Score	Weighted Score	Number of Religious Asset and Trekking Route	Score	Weighted Score	Total Score	
W-06	Madi	43	81.4	4.88	162	94.9	7.12	266	1.33	86.8	5.21	5	80.8	4.85	0	100.0	4.50	78.18	78
W-05	Lower Jhimruk	54	65.7	3.94	186	94.1	7.06	210	1.47	85.2	5.11	3	88.5	5.31	0	100.0	4.50	72.57	73
W-23	Nalsyagu Gad	31	98.6	5.92	90	97.2	7.29	126	0.32	98.2	5.89	5	80.8	4.85	0	100.0	4.50	69.57	70
W-02	Chera-1	51	70.0	4.20	75	97.6	7.32	97	0.65	94.4	5.66	10	61.5	3.69	0	100.0	4.50	66.24	66
W-12	Tila - 1	86	20.0	1.20	44	98.6	7.40	208	0.34	97.9	5.88	0	100.0	6.00	0	100.0	4.50	66.13	66
W-25	Naumure (W. Rapti)	68	45.7	2.74	615	80.6	6.05	613	2.50	73.6	4.42	9	65.4	3.92	1	90.0	4.05	65.54	66
W-10	Sharada - 2	23	100.0	6.00	154	95.1	7.14	142	1.47	85.2	5.11	0	100.0	6.00	0	100.0	4.50	65.21	65
W-20	Bhanakot	110	0.0	0.00	361	88.6	6.65	1,078	1.33	86.8	5.21	5	80.8	4.85	1	90.0	4.05	65.15	65
E-01	Dudh Koshi	21	100.0	6.00	52	98.4	7.38	418	1.39	86.1	5.16	8	69.2	4.15	1	90.0	4.05	65.13	65
E-06	Kokhajor-1	51	70.0	4.20	102	96.8	7.26	130	1.17	88.6	5.32	8	69.2	4.15	0	100.0	4.50	63.87	64
W-03	Chera-2	49	72.9	4.37	114	96.4	7.23	144	1.38	86.2	5.17	6	76.9	4.62	0	100.0	4.50	63.48	63
E-02	Dukh Koshi-2	15	100.0	6.00	71	97.8	7.33	225	0.49	96.2	5.77	7	73.1	4.38	0	100.0	4.50	63.29	63
E-12	Tama Koss-3	21	100.0	6.00	56	98.2	7.37	136	0.47	96.4	5.78	18	30.8	1.85	1	90.0	4.05	63.12	63
W-01	Barbung Khola	67	47.1	2.83	0	100.0	7.50	19	0.15	100.0	6.00	2	92.3	5.54	0	100.0	4.50	62.73	63
E-17	Sunkosi No.3	27	100.0	6.00	343	89.2	6.69	978	1.82	81.2	4.87	11	57.7	3.46	5	50.0	2.25	62.38	62
C-02	Lower Badigad	36	91.4	5.48	366	88.5	6.64	671	1.76	81.9	4.91	11	57.7	3.46	0	100.0	4.50	61.70	62
E-10	Rosi-2	32	97.1	5.83	125	96.1	7.20	151	1.42	85.8	5.15	2	92.3	5.54	0	100.0	4.50	61.45	61
C-08	Andhi Khola	38	88.6	5.32	97	96.9	7.27	158	0.88	91.9	5.51	9	65.4	3.92	1	90.0	4.05	60.75	61
E-09	Piluwa-2	5	100.0	6.00	13	99.6	7.47	49	0.46	96.6	5.80	8	69.2	4.15	1	90.0	4.05	60.31	60
W-11	Thuli Gad - 2	42	82.9	4.97	108	96.6	7.24	159	1.33	86.8	5.21	3	88.5	5.31	2	80.0	3.60	60.29	60
C-11	Madi- Ishaneshor	10	100.0	6.00	89	97.2	7.29	264	3.07	67.2	4.03	6	76.9	4.62	2	80.0	3.60	59.37	59
W-24	Sarada Babai	32	97.1	5.83	359	88.7	6.65	369	4.92	46.4	2.79	3	88.5	5.31	2	80.0	3.60	58.63	59
W-21	Thapna	56	62.9	3.77	1,495	52.9	3.97	2,646	5.29	42.3	2.54	11	57.7	3.46	8	20.0	0.90	58.49	58
E-20	Indrawati	15	100.0	6.00	179	94.4	7.08	521	5.71	37.5	2.25	11	57.7	3.46	1	90.0	4.05	57.95	58
C-01	Kaligandaki-Modi	11	100.0	6.00	436	86.3	6.47	549	0.67	94.2	5.65	19	26.9	1.62	10	0.0	0.00	56.26	56
W-22	SR-6	25	100.0	6.00	1,291	59.3	4.45	1,431	2.23	76.7	4.60	26	0.0	0.00	9	10.0	0.45	55.83	56
C-05	Upper Daraudi	18	100.0	6.00	72	97.7	7.33	174	1.56	84.2	5.05	5	80.8	4.85	0	100.0	4.50	53.76	54
C-18	Ridi Khola	35	92.9	5.57	51	98.4	7.38	429	4.42	52.0	3.12	7	73.1	4.38	0	100.0	4.50	53.48	53
W-26	Lohare Khola	92	11.4	0.68	243	92.3	6.93	422	6.30	30.9	1.86	9	65.4	3.92	4	60.0	2.70	48.71	49
W-17	BR-4	51	70.0	4.20	3,175	0.0	0.00	3,565	5.34	41.7	2.50	13	50.0	3.00	9	10.0	0.45	48.64	49
C-03	Lower Daraudi	9	100.0	6.00	677	78.7	5.90	1,088	9.05	0.0	0.00	14	46.2	2.77	1	90.0	4.05	48.61	49

Table 10.1.4.3-6 Impact on Protected Areas

No.	Project Name	World Heritage	National Park	National Park (Buffer Zone)	Wildlife Reserve	Ramsar	Key Biodiversity Area	Total Point
E-01	Dudh Koshi				1	1		2
E-02	Dukh Koshi-2				1	1		2
E-06	Kokhajor-1							0
E-09	Piluwa-2				1	1		2
E-10	Rosi-2				1	1		2
E-12	Tama Koss-3				1	1		2
E-17	Sunkosi No.3				1	1		2
E-20	Indrawati				1	1		2
C-01	Kaligandaki-Modi	1	1	1				3
C-02	Lower Badigad	1	1	1				3
C-03	Lower Daraudi	1	1	1				3
C-05	Upper Daraudi	1	1	1				3
C-08	Andhi Khola	1	1	1				3
C-11	Madi-Ishaneshor	1	1	1				3
C-18	Ridi Khola	1	1	1				3
W-01	Barbung Khola			1				1
W-02	Chera-1			1				1
W-03	Chera-2			1				1
W-05	Lower Jhimruk			1				1
W-06	Madi			1				1
W-10	Sharada-2		1	1			2	3
W-11	Thuli Gad-2			1				1
W-12	Tila-1			1				1
W-17	BR-4			1				1
W-20	Bhanakot			1				1
W-21	Thapna			1				1
W-22	SR-6			1				1
W-23	Nalsyagu Gad			1				1
W-24	Sarada Babai		1	1			2	3
W-25	Naumure (W. Rapti)			1				1
W-26	Lohare Khola			1				1

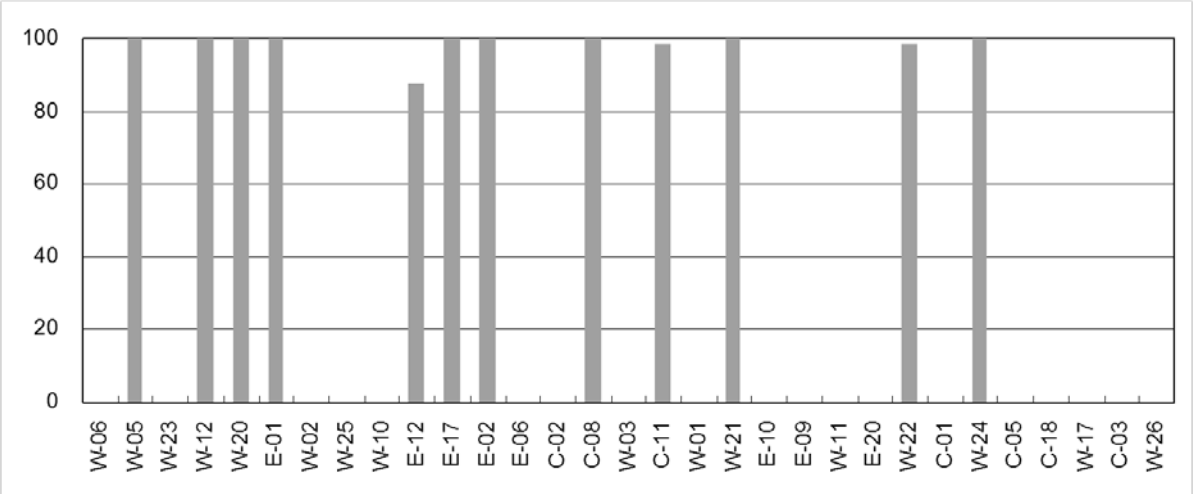
Table 10.1.4.3-7 Impact on Conservation Species

No.	Project Name	Panthera tigris (EN)		Lutra lutra (NT)		Macaca assamensis (NT)		Panthera pardus (NT)		Melursus ursinus (VU)		Neofelis nebulosa (VU)		Ursus thibetanus (VU)		Total Point
		Habitat	Point	Habitat	Point	Habitat	Point	Habitat	Point	Habitat	Point	Habitat	Point	Habitat	Point	
E-01	Dudh Koshi			1	5	1	5					1	5	5	2	17
E-02	Dukh Koshi-2			1	5	1	5					1	5	5	2	17
E-06	Kokhajor-1			1	5	1	5					1	5	5	2	17
E-09	Piluwa-2			1	5	1	5					1	5	5	2	17
E-10	Rosi-2			1	5	1	5					1	5	5	2	17
E-12	Tama Koss-3			1	5	1	5					1	5	5	2	17
E-17	Sunkosi No.3			1	5	1	5					1	5	5	2	17
E-20	Indrawati			1	5	1	5					1	5	5	2	17
C-01	Kaligandaki-Modi			1	5	1	5							6	1	11
C-02	Lower Badigad			1	5	1	5			5	1			5	2	13
C-03	Lower Daraudi			1	5	1	5					1	5	5	2	17
C-05	Upper Daraudi			1	5	1	5					1	5	5	2	17
C-08	Andhi Khola			1	5	1	5			5	1	1	5	5	2	18
C-11	Madi-Ishaneshor			1	5	1	5					1	5	5	2	17
C-18	Ridi Khola			1	5	1	5			5	1			5	2	13
W-01	Barbung Khola			1	5	1	5	1	5					6	1	16
W-02	Chera-1			1	5	1	5			5	1			6	1	12
W-03	Chera-2			1	5	1	5			5	1			5	2	13
W-05	Lower Jhimruk			1	5	1	5			5	1			5	2	13
W-06	Madi			1	5					5	1			6	1	7
W-10	Sharada-2	1	5							5	1			5	2	8
W-11	Thuli Gad-2	1	5	1	5	1	5			5	1			5	2	18
W-12	Tila-1			1	5	1	5							2	4	14
W-17	BR-4			1	5	1	5			5	1			5	2	13
W-20	Bhanakot			1	5	1	5							6	1	11
W-21	Thapna			1	5	1	5			5	1			5	2	13
W-22	SR-6	1	5	1	5	1	5							5	2	17
W-23	Nalsyagu Gad			1	5	1	5							2	4	14
W-24	Sarada Babai	1	5							1	5			5	2	12
W-25	Naumure (W. Rapti)	1	5	1	5					5	1			5	2	13
W-26	Lohare Khola			1	5	1	5			5	1			6	1	12

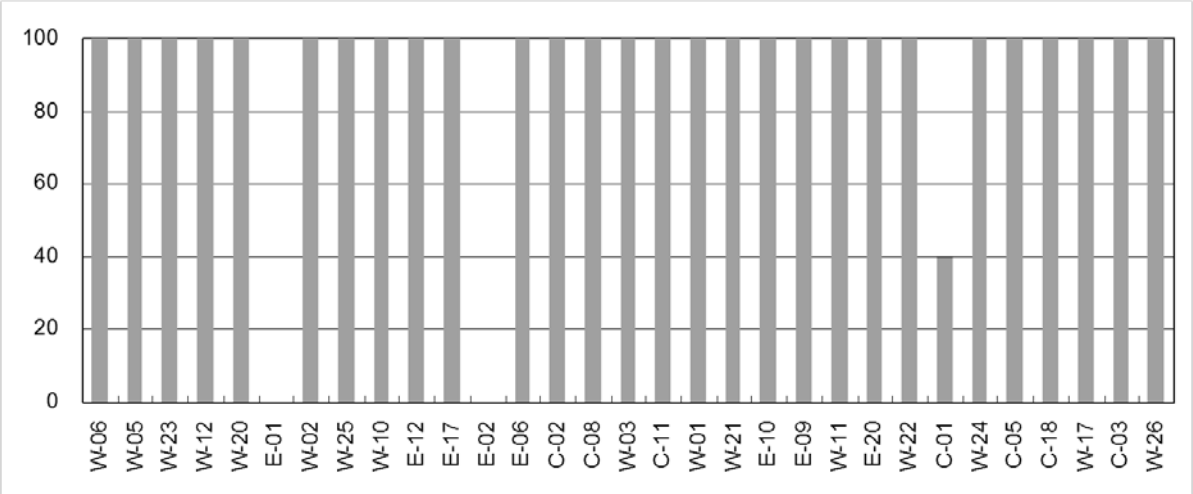
Table 10.1.4.3-8 Impact on Tourism

No.	Project Name	Church	Monument	Mosque	Temple	Trecking	Total
E-01	Dudh Koshi				1		1
E-02	Dukh Koshi-2						0
E-06	Kokhajor-1						0
E-09	Piluwa-2				1		1
E-10	Rosi-2						0
E-12	Tama Koss-3				1		1
E-17	Sunkosi No.3				5		5
E-20	Indrawati				1		1
C-01	Kaligandaki-Modi				10		10
C-02	Lower Badigad						0
C-03	Lower Daraudi				1		1
C-05	Upper Daraudi						0
C-08	Andhi Khola				1		1
C-11	Madi- Ishaneshor				2		2
C-18	Ridi Khola						0
W-01	Barbung Khola						0
W-02	Chera-1						0
W-03	Chera-2						0
W-05	Lower Jhimruk						0
W-06	Madi						0
W-10	Sharada-2						0
W-11	Thuli Gad - 2		1		1		2
W-12	Tila-1						0
W-17	BR-4				9		9
W-20	Bhanakot				1		1
W-21	Thapna				8		8
W-22	SR-6				9		9
W-23	Nalsyagu Gad						0
W-24	Sarada Babai				2		2
W-25	Naumure (W. Papti)				1		1
W-26	Lohare Khola				3	1	4

Reliability of flow data (Score)



Risk of a GLOF (Score)



Sedimentation (Life Time of a reservoir: year)

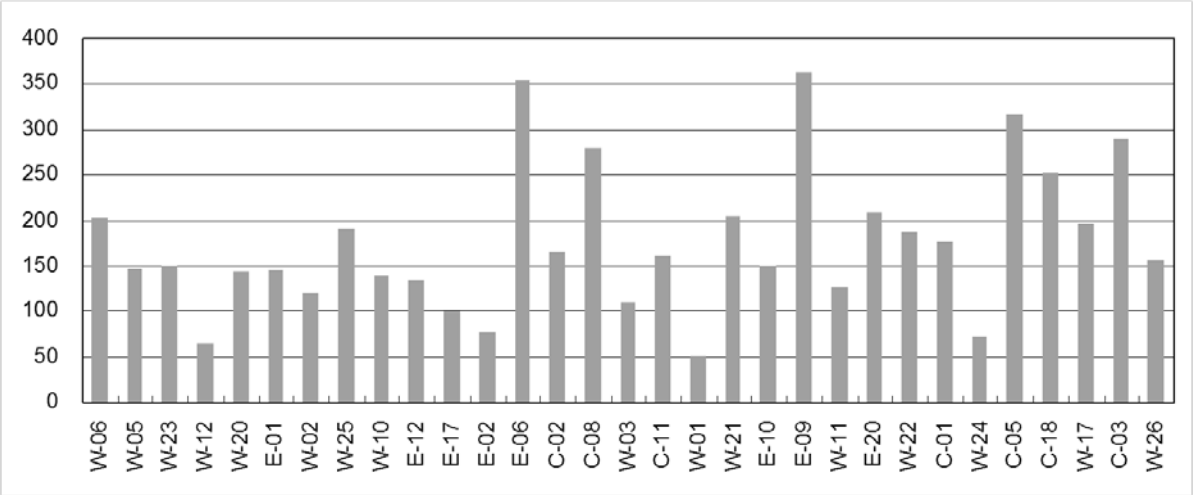
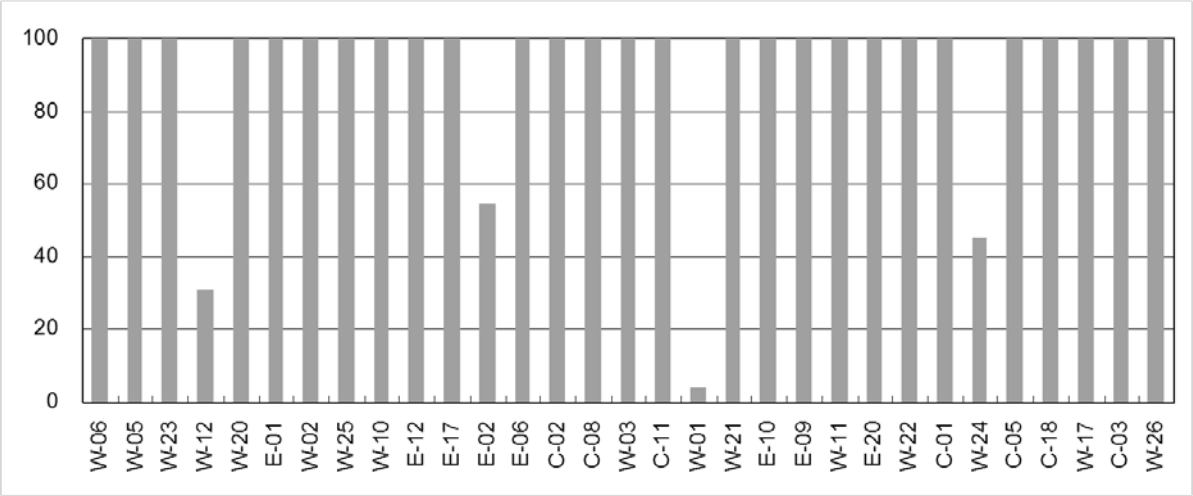
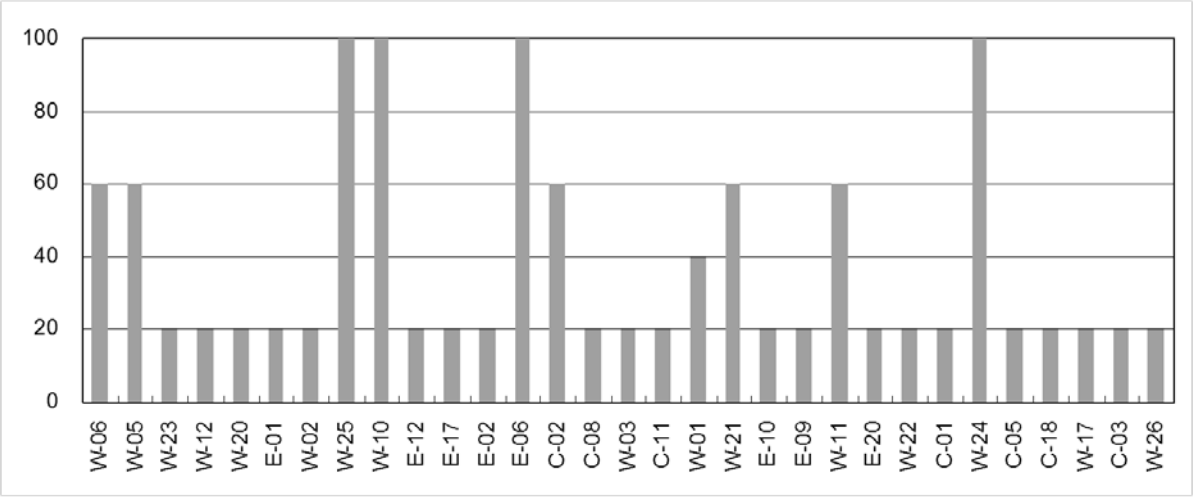


Figure 10.1.4.3-1 Evaluation Score of Each Project (before weighting) (1/13)

Sedimentation (Score)



Seismicity (Score)



Geological condition of a site (Score)

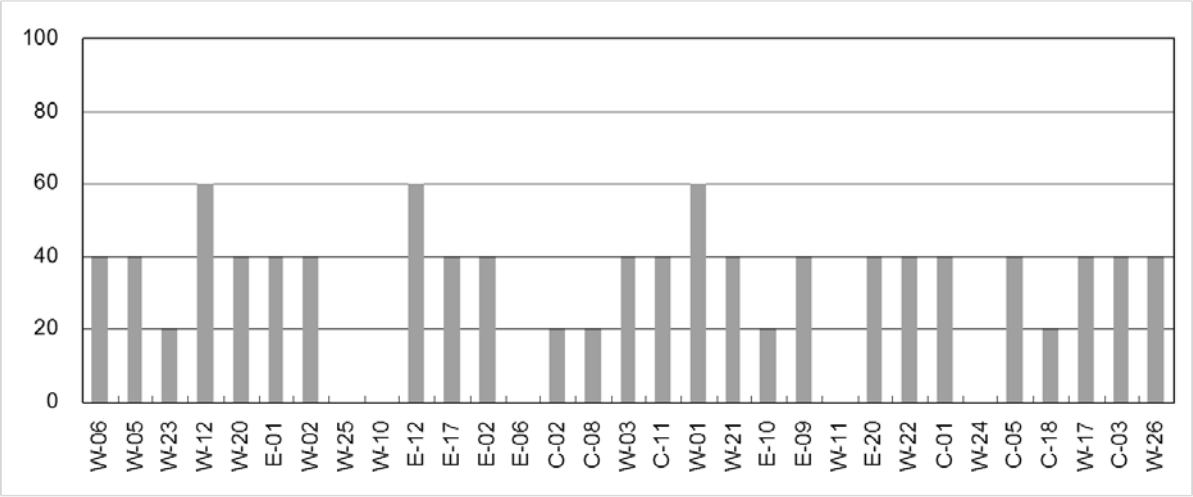
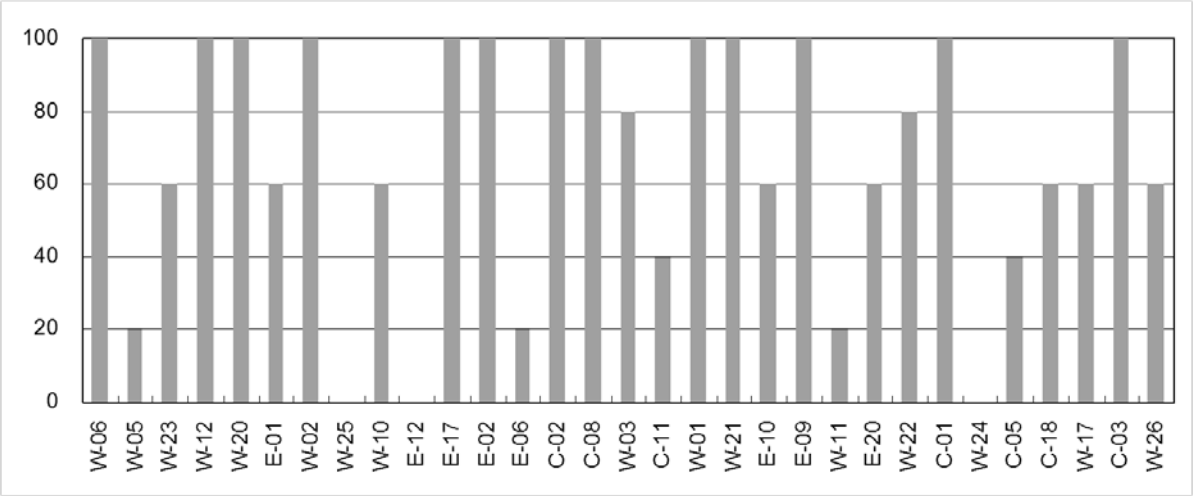
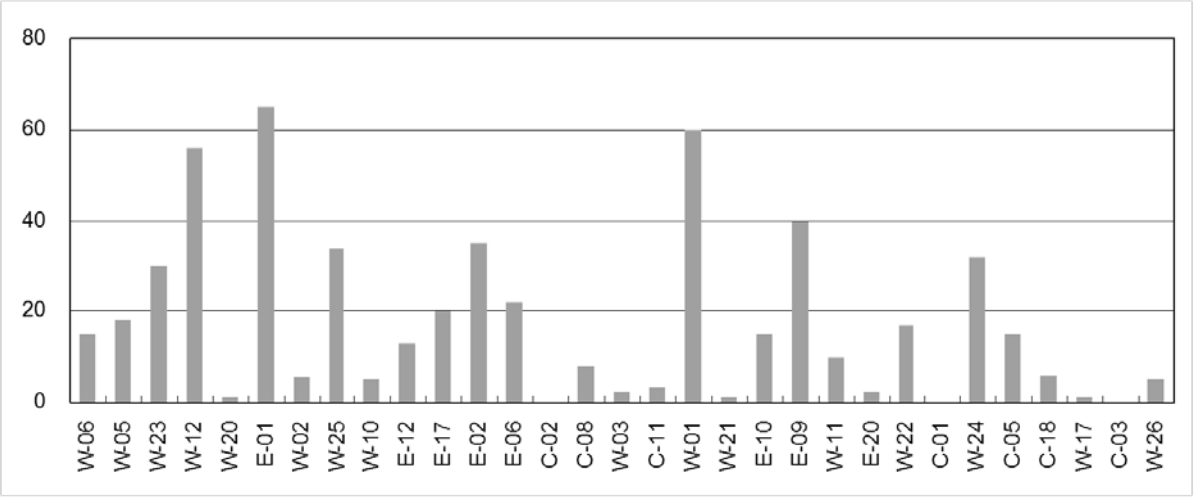


Figure 10.1.4.3-1 Evaluation Score of Each Project (before weighting) (2/13)

Natural hazards (earthquakes) (Score)



Length of access roads (km)



Length of access roads (Score)

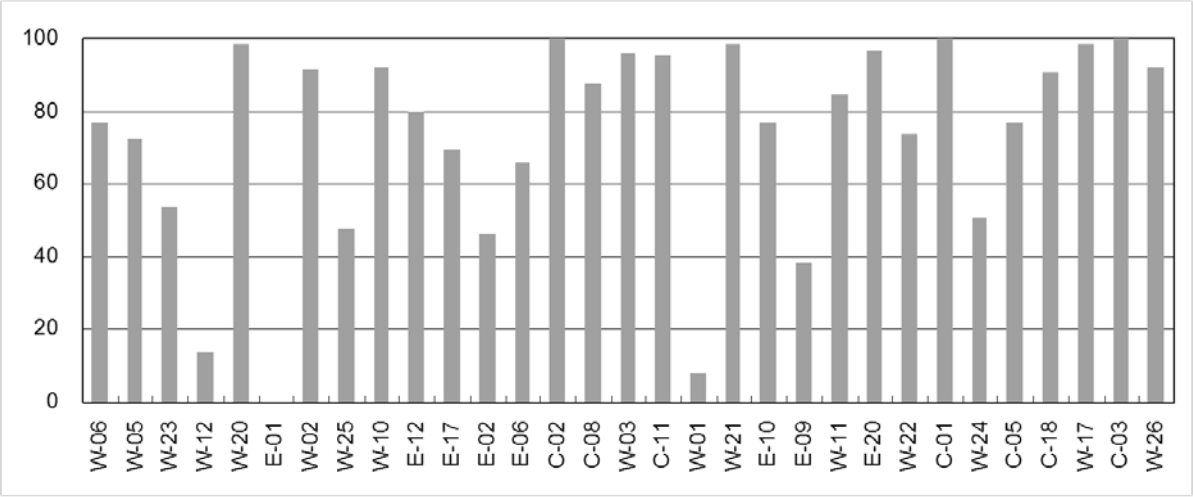
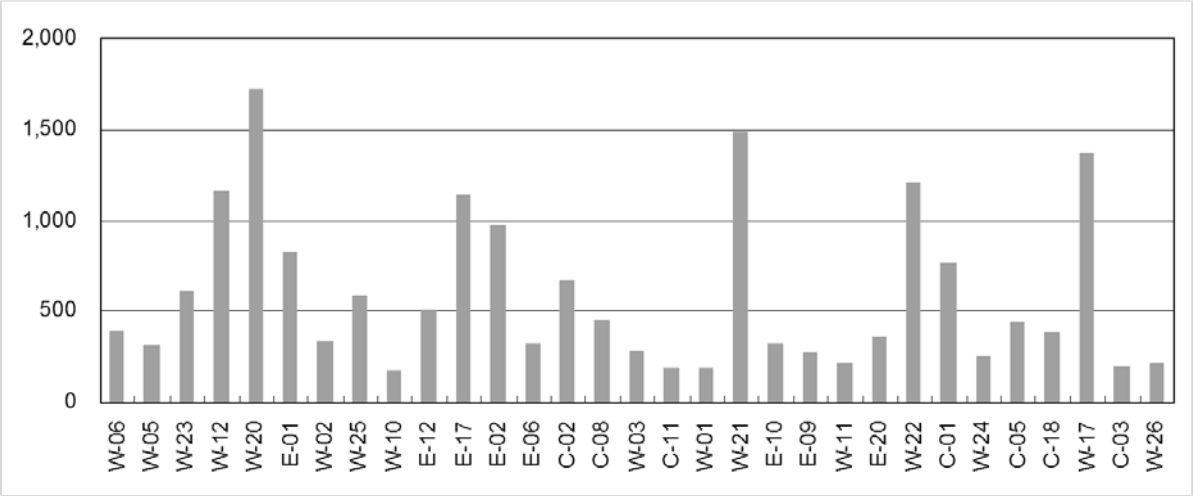
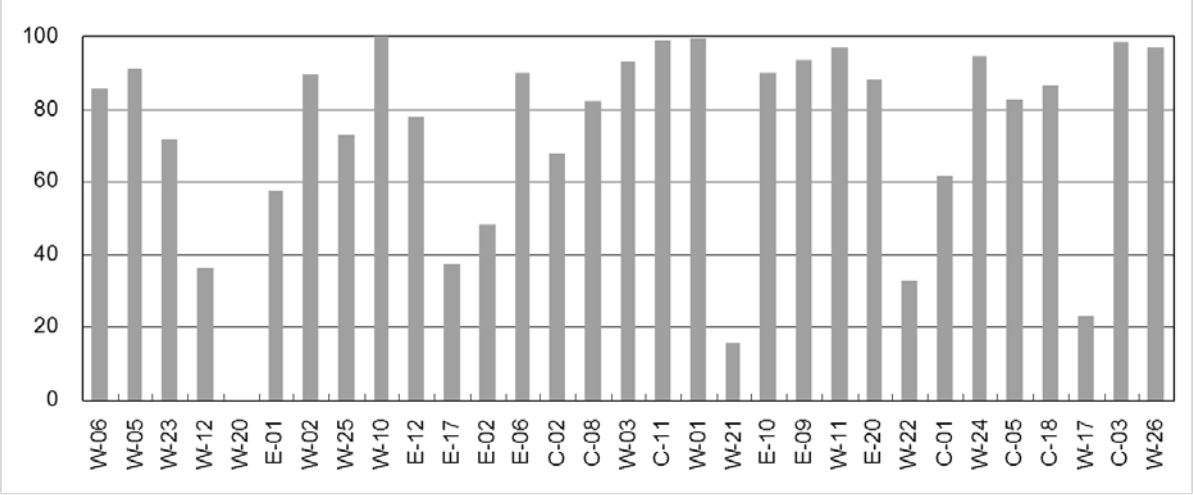


Figure 10.1.4.3-1 Evaluation Score of Each Project (before weighting) (3/13)

Difficulty level of financing (2012 project cost: MUS$)



Difficulty level of financing (Score)



Reliability of the development plan (Score)

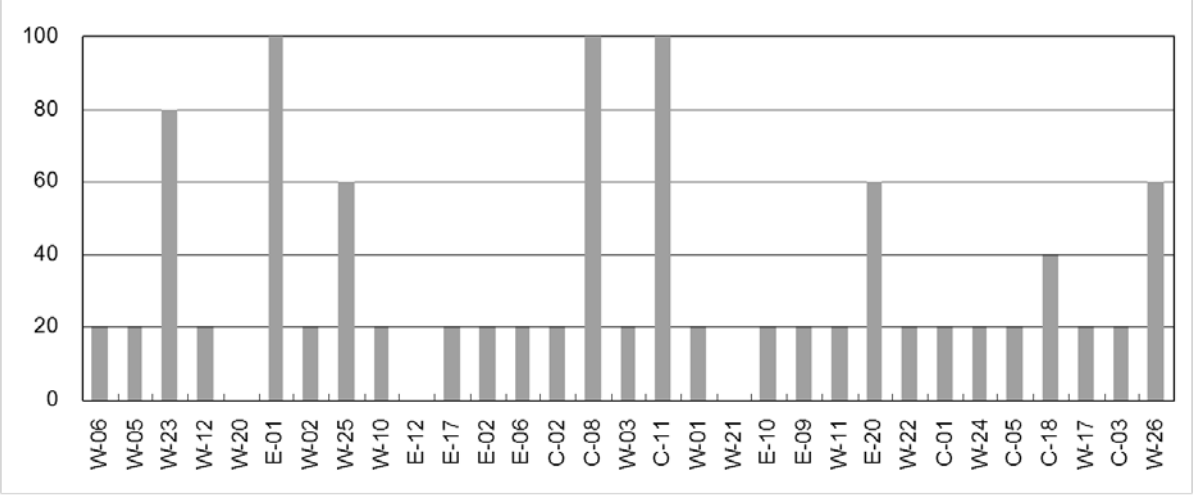
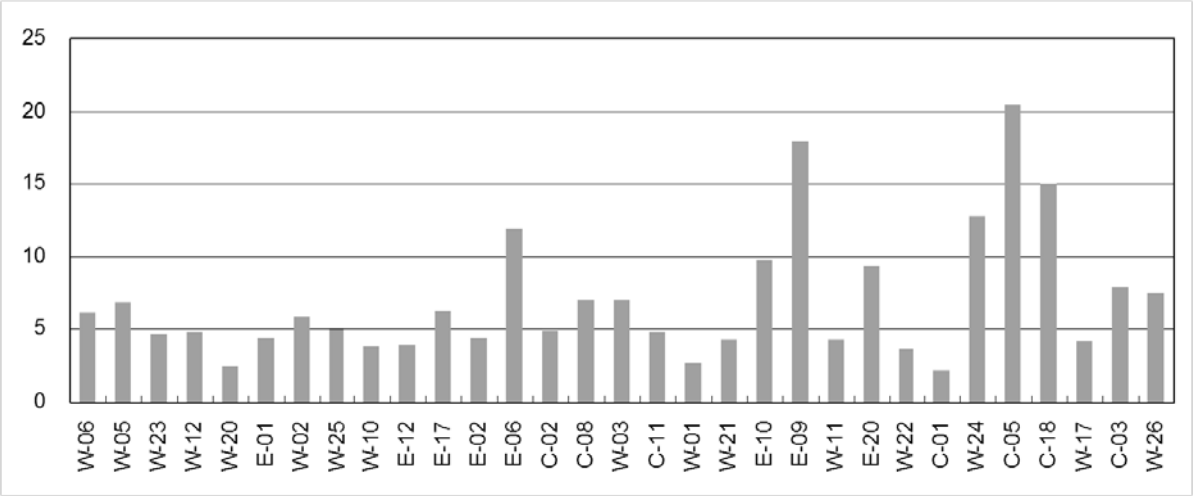
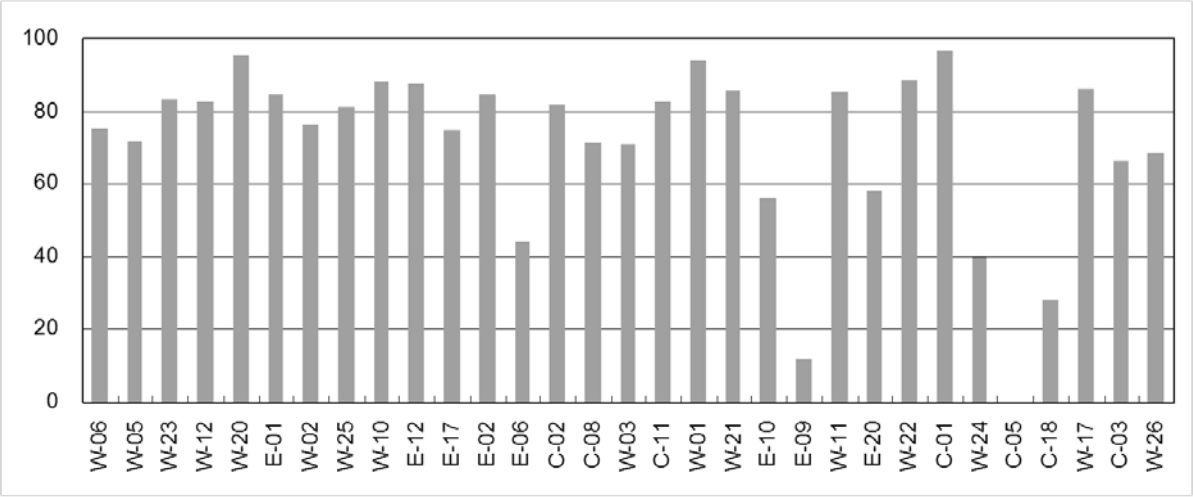


Figure 10.1.4.3-1 Evaluation Score of Each Project (before weighting) (4/13)

Unit generation cost (UScent/kWh)



Unit generation cost (Score)



Installed Capacity (MW)

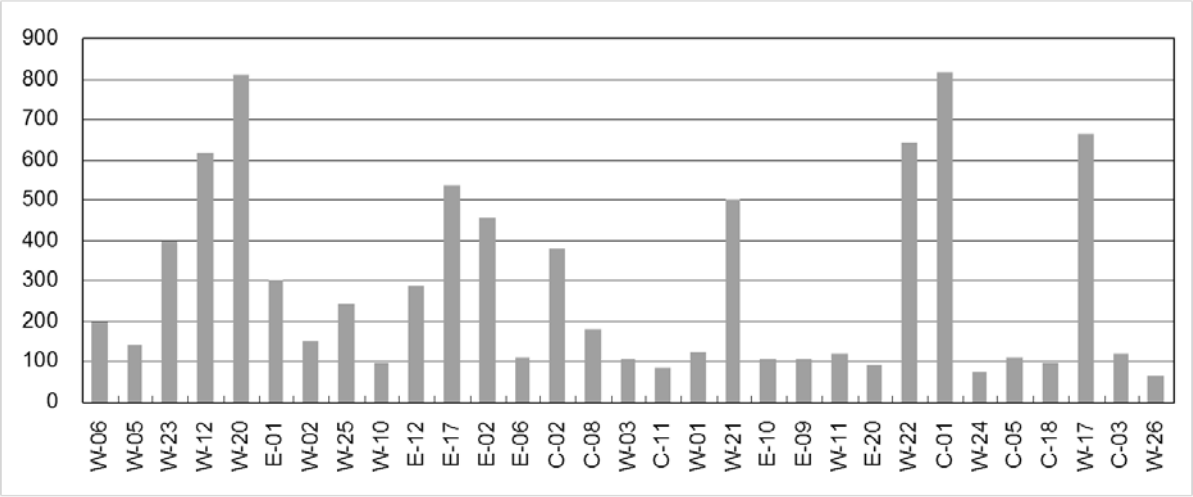
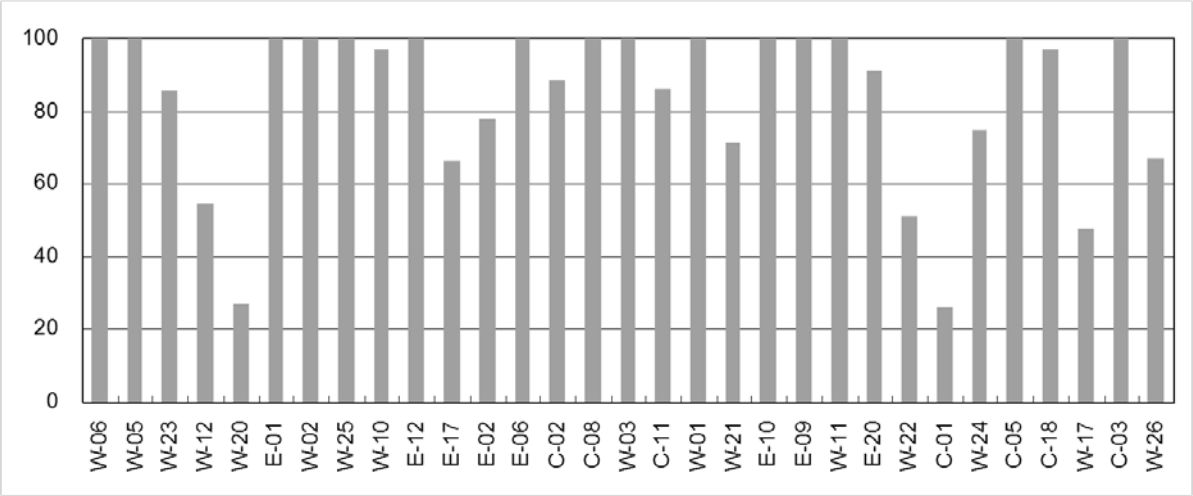
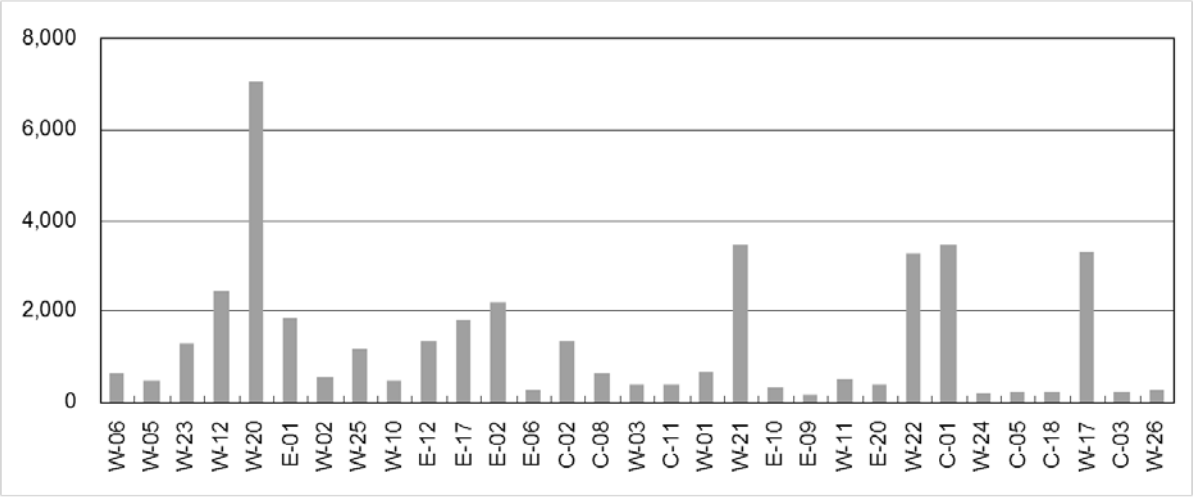


Figure 10.1.4.3-1 Evaluation Score of Each Project (before weighting) (5/13)

Installed Capacity (Score)



Annual energy production (GWh)



Annual energy production (Score)

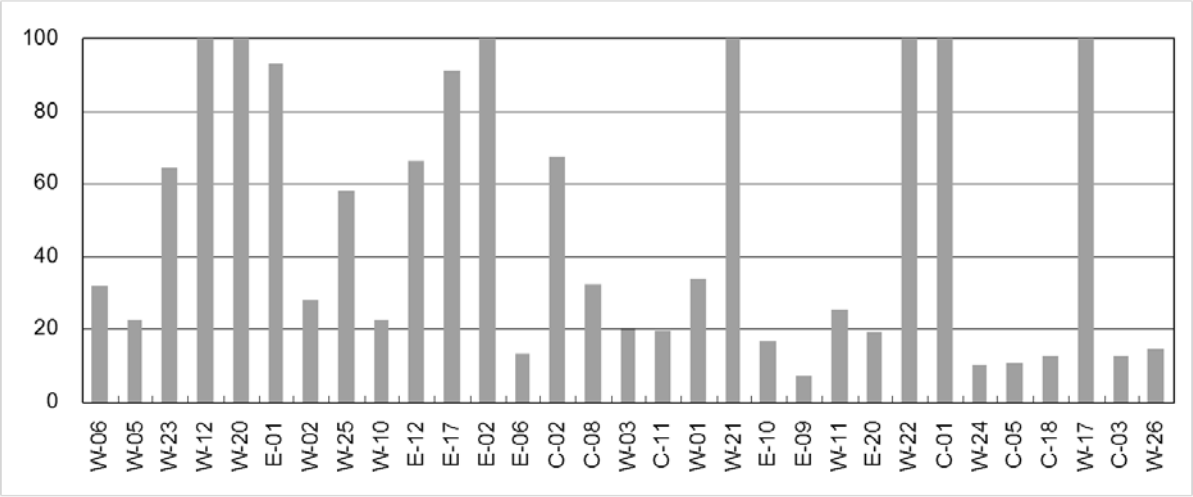
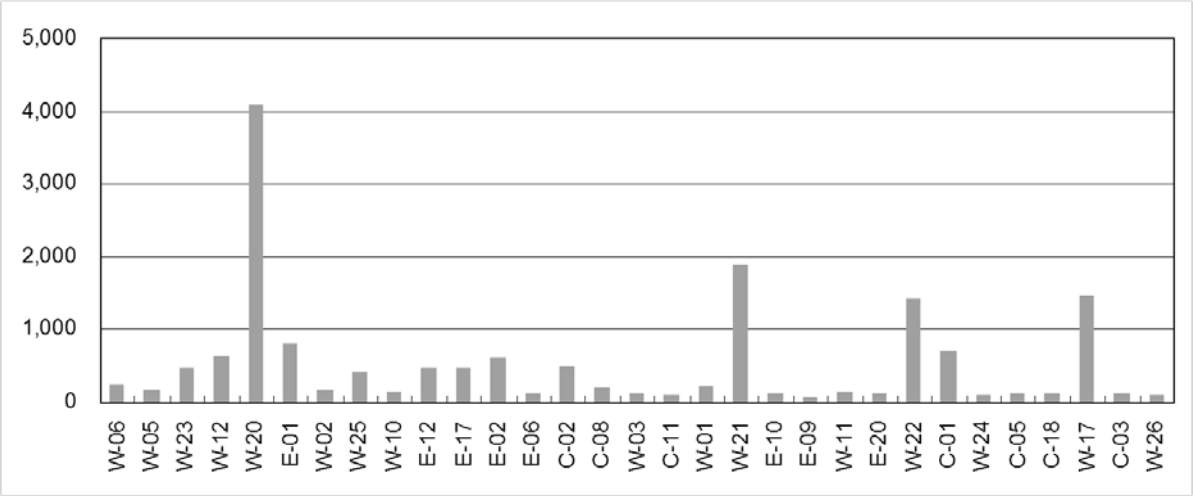
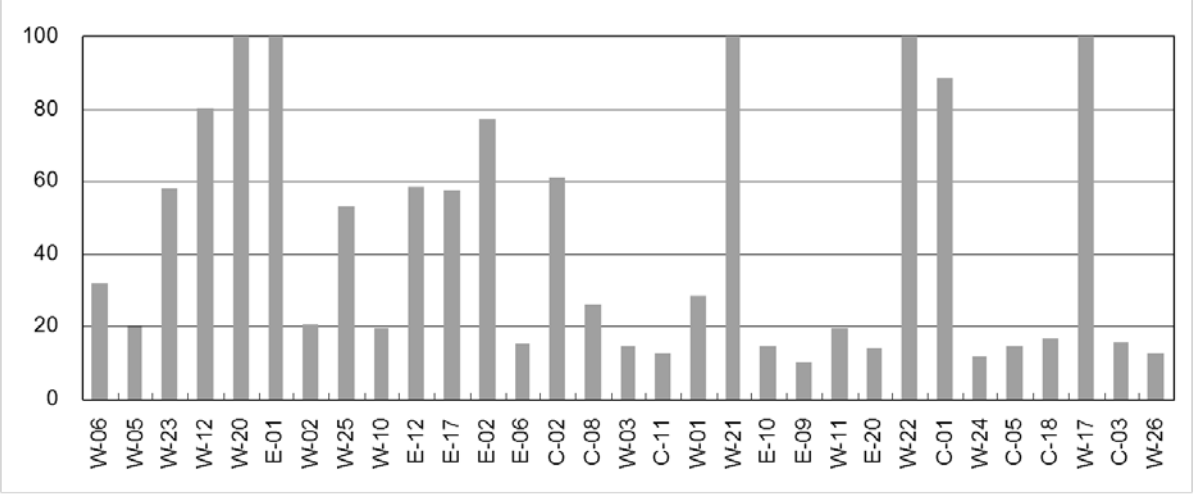


Figure 10.1.4.3-1 Evaluation Score of Each Project (before weighting) (6/13)

Energy production in the dry season (GWh)



Energy production in the dry season (Score)



Impact on forest (Inundated forest area: ha)

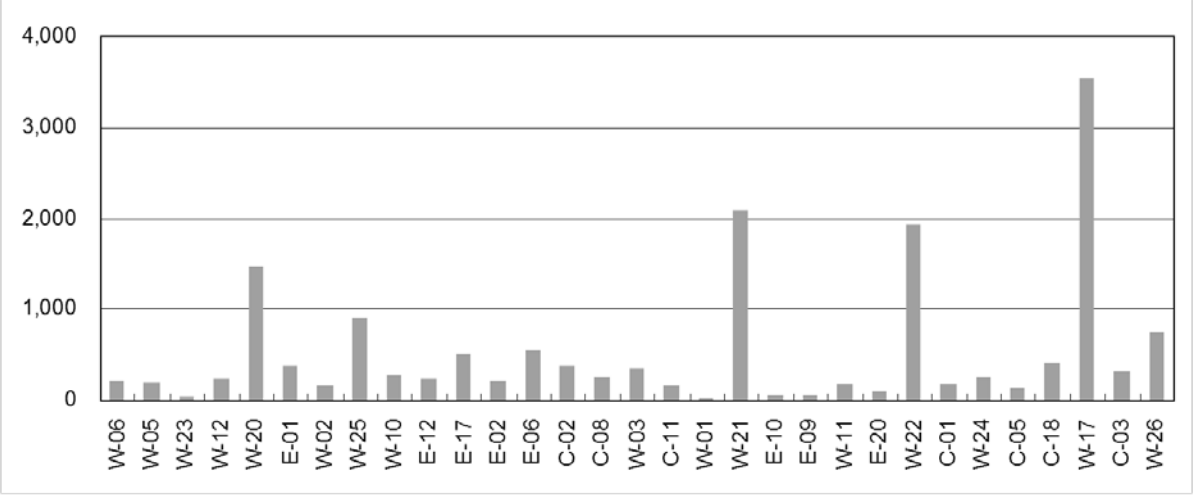
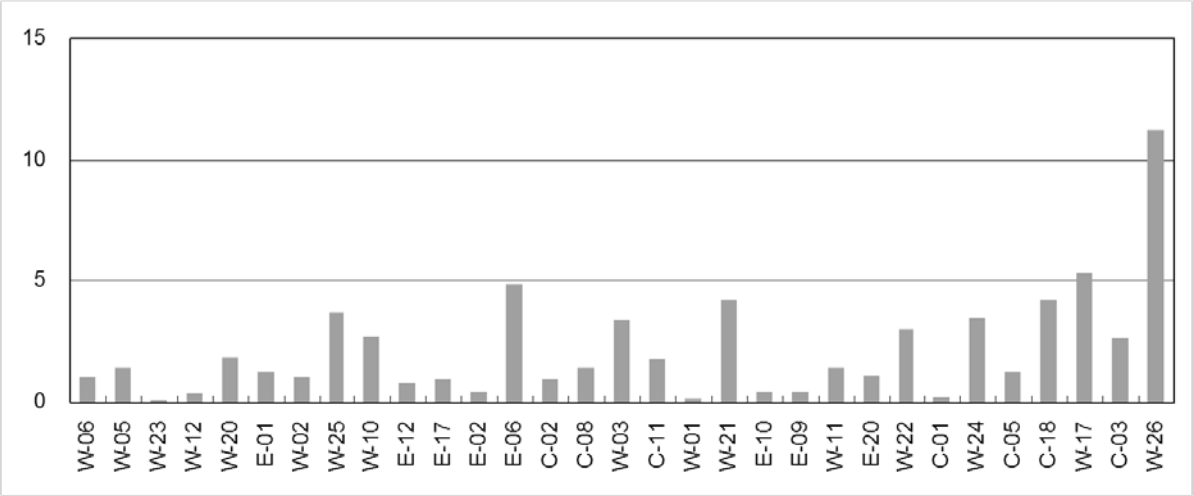
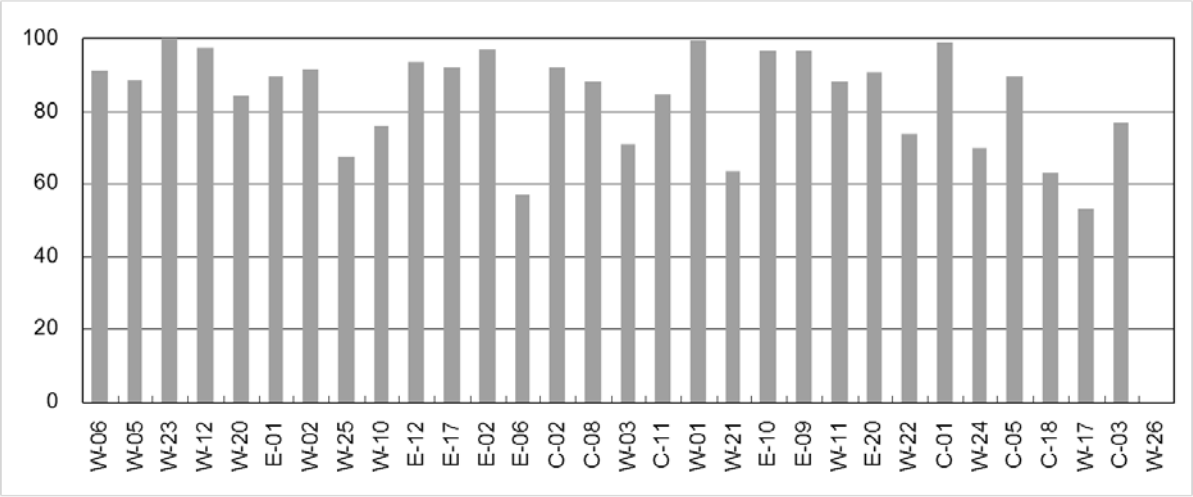


Figure 10.1.4.3-1 Evaluation Score of Each Project (before weighting) (7/13)

Impact on forest (Unit inundated forest area: ha/MW)



Impact on forest (Score)



Impact on protected areas (Score)

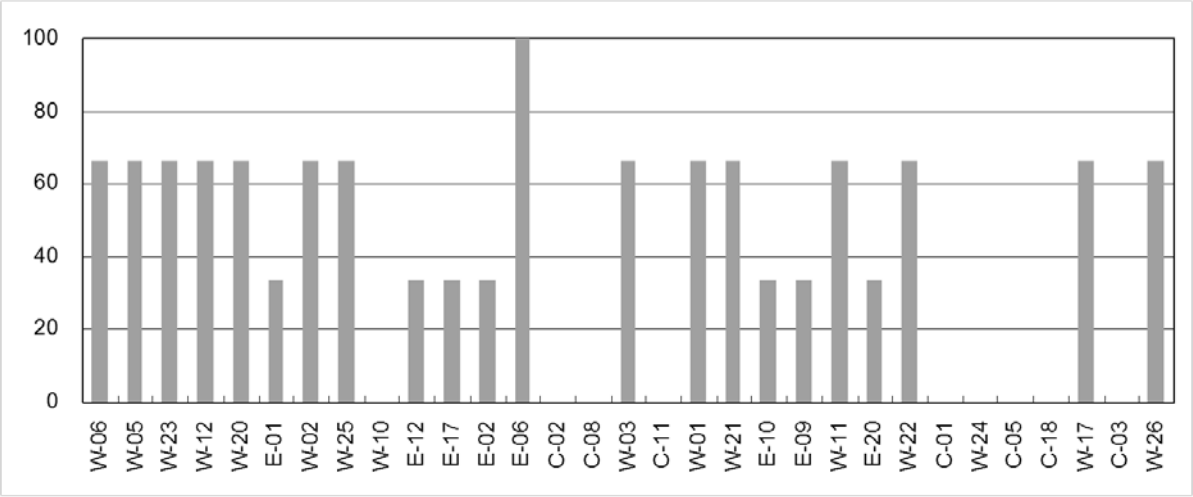
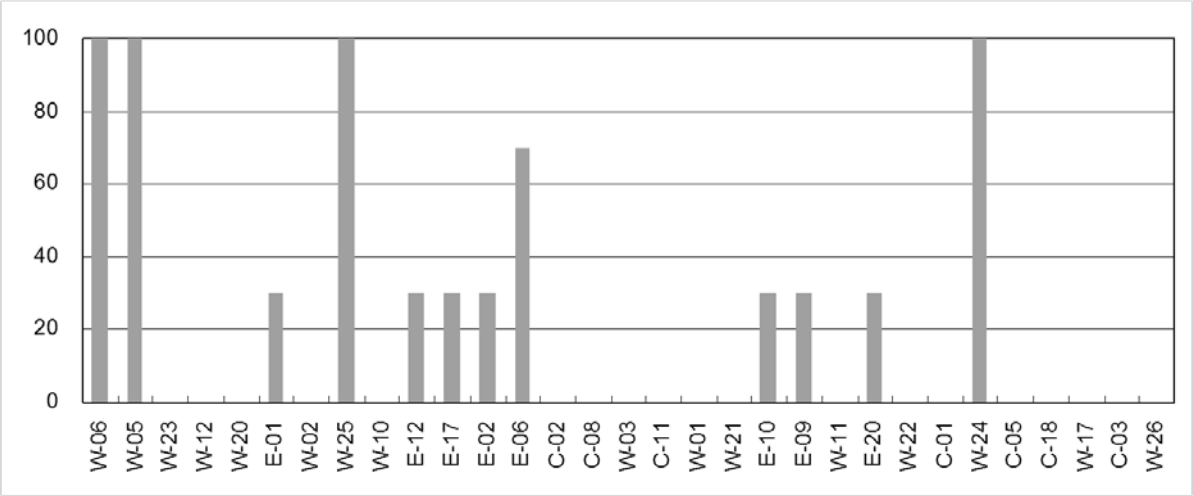
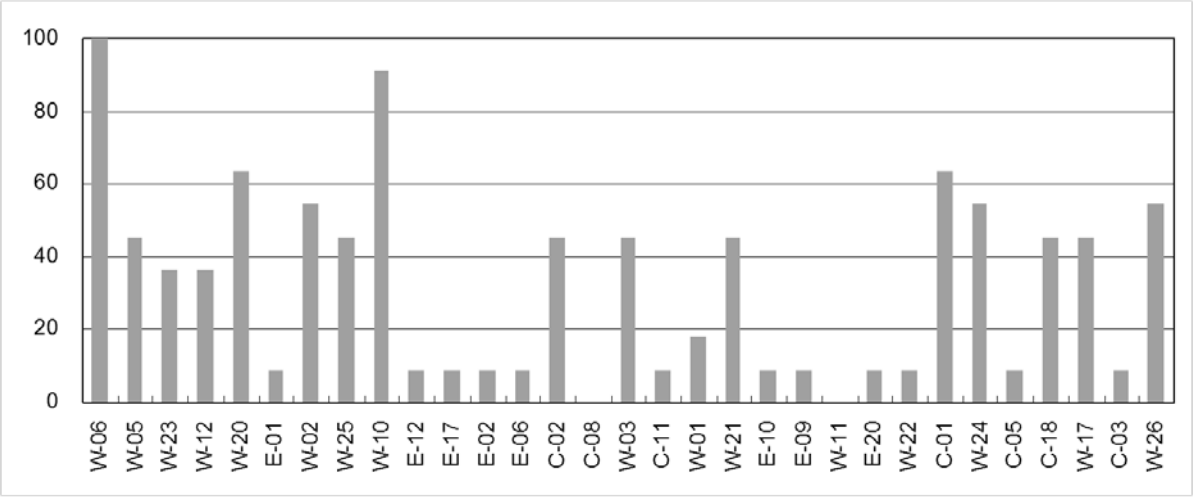


Figure 10.1.4.3-1 Evaluation Score of Each Project (before weighting) (8/13)

Impact on fishes (Score)



Impact on conservation species (Score)



Impact on locality by construction of transmission lines (km)

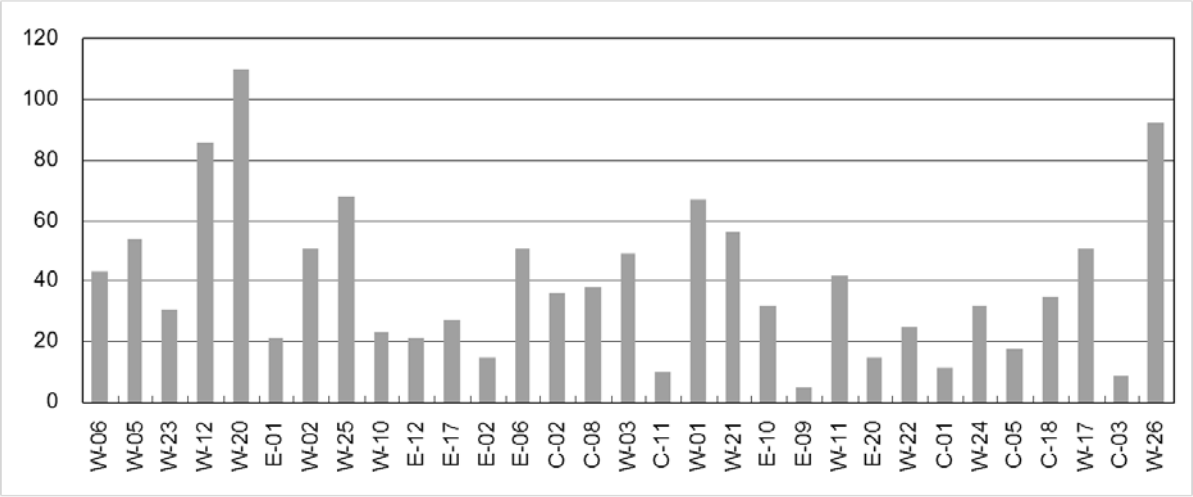
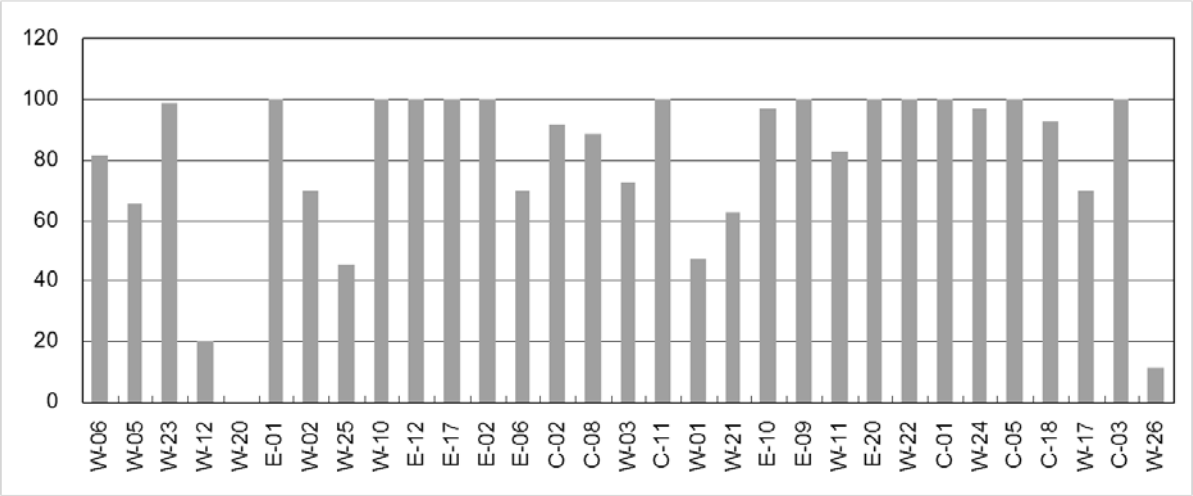
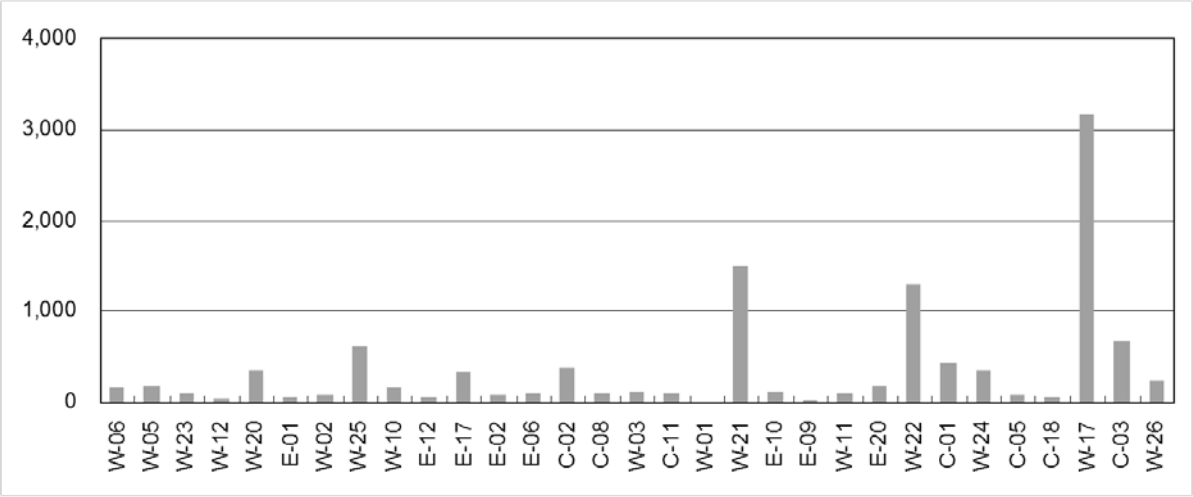


Figure 10.1.4.3-1 Evaluation Score of Each Project (before weighting) (9/13)

Impact on locality by construction of transmission lines (Score)



Impact on households (Households)



Impact on households (Score)

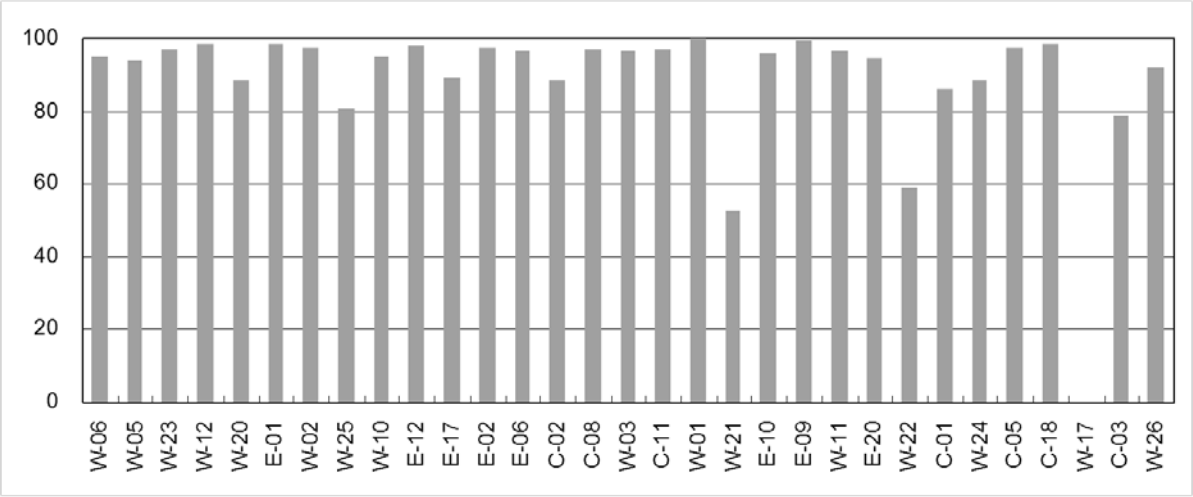
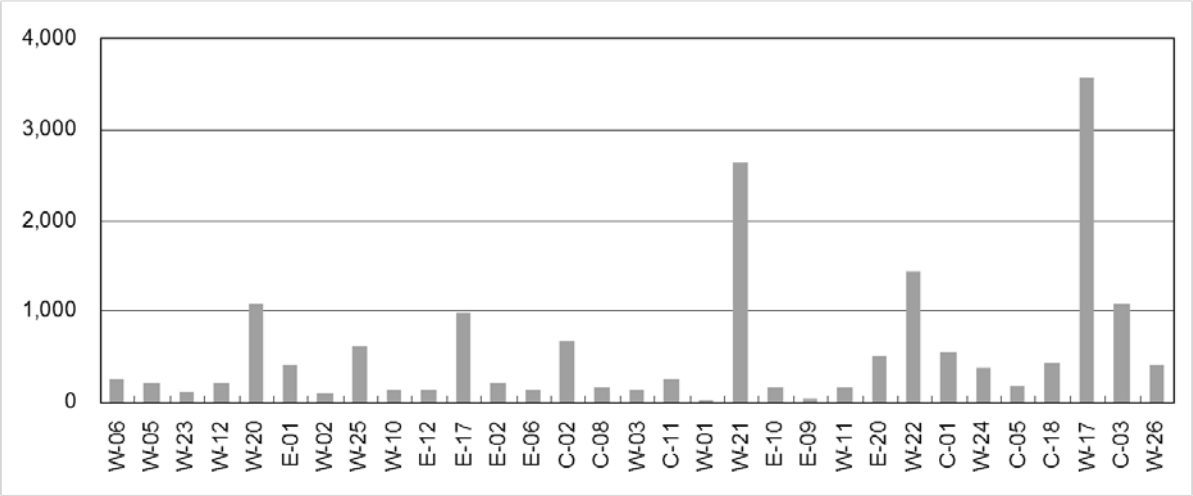
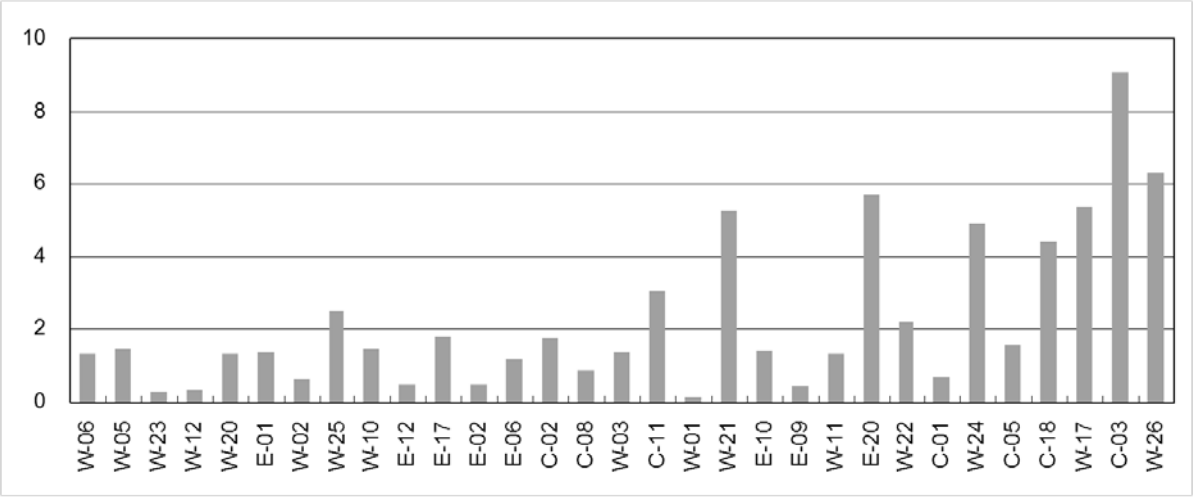


Figure 10.1.4.3-1 Evaluation Score of Each Project (before weighting) (10/13)

Impact on agriculture (Inundated agricultural land: ha)



Impact on agriculture (Unit inundated agricultural land: ha/MW)



Impact on agriculture (Score)

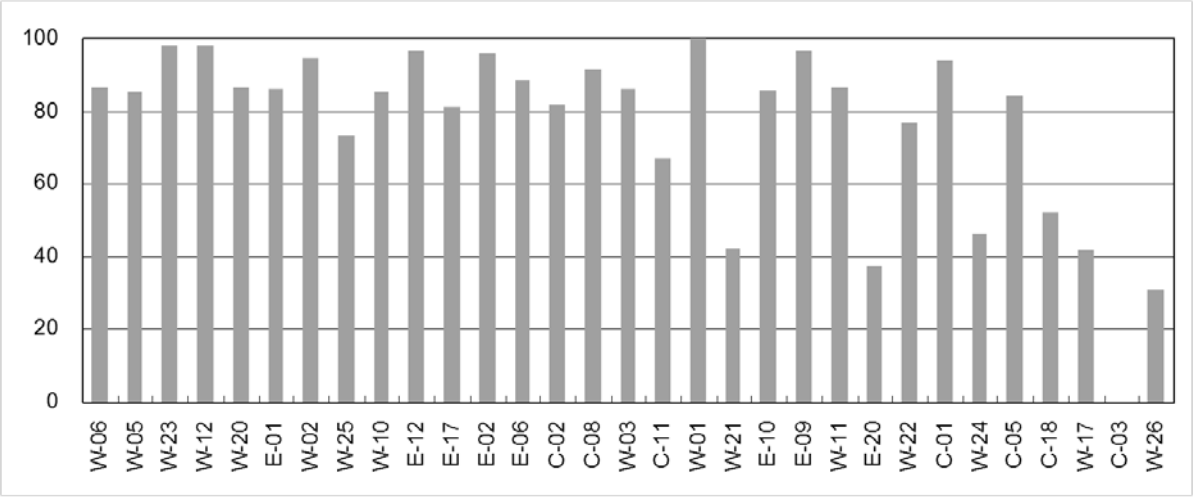
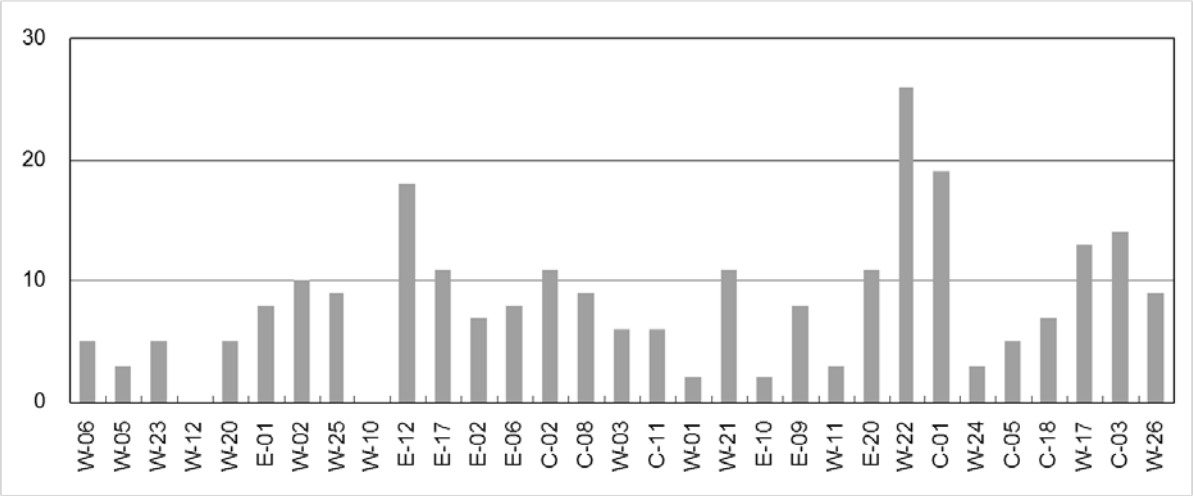
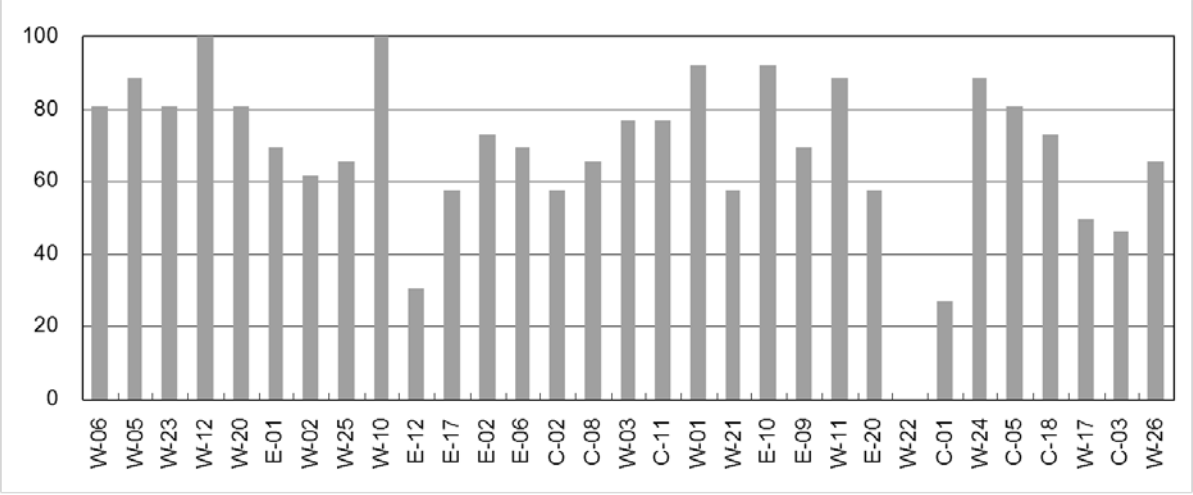


Figure 10.1.4.3-1 Evaluation Score of Each Project (before weighting) (11/13)

Impact on ethnic minorities (Number of ethnic minority groups)



Impact on ethnic minorities (Score)



Impact on tourism (Number of religious assets and trekking routes)

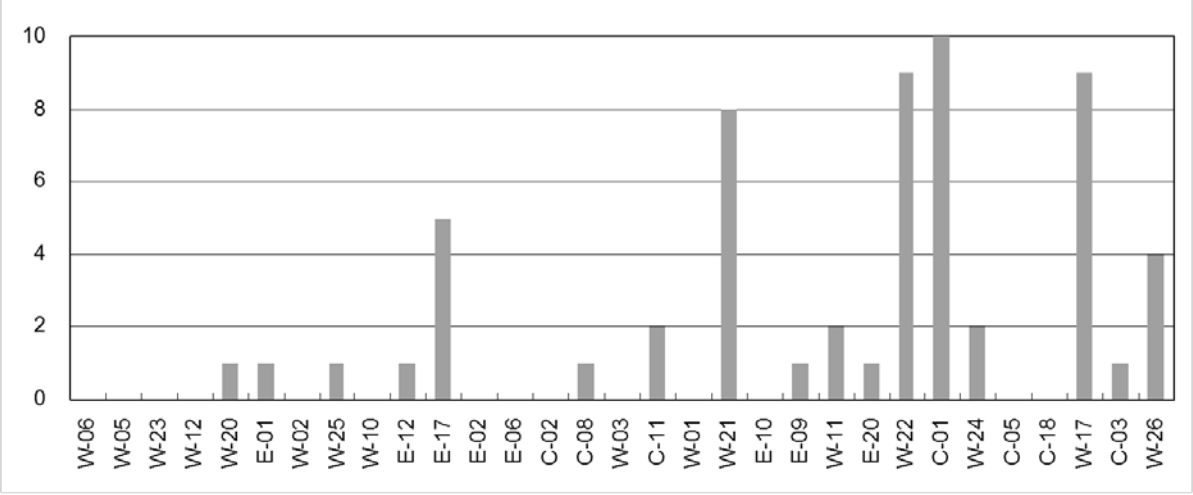


Figure 10.1.4.3-1 Evaluation Score of Each Project (before weighting) (12/13)

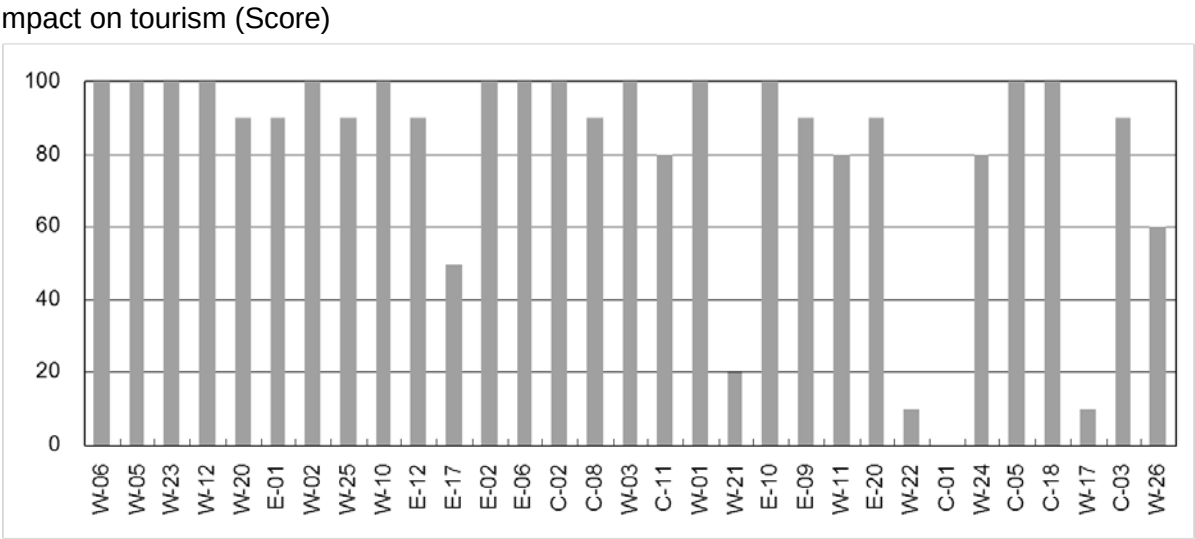


Figure 10.1.4.3-1 Evaluation Score of Each Project (before weighting) (13/13)

10.1.5 Selection of Promising Projects (The Third Step)

As described in "10.1.4 Evaluation of Candidate Projects," evaluation of technical/economical conditions and the impact on the natural/social environment of the 31 candidate projects were conducted. Based on the evaluation results, the promising projects were selected from the top, as a general rule, taking into consideration 1) the total installed capacity of promising projects, 2) the number of projects in each river basin, and 3) overlap with issued survey/construction licenses for generation, and also the positive and negative effects on the local economy by implementation of power development projects and avoiding concentration of negative effects on the environment and society.

(1) Total Installed Capacity of Promising Projects

Promising projects are projects that are considered to have a high possibility of being included in the master plan of storage-type hydroelectric power project in Nepal as the result of evaluation described in Section 10.1.4 above. For these promising projects, environmental and geological surveys were conducted by a local consulting firm. The total installed capacity of the promising projects was decided as follows.

Since development of projects of which FS or Pre-FS is currently in progress have not yet been determined, it is not able to consider them to be the future fixed supply capacity. Similarly, other than the projects under construction or of which development has already determined, like the Tanahu project, projects to which construction licenses have already been issued are not considered to be the future fixed supply capacity. Because they obtained only a construction right but construction of them have not yet been determined.

In May 2012, when the total installed capacity of promising projects was studied, the required total installed capacity of storage-type hydropower project to be developed by FY2031/32 is estimated at about 2,900 MW by deducting the existing capacity and power import from the

demand. This means that about 2,200 MW of development is required in addition to the Tanahu project (140 MW) and the Budhi Gandaki project (600 MW) that are now in the detailed design stage. Taking into consideration that there is a possibility of review on the required development capacity and also a possibility that some promising projects may be judged unfeasible by the results of the environmental and geological survey for the promising projects, the required total installed capacity of promising projects were decided to be about 2,600 MW (≈ 2,200 MW × 1.2).

(2) Number of Projects in Each River Basin

Kathmandu, the capital city of Nepal with large power demands, is located in the Central Region in terms of administrative areas, and this region corresponds to the western part of the eastern river basin and the eastern part of the central river basin.

However, as shown in Table 10.1.4.3-2, many projects in the western river basin were ranked near the top. Therefore, if promising projects were selected simply by rank, seven or eight out of ten were in the western river basin that is far from Kathmandu. Taking into consideration that these projects are located far from demand centers like Kathmandu, and that it will take time for construction of a backbone transmission line to the western river basin to which these projects will be connected, and also taking into consideration the economic effects on regions by development of the projects, the maximum number of promising projects in one river basin was decided to be five (5).

Table 10.1.5-1 shows the promising projects of each case when the number of projects in each river basin was limited to five.

Table 10.1.5-1 Promising Projects (Number of promising projects in each river basin is five or less)

Base Case

Technical : 50%, Environmental : 50%

No.	Project Name	P (MW)	Ranking
W-06	Madi	199.8	1 (W1)
W-05	Lower Jhimruk	142.5	2 (W2)
W-23	Nalsyagu Gad	400.0	3 (W3)
W-12	Tila - 1	617.2	4 (W4)
W-20	Bhanakot	810.0	5 (W5)
E-01	Dudh Koshi	300.0	6 (E1)
W-02	Chera-1	148.7	—
W-25	Naumure (W. Rapti)	245.0	—
W-10	Sharada - 2	96.8	—
E-12	Tama Koss-3	287.0	7 (E2)
E-17	Sunkosi No.3	536.0	8 (E3)
E-02	Dukh Koshi-2	456.6	9 (E4)
E-06	Kokhajor-1	111.5	10 (E5)
C-02	Lower Badigad	380.3	
C-08	Andhi Khola	180.0	
W-03	Chera-2	104.3	
C-11	Madi- Ishaneshor	86.0	
W-01	Barbung Khola	122.9	
W-21	Thapna	500.0	
E-10	Rosi-2	106.5	
E-09	Piluwa-2	107.3	
W-11	Thuli Gad - 2	119.7	
E-20	Indrawati	91.2	
W-22	SR-6	642.0	
C-01	Kaligandaki-Modi	816.4	
W-24	Sarada Babai	75.0	
C-05	Upper Daraudi	111.4	
C-18	Ridi Khola	97.0	
W-17	BR-4	667.0	
C-03	Lower Daraudi	120.2	
W-26	Lohare Khola	67.0	

Case-1

Technical : 60%, Environmental : 40%

No.	Project Name	P (MW)	Ranking
W-06	Madi	199.8	1 (W1)
W-05	Lower Jhimruk	142.5	2 (W2)
W-23	Nalsyagu Gad	400.0	3 (W3)
W-20	Bhanakot	810.0	4 (W4)
E-01	Dudh Koshi	300.0	5 (E1)
W-12	Tila - 1	617.2	6 (W5)
W-02	Chera-1	148.7	—
E-17	Sunkosi No.3	536.0	7 (E2)
C-08	Andhi Khola	180.0	8 (C1)
W-21	Thapna	500.0	—
W-25	Naumure (W. Rapti)	245.0	—
W-10	Sharada - 2	96.8	—
E-12	Tama Koss-3	287.0	9 (E3)
C-02	Lower Badigad	380.3	10 (C2)
C-11	Madi- Ishaneshor	86.0	
W-03	Chera-2	104.3	
E-02	Dukh Koshi-2	456.6	
W-22	SR-6	642.0	
W-01	Barbung Khola	122.9	
E-06	Kokhajor-1	111.5	
E-10	Rosi-2	106.5	
W-11	Thuli Gad - 2	119.7	
C-01	Kaligandaki-Modi	816.4	
E-20	Indrawati	91.2	
E-09	Piluwa-2	107.3	
W-24	Sarada Babai	75.0	
W-17	BR-4	667.0	
C-18	Ridi Khola	97.0	
C-03	Lower Daraudi	120.2	
C-05	Upper Daraudi	111.4	
W-26	Lohare Khola	67.0	

Case-2

Technical : 40%, Environmental : 60%

No.	Project Name	P (MW)	Ranking
W-06	Madi	199.8	1 (W1)
W-05	Lower Jhimruk	142.5	2 (W2)
W-23	Nalsyagu Gad	400.0	3 (W3)
W-02	Chera-1	148.7	4 (W4)
W-12	Tila - 1	617.2	5 (W5)
W-25	Naumure (W. Rapti)	245.0	—
W-10	Sharada - 2	96.8	—
W-20	Bhanakot	810.0	—
E-01	Dudh Koshi	300.0	6 (E1)
E-06	Kokhajor-1	111.5	7 (E2)
W-03	Chera-2	104.3	—
E-02	Dukh Koshi-2	456.6	8 (E3)
E-12	Tama Koss-3	287.0	9 (E4)
W-01	Barbung Khola	122.9	—
E-17	Sunkosi No.3	536.0	10 (E5)
C-02	Lower Badigad	380.3	
E-10	Rosi-2	106.5	
C-08	Andhi Khola	180.0	
E-09	Piluwa-2	107.3	
W-11	Thuli Gad - 2	119.7	
C-11	Madi- Ishaneshor	86.0	
W-24	Sarada Babai	75.0	
W-21	Thapna	500.0	
E-20	Indrawati	91.2	
C-01	Kaligandaki-Modi	816.4	
W-22	SR-6	642.0	
C-05	Upper Daraudi	111.4	
C-18	Ridi Khola	97.0	
W-26	Lohare Khola	67.0	
W-17	BR-4	667.0	
C-03	Lower Daraudi	120.2	

E: Eastern River Basin, C: Central River Basin, W: Western River Basin.

(3) Overlap with Issued Survey and Construction Licenses for Generation

As shown in Table 10.1.5-2, a large number of survey and construction licenses for generation have been issued by the Department of Electricity Development (DOED) under the Ministry of Energy to promote development of hydroelectric power by the private sector.

Table 10.1.5-2 Issued Survey and Construction Licenses for Generation

(As of May 13, 2012)

Item		Number	Total Capacity (MW)	Remarks
Survey License	Below 1 MW	202	148.405	
	1 to 25 MW	175	1,087.899	
	25 to 100 MW	52	2,766.600	
	Above 100 MW	29	8,470.000	
Construction License		74	1,777.556	Including existing and under construction

Source: DOED's website

The NEA and the Study Team checked the locations of projects ranked near the top against the areas of the survey and construction licenses (1 MW or more) issued as of May 13, 2012, and found that the locations of the following four projects overlapped with the project areas of issued licenses. The NEA and the Study Team sought a comment from the DOED on the likelihood of implementation of the projects selected in this study in the project area of issued licenses.

Tila 1 (W-12: 617.2 MW)
Bhanakot (W-20: 810 MW)
Tama Koshi 3 (E-12: 287 MW)
Dudh Koshi 2 (E-02: 156.6 MW)

According to the DOED, even if storage-type projects make effective use of river water more than ROR type projects, it is difficult to develop storage-type projects at the site where licenses have already been issued to another agency/company, and it is better not to include these projects in the promising projects of the Study. Taking this into consideration, the NEA and the Study Team decided that these four projects should not be selected as the promising projects.

In the column "Ranking (1)" in Table 10.1.5-3, the promising projects excluding the above-mentioned four projects (shaded projects) are shown.

Table 10.1.5-3 Promising Projects (taking issued licenses into consideration)

Base Case

Technical point : 50%, Environmental point : 50%

No.	Project Name	P (MW)	Ranking (1)	Ranking (2)
W-06	Madi	199.8	1 (W1)	1 (W1)
W-05	Lower Jhimruk	142.5	2 (W2)	2 (W2)
W-23	Nalsyagu Gad	400.0	3 (W3)	3 (W3)
~~W-12~~	~~Tila - 1~~	~~617.2~~	—	~~4 (W4)~~
~~W-20~~	~~Bhanakot~~	~~810.0~~	—	~~5 (W5)~~
E-01	Dudh Koshi	300.0	4 (E1)	6 (E1)
W-02	Chera-1	148.7	5 (W4)	—
W-25	Naumure (W. Rapti)	245.0	6 (W5)	—
W-10	Sharada - 2	96.8	—	—
~~E-12~~	~~Tama Koss-3~~	~~287.0~~	—	~~7 (E2)~~
E-17	Sunkosi No.3	536.0	7 (E2)	8 (E3)
~~E-02~~	~~Dukh Koshi-2~~	~~456.6~~	—	~~9 (E4)~~
E-06	Kokhajor-1	111.5	8 (E3)	10 (E5)
C-02	Lower Badigad	380.3	9 (C1)	
C-08	Andhi Khola	180.0	10 (C2)	
W-03	Chera-2	104.3		
C-11	Madi- Ishaneshor	86.0		
W-01	Barbung Khola	122.9		
W-21	Thapna	500.0		
E-10	Rosi-2	106.5		
E-09	Piluwa-2	107.3		
W-11	Thuli Gad - 2	119.7		
E-20	Indrawati	91.2		
W-22	SR-6	642.0		
C-01	Kaligandaki-Modi	816.4		
W-24	Sarada Babai	75.0		
C-05	Upper Daraudi	111.4		
C-18	Ridi Khola	97.0		
W-17	BR-4	667.0		
C-03	Lower Daraudi	120.2		
W-26	Lohare Khola	67.0		

Case-1

Technical point : 60%, Environmental point : 40%

No.	Project Name	P (MW)	Ranking (1)	Ranking (2)
W-06	Madi	199.80	1 (W1)	1 (W1)
W-05	Lower Jhimruk	142.50	2 (W2)	2 (W2)
W-23	Nalsyagu Gad	400.00	3 (W3)	3 (W3)
~~W-20~~	~~Bhanakot~~	~~810.00~~	—	~~4 (W4)~~
E-01	Dudh Koshi	300.00	4 (E1)	5 (E1)
~~W-12~~	~~Tila - 1~~	~~617.20~~	—	~~6 (W5)~~
W-02	Chera-1	148.70	5 (W4)	—
E-17	Sunkosi No.3	536.00	6 (E2)	7 (E2)
C-08	Andhi Khola	180.00	7 (C1)	8 (C1)
W-21	Thapna	500.00	8 (W5)	—
W-25	Naumure (W. Rapti)	245.00	—	—
W-10	Sharada - 2	96.80	—	—
~~E-12~~	~~Tama Koss-3~~	~~287.00~~	—	~~9 (E3)~~
C-02	Lower Badigad	380.30	9 (C2)	10 (C2)
C-11	Madi- Ishaneshor	86.00	10 (C3)	
W-03	Chera-2	104.30		
~~E-02~~	~~Dukh Koshi-2~~	~~456.60~~		
W-22	SR-6	642.00		
W-01	Barbung Khola	122.90		
E-06	Kokhajor-1	111.50		
E-10	Rosi-2	106.50		
W-11	Thuli Gad - 2	119.70		
C-01	Kaligandaki-Modi	816.40		
E-20	Indrawati	91.20		
E-09	Piluwa-2	107.30		
W-24	Sarada Babai	75.00		
W-17	BR-4	667.00		
C-18	Ridi Khola	97.00		
C-03	Lower Daraudi	120.20		
C-05	Upper Daraudi	111.40		
W-26	Lohare Khola	67.00		

Case-2

Technical point : 40%, Environmental point : 60%

No.	Project Name	P (MW)	Ranking (1)	Ranking (2)
W-06	Madi	199.8	1 (W1)	1 (W1)
W-05	Lower Jhimruk	142.5	2 (W2)	2 (W2)
W-23	Nalsyagu Gad	400.0	3 (W3)	3 (W3)
W-02	Chera-1	148.7	4 (W4)	4 (W4)
~~W-12~~	~~Tila - 1~~	~~617.2~~	—	~~5 (W5)~~
W-25	Naumure (W. Rapti)	245.0	5 (W5)	—
W-10	Sharada - 2	96.8	—	—
~~W-20~~	~~Bhanakot~~	~~810.0~~	—	—
E-01	Dudh Koshi	300.0	6 (E1)	6 (E1)
E-06	Kokhajor-1	111.5	7 (E2)	7 (E2)
W-03	Chera-2	104.3	—	—
~~E-02~~	~~Dukh Koshi-2~~	~~456.6~~	—	~~8 (E3)~~
~~E-12~~	~~Tama Koss-3~~	~~287.0~~	—	~~9 (E4)~~
W-01	Barbung Khola	122.9	—	—
E-17	Sunkosi No.3	536.0	8 (E3)	10 (E5)
C-02	Lower Badigad	380.3	9 (C1)	
E-10	Rosi-2	106.5	10 (E4)	
C-08	Andhi Khola	180.0		
E-09	Piluwa-2	107.3		
W-11	Thuli Gad - 2	119.7		
C-11	Madi- Ishaneshor	86.0		
W-24	Sarada Babai	75.0		
W-21	Thapna	500.0		
E-20	Indrawati	91.2		
C-01	Kaligandaki-Modi	816.4		
W-22	SR-6	642.0		
C-05	Upper Daraudi	111.4		
C-18	Ridi Khola	97.0		
W-26	Lohare Khola	67.0		
W-17	BR-4	667.0		
C-03	Lower Daraudi	120.2		

E: Eastern River Basin, C: Central River Basin, W: Western River Basin. (Example: "E1" = the 1st place in the Eastern River Basin, "C2" = the 2nd place in the Central River Basin.)

Shaded projects: Excluded projects because of competence of issued licenses.

Ranking (1) : Issued licenses are considered. Ranking (2) : Issued licenses are not considered.

(4) Selection of Promising Projects

As shown in Table 10.1.5-4, the total installed capacity of the promising projects was about 2,600 MW to 2,900 MW, which is equal to or more than the required total installed capacity of the promising projects.

Since the projects selected in each case are a little different, 13 projects were selected in total, and seven projects were selected as the promising projects in all cases, three projects in two cases, and three projects in one case.

Taking this into consideration, seven projects selected in all cases and three projects selected in two cases (with "✓" in Table 10.1.4-4) were selected as the promising projects.

Table 10.1.5-4 Selection of Promising Projects

No.	Project Name	P (MW)	Base Case	Case-1	Case-2	Number of selected project	Promising Project
E-01	Dudh Koshi	300.0	E1	E1	E1	3	✓
E-06	Kokhajor-1	111.5	E3	—	E2	2	✓
E-10	Rosi-2	106.5	—	—	E4	1	
E-17	Sunkosi No.3	536.0	E2	E2	E3	3	✓
C-02	Lower Badigad	380.3	C1	C2	C1	3	✓
C-08	Andhi Khola	180.0	C2	C1	—	2	✓
C-11	Madi- Ishaneshor	86.0	—	C3	—	1	
W-02	Chera-1	148.7	W4	W4	W4	3	✓
W-05	Lower Jhimruk	142.5	W2	W2	W2	3	✓
W-06	Madi	199.8	W1	W1	W1	3	✓
W-21	Thapna	500.0	—	W5	—	1	
W-23	Nalsyagu Gad	400.0	W3	W3	W3	3	✓
W-25	Naumure (W. Rapti)	245.0	W5	—	W5	2	✓
Total Installed Capacity (MW)			2,643.8	2,873.3	2,570.3	—	2,643.8

E: Eastern River Basin, C: Central River Basin, W: Western River Basin.
Example: "E1" = the 1st place in the Eastern River Basin, "C2" = the 2nd place in the Central River Basin.

Table 10.1.5-5 shows the promising projects that were finally selected.

Table 10.1.5-5 Promising Projects

No.	Project Name	P (MW)
E-01	Dudh Koshi	300.0
E-06	Kokhajor-1	111.5
E-17	Sunkosi No.3	536.0
C-02	Lower Badigad	380.3
C-08	Andhi Khola	180.0
W-02	Chera-1	148.7
W-05	Lower Jhimruk	142.5
W-06	Madi	199.8
W-23	Nalsyagu Gad	400.0
W-25	Naumure (W. Rapti)	245.0
Total Installed Capacity (MW)		2,643.8

10.2 Evaluation of Selected Promising Projects

10.2.1 Selected Promising Projects

10.2.1.1 List of Promising Projects

The 10 projects selected as promising projects are listed below. Out of a total of 75 districts, the development ranking of a district where each project is located at is shown in parentheses for reference.

Table 10.2.1.1-1 Promising Projects

No.	Project Name	(MW)	District (Ranking)*	River (Major River Basin)
E-01	Dudh Koshi	300.0	Okhaldhunga (50/75), Khotang (48/75), Solukhumbu (44/75)	Dudh Koshi to Baiku Khola (Koshi)
E-06	Kokhajor-1	111.5	Sinduli (51/75), Kabhrepalanchok (6/75)	Kokhajor to Bagmati (Bagmati)
E-17	Sun Koshi No.3	536.0	Ramechhap (56/75), Kabhrepalanchok (6/75), Sindhupalchok (43/75)	Sun Koshi (Koshi)
C-02	Lower Badigad	380.3	Gulmi (33/75)	Badigad (Gandaki)
C-08	Andhi Khola	180.0	Syangja (9/75)	Andhi Khola to Kali Gandaki (Gandaki)
W-02	Chera-1	148.7	Jajarkot (62/75)	Chera (Karnali)
W-05	Lower Jhimruk	142.5	Arghakhanchi (27/75), Pyuthan (54/75)	Jhimruk (Karnali)
W-06	Madi	199.8	Rolpa (66/75)	Madi (Karnali)
W-23	Nalsyau Gad	410.0	Jajarkot (62/75)	Nalsyau Gad (Karnali)
W-25	Naumure (W. Rapti)	245.0	Arghakhanchi (27/75), Pyuthan (54/75)	West Rapti (Karnali)

*): Development ranking based on the Composite Index (Source: Central Bureau of Statistics. 2003. District level indicators of Nepal for monitoring overall development. Kathmandu, Nepal.)

The locations of the promising projects are shown below in Figure 10.2.1.1-1.

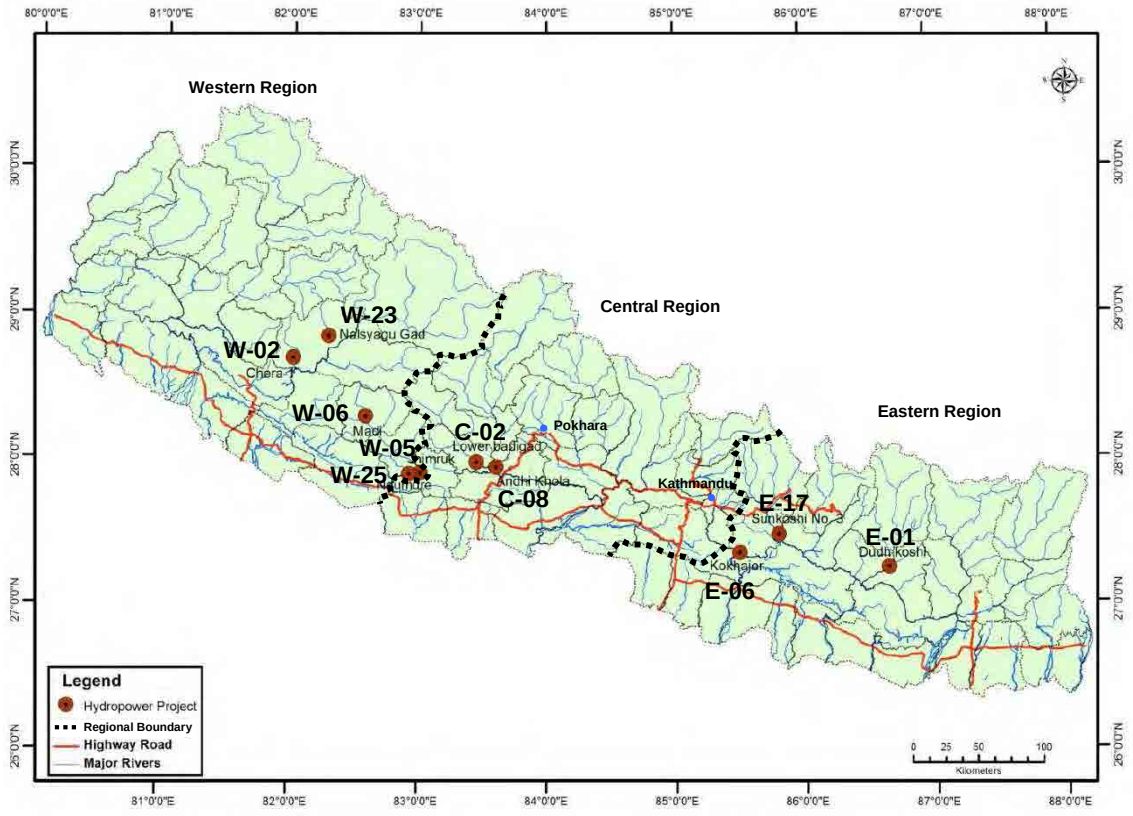


Figure 10.2.1.1-1 Locations of Promising Projects

The locations of promising projects are plotted in the isohyetal map and seismic hazard map of Nepal as follows. (See Figure 10.2.1.1-2 and Figure 10.2.1.1-3)

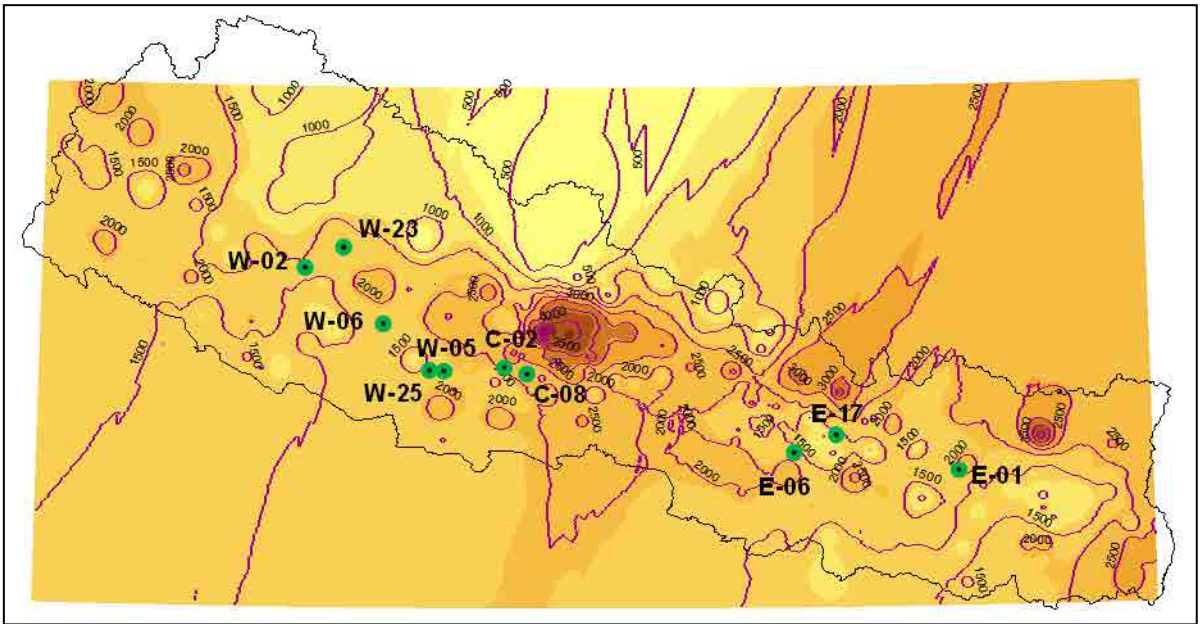


Figure 10.2.1.1-2 Locations of Promising Projects in an Isohyetal Map

Rainfall data at the nearest gauging station from each promising project site are shown in Table 10.2.1.1-2.

Table 10.2.1.1-2 Rainfall Data at the Nearest Gauging Stations for Promising Projects

(mm)

No.	Project Name	Gauging Station	Station Index	District	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
E-01	Dudh Koshi	OKHALDHUNGA	1206	Okhaldhunga	14.2	14.4	27.9	59.8	145.8	316.2	461.1	402.4	241.1	71.4	10.2	9.9	1,774.4
E-06	Kokhajor-1	PANCHKHAL	1036	Kabhre	11.8	16.9	21.4	44.2	98.1	202.2	291.3	286.4	165.3	51.0	7.6	13.4	1,209.5
E-17	Sun Koshi No.3	MANTHALI	1123	Ramechhap	14.3	13.6	24.2	40.5	85.8	143.6	295.7	203.8	123.7	36.1	5.6	7.0	994.0
C-02	Lower Badigad	TAMGHAS	0725	Gulmi	25.9	34.2	31.3	55.5	139.5	316.0	496.7	428.6	272.9	49.4	11.4	17.3	1,878.8
C-08	Andhi Khola	CHAPKOT	0810	Syangja	23.2	24.4	33.8	57.3	140.7	332.7	520.3	377.7	236.7	68.1	7.2	14.7	1,836.8
W-02	Chera-1	JAJARKOT	0404	Jajarkot	30.3	35.4	37.2	35.0	61.9	282.0	478.8	487.0	250.8	68.7	10.4	19.0	1,796.6
W-05	Lower Jhimruk	KHANCHIKOT	0715	Arghakhanchi	26.9	35.4	30.2	36.6	105.7	280.0	495.1	390.0	269.2	67.2	12.5	23.6	1,772.3
W-06	Madi	LIBANG GAUN	0504	Rolpa	28.1	48.0	39.5	46.9	106.6	293.5	417.3	382.7	264.0	53.6	10.3	17.0	1,707.5
W-23	Nalsyau Gad	JAJARKOT	0404	Jajarkot	30.3	35.4	37.2	35.0	61.9	282.0	478.8	487.0	250.8	68.7	10.4	19.0	1,796.6
W-25	Naumure	KHANCHIKOT	0715	Arghakhanchi	26.9	35.4	30.2	36.6	105.7	280.0	495.1	390.0	269.2	67.2	12.5	23.6	1,772.3

Source: Department of Hydrology and Meteorology: DHM

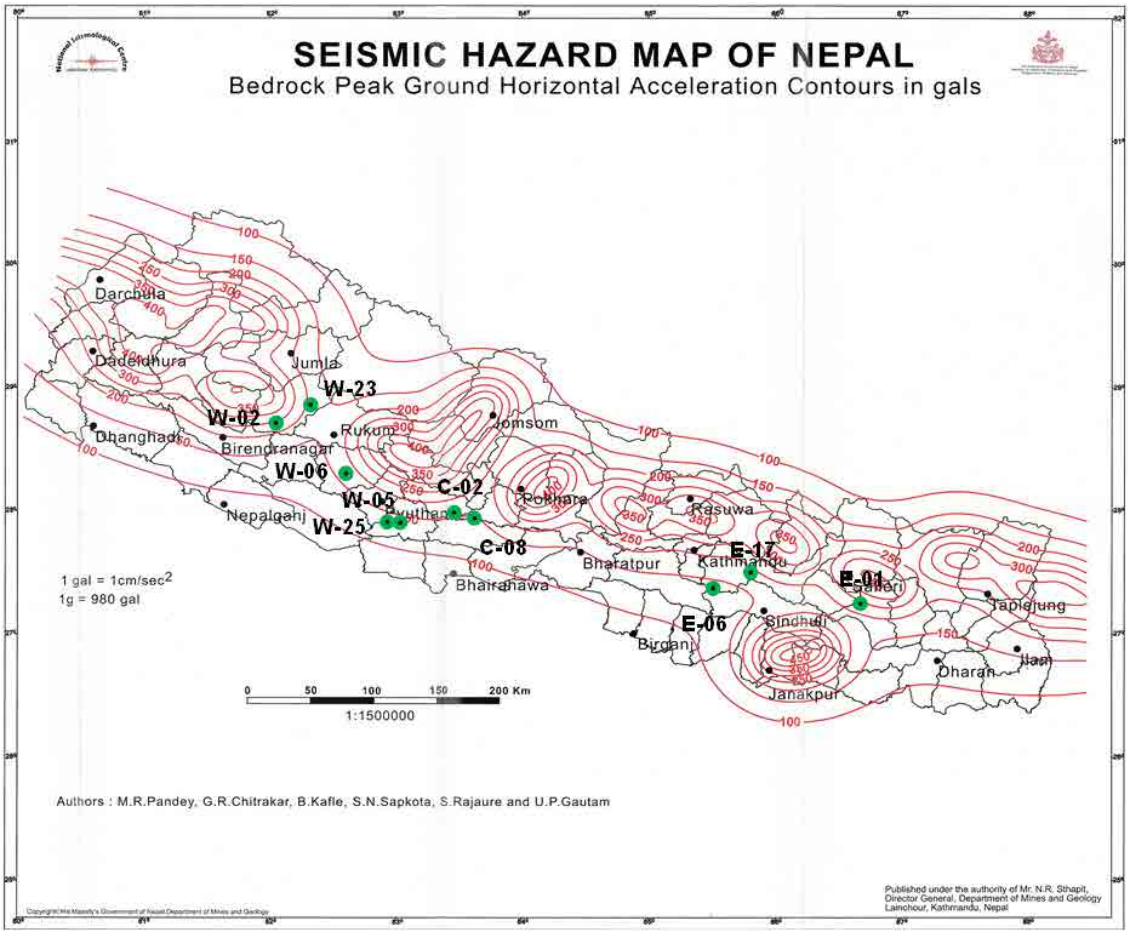


Figure 10.2.1.1-3 Locations of Promising Projects in a Seismic Hazard Map

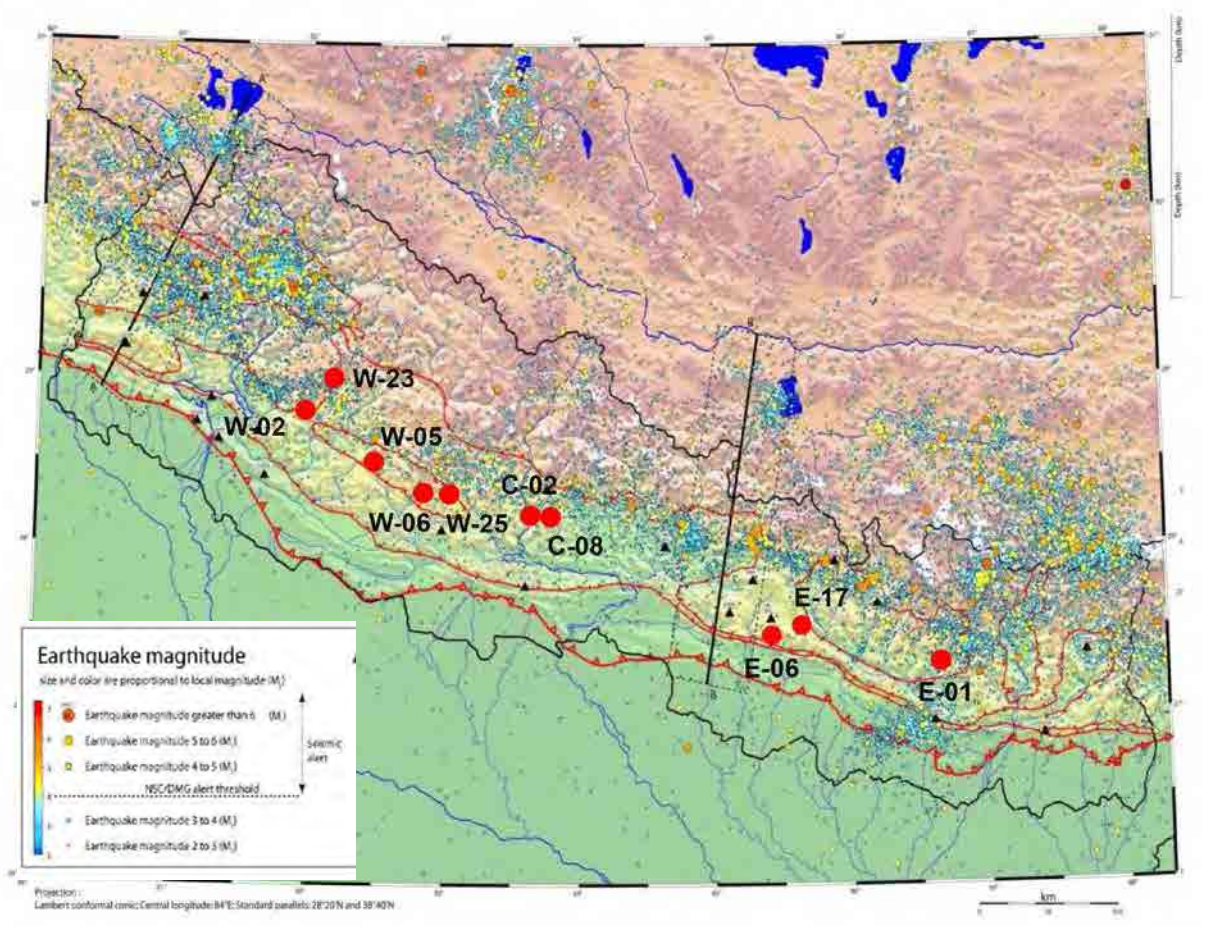


Figure 10.2.1.1-4 Locations of Promising Projects on an Earthquake Magnitude Map

The salient features of the promising projects are summarized in Table 10.2.1.1-3.

Table 10.2.1.1-3 Salient Features of Promising Projects

No.	Unit	E-01	E-06	E-17	C-02	C-08	W-02	W-05	W-06	W-23	W-25
Project Name		Dudh Koshi	Kokhajor-1	Sun Koshi No.3	Lower Badigad	Andhi Khola	Chera-1	Lower Jhimruk	Madi	Nalsyau Gad	Naumure (W. Rapti)
Installed Capacity	MW	300.0	111.5	536.0	380.3	180.0	148.7	142.5	199.8	410.0	245.0
Catchment Area	km^2	4,100.0	281.0	5,520.0	2,050.0	475.0	809.0	995.0	674.0	571.5	3,430.0
Dam Height	m	180.0	107.0	140.0	191.0	157.0	186.0	167.0	190.0	200.0	190.0
Total Storage Volume	MCM	687.4	218.7	1,220.0	995.9	336.5	254.9	386.0	359.5	419.6	1,021.0
Effective Storage Volume	MCM	442.1	166.1	555.0	505.5	238.7	141.1	211.6	235.1	296.3	580.0
Reservoir Area	km^2	11.1	4.6	30.1	13.7	5.5	4.0	6.0	7.7	6.3	19.8
Full Supply Level	m	580.0	437.0	700.0	688.0	675.0	866.0	597.0	1,090.0	1,570.0	517.0
Minimum Operating Level	m	530.0	390.0	674.0	654.0	626.7	814.0	557.0	1,030.0	1,498.0	474.2
Tail Water Level	m	303.4	200.0	575.0	475.0	368.5	640.0	390.0	800.0	872.0	358.0
Rated Gross Head	m	275.0	226.3	116.3	196.0	307.0	220.0	194.6	280.8	649.3	162.6
Rated Net Head	m	249.3	205.6	109.3	192.5	286.3	217.6	190.4	277.0	635.5	154.5
Rated Power Discharge	m^3/sec	136.0	63.9	570.0	232.6	81.4	80.5	88.1	84.9	75.0	185.6
Total Energy	GWh	1,909.6	278.9	1,883.6	1,366.0	648.7	563.2	454.7	621.1	1,406.1	1,157.5
Dry Energy	GWh	523.3	94.1	335.9	354.7	137.1	120.6	94.4	170.7	581.8	309.9
Length of Access Road	km	65.0	22.0	20.0	0	8.0	5.5	18.0	15.0	25.0	34.0
Length of Transmission Line	km	43.0	62.0	35.0	49.0	49.0	66.0	75.0	62.0	112.0	79.0
Project Cost	MUS$	1,144.0	476.5	1,690.5	1,209.8	665.8	576.9	520.9	637.3	966.9	954.5
Unit Generation Cost	¢ /kWh	6.0	17.1	9.0	8.9	10.3	10.2	11.5	10.3	6.9	8.2
EIRR (8% of Interest Rate, 12NRs/kWh)	%	17.6	7.6	13.1	13.2	13.0	12.6	10.9	12.3	15.6	15.2
FIRR (8% of Interest Rate, 12NRs/kWh)	%	30.0	n.a.	19.4	19.8	19.1	17.8	11.5	16.8	25.8	25.3
Forest Land to be submerged	km^2	4.1	2.9	8.2	3.3	1.5	1.5	1.9	1.6	0.8	7.9
Downstream Protected Area	nos	2	1	2	3	3	3	2	2	3	2
Protected Species in the Project Area	nos	20	11	18	17	15	16	19	15	8	20
Dewatering Area	km	60	21	1	4	60	7	8	10	11	1
Reported Fish species	nos	24	7	21	12	6	11	11	8	8	16
Resettlement (Household)	nos	63	92	1,599	1,606	542	566	229	336	263	456
Cultivated land to be submerged	km^2	3.3	1.7	9.4	5.9	1.7	1.1	2.0	1.9	2.5	6.1
Fishermen	nos	154	-	712	217	156	25	254	100	115	43
Road to be submerged	km	5	-	39	26	3	4	3	11	-	2

The source reports of the promising projects are shown in Table 10.2.1.1-4.

Table 10.2.1.1-4 Source Reports of Promising Projects

No.	Project Name	Source Report
E-01	Dudh Koshi	Dudh Koshi Hydroelectric Project Feasibility Study, 1998, CIWEC (Canadian International Water and Energy Consultants)
E-06	Kokhajor-1	Update and Review of Identification and Feasibility Study of Storage Project, 2002, NEA
E-17	Sun Koshi No.3	Master Plan Study on the Koshi River Water Resources Development, 1985, JICA
C-02	Lower Badigad	Update and Review of Identification and Feasibility Study of Storage Project, 2002, NEA
C-08	Andhi Khola	Feasibility Study on Andhi Khola Hydroelectric Project, 1998, NEA
W-02	Chera-1	Update and Review of Identification and Feasibility Study of Storage Project, 2002, NEA
W-05	Lower Jhimruk	Update and Review of Identification and Feasibility Study of Storage Project, 2002, NEA
W-06	Madi	Update and Review of Identification and Feasibility Study of Storage Project, 2002, NEA
W-23	Nalsyau Gad	Nalsyau Gad Storage Hydroelectric Project Feasibility Study, Executive Summary, 2012, NEA
W-25	Naumure (W.Rapti)	Naumure (W.Rapti) Hydroelectric Project Pre-Feasibility Study, 1990, NEA

In addition to the above, the following master plan studies have been conducted in terms of storage-type hydroelectric power projects.

- Identification and Feasibility Study of Storage Project, 2000-2004, NEA
- Master Plan of Hydroelectric Development in Nepal, 1974, JICA
- Gandaki River Basin Power Study, Basin Study, Basin Master Plan, 1979, UNDP
- Master Plan Study for Water Resource Development of the Upper Karnali River and Mahakali River Basin, 1993, JICA
- Medium Hydropower Study Project, Power Sector Efficiency Project, 1997, World Bank and CIWEC

Furthermore, the following studies such as Pre-FS, FS, etc. have been conducted for storage-type hydroelectric power projects.

- FS and DD on Budhi Gandaki Project, since 2012, GON
- Review of Indrawati Storage Hydroelectric Project, 2011, NEA

- Detailed Survey on Tamor (Terathum) Storage Project, 2010, NEA
- FS on Seti-Trisuli Project, 2005, NEA
- FS on Madi-Ishaneshore Storage Hydroelectric Project, 2002, NEA
- Pre-FS on Utter Ganga Storage Project, 2004, NEA
- Detailed Engineering on West Seti Project, 1997, GON
- FS on Kankai Project 1985, NEA
- Pre-FS on Kali Gandaki-2 Hydroelectric Project, 1985, NEA
- Preliminary Study on Thuligad, Seti-SR1 and Sarda -Kalleri, MOWR
- Bag-Mati Multipurpose Project, 1981, GON

The general layout and salient features of each promising project is shown from the next page.

(1) Dudh Koshi Project (E-01)

The Dudh Koshi Project is a 300 MW storage-type hydroelectric power project located in the Okhaldhunga, Khotang and Solukhumbu Districts in the eastern region. The intake is located at the Dudh Koshi river and the outlet is located at the Baiku Khola river. This project was originally discovered in the "Master Plan Study on the Koshi River Water Resources Development, 1985" carried out by JICA. After that, the "Dudh Koshi Hydroelectric Project Feasibility Study" was carried out by CIWEC (Canadian International Water and Energy Consultants) and the study results were summarized in the report in 1998.

As hydrological characteristics, the annual rainfall at the Okhaldhunga gauging station nearest to the project site is 1,774 mm and the average river discharge at the dam site is significant, 224 m^3/s. The catchment area is 4,100 km^2, and the specific sediment volume is estimated to be 2,540 $t/km^2/year$. This is smaller than the 3,300 $t/km^2/year$ value adopted by the NEA as an average specific sedimentation volume in the eastern region. It has to be noted that three glacier lakes having a high risk of a GLOF are identified in the drainage basin.

From a geological view point, the project area lies in the Lesser Himalaya Zone and is composed mainly of phyllite, quartzite, schist and gneiss. The reservoir area is underlain mainly by phyllite. This area is water tight and slopes in its surrounding area are stable. The dam site is underlain by quartzite and phyllite, which form relatively permeable rock. The headrace tunnel route passes phyllite, quartzite, schist, gneiss and three major local faults. The portions of overburden of more than about 1,000 m and crossing faults would need strong tunnel support. The underground power house is located in hard and compact gneiss rock. The project area is located in the area where a large acceleration of 240 mgal is shown on the seismic hazard map. However, it is away from large tectonic thrusts at a long distance of 26 km and from epicenters of larger than M4 at a relatively long distance of 10 km.

From the view point of the natural and social environment, the impact on the Natural Environment is relatively high and impact on the Social Environment is average. The Dudh Koshi Project is located in the Koshi river basin and the reservoir area is 11.1 km^2. The number of recorded plants is 67, which is the highest next to the Madi Project. The number of recorded fauna is relatively high, with numbers such as 24 mammals, 51 birds, and 17 Herpetofauna. The number of fish species is the highest, which is 24. The length of the dewatering area is 60km, which is the longest together with the Andhi Khola Project. The length of the Transmission Line is 43km, which is relatively short. The number of resettlements is the lowest, which is 63, and the number of resettlements per unit of generation power is also the lowest, around 0.21 HH/MW. The affected irrigation scheme is one which is relatively low. Rafting activities are found in the reservoir area. There is no development plan in the reservoir area. The Indigenous groups in the reservoir area are Newar (Advanced), Magar (Disadvantaged), Tamang (Disadvantaged) and Majhi (Marginalised).

From the view point of hydropower planning, two alternatives are compared in terms of layout in FS. One is a layout that has a rockfill dam and headrace tunnel of 13.3 km conducting water to the powerhouse with 127.35 m of a water head. The other is a layout that has a concrete gravity dam and powerhouse located at the left bank immediately downstream of the dam site. FS concludes that the layout of the rockfill dam and headrace tunnel is more economical. Although inflow into the Kurule dam, which diverts river water from the Sun Koshi river to the Kamala river for irrigation and hydropower projects in Sun Koshi Multipurpose Scheme (Phase

I) would decrease since the Kurule dam is located upstream of the outlet of the Dudh Koshi project, it is concluded that there would be no adverse effect because the necessary water volume could be secured for the projects. Further, FS also concludes that the flood volume of a GLOF is less than that of a PMF and can be controlled to flow down safely by installing an emergency spillway, assuming the case that the main spillway gates are out of order. However, a sand flushing facility such as that adopted in the Tanahu project, which enables flushing out the sediment produced by a GLOF has to be studied, since several glacier lakes having potential risk of a GLOF exist upstream of the Dudh Koshi project. The dam type that enables installation of such a sand flushing facility in the dam also has to be studied.

The location, basic layout and salient features of the project are shown below.

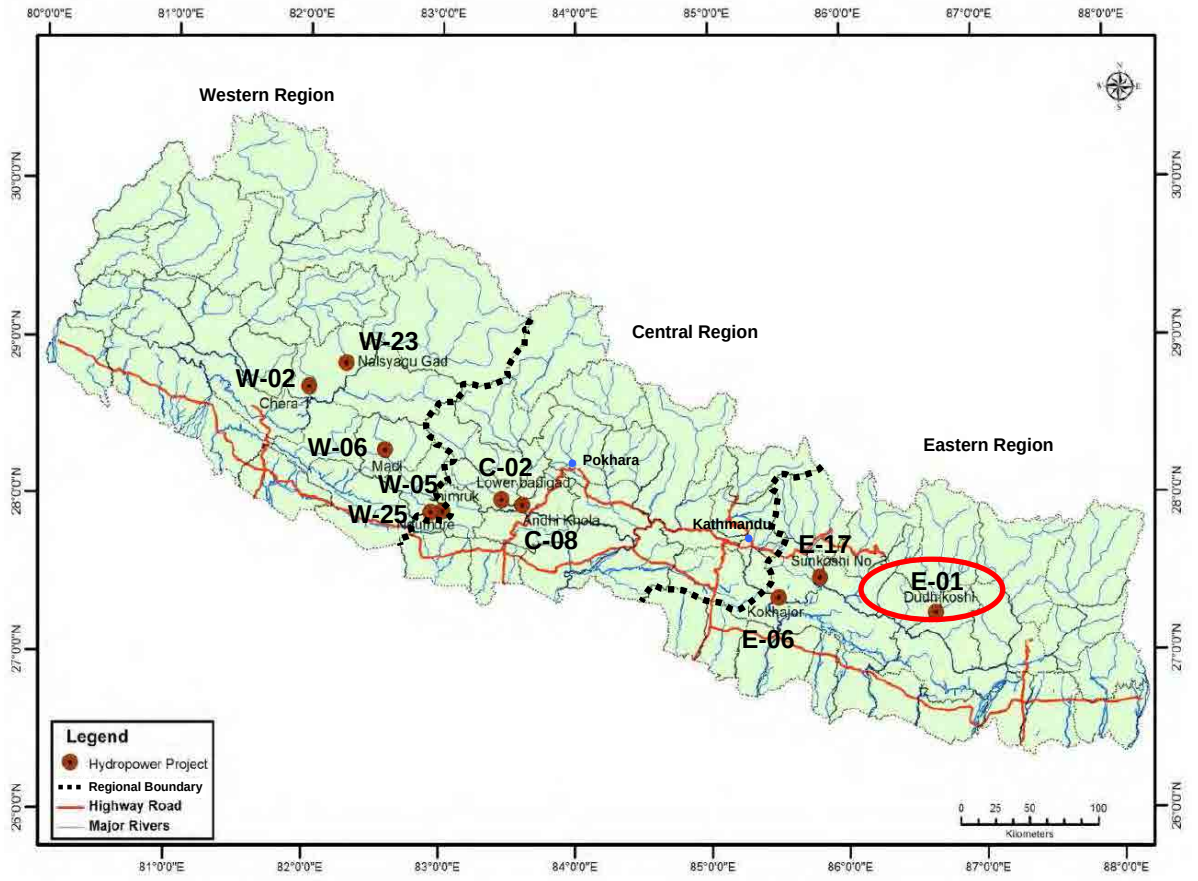


Figure 10.2.1.1-5 Location of the Dudh Koshi Project (E-01)

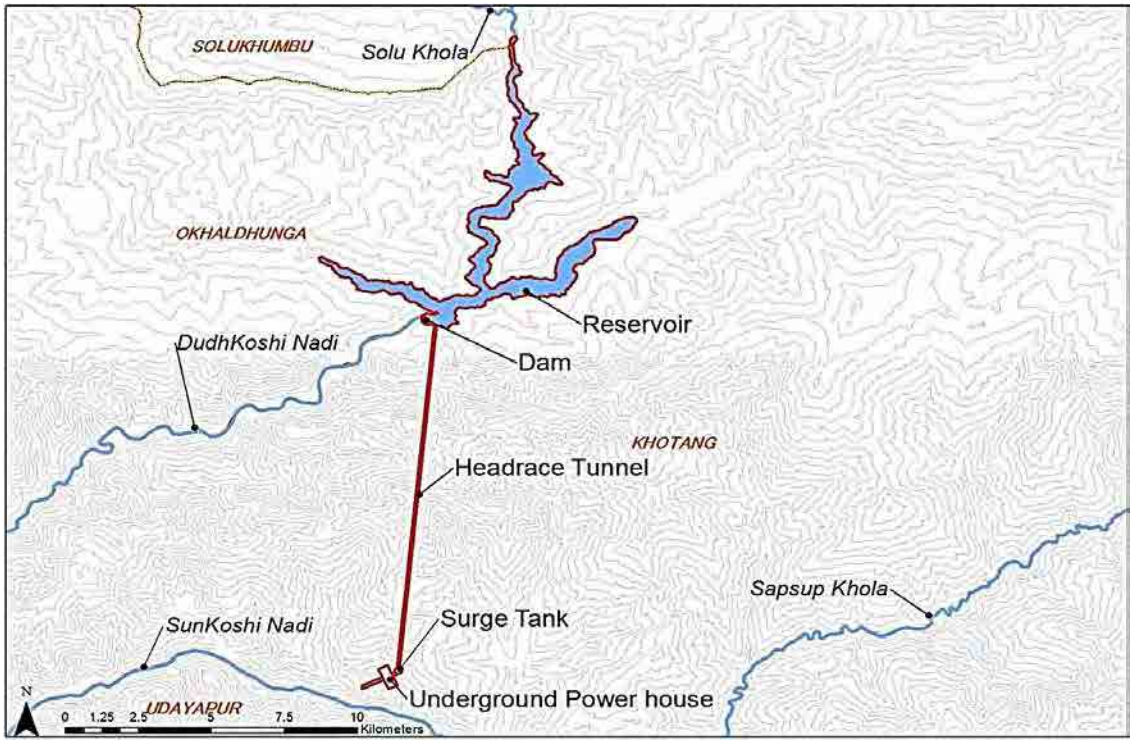


Figure 10.2.1.1-6 General Layout of the Dudh Koshi Project (E-01)

Table 10.2.1.1-5 Salient Features of the Dudh Koshi Project (E-01)

Item	Unit	Dudh Koshi Project
Installed Capacity	MW	300.0
Catchment Area	km^2	4,100.0
Dam Height	m	180.0
Total Storage Volume	MCM	687.4
Effective Storage Volume	MCM	442.1
Reservoir Area	km^2	11.1
Full Supply Level	m	580.0
Minimum Operating Level	m	530.0
Tail Water Level	m	303.4
Rated Gross Head	m	275.0
Rated Net Head	m	249.3
Rated Power Discharge	m^3/sec	136.0
Total Energy	GWh	1,909.6
Dry Energy	GWh	523.3
Length of Access Road	km	65.0
Length of Transmission Line	km	43.0
Project Cost	MUS$	1,144.0
Unit Generation Cost	¢ /kWh	6.0
EIRR (8% of Interest Rate, 12NRs/kWh)	%	17.6
FIRR (8% of Interest Rate, 12NRs/kWh)	%	30.0
Forest Land to be submerged	km^2	4.1
Downstream Protected Area	nos	2
Protected Species in the Project Area	nos	20
Dewatering Area	km	60
Reported Fish species	nos	24
Resettlement (Household)	nos	63
Cultivated land to be submerged	km^2	3.30
Fishermen	nos	154
Road to be submerged	km	5

(2) Kokhajor-1 Project (E-06)

The Kokhajor-1 Project is a 111.5 MW storage-type hydroelectric power project located in the Sinduli and Kabhrepalanchok Districts in the eastern region. The intake is located at the Kokhajor river and the outlet is located at the Bagmati river. The latest study for this project was conducted in the "Update and Review of Identification and Feasibility Study of Storage Project, 2002, NEA." The study level for this project stays at the desk study level.

As hydrological characteristics, the annual rainfall at Panchkhal gauging station nearest to the project site is 1,209.5 mm and the average river discharge at the dam site is 17 m^3/s. The drainage area is 281 km^2, and the specific sediment volume is estimated to be 5,900 $t/km^2/year$. This is larger than 3,300 $t/km^2/year$, which is the value adopted by the NEA as average specific sedimentation volume in the eastern region. No glacier lake having a high risk of a GLOF is identified in the drainage basin.

From a geological view point, the project area lies in the Sub Himalaya Zone and is composed mainly of conglomerate, sandstone and mudstone. The reservoir area is underlain mainly by conglomerate and sandstone. The conglomerate, not well cemented and pervious, provides a corner where water tightness should be confirmed and has slopes which are easily eroded. The dam site is underlain by sandstone and mudstone which form a relatively soft and relatively pervious rock. The headrace tunnel route passes sandstone and mudstone, which form a medium hard to relatively soft rock. The portions close to a maximum overburden of about 600 m and need strong tunnel support. The bedrock of the powerhouse site is composed of sandstone and mudstone. The project area is located in an area where a large acceleration of 300 mgal is shown on the seismic hazard map. It is close to a large tectonic thrust (MBT) at a short distance of 2.5 km. It is away from epicenters larger than M4 at a long distance of 26 km.

Impact on both the Natural Environment and the Social Environment is average. Kokhajor-1 is located in Bagmati river basin, and the reservoir area is 4.6 km^2, which is the smallest next to Chera-1. The number of recorded fauna is relatively low, with numbers such as 13 mammals, 21 birds, and 8 Herpetofauna. The number of resettlements is 92, which are the lowest next to Dudh Koshi and the number of resettlement per unit generation is also low, at about 0.83 HH/MW. The affected Agricultural Land area is the lowest at 1.7 km^2. There are only 2 affected irrigation schemes. One micro hydropower plant exists in the reservoir area. No fishermen were observed and neither drivable roads nor suspension bridges are affected. There used to be trouble related to construction of a cement plant. The Indigenous groups in the reservoir area are the Magar (Disadvantaged) and Tamang (Disadvantaged).

From the view point of hydropower planning, the proposed rockfill dam, which has a height of 107 m and volume of 4.7 million m^3, is the smallest among the 10 promising projects. Therefore, the risk in construction of the dam seems relatively low. In terms of the waterway layout, the length of the headrace tunnel is 6.6 km and the penstock is 2 km. Since the length of the waterway is relatively long, the works for the headrace tunnel will be on the critical path in the construction stage.

The location, basic layout and salient features of the project are shown below.

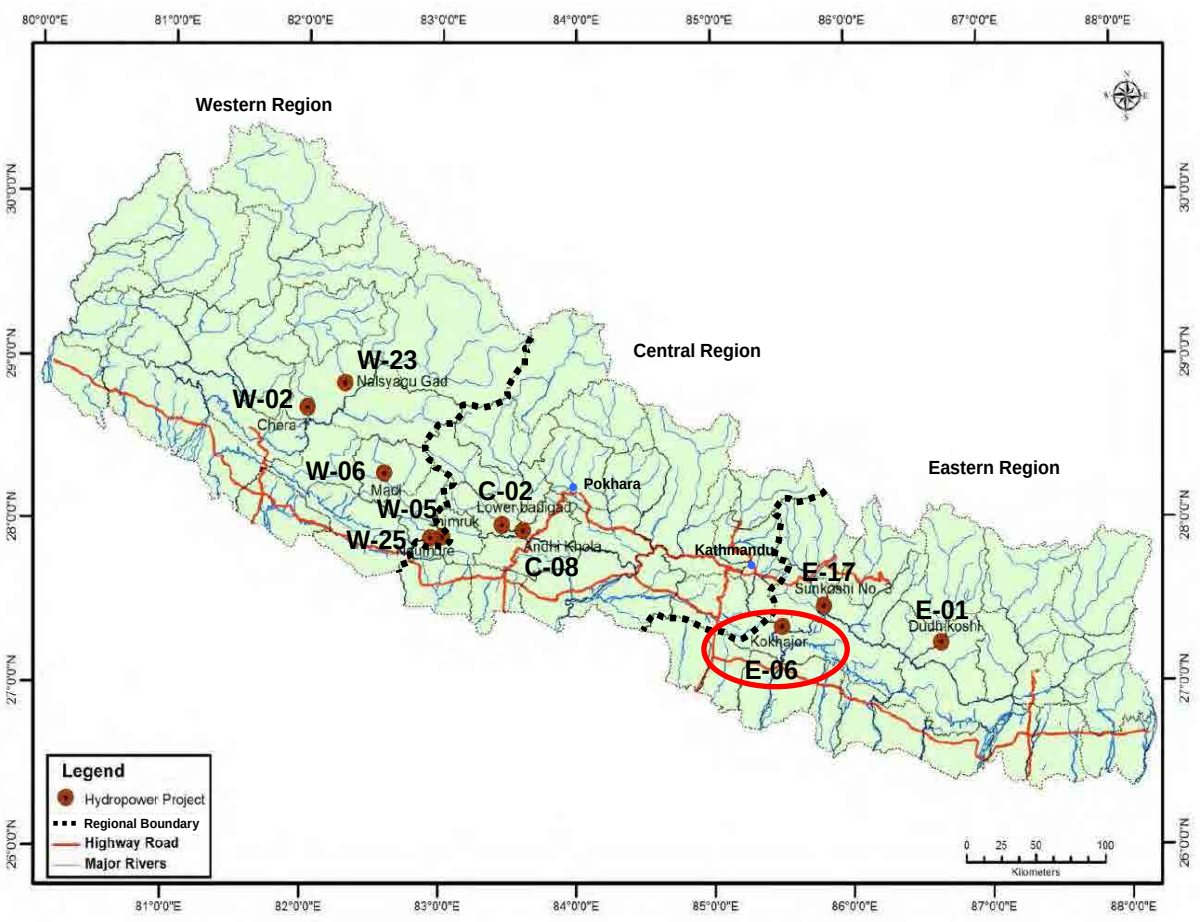


Figure 10.2.1.1-7 Location of the Kokhajor-1 Project (E-06)

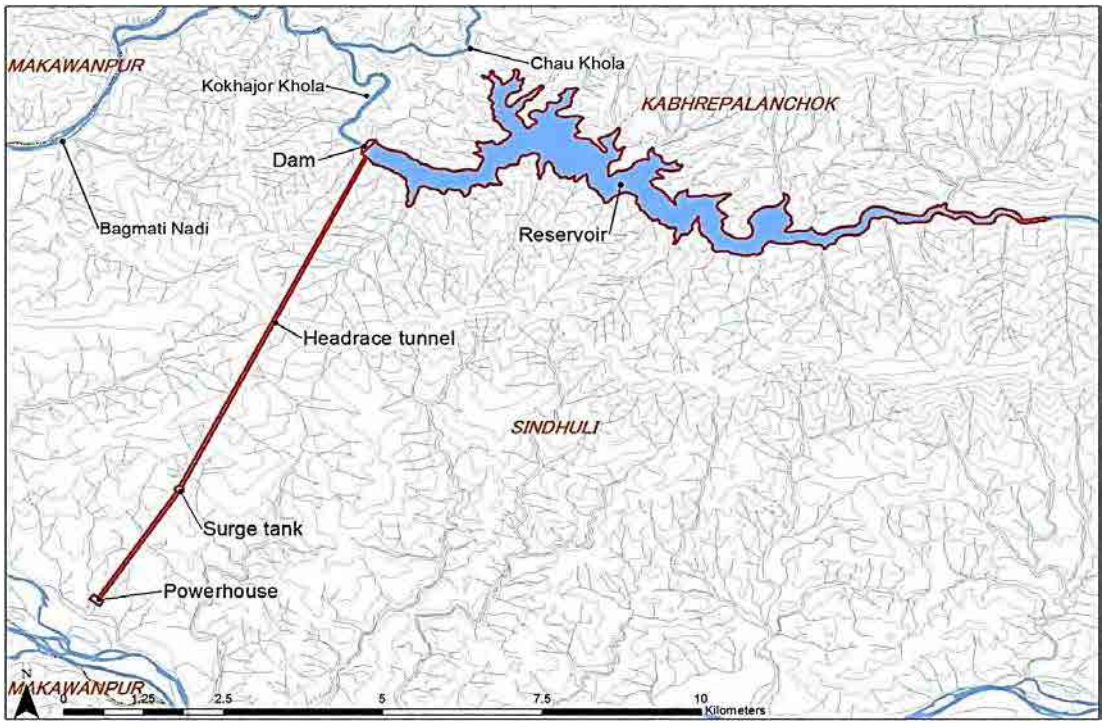


Figure 10.2.1.1-8 General Layout of the Kokhajor-1 Project (E-06)

Table 10.2.1.1-6 Salient Features of the Kokhajor-1 Project (E-06)

Item	Unit	Kokhajor-1 Project
Installed Capacity	MW	111.5
Catchment Area	km^2	281.0
Dam Height	m	107.0
Total Storage Volume	MCM	218.7
Effective Storage Volume	MCM	166.1
Reservoir Area	km^2	4.6
Full Supply Level	m	437.0
Minimum Operating Level	m	390.0
Tail Water Level	m	200.0
Rated Gross Head	m	226.3
Rated Net Head	m	205.6
Rated Power Discharge	m^3/sec	63.9
Total Energy	GWh	278.9
Dry Energy	GWh	94.1
Length of Access Road	km	22.0
Length of Transmission Line	km	62.0
Project Cost	MUS$	476.5
Unit Generation Cost	¢ /kWh	17.1
EIRR (8% of Interest Rate, 12NRs/kWh)	%	7.6
FIRR (8% of Interest Rate, 12NRs/kWh)	%	n.a.
Forest Land to be submerged	km^2	2.9
Downstream Protected Area	nos	1
Protected Species in the Project Area	nos	11
Dewatering Area	km	21
Reported Fish species	nos	7
Resettlement (Household)	nos	92
Cultivated land to be submerged	km^2	1.70
Fishermen	nos	-
Road to be submerged	km	-

(3) Sun Koshi No.3 Project (E-17)

The Sun Koshi No.3 Project is a 536 MW storage-type hydroelectric power project located at the Sun Koshi river in the Ramechhap, Kabhrepalanchok and Sindhupalchok Districts in the eastern region. This project was originally discovered in the "Master Plan Study on the Koshi River Water Resource Development, 1985" carried out by JICA. The study level for this project stays at the desk study level.

As hydrological characteristics, the annual rainfall at Manthali gauging station nearest to the project site is 994 mm, however, the average river discharge at the dam site is significant, 220 m^3/s. The catchment area is 5,520 km^2, and the specific sediment volume is estimated to be 1,871 $t/km^2/year$. This is smaller than 3,300 $t/km^2/year$, which is the value adopted by the NEA as average specific sedimentation volume in the eastern region. It has to be noted that two glacier lakes having a high risk of a GLOF are identified in the drainage basin.

From a geological view point, the project area lies in the Lesser Himalaya Zone and is composed mainly of quartzite, slate and phyllite. The reservoir area is underlain mainly by quartzite and slate. This area is water tight, but slopes in its surrounding area are widely covered with colluvium, which would provide many unstable slopes. The dam site is underlain by quartzite, which is intercalated by phyllite and forms hard and impervious rock. The headrace tunnel route passes through quartzite which is intercalated by phyllite, and forms hard and compact rock. The bedrock of the powerhouse site is composed of quartzite and phyllite. The project area is located in the area where a medium acceleration of 190 mgal is shown on the seismic hazard map. It is away from a large tectonic thrust (MBT) at a long distance of 16 km and from epicenters larger than M4 at a long distance of 28 km.

The impact on the Natural Environment is average and the impact on the Social Environment is high. Sun Koshi No.3 is located in the Koshi river basin and the reservoir area is 30.1 km^2, which is the largest in the 10 promising projects. The impact on forest is also the largest, which is 8.15 km^2. The number of recorded fishes is 21, which are relatively high. The dewatering area is the smallest at 0.5 km. The length of the Transmission Line is relatively shorter and is about 35 km. The number of resettlements is 1,599, which is the largest next to Lower Badigad. The affected Agricultural land is also the largest at 9.4 km^2. The number of affected fishermen will be 712 and the affected fish markets will be 7, which is the highest out of the 10 promising projects. Around 20,000 tourists are visiting the project site every year, which is the biggest impact on tourism. 15km of paved roads, 24.4 km of drivable roads, 13 suspension bridges, and 22 water supply schemes will be affected. Two irrigation projects, one ring road, one bridge, one water pump, and four road expansion projects are planned in the reservoir area. There used to be trouble related to the road expansion plan. The Indigenous groups in the reservoir area are the Newar (Advanced), Magar (Disadvantaged), Tamang (Disadvantaged), Majhi (Marginalised) and Tharu (Marginalised).

From the view point of hydropower planning, the proposed concrete dam with a height of 140 m makes a large effective reservoir volume of 555 million m^3. The large rated power discharge of 570 m^3/s is required to gain 536 MW of installed capacity due to the small effective head of 109 m. Therefore, a large size of electromechanical equipment is also required, which makes the construction cost relatively high. The setting of a full supply level of the reservoir has to be reviewed since 6 km of the Araniko Highway which will connect Nepal and China is to be submerged in the reservoir, having a length of 30 km in the current layout. Furthermore, a

spillway which can control a GLOF and a sand flushing facility which enables flushing out sedimentation produced by a GLOF has to be planned.

The location, basic layout and salient features of the project are shown below.

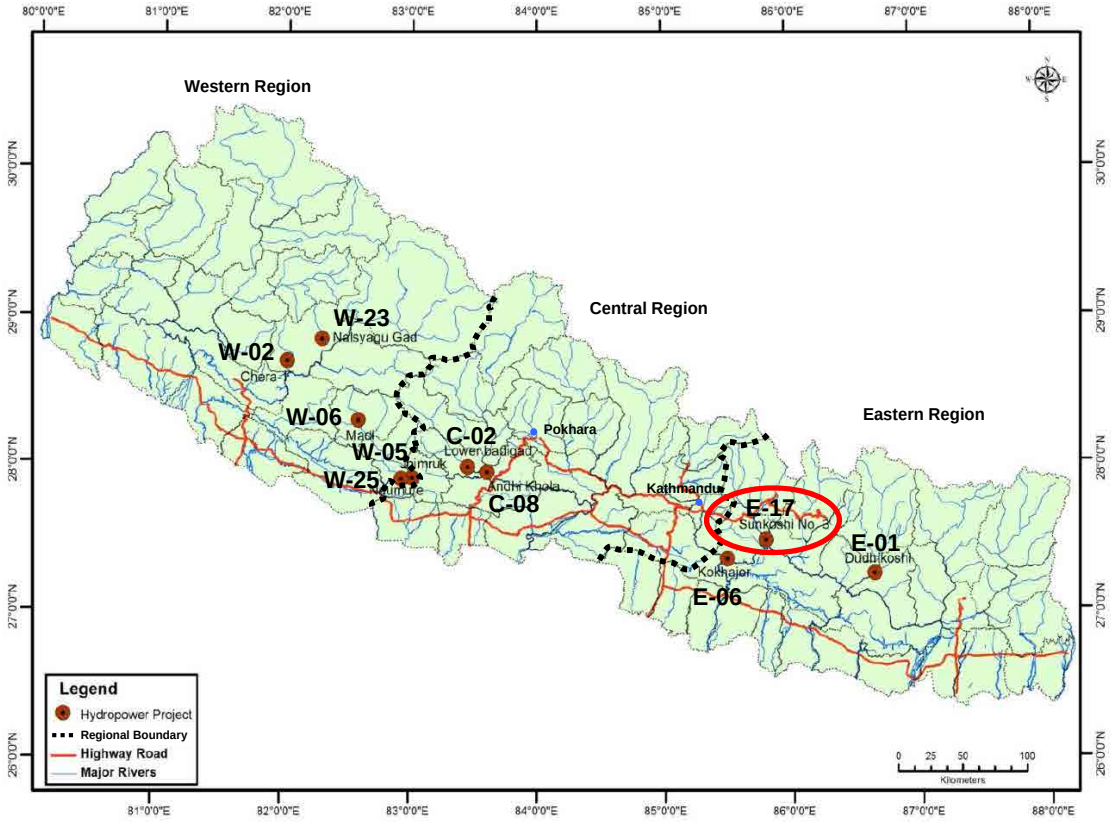


Figure 10.2.1.1-9 Location of the Sun Koshi No.3 Project (E-17)

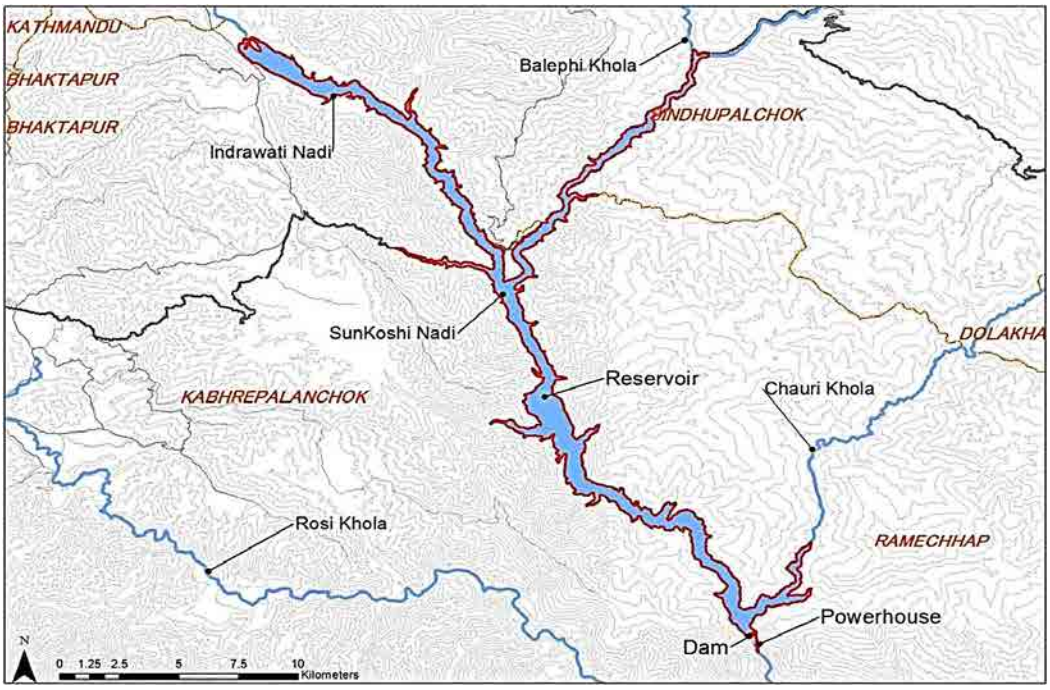


Figure 10.2.1.1-10 General Layout of the Sun Koshi No.3 Project (E-17)

Table 10.2.1.1-7 Salient Features of the Sun Koshi No.3 Project (E-17)

Item	Unit	Sun Koshi No.3 Project
Installed Capacity	MW	536.0
Catchment Area	km^2	5,520.0
Dam Height	m	140.0
Total Storage Volume	MCM	1,220.0
Effective Storage Volume	MCM	555.0
Reservoir Area	km^2	30.1
Full Supply Level	m	700.0
Minimum Operating Level	m	674.0
Tail Water Level	m	575.0
Rated Gross Head	m	116.3
Rated Net Head	m	109.3
Rated Power Discharge	m^3/sec	570.0
Total Energy	GWh	1,883.6
Dry Energy	GWh	335.9
Length of Access Road	km	20.0
Length of Transmission Line	km	35.0
Project Cost	MUS$	1,690.5
Unit Generation Cost	¢ /kWh	9.0
EIRR (8% of Interest Rate, 12NRs/kWh)	%	13.1
FIRR (8% of Interest Rate, 12NRs/kWh)	%	19.4
Forest Land to be submerged	km^2	8.2
Downstream Protected Area	nos	2
Protected Species in the Project Area	nos	18
Dewatering Area	km	1
Reported Fish species	nos	21
Resettlement (Household)	nos	1,599
Cultivated land to be submerged	km^2	9.40
Fishermen	nos	712
Road to be submerged	km	39

(4) Lower Badigad Project (C-02)

The Lower Badigad Project is a 380.3 MW storage-type hydroelectric power project located at the Badigad river in Gulmi District in the central region. The latest study for this project was conducted in the "Update and Review of Identification and Feasibility Study of Storage Project, 2002, NEA." The study level for this project stays at the desk study level.

As hydrological characteristics, the annual rainfall at the Tamghas gauging station nearest to the project site is 1,879 mm and the average river discharge at the dam site is 83.7 m^3/s. The drainage area is 2,050 km^2, and the specific sediment volume is estimated to be 2,526 $t/km^2/year$. This is larger than 4,400 $t/km^2/year$, which is the value adopted by the NEA as average specific sedimentation volume in the central region. No glacier lakes having a high risk of a GLOF are identified in the drainage basin.

From a geological view point, the project area lies in the Lesser Himalaya Zone and is composed mainly of quartzite, slate, phyllite and limestone. There is an active fault (named the Badigad Fault) along the Badigad River. The reservoir area is underlain mainly by slate and limestone. Limestone is limited in the reservoir area and would not affect water tightness. However, there is a major active landslide named Gultung Pahiro, which is located in the area surrounding the reservoir area and provides a large volume of sediment. The dam site is underlain by quartzite and slate, but it is crossed by the active Badigad Fault. The headrace tunnel route passes through slate and quartzite, which form hard and compact rock. Power house site is underlain mainly by slate. It is covered with thick river deposits. The project area is located in the area where a relatively small acceleration of 170mgal is shown on the seismic hazard map. It is away from a large tectonic thrust (MBT) at a long distance of 25km, but an active fault (the Badigad Fault) crosses the dam site. It is away from epicenters larger than M4 at a long distance of 30km.

The impact on the Natural Environment is average and the impact on the Social Environment is high. Lower Badigad is located in the Gandaki River Basin. The reservoir area is 13.7 km^2. There are three protected areas downstream of the river and five important species which depend on water habitat that are known. The length of the Transmission Line is relatively short at 49 km. The number of resettlements is the highest at 1,606. The number of resettlements per unit generation is the biggest at 4.22 HH/MW. The number of affected industries is also the highest at 11. The number of Indigenous groups is 7 (Newar (Advanced), Thakali (Advanced), Magar (Disadvantaged), Gurung (Disadvantaged), Tharu (Marginalised), Bote (Highly Marginalised), Majhi (Highly Marginalised)) which is the highest. The affected agricultural land is 5.9 km^2 which is relatively large. The affected irrigation systems are 58, which is the highest. The number of the fishermen is 217, which is relatively high. 26.1 km motorable roads, 11 suspension bridges, 2 micro hydropower plants and 29 water supply schemes will be affected.

From the view point of hydropower planning, the proposed rockfill dam with a height of 191 m makes a large effective reservoir volume of 505 million m^3. The rated power discharge of 233 m^3/s is required to gain 380 MW of installed capacity with an effective head of 192.5 m. Although the specific sediment yield for the Lower Badigad project is estimated from that for Andhi Khola project located adjacent to Lower Badigad, there is a possibility that the actual specific sediment yield would be substantially larger than the estimation since a large-scale land slide is confirmed in the reservoir as a result of the site reconnaissance. Therefore, a sand flushing facility such as that adopted in the Tanahu project, which enables flushing out the

sediment, has to be planned. Furthermore, the dam type that enables installing such a sand flushing facility in the dam also has to be studied.

The location, basic layout and salient features of the project are shown below.

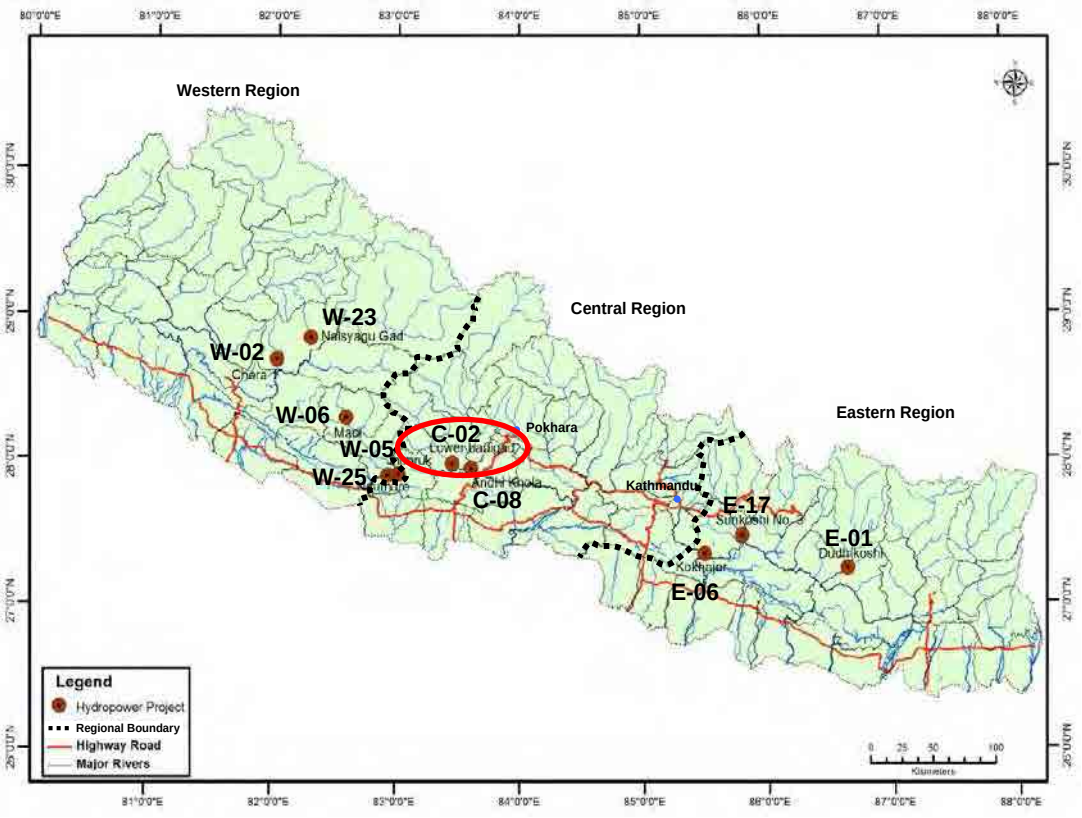


Figure 10.2.1.1-11 Location of the Lower Badigad Project (C-02)

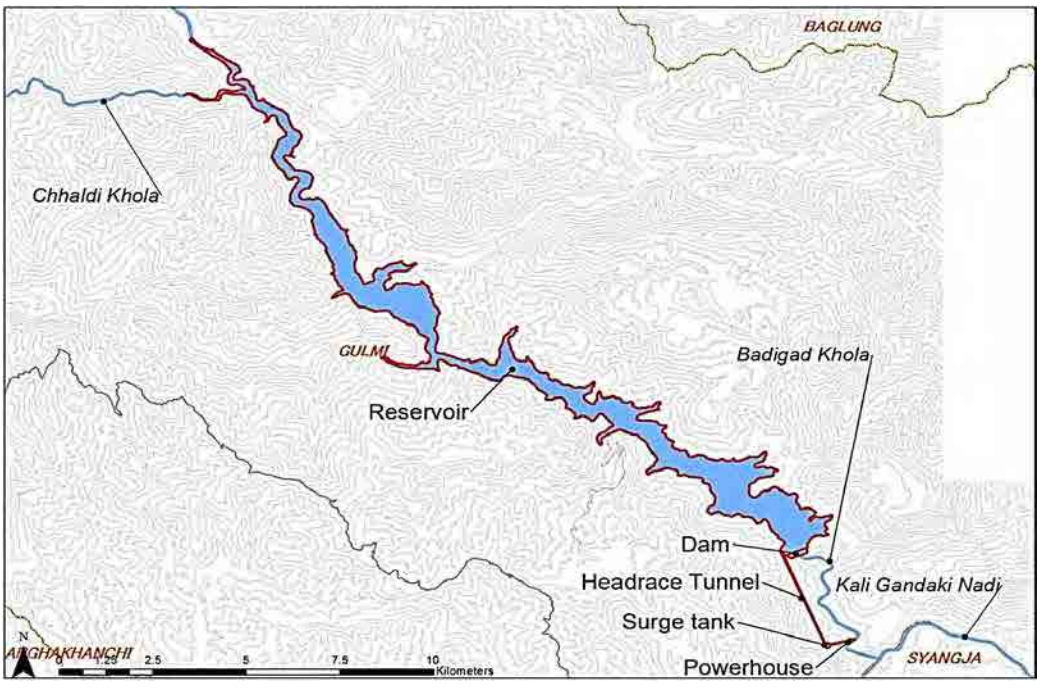


Figure 10.2.1.1-12 General Layout of the Lower Badigad Project (C-02)

Table 10.2.1.1-8 Salient Features of the Lower Badigad Project (C-02)

Item	Unit	Lower Badigad Project
Installed Capacity	MW	380.3
Catchment Area	km^2	2,050.0
Dam Height	m	191.0
Total Storage Volume	MCM	995.9
Effective Storage Volume	MCM	505.5
Reservoir Area	km^2	13.7
Full Supply Level	m	688.0
Minimum Operating Level	m	654.0
Tail Water Level	m	475.0
Rated Gross Head	m	196.0
Rated Net Head	m	192.5
Rated Power Discharge	m^3/sec	232.6
Total Energy	GWh	1,366.0
Dry Energy	GWh	354.7
Length of Access Road	km	0
Length of Transmission Line	km	49.0
Project Cost	MUS$	1,209.8
Unit Generation Cost	¢ /kWh	8.9
EIRR (8% of Interest Rate, 12NRs/kWh)	%	13.2
FIRR (8% of Interest Rate, 12NRs/kWh)	%	19.8
Forest Land to be submerged	km^2	3.3
Downstream Protected Area	nos	3
Protected Species in the Project Area	nos	17
Dewatering Area	km	4
Reported Fish species	nos	12
Resettlement (Household)	nos	1,606
Cultivated land to be submerged	km^2	5.9
Fishermen	nos	217
Road to be submerged	km	26

(5) Andhi Khola Project (C-08)

The Andhi Khola Project is a 180 MW storage-type hydroelectric power project located in the Syangja District in the central region. The intake is located at the Andhi Khola river and the outlet is located at the Kali Gandaki river. The latest study for this project was conducted in the "Feasibility Study on the Andhi Khola Hydroelectric Project, 2002, NEA." The study level for this project attains the Feasibility Study level.

As hydrological characteristics, the annual rainfall at the Chapkot gauging station nearest to the project site is 1,837 mm and the average river discharge at the dam site is 30.1 m^3/s. The drainage area is 4,750 km^2, and the specific sediment volume is estimated to be 2,526 $t/km^2/year$. This is larger than 4,400 $t/km^2/year$, which is the value adopted by the NEA as average specific sedimentation volume in the central region. No glacier lakes having a high risk of a GLOF are identified in the drainage basin.

From a geological view point, the project area lies in the Lesser Himalaya Zone and is composed mainly of slate. The reservoir area is mainly underlain by slate. This area is water tight, but many landslides are distributed on the slopes in its surrounding area. The dam site is underlain by slate, but it is not favorable for a dam site because its left bank is covered with thick deposits. The headrace tunnel route passes through slate, which forms fragile rock. The power house site is underlain by fragile slate. It is covered with thick river deposits. The project area is located in an area where a medium acceleration of 200 mgal is shown on the seismic hazard map. It is away from a large tectonic thrust (MBT) at a long distance of 25 km and from epicenters larger than M4 at a long distance of 40 km.

Both the impact on the Natural Environment and the Social Environment is average. Andhi Khola is located in the Gandaki River Basin and the reservoir area is 5.5 km^2. The affected forest area is only 1.51 km^2. The number of affected fauna is also low, with numbers such as 12 mammals, 16 birds, and 6 Herpetofauna. The dewatering area is 60 km, which is the longest together with Dudh Koshi. There are three protected areas downstream of the project site and five important species that depend on water are known. The length of the transmission line is 49 km, which is relatively short. The number of resettlement is 542, which is not high, but the resettlement per unit generation is relatively high at 3.01 HH/MW. The Indigenous groups in the reservoir area are the Newar (Advanced), Magar (Disadvantaged), and Gurung (Disadvantaged).

From the view point of hydropower planning, the location of proposed dam site for 157 m of a Concrete Faced Rockfill Dam (CFRD) has to be reviewed since the geological condition of the left bank of the dam site does not seem suitable as a foundation for a CFRD. The implementation of the Andhi Khola project will decrease inflow to the reservoir and energy production of the Kali Gandaki A project located downstream of the Andhi Khola project. On the other hand, rising of the intake dam is planned at the Kali Gandaki A Hydropower Plant. Therefore, implementation of the Andhi Khola project should be examined comprehensively in consideration of the Kali Gandaki A Hydropower Project.

Further, the Andhi Khola Hydropower Plant (5.1 MW) is owned and operated by the Butwal Power Company, and the plant exists in the reservoir. A comparison study was conducted in FS. In the study, two cases were compared. One was for abolishment with full compensation and the other was to continue to operate with some renovation by implementation of the Andhi Khola Storage Project. As a result of the study, it was concluded that to operate with some renovation will be more economical. At the moment, the power plant is under renovation to expand the

install capacity to 9 MW. The renovation work will be completed and commenced in 2013. Therefore, the handling of the renovated power plant in terms of compensation or reinforcement has to be reviewed.

The location, basic layout and salient features of the project are shown below.

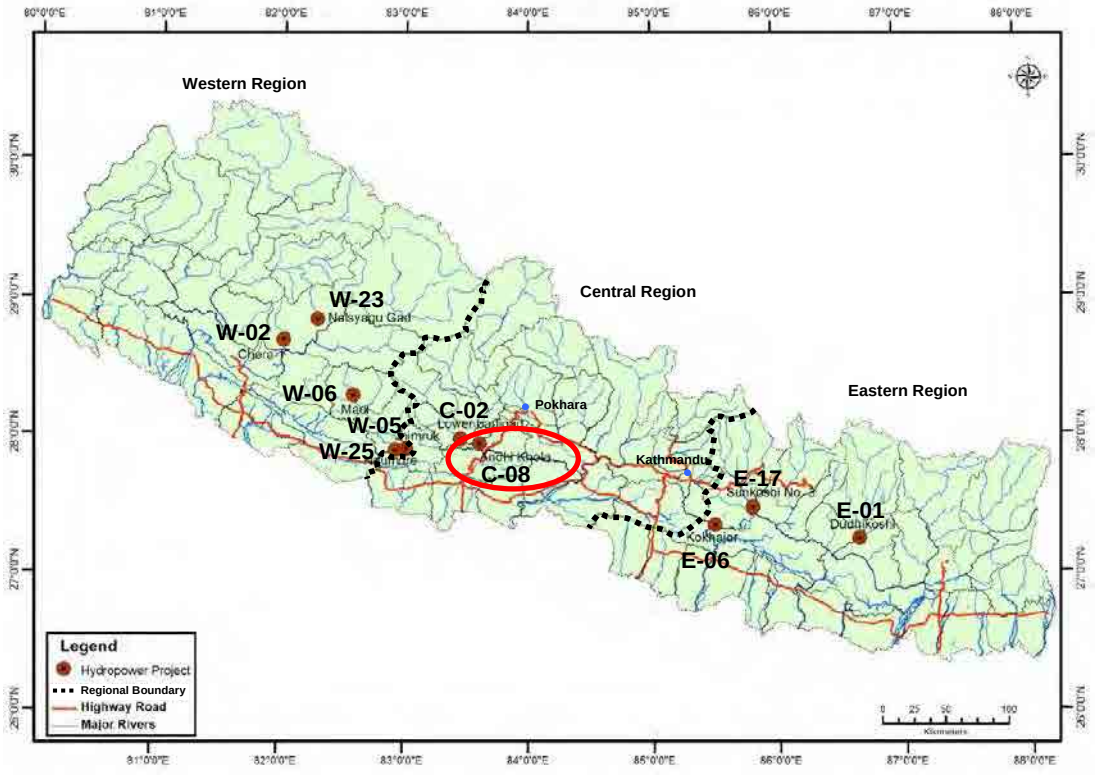


Figure 10.2.1.1-13 Location of the Andhi Khola Project (C-08)

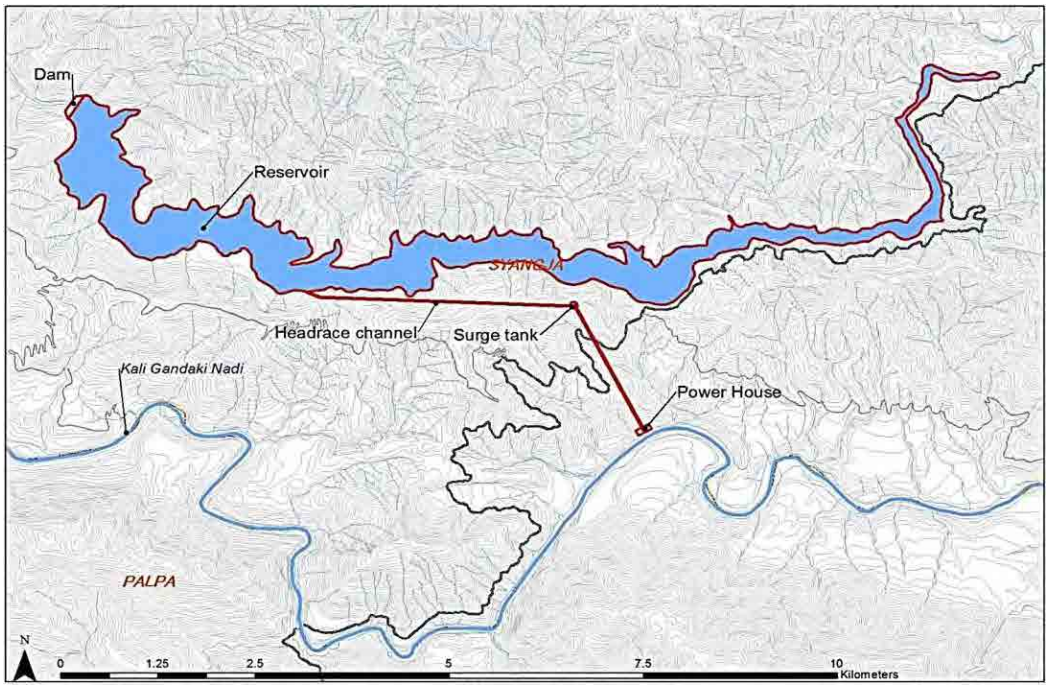


Figure 10.2.1.1-14 General Layout of the Andhi Khola Project (C-08)

Table 10.2.1.1-9 Salient Features of the Andhi Khola Project (C-08)

Item	Unit	Andhi Khola Project
Installed Capacity	MW	180.0
Catchment Area	km^2	475.0
Dam Height	m	157.0
Total Storage Volume	MCM	336.5
Effective Storage Volume	MCM	238.7
Reservoir Area	km^2	5.5
Full Supply Level	m	675.0
Minimum Operating Level	m	626.7
Tail Water Level	m	368.5
Rated Gross Head	m	307.0
Rated Net Head	m	286.3
Rated Power Discharge	m^3/sec	81.4
Total Energy	GWh	648.7
Dry Energy	GWh	137.1
Length of Access Road	km	8.0
Length of Transmission Line	km	49.0
Project Cost	MUS$	665.8
Unit Generation Cost	¢ /kWh	10.3
EIRR (8% of Interest Rate, 12NRs/kWh)	%	13.0
FIRR (8% of Interest Rate, 12NRs/kWh)	%	19.1
Forest Land to be submerged	km^2	1.5
Downstream Protected Area	nos	3
Protected Species in the Project Area	nos	15
Dewatering Area	km	60
Reported Fish species	nos	6
Resettlement (Household)	nos	542
Cultivated land to be submerged	km^2	1.7
Fishermen	nos	156
Road to be submerged	km	3

(6) Chera-1 Project (W-02)

The Chera-1 Project is a 148.7 MW storage-type hydroelectric power project located at the Chera river in the Jajarkot District in the western region. The latest study for this project was conducted in the "Update and Review of Identification and Feasibility Study of Storage Project, 2002, NEA." The study level for this project remains at the desk study level.

As hydrological characteristics, the annual rainfall at the Jajarkot gauging station nearest to the project site is 1,797 mm and the average river discharge at the dam site is 34.81 m^3/s. The drainage area is 809 km^2, and the specific sediment volume is estimated to be 1,000 $t/km^2/year$. This is larger than 3,960 $t/km^2/year$, which is the value adopted by the NEA as average specific sedimentation volume in the central region. No glacier lakes having a high risk of a GLOF are identified in the drainage basin.

From a geological view point, the project area lies in the Lesser Himalaya Zone and is composed mainly of meta-diamictite, quartzite and schist. The reservoir area is underlain mainly by meta-diamictite, quartzite and schist. Meta-diamictite is calcareous and should be investigated to confirm its water tightness. The dam site is underlain by meta-diamictite, which needs further investigation to confirm water tightness. The headrace tunnel route passes through meta-diamictite, schist and quartzite, which form hard and compact rock. The bedrock of the powerhouse site is mainly composed of quartzite. The project area is located in an area where a large acceleration of 250mgal is shown on the seismic hazard map. However, it is away from a large tectonic thrust (MBT) at a long distance of 30km and from epicenters larger than M4 at a relatively long distance of 10km.

The impact on the Natural Environment is average and the impact on the Social Environment is low. Chera-1 is located in the Karnali river basin and the reservoir is the smallest at 4km^2. The affected forest area is 1.46 km^2, which is the smallest next to Nalsyau Gad. There are three projected areas downstream of the project area and six important species that depend on water are known. The number of resettlements is 566, which is average, but the number of resettlements per unit generation is 3.81 HH/MW, which is the highest next to Lower Badigad. There is only one affected Indigenous group (Magar (Disadvantaged)). The affected Agricultural land is 1.1 $km^{2,}$ which is also the smallest next to Kokhajor-1. The number of fishermen is small at 25. There are no big development plans in the reservoir area.

From the view point of hydropower planning, a large rockfill dam with a height of 186 m and volume of 10 million m^3 is planned. Since it is recognized that the geological condition at dam site has to be confirmed in terms of water tightness, the works for dam will be on the critical path on the construction stage. The length of headrace tunnel is approximately 4 km. In the current layout, no specific risks are identified at the tunnel site in terms of geological conditions. The powerhouse is of a conventional open type, and no specific technical risks are identified at the powerhouse site.

The location, basic layout and salient features of the project are shown below.

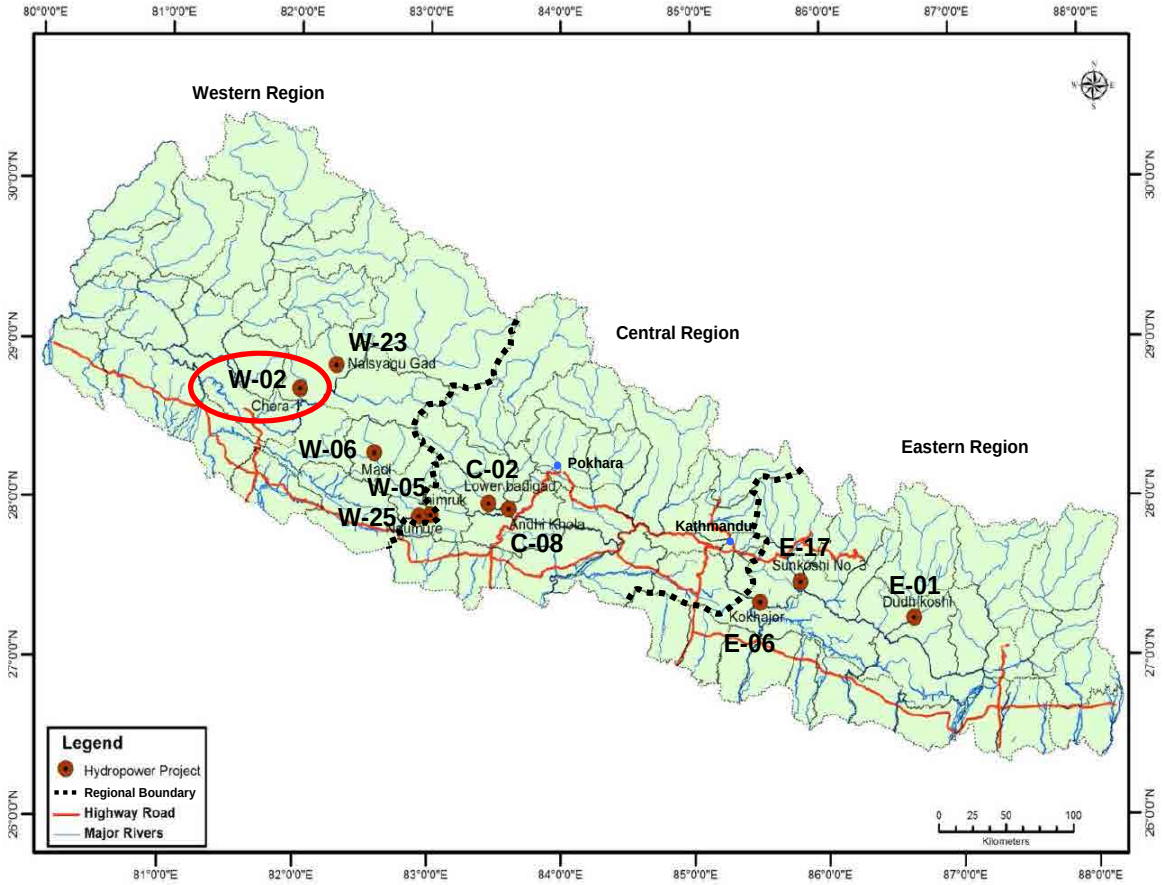


Figure 10.2.1.1-15 Location of the Chera-1 Project (W-02)

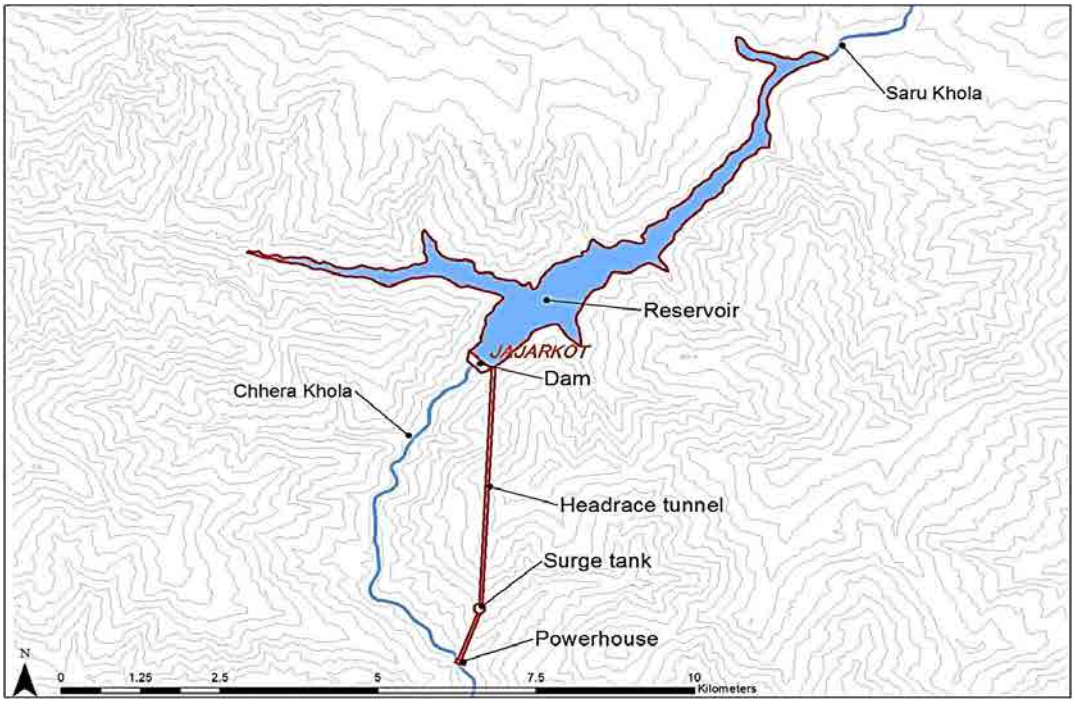


Figure 10.2.1.1-16 General Layout of the Chera-1 Project (W-02)

Table 10.2.1.1-10 Salient Features of the Chera-1 Project (W-02)

Item	Unit	Chera-1 Project
Installed Capacity	MW	148.7
Catchment Area	km^2	809.0
Dam Height	m	186.0
Total Storage Volume	MCM	254.9
Effective Storage Volume	MCM	141.1
Reservoir Area	km^2	4.0
Full Supply Level	m	866.0
Minimum Operating Level	m	814.0
Tail Water Level	m	640.0
Rated Gross Head	m	220.0
Rated Net Head	m	217.6
Rated Power Discharge	m^3/sec	80.5
Total Energy	GWh	563.2
Dry Energy	GWh	120.6
Length of Access Road	km	5.5
Length of Transmission Line	km	66.0
Project Cost	MUS$	576.9
Unit Generation Cost	¢ /kWh	10.2
EIRR (8% of Interest Rate, 12NRs/kWh)	%	12.6
FIRR (8% of Interest Rate, 12NRs/kWh)	%	17.8
Forest Land to be submerged	km^2	1.5
Downstream Protected Area	nos	3
Protected Species in the Project Area	nos	16
Dewatering Area	km	7
Reported Fish species	nos	11
Resettlement (Household)	nos	566
Cultivated land to be submerged	km^2	1.1
Fishermen	nos	25
Road to be submerged	km	4

(7) Lower Jhimruk Project(W-05)

The Lower Jhimruk Project is a 142.5 MW storage-type hydroelectric power project located at the Jhimruk river in the Arghakhachi District and the Pyuthan District in the western region. The latest study for this project was conducted in the "Update and Review of Identification and Feasibility Study of Storage Project, 2002, NEA." The study level for this project remains at the desk study level.

As hydrological characteristics, the annual rainfall at the Khanchikot gauging station nearest to the project site is 1,772 mm and the average river discharge at the dam site is 33.9 m^3/s. The drainage area is 995 km^2, and the specific sediment volume is estimated to be 5,750 $t/km^2/year$. This is larger than 3,960 $t/km^2/year$, which is the value adopted by the NEA as average specific sedimentation volume in the western region. No glacier lakes having a high risk of a GLOF are identified in the drainage basin.

From a geological view point, the project area lies in the Lesser Himalaya Zone and is composed mainly of shale, sandstone and dolomite. The reservoir area is underlain mainly by shale, sandstone and dolomite. Dolomite should be investigated to confirm its water tightness. The dam site is underlain by shale and sandstone, which form sound and impervious bedrock. The headrace tunnel route passes through shale and sandstone, which would form hard and compact rock. It also passes through one major fault. The bedrock of the powerhouse site is composed of sheared slate, which would decrease the stability of slopes behind the powerhouse site. The project area is located in an area where a relatively small acceleration of 150 mgal is shown on the seismic hazard map. It is away from epicenters larger than M4 at a long distance of 34 km. However, it is close to a large tectonic thrust (MBT) at a short distance of 2 km.

The impact on the Natural Environment is average and the impact on the Social Environment is low. Lower Jhimruk is located in the Rapti river basin and the reservoir area is 6 km^2. The affected forest area is not large at 1.87 km^2. The recorded number of plants is relatively high at 55. The recorded number of fauna is relatively high with numbers such as 23 mammals, 49 birds, and 17 Herpetofauna. The number of resettlements is 229. There are 3 affected irrigation systems. The number of fishermen is 254, which is relatively high next to Sun Koshi No.3. The Indigenous groups in the reservoir area are the Newar (Advanced), Magar (Disadvantaged), Gurung (Disadvantaged) and Kumal (Marginalised).

From the view point of hydropower planning, a rockfill dam with a height of 167 m and a volume of 7 million m^3 as well as a headrace tunnel of 6 km are planned. In the current layout, the dam and powerhouse of the Lower Jhimruk project are located in the reservoir of the Naumure project located downstream of the Lower Jhimruk. Therefore, it is impossible to construct both projects with the current layouts. It is at least necessary to change the layout of either project to implement both projects.

The location, basic layout and salient features of the project are shown below.

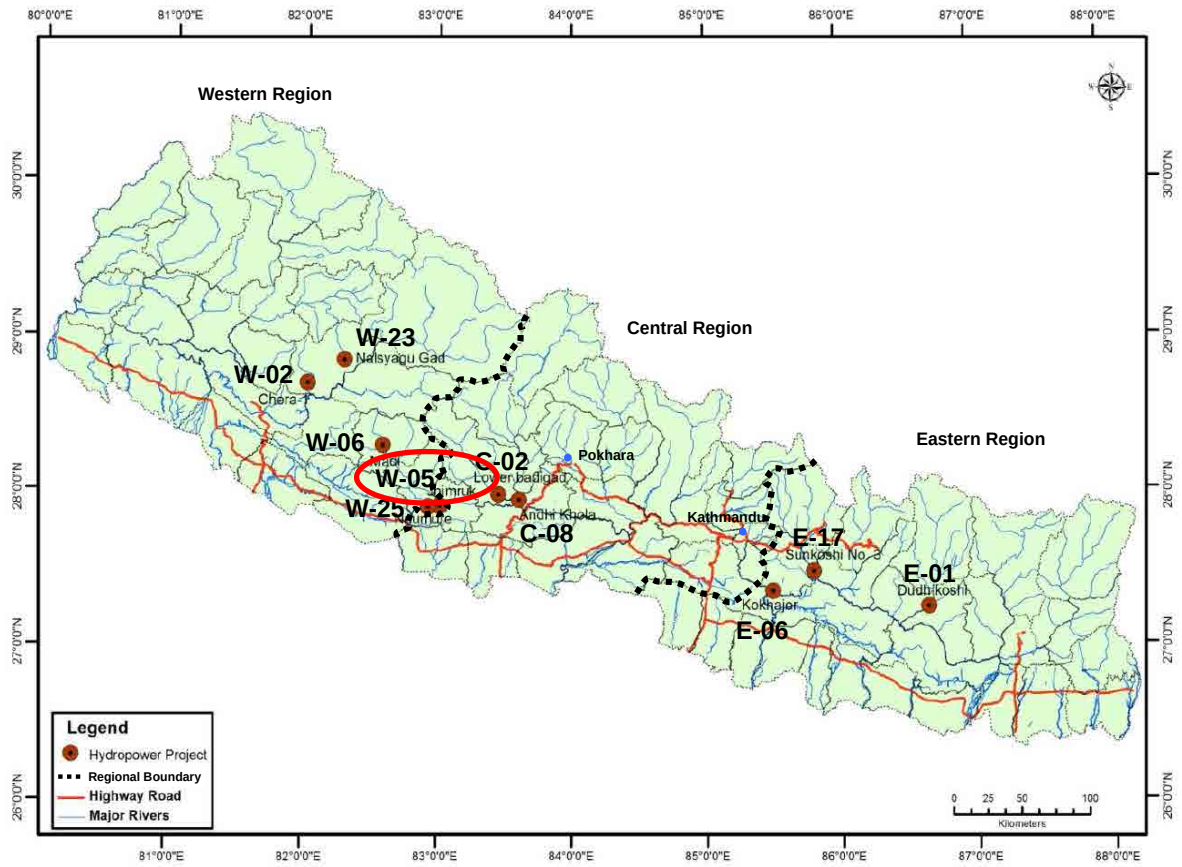


Figure 10.2.1.1-17 Location of the Lower Jhimruk Project (W-05)

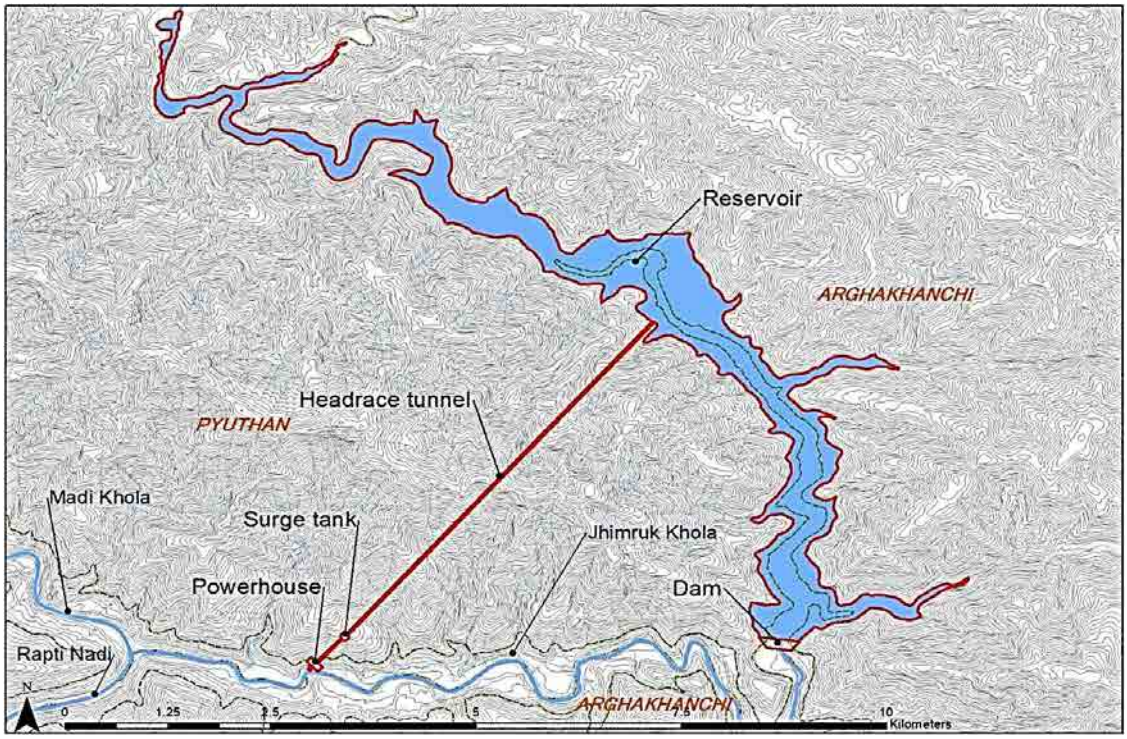


Figure 10.2.1.1-18 General Layout of the Lower Jhimruk Project (W-05)

Table 10.2.1.1-11 Salient Features of the Lower Jhimruk Project (W-05)

Item	Unit	Lower Jhimruk Project
Installed Capacity	MW	142.5
Catchment Area	km^2	995.0
Dam Height	m	167.0
Total Storage Volume	MCM	386.0
Effective Storage Volume	MCM	211.6
Reservoir Area	km^2	6.0
Full Supply Level	m	597.0
Minimum Operating Level	m	557.0
Tail Water Level	m	390.0
Rated Gross Head	m	194.6
Rated Net Head	m	190.4
Rated Power Discharge	m^3/sec	88.1
Total Energy	GWh	454.7
Dry Energy	GWh	94.4
Length of Access Road	km	18.0
Length of Transmission Line	km	75.0
Project Cost	MUS$	520.9
Unit Generation Cost	¢ /kWh	11.5
EIRR (8% of Interest Rate, 12NRs/kWh)	%	10.9
FIRR (8% of Interest Rate, 12NRs/kWh)	%	11.5
Forest Land to be submerged	km^2	1.9
Downstream Protected Area	nos	2
Protected Species in the Project Area	nos	19
Dewatering Area	km	8
Reported Fish species	nos	11
Resettlement (Household)	nos	229
Cultivated land to be submerged	km^2	2.0
Fishermen	nos	254
Road to be submerged	km	3

(8) Madi Project (W-06)

The Madi Project is a 199.8 MW storage-type hydroelectric power project located at the Madi river in the Rolpa District in the western region. The latest study for this project was conducted in the "Update and Review of Identification and Feasibility Study of Storage Project, 2002, NEA." The study level for this project remains at the desk study level.

As hydrological characteristics, the annual rainfall at the Libang Gaun gauging station nearest to the project site is 1,708 mm and the average river discharge at the dam site is 30.6 m^3/s. The drainage area is 674 km^2, and the specific sediment volume is estimated to be 5,750 $t/km^2/year$. This is larger than 3,960 $t/km^2/year$, which is the value adopted by NEA as average specific sedimentation volume in the western region. No glacier lakes having a high risk of a GLOF is identified in the drainage basin.

From a geological view point, the project area lies in the Lesser Himalaya Zone and is composed mainly of limestone, shale, slate and sandstone. The reservoir area is underlain mainly by limestone, shale and sandstone. The limestone should be investigated to confirm its water tightness. Large landslides are distributed in the reservoir surrounding area, which is widely covered by colluvium. The dam site is underlain by limestone and slate, which form sound bedrock. The limestone seems watertight because it is siliceous and without any solution features on its surface. The headrace tunnel route passes through slate and limestone, which would form hard and compact rock. The bedrock of the powerhouse site is composed of slate and limestone. The project area is located in an area where a relatively small acceleration of 160 mgal is shown on the seismic hazard map. It is away from a large tectonic thrust (MBT) at a long distance of 25 km and from epicenters the larger than M4 at a long distance of 35 km.

The impact on the Natural Environment is average and the impact on the Social Environment is relatively lower. Madi is located in the Rapti river basin and the reservoir area is 7.7km^2. The affected forest area is small at 1.64 km^2. The number of recorded plant species is the largest at 74. The number of recorded fauna is relatively low, with numbers such as 18 mammals, 21 birds, and 9 Herpetofauna. The number of resettlement is 336. 11.2 km of drivable roads, 6 suspension bridges, and 22 water supply schemes will be affected. The Indigenous group in the reservoir area is the Magar (Disadvantaged).

From the view point of hydropower planning, a rockfill dam with a height of 190 m and volume of 9 million m^3 as well as a headrace tunnel of 6 km are planned. In the current layout, no specific risks are identified at the dam site and tunnel site in terms of geological conditions. The powerhouse is of a conventional open type, and no specific technical risks are identified at the powerhouse site.

The location, basic layout and salient features of the project are shown below.

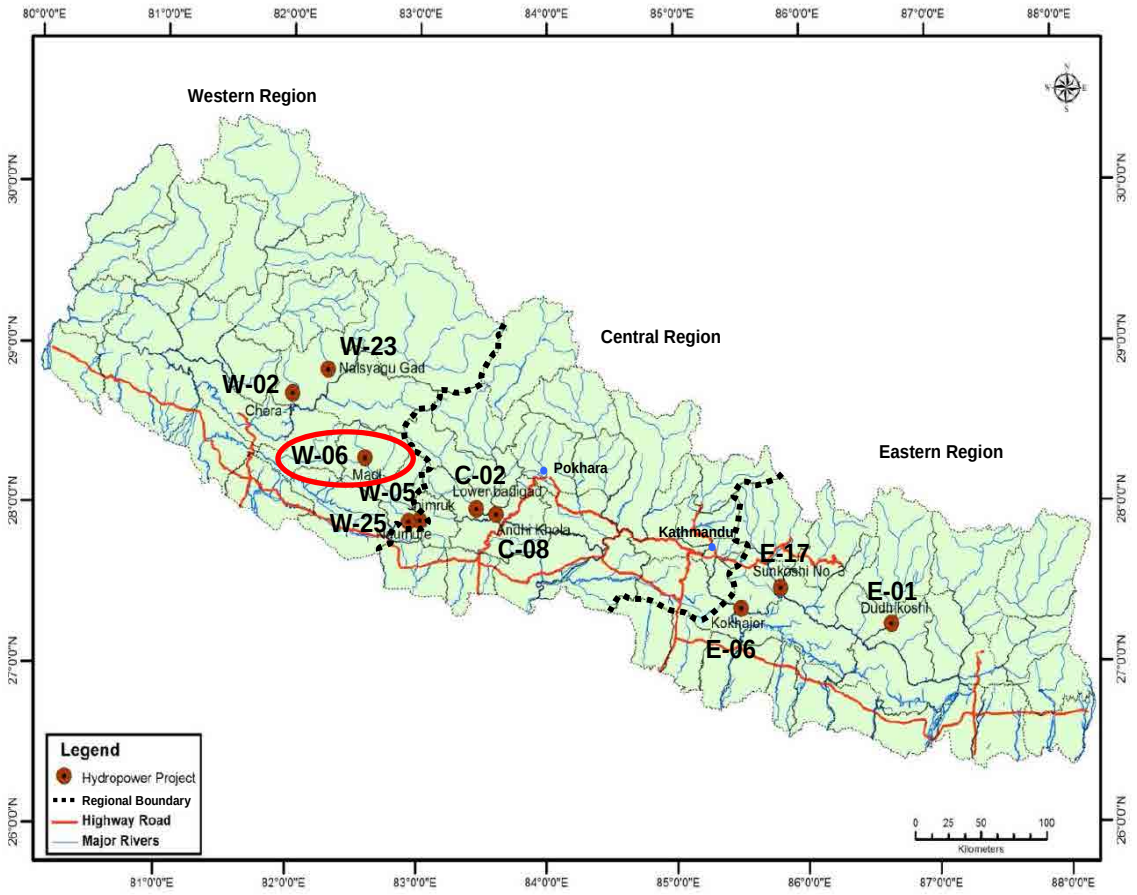


Figure 10.2.1.1-19 Location of the Madi Project (W-06)

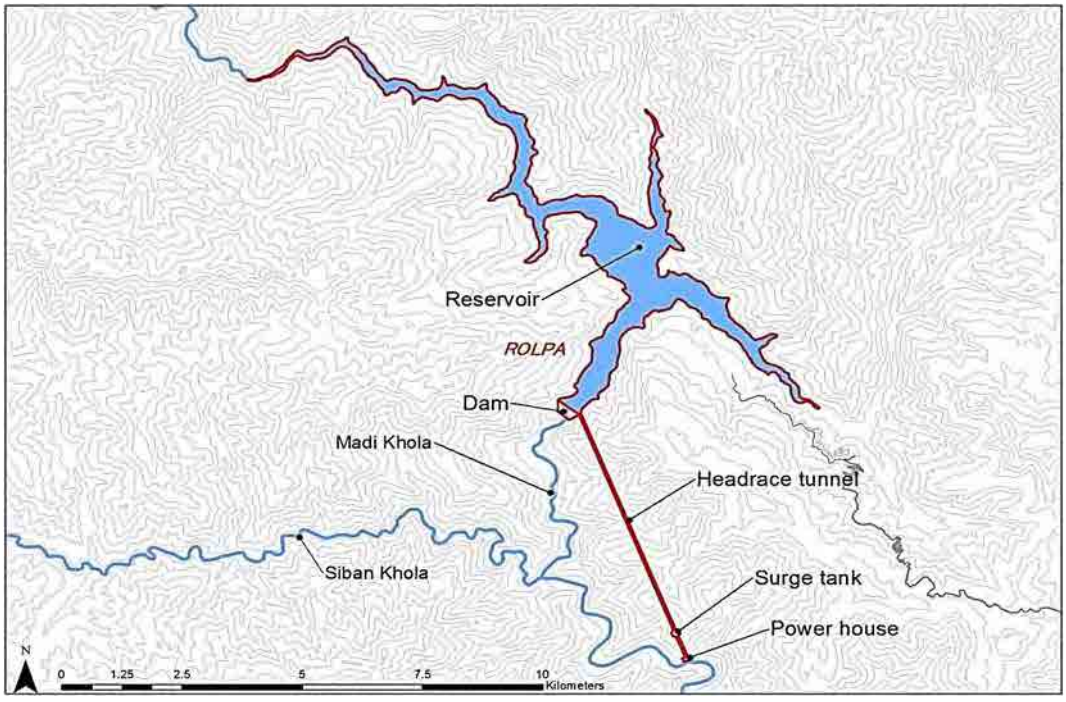


Figure 10.2.1.1-20 General Layout of the Madi Project (W-06)

Table 10.2.1.1-12 Salient Features of the Madi Project (W-06)

Item	Unit	Madi Project
Installed Capacity	MW	199.8
Catchment Area	km^2	674.0
Dam Height	m	190.0
Total Storage Volume	MCM	359.5
Effective Storage Volume	MCM	235.1
Reservoir Area	km^2	7.7
Full Supply Level	m	1,090.0
Minimum Operating Level	m	1,030.0
Tail Water Level	m	800.0
Rated Gross Head	m	280.8
Rated Net Head	m	277.0
Rated Power Discharge	m^3/sec	84.9
Total Energy	GWh	621.1
Dry Energy	GWh	170.7
Length of Access Road	km	15.0
Length of Transmission Line	km	62.0
Project Cost	MUS$	637.3
Unit Generation Cost	¢ /kWh	10.3
EIRR (8% of Interest Rate, 12NRs/kWh)	%	12.3
FIRR (8% of Interest Rate, 12NRs/kWh)	%	16.8
Forest Land to be submerged	km^2	1.6
Downstream Protected Area	nos	2
Protected Species in the Project Area	nos	15
Dewatering Area	km	10
Reported Fish species	nos	8
Resettlement (Household)	nos	336
Cultivated land to be submerged	km^2	1.9
Fishermen	nos	100
Road to be submerged	km	11

(9) Nalsyau Gad Project (W-23)

The Nalsyau Gad Project is a 410 MW storage-type hydroelectric power project located at the Nalsyagu Gad river in the Jajarkot District in the western region. For existing studies, a pre feasibility study was conducted in 2004 by the NEA. After that, a feasibility study commenced in 2010 and had been completed in 2012.

As hydrological characteristics, the annual rainfall at the Jajarkot gauging station nearest to the project site is 1,797 mm and the average river discharge at the dam site is 26.4 m^3/s. The drainage area is 570 km^2, and the specific sediment volume is estimated to be 3,960 $t/km^2/year$. This is the same value adopted by the NEA as average specific sedimentation volume in the western region. No glacier lakes having a high risk of a GLOF are identified in the drainage basin.

From a geological view point, the project area lies in the Lesser Himalaya Zone and is composed mainly of dolomite, slate and quartzite. The reservoir area is underlain by dolomite and slate. The dolomite should be investigated to confirm its water tightness. The dam site is underlain by dolomite, which forms sound bedrock, but this needs further investigation to confirm water tightness. The headrace tunnel route passes through dolomite, slate, quartzite and two major sheared zones. The bedrock of power house site is mainly composed of phyllite and quartzite. The project area is located in an area where a medium acceleration of 200 mgal is shown on the seismic hazard map. It is away from a large tectonic thrust (MBT) at a long distance of 60 km and from epicenters larger than M4 at a relatively long distance of 7 km.

Both the impact on the Natural Environment and the Social Environment are relatively low. Nalsyau Gad is located in the Karnali river basin and the reservoir area is 6.3 km^2. The affected forest area is the lowest out of the ten promising projects at 0.76 km^2. Although the number of recorded plant species is relatively high at 59, the number of recorded fauna is relatively low, with numbers such as 11 mammals, 13 birds, and 8 Herpetofauna. There are three protected species downstream of the project area and 6 important species that depend on water are known. The length of the Transmission line is the longest, which is 112 km. The number of resettlements is as average at 263, but the number of resettlements per unit generation is lower, which is 0.64 HH/MW. There are no affected Indigenous groups, no affected irrigation systems, and no affected drivable roads.

From the view point of hydropower planning, a large rockfill dam with a height of 200 m and volume of 18 million m^3 are planned in the current layout. Since it is recognized that the geological condition at the dam site has to be confirmed in terms of water tightness, the work for the dam will be on the critical path in the construction stage. It should be noted that the headrace tunnel of 8 km passes through two large fracture zones. Since the powerhouse is of an underground type, the construction risk will be relatively higher. Therefore, geological investigations should be carried out as detail as possible in the detailed design stage. Furthermore, the effective head of this project is 635 m, which is extremely large. The turbine is planned to be of a Pelton type. It should be noted that the penstock has to be designed carefully since the water pressure in the penstock near the powerhouse is to be extremely high.

The location, basic layout and salient features of the project are shown below.

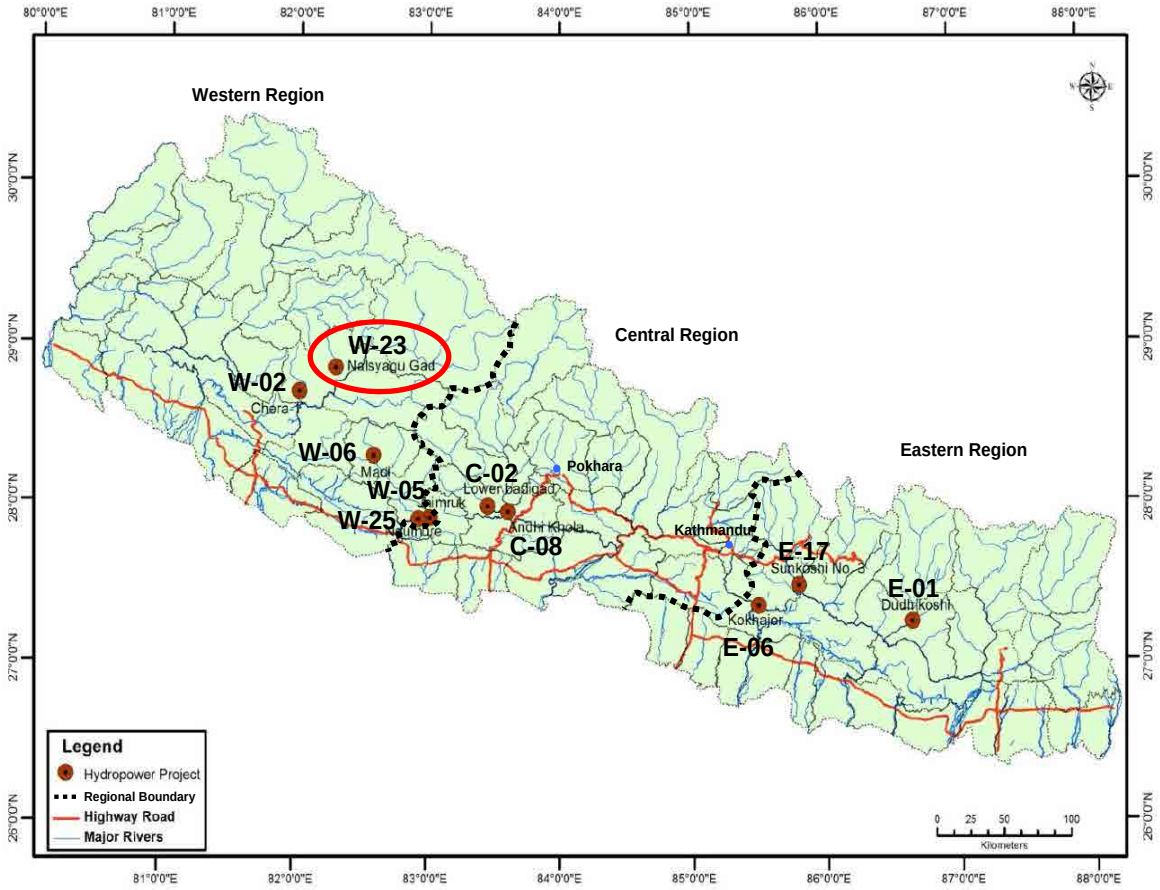


Figure 10.2.1.1-21 Location of the Nalsyau Gad Project (W-23)

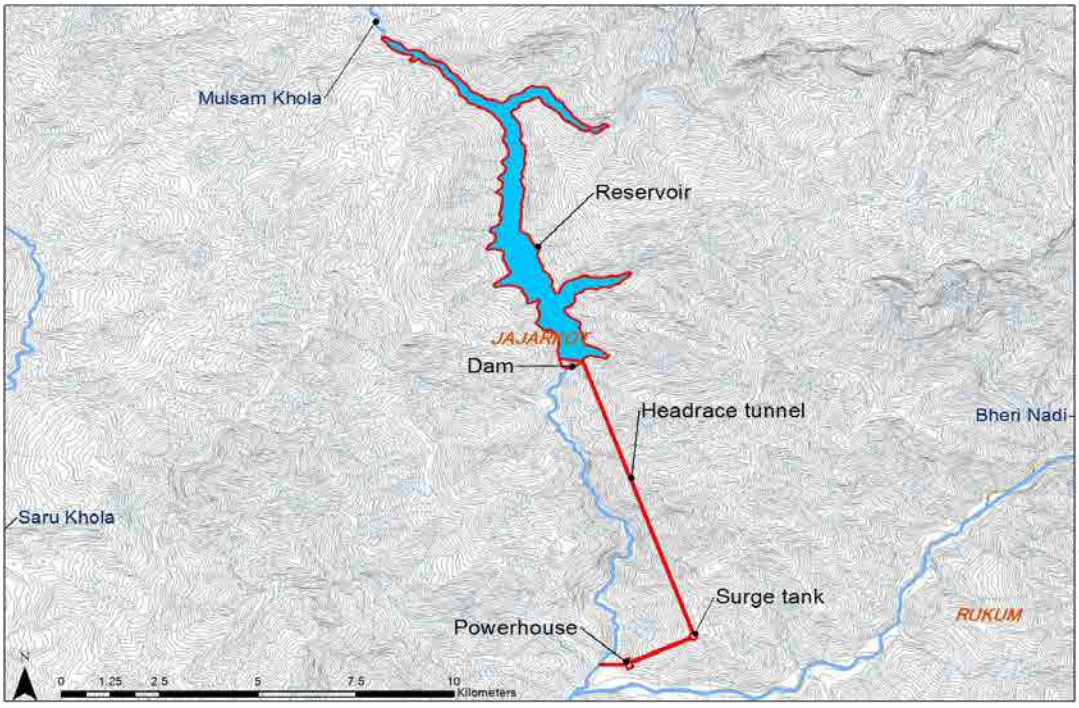


Figure 10.2.1.1-22 General Layout of the Nalsyau Gad Project (W-23)

Table 10.2.1.1-13 Salient Features of the Nalsyau Gad Project (W-23)

Item	Unit	Nalsyau Gad Project
Installed Capacity	MW	410.0
Catchment Area	km^2	571.5
Dam Height	m	200.0
Total Storage Volume	MCM	419.6
Effective Storage Volume	MCM	296.3
Reservoir Area	km^2	6.3
Full Supply Level	m	1,570.0
Minimum Operating Level	m	1,498.0
Tail Water Level	m	872.0
Rated Gross Head	m	649.3
Rated Net Head	m	635.5
Rated Power Discharge	m^3/sec	75.0
Total Energy	GWh	1,406.1
Dry Energy	GWh	581.8
Length of Access Road	km	25.0
Length of Transmission Line	km	112.0
Project Cost	MUS$	966.9
Unit Generation Cost	¢ /kWh	6.9
EIRR (8% of Interest Rate, 12NRs/kWh)	%	15.6
FIRR (8% of Interest Rate, 12NRs/kWh)	%	25.8
Forest Land to be submerged	km^2	0.8
Downstream Protected Area	nos	3
Protected Species in the Project Area	nos	8
Dewatering Area	km	11
Reported Fish species	nos	8
Resettlement (Household)	nos	263
Cultivated land to be submerged	km^2	2.5
Fishermen	nos	115
Road to be submerged	km	-

(10) Naumure (W. Rapti) Project (W-25)

The Naumure Project is a 245 MW storage-type hydroelectric power project located at the West Rapti river in the Argakhanchi District and the Pyuthan District in the western region. The latest study was conducted in the "Naumure (W.Rapti) Hydroelectric Project Pre-Feasibility Study, 1990, NEA." The study level for this project attains the pre-feasibility study level.

As hydrological characteristics, the annual rainfall at Khanchikot gauging station nearest to the project site is 1,772 mm and the average river discharge at the dam site is 138.7 m^3/s. The drainage area is 3,430 km^2, and the specific sediment volume is estimated to be 5,750 $t/km^2/year$. This is larger than 3,960 $t/km^2/year$, which is the value adopted by the NEA as average specific sedimentation volume in the western region. No glacier lakes having a high risk of a GLOF are identified in the drainage basin.

From a geological view point, the project area lies both in the Lesser Himalaya Zone and in the Sub Himalaya Zone. These zones are divided by MBT. The Lesser Himalaya Zone is composed mainly of shale, quartzite and limestone. The Sub Himalaya Zone is composed mainly of sandstone and siltstone. The upstream portion of the reservoir area is in the Lesser Himalaya Zone and the downstream portion of reservoir area is in the Sub Himalaya Zone, which increases reservoir water tightness. Rocks close to MBT are sheared and would provide unstable slopes. The dam site, headrace tunnel route and powerhouse site are located in the Sub Himalaya Zone. The dam site is underlain by sandstone and siltstone, which form medium-hard and relatively permeable bedrock. The headrace tunnel route passes through sound sandstone. The bedrock of the powerhouse site is mainly composed of sandstone and siltstone, which would not be suitable for an underground power house. The project area is located in the area where a relatively small acceleration of 130 mgal is shown on the seismic hazard map. It is away from epicenters larger than M4 at a relatively long distance of 40 km. However, it is close to a large tectonic thrust (MBT) at a short distance of 3 km.

The impact on the Natural Environment is relatively high and the impact on the Social Environment is average. Naumure (W. Rapti) is located in the Rapti river basin and the reservoir area is 19.8 km^2, which is the biggest next to Sun Koshi No.3. The affected forest area is 7.85 km^2, which is the largest next to Sun Koshi No.3. The number of recorded plant species is relatively high at 55. The number of recorded fauna is also high, with numbers such as 24 mammals, 49 birds, and 17 Herpetofauna. The dewatering area is the shortest at 0.5 km. The number of resettlements is 456. The affected agricultural land is 6.1 km^2, which is the largest next to Sun Koshi No.3. The number of fishermen is relatively small at 43.The Indigenous groups in the reservoir area are the Magar (Disadvantaged) and the Gurung (Disadvantaged).

From the view point of hydropower planning, a large rockfill dam with a height of 190 m and a volume of 13.2 million m^3 are planned in the current layout. It is recognized that the work for dam will be on the critical path in the construction stage.

In the current layout, the dam and powerhouse upstream of the Lower Jhimruk project located upstream of the Naumure project, are located in the reservoir of the Naumure project. Therefore, it is impossible to construct both projects with the current layouts. It is at least necessary to change the layout of either project to implement both projects. In addition, it should be noted that the Naumure project would be developed as a multipurpose project since implementation of irrigation project is planned.
The location, basic layout and salient features of the project are shown below.

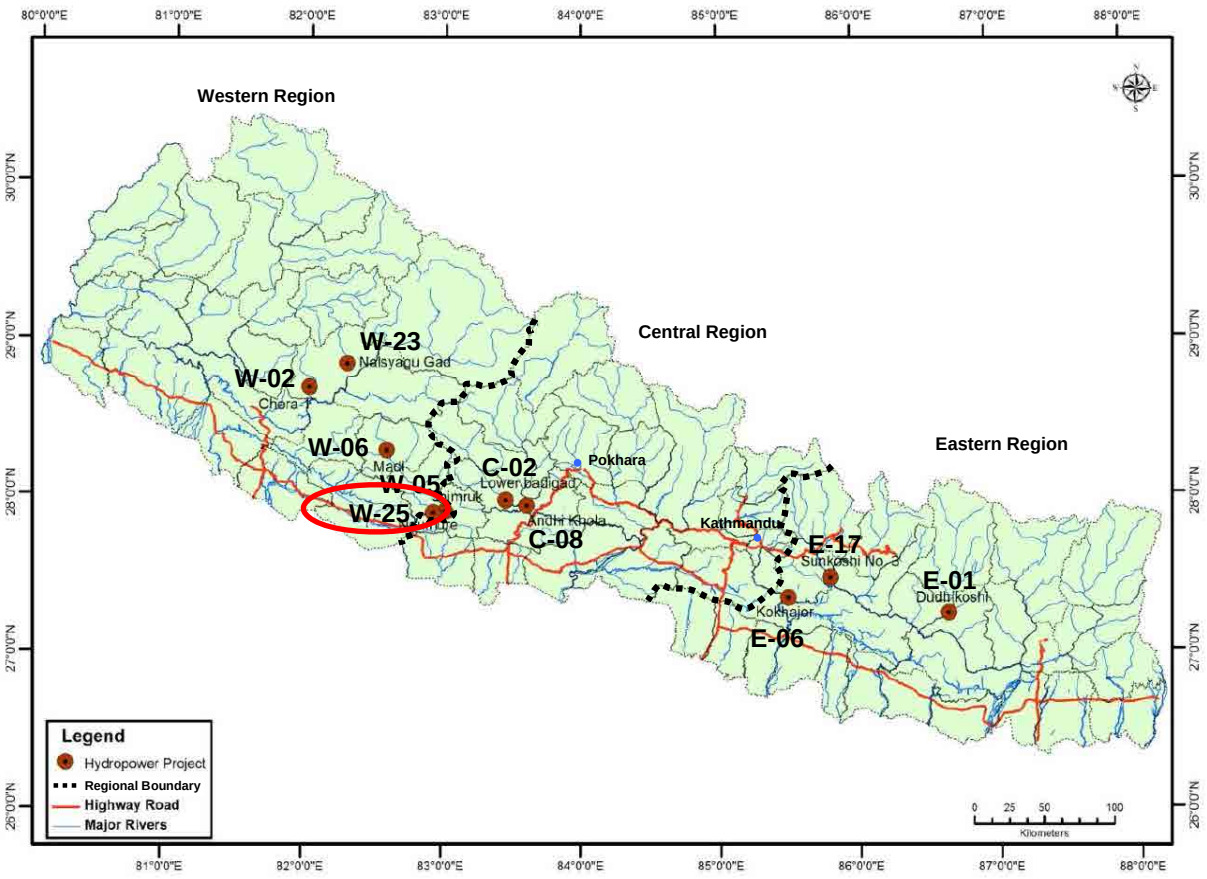


Figure 10.2.1.1-23 Location of the Naumure (W. Rapti) Project (W-25)

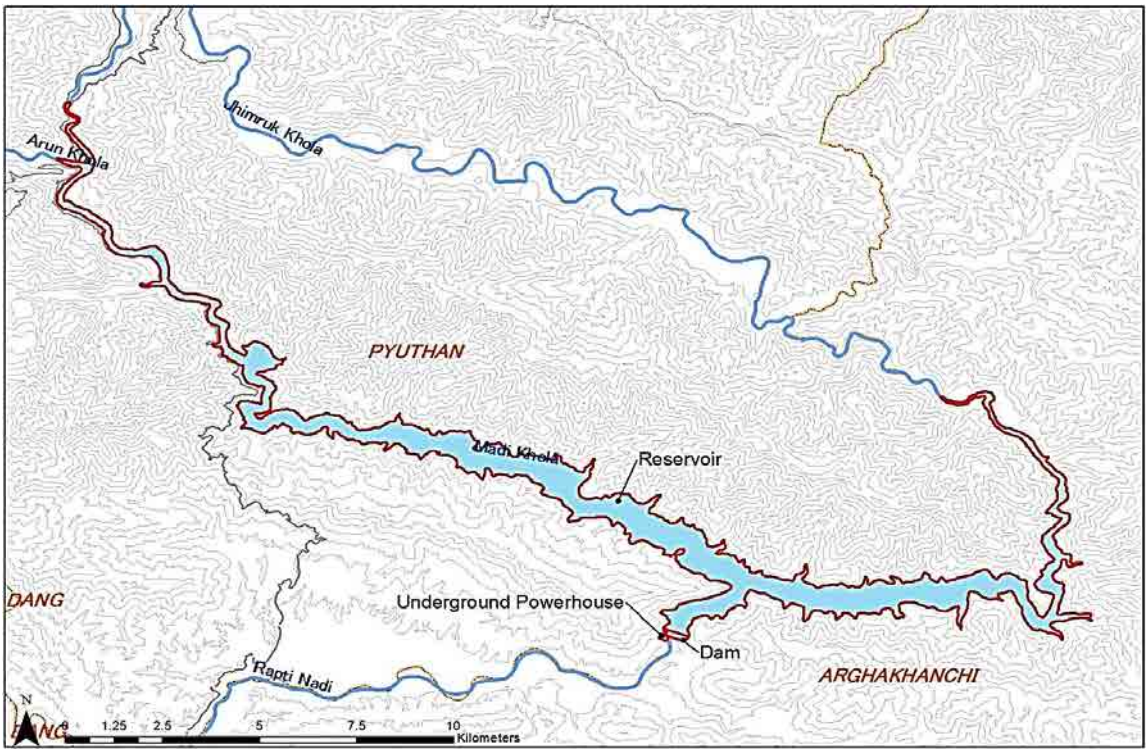


Figure 10.2.1.1-24 General Layout of the Naumure (W. Rapti) Project (W-25)

Table 10.2.1.1-14 Salient Features of the Naumure (W. Rapti) Project (W-25)

Item	Unit	Naumure Project
Installed Capacity	MW	245.0
Catchment Area	km^2	3,430.0
Dam Height	m	190.0
Total Storage Volume	MCM	1,021.0
Effective Storage Volume	MCM	580.0
Reservoir Area	km^2	19.8
Full Supply Level	m	517.0
Minimum Operating Level	m	474.2
Tail Water Level	m	358.0
Rated Gross Head	m	162.6
Rated Net Head	m	154.5
Rated Power Discharge	m^3/sec	185.6
Total Energy	GWh	1,157.5
Dry Energy	GWh	309.9
Length of Access Road	km	34.0
Length of Transmission Line	km	79.0
Project Cost	MUS$	954.5
Unit Generation Cost	¢ /kWh	8.2
EIRR (8% of Interest Rate, 12NRs/kWh)	%	15.2
FIRR (8% of Interest Rate, 12NRs/kWh)	%	25.3
Forest Land to be submerged	km^2	7.9
Downstream Protected Area	nos	2
Protected Species in the Project Area	nos	20
Dewatering Area	km	1
Reported Fish species	nos	16
Resettlement (Household)	nos	456
Cultivated land to be submerged	km^2	6.1
Fishermen	nos	43
Road to be submerged	km	2

10.2.1.2 Evaluation of Hydrological Data and Energy

(1) Hydrology

As for hydrological data of the 10 promising projects, 3 items, namely, the reliability of flow data, risk of GLOF, sedimentation of were researched and evaluated. Details of the hydrological study are described for each project and summarized in Appendix-2.

1) Reliability of Flow Data

Flow data is indispensable for energy calculation and has a decisive influence on the economical efficiency of a project. As for the 10 promising projects, the study results on reliability of the flow data of each project are summarized in the following table.

Table 10.2.1.2-1 Summary of Study Results for the Reliability on Flow Data

No.	Project Name	Reliability of Flow Data
E-01	Dudh Koshi	The gauging station 670 is located 1.5 km upstream from the dam axis. The reliability of flow data of the project is relatively higher.
E-06	Kokhajor-1	Since there is no gauging station near the project site, the flow of the project is calculated by Regional Analysis. The reliability of flow data of the project is relatively lower.
E-17	Sun Koshi No.3	Gauging station 630 is located 8 km upstream from the dam axis. Multiplying the flow data of the gauging station by the rate of catchment area of the project site to one of the gauging stations gives the flow data of the project. The reliability of flow data of the project is relatively higher.
C-02	Lower Badigad	Since there is no gauging station near the project site, the flow of the project is calculated by Regional Analysis. The reliability of flow data of the project is relatively lower.
C-08	Andhi Khola	Gauging station 415 is located 1.5 km upstream from the dam axis. Multiplying the flow data of the gauging station by the rate of catchment area of the project site to one of the gauging stations gives the flow data of the project. The reliability of flow data of the project is relatively higher.
W-02	Chera-1	Since there is no gauging station near the project site, the flow of the project is calculated by Regional Analysis. The reliability of flow data of the project is relatively lower.
W-05	Lower Jhimruk	Gauging station 330 is located 27 km upstream from the dam axis. Multiplying the flow data of the gauging station by the rate of catchment area of the project site to one of the gauging stations gives the flow data of the project. The reliability of flow data of the project is relatively higher.
W-06	Madi	Since there is no gauging station near the project site, the flow of the project is calculated by Regional Analysis. The reliability of flow data of the project is relatively lower.
W-23	Nalsyau Gad	-ditto-
W-25	Naumure(W.Rapti)	-ditto-

2) Risk of GLOF

Similarly, the study results on the risk of a GLOF of each promising project are summarized in

the following table.

Table 10.2.1.2-2 Summary of Study Result on Risk of a GLOF

No.	Project Name	Risk of a GLOF
E-01	Dudh Koshi	There are 10 potentially critical glacial lakes upstream of the Dudh Koshi project. Out of 10, 3 glacial lakes are classified in category I, which is high risk. Therefore, the risk of a GLOF of the project is high. Imja Tsho is the highest risky glacial lake in terms of a GLOF.
E-06	Kokhajor-1	There is no potentially critical glacier lake in terms of a GLOF upstream of the project site.
E-17	Sun Koshi No.3	There are nine potentially critical glacial lakes in terms of a GLOF upstream of the Sun Koshi basin. All of them are located in Tibet. Lumi Chimi Lake and Gangxi Co Lake are the high risk glacial lakes. Both of them are the end moraine dammed glacial lakes and category I. The risk of a GLOF of the project is high.
C-02	Lower Badigad	There is no potentially critical glacier lake in terms of a GLOF upstream of the project site.
C-08	Andhi Khola	-ditto-
W-02	Chera-1	-ditto-
W-05	Lower Jhimruk	-ditto-
W-06	Madi	-ditto-
W-23	Nalsyau Gad	-ditto-
W-25	Naumure (W. Rapti)	-ditto-

3) Sedimentation

Similarly, in order to evaluate the influence of sedimentation on the 10 promising projects, the life of the reservoir of each project was estimated. The result is summarized in the following table.

Table 10.2.1.2-3 Summary of Study Results on Life of a Reservoir

No.	Project Name	Specific Sediment Yield ($t/km^2/yr$)	Sediment Yield ($10^6 m^3/yr$)	Total Storage Volume (10^6 m^3)	Life time of Storage (years)
E-01	Dudh Koshi	2,540	6.9	687.4	100
E-06	Kokhajor-1	5,900	1.1	218.7	199
E-17	Sun Koshi No.3	1,871	6.9	1,220.0	177
C-02	Lower Badigad	2,526	5.2	995.9	192
C-08	Andhi Khola	2,526	1.2	336.5	280
W-02	Chera-1	1,000	0.5	254.9	510
W-05	Lower Jhimruk	5,750	3.8	386.0	102
W-06	Madi	5,750	2.6	359.5	138
W-23	Nalsyau Gad	3,960	1.5	419.6	280
W-25	Naumure (W. Rapti)	5,750	13.1	1,021.0	78

(2) Energy Calculation

The energy calculation was conducted by using flow data obtained from the hydrological study and planning features in order to evaluate the annual energy production of the 10 promising projects.

1) Calculation Method

The energy calculation for each project was conducted by using "Energy Calculation based on Dynamic Programming Ver.1.70", which is a computer program developed by J-POWER. The program enables estimation of maximized annual energy by optimizing the reservoir operation rule of a project based on the concept of optimization by Dynamic Program (DP).

The Dynamic Program's mathematical meaning is to determine the control vector which can make the evaluating function value maximum or minimum under given restraint conditions, which is based upon the optimum principal. The optimum principal is the optimized plan which can make its optimum decision on conditions from the primary decision to result for whatever primary conditions there area and the decision of the system.

In the case of reservoir operation rule optimization, the evaluating function corresponds to annual energy, the outflow discharge from reservoir and reservoir volume on a given inflow discharge to the reservoir corresponds to restriction conditions, and the control vector against the above issues corresponds to the reservoir operation rule.

2) Data for Calculation

The project parameters required for energy calculation such as the Full Supply Level (FSL), Minimum Operational Level (MOL) and Water Level-Storage Volume Curve of the reservoir, effective head, power discharge, etc. were excerpted from the source reports.

However, since turbine efficiency and generator efficiency have been improved in recent years, the design review for electromechanical equipment of promising projects was carried out by using "HD Wiz", which is a computer program developed by J-POWER based on existing hydropower plant data around world. The installed capacities obtained from the result of this design review were used for the energy calculation. The details of the design review for electromechanical equipment of each promising project is described in Appendix 2.

The peak hour was established as 12 hours for energy calculation in consultation with the NEA. The promising projects except Nalsyau Gad are planned on condition that the peak hour is 6 hours basically in the existing studies.

As for flow data, the data estimated in the hydrological analysis were used. The details of the hydrological study and the flow data used for energy calculation are described in Appendix 2. The following table shows average monthly flows at the dam sites of promising projects.

Table 10.2.1.2-4 Summary of River Discharge Data for Promising Projects

(Unit: m^3/s)

No.	Project Name	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	Average Discharge
E-01	Dudh Koshi	45.6	35.8	33.8	45.7	84.0	282.5	651.6	652.3	519.5	188.7	89.5	59.9	224.1
E-06	Kokhajor-1	3.7	3.1	2.9	3.2	4.6	16.1	45.0	53.2	38.3	17.4	8.2	5.2	16.7
E-17	Sun Koshi No.3	62.5	55.8	52.8	58.6	90.0	211.7	574.8	701.0	440.0	208.3	106.7	78.7	220.1
C-02	Lower Badigad	21.2	18.3	17.5	20.3	31.8	85.1	216.7	261.6	184.1	82.1	39.7	26.3	83.7
C-08	Andhi Khola	4.7	3.9	3.2	3.0	6.3	33.3	99.8	94.1	67.2	26.7	9.9	6.1	30.1
W-02	Chera-1	9.3	8.0	7.6	8.5	12.8	34.2	88.6	108.2	77.1	35.0	16.8	11.0	34.8
W-05	Lower Jhimruk	9.4	7.9	6.6	6.7	6.9	20.5	68.9	115.7	97.4	39.6	16.1	10.5	33.9
W-06	Madi	7.9	6.8	6.4	7.2	10.8	30.0	78.9	95.8	68.4	31.0	14.8	9.7	30.6
W-23	Nalsyau Gad	6.8	5.8	5.5	6.1	9.1	25.7	68.0	82.6	59.1	26.9	12.8	8.3	26.4
W-25	Naumure (W. Rapti)	33.4	28.9	27.9	32.8	52.5	143.6	363.6	434.9	303.9	134.2	65.1	43.3	138.7

3) Calculation Result

The results of annual energy calculation for promising projects are summarized in the following table. Only for W-23 Nalsyau Gad, the energy estimated in the feasibility study report is adopted as results since the feasibility study had just been completed in 2012 and the total energy was nearly equal to that estimated by the Study Team in consultation with the NEA.

Table 10.2.1.2-5 Summary of Energy Calculation Results for Promising Projects

(Unit: GWh)

No.	Project Name	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	Total Energy	Dry Energy
E-01	Dudh Koshi	103.0	90.7	97.1	123.5	165.2	190.4	220.7	225.5	218.3	222.4	143.8	109.0	1,909.6	523.3
E-06	Kokhajor-1	19.9	17.6	18.8	17.6	16.3	15.1	18.4	35.6	57.6	21.8	19.9	20.3	278.9	94.1
E-17	Sun Koshi No.3	71.3	63.6	67.4	61.6	61.7	134.4	358.2	404.3	325.2	182.6	81.3	72.0	1,883.6	335.9
C-02	Lower Badigad	73.9	66.7	72.5	67.6	67.4	65.7	151.2	294.0	261.6	100.0	71.5	73.9	1,366.0	354.7
C-08	Andhi Khola	37.1	33.0	18.0	0.0	14.6	28.8	89.4	146.5	130.3	52.5	49.4	49.1	648.7	137.1
W-02	Chera-1	26.4	22.7	23.5	21.2	20.7	20.8	98.6	114.2	110.5	51.6	26.3	26.9	563.2	120.6
W-05	Lower Jhimruk	19.7	17.6	19.0	18.2	20.7	47.1	73.9	61.7	70.7	66.2	20.0	19.9	454.8	94.4
W-06	Madi	36.0	32.2	34.4	31.9	31.6	30.4	34.7	136.2	125.4	56.9	35.1	36.2	621.1	170.7
W-23	Nalsyau Gad	152.5	126.3	114.4	61.5	25.4	24.6	25.4	250.5	294.2	139.4	64.8	127.1	1,406.1	581.8
W-25	Naumure (W. Rapti)	68.8	58.1	59.3	52.1	47.3	79.5	152.7	185.2	179.2	133.9	69.8	71.7	1,157.5	309.9

10.2.1.3 Geological Investigation and Evaluation

(1) Geological Investigation

The study level of promising projects varies from Desk Study to FS. To increase the topographic and geological data of projects which remain at the Desk Study level, subcontract work was conducted for promising projects from July 2012 to February 2013. Among the 10 promising projects, geological and engineering geological review was conducted for the Dudh Koshi Project and the Nalsyau Gad Project which have a study level of FS. For the remaining 8 projects, satellite image interpretation and a geological field survey were conducted. A geological field survey of each project was conducted for about 5 days.

(2) Evaluation Method for Site Geology

At the stage of evaluating a promising project, the evaluation for geology consists of 3 criteria, namely, "Geological conditions of the site", "Thrust and fault" and "Seismicity." The evaluation methods of "Geological conditions of the site" are changed according to above-mentioned geological investigation and are described in this section. The content of the criterion is "Thrust and fault" and is the same as "Natural hazards (earthquakes)" which was applied for selecting promising projects. There is no change in the sub-criterion "Seismicity", which was also applied for selecting promising projects. The evaluation criteria of these two points are shown in 10.2.2.1 (2).

The hydroelectric project area is composed of major structure sites, i.e. the reservoir area, dam site, headrace tunnel route and power station site. Those representing necessary conditions of these structure sites are as follows:

- Reservoir area: watertightness, stability of surrounding slopes
- Dam site: stability of foundation rock, watertightness
- Headrace tunnel: stability of foundation rock
- Powerhouse: stability of foundation rock, stability of the rear slope

Evaluation of these structure sites are shown below.

a) Reservoir Area

Watertightness of the reservoir area is evaluated based on the distribution of carbonate rocks and the condition of joints of the rockmasss.

The stability of surrounding slopes is evaluated based on the distribution and size of landslides and the distribution of dip slopes.

b) Dam Site

Stability of dam foundation is evaluated based on soundness of rockmass as foundation rock for a rock fill dam.

Watertightness of the dam site is evaluated based on the distribution of carbonate rocks and the condition of joints of the rockmasss. This evaluation should be more conservative than the case of a reservoir.

c) Headrace Tunnel Route

Stability of the tunnel foundation is evaluated based on the strength of the rockmass and overburden of the tunnel, which controls the stability of tunnel walls during construction work.

d) Powerhouse Site

Powerhouse sites are assumed to be open type, except a project in which the underground type is adopted in FS. Stability of an open type powerhouse foundation is evaluated based on the soundness of the rockmass, which is the same for the dam site.

Stability of the slope behind the powerhouse is evaluated based on the distribution of the landslide and dip slopes.

In a zone of considerable width along major faults, usually the quality of the rockmass has been decreased by the movement of the fault. In case a fault with more than 1m wide of a sheared zone is known in the structure site, the evaluation is lowered by subtracting the score. Thick river deposits usually introduce difficulties in construction of dams and powerhouses. In case that thick river deposits more than 30 m are assumed to exist, evaluation of the dam site or powerhouse site is lowered by subtracting the score.

Evaluation criterion for site geology is compiled in 10.2.2.1 (2).

(3) Result of Evaluation for Site Geology

Geological outline and results of the evaluation of site geology are shown in Table 10.2.1.3-1~10.

The score for each sub-item and that of the structure sites are shown with red letters in Table 10.2.1.3-1. Sub-items of low scores and with subtracted scores are those with disadvantages in an engineering geological point of view.

Table 10.2.1.3-1 Evaluation of Site Geology of the Dudh Koshi Project

	Geology				Soundness	Water Tightness	Slope Stability	Score
	Formation	Lithology	Fault	Rivere dep.				
Reservoir Area	Okhaidunga Phyllite Zone and Dudh Koshi Dome Zone	phyllite90%, quartzite10%	d -20 2 major local faults (Ekuluade Fault, Vichalo F.)			b 100 watertight	c 100 small scale slides	A 80
Dam Site	Okhaidunga Phyllite Zone	quartzite on the left bank, phyllite on the right bank	d 0 no major fault	e 0 20m	a 100 RQD<30-66%, RMR:40-60, Q value:4-6	b 60 groundwater level is slightly higher than river level on the left bank	a few instabilities	B 80
Headrace Tunnel Route	Okhaidunga Phyllite Zone	phyllite and quartzite	d -20 3 major local faults (Dudh Koshi Fault, Halesi F. Sun Koshi F.)		a 60 Fair (RMR:40-60, Q value:4-9,), maximum rock cover 1250m and about 4km long section is more than 1000m			C 40
	Manebhanjyug Phyllite-Limestone Zone	limestone and carbonatious phyllite						
	Mahabharat Zone	Sch and gneiss						
Powerhouse Site (underground)	Mahabharat Zone	schistose gneiss	d 0 no major fault	e 0 -	a 100 (Fair to Good: RQD 72%, RMR:50-70, Q value:5-12,)		c 100 -	D100

a, b, c = 100 or 60 or 20 (60 and 20 show a disadvantage)

d, e = 0 or -20 or lower scpre (-20 and lower score show a disadvantage)

A= (b+c)/2+d B= (a+b)/2+d+e C=a+d D= (a+c)/2+d+e

Table 10.2.1.3-2 Evaluation of Site Geology of the Kokhajor-1 Project

	Geology				Soundness	Water Tightness	Slope Stability	Score
	Formation	Lithology	Fault	Rivere deposits				
Reservoir Area			0			60	60	60
	Upper Siwaliks:	conglomerate with sandstone and mudstone	no major fault		soft (sometimes hard)	poorly-cemented conglomerates of the Upper Siwaliks are quite pervious	vulnerable to erosion (erode easily) and many shallow slumps,	
	Middle Siwaliks:	sandstone			moderately hard, and relatively strong.	relatively impervious	generally stable and a few rockslides	
Dam Site			0	0	100	60		80
	Middle Siwaliks:	sandstone and mudstone	no major fault	10 to some30m thick	relatively soft	moderately to slightly pervious		
Headrace Tunnel Route			0		60			60
	Middle Siwaliks:	sandstone interbedded with mudstone	no major fault		moderately strong			
	Lower Siwaliks	sandstone and mudstone			relatively soft, maximum overburden 600m			
Powerhouse Site			0	0	100		100	100
	Lower Siwaliks	sandstone and mudstone	no major fault	10-20m thick	relatively soft		bedding planes dip towards the mountain	

Table 10.2.1.3-3 Evaluation of Site Geology of the Sun Koshi No.3 Project

	Geology				Soundness	Water Tightness	Slope Stability	Score
	Formation	Lithology	Fault	Rivere deposits				
Reservoir Area			-20			100	60	60
	Kuncha Formation	quartzite with schist	a fault passing along the Indrawati River				wide desrtibution of colluviums	
	Benighat Slate	slate with limestone				limestone may be peamiable, butdestributed in middle stream of the reservoir area		
Dam Site			0	0	100	100		100
	Kuncha Formation	quartzite with thin phyllite	no major fault	not thick	hard	impervious		
HeadraceTunnel Route			0		100			100
	Kuncha Formation	quartzite with thin phyllite	no major fault		hard, maximum overburden 300m			
Powerhouse Site			0	0	100		100	100
	Kuncha Formation	quartzite with few bands of phyllite	no major fault	not thick	medium hard		stable	

Table 10.2.1.3-4 Evaluation of Site Geology of the Lower Badigad Project

	Geology				Soundness	Water Tightness	Slope Stability	Score
	Formation	Lithology	Fault	Rivere deposits				
Reservoir Area			-20			100	20	40
	Benighat Slate	slate with limestone, and quartzite with shale	Badigad Fault (active)	alluvium > 30m thick		impervious	relatively stable except active Gultung Pahiro, mainly rockslides	
	Dhading Dolomite	limestone and dolomite				may be permeable, but limited distibution in reservoir area		
Dam Site			-80	-20	100	100		0
	Benighat Slate	quartzite and shale	Badigad Fault (active)	more than 30m thick assumed by the thickness in reservoir area	medium strong to strong	impervious		
Headrace Tunnel Route			0		100			100
	Benighat Slate	quartzite and shale	no major fault		medium strong to strong, maximum overburden 200m			
Powerhouse Site			0	-20	100		100	80
	Benighat Slate	quartzite and shale	no major fault	> 50m	medium strong to strong		bedding planes dip toward mountain	

Table 10.2.1.3-5 Evaluation of Site Geology of the Andhi Khola Project

	Geology				Soundness	Water Tightness	Slope Stability	Score
	Formation	Lithology	Fault	Rivere deposits				
Reservoir Area			-20			100	20	40
	Dhading Dolomite	thick bedded dolomite	Andhi Khola Fault、Keware Fault			dolomite in limited area		
	Benighat Slate	slate with many carbonate bands			slates are highly weathered and highly fragile	watertight	highly unstable as manifested by many landslides	
Dam Site			0	0	20	20		20
	Benighat Slate	laminated light gray slate	no major fault	2.7m thick by boring	thick terrace deposits above el. 606 on the left bank	thick terrace deposits above el. 606m on the left bank		
Headrace Tunnel Route			0		60			60
	Benighat Slate	light to dark gray, laminated slate	no major fault		slates are highly fragile and intensely deformed, maximum overburden 350m			
Power house	Site		0	-20	60		60	40
	Benighat Slate	light gray, carbonaceous slate	no major fault	45m thick sand and gravel	slates are highly fragile		a large landslide	

Table 10.2.1.3-6 Evaluation of Site Geology of the Chera-1 Project

	Geology				Soundness	Water Tightness	Slope Stability	Score
	Formation	Lithology	Fault	Rivere deposits				
Reservoir Area			0			60	100	80
	Meta-diamictite	meta-diamictite including calcareous clasts	no major fault	alluvial deposits are limited in distribution and they are less than 25 m thick		dissolution cavities of calcareous clasts	major landslides are limited	
	Lower Quartzite	quartzite with schist						
	Lower Schist	phyllite or garnet schist and quartzite						
Dam Site			0	0	100	60		80
	Meta-diamictite	meta-diamictite including calcareous clasts	no major fault		categorised as good or fair	impervious, however calcareous nature of the meta-diamictite should be studied in more detail		
Headrace Tunnel Route			0		100			100
	Meta-diamictite	meta-diamictite including calcareous clasts	no major fault		comparatively strong, tunnel alignment makes an acute angle with the foliation、overburden < 500m			
	Upper Quartzite	quartzite with schist and phyllite						
	Upper Schist	garnet schists with quartzite						
Powerhouse Site			0	0	100		100	100
	Upper Schist	thick-banded quartzite with sporadic schist partings	no major fault	assumed same as reservoir area i.e. less than 25m thick	comparatively strong		gentle dipping bedding plane	

Table 10.2.1.3-7 Evaluation of Site Geology of the Lower Jhimruk Project

	Geology				Soundness	Water Tightness	Slope Stability	Score
	Formation	Lithology	Fault	Rivere deposits				
Reservoir Area			-20			60	100	60
	Khamari Formation, Eocene Beds, Dhurbang Khola F.	shale, sandstone and dolomite	a major fault			distribution of dolomite	mass-wasting phenomena are not abundant, relatively stable	
Dam site			0	0	100	100		100
	Khamari Formation	shale and sandstone	no major fault	not thick	sound	impervious	relatively stable	
Headrace Tunnel Route			-20		100			80
	Khamari F, Eocene Beds, Dhurbang Khola F. Ranagaon F.	shale, sandstone	a major fault		maximun overburden 700m			
Powerhouse Site			0	0	100		60	80
	Ranagaon Formation	shale	no major fault	thick	sheared bed rock		sheared bed rock	

Table 10.2.1.3-8 Evaluation of Site Geology of the Madi Project

	Geology				Soundness	Water Tightness	Slope Stability	Score
	Formation	Lithology	Fault	Rivere deposits				
Reservoir Area			-20			60	60	40
	Garnet Schist Unit	chlorite to garnet schist	one fault between Garnet Schist Unit and Sattin Formation, and another fault between Sattin Formation and Srichaur Formation				most area is covered with colluvium, major slides are observed along the Dhansi Khola (along a fault)	
	Sattin Formation	sandstone and shale with some coal seams						
	Srichaur Formation	shale, phyllite and thin-bedded limestone						
	Ranibas Formation	medium-to thick-bedded limestone with few bands of black slate				limestone present in the most part of the project will create some problem.		
Dam Site			0	0	100	100		100
	Ranibas Formation	slate and limestone	no major fault	supposed to be thick		limestone is siliceous and shows no evidence of any cavern structure from the surface		
Headrace Tunnel Route			0		100			100
	Ranibas Formation	supposed to be slate and limestone	no major fault		maximum overburden about 400m			
Powerhouse Site			0	0	100		100	100
	Ranibas Formation	supposed to be slate and limestone	no major fault	supposed to be thick	supposed to be sound		supposed to be stable	

Table 10.2.1.3-9 Evaluation of Site Geology of the Nalsyau Gad Project

	Geology				Soundness	Water Tightness	Slope Stability	Score
	Formation	Lithology	Fault	Rivere deposits				
Reservoir Area			-20			60	100	60
		slate	Nalsyau Gad Fault			impervious	no major landslids	
		dolomite				further investigations are needed		
Dam Site			0	0	100	60		80
		dolomite	no major fault	10m thick by a boring	fair	further investigations are needed		
Headrace Tunnel Route			-20		100			80
		dolomite75%, remainings are quartzite, phyllite and slate	2 large sheared zones		bedding plane perpendicular to tonnel axis, max. overburden 500m			
Powerhouse Site			0	0	100		100	100
		phyllite, quartzite and shale	no major fault	infered 15m thick	sound		strikes of bedding plane are about perpendicular to slope	

Table 10.2.1.3-10 Evaluation of Site Geology of the Naumure (W. Rapti) Project

	Geology				Soundness	Water Tightness	Slope Stability	Score
	Formation	Lithology	Fault	Rivere deposits				
Reservoir Area			−20			100	60	60
	Middle Siwaliks	sandston and siltstone	MBT			slightly pervious and could pose threat of minor seepage	rocks near MBT are sheared and easily become unstable	
	Lower Siwaliks	sandstone with shale						
	Sangram Formation	black shale			weakest unit			
	Syangja Formation	calcareous quartzites and quartzitic limestpne with shale			.			
	Lakharpatta Formation	limestone and dolomites with thin shales and quartizes				possible leakage through this Formation will be blocked by Siwaliks distributed to the south of MBT		
Dam Site	Middle Siwaliks	sandstone and siltstones	0 no major fault	0 20m thick by a boring	100 good to fair	60 slightly pervious and could pose threat of minor seepage、think careful for dam site		80
Headrace Tunnel Route	Middle Siwaliks	sandstone	0 no major fault		100 overburden <60m			100
Powerhouse Site	Middle Siwaliks	mudstone with sandstone	0 no major fault	0 about 20m thick	100 sound		100 strikes of bedding plane are about perpendicular to slope	100

10.2.1.4 Environmental Survey and Evaluation

The environmental survey consists of the natural environmental survey and the social environmental survey in addition to the literature survey and satellite image analysis. The environmental survey was conducted for the 10 promising projects, putting about 5 days in each project (see Table 10.2.1.4-1). Regarding the natural environmental survey, sample survey of plants, survey of animal footprints, and hearing survey with residents and fishermen, they were conducted in the field to collect the necessary information. Meanwhile in the social environment, the key tools used under this survey were: Focus Group Discussions (FGD), Key Informal Surveys (KIS) and observation tools. Besides field level participatory study, district-level information was collected from different line agencies using a checklist wherever possible. The numbers obtained in this survey are the estimations based on a simple survey conducted with the purpose of relative comparison of related projects. Therefore the results have a margin of error of about 10 to 20%. The detail of the survey is shown in Appendix 3.

Table 10.2.1.4-1 Environmental Survey Method

Biological survey	• *Review of available literature on flora and fauna* • *Mapping of forest area using the latest (2010/2012) remote sensing data* • *On site survey of forests (plot sampling) and wildlife (mammal, birds, and herpetofauna)* • *Consultation with locals on flora and fauna* • *Consultation with the fishermen on fish diversity*
Social survey	• Mapping of agricultural lands, housing structures, and other infrastructures using the latest (2010/2012) remote sensing data • On site focus group discussion to unravel demography, landholding, agricultural productivity, markets, institutions, historic disaster records etc. • Consultation with fishermen on fishery dependency and markets

(1) Impact on Natural Environment

The main subjects of the natural environmental survey were: forest, flora, terrestrial fauna, aquatic fauna, as well as protected areas in the downstream and rare species in the downstream. The land use was also analysed using 1996 topographic maps. These maps were updated based on satellite images taken from 2010 to 2012 and were analysed in order to observe the tendency of changes of land use.

a. Impact on Forest

Comparing the forest area submerged in a reservoir area, the impact on Sun Koshi No. 3 and Namure are significant with more than 7 km^2 of submerged forest area. More than 400,000 trees will also be affected. On the other hand, the submerged forest area of Nalsyau Gad and Chera-1 are less than 1 km^2, and there will be less than 40,000 affected trees. Regarding the crown coverage, Kokhajor-1 and Dudh Koshi are relatively high with more than 50%. In contrast, Madi and Nalsyau Gad are relatively low with less than 20%. In comparison with the 1996 land use map and the satellite image taken in 2010/2011, the forest land of Namure and Andhi Khola have decreased by more than 1 km^2. By contrast, for Sun Koshi No. 3, an

increase of forest land of more than 3 km^2 has been observed (see Table 10.2.1.4-1).

Table 10.2.1.4-2 Impact on Forest in the Reservoir Area

No.	W-02	W-05	W-06	W-23	W-25	C-02	C-08	E-01	E-06	E-17
Project Name	Chera-1	Lower Jhimruk	Madi	Nalsyau Gad	Naumure (W. Rapti)	Lower Badigad	Andhi Khola	Dudh Koshi	Kokhajor-1	Sun Koshi No. 3
Land Use Reservoir Area (2010 to 2012)										
Forest land (km^2)	1.46	1.87	1.64	0.76	7.85	3.304	1.51	4.10	2.89	8.16
Bush/Shrub land (km^2)	0.72	0.51	2.02	0.89	1.22	0.589	0.38	0.32	0.02	2.57
Cultivated land (km^2)	1.08	2.04	1.92	2.54	6.11	5.896	1.65	3.30	0.59	9.39
Water and Sand Bodies etc. (km^2)	0.71	0.89	1.04	0.54	4.27	2.930	1.07	3.03	1.04	9.49
Grass Land (km^2)	0.02	0.30	1.04	0.90	0.03	0.908	0.91	0.27	0.06	0.47
Land Use Change (1996/2010, 2011) - Reservoir Area										
Forest land (km^2)	0.12	-0.60	-0.50	-0.25	-1.28	-0.444	-1.03	0.29	-0.005	3.09
Bush/Shrub land (km^2)	-0.09	0.40	0.38	-0.43	0.88	0.275	0.25	-0.16	0.02	-0.91
Cultivated land (km^2)	-0.10	-0.22	-0.75	0.28	0.00	-0.800	0.07	-0.87	0.25	-0.46
Water and Sand Bodies etc. (km^2)	0.32	0.05	0.00	-0.33	0.01	0.074	-0.16	0.62	-0.33	-1.35
Grass Land (km^2)	-0.04	0.30	0.87	0.05	0.03	0.908	0.86	0.13	0.06	-0.36
Average Crown Coverage (%)	41	26	15	20	40	38	38	53	70	38
Number of trees in the reservoir area	38,088	83,776	36,982	9,776	485,130	129,360	77,312	242,720	202,300	520,608

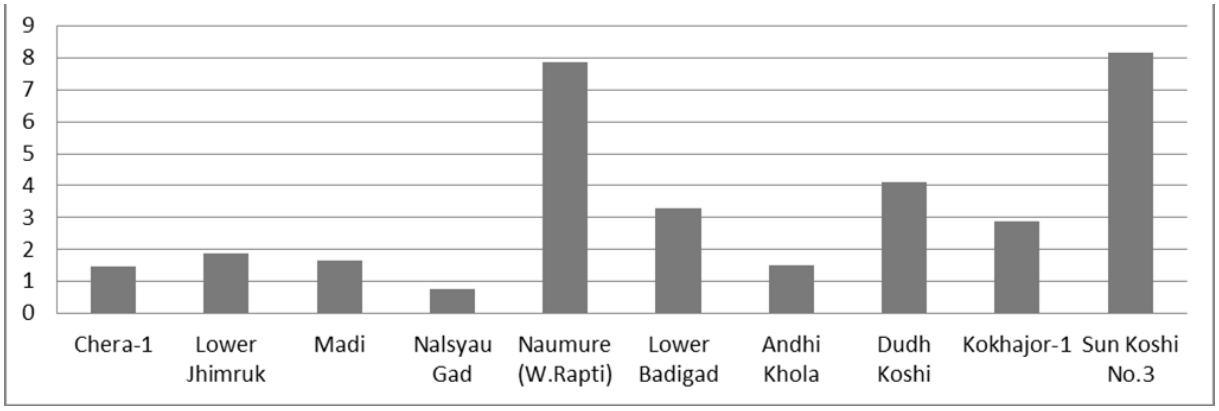


Figure 10.2.1.4-1 Forest land in the Reservoir Area(km^2)

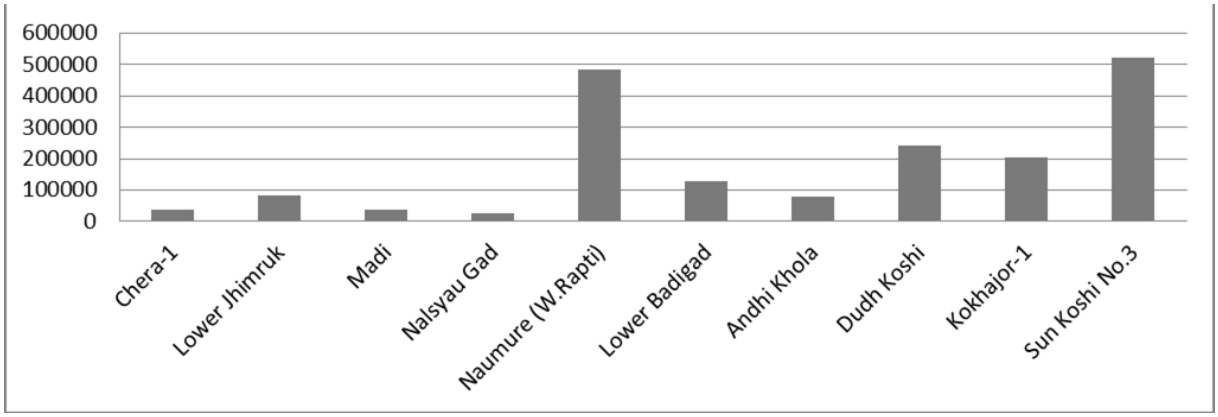


Figure 10.2.1.4-2 Number of Trees in the Reservoir Area

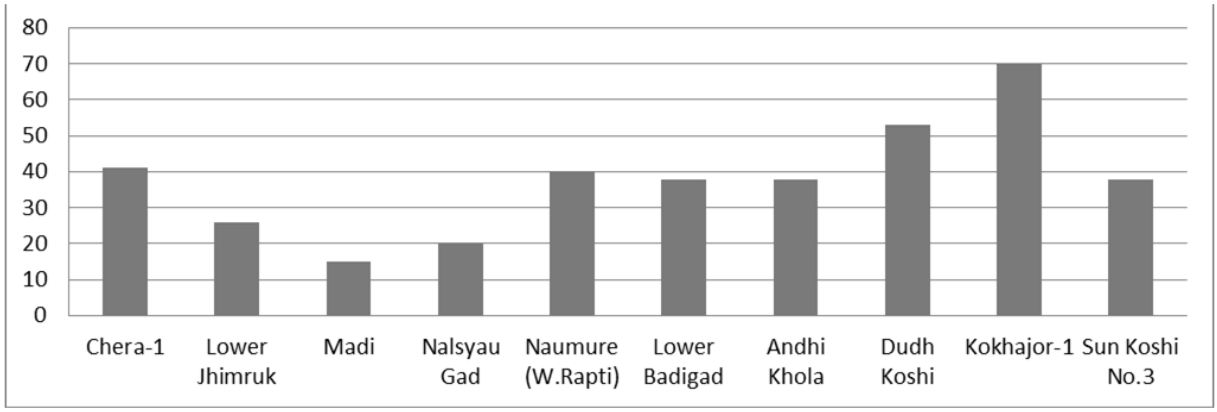


Figure 10.2.1.4-3 Average of Crown Coverage in the Reservoir Area (%)

b. Impact on Flora

The vegetation composition of each project site belongs to a upper sub-tropical or sub-tropical and the dominant trees in these areas are trees such as: Khyar and Hill sal forest, Mixed hardwood forest, Pine forest, Sisso forest and Mixed broad leaved forest. Regarding the community forest which was used by surrounding residents to collect firewood, there are 25 places for Naumure (W. Rapti), 24 places for Madi and only less than 4 places for Andhi Khola, Dudh Koshi and Sun Koshi No. 3.

Regarding plant species, there are many reported species for Madi (74 species) and for Dudh Koshi (67 species). In contrast, there are relatively few reported species for Kokhajor-1 (10 species), and Chera-1 (35 species). The largest number of reported species of conservation significance is for Madi as 6 species and the smallest number is for Nalsyau Gad as 1 species.

Table 10.2.1.4-3 Impact on Flora in the Reservoir Area

No. Project Name	W-02 Chera-1	W-05 Lower Jhimruk	W-06 Madi	W-23 Nalsyau Gad	W-25 Naumure (W. Rapti)	C-02 Lower Badigad	C-08 Andhi Khola	E-01 Dudh Koshi	E-06 Kokhajor-1	E-17 Sun Koshi No. 3
VEGETATION COMPOSITION	Upper Sub-tropical species	Sub-tropical species	Subtropical species	Upper Sub-tropical species	Sub-tropical species	Upper Sub-tropical species	Sub-tropical species	Upper Sub-tropical species	Sub-tropical Species	Sub-tropical species
FOREST TYPE	Mainly Hill sall Forest	Mainly hill sall	Hill Sal Forest and Pine Forest	Mixed hardwood forest and Pine forest	Mainly Hill sall forest	. Khayar /Sisso forest, Hill sal forest and Mixed broad leaved forest	Khyar and Hill sal forest	Mixed broad leaved forests and Hill sal Forest.	Hill Sal forest	Khyar and Hill sal forest
DOMINANT TREE SPECIES	Shoera robusta (Sal)	Shoera robusta (Sal)	Shorea robusta and Pinus roxburgii	Bombax ceiba , : Celtis australis , Pinus roxburgii	Shoera robusta (Sal)	Acacia catechu (Khayar), Bombax ceibia (Simal),Shoera robusta (Sal) and Schima wallichii (chilaune)	Acacia catechu (Khayar), Bombax ceibia (Simal),Shoera robusta (Sal) and Schima wallichii (chilaune)	Shoera robusta (Sal)	Shorea robusta, Acacia catechu, Adina cardifolia, Terminalia alata, Bombax ceiba	Acacia catechu (Khayar), Bombax ceibia (Simal),Shoera robusta (Sal) and Schima wallichii (chilaune)
NO OF COMMUNITY FOREST IN RESERVOIR AREA	12	6	24	9	25	12	3	11	4	4
NO OF GOVERNMENT FOREST IN RESERVOIR AREA	0	3	0	0	2	2	1	2	1	0
NO OF LEASEHOLD FOREST IN RESERVOIR AREA	1	0	0	0	0	0	0	0	0	0
No OF PRIVATE FOREST IN RESERVOIR	0				0	0	0	1	0	0
AVERAGE TREE NO. PER HECTOR OF FOREST	529	426	225	323	618	392	521	592	700	638
AVERAGE CROWN COVERAGE	41	26	15	20	40	38	38	53	70	38

No. Project Name	W-02 Chera-1	W-05 Lower Jhimruk	W-06 Madi	W-23 Nalsyau Gad	W-25 Naumure (W. Rapti)	C-02 Lower Badigad	C-08 Andhi Khola	E-01 Dudh Koshi	E-06 Kokhajor-1	E-17 Sun Koshi No. 3
NO OF TREES IN THE RESERVOIR AREA	38088	83776	36982	4160	485130	129360	77312	242720	202300	520608
No OF PLANT SPECIES REPORTED	35	55	74	59	55	>45	41	67	10	46
NO OF SPECIES OF CONSERVATION SIGNIFICANCE	3	4	6	1	4	5	5	3	3	5
NO OF IUCN CONSERVATION SPECIES IN RESERVOIR	0	0	0	0	0	0	0	0	0	0
NO OF CITES CONSERVATION SPECIES IN RESERVOIR	0	1(II)	1 (II)	0	1(II)	1(II)	1 (II)	0	0	0
NO OF GOVERNMENT PROTECTED SPECIES IN RESERVOIR	3	4	5	1	4	4	5	3	3	5

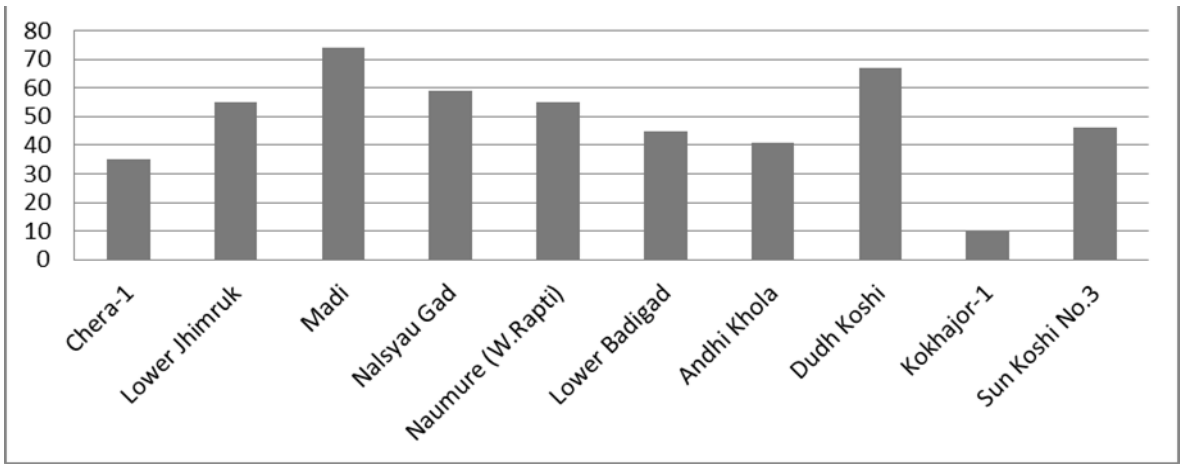


Figure 10.2.1.4-4 Number of Plant Species Reported in the Reservoir Area

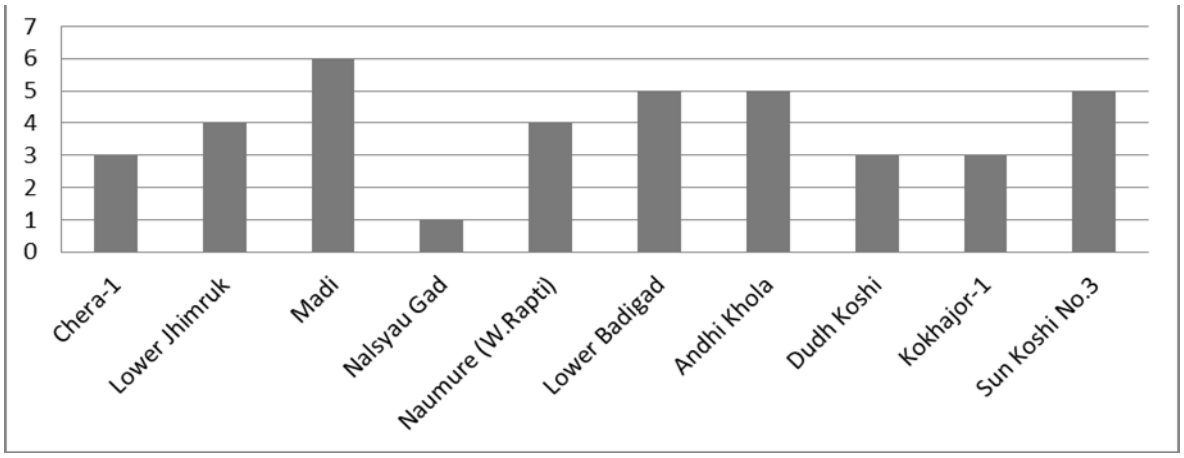


Figure 10.2.1.4-5 Number of Plant Species of Conservation Significance in the Reservoir Area

c. Impact on Terrestrial Fauna

Regarding terrestrial fauna, Naumure and Lower Jhimruk conserve their habitat relatively well. On the other hand, the habitat of terrestrial fauna is divided by farmland, houses and firewood collection places in other project sites. The quality of habitats have been decreased. Reflecting the conditions of these habitats, the number of mammal species and herpetofauna species are relatively large in Lower Jhimruk, Naumure (W. Rapti) and Dudh Koshi, and relatively small in Nalsyau Gad, Andhi Khola and Sun Koshi No. 3. Meanwhile, the number of bird species has a tendency to increase even in a large impact area, with 51 species for Dudh Koshi and 50 species for Sun Koshi No. 3 that have been reported.

Table 10.2.1.4-4 Impact on terrestrial Fauna

No.	W-02	W-05	W-06	W-23	W-25	C-02	C-08	E-01	E-06	E-17
Project Name	**Chera-1**	**Lower Jhimruk**	**Madi**	**Nalsyau Gad**	**Naumure (W. Rapti)**	**Lower Badigad**	**Andhi Khola**	**Dudh Koshi**	**Kokhajor-1**	**Sun Koshi No. 3**
NO OF MAMMAL SPECIES REPORTED	15	23	18	11	24	21	12	24	13	11
NO OF BIRD SPECIES REPORTED	28	49	21	13	49	30	16	51	21	50
NO OF HERPETOFAUNA SPECIES REPORTED	13	17	9	8	17	9	6	17	8	9
HABITAT CONDITIONS	Degraded and fragmented	Partially degraded by human encroachment	DEGRADED AND FRAGMENTED	high degree of human encroachment /degraded	Good habitat area for wildlife	Disturbed and fragmented due to human encroachment	Degraded and fragmented due to human encroachment	Disturbed by human interference	Fragmented and degraded due to intervening of settlement fodder collection	Degraded and fragmented by human encroachment
MIGRATION ROUTE	Seasonal habitat for feeding	Seasonal habitat for feeding	SEASONAL FEEDING SITE	seasonal feeding habitat of jaleva and a few mammalian species	Seasonal ground for feeding only	seasonal feeding ground for a number of species	Seasonal ground for feeding only	Seasonal feeding ground for jalewa	seasonal feeding ground for a number of species	Seasonal feeding ground
NO OF CONSERVATION MAMMALIAN SPECIES REPORTED (RESERVOIR)	7	8	7	6	9	9	7	9	4	6
NO OF IUCN CONSERVATION SPECIES IN RESERVOIR	3(NT), 1 (VU)	3 (NT), 1 (VU)	4 (NT)	3 (NT), 1 (VU)	5(NT), 1 (VU)	2 (NT), 1 (VU), 1 (EN)	2(NT), 1 (VU)	5 (NT), 1 (VU)	2(NT)	1(EN), 1 (NT)
NO OF CITES CONSERVATION SPECIES IN RESERVOIR	3 (III), 2 (I)	3(III), 3 (I)	4 (I) AND 3 (III)	4(I), 2 (III)	3(III), 3 (I)	3 (III), 3 (I), 2(II)	3 (III), 2 (I) and 1 (II)	3 (III), 3 (I)	2(I), 1 (II), 1 (III)	2(III), 2 (II), 2 (I)
NO OF GON CONSERVATION SPECIES IN RESERVOIR	1	1	1	1	2	0	0	1	1	1
NO OF CONSERVATION BIRD SPECIES REPORTED	2	3	1	0	3	3	1	3	2	4

No.	W-02	W-05	W-06	W-23	W-25	C-02	C-08	E-01	E-06	E-17
Project Name	**Chera-1**	**Lower Jhimruk**	**Madi**	**Nalsyau Gad**	**Naumure (W. Rapti)**	**Lower Badigad**	**Andhi Khola**	**Dudh Koshi**	**Kokhajor-1**	**Sun Koshi No. 3**
(RESERVOIR)										
NO OF IUCN CONSERVATION SPECIES IN RESERVOIR	1 (EN)	1(EN)	0	0	1 (EN)	1(CR), 1(EN), 1 (VU)	0	1(EN)	1(VU)	2(VU), 1(CR), 1 (NT)
NO OF CITES CONSERVATION SPECIES IN RESERVOIR	1(I)	1(I), 1 (II)	1 (I)	0	1(I), 1 (II)	0	I(I)	1(I), 1 (II)	1(I), 1 (III)	1 (I)
NO OF GON CONSERVATION SPECIES IN RESERVOIR	1	0	1	0	0	0	1	1	1	0
NO OF CONSERVATION HERPETOFAUNA SPECIES REPORTED (RESERVOIR)	4	4	1	1	4	0	2	5	1	3
NO OF IUCN CONSERVATION SPECIES IN RESERVOIR	0	0	0	0	0	0	0	0	0	1(VU)
NO OF CITES CONSERVATION SPECIES IN RESERVOIR	2(III), 2 (II)	2(II), 1 (III), 1 (I)	1 (II)	1 (I)	3(II), 1 (III)	0	1(I) AND 1 (II)	3(II), 1 (III), 1 (I)	1 (I)	2(II), 1 (I)
NO OF GON CONSERVATION SPECIES IN RESERVOIR	0	1	1	1	1	0	1	1	1	1

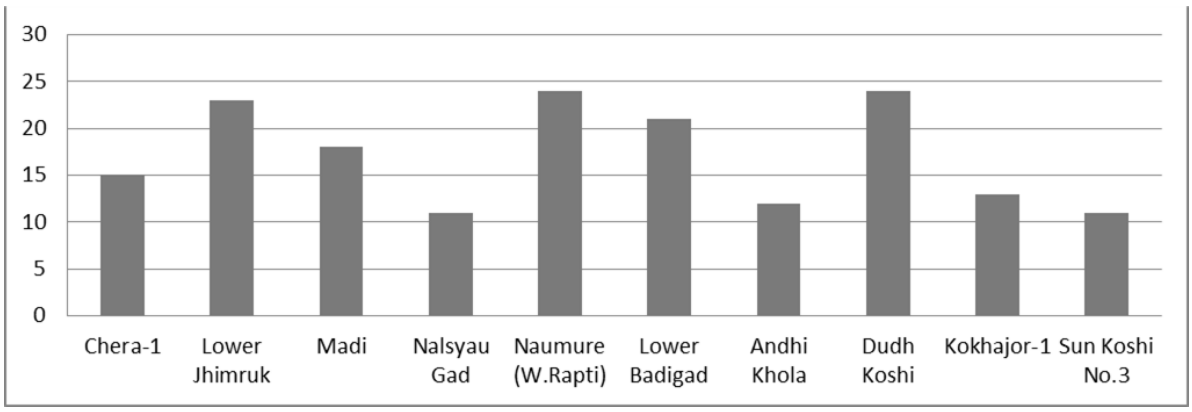


Figure 10.2.1.4-6 Number of Mammal Species Reported in the Reservoir Area

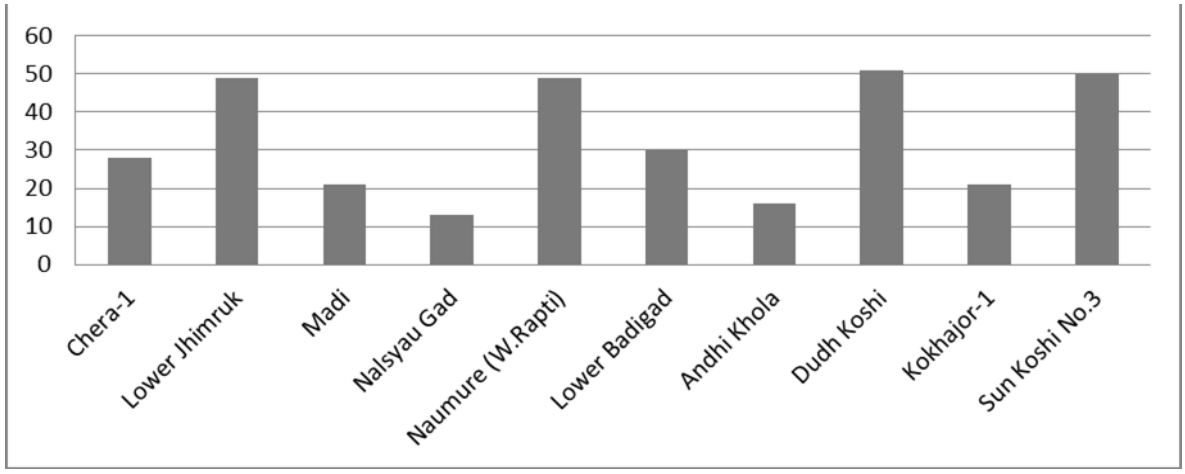


Figure 10.2.1.4-7 Number of Bird Species Reported in the Reservoir Area

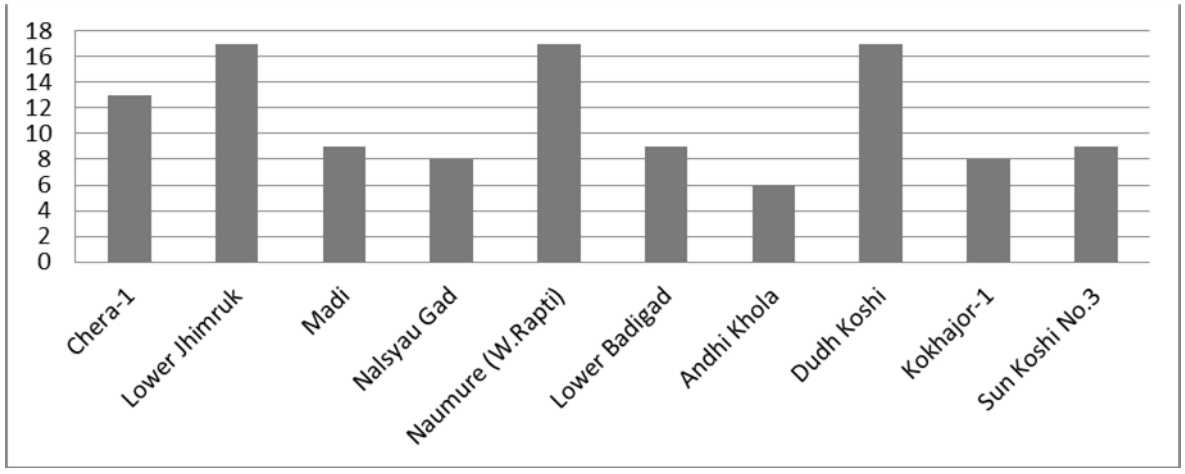


Figure 10.2.1.4-8 Number of Herpetofauna Species Reported in the Reservoir Area

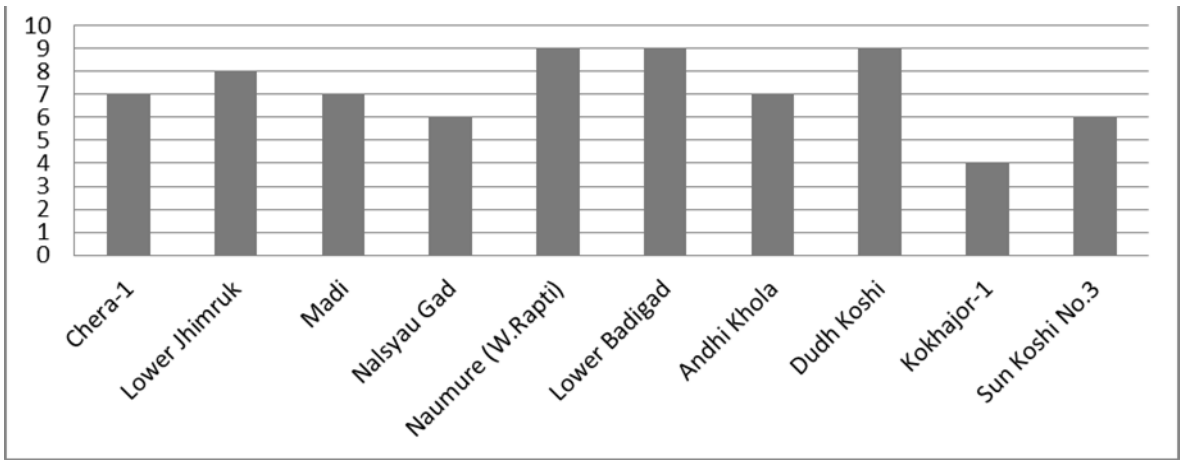


Figure 10.2.1.4-9 Number of Conservation Mammalian Species Reported in the Reservoir Area

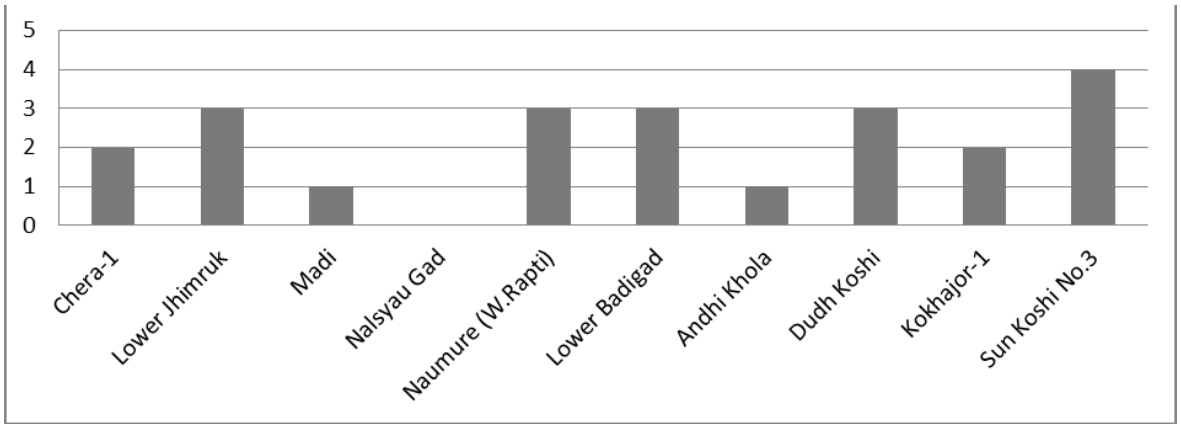


Figure 10.2.1.4-10 Number of Conservation Bird Species Reported in the Reservoir Area

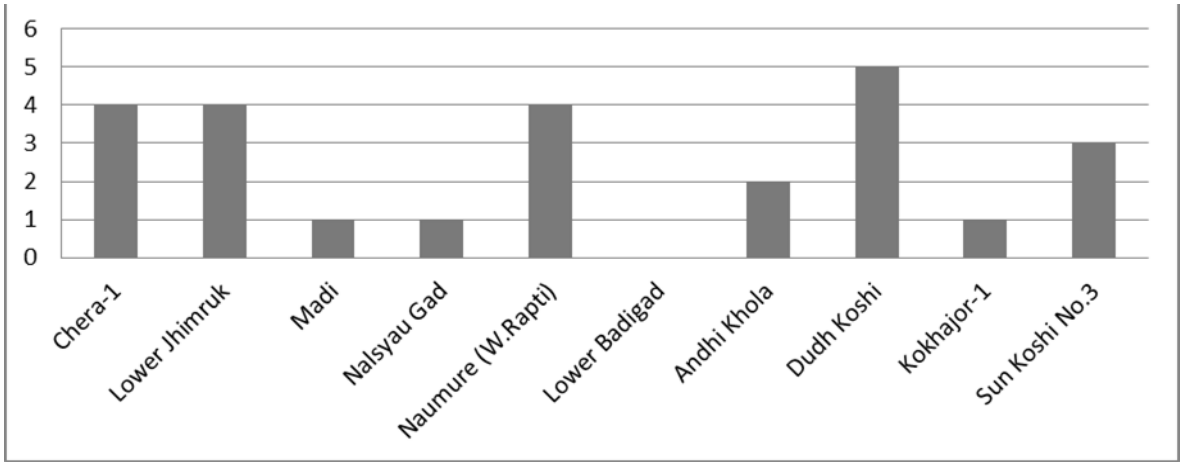


Figure 10.2.1.4-11 Number of Conservation Herpetofauna Species Reported in the Reservoir Area

d. Impact on Fish

The impact on aquatic fauna has been evaluated, taking into account fish species, the number of fish species of conservation significance and the length of the recession area. In the field,

interviews with fishermen were conducted to collect information and the length of the recession area was measured on topographic maps. Regarding the number of fish species, the largest number of fish species was 24 species reported for Dudh Koshi, a relatively small number of 6 fish species for Andhi Khola and 7 species for Kokhajor-1 were reported.

Andhi Khola and Dudh Koshi have the longest recession area of 60 km. In contrast, Sun Koshi No. 3 and Naumure (W. Rapti) have the short recession that are less than 1 km. Table 10.2.1.4-5, Figure 10.2.1.4-12, Figure 10.2.1.4-13 and Figure 10.2.1.4-14 show the results of the impact on aquatic fauna.

Table 10.2.1.4-5 Impact on Fish

No.	W-02	W-05	W-06	W-23	W-25	C-02	C-08	E-01	E-06	E-17
Project Name	**Chera-1**	**Lower Jhimruk**	**Madi**	**Nalsyau Gad**	**Naumure (W. Rapti)**	**Lower Badigad**	**Andhi Khola**	**Dudh Koshi**	**Kokhajor-1**	**Sun Koshi No. 3**
NO OF FISH SPECIESEIS REPORTED	11	11	8	8	16	12	6	24	7	21
NO OF FISH SPECIES OF CONSERVATION SIGNIFICANCE	2	2	3	2	2	4	2	3	2	3
NO OF IUCN CONSERVATION SPECIES IN RESERVOIR	2 (NT)	2(NT)	2(NT) 1(VU)	1 (NT), 1 (VU)	2 (NT)	2 (NT), 1 (VU), 1 (EN)	1 (NT), 1 (VU)	3 (NT)	2(NT)	3 (NT)
NO OF CITES CONSERVATION SPECIES IN RESERVOIR	0	0	0	0	0	0	0	0	0	0
NO OF GON CONSERVATION SPECIES IN RESERVOIR	0	0	0	0	0	0	0	0	0	0
Length of Recession Area (km)	7	8	10	11	0.5	4	60	60	21	0.5

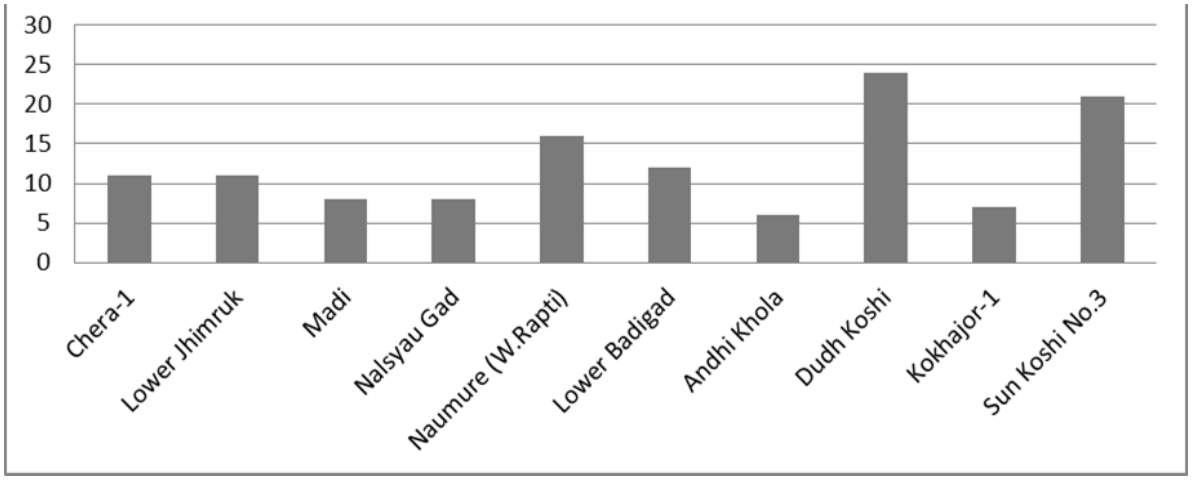


Figure 10.2.1.4-12 Number of Fish Species Reported in the Reservoir Area

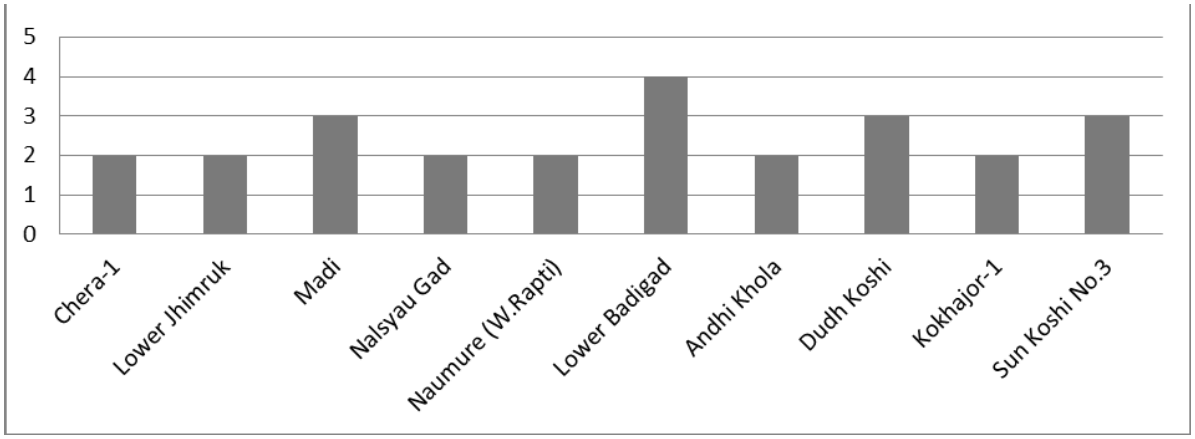


Figure 10.2.1.4-13 Number of Fish Species of Conservation Significance in the Reservoir Area

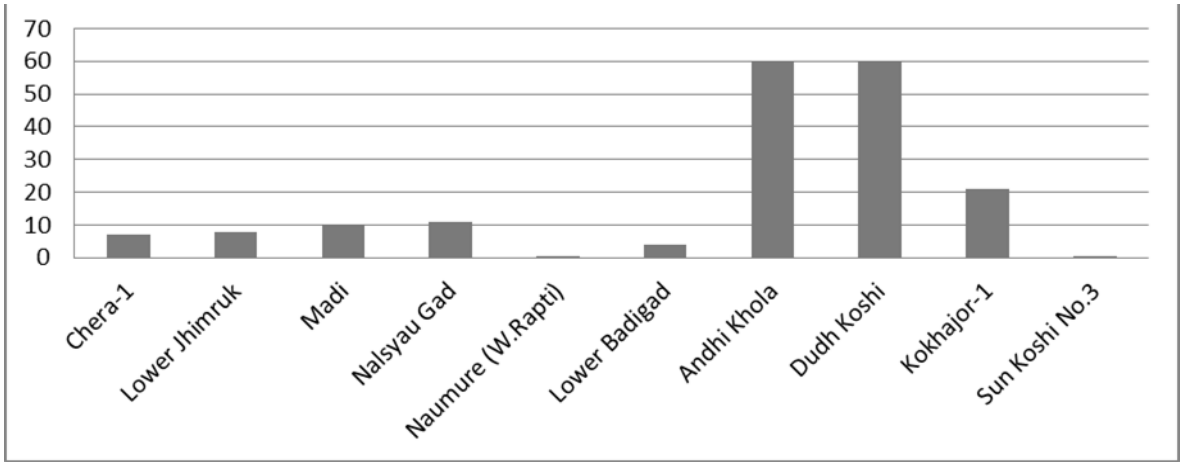


Figure 10.2.1.4-14 Length of Recession Area (km)

e. Impact on Rare Species and Protected Area in the Downstream

All the rivers on which the ten promising projects are located run through into India in their downstream, join to the Ganges River and leak to the Indian Ocean. Studies were conducted about distribution of protected areas in the downstream of project sites in India and in Nepal. Studies were also conducted on the distribution of species listed in IUCN red list relatively clear of distribution in India. The largest number of protected areas is the 3 for Chera-1 and Nalsyau Gad and the smallest is 1 for Kokhajor-1. The largest number of rare species is also reported for Chera-1 and Nalsyau Gad as 6 species and the smallest is 3 for Dudh Koshi, Kokhajor-1 and Sun Koshi No. 3. Regarding the Ganges River Dolphin, it is distributed to the downstream of all projects. Table 10.2.1.4-6, Figure 10.2.1.4-15 and Figure 10.2.1.4-16 show the results of the survey about the impact on rare species and protected areas in the downstream.

Table 10.2.1.4-6 Impact on Rare Species and Protected Area in the Downstream

No.	W-02	W-05	W-06	W-23	W-25	C-02	C-08	E-01	E-06	E-17
Project Name	**Chera-1**	**Lower Jhimruk**	**Madi**	**Nalsyau Gad**	**Naumure (W. Rapti)**	**Lower Badigad**	**Andhi Khola**	**Dudh Koshi**	**Kokhajor-1**	**Sun Koshi No.3**
Number of the protected area downstream	**3**	**2**	**2**	**3**	**2**	**3**	**3**	**2**	**1**	**2**
Bardia National Park (Inc. Buffer zone, Extension and KBA)	1	1	1	1	1					
Chitwan National Park (Inc. KBA)						1	1			
Koshi Tappu Wildlife Reserve (Inc. KBA)								1		1
Valmiki Sanctuary (India)						1	1			
Katarniyaghat Sanctuaire (India)	1			1						
Ganga Dolphin Sanctuary (India)	1	1	1	1	1	1	1	1	1	1
Number of the protected species downstream	**6**	**4**	**4**	**6**	**4**	**5**	**5**	**3**	**3**	**3**
Red-crowned roofed turtle (Batagur kachuga)										
Gharial (Gavialis gangeticus)	1	1	1	1	1	1	1			
Chrysomma altirostre (Jerdon's Babbler)						1	1		1	
Gallinago nemoricola (Wood Snipe)								1	1	1
Leptoptilos dubius (Greater Adjutant)						1	1	1	1	1
Nanorana ercepeae	1	1	1	1	1					
Nanorana minica	1			1						
Nanorana rostandi	1	1	1	1	1	1	1			
Prinia burnesii (Rufous-vented Prinia)								1		1
Rhinoceros unicornis (Indian Rhinoceros)	1			1		1	1			
Rucervus duvaucelii (Barasingha)	1	1	1	1	1					

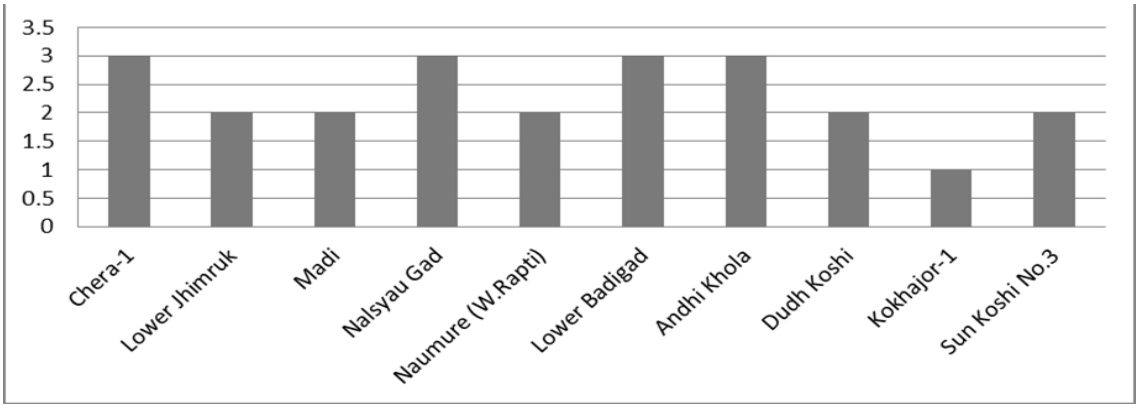


Figure 10.2.1.4-15 Number of the Protected Area in the Downstream

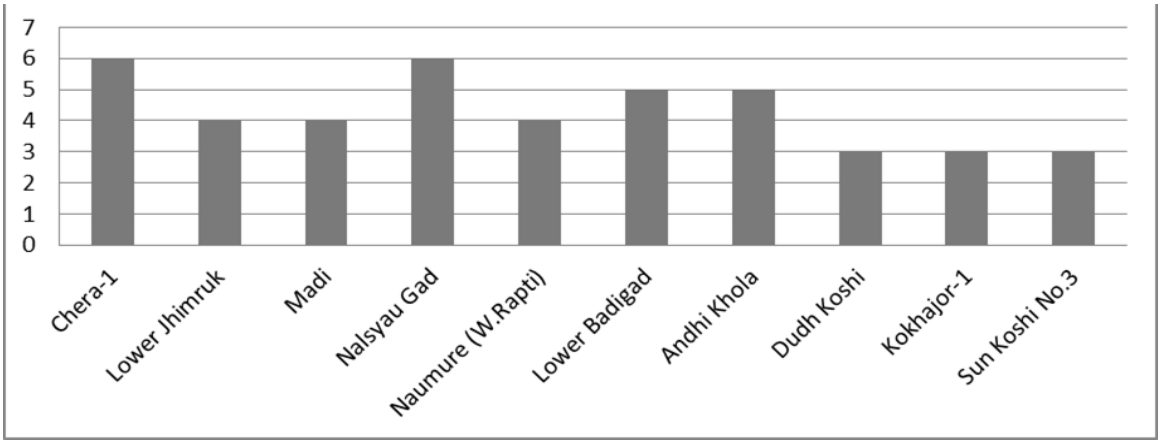


Figure 10.2.1.4-16 Number of the Protected Species in the Downstream

f. Impact by Transmission Lines

Construction of new hydroelectric power plants will be accompanied by not only an impact in the submerged area by the reservoir but also land acquisition and deforestation for construction of transmission lines. Construction of transmission lines also has a risk to make an impact on cultivated lands and residential areas. However, the transmission line route has not been determined at this time and the routes between planned substations and power stations were covered by forest land for almost all of the promising projects. Therefore, the impact by transmission line was evaluated with its lengths which make an impact on forest land. The longest transmission line was 112 km for Nalsyau Gad and the shortest was 35 km for Sun Koshi No. 3. Table 10.2.1.4-7 and Figure 10.2.1.4-17 show the results of the impact by transmission line.

Table 10.2.1.4-7 Length of Transmission Lines

Project Name	W-02 Chera-1	W-05 Lower Jhimruk	W-06 Madi	W-23 Nalsyau Gad	W-25 Naumure (W.Rapti)	C-02 Lower Badigad	C-08 Andhi Khola	E-01 Dudh Koshi	E-06 Kokhajor-1	E-17 Sun Koshi No.3
Length of Transmission Lines (km)	66	75	62	112	79	49	49	43	62	35

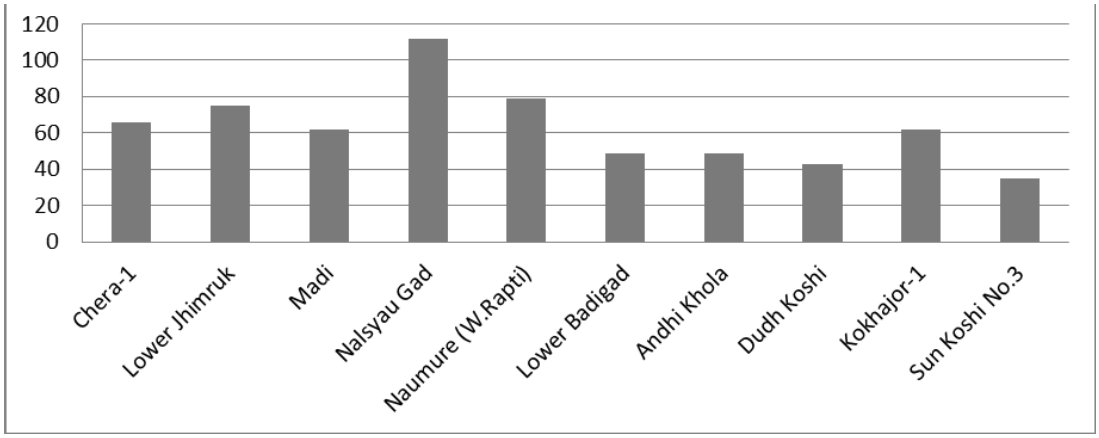


Figure 10.2.1.4-17 Impact on Forest by Transmission Lines

(2) Impact on the Social Environment

The impact on the social environment was evaluated mainly by the impact on the buildings, ethnic minority groups, agriculture, fisheries, tourism and culture, existing infrastructure, and development plans for other sectors. The brief summary of each of the survey results are as follows.

a. Impact on Buildings

The impact on buildings was evaluated by the number of households, schools and industries in the reservoir area. The number of households was basically estimated based on the number of structures that were counted from satellite images and placement and usage of households observed in the field. Regarding the number of schools and industries, these were studied by interview surveys in the field. The estimated number of households is more than 1,500 in places relatively close to the capital such as Sun Koshi No. 3 and Lower Badigad. On the other hand, only 63 households have been reported for Dudh Koshi. The numbers of schools and industries show similar trends.

Table 10.2.1.4-8, Figure 10.2.1.4-18, Figure 10.2.1.4-19 and Figure 10.2.1.4-20 show the results of impact on buildings.

Table 10.2.1.4-8 Impact on Buildings

No.	W-02	W-05	W-06	W-23	W-25	C-02	C-08	E-01	E-06	E-17
Project Name	**Chera-1**	**Lower Jhimruk**	**Madi**	**Nalsyau Gad**	**Naumure**	**Lower Badigad**	**Andhi Khola**	**Dudh Koshi**	**Kokhajor-1**	**Sun Koshi No.3**
Number of Households in the reservoir	566	229	336	291	456	1606	542	63	219	1599
Schools	3	4	2	2	5	18	9	-	6	19
Industries	-	3	-	-	-	11	6	-	0	2 (Brick Factories)

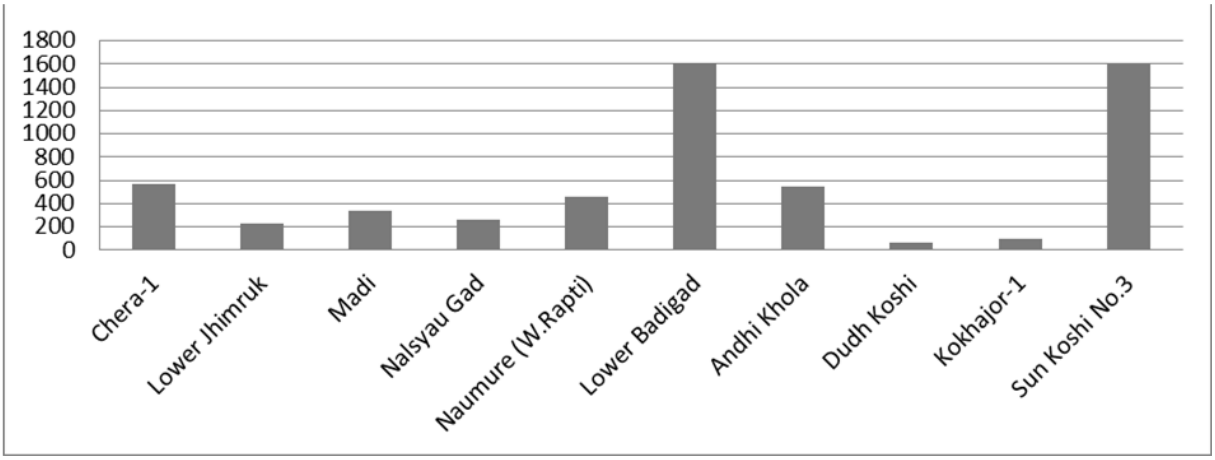


Figure 10.2.1.4-18 Number of Households

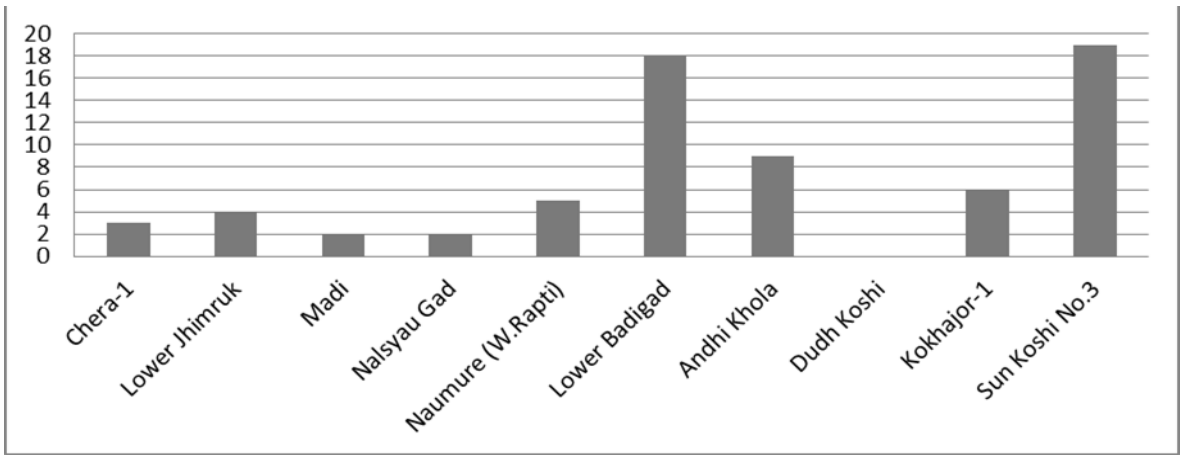


Figure 10.2.1.4-19 Number of Schools

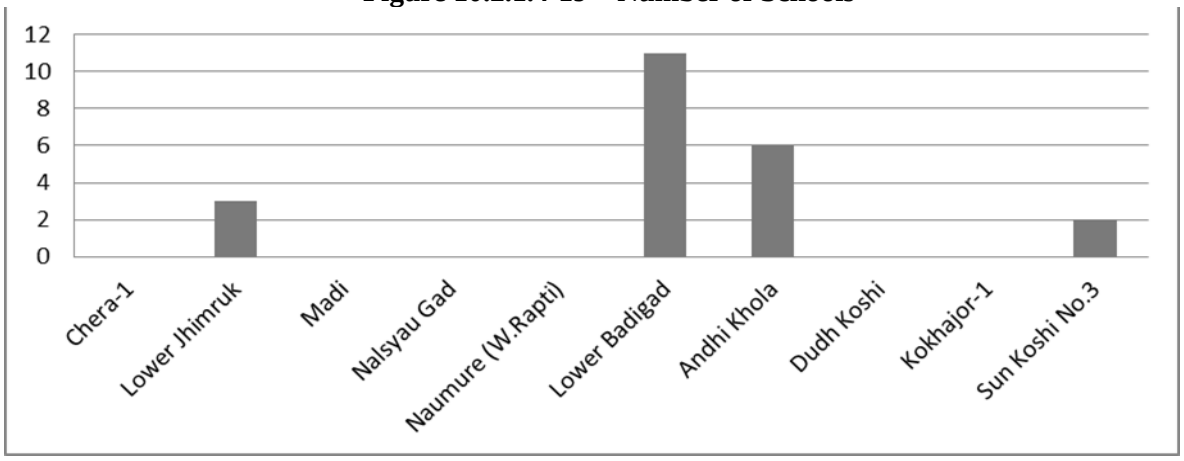


Figure 10.2.1.4-20 Number of Industries

b. Impact on Ethnic Minority Groups

The impact on ethnic minority groups was evaluated with the number of the ethnic minority groups observed with interview surveys in the field. Ethnic minority groups were selected from 59 Adivasi/Janajati designated in the National Foundation for Development of Indigenous Nationalities Act (2002), excluding advanced groups. The largest number of minority groups observed in this survey was 5 groups for Lower Badigad, and the smallest number was 0 for Nalsyau Gad. Table 10.2.1.4-9 and Figure 10.2.1.4-21 show the results of the impact on ethnic minority groups.

Table 10.2.1.4-9 Number of Ethnic Minority Groups

Project Name	W-02 Chera-1	W-05 Lower Jhimruk	W-06 Madi	W-23 Nalsyau Gad	W-25 Naumure (W.Rapti)	C-02 Lower Badigad	C-08 Andhi Khola	E-01 Dudh Koshi	E-06 Kokhajor-1	E-17 Sun Koshi No.3
Total Numbers of Ethnic Minority Groups	1	3	1	0	2	5	2	3	2	4
Magar (Disadvantaged)	√	√	√	×	√	√	√	√	√	√
Gurung (Disdavnataged)	×	√	×	×	√	√	√	×	×	×
Tamang (Disadvantaged)	×	×	×	×	×	×	×	√	√	√
Majhi (Marginalised)	×	×	×	×	×	×	×	√	×	√
Kumal (Marginalised)	×	√	×	×	×	×	×	×	×	×
Tharu (Marginalised)	×	×	×	×	×	√	×	×	×	√
Bote (Highly Marginalised)	×	×	×	×	×	√	×	×	×	×
Majhi (High Marginalised)	×	×	×	×	×	√	×	×	×	×

NOTE: √ = Presence × = Absence

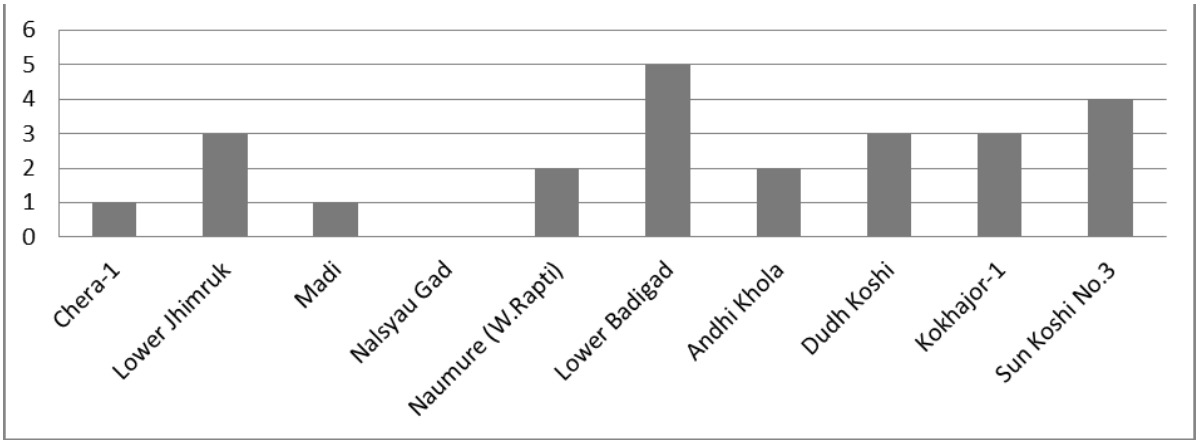


Figure 10.2.1.4-21 Numbers of Ethnic Minority Groups

c. Impact on Agriculture

The impact on agriculture was evaluated by the cultivated land in the reservoir area estimated based on the satellite image analysis and the number of irrigation systems observed with the interview survey. Regarding the cultivated land, the impact on Sun Koshi No. 3 was the biggest as 9.4 km^2, and the smallest was 1.1 km^2 for Chera-1. About the number of irrigation systems, a relatively large number of irrigation systems were observed for the projects in a narrow valley such as the Lower Badigad, Namure and Andhi Khola. It was relatively small for Nalsyau Gad, Dudh Koshi and Kokhajor-1. Table 10.2.1.4-10, Figure 10.2.1.4-22 and Figure 10.2.1.4-23 show the results of the impact on agriculture.

Table 10.2.1.4-10 Impact on Agriculture

No.	W-02	W-05	W-06	W-23	W-25	C-02	C-08	E-01	E-06	E-17
Project Name	**Chera-1**	**Lower Jhimruk**	**Madi**	**Nalsyau Gad**	**Naumure**	**Lower Badigad**	**Andhi Khola**	**Dudh Koshi**	**Kokhajor-1**	**Sun Koshi No.3**
Cultivated land (km^2)	1.1	2.0	1.9	2.5	6.1	5.9	1.7	3.3	1.7	9.4
Land Use Change (1996-2010/2011) - Cultivated land (km^2)	0.10	-0.22	-0.75	0.13	0.00	-0.80	0.07	-0.87	0.25	-0.46
Irrigation	7	3	16	0	25	58	23	1	2	20

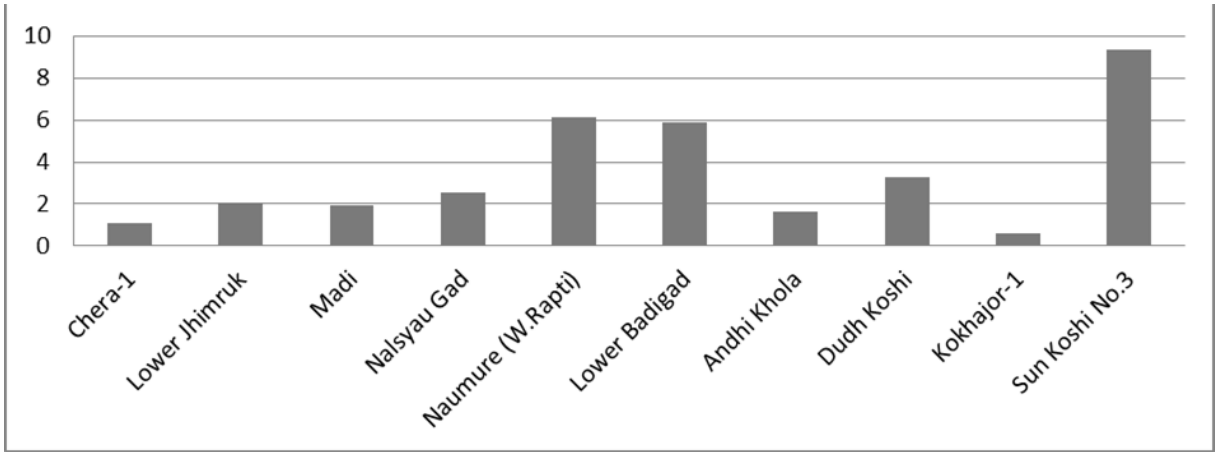


Figure 10.2.1.4-22 Impact on Cultivated Land (km^2)

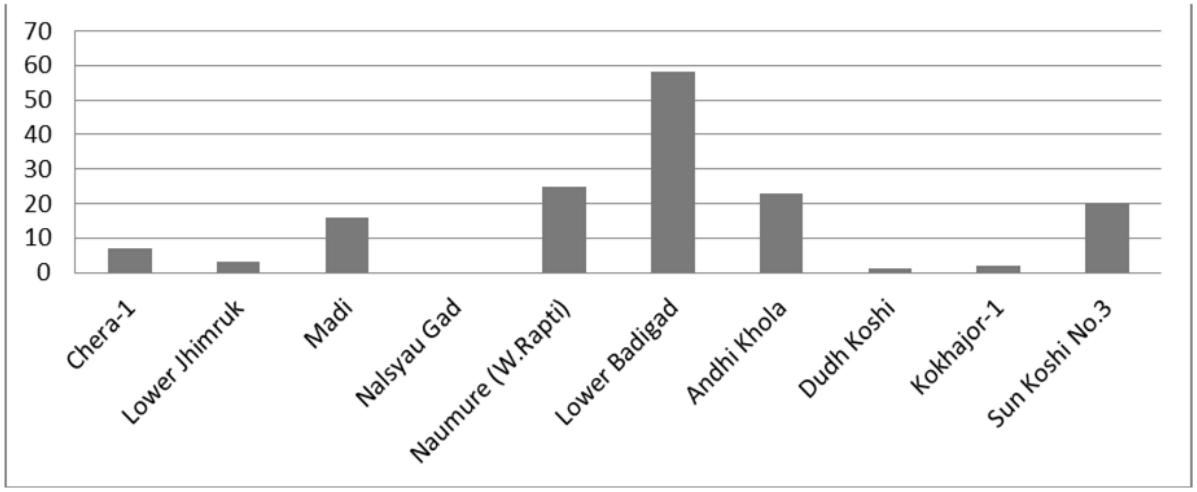


Figure 10.2.1.4-23 Impact on the Number of Irrigation Systems

d. Impact on Fisheries

Interview surveys with fishermen in the field were conducted for the survey about the impact on fisheries, and necessary data such as the type of fisherman (full-time workers, seasonal workers, part-time), average catch (kg/day), self-consumption rate, the number of the nearest fish markets, the average of total sales of fish markets (Rs/day), the average cost of fish (Rs/kg), the average annual income of fisherman and the fish availability compared to past. Based on the results of these surveys, the average of total availability of fish (kg/day) and the total sales in the nearest fish market, and the total annual income of fishermen were calculated to compare the results between the projects. Regarding the number of fishermen, the largest number was more than 700 for Sun Koshi No. 3, and no fishermen could be observed for Kokhajor-1. About the number of fish markets, the relatively large number of 7 was observed for Sun Koshi No. 3, Lower Badigad and Dudh Koshi. For these same three projects, the availability of fish and the total sales in the nearest fish market, and the total annual income of fisherman have tended to be large. Regarding the length of the recession area, Sun Koshi No. 3 and Naumure are as short as 0.5 km, meanwhile Dudh Koshi and Andhi Khola are as long as 60 km. Table 10.2.1.4-11, Figure 10.2.1.4-24, Figure 10.2.1.4-25, Figure 10.2.1.4-26, Figure 10.2.1.4-27 and Figure 10.2.1.4-28 show the above-mentioned results. The amount of fish in recent years has shown to basically decline by an increase in fishing pressure with the exception of Lower Badigad, which has shown a tendency to increase. Regarding the situation of Lower Badigad, there are two reasons assumed: 1) fishery regulation was enhanced about fishing with dynamite and poison, and 2) fish were run-up bypassing the block of run-ups by the Kaligandaki A hydroelectric power plant.

Table 10.2.1.4-11 Impact on Fisheries

No.	W-02	W-05	W-06	W-23	W-25	C-02	C-08	E-01	E-06	E-17
Project Name	**Chera-1**	**Lower Jhimruk**	**Madi**	**Nalsyau Gad**	**Naumure**	**Lower Badigad**	**Andhi Khola**	**Dudh Koshi**	**Kokhajor-1**	**Sun Koshi No.3**
Number of FISHERMEN	25	254	100	115	43	217	156	154	0	712
OCCUPATIONAL FISHERMEN (RESERVOIR)	23	4	0	12	0	86	0	20	0	80
PART TIME FISHERMEN	2	21	39	45	43	91	50	71	0	450
RECREATIONAL FISHERMEN	0	All	61	58	0	40	106	All	0	182
AVERAGE CATCH (KG) /DAY	1.5		1	1.5	1	3	1.5	2	0	2
CONSUMED AT HOME	50%	50%	75%	35%	50%	25%	50%	50%	0	25%
SOLD IN THE MARKET	50%	50%	25%	65%	50%	75%	50%	50%	0	75%
NO OF NEAREST FISH MARKET	4	3	3	3	2	7	3	7	0	7
AVAILABILITY OF FISH IN THE MARKET IN A DAY (KG/DAY)	5 to 20	2 to 25	3 to 5	2 to 5	2 to 13	4 to 25	2 to 15	5 to 15	0	10 to 30
AVERAGE COST OF FISH (NRS/KG)	200	180	300	200	250 to 300	250	250 to 350	250	0	250 to 350
AVERAGE ANNUAL INCOME BY OCCUPATIONAL AND PART TIME FISHERMEN	15000	9000	7000	20000	9000	10 to 12000	10000 to 12000	20000	0	7000
FISH AVAILABILITY COMPARED TO PAST	Less	Less	Less	Less	Less	Increased	Less	Less	No record	Less
Availability of fish in the Market (kg/day)	50	40.5	12	10.5	15	101.5	25.5	70	0	140
Total sale of fish (Rs./day)	10000	7290	3600	2100	4125	25375	7650	17500	0	42000
Total income (Rs./year)	375,000	225,000	273,000	1,140,000	387,000	1,062,885	550,000	1,820,000	0	3,710,000
Length of Recession Area	7	8	10	11	0.5	4	60	60	21	0.5

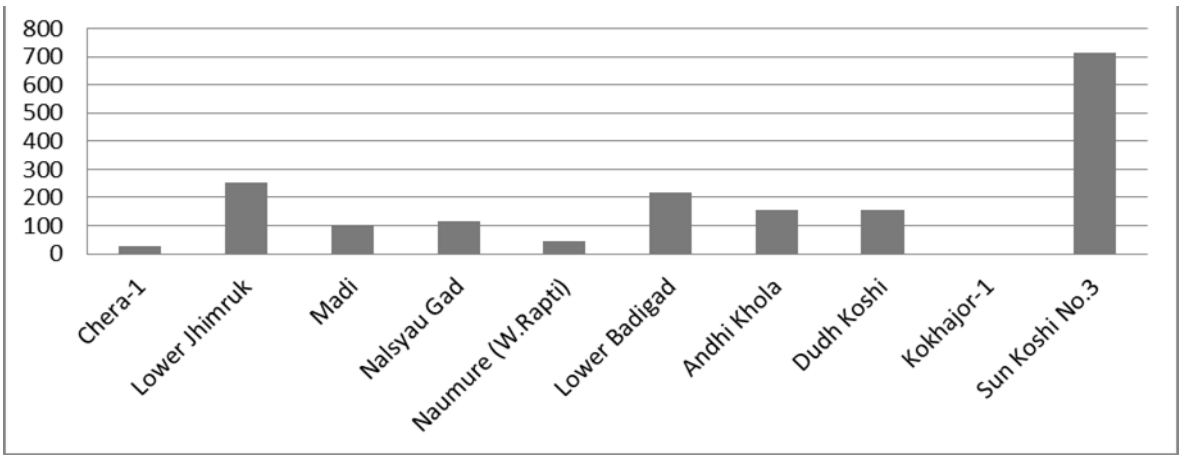


Figure 10.2.1.4-24 Impact on Number of Fishermen

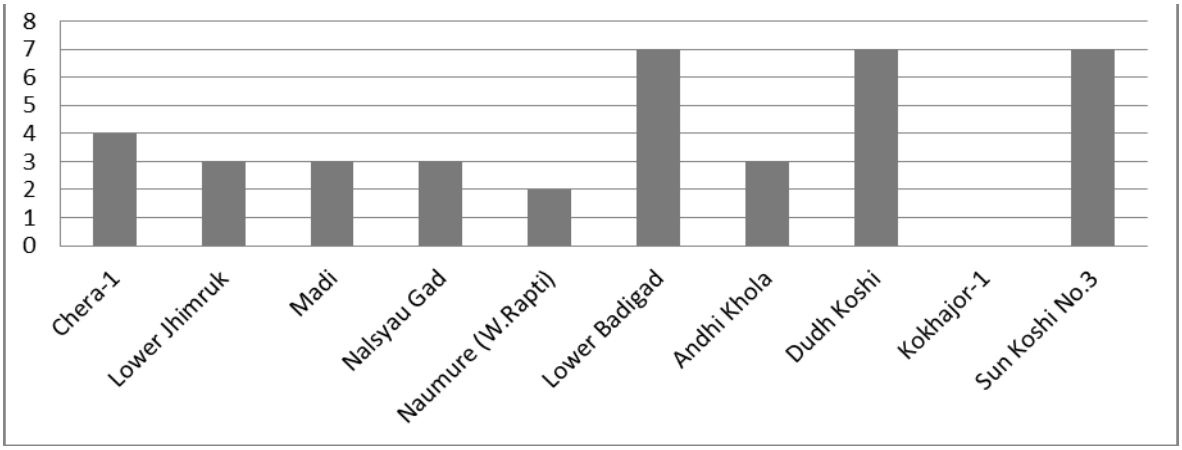


Figure 10.2.1.4-25 Number of the Nearest Fish Markets

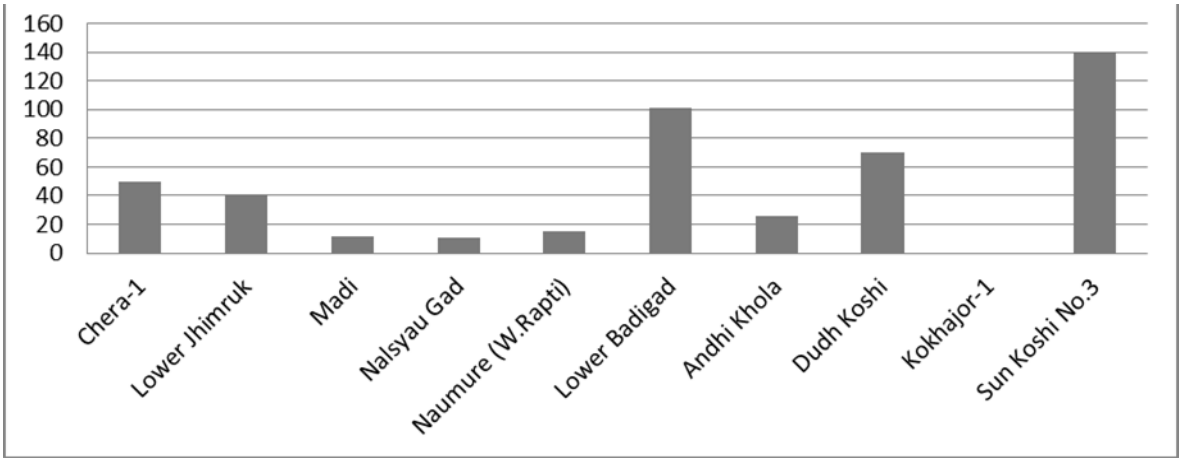


Figure 10.2.1.4-26 Availability of Fish in the Market (kg/day)

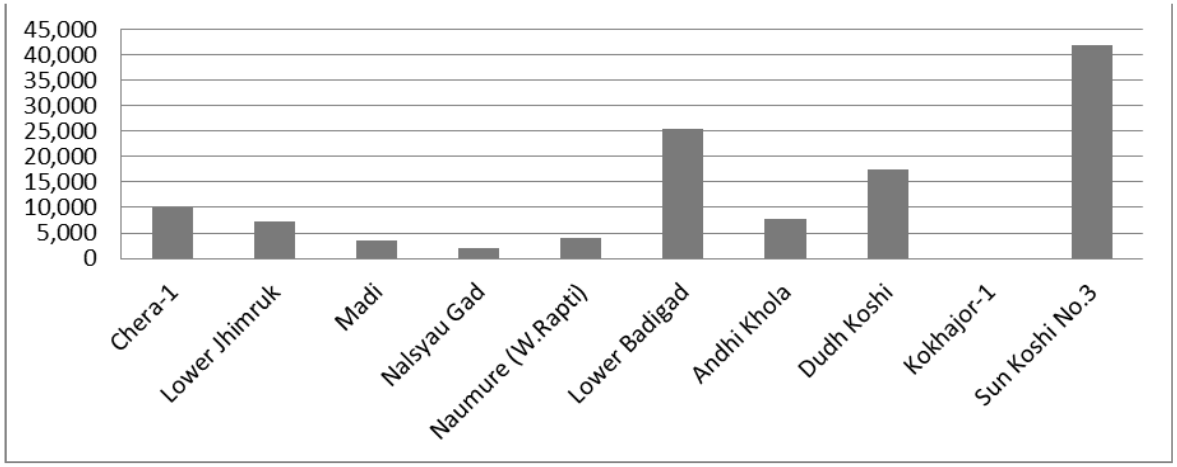


Figure 10.2.1.4-27 Total Sales of Fish Markets (Rs./day)

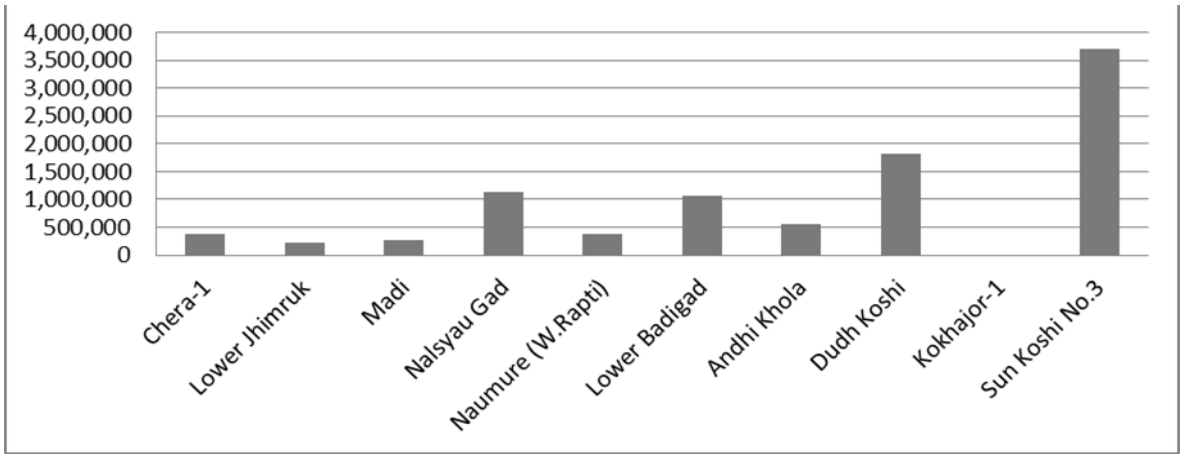


Figure 10.2.1.4-28 Total Income of Fishermen (Rs./Year)

e. Impact on Tourism and Culture

The information on the number of cultural structures (temples), unique handicrafts, tourist facilities, tourists (pers./year), etc. have been collected for the survey about the impact on tourism and culture. Regarding the Hindu festivals, many festivals were conducted everywhere and it was difficult to confirm the concrete number of festivals and pilgrimages. About the number of temples, the largest number was 10 for Sun Koshi No. 3, and there were no reported temples for Kokhajor-1 and Nalsyau Gad. Regarding handicrafts, living items such as straw matting (Gundri), bamboo baskets (Doko) have been made in Lower Jhimruk. Products with goat hair in Nalsyau Gad and bags in Andhi Khola have also been made. In the reservoir area of Sun Koshi No. 3, there are a number of hotels which collect about 20,000 tourists a year in total. In Dudh Koshi, rafting tourism has been carrying in two places. Table 10.2.1.4-12, Figure 10.2.1.4-29, Figure 10.2.1.4-30 and Figure 10.2.1.4-31show the above mentioned results.

Table 10.2.1.4-12 Impact on Tourism and Culture

Project Name	W-02 Chera-1	W-05 Lower Jhimruk	W-06 Madi	W-23 Nalsyau Gad	W-25 Naumure (W. Rapti)	C-02 Lower Badigad	C-08 Andhi Khola	E-01 Dudh Koshi	E-06 Kokhajor-1	E-17 Sun Koshi No.3
Cultural Aspects										
Number of Cultural Structures (Temples)	1	1	4	-	2	9	5	2	0	>10
Type of Cultural Festivals	Hindu Culture (Dasain, Tihar, Teeja, Manghe Sankrati) and Magar Diwas, Lhosar, Sonam Losar, Bisket Sankrati, Ekadashi, Pitri Puja, Ghatu Nach, Lakhe, Botre (Barki, Dhanya Purne), and Purnima among Janjati/Adivasi in all the project sites.									
Unique Handicrafts	-	Gundri/ Doko/ Mandro for self-use	-	Bakral from Goat wool	Mandal as per need	-	Nepali Bag and Woolen Products	-	-	-
Tourism										
Number of Tourist Facilities	None	-	-	-	-	-	None	2 (Rafting)	-	10
Number of Tourists/Yr	none	-	-	-	-	-	None	10	-	20,000

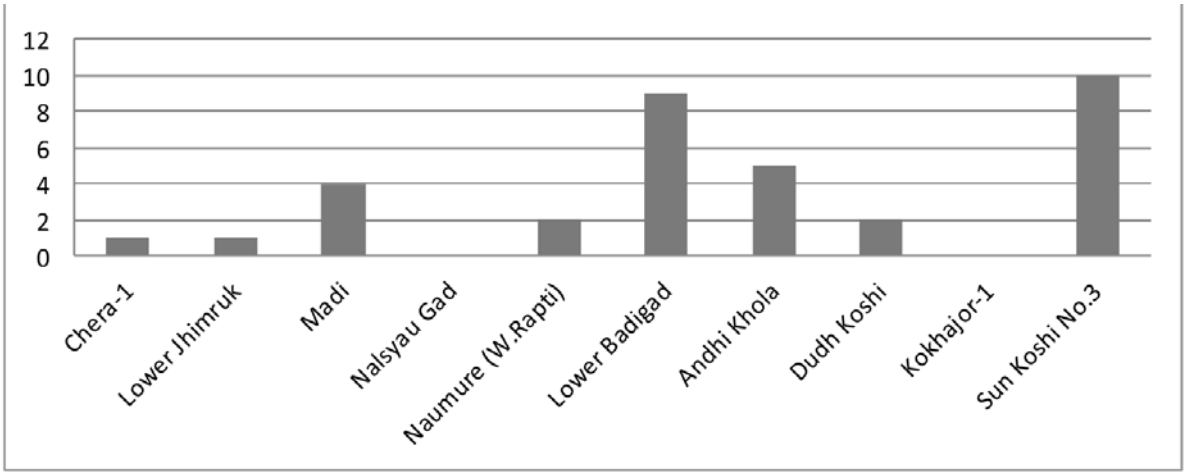


Figure 10.2.1.4-29 Number of Cultural Structures (Temples)

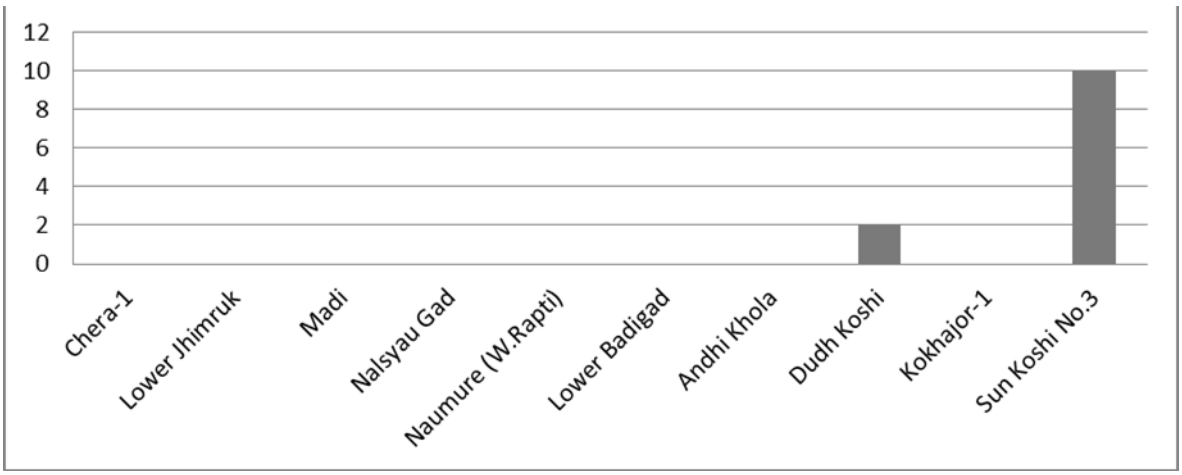


Figure 10.2.1.4-30 Number of Tourist Facilities

Figure 10.2.1.4-31 Number of Tourists/Year

f. Impact on Infrastructure

Regarding the survey about the impact on infrastructure, it was conducted mainly about the length and type of road (paved road, gravel road), the number of bridges (suspension bridges, drivable bridges), and existing water mills/turbines and drinking water schemes. The road length was measured on maps based on the information collected in the field. The number of bridges and water schemes were confirmed with interview surveys in the field. Regarding the impact on roads, Sun Koshi No. 3, where the national road leading to China will be submerged, shows a relatively significant impact. The impact on Lower Badigad will also be significant because 20 km of drivable road will be affected. On the other hand, Nalsyau Gad and Kokhajor-1 will be almost unaffected. Regarding bridges, Sun Koshi No. 3 and Lower Badigad have more than 10 bridges which will also be affected. In Lower Badigad and Nalsyau Gad, there are more than 20 micro hydro and small water turbines for agriculture that will be affected. About Andhi Khola, a hydropower plant with 5 MW exists in the reservoir area. The number of drinking water schemes were relatively large for Lower Badigad, Madi and Sun Koshi No. 3. Table 10.2.1.4-13, Figure 10.2.1.4-32, Figure 10.2.1.4-34 and Figure 10.2.1.4-35 show the above mentioned results.

Table 10.2.1.4-13 Impact on Infrastructure

Project Name	W-02 Chera-1	W-05 Lower Jhimruk	W-06 Madi	W-23 Nalsyau Gad	W-25 Naumure (W. Rapti)	C-02 Lower Badigad	C-08 Andhi Khola	E-01 Dudh Koshi	E-06 Kokhajor-1	E-17 Sun Koshi No.3
Black Topped Drivable Roads (km)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0
Gravel drivable roads (km)	3.8	3.3	11.2	0.0	1.8	26.1	3.4	5.0	0.0	24.4
Main Foot Trails (km)	0.3	0.0	13.6	2.0	9.8	2.5	0.0	3.2	0.0	2.5
Local Foot Trails (km)	4.6	19.5	14.6	20.9	50.5	16.1	13.0	17.9	5.2	16.1
Suspension Bridges	1	3	6	4	11	11	11	5	0	13
Drivable Bridges	0	0	0	0	2	1	0	0	0	1
Fords	2	0	2		5	3	0	2	1	32
Water Mill/Turbines	9	-	2	20	-	24	-	--	10	15
Hydropower		-	4(0.23 MW)	-	-	2 (28 kW & 0.7 MW)	1(11MW)		1(1.5 kW)	-
Drinking Water Schemes	2	7	22	-	17	29	10	5	10	22

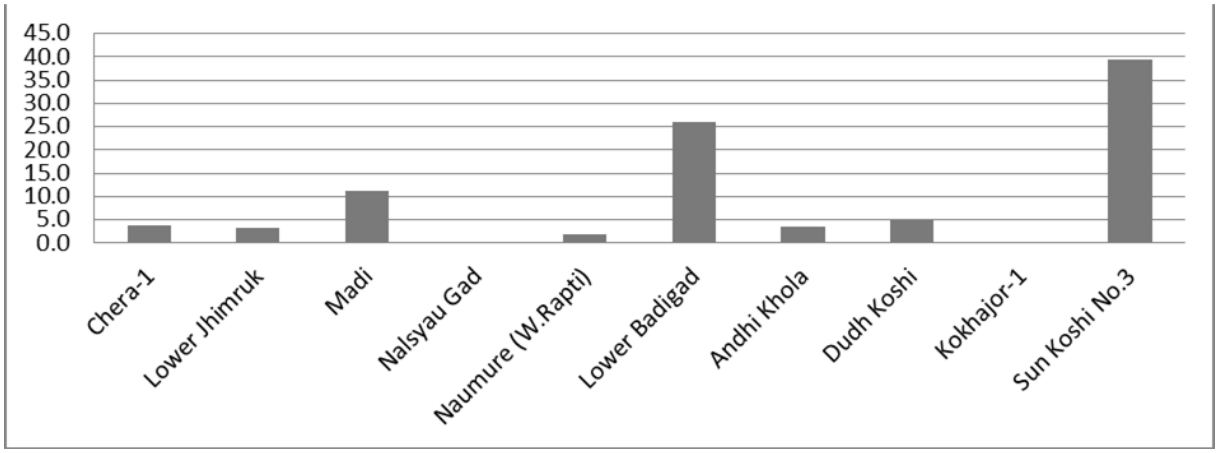


Figure 10.2.1.4-32 Impact on Roads

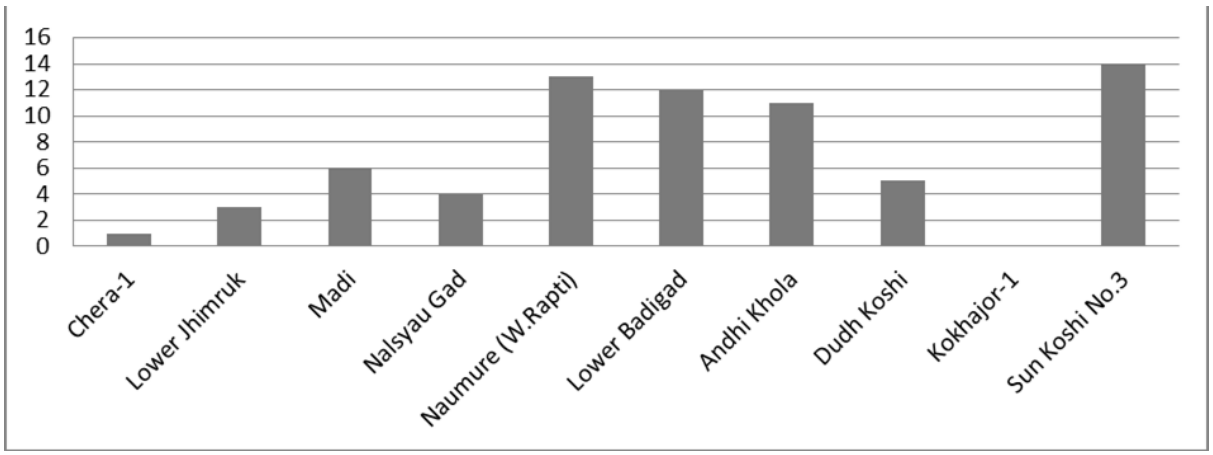


Figure 10.2.1.4-33 Impact on Bridges

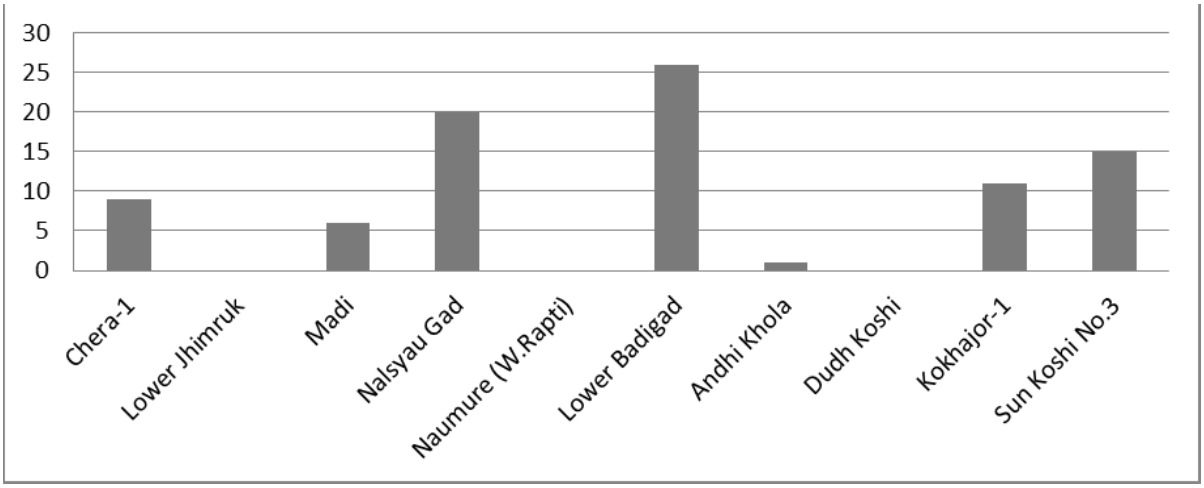


Figure 10.2.1.4-34 Impact on Water Mills / Hydropower

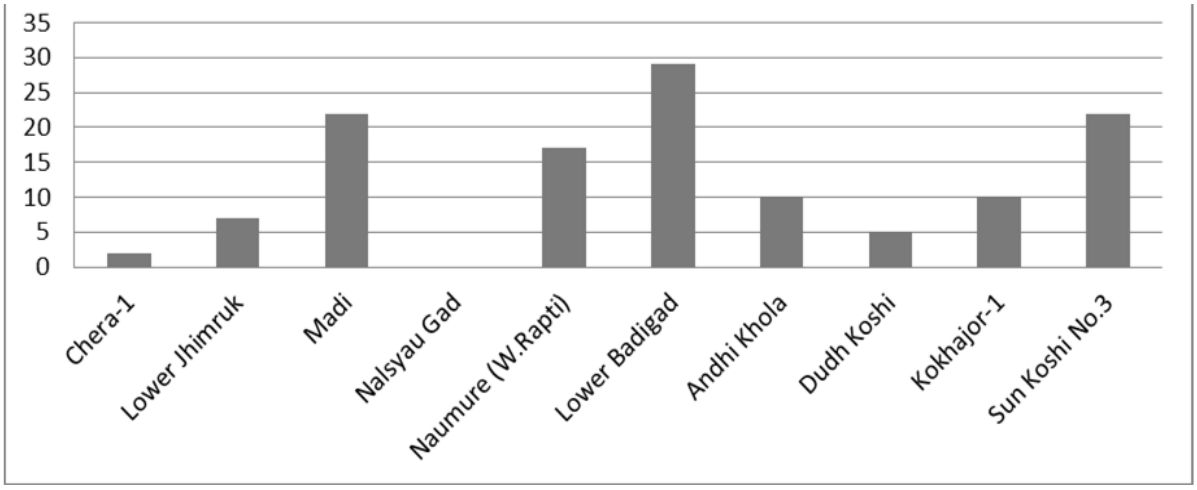


Figure 10.2.1.4-35 Impact on Drinking Water Schemes

g. Impact on the Local Economy and the Existing Development Plans

Regarding the impact on the local economy and the existing development plans, interview surveys were mainly conducted about the number of markets, the ongoing and proposed development plans and the previous experience/issues. A relatively large number of markets were reported in thickly populated places such as Sun Koshi No. 3 and Lower Badigad, and small numbers were reported in thinly populated places such as Kokhajor-1 and Lower Jhimruk. The largest number of existing development plans was 10 as reported for Sun Koshi No. 3 and there were no observed development plans for Dudh Koshi and Chera-1. Regarding the previous experience/issues, some conflicts were reported: 1) a small dispute with the extension of road for Sun Koshi No. 3, and 2) dispute with the construction of a cement plant for Kokhajor-1. However, there was no reported conflict due to hydropower development in the past. Table 10.2.1.4-14, Figure 10.2.1.4-36, Figure 10.2.1.4-37 and Figure 10.2.1.4-38 show the above-mentioned results.

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Table 10.2.1.4-14 Impact on the Local Economy and the Existing Development Plan

	W-02 Chera-1	W-05 Lower Jhimruk	W-06 Madi	W-23 Nalsyau Gad	W-25 Naumure (W.Rapti)	C-02 Lower Badigad	C-08 Andhi Khola	E-01 Dudh Koshi	E-06 Kokhajor-1	E-17 Sun Koshi No.3
Market	4	-	2	1	3 Shops	5	4	1	0	5
Ongoing/Proposed Development Plans	None	1 Drinking Water Scheme	2 HP, 1 Irrigation	1 Suspension Bridge, 1 DW Scheme	1 CF, 1 Irrigation, 1 Alternative Energy	1Irrigation,2 HP	Aquatic Firm and Adhi Khola Development Program	None	2 irrigation, 1 micro hydro, 1 hospital, 2 road project	2 Irrigation, 1 Ring Road, 1 Bridge,1 Water Pump, 1 Kinmbu Farming, 4 Road Expansion
Previous Experience/Issues	None	None	None	None	None	None	None	None	Had trouble related to construction of Salimar cement industry	Minor Disputes during road expansion

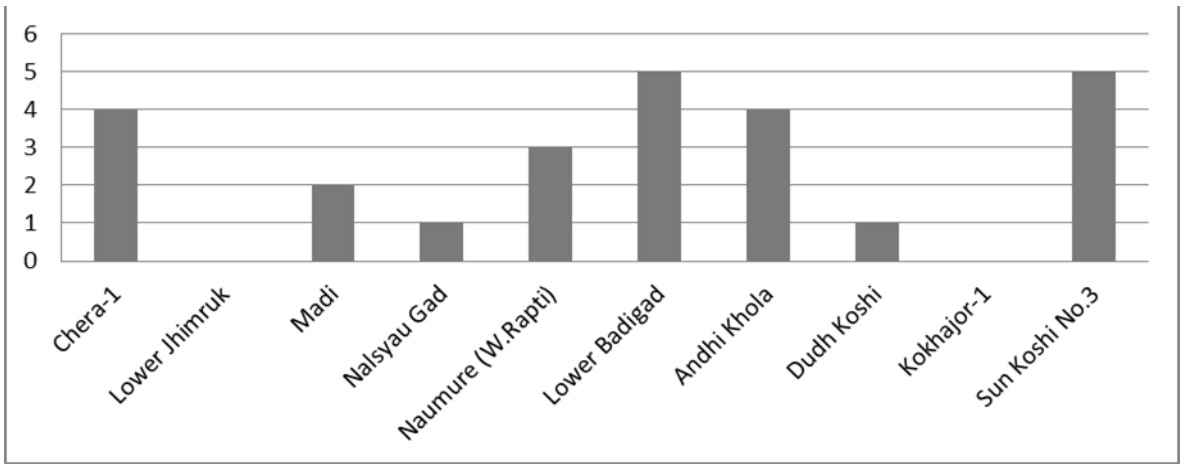

Figure 10.2.1.4-36 Number of Markets

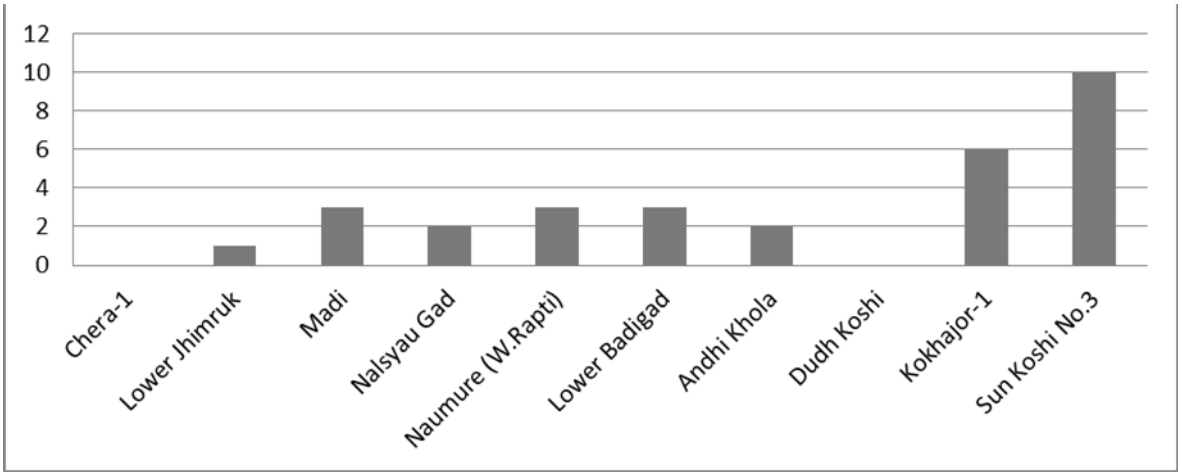

Figure 10.2.1.4-37 Number of Existing Development Plans

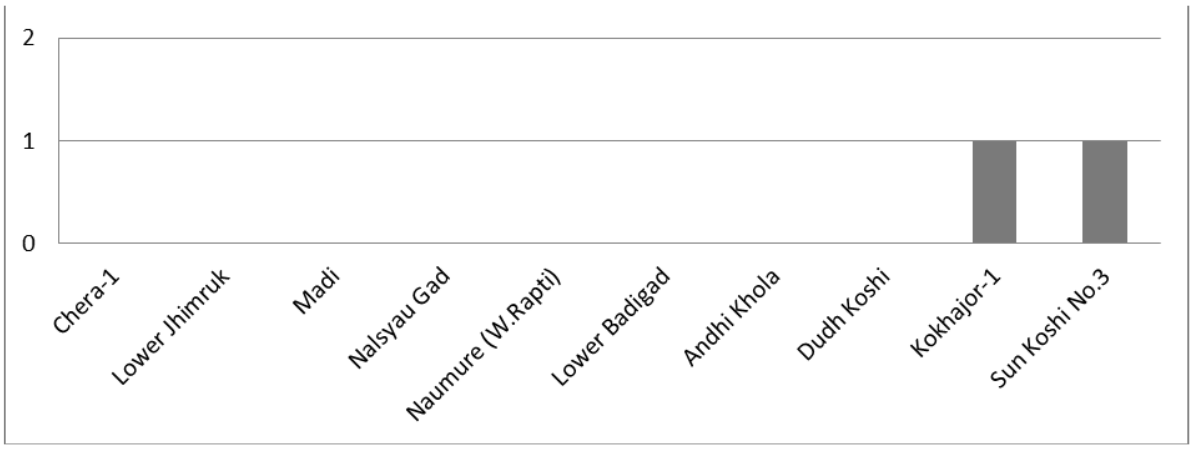

Figure 10.2.1.4-38 Number of Previous Experiences / Issues

(3) Evaluation of the Natural Environment and Social Environment

a. Evaluation Criteria

Evaluation points were calculated with a relative evaluation, 0 points had been given for the biggest impact and 100 points had been given for the smallest impact. In addition, for evaluation of the impact on forest area, the number of households and amount of cultivated land used a value obtained by dividing the installed capacity. (See 10.2.2.1(5) to (6))

b. Results of the Evaluation

The high late and low rate of the evaluation results were mixed for all projects as a result of a relative evaluation based on the evaluation criteria.

In the Chera-1 project, the impact on the natural environment is relatively small and the impact on cultivated land and tourism is also small. On the other hand, there are some issues such as distribution of protected areas in the downstream and the number of households is relatively significant (see Figure 10.2.1.4-39).

In the Lower Jhimruk project, a relatively large number of rare species and ethnic minority groups are reported. But the impact on infrastructure and tourism is not so significant (see Figure 10.2.1.4-40).

In the Madi project, the diversity of plants is high and a relatively large number of rare fishes are reported. The impact on cultivated land and tourism is not so significant (see Figure 10.2.1.4-41).

In the Nalsyau Gad project, the length of the transmission line is long, and protected areas and protected species are distributed in the downstream. However, there is almost no impact on households, cultivated land and infrastructure (see Figure 10.2.1.4-42).

In the Namure project, the impact on forests, flora, fauna, and cultivated land are relatively large. On the other hand, the impact on fisheries and tourism is relatively small (see Figure 10.2.1.4-43).

In the Lower Badigad project, in comparison with other projects, the impact on rare mammals and fishes is relatively large as well as the impact on households, temples, roads and bridges (see Figure 10.2.1.4-44).

In the Andhi Khola project, the impact on forests, birds and fish is relatively small and the impact on cultivated land is not so significant. However, there is an existing hydroelectric power plant of 5 MW which will be submerged, and the impact on places such as households, school, retail stores is relatively significant (see Figure 10.2.1.4-45).

In the Dudh Koshi project, while the impact on mammals, birds and fishes is relatively large, the impact on households and existing infrastructures is relatively small (see Figure 10.2.1.4-46).

In the Kokhajor-1 project, the impact on forests is relatively large and there are many ethnic minority groups. But the impact on cultivated land, fisheries, and existing infrastructure is relatively small (see Figure 10.2.1.4-47).

Table 10.2.1.4-15 Result of the Evaluation about the Natural Environment

Project Name		W-02	W-05	W-06	W-23	W-25	C-02	C-08	E-01	E-06	E-17
		Chera-1	Lower Jhimruk	Madi	Nalsyau Gad	Naumure (W.Rapti)	Lower Badigad	Andhi Khola	Dudh Koshi	Kokhajor-1	Sun Koshi No.3
Impact on Forest											
Forest land (km^2)	Point	1.46	1.87	1.64	0.76	7.85	3.304	1.51	4.1	2.89	8.16
	P/MW	0.01	0.01	0.01	0.00	0.03	0.01	0.01	0.01	0.03	0.02
	Score	***74***	***63***	***79***	***100***	***0***	***77***	***78***	***61***	***20***	***56***
Average Crown Coverage (%)	Point	41	26	15	20	40	38	38	53	70	38
	Score	***53***	***80***	***100***	***91***	***55***	***58***	***58***	***31***	***0***	***58***
Number of trees	Point	38,088	83,776	36,982	24,580	485,130	129,360	77,312	42,720	202,300	520,608
	P/MW	256.1	587.9	185.1	60.0	1980.1	340.2	429.5	809.1	1814.3	971.3
	Score	***90***	***73***	***93***	***100***	***0***	***85***	***81***	***61***	***9***	***53***
Impact on Flora											
Number of Plant species	Point	35	55	74	59	55	45	41	67	10	46
	Score	***61***	***30***	***0***	***23***	***30***	***45***	***52***	***11***	***100***	***44***
Number of Plant species of conservation significance	Point	3	4	6	1	4	5	5	3	3	5
	Score	***60***	***40***	***0***	***100***	***40***	***20***	***20***	***60***	***60***	***20***
Impact on Fauna											
Number of Mammal species	Point	15	23	18	11	24	21	12	24	13	11
	Score	***69***	***8***	***46***	***100***	***0***	***23***	***92***	***0***	***85***	***100***
Number of conservation Mammalian species	Point	7	8	7	6	9	9	7	9	5	6
	Score	***50***	***25***	***50***	***75***	***0***	***0***	***50***	***0***	***100***	***75***

Project Name		W-02	W-05	W-06	W-23	W-25	C-02	C-08	E-01	E-06	E-17
		Chera-1	Lower Jhimruk	Madi	Nalsyau Gad	Naumure (W.Rapti)	Lower Badigad	Andhi Khola	Dudh Koshi	Kokhajor-1	Sun Koshi No.3
Number of Bird species	Point	28	49	21	13	49	30	16	51	21	50
	Score	***61***	***5***	***79***	***100***	***5***	***55***	***92***	***0***	***79***	***3***
Number of conservation Bird species	Point	2	3	1	0	3	3	1	3	2	4
	Score	***50***	***25***	***75***	***100***	***25***	***25***	***75***	***25***	***50***	***0***
Number of Herpetofauna species	Point	13	17	9	8	17	9	6	17	8	9
	Score	***36***	***0***	***73***	***82***	***0***	***73***	***100***	***0***	***82***	***73***
Number of conservation Herpetofauna species	Point	4	4	1	1	4	0	2	5	1	3
	Score	***20***	***20***	***80***	***80***	***20***	***100***	***60***	***0***	***80***	***40***
Impact on Protected Area											
Number of the protected area downstream	Point	3	2	2	3	2	3	3	2	1	2
	Score	***0***	***50***	***50***	***0***	***50***	***0***	***0***	***50***	***100***	***50***
Number of the protected species downstream	Point	6	4	4	6	4	5	5	3	3	3
	Score	***0***	***67***	***67***	***0***	***67***	***33***	***33***	***100***	***100***	***100***
Impact on Aquatic fauna											
Length of recession area (km)	Point	7	8	10	11	0.5	4	60	60	21	0.5
	Score	***89***	***87***	***84***	***82***	***100***	***94***	***0***	***0***	***66***	***100***
Number of Fish species reported	Point	11	11	8	8	16	12	6	24	7	21
	Score	***72***	***72***	***89***	***89***	***44***	***67***	***100***	***0***	***94***	***17***
Number of Fish species of	Point	2	2	3	2	2	4	2	3	2	3
	Score	***100***	***100***	***50***	***100***	***100***	***0***	***100***	***50***	***100***	***50***

Project Name		W-02 Chera-1	W-05 Lower Jhimruk	W-06 Madi	W-23 Nalsyau Gad	W-25 Naumure (W.Rapti)	C-02 Lower Badigad	C-08 Andhi Khola	E-01 Dudh Koshi	E-06 Kokhajor-1	E-17 Sun Koshi No.3
conservation significance											
Impact of Transmission Line											
Length of Transmission Line (km)	Point	66	75	62	112	79	49	49	43	62	35
	Score	***60***	***48***	***65***	***0***	***43***	***82***	***82***	***90***	***65***	***100***

Table 10.2.1.4-16 Result of the evaluation about the Social Environment

Project Name		W-02 Chera-1	W-05 Lower Jhimruk	W-06 Madi	W-23 Nalsyau Gad	W-25 Naumure (W.Rapti)	C-02 Lower Badigad	C-08 Andhi Khola	E-01 Dudh Koshi	E-06 Kokhajor-1	E-17 Sun Koshi No.3
Impact on buildings											
Household	Point	566	229	336	263	456	1,606	542	63	92	1,599
	P/MW	3.81	1.61	1.68	0.64	1.86	4.22	3.01	0.21	0.83	2.98
	Score	***10***	***65***	***63***	***89***	***59***	***0***	***30***	***100***	***85***	***31***
Schools	Point	3	4	2	2	5	18	9	0	6	19
	P/MW	0.02	0.03	0.01	0.00	0.02	0.05	0.05	0.00	0.05	0.04
	Score	***63***	***48***	***81***	***91***	***62***	***12***	***7***	***100***	***0***	***34***
Industries	Point	0	3	0	0	0	11	6	0	0	2
	P/MW	0.000	0.021	0.000	0.000	0.000	0.029	0.033	0.000	0.000	0.004
	Score	***100***	***37***	***100***	***100***	***100***	***13***	***0***	***100***	***100***	***89***
Ethnic Minority Group											
Ethnic Minority Groups	Point	1	3	1	0	2	5	2	3	2	4
	Score	***80***	***40***	***80***	***100***	***60***	***0***	***60***	***40***	***60***	***20***

Project Name		W-02	W-05	W-06	W-23	W-25	C-02	C-08	E-01	E-06	E-17
		Chera-1	Lower Jhimruk	Madi	Nalsyau Gad	Naumure (W.Rapti)	Lower Badigad	Andhi Khola	Dudh Koshi	Kokhajor-1	Sun Koshi No.3
Agriculture											
Cultivated land (km^2)	Point	1.08	2.04	1.92	2.54	6.11	5.896	1.65	3.3	0.59	9.39
	P/MW	0.007	0.014	0.010	0.006	0.025	0.016	0.009	0.011	0.005	0.018
	Score	***90***	***54***	***78***	***95***	***0***	***48***	***80***	***71***	***100***	***38***
Irrigation system	Point	7	3	16	0	25	58	23	1	2	20
	Score	***88***	***95***	***72***	***100***	***57***	***0***	***60***	***98***	***97***	***66***
Impact on Fishery											
Fishermen	Point	25	254	100	115	43	217	156	154	0	712
	Score	***96***	***64***	***86***	***84***	***94***	***70***	***78***	***78***	***100***	***0***
Fish markets	Point	4	3	3	3	2	7	3	7	0	7
	Score	***43***	***57***	***57***	***57***	***71***	***0***	***57***	***0***	***100***	***0***
Fish catch (kg/day)	Point	37.5	40.5	12	10.5	15	101.5	25.5	70	0	140
	Score	***73***	***71***	***91***	***93***	***89***	***28***	***82***	***50***	***100***	***0***
Total sale of fish (Rs./day)	Point	7500	7290	3600	2100	4125	25375	7650	17500	0	42000
	Score	82	83	91	95	90	40	82	58	100	0
Total income (Rs./year)	Point	375,000	225,000	273,000	1,140,000	387,000	1,062,885	550,000	1,820,000	-	3,710,000
	Score	***90***	***94***	***93***	***69***	***90***	***71***	***85***	***51***	***100***	***0***
Tourism and culture											
Number of Cultural Structures (Temples)	Point	1	1	4	0	2	9	5	2	0	10
	Score	***90***	***90***	***60***	***100***	***80***	***10***	***50***	***80***	***100***	***0***
Number of Tourist Facilities	Point	0	0	0	0	0	0	0	10	0	20,000
	Score	100	100	100	100	100	100	100	100	100	0
Number of	Point	0	0	0	0	0	0	0	410	0	20000

Project Name		W-02	W-05	W-06	W-23	W-25	C-02	C-08	E-01	E-06	E-17
		Chera-1	Lower Jhimruk	Madi	Nalsyau Gad	Naumure (W.Rapti)	Lower Badigad	Andhi Khola	Dudh Koshi	Kokhajor-1	Sun Koshi No.3
Tourists/Yr	Score	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***98***	***100***	***0***
Infrastructure											
Length of Road (paved and graveled, km)	Point	3.8	3.3	11.2	0.0	1.8	26.1	3.4	5.0	0.0	39.5
	Score	90	92	72	100	95	34	91	87	100	0
Number of Bridges	Point	1	3	6	4	13	12	11	5	0	14
	Score	93	79	57	71	7	14	21	64	100	0
Number of Water Mill/Hydropower	Point	9	0	6	20	0	26	1	0	11	15
	Score	***65***	***100***	***77***	***23***	***100***	***0***	***96***	***100***	***58***	***42***
Number of Drinking Water Schemes	Point	2	7	22	0	17	29	10	5	10	22
	Score	***93***	***76***	***24***	***100***	***41***	***0***	***66***	***83***	***66***	***24***
Economy and Development Plan											
Number of Market	Point	4	0	2	1	3	5	4	1	0	5
	Score	***20***	***100***	***60***	***80***	***40***	***0***	***20***	***80***	***100***	***0***
Number of Ongoing/Proposed Development Plans	Point	0	1	3	2	3	3	2	0	6	10
	Score	***100***	***90***	***70***	***80***	***70***	***70***	***80***	***100***	***40***	***0***
Previous Experience/Issues	Point	0	0	0	0	0	0	0	0	1	1
	Score	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***0***	***0***

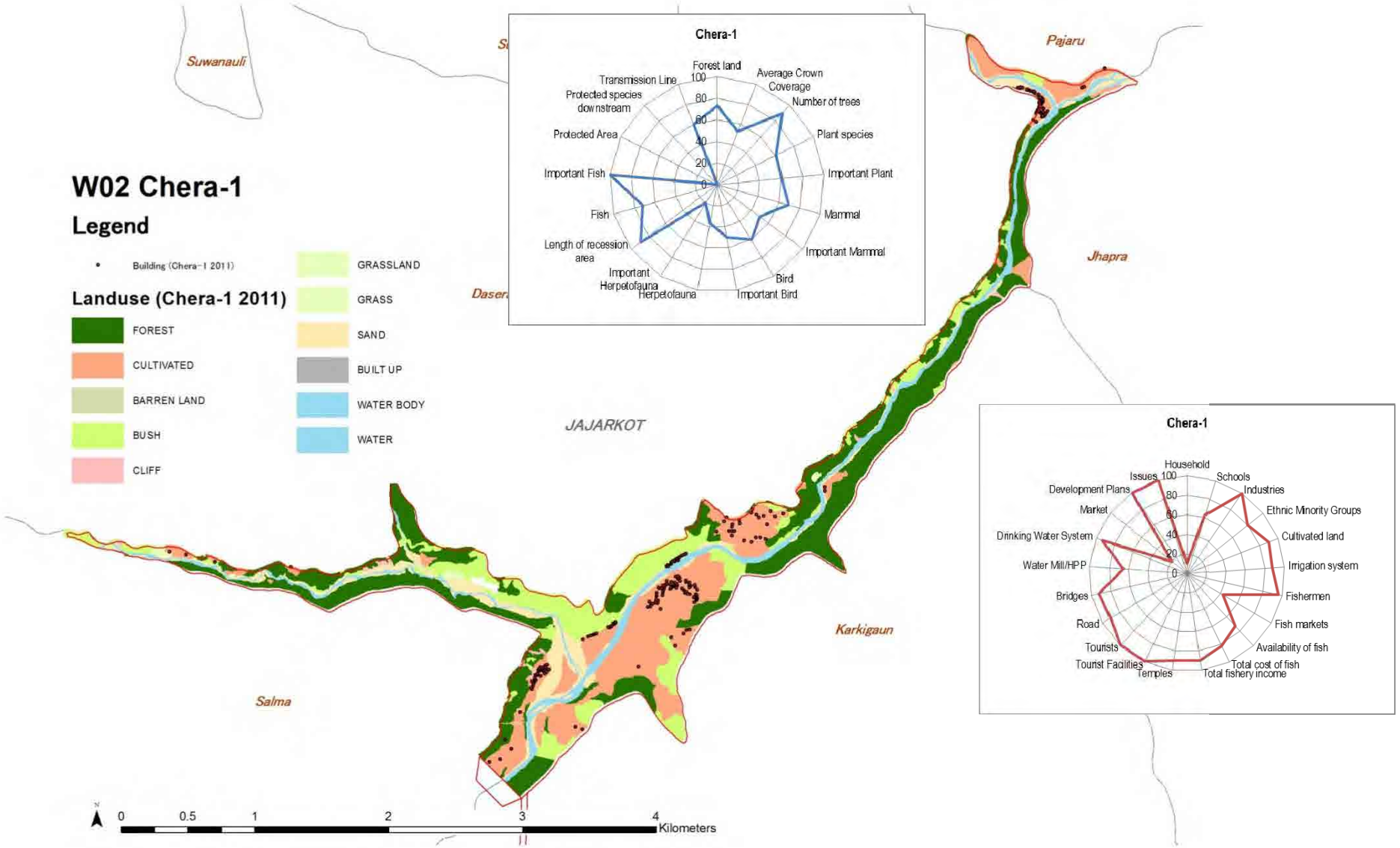

Figure 10.2.1.4-39 Land Use and Buildings in the Reservoir Area of Chera-1

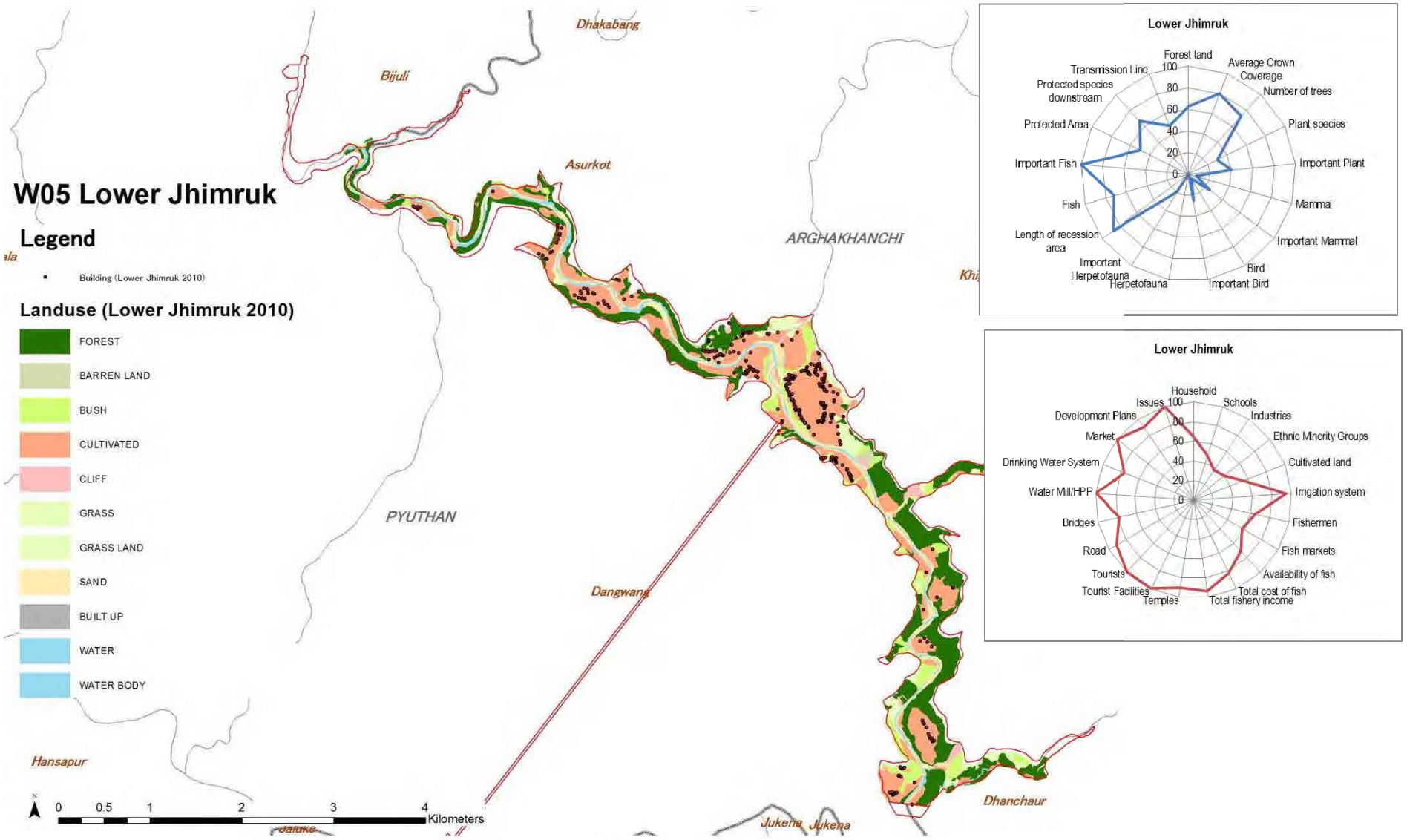

Figure 10.2.1.4-40 Land Use and Buildings in the Reservoir Area of Lower Jhimruk

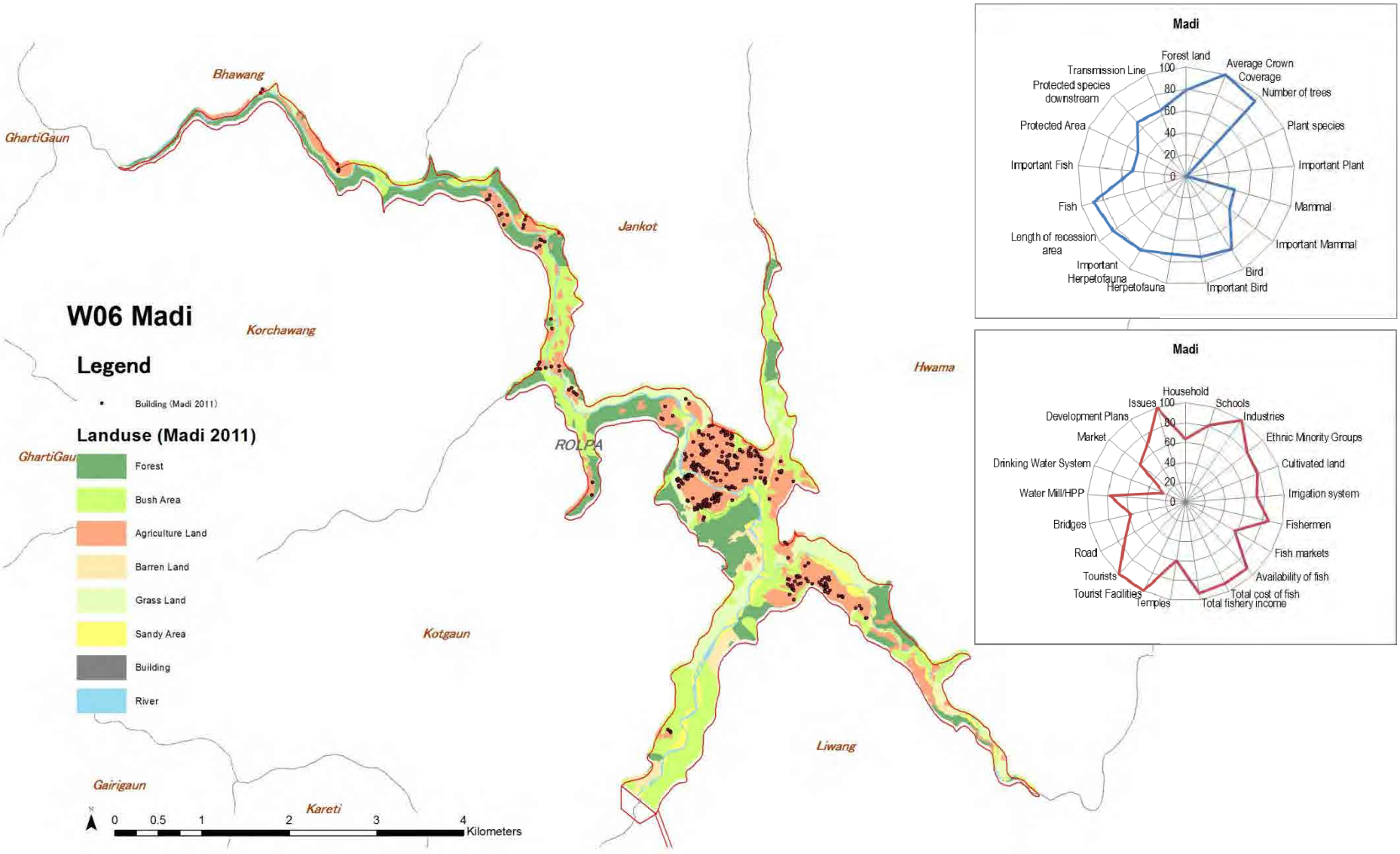

Figure 10.2.1.4-41 Land Use and Buildings in the Reservoir Area of Madi

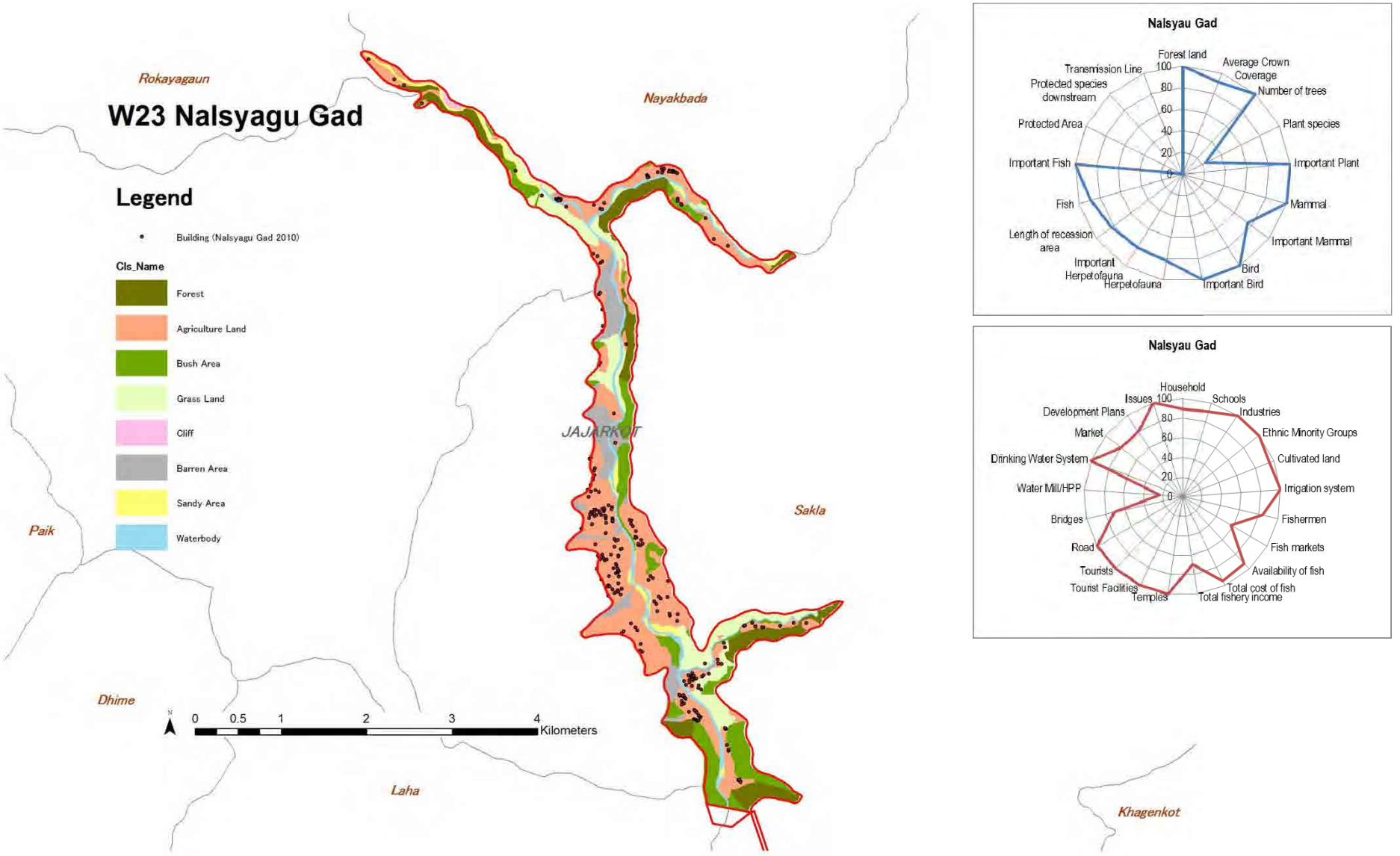

Figure 10.2.1.4-42 Land Use and Buildings in the Reservoir Area of Nalsyau Gad

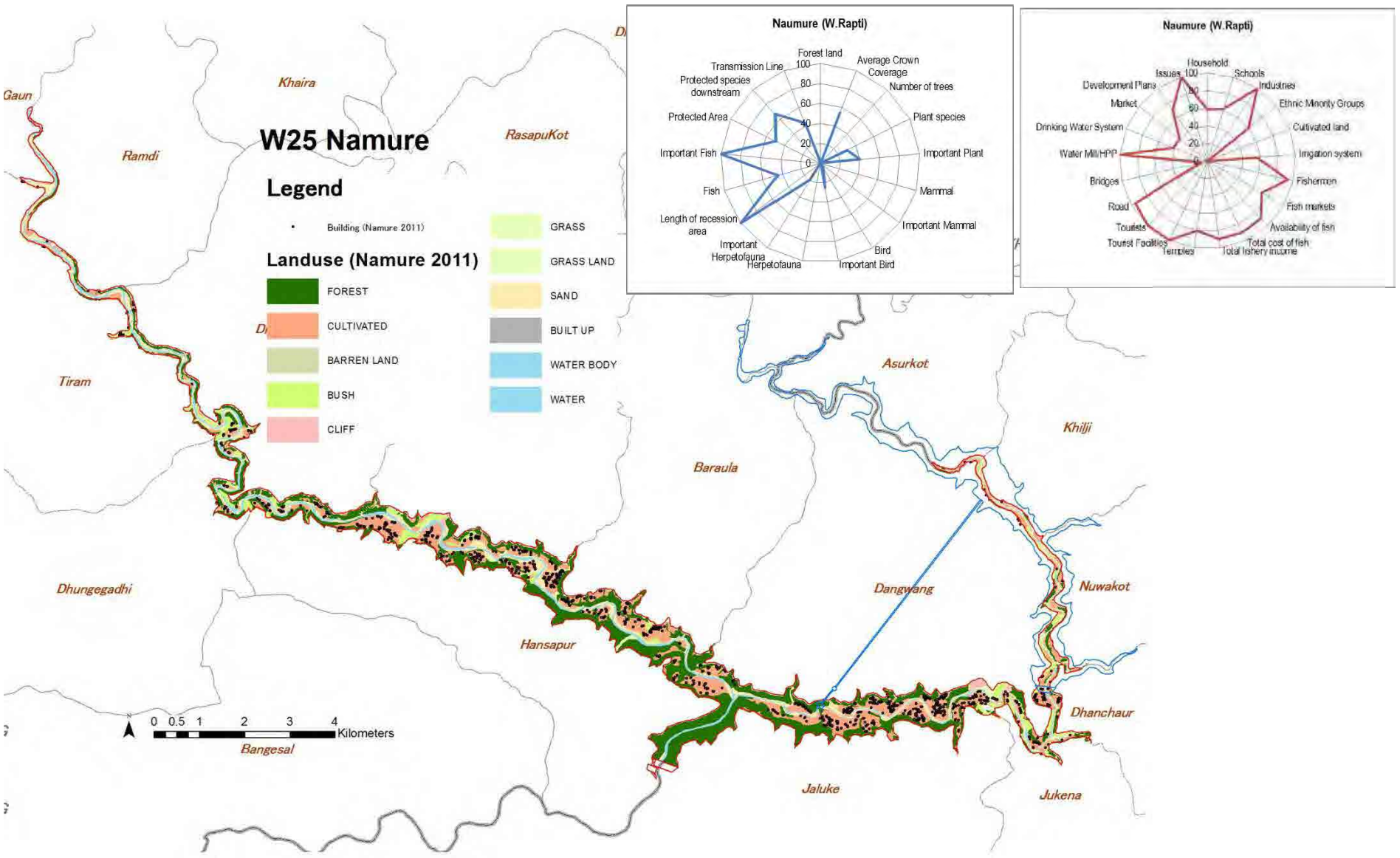

Figure 10.2.1.4-43 Land Use and Buildings in the Reservoir Area of Naumure

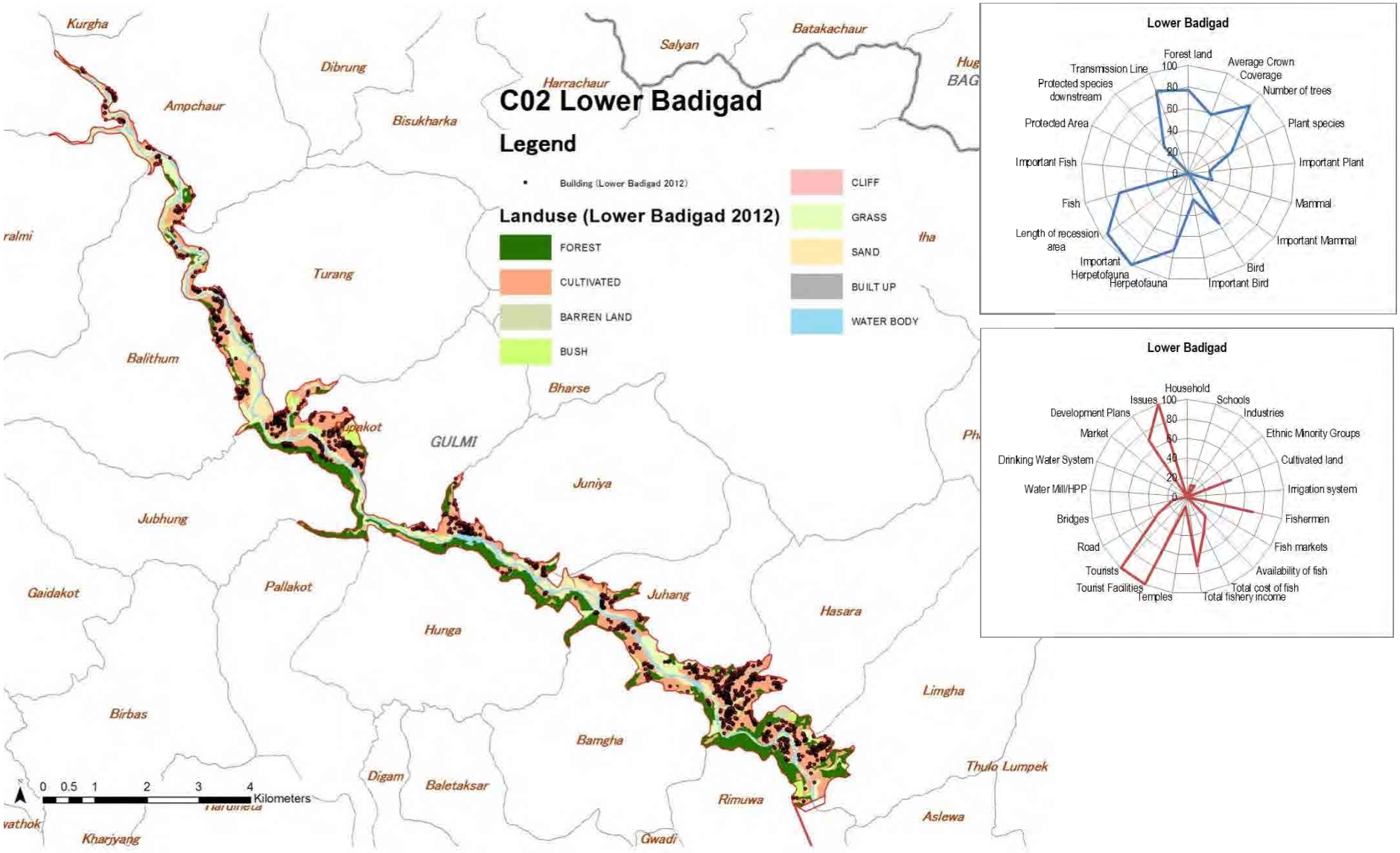

Figure 10.2.1.4-44 Land Use and Buildings in the Reservoir Area of Lower Badigad

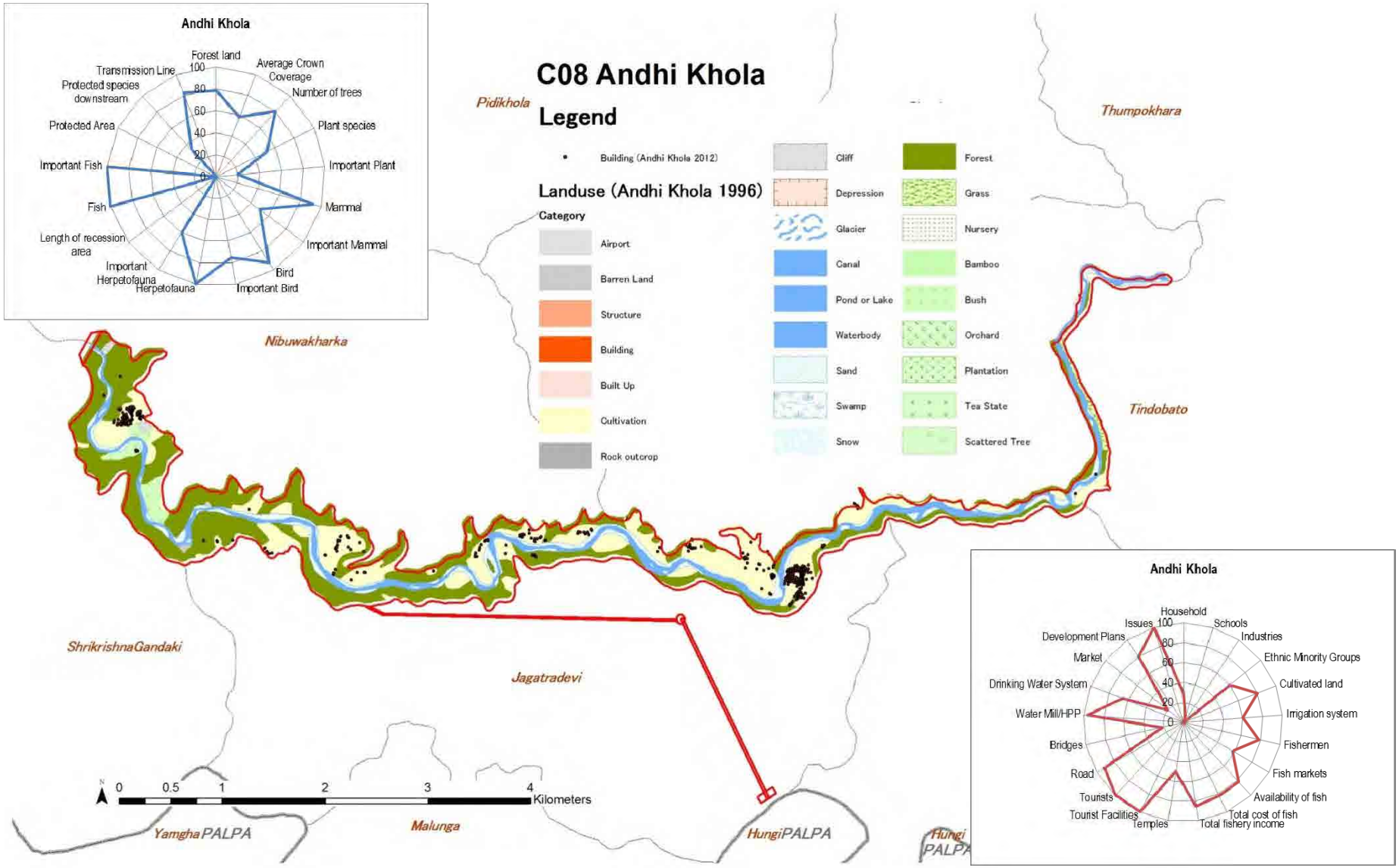

Figure 10.2.1.4-45 Land Use and Buildings in the Reservoir Area of Andhi Khola

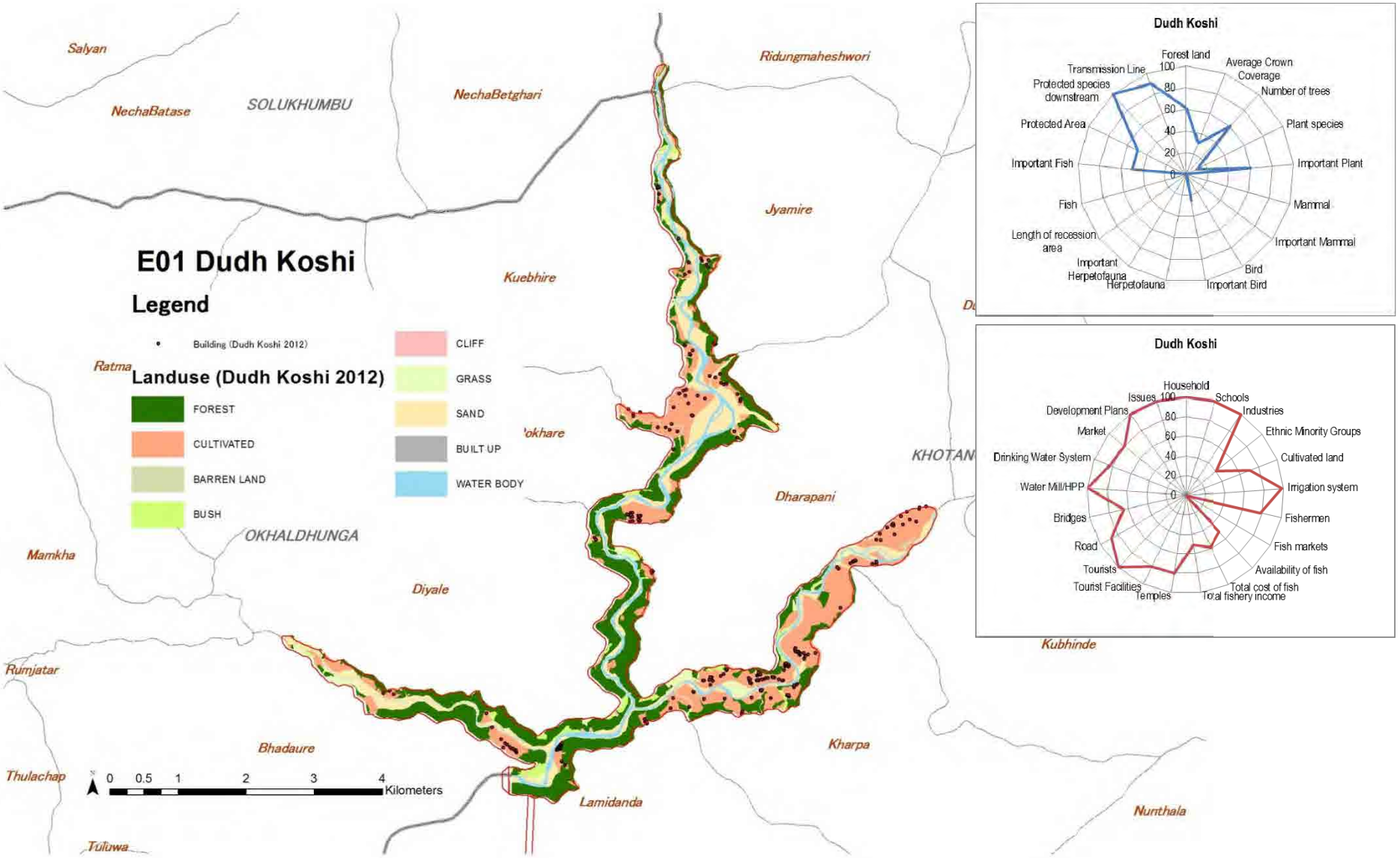

Figure 10.2.1.4-46 Land Use and Buildings in the Reservoir Area of Dudh Koshi

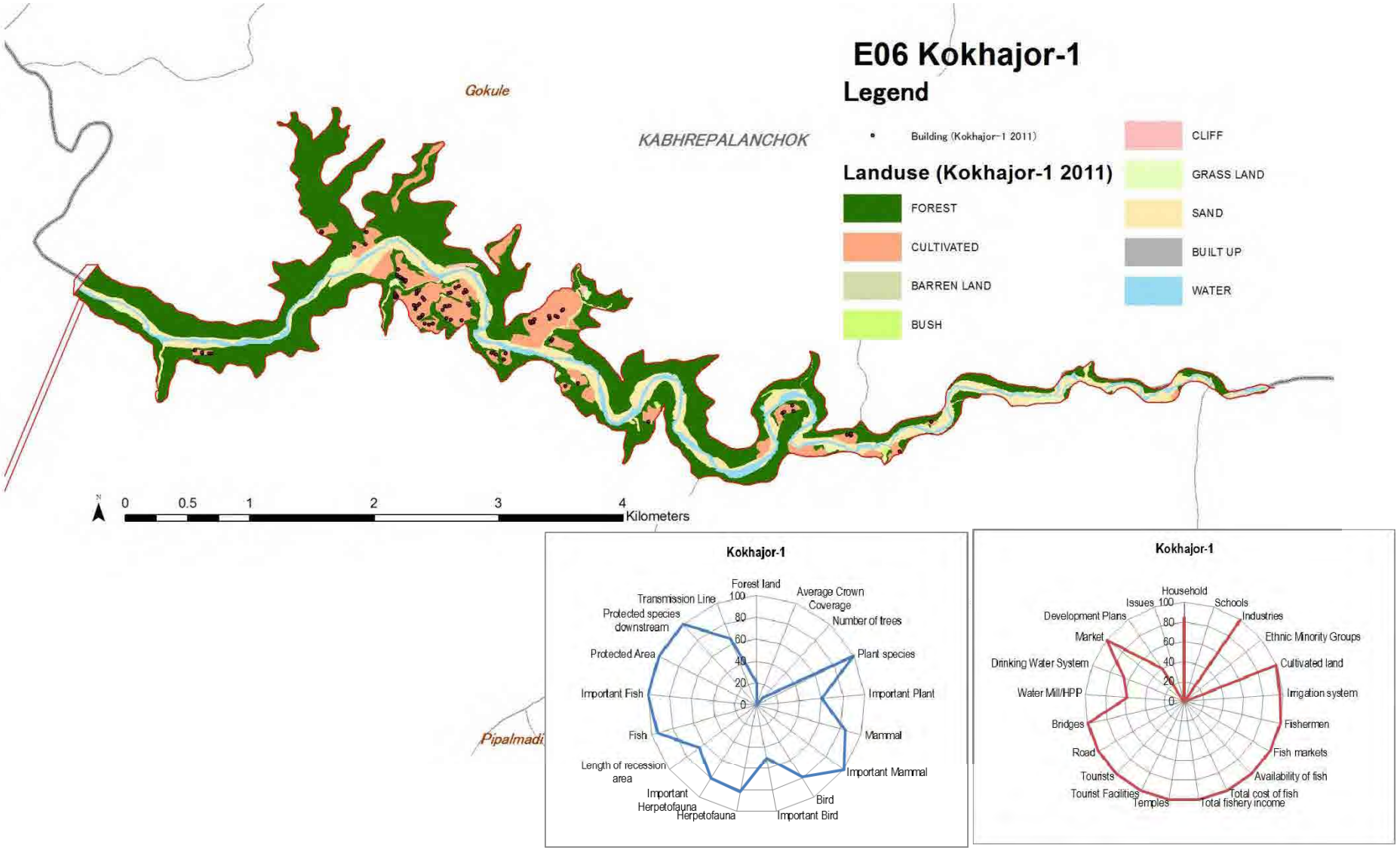

Figure 10.2.1.4-47 Land Use and Buildings in the Reservoir Area of Kokhajor-1

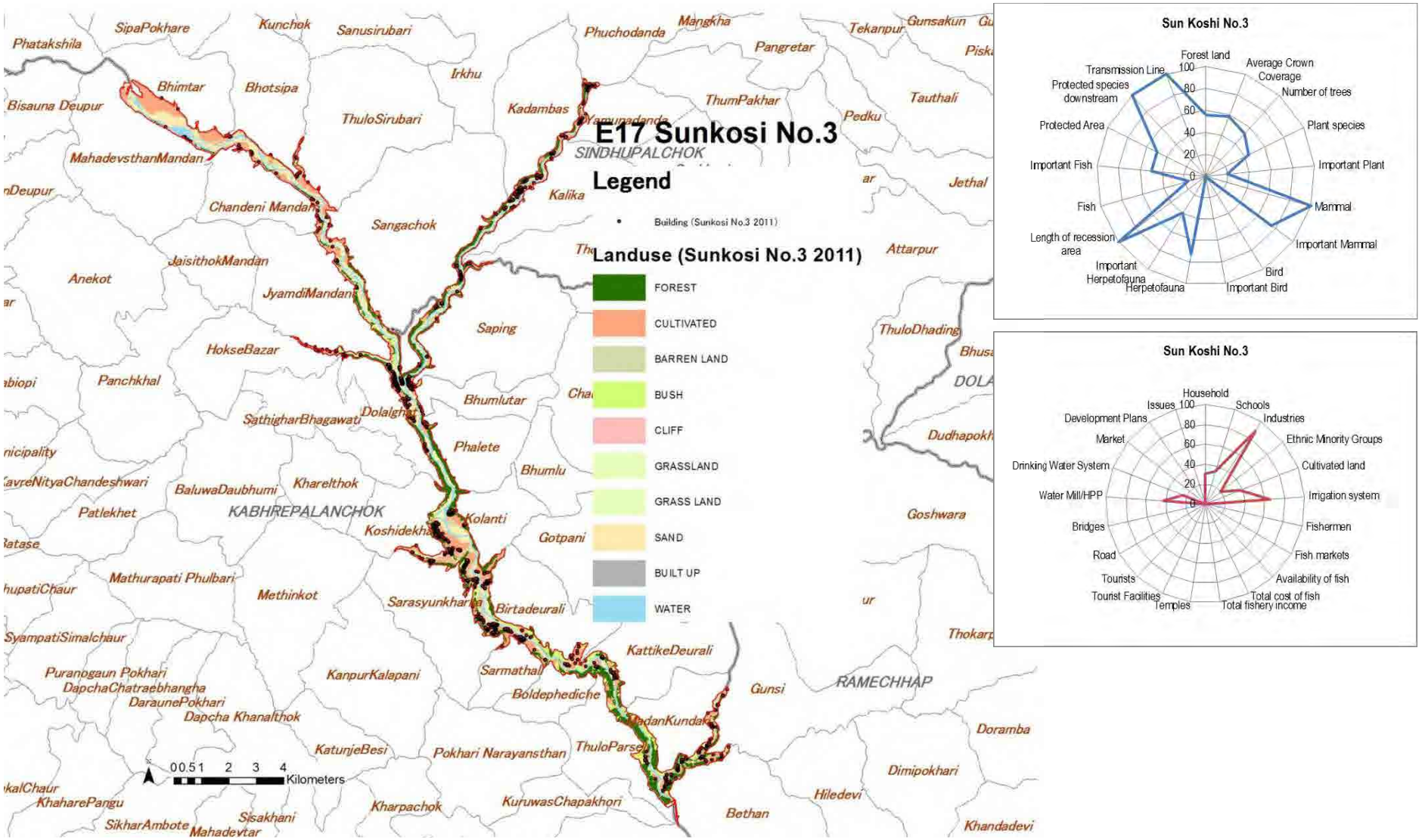

Figure 10.2.1.4-48 Land Use and Buildings in the Reservoir Area of Sun Koshi No.3

10.2.1.5 Evaluation of Project Cost and Lead Time to Commencement of Operation

(1) Project Cost

There were some differences among the project costs of the ten promising projects in terms of time points of estimation and accuracy. In order to evaluate them as equally as possible, each project cost was escalated to the present price level and necessary adjustments such as increase of contingency depending on the study level, etc. were made.

1) Revision of Project Cost

In order to evaluate the project costs on the same level, each project cost was escalated from the time point of estimation in the source report to the present (Year 2013) price level with the escalation rate established based on the Inflation Rate of Consumer Price of major advanced economies (G7) published in the database of the International Monetary Fund (IMF), "World Economic Outlook Database, October 2012".

On that basis, the environmental mitigation costs were replaced by the latest ones estimated from the result of site investigation. The costs of electromechanical equipment were also replaced by the latest ones estimated from the international market price.

The cost for civil work was divided into 3 parts, namely, the cost for dams and reservoirs, the cost for waterway tunnels, and the cost for powerhouses. The ratio of contingency for the cost of each work was determined based on the study level and the result of the geological investigation at the site.

The idea for contingency ratios established for the FS or Pre FS-level projects in the source reports, such as 10% for open work, 15% for underground work, etc. were maintained as they were. While the contingency ratios for desk study-level projects was basically established as 25% of civil cost in the source reports. They were revised depending on the geological evaluation of dam and reservoir site, waterway tunnel site and powerhouse site based on the result of site investigations. The largest contingency ratio was only applied for Sun Koshi No.3 because there was very limited information about civil structures, even though the geological evaluation was relatively good.

Table 10.2.1.5-1 Physical Contingency Ratio of Civil Work for Desk Study-Level Projects

No.	Project Name	Dam (%)	Waterway (%)	Powerhouse (%)
E-06	Kokhajor-1	27.5	27.5	25.0
	Geological Condition	Poor	Poor	Fair
E-17	Sun Koshi No.3	30.0	30.0	30.0
	Geological Condition	Fair	Fair	Fair
C-02	Lower Badigad	30.0	25.0	25.0
	Geological Condition	Very Poor	Fair	Fair
W-02	Chera-1	25.0	25.0	25.0
	Geological Condition	Fair	Fair	Fair
W-05	Lower Jhimruk	27.5	25.0	25.0
	Geological Condition	Poor	Fair	Fair
W-06	Madi	27.5	25.0	25.0
	Geological Condition	Poor	Fair	Fair

2) Cost of Promising Projects

A price contingency established as 10% of each construction cost estimated with the above-mentioned revision and an interest during construction established with the interest ratio of 8% were added in the construction cost to estimate total project cost. The costs of 10 promising projects are summarized in the following table.

The construction cost estimated in the feasibility study report is used only for the Nalsyau Gad project (W-23) as it is except this price contingency and interest during construction since the feasibility study had just been completed in 2012.

Table 10.2.1.5-2 Summary of Project Cost for Promising Projects

(Unit: Million US$)

No.	E-01	E-06	E-17	C-02	C-08	W-02	W-05	W-06	W-23	W-25
Project Name	Dudh Koshi	Kokhajor-1	Sun Koshi No.3	Lower Badigad	Andhi Khola	Chera-1	Lower Jhimruk	Madi	Nalsyau Gad	Naumure
Installed Capacity (MW)	300	111.5	536	380.3	180	148.7	142.5	199.8	410	245
1. Preliminary works and access road	69	15	11	41	2	27	23	24	70	15
2. Environmental mitigation cost	60	18	269	180	51	18	59	54	12	184
3. Civil Works	449	191	543	369	274	231	171	220	369	287
3.1 Dam	302	74	491	267	229	155	108	146	283	260
3.2 Waterway	121	112	28	85	41	68	56	65	69	15
3.3 Powerhouse	25	5	23	17	4	7	7	9	16	12
4. Hydromechanical-Equipment	21	11	27	23	43	12	11	14	31	14
5. Electro-mechanical Equipment	118	55	155	141	80	69	67	86	115	101
6. Transmission Line	9	12	11	13	9	13	14	12	23	15
7. Base Cost	726	302	1,016	766	460	369	344	410	620	617
8. Administration & Engineering service	68	15	92	32	31	16	15	18	61	49
9. Physical Contingency	79	61	181	125	39	68	55	71	57	63
9.1 Contingency for Civil Works	65	52	163	106	29	58	45	59	48	48
9.2 Contingency for E&M equipment	14	9	18	19	10	10	10	12	8	14
10. Price Contingency (10% of above)	87	38	129	92	53	45	41	50	74	73
11. Interest during Construction (i=8%)	184	60	272	195	84	80	66	88	156	154
10. Project Cost	1,144	476	1,691	1,210	666	577	521	637	967	955

(2) Lead Time to Commencement of Operation

The required lead time to the commencement of operation was estimated from each project stage and construction period.

1) Project Stage

The required times to the commencement of construction differ depending on project. The time to be required on each stage was empirically established as follows:

Table 10.2.1.5-3 Summary of Required Time to Commencement of Construction

Stage	Time (Year)	Remarks
Pre FS	1.0	Study prior to FS
FS	1.5	-
Financial Arrangement	2.0	(Commencement of access road construction)
Tendering	1.0	Selection of consultant
Detailed Design	2.0	Including preparation of tender documents
Tendering	1.0	Selection of contractor
Commencement of Construction	-	-

2) Construction Period

The construction periods differ depending on the project. The construction period of FS- or Pre FS-level project established in the source report was maintained as it was. The construction period of a desk study-level project was established considering the scale of dams and the length of waterway tunnels as a major structure of a project, and the results of geological investigation at sites are as shown in the following table. Construction time for preparatory work such as construction of access road, camp, etc. is not included in the construction period since they are normally implemented during the time between financial arrangement and the commencement of construction in Nepal.

Table 10.2.1.5-4 Summary of Construction Period for Promising Projects

No.	Project Name	Installed Capacity (MW)	Dam Height (m)	Dam Type	Dam Volume (MCM)	Tunnel Length (km)	Construction Period (Year)
E-01	Dudh Koshi	300.0	180	Rockfill	9.2	13.3	6.0
E-06	Kokhajor-1	111.5	107	Rockfill	4.7	6.6	4.5
E-17	Sun Koshi No.3	536.0	140	Concrete Gravity	1.9	-	6.0
C-02	Lower Badigad	380.3	191	Rockfill	16.9	4.4	6.0
C-08	Andhi Khola	180.0	157	Concrete Faced Rockfill	8.2	3.4	4.5
W-02	Chera-1	148.7	186	Rockfill	9.8	4.3	5.0
W-05	Lower Jhimruk	142.5	167	Rockfill	6.8	5.8	4.5
W-06	Madi	199.8	190	Rockfill	9.2	5.7	5.0
W-23	Nalsyau Gad	410.0	200	Rockfill	17.9	8.2	6.0
W-25	Naumure (W.Rapti)	245.0	190	Rockfill	13.2	-	6.0

3) Lead Time to Commencement of Operation

As a result of the study mentioned above, the lead time to commencement of operation for each project is summarized in the following table.

Table 10.2.1.5-5 Summary of Lead Time to COD for Promising Projects

(Unit: Year)

No.	E-01	E-06	E-17	C-02	C-08	W-02	W-05	W-06	W-23	W-25
Project Name	Dudh Koshi	Kokhajor-1	Sun Koshi No.3	Lower Badigad	Andhi Khola	Chera-1	Lower Jhimruk	Madi	Nalsyau Gad	Naumure
Installed Capacity (MW)	300	111.5	536	380.3	180	148.7	142.5	199.8	410	245
Pre-Feasibility Study	-	1.0	1.0	1.0	-	1.0	1.0	1.0	-	-
Feasibility Study	-	1.5	1.5	1.5	1.5	1.5	1.5	1.5	-	1.5
Financial Arrangement	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Selection of Consultant	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Detailed Design	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Selection of Contractor	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Construction	6.0	4.5	6.0	6.0	4.5	5.0	4.5	5.0	6.0	6.0
Total (Year)	12.0	13.0	14.5	14.5	12.0	13.5	13.0	13.5	12.0	13.5

10.2.2 Evaluation of Promising Projects

Ten promising projects were selected in Section 10.1.5 and their details were described in Section 10.2.1. In this section, evaluation of these ten promising projects were conducted based on the existing documents and the results of site surveys conducted by the Study Team and a Nepalese consulting firm.

10.2.2.1 Evaluation Items and Evaluation Criteria

The evaluation items and evaluation criteria are basically similar to the items and criteria that were used for the evaluation of candidate projects as mentioned in Section 10.1.4. However, taking into account the comments obtained in the stakeholder meetings, some evaluation items were added and some modifications were made in the evaluation criteria as described below.

Technical and Economical Conditions

- Hydrological Conditions
  - Reliability of flow data, risk of a glacier lake outburst flood (GLOF), and sedimentation.
- Geological Conditions
  - Geological conditions of project site, thrusts and faults [1)], and seismicity.

  [1)]: The name of "Natural hazards (earthquakes)" in Section 10.1.4.1 was changed.
- Time to commencement of commercial operation [2)]

  [2)]: In Section 10.1.4.1, this item was evaluated as "Lead Time to Implementation of the Project" by "Length of access road," "Difficulty level of funding," and "Reliability of the development plan (current stage of study)."
- Effectiveness of Project
  - Unit generation cost, installed capacity, annual energy production, and energy production in the dry season.

Impact on the Environment

- Impact on the Natural Environment
  - Impact on forests, impact on flora [3)], impact on terrestrial fauna [3)], impact on protected areas, impact on aquatic fauna, and the impact of transmission line [4)].

  [3)]: Added items.

  [4)]: This item was moved from "Impact on the social environment."
- Impact on the Social Environment
  - Impact on households, etc., impact on ethnic minorities, impact on agriculture, impact of fishery [5)], impact on tourism, impact on infrastructure [5)], and the impact on the rural economy and development plans [5)].

  [5)]: Added items.

(1) Hydrology

Same as the evaluation of candidate projects, evaluation items for hydrology are “Reliability of flow data,” “Risk of a glacier lake outburst flood (GLOF),” and “Sedimentation.”

1) Reliability of flow data

Evaluation methods and point allocation of the reliability of flow data are the same as those that were used for the evaluation of candidate projects, and the details are described in 10.1.4.1 (1) 1).

The evaluation criterion for the reliability of flow data is shown in Table 10.2.2.1-1

Table 10.2.2.1-1 Evaluation Criterion for the Reliability of Flow Data

Flow Data	Estimated by the formula derived from the flow data gauged in the all gauging stations of Nepal	Gauged at the site but there are some missing data	Gauged at the site for 10 years
Score	0	100 × Number of existing data / (12 months × 10 years)	100

2) Risk of a GLOF

Evaluation methods and point allocation of risk of a GLOF are the same as those that were used for the evaluation of candidate projects, and the details are described in 10.1.4.1 (1) 2).

The evaluation criterion for the reliability of flow data is shown in Table 10.2.2.1-2

Table 10.2.2.1-2 Evaluation Criterion for Risk of a GLOF

Number of glacial lakes identified as “potentially critical” by ICIMOD located along the upper reaches of the dam	None	One or more		
		Low risk	Medium risk	High risk
Score	100	40	20	0

3) Sedimentation

Evaluation method and point allocation of sedimentation are basically the same as those that were used for evaluation of candidate projects, and the details are described in 10.1.4.1 (1) 3). However, since nine out of ten projects have the same score if the same point allocation is used, the point allocation was modified to obtain an appropriate evaluation result.

The evaluation criterion for sedimentation is shown in Table 10.2.2.1-3

Table 10.2.2.1-3 Evaluation Criterion for Sedimentation

Life of Reservoir	78 (Min.)	Min. - 300 years	More than 300 years
Score	0	Linear interpolation	100

(2) Geology

Evaluation items for geology are "Geological conditions of the site," "Natural hazards (earthquakes)," and "Seismicity." The name of "Natural hazards (earthquakes)" was changed to "Thrusts and faults." The details of each evaluation method were described in 10.1.4.1 (2).

1) Geological conditions of the site

For promising projects other than the Dudh Koshi Project and the Nalsyau Gad Project that are in the FS stage, a geological site survey of promising projects was conducted by a Nepalese consulting company through a subcontract. Based on the survey results, the geological conditions of the reservoir, dam, headrace tunnel and powerhouse were separately evaluated.

Evaluation criterion for site geology is shown in Table 10.2.2.1-4 to Table 10.2.2.1-6

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Table 10.2.2.1-4 Evaluation Criteria for Geological Conditions of the Site (Basic Evaluation)

Structure	Item	Score	State	Reference*
Reservoir	Water tightness	100	Impervious	Not karstified and most joints are tight.
		60	Medium	Weakly karstified or some joints are open.
		20	Pervious	Karstified or most joints are open.
	Slope Stability	100	Stable	Few landslides and area of dip slope is limited.
		60	Medium	Some landslides or area of dip slopes is moderately wide.
		20	Unstable	Many landslides or area of dip slope is wide.
Dam	Soundness	100	Hard and compact	Ordinal Quartzite, Limestone, Sandstone, Phyllite and Slate.
		60	Medium	Ordinal Mudstone
		20	Soft	Softer than ordinal Mudstone
		100	Impervious	Not karstified and most joints are tight.
	Water tightness	60	Medium	Weakly karstified or some joints are open.
		20	Pervious	Karstified or most joints are open.
Headrace Tunnel	Soundness	100	Strong	Ordinal Quartzite, Limestone and Sandstone.
		60	Medium	Ordinal Phyllite and Slate under thick overburden. Ordinal Mudstone or weak rocks.
		20	Weak	Ordinal Mudstone or weak rocks, under thick overburden.
Power House	Soundness	100	Hard and compact	Ordinal Quartzite, Limestone, Sandstone, Phyllite and Slate.
		60	Medium	Ordinal Mudstone
		20	Soft	Softer than ordinal Mudstone
	Slope Stability	100	Stable	Few landslides and area of dip slope is limited.
		60	Medium	Some landslides or area of dip slopes is moderately wide.
		20	Unstable	Many landslides or area of dip slope is wide.

* In reference of soundness, fore example, ordinal rocks are shown. Observed rocks and their condition should be described.

Table 10.2.2.1-5 Evaluation Criteria for Geological Conditions of the Site (Deduction of point)

Item	Reference and Score of Subtractaction
Fault	This item is applied for all structure sites. In case of the existence of large or active faults, subtract 20 points. Large fault are those with a > 1 m thick sheared zone.
Thick deposit	This item is applied for dam sites and power house sites. In case of the existence of alluvium and colluvium >30 m in the vicinity of valley bottom, subtract 20 points.

Table 10.2.2.1-6 Evaluation Criteria for Geological Conditions of Site (Score)

Structure site	Reservoir		Dam		Headrace Tunnel	Power House	
Item	Water tightness	Slope stability	Soundness	Water tightness	Soundness	Soundness	Slope stability
Basic evaluation	A	B	E	F	J	M	N
Subtract by fault	C (negative)		G (negative)		K (negative)	O (negative)	
Subtract by thick deposits	---		H (negative)		----	P (negative)	
Score of each site	D = (A + B) / 2 + C		I = (E + F) / 2 + G + H		L = J + K	Q = (M + N) / 2 + O + P	
Score of project area	R = (D + I + L + Q) / 4						

2) Thrusts and faults

The evaluation methods and point allocation of risk of thrusts and faults are the same as "Natural hazards (earthquakes)" used for the evaluation of candidate projects, and the detail is described in 10.1.4.1 (2) 2).

The evaluation criterion for reliability of flow data is shown in Table 10.2.2.1-7

Table 10.2.2.1-7 Evaluation Criterion for Large Tectonic Thrust and Fault

Distance to large tectonic thrusts	> 12.8 km	12.8 km > > 3.2 km	3.2 km > > 1.6 km	1.6 km >
Score*1)	100	60	20	0

*1): In case of the closeness to other faults < 1 km, subtract 20.
In case of the closeness < 100 m, subtract 40.

3) Seismicity

The evaluation methods and point allocation of risk of thrusts and faults are the same as those that were used for evaluation of candidate projects, and the details are described in 10.1.4.1 (2) 3).

The evaluation criterion for reliability of flow data is shown in Table 10.2.2.1-8 to Table 10.2.2.1-10.

Table 10.2.2.1-8 Evaluation Criterion for Seismicity (Class by Area)

Area	Higher Himalaya (Tibetan-Techys Zone)	Metamorphic zone (Higher Himalaya Crystalline)	Lesser Himalaya	Siwaliks (Sub-Himalaya)	Terai Zone
Class	1	1	2	3	3

Table 10.2.2.1-9 Evaluation Criterion for Seismicity (Class by Acceleration)

Acceleration	> 240 gal	240 gal > > 180 gal	180 gal >
Class	1	2	3

Table 10.2.2.1-10 Evaluation Criterion for Seismicity (Matrix of Score)

Acceleration \ Area	1	2	3
1	20	20	20
2	40	20	60
3	80	60	100

(3) Time to Commencement of Commercial Operation

In the evaluation of candidate projects, this evaluation item was evaluated by the length of

access roads, difficulty level of funding, and reliability of the development plan as shown in 10.1.4.1 (3). In the evaluation of promising projects, the lead time to commercial operation was estimated and the required time was directly evaluated, instead of these three items.

The lead time consists of seven stages, "Pre-FS," "FS," "Financial arrangement," "Tendering (selection of consultant)," "Detailed design," "Tendering (selection of contractor)," and "Construction" as shown in Table 10.2.2.1-11.

Table 10.2.2.1-11 Time required for Each Stage

Stage	Time (Year)	Remarks
Pre FS	1.0	Study prior to FS
FS	1.5	
Financial arrangement	2.0	(Commencement of access road construction)
Tendering	1.0	Selection of consultant
Detailed design	2.0	Including preparation of tender documents
Tendering	1.0	Selection of contractor
Construction	4.5 – 6.0	Depending on project (without access road construction)

For example, the lead time of a project in the desk-study level is the total time from pre-FS to construction, and the lead time of a project in the pre-FS level is the total time from FS to construction.

The project with 10 years in lead time was scored with 100 points, the project with 20 years in lead time was scored with 0 points, and other projects were scored with points obtained by linear interpolation with a lead time. (See Table 10.2.2.1-12)

Table 10.2.2.1-12 Evaluation Criterion for Lead Time to Commencement of Commercial Operation

Time to commencement of commercial operation (Year)	10	10 – 20	20
Score (points)	100	Linear interpolation	0

(4) Effectiveness of Project

1) Unit generation cost

The evaluation method is basically the same one that was used for evaluation of candidate projects; the following simplified calculation formula was used.

$$\textit{Unit generation cost (US cent/kWh)} = \textit{Project cost / Annual energy production (kWh)} \times \textit{expense rate}$$

The project with the smallest unit generation cost was scored with 100 points, the project with the largest unit generation cost was scored with 0 points, and other projects were scored with points obtained by linear interpolation with a unit generation cost.

Since the number of projects was changed from 31 candidate projects to 10 promising projects, and also their project costs of promising projects were reviewed, the minimum unit generation cost changed from 2.21 USc/kWh to 4.57 USc/kWh and the maximum changed from 20.42 USc/kWh to 13.58 USc/kWh as shown in Table 10.2.2.1-13.

Table 10.2.2.1-13 Evaluation Criterion for Unit Generation Cost

Unit Generation Cost (US cent/kWh)	4.57 (Minimum)	2.21 - 20.42	13.58 (Maximum)
Score	100	Linear interpolation	0

Note: Unit Generation Cost = Project Cost / Annual Energy Production × 10%

2) Installed Capacity

In the evaluation of candidate projects described in 10.1.4.1 (4) 2), since the suitable development scale was expected to be from 100 MW to 300 MW in the Scope of Work of this Study, the evaluation points were gradually decreased for projects more than 300 MW.

In the evaluation of promising projects, importance was put on a large installed capacity because of its effect on mitigating load shedding. Since the maximum installed capacity among the promising projects is also 536 MW, though there might be some minor difficulties of financing, etc., development of this scale of projects seems to have a sufficient probability. Therefore, point allocation for evaluation of the installed capacity was modified as shown in Table 10.2.2.1-14.

Table 10.2.2.1-14 Evaluation Criterion for Installed Capacity

Installed Capacity (MW)	0	0 – 300	300	More than 300
Score	0	Linear interpolation	100	100

3) Annual Energy Production

In the evaluation of candidate projects described in 10.1.4.1 (4) 3), the evaluation point was proportional to annual energy production up to 2,000 GWh, and it is constant (full score) to 2,000 GWh and over.

In the evaluation of promising projects, since the maximum among the promising projects was 1,910 GWh, the evaluation point was determined proportional to annual energy production up to 1,910 GWh, the maximum value, as shown in Table 10.2.2.1-15.

Table 10.2.2.1-15 Evaluation Criterion for Annual Energy Production

Annual Energy Production (GWh)	0	0 - 1,910	1,910 (Max.)
Score	0	Linear interpolation	100

4) Energy Production in the Dry Season

Same as the above-mentioned annual energy production, the evaluation point of dry season energy was determined proportional to dry energy up to 523 MW, the maximum value, as shown in Table 10.2.2.1-16.

Table 10.2.2.1-16 Evaluation Criterion for Energy Production in the Dry Season

Energy Production in Dry Season (GWh)	0	0 - 523	523 (Max.)
Score	0	Linear interpolation	100

(5) Impact on the Natural Environment

1) Impact on Forests

The impact on forests was evaluated by the total of evaluation scores of forest land per unit installed capacity, average crown coverage[1], and the number of trees per unit installed capacity.

Regarding forest land per unit installed capacity, the project with the smallest forest land per unit installed capacity was evaluated at 100 points, the project with the largest was evaluated at 0 points, and other projects were evaluated by linear interpolation. Regarding crown coverage, 100 points were given to the project with the largest coverage and 0 points to the project with the smallest coverage, and the other projects were evaluated by linear interpolation. The project with the largest number of trees per unit installed capacity was evaluated at 0 points and the smallest number was evaluated at 100 points.

Table 10.2.2.1-17 shows the largest/smallest values and corresponding evaluation points.

Table 10.2.2.1-17 Evaluation Criterion for Impact on Forest

Items			Min Impact		Max impact
Impact on Forest	Forest land (km2) Forest land (km2/MW)	*Value*	0.3	-	8.2
		Point	0.001	-	0.0032
		Score	100	Linear interpolation	0
	Average Crown Coverage (%)	*Point*	15.0	-	70.0
		Score	100	Linear interpolation	0
	Number of trees (nos) Number of trees (nos/MW)	*Value*	9,776	-	520,608
		Point	24.4	-	1980.1
		Score	100	Linear interpolation	0

2) Impact on Flora

The impact on flora was evaluated by the number of plant species reported and the number of plant species of conservation significance. For both evaluation items, the project with the largest number was evaluated at 0 points, the smallest number at 100 points, and the other projects were evaluated by linear interpolation.

[1] The ratio of area that is covered by leaf and branch.

Table 10.2.2.1-18 shows the largest/smallest values and corresponding evaluation points.

Table 10.2.2.1-18 Evaluation Criterion for Impact of Flora

Items			Min Impact		Max impact
Impact on Flora	Number of Plant species reported	*Point*	0.0	-	74.0
		Score	100	Linear interpolation	0
	Number of Plant species of conservation significance	*Point*	0.0	-	6.0
		Score	100	Linear interpolation	0

3) Impact on Terrestrial Fauna

The impact on terrestrial fauna was evaluated by the number of mammal/bird/herpetofauna species reported, and the numbers of conservation mammal/bird/herpetofauna species reported in the reservoir area. For all evaluation items.

The project with the largest number of species was evaluated at 0 points, the smallest number of species at 100 points, and the other projects were evaluated by linear interpolation.

Table 10.2.2.1-19 shows the largest/smallest values and corresponding evaluation points.

Table 10.2.2.1-19 Evaluation Criterion for Impact on Terrestrial Fauna

Items			Min Impact		Max impact
Impact on Terrestrial Fauna	Number of Mammal species reported	*Point*	11.0	-	24.0
		Score	100	Linear interpolation	0
	Number of conservation Mammalian species reported	*Point*	4.0	-	9.0
		Score	100	Linear interpolation	0
	Number of Bird species reported	*Point*	13.0	-	51.0
		Score	100	Linear interpolation	0
	Number of conservation Bird species reported	*Point*	0.0	-	4.0
		Score	100	Linear interpolation	0
	Number of Herpetofauna species reported	*Point*	6.0	-	17.0
		Score	100	Linear interpolation	0
	Number of conservation Herpetofauna species reported	*Point*	0.0	-	5.0
		Score	100	Linear interpolation	0

4) Impact on Protected Areas

Projects located in a protected area had already been excluded from the promising projects by the screening described in Section 10.1.3.

The impact on protected area was evaluated by the number of protected area in the downstream and the number of protected species in the downstream. The project with the largest number of protected areas/protected species in the downstream was given 0 points, the smallest number was given 100 points, and the other projects were evaluated by linear interpolation.

Table 10.2.2.1-20 shows the largest/smallest values and corresponding evaluation points.

Table 10.2.2.1-20 Evaluation Criterion for Impact on Protected Area

Items			Min Impact		Max impact
Impact on Protected Area	Number of the protected area downstream	*Point*	1.0	-	3.0
		Score	100	Linear interpolation	0
	Number of the protected species downstream	*Point*	3.0	-	6.0
		Score	100	Linear interpolation	0

5) Impact on Aquatic Fauna

The impact on aquatic fauna was evaluated by the length of the recession area, number of fish species reported, and number of fish species of conservation significance. Regarding the length of the recession area, the project with the longest recession area was evaluated at 0 points, the shortest 100 points, and the other projects were evaluated by linear interpolation.

Table 10.2.2.1-21 shows the largest/smallest values and corresponding evaluation points.

Table 10.2.2.1-21 Evaluation Criterion for Impact on Aquatic Fauna

Items			Min Impact		Max impact
Impact on Aquatic fauna	Length of recession area (km)	*Point*	0.5	-	60.0
		Score	100	Linear interpolation	0
	Number of Fish species reported	*Point*	6.0	-	24.0
		Score	100	Linear interpolation	0
	Number of Fish species of conservation significance	*Point*	2.0	-	4.0
		Score	100	Linear interpolation	0

6) Impact of Construction of Transmission Lines

The impact of construction of transmission lines was evaluated by the length of transmission lines. The project with the longest transmission line was evaluated at 0 points, the shortest 100 points, and the other projects were evaluated by linear interpolation.

Table 10.2.2.1-22 shows the largest/smallest values and corresponding evaluation points.

Table 10.2.2.1-22 Evaluation Criterion for Impact of Transmission Lines

Items			Min Impact		Max impact
Impact of Transmission Line	Length of Transmission Line (km)	*Point*	33.0	-	79.0
		Score	100	Linear interpolation	0

(6) Impact on the Social Environment

1) Impact on Households, etc.

The impact on households, etc. was evaluated by the number of households/schools/workshops to be relocated per unit installed capacity. For these evaluation items, 0 points were given to the project with the largest number, 100 points to the smallest number, and the other projects

were evaluated by linear interpolation.

Table 10.2.2.1-23 shows the largest/smallest values and corresponding evaluation points.

Table 10.2.2.1-23 Evaluation Criterion for Impact on Households, etc.

Items			Min Impact		Max impact
Impact on Household, etc.	Number of Household (nos//MW)	*Point*	0.2	-	4.2
		Score	100	Linear interpolation	0
	Number of Schools (nos/MW)	*Point*	0.00	-	0.05
		Score	100	Linear interpolation	0
	Number of Industries (nos/MW)	*Point*	0.00	-	0.03
		Score	100	Linear interpolation	0

2) Impact on Ethnic Minorities

The impact on ethnic minorities was evaluated by the number of ethnic groups under the Disadvantaged, Marginalised, and Highly Marginalised categories. The project with the largest number of ethnic groups was evaluated at 0 points, the largest number at 100 points, and the other projects were evaluated by linear interpolation.

Table 10.2.2.1-24 shows the largest/smallest values and corresponding evaluation points.

Table 10.2.2.1-24 Evaluation Criterion for Impact on Ethnic Minority Groups

Items			Min Impact		Max impact
Ethnic Minority Group	Total Numbers of Ethnic Minority Groups	*Point*	0	-	5
		Score	100	Linear interpolation	0

3) Impact on Agriculture

The impact on agriculture was evaluated by the area of cultivated land per unit installed capacity and the number of irrigation systems. The project with the largest cultivated land per unit installed capacity was evaluated at 0 points, the smallest at 100 points, and the other projects were evaluated by linear interpolation. Regarding the impact on irrigation systems, the project with the largest number was given 0 points, the smallest 100 points, and the other projects were evaluated by linear interpolation.

Table 10.2.2.1-25 shows the largest/smallest values and corresponding evaluation points.

Table 10.2.2.1-25 Evaluation Criterion for Impact on Agriculture

Items			Min Impact		Max impact
Agriculture	*Cultivated land (km2/MW)*	*Point*	0.003	-	0.025
		Score	100	Linear interpolation	0
	Number of Irrigation systens	*Point*	0	-	58
		Score	100	Linear interpolation	0

4) Impact on Fishery

The impact on fishery was evaluated by the number of fishermen and fish markets, availability of fish in the market, sales amount of fish, and the total income of fishermen. For all these evaluation items, the project with the largest number was given 0 points, the smallest 100 points, and the other projects were evaluated by linear interpolation.

Table 10.2.2.1-26 shows the largest/smallest values and corresponding evaluation points.

Table 10.2.2.1-26 Evaluation Criterion for Impact on Fishery

Items			Min Impact		Max impact
Impact on Fish and Fishery	Number of Fishermen	*Point*	0	-	712
		Score	100	Linear interpolation	0
	Number of the nearest fish markets	*Point*	0	-	7
		Score	100	Linear interpolation	0
	Availability of fish in the Market (kg/day)	*Point*	0	-	140
		Score	100	Linear interpolation	0
	Total sale of fish (Rp/day)	*Point*	0	-	42000
		Score	100	Linear interpolation	0
	Total income (Rp/year)	*Point*	0	-	3,710,000
		Score	100	Linear interpolation	0

5) Impact on Tourism and Culture

The impact on tourism and culture was evaluated by the number of temples, tourist facilities, and tourists. The project with the largest number was evaluated at 0 points, the smallest number at 100 points, and the other projects were evaluated by linear interpolation.

Table 10.2.2.1-27 shows the largest/smallest values and corresponding evaluation points.

Table 10.2.2.1-27 Evaluation Criterion for Impact on Tourism and Culture

Items			Min Impact		Max impact
Tourism and culture	Number of Cultural Structures (Temples)	*Point*	0	-	10
		Score	100	Linear interpolation	0
	Number of Tourist Facilities	*Point*	0	-	10
		Score	100	Linear interpolation	0
	Number of Tourists/Yr	*Point*	0	-	20,000
		Score	100	Linear interpolation	0

6) Impact on Infrastructure

The impact on infrastructure was evaluated by the length of roads, the number of bridges, the number of water mills/turbines/hydropower plants, and the number of drinking water schemes. The project with the longest/largest was evaluated at 0 points, the shortest/smallest at 100 points, and the other projects were evaluated by linear interpolation.

Table 10.2.2.1-28 shows the largest/smallest values and corresponding evaluation points.

Table 10.2.2.1-28 Evaluation Criterion for Impact on Infrastructure

Items			Min Impact		Max impact
Infrastructure	Road (paved and graveled, km)	*Point*	0	-	29.75
		Score	100	Linear interpolation	0
	Bridge	*Point*	2	-	18
		Score	100	Linear interpolation	0
	Water Mill/Hydropower	*Point*	0	-	26
		Score	100	Linear interpolation	0
	Drinking Water Schemes	*Point*	0	-	29
		Score	100	Linear interpolation	0

7) Impact on the Rural Economy and Development Plan

The impact on the rural economy and development plans was evaluated by the number of markets, the number of development plans (on-going and planning), and the number of previous issues. The project with the largest number was evaluated at 0 points, the smallest number at 100 points, and the other projects were evaluated by linear interpolation.

Table 10.2.2.1-29 shows the largest/smallest values and corresponding evaluation points.

Table 10.2.2.1-29 Evaluation Criterion for Impact on the Rural Economy and Development Plan

Items			Min Impact		Max impact
Economy Development	Market	*Point*	0	-	5
		Score	100	Linear interpolation	0
	Ongoing/Proposed Development Plans	*Point*	0	-	10
		Score	100	Linear interpolation	0
	Previous Experience/Issues	*Point*	0	-	1
		Score	100	Linear interpolation	0

10.2.2.2 Weighting of Evaluation Items

In the same matter as the evaluation of candidate projects, the evaluation items described in Section 10.2.2.1 above were weighted depending on the importance in the objective of the Study. Scores of each evaluation item were multiplied by the weight of such evaluation items, and the total of weighted scores of all evaluation items is the evaluation score of the project in question.

Taking into consideration the results of the questionnaire in the second stakeholders meeting, the following four cases of combination of weights of technical and economical conditions and the impact of the environment were prepared.

Case 1: The same importance on technical and economical conditions and impact on the environment
(50% for technical and economical conditions, 50% for impact on the environment)

Case 2: Technically and economically oriented (60% for technical and economical conditions, 40% for impact on the environment)

Case 3: Environmentally oriented (40% for technical and economical conditions, 60% for impact on the environment)

Case 4: Extremely technically and economically oriented (the average of questionnaire results. 75% for technical and economical conditions, 25% for impact on the environment)

Regarding the subcategories in technical and environmental conditions, and also taking into consideration the result of the above-mentioned questionnaire , the weight of hydrological conditions was increased from 25% to 30% and that of the lead time was decreased from 25% to 20%. In the impact on the environment, the weight of the social environment was increased from 50% to 60% and that of the natural environment was decreased from 50% to 40%.

Regarding the weights of individual evaluation items in the category of impact on the environment, relatively large weights were given to “number of households, etc.,” “agriculture,” and “fishery,” as they have an impact on the livelihood of people living in the area.

Table 10.2.2.2-1 to Table 10.2.2.2-4 show the weights and point allocations of each case.

Table 10.2.2.2-1 Weight of Evaluation Item (Case 1: Even weight)

Category	%	Subcategory	%	Evaluation Item	%	Point
Technical and Economical Conditions	50	Hydrological Conditions	30	Reliability of flow data	35	5.25
				Risk of a GLOF	30	4.50
				Sedimentation	35	5.25
		Geological Conditions	25	Seismicity	25	3.13
				Geological conditions of the site	50	6.24
				Thrust and fault	25	3.13
		Lead time	20	Time to commencement of commercial operation	100	10.00
		Effectiveness of the Project	25	Unit generation cost	25	3.13
				Installed capacity	20	2.50
				Annual energy production	10	1.25
				Energy production in the dry season	45	5.62
Impact on the Environment	50	Impact on the Natural Environment	40	Impact on forests	(23)	—
				Forest land	*9*	*1.80*
				Number of trees in the reservoir area	*7*	*1.40*
				Average of crown coverage	*7*	*1.40*
				Impact on flora	(16)	—
				Number of plant species reported	*8*	*1.60*
				Number of plant species of conservation significance	*8*	*1.60*
				Impact on terrestrial fauna	(17)	—
				Number of mammal species reported	*3*	*0.60*
				Number of bird species reported	*2*	*0.40*
				Number of herpetofauna species reported	*2*	*0.40*
				Number of conservation mammalian species reported (reservoir)	*4*	*0.80*
				Number of conservation bird species reported (reservoir)	*3*	*0.60*
				Number of conservation herpetofauna species reported (reservoir)	*3*	*0.60*
				Impact on aquatic fauna	(22)	—
				Number of fish species reported	*9*	*1.80*
				Number of fish species of conservation significance	*9*	*1.80*
				Length of recession area	*4*	*0.80*
				Impact on protected areas	(16)	—
				Number of protected areas in the downstream	*8*	*1.60*
				Number of protected species in the downstream	*8*	*1.60*
				Impact of transmission line	(6)	
				Length of transmission line	*6*	*1.20*
		Impact on the Social Environment	60	Impact on households, etc.	(17)	—
				Number of estimated households	*10*	*3.00*
				Number of schools	*4*	*1.20*
				Number of industries	*3*	*0.90*
				Impact on ethnic minorities	(8)	—
				Number of ethnic minority groups	*8*	*2.40*
				Impact on agriculture	(19)	—
				Impact on irrigation	*9*	*2.70*
				Impact on agricultural land	*10*	*3.00*
				Impact on fishery	(15)	—
				Number of fishermen	*3*	*0.90*
				Number of fish market	*2*	*0.60*
				Availability of fish in the market	*1*	*0.30*
				Sales amount of fish	*3*	*0.90*
				Total income	*3*	*0.90*
				Length of recession area	*3*	*0.90*
				Impact on tourism and culture	(14)	—
				Number of cultural structures	*6*	*1.80*
				Number of tourist facilities	*4*	*1.20*
				Number of tourists	*4*	*1.20*
				Impact on infrastructure	(19)	—
				Impact on roads	*7*	*2.10*
				Impact on bridges	*4*	*1.20*
				Impact on water mill, turbine, hydropower plant	*4*	*1.20*
				Impact on drinking water schemes	*4*	*1.20*
				Impact on the rural economy and development plans	(8)	—
				Impact on market	*4*	*1.20*
				Number of development plans	*2*	*0.60*
				Previous issues	*2*	*0.60*
				Total		100

Table 10.2.2.2-2 Weight of Evaluation Item (Case 2: Technical conditions oriented)

Category	%	Subcategory	%	Evaluation Item	%	Point
Technical and Economical Conditions	60	Hydrological Conditions	30	Reliability of flow data	35	6.30
				Risk of a GLOF	30	5.40
				Sedimentation	35	6.30
		Geological Conditions	25	Seismicity	25	3.75
				Geological conditions of the site	50	7.50
				Thrust and fault	25	3.75
		Lead time	20	Time to commencement of commercial operation	100	12.00
		Effectiveness of the Project	25	Unit generation cost	25	3.75
				Installed capacity	20	3.00
				Annual energy production	10	1.50
				Energy production in the dry season	45	6.75
Impact on the Environment	40	Impact on the Natural Environment	40	Impact on forests	(23)	—
				Forest land	*9*	*1.44*
				Number of trees in the reservoir area	*7*	*1.12*
				Average of crown coverage	*7*	*1.12*
				Impact on flora	(16)	—
				Number of plant species reported	*8*	*1.28*
				Number of plant species of conservation significance	*8*	*1.28*
				Impact on terrestrial fauna	(17)	—
				Number of mammal species reported	*3*	*0.48*
				Number of bird species reported	*2*	*0.32*
				Number of herpetofauna species reported	*2*	*0.32*
				Number of conservation mammalian species reported (reservoir)	*4*	*0.64*
				Number of conservation bird species reported (reservoir)	*3*	*0.48*
				Number of conservation herpetofauna species reported (reservoir)	*3*	*0.48*
				Impact on aquatic fauna	(22)	—
				Number of fish species reported	*9*	*1.44*
				Number of fish species of conservation significance	*9*	*1.44*
				Length of recession area	*4*	*0.64*
				Impact on protected areas	(16)	—
				Number of protected areas in the downstream	*8*	*1.28*
				Number of protected species in the downstream	*8*	*1.28*
				Impact of transmission lines	(6)	
				Length of transmission line	*6*	*0.96*
		Impact on the Social Environment	60	Impact on households, etc.	(17)	—
				Number of estimated households	*10*	*2.40*
				Number of schools	*4*	*0.96*
				Number of industries	*3*	*0.72*
				Impact on ethnic minorities	(8)	—
				Number of ethnic minority groups	*8*	*1.92*
				Impact on agriculture	(19)	—
				Impact on irrigation	*9*	*2.16*
				Impact on agricultural land	*10*	*2.40*
				Impact on fishery	(15)	—
				Number of fishermen	*3*	*0.72*
				Number of fish market	*2*	*0.48*
				Availability of fish in the market	*1*	*0.24*
				Sales amount of fish	*3*	*0.72*
				Total income	*3*	*0.72*
				Length of recession area	*3*	*0.72*
				Impact on tourism and culture	(14)	—
				Number of cultural structures	*6*	*1.44*
				Number of tourist facilities	*4*	*0.96*
				Number of tourists	*4*	*0.96*
				Impact on infrastructure	(19)	—
				Impact on roads	*7*	*1.68*
				Impact on bridges	*4*	*0.96*
				Impact on water mill, turbine, hydropower plant	*4*	*0.96*
				Impact on drinking water schemes	*4*	*0.96*
				Impact on the rural economy and development plans	(8)	—
				Impact on market	*4*	*0.96*
				Number of development plans	*2*	*0.48*
				Previous issues	*2*	*0.48*
				Total		100

Table 10.2.2.2-3 Weight of Evaluation Item (Case 3: Environmental impact oriented)

Category	%	Subcategory	%	Evaluation Item	%	Point
Technical and Economical Conditions	40	Hydrological Conditions	30	Reliability of flow data	35	4.20
				Risk of a GLOF	30	3.60
				Sedimentation	35	4.20
		Geological Conditions	25	Seismicity	25	2.50
				Geological conditions of the site	50	5.00
				Thrust and fault	25	2.50
		Lead time	20	Time to commencement of commercial operation	100	8.00
		Effectiveness of the Project	25	Unit generation cost	25	2.50
				Installed capacity	20	2.00
				Annual energy production	10	1.00
				Energy production in the dry season	45	4.50
Impact on the Environment	60	Impact on the Natural Environment	40	Impact on forests	(23)	—
				Forest land	*9*	*2.16*
				Number of trees in the reservoir area	*7*	*1.68*
				Average of crown coverage	*7*	*1.68*
				Impact on flora	(16)	—
				Number of plant species reported	*8*	*1.92*
				Number of plant species of conservation significance	*8*	*1.92*
				Impact on terrestrial fauna	(17)	—
				Number of mammal species reported	*3*	*0.72*
				Number of bird species reported	*2*	*0.48*
				Number of herpetofauna species reported	*2*	*0.48*
				Number of conservation mammalian species reported (reservoir)	*4*	*0.96*
				Number of conservation bird species reported (reservoir)	*3*	*0.72*
				Number of conservation herpetofauna species reported (reservoir)	*3*	*0.72*
				Impact on aquatic fauna	(22)	—
				Number of fish species reported	*9*	*2.16*
				Number of fish species of conservation significance	*9*	*2.16*
				Length of recession area	*4*	*0.96*
				Impact on protected areas	(16)	—
				Number of protected areas in the downstream	*8*	*1.92*
				Number of protected species in the downstream	*8*	*1.92*
				Impact of transmission lines	(6)	
				Length of transmission line	*6*	*1.44*
		Impact on the Social Environment	60	Impact on households, etc.	(17)	—
				Number of estimated households	*10*	*3.60*
				Number of schools	*4*	*1.44*
				Number of industries	*3*	*1.08*
				Impact on ethnic minorities	(8)	—
				Number of ethnic minority groups	*8*	*2.88*
				Impact on agriculture	(19)	—
				Impact on irrigation	*9*	*3.24*
				Impact on agricultural land	*10*	*3.60*
				Impact on fishery	(15)	—
				Number of fishermen	*3*	*1.08*
				Number of fish market	*2*	*0.72*
				Availability of fish in the market	*1*	*0.36*
				Sales amount of fish	*3*	*1.08*
				Total income	*3*	*1.08*
				Length of recession area	*3*	*1.08*
				Impact on tourism and culture	(14)	—
				Number of cultural structures	*6*	*2.16*
				Number of tourist facilities	*4*	*1.44*
				Number of tourists	*4*	*1.44*
				Impact on infrastructure	(19)	—
				Impact on roads	*7*	*2.52*
				Impact on bridges	*4*	*1.44*
				Impact on water mill, turbine, hydropower plant	*4*	*1.44*
				Impact on drinking water schemes	*4*	*1.44*
				Impact on the rural economy and development plans	(8)	—
				Impact on market	*4*	*1.44*
				Number of development plans	*2*	*0.72*
				Previous issues	*2*	*0.72*
Category				Total		100

Table 10.2.2.2-4 Weight of Evaluation Item (Case 4: Technical conditions oriented extremely)

Category	%	Subcategory	%	Evaluation Item	%	Point
Technical and Economical Conditions	75	Hydrological Conditions	30	Reliability of flow data	35	7.88
				Risk of a GLOF	30	6.75
				Sedimentation	35	7.88
		Geological Conditions	25	Seismicity	25	4.69
				Geological conditions of the site	50	9.38
				Thrust and fault	25	4.69
		Lead time	20	Time to commencement of commercial operation	100	15.00
		Effectiveness of the Project	25	Unit generation cost	25	4.69
				Installed capacity	20	3.75
				Annual energy production	10	1.88
				Energy production in the dry season	45	8.44
Impact on Environment	25	Impact on the Natural Environment	40	Impact on forests	(23)	—
				Forest land	*9*	*0.90*
				Number of trees in the reservoir area	*7*	*0.70*
				Average of crown coverage	*7*	*0.70*
				Impact on flora	(16)	—
				Number of plant species reported	*8*	*0.80*
				Number of plant species of conservation significance	*8*	*0.80*
				Impact on terrestrial fauna	(17)	—
				Number of mammal species reported	*3*	*0.30*
				Number of bird species reported	*2*	*0.20*
				Number of herpetofauna species reported	*2*	*0.20*
				Number of conservation mammalian species reported (reservoir)	*4*	*0.40*
				Number of conservation bird species reported (reservoir)	*3*	*0.30*
				Number of conservation herpetofauna species reported (reservoir)	*3*	*0.30*
				Impact on aquatic fauna	(22)	—
				Number of fish species reported	*9*	*0.90*
				Number of fish species of conservation significance	*9*	*0.90*
				Length of recession area	*4*	*0.40*
				Impact on protected areas	(16)	—
				Number of protected areas in the downstream	*8*	*0.80*
				Number of protected species in the downstream	*8*	*0.80*
				Impact of transmission lines	(6)	
				Length of transmission line	*6*	*0.60*
		Impact on the Social Environment	60	Impact on households, etc.	(17)	—
				Number of estimated households	*10*	*1.50*
				Number of schools	*4*	*0.60*
				Number of industries	*3*	*0.45*
				Impact on ethnic minorities	(8)	—
				Number of ethnic minority groups	*8*	*1.20*
				Impact on agriculture	(19)	—
				Impact on irrigation	*9*	*1.35*
				Impact on agricultural land	*10*	*1.50*
				Impact on fishery	(15)	—
				Number of fishermen	*3*	*0.45*
				Number of fish market	*2*	*0.30*
				Availability of fish in the market	*1*	*0.15*
				Sales amount of fish	*3*	*0.45*
				Total income	*3*	*0.45*
				Length of recession area	*3*	*0.45*
				Impact on tourism and culture	(14)	—
				Number of cultural structures	*6*	*0.90*
				Number of tourist facilities	*4*	*0.60*
				Number of tourists	*4*	*0.60*
				Impact on infrastructure	(19)	—
				Impact on roads	*7*	*1.05*
				Impact on bridges	*4*	*0.60*
				Impact on water mill, turbine, hydropower plant	*4*	*0.60*
				Impact on drinking water schemes	*4*	*0.60*
				Impact on the rural economy and development plans	(8)	—
				Impact on market	*4*	*0.60*
				Number of development plans	*2*	*0.30*
				Previous issues	*2*	*0.30*
				Total		100

10.2.2.3 Result of the Evaluation

The ten promising projects selected in "10.1.5 Selection of Promising Projects" were evaluated by the evaluation method described in "10.2.2.1 Evaluation Items and Evaluation Criteria," and each evaluation point was weighted by the weight described in "10.2.2.2 Weighting of Evaluation Items," then the evaluation score of each project was obtained by summing up all the weighted points. The numerical values and information, etc. of evaluation items were obtained from existing study reports, topographical and geological maps, and other reference literature, and also from the results of site surveys conducted by the Study Team and a Nepalese consulting firm.

As the results of the evaluation, though the evaluation score is different case by case, the Nalsyau Gad Project obtained the highest score in the all cases. The Dudh Koshi, Andhi Khola, Chera-1, Lower Jhimruk, and Madi Projects obtained the second to the sixth scores. The Kokhajor-1, Naumure (W. Rapti), Sun Koshi No. 3, and Lower Badigad Projects were seventh to tenth places.

The difference in score between the Nalsyau Gad Project and the second-ranked project was 9 to 14 points, and the difference between the sixth-ranked project and the seventh-ranked project was 2 to 5 points.

Table 10.2.2.3-1 shows the evaluation score and ranking of each project, their details are shown in Table 10.2.2.3-2 to Table 10.2.2.3-5, and details of the evaluation on geological conditions, time to commencement of commercial operation, and unit generation cost are shown in Table 10.2.2.3-6 to Table 10.2.2.3-10. The characteristics of each subcategory of each project are shown in Figure 10.2.2.3-1 by setting the full score of each subcategory at 100 points.

Table 10.2.2.3-1 Evaluation Score and Ranking (Summary)

No.	Project Name	P (MW)	Case-1		Case-2		Case-3		Case-4	
			Score	Ranking	Score	Ranking	Score	Ranking	Score	Ranking
W-23	Nalsyau Gad	410	77	1	76	1	78	1	75	1
E-01	Dudh Koshi	300	65	2	65	2	64	3	66	2
W-02	Chera-1	148.7	65	2	64	3	66	2	63	4
C-08	Andhi Khola	180	64	4	64	3	63	6	65	3
W-06	Madi	199.8	63	5	62	5	64	3	60	5
W-05	Lower Jhimruk	142.5	63	5	62	5	64	3	60	5
E-06	Kokhajor-1	111.5	58	7	56	7	61	7	51	10
W-25	Naumure (W. Rapti)	245	56	8	56	7	56	8	56	8
E-17	Sun Koshi No .3	536	50	9	53	9	47	9	57	7
C-02	Lower Badigad	380.3	47	10	49	10	45	10	53	9

Case 1: Technical and Economical Conditions = 50%, Impact on the Environment = 50%
Case 2: Technical and Economical Conditions = 60%, Impact on the Environment = 40%
Case 3: Technical and Economical Conditions = 40%, Impact on the Environment = 60%
Case 4: Technical and Economical Conditions = 75%, Impact on the Environment = 25%

Regarding these ten promising projects, the presence or absence of critical obstructive factors was confirmed.

- Projects located in national parks or conservation areas were excluded in the first step of selection of promising projects described in Section 10.1.3 (3). It was also confirmed in the

evaluation of the "Impact on Protected Areas" described in Section 10.2.2.1 (5) 4) that the locations of the ten promising projects are outside of these areas.

- The maximum number of households to be relocated is 1,600 in the Lower Badigad Project.
- Regarding rare species, it was confirmed by an interview with the WWF that there are not any projects that should not be implemented because of a big impact on a rare species. However, since information about the distribution condition of rare species is insufficient in Nepal, it was not possible to confirm that there are not any critical habitats of rare species in the project areas.

Characteristics of each promising project are described below.

(1) Nalsyau Gad Project

The Nalsyau Gad project is a 410 MW storage-type hydroelectric power project (HPP), which is located in the Jajarkot District, Bheri Zone, in the Midwest Region. A feasibility study was conducted from 2010 to 2012, and the reliability of the project plan is high.

The annual energy production is 1,406 GWh, and the energy production in the dry season is 582 GWh, which is the largest in the promising projects. The generation cost is 6.9 USc/kWh and the EIRR is 15.6%, so this project has high economic efficiency.

The specific sediment volume is estimated at 3,960 t/km^2/year, which is the same value adopted by the NEA as the average specific sedimentation volume in the western region.

The reservoir area is 6.3 km^2, which is relatively small in the promising projects, and the inundated forest area is 0.76 km^2 (0.0019 km^2/MW), which is the smallest in the promising projects. The number of resettlements is 263 householes (0.64/MW) and the inundated cultivated land is 2.54 km^2 (0.0061 km^2/MW).

Although it is located in the Midwest Region, far from Kathmandu which has the largest demand in the country, this project is a good project as a whole.

(2) Dudh Koshi Project

The Dudh Koshi project is a 300 MW storage-type HPP, which is located in the Okhaldhunga District, Khotang District and Solukhumbu District in Sagarmatha Zone, in the East Region. This project was studied in the "Master Plan Study on the Koshi River Water Resources Development" in 1985 by JICA, and a feasibility study was conducted in 1998 by a Canadian consulting firm. Flow measurement is being carried out in the vicinity of the dam site, and the reliability of the project plan is high. Three glacial lakes that have possibilities of a GLOF exist in the upstream basin. According to the above-mentioned feasibility study report, a GLOF is able to be controlled with spillways that are designed for a probable maximum flood (PMF).

The annual energy generation is 1,910 GWh, which is the largest in the promising projects, and the energy production in the dry season is also as large as 523 GWh, and the plant factor is 73%. The generation cost is 6.0 USc/kWh and the EIRR is 17.6%, so this project has high economic efficiency. This project is located in the East Region, and the linear distance to Kathmandu is about 140 km.

The specific sediment volume is estimated at 2,540 t/km^2/year, smaller than 3,300 t/km^2/year which is the value adopted by the NEA as the average specific sedimentation volume in the eastern region.

The reservoir area is 11.1 km^2, the inundated forest area and cultivated land are 4.1 km^2 (0.0137 km^2/MW) and 3.3 km^2 (0.0110 km^2/MW) respectively, and the number of resettlements is as small as 63 house holds (0.21/MW).

In this study, the layout that was studied in the above-mentioned FS report was adopted. This layout has the largest installed capacity and energy production compared to other layouts of this project. In this layout, however, the water released from the Dudh Koshi power station bypasses the Kurule dam of the Sun Koshi Multipurpose Scheme (Phase I). Although inflow into the Kurule dam, which diverts river water from the Sun Koshi river to the Kamala river for irrigation and hydropower projects, would decrease, it is concluded in the FS report that there would be no adverse effect because the necessary water volume could be secured for the Sun Koshi multipurpose project.

(3) Chera-1 Project

The Chera-1 project is a 148.7 MW storage-type HPP, which is located in the Jajarkot District, Bheri Zone, in the Midwest Region. This project is at the desk-study stage.

Though the installed capacity is similar to the Tanahu HPP (140 MW), the dam height is as high as 186 m, which is similar to that in the above-mentioned Dudh Koshi HPP. The annual energy production is 563 GWh and the energy production in the dry season is 121 GWh. The generation cost is 10.2 USc/kWh and EIRR is 12.6%, and they are average values in the promising projects.

The specific sediment volume is estimated at 1,000 t/km^2/year, smaller than 3,960 t/km^2/year which is the value adopted by the NEA as the average specific sedimentation volume in the western region.

The reservoir area is as small as 4.0 km^2, and the inundated forest area and the inundated cultivated land are 1.46 km^2 (0.098 km^2/MW) and 1.08 km^2 (0.0073 km^2/MW) respectively. However, the number of resettlements is as large as 566 households (3.81/MW).

(4) Andhi Khola Project

The Andhi Khola project is a 180 MW storage-type HPP, which is located in the Syangja District, Gandaki Zone, in the West Region. Its damsite is about 2 km upstream from the regulating pond of the existing Kaligandaki A hydroelectric power station. A feasibility study was conducted in 2002.

The annual energy production and the energy production in the dry season are 649 GWh and 137 GWh respectively. The generation cost is 10.3 USc/kWh and EIRR is 13.0%, and they are similar to the above-mentioned Chera-1 project.

The specific sediment volume is estimated at 2,526 t/km^2/year, smaller than 4,400 t/km^2/year

which is the value adopted by the NEA as the average specific sedimentation volume in the central region.

The reservoir area is 5.5 km^2, the inundated forest and cultivated land are relatively small, 1.51 km^2 (0.084 km^2/MW) and 1.65 km^2 (0.0092 km^2/MW) respectively, and the number of resettlements is 542 households (3.01/MW), which is relatively large in the promising projects.

When the Andhi Khola project is implemented, since the inflow to the above-mentioned existing Kaligandaki A hydroelectric power station decreases, and there is also a plan of heightening the Kaligandaki A dam, a comprehensive study including the existing facilities is required before implementation of this project.

(5) Madi Project

The Madi project is a 199.8 MW storage-type HPP, which is located in the Ropla District, Rapti Zone, in the Midwest Region. This project is at the desk-study stage.

The annual energy production and the energy production in the dry season are 621 GWh and 121 GWh respectively. The generation cost is 10.3 USc/kWh and EIRR is 12.3% respectively, and its economic efficiency is similar to the above-mentioned Chera-1 project and the Andhi Khola project.

The specific sediment volume is estimated at 5,750 t/km^2/year, larger than 3,960 t/km^2/year which is the value adopted by the NEA as the average specific sedimentation volume in the western region.

The reservoir area is 7.7 km^2, and the inundated forest area and cultivated land are as small as 1.64 km^2 (0.082 km^2/MW and 1.92 km^2 (0.096 km^2/MW) respectively. The number of resettlements is 366 households (1.68/MW).

(6) Lower Jhimruk Project

The Lower Jhimruk project is a 142.5 MW storage-type HPP, which is located in the Arghakhanchi District, Lumbini Zone, in the West Region and in Pyuthan District, Rapti Zone, in the Midwest Region. This project is a the desk-study stage.

The annual energy production and the energy production in the dry season are 455 GWh and 94 GWh respectively. The generation cost is 11.5 USc/kWh and EIRR is 10.9%, and they are average values in the promising projects.

The specific sediment volume is estimated at 5,750 t/km^2/year, larger than 3,960 t/km^2/year, which is the value adopted by the NEA as the average specific sedimentation volume in the western region.

The reservoir area is medium size at 6.0 km^2, the inundated forest area and the cultivated land are relatively small, 1.87 km^2 (0.131 km^2/MW) and 2.04 km^2 (0.096 km^2/MW) respectively. The number of resettlements is 229 households (1.61/MW).

Since the dam site of this project is located in the reservoir area of the Naumure project

mentioned below, these two projects are not able to be compatible. When both projects are implemented, the layout of one project, or both, should be altered.

(7) Kokhajor-1 Project

The Kokhajor-1 project is a 111.5 MW storage-type HPP, which is located in the Sindhuli District in Janakpur Zone and the Kavrepalanchok District in Bagmati Zone, in the Central Region. This project is the smallest project in terms of installed capacity. This project is at the desk-study stage.

The annual energy production and the energy production in the dry season are 279 GWh and 94 GWh respectively. The generation cost is 17.1 USc/kWh and EIRR is 7.6%, and these values indicate that this project is economically inefficient.

The specific sediment volume is estimated at 5,900 t/km^2/year, larger than 3,300 t/km^2/year which is the value adopted by the NEA as the average specific sedimentation volume in the eastern region.

The reservoir area is 4.6 km^2, the inundated forest area and the cultivated land is as small as 2.89 km^2 (0.0259 km^2/MW) and 1.7 km^2 (0.0154 km^2/MW) respectively, and the number of resettlement is 92 households (0.83/MW), which is also small in the promising projects.

This project is favorable from an environmental viewpoint, but implementation of this project is, however, difficult from the viewpoint of economic efficiency.

(8) Naumure (W. Rapti) Project

The Naumure (W. Rapti) project is a 245 MW storage-type HPP, which is located in the Arghakhanchi District, Lumbini District, in the West Region and the Pyuthan District, Rapti Zone, in the Midwest Region. This project is at the desk-study stage.

The annual energy production and the energy production in the dry season are 1,158 GWh and 310 GWh respectively. The generation cost is 8.2 USc/kWh and EIRR is 15.2%, and this project has high economic efficiency.

The specific sediment volume is estimated at 5,750 t/km^2/year, larger than 3,960 t/km^2/year, which is the value adopted by the NEA as the average specific sedimentation volume in the western region.

The reservoir area is as large as 19.8 km^2, and the inundated forest area and cultivated land are also large, at 7.85 km^2 (0.0320 km^2/MW) and 6.11 km^2 (0.0249 km^2/MW) respectively. The number of resettlements is 456 households (1.86/MW).

In the Study, only power generation was considered as the purpose of the Naumure project. However there is the possibility of implementing the Naumure project as a multi-purpose project with irrigation. Therefore, a study on multi-purpose development should be conducted before implementing this as a power generation project.

(9) Sun Koshi No. 3 Project

The Sun Koshi No. 3 project is a 536 MW storage-type HPP, which is located in the Kavrepalanchok District and the Sindhupalchok District, Bagmati Zone, in the Central Region. This is the largest project in terms of installed capacity among the promising projects. This project is at the desk-study stage.

The annual energy production is as large as 1,884 GWh, but the energy production in the dry season is as small as 336 GWh despite the large installed capacity.

The specific sediment volume is estimated at 1,871 t/km^2/year, smaller than 3,300 t/km^2/year, which is the value adopted by the NEA as the average specific sedimentation volume in the eastern region.

The reservoir area is 30.1 km^2, which is the largest in the promising projects, and the inundated forest area and the inundated cultivated land are 8.16 km^2 (0.0152 km^2/MW) and 9.39 km^2 (0.0175 km^2/MW) respectively, which are also the largest in the promising projects. The number of resettlements is also as large at 1,599 households (2.98/MW).

In addition to the large inundation of forest area and cultivated land, this project requires 39 km of inundation of major national roads. Replacing these national roads are one of the crucial issues for implementing this project.

(10) Lower Badigad Project

The Lower Badigad project is a 380.3 MW storage-type HPP, which is located in the Gulmi District, Lumbini Zone, in the West Region. This project is at the desk-study stage.

The annual energy production and the energy production in the dry season are 1,366 GWh and 354 GWh respectively. The generation cost is 8.9 USc/kWh and EIRR is 13.2%, which are average values in the promising projects.

The specific sediment volume is estimated at 2,526 t/km^2/year, smaller than 4,400 t/km^2/year, which is the value adopted by the NEA as the average specific sedimentation volume in the central region. However, since large-scale slope failures exist in the upstream area of the reservoir, actual specific sediment volume might be considerably larger than the estimated value.

The reservoir area is as large as 13.7 km^2, the inundated forest area and the inundated cultivated land areas are 3.3 km^2 (0.087 km^2/MW) and 5.9 km^2 (0.0155 km^2/MW) respectively. The number of resettlements is as large as 1,606 house holds (4.22/MW), the largest in the promising projects together with the above-mentioned Sun Koshi No. 3 project.

Table 10.2.2.3-2 (1) Evaluation Score and Ranking of Case 1 (1/8)

Category		Technical and Economical Conditions																				
Subcategory		Hydrological conditions									Geological conditions						Lead time			Effectiveness of project		
Evaluation Item		Reliability of flow data			Risk of GLOF			Sedimentation			Seismicity (refer to Table 8.7.3-6)		Geological conditions of site (refer to Table 8.7.3-7)		Thrust and fault (refer to Table 8.7.3-8)		Time to commencement of commercial operation (refer to Table 8.7.3-9)			Unit generation cost (refer to Table 8.7.3-10)		
Weight (%)				5.25			4.50			5.25		3.13		6.24		3.13			10.00			3.13
No.	Project Name	Calculation Method	Score	Weighted Score	Risk	Score	Weighted Score	Life Time of Reservoir (year)	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	(year)	Score	Weighted Score	(USc/kWh)	Score	Weighted Score
E-01	Dudh Koshi	GS670	100.0	5.25	High	0.0	0.00	100.0	9.9	0.52	20.0	0.63	75.0	4.68	80.0	2.50	12.0	80.0	8.00	5.99	100.0	3.13
E-06	Kokhajor-1	RH	0.0	0.00	None	100.0	4.50	199.0	54.5	2.86	20.0	0.63	75.0	4.68	20.0	0.63	13.0	70.0	7.00	17.08	0.0	0.00
E-17	Sun Koshi No.3	GS630*As/Ag	100.0	5.25	High	0.0	0.00	177.0	44.6	2.34	20.0	0.63	90.0	5.62	100.0	3.13	14.5	55.0	5.50	8.97	73.1	2.29
C-02	Lower Badigad	RH	0.0	0.00	None	100.0	4.50	192.0	51.4	2.70	60.0	1.88	55.0	3.43	60.0	1.88	14.5	55.0	5.50	8.86	74.1	2.32
C-08	Andhi Khola	GS415*As/Ag	100.0	5.25	None	100.0	4.50	280.0	91.0	4.78	20.0	0.63	40.0	2.50	80.0	2.50	12.0	80.0	8.00	10.26	61.5	1.92
W-02	Chera-1	RH	0.0	0.00	None	100.0	4.50	510.0	100.0	5.25	20.0	0.63	90.0	5.62	100.0	3.13	13.5	65.0	6.50	10.24	61.7	1.93
W-05	Lower Jhimruk	GS330*As/Ag	100.0	5.25	None	100.0	4.50	102.0	10.8	0.57	60.0	1.88	80.0	4.99	20.0	0.63	13.0	70.0	7.00	11.46	50.7	1.59
W-06	Madi	RH	0.0	0.00	None	100.0	4.50	138.0	27.0	1.42	60.0	1.88	85.0	5.30	100.0	3.13	13.5	65.0	6.50	10.26	61.5	1.92
W-23	Nalsyau Gad	RH	0.0	0.00	None	100.0	4.50	280.0	91.0	4.78	0.0	0.00	80.0	4.99	80.0	2.50	12.0	80.0	8.00	6.88	92.0	2.88
W-25	Naumure (W. Rapti)	RH	0.0	0.00	None	100.0	4.50	78.0	0.0	0.00	100.0	3.13	85.0	5.30	20.0	0.63	13.5	65.0	6.50	8.25	79.6	2.49

Table 10.2.2.3-2 (2) Evaluation Score and Ranking of Case 1 (2/8)

Category		Technical and Economical Conditions (cont.)									Impact on Environment											
Subcategory		Effectiveness of project (cont.)									Impact of natural environment											
											Impact on forest											
Evaluation Item		Installed capacity			Annual energy production			Energy production in the dry season			Forest land				Number of trees in the reservoir area				Average of crown coverage		
Weight (%)				2.50			1.25			5.62				1.80				1.40				1.40
No.	Project Name	(MW)	Score	Weighted Score	(GWh)	Score	Weighted Score	(GWh)	Score	Weighted Score	(km2)	(km2/MW)	Score	Weighted Score	(nos)	(/MW)	Score	Weighted Score	(%)	Score	Weighted Score
E-01	Dudh Koshi	300.0	100.0	2.50	1,909.6	100.0	1.25	523.3	89.9	5.05	4.1	0.0137	60.9	1.10	242,720	809	61.0	0.85	53	30.9	0.43
E-06	Kokhajor-1	111.5	37.2	0.93	278.9	14.6	0.18	94.1	16.2	0.91	2.9	0.0259	20.3	0.37	202,300	1,814	8.6	0.12	70	0.0	0.00
E-17	Sun Koshi No.3	536.0	100.0	2.50	1,883.6	98.6	1.23	335.9	57.7	3.24	8.2	0.0152	55.7	1.00	520,608	971	52.5	0.74	38	58.2	0.81
C-02	Lower Badigad	380.3	100.0	2.50	1,366.0	71.5	0.89	354.7	61.0	3.43	3.3	0.0087	77.4	1.39	129,360	340	85.4	1.20	38	58.2	0.81
C-08	Andhi Khola	180.0	60.0	1.50	648.7	34.0	0.43	137.1	23.6	1.33	1.5	0.0084	78.4	1.41	77,312	430	80.8	1.13	38	58.2	0.81
W-02	Chera-1	148.7	49.6	1.24	563.2	29.5	0.37	120.6	20.7	1.16	1.5	0.0098	73.6	1.33	38,088	256	89.8	1.26	41	52.7	0.74
W-05	Lower Jhimruk	142.5	47.5	1.19	454.7	23.8	0.30	94.4	16.2	0.91	1.9	0.0131	62.7	1.13	83,776	588	72.5	1.02	26	80.0	1.12
W-06	Madi	199.8	66.6	1.67	621.1	32.5	0.41	170.7	29.3	1.65	1.6	0.0082	78.9	1.42	36,982	185	93.5	1.31	15	100.0	1.40
W-23	Nalsyau Gad	410.0	100.0	2.50	1,406.1	73.6	0.92	581.8	100.0	5.62	0.8	0.0019	100.0	1.80	24,580	60	100.0	1.40	20	90.9	1.27
W-25	Naumure (W. Rapti)	245.0	81.7	2.04	1,157.5	60.6	0.76	309.9	53.3	3.00	7.9	0.0320	0.0	0.00	485,130	1,980	0.0	0.00	40	54.5	0.76

Table 10.2.2.3-2 (3) Evaluation Score and Ranking of Case 1 (3/8)

Category		Impact on Environment (cont.)																					
Subcategory		Impact of natural environment (cont.)																					
		Impact on flora						Impact on terrestrial fauna															
Evaluation Item		Number of plant species reported			Number of plant species of conservation significance			Number of mammal species reported			Number of bird species reported			Number of herpetofauna species reported			Number of conservation mammalian species reported (reservoir)			Number of conservation bird species reported (reservoir)			Number of conservation herpetofauna species reported (reservoir)		
Weight (%)				1.60			1.60			0.60			0.40			0.40			0.80			0.60			0.60
No.	Project Name		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score
E-01	Dudh Koshi	67	10.9	0.18	3	60.0	0.96	24	0.0	0.00	51	0.0	0.00	17	0.0	0.00	9	0.0	0.00	3	25.0	0.15	5	0.0	0.00
E-06	Kokhajor-1	10	100.0	1.60	3	60.0	0.96	13	84.6	0.51	21	78.9	0.32	8	81.8	0.33	5	100.0	0.80	2	50.0	0.30	1	80.0	0.48
E-17	Sun Koshi No.3	46	43.8	0.70	5	20.0	0.32	11	100.0	0.60	50	2.6	0.01	9	72.7	0.29	6	75.0	0.60	4	0.0	0.00	3	40.0	0.24
C-02	Lower Badigad	45	45.3	0.73	5	20.0	0.32	21	23.1	0.14	30	55.3	0.22	9	72.7	0.29	9	0.0	0.00	3	25.0	0.15	0	100.0	0.60
C-08	Andhi Khola	41	51.6	0.83	5	20.0	0.32	12	92.3	0.55	16	92.1	0.37	6	100.0	0.40	7	50.0	0.40	1	75.0	0.45	2	60.0	0.36
W-02	Chera-1	35	60.9	0.98	3	60.0	0.96	15	69.2	0.42	28	60.5	0.24	13	36.4	0.15	7	50.0	0.40	2	50.0	0.30	4	20.0	0.12
W-05	Lower Jhimruk	55	29.7	0.48	4	40.0	0.64	23	7.7	0.05	49	5.3	0.02	17	0.0	0.00	8	25.0	0.20	3	25.0	0.15	4	20.0	0.12
W-06	Madi	74	0.0	0.00	6	0.0	0.00	18	46.2	0.28	21	78.9	0.32	9	72.7	0.29	7	50.0	0.40	1	75.0	0.45	1	80.0	0.48
W-23	Nalsyau Gad	59	23.4	0.38	1	100.0	1.60	11	100.0	0.60	13	100.0	0.40	8	81.8	0.33	6	75.0	0.60	0	100.0	0.60	1	80.0	0.48
W-25	Naumure (W. Rapti)	55	29.7	0.48	4	40.0	0.64	24	0.0	0.00	49	5.3	0.02	17	0.0	0.00	9	0.0	0.00	3	25.0	0.15	4	20.0	0.12

Table 10.2.2.3-2 (4) Evaluation Score and Ranking of Case 1 (4/8)

Category		Impact on Environment (cont.)																	
Subcategory		Impact of natural environment (cont.)																	
		Impact on aquatic fauna									Impact on protected area						Impact of transmission line		
Evaluation Item		Number of fish species reported			Number of fish species of conservation significance			Length of recession area			Number of protected areas in the downstream			Number of protected species in the downstream			Length of transmission line		
Weight (%)				1.80			1.80			0.80			1.60			1.60			1.20
No.	Project Name		Score	Weighted Score		Score	Weighted Score	(km)	Score	Weighted Score		Score	Weighted Score		Score	Weighted Score	(km)	Score	Weighted Score
E-01	Dudh Koshi	24	0.0	0.00	3	50.0	0.90	60	0.0	0.00	2	50.0	0.80	3	100.0	1.60	43	89.6	1.08
E-06	Kokhajor-1	7	94.4	1.70	2	100.0	1.80	21	65.5	0.52	1	100.0	1.60	3	100.0	1.60	62	64.9	0.78
E-17	Sun Koshi No.3	21	16.7	0.30	3	50.0	0.90	1	100.0	0.80	2	50.0	0.80	3	100.0	1.60	35	100.0	1.20
C-02	Lower Badigad	12	66.7	1.20	4	0.0	0.00	4	94.1	0.75	3	0.0	0.00	5	33.3	0.53	49	81.8	0.98
C-08	Andhi Khola	6	100.0	1.80	2	100.0	1.80	60	0.0	0.00	3	0.0	0.00	5	33.3	0.53	49	81.8	0.98
W-02	Chera-1	11	72.2	1.30	2	100.0	1.80	7	89.1	0.71	3	0.0	0.00	6	0.0	0.00	66	59.7	0.72
W-05	Lower Jhimruk	11	72.2	1.30	2	100.0	1.80	8	87.4	0.70	2	50.0	0.80	4	66.7	1.07	75	48.1	0.58
W-06	Madi	8	88.9	1.60	3	50.0	0.90	10	84.0	0.67	2	50.0	0.80	4	66.7	1.07	62	64.9	0.78
W-23	Nalsyau Gad	8	88.9	1.60	2	100.0	1.80	11	82.4	0.66	3	0.0	0.00	6	0.0	0.00	112	0.0	0.00
W-25	Naumure (W. Rapti)	16	44.4	0.80	2	100.0	1.80	1	100.0	0.80	2	50.0	0.80	4	66.7	1.07	79	42.9	0.51

Table 10.2.2.3-2 (5) Evaluation Score and Ranking of Case 1 (5/8)

Category		Impact on Environment (cont.)																				
Subcategory		Impact on social environment																				
		Impact on household, etc.												Impact on ethnic minority			Impact on agriculture				
Evaluation Item		Number of estimated households				Number of schools				Number of industries				Number of ethnic minority groups			Impact on irrigation			Impact on agricultural land			
Weight (%)					3.00				1.20				0.90			2.40			2.70				3.00
No.	Project Name		(/MW)	Score	Weighted Score		(/MW)	Score	Weighted Score		(/MW)	Score	Weighted Score		Score	Weighted Score	(facilities)	Score	Weighted Score	(km2)	(km^2/MW)	Score	Weighted Score
E-01	Dudh Koshi	63	0.21	100.0	3.00	0	0.0000	100.0	1.20	0	0.0000	100.0	0.90	3	40.0	0.96	1	98.3	2.65	3.3	0.0110	74.0	2.22
E-06	Kokhajor-1	92	0.83	84.7	2.54	6	0.0538	0.0	0.00	0	0.0000	100.0	0.90	5	0.0	0.00	2	96.6	2.61	1.7	0.0154	50.5	1.51
E-17	Sun Koshi No.3	1,599	2.98	30.9	0.93	19	0.0354	34.1	0.41	2	0.0037	88.8	0.80	4	20.0	0.48	20	65.5	1.77	9.4	0.0175	39.4	1.18
C-02	Lower Badigad	1,606	4.22	0.0	0.00	18	0.0473	12.0	0.14	11	0.0289	13.2	0.12	5	0.0	0.00	58	0.0	0.00	5.9	0.0155	50.1	1.50
C-08	Andhi Khola	542	3.01	30.2	0.91	9	0.0500	7.1	0.09	6	0.0333	0.0	0.00	2	60.0	1.44	23	60.3	1.63	1.7	0.0092	83.7	2.51
W-02	Chera-1	566	3.81	10.4	0.31	3	0.0202	62.5	0.75	0	0.0000	100.0	0.90	1	80.0	1.92	7	87.9	2.37	1.1	0.0073	93.8	2.81
W-05	Lower Jhimruk	229	1.61	65.2	1.96	4	0.0281	47.8	0.57	3	0.0211	36.8	0.33	3	40.0	0.96	3	94.8	2.56	2.0	0.0143	56.4	1.69
W-06	Madi	336	1.68	63.3	1.90	2	0.0100	81.4	0.98	0	0.0000	100.0	0.90	1	80.0	1.92	16	72.4	1.96	1.9	0.0096	81.4	2.44
W-23	Nalsyau Gad	263	0.64	89.2	2.68	2	0.0049	90.9	1.09	0	0.0000	100.0	0.90	0	100.0	2.40	0	100.0	2.70	2.5	0.0061	100.0	3.00
W-25	Naumure (W. Rapti)	456	1.86	58.9	1.77	5	0.0204	62.1	0.74	0	0.0000	100.0	0.90	2	60.0	1.44	25	56.9	1.54	6.1	0.0249	0.0	0.00

Table 10.2.2.3-2 (6) Evaluation Score and Ranking of Case 1 (6/8)

Category		Impact on Environment (cont.)																
Subcategory		Impact on social environment (cont.)																
		Impact on fishery																
Evaluation Item		Number of fishermen (reservoir)			Number of fish market			Availability of fish in the market			Sales amount of fish			Total income			Length of recession area		
Weight (%)				0.90			0.60			0.30			0.90			0.90			0.90
No.	Project Name		Score	Weighted Score		Score	Weighted Score	(kg/day)	Score	Weighted Score	(Rs/day)	Score	Weighted Score	(Rs/year)	Score	Weighted Score	(km)	Score	Weighted Score
E-01	Dudh Koshi	154	78.4	0.71	7	0.0	0.00	70.0	50.0	0.15	17,500	58.3	0.53	1,820,000	50.9	0.46	60	0.0	0.00
E-06	Kokhajor-1	0	100.0	0.90	0	100.0	0.60	0.0	100.0	0.30	0	100.0	0.90	0	100.0	0.90	21	65.5	0.59
E-17	Sun Koshi No.3	712	0.0	0.00	7	0.0	0.00	140.0	0.0	0.00	42,000	0.0	0.00	3,710,000	0.0	0.00	1	100.0	0.90
C-02	Lower Badigad	217	69.5	0.63	7	0.0	0.00	101.5	27.5	0.08	25,375	39.6	0.36	1,062,885	71.4	0.64	4	94.1	0.85
C-08	Andhi Khola	156	78.1	0.70	3	57.1	0.34	25.5	81.8	0.25	7,650	81.8	0.74	550,000	85.2	0.77	60	0.0	0.00
W-02	Chera-1	25	96.5	0.87	4	42.9	0.26	37.5	73.2	0.22	7,500	82.1	0.74	375,000	89.9	0.81	7	89.1	0.80
W-05	Lower Jhimruk	254	64.3	0.58	3	57.1	0.34	40.5	71.1	0.21	7,290	82.6	0.74	225,000	93.9	0.85	8	87.4	0.79
W-06	Madi	100	86.0	0.77	3	57.1	0.34	12.0	91.4	0.27	3,600	91.4	0.82	273,000	92.6	0.83	10	84.0	0.76
W-23	Nalsyau Gad	115	83.8	0.75	3	57.1	0.34	10.5	92.5	0.28	2,100	95.0	0.86	1,140,000	69.3	0.62	11	82.4	0.74
W-25	Naumure (W. Rapti)	43	94.0	0.85	2	71.4	0.43	15.0	89.3	0.27	4,125	90.2	0.81	387,000	89.6	0.81	1	100.0	0.90

Table 10.2.2.3-2 (7) Evaluation Score and Ranking of Case 1 (7/8)

Category		Impact on Environment (cont.)																			
Subcategory		Impact on social environment (cont.)																			
		Impact on tourism and culture									Impact on infrastructure										
Evaluation Item		Number of cultural structures (temples)			Number of tourist facilities			Number of tourists			Impact on roads			Impact on bridges			Impact on water mill, turbine, hydropower plant			Impact on drinking water schemes		
Weight (%)				1.80			1.20			1.20			2.10			1.20			1.20			1.20
No.	Project Name		Score	Weighted Score		Score	Weighted Score	(per year)	Score	Weighted Score	Inundated road (km)	Score	Weighted Score	Number of inundated bridge	Score	Weighted Score	Number of facilities	Score	Weighted Score		Score	Weighted Score
E-01	Dudh Koshi	2	80.0	1.44	2	80.0	0.96	10	100.0	1.20	5.0	87.4	1.84	5	64.3	0.77	0	100.0	1.20	5	82.8	0.99
E-06	Kokhajor-1	0	100.0	1.80	0	100.0	1.20	0	100.0	1.20	0.0	100.0	2.10	0	100.0	1.20	11	57.7	0.69	10	65.5	0.79
E-17	Sun Koshi No.3	10	0.0	0.00	10	0.0	0.00	20,000	0.0	0.00	39.5	0.0	0.00	14	0.0	0.00	15	42.3	0.51	22	24.1	0.29
C-02	Lower Badigad	9	10.0	0.18	0	100.0	1.20	0	100.0	1.20	26.1	34.0	0.71	12	14.3	0.17	26	0.0	0.00	29	0.0	0.00
C-08	Andhi Khola	5	50.0	0.90	0	100.0	1.20	0	100.0	1.20	3.4	91.3	1.92	11	21.4	0.26	0	100.0	1.20	10	65.5	0.79
W-02	Chera-1	1	90.0	1.62	0	100.0	1.20	0	100.0	1.20	3.8	90.5	1.90	1	92.9	1.11	9	65.4	0.78	2	93.1	1.12
W-05	Lower Jhimruk	1	90.0	1.62	0	100.0	1.20	0	100.0	1.20	3.3	91.6	1.92	3	78.6	0.94	0	100.0	1.20	7	75.9	0.91
W-06	Madi	4	60.0	1.08	0	100.0	1.20	0	100.0	1.20	11.2	71.5	1.50	6	57.1	0.69	6	76.9	0.92	22	24.1	0.29
W-23	Nalsyau Gad	0	100.0	1.80	0	100.0	1.20	0	100.0	1.20	0.0	100.0	2.10	4	71.4	0.86	20	23.1	0.28	0	100.0	1.20
W-25	Naumure (W. Rapti)	2	80.0	1.44	0	100.0	1.20	0	100.0	1.20	1.8	95.4	2.00	13	7.1	0.09	0	100.0	1.20	17	41.4	0.50

Table 10.2.2.3-2 (8) Evaluation Score and Ranking of Case 1 (8/8)

Category		Impact on Environment (cont.)											
Subcategory		Impact on social environment (cont.)											
		Impact on rural economy and development plan											
Evaluation Item		Impact on market			Number of ongoing or proposed development plans			Previous issues					
Weight (%)				1.20			0.60			0.60	100.00	100	
No.	Project Name		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score	Total Score		Ranking
E-01	Dudh Koshi	1	80.0	0.96	0	100.0	0.60	0	100.0	0.60	64.90	65	2
E-06	Kokhajor-1	0	100.0	1.20	6	40.0	0.24	1	0.0	0.00	58.28	58	7
E-17	Sun Koshi No.3	5	0.0	0.00	10	0.0	0.00	1	0.0	0.00	49.91	50	9
C-02	Lower Badigad	5	0.0	0.00	3	70.0	0.42	0	100.0	0.60	47.14	47	10
C-08	Andhi Khola	4	20.0	0.24	2	80.0	0.48	0	100.0	0.60	63.65	64	4
W-02	Chera-1	4	20.0	0.24	0	100.0	0.60	0	100.0	0.60	64.89	65	3
W-05	Lower Jhimruk	0	100.0	1.20	1	90.0	0.54	0	100.0	0.60	62.90	63	6
W-06	Madi	2	60.0	0.72	3	70.0	0.42	0	100.0	0.60	63.06	63	5
W-23	Nalsyau Gad	1	80.0	0.96	2	80.0	0.48	0	100.0	0.60	77.25	77	1
W-25	Naumure (W. Rapti)	3	40.0	0.48	3	70.0	0.42	0	100.0	0.60	55.89	56	8

Table 10.2.2.3-3 (1) Evaluation Score and Ranking of Case 2 (1/8)

Category		Technical and Economical Conditions																				
Subcategory		Hydrological conditions									Geological conditions						Lead time			Effectiveness of project		
Evaluation Item		Reliability of flow data			Risk of GLOF			Sedimentation			Seismicity (refer to Table 8.7.3-6)		Geological conditions of site (refer to Table 8.7.3-7)		Thrust and fault (refer to Table 8.7.3-8)		Time to commencement of commercial operation (refer to Table 8.7.3-9)			Unit generation cost (refer to Table 8.7.3-10)		
Weight (%)		6.30			5.40			6.30			3.75		7.50		3.75		12.00			3.75		
No.	Project Name	Calculation Method	Score	Weighted Score	Risk	Score	Weighted Score	Life Time of Reservoir (year)	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	(year)	Score	Weighted Score	(USc/kWh)	Score	Weighted Score
E-01	Dudh Koshi	GS670	100.0	6.30	High	0.0	0.00	100.0	9.9	0.62	20.0	0.75	75.0	5.63	80.0	3.00	12.0	80.0	9.60	5.99	100.0	3.75
E-06	Kokhajor-1	RH	0.0	0.00	None	100.0	5.40	199.0	54.5	3.43	20.0	0.75	75.0	5.63	20.0	0.75	13.0	70.0	8.40	17.08	0.0	0.00
E-17	Sun Koshi No.3	GS630*As/Ag	100.0	6.30	High	0.0	0.00	177.0	44.6	2.81	20.0	0.75	90.0	6.75	100.0	3.75	14.5	55.0	6.60	8.97	73.1	2.74
C-02	Lower Badigad	RH	0.0	0.00	None	100.0	5.40	192.0	51.4	3.24	60.0	2.25	55.0	4.13	60.0	2.25	14.5	55.0	6.60	8.86	74.1	2.78
C-08	Andhi Khola	GS415*As/Ag	100.0	6.30	None	100.0	5.40	280.0	91.0	5.73	20.0	0.75	40.0	3.00	80.0	3.00	12.0	80.0	9.60	10.26	61.5	2.31
W-02	Chera-1	RH	0.0	0.00	None	100.0	5.40	510.0	100.0	6.30	20.0	0.75	90.0	6.75	100.0	3.75	13.5	65.0	7.80	10.24	61.7	2.31
W-05	Lower Jhimruk	GS330*As/Ag	100.0	6.30	None	100.0	5.40	102.0	10.8	0.68	60.0	2.25	80.0	6.00	20.0	0.75	13.0	70.0	8.40	11.46	50.7	1.90
W-06	Madi	RH	0.0	0.00	None	100.0	5.40	138.0	27.0	1.70	60.0	2.25	85.0	6.38	100.0	3.75	13.5	65.0	7.80	10.26	61.5	2.31
W-23	Nalsyau Gad	RH	0.0	0.00	None	100.0	5.40	280.0	91.0	5.73	0.0	0.00	80.0	6.00	80.0	3.00	12.0	80.0	9.60	6.88	92.0	3.45
W-25	Naumure (W. Rapti)	RH	0.0	0.00	None	100.0	5.40	78.0	0.0	0.00	100.0	3.75	85.0	6.38	20.0	0.75	13.5	65.0	7.80	8.25	79.6	2.99

Table 10.2.2.3-3 (2) Evaluation Score and Ranking of Case 2 (2/8)

Category		Technical and Economical Conditions (cont.)									Impact on Environment											
Subcategory		Effectiveness of project (cont.)									Impact of natural environment											
											Impact on forest											
Evaluation Item		Installed capacity			Annual energy production			Energy production in the dry season			Forest land				Number of trees in the reservoir area				Average of crown coverage			
Weight (%)		3.00			1.50			6.75			1.44				1.12				1.12			
No.	Project Name	(MW)	Score	Weighted Score	(GWh)	Score	Weighted Score	(GWh)	Score	Weighted Score	(km2)	(km2/MW)	Score	Weighted Score	(nos)	(/MW)	Score	Weighted Score	(%)	Score	Weighted Score	
E-01	Dudh Koshi	300.0	100.0	3.00	1,909.6	100.0	1.50	523.3	89.9	6.07	4.1	0.0137	60.9	0.88	242,720	809	61.0	0.68	53	30.9	0.35	
E-06	Kokhajor-1	111.5	37.2	1.12	278.9	14.6	0.22	94.1	16.2	1.09	2.9	0.0259	20.3	0.29	202,300	1,814	8.6	0.10	70	0.0	0.00	
E-17	Sun Koshi No.3	536.0	100.0	3.00	1,883.6	98.6	1.48	335.9	57.7	3.89	8.2	0.0152	55.7	0.80	520,608	971	52.5	0.59	38	58.2	0.65	
C-02	Lower Badigad	380.3	100.0	3.00	1,366.0	71.5	1.07	354.7	61.0	4.12	3.3	0.0087	77.4	1.11	129,360	340	85.4	0.96	38	58.2	0.65	
C-08	Andhi Khola	180.0	60.0	1.80	648.7	34.0	0.51	137.1	23.6	1.59	1.5	0.0084	78.4	1.13	77,312	430	80.8	0.90	38	58.2	0.65	
W-02	Chera-1	148.7	49.6	1.49	563.2	29.5	0.44	120.6	20.7	1.40	1.5	0.0098	73.6	1.06	38,088	256	89.8	1.01	41	52.7	0.59	
W-05	Lower Jhimruk	142.5	47.5	1.43	454.7	23.8	0.36	94.4	16.2	1.09	1.9	0.0131	62.7	0.90	83,776	588	72.5	0.81	26	80.0	0.90	
W-06	Madi	199.8	66.6	2.00	621.1	32.5	0.49	170.7	29.3	1.98	1.6	0.0082	78.9	1.14	36,982	185	93.5	1.05	15	100.0	1.12	
W-23	Nalsyau Gad	410.0	100.0	3.00	1,406.1	73.6	1.10	581.8	100.0	6.75	0.8	0.0019	100.0	1.44	24,580	60	100.0	1.12	20	90.9	1.02	
W-25	Naumure (W. Rapti)	245.0	81.7	2.45	1,157.5	60.6	0.91	309.9	53.3	3.60	7.9	0.0320	0.0	0.00	485,130	1,980	0.0	0.00	40	54.5	0.61	

Table 10.2.2.3-3 (3) Evaluation Score and Ranking of Case 2 (3/8)

Category		Impact on Environment (cont.)																					
Subcategory		Impact of natural environment (cont.)																					
		Impact on flora						Impact on terrestrial fauna															
Evaluation Item		Number of plant species reported			Number of plant species of conservation significance			Number of mammal species reported			Number of bird species reported			Number of herpetofauna species reported			Number of conservation mammalian species reported (reservoir)			Number of conservation bird species reported (reservoir)			Number of conservation herpetofauna species reported (reservoir)		
Weight (%)				1.28			1.28			0.48			0.32			0.32			0.64			0.48			0.48
No.	Project Name		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score
E-01	Dudh Koshi	67	10.9	0.14	3	60.0	0.77	24	0.0	0.00	51	0.0	0.00	17	0.0	0.00	9	0.0	0.00	3	25.0	0.12	5	0.0	0.00
E-06	Kokhajor-1	10	100.0	1.28	3	60.0	0.77	13	84.6	0.41	21	78.9	0.25	8	81.8	0.26	5	100.0	0.64	2	50.0	0.24	1	80.0	0.38
E-17	Sun Koshi No.3	46	43.8	0.56	5	20.0	0.26	11	100.0	0.48	50	2.6	0.01	9	72.7	0.23	6	75.0	0.48	4	0.0	0.00	3	40.0	0.19
C-02	Lower Badigad	45	45.3	0.58	5	20.0	0.26	21	23.1	0.11	30	55.3	0.18	9	72.7	0.23	9	0.0	0.00	3	25.0	0.12	0	100.0	0.48
C-08	Andhi Khola	41	51.6	0.66	5	20.0	0.26	12	92.3	0.44	16	92.1	0.29	6	100.0	0.32	7	50.0	0.32	1	75.0	0.36	2	60.0	0.29
W-02	Chera-1	35	60.9	0.78	3	60.0	0.77	15	69.2	0.33	28	60.5	0.19	13	36.4	0.12	7	50.0	0.32	2	50.0	0.24	4	20.0	0.10
W-05	Lower Jhimruk	55	29.7	0.38	4	40.0	0.51	23	7.7	0.04	49	5.3	0.02	17	0.0	0.00	8	25.0	0.16	3	25.0	0.12	4	20.0	0.10
W-06	Madi	74	0.0	0.00	6	0.0	0.00	18	46.2	0.22	21	78.9	0.25	9	72.7	0.23	7	50.0	0.32	1	75.0	0.36	1	80.0	0.38
W-23	Nalsyau Gad	59	23.4	0.30	1	100.0	1.28	11	100.0	0.48	13	100.0	0.32	8	81.8	0.26	6	75.0	0.48	0	100.0	0.48	1	80.0	0.38
W-25	Naumure (W. Rapti)	55	29.7	0.38	4	40.0	0.51	24	0.0	0.00	49	5.3	0.02	17	0.0	0.00	9	0.0	0.00	3	25.0	0.12	4	20.0	0.10

Table 10.2.2.3-3 (4) Evaluation Score and Ranking of Case 2 (4/8)

Category		Impact on Environment (cont.)														
Subcategory		Impact of natural environment (cont.)														
		Impact on aquatic fauna									Impact on protected area					Impact of transmission line
Evaluation Item		Number of fish species reported			Number of fish species of conservation significance			Length of recession area			Number of protected areas in the downstream			Number of protected species in the downstream			Length of transmission line		
Weight (%)				1.44			1.44			0.64			1.28			1.28			0.96
No.	Project Name		Score	Weighted Score		Score	Weighted Score	(km)	Score	Weighted Score		Score	Weighted Score		Score	Weighted Score	(km)	Score	Weighted Score
E-01	Dudh Koshi	24	0.0	0.00	3	50.0	0.72	60	0.0	0.00	2	50.0	0.64	3	100.0	1.28	43	89.6	0.86
E-06	Kokhajor-1	7	94.4	1.36	2	100.0	1.44	21	65.5	0.42	1	100.0	1.28	3	100.0	1.28	62	64.9	0.62
E-17	Sun Koshi No.3	21	16.7	0.24	3	50.0	0.72	1	100.0	0.64	2	50.0	0.64	3	100.0	1.28	35	100.0	0.96
C-02	Lower Badigad	12	66.7	0.96	4	0.0	0.00	4	94.1	0.60	3	0.0	0.00	5	33.3	0.43	49	81.8	0.79
C-08	Andhi Khola	6	100.0	1.44	2	100.0	1.44	60	0.0	0.00	3	0.0	0.00	5	33.3	0.43	49	81.8	0.79
W-02	Chera-1	11	72.2	1.04	2	100.0	1.44	7	89.1	0.57	3	0.0	0.00	6	0.0	0.00	66	59.7	0.57
W-05	Lower Jhimruk	11	72.2	1.04	2	100.0	1.44	8	87.4	0.56	2	50.0	0.64	4	66.7	0.85	75	48.1	0.46
W-06	Madi	8	88.9	1.28	3	50.0	0.72	10	84.0	0.54	2	50.0	0.64	4	66.7	0.85	62	64.9	0.62
W-23	Nalsyau Gad	8	88.9	1.28	2	100.0	1.44	11	82.4	0.53	3	0.0	0.00	6	0.0	0.00	112	0.0	0.00
W-25	Naumure (W. Rapti)	16	44.4	0.64	2	100.0	1.44	1	100.0	0.64	2	50.0	0.64	4	66.7	0.85	79	42.9	0.41

Table 10.2.2.3-3 (5) Evaluation Score and Ranking of Case 2 (5/8)

Category		Impact on Environment (cont.)																				
Subcategory		Impact on social environment																				
		Impact on household, etc.												Impact on ethnic minority			Impact on agriculture				
Evaluation Item		Number of estimated households				Number of schools				Number of industries				Number of ethnic minority groups			Impact on irrigation			Impact on agricultural land			
Weight (%)		2.40				0.96				0.72				1.92			2.16			2.40			
No.	Project Name		(/MW)	Score	Weighted Score		(/MW)	Score	Weighted Score		(/MW)	Score	Weighted Score		Score	Weighted Score	(facilities)	Score	Weighted Score	(km2)	(km^2/MW)	Score	Weighted Score
E-01	Dudh Koshi	63	0.21	100.0	2.40	0	0.0000	100.0	0.96	0	0.0000	100.0	0.72	3	40.0	0.77	1	98.3	2.12	3.3	0.0110	74.0	1.78
E-06	Kokhajor-1	92	0.83	84.7	2.03	6	0.0538	0.0	0.00	0	0.0000	100.0	0.72	5	0.0	0.00	2	96.6	2.09	1.7	0.0154	50.5	1.21
E-17	Sun Koshi No.3	1,599	2.98	30.9	0.74	19	0.0354	34.1	0.33	2	0.0037	88.8	0.64	4	20.0	0.38	20	65.5	1.42	9.4	0.0175	39.4	0.95
C-02	Lower Badigad	1,606	4.22	0.0	0.00	18	0.0473	12.0	0.12	11	0.0289	13.2	0.10	5	0.0	0.00	58	0.0	0.00	5.9	0.0155	50.1	1.20
C-08	Andhi Khola	542	3.01	30.2	0.72	9	0.0500	7.1	0.07	6	0.0333	0.0	0.00	2	60.0	1.15	23	60.3	1.30	1.7	0.0092	83.7	2.01
W-02	Chera-1	566	3.81	10.4	0.25	3	0.0202	62.5	0.60	0	0.0000	100.0	0.72	1	80.0	1.54	7	87.9	1.90	1.1	0.0073	93.8	2.25
W-05	Lower Jhimruk	229	1.61	65.2	1.56	4	0.0281	47.8	0.46	3	0.0211	36.8	0.27	3	40.0	0.77	3	94.8	2.05	2.0	0.0143	56.4	1.35
W-06	Madi	336	1.68	63.3	1.52	2	0.0100	81.4	0.78	0	0.0000	100.0	0.72	1	80.0	1.54	16	72.4	1.56	1.9	0.0096	81.4	1.95
W-23	Nalsyau Gad	263	0.64	89.2	2.14	2	0.0049	90.9	0.87	0	0.0000	100.0	0.72	0	100.0	1.92	0	100.0	2.16	2.5	0.0061	100.0	2.40
W-25	Naumure (W. Rapti)	456	1.86	58.9	1.41	5	0.0204	62.1	0.60	0	0.0000	100.0	0.72	2	60.0	1.15	25	56.9	1.23	6.1	0.0249	0.0	0.00

Table 10.2.2.3-3 (6) Evaluation Score and Ranking of Case 2 (6/8)

Category		Impact on Environment (cont.)																	
Subcategory		Impact on social environment (cont.)																	
		Impact on fishery																	
Evaluation Item		Number of fishermen (reservoir)			Number of fish market			Availability of fish in the market			Sales amount of fish			Total income			Length of recession area		
Weight (%)		0.72			0.48			0.24			0.72			0.72			0.72		
No.	Project Name		Score	Weighted Score		Score	Weighted Score	(kg/day)	Score	Weighted Score	(Rs/day)	Score	Weighted Score	(Rs/year)	Score	Weighted Score	(km)	Score	Weighted Score
E-01	Dudh Koshi	154	78.4	0.56	7	0.0	0.00	70.0	50.0	0.12	17,500	58.3	0.42	1,820,000	50.9	0.37	60	0.0	0.00
E-06	Kokhajor-1	0	100.0	0.72	0	100.0	0.48	0.0	100.0	0.24	0	100.0	0.72	0	100.0	0.72	21	65.5	0.47
E-17	Sun Koshi No.3	712	0.0	0.00	7	0.0	0.00	140.0	0.0	0.00	42,000	0.0	0.00	3,710,000	0.0	0.00	1	100.0	0.72
C-02	Lower Badigad	217	69.5	0.50	7	0.0	0.00	101.5	27.5	0.07	25,375	39.6	0.29	1,062,885	71.4	0.51	4	94.1	0.68
C-08	Andhi Khola	156	78.1	0.56	3	57.1	0.27	25.5	81.8	0.20	7,650	81.8	0.59	550,000	85.2	0.61	60	0.0	0.00
W-02	Chera-1	25	96.5	0.69	4	42.9	0.21	37.5	73.2	0.18	7,500	82.1	0.59	375,000	89.9	0.65	7	89.1	0.64
W-05	Lower Jhimruk	254	64.3	0.46	3	57.1	0.27	40.5	71.1	0.17	7,290	82.6	0.60	225,000	93.9	0.68	8	87.4	0.63
W-06	Madi	100	86.0	0.62	3	57.1	0.27	12.0	91.4	0.22	3,600	91.4	0.66	273,000	92.6	0.67	10	84.0	0.61
W-23	Nalsyau Gad	115	83.8	0.60	3	57.1	0.27	10.5	92.5	0.22	2,100	95.0	0.68	1,140,000	69.3	0.50	11	82.4	0.59
W-25	Naumure (W. Rapti)	43	94.0	0.68	2	71.4	0.34	15.0	89.3	0.21	4,125	90.2	0.65	387,000	89.6	0.64	1	100.0	0.72

Table 10.2.2.3-3 (7) Evaluation Score and Ranking of Case 2 (7/8)

Category		Impact on Environment (cont.)																				
Subcategory		Impact on social environment (cont.)																				
		Impact on tourism and culture									Impact on infrastructure											
Evaluation Item		Number of cultural structures (temples)			Number of tourist facilities			Number of tourists			Impact on roads			Impact on bridges			Impact on water mill, turbine, hydropower plant			Impact on drinking water schemes		
Weight (%)				1.44			0.96			0.96			1.68			0.96			0.96			0.96
No.	Project Name		Score	Weighted Score		Score	Weighted Score	(per year)	Score	Weighted Score	Inundated road (km)	Score	Weighted Score	Number of inundated bridge	Score	Weighted Score	Number of facilities	Score	Weighted Score		Score	Weighted Score
E-01	Dudh Koshi	2	80.0	1.15	2	80.0	0.77	10	100.0	0.96	5.0	87.4	1.47	5	64.3	0.62	0	100.0	0.96	5	82.8	0.79
E-06	Kokhajor-1	0	100.0	1.44	0	100.0	0.96	0	100.0	0.96	0.0	100.0	1.68	0	100.0	0.96	11	57.7	0.55	10	65.5	0.63
E-17	Sun Koshi No.3	10	0.0	0.00	10	0.0	0.00	20,000	0.0	0.00	39.5	0.0	0.00	14	0.0	0.00	15	42.3	0.41	22	24.1	0.23
C-02	Lower Badigad	9	10.0	0.14	0	100.0	0.96	0	100.0	0.96	26.1	34.0	0.57	12	14.3	0.14	26	0.0	0.00	29	0.0	0.00
C-08	Andhi Khola	5	50.0	0.72	0	100.0	0.96	0	100.0	0.96	3.4	91.3	1.53	11	21.4	0.21	0	100.0	0.96	10	65.5	0.63
W-02	Chera-1	1	90.0	1.30	0	100.0	0.96	0	100.0	0.96	3.8	90.5	1.52	1	92.9	0.89	9	65.4	0.63	2	93.1	0.89
W-05	Lower Jhimruk	1	90.0	1.30	0	100.0	0.96	0	100.0	0.96	3.3	91.6	1.54	3	78.6	0.75	0	100.0	0.96	7	75.9	0.73
W-06	Madi	4	60.0	0.86	0	100.0	0.96	0	100.0	0.96	11.2	71.5	1.20	6	57.1	0.55	6	76.9	0.74	22	24.1	0.23
W-23	Nalsyau Gad	0	100.0	1.44	0	100.0	0.96	0	100.0	0.96	0.0	100.0	1.68	4	71.4	0.69	20	23.1	0.22	0	100.0	0.96
W-25	Naumure (W. Rapti)	2	80.0	1.15	0	100.0	0.96	0	100.0	0.96	1.8	95.4	1.60	13	7.1	0.07	0	100.0	0.96	17	41.4	0.40

Table 10.2.2.3-3 (8) Evaluation Score and Ranking of Case 2 (8/8)

Category		Impact on Environment (cont.)										
Subcategory		Impact on social environment (cont.)										
		Impact on rural economy and development plan										
Evaluation Item		Impact on market			Number of ongoing or proposed development plans			Previous issues				
Weight (%)				0.96			0.48			0.48	100.00	100
No.	Project Name		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score	Total Score		Ranking
E-01	Dudh Koshi	1	80.0	0.77	0	100.0	0.48	0	100.0	0.48	65.33	65	2
E-06	Kokhajor-1	0	100.0	0.96	6	40.0	0.19	1	0.0	0.00	55.54	56	8
E-17	Sun Koshi No.3	5	0.0	0.00	10	0.0	0.00	1	0.0	0.00	52.62	53	9
C-02	Lower Badigad	5	0.0	0.00	3	70.0	0.34	0	100.0	0.48	49.36	49	10
C-08	Andhi Khola	4	20.0	0.19	2	80.0	0.38	0	100.0	0.48	64.21	64	3
W-02	Chera-1	4	20.0	0.19	0	100.0	0.48	0	100.0	0.48	64.04	64	4
W-05	Lower Jhimruk	0	100.0	0.96	1	90.0	0.43	0	100.0	0.48	61.83	62	5
W-06	Madi	2	60.0	0.58	3	70.0	0.34	0	100.0	0.48	61.80	62	6
W-23	Nalsyau Gad	1	80.0	0.77	2	80.0	0.38	0	100.0	0.48	76.45	76	1
W-25	Naumure (W. Rapti)	3	40.0	0.38	3	70.0	0.34	0	100.0	0.48	56.04	56	7

Table 10.2.2.3-4 (1) Evaluation Score and Ranking of Case 3 (1/8)

Category		Technical and Economical Conditions																				
Subcategory		Hydrological conditions									Geological conditions						Lead time			Effectiveness of project		
Evaluation Item		Reliability of flow data			Risk of GLOF			Sedimentation			Seismicity (refer to Table 8.7.3-6)		Geological conditions of site (refer to Table 8.7.3-7)		Thrust and fault (refer to Table 8.7.3-8)		Time to commencement of commercial operation (refer to Table 8.7.3-9)			Unit generation cost (refer to Table 8.7.3-10)		
Weight (%)				4.20			3.60			4.20		2.50		5.00		2.50			8.00			2.50
No.	Project Name	Calculation Method	Score	Weighted Score	Risk	Score	Weighted Score	Life Time of Reservoir (year)	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	(year)	Score	Weighted Score	(USc/kWh)	Score	Weighted Score
E-01	Dudh Koshi	GS670	100.0	4.20	High	0.0	0.00	100.0	9.9	0.42	20.0	0.50	75.0	3.75	80.0	2.00	12.0	80.0	6.40	5.99	100.0	2.50
E-06	Kokhajor-1	RH	0.0	0.00	None	100.0	3.60	199.0	54.5	2.29	20.0	0.50	75.0	3.75	20.0	0.50	13.0	70.0	5.60	17.08	0.0	0.00
E-17	Sun Koshi No.3	GS630*As/Ag	100.0	4.20	High	0.0	0.00	177.0	44.6	1.87	20.0	0.50	90.0	4.50	100.0	2.50	14.5	55.0	4.40	8.97	73.1	1.83
C-02	Lower Badigad	RH	0.0	0.00	None	100.0	3.60	192.0	51.4	2.16	60.0	1.50	55.0	2.75	60.0	1.50	14.5	55.0	4.40	8.86	74.1	1.85
C-08	Andhi Khola	GS415*As/Ag	100.0	4.20	None	100.0	3.60	280.0	91.0	3.82	20.0	0.50	40.0	2.00	80.0	2.00	12.0	80.0	6.40	10.26	61.5	1.54
W-02	Chera-1	RH	0.0	0.00	None	100.0	3.60	510.0	100.0	4.20	20.0	0.50	90.0	4.50	100.0	2.50	13.5	65.0	5.20	10.24	61.7	1.54
W-05	Lower Jhimruk	GS330*As/Ag	100.0	4.20	None	100.0	3.60	102.0	10.8	0.45	60.0	1.50	80.0	4.00	20.0	0.50	13.0	70.0	5.60	11.46	50.7	1.27
W-06	Madi	RH	0.0	0.00	None	100.0	3.60	138.0	27.0	1.14	60.0	1.50	85.0	4.25	100.0	2.50	13.5	65.0	5.20	10.26	61.5	1.54
W-23	Nalsyau Gad	RH	0.0	0.00	None	100.0	3.60	280.0	91.0	3.82	0.0	0.00	80.0	4.00	80.0	2.00	12.0	80.0	6.40	6.88	92.0	2.30
W-25	Naumure (W. Rapti)	RH	0.0	0.00	None	100.0	3.60	78.0	0.0	0.00	100.0	2.50	85.0	4.25	20.0	0.50	13.5	65.0	5.20	8.25	79.6	1.99

Table 10.2.2.3-4 (2) Evaluation Score and Ranking of Case 3 (2/8)

Category		Technical and Economical Conditions (cont.)									Impact on Environment											
Subcategory		Effectiveness of project (cont.)									Impact of natural environment											
											Impact on forest											
Evaluation Item		Installed capacity			Annual energy production			Energy production in the dry season			Forest land				Number of trees in the reservoir area				Average of crown coverage		
Weight (%)				2.00			1.00			4.50				2.16				1.68				1.68
No.	Project Name	(MW)	Score	Weighted Score	(GWh)	Score	Weighted Score	(GWh)	Score	Weighted Score	(km2)	(km2/MW)	Score	Weighted Score	(nos)	(/MW)	Score	Weighted Score	(%)	Score	Weighted Score
E-01	Dudh Koshi	300.0	100.0	2.00	1,909.6	100.0	1.00	523.3	89.9	4.05	4.1	0.0137	60.9	1.31	242,720	809	61.0	1.02	53	30.9	0.52
E-06	Kokhajor-1	111.5	37.2	0.74	278.9	14.6	0.15	94.1	16.2	0.73	2.9	0.0259	20.3	0.44	202,300	1,814	8.6	0.15	70	0.0	0.00
E-17	Sun Koshi No.3	536.0	100.0	2.00	1,883.6	98.6	0.99	335.9	57.7	2.60	8.2	0.0152	55.7	1.20	520,608	971	52.5	0.88	38	58.2	0.98
C-02	Lower Badigad	380.3	100.0	2.00	1,366.0	71.5	0.72	354.7	61.0	2.75	3.3	0.0087	77.4	1.67	129,360	340	85.4	1.43	38	58.2	0.98
C-08	Andhi Khola	180.0	60.0	1.20	648.7	34.0	0.34	137.1	23.6	1.06	1.5	0.0084	78.4	1.69	77,312	430	80.8	1.36	38	58.2	0.98
W-02	Chera-1	148.7	49.6	0.99	563.2	29.5	0.30	120.6	20.7	0.93	1.5	0.0098	73.6	1.59	38,088	256	89.8	1.51	41	52.7	0.89
W-05	Lower Jhimruk	142.5	47.5	0.95	454.7	23.8	0.24	94.4	16.2	0.73	1.9	0.0131	62.7	1.35	83,776	588	72.5	1.22	26	80.0	1.34
W-06	Madi	199.8	66.6	1.33	621.1	32.5	0.33	170.7	29.3	1.32	1.6	0.0082	78.9	1.71	36,982	185	93.5	1.57	15	100.0	1.68
W-23	Nalsyau Gad	410.0	100.0	2.00	1,406.1	73.6	0.74	581.8	100.0	4.50	0.8	0.0019	100.0	2.16	24,580	60	100.0	1.68	20	90.9	1.53
W-25	Naumure (W. Rapti)	245.0	81.7	1.63	1,157.5	60.6	0.61	309.9	53.3	2.40	7.9	0.0320	0.0	0.00	485,130	1,980	0.0	0.00	40	54.5	0.92

Table 10.2.2.3-4 (3) Evaluation Score and Ranking of Case 3 (3/8)

Category		Impact on Environment (cont.)																					
Subcategory		Impact of natural environment (cont.)																					
		Impact on flora						Impact on terrestrial fauna															
Evaluation Item		Number of plant species reported			Number of plant species of conservation significance			Number of mammal species reported			Number of bird species reported			Number of herpetofauna species reported			Number of conservation mammalian species reported (reservoir)			Number of conservation bird species reported (reservoir)			Number of conservation herpetofauna species reported (reservoir)		
Weight (%)				1.92			1.92			0.72			0.48			0.48			0.96			0.72			0.72
No.	Project Name		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score
E-01	Dudh Koshi	67	10.9	0.21	3	60.0	1.15	24	0.0	0.00	51	0.0	0.00	17	0.0	0.00	9	0.0	0.00	3	25.0	0.18	5	0.0	0.00
E-06	Kokhajor-1	10	100.0	1.92	3	60.0	1.15	13	84.6	0.61	21	78.9	0.38	8	81.8	0.39	5	100.0	0.96	2	50.0	0.36	1	80.0	0.58
E-17	Sun Koshi No.3	46	43.8	0.84	5	20.0	0.38	11	100.0	0.72	50	2.6	0.01	9	72.7	0.35	6	75.0	0.72	4	0.0	0.00	3	40.0	0.29
C-02	Lower Badigad	45	45.3	0.87	5	20.0	0.38	21	23.1	0.17	30	55.3	0.27	9	72.7	0.35	9	0.0	0.00	3	25.0	0.18	0	100.0	0.72
C-08	Andhi Khola	41	51.6	0.99	5	20.0	0.38	12	92.3	0.66	16	92.1	0.44	6	100.0	0.48	7	50.0	0.48	1	75.0	0.54	2	60.0	0.43
W-02	Chera-1	35	60.9	1.17	3	60.0	1.15	15	69.2	0.50	28	60.5	0.29	13	36.4	0.17	7	50.0	0.48	2	50.0	0.36	4	20.0	0.14
W-05	Lower Jhimruk	55	29.7	0.57	4	40.0	0.77	23	7.7	0.06	49	5.3	0.03	17	0.0	0.00	8	25.0	0.24	3	25.0	0.18	4	20.0	0.14
W-06	Madi	74	0.0	0.00	6	0.0	0.00	18	46.2	0.33	21	78.9	0.38	9	72.7	0.35	7	50.0	0.48	1	75.0	0.54	1	80.0	0.58
W-23	Nalsyau Gad	59	23.4	0.45	1	100.0	1.92	11	100.0	0.72	13	100.0	0.48	8	81.8	0.39	6	75.0	0.72	0	100.0	0.72	1	80.0	0.58
W-25	Naumure (W. Rapti)	55	29.7	0.57	4	40.0	0.77	24	0.0	0.00	49	5.3	0.03	17	0.0	0.00	9	0.0	0.00	3	25.0	0.18	4	20.0	0.14

Table 10.2.2.3-4 (4) Evaluation Score and Ranking of Case 3 (4/8)

Category		Impact on Environment (cont.)														
Subcategory		Impact of natural environment (cont.)														
		Impact on aquatic fauna									Impact on protected area					Impact of transmission line
Evaluation Item		Number of fish species reported			Number of fish species of conservation significance			Length of recession area			Number of protected areas in the downstream			Number of protected species in the downstream			Length of transmission line		
Weight (%)				2.16			2.16			0.96			1.92			1.92			1.44
No.	Project Name		Score	Weighted Score		Score	Weighted Score	(km)	Score	Weighted Score		Score	Weighted Score		Score	Weighted Score	(km)	Score	Weighted Score
E-01	Dudh Koshi	24	0.0	0.00	3	50.0	1.08	60	0.0	0.00	2	50.0	0.96	3	100.0	1.92	43	89.6	1.29
E-06	Kokhajor-1	7	94.4	2.04	2	100.0	2.16	21	65.5	0.63	1	100.0	1.92	3	100.0	1.92	62	64.9	0.94
E-17	Sun Koshi No.3	21	16.7	0.36	3	50.0	1.08	1	100.0	0.96	2	50.0	0.96	3	100.0	1.92	35	100.0	1.44
C-02	Lower Badigad	12	66.7	1.44	4	0.0	0.00	4	94.1	0.90	3	0.0	0.00	5	33.3	0.64	49	81.8	1.18
C-08	Andhi Khola	6	100.0	2.16	2	100.0	2.16	60	0.0	0.00	3	0.0	0.00	5	33.3	0.64	49	81.8	1.18
W-02	Chera-1	11	72.2	1.56	2	100.0	2.16	7	89.1	0.86	3	0.0	0.00	6	0.0	0.00	66	59.7	0.86
W-05	Lower Jhimruk	11	72.2	1.56	2	100.0	2.16	8	87.4	0.84	2	50.0	0.96	4	66.7	1.28	75	48.1	0.69
W-06	Madi	8	88.9	1.92	3	50.0	1.08	10	84.0	0.81	2	50.0	0.96	4	66.7	1.28	62	64.9	0.94
W-23	Nalsyau Gad	8	88.9	1.92	2	100.0	2.16	11	82.4	0.79	3	0.0	0.00	6	0.0	0.00	112	0.0	0.00
W-25	Naumure (W. Rapti)	16	44.4	0.96	2	100.0	2.16	1	100.0	0.96	2	50.0	0.96	4	66.7	1.28	79	42.9	0.62

Table 10.2.2.3-4 (5) Evaluation Score and Ranking of Case 3 (5/8)

Category		Impact on Environment (cont.)																				
Subcategory		Impact on social environment																				
		Impact on household, etc.												Impact on ethnic minority			Impact on agriculture				
Evaluation Item		Number of estimated households				Number of schools				Number of industries				Number of ethnic minority groups			Impact on irrigation			Impact on agricultural land			
Weight (%)					3.60				1.44				1.08			2.88			3.24				3.60
No.	Project Name		(/MW)	Score	Weighted Score		(/MW)	Score	Weighted Score		(/MW)	Score	Weighted Score		Score	Weighted Score	(facilities)	Score	Weighted Score	(km2)	(km^2/MW)	Score	Weighted Score
E-01	Dudh Koshi	63	0.21	100.0	3.60	0	0.0000	100.0	1.44	0	0.0000	100.0	1.08	3	40.0	1.15	1	98.3	3.18	3.3	0.0110	74.0	2.66
E-06	Kokhajor-1	92	0.83	84.7	3.05	6	0.0538	0.0	0.00	0	0.0000	100.0	1.08	5	0.0	0.00	2	96.6	3.13	1.7	0.0154	50.5	1.82
E-17	Sun Koshi No.3	1,599	2.98	30.9	1.11	19	0.0354	34.1	0.49	2	0.0037	88.8	0.96	4	20.0	0.58	20	65.5	2.12	9.4	0.0175	39.4	1.42
C-02	Lower Badigad	1,606	4.22	0.0	0.00	18	0.0473	12.0	0.17	11	0.0289	13.2	0.14	5	0.0	0.00	58	0.0	0.00	5.9	0.0155	50.1	1.80
C-08	Andhi Khola	542	3.01	30.2	1.09	9	0.0500	7.1	0.10	6	0.0333	0.0	0.00	2	60.0	1.73	23	60.3	1.96	1.7	0.0092	83.7	3.01
W-02	Chera-1	566	3.81	10.4	0.37	3	0.0202	62.5	0.90	0	0.0000	100.0	1.08	1	80.0	2.30	7	87.9	2.85	1.1	0.0073	93.8	3.38
W-05	Lower Jhimruk	229	1.61	65.2	2.35	4	0.0281	47.8	0.69	3	0.0211	36.8	0.40	3	40.0	1.15	3	94.8	3.07	2.0	0.0143	56.4	2.03
W-06	Madi	336	1.68	63.3	2.28	2	0.0100	81.4	1.17	0	0.0000	100.0	1.08	1	80.0	2.30	16	72.4	2.35	1.9	0.0096	81.4	2.93
W-23	Nalsyau Gad	263	0.64	89.2	3.21	2	0.0049	90.9	1.31	0	0.0000	100.0	1.08	0	100.0	2.88	0	100.0	3.24	2.5	0.0061	100.0	3.60
W-25	Naumure (W. Rapti)	456	1.86	58.9	2.12	5	0.0204	62.1	0.89	0	0.0000	100.0	1.08	2	60.0	1.73	25	56.9	1.84	6.1	0.0249	0.0	0.00

Table 10.2.2.3-4 (6) Evaluation Score and Ranking of Case 3 (6/8)

Category		Impact on Environment (cont.)																	
Subcategory		Impact on social environment (cont.)																	
		Impact on fishery																	
Evaluation Item		Number of fishermen (reservoir)			Number of fish market			Availability of fish in the market			Sales amount of fish			Total income			Length of recession area		
Weight (%)				1.08			0.72			0.36			1.08			1.08			1.08
No.	Project Name		Score	Weighted Score		Score	Weighted Score	(kg/day)	Score	Weighted Score	(Rs/day)	Score	Weighted Score	(Rs/year)	Score	Weighted Score	(km)	Score	Weighted Score
E-01	Dudh Koshi	154	78.4	0.85	7	0.0	0.00	70.0	50.0	0.18	17,500	58.3	0.63	1,820,000	50.9	0.55	60	0.0	0.00
E-06	Kokhajor-1	0	100.0	1.08	0	100.0	0.72	0.0	100.0	0.36	0	100.0	1.08	0	100.0	1.08	21	65.5	0.71
E-17	Sun Koshi No.3	712	0.0	0.00	7	0.0	0.00	140.0	0.0	0.00	42,000	0.0	0.00	3,710,000	0.0	0.00	1	100.0	1.08
C-02	Lower Badigad	217	69.5	0.75	7	0.0	0.00	101.5	27.5	0.10	25,375	39.6	0.43	1,062,885	71.4	0.77	4	94.1	1.02
C-08	Andhi Khola	156	78.1	0.84	3	57.1	0.41	25.5	81.8	0.29	7,650	81.8	0.88	550,000	85.2	0.92	60	0.0	0.00
W-02	Chera-1	25	96.5	1.04	4	42.9	0.31	37.5	73.2	0.26	7,500	82.1	0.89	375,000	89.9	0.97	7	89.1	0.96
W-05	Lower Jhimruk	254	64.3	0.69	3	57.1	0.41	40.5	71.1	0.26	7,290	82.6	0.89	225,000	93.9	1.01	8	87.4	0.94
W-06	Madi	100	86.0	0.93	3	57.1	0.41	12.0	91.4	0.33	3,600	91.4	0.99	273,000	92.6	1.00	10	84.0	0.91
W-23	Nalsyau Gad	115	83.8	0.91	3	57.1	0.41	10.5	92.5	0.33	2,100	95.0	1.03	1,140,000	69.3	0.75	11	82.4	0.89
W-25	Naumure (W. Rapti)	43	94.0	1.01	2	71.4	0.51	15.0	89.3	0.32	4,125	90.2	0.97	387,000	89.6	0.97	1	100.0	1.08

Table 10.2.2.3-4 (7) Evaluation Score and Ranking of Case 3 (7/8)

Category		Impact on Environment (cont.)																				
Subcategory		Impact on social environment (cont.)																				
		Impact on tourism and culture									Impact on infrastructure											
Evaluation Item		Number of cultural structures (temples)			Number of tourist facilities			Number of tourists			Impact on roads			Impact on bridges			Impact on water mill, turbine, hydropower plant			Impact on drinking water schemes		
Weight (%)				2.16			1.44			1.44			2.52			1.44			1.44			1.44
No.	Project Name		Score	Weighted Score		Score	Weighted Score	(per year)	Score	Weighted Score	Inundated road (km)	Score	Weighted Score	Number of inundated bridge	Score	Weighted Score	Number of facilities	Score	Weighted Score		Score	Weighted Score
E-01	Dudh Koshi	2	80.0	1.73	2	80.0	1.15	10	100.0	1.44	5.0	87.4	2.20	5	64.3	0.93	0	100.0	1.44	5	82.8	1.19
E-06	Kokhajor-1	0	100.0	2.16	0	100.0	1.44	0	100.0	1.44	0.0	100.0	2.52	0	100.0	1.44	11	57.7	0.83	10	65.5	0.94
E-17	Sun Koshi No.3	10	0.0	0.00	10	0.0	0.00	20,000	0.0	0.00	39.5	0.0	0.00	14	0.0	0.00	15	42.3	0.61	22	24.1	0.35
C-02	Lower Badigad	9	10.0	0.22	0	100.0	1.44	0	100.0	1.44	26.1	34.0	0.86	12	14.3	0.21	26	0.0	0.00	29	0.0	0.00
C-08	Andhi Khola	5	50.0	1.08	0	100.0	1.44	0	100.0	1.44	3.4	91.3	2.30	11	21.4	0.31	0	100.0	1.44	10	65.5	0.94
W-02	Chera-1	1	90.0	1.94	0	100.0	1.44	0	100.0	1.44	3.8	90.5	2.28	1	92.9	1.34	9	65.4	0.94	2	93.1	1.34
W-05	Lower Jhimruk	1	90.0	1.94	0	100.0	1.44	0	100.0	1.44	3.3	91.6	2.31	3	78.6	1.13	0	100.0	1.44	7	75.9	1.09
W-06	Madi	4	60.0	1.30	0	100.0	1.44	0	100.0	1.44	11.2	71.5	1.80	6	57.1	0.82	6	76.9	1.11	22	24.1	0.35
W-23	Nalsyau Gad	0	100.0	2.16	0	100.0	1.44	0	100.0	1.44	0.0	100.0	2.52	4	71.4	1.03	20	23.1	0.33	0	100.0	1.44
W-25	Naumure (W. Rapti)	2	80.0	1.73	0	100.0	1.44	0	100.0	1.44	1.8	95.4	2.40	13	7.1	0.10	0	100.0	1.44	17	41.4	0.60

Table 10.2.2.3-4 (8) Evaluation Score and Ranking of Case 3 (8/8)

Category		Impact on Environment (cont.)											
Subcategory		Impact on social environment (cont.)											
		Impact on rural economy and development plan											
Evaluation Item		Impact on market			Number of ongoing or proposed development plans			Previous issues					
Weight (%)				1.44			0.72			0.72	100.00	100	
No.	Project Name		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score	Total Score		Ranking
E-01	Dudh Koshi	1	80.0	1.15	0	100.0	0.72	0	100.0	0.72	64.45	64	3
E-06	Kokhajor-1	0	100.0	1.44	6	40.0	0.29	1	0.0	0.00	61.02	61	7
E-17	Sun Koshi No.3	5	0.0	0.00	10	0.0	0.00	1	0.0	0.00	47.20	47	9
C-02	Lower Badigad	5	0.0	0.00	3	70.0	0.50	0	100.0	0.72	44.98	45	10
C-08	Andhi Khola	4	20.0	0.29	2	80.0	0.58	0	100.0	0.72	63.00	63	6
W-02	Chera-1	4	20.0	0.29	0	100.0	0.72	0	100.0	0.72	65.71	66	2
W-05	Lower Jhimruk	0	100.0	1.44	1	90.0	0.65	0	100.0	0.72	63.92	64	5
W-06	Madi	2	60.0	0.86	3	70.0	0.50	0	100.0	0.72	64.34	64	4
W-23	Nalsyau Gad	1	80.0	1.15	2	80.0	0.58	0	100.0	0.72	78.03	78	1
W-25	Naumure (W. Rapti)	3	40.0	0.58	3	70.0	0.50	0	100.0	0.72	55.70	56	8

Table 10.2.2.3-5 (1) Evaluation Score and Ranking of Case 4 (1/8)

Category		Technical and Economical Conditions																				
Subcategory		Hydrological conditions									Geological conditions						Lead time			Effectiveness of project		
Evaluation Item		Reliability of flow data			Risk of GLOF			Sedimentation			Seismicity (refer to Table 8.7.3-6)		Geological conditions of site (refer to Table 8.7.3-7)		Thrust and fault (refer to Table 8.7.3-8)		Time to commencement of commercial operation (refer to Table 8.7.3-9)			Unit generation cost (refer to Table 8.7.3-10)		
Weight (%)		7.88			6.75			7.88			4.69		9.38		4.69		15.00			4.69		
No.	Project Name	Calculation Method	Score	Weighted Score	Risk	Score	Weighted Score	Life Time of Reservoir (year)	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	(year)	Score	Weighted Score	(USc/kWh)	Score	Weighted Score
E-01	Dudh Koshi	GS670	100.0	7.88	High	0.0	0.00	100.0	9.9	0.78	20.0	0.94	75.0	7.04	80.0	3.75	12.0	80.0	12.00	5.99	100.0	4.69
E-06	Kokhajor-1	RH	0.0	0.00	None	100.0	6.75	199.0	54.5	4.29	20.0	0.94	75.0	7.04	20.0	0.94	13.0	70.0	10.50	17.08	0.0	0.00
E-17	Sun Koshi No.3	GS630*As/Ag	100.0	7.88	High	0.0	0.00	177.0	44.6	3.51	20.0	0.94	90.0	8.44	100.0	4.69	14.5	55.0	8.25	8.97	73.1	3.43
C-02	Lower Badigad	RH	0.0	0.00	None	100.0	6.75	192.0	51.4	4.05	60.0	2.81	55.0	5.16	60.0	2.81	14.5	55.0	8.25	8.86	74.1	3.48
C-08	Andhi Khola	GS415*As/Ag	100.0	7.88	None	100.0	6.75	280.0	91.0	7.17	20.0	0.94	40.0	3.75	80.0	3.75	12.0	80.0	12.00	10.26	61.5	2.88
W-02	Chera-1	RH	0.0	0.00	None	100.0	6.75	510.0	100.0	7.88	20.0	0.94	90.0	8.44	100.0	4.69	13.5	65.0	9.75	10.24	61.7	2.89
W-05	Lower Jhimruk	GS330*As/Ag	100.0	7.88	None	100.0	6.75	102.0	10.8	0.85	60.0	2.81	80.0	7.50	20.0	0.94	13.0	70.0	10.50	11.46	50.7	2.38
W-06	Madi	RH	0.0	0.00	None	100.0	6.75	138.0	27.0	2.13	60.0	2.81	85.0	7.97	100.0	4.69	13.5	65.0	9.75	10.26	61.5	2.88
W-23	Nalsyau Gad	RH	0.0	0.00	None	100.0	6.75	280.0	91.0	7.17	0.0	0.00	80.0	7.50	80.0	3.75	12.0	80.0	12.00	6.88	92.0	4.31
W-25	Naumure (W. Rapti)	RH	0.0	0.00	None	100.0	6.75	78.0	0.0	0.00	100.0	4.69	85.0	7.97	20.0	0.94	13.5	65.0	9.75	8.25	79.6	3.73

Table 10.2.2.3-5 (2) Evaluation Score and Ranking of Case 4 (2/8)

Category		Technical and Economical Conditions (cont.)									Impact on Environment											
Subcategory		Effectiveness of project (cont.)									Impact of natural environment											
											Impact on forest											
Evaluation Item		Installed capacity			Annual energy production			Energy production in the dry season			Forest land				Number of trees in the reservoir area				Average of crown coverage			
Weight (%)		3.75			1.88			8.44			0.90				0.70				0.70			
No.	Project Name	(MW)	Score	Weighted Score	(GWh)	Score	Weighted Score	(GWh)	Score	Weighted Score	(km2)	(km2/MW)	Score	Weighted Score	(nos)	(/MW)	Score	Weighted Score	(%)	Score	Weighted Score	
E-01	Dudh Koshi	300.0	100.0	3.75	1,909.6	100.0	1.88	523.3	89.9	7.59	4.1	0.0137	60.9	0.55	242,720	809	61.0	0.43	53	30.9	0.22	
E-06	Kokhajor-1	111.5	37.2	1.40	278.9	14.6	0.27	94.1	16.2	1.37	2.9	0.0259	20.3	0.18	202,300	1,814	8.6	0.06	70	0.0	0.00	
E-17	Sun Koshi No.3	536.0	100.0	3.75	1,883.6	98.6	1.85	335.9	57.7	4.87	8.2	0.0152	55.7	0.50	520,608	971	52.5	0.37	38	58.2	0.41	
C-02	Lower Badigad	380.3	100.0	3.75	1,366.0	71.5	1.34	354.7	61.0	5.15	3.3	0.0087	77.4	0.70	129,360	340	85.4	0.60	38	58.2	0.41	
C-08	Andhi Khola	180.0	60.0	2.25	648.7	34.0	0.64	137.1	23.6	1.99	1.5	0.0084	78.4	0.71	77,312	430	80.8	0.57	38	58.2	0.41	
W-02	Chera-1	148.7	49.6	1.86	563.2	29.5	0.55	120.6	20.7	1.75	1.5	0.0098	73.6	0.66	38,088	256	89.8	0.63	41	52.7	0.37	
W-05	Lower Jhimruk	142.5	47.5	1.78	454.7	23.8	0.45	94.4	16.2	1.37	1.9	0.0131	62.7	0.56	83,776	588	72.5	0.51	26	80.0	0.56	
W-06	Madi	199.8	66.6	2.50	621.1	32.5	0.61	170.7	29.3	2.47	1.6	0.0082	78.9	0.71	36,982	185	93.5	0.65	15	100.0	0.70	
W-23	Nalsyau Gad	410.0	100.0	3.75	1,406.1	73.6	1.38	581.8	100.0	8.44	0.8	0.0019	100.0	0.90	24,580	60	100.0	0.70	20	90.9	0.64	
W-25	Naumure (W. Rapti)	245.0	81.7	3.06	1,157.5	60.6	1.14	309.9	53.3	4.50	7.9	0.0320	0.0	0.00	485,130	1,980	0.0	0.00	40	54.5	0.38	

Table 10.2.2.3-5 (3) Evaluation Score and Ranking of Case 4 (3/8)

Category		Impact on Environment (cont.)																					
Subcategory		Impact of natural environment (cont.)																					
		Impact on flora						Impact on terrestrial fauna															
Evaluation Item		Number of plant species reported			Number of plant species of conservation significance			Number of mammal species reported			Number of bird species reported			Number of herpetofauna species reported			Number of conservation mammalian species reported (reservoir)			Number of conservation bird species reported (reservoir)			Number of conservation herpetofauna species reported (reservoir)		
Weight (%)				0.80			0.80			0.30			0.20			0.20			0.40			0.30			0.30
No.	Project Name		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score
E-01	Dudh Koshi	67	10.9	0.09	3	60.0	0.48	24	0.0	0.00	51	0.0	0.00	17	0.0	0.00	9	0.0	0.00	3	25.0	0.08	5	0.0	0.00
E-06	Kokhajor-1	10	100.0	0.80	3	60.0	0.48	13	84.6	0.25	21	78.9	0.16	8	81.8	0.16	5	100.0	0.40	2	50.0	0.15	1	80.0	0.24
E-17	Sun Koshi No.3	46	43.8	0.35	5	20.0	0.16	11	100.0	0.30	50	2.6	0.01	9	72.7	0.15	6	75.0	0.30	4	0.0	0.00	3	40.0	0.12
C-02	Lower Badigad	45	45.3	0.36	5	20.0	0.16	21	23.1	0.07	30	55.3	0.11	9	72.7	0.15	9	0.0	0.00	3	25.0	0.08	0	100.0	0.30
C-08	Andhi Khola	41	51.6	0.41	5	20.0	0.16	12	92.3	0.28	16	92.1	0.18	6	100.0	0.20	7	50.0	0.20	1	75.0	0.23	2	60.0	0.18
W-02	Chera-1	35	60.9	0.49	3	60.0	0.48	15	69.2	0.21	28	60.5	0.12	13	36.4	0.07	7	50.0	0.20	2	50.0	0.15	4	20.0	0.06
W-05	Lower Jhimruk	55	29.7	0.24	4	40.0	0.32	23	7.7	0.02	49	5.3	0.01	17	0.0	0.00	8	25.0	0.10	3	25.0	0.08	4	20.0	0.06
W-06	Madi	74	0.0	0.00	6	0.0	0.00	18	46.2	0.14	21	78.9	0.16	9	72.7	0.15	7	50.0	0.20	1	75.0	0.23	1	80.0	0.24
W-23	Nalsyau Gad	59	23.4	0.19	1	100.0	0.80	11	100.0	0.30	13	100.0	0.20	8	81.8	0.16	6	75.0	0.30	0	100.0	0.30	1	80.0	0.24
W-25	Naumure (W. Rapti)	55	29.7	0.24	4	40.0	0.32	24	0.0	0.00	49	5.3	0.01	17	0.0	0.00	9	0.0	0.00	3	25.0	0.08	4	20.0	0.06

Table 10.2.2.3-5 (4) Evaluation Score and Ranking of Case 4 (4/8)

Category		Impact on Environment (cont.)																	
Subcategory		Impact of natural environment (cont.)																	
		Impact on aquatic fauna									Impact on protected area						Impact of transmission line		
Evaluation Item		Number of fish species reported			Number of fish species of conservation significance			Length of recession area			Number of protected areas in the downstream			Number of protected species in the downstream			Length of transmission line		
Weight (%)				0.90			0.90			0.40			0.80			0.80			0.60
No.	Project Name		Score	Weighted Score		Score	Weighted Score	(km)	Score	Weighted Score		Score	Weighted Score		Score	Weighted Score	(km)	Score	Weighted Score
E-01	Dudh Koshi	24	0.0	0.00	3	50.0	0.45	60	0.0	0.00	2	50.0	0.40	3	100.0	0.80	43	89.6	0.54
E-06	Kokhajor-1	7	94.4	0.85	2	100.0	0.90	21	65.5	0.26	1	100.0	0.80	3	100.0	0.80	62	64.9	0.39
E-17	Sun Koshi No.3	21	16.7	0.15	3	50.0	0.45	1	100.0	0.40	2	50.0	0.40	3	100.0	0.80	35	100.0	0.60
C-02	Lower Badigad	12	66.7	0.60	4	0.0	0.00	4	94.1	0.38	3	0.0	0.00	5	33.3	0.27	49	81.8	0.49
C-08	Andhi Khola	6	100.0	0.90	2	100.0	0.90	60	0.0	0.00	3	0.0	0.00	5	33.3	0.27	49	81.8	0.49
W-02	Chera-1	11	72.2	0.65	2	100.0	0.90	7	89.1	0.36	3	0.0	0.00	6	0.0	0.00	66	59.7	0.36
W-05	Lower Jhimruk	11	72.2	0.65	2	100.0	0.90	8	87.4	0.35	2	50.0	0.40	4	66.7	0.53	75	48.1	0.29
W-06	Madi	8	88.9	0.80	3	50.0	0.45	10	84.0	0.34	2	50.0	0.40	4	66.7	0.53	62	64.9	0.39
W-23	Nalsyau Gad	8	88.9	0.80	2	100.0	0.90	11	82.4	0.33	3	0.0	0.00	6	0.0	0.00	112	0.0	0.00
W-25	Naumure (W. Rapti)	16	44.4	0.40	2	100.0	0.90	1	100.0	0.40	2	50.0	0.40	4	66.7	0.53	79	42.9	0.26

Table 10.2.2.3-5 (5) Evaluation Score and Ranking of Case 4 (5/8)

Category		Impact on Environment (cont.)																				
Subcategory		Impact on social environment																				
		Impact on household, etc.												Impact on ethnic minority			Impact on agriculture				
Evaluation Item		Number of estimated households				Number of schools				Number of industries				Number of ethnic minority groups			Impact on irrigation			Impact on agricultural land			
Weight (%)					1.50				0.60				0.45			1.20			1.35				1.50
No.	Project Name		(/MW)	Score	Weighted Score		(/MW)	Score	Weighted Score		(/MW)	Score	Weighted Score		Score	Weighted Score	(facilities)	Score	Weighted Score	(km2)	(km^2/MW)	Score	Weighted Score
E-01	Dudh Koshi	63	0.21	100.0	1.50	0	0.0000	100.0	0.60	0	0.0000	100.0	0.45	3	40.0	0.48	1	98.3	1.33	3.3	0.0110	74.0	1.11
E-06	Kokhajor-1	92	0.83	84.7	1.27	6	0.0538	0.0	0.00	0	0.0000	100.0	0.45	5	0.0	0.00	2	96.6	1.30	1.7	0.0154	50.5	0.76
E-17	Sun Koshi No.3	1,599	2.98	30.9	0.46	19	0.0354	34.1	0.20	2	0.0037	88.8	0.40	4	20.0	0.24	20	65.5	0.88	9.4	0.0175	39.4	0.59
C-02	Lower Badigad	1,606	4.22	0.0	0.00	18	0.0473	12.0	0.07	11	0.0289	13.2	0.06	5	0.0	0.00	58	0.0	0.00	5.9	0.0155	50.1	0.75
C-08	Andhi Khola	542	3.01	30.2	0.45	9	0.0500	7.1	0.04	6	0.0333	0.0	0.00	2	60.0	0.72	23	60.3	0.81	1.7	0.0092	83.7	1.26
W-02	Chera-1	566	3.81	10.4	0.16	3	0.0202	62.5	0.38	0	0.0000	100.0	0.45	1	80.0	0.96	7	87.9	1.19	1.1	0.0073	93.8	1.41
W-05	Lower Jhimruk	229	1.61	65.2	0.98	4	0.0281	47.8	0.29	3	0.0211	36.8	0.17	3	40.0	0.48	3	94.8	1.28	2.0	0.0143	56.4	0.85
W-06	Madi	336	1.68	63.3	0.95	2	0.0100	81.4	0.49	0	0.0000	100.0	0.45	1	80.0	0.96	16	72.4	0.98	1.9	0.0096	81.4	1.22
W-23	Nalsyau Gad	263	0.64	89.2	1.34	2	0.0049	90.9	0.55	0	0.0000	100.0	0.45	0	100.0	1.20	0	100.0	1.35	2.5	0.0061	100.0	1.50
W-25	Naumure (W. Rapti)	456	1.86	58.9	0.88	5	0.0204	62.1	0.37	0	0.0000	100.0	0.45	2	60.0	0.72	25	56.9	0.77	6.1	0.0249	0.0	0.00

Table 10.2.2.3-5 (6) Evaluation Score and Ranking of Case 4 (6/8)

Category		Impact on Environment (cont.)																
Subcategory		Impact on social environment (cont.)																
		Impact on fishery																
Evaluation Item		Number of fishermen (reservoir)			Number of fish market			Availability of fish in the market			Sales amount of fish			Total income			Length of recession area		
Weight (%)				0.45			0.30			0.15			0.45			0.45			0.45
No.	Project Name		Score	Weighted Score		Score	Weighted Score	(kg/day)	Score	Weighted Score	(Rs/day)	Score	Weighted Score	(Rs/year)	Score	Weighted Score	(km)	Score	Weighted Score
E-01	Dudh Koshi	154	78.4	0.35	7	0.0	0.00	70.0	50.0	0.08	17,500	58.3	0.26	1,820,000	50.9	0.23	60	0.0	0.00
E-06	Kokhajor-1	0	100.0	0.45	0	100.0	0.30	0.0	100.0	0.15	0	100.0	0.45	0	100.0	0.45	21	65.5	0.29
E-17	Sun Koshi No.3	712	0.0	0.00	7	0.0	0.00	140.0	0.0	0.00	42,000	0.0	0.00	3,710,000	0.0	0.00	1	100.0	0.45
C-02	Lower Badigad	217	69.5	0.31	7	0.0	0.00	101.5	27.5	0.04	25,375	39.6	0.18	1,062,885	71.4	0.32	4	94.1	0.42
C-08	Andhi Khola	156	78.1	0.35	3	57.1	0.17	25.5	81.8	0.12	7,650	81.8	0.37	550,000	85.2	0.38	60	0.0	0.00
W-02	Chera-1	25	96.5	0.43	4	42.9	0.13	37.5	73.2	0.11	7,500	82.1	0.37	375,000	89.9	0.40	7	89.1	0.40
W-05	Lower Jhimruk	254	64.3	0.29	3	57.1	0.17	40.5	71.1	0.11	7,290	82.6	0.37	225,000	93.9	0.42	8	87.4	0.39
W-06	Madi	100	86.0	0.39	3	57.1	0.17	12.0	91.4	0.14	3,600	91.4	0.41	273,000	92.6	0.42	10	84.0	0.38
W-23	Nalsyau Gad	115	83.8	0.38	3	57.1	0.17	10.5	92.5	0.14	2,100	95.0	0.43	1,140,000	69.3	0.31	11	82.4	0.37
W-25	Naumure (W. Rapti)	43	94.0	0.42	2	71.4	0.21	15.0	89.3	0.13	4,125	90.2	0.41	387,000	89.6	0.40	1	100.0	0.45

Table 10.2.2.3-5 (7) Evaluation Score and Ranking of Case 4 (7/8)

Category		Impact on Environment (cont.)																			
Subcategory		Impact on social environment (cont.)																			
		Impact on tourism and culture									Impact on infrastructure										
Evaluation Item		Number of cultural structures (temples)			Number of tourist facilities			Number of tourists			Impact on roads			Impact on bridges			Impact on water mill, turbine, hydropower plant			Impact on drinking water schemes		
Weight (%)				0.90			0.60			0.60			1.05			0.60			0.60			0.60
No.	Project Name		Score	Weighted Score		Score	Weighted Score	(per year)	Score	Weighted Score	Inundated road (km)	Score	Weighted Score	Number of inundated bridge	Score	Weighted Score	Number of facilities	Score	Weighted Score		Score	Weighted Score
E-01	Dudh Koshi	2	80.0	0.72	2	80.0	0.48	10	100.0	0.60	5.0	87.4	0.92	5	64.3	0.39	0	100.0	0.60	5	82.8	0.50
E-06	Kokhajor-1	0	100.0	0.90	0	100.0	0.60	0	100.0	0.60	0.0	100.0	1.05	0	100.0	0.60	11	57.7	0.35	10	65.5	0.39
E-17	Sun Koshi No.3	10	0.0	0.00	10	0.0	0.00	20,000	0.0	0.00	39.5	0.0	0.00	14	0.0	0.00	15	42.3	0.25	22	24.1	0.14
C-02	Lower Badigad	9	10.0	0.09	0	100.0	0.60	0	100.0	0.60	26.1	34.0	0.36	12	14.3	0.09	26	0.0	0.00	29	0.0	0.00
C-08	Andhi Khola	5	50.0	0.45	0	100.0	0.60	0	100.0	0.60	3.4	91.3	0.96	11	21.4	0.13	0	100.0	0.60	10	65.5	0.39
W-02	Chera-1	1	90.0	0.81	0	100.0	0.60	0	100.0	0.60	3.8	90.5	0.95	1	92.9	0.56	9	65.4	0.39	2	93.1	0.56
W-05	Lower Jhimruk	1	90.0	0.81	0	100.0	0.60	0	100.0	0.60	3.3	91.6	0.96	3	78.6	0.47	0	100.0	0.60	7	75.9	0.46
W-06	Madi	4	60.0	0.54	0	100.0	0.60	0	100.0	0.60	11.2	71.5	0.75	6	57.1	0.34	6	76.9	0.46	22	24.1	0.14
W-23	Nalsyau Gad	0	100.0	0.90	0	100.0	0.60	0	100.0	0.60	0.0	100.0	1.05	4	71.4	0.43	20	23.1	0.14	0	100.0	0.60
W-25	Naumure (W. Rapti)	2	80.0	0.72	0	100.0	0.60	0	100.0	0.60	1.8	95.4	1.00	13	7.1	0.04	0	100.0	0.60	17	41.4	0.25

Table 10.2.2.3-5 (8) Evaluation Score and Ranking of Case 4 (8/8)

Category		Impact on Environment (cont.)											
Subcategory		Impact on social environment (cont.)											
		Impact on other sector's development											
Evaluation Item		Impact on market			Number of ongoing or proposed development plans			Previous issues					
Weight (%)				0.60			0.30			0.30	100.03	100	
No.	Project Name		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score	Total Score		Ranking
E-01	Dudh Koshi	1	80.0	0.48	0	100.0	0.30	0	100.0	0.30	66.02	66	2
E-06	Kokhajor-1	0	100.0	0.60	6	40.0	0.12	1	0.0	0.00	51.46	51	10
E-17	Sun Koshi No.3	5	0.0	0.00	10	0.0	0.00	1	0.0	0.00	56.69	57	7
C-02	Lower Badigad	5	0.0	0.00	3	70.0	0.21	0	100.0	0.30	52.63	53	9
C-08	Andhi Khola	4	20.0	0.12	2	80.0	0.24	0	100.0	0.30	65.15	65	3
W-02	Chera-1	4	20.0	0.12	0	100.0	0.30	0	100.0	0.30	62.79	63	4
W-05	Lower Jhimruk	0	100.0	0.60	1	90.0	0.27	0	100.0	0.30	60.26	60	5
W-06	Madi	2	60.0	0.36	3	70.0	0.21	0	100.0	0.30	59.91	60	6
W-23	Nalsyau Gad	1	80.0	0.48	2	80.0	0.24	0	100.0	0.30	75.34	75	1
W-25	Naumure (W. Rapti)	3	40.0	0.24	3	70.0	0.21	0	100.0	0.30	56.28	56	8

Table 10.2.2.3-6 Evaluation of Seismicity

No.	Project	Area	Acceleration	Area - Acceleration Matrix	Basic score	Closeness to epicenters greater then M4 (km)	Project score
		Class	Class			Subtraction	
E-01	Dudh Koshi	LH	M	2, 2	20	L = 10	
		2	2			0	20
E-06	Kokhajor-1	SI	S	3, 1	20	L = 26	
		3	1			0	20
E-17	Sunkosi No.3	LH	M	2, 2	20	L = 28	
		2	2			0	20
C-02	Lower Badigad	LH	L	2, 3	60	L = 30	
		2	3			0	60
C-08	Andhi Khola	LH	M	2, 2	20	L = 40	
		2	2			0	20
W-02	Chera-1	LH	S	2, 1	20	L = 10	
		2	1			0	20
W-05	Lower Jhimruk	LH	L	2, 3	60	L = 34	
		2	3			0	60
W-06	Madi	LH	L	2, 3	60	L = 35	
		2	3			0	60
W-23	Nalsyau Gad	LH	M	2, 2	20	L = 7	
		2	2			-20	0
W-25	Naumure (W. Rapti)	SI	L	3, 3	100		
		3	3			0	100

Area: HH = Higher Himalaya (Tibetan-Techys Zone), MZ = Metamorphic zone (Higher Himalaya), LH = Lesser Himalaya, SI = Siwaliks (Sub-Himalaya), TZ = Terai Zone

Accelelation: L (240 gal < α), M (180 gal < α < 240 gal), S (α < 180 gal)

Table 10.2.2.3-7 Evaluation of Geological Condition of the Site

No.	Project	Reservoir				Dam					Headrace Tunnel			Power House					Project score
		Water tightness	Slope stability	Fault	Score	Soundness	Water tightness	Fault	Thick deposit	Score	Soundness	Fault	Score	Soundness	Site stability	Fault	Thick deposit	Score	
E-01	Dudh Koshi	Impervious	Stable			Hard	Medium				Medium			Hard	Stable				
		100	100	-20	80	100	60	0	0	80	60	-20	40	100	100	0	0	100	75
E-06	Kokhajor-1	Pervious	Medium			Hard	Medium				Medium			Hard	Stable				
		60	60	0	60	100	60	0	0	80	60	0	60	100	100	0	0	100	75
E-17	Sunkosi No.3	Impervious	Medium			Hard	Impervious				Strong			Hard	Stable				
		100	60	-20	60	100	100	0	0	100	100	0	100	100	100	0	0	100	90
C-02	Lower Badigad	Impervious	Unstable			Hard	Medium	Active			Strong			Hard	Stable				
		100	20	-20	40	100	60	-80	-20	0	100	0	100	100	100	0	-20	80	55
C-08	Andhi Khola	Impervious	Unstable			Soft	Pervious				Medium			Hard	Stable				
		100	20	-20	40	20	20	0	0	20	60	0	60	60	60	0	-20	40	40
W-02	Chera-1	Medium	Stable			Hard	Medium				Strong			Hard	Stable				
		60	100	0	80	100	60	0	0	80	100	0	100	100	100	0	0	100	90
W-05	Lower Jhimruk	Medium	Stable			Hard	Impervious				Strong			Hard	Stable				
		60	100	-20	60	100	100	0	0	100	100	-20	80	100	60	0	0	80	80
W-06	Madi	Medium	Medium			Hard	Impervious				Strong			Hard	Stable				
		60	60	-20	40	100	100	0	0	100	100	0	100	100	100	0	0	100	85
W-23	Nalsyau Gad	Medium	Stable			Hard	Medium				Strong			Hard	Stable				
		60	100	-20	60	100	60	0	0	80	100	-20	80	100	100	0	0	100	80
W-25	Naumure (W. Rapti)	Impervious	Medium			Hard	Medium				Strong			Hard	Stable				
		100	60	-20	60	100	60	0	0	80	100	0	100	100	100	0	0	100	85

Table 10.2.2.3-8 Evaluation of Thrusts and Faults

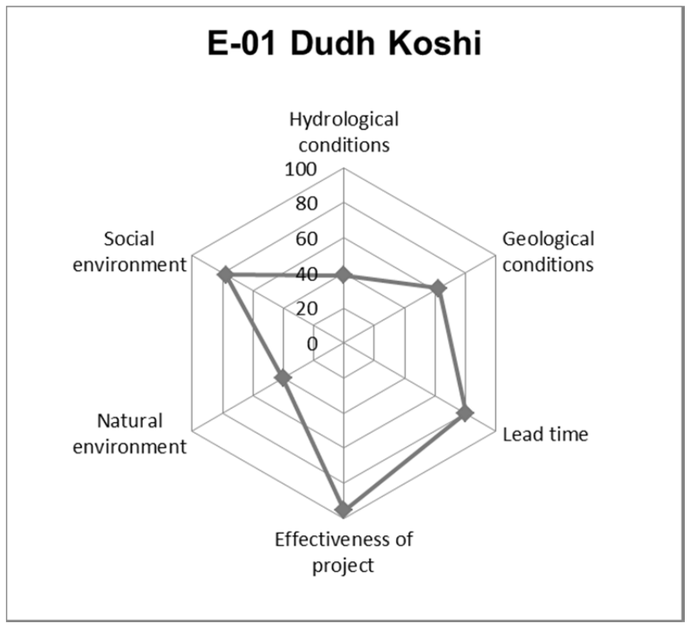
No.	Project	Distance to large techtonic thrusts (km)			Basic score	Closseness to other faults (km)	Subtruction	Project score
		MBT	MCT	Minimum				
E-01	Dudh Koshi	32.0	26.0	26.0	100	0.5	-20	80
E-06	Kokhajor-1	2.5		2.5	20	> 1	0	20
E-17	Sunkosi No.3	16.0		16.0	100	> 1	0	100
C-02	Lower Badigad	25.0		25.0	100	0.0	-40	60
C-08	Andhi Khola	25.0		25.0	100	< 1	-20	80
W-02	Chera-1	30.0		25.0	100	> 1	0	100
W-05	Lower Jhimruk	2.0		2.0	20	> 1	0	20
W-06	Madi	25.0		25.0	100	> 1	0	100
W-23	Nalsyau Gad	60.0		60.0	100	0.5	-20	80
W-25	Naumure (W. Rapti)	3.0		3.0	20	> 1	0	20

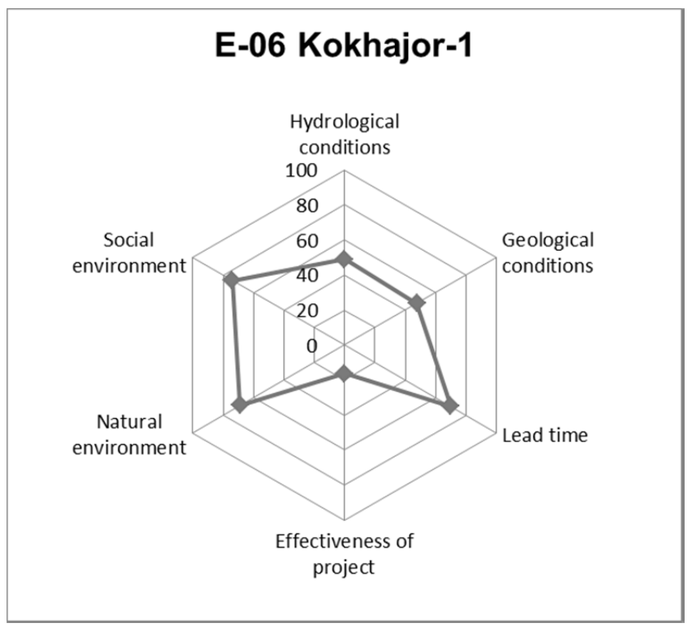
Table 10.2.2.3-9 Evaluation of Time to Commencement of Commercial Operation

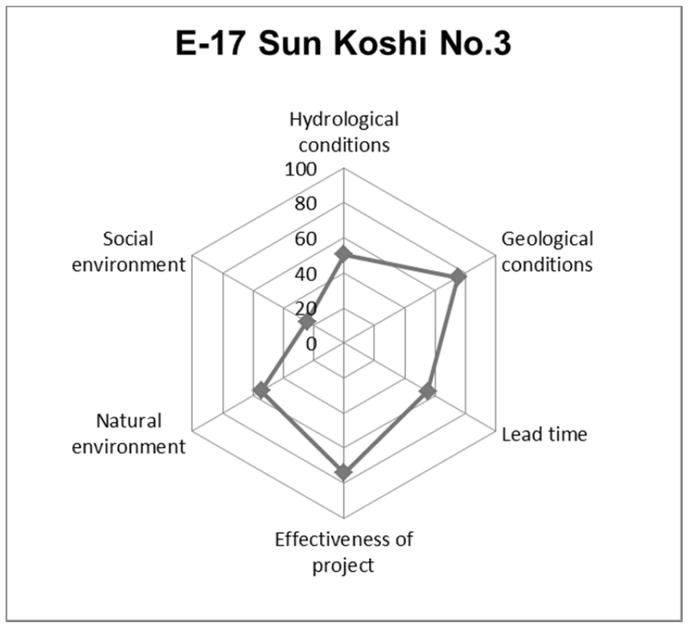
No.	Project	P (MW)	Pre-FS	FS	Financial Arrangement	Selection of Consultant	DD	Selection of Contractor	Construction	Total (Year)	Score (point)
E-01	Dudh Koshi	300.0			2.0	1.0	2.0	1.0	6.0	12.0	80
E-06	kokhajor-1	111.5	1.0	1.5	2.0	1.0	2.0	1.0	4.5	13.0	70
E-17	Sun Koshi No.3	536.0	1.0	1.5	2.0	1.0	2.0	1.0	6.0	14.5	55
C-02	Lower Badigad	380.3	1.0	1.5	2.0	1.0	2.0	1.0	6.0	14.5	55
C-08	Andhi Khola	180.0		1.5	2.0	1.0	2.0	1.0	4.5	12.0	80
W-02	Chara-1	148.7	1.0	1.5	2.0	1.0	2.0	1.0	5.0	13.5	65
W-05	Lower Jhimruk	142.5	1.0	1.5	2.0	1.0	2.0	1.0	4.5	13.0	70
W-06	Madi	199.8	1.0	1.5	2.0	1.0	2.0	1.0	5.0	13.5	65
W-23	Nalsyau Gad	400.0			2.0	1.0	2.0	1.0	6.0	12.0	80
W-25	Naumure	245.0		1.5	2.0	1.0	2.0	1.0	6.0	13.5	65

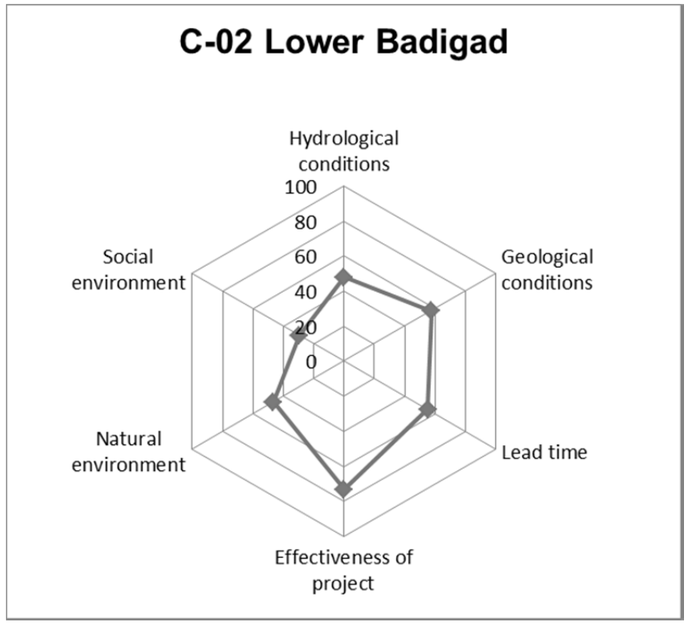
Table 10.2.2.3-10 Evaluation of Unit Generation Cost

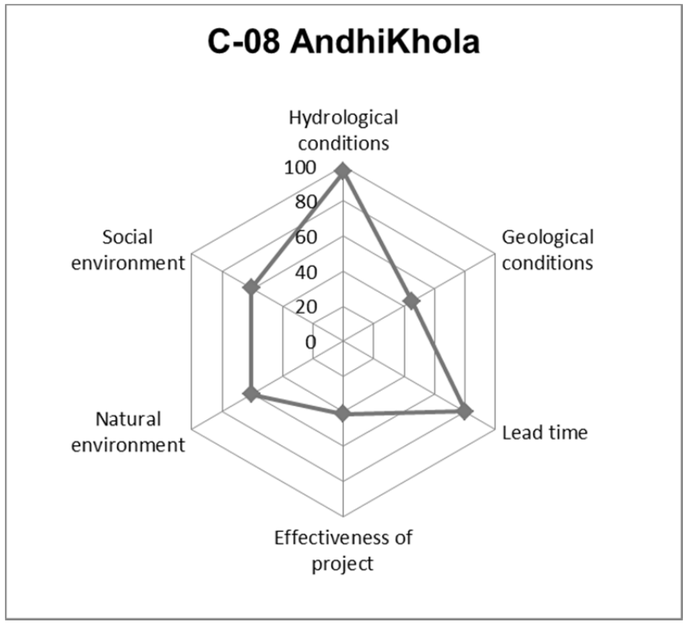
No.	Project	P (MW)	E (GWh)	Project cost (US$)	Expense rate	Unit generation cost (USC/kWh)	Score
E-01	Dudh Koshi	300.0	1,909.6	1,144,039,000	0.10	5.99	100.0
E-06	kokhajor-1	111.5	278.9	476,468,000	0.10	17.08	0.0
E-17	Sun Koshi No.3	536.0	1,883.6	1,690,504,000	0.10	8.97	73.1
C-02	Lower Badigad	380.3	1,366.0	1,209,838,000	0.10	8.86	74.1
C-08	Andhi Khola	180.0	648.7	665,805,000	0.10	10.26	61.5
W-02	Chara-1	148.7	563.2	576,856,000	0.10	10.24	61.7
W-05	Lower Jhimruk	142.5	454.7	520,860,000	0.10	11.46	50.7
W-06	Madi	199.8	621.1	637,310,000	0.10	10.26	61.5
W-23	Nalsyau Gad	410.0	1,406.1	966,869,000	0.10	6.88	92.0
W-25	Naumure	245.0	1,157.5	954,512,000	0.10	8.25	79.6

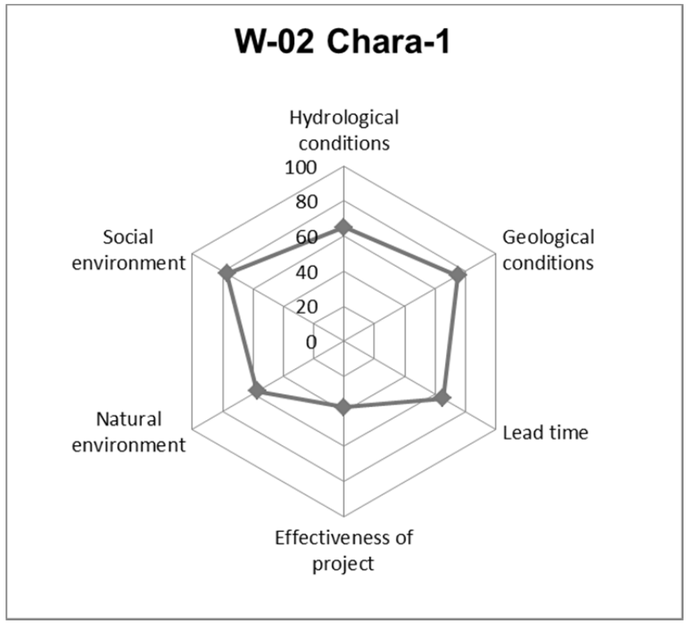






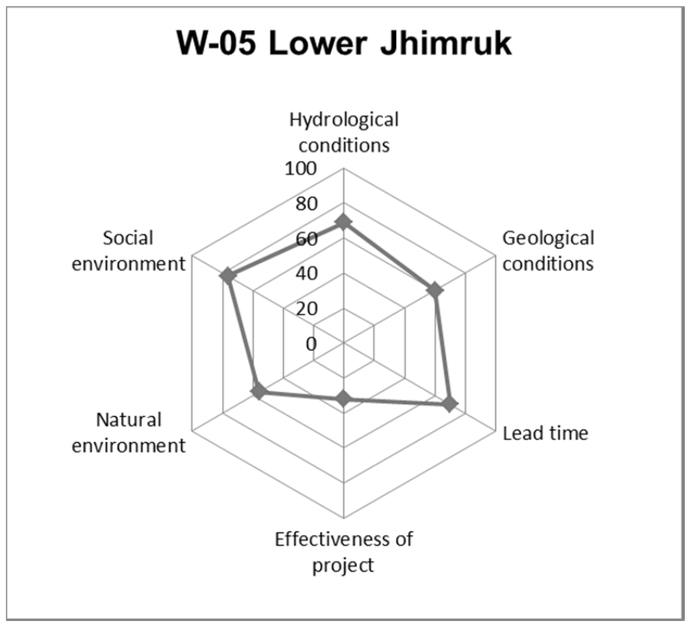


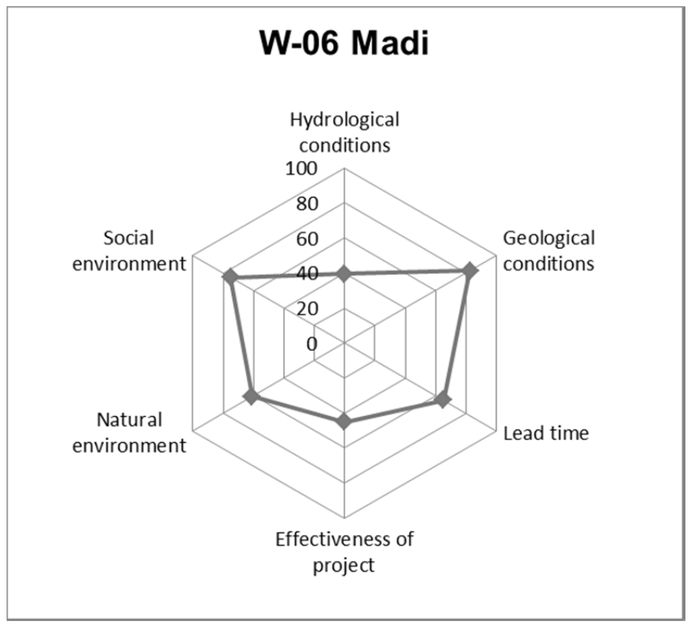


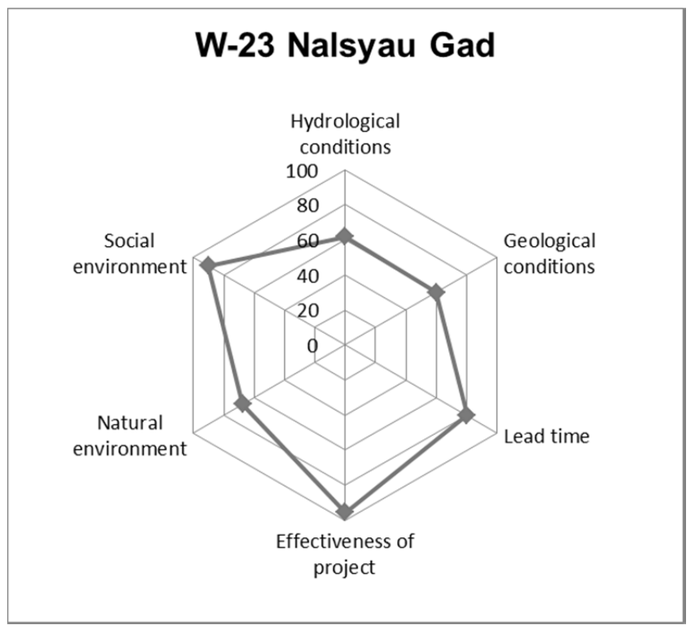


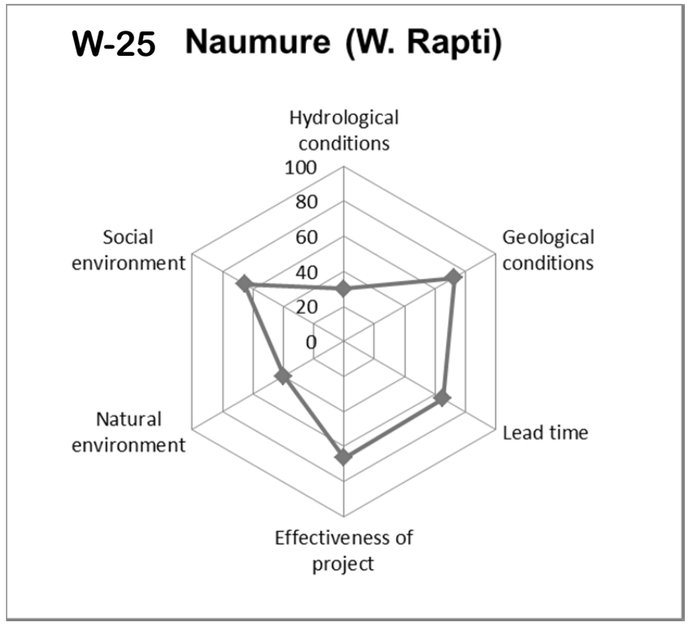
Note: The evaluation result of Case 1.

Figure 10.2.2.3-1 (1) Characteristics of Promising Projects (1)









Note: The evaluation result of Case 1.

Figure 10.2.2.3-1 (2) Characteristics of Promising Projects (2)

Chapter 11

Transmission Line Expansion Plan

Chapter 11 Transmission Line Expansion Plan

11.1 Conceptual Design of the Nepal Power System in 2032

The Nepal Power System extends from east to west and demand is located around Kathmandu and south of the Central Region. Some promising projects of a large size of generation are also planned to be located in the West Region. Therefore, reinforcements of transmission lines from east to west will be required. Consequently, the Nepal Power System in the future should be composed of 400 kV transmission lines from east to west, 220 kV transmission lines from north to south, and a 220 kV loop transmission line around Kathmandu in order to ensure power system reliability. The Power System Map in FY2031/32 is shown in Figure 11.1-1.

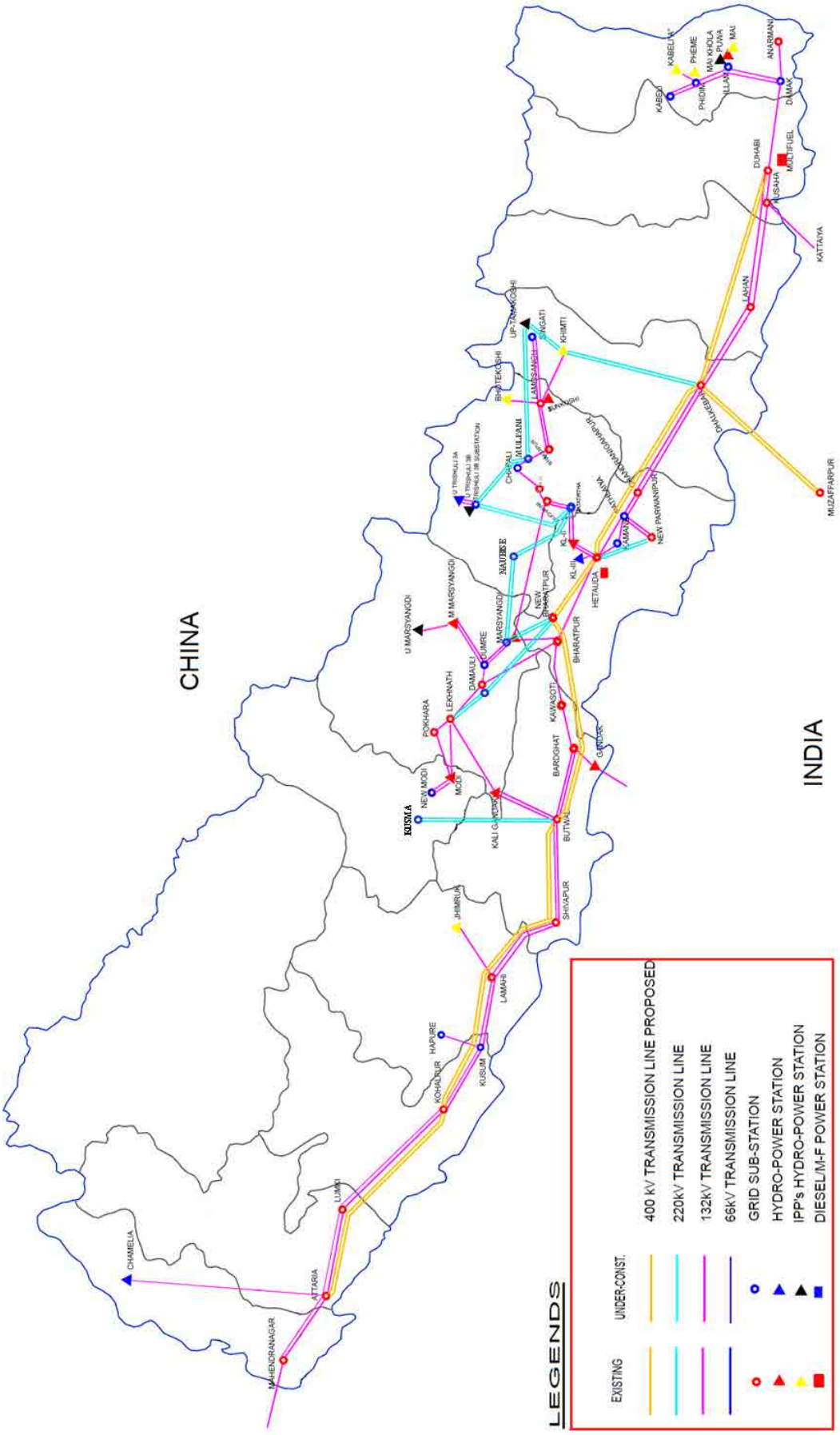


Figure 11.1-1 Power System Map in FY2031/32

11.2 Transmission Facilities Expansion Plan by the NEA

The latest Transmission Facilities Expansion Plan offered by the NEA is shown in Table 11.2-1.

Table 11.2-1 Transmission Facilities Expansion Plan by NEA

	Project	Status	Expected Commissioning
1a	Khimti - Dhalkebar D/C, 220 kV TL (75 km), strung S/C & Charged at 132 kV	Under Construction	2012/13
1b	Second Circuit Stringing of Khimti - Dhalkebar D/C, 220 kV TL (75 km)	Tender Preparation	2013/14
2	Capacitor Bank	Under Construction	2011/12
3	Matatirtha 132 kV substation Expansion	Under Construction	2012/13
4	Syangja 132/33 kV, 30 MVa Substation	Under Construction	2012/13
5	Hetauda, Kamane 132/33 kV, 30 MVa Substation	Under Construction	2012/13
6	Pathlaiya 132 kV Switching Substation	Under Construction	2012/13
7	Kusum - Hapure 132 kV Project	Under Construction	2013/14
8	New Hetauda - New Bharatpur DC 220 kV TL (70 km)	Under Construction	2013/14
9	Singati - Lamosangu 132 kV DC Transmission Line (40 km)	Under Construction	2013/14
10	Hetauda - KL-II - Siuchatar 132 kV Second Circuit Stringing	Under Construction	2013/14
11a	Kabeli Corridor Damak Substation	Under Construction	2012/13
11b	Kabeli Corridor Substations Illam, Phidim, Kabeli	Tendering	2014/15
11c	Kabeli Corridor 132 kV Transmission Line (65 km)	Under Construction	2014/15
12	New Bharatpur - Bardaghat DC 220 kV Transmission Line (70 km)	Under Construction	2014/15
13	Dumre - Damauli - Marsyangdi 132 kV Transmission Line (56 km)	Under Construction	2014/15
14	Butwal - Kohalpur 132 kV Second Circuit Stringing	Under Construction	2014/15
15	Chapali 132 kV Substation	Under Construction	2014/15
16	Dhalkebar - Bhittamod 400 kV Transmission Line (40 km) (Nepal Portion Cross Border)	Tender Preparation	2014/15
17	Sunkoshi 132kV Substation	Pending	Pending
18	Lamahi - Ghorahi 132 kV Transmission Line for Ghorahi Cement Industry	Tendering	2014/15
19	Lekhnath - Damauli 220 kV Transmission Line (45 km)	Approached to Tanahu Project	2015/16
20	Thankot - Chapagaun - Bhaktapur 132 kV Transmission Line (28 km)	TL Tender Preparation	2015/16
21	Modi - Lekhnath 132 kV Transmission Line (45 km)	Pending	2015/16
22	Hapure - Tulsipur 132 kV Transmission Line (20 km)	Pending	2015/16
23	Marsyangdi - Kathmandu 220 kV Transmission Line (85 km)	Land Acquisition for SS	2016/17
24	Chilime - Trishuli 220 kV Transmission Line	Pending	2015/16
25	Samudratar - Naubise/Chapali 132 kV Transmission Line (50 km)	Pending	2016/17 scope changed
26	Trishuli 3B Hub Substation	Study	2015/16
27	Ramechhap - Garjang - Khimti 132kV Transmission Line (50 km)	IEE	2015/16
28	Karnali Corridor (Lamki - Upper Karnali) 132 kV Transmission Line (60 km)	Study	2015/16
29	Nepal - India Transmission & Trade Project (Hetauda - Dhalkebar - Duhabi 400 kV Transmission Line)	Tendering	2015/16
30	Madi - Lekhnath 132 kV Transmission Line (22 km)	-	2016/17
31	Baneshwor - Bhaktapur UG Cable 132 kV	Study	2015/16

	Project	Status	Expected Commissioning
32	Kohalpur - Mahendranagar 132 kV 2nd Circuit Stringing	Tender Preparation	2015/16
33	Mirchaiya - Katari 132 kV Transmission Line Cement Industry	Tender Preparation	2015/16
34	Matatirtha - Naubise 33 kV Transmission Line for Cement Industry	Pending	-
35	Matatirtha - Malta 33 kV Transmission Line for Cement Industry	Estimate preparation for tendering	-
36	Tulsipur - Kapurkot 33 kV Transmission Line for Cement Industry	Estimate preparation for tendering	-
37	Mirchaiya Katari 132 kV Transmission Line for Maruti Cement Industry	Tender Preparation	2014/15
38	Koshi 220 kV Corridor (Basantpu r- Kusaha) Transmission Line (90 km) Duhabi - Dharan - Dhankuta - Tirtire	Tender Preparation	2015/16
39	Marsyangdi Corridor with Mid Marsyang -Manang Transmission Corridor (51 km)	Study	2015/16
40	Solu Corridor 132 kV Transmission Line (Katari - Okhaldhunga - Solu) (70 km)	Study	2015/16
41	Kali Gandaki 220 kV Transmission Corridor (150 km)	Pending	2015/16
42	Tamakoshi (Khimti) - Kathmandu 220 kV Transmission Line (100 km)	Survey	2016/17
43	Kaski (Bhurjung) - Parbat (Kushma) 132 kV Transmission Line (65 km)	-	-
44	Kohalpur - Surkhet 132 kV Transmission Line (55 km)	Tender Preparation	2016/17
45	Gulmi (Paudi Amrai) - Arghakhachi - Chanauta 132 kV Transmission Line (60 km)	Survey	2016/17
46	Marsyangdi - Bharatpur 220 kV Transmission Line	Pending	2015/16
47	Bajhang - Deepayal - Attariya 132 kV Transmission Line (110 km)	Pending	2016/17
48	Surkhet - Dailekh - Jumla 132 kV Transmission Line (110 km)	Pending	2016/17
49	Kaligandaki - Gulmi (Jhimruk) 132 kV Transmission Line (90 km)	Pending	2016/17
50	Hetauda - Butwal 400 kV Transmission Line (160 km)	Pending	2016/17
51	Dordi Corridor	Study	2016/17
52	Butwal - Lamki 400 kV Transmission Line (220 km)	Pending	2018/19
53	Lamki - Mahendranagar 400 kV Transmission Line (105 km)	Pending	2018/19
54	Butwal - Lumbini 132 kV Transmission Line	Pending	2018/19
55	Dhalkebar - Loharpatti 132 kV Transmission Line	Pending	2018/19
56	Budhiganga - Umedi - Pahalmanpur 132kV Transmission Line	Study	2018/19
57	Bardiya - Bhrigaon 132kV Substation	-	2018/19
58	Balefi - Barhabise 132 kV Transmission Line	Study	2018/19
59	Rupani 132 kV Substation	Study	2018/19
60	Butwal - Sunauli 400 kV Transmission Line (25 km)	Pending	2019/20
61	Duhabi - Jogbani 400 kV Transmission Line (20 km)	Pending	2019/20
62	Duhabi - Anarmani 400kV Transmission Line (80km)	Pending	2019/20
63	Chandranighahapur Reinforcement Project	Project Completed	

11.3 Additional Transmission Line Plan by Study Team

Transmission Lines recommended by the JICA Study Team are shown below.

1) Hetauda S/S -Parawani S/S 220 kV Transmission Line

   - For the overloading condition around the Parawani S/S

   -Hetauda S/S - Parawani S/S, 220 kV Double Circuit, 54 km

   - 220 kV/132 kV substation at the Parawani S/S

2) Trishuli S/S -Mulpani S/S 220 kV Transmission Line

   - For the overloading condition around Kathomandu

   -Trishuli S/S -Mulpani S/S 220 kV, Double Circuit, 44 km

11.4 Transmission Line Plan for Planned Generation Projects

11.4.1 Projects under Construction or with a High probability of Construction[1]

Transmission lines for the Projects under Construction or with a High probability of Construction, described in Chapter 8, are shown below.

1) Kulekhani III P/S (14 MW)

   -Kulekhani III P/S - Hetauda S/S, 132 kV, Double Circuit, 3.5 km

2) Tanahu P/S (140 MW)

   -Tanahu P/S - Bharatpur S/S, 220 kV, Double Circuit, 40km

3) Budhi Gandaki P/S (600 MW)

   - Budhi Gandaki P/S - Naubise S/S, 220 kV, Double Circuit, 65 km

4) Upper Tamakoshi P/S (456 MW)

   -Upper Tamakoshi P/S - Khimti S/S, 220 kV, Double Circuit, 47 km

5) Rahughat P/S (32 MW)

   -Rahughat P/S - Modi S/S, 132 kV, Double Circuit, 28 km

6) Middle Bhotekoshi P/S (102 MW)

   -Middle Bhotekoshi P/S - Barhabise Hub, 220 kV, Double Circuit, 4 km

7) Rasuwagadi P/S (111 MW)

   -Rasuwagadi P/S - Chillime Hub, 132 kV, Double Circuit, 10 km

8) Sanjen P/S (42.9 MW)

   -Sanjen P/S - Chillime Hub, 132 kV, Double Circuit, 1.2 km

9) Upper Sanjen P/S (50 MW)

   -Upper Sanjen P/S - Tadi Kuna S/S, 132 kV, Double Circuit, 20 km

[1] These projects are in the detailed design stage or PPA is concluded.

10) Mistri P/S (42 MW)

-Mistri P/S - Dana S/S, 132 kV, Double Circuit, 4 km

11) Khani Khola P/S (25 MW)

-Khani Khola P/S - Singati S/S, 132 kV, Double Circuit, 4 km

12) Upper Trishuli 3A P/S (60 MW)

-Upper Trishuli 3A P/S - Matatirtha S/S, 220 kV, Double Circuit, 48 km

13) Upper Trishuli 3B P/S (37 MW)

-Upper Trishuli 3B P/S - Upper Trishuli 3A Hub, 220 kV, Double Circuit, 5 km

14) Upper Modi A P/S (47 MW)

-Upper Modi A P/S - New Modi S/S, 132 kV, Double Circuit, 7.5 km

11.4.2 Storage-type Hydroelectric Power Projects by the Study Team

Transmission lines for the Storage-type Hydroelectric Power Projects by the Study Team are shown below.

1) Dudh Koshi P/S (300 MW)

- In order to supply the Eastern area and Central area with electricity, the Dudh Koshi P/S should be connected to the Dhalkebar S/S with 220 kV transmission lines.

-Dudh Koshi P/S - Dhalkebar S/S, 220 kV, Double Circuit, 93 km

2) Andhi Khola P/S (180 MW)

- The Andhi KholaP/S should be connected to a 220 kV Transmission-Line between the Kusma S/S and Butwal S/S.

-Andhi Khola - 220 kV Transmission-Line between the Kusma S/S and Butwal S/S, 220 kV, Double Circuit, 5 km

3) Nalsyau Gad P/S (410MW)

- The Nalsyau Gad P/S should be connected to the junction of the transmission line between the Chera-1 P/S and Kohalpur 400kV S/S.

-Nalsyau Gad P/S - Junction, 400 kV, Double Circuit, 55 km

4) Chera-1 P/S (149 MW)

- The Chera-1 P/S and Nalsyau Gad P/S would generate relatively a lot of power and their site would be far from the load center. Therefore they should be connected to the power system with 400kV transmission lines.
- The Chera-1 P/S and Nalsyau Gad P/S would be connected to the 400kV network planned by the NEA at the Kohalpur S/S.

-Chera-1 P/S - Junction, 400 kV, Double Circuit, 25 km

-Junction - Kohalpur 400 kV S/S, 400 kV, Double Circuit, 72 km

5) Naumure P/S (245 MW)

- The Naumure P/S and Madi P/S would generate relatively a lot of power and their site would be far from the load center. Therefore they should be connected to the power system with 400kV transmission lines.
- The Naumure P/S and Madi P/S would be connected to the 400 kV network planned by the NEA at Shivapur S/S.
- Naumure P/S -Junction, 400 kV, Double Circuit, 12 km
- Junction- Shivapur S/S, 400 kV, Double Circuit, 37 km

6) Madi P/S (200 MW)

- The Madi P/S should be connected to the junction of the transmission line between the Naumure P/S and Shivapur 400 kV S/S.

-Madi P/S-Junction, 400 kV, Double Circuit, 67 km

7) Sun Koshi No.3 (536 MW)

- The Sun Koshi No.3 P/S should be connected to the Dhalkebar S/S with the 220 kV transmission lines.
- Sun Koshi No.3 P/S - Dhalkebar S/S, 220 kV, Double Circuit, 87 km

8) Lower Badigad P/S (380 MW)

-Lower Badigad P/S - Andhi Khola P/S, 220 kV, Double Circuit, 18 km

11.5 Power System Impact Study

11.5.1 Scope of the study

The power system analysis for the FY 2031/32 condition was carried out in the Promising Projects.

Power system analysis

- Power Flow Analysis
- Short Circuit Current Analysis
- Dynamic Stability Analysis

11.5.2. Assumptions in the study

The study was carried out based on the criteria and the assumptions below and PSS/E, Version-32 simulation software was used for the analysis.

(1) Criteria for the analysis

1) Voltage (above 66 kV)

- Voltage variation in normal operation: +/- 5% of nominal voltage

- Voltage variation during emergencies: +/- 10% of nominal voltage

2) Frequency variation during emergencies: +/- 5% of nominal frequency

3) Contingency for Load Flow Study: N-1 conditions

4) Load Characteristics

- Active Power: constant current
- Reactive Power: constant admittance

5) Fault Sequence for Stability Analyses

- Above 220kV: 3 Lines to Ground fault - 5 cycles - fault clear
- Up to 132kV: 3 Lines to Ground fault - 7 cycles - fault clear

(2) Demand

- The peak power demand of 4,866 MW in FY2031/32 (high case) was estimated by the Study Team.

(3) Net Work Data

- The demand in FY 2031/32 would be much more than in FY 2018/19. Therefore the appropriate reinforcement for the Power System was considered with the NEA's latest analyses data for the FY 2018/19 condition.
- The Muzaffarpur bus was taken as the Swing Bus, and it was connected to Nepal as an intertie line.

11.5.3 Power Flow Analysis

The results of the power flow analysis were shown in Figure 11.5.3-1 Power Flow Diagram in FY 2031/2032 Peak.

- No thermal criteria violations and no voltage violations were observed on the Power System above 132 kV.
- The transmission line planned by the NEA between the Naubise S/S and Matatirtha S/S would be in an overloading condition when one of the two circuits is out of service and when the Budhi Gandaki P/S will be in service. Therefore their conductor size should be reviewed.
- The transformers' MVA rating and tap range should be determined based on the expected demand trend and installed generation.
- The voltage of 400 kV transmission lines would tend to be raised by their charging. Therefore an appropriate plan for the installing shunt reactors would be required according to the transmission line expansion.
- The voltage of the power system less than 132 kV would be lowered by their increased demands. Therefore an appropriate plan for the installing capacitors would be required according to the demand trend.

- Reinforcement of transmission lines and the transformers in the less than 66 kV network includes the distribution system, which would be required for the demand increase. They should also be studied considering the demand trend.

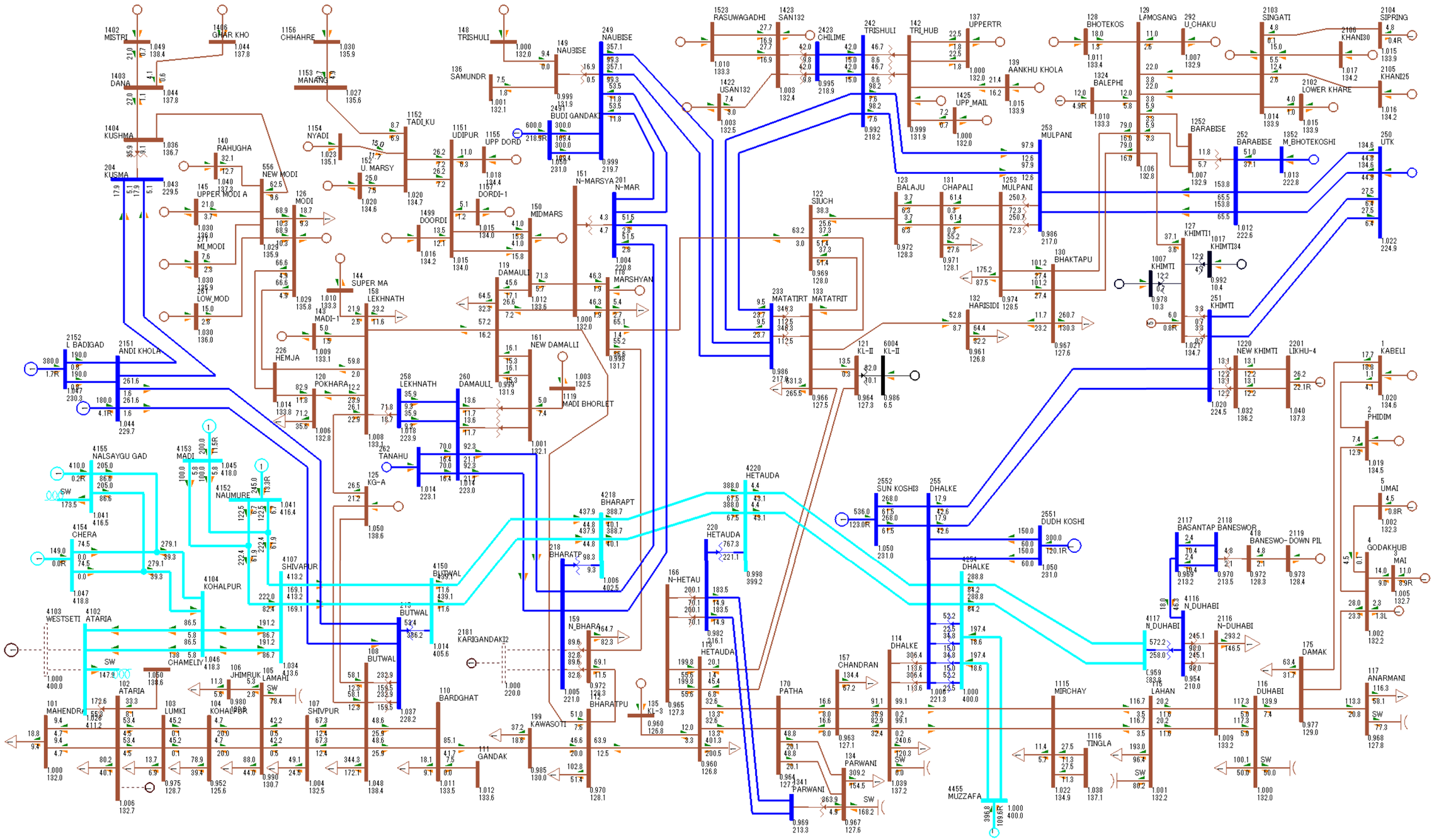


Figure 11.5.3-1 Power Flow Diagram in FY 2031/2032 Peak

11.5.4 Short Circuit Current Analysis

The Three Phase Fault Current at the power stations of the Promising Projects and the substations connected to them are shown in Table 11.5.4-1. Those of the currents were sufficiently small.

Table 11.5.4-1 Short Circuit Current in FY 2031/32 Peak

P/S or S/S		Fault Current	P/S or S/S		Fault Current
New Duhabi S/S	132 kV	12.1 kA	New Bharatpur S/S	132 kV	18.7 kA
	220 kV	9.3 kA		220 kV	17.0 kA
	400 kV	6.8 kA		400 kV	12.2 kA
Dhalkebar S/S	132 kV	24.1 kA	Kusma S/S	132 kV	8.6 kA
	220 kV	23.5 kA		220 kV	8.6 kA
	400 kV	15.1 kA	AndhiKhola P/S	220 kV	12.0 kA
DudhKoshi P/S	220 kV	9.4 kA	Lower Badigad P/S	220 kV	10.9 kA
Sun Koshi P/S	220 kV	11.6 kA	Butwal S/S	132 kV	17.7 kA
Parawani S/S	132 kV	15.5 kA		220 kV	14.1 kA
	220 kV	10.1 kA		400 kV	11.2 kA
New Hetauda S/S	132 kV	22.5 kA	Shivapur S/S	400 kV	9.9 kA
	220 kV	16.7 kA	Naumure P/S	400 kV	8.3 kA
	400 kV	12.3 kA	Madi P/S	400 kV	6.8 kA
Naubise S/S	132 kV	4.9 kA	Kohalpur S/S	400 kV	7.2 kA
	220 kV	16.5 kA	Chera-1 P/S	400 kV	6.0 kA
BudhiGandaki P/S	220 kV	12.7 kA	Nalsygu Gad P/S	400 kV	6.0 kA
New Damauli S/S	132 kV	13.8 kA	Ataria S/S	132 kV	8.5 kA
	220 kV	12.4 kA		400 kV	4.5 kA
Tanahu P/S	220 kV	12.0 kA			

11.5.5 Dynamic Stability Analysis

Dynamic Stability Analysis was carried out for the Power System in FY2031/2032. The results are shown in Figure 11.5.5-1 to Figure 11.5.5-17.

- As for the results of study, it was judged that the power system was stable for all cases.
- Some of the large size units of Hydro Power Generation will be located in the Western Area, far from the load-center. Therefore the Power System Stabilizer will have to be prepared for the large size units because of the power system stability.

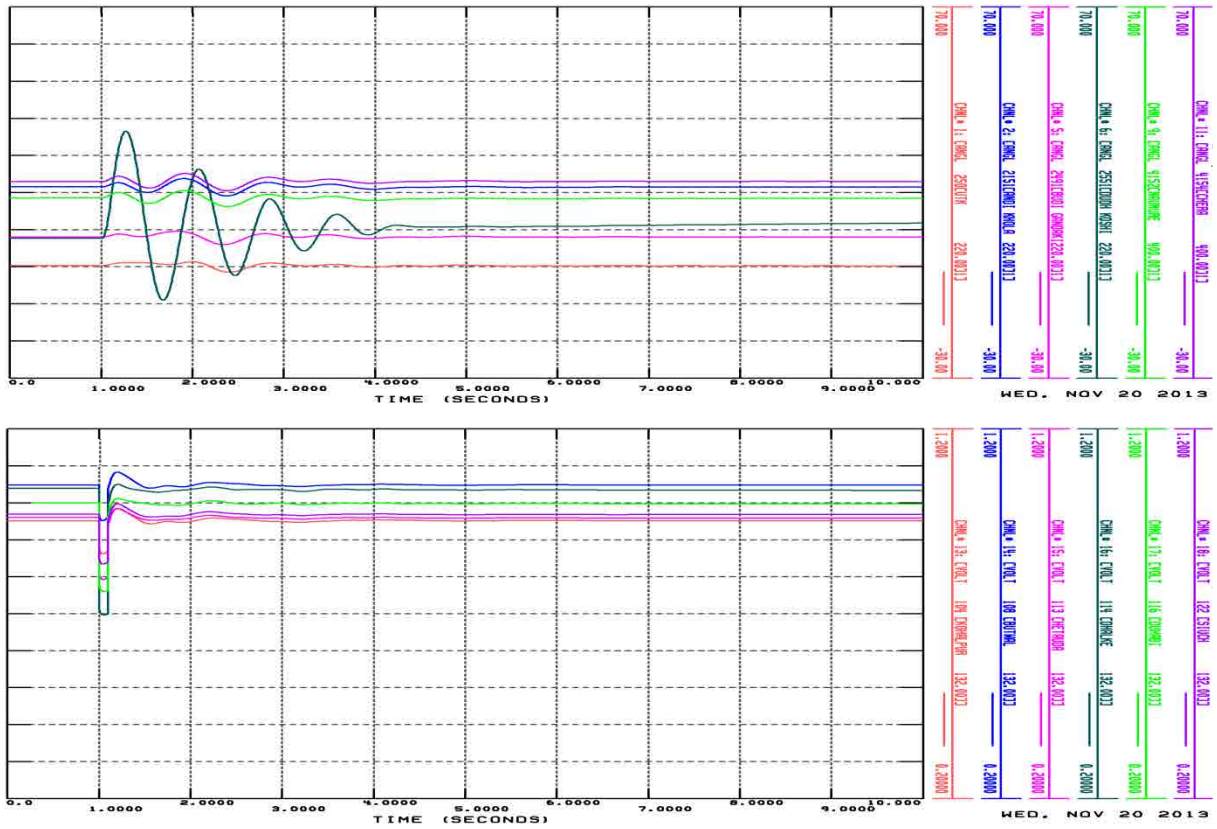


Figure 11.5.5-1 Dudh Koshi P/S - Dhalkebar 220 kVS/S, 3LG fault 100msec 1cct open

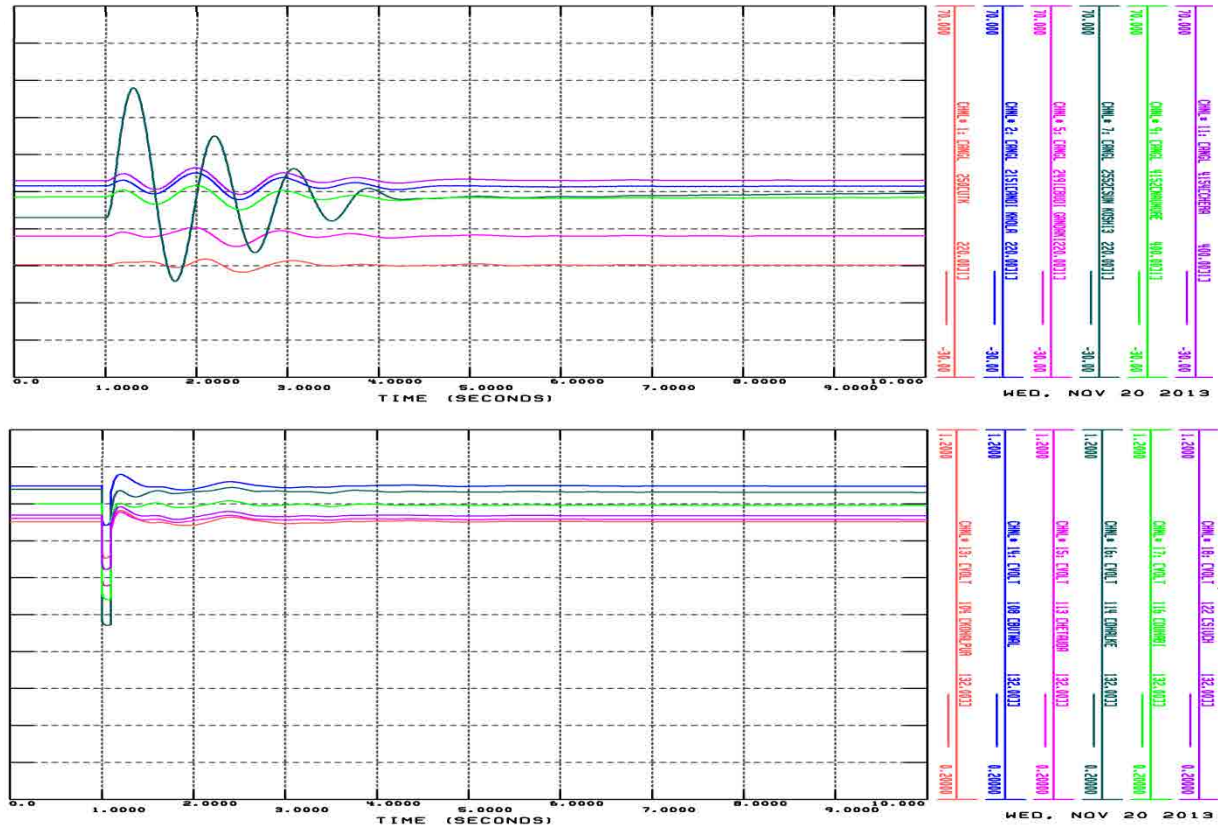


Figure 11.5.5-2 Sun Koshi No.3P/S - Dhalkebar 220 kVS/S, 3LG fault 100msec 1cct open

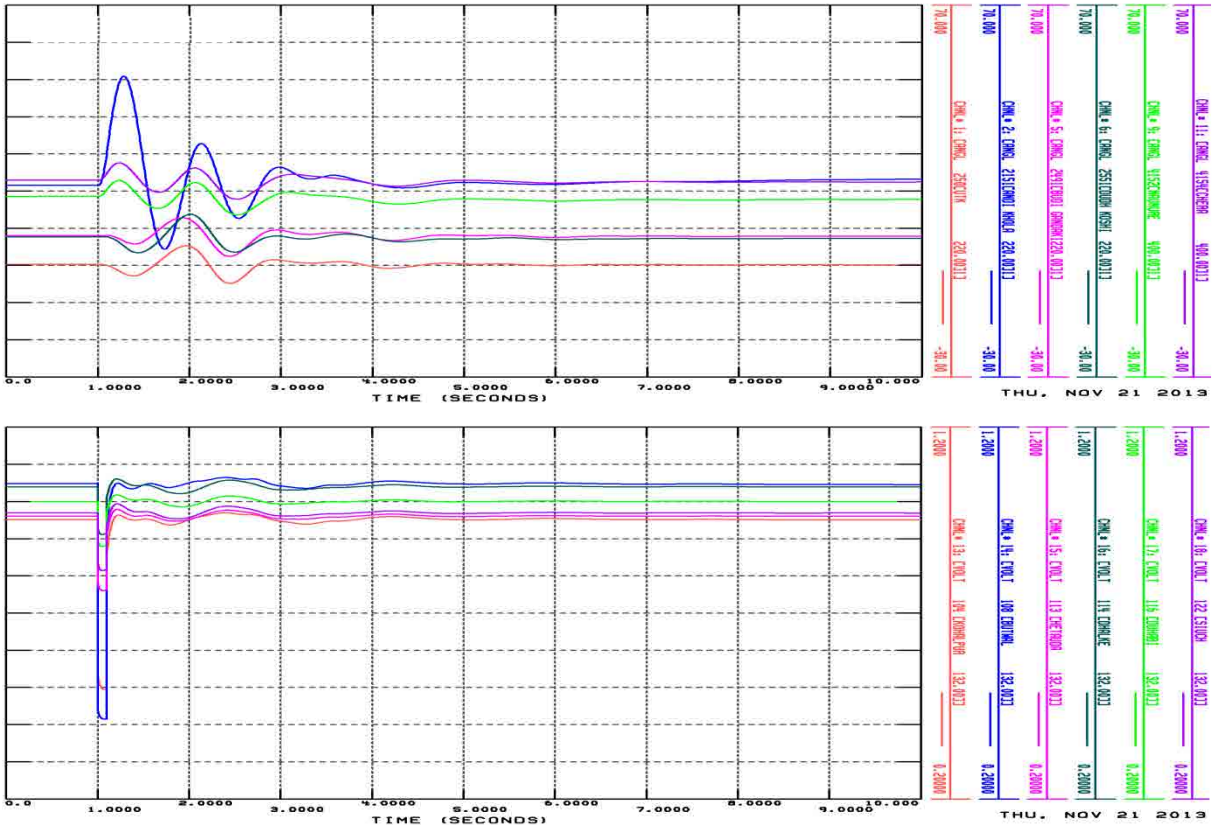


Figure 11.5.5-3 Andi Khola P/S - Butwal 220 kV S/S, 3LG fault 100msec 1cct open

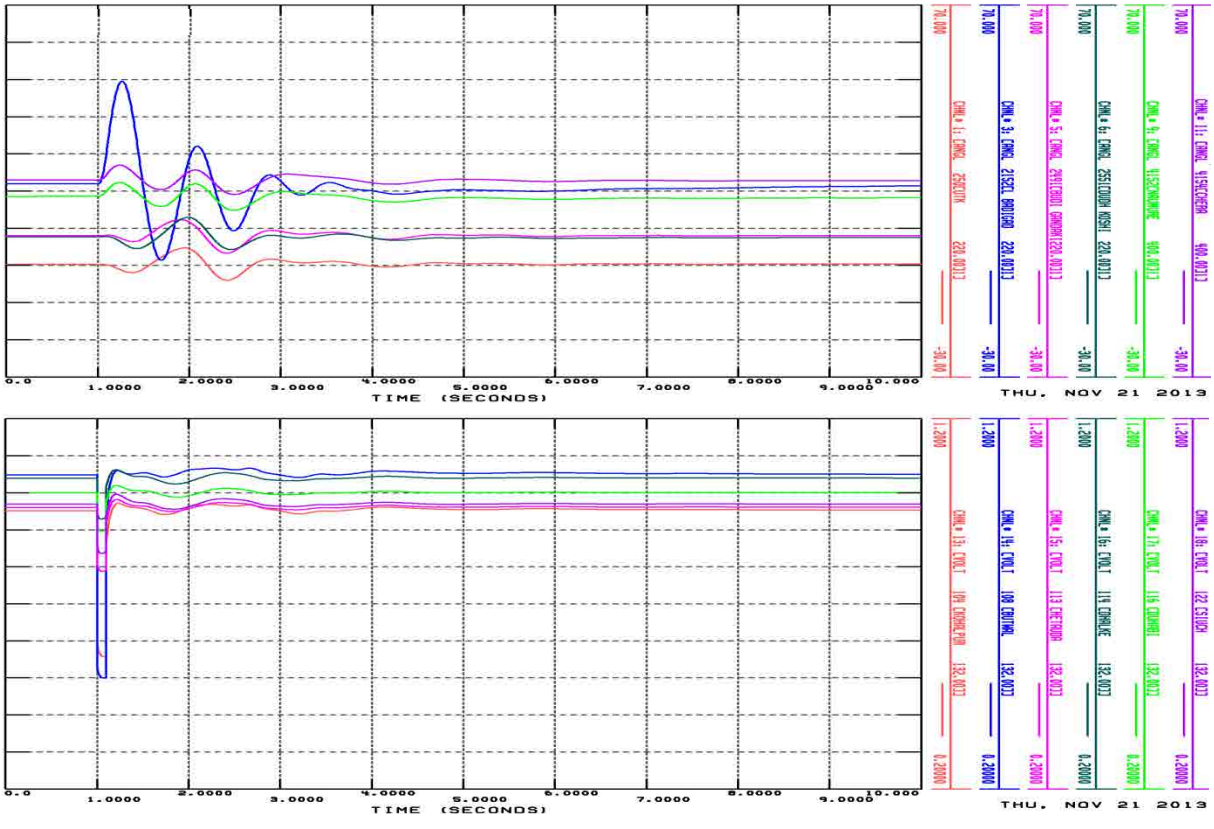


Figure 11.5.5-4 Lower Badigad P/S - Andhi KholaP/S, 3LG fault 100msec 1cct open

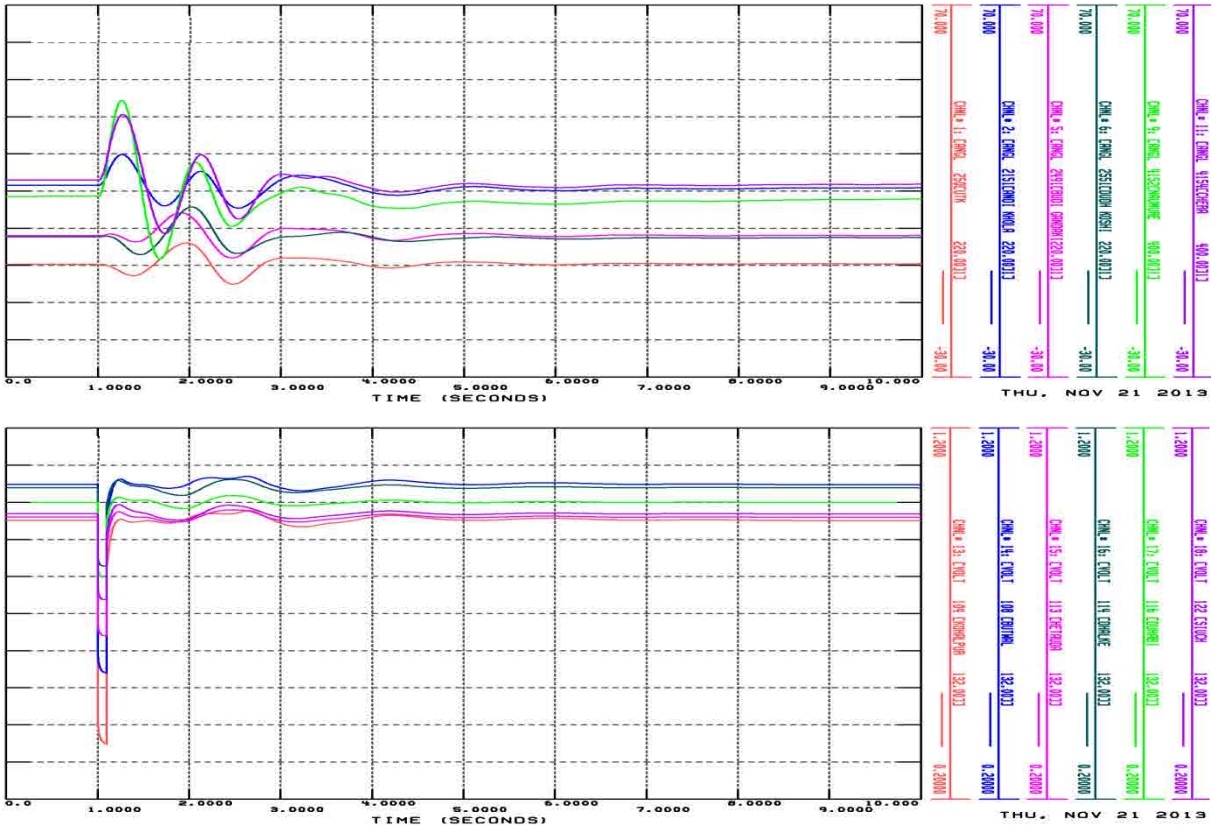


Figure 11.5.5-5 Naumure P/S - Shivapur 400 kV S/S, 3LG fault 100msec 1cct open

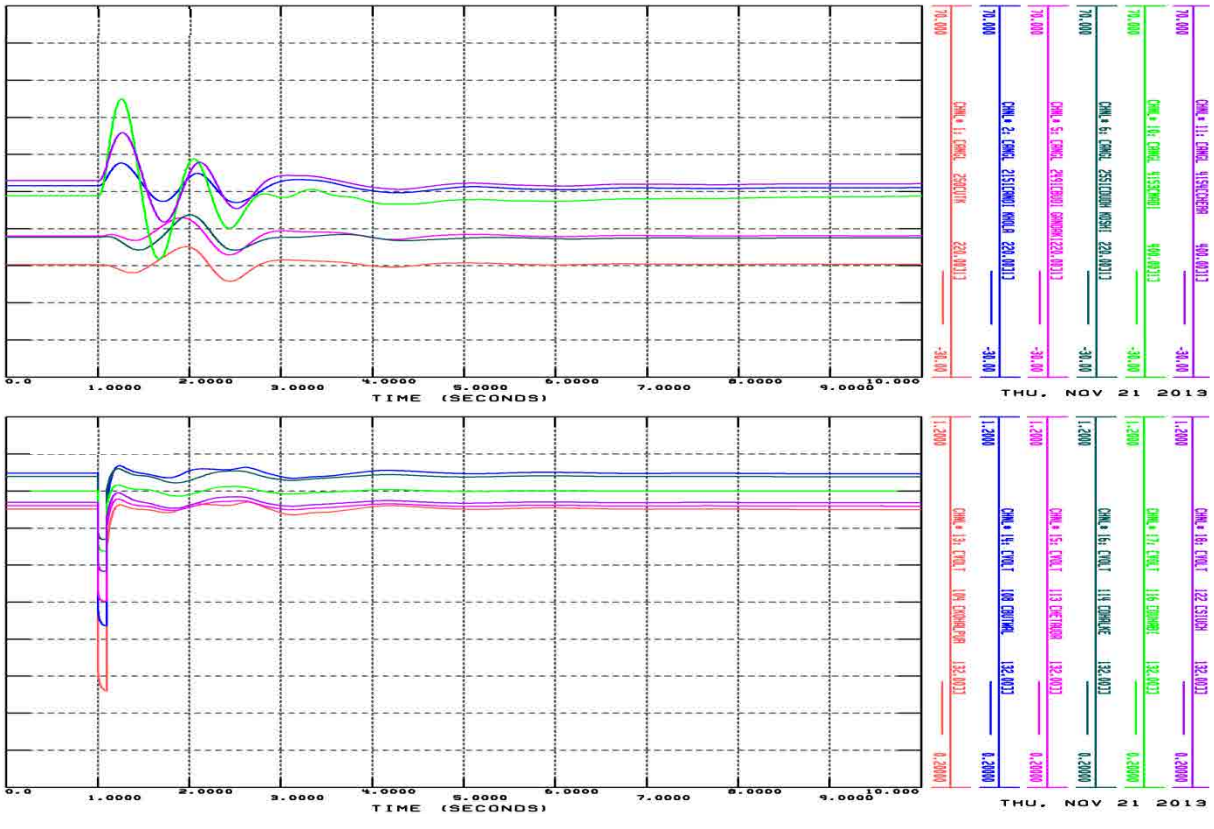


Figure 11.5.5-6 Madi P/S - Shivapur 400 kV S/S, 3LG fault 100msec 1cct open

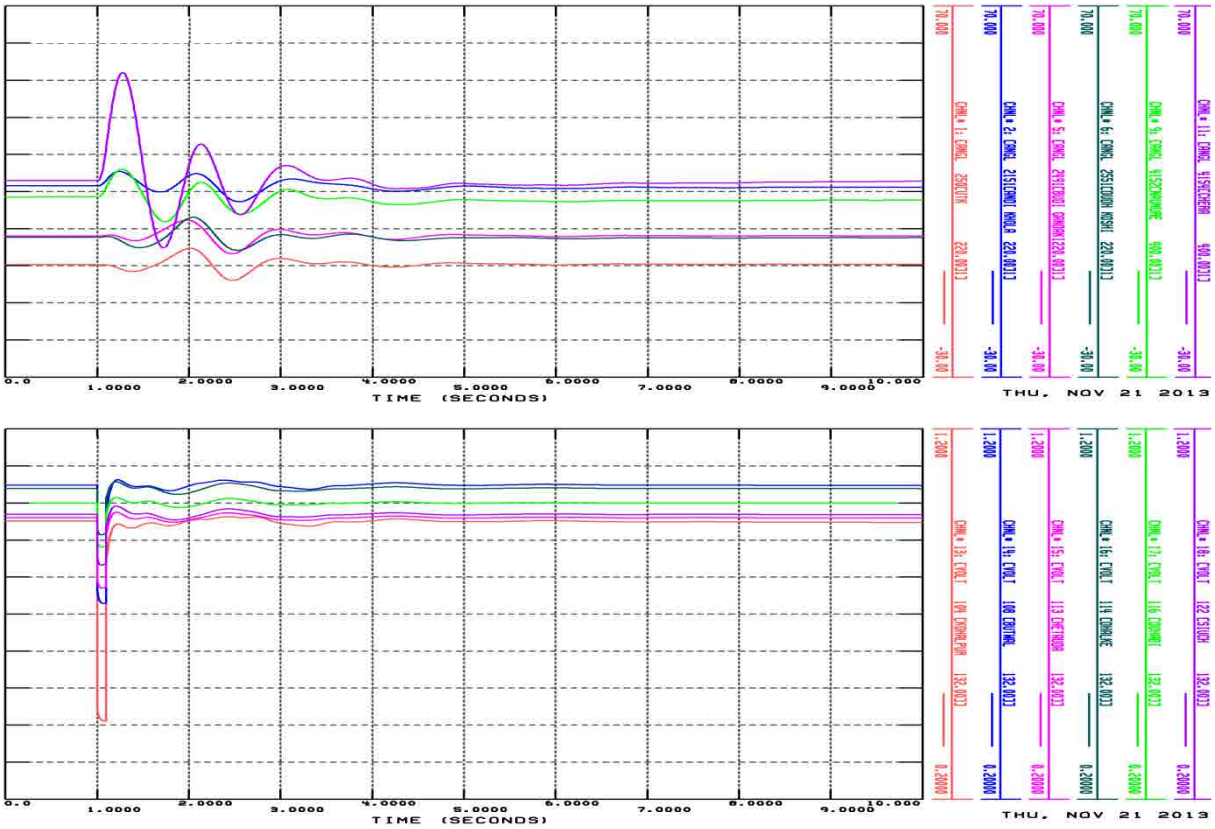


Figure 11.5.5-7 Chera-1 P/S - Kohalpur 400 kV S/S, 3LG fault 100msec 1cct open

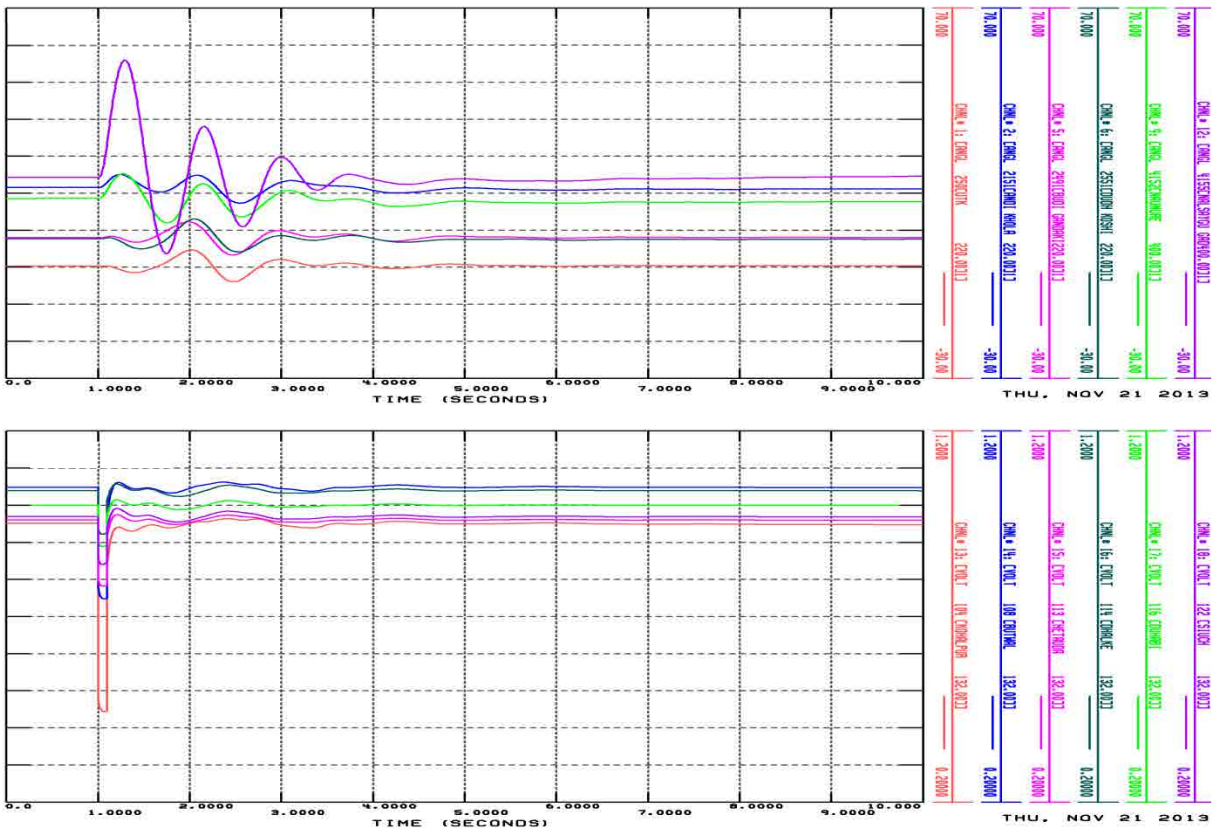


Figure 11.5.5-8 Nalsyau Gad P/S - Kohalpur 400 kV S/S, 3LG fault 100msec 1cct open

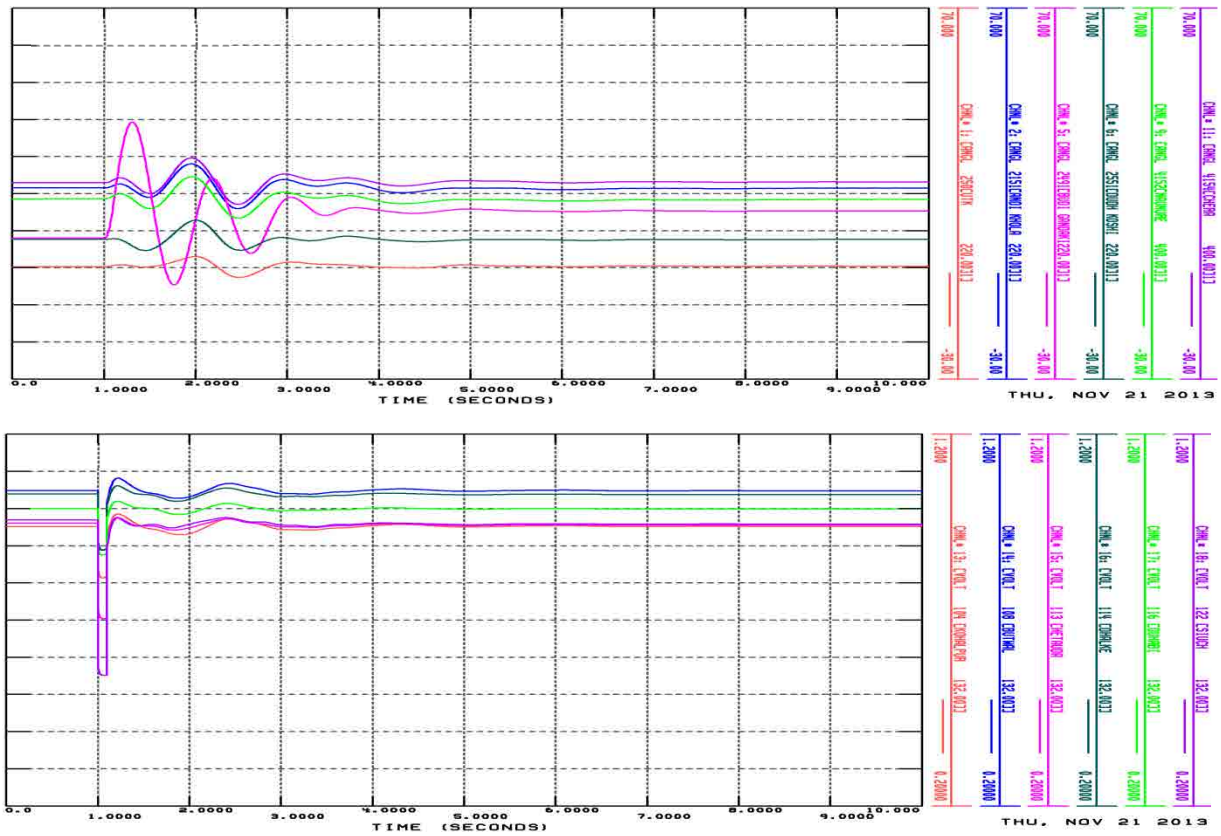


Figure 11.5.5-9 Budhi Gandaki P/S - Naubise 220 kVS/S, 3LG fault 100msec 1cct open

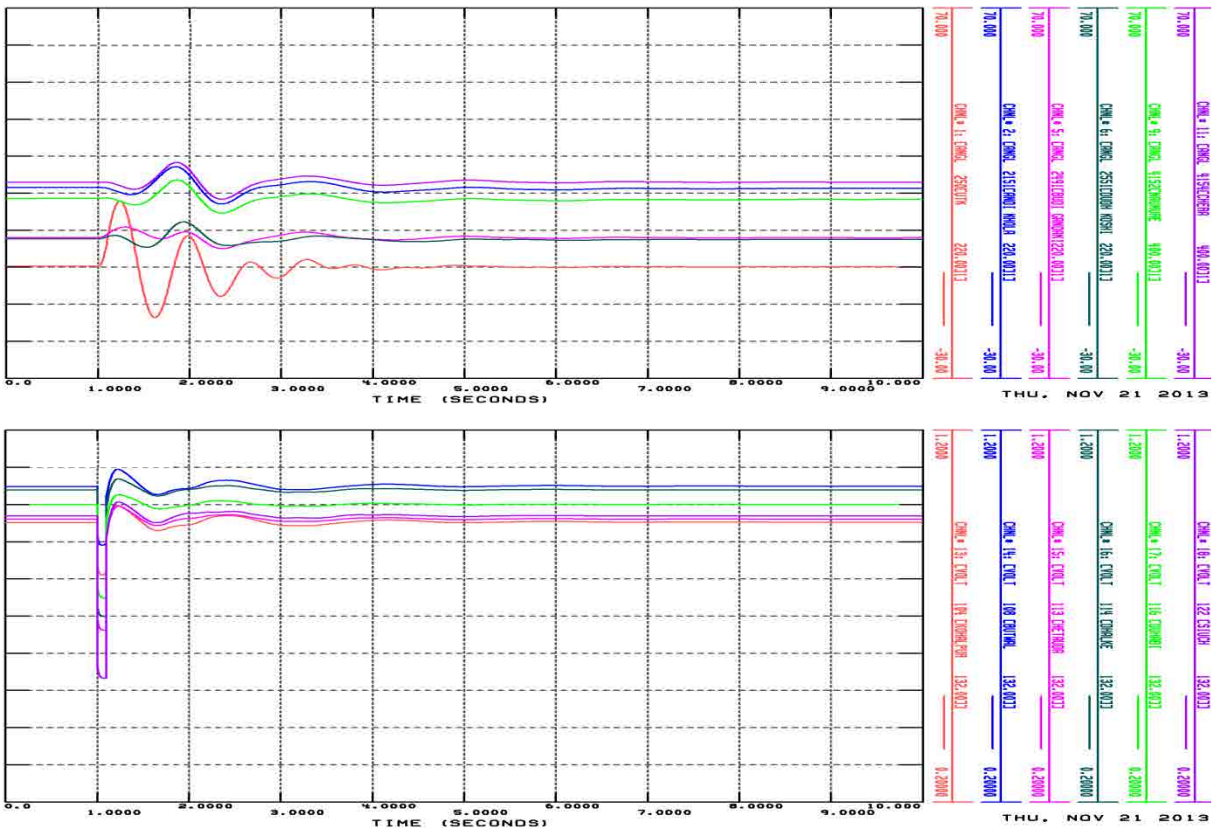


Figure 11.5.5-10 Upper Tamakoshi P/S - Khimti 220 kVS/S, 3LG fault 100msec 1cct open

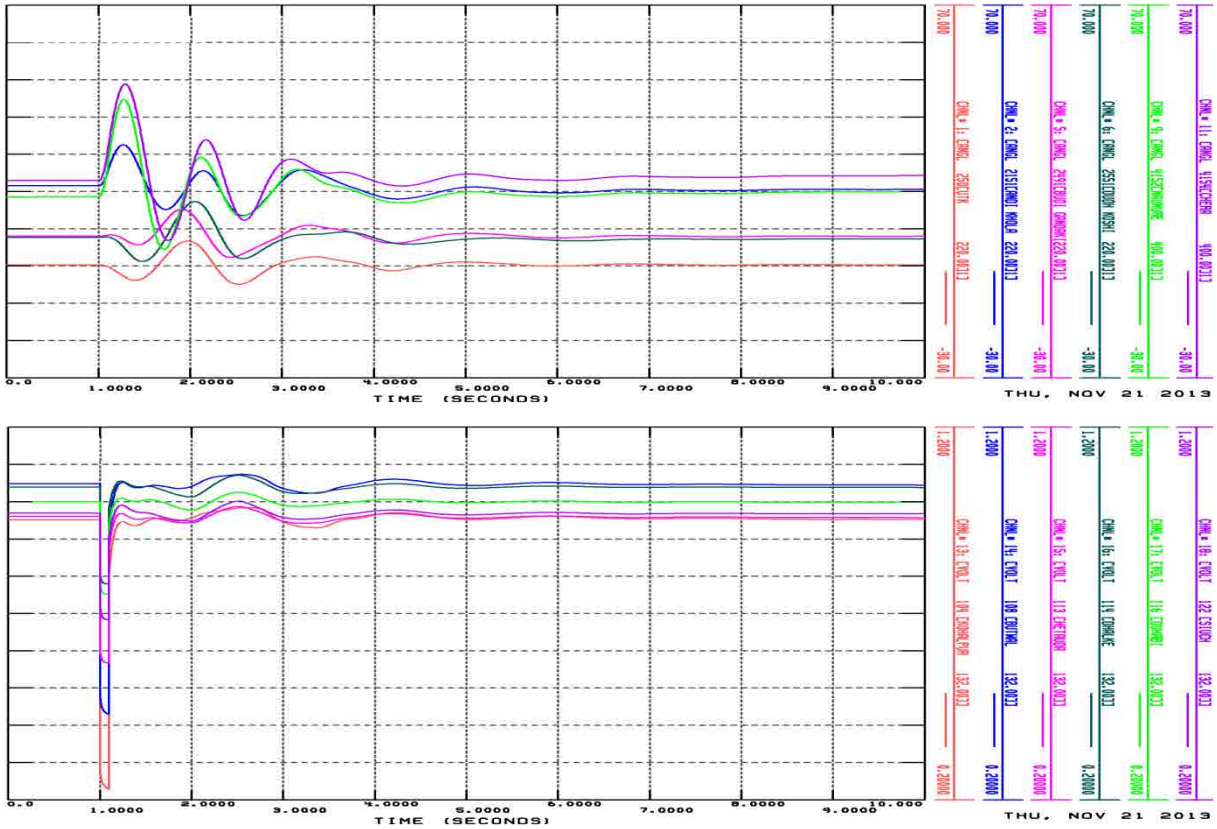


Figure 11.5.5-11 Shivapur 400 kV S/S - Butwal 400 kV S/S, 3LG fault 100msec 1cct open

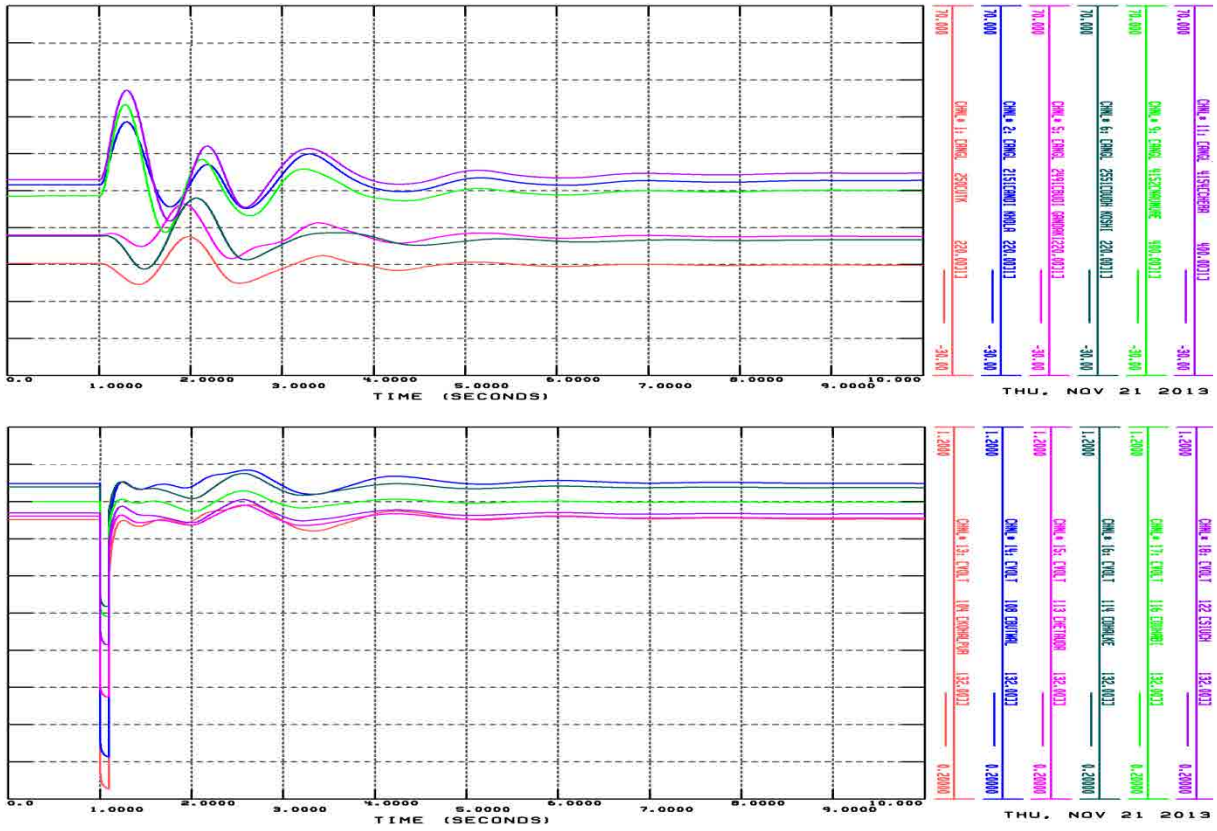


Figure 11.5.5-12 Butwal 400 kV S/S - Bharatpur 400 kV S/S, 3LG fault 100msec 1cct open

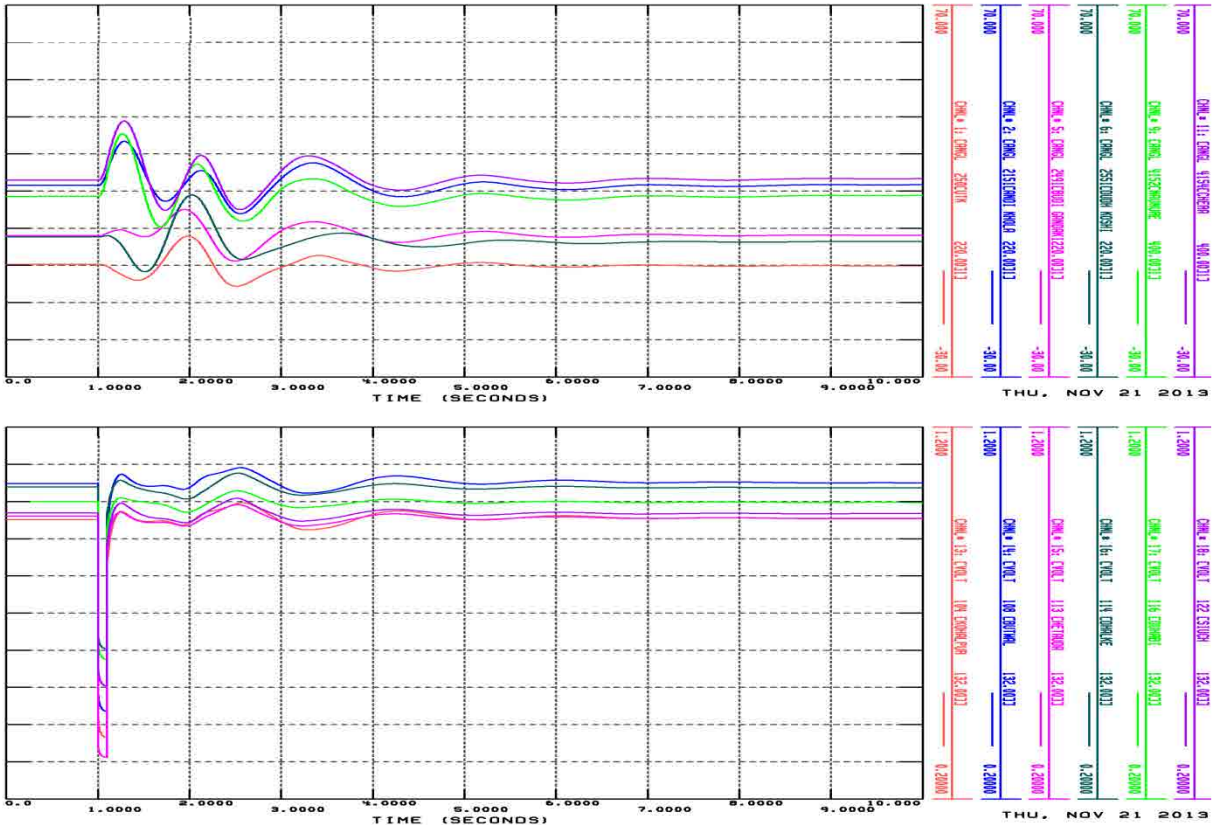


Figure 11.5.5-13 Bharatpur 400 kV S/S - Hetauda 400 kV S/S, 3LG fault 100msec 1cct open

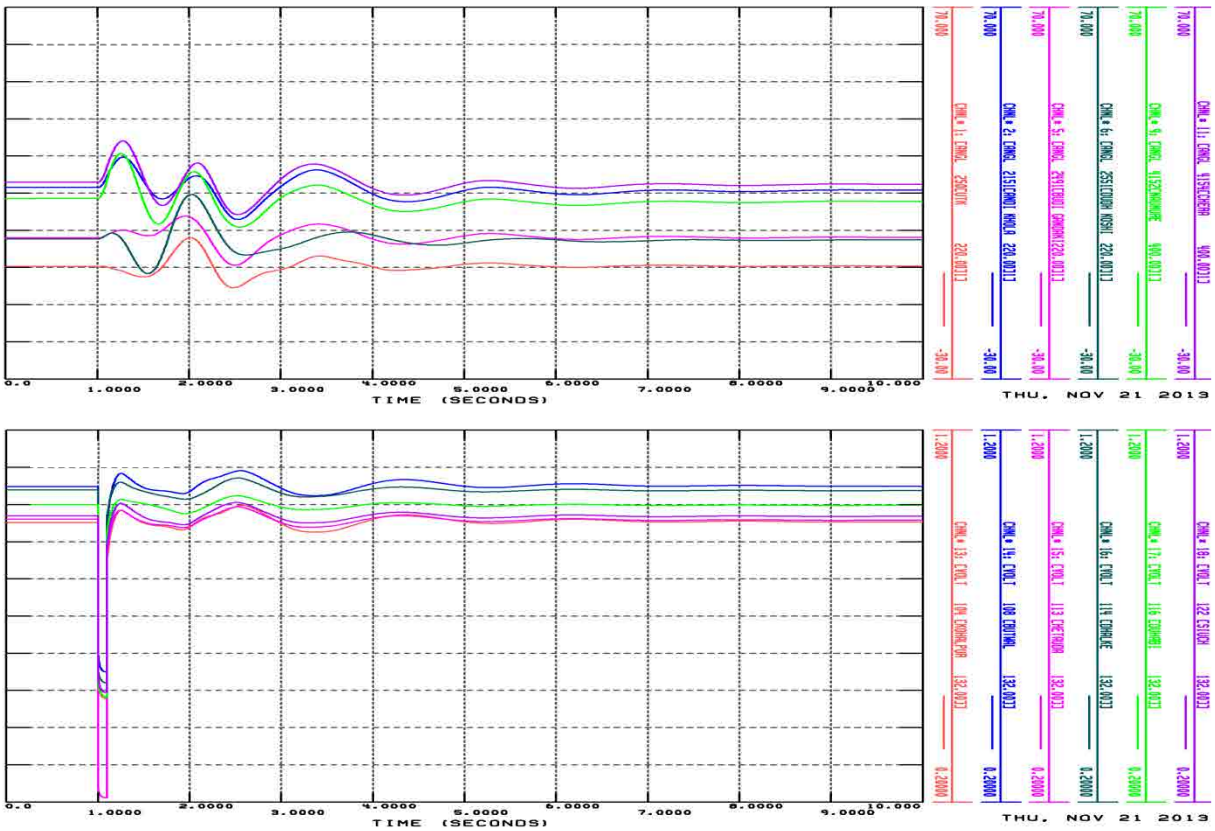


Figure 11.5.5-14 Hetauda 400 kV S/S - Dhalkebar 400 kV S/S, 3LG fault 100msec 1cct open

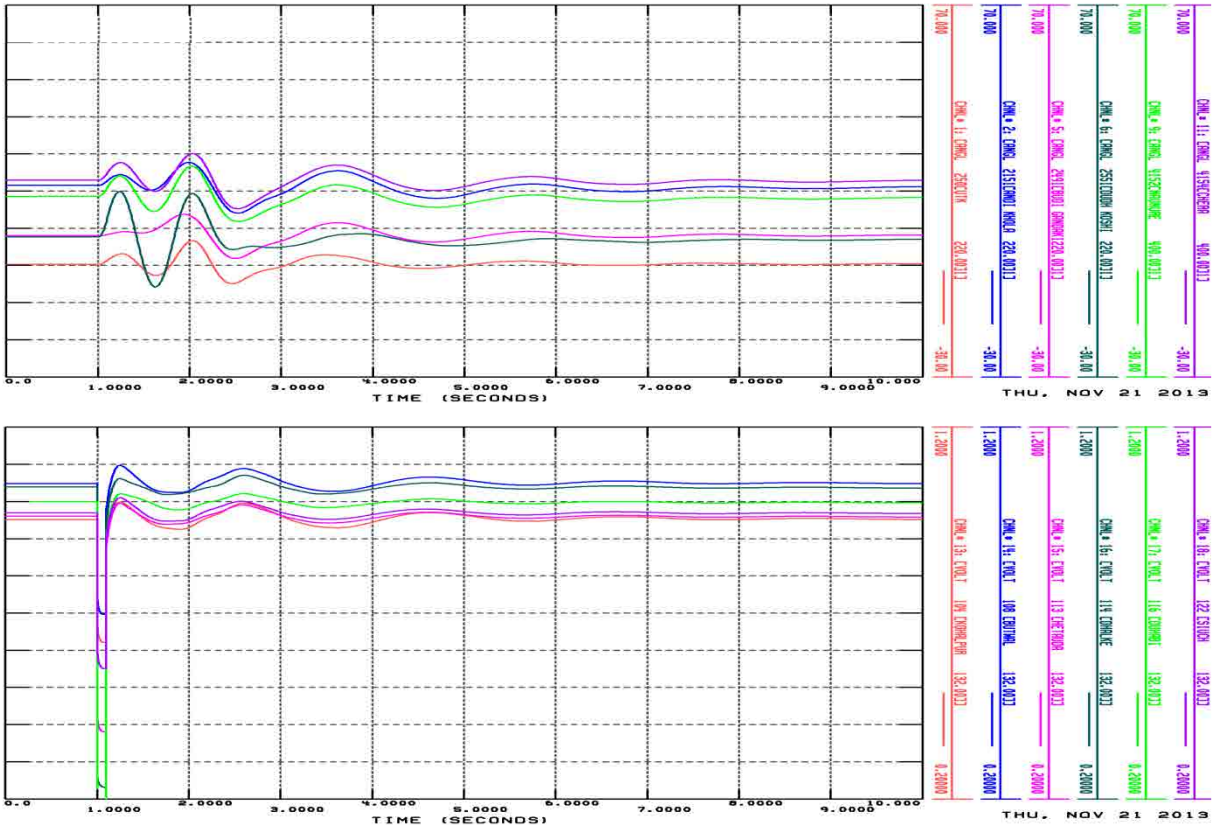


Figure 11.5.5-15 Dhalkebar 400 kV S/S - Muzzaffarpur 400 kV S/S, 3LG fault 100msec 1cct open

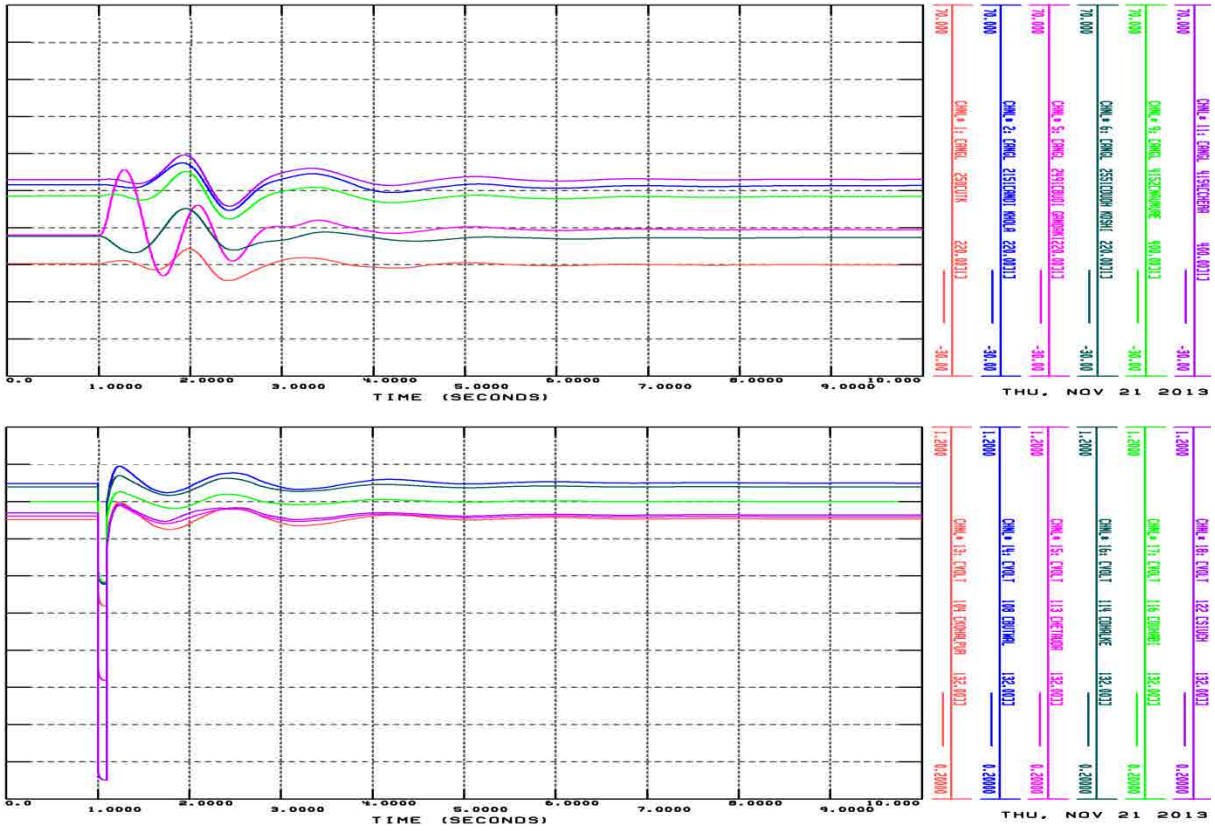


Figure 11.5.5-16 Naubise 220 kV S/S - Matatirtha 220 kV S/S, 3LG fault 100msec 1cct open

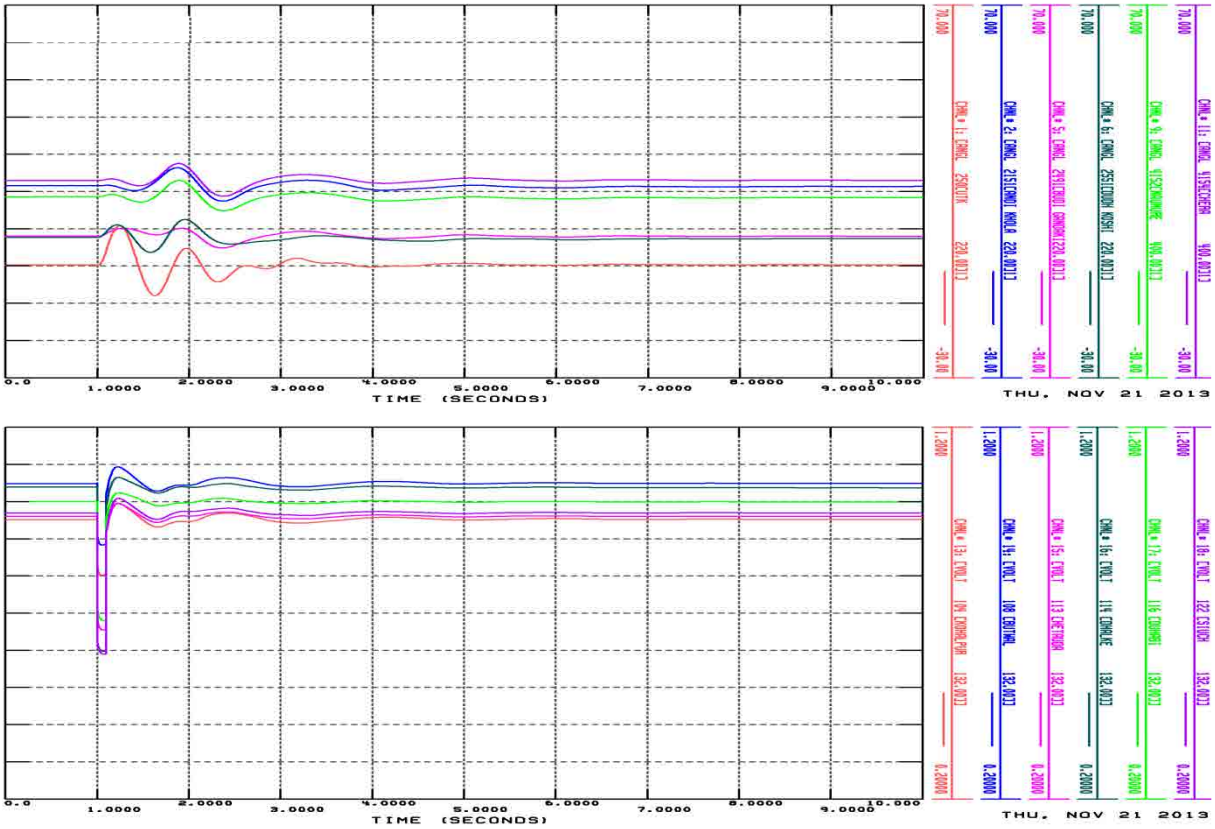


Figure 11.5.5-17 Khimti 220 kV S/S - Dhalkebar 220 kV S/S, 3LG fault 100msec 1cct open

11.6 Review for the Transmission Line Expansion Plan

The Power System Analysis was carried out for the Power System in FY2031/32 peak demand. The results of the analysis also showed that any problem in the power system were not observed for the Promising Projects of the Study Team and Transmission Line Expansion Plan of the NEA. Reinforcement of the network less than 66 kV including the distribution system would be required for the demand increase. Each of these should also be studied according to the growing individual demand.

Chapter 12

Environmental and Social Considerations

Chapter 12 Environmental and Social Considerations

12.1 Strategic Environmental Assessment

A strategic environmental assessment was applied in this study. Regarding the comparative study of the projects, economic and technical aspects, natural and social environmental aspects were treated as equally as possible. In addition, to ensure an objective of evaluation, the assessment aimed to align the collected information level and to make a quantitative evaluation. Disclosing information and holding consultation with stakeholders are actively conducted, and three stakeholders meetings were held in the Study.

The results of the strategic environmental assessment (SEA) are shown in Appendix 3 as the SEA Report. The following is the delineation of the results of the SEA.

12.1.1 Target Setting of SEA

The electricity power demand in FY2031/32 is forecasted at 4,279 MW (Base Case) as described in Chapter 7. The target of the SEA is to propose 10 promising projects and their developing order in order to fulfill this demand mainly by storage type hydroelectric power projects in an environmentally sustainable manner without having a serious impact on the natural environment and social issues. The run-of-river type hydroelectric power projects are not considered in the SEA. But they are included in development planning in this report.

12.1.2 First Step of SEA

In the first step of SEA, screening of 67 potential projects listed in the long list (see Table 12.1.2-1) was conducted to exclude inappropriate projects and to select candidate projects. As a result of the screening, (1) 5 projects which are on-going projects in a detailed design or feasibility study stage, (2) 6 projects of which location is overlapping with other projects, (3) 36 projects which were deemed inappropriate as a storage-type hydroelectric power project in Nepal were excluded, and 31 candidate projects were selected.

Table 12.1.2-1 Potential Projects (67 projects) at the First Step

Eastern River Basin			Central River Basin			Western River Basin		
No.	Project Name	Capacity (MW)	No.	Project Name	Capacity (MW)	No.	Project Name	Capacity (MW)
E-01	Dudh Koshi	300.0	C-01	Kaligandaki-Modi	816.4	W-01	Barbung Khola	122.9
E-02	Dudh Koshi-2	456.6	C-02	Lower Badigad	380.3	W-02	Chera-1	148.7
E-03	Dudh Koshi-3	1,048.6	C-03	Lower Daraudi	120.2	W-03	Chera-2	104.3
E-04	Dudh Koshi-4	1,603.0	C-04	Seti-Trisuli	128.0	W-04	Humla-Karnali	467.1
E-05	Khimti	128.1	C-05	Upper Daraudi	111.4	W-05	Lower Jhimruk	142.5
E-06	Kokhajor-1	111.5	C-06	Kaligandaki-2	660.0	W-06	Madi	199.8
E-07	Likhu-1	91.2	C-07	Budhi Gandaki	600.0	W-07	Mugu Karnali	3,843.8
E-08	Mulghat	2,647.7	C-08	Andhi Khola	180.0	W-08	Sani Bhari-1	763.5
E-09	Piluwa-2	107.3	C-09	Langrang Khola	218.0	W-09	Sani Bhari-2	646.9
E-10	Rosi-2	106.5	C-10	Uttar Ganga	300.0	W-10	Sharada-2	96.8
E-11	Sankhuwa-1	176.0	C-11	Madi-Ishaneshor	86.0	W-11	Thuli Gad-2	119.7
E-12	Tama Koshi-3	330.0	C-12	Kali Gandaki No.1	1,500.0	W-12	Tila-1	617.2
E-13	Tamor No.1	696.0	C-13	Marsyangdi	510.0	W-13	Tila-3	481.9
E-14	Tamor (Terahathum)	380.0	C-14	Seti (Gandaki)	230.0	W-14	Thuli Gad	120.0
E-15	Sun Koshi No.1	1,357.0	C-15	Dev Ghat	150.0	W-15	LR-1	98.0
E-16	Sun Koshi No.2	1,110.0	C-16	Bhomichok	200.0	W-16	BR-3B	801.0
E-17	Sun Koshi No.3	536.0	C-17	Trishulganga	1,500.0	W-17	BR-4	667.0
E-18	Sun Koshi No.3	432.0	C-18	Ridi Khola	97.0	W-18	Surkhet	600.0
E-19	Sun Koshi No.3	190.0	C-19	Bagmati MP *	140.0	W-19	Lakarpata	1,200.0
E-20	Indrawati	91.2				W-20	Bhanakot	810.0
E-21	Kankai	90.0				W-21	Thapna	500.0
						W-22	SR-6	642.0
						W-23	Nalsyagu Gad	400.0
						W-24	Sarada Babai	75.0
						W-25	Naumure (W. Rapti)	245.0
						W-26	Lohare Khola	67.0
						W-27	Nisti-Panah *	90.4

*: Added in January 2012.

Table 12.1.2-2 Excluded Projects

Excluded conditions		Excluded projects
(1) On-going project		Budhi Gandaki (C-07: 600 MW) Tamor (Terahathum) (E-14: 530 MW) Kaligandaki-2 (C-06: 660 MW) Bagmati Multipurpose (C-19: 140 MW) Nisti-Panah (W-27: 90.4 MW)
(2) Overlapped project		Tamor No. 1 (E-13: 696 MW) Sun Koshi No. 3 (E-18: 432 MW) Sun Koshi No. 3 (E-19: 190 MW) Seti (Gandaki) (C-14: 230 MW) Thuli Gad (W-14: 120 MW) LR-1 (W-15: 98 MW)
(3) Not appropriate projects	Installed capacity > 1,000 MW	Dudh Koshi-3 (E-03: 1,048.6 MW) Dudh Koshi-4 (E-04: 1,603 MW) Mulghat (E-08: 2,647.7 MW) Sun Koshi No.1 (E-15: 1,357 MW) Sun Koshi No.2 (E-16: 1,110 MW) Kali Gandaki No.1 (C-12: 1,500 MW) Trishulganga (C-17: 1,500 MW) Mugu Karnali (W-07: 3,843.8 MW) Lakarpata (W-19: 1,200 MW)
	Dam height > 300m	Dudh Koshi-3 (E-03: 357m) Dudh Koshi-4 (E-04: 425m) Mugu Karnali (W-07: 694m) Sani Bhari-1 (W-08: 417m) Sani Bhari-2 (W-09: 330m) Tila-3 (W-13: 338m)
	Project cost > US$ 2,000M	Dudh Koshi-3 (E-03: 22.6 MUS$) Dudh Koshi-4 (E-04: 28.7 MUS$) Mulghat (E-08: 23.7 MUS$) Mugu Karnali (W-07: 48.7 MUS$)
	Regulating Capacity < 5%	Khimti (E-05: 2.91%) Likhu-1 (E-07: 2.87%) Sun Koshi No.1 (E-15: 0.19%) Seti-Trisuli (C-04: 2.56%) Dev Ghat (C-15: 0.32%) Bhomichok (C-16: 0.07%) Humla-Karnali (W-04: 2.73%) Tila-3 (W-13: 2.13%)
	Number of resettlement > 5,000	Kankai (E-21: 11,700) Kaligandaki-2 (C-06: 7,000) Marsyangdi (C-13: 5,170) BR-3B: (W-16: 9,270) Surkhet (W-18: 6,600) Lakarpata (W-19: 20,400)
	National parks and protected area	Sankhuwa-1 (E-11: Makalu-Barun Conservation Area) Langtang Khola (C-09: Langtang National Park) Uttar Ganga (C-10: Dhorpatan Hunting Reserve)

12.1.3 Second Step of SEA

The second step aims to select 10 promising projects from 31 projects listed as candidates (see Table 12.1.3-1 and Figure 12.1.3-1). The data used for evaluation are based on the existing documents. No site survey is conducted at this step. 22 items are used for the evaluation; 13 economic and technical items, 4 natural environmental items and 5 social environmental items (see Table 12.1.3-2). Each of the evaluation items were evaluated numerically and subjected to sensitivity analysis of three patterns. As a result, projects in the western part such as the Madi and Lower Jhimruk were ranked at the top (see Table 12.1.3-3). Taking the regional balance and conflict with the licenses already issued to other projects into account, 10 promising projects were selected through consultation with the NEA and the DOED. The selected projects were the Dudh Koshi, Kokhajor-1, Sun Koshi No.3, Lower Badigad, Andhi Khola, Chera-1, Lower Jhimruk, Madi, Nalsyau Gad and Naumure (W. Rapti). The details of these promising projects selection are described in Chapter 7 of the SEA Report (Appendix-3).

Table 12.1.3-1 Candidate Projects at the Second Step (31 projects)

No.	Project Name	River	Installed Capacity (MW)	Total Energy (GWh)	Dry Energy (GWh)	Reservoir Area (km^2)	FSL (m)
E-01	Dudh Koshi	Dudh Koshi to Baiku Khola	300.0	1,864.6	821.3	11.05	580.0
E-02	Dudh Koshi-2	Dudh Koshi	456.6	2,225.5	617.5	5.22	907.0
E-06	Kokhajor-1	Kokhajor	111.5	270.7	124.1	8.92	437.0
E-09	Piluwa-2	Piluwa	107.3	152.9	83.0	1.37	624.0
E-10	Rosi-2	Roshi	106.5	334.1	117.8	4.31	734.0
E-12	Tama Koss-3	Tamakoshi	287.0	1,325.3	468.8	5.84	965.0
E-17	Sun Koshi No.3	Sun Koshi	432.0	1,419.0	300.5	23.99	670.5
E-20	Indrawati	Indrawati	91.2	954.0	542.4	12.75	724.0
C-01	Kaligandaki-Modi	Confluence of Karigandaki and Modi	816.4	3,477.4	709.3	16.34	839.0
C-02	Lower Badigad	Badigad	380.3	1,354.4	486.8	13.65	688.0
C-03	Lower Daraudi	Daraudi	120.2	251.7	126.8	17.28	411.0
C-05	Upper Daraudi	Daraudi	111.4	217.7	116.7	4.14	673.0
C-08	Andhi Khola	Andhi Khola	180.0	431.5	191.0	5.52	675.0
C-11	Madi- Ishaneshor	Madi	86.0	393.3	103.5	5.35	590.0
C-18	Ridi Khola	Ridi	97.0	255.3	133.7	9.37	770.0
W-01	Barbung Khola	Barbung	122.9	683.5	227.1	2.21	3,246.0
W-02	Chera-1	Chera	148.7	557.8	166.2	4.00	866.0
W-03	Chera-2	Chera	104.3	402.6	117.7	6.85	753.0
W-05	Lower Jhimruk	Jhimruk	142.5	456.3	163.4	4.98	597.0
W-06	Madi	Madi	199.8	642.9	256.4	7.66	1,090.0
W-10	Sharada - 2	Sharada	96.8	455.6	159.6	5.38	568.0
W-11	Thuli Gad - 2	Thuligad	119.7	513.5	157.9	5.42	765.0
W-12	Tila - 1	Tila	617.2	2,428.7	642.9	5.55	2,089.0
W-17	BR-4	Bheri	667.0	3,315.3	1,479.8	100.64	794.0
W-20	Bhanakot	Karnali	810.0	7,042.2	4,089.3	50.29	1,080.0
W-21	Thapna	Bheri	500.0	3,450.5	1,894.4	81.35	740.0
W-22	SR-6	Seti (West)	642.0	3,284.1	1,425.5	51.20	603.0
W-23	Nalsyau Gad	Nalsyau Gad	400.0	795.2	248.5	2.66	1,525.0
W-24	Sarada Babai	Sarada & Babai	75.0	202.0	92.6	7.50	730.0
W-25	Naumure (W. Papti)	West Rapti	245.0	1,165.1	425.2	19.76	517.0
W-26	Lohare Khola	Lohare	67.0	292.7	100.9	16.03	780.0

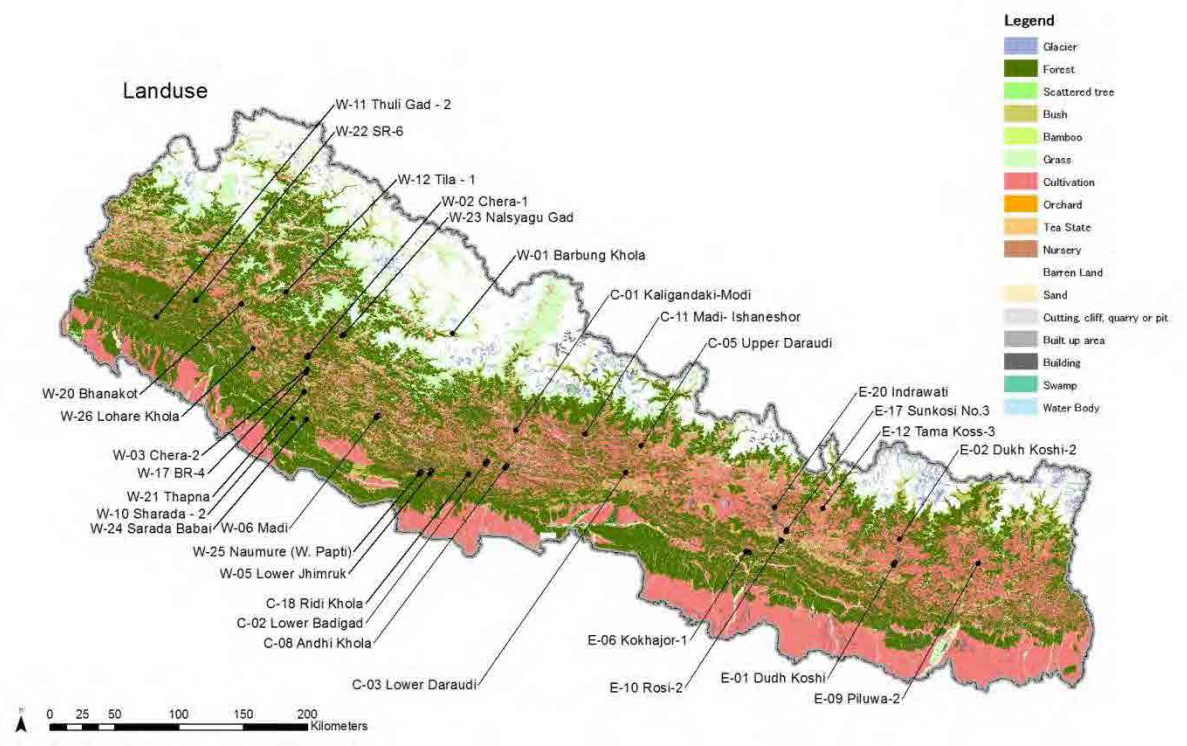


Figure 12.1.3-1 Location of Candidate Projects at the Second Step

Table 12.1.3-2 Evaluation Items and Weight at the Second Step (Base Case)

Category	%	Subcategory	%	Evaluation Item	%	Point
Technical and Economical Conditions	50	Hydrological Conditions	25	Reliability of flow data	25	3.13
				Risk of GLOF	40	5.00
				Sedimentation	35	4.37
		Geological Conditions	25	Seismicity	30	3.75
				Geological conditions of the site	40	5.00
				Natural hazard (earthquake)	30	3.75
		Lead Time	20	Length of access road	25	2.50
				Difficulty level of funding	35	3.50
				Reliability of development plan	40	4.00
		Effectiveness of Project	30	Unit generation cost	25	3.75
				Installed capacity	20	3.00
				Annual energy production	20	3.00
				Energy production in the dry season	35	5.25
Impact on Environment	50	Impact on Natural Environment	50	Impact on forest	25	6.25
				Impact on protected area	30	7.50
				Impact on fishes	20	5.00
				Impact on conservation species	25	6.25
		Impact on Social Environment	50	Impact on locality by construction of transmission line	20	5.00
				Impact on household	25	6.25
				Impact on agriculture	20	5.00
				Impact on ethnic minority	20	5.00
				Impact on tourism	15	3.75
				Total		100

Table 12.1.3-3 Evaluation Results of Candidate Projects

Base Case
Technical : 50%, Environmental : 50%

No.	Project Name	P (MW)	Ranking
W-06	Madi	199.8	1 (W1)
W-05	Lower Jhimruk	142.5	2 (W2)
W-23	Nalsyagu Gad	400.0	3 (W3)
W-12	Tila - 1	617.2	
W-20	Bhanakot	810.0	
E-01	Dudh Koshi	300.0	4 (E1)
W-02	Chera-1	148.7	5 (W4)
W-25	Naumure (W. Rapti)	245.0	6 (W5)
W-10	Sharada - 2	96.8	—
E-12	Tama Koss-3	287.0	
E-17	Sunkosi No.3	536.0	7 (E2)
E-02	Dukh Koshi-2	456.6	
E-06	Kokhajor-1	111.5	8 (E3)
C-02	Lower Badigad	380.3	9 (C1)
C-08	Andhi Khola	180.0	10 (C2)
W-03	Chera-2	104.3	
C-11	Madi- Ishaneshor	86.0	
W-01	Barbung Khola	122.9	
W-21	Thapna	500.0	
E-10	Rosi-2	106.5	
E-09	Piluwa-2	107.3	
W-11	Thuli Gad - 2	119.7	
E-20	Indrawati	91.2	
W-22	SR-6	642.0	
C-01	Kaligandaki-Modi	816.4	
W-24	Sarada Babai	75.0	
C-05	Upper Daraudi	111.4	
C-18	Ridi Khola	97.0	
W-17	BR-4	667.0	
C-03	Lower Daraudi	120.2	
W-26	Lohare Khola	67.0	

Case-1
Technical : 60%, Environmental : 40%

No.	Project Name	P (MW)	Ranking
W-06	Madi	199.8	1 (W1)
W-05	Lower Jhimruk	142.5	2 (W2)
W-23	Nalsyagu Gad	400.0	3 (W3)
W-20	Bhanakot	810.0	
E-01	Dudh Koshi	300.0	4 (E1)
W-12	Tila - 1	617.2	
W-02	Chera-1	148.7	5 (W4)
E-17	Sunkosi No.3	536.0	6 (E2)
C-08	Andhi Khola	180.0	7 (C1)
W-21	Thapna	500.0	8 (W5)
W-25	Naumure (W. Rapti)	245.0	
W-10	Sharada - 2	96.8	
E-12	Tama Koss-3	287.0	
C-02	Lower Badigad	380.3	9 (C2)
C-11	Madi- Ishaneshor	86.0	10 (C3)
W-03	Chera-2	104.3	
E-02	Dukh Koshi-2	456.6	
W-22	SR-6	642.0	
W-01	Barbung Khola	122.9	
E-06	Kokhajor-1	111.5	
E-10	Rosi-2	106.5	
W-11	Thuli Gad - 2	119.7	
C-01	Kaligandaki-Modi	816.4	
E-20	Indrawati	91.2	
E-09	Piluwa-2	107.3	
W-24	Sarada Babai	75.0	
W-17	BR-4	667.0	
C-18	Ridi Khola	97.0	
C-03	Lower Daraudi	120.2	
C-05	Upper Daraudi	111.4	
W-26	Lohare Khola	67.0	

Case-2
Technical : 40%, Environmental : 60%

No.	Project Name	P (MW)	Ranking
W-06	Madi	199.8	1 (W1)
W-05	Lower Jhimruk	142.5	2 (W2)
W-23	Nalsyagu Gad	400.0	3 (W3)
W-02	Chera-1	148.7	4 (W4)
W-12	Tila - 1	617.2	
W-25	Naumure (W. Rapti)	245.0	5 (W5)
W-10	Sharada - 2	96.8	—
W-20	Bhanakot	810.0	—
E-01	Dudh Koshi	300.0	6 (E1)
E-06	Kokhajor-1	111.5	7 (E2)
W-03	Chera-2	104.3	—
E-02	Dukh Koshi-2	456.6	—
E-12	Tama Koss-3	287.0	—
W-01	Barbung Khola	122.9	—
E-17	Sunkosi No.3	536.0	8 (E3)
C-02	Lower Badigad	380.3	9 (C1)
E-10	Rosi-2	106.5	10 (E4)
C-08	Andhi Khola	180.0	
E-09	Piluwa-2	107.3	
W-11	Thuli Gad - 2	119.7	
C-11	Madi- Ishaneshor	86.0	
W-24	Sarada Babai	75.0	
W-21	Thapna	500.0	
E-20	Indrawati	91.2	
C-01	Kaligandaki-Modi	816.4	
W-22	SR-6	642.0	
C-05	Upper Daraudi	111.4	
C-18	Ridi Khola	97.0	
W-26	Lohare Khola	67.0	
W-17	BR-4	667.0	
C-03	Lower Daraudi	120.2	

E: Eastern River Basin, C: Central River Basin, W: Western River Basin.

12.1.4 Third Step of SEA

In the third step of SEA, the site survey for the 10 promising projects (see Table 12.1.4-1 and Figure 12.1.4-1) selected in the second step of SEA was conducted. Based on the results of the site survey, an overall rating point was given to each project. 11 economic and technical items, 17 natural environmental items, 22 social issues items, and 63 items in total were used for evaluation (see Table 12.1.4-2). For the evaluation results, 4 cases of sensitivity analysis were carried out. For example, in Case-1, an equal weight of 50% is placed in both economic and technical items and environmental items. In Case-4, 75% of the weight is placed in economic and technical items. However, the evaluation results were not so different among the 4 cases. The Nalsyau Gad, Dudh Koshi and Andhi Khola projects had relatively high ratings for all cases. The evaluation results are shown in the Table 12.1.4-3. Detailed explanations of the alternative study results are described in Chapter 8 of the SEA report (Appendix 3).

Table 12.1.4-1 Promising Projects at the Third Step (10 projects)

Project		District	Installed Capacity (MW)	Dam Height (m)	Full Supply Level (m)	Reservoir Area (km^2)	Annual Energy (GWh)	Project Cost (MUS$)
E-01	Dudh Koshi	Okhaldhunga, Khotang, Solukhumbu	300.0	180	580	11.1	1,910	1,144
E-06	Kokhajor-1	Sinduli, Kabhrepalanchok	111.5	107	437	4.6	279	477
E-17	Sun Koshi No.3	Ramechhap, Kabhrepalanchok, Sindhupalchok	536.0	140	700	30.1	1,884	1,691
C-02	Lower Badigad	Gulmi	380.3	191	688	13.7	1,366	1,210
C-08	Andhi Khola	Syangja	180.0	157	675	5.5	649	666
W-02	Chera-1	Jajarkot	148.7	186	866	4.0	563	577
W-05	Lower Jhimruk	Arghakhachi, Pyuthan	142.5	167	597	6.0	455	521
W-06	Madi	Rolpa	199.8	190	1,090	7.7	621	637
W-23	Nalsyau Gad	Jajarkot	410.0	200	1,570	6.3	1,406	967
W-25	Naumure (W. Rapti)	Argakhanchi, Pyuthan	245.0	190	517	19.8	1,158	955

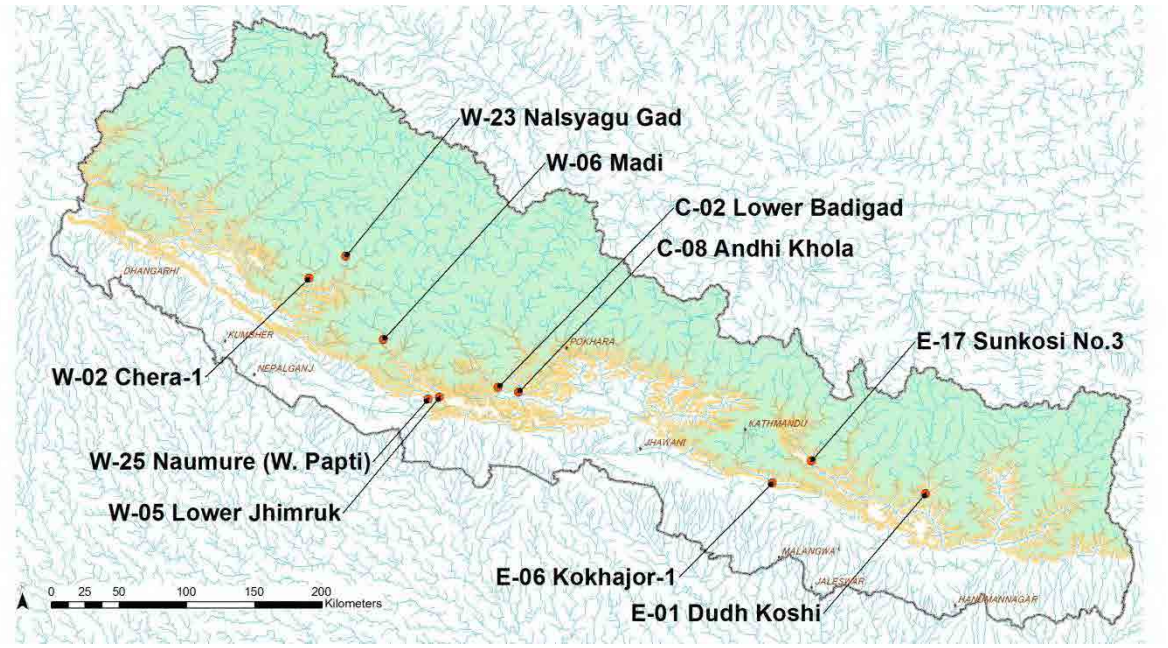


Figure 12.1.4-1 Location of Promising Projects at the Third Step

Table 12.1.4-2 Evaluation Items and Weight at the Third Step (Base Case)

Category	%	Subcategory	%	Evaluation Item	%	Point
Technical and Economical Conditions	50	Hydrological Conditions	30	Reliability of flow data	**35**	**5.25**
				Risk of GLOF	30	4.50
				Sedimentation	35	5.25
		Geological Conditions	25	Seismicity	25	3.13
				Geological conditions of the site	50	6.24
				Thrust and fault	25	3.13
		Lead time	20	Time to commencement of commercial operation	100	10.00
		Effectiveness of the Project	25	Unit generation cost	25	3.13
				Installed capacity	20	2.50
				Annual energy production	10	1.25
				Energy production in the dry season	45	5.62
Impact on the Environment	50	Impact on the Natural Environment	40	Impact on forest	(23)	—
				Forest land	*9*	*1.80*
				Number of trees in the reservoir area	*7*	*1.40*
				Average of crown coverage	*7*	*1.40*
				Impact on flora	(16)	—
				Number of plant species reported	*8*	*1.60*
				Number of plant species of conservation significance	*8*	*1.60*
				Impact on terrestrial fauna	(17)	—
				Number of mammal species reported	*3*	*0.60*
				Number of bird species reported	*2*	*0.40*
				Number of herpetofauna species reported	*2*	*0.40*
				Number of conservation mammalian species reported (reservoir)	*4*	*0.80*
				Number of conservation bird species reported (reservoir)	*3*	*0.60*
				Number of conservation herpetofauna species reported (reservoir)	*3*	*0.60*
				Impact on aquatic fauna	(22)	—
				Number of fish species reported	*9*	*1.80*
				Number of fish species of conservation significance	*9*	*1.80*
				Length of recession area	*4*	*0.80*
				Impact on protected area	(16)	—
				Number of protected areas in the downstream	*8*	*1.60*
				Number of protected species in the downstream	*8*	*1.60*
				Impact of transmission line	(6)	
				Length of transmission line	*6*	*1.20*
		Impact on the Social Environment	60	Impact on household, etc.	(17)	—
				Number of estimated households	*10*	*3.00*
				Number of schools	*4*	*1.20*
				Number of industries	*3*	*0.90*
				Impact on ethnic minority	(8)	—
				Number of ethnic minority groups	*8*	*2.40*
				Impact on agriculture	(19)	—
				Impact on irrigation	*9*	*2.70*
				Impact on agricultural land	*10*	*3.00*
				Impact on fishery	(15)	—
				Number of fishermen	*3*	*0.90*
				Number of fish market	*2*	*0.60*
				Availability of fish in the market	*1*	*0.30*
				Sales amount of fish	*3*	*0.90*
				Total income	*3*	*0.90*
				Length of recession area	*3*	*0.90*
				Impact on tourism and culture	(14)	—
				Number of cultural structures	*6*	*1.80*
				Number of tourist facilities	*4*	*1.20*
				Number of tourists	*4*	*1.20*
				Impact on infrastructure	(19)	—
				Impact on roads	*7*	*2.10*
				Impact on bridges	*4*	*1.20*
				Impact on water mill, turbine, hydropower plant	*4*	*1.20*
				Impact on drinking water schemes	*4*	*1.20*
				Impact on rural economy and development plan	(8)	—
				Impact on market	*4*	*1.20*
				Number of development plans	*2*	*0.60*
				Previous issues	*2*	*0.60*
				Total		100

Table 12.1.4-3 Evaluation Results of Promising Projects

No.	Project Name	P (MW)	Case-1		Case-2		Case-3		Case-4	
			Score	Ranking	Score	Ranking	Score	Ranking	Score	Ranking
W-23	Nalsyau Gad	410	77	1	76	1	78	1	75	1
E-01	Dudh Koshi	300	65	2	65	2	64	3	66	2
W-02	Chera-1	148.7	65	2	64	3	66	2	63	4
C-08	Andhi Khola	180	64	4	64	3	63	6	65	3
W-06	Madi	199.8	63	5	62	5	64	3	60	5
W-05	Lower Jhimruk	142.5	63	5	62	5	64	3	60	5
E-06	Kokhajor-1	111.5	60	7	57	7	63	6	52	10
W-25	Naumure (W. Rapti)	245	56	8	56	8	56	8	56	8
E-17	Sun Koshi No.3	536	50	9	53	9	47	9	57	7
C-02	Lower Badigad	380.3	47	10	49	10	45	10	53	9

Case 1: Technical and Economical Conditions = 50%, Impact on the Environment = 50%
Case 2: Technical and Economical Conditions = 60%, Impact on the Environment = 40%
Case 3: Technical and Economical Conditions = 40%, Impact on the Environment = 60%
Case 4: Technical and Economical Conditions = 75%, Impact on the Environment = 25%

12.1.5 Cumulative Impact

Cumulative impact was studied considering 30 existing hydroelectric power projects shown in Figure 12.1.5-1, 12 existing irrigation projects (including India downstream), existing roads, 21 hydroelectric projects shown in Figure 12.1.5-2, investigation rights issue areas for hydroelectric power, 2 large-scale planned irrigation projects and road plans.

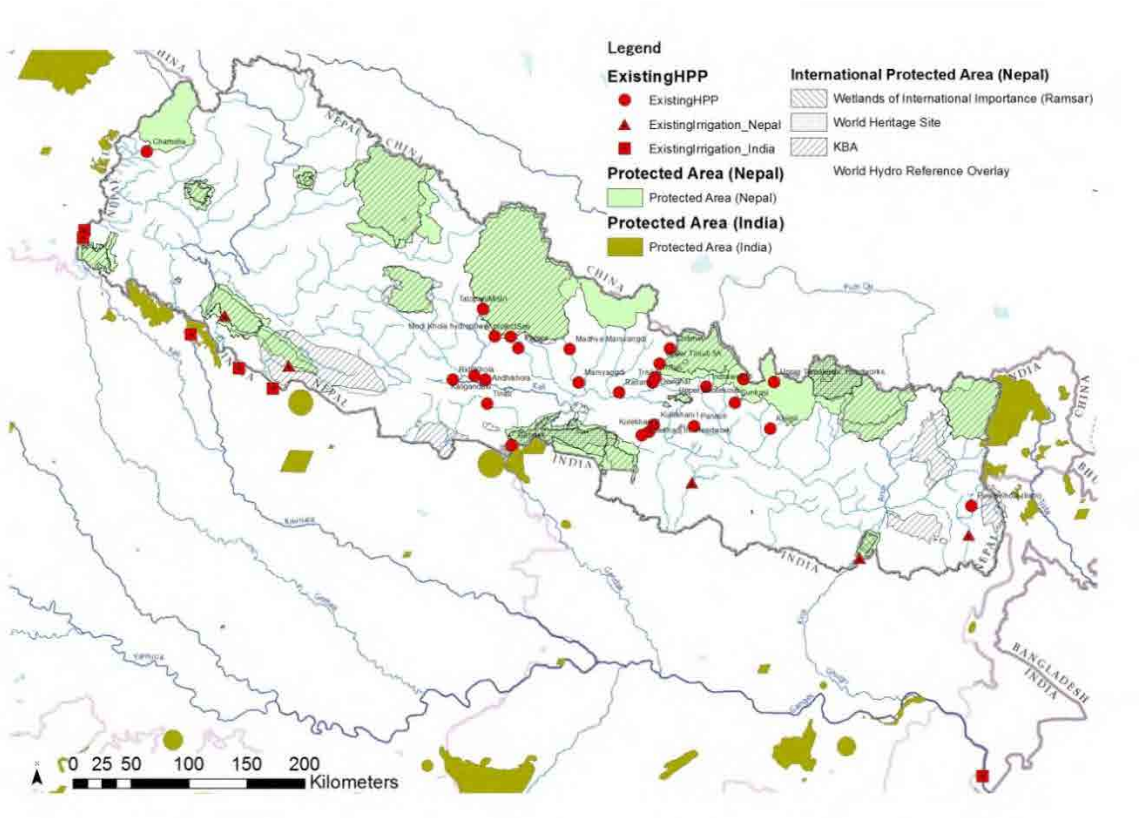


Figure 12.1.5-1 Existing HPPs and Irrigation Barrage

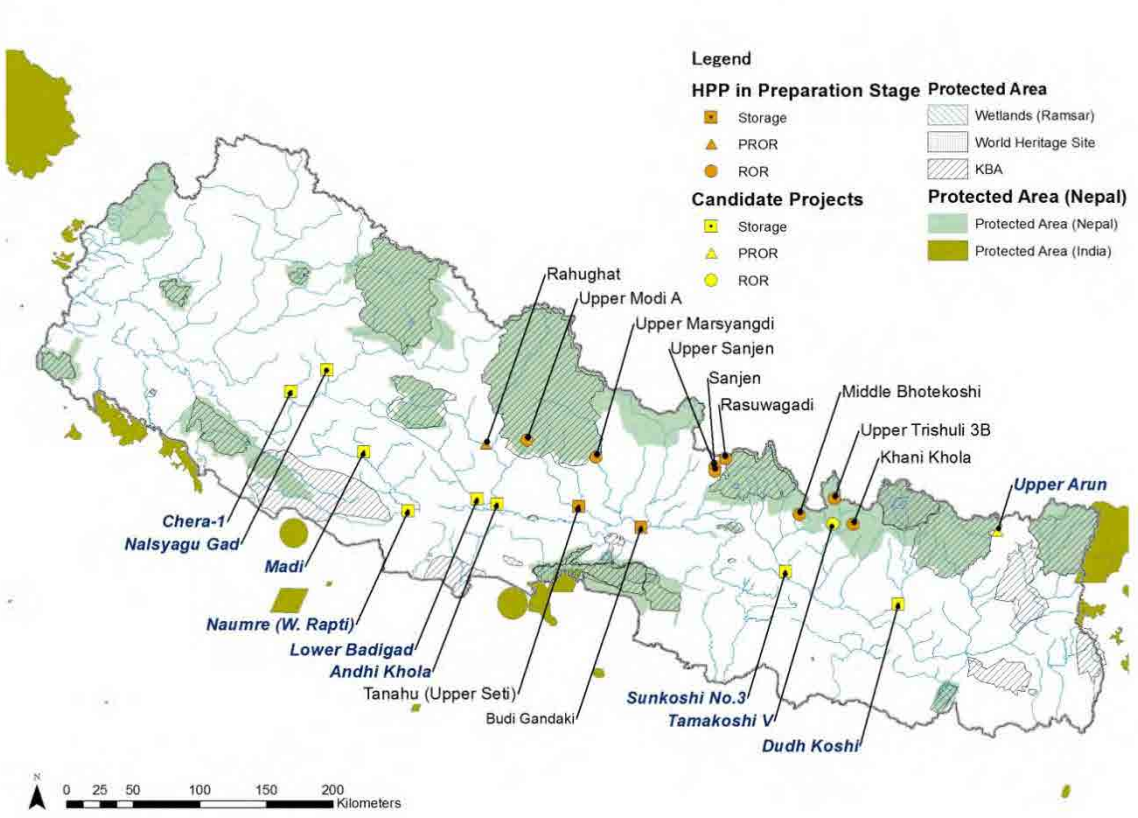


Figure 12.1.5-2 Possible HPPs in Nepal

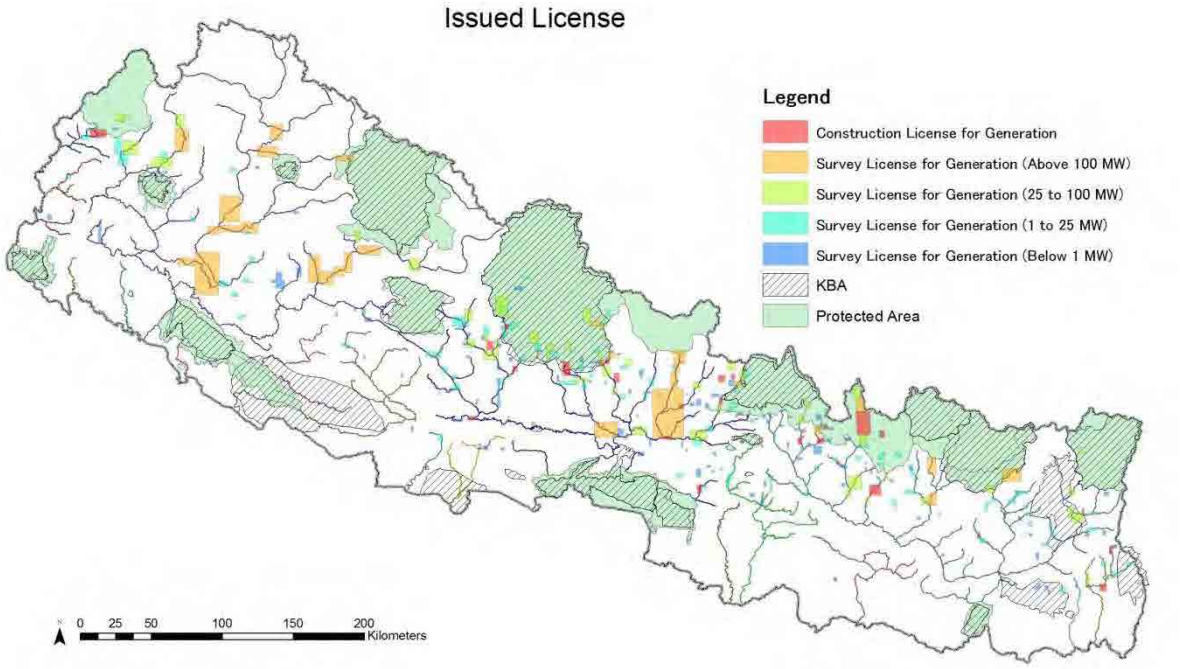


Figure 12.1.5-3 Issued Licenses by the Ministry of Energy (2012)

As a result of scoping, three items were selected for cumulative impact assessment: (1) Water regulation effects on a wetland ecosystem, (2) Barrier effects on migration fish, and (3) Impact on terrestrial ecosystems through development concentration.

(1) Water Regulation Effects on a Wetland Ecosystem,

In order to see the cumulative effects on water regulation, all the existing and planned storage type hydroelectric power plants were identified and the catchment area was measured by river systems (see Table 12.1.5-1). The Karnali river system has two planned projects in different tributaries. If all of the two projects are developed, the water flow from 3.2% of the river basin will be regulated. As a result, the Bardia National Park Buffer Zone located downstream and 28 protected species might be affected. The Rapti river system has two planned hydroelectric power plants. If two projects are developed, the water flow from 66.6% of the river basin will be regulated and the Banke National Park Buffer Zone and 15 protected species might be affected. The Gandaki river system has four existing storage type project and six planned storage type projects. If all the four projects are developed, the water flow from 64.6 % of the river basin will be regulated. It might violate the Gandaki Irrigation and Power Project Agreement (1959) signed between Nepal and India. In addition, the Chitwan National Park located downstream and 27 protected species might be affected. In the Koshi river system, there are two planned projects in different tributaries. If all the projects are developed, the water flow from 17.8 % of the river basin will be regulated. It might violate the Kosi Project Agreement signed between Nepal and India. The Koshi Tappu Wildlife Reserve and 15 protected species might be also affected.

Table 12.1.5-1 Existing and Planned Storage type Major Hydroelectric power Projects

River System	Water Shed Area km2 (A)	Name	Condition	Catchment * Area (B)	Rate (B/A)		International Treaty	Downstream Protected area	Protected Species recorded downstream area
Kalnari	42,890	Chera-1	Candidate	809	1.9%	3.2%	-	Bardia National Park Buffer Zone	28 (CR 1, EN 7, VU 10, NT 10) Pygmy Hog (CR), Asian Elephant (EN), Hog Deer (EN), Ganges River Dolphin (EN), Dhole (EN), Royal Bengal Tiger (EN), Fishing Cat (EN), Hispid Hare (EN), Greater One-horned Rhino (VU), Swamp Deer (VU), Sambar (VU), Four-horned Antelope (VU), Clouded Leopard (VU), Sloth Bear (VU), Smooth-coated Otter (VU), Himalayan Black Bear (VU), Asian Small-clawed Otter (VU), Marbled Cat (VU)
		Nalsyau Gad	Candidate	572	1.3%				
Rapti	5,150	Naumure (W. Rapti)	Candidate	3,430	66.6%	66.6%	-	Banke National Park Buffer Zone	15 (CR 0, EN 3, VU 4, NT 8) Asian Elephant (EN), Royal Bengal Tiger (EN), Fishing Cat (EN), Sambar (VU), Sloth Bear (VU), Smooth-coated Otter (VU), Himalayan Black Bear (VU)
		Madi	Candidate	(764)	(14.8%)				
Gandaki	31,100	Kulekhani III Headwork	Construction	21	0.1%	64.6%	Gandak Irrigation and Power Project Agreement	Chitwan National Park	27 (CR 1, EN 7, VU 9, NT 10) Pygmy Hog (CR), Asian Elephant (EN), Hog Deer (EN), Ganges River Dolphin (EN), Dhole (EN), Royal Bengal Tiger (EN), Fishing Cat (EN), Hispid Hare (EN), Greater One-horned Rhino (VU), Gaur (VU), Sambar (VU), Four-horned Antelope (VU), Clouded Leopard (VU), Sloth Bear (VU), Smooth-coated Otter (VU), Himalayan Black Bear (VU), Marbled Cat (VU)
		Andhi Khola	Candidate	475	1.5%				
		Lower Badigad	Candidate	2,050	6.6%				
		Budi Gandaki	Preparation Stage of Construction	16,066	51.7%				
		Tanahu	Preparation Stage of Construction	1,474	4.7%				
Bagmati	2,700	Kulekhani No.1	Existing	579	21.4%	21.4%	-	-	12 (CR 0, EN 2, VU 2, NT 8) Asian Elephant (EN), Chinese Pangolin (EN), Sambar (VU), Himalayan Black Bear (VU)
Koshi	54,100	Dudh Koshi	Candidate	4,100	7.6%	17.8%	Kosi Project Agreement	Koshi Tappu Wildlife Reserve	15 (CR 0, EN 5, VU 3, NT 7) Asian Elephant (EN), Wild Water Buffalo (EN), Ganges River Dolphin (EN), Dhole (EN), Fishing Cat (EN), Smooth-coated Otter (VU), Himalayan Black Bear (VU), Binturong (VU)
		Sun Koshi No.3	Candidate	5,520	10.2%				

*: The figures in ( ) means that the area is included in Naumure's catchmet area.

(2) Barrier effects on migration fish

From an ichthyological point of view, the rivers which have continuous barriers seem to be difficult for the fish to inhabit. In particular, the long distance migration fishes need access to the high mountain areas with cold water that is suitable for spawning. Most of the IUCN red list fish species in Nepal are cold water migration fishes. Currently most of the existing major barriers are concentrated in the Gandaki and Koshi river systems. On the other hand, eight other main river systems are free of barriers (see Table 12.1.5-2, Figure 12.1.5-4, 12-1.5-5 and 12.1.5-6). However, seven of these rivers do not reach a high mountain area. Only the Karnali river system reaches a cold water area. Some of the existing barriers have fish ladders but some of them do not have any mitigation. Because of a lack of data, actual barrier effects and mitigation effects are not clearly identified. But in case all the planned HPP and irrigation projects will be developed, it might cause a serious impact on fish diversity in Nepal.

Table 12.1.5-2 Number of Existing and Planned HPP in Each River Basin

River System	*Existing*		*Planned*		*Construction license*	*Survey License*			
	HPP	*Irrigation*	*HPP*	*Irrigation*		*Over 100MW*	*25-under 100MW*	*1-under 25MW*	*Under 1MW*
Mahakali	1	2	0	0	1	0	2	5	3
Mahana	0	0	0	0	0	0	0	0	0
Kandra	0	0	0	0	0	0	0	0	0
Karnali	0	0	2	0	0	15	5	26	16
Babai	0	2	0	0	0	0	0	0	0
Rapti	0	2	2	0	1	0	0	3	3
Banganga	0	0	0	0	0	0	0	1	0
Danau	0	0	0	0	0	0	0	0	7
Gandak	20	0	10	1	24	9	28	68	72
Bakaiya	0	0	0	0	0	0	0	0	1
Bagmati	0	1	0	0	0	0	0	6	4
Kamala	0	0	0	0	0	0	0	0	0
Koshi	6	1	7	1	18	5	15	52	52
Ratuwa	0	0	0	0	0	0	0	0	1
Kankaimai	1	1	0	0	2	0	1	8	2

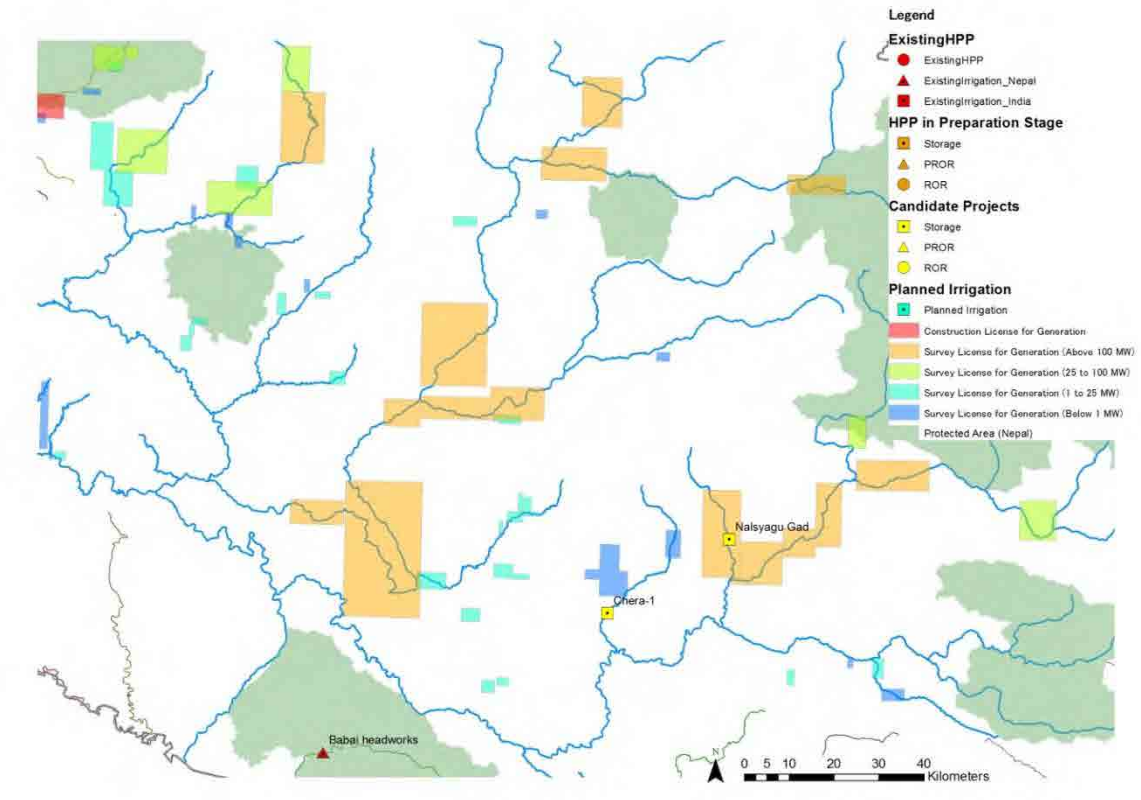


Figure 12.1.5-4 Existing and Planned Barriers in the Karnali River System

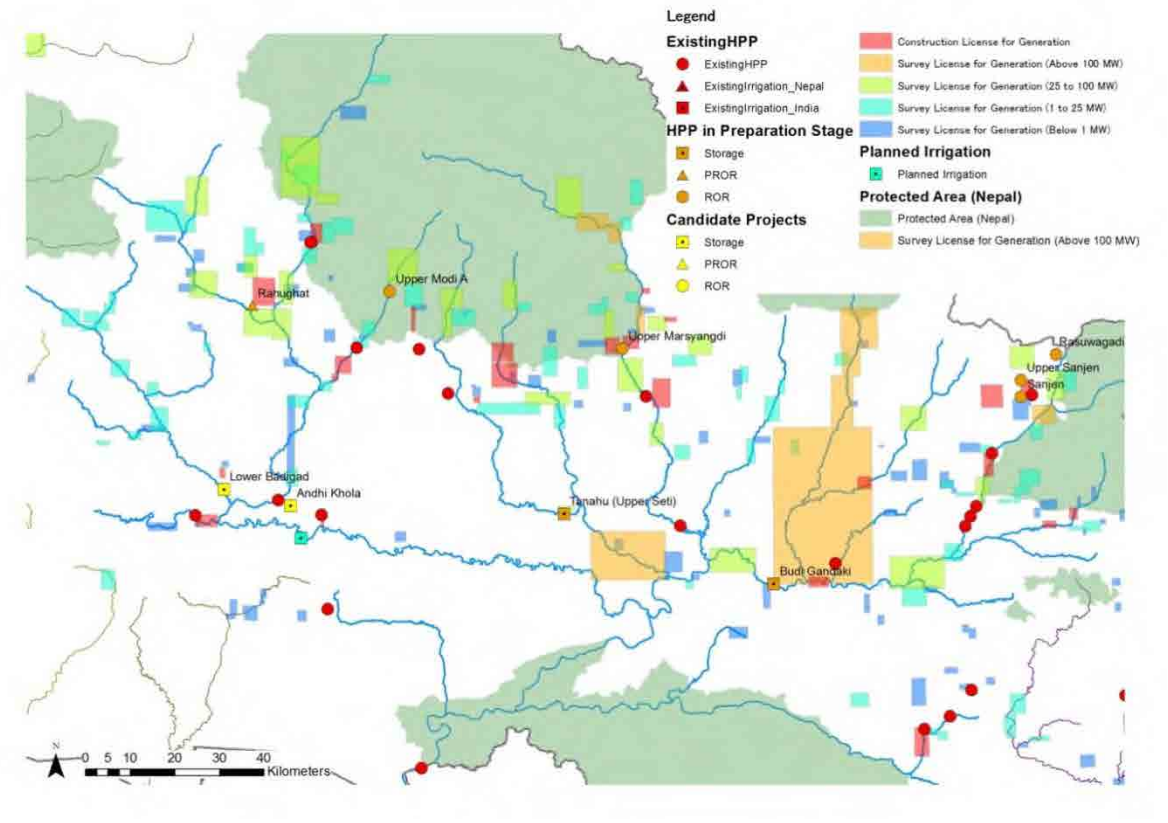


Figure 12.1.5-5 Existing and Planned Barriers in the Gandaki River System

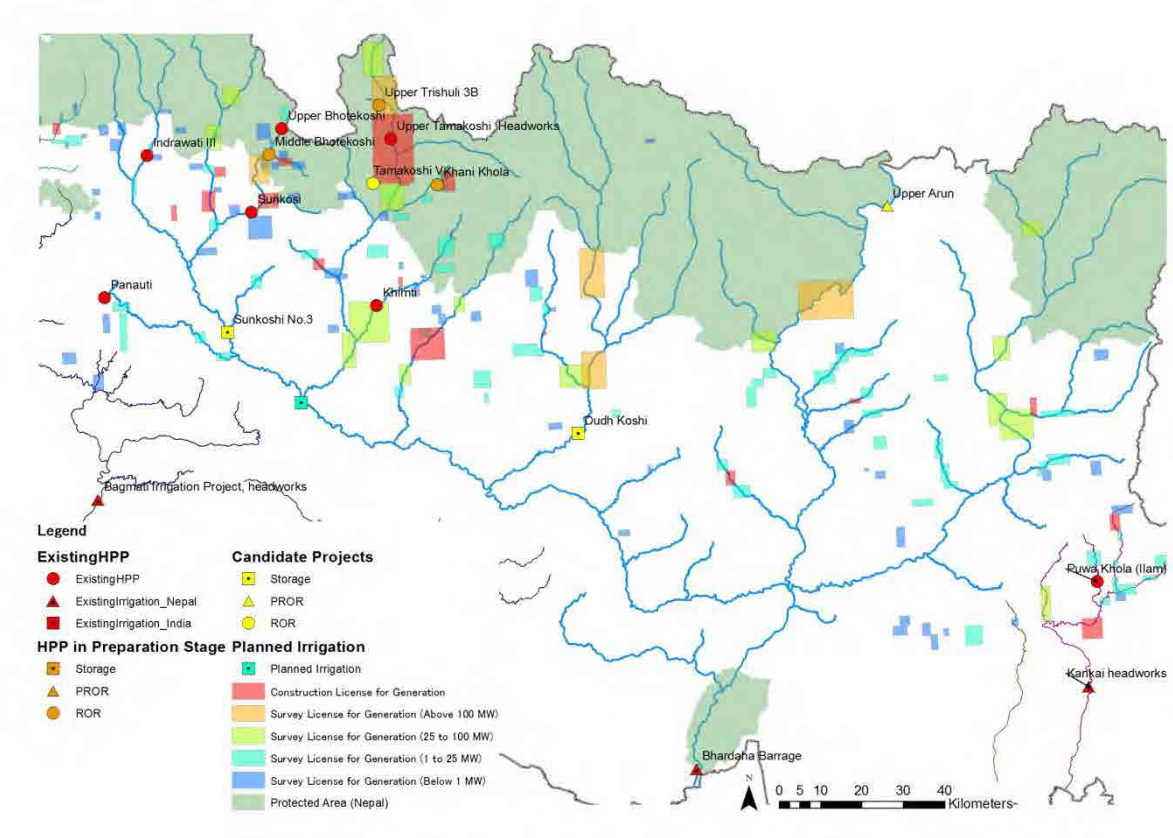


Figure 12.1.5-6 Existing and Planned Barriers in the Koshi River System

(3) Impact on terrestrial ecosystems through development concentration.

The impact on the forest ecosystem will be accelerated by road construction together with HPP and irrigation projects. The high risk areas are the Bajhang District in the Far-Western region, Mugu District, Humla District, Kalikot District, Jajarkot District in the Mid-Western region, Myagdi District, Kaski District, Lamjung District in the Western region, Rasuwa District in the Central region, and Solukhumbu District, Sangkhuwasabha District, Taplejung District in the Eastern region. Without putting in place appropriate controls, encroachment, illegal logging, illegal hunting, and illegal fishing might expand around the project's concentrated area.

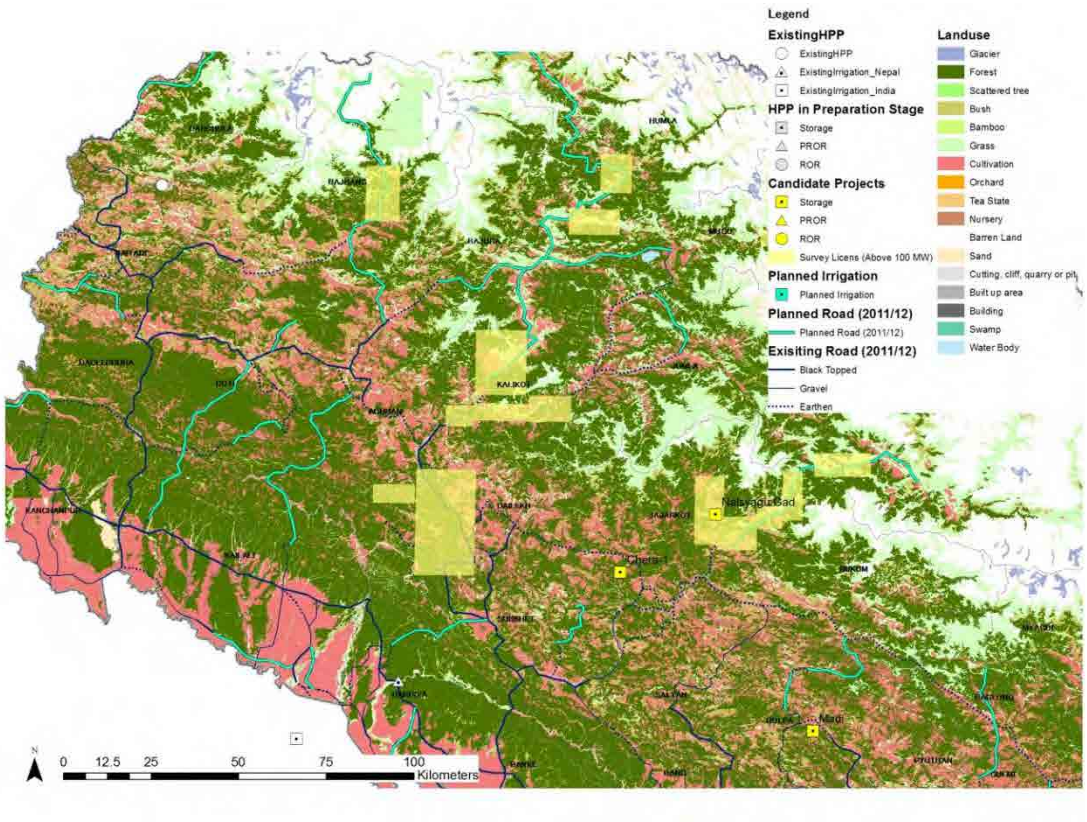


Figure 12.1.5.7 Land Use and Existing and Planned Projects (West)

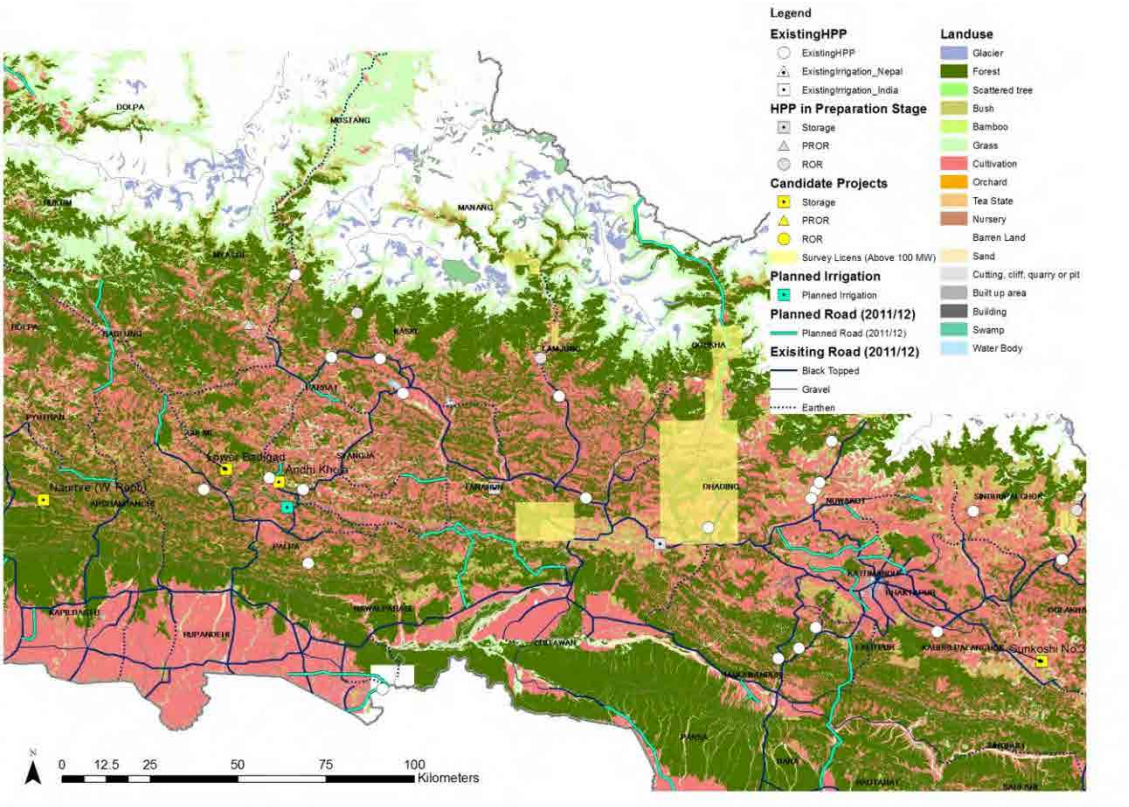


Figure 12.1.5-8 Land Use and Existing and Planned Projects (Center)

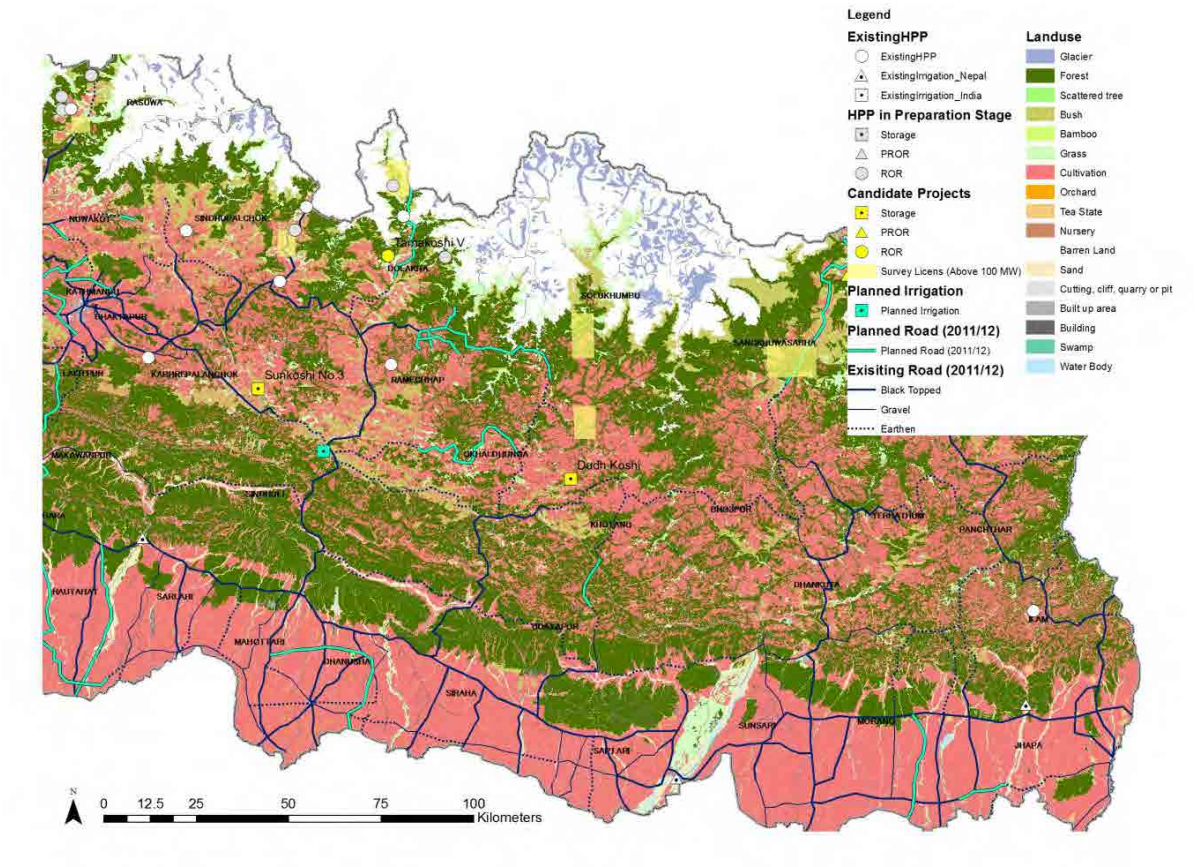


Figure 12.1.5-9 Land Use and Existing and Planned Projects (East)

12.1.6 Mitigation Measures

(1) Mitigation for Individual Project

Chera-1 Project

One of the issues of concern in the Chera-1 Project is compensation for resettlement. A survey should take enough time for more than 550 resettlements and be sure to give equality for people during negotiations. If possible, all of the villagers will be able to move to the same area along with their culture. It should also take enough time for a survey for the 60 km transmission line.

Lower Jhimruk Project

The Lower Jhimruk Project needs a detailed biological survey in EIA because a relatively high number of important species are identified. Important forest and grass land as habitats for wildlife should also be identified. The negotiation process for resettlement should be done carefully for ethnic minorities even if the number of people resettled is around 200. Compensation for income from agriculture and fishery should be considered including vocational training.

Madi Project

The Madi Project needs a detailed biological survey including a fish survey and careful

mitigation measures in EIA, because floral diversity and the number of important fish species are relatively high.

Nalsyau Gad Project

A preliminary transmission survey will be required before EIA or IEE for the transmission line, because the route is around 112 km long. A water regulation plan during the rainy season and dry season should be carefully determined in order to minimize the impact on the protected area and protected species. The household survey for the resettlement should take enough time because it counts around 300 households.

Naumure (W. Rapti) Project

The Naumure Project needs a detailed biological survey in EIA, because 8 km^2 of forest land will be submerged and it will cause habitat loss for terrestrial fauna. Vocational training for people who cannot live on farming might be required because more than 6 km^2 of farm land will be lost.

Lower Badigad Project

The Lower Badigad Project needs a detailed biological survey in EIA because a relatively large number of important mammals and fishes are identified. Relocation area for 1,500 households should be considered in the early stage of designing. Water regulation in the rainy season and the refresh rate in the dry season should be carefully examined considering the impact on the protected area and protected species.

Andhi Khola Project

There is an 11 MW existing off-grid HPP in the reservoir of the Andhi Khola Project. If it has to be stopped for the construction, alternative electricity supply to local people should be considered. In addition to provision of a settlement area for more than 500 resettlements, some income compensation should also be considered for the affected retailing store.

Dudh Koshi Project

A slightly wider area for the mammals and birds survey will be required in order to identify the migration route in the EIA study. The offset mitigation for fish should be considered at an early stage of the EIA study. The number of resettlements is low, but the farm land in the reservoir area is very fertile. It means income compensation for many farmers might be required. The existing EIA report was made based on data in 1997 and it was not approved by the Ministry of Environment. Then the EIA study should be conducted again and get a certificate through the Ministry of Environment.

Kokhajor-1Project

Forest compensation should be considered carefully in the EIA study. The study for resettlement should be taken care of for each ethnic minority group, even if the number of resettlements is 200, which is relatively low.

Sun Koshi No.3 Project

The compensation process would be critical for the Sun Koshi No.3 Project, because the

number of resettlements will be more than 1,500. In addition, there are some accommodations for tourists. Alternatives for 15 km national highway which will be submerged in the reservoir area should also be prepared. Vocational support and entrepreneurial capability building might be needed for the farmers and fishermen who lose their source of income.

(2) Mitigation for Cumulative Impact

Mitigation for cumulative impact often involves a number of ministries and the mitigation that can be implemented on a project-by-project basis is very small. The following are the suggestions recommended for three kinds of impact.

Impact on the downstream wetland ecosystems by flow rate adjustment

In case there are a number of projects in the same river system, the impact by water regulation will be significant even if the water regulation rate of each project is not so high. The following are some proposals to reduce such effects even a little.

a) Re-regulating reservoir

A re-regulating reservoir is one of the solutions to average the daily variation of water discharge. It will maintain downstream aquatic ecology and avoid risk to humans and wildlife. However, this might become another barrier for fishes and it cannot control annual variation.

b) Coordinate operation

Coordinated operation of several storage-type hydroelectric power plants in the same river system might be able to reduce the cumulative impact. In a place where accidents by sudden flooding are a concern, careful control of water regulation timing and rates are recommended.

c) Strategic watershed development control

Strategic watershed planning for each watershed with its conservation target is needed coordinating with the Ministry of Energy, Ministry of Irrigation, Department of Water Supply, Department of Soil Conservation and Watershed Management, Ministry of Forests and Soil Conservation and other sectors. The acceptable water regulating revel should be identified from the point of view of wildlife conservation. Then total volume control can be planned.

Barrier effects on migration fish

Hydropower, irrigation, and water supply will block fish migration. Many planned barriers will accelerate higher risk. The following are some suggested mitigations for this.

a) Minimizing the number of barriers

Smaller numbers of barriers are better for fishes. Even if fish ladders or other mitigations are installed, they are not perfect mitigation which restores rivers to their original condition. To

minimize the number of barriers, constructing a limited number of storage type HPPs seems better than the construction of many small ROR type projects.

b) Barrier free river

Keep at least one or two tributary river corridors in each of the west, center and east areas for the maintenance of key Himalayan fish species. For example, the Thuli Gad and Barun Khola in the Karnali system, the Lundri Khola in the Rapti system, and the Badigad Khola and Budhi Khola in the Gandaki system might be candidate rivers. However, it is recommended to identify these barrier free rivers once the fish conservation plan has been developed. This plan will be developed based on a nationwide fish census to be described hereinafter.

c) Fish ladders and hatcheries

Fish ladders/hatchery are not perfect mitigations but they are better than doing nothing at all. Legalizing provision of fish ladders for projects with dams less than 30m high (hydropower, irrigation, or water supply projects) not only for new projects but also existing projects is recommended. It is also recommended to legalize fish hatcheries in order to deliver affected fish resources for all the projects with dams higher than 30m. If possible, delivering fish resource systems from existing and planned fish hatcheries might be effective after detailed examination of the genetic lineage between the rivers.

d) Fish migratable flashing gate

Some new barriers will attach sediment flushing gates at the bottom to the middle level of the dam. If some additional devices might be attached on the gate, fishes might be able to migrate after flushing.

e) Nationwide fish census

Conducting a nationwide fish census is recommended in Nepal. There is no reliable fish distribution database and it is difficult to see the actual impact and effect of existing barriers. In order to identify hot spots for fish, a periodic nationwide fish census survey is highly recommended.

f) Fish conservation plan

Formulation of a fish conservation plan is required before Nepali fish diversity falls into a critical situation. In addition to the cumulative barrier effect, the invasion of exotic fishes to Nepal is also anticipated. Based on the fish monitoring result, a fish conservation plan should be prepared. This fish conservation plan might be useful for appropriate watershed management. Formulating a fish conservation plan is necessary to accomplish sustainable development and the Directorate of Fisheries Development and international NGOs will take on big roles for this formulation.

<u>Countermeasures against the Impact of Development Concentration</u>

a) Strategic watershed development control

Strategic watershed development control is required before deregulated development and forest loss. Even if it is outside of the protected area, some forests used for migration corridors and some high grade ecosystem sometimes remain. Such kind of places should be identified and informed to the development department.

b) Assured tree planting

The forest norm in Nepal is giving options to the developer such as planting trees or paying compensation fees to the Department of Forestry. But sometimes, the compensation fee is not correctly used for planting trees, because of lack of planting area. In order to assure planting of trees, developers should be responsible for tree planting from start to finish.

c) Construction road management

Construction of road and access roads for hydropower plants might become a trigger of illegal logging. In case the roads connect to high value forests, they should be controlled carefully.

d) Specialized mitigation organization

Installation of a mitigation organization might be useful. Many HPPs including small size ones will be developed in a few decades in Nepal. However, it is a bit difficult to impose implementation of effective environmental mitigation on each project owner, because they are not biology professionals. In some cases, not only the planning of mitigation measures but also monitoring and operation are not able to be expected by project owners. In order to solve these problems, establishment of specialized organization in mitigation which covers all the mitigation planning and monitoring work and which is paid by project owners is required. With this kind of organization, rehabilitation of heavily damaged areas can be concentrated on effectively and efficiently.

12.1.7 Stakeholder Meeting

During the Study period, a total of three stakeholders meetings have been conducted in Kathmandu, inviting the mass media, representatives of government agencies and political parties. At the second and third stakeholders meetings, holding of those meetings was told to related districts in which promising projects are located. However, there were no participants from these districts.

In addition, interviews and hearings were conducted with a wide range of stakeholders such as the western regional office of Pokhara, ministries related to environment and forest, and SEA report evaluation meeting members composed of NGOs, the WWF, each of the related district offices and residents.

The details of these consultations are shown in Chapter 12 of the SEA Report (Appendix 3) and the Annex 12-21 of the SEA Report in Appendix 5.

(1) The 1st Stakeholders Meeting

On February 17, 2012, the first meeting that was co-hosted by the NEA and the Study Team was

organized in Kathmandu. 51 participants including the Study Team were recorded for this meeting.

The purpose of this stakeholders meeting was to enable the stakeholders to understand the objective, goal, study method and schedule, etc. of the Study, and to obtain comments on the appropriateness of evaluation items. In the meeting, the Study Team introduced about 67 candidate projects and explained the evaluation items with which the candidate projects are evaluated. Collection of comments by a questionnaire survey was also conducted to understand which evaluation items the stakeholders put importance on.

(2) The 2nd Stakeholders meeting

On November 28, 2012, the second meeting that was co-hosted by NEA and the Study Team was organized in Kathmandu. 83 participants including the Study Team were recorded for this meeting.

In this second stakeholders meeting, the process of selecting 10 promising projects among the above 67 candidate projects and their results were explained. Preliminary reports of the site survey of these 10 promising projects, and draft of the evaluation method of these projects were also explained. In the meeting, hearing and collecting the comments to understand the stakeholders' opinions about the evaluation items with which promising projects were evaluated.

(3) The 3rd Stakeholders Meeting

The Study team conducted the evaluation about the 10 promising projects, taking into consideration the comments raised in the second stakeholders meeting and the result of site survey, with the purpose of sharing the results of the Study and the evaluation of 10 promising projects.

On February 13, 2013, the third meeting that was co-hosted by the NEA and the Study Team was held in Kathmandu. 107 participants including the Study Team were recorded for this meeting.

In this meeting, the results of the power demand forecast and the evaluation results of promising projects taking into account the comments collected in the second stakeholders meeting were explained. The opinions were collected from stakeholders about the points which should be carefully noted for making the master plan of storage type hydroelectric power development.

12.2 Suggestions for EIAs in the FS stage

12.2.1 Required documents for Environmental and Social Consideration

(1) Environment Impact Assessment (EIA/IEE)

EIA procedures in Nepal are stipulated in the Amendment (January 27, 2010) of Environment

Protection Regulation (1997) and National Environment Impact Assessment Guidelines (1993). Amendment (2010) requires IEE for transmission projects of more than 132 kV and hydropower projects whose output is from 1MW to 50 MW. EIA is required for hydropower projects which have an output of more than 50 MW. The matters to be mentioned in IEE/EIA are also stipulated in EPR 1997 (See Section 4.4, Appendix 3 SEA report). Table 12.2.1-1 shows the required documents for hydropower and related projects.

Table 12.2.1-1 Required EIA Documents for Transmission Lines and Hydropower Plants

Project Type	Project size	Required Document
Transmission line	132 kV and more	IEE
Hydropower plant	1MW to 50 MW	IEE
	more than 50MW	EIA
Rural Electrification Projects	-	-

Source: Environment Protection Regulation (1997) Amendment (2010)

(2) Environmental Management Plan

The JICA Guidelines for Environmental and Social Consideration 2010 (Hereafter referred to as JICA Guidelines) treat the Environmental Management Plan (EMP) as a part of EIA. But if it requires an updated EMP based on a detailed design, it can be prepared independently.

(3) Resettlement Action Plan

JICA Guidelines are suggesting to follow OP 4.12, Annex A - Involuntary Resettlement Instruments by prepared the World Bank when a large number of resettlements will happen. Table 12.2.1-2 shows the required information of RAP based on OP 4.12, Annex A. All the possible projects for FS have to prepare RAP.

Table 12.2.1-2 Required Information of RAP

1. Description of the project.
2. Potential impact.
3. Objectives.
4. Socioeconomic studies. The findings of socioeconomic studies to be conducted in the early stages of project preparation and with the involvement of potentially displaced people, including
   - (a) The results of a census survey
   - (b) Other studies describing the following
     - (i) land tenure and transfer systems,
     - (ii) the patterns of social interaction in the affected communities,
     - (iii) public infrastructure and social services that will be affected; and
     - (iv) social and cultural characteristics of displaced communities.

5. Legal framework.
6. Institutional Framework.
7. Eligibility.
8. Valuation of and compensation for losses.
9. Resettlement measures.
10. Site selection, site preparation, and relocation.
11. Housing, infrastructure, and social services.
12. Environmental protection and management.
13. Community participation. Involvement of people resettling and host communities,

    (a) a description of the strategy for consultation with and participation of people resettling and hosts in the design and implementation of the resettlement activities;

    (b) a summary of the views expressed and how these views were taken into account in preparing the resettlement plan;

    (c) a review of the resettlement alternatives presented and the choices made by displaced persons regarding options available to them, including choices related to forms of compensation and resettlement assistance, to relocating as individuals, families or as parts of preexisting communities or kinship groups, to sustaining existing patterns of group organization, and to retain access to cultural property (e.g. places of worship, pilgrimage centers, cemeteries); and

    (d) institutionalized arrangements by which displaced people can communicate their concerns to project authorities throughout planning and implementation, and measures to ensure that such vulnerable groups as indigenous people, ethnic minorities, the landless, and women are adequately represented.
14. Integration with host populations.
15. Grievance procedures.
16. Organizational responsibilities.
17. Implementation schedule.
18. Costs and budget.
19. Monitoring and evaluation.

Source: OP 4.12, Annex A - Involuntary Resettlement Instruments, World Bank

(4) Indigenous People Plan

JICA Guidelines suggest Indigenous People Plan (IPP) which includes the contents in OP 4.10, Annex B – Indigenous People Plan, if the projects affect indigenous people. IPP should be prepared when impact on indigeuous people by implementing the projects is obvious. Table 12.2.1-3 shows the main contents of IPP based on the OP 4.10, Annex B (World Bank).

Table 12.2.1-3 Required Information of IPP

(a) A summary of the information referred to in the following.
- A review, on a scale appropriate to the project, of the legal and institutional framework applicable to Indigenous Peoples.
- Gathering of baseline information on the demographic, social, cultural, and political characteristics of the affected Indigenous Peoples' communities, the land and territories that they have traditionally owned or customarily used or occupied, and the natural resources on which they depend.

(b) A summary of the social assessment.

(c) A summary of results of the free, prior, and informed consultation with the affected Indigenous Peoples' communities that was carried out during project preparation and that led to broad community support for the project.

(d) A framework for ensuring free, prior, and informed consultation with the affected Indigenous Peoples' communities during project implementation.

(e) An action plan of measures to ensure that the Indigenous Peoples receive social and economic benefits that are culturally appropriate, including, if necessary, measures to enhance the capacity of the project implementing agencies.

(f) When potential adverse effects on Indigenous Peoples are identified, an appropriate action plan of measures is drafted to avoid, minimize, mitigate, or compensate for these adverse effects.

(g) The cost estimates and financing plan for the IPP.

(h) Accessible procedures appropriate to the project to address grievances by the affected Indigenous Peoples' communities arising from project implementation. When designing the grievance procedures, the borrower takes into account the availability of judicial recourse and customary dispute settlement mechanisms among the Indigenous Peoples.

(i) Mechanisms and benchmarks appropriate to the project for monitoring, evaluating, and reporting on the implementation of the IPP. The monitoring and evaluation mechanisms should include arrangements for the free, prior, and informed consultation with the affected Indigenous Peoples' communities.

Source: OP 4.10, Annex B - Indigenous Peoples Plan, World Bank

12.2.2 Comprehensive Scoping in FS stage

It is difficult to conduct site specific scoping, because it is undecided which projects will be selected for the next FS. Then comprehensive scoping for ten promising projects is conducted. The risk of land slide around the reservoir might be high, because most of the sites are located in precipitous terrain. The risk of water accidents would rise if there is no re-regulating pond. The low rate of water rotation might cause eutrophication and dams without sedimentation flushing gates raise the flood risk near the back water of the reservoir. All the dams block migration of fishes. If the construction of the transmission line divides the forest, it will have an impact on the environment; the animal migration will be inhibited and the land use of the ground under the transmission line will be limited.

The Table 12.2.2-1 shows scoping for hydropower plants and Table 12.2.2-2 shows scoping on transmission lines.

Table 12.2.2-1 Comprehensive Scoping for Hydropower Plant

Items		Possible Impact	
		Construction Period	Operation Period
Physical	Air	Exhaust gas from construction vehicles and machines	-
	Water quality	Turbid water	Eutrophication in the reservoir
	Water flow	-	Dewatering area, water flow changing downstream of the powerhouse, flood near the back water of the reservoir, reducing flood at the downstream of the powerhouse
	Waste	Cut trees in the reservoir, left buildings in the reservoir	Waste inflow the reservoir
	Soil pollution	-	-
	Topography and geology	Topographic change by earth work	Landslide around the reservoir, changing erosion and sedimentation patterns downstream of the powerhouse
	Noise and vibration	Noise and vibration from construction vehicle and construction machines, and blasting	-
	Subsidence	-	-
	Odor	-	Odor by eutrophication and sludge in the reservoir
	Bottom sediment	-	Sedimentation of the sludge in the reservoir
Natural	Protected area	-	Impact by changing water flow
	Terrestrial ecosystem	Forest loss, habitat loss	Segmentation of the corridors, Increasing of the illegal logging and hunting Cumulative impact of ecosystem
	Aquatic ecosystem	Barrier on fish migration route	Habitat change by water flow, water temperature, water quality, Increase of illegal fishing Cumulative impact on the protected area downstream Cumulative impact on migration fishes
Social	Resettlement	Resettlement, land acquisition, structure loss	-
	Water use	Damage on water sources and water supply system	Decreasing of the irrigation water at the dewatering area and downstream of the powerhouse
	Accident	Accidents by construction vehicles and blasting	Drowning by peak generation
	Life and livelihood	Loss of job by land acquisition	Income loss by changing water flow
	Land use and natural resource use	Loss of Farm land, agroforestry, quarry, intake, and pasture area	Land loss by landslide
	Infrastructure	Fragmentation of road, bridge, electricity line, water pipe, irrigation, and telephone line	-
	Culture	Temple, worship places	-
	Landscape	-	Landscape impact by weir
	Ethnic minority and indigenous people	Diaspora by resettlement	-
	Working environment and work safety	Infectious disease by workers	-

Table 12.2.2-2 Comprehensive Scoping on Transmission Line

Item		Possible Impact	
		Construction Period	Operation Period
Physical	Air	Exhaust gas from construction vehicles and machines	-
	Water quality	Turbid water	-
	Water flow	-	-
	Waste	Cut trees	-
	Soil pollution	-	-
	Topography and geology	Topographic change by earth work	-
	Noise and vibration	Noise and vibration by construction vehicles and machines	-
	Subsidence	-	-
	Odor	-	-
	Bottom sediment	-	-
Natural	Protected area	Fragmentation of the protected area	Fragmentation of the protected area
	Terrestrial ecosystem	Forest loss	Fragmentation of the migration route, increasing illegal logging and hunting
	Aquatic ecosystem	-	-
Social	Resettlement	Resettlement and land acquisition by towers	Land use restriction under the transmission line
	Water use	-	-
	Accident	Traffic accidents by construction vehicles	-
	Life and Livelihood	Loss of job by land acquisition	Income loss by land use restriction
	Land use and natural resource use	-	-
	Infrastructure	-	-
	Culture	-	-
	Landscape	-	Impact on landscape at the view points by tower and transmission lines
	Ethnic minority and indigenous people	Diaspora by resettlement-	-
	Work environment and work safety	Infectious disease by workers	-

12.2.3 Attention issues of the Physical Environment

(1) Air quality

- Anticipated Impact: Impact on air would be mainly gas emission caused by construction vehicles and trucks and dust caused by trucks.
- Suggestions for survey: It might be possible to assess the impact without site survey because all the projects are located in an area where air pollution is not high. If an air quality survey is conducted as a baseline of monitoring, the dry season should not be excluded, the day time of weekdays should be selected, and the main trunk road which will be used for truck route should be selected.
- Suggestions for impact assessment: After confirming the truck route and the number of trucks, the possible affected area should be marked on the map and the number of affected houses should be estimated. The possible impact should be clearly explained to the affected people at

the Stakeholder Meetings and EIA report.

- Suggestions for mitigation planning: An alternative truck route can be considered if there is not any effective mitigation.
- Suggestions for monitoring planning: Monitoring items should be include both ambient air and vehicle gas emission. Monitoring points, items, timing, measuring methods, survey time, responsible organization, reporting format, target value, and audit timing should be identified. Penalty rules can be suggested for not fulfilling the target value.

(2) Water quality

- Anticipated impact: Discharge of turbid water during construction, turbid water, nutrient enrichment, anoxic water mass, and low water temperature layer generation in the reservoir; and the impact on the river water quality by discharged water from the reservoir during operation. The risk would be high if there is expected population growth without a sewage system. The impact on river water might affect not only fish but also water use downstream such as for irrigation, drinking water supply, and/or industrial water supply.
- Suggestions for the survey: Water sampling points should cover not only the dam site and the outlet site but also future monitoring points and fish survey points. If possible, the sampling timings should be the same as the fish survey, hopefully four times a year, and at least during the wet and dry seasons.
- Suggestions for impact assessment: The predicted water quality should be shown by water quality items, by locations, and by seasons. If possible the water quality before mitigation and after mitigation can explain the effectiveness of the mitigations. The predicted result should be sent to the biological expert and social expert for their predictions.
- Suggestions for mitigation planning: The mitigation should be designed with civil engineers and the ability to implement as well as the maintenance capability in Nepal should be considered. If possible, several alternatives can be compared.
- Suggestions for monitoring planning: Discharged water monitoring and river water monitoring should be planned respectively. River water monitoring should be planned with fish experts through sampling points of analyzed items, sampling timing, sampling methods, reporting format, target value, and audit timing.

(3) Water flow

- Anticipated impact: Sedimentation in the reservoir might cause a rise in the river bed level at the upper reach of the reservoir. River water discharge will be extremely reduced between the dam and the outlet. The monthly average river discharge will be changed by water storage. If there is no reregulating reservoir, the river water downstream of the outlet will be increased rapidly by peak generation. The river water volume will be changed by sand flush operation. Reduction of ground water or springs by tunneling is anticipated as well. If some activities, such as irrigation, drinking water intake, industrial water intake, fishery, river bathing, cloth washing, rafting, exist in the water flow impact area, they might be affected. If there are some

storage type dams in the same river system, the impact will be cumulated after the confluence.

- Suggestions for the survey: River crossing measurements at high risk points are suggested for correct impact assessment. Survey points should be carefully selected with the social survey expert.
- Suggestions for impact assessment: Water volume, water level and current velocity should be predicted by month and time considering peak generation and sand flush operation. If it is required, prediction result of sedimentation, river bed degradation by a topography and geology expert could be used. The prediction results of water flow should be shared with a social expert and explained clearly to the affected people at the stakeholder meeting. If there are some irrigation dams or storage type power plants in the same river system, cumulative impact at the Indian border should be assessed to confirm the consistency of the Gandak Irrigation and Power Project Agreement and the Kosi Project Agreement.
- Suggestions for mitigation planning: Mitigation should be selected feasible and practical items with civil engineers, if possible alternative mitigations could be compared by effectiveness and cost. Responsible organizations for mitigation, initial cost, maintenance cost should be examined as well.
- Suggestions for monitoring planning: High risk points should be selected as monitoring points. Responsible organizations, monitoring timing, reporting format, target value, audit organizations, and audit timing should be planned.

(4) Waste

- Anticipated impact: Wreckage of building and removed plants in the reservoir area, waste oil, waste wood, waste metal, waste plastics, domestic waste from construction sites might be produced during construction. Floating waste captured by screens will be generated during whole operation year.
- Suggestions for the survey: The exact volume of generated waste should be surveyed, treatment methods should be studied, and management costs at similar projects should be estimated.
- Suggestions for impact assessment: The possible waste volume should be estimated considering the difference of project sizes.
- Suggestions for mitigation planning: Practical and effective measures should be suggested to avoid similar problems with other projects. Classification and recycling of waste should be considered for reduction of its volume.
- Suggestions for monitoring planning: Volume of generated waste and treatment ways should be periodically monitored during construction and operation respectively.

(5) Topography and geology

- Anticipated impact: The landform will be changed by quelling and dumping. The river bed level downstream of the dam might be lowered by decreased sediment supply if there is no sand flush gate at the dam. The risk of landslides would be higher around the reservoir. Huge

amounts of sediment might flow in the reservoir when a GLOF occurs. Landslides might be caused by Access Roads and/or Transmission Lines if civil work is inadequate.

- Suggestions for the survey: Landslide surveys should be done in the area above the minimum operation level and high risk areas should be identified. The survey results should be recorded in a survey slip format with latitude and longitude, and photo shooting direction in order to use in the monitoring survey in a later stage.
- Suggestions for impact assessment: Predicted points with a high risk of land slide should be sent to social experts and used for the impact assessment on land use. The predicted results should be explained clearly to the affected land owners at the stakeholders meeting or in other ways.
- Suggestions for mitigation planning: Feasible and practical methods in Nepal should be taken based on land use and impact the extent of discussions with civil engineers.
- Suggestions for monitoring planning: Monitoring points, report format, and frequency should be planned for each assessed impact.

(6) Noise and vibration

- Anticipated impact: Noise and vibration are the main issues during construction. Vibration on houses caused by transporter vehicles, noise from rock quarries and plant operation, and building cracks caused by blasting work might draw complaints.
- Suggestions for the survey: If the survey is re-commissioned, the survey time, location, timing, and measurement methods should be clearly instructed, because the survey methods are not strictly stipulated by the Nepalese government. The working area, truck route, blasting points, and location of buildings should be confirmed. The existing cracking and leaning of the buildings can be recorded before the start of construction, if required.
- Suggestions for impact assessment: The impact area should be identified based on the work layout maps. If there are any schools/hospitals in the impact area, alternative truck routes should be examined with civil engineers. The possible extent of the impact, timing, and duration should be clearly explained to the possibly affected people at the stakeholders meeting.
- Suggestions for mitigation planning: Practical and sustainable mitigation measures in Nepal should be suggested. Several alternatives can be compared.
- Suggestions for monitoring planning: Survey points, timing, survey methods should be instructed in detail.

(7) Odor

- Anticipated impact: Odor might be generated when domestic waste and human waste are not treated appropriately. Reservoirs without a sand flushing gate might cause odor from sludge in the reservoir.
- Suggestions for the survey: Distribution of the houses which might be affected by odor should be identified.

- Suggestions for impact assessment: It is a bit difficult to estimate the exact impact area and extent of the impact of the odor, but if the odor risk cannot be excluded, the risk should be explained to the possibly affected people at the stakeholders meeting.
- Suggestions for mitigation planning: In order to reduce the odor risk, the layout of the working area can be examined with civil engineers, for example, domestic waste and human waste treatment facilities could be located as far as possible from local houses.
- Suggestions for monitoring planning: Survey points, survey methods, and the reporting format should be instructed in detail.

(8) Sedimentation

- Anticipated impact: Reservoirs without a sand flushing gate might suffer from sedimentation.
- Suggestions for the survey: Land use, terrain slope, land slide, water volume, and rainfall in the river system will be gathered.
- Suggestions for impact assessment: Sediment volume and sedimentation speed will be estimated by civil engineers.
- Suggestions for mitigation planning: Practical and sustainable mitigation measures at the project site should be selected by comparing various types of mitigation measures.
- Suggestions for monitoring planning: Discussing with civil engineers, suitable monitoring points, monitoring methods and reporting formats should be examined.

12.2.4 Attention issues of the Natural Environment

(1) Protected Area

- Anticipated impact: Candidate projects are not located in a protected area but protected areas exist downstream. If there are several major irrigation systems and hydropower plants, reduction of river flow in the wet season, increase of river flow in the dry season, fewer floods, and deduction of yearly river flow might become cumulative. If this happens, the impact would affect the species and ecosystems in the protected area which depend on natural water flow and floods.
- Suggestions for the survey: Major planned and existing irrigation facilities and storage type hydropower plants should be examined for their regulation rates.
- Suggestions for impact assessment: Monthly simulation of river water flow at the point in the protected area is recommended. The impact on protected area could be examined with the Department of National Parks and Wildlife Conservation and NGOs.
- Suggestions for mitigation planning: The mitigation through one project would be limited. Then cooperative mitigations with other projects would be recommended.
- Suggestions for monitoring planning: The monitoring plan should include compliance monitoring.

(2) Plants

- Anticipated impact: Vegetation loss around rivers due to hydropower projects is inescapable. Even if the types of vegetation are common ones but are used by animals as a migration route, the vegetation loss might affect the habitat of the migrating species.
- Suggestions for the survey: Not only the location of the protected species but also the vegetation used frequently by protected animals should be identified. The area of invasive species, degraded vegetation and erosion area should be identified as well. The survey should be conducted at least two times a year in the wet and dry seasons. The survey area should include reservoirs, dams, generation plants, camp sites, quarries, dumping sites, access roads, construction roads, and transmission routes. It should be expanded to the tree planting area for mitigation.
- Suggestions for impact assessment: Loss of a vegetation area should be predicted by the vegetation class. Predictions of disappearance should be done for protected plants.
- Suggestions for mitigation planning: Mitigation of planting and transplanting should be explained with its area, timing, and methods in detail.
- Suggestions for monitoring planning: Both compliance monitoring and impact monitoring should be included. Monitoring locations, timing and frequency should be instructed in detail.

(3) Terrestrial animals

- Anticipated impact: Vegetation along the river is likely to be used for migration routes for some terrestrial animals. Reservoirs, access roads, and transmission lines might also be barriers for migrations.
- Suggestions for the survey: In order to raise the survey accuracy, Japanese professional surveyors are hopefully placed by categories (mammal, bird, reptile, amphibian and insect). If there are any protected species in the project area, it is recommended to expand the survey area and identify the habitat position in the entire habitat.
- Suggestions for impact assessment: Get information about the vegetation change and land use change from plant experts and social experts, and the possible affected habitat should be identified.
- Suggestions for mitigation planning: Mitigation might include preservation of important habitat and defragmentation of the migration route. The exact location of the mitigation should be instructed in detail.
- Suggestions for monitoring planning: The monitoring plan should include monitoring points, timing, methods, and the reporting format in detail.

(4) Aquatic species

- Anticipated impact: Construction of barriers will block migration of cold water fishes for spawning. If the river is the last river in the river system which has no barrier for cold water fishes, the risk of extinction of the species would be extremely high. Changing of the water

environment such as water quality, water volume, and water temperature might cause a serious impact on resident species as well.

- Suggestions for the survey: The wet season (which is migration season) should not be excluded from the survey time. If possible the other rivers in the same river system would be hopefully surveyed before a detailed survey at the project site. Effectiveness of the mitigation of other hydropower projects in Nepal can be surveyed.
- Suggestions for impact assessment: Get the prediction result from the expert of water quality and water flow, and the extent of impact should be estimated by locations and by species in detail.
- Suggestions for mitigation planning: Mitigation should be practical and sustainable considering the effectiveness of the mitigation of other projects.
- Suggestions for monitoring planning: Monitoring should include both compliance monitoring and impact monitoring.

12.2.5 Attention issues of the Social Environment

(1) Resettlement and land acquisition

- Anticipated impact: All the projects might cause resettlement and land acquisition.
- Suggestions for survey: All the information in the survey area required for RAP should be gathered and arranged in GIS and the database. In order to avoid gaps in the survey, detail survey methods and arrangement methods should be taught to the re-commissioned survey company. The survey area should include a reservoir, power plant, quarry site, construction road, tentative working area, and resettlement area. In order to cover indirect impact, the survey area should expand to houses and land around the direct impact area. In addition to house owners and land owners, tenant farmers, tenants of a house, servants, illegal land users, and non-registered land users should also be surveyed. Elderly people, women, children, disabled people, and poor households should be covered.
- Suggestions for impact assessment: The impact should be distinguished between direct impact, such as resettlement and land acquisition, and indirect impact, such as business degradation or access problems. Permanent impact and temporary impact, such as the land returned after construction, should be distinguished as well. The rules of the buffer zone around the reservoir should be clearly defined and the boundary should be marked on the map. The predicted impact should be clearly explained in the SHM and considered for people who are illiterate.
- Suggestions for mitigation planning: An entitlement matrix should be prepared for all of the anticipated social impact based on the format or RAP. Caution for the compensation rate should not be that different compared to other similar projects around the area. Selectable compensations such as land or money would be more preferable than just one option.
- Suggestions for monitoring planning: Compliance monitoring should be included.

(2) Water use

- Anticipated impact: Spring water use in the reservoir area and over the tunnel route, water use at the recession area, and water use downstream of the dam and outlet might be affected.
- Suggestions for the survey: Locations and user location of the wells over the tunnel route and reservoir should be surveyed. Location, water rights of drinking water intake, irrigation water intake, industrial water intake, fish farming intake and their water discharge should be surveyed in the recession area. The fishery area, sand mining points, clothes washing, river bathing, river side camping sites, rafting activities, and religious activities should be surveyed at the dewatering area as well. Water use timing should be examined too, because some activities might be done only in the wet season. The survey area would be up to the confluence with the bigger river. If serious impact is predicted at some points, the surveyor should ask the water flow expert to add prediction points for the river water level.
- Suggestions for impact assessment: Based on the predicted water flow, impact, impact value, location, and timing should be examined. The people affected should have this explained to them clearly at the SHM or in other ways.
- Suggestions for mitigation planning: If any impact on water use is confirmed, it should be added in the Entitlement Matrix in RAP and prepared in the compensation rules.
- Suggestions for monitoring planning: Monitoring should include both compliance monitoring and impact monitoring.

(3) Accident

- Anticipated impact: Accidents might happen on community roads by construction vehicles and industrial injuries at the site during construction. Flushing water from a dam and an exponential increase in river flow by peak generation might cause water accidents downstream of the dam if there is no re-regulating of reservoirs.
- Suggestions for the survey: School roads and commuting roads, camping sites along the river, and river bathing sites should be surveyed. If possible, previous accidents near the project site or similar projects should be surveyed along with their reasons.
- Suggestions for impact assessment: The overlapped route between truck routes and school roads should be investigated. If any risks are predicted, it should be explained clearly to the affected people at the stakeholder meeting or in other ways.
- Suggestions for mitigation planning: If serious impact is predicted, alternative truck routes should be examined. Compliance with Labor Act 2048 (1992), some measures for the environment of the workers such as industrial accident prevention planning, health and safety planning, and safety education for workers should be prepared in the EMP.
- Suggestions for monitoring planning: In addition to monitoring for probable accidents, compliance monitoring for mitigation should also be planned.

(4) Life and Livelihood

- Anticipated impact: Not only for people affected by resettlement or land acquisition, but also for people affected only by water use who might have difficulty in their life and livelihood. People who have to release their cultivation land and/or a business which loses customers might be affected even if they do not need to be relocated. Fish farming, fishery, sand mining and rafting businesses might also have their income decreased.
- Suggestions for the survey: All the information required for RAP should be surveyed such as current income, possible downturn in income and so on.
- Suggestions for impact assessment: Possible downturn in income and the necessity of changing the work should be assessed one by one.
- Suggestions for mitigation planning: Mitigations should be selectable for the affected people, for example, mitigation for people who would like to change their jobs or mitigation for those who would not like to change their jobs.
- Suggestions for monitoring planning: The monitoring plan should cover not only the monitoring life and livelihood but also compliance monitoring for monitoring.

(5) Use of land and natural resources

- Anticipated impact: Residential land, agricultural land, grazing ground, national forest, community forest, and private forest might be lost through being submerged.
- Suggestions for the survey: Precise maps which show national maps and community forests might not exist. Then the forest boundaries should be clarified by the District Forest Office or Community Forestry User Groups (CFUGs). Attention should be paid if the land category shows the exact land use. If possible, alternative tree planting area for mitigation would be surveyed too. The number of users and actual usage should be surveyed on community forests.
- Suggestions for impact assessment: After identifying the impact area on the map, the exact extent of the impact should be predicted.
- Suggestions for mitigation planning: Although forest mitigation methods are stipulated in the forest guideline (2006) and Forest Norms (2003) by the Ministry of Forest and Soil Conservation, there is a special rule (Shaskiya & Arthik Sudhar-AP 2069_Governance reform-30 Ashoj-2069) for hydropower plants which shows the rate as 1:2 for cutting and planting trees. The detail tree compensation plan can be started after issuance of a construction license. Then the compensation plan in EMP will be a tentative one.
- Suggestions for monitoring planning: The monitoring plan should include compliance monitoring for the planned mitigation.

(6) Infrastructure

- Anticipated impact: The project might affect local infrastructure such as roads, suspension bridges, distribution lines, telephone lines, water supply facilities, sewerage systems, and so on. The impact on roads might cause fragmentation of communities.

- Suggestions for the survey: The location of all the infrastructure on the map should be identified.
- Suggestions for impact assessment: The affected locations should be identified and the infrastructure maps and design maps renewed. The possible community fragmentation area should be identified.
- Suggestions for mitigation planning: Mitigation will reinstall equivalent value as a basic rule. But it can be added value based on a user request.
- Suggestions for monitoring planning: Compliance monitoring for planned mitigation should be included.

(7) Culture

- Anticipated impact: Traditional buildings, buried cultural property, festivals and traditional arts might be lost by inundation.
- Suggestions for the survey: The survey area for intangible cultural properties should be expanded not only directly to the impact area but also to the whole village.
- Suggestions for impact assessment: The impact should be assessed whether the project might affect the sustainability of traditional festivals and/or traditional arts or not.
- Suggestions for mitigation planning: If serious cultural assets are identified, adequate mitigation including trans-buildings should be carefully examined.
- Suggestions for monitoring planning: The monitoring plan should include compliance monitoring.

(8) Landscape

- Anticipated impact: Landscape from viewpoints might be affected by the existence of power plant facilities.
- Suggestions for the survey: Viewpoints around the project area should be visited and the view, yearly users, and main view direction should be examined.
- Suggestions for impact assessment: The landscape after construction from the viewpoints should be simulated.
- Suggestions for mitigation planning: If serious impact on landscapes is predicted, avoidance or minimization measures should be examined.
- Suggestions for monitoring planning: Compliance monitoring should be included.

(9) Ethnic minority and indigenous people

- Anticipated impact: Ethnic minorities are confirmed at all the candidate project sites. Then the impact on these people is anticipated.
- Suggestions for the survey: Required information for the IPP should be gathered in the case that impact on indigenous people is confirmed. More attention should be paid to language,

culture, festival, traditional architecture and traditional natural resources. Not only the affected indigenous people but also the entire distribution of the groups and distribution centers should be examined. Traditional practices for relocation such as the direction, timing, relationship between other groups, and land conditions should be examined. If required, meetings in the group should be supported. If there are any conflicts and problems among or between groups, the actual conditions should be surveyed. Surveys in the dry season would be effective because of road fragmentation by landslides in the wet season.

- Suggestions for impact assessment: Whether the center of the ethnic groups will be affected or not should be assessed. Not only the resources of livelihood but also the resources of festivals or custom should be examined if they are affected. The result of the assessment should be informed not only to the affected people but also to all of the ethnic group if required.
- Suggestions for mitigation planning: Mitigation measures should be considered to avoid diaspora and fragmentation of the ethnic groups, and to sustain cultural inheritance. From selection of the resettlement area to compensation methods, they should not be provided in one way from project owner to the affected people. They should be decided in a participatory way that takes enough time. Make sure to be cautious for conflicts and problems in the groups so they do not become worse.
- Suggestions for monitoring planning: The monitoring plan should be divided into the owner's monitoring and audit monitoring. Adequacy of a grievance adjustment should be monitored as well.

(10) Working environment and work safety

- Anticipated impact: Labor accidents, fights, food poisoning, communicable diseases, and child labor are anticipated.
- Suggestions for the survey: Hearing surveys at nearby and similar projects are suggested and previous work accidents/diseases and their causes should be examined.
- Suggestions for impact assessment: Possibility of the occurrence of similar problems should be predicted.
- Suggestions for mitigation planning: Precaution measures should be prepared especially for communicable diseases such as HIV/AIDS.
- Suggestions for monitoring planning: The monitoring plan should include both accident monitoring by project owners and compliance monitoring by audit organizations.

Chapter 13

Conclusion and Recommendations

Chapter 13 Conclusion and Recommendations

13.1 Conclusion

The Study Team conducted the "Nationwide Master Plan Study on Storage-type Hydroelectric Power Development in Nepal" for about two years from January 2012 to February 2014. The Study has revealed that, for the base case of the demand forecast, construction of storage-type HPPs totaling 1,993 MW including the Kulekhani No. 3, the Tanahu, and the Budhi Gandaki HPPs that are currently under construction or in the preparation stage is required by FY2031/32 for resolving current load shedding and meeting the increase in power demand.

13.1.1 Power Demand Forecast

The demand forecasting model adopted by the NEA for the nation-wide power demand forecast is a dynamic model employing principles of economic theories, and the Study Team also adopted that model. NEA's model consists of three sub-models: namely, a) a sub-model for domestic sector demand, b) a sub-model for industry, and the commerce and service sector, and c) a sub-model for irrigation. Scenarios of economic growth and prices were reflected in the power demand forecast through setting of parameters.

In addition to the base case, the forecasts for a high case and a low case were conducted, and a sensitivity analysis was conducted. In the high case, GDP growth and a power price increase were set higher than in the base case, and in the low case, they were set lower than in the base case.

As a result, the peak demand and the energy demand in FY 2031/32 were estimated at 4,279 MW and 19,493 GWh respectively for the base case corresponding to 1,027 MW and 5,380 GWh in FY2011/12. The forecasted power demands of each year up to FY 2031/32 are shown in Table 13.1.1-1.

Table 13.1.1-1 Sensitivity Analysis of Power Demand Forecasts

Fiscal year	Comparision of energy demand forecasts (GWh)			Comparision of generation capacity forecasts (MW)		
	Base case	High case	Low case	Base case	High case	Low case
2012/13	5,607	5,537	5,650	1,231	1,216	1,240
2013/14	5,818	5,678	5,907	1,277	1,247	1,297
2014/15	6,049	5,851	6,202	1,328	1,284	1,361
2015/16	6,294	6,031	6,514	1,382	1,324	1,430
2016/17	6,556	6,290	6,847	1,439	1,381	1,503
2017/18	6,836	6,888	7,192	1,501	1,512	1,579
2018/19	7,176	7,512	7,522	1,575	1,649	1,651
2019/20	7,823	8,174	7,869	1,717	1,794	1,728
2020/21	8,504	8,880	8,237	1,867	1,949	1,808
2021/22	9,252	9,670	8,738	2,031	2,123	1,918
2022/23	9,881	10,342	9,307	2,169	2,270	2,043
2023/24	10,572	11,066	9,922	2,321	2,429	2,178
2024/25	11,447	11,974	10,702	2,513	2,629	2,349
2025/26	12,364	13,002	11,538	2,714	2,854	2,533
2026/27	13,325	14,089	12,426	2,925	3,093	2,728
2027/28	14,386	15,260	13,390	3,158	3,350	2,939
2028/29	15,531	16,557	14,426	3,410	3,635	3,167
2029/30	16,744	18,147	15,524	3,676	3,984	3,408
2030/31	18,066	19,993	16,680	3,966	4,389	3,662
203132	19,493	22,166	17,921	4,279	4,866	3,934

13.1.2 Power Development Plan

The total installed capacity of generation facilities in Nepal as of the end of FY 2011/12 was 718,621 kW. Hydroelectric power generation accounts for 93% of this, and 86% of these are ROR-type HPPs. Since their generating capacities drop in the dry season because of a decrease in river flow, the whole supply capacity of the country drops significantly. On the other hand, the power demand peaks in the dry season. Therefore it is necessary to strengthen the supply capacity in the dry season in electric power development from now on.

In general, the generating capacity of thermal power generation is not affected by the dry season. However, since Nepal depends on imports for nearly all of its fossil fuel, a huge amount of foreign currency is necessary for purchasing fuel for thermal power generation. Moreover, costs for long-distance transportation are required because Nepal is a landlocked country. Therefore, it is practically impossible to construct coal-fired or LNG-fired thermal power plants for base load and gas turbine power plants for peak load.

On the other hand, Nepal is rich in hydropower resources and its economically exploitable hydropower is estimated at 42,000 MW. Development of hydroelectric power generation utilizing this plentiful amount of hydropower is one of policies of the country.

Taking these situations into consideration, the power development plan was formulated based on the scenario below.

- The main electric power source in the national grid (INPS) is hydroelectric power generation utilizing hydropower energy that is one of the country's abundant domestic resources.
- Storage-type hydroelectric power generation is developed for securing the supply capacity of

the INPS by compensating the decrease in the supply capacity of ROR-type hydroelectric power generation in the dry season.

- ROR-type hydroelectric power generation is developed continuously for utilizing abundant hydropower energy.
- Imports of electricity from India is kept on for power supply to the areas near the border.
- Power generation using renewable energy like wind power and solar power is promising in the long term. However, this is not considered in the power development plan in the next two decades because the proportion in the INPS is considered to be very small taking into consideration its generation cost and effects on stability of the power network.

The result of the Study shows that 5,268 MW of the generation facilities, including imports from India, is necessary in FY 2031/32 for the base case of the power demand forecast, and the total installed capacity to be constructed for the 20 years from FY2012/13 to FY2031/32 is 4,257 MW including projects currently under construction and in the preparation stage.

The power development plans for the base/high/low cases of the power demand forecast are shown in Table 13.1.2-1.

Table 13.1.2-1 Power Development Plan

Base Case

FY	Project	Total Installed Capacity (MW)	LOLP (%)
(2011/12)	(Existing)	862.1	——
2012/13	--------	862.1	50.375
2013/14	--------	862.1	53.789
2014/15	--------	862.1	57.975
2015/16	**Kulekhani No. 3 (14)**, Chameliya (30), Khani Khola (25)	1,081.1	32.637
2016/17	Upper Sanjen (11), Sanjen (42.9), Upper Trishuli 3A (60), Upper Tamakoshi (456)	1,651.0	2.733
2017/18	Madhya (Middle) Botekoshi (102), Rasuwagadi (111), Rahughat (32), Upper Marsyangdi (50), Mistri (42)	1,988.0	1.575
2018/19	ROR (100 in total)	2,088.0	1.927
2019/20	Upper Trishuli 3B (37), ROR (100 in total)	2,225.0	2.579
2020/21	**Tanahu (140)**, Upper Modi A (42), ROR (100 in total)	2,507.0	1.919
2021/22	Tamakoshi V (87)	2,594.0	3.087
2022/23	**Budhi Gandaki (600)**	3,194.0	0.130
2023/24	--------	3,194.0	0.516
2024/25	ROR (100 in total)	3,294.0	1.225
2025/26	Upper Arun (335), ROR (100 in total)	3,729.0	0.666
2026/27	**Dudh Koshi (300)**	4,029.0	0.336
2027/28	--------	4,029.0	1.079
2028/29	**Nalsyau Gad (410)**	4,439.0	0.440
2029/30	**Andhi Khola (180)**, ROR (300 in total)	4,919.0	1.331
2030/31	--------	4,919.0	1.330
2031/32	**Chera-1 (149)**, **Madi (200)**	5,268.0	1.232

Note: Projects listed in boldface are storage-type projects.
The total installed capacities include import from India.
The allowable upper limit of LOLP is 1.375%, equivalent to 5 days supply shortage in a year.

High Case

FY	Project	Total Installed Capacity (MW)	LOLP (%)
(2011/12)	(Existing)	862.1	——
2012/13	--------	862.1	49.198
2013/14	--------	862.1	51.573
2014/15	--------	862.1	54.322
2015/16	**Kulekhani No. 3 (14)**, Chameliya (30), Khani Khola (25)	1,081.1	27.323
2016/17	Upper Sanjen (11), Sanjen (42.9), Upper Trishuli 3A (60), Upper Tamakoshi (456)	1,651.0	1.945
2017/18	Madhya (Middle) Botekoshi (102), Rasuwagadi (111), Rahughat (32), Upper Marsyangdi (50), Mistri (42)	1,988.0	1.680
2018/19	ROR (100 in total)	2,088.0	2.695
2019/20	Upper Trishuli 3B (37), ROR (100 in total)	2,225.0	3.334
2020/21	Tanahu (140), Upper Modi A (42), ROR (100 in total)	2,507.0	2.625
2021/22	Tamakoshi V (87)	2,594.0	3.923
2022/23	**Budhi Gandaki (600)**	3,194.0	0.345
2023/24	--------	3,194.0	0.967
2024/25	Upper Arun (335), ROR (200 in total)	3,729.0	0.403
2025/26	--------	3,729.0	1.218
2026/27	**Dudh Koshi (300)**	4,029.0	0.824
2027/28	**Nalsyau Gad (410)**	4,439.0	0.309
2028/29	--------	4,439.0	1.167
2029/30	**Andhi Khola (180)**, **Chera-1 (149)**	4,768.0	1.397
2030/31	**Madi (200)**, **Naumure (245)**, ROR (100 intotal)	5,313.0	1.025
2031/32	**Sun Koshi No. 3(536)**, **Lower Badigad (380)**, ROR (100 in total)	6,329.0	0.672

Note: Projects listed in boldface are storage-type projects.
The total installed capacities include import from India.
The allowable upper limit of LOLP is 1.375%, equivalent to 5 days supply shortage in a year.

Low Case

FY	Project	Total Installed Capacity (MW)	LOLP (%)
(2011/12)	(Existing)	862.1	——
2012/13	--------	862.1	51.054
2013/14	--------	862.1	55.341
2014/15	--------	862.1	60.972
2015/16	**Kulekhani No. 3 (14)**, Chameliya (30), Khani Khola (25)	1,081.1	36.845
2016/17	Upper Sanjen (11), Sanjen (42.9), Upper Trishuli 3A (60), Upper Tamakoshi (456)	1,651.0	3.802
2017/18	Madhya (Middle) Botekoshi (102), Rasuwagadi (111), Rahughat (32), Upper Marsyangdi (50), Mistri (42)	1,988.0	2.389
2018/19	ROR (100 in total)	2,088.0	2.716
2019/20	Upper Trishuli 3B (37), ROR (100 in total)	2,225.0	2.678
2020/21	**Tanahu (140)**, Upper Modi A (42), ROR (100 in total)	2,507.0	1.453
2021/22	Tamakoshi V (87)	2,594.0	2.135
2022/23	**Budhi Gandaki (600)**	3,194.0	0.017
2023/24	--------	3,194.0	0.144
2024/25	--------	3,194.0	0.621
2025/26	ROR (100 in total)	3,294.0	1.338
2026/27	Upper Arun (335), ROR (100 in total)	3,729.0	0.712
2027/28	**Dudh Koshi (300)**	4,029.0	0.370
2028/29	--------	4,029.0	1.117
2029/30	**Nalsyau Gad (410)**	4,439.0	0.435
2030/31	--------	4,439.0	1.275
2031/32	**Andhi Khola (180)**, ROR (200 in total)	4,819.0	1.351

Note: Projects listed in boldface are storage-type projects.
The total installed capacities include import from India.
The allowable upper limit of LOLP is 1.375%, equivalent to 5 days supply shortage in a year.

13.1.3 Development Plan of Hydroelectric Power Generation

In the above-mentioned power development plans, the total installed capacities of storage-type HPPs are 1,993 MW for the base case of demand forecast, 3,154 MW for the high case, and 1,664 MW for the low case. Table 13.1.3-1 shows HPPs that are constructed for each case of the demand forecast and commencement years of commercial operation.

Table 13.1.3-1 Storage-type Projects to be implemented

Project	Capacity (MW)	Commissioning Year (FY)		
		Base Case	High Case	Low Case
Kulekhani No. 3	14	2015/16	2015/16	2015/16
Tanahu	140	2020/21	2020/21	2020/21
Budhi Gandaki	600	2022/23	2022/23	2022/23
Dudh Koshi	300	2026/27	2026/27	2027/28
Nalsyau Gad	410	2028/29	2027/28	2029/30
Andhi Khola	180	2029/30	2029/30	2031/32
Chera-1	149	2031/32	2029/30	----
Madi	200	2031/32	2030/31	----
Naumure	245	----	2030/31	----
Sun Koshi No. 3	536	----	2031/32	----
Lower Badigad	380	----	2031/32	----
Total Capacity	----	1,993 MW	3,154 MW	1,644 MW

As shown in Table 13.1.3-2, the investments required for implementation of these storage-type HPPs excluding the Kulekhani No. 3 and the Tanahu projects are US$ 4,209 million (IDC and price contingency are not included) for the base case, US$ 7,149 million for the high case, and US$ 3,257 million for the low case. In addition to these investments to these storage-type HPPs, there is investment to the projects that are now under construction and in a preparation stage, and investment to ROR-type HPPs to be implemented in and after FY2018/19 to meet the power demand in the future.

Table 13.1.3-2 Construction Cost of Storage-type HPPs

Project	Capacity (MW)	Project Cost (million US$)*		
		Base Case	High Case	Low Case
Budhi Gandaki	600	1,118	1,118	1,118
Dudh Koshi	300	873	873	873
Nalsyau Gad	410	737	737	737
Andhi Khola	180	529	529	529
Chera-1	149	452	452	----
Madi	200	499	499	----
Naumure	245	----	728	----
Sun Koshi No. 3	536	----	1,289	----
Lower Badigad	380	----	923	----
Total	----	4,209	7,149	3,257

*: IDC and price contingencies are not included.

13.2 Recommendations

The Study has revealed that construction of storage-type HPPs totaling 1,993 MW (for the base case of the demand forecast) is required by FY2031/32, including the Kulekhani No. 3, the Tanahu, and the Budhi Gandaki HPPs that are now under construction or in a preparation stage, for resolving current load shedding and meeting an increase in demand. Nepal is abundant in hydropower resources, but meanwhile it has difficulty in developing thermal electric power generation. Therefore, hydroelectric power generation will continue to play a predominant role in electric power supply, not only storage-type but construction of hydroelectric power stations including the ROR-type is very important.

The Study Team makes the following recommendations for further development of hydroelectric power generation in Nepal.

13.2.1 Recommendations on Implementation of Next-level Studies

In general, it takes a long time for hydroelectric power projects in a planning stage to be put into operation, and the storage-type hydroelectric power projects which are included in the power development plan also need 10 to 15 years until the start of commercial operation. Therefore, next-level studies on them should be conducted as early as possible for implementation of these projects on their schedule.

Among the storage-type hydroelectric power projects which were studied by the Study Team, the Dudh Koshi, Nalsyau Gad, and Andhi Khola projects were required to be put into operation in the late 2020s, feasibility studies of these projects have already been finished and the next study level is the review of FS or preparation of the detailed project report. The Study Team recommends conducting next-level studies on these projects taking the following matters into consideration.

(1) Confirmation of Background of Project

Common items

- The current situation of economy, society and power sector and challenges
- Actual achievement and future plan of cooperation to the power sector by donor countries and international financial institutions

(2) Information Collection of Existing Studies

Common items

- Collection of information regarding existing studies and update of information by hearings from related organizations

Dudh Koshi Project

- In order to verify the influence on downstream projects such as Sun Koshi Multipurpose Scheme (Phase I) by implementing this project, certain items should be collected. These

include items such as the latest information of the Sun Koshi No. 1 hydroelectric power project, the Sun Koshi diversion project that will divert river water from the Kurule dam located downstream of the Sun Koshi No. 1 dam to the Kamala river for irrigation and hydroelectric power generation, and the Sapta Koshi High Dam hydroelectric power project as well.

Andhi Khola Project

- The latest information about the raising of the intake dam of the existing Kaligandaki A hydroelectric power plant which locates downstream of this project, and the information about the existing Andhi Khola hydroelectric power plant (IPP) that will be affected by implementing this project.

(3) Review of Layout

Common items

- Verification of the optimum type and height of the dam, waterway route, type and location of the powerhouse

Dudh Koshi Project

- Management of sedimentation produced by a GLOF
- Influence on downstream projects such as the Sun Koshi Multipurpose Scheme (Phase I)

Andhi Khola Project

- Impact on this project by the raising of the intake dam of the existing Kaligandaki A hydroelectric power plant
- Impact on energy production of the existing Kaligandaki A hydroelectric power plant by implementing this project
- Impact on the existing Andhi Khola hydroelectric power plant (IPP)

(4) Meteorological and Hydrological Study

Common items

- Update of meteorological and hydrological data
- Review of hydrological analysis

Dudh Koshi Project

- Sediment simulation considering sedimentation produced by a GLOF

(5) Topographical and Geological Study

Common items

- Verification of water tightness at dam and reservoir sites
- Verification of activity of faults

(6) Review of Basic Design

Common items

- Optimization of parameters for power generation
- Adoption of dam type considering topographical and geological conditions at selected dam sites
- Detailed study on transmission line routes
- Review of Power System Analysis

Dudh Koshi Project

- Optimization of the development plan taking into consideration a function of supplying for base demand in the dry season and calculation of energy production
- Study on a sand flushing facility that enables disposal of sedimentation produced by a GLOF
- Study on a spillway structure that enables handling a GLOF

Nalsyau Gad Project

- Study on installation of an appropriate reactive power supply facility based on the capacity of voltage adjustment

Andhi Khola Project

- Optimization of the development plan taking into consideration a function of supplying for base demand in the dry season and calculation of energy production

(7) Study on Construction and Procurement Plan

- Study on the construction method for structures indicated in the basic design
- Study on the procurement schedule for required equipment

(8) Preparation of Project Implementation Schedule

- Preparation of an implementation schedule including periods for resettlement, land acquisition, procurement procedure, detailed design, construction, etc.

(9) Estimation of Project Cost

(10) Project Implementation Structure

- Confirmation of the implementation structure for the project
- Confirmation of the implementing agency in terms of work responsibility, organization structure, personnel distribution, financial situation, technical level, experience of implementation of similar projects, etc.

(11) Operation and Maintenance (O&M) Structure after Commencement of Operation

- Confirmation of the structure for operation and maintenance
- Confirmation of the O&M agency in terms of work responsibility, organization structure, personnel distribution, financial situation, technical level, experience of O&M for similar projects, etc.

(12) Support for Preparation of EIA and RAP

- Verification of the system and organization for environmental and social consideration
- Verification of the environmental and social situation at the project site
- Support for preparation of TOR of EIA and the stakeholders meeting (especially being secured of direct discussion with the socially vulnerable such as ethnic minorities)
- Support for environmental and social investigations (same as above)
- Support for prediction and evaluation of impact (including impact on transmission lines and access roads)
- Support for mitigation measures (including avoidance, minimization, compensation) and a comparison study of alternatives
- Support for preparation of a draft monitoring plan
- Preparation of a draft environmental check list
- Preparation of an EIA Report and RAP Report and support for disclosure of information (including study of alternative land acquisition by resettlement)
- Support for EIA procedures

(13) Poverty Reduction and Promotion of Social Development

- Social investigation for communities in the project area in terms of population and households to be profited, including percentage of the poor, the current situation of electrification, electricity tariffs, cost for connection to grid, and the monthly electric power consumption in an average family

(14) Study on Points to Consider for Project Implementation

- General circumstances of procurement in similar projects in Nepal
- Basic policy of bidding methods and conditions of contracts
- Selection method of consultants
- Selection policy of contractors

(15) Effectiveness of the Project

- The effectiveness of the project will be evaluated in terms of quantitative effect and qualitative effect. The quantitative index in terms of operation and effect and their target values should be established as quantitatively as possible. The number of beneficiary, EIRR, FIRR and the effect by decreasing electricity to be imported from India (GWh and its cost converted to US$) will be established as the quantitative indexes. Further, the effect by increasing electricity to be generated by implementing the project will be estimated and the effect for mitigation of green house gas emissions will be studied.

Further, regarding Chera-1, Madi, Naumure, Sun Koshi No. 3 and Lower Badigad, the following studies are recommended on the next study stage of each project.

Chera-1 Project

Since this project is currently in the desk study level, it is recommended that the project feasibility should be studied in detail by implementing Pre-FS or FS.

Madi Project

Since this project is currently in the desk study level, it is recommended that the project feasibility should be studied in detail by implementing Pre-FS or FS.

Naumure Project

The Pre FS for this project has been completed. Although this project was reviewed as a hydroelectric power project in this study, it is recommended that an FS should be implemented as multipurpose project, since this project could be implemented as a multipurpose project with irrigation.

Sun Koshi No. 3 Project

Since this project is currently in the desk study level, it is recommended that the project feasibility should be studied in detail by implementing Pre-FS or FS. The current power development plan requires resettlement of approximately 1,600 households and relocation of 15 km of paved road. Therefore, mitigation for impact on the social environment including the above should be considered in the next study stage. There is information that the government of Nepal is planning to request the ADB to prepare a Detailed Project Report

for this project.

Lower Badigad Project

Since this project is currently in the desk study level, it is recommended that the project feasibility should be studied in detail by implementing Pre-FS or FS. Since there is a large-scale land slide in the reservoir area of the current development plan, a large amount of sediment is predicted. Therefore, countermeasures for sediment should be considered including relocation of dam site in the next study stage.

13.2.2 Other Recommendations

(1) Coordination between Water Resources Development and Environmental Conservation

In Nepal, since water power is virtually the only domestic energy for a couple of decades from now, development of significant amounts of hydroelectric power generation are necessary as described in the above. Meanwhile, agriculture accounts for 37% of GDP, and there are many irrigation development projects for promoting the agricultural industry. If these development projects, hydroelectric power and irrigation, are implemented without coordination, there is concern about considerably negative impact on the natural and social environment in not only the project area but also the downstream area. To minimize this negative impact, the government of Nepal should coordinate among the ministries and agencies in charge of power generation, irrigation, and environmental conservation, and set a target of environmental conservation for water resource development for each river basin.

(2) Reasonable Price Setting

Since the NEA is obliged to purchase electricity from IPPs under the all-quantity buyback at fixed price contract, the NEA has to purchase electricity from IPPs even in the rainy season when the NEA has enough supply capacity or has to pay penalty to IPPs for not buying electricity from them. This procurement arrangement between the NEA and IPPs results in NEAs' poor financial position. Therefore, it is recommended that the purchase price from IPPs should be adjusted and reduced to a reasonable level by establishing a competitive electricity wholesale market.

For the retail power price charged by the NEA, it is considered that the price is still too low to sustain the NEA to be financially sound, even after the 20% price increase in July 2012 when the price determined in 2001 was reviewed and adjusted. Thus, the NEA should consider upward adjustment of the retail price to a level acceptable to consumers and to secure the NEA’s good financial position. The upward adjustment should result in contraction of demand due to the rational reaction of consumers instead of forced demand cut by load shedding.

(3) Mobilization of Financial Resources

If the wholesale price of power projects is sufficiently high, the projects will perform financially well, attracting investment from the private sector. However, if the price is too high,

the economic growth of the country must be suppressed. Due to the public goods nature of electricity, the NEA has to provide consumers with electricity at the lowest possible price and keep the NEA financially viable. Therefore, the NEA is expected to implement power projects in order to supply electricity at a price through the mobilization of concessional loans under Official Development Assistance (ODA) arrangements or of government funds.

(4) Remediation in System Loss

The system loss of the Integrated Nepal Power System (INPS) is currently more than 25% and the NEA has not been able to achieve reduction in the loss for the last 20 years. Addressing the system loss consisting of a technical loss and a loss by power theft requires a significant amount of investment to improve the INPS. Minimizing the system loss apparently results in an increase in the energy supply, decrease in the frequency of load shedding, and improvement of the financial position of the NEA.

(5) Demand Side Management

One of the high-priority issues of the power sector of Nepal is to resolve load shedding, and this is urgently needed to strengthen the supply capacity. Meanwhile, it is possible to curb the increase in necessary supply capacity by harnessing demand through demand side management (DSM). Since the current total power demand is not so high, the effect of DSM on resolving load shedding is limited. However, DSM will be one of the measures for satisfying the power demand in the future like the construction of power supply facilities. In Nepal, Time of Day (TOD) tariff rates have already been introduced, and in the future, DSM should be aggressively implemented taking into consideration introducing seasonal tariff rates and subsidies for introducing energy saving devices, etc.

(6) Human Resource Development

As stated above, Nepal needs to implement about 5,000 MW of hydroelectric power development projects including ROR-type projects in the next 20 years. However, the number of specialists required for implementing these projects is not enough. The human resource development of specialists for design of hydroelectric power development policy and for planning and evaluation of hydroelectric power development project in particular, is an urgent issue.

In addition, human resource development in the field of environmental surveys is also very important. Improving the ability of working-level researchers for environmental surveys on flora and fauna, social conditions, and the monitoring of impact by project implementation, etc. are required not only by hydroelectric power projects but also for other large-scale projects like irrigation development projects.

One of the concrete ways to help this in the short term is OJT (on the job training) in an actual project by sending experts to related organizations or hiring consultants for human resource development in this field. In the long term, there should be establishment of a course in this field in a college and establishment of a vocational school for education and training of personnel for operation and maintenance.