# Appendix 3

# Strategic Environmental Assessment Report

**Japan International Cooperation Agency**
**Nepal Electricity Authority**

# Nationwide Master Plan Study
# on
# Storage-type Hydroelectric Power Development
# in
# Nepal

# Strategic Environmental Assessment
# Report

**February 2014**

**Electric Power Development Co., Ltd.**
**(J-POWER)**

# Table of Contents

## List of Annexes

The following SEA Annexes are included in Appendix 5 of Final Report.

## List of Tables

## List of Figures

# Chapter 1 Introduction

The method of Strategic Environmental Assessment (SEA) is adopted for the project evaluation in the Nationwide Master Plan Study on Storage Type Hydroelectric Power Development in Nepal. This SEA report is an appendix of the final report of the Nationwide Master Plan Study on Storage Type Hydroelectric Power Development in Nepal. The SEA study contains both technical and environmental aspects. But some technical issues such as Hydrology and Geology are consisted for SEA evaluation. More detail discussions on the technical matters are described in the final report.

# Chapter 2 Target Setting of SEA

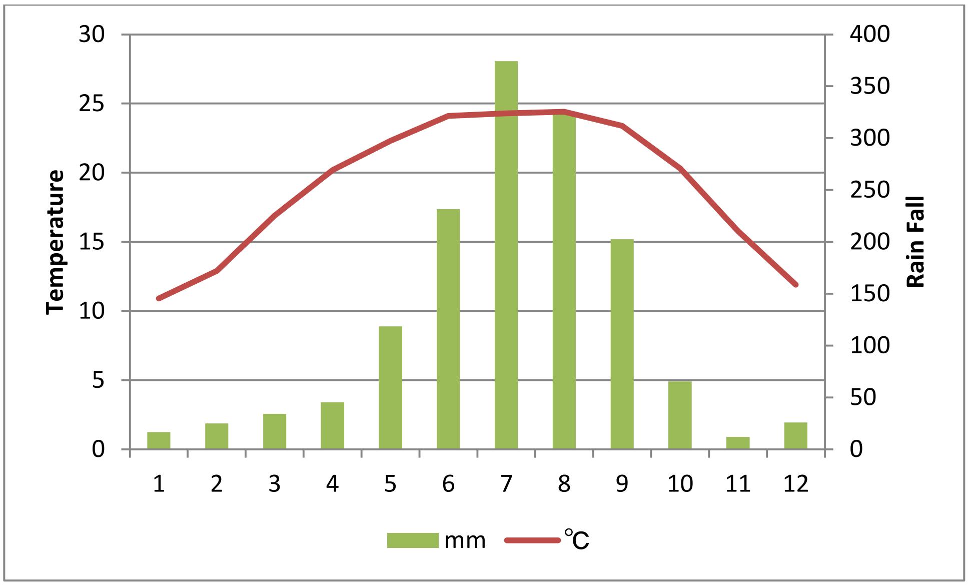
The electricity power demand in FY2031/32 is forecasted at 4,279 MW (Base case) as described in Chapter 7 of the Final report. The target of the SEA is to propose 10 promising projects and their developing order in order to fulfill this demand mainly by storage type hydroelectric power projects in environmentally sustainable manners without having serious impact on 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 the main report.

# Chapter 3 Environmental Baseline

The environmental baseline in Nepal is briefly summarized in this section. The site survey results for the third step are attached as SEA Annex 11 – SEA Annex 21 in Appendix 5. The site surveys were conducted only in dry season. Then some fauna and flora of rainy season might be lacked.

## 3.1 Temperature and Rainfall

The lowest average temperature in Kathmandu (Alt. 1,336 m) is 10.9 °C in January and the highest is 24.4°C. The annual rainfall is 1,476 mm. Dry seasons is May to October and rainy season is November to April. Rainfall pattern in a year is almost similar in the country. The monthly rainfall and temperature is shown in Figure 3.1-1.




Source: Japan Meteorological Agency

**Figure 3.1-1 Rainfall and Temperature in Kathmandu (1981-2010)**

## 3.2 Geography

Nepal has Low zone under 1,000 m along southern Indian border and the elevation goes up toward North East until Himalaya Mountain range over 8,000 m. Most of the possible HPPs locate around 1,000 m to 1,500 m. The elevation map is shown in Figure 3.2-1.

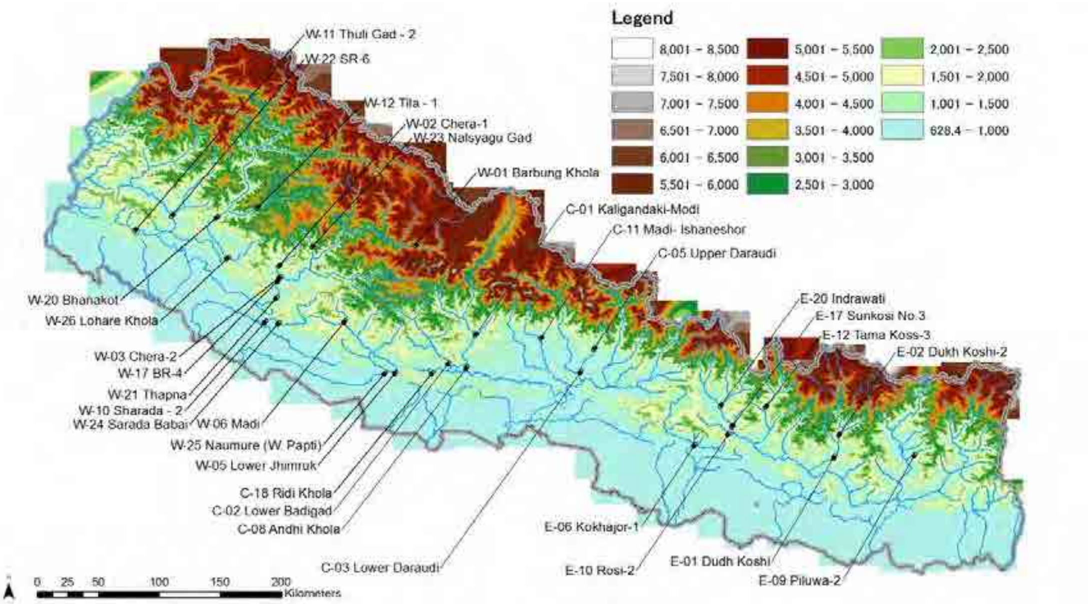



**Figure 3.2-1 Elevation Map**

## 3.3 River System

All the river systems in Nepal flow North to South and gathered in Ganges River in India. There are 15 major river systems and Karnali, Gandaki, Koshi is the three big water systems. The river system is shown in the Figure 3.3-1.

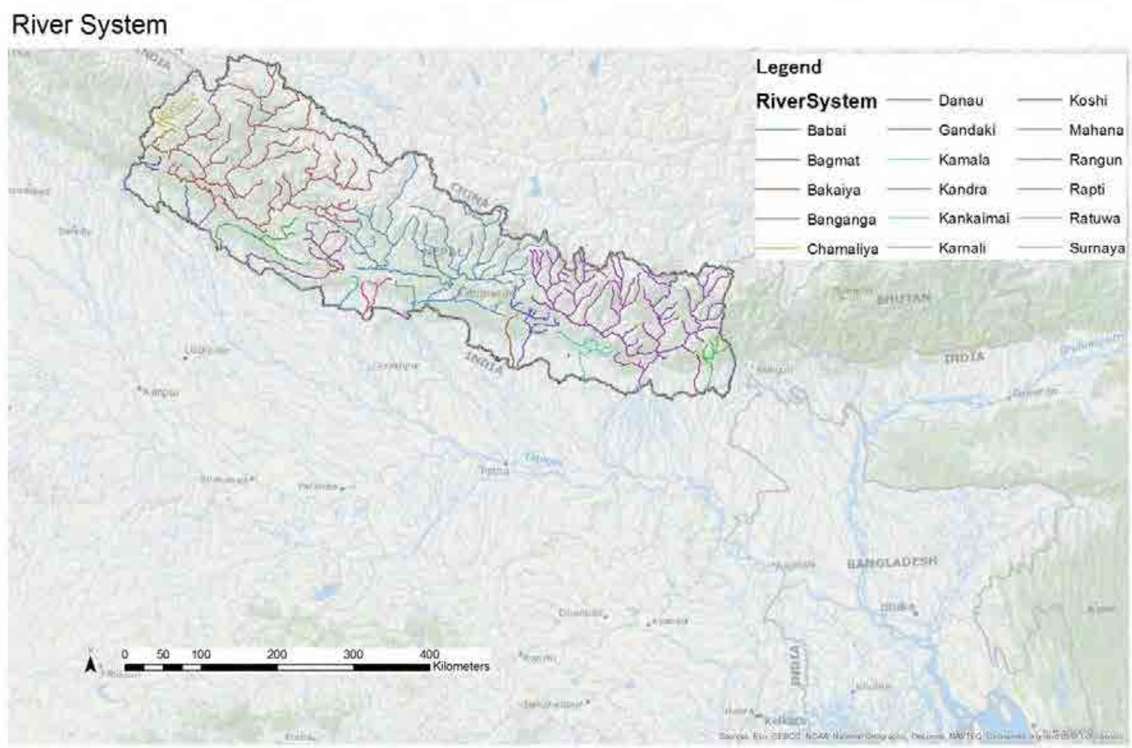



**Figure 3.3-1 River systems in Nepal**

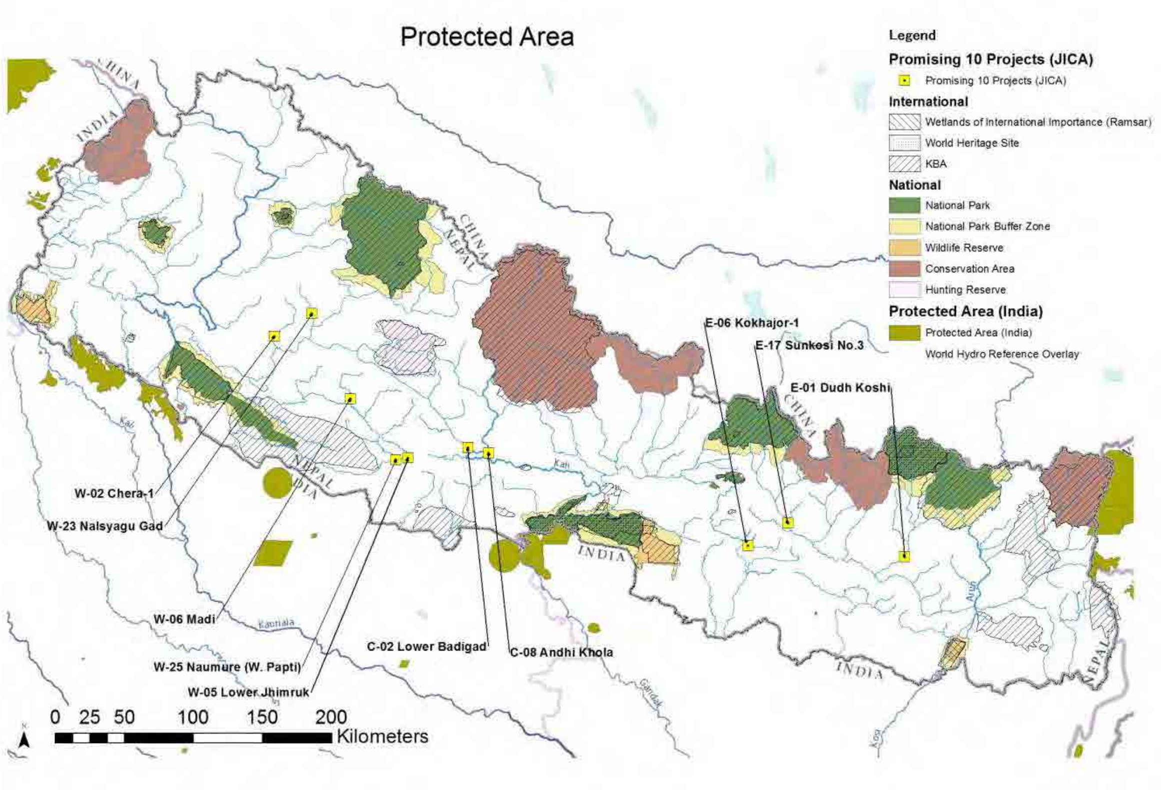
## 3.4 Protected Area

Protected areas in Nepal have two types such as international protected areas and national protected areas.

International protected areas include World Heritage, registered wetlands under the Ramsar Convention, and the Key Biodiversity Areas (KBA)[1]. National protected areas designated by the National Parks and Wild Conservation Act 2029 (1973) are National Parks, Wildlife Reserves, Hunting Reserves, Conservation Areas and National Park/Wildlife Reserve Buffer Zones (See Figure 3.4-1, Table 3.4-1, Table 3.4-2, and Table 3.4-3). Development approval will be needed before hydro-electric development and additional regulation will be adapted for environmental flow. The

[1] 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 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)

protected areas indirectly affected by hydroelectric power development are the Bardia National Park downstream of the Kankaimai , Rapti  and Babai rivers, the Chitwan National Park downstream of the Gandaki river, and the Koshi Tappu Wildlife Reserve downstream of the Koshi river.




Source: Department of National Parks and Wildlife Conservation (2013), World Database of Protected Area (2011)

**Figure 3.4-1 National Parks and World Heritage**

**Table 3.4-1 National Protected Area in Nepal**

| *Designation Type* | *Name* | *Designated Year* |
|---|---|---|
| **National Park** | Langtang NP | 1976 |
| | Sagarmatha NP | 1976 |
| | Chitwan NP | 1973 |
| | Rara NP | 1976 |
| | Bardiya NP | 1984 |
| | Shey Phoksundo NP | 1984 |
| | Khaptad NP | 1984 |
| | Shivapuri Nagarjun NP | 2002 |
| | Makalu Barun NP | 1991 |
| | Banke NP | 2010 |
| **National Park - Buffer Zone** | Chitwan NP BZ | 1996 |
| | Bardiya NP BZ | 1996 |
| | Sagarmatha NP BZ | 2002 |
| | Rara NP BZ | 2006 |
| | Langtang NP BZ | 1998 |
| | Makalu Barun NP BZ | 1999 |
| | Khaptad NP BZ | 2006 |

| *Designation Type* | *Name* | *Designated Year* |
|---|---|---|
| | Shey Phoksundo NP BZ | 1998 |
| | Banke NP BZ | 2010 |
| **Wildlife Reserve** | Shuklaphanta WR | 1976 |
| | Koshi Tappu WR | 1976 |
| | Parsa WR | 1984 |
| **Wildlife Reserve- Buffer Zone** | Parsa WR BZ | 2005 |
| | Koshi Tappu WR BZ | 2004 |
| | Shuklaphanta WR BZ | 2004 |
| **Conservation Area** | Annapurna CA | 1992 |
| | Kanchanjunga CA | 1997 |
| | Manasalu CA | 1998 |
| | Krishnasar CA | 2009 |
| | Gaurishankar CA | 2010 |
| | Api Nampa CA | 2010 |
| **Hunting Reserve** | Dhorpatan HR | 1987 |

### Table 3.4-2 International Protected Area in Nepal

| *Designation Type* | *Name* | *Designated Year* |
|---|---|---|
| **World Heritage Site** | Sagarmatha National Park | 1979 |
| | Chitwan National Park | 1984 |
| **Wetlands of International Importance (Ramsar)** | Koshi Tappu | 1987 |
| | Gokyo and associated lakes | 2007 |
| | Gosaikunda and associated lakes | 2007 |
| | Phoksundo Lake | 2007 |
| | Rara Lake | 2007 |
| | Mai Pokhari | 2008 |
| | Beeshazar and associated lakes | 2003 |
| | Ghodaghodi Lake Area | 2003 |
| | Jagadishpur Reservoir | 2003 |

**Table 3.4-3 List of Key Biodiversity Area in Nepal**

| *Name* | *Area ($km^2$)* | *Source* |
|---|---:|---|
| Shivapuri National Park | 91.4 | KBA data supplied by Jack Tordoff, BirdLife International |
| Bardia National Park | 912.5 | KBA data supplied by Jack Tordoff, BirdLife International |
| Dharan forests | 771.4 | KBA data supplied by Jack Tordoff, BirdLife International |
| Kanchenjungha Conservation Area | 1,749.7 | KBA data supplied by Jack Tordoff, BirdLife International |
| Langtang National Park | 1,536.9 | KBA data supplied by Jack Tordoff, BirdLife International |
| Sagarmatha National Park | 1,130.0 | KBA data supplied by Jack Tordoff, BirdLife International |
| Makalu Barun National Park | 2,354.4 | KBA data supplied by Jack Tordoff, BirdLife International |
| Annapurna Conservation Area | 7,414.6 | KBA data supplied by Jack Tordoff, BirdLife International |
| Chitwan National Park | 1,184.3 | WDPA 2009 - Latest Info: Official Agency reply (Dept. of National Parks and Wildlife Conservation - government focal point) received via D. Joshi (IUCN Nepal) for the UN List 2003 request, June 2003 |
| Sukla Phanta Wildlife Reserve | 370.8 | WDPA 2009 - Latest Info: Official Agency reply (Dept. of National Parks and Wildlife Conservation - government focal point) received via D. Joshi (IUCN Nepal) for the UN List 2003 request, June 2003 |
| Shey-Phoksundo National Park | 3,649.1 | WDPA 2009 - Latest Info: Official Agency reply (Dept. of National Parks and Wildlife Conservation - government focal point) received via D. Joshi (IUCN Nepal) for the UN List 2003 request, June 2003 |
| Khaptad National Park | 234.3 | WDPA 2009 - Latest Info: Official Agency reply (Dept. of National Parks and Wildlife Conservation - government focal point) received via D. Joshi (IUCN Nepal) for the UN List 2003 request, June 2003. |
| Dhorpatan Hunting Reserve | 1,320.2 | WDPA 2009 - Latest Info: Official Agency reply (Dept. of National Parks and Wildlife Conservation - gov. focal point) received via D. Joshi (IUCN Nepal) for the UN List 2003 request, June 2003 & Dhorpatan HR Website, accessed 3/08/2004. |
| Parsa Wildlife Reserve | 478.4 | WDPA 2009 - Latest Info: Official Agency reply (Dept. of National Parks and Wildlife Conservation - government focal point) received via D. Joshi (IUCN Nepal) for the UN List 2003 request, June 2003 |
| Tamur valley and Watershed | 1,339.7 | KBA data supplied by Jack Tordoff, BirdLife International |
| Mai Valley forests | 579.1 | KBA data supplied by Jack Tordoff, BirdLife International |
| Nawalparasi forests | 59.0 | Based on feedback from Partner, IBA Directory and Google Earth |
| Rara National Park | 116.8 | Based on feedback from Partner, IBA Directory and Google Earth |
| Ghodaghodi Lake | 11.0 | Based on feedback from Partner, IBA Directory and Google Earth |
| Rampur valley | 27.9 | Based on feedback from Partner, IBA Directory and Google Earth |
| Phulchowki Mountain forests | 11.5 | Based on feedback from Partner, IBA Directory and Google Earth |
| Barandabhar forests and wetlands | 168.3 | Based on feedback from Partner, IBA Directory and Google Earth |
| Dang Deukhuri foothill forests and west Rapti wetlands | 3,502.0 | Based on feedback from Partner, IBA Directory and Google Earth |
| Farmlands in Lumbini area | 733.9 | Based on feedback from Partner, IBA Directory and Google Earth |
| Jagdishpur Reservoir | 4.6 | Based on feedback from Partner, IBA Directory and Google Earth |
| Urlabari forest groves | 22.1 | Based on feedback from Partner, IBA Directory and Google Earth |
| Koshi Tappu Wildlife Reserve and Koshi Barrage | 217.4 | Based on feedback from Partner, IBA Directory and Google Earth |

Source: Integrated Biodiversity Assessment Tool (2012), etc.

## 3.5 Conservation Species

88 species which are above rank VU (Vulnerable) are listed on IUCN (International Union for Conservation of Nature) red list in Nepal (See Table 3.5-1). Distribution areas of some species are proved. The Government of Nepal also identifies the 39 protected wildlife in the National Parks and Wildlife Conservation Act, 2029 (1973).

**Table 3.5-1 IUCN Red-List Species and Protected Wildlife in Nepal**

**PLANTAE**

| Family | Genus | Species | Common names (Eng.) | Status |
|---|---|---|---|---|
| SCAPANIACEAE | *Andrewsianthus* | *ferrugineus* | | EN |
| SOLENOSTOMATACEAE | *Diplocolea* | *sikkimensis* | | EN |
| TAKAKIACEAE | *Takakia* | *ceratophylla* | | VU |
| SOLENOSTOMATACEAE | *Scaphophyllum* | *speciosum* | | VU |
| CYCADACEAE | *Cycas* | *pectinata* | | VU |
| LEGUMINOSAE | *Dalbergia* | *latifolia* | Bombay Blackwood, Indian Rosewood, Indonesian Rosewood, Malabar Rosewood | VU |
| ULMACEAE | *Ulmus* | *wallichiana* | | VU |

**MAMMALIA**

| Family | Genus | Species | Common names (Eng.) | Status | GON |
|---|---|---|---|---|---|
| SUIDAE | *Porcula* | *salvania* | Pygmy Hog | CR | |
| MURIDAE | *Apodemus* | *gurkha* | Himalayan Wood Mouse, Himalayan Field Mouse | EN | |
| CERVIDAE | *Axis* | *porcinus* | Hog Deer, Indochinese Hog Deer, Thai Hog Deer | EN | |
| BOVIDAE | *Bubalus* | *arnee* | Asian Buffalo, Asiatic Buffalo, Indian Buffalo, Indian Water Buffalo, Water Buffalo, Wild Asian Buffalo, Wild Water Buffalo | EN | x |
| LEPORIDAE | *Caprolagus* | *hispidus* | Hispid Hare, Assam Rabbit | EN | x |
| CANIDAE | *Cuon* | *alpinus* | Dhole, Asiatic Wild Dog, Indian Wild Dog, Red Dog | EN | |
| ELEPHANTIDAE | *Elephas* | *maximus* | Asian Elephant, Indian Elephant | EN | x |
| MANIDAE | *Manis* | *pentadactyla* | Chinese Pangolin | EN | x |
| MOSCHIDAE | *Moschus* | *chrysogaster* | Alpine Musk Deer, Himalayan Musk Deer | EN | x |
| MOSCHIDAE | *Moschus* | *fuscus* | Black Musk Deer, Dusky Musk Deer | EN | |
| MOSCHIDAE | *Moschus* | *leucogaster* | Himalayan Muskdeer, Himalayan Musk-deer, Himalayan Musk Deer | EN | |
| FELIDAE | *Panthera* | *tigris* | Tiger | EN | x |
| FELIDAE | *Panthera* | *uncia* | Snow Leopard, Ounce | EN | x |
| BOVIDAE | *Pantholops* | *hodgsonii* | Chiru, Tibetan Antelope | EN | x |
| PLATANISTIDAE | *Platanista* | *gangetica* | South Asian River Dolphin, Blind River Dolphin, Ganges Dolphin, Ganges River Dolphin, Ganges Susu, Indus River Dolphin | EN | x |
| FELIDAE | *Prionailurus* | *viverrinus* | Fishing Cat | EN | |
| AILURIDAE | *Ailurus* | *fulgens* | Red Panda, Lesser Panda, Red Cat-bear | VU | x |

| ***Family*** | ***Genus*** | ***Species*** | ***Common names (Eng.)*** | ***Status*** | ***GON*** |
|---|---|---|---|---|---|
| MUSTELIDAE | *Aonyx* | *cinerea* | Asian Small-clawed Otter, Oriental Small-clawed Otter, Small-clawed Otter | VU | |
| VIVERRIDAE | *Arctictis* | *binturong* | Binturong, Bearcat, Palawan Binturong | VU | |
| BOVIDAE | *Bos* | *mutus* | Wild Yak, Yak | VU | x |
| BOVIDAE | *Bos* | *gaurus* | Gaur, Indian Bison | VU | x |
| MUSTELIDAE | *Lutrogale* | *perspicillata* | Smooth-coated Otter, Indian Smooth-coated Otter | VU | |
| URSIDAE | *Melursus* | *ursinus* | Sloth Bear | VU | |
| VESPERTILIONIDAE | *Myotis* | *sicarius* | Mandelli's Mouse-eared Myotis, Mandelli's Mouse-eared Bat | VU | |
| FELIDAE | *Neofelis* | *nebulosa* | Clouded Leopard | VU | x |
| FELIDAE | *Pardofelis* | *marmorata* | Marbled Cat | VU | |
| RHINOCEROTIDAE | *Rhinoceros* | *unicornis* | Greater One-horned Rhino, Great Indian Rhinoceros, Indian Rhinoceros | VU | x |
| CERVIDAE | *Rucervus* | *duvaucelii* | Barasingha, Swamp Deer | VU | |
| CERVIDAE | *Rusa* | *unicolor* | Sambar, Sambar Deer | VU | |
| BOVIDAE | *Tetracerus* | *quadricornis* | Four-horned Antelope, Chousingha | VU | x |
| URSIDAE | *Ursus* | *thibetanus* | Asiatic Black Bear, Himalayan Black Bear | VU | |
| BOVIDAE | *Capricornis* | *thar* | Himalayan Serow | NT | |
| BOVIDAE | *Hemitragus* | *jemlahicus* | Himalayan Tahr | NT | |
| HYAENIDAE | *Hyaena* | *hyaena* | Striped Hyaena | NT | x |
| MUSTELIDAE | *Lutra* | *lutra* | Eurasian Otter, Common Otter, European Otter, European River Otter, Old World Otter | NT | |
| CERCOPITHECIDAE | *Macaca* | *assamensis* | Assam Macaque, Assamese Macaque | NT | x |
| BOVIDAE | *Naemorhedus* | *goral* | Himalayan Goral, Goral | NT | |
| BOVIDAE | *Ovis* | *ammon* | Argali, Wild Sheep | NT | x |
| FELIDAE | *Panthera* | *pardus* | Leopard | NT | |
| SCIURIDAE | *Petaurista* | *nobilis* | Bhutan Giant Flying Squirrel, Grays Giant Flying Squirrel, Noble Giant Flying Squirrel | NT | |
| SCIURIDAE | *Ratufa* | *bicolor* | Black Giant Squirrel, Malayan Giant Squirrel | NT | |
| CERCOPITHECIDAE | *Semnopithecus* | *hector* | Tarai Gray Langur, Gray Langur, Hanuman Langur, Lesser Hill Langur, Tarai Sacred Langur | NT | |
| VIVERRIDAE | *Viverra* | *zibetha* | Large Indian Civet | NT | |
| Cervidae | *Cervus* | *duvaucelii* | Swamp Deer | | x |
| Felidae | *Lynx* | *lynx* | Lynx | | x |
| MANIDAE | *Manis* | *crasscaudata* | Pangolin | | x |
| Canidae | *Canis* | *lupus* | Gray Wolf | | x |
| Viverridae | *Prionodon* | *pardicolor* | Lingsang | | x |
| FELIDAE | *Prionailurus* | *bengalensis* | Leopard Cat | | x |
| Suidae | *Sus* | *salvanius* | Pygmy Hog | | x |
| URSIDAE | *Ursus* | *arctos* | Himalayan Brown Beer | | x |

**AVES**

| *Family* | *Genus* | *Species* | *Common names (Eng.)* | *Status* | *GON* |
|---|---|---|---|---|---|
| ARDEIDAE | *Ardea* | *insignis* | White-bellied Heron, Imperial Heron | CR | |
| ACCIPITRIDAE | *Gyps* | *bengalensis* | White-rumped Vulture, Asian White-backed Vulture, Oriental White-backed Vulture, White-backed Vulture | CR | |
| ACCIPITRIDAE | *Gyps* | *tenuirostris* | Slender-billed Vulture | CR | |
| OTIDIDAE | *Houbaropsis* | *bengalensis* | Bengal Florican, Bengal Bustard | CR | x |
| ACCIPITRIDAE | *Sarcogyps* | *calvus* | Red-headed Vulture, Indian Black Vulture, Pondicherry Vulture | CR | |
| ANATIDAE | *Rhodonessa* | *caryophyllacea* | Pink-headed Duck | CR | |
| ACCIPITRIDAE | *Neophron* | *percnopterus* | Egyptian Vulture, Egyptian Eagle | EN | |
| CICONIIDAE | *Leptoptilos* | *dubius* | Greater Adjutant | EN | |
| OTIDIDAE | *Sypheotides* | *indicus* | Lesser Florican, Likh | EN | |
| ACCIPITRIDAE | *Aquila* | *clanga* | Greater Spotted Eagle, Spotted Eagle | VU | |
| ACCIPITRIDAE | *Aquila* | *hastata* | Indian Spotted Eagle | VU | |
| ACCIPITRIDAE | *Aquila* | *heliaca* | Eastern Imperial Eagle, Asian Imperial Eagle, Imperial Eagle | VU | |
| PHASIANIDAE | *Catreus* | *wallichi* | Cheer Pheasant, Chir Pheasant, Wallich's Pheasant | VU | x |
| SYLVIIDAE | *Chaetornis* | *striata* | Bristled Grassbird | VU | |
| OTIDIDAE | *Chlamydotis* | *undulata* | Houbara Bustard, Houbara | VU | |
| TIMALIIDAE | *Chrysomma* | *altirostre* | Jerdon's Babbler | VU | |
| EMBERIZIDAE | *Emberiza* | *aureola* | Yellow-breasted Bunting | VU | |
| FALCONIDAE | *Falco* | *cherrug* | Saker Falcon, Saker | VU | |
| FALCONIDAE | *Falco* | *naumanni* | Lesser Kestrel | VU | |
| MUSCICAPIDAE | *Ficedula* | *subrubra* | Kashmir Flycatcher | VU | |
| PHASIANIDAE | *Francolinus* | *gularis* | Swamp Francolin | VU | |
| SCOLOPACIDAE | *Gallinago* | *nemoricola* | Wood Snipe | VU | |
| GRUIDAE | *Grus* | *antigone* | Sarus Crane | VU | x |
| ACCIPITRIDAE | *Haliaeetus* | *leucoryphus* | Pallas's Fish-eagle, Band-tailed Fish-eagle, Pallas's Fish Eagle, Pallas's Sea-eagle | VU | |
| CICONIIDAE | *Leptoptilos* | *javanicus* | Lesser Adjutant | VU | |
| PICIDAE | *Mulleripicus* | *pulverulentus* | Great Slaty Woodpecker | VU | |
| PLOCEIDAE | *Ploceus* | *megarhynchus* | Yellow Weaver, Finn's Baya Weaver, Finn's Weaver, Himalayan Weaver | VU | |
| CISTICOLIDAE | *Prinia* | *cinereocapilla* | Grey-crowned Prinia | VU | |
| LARIDAE | *Rynchops* | *albicollis* | Indian Skimmer | VU | |
| MUSCICAPIDAE | *Saxicola* | *insignis* | White-throated Bushchat, Hodgson's Bushchat, White-throated Bush Chat | VU | |
| TIMALIIDAE | *Turdoides* | *longirostris* | Slender-billed Babbler | VU | |

| *Family* | *Genus* | *Species* | *Common names (Eng.)* | *Status* | *GON* |
|---|---|---|---|---|---|
| ANATIDAE | *Anas* | *falcata* | Falcated Duck, Falcated Teal | NT | |
| ANHINGIDAE | *Anhinga* | *melanogaster* | Oriental Darter, Darter | NT | |
| ANATIDAE | *Aythya* | *nyroca* | Ferruginous Duck, Ferruginous Pochard, White-eyed Pochard | NT | |
| BUCEROTIDAE | *Buceros* | *bicornis* | Great Hornbill | NT | x |
| ACCIPITRIDAE | *Circus* | *macrourus* | Pallid Harrier, Pale Harrier | NT | |
| CICONIIDAE | *Ephippiorhynchus* | *asiaticus* | Black-necked Stork | NT | |
| FALCONIDAE | *Falco* | *jugger* | Laggar Falcon | NT | |
| SYLVIIDAE | *Graminicola* | *bengalensis* | Rufous-rumped Grassbird | NT | |
| ACCIPITRIDAE | *Ichthyophaga* | *humilis* | Lesser Fish-eagle, Lesser Fish Eagle, Lesser Fishing Eagle | NT | |
| ACCIPITRIDAE | *Ichthyophaga* | *ichthyaetus* | Grey-headed Fish-eagle, Grey-headed Fish Eagle, Grey-headed Fishing Eagle | NT | |
| INDICATORIDAE | *Indicator* | *xanthonotus* | Yellow-rumped Honeyguide | NT | |
| SCOLOPACIDAE | *Limosa* | *limosa* | Black-tailed Godwit | NT | |
| CICONIIDAE | *Mycteria* | *leucocephala* | Painted Stork | NT | |
| SCOLOPACIDAE | *Numenius* | *arquata* | Eurasian Curlew, Curlew | | |
| PELECANIDAE | *Pelecanus* | *philippensis* | Spot-billed Pelican, Grey Pelican | NT | |
| SYLVIIDAE | *Phylloscopus* | *tytleri* | Tytler's Leaf-warbler, Tytler's Leaf Warbler | NT | |
| TIMALIIDAE | *Spelaeornis* | *caudatus* | Rufous-throated Wren-babbler, Short-tailed Wren-babbler, Tailed Wren-babbler | NT | |
| TIMALIIDAE | *Sphenocichla* | *humei* | Blackish-breasted Babbler | NT | |
| LARIDAE | *Sterna* | *acuticauda* | Black-bellied Tern | NT | |
| THRESKIORNITHIDAE | *Threskiornis* | *melanocephalus* | Black-headed Ibis | NT | |
| CICONIIDAE | *Ciconia* | *nigra* | Black Stork | | x |
| CICONIIDAE | *Ciconia* | *ciconia* | White Stork | | x |
| OTIDAE | *Eupodotis* | *indica* | Lesser Florican | | x |
| PHASIANIDAE | *Lophophorus* | *impejanus* | Impeyon pheasant | | x |

**REPTILIA**

| *Family* | *Genus* | *Species* | *Common names (Eng.)* | *Status* | *GoN* |
|---|---|---|---|---|---|
| GEOEMYDIDAE | *Batagur* | *kachuga* | Bengal Roof Turtle, Red-crowned Roofed Turtle | CR | |
| GAVIALIDAE | *Gavialis* | *gangeticus* | Gharial, Fish-eating Crocodile, Gavial, Indian Gavial, Indian Gharial, Long-nosed Crocodile | CR | x |
| TESTUDINIDAE | *Indotestudo* | *elongata* | Elongated Tortoise, Pineapple Tortoise, Red-nosed Tortoise, Yellow-headed Tortoise, Yellow Tortoise | EN | |
| GEOEMYDIDAE | *Hardella* | *thurjii* | Crowned River Turtle | VU | |
| TRIONYCHIDAE | *Nilssonia* | *hurum* | Indian Peacock Softshell Turtle, Peacock Soft-shelled Turtle | VU | |
| ELAPIDAE | *Ophiophagus* | *hannah* | Hamadryad, King Cobra | VU | |
| BOIDAE | *Python* | *molurus* | Asiatic Rock Python, Burmese Python, Indian Python, Tiger Python | | x |
| Varanidae | *Varanus* | *flavescens* | Golden Monitor Lizard | | x |

**AMPHIBIA**

| *Family* | *Genus* | *Species* | *Status* |
|---|---|---|---|
| DICROGLOSSIDAE | *Nanorana* | *minica* | VU |
| DICROGLOSSIDAE | *Nanorana* | *rostandi* | VU |
| MEGOPHRYIDAE | *Scutiger* | *nepalensis* | VU |
| RANIDAE | *Hylarana* | *chitwanensis* | NT |
| DICROGLOSSIDAE | *Nanorana* | *annandalii* | NT |
| DICROGLOSSIDAE | *Nanorana* | *ercepeae* | NT |

**ACTINOPTERYGII**

| *Family* | *Genus* | *Species* | *Common names (Eng.)* | *Status* |
|---|---|---|---|---|
| CYPRINIDAE | *Schizothorax* | *nepalensis* | Snow Trout | CR |
| CYPRINIDAE | *Schizothorax* | *raraensis* | Rara Snowtrout | CR |
| CLARIIDAE | *Clarias* | *magur* | Wagur, Mangur, Manguri | EN |
| CYPRINIDAE | *Tor* | *putitora* | Putitor Mahseer, Golden Mahaseer | EN |
| CYPRINIDAE | *Cyprinion* | *semiplotum* | Assamese Kingfish | VU |
| CYPRINIDAE | *Puntius* | *chelynoides* | Dark mahseer | VU |
| CYPRINIDAE | *Schizothorax* | *richardsonii* | | VU |
| SCHILBEIDAE | *Ailia* | *coila* | Gangetic ailia | NT |
| SISORIDAE | *Bagarius* | *bagarius* | | NT |
| SISORIDAE | *Bagarius* | *yarrelli* | | NT |
| NOTOPTERIDAE | *Chitala* | *chitala* | | NT |
| CYPRINIDAE | *Labeo* | *pangusia* | Pangusia labeo | NT |
| CYPRINIDAE | *Neolissochilus* | *hexagonolepis* | Katli | NT |
| BALITORIDAE | *Schistura* | *devdevi* | | NT |
| CYPRINIDAE | *Tor* | *tor* | mahseer | NT |
| SILURIDAE | *Wallago* | *attu* | | NT |

**CHONDRICHTHYES**

| *Family* | *Genus* | *Species* | *Common names (Eng)* | *Status* |
|---|---|---|---|---|
| DASYATIDAE | *Himantura* | *fluviatilis* | Ganges Stingray | EN |
| CARCHARHINIDAE | *Carcharhinus* | *leucas* | Bull Shark | NT |

| *Family* | *Genus* | *Species* | *Common names (Eng)* | *Status* |
|---|---|---|---|---|
| CARCHARHINIDAE | *Carcharhinus* | *leucas* | Bull Shark | NT |
| DASYATIDAE | *Himantura* | *fluviatilis* | Ganges Stingray | EN |

**INSECTA**

| *Family* | *Genus* | *Species* | *Common names (Eng)* | *Sstatus* |
|---|---|---|---|---|
| PLATYCNEMIDIDAE | *Calicnemia* | *nipalica* | | VU |
| CHLOROGOMPHIDAE | *Chlorogomphus* | *selysi* | | VU |
| EPIOPHLEBIIDAE | *Epiophlebia* | *laidlawi* | Relict Himalayan Dragonfly | NT |
| CORDULEGASTRIDAE | *Neallogaster* | *ornata* | | NT |

**GASTROPODA**

| *Family* | *Genus* | *Species* | *Status* |
|---|---|---|---|
| POMATIOPSIDAE | *Tricula* | *mahadevensis* | VU |

Source: IUCN Red List of Threatened Species. Version 2012.2

Most of rare fishes which travel long distances are the cold –water fish. These fishes are going down to low altitude during the dry season, and are running up to lay eggs in cold water during the rainy season. There are fishes which move over a large elevation difference; *Tor Tor, Labeo Pangusia,* Gagarium *Yarreleli* move between the altitude from EL.140 m below to EL.800 m, *Tor Putitora,* Neolissochilus move between the altitude EL.140 m below to EL.1,300 m, *Schizothoraz richardsonii* move between the altitude EL.140m to more than EL.1,300 m. The Figure 3.5-1 shows the estimated habitat of important fishes in Nepal.

However, distribution of rare fishes in Nepal has not been investigated enough and its distribution across the country is not fully figured out.

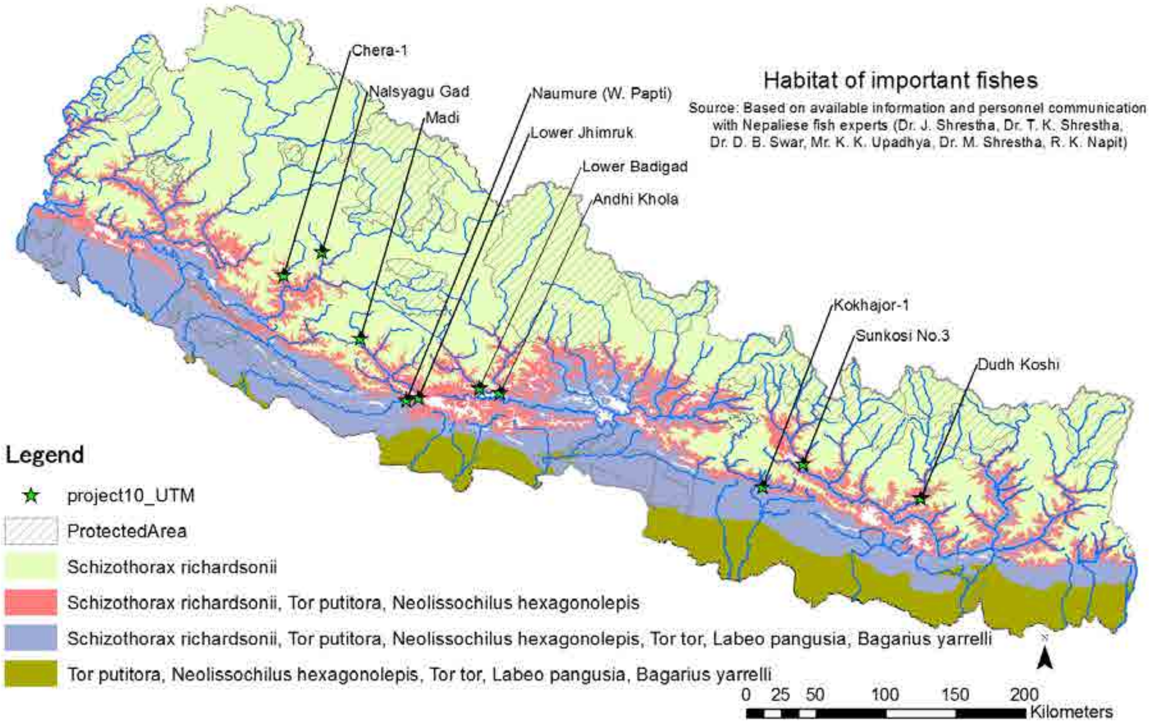
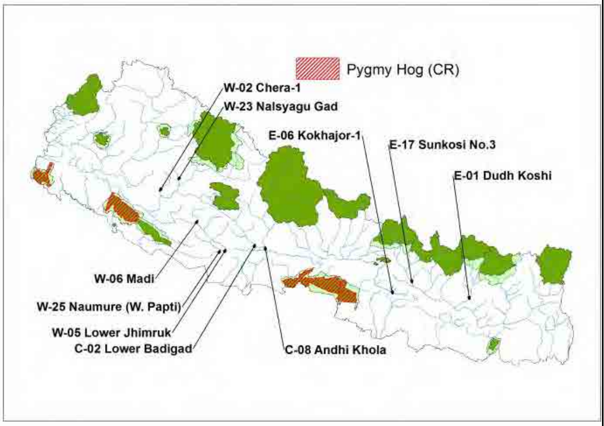
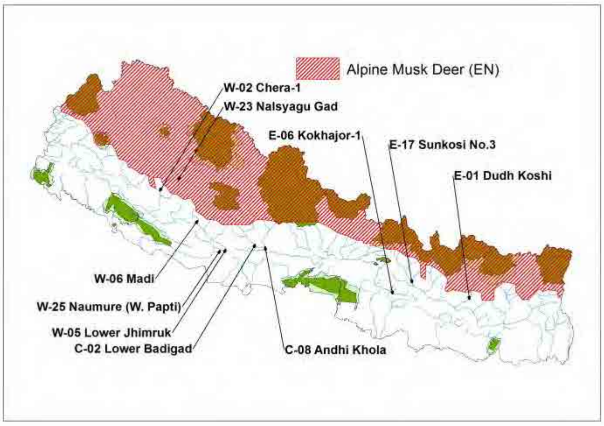
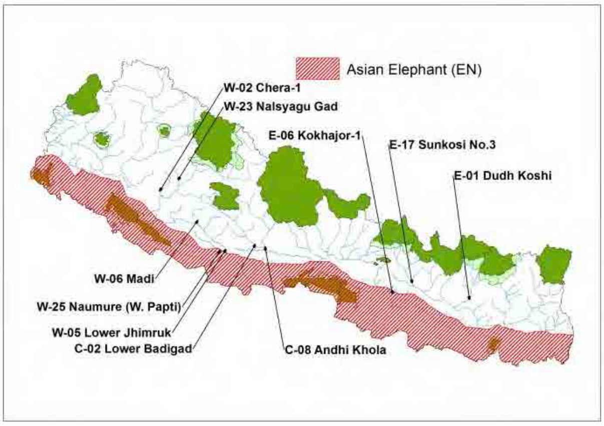


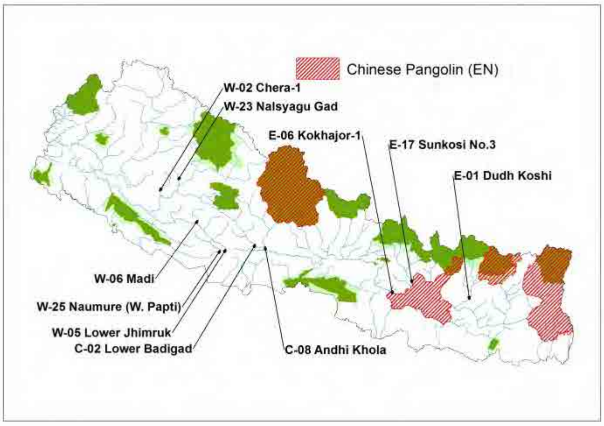

**Figure 3.5-1 Habitat of Important Fishes in Nepal**

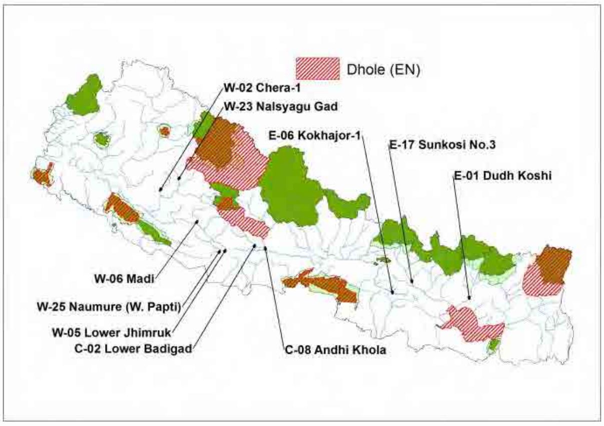
## Table 3.5-2 Distribution maps of National Red List Mammals in Nepal

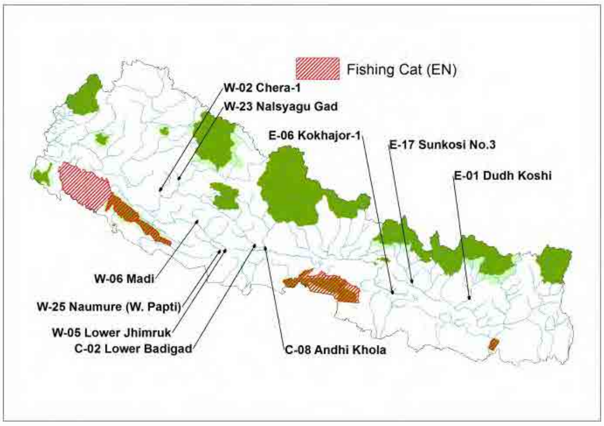


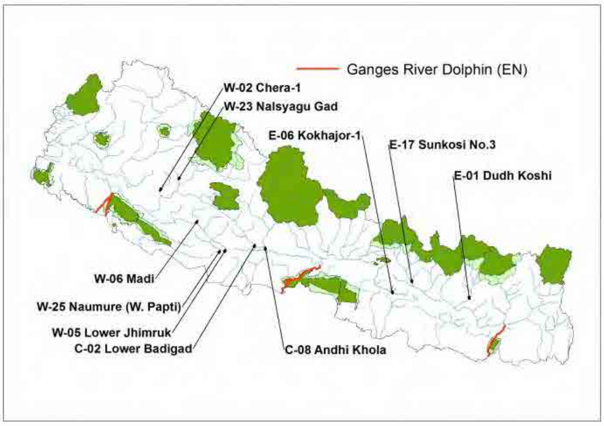



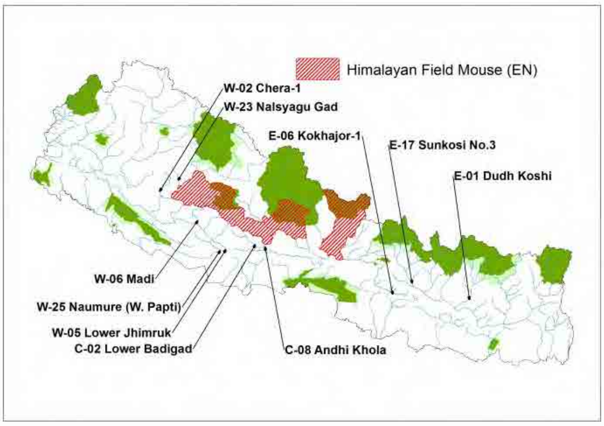



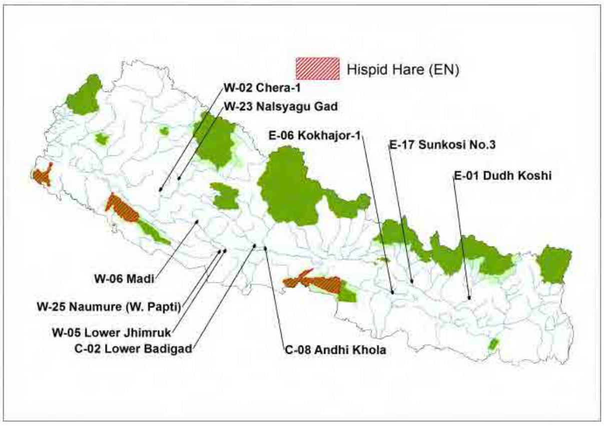



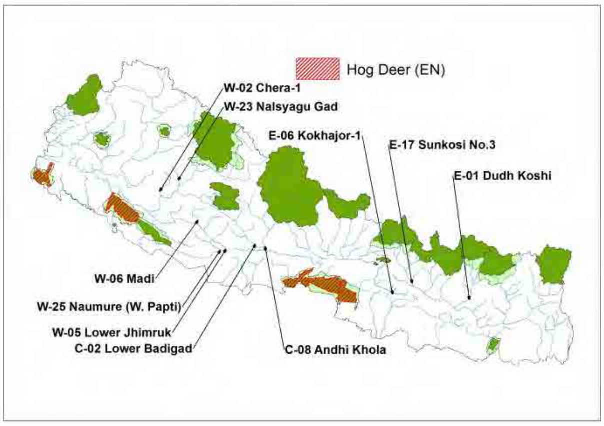



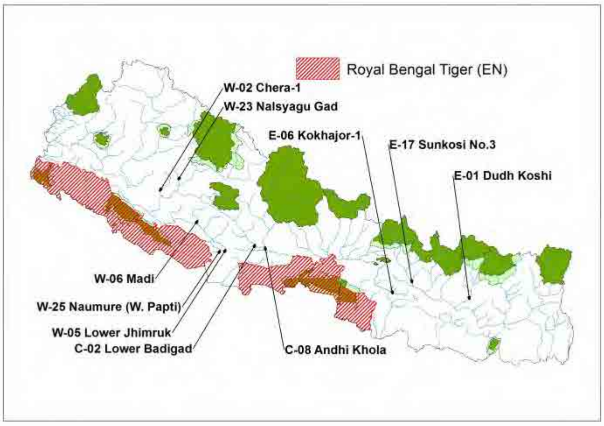



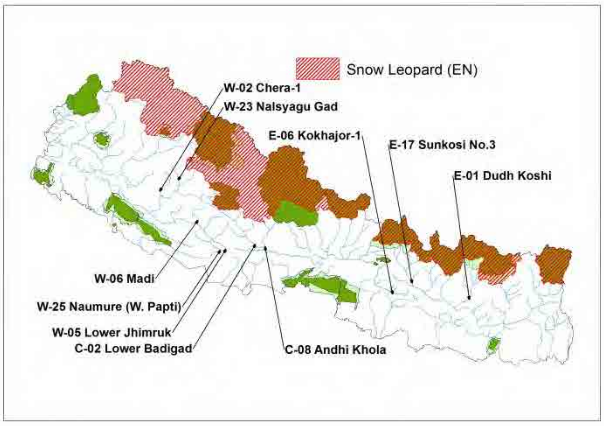

Ganges River Dolphin (EN)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

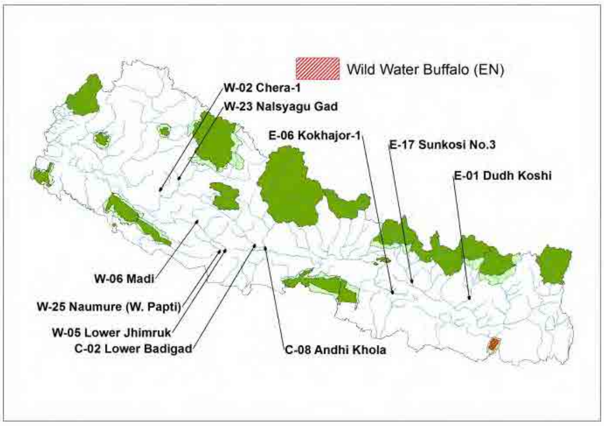

Himalayan Field Mouse (EN)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

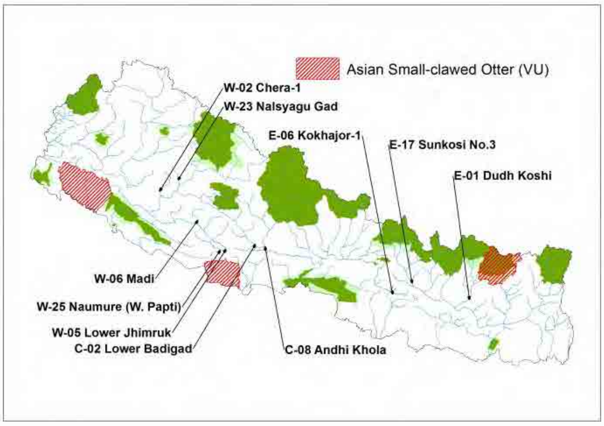

Hispid Hare (EN)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

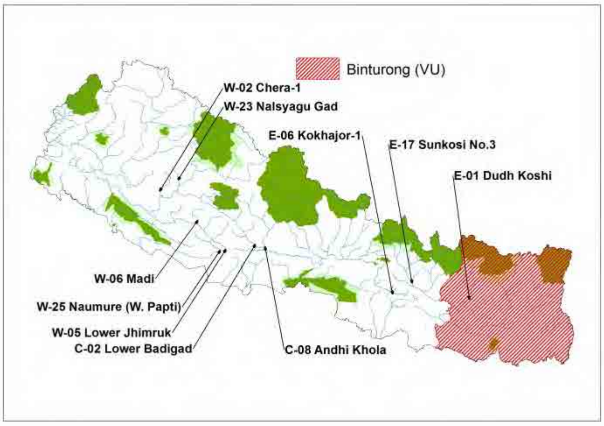

Hog Deer (EN)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

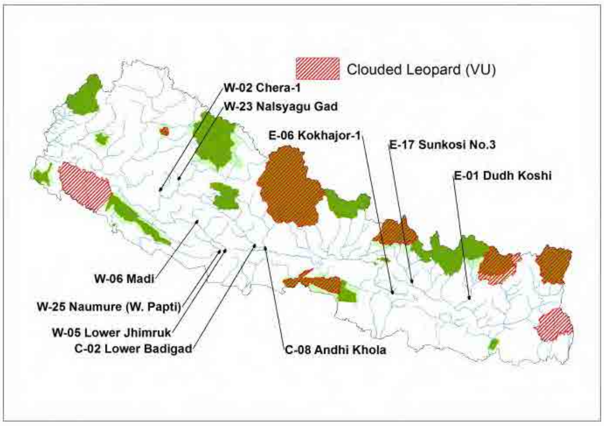

Royal Bengal Tiger (EN)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

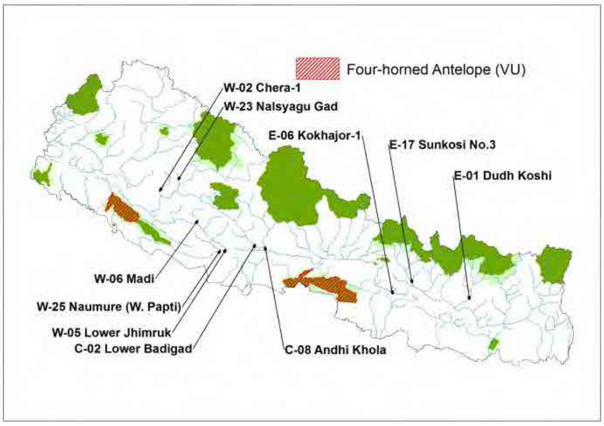

Snow Leopard (EN)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

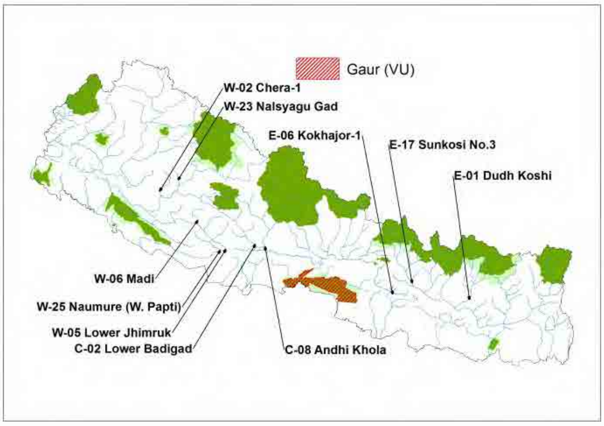

Wild Water Buffalo (EN)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

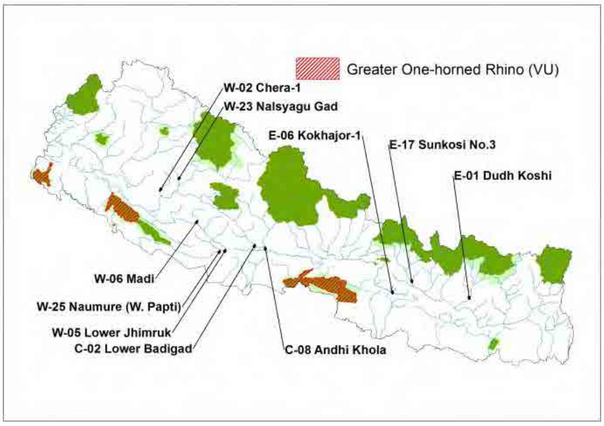

Asian Small-clawed Otter (VU)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

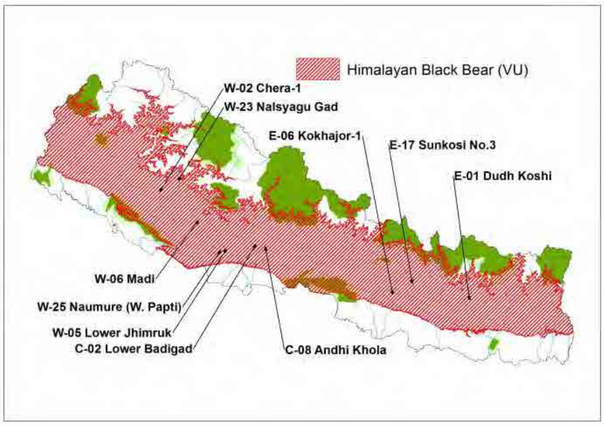

Binturong (VU)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

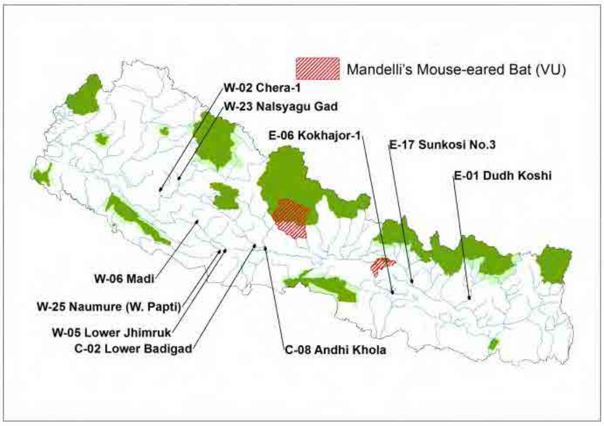

Clouded Leopard (VU)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

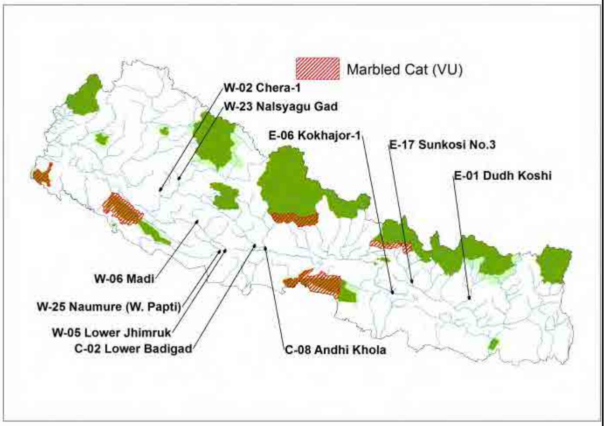

Four-horned Antelope (VU)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

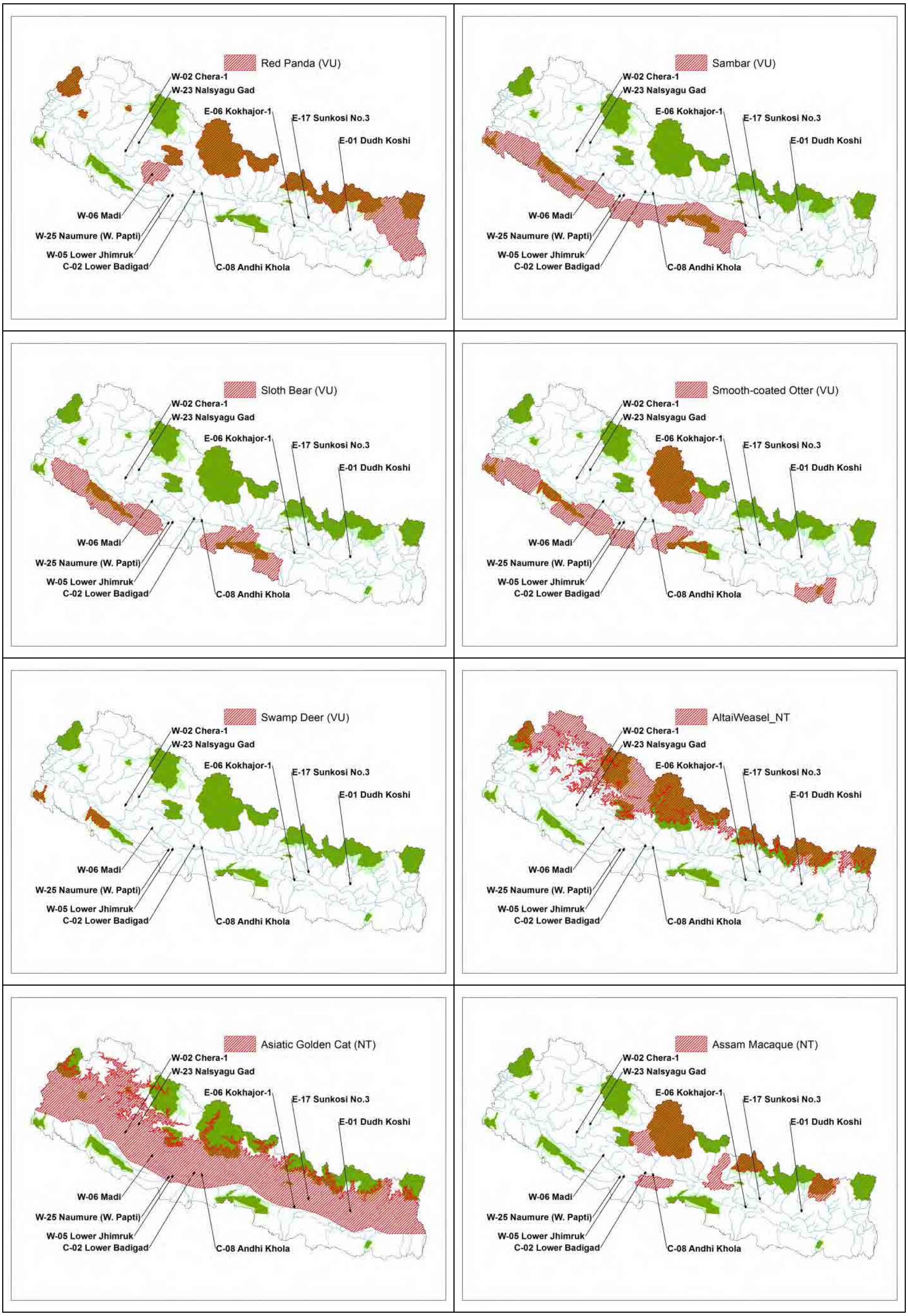

Gaur (VU)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

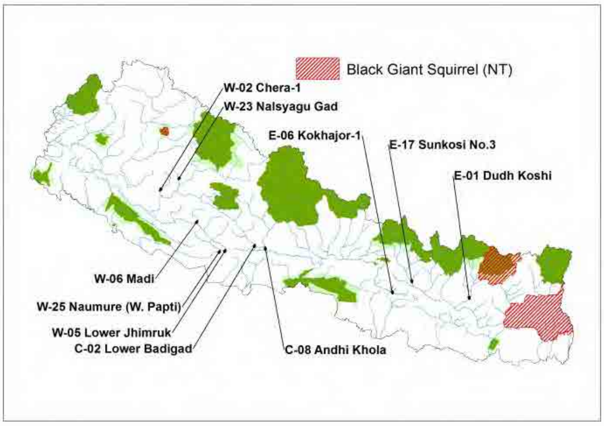

Greater One-horned Rhino (VU)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

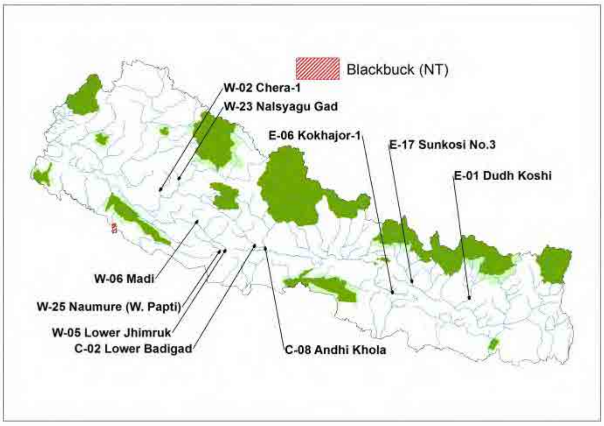

Himalayan Black Bear (VU)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

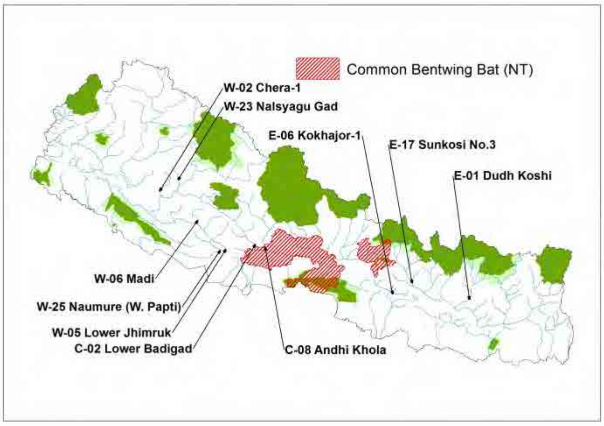

Mandelli's Mouse-eared Bat (VU)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

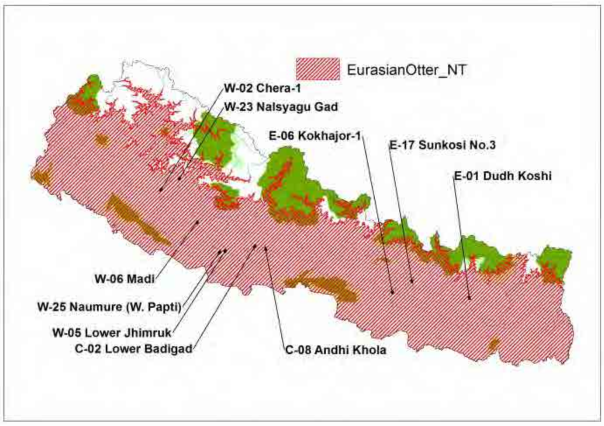

Marbled Cat (VU)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

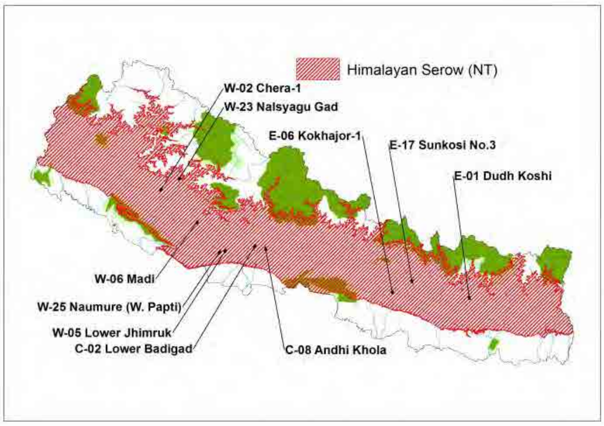

Red Panda (VU)
Sambar (VU)
Sloth Bear (VU)
Smooth-coated Otter (VU)
Swamp Deer (VU)
AltaiWeasel_NT
Asiatic Golden Cat (NT)
Assam Macaque (NT)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

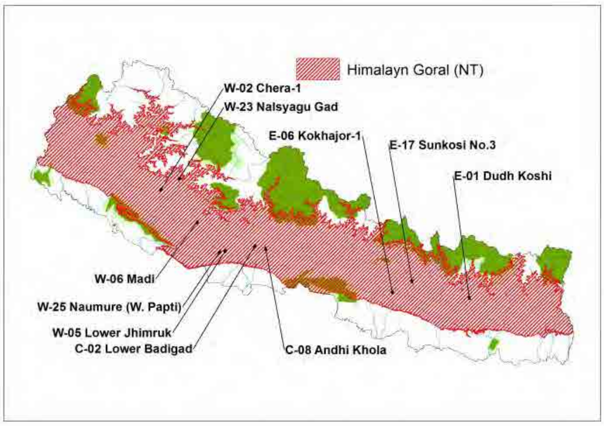

Black Giant Squirrel (NT)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

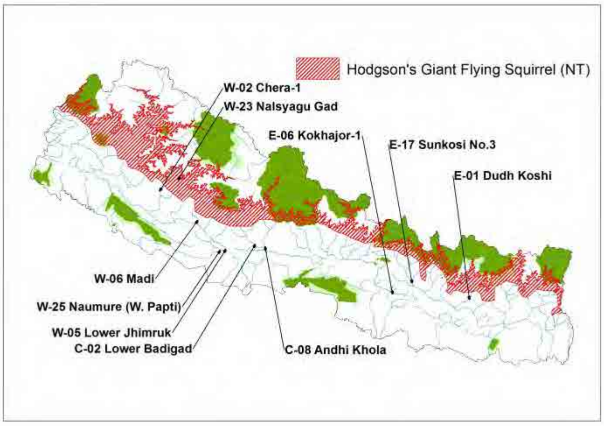

Blackbuck (NT)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

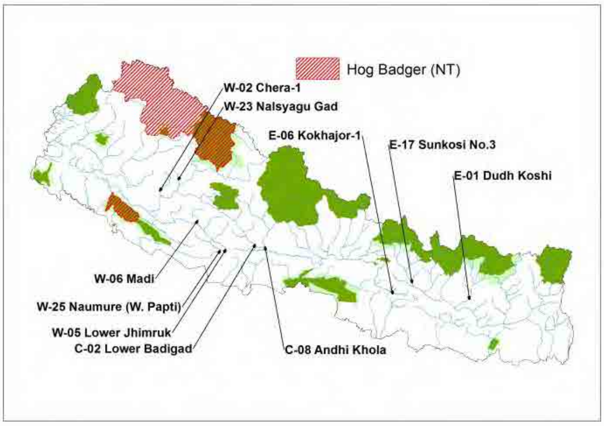

Common Bentwing Bat (NT)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

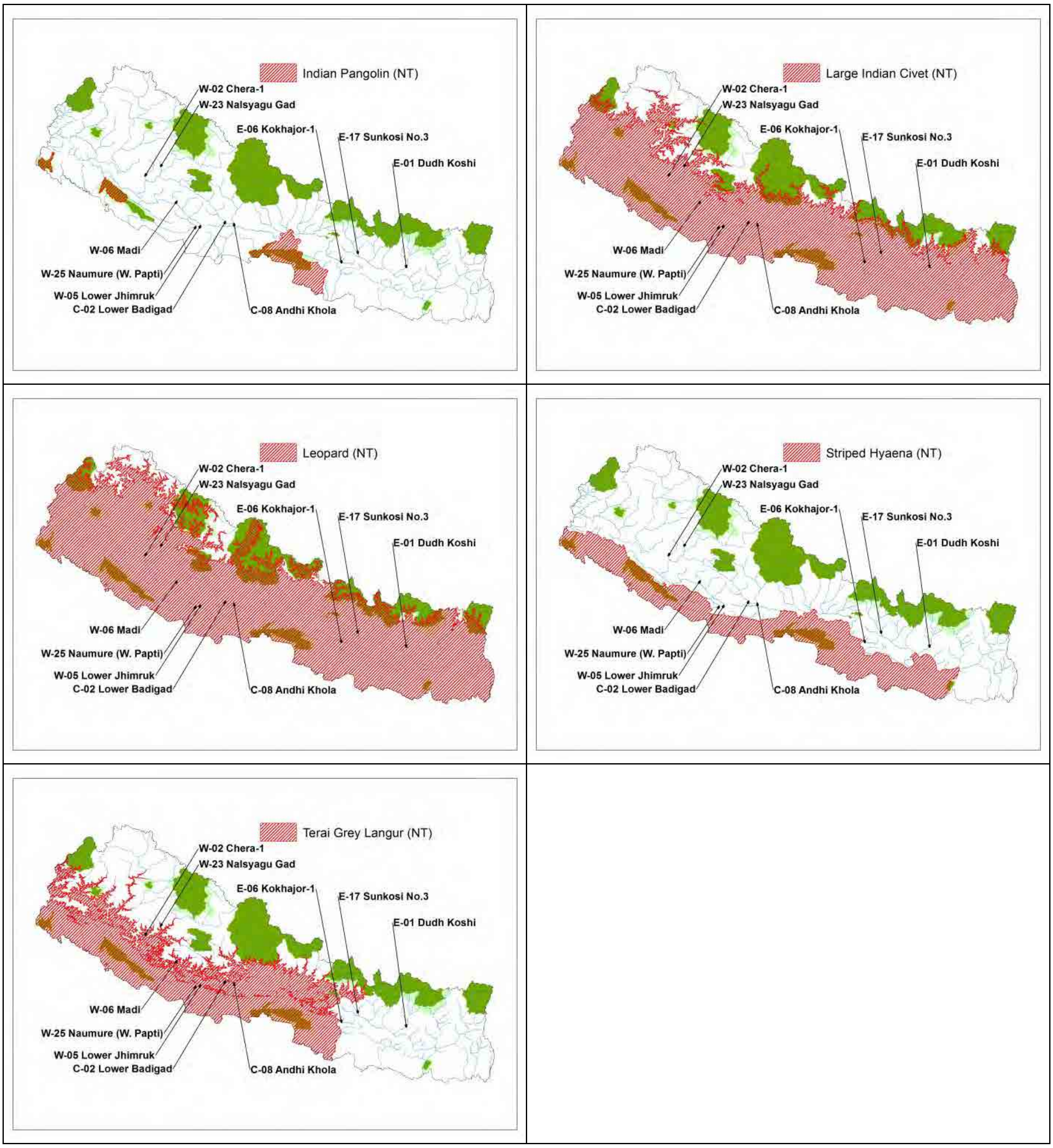

EurasianOtter_NT
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola


Himalayan Serow (NT)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola


Himalayn Goral (NT)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola


Hodgson's Giant Flying Squirrel (NT)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola

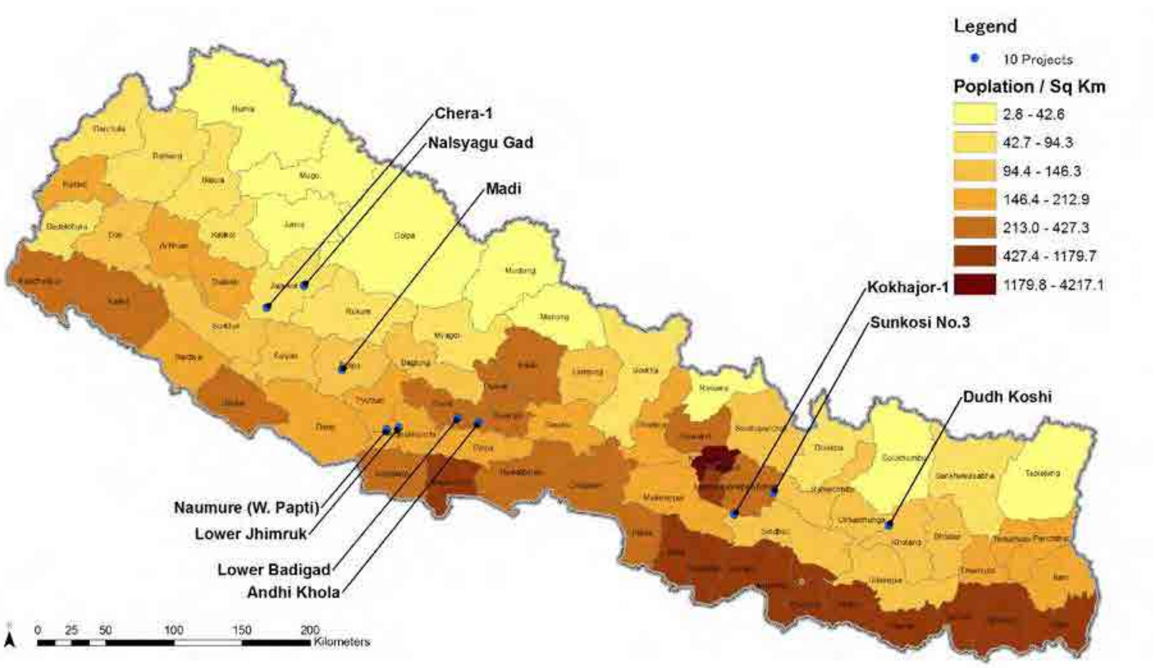

Hog Badger (NT)
W-02 Chera-1
W-23 Nalsyagu Gad
E-06 Kokhajor-1
E-17 Sunkosi No.3
E-01 Dudh Koshi
W-06 Madi
W-25 Naumure (W. Papti)
W-05 Lower Jhimruk
C-02 Lower Badigad
C-08 Andhi Khola




Source: The Status of Nepal's Mammals: The National Red List Series (IUCN 2012)

## 3.6 Population

Population of Nepal has been growing average 2.2% per year since 1960. The census data in 2011 show total population is 26,494,504. Child Mortality Rate has been decreasing from 290 to 48 per 1,000 and Life Expectancy at birth has been increasing from 38.5 to 68.5 years since 1960 to 2011. The population density is higher in Kathmandu, Pokara and low land along the Indian border than the other area. Figure 3.6-1 shows the population density map.




Source: Population census (2011)

**Figure 3.6-1 Population density in Nepal**

## 3.7 Administrative Boundary

Nepal has five Development Regions, 14 Zones, 75 Districts and 4,056 Village Development Committees. Figure 3.7-1 shows the map of the boundaries.

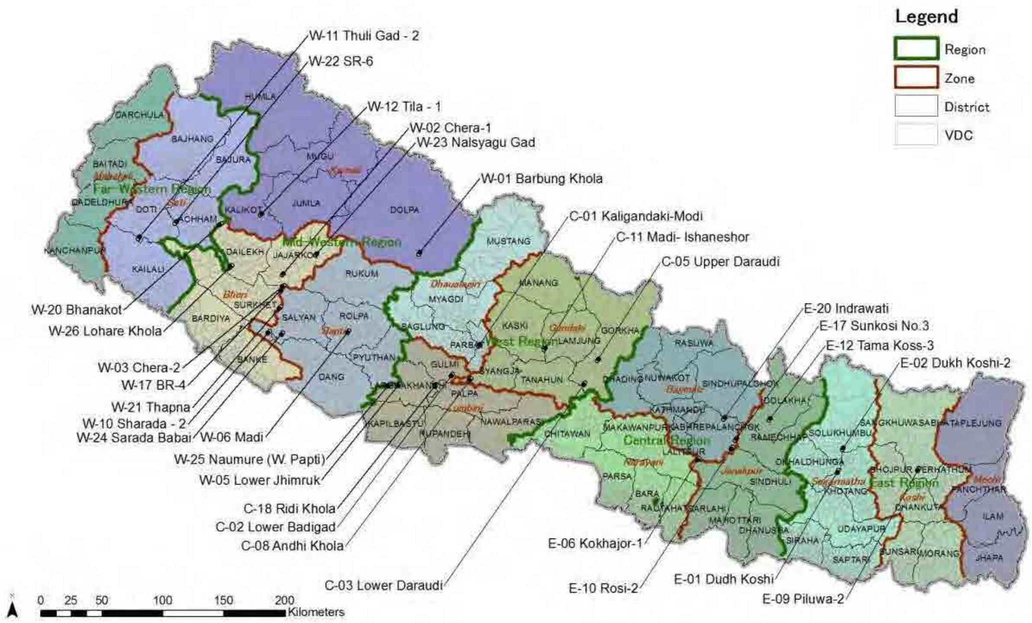



**Figure 3.7-1 Administrative boundaries**

## 3.8 Ethnicity

Nepal has various ethnic groups. 128 ethnic groups are recorded in the population census 2011. These ethnic groups are classified in six groups such as Adivasi/Janajati, BCTS, Dalit, Madhesi, Religious Minority, and others. Adivasi/Janajati is indigenous people who account for 36% of the national total population (See Table 3.8-2). BCTS (Brahmin/Chhetri/Thakuri/Sanyashi Dalit) is high caste people who account for 32%. Dalit is bottom caste people who account for 14%. Madhesi is the people living in Tarai plain who account for 14%[2]. Religious Minority means Islamic people who account for 4% (See Table 3.8-1). The National Foundation for Development of Indigenous Nationalities Act (2002) identified 59 ethnic groups as Adivasi/Janajati which own language, religion, tradition, culture, civilization and traditional egalitarian social structure and classified in five groups from endangered to advantaged based on the alienations. But it cannot be concluded that these counted groups are only the indigenous people. 48 out of 59 Adivasi/Janajatis are listed on the Census 2011 and other groups are under discussion if they are to be included in Adivasi/Janajati now. Then the classification of ethnic groups in Nepal is a matter of argument because of the history that Rana families forced no-Hindu groups into caste system and various epithets.

**Table 3.8-1 Population of Ethnic Gropes**

| Category | | Name | Madhesi | Population | | Rate | |
|---|---|---|---|---|---|---|---|
| Adivasi/ Janajati | Endangered | Meche | * | 4,867 | 21,284 | 0.0% | 0.1% |
| | | Raji | * | 4,235 | | 0.0% | |
| | | Lepcha | | 3,445 | | 0.0% | |
| | | Pattharkatta/ Kushwadiya | * | 3,182 | | 0.0% | |
| | | Hayu | | 2,925 | | 0.0% | |
| | | Kisan | * | 1,739 | | 0.0% | |
| | | Raute | | 618 | | 0.0% | |
| | | Kusunda | | 273 | | 0.0% | |
| | | Bankariya | | - | | - | |
| | | Mugali | | - | | - | |
| | Highly marginalized | Dhanuk | * | 219,808 | 594,030 | 0.8% | 2.2% |
| | | Danuwar | * | 84,115 | | 0.3% | |
| | | Majhi | * | 83,727 | | 0.3% | |
| | | Chepang /Praja | | 68,399 | | 0.3% | |
| | | Satar/ Santhal | * | 51,735 | | 0.2% | |
| | | Jhangad/ Dhagar | * | 37,424 | | 0.1% | |
| | | Thami | * | 28,671 | | 0.1% | |
| | | Bote | * | 10,397 | | 0.0% | |
| | | Brahmu/ Baramo | | 8,140 | | 0.0% | |
| | | Lhomi | | 1,614 | | 0.0% | |
| | | Thudam | | - | | - | |
| | | Siyar (Chumba) | | - | | - | |

[2] Total population of Madheshi of 71 ethnics which are listed on Census 2011 out of 94 Madhesi ethnics (GoN on Magh 21, 2065 (2009) identified) are 12,449,631 which is 47% of total national population. But this figure excluded the Madheshi which are overlapped with Adivasi/Janajati or Dalit.

| Category | | Name | Madhesi | Population | | Rate | |
|---|---|---|---|---|---|---|---|
| | Marginalized | Tharu | * | 1,737,470 | 3,891,696 | 6.6% | 14.7% |
| | | Tamang | | 1,539,830 | | 5.8% | |
| | | Kumal | * | 121,196 | | 0.5% | |
| | | Gharti/Bhujel | | 118,650 | | 0.4% | |
| | | Rajbansi | * | 115,242 | | 0.4% | |
| | | Kumhar | * | 62,399 | | 0.2% | |
| | | Sunuwar | | 55,712 | | 0.2% | |
| | | Gangai | * | 36,988 | | 0.1% | |
| | | Dhimal | * | 26,298 | | 0.1% | |
| | | Tajpuriya | * | 19,213 | | 0.1% | |
| | | Darai | * | 16,789 | | 0.1% | |
| | | Pahari | | 13,615 | | 0.1% | |
| | | Bhote | | 13,397 | | 0.1% | |
| | | Dura | | 5,394 | | 0.0% | |
| | | Dolpo | | 4,107 | | 0.0% | |
| | | Lhopa | | 2,624 | | 0.0% | |
| | | Topkegola | | 1,523 | | 0.0% | |
| | | Walung | | 1,249 | | 0.0% | |
| | | Free | | - | | - | |
| | | Mugali | | - | | - | |
| | | Larke (Nupriba) | | - | | - | |
| | Disadvantaged | Magar | | 1,887,733 | 3,587,191 | 7.1% | 13.5% |
| | | Rai | | 620,004 | | 2.3% | |
| | | Gurung | | 522,641 | | 2.0% | |
| | | Limbu | | 387,300 | | 1.5% | |
| | | Sherpa | | 112,946 | | 0.4% | |
| | | Yakkha | | 24,336 | | 0.1% | |
| | | Chhantyal/Chhantel | | 11,810 | | 0.0% | |
| | | Hyolmo | | 10,752 | | 0.0% | |
| | | Jirel | | 5,774 | | 0.0% | |
| | | Byasi/Sauka | | 3,895 | | 0.0% | |
| | | Tangbe | | - | | - | |
| | | Tin Gaunle Thakali | | - | | - | |
| | | Bahra Gaunle | | - | | - | |
| | | Marphali Thakali | | - | | - | |
| | Advanced | Newar | | 1,321,933 | 1,335,148 | 5.0% | 5.0% |
| | | Thakali | | 13,215 | | 0.0% | |
| | Others | Janajati Others | | 1,228 | 1,228 | 0.0% | 0.0% |
| BCTS | | Chhetree | | 4,398,053 | 8,412,507 | 16.6% | 31.8% |
| | | Brahman - Hill | * | 3,226,903 | | 12.2% | |
| | | Thakuri | | 425,623 | | 1.6% | |
| | | Sanyasi/Dasnami | * | 227,822 | | 0.9% | |
| | | Brahman - Tarai | * | 134,106 | | 0.5% | |
| Dalit | | Kami | | 1,258,554 | 3,594,447 | 4.8% | 13.6% |
| | | Damai/Dholi | | 472,862 | | 1.8% | |
| | | Sarki | | 374,816 | | 1.4% | |
| | | Chamar/ Harijan/ Ram | * | 335,893 | | 1.3% | |
| | | Musahar | * | 234,490 | | 0.9% | |

| Category | Name | Madhesi | Population | | Rate | |
|---|---|---|---|---|---|---|
| | Dusadh/ Pasawan/ Pasi | * | 208,910 | | 0.8% | |
| | Dhobi | * | 109,079 | | 0.4% | |
| | Tatma/Tatwa | * | 104,865 | | 0.4% | |
| | Lohar | * | 101,421 | | 0.4% | |
| | Khatwe | * | 100,921 | | 0.4% | |
| | Bantar/Sardar | * | 55,104 | | 0.2% | |
| | Badi | | 38,603 | | 0.1% | |
| | Dom | * | 13,268 | | 0.1% | |
| | Kori | * | 12,276 | | 0.0% | |
| | Gaine | | 6,791 | | 0.0% | |
| | Sarbaria | * | 4,906 | | 0.0% | |
| | Halkhor | | 4,003 | | 0.0% | |
| | Chidimar | * | 1,254 | | 0.0% | |
| | Kalar | * | 1,077 | | 0.0% | |
| | Dalit Others | | 155,354 | | 0.6% | |
| Madhesi (Other) | Yadav | * | 1,054,458 | 3,747,586 | 4.0% | 14.1% |
| | Teli | * | 369,688 | | 1.4% | |
| | Koiri/Kushwaha | * | 306,393 | | 1.2% | |
| | Kurmi | * | 231,129 | | 0.9% | |
| | Mallaha | * | 173,261 | | 0.7% | |
| | Kewat | * | 153,772 | | 0.6% | |
| | Kathabaniyan | * | 138,637 | | 0.5% | |
| | Kalwar | * | 128,232 | | 0.5% | |
| | Kanu | * | 125,184 | | 0.5% | |
| | Hajam/Thakur | * | 117,758 | | 0.4% | |
| | Sudhi | * | 93,115 | | 0.4% | |
| | Halwai | * | 83,869 | | 0.3% | |
| | Baraee | * | 80,597 | | 0.3% | |
| | Bin | * | 75,195 | | 0.3% | |
| | Nuniya | * | 70,540 | | 0.3% | |
| | Sonar | * | 64,335 | | 0.2% | |
| | Kahar | * | 53,159 | | 0.2% | |
| | Marwadi | * | 51,443 | | 0.2% | |
| | Kayastha | * | 44,304 | | 0.2% | |
| | Rajput | * | 41,972 | | 0.2% | |
| | Lodh | * | 32,837 | | 0.1% | |
| | Badhaee | * | 28,932 | | 0.1% | |
| | Bangali | * | 26,582 | | 0.1% | |
| | Gaderi/Bhedihar | * | 26,375 | | 0.1% | |
| | Mali | * | 14,995 | | 0.1% | |
| | Dhunia | * | 14,846 | | 0.1% | |
| | Rajdhob | * | 13,422 | | 0.1% | |
| | Rajbhar | * | 9,542 | | 0.0% | |
| | Punjabi/Sikh | * | 7,176 | | 0.0% | |
| | Amat | * | 3,830 | | 0.0% | |
| | Munda | * | 2,350 | | 0.0% | |
| | Dev | * | 2,147 | | 0.0% | |
| | Kamar | * | 1,787 | | 0.0% | |

| Category | Name | Madhesi | Population | | Rate | |
|---|---|---|---|---|---|---|
| | Koche | * | 1,635 | | 0.0% | |
| | Nurang | * | 278 | | 0.0% | |
| | Terai Others | * | 103,811 | | 0.4% | |
| Religious Minority | Musalman | * | 1,164,255 | 1,164,255 | 4.4% | 4.4% |
| Others | Kulung | | 28,613 | 145,132 | 0.1% | 0.5% |
| | Ghale | | 22,881 | | 0.1% | |
| | Khawas | | 18,513 | | 0.1% | |
| | Undefined Others | | 15,277 | | 0.1% | |
| | Nachhiring | | 7,154 | | 0.0% | |
| | Yamphu | | 6,933 | | 0.0% | |
| | Chamling | | 6,668 | | 0.0% | |
| | Foreigner | | 6,651 | | 0.0% | |
| | Aathpariya | | 5,977 | | 0.0% | |
| | Bantaba | | 4,604 | | 0.0% | |
| | Thulung | | 3,535 | | 0.0% | |
| | Mewahang Bala | | 3,100 | | 0.0% | |
| | Bahing | | 3,096 | | 0.0% | |
| | Natuwa | | 3,062 | | 0.0% | |
| | Dhankar/ Dharikar | | 2,681 | | 0.0% | |
| | Dhandi | | 1,982 | | 0.0% | |
| | Samgpang | | 1,681 | | 0.0% | |
| | Khaling | | 1,571 | | 0.0% | |
| | Loharung | | 1,153 | | 0.0% | |
| Total | | | 26,494,504 | | 100.0% | |

Source: Census 2011; Nepal Federation of Indigenous Nationalities Act (2004); GoN on 2065 Magh 21 (2009-2-3)

**Table 3.8-2 Definition of Janajati**

"Nationality (Janajati) is that community which has its own mother tongue and traditional culture and yet do not fall under the conventional four fold Varna of Hindu or Hindu hierarchical caste structure. A Janajati group has the following characteristics:

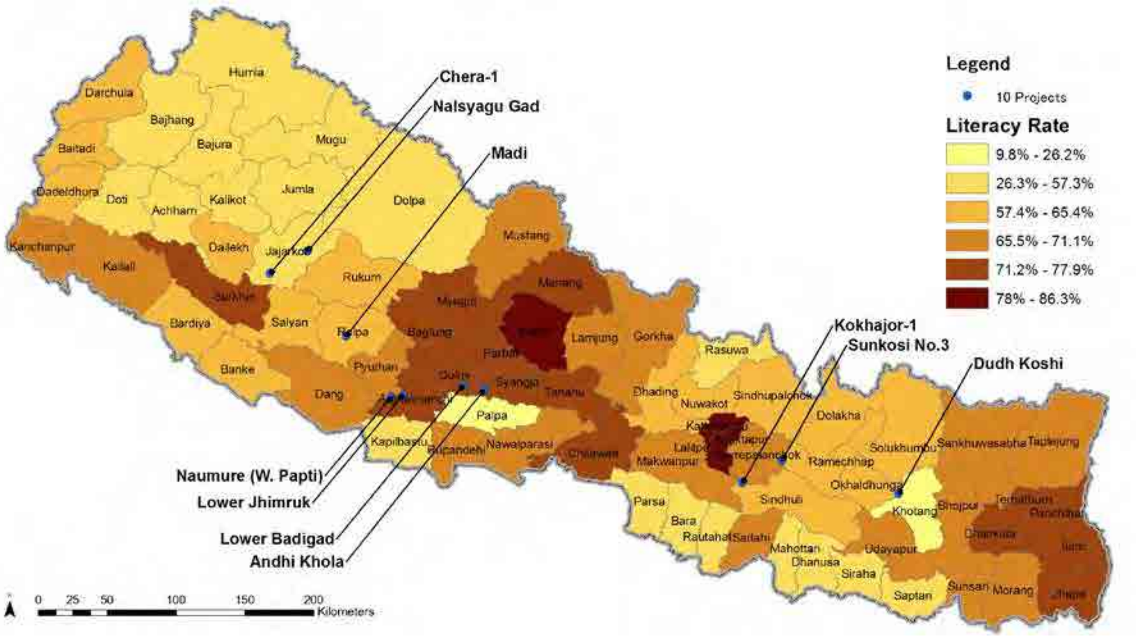
- A distinct collective identity
- Own language, religion, tradition, culture and civilization; own traditional egalitarian social structure
- Traditional homeland or geographical area
- Written or oral history
- Having "we-feeling"
- Have had no decisive role in politics and government in modern Nepal;

Who declare themselves as Janajati"

Source: The National Committee for Development of Nationalities (1996)

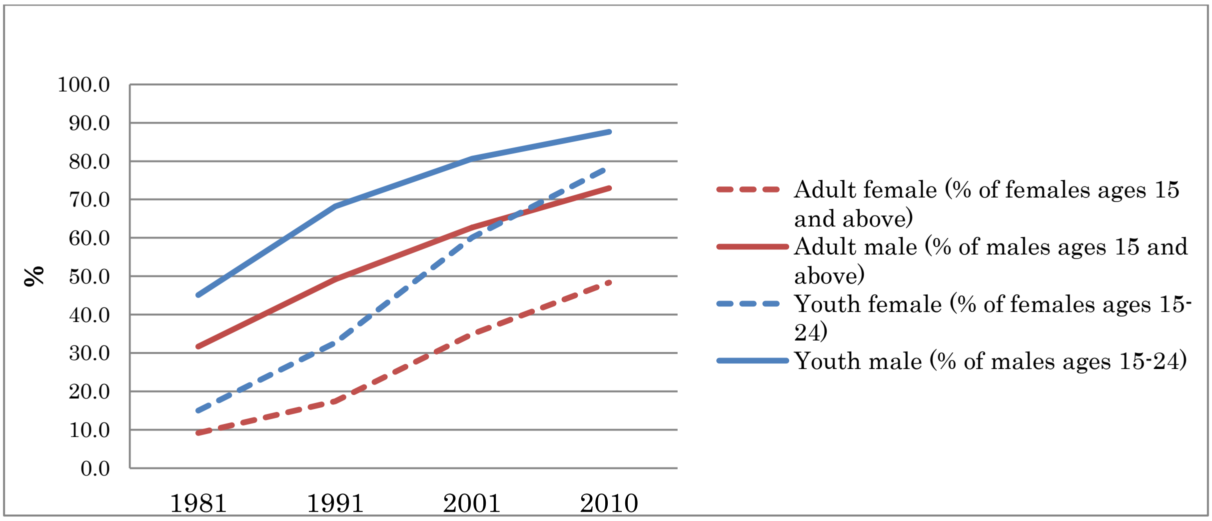
## 3.9 Literacy Rate

Literacy rate in Nepal is 65.2%. Leteracy rate in urban area such as Kathmandu, Lalitpur, Kaski, Bhaktapur are higher than 80% but rural area such as Humla, Mahottari, Rautahat, Palpa, Khotang are lower than 50%. Adult literacy rate has been kept increasing 20.6% to 60.3% since 1981. But the difference between a man and a woman are big and the rate of femal women ages 15 and above in 2010 was still 48.3%.




Source: Census 2011

**Figure 3.9-1 Literacy Rate**

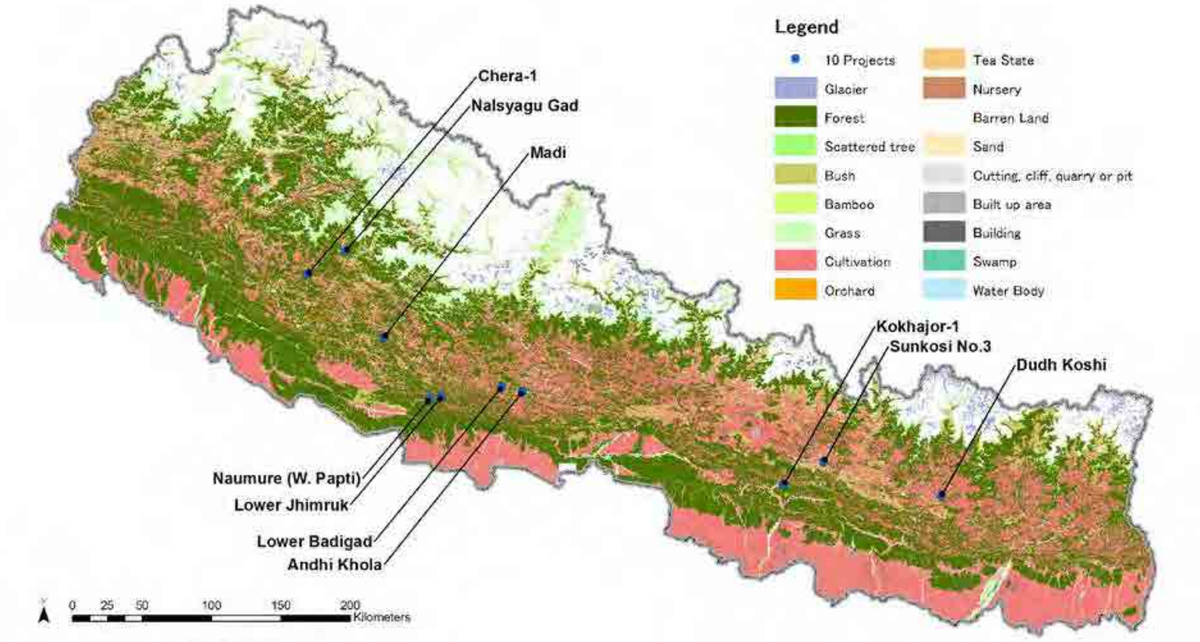



Source: UNESCO Institute for Statistics

**Figure 3.9-2 Literacy rate growth**

## 3.10 Land Use

The land above around EL.4,000 m is covered with ice and snow and below EL.4,000 m is covered with forest and cultivation area. Low land around Indian border and Kathmandu valley are mainly used as cultivation. Figure 3.10-1 shows the Land Use map.




Source: 1:25,000 and 1:50,000 topography map (Survey Department, Nepal)

**Figure 3.10-1 Land Use Map**

## 3.11 Rafting

Rafting is one of the popular tourism activities in Nepal. Main rafting routes are in Kalnari river system, Gandaki river system, and river system. According to the Nepal Tourism Statistics (2011) the number of tourists for rafting is increasing 262% per year from 2007. It is reported 2,181 tourists enjoyed by rafting in 2011. Main rafting routes are in the Kalnari, Gandaki , and Koshi river systems. Figure 3.11-1 shows main rafting routes.

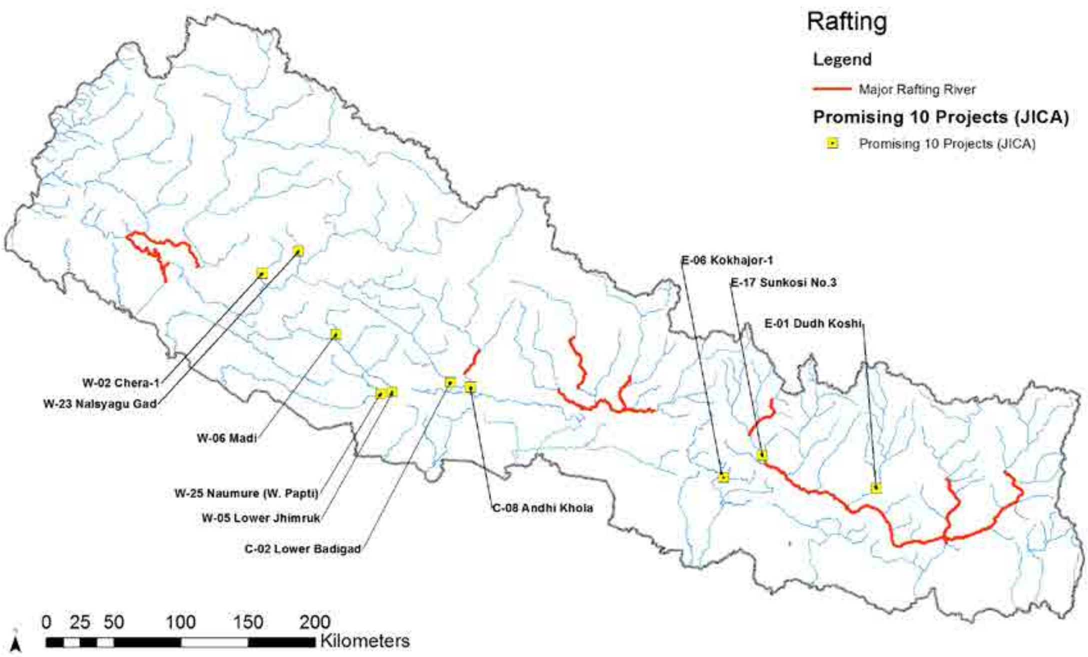
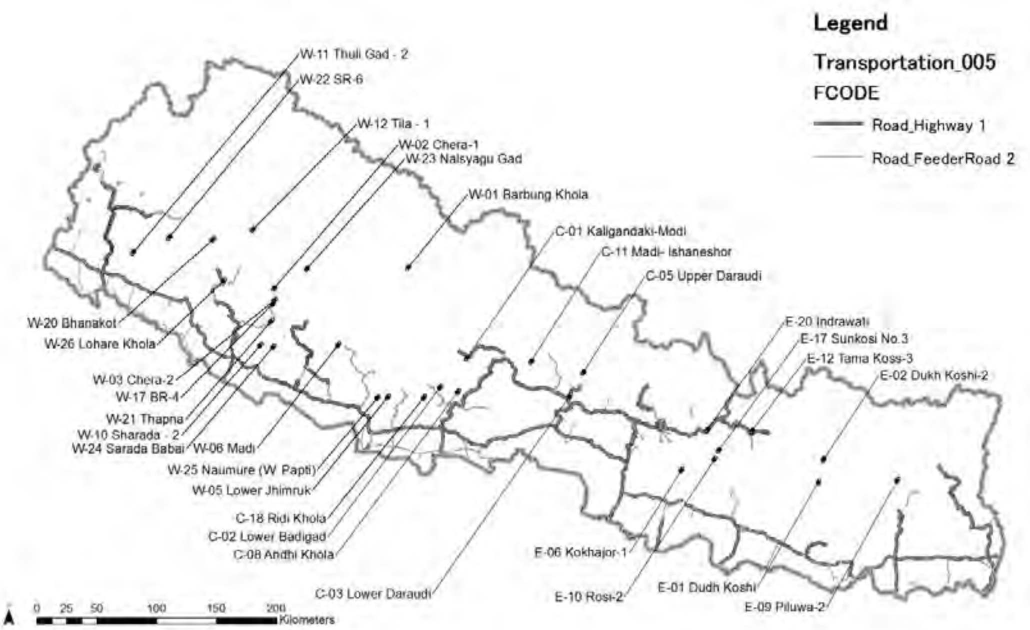



**Figure 3.11-1 Major Rafting Routes**

## 3.12 Transportation

National roads of Nepal cut longitudinally West to East. But the transportation of goods has many difficulties, because the roads are easily to be blocked by the landslide in rainy season. Figure 3.12-1 shows main National roads in Nepal.




Source: 1:25,000 and 1:50,000 topography map (Survey Department, Nepal)

**Figure 3.12-1 Main national roads in Nepal**

# Chapter 4 Law and Regulations

Environment protection Act (1997) and National Environment Impact Assessment Guidelines (1993) stipulate EIA procedures in Nepal. But there are no laws and regulations which provide SEA procedures. Land compensation is stipulated by Land Acquisition Act 2034 (1977) and Land Acquisition Guidelines 2049(1993). But they are only mentioning the payment compensation and far different from the resettlement guidelines by JICA; it does not meet the requirement of JICA. Forest compensation is prescribed by Forest Act 2049 (1993 and 1995 amendments) and Forest Regulation 2052 (1995). But the detail discussion of the compensation cannot be started until issuance of the generation license which can be obtained after financing. Drinking water standard is provided by National Drinking Water Quality Standards, 2062 but there is no ambient river water quality standard in Nepal. Other laws and regulations related with Environment are as follows.

## 4.1 Related Laws and Regulations

Following are the key policy instruments of the Government of Nepal attracted by the project in the process of development licensing, surveys, design, development and operation.

- Aquatic Animals Protection Act 2017 (1960) and Amendment 2055 (1999);
- District Development Committee (Working Agreements) Rules 2050 (1993);
- Electricity Act 2049 (1992) and Electricity Rules 2050 (1993);
- Environment Protection Act 2053 (1997) and Environment Protection Regulations 2054 (1997);
- Explosives Substances Act 2018 (1961);
- Forest Act 2049 (1993 and 1995 amendments) and Forest Regulation 2051 (1995);
- Hydropower Development Policy 2056 (2001);
- Labor Act 2048 (1992);
- Land Administration Act 2024 (1967);
- Land Acquisition Act 2034 (1977) and Land Acquisition Guidelines 2049 (1993);
- Local Self Governance Act 2055 (1999) and Local Self Governance Regulation 2056 (1999);
- National Parks and Wildlife Conservation Act 2029 (1973) and National Parks and Wildlife Conservation Regulation 2030 (1974);
- Public Roads Act 2031 (1974);
- Soil and Watershed Conservation Act 2039 (1982);
- Solid Waste (Management and Resource Mobilization) Act 2044 (1987), repealed 2067 (2010);
- Village Development Committee (Working Procedures) Rules 2050 (1994); and,
- Water Resources Act 2049 (1992) and Water Resources Rules 2050 (1993).

Regarding the compliance labor environment and Land Acquisition in Nepal, these are determined by Labor Act 2048 (1992) and Land Acquisition Act 2034 (1977). The followings are the brief summary of these acts, respectively.

Labor Act 2048 (1992)

This act is consisting with 11 chapters and stipulates various conditions for labors.

Employment and job security is stipulated in Chapter 2, such as classification of the posts, prohibition on child labor and restriction on minor and women, on job security, retrenchment and reemployment and so on. The labor condition about working hours is stipulated in Chapter 3, and about remuneration is stipulated in mainly in Chapter 4. Regarding the measurement aimed at industrial accident prevention relating to occupational health and safety, it is stipulated in chapter 5. Welfare arrangements are stipulated in Chapter 6. Special arrangement applicable in respect of specific enterprise such as construction enterprise, it is stipulated in Chapter 7. Chapter 8 determined conduct and penalties and Chapter 10 determined settlements of labor disputes. Other Chapters describe preliminary, board officers and other provision and Miscellaneous.

Land Acquisition Act 2034 (1977)

This act is consisting 43 sections and stipulates the compensation measures and its institutional framework.

Section 3 stipulates power of Government to Acquire Lands anywhere for public purpose subject to compensation. Section 4 empowers government to acquire land upon request by institutions for indicated purpose in this section subject to the payment of compensation and all expenses stipulated in this act. Section 5, 6, 7 and 8 stipulate provisions and procedures for initiating initial land acquisition process and estimating compensation rates. Section 9 and 10 stipulate procedures and provisions for notification to land acquisition. Section 11 stipulates right of landowners to file complain within a time-limit of seven days from the date of the publication of the notice with regards to the land right, if they might be affected by the notice., Section 13, 14, and 15 stipulate procedures and provisions of compensation fixation. Section 16 and 17 stipulate criteria for compensation fixation. Section 19 stipulates discloser of the compensation entitlement through public notification. Section 25 stipulates the special cases such as urgent necessity to maintain transport or communication facilities, or to ensure the safety. In these cases, provision of complain against the compensation rates to the Ministry or Home Affairs and the decision of the Ministry of Home Affairs on complain is final according to this section. Section 39 stipulates the penalties for the case necessary process has not correctly taken as described in this act. Other sections describe the role and necessary preparation taking by government side, the rules for a special case such as the land acquisition for diplomatic missions and international agencies and other rules relating to acquire or sell the land.

## 4.2 Policies and Guidelines

Following policies and guidelines of the government of Nepal will have to be complied in the environmental study including study procedures, impact identification and prediction, design of the mitigation prescriptions and so on.

- Hydropower Development Policy 2056 (2001);
- National Environmental Impact Assessment Guidelines 2049 (1993);
- Draft EIA Guidelines for Water Resources Sector 2050 (1994);
- EIA Guidelines for Forestry Sector 2050 (1995);
- Forestry Sector Policy 2057 (2000);
- Water Resource strategy, 2002;
- Land use policy, 2068;
- Nepal Biodiversity strategy, 2002;
- Sustainable Development Agenda for Nepal, 2003;
- Climate change policy, 2011;
- Leasehold Forestry policy, 2002;
- National Agriculture policy, 2004;
- Rural Energy Policy, 2006;
- Agrobiodiversity policy, 2007;
- Tourisum policy, 2009;
- Forest Fire Management Strategy, 2010;
- National wetland Policy, 2012; and,
- Irrigation policy, 2013.

### 4.3 International Agreement and Treaty

The international Agreements and treaties applicable to the Study are as follows.

- Biosphere Reserves
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1973)
- International Tropical Timber Agreement for the Asia and Pacific Region (1956)
- Ramsar Convention (1971)
- World Heritage Site Convention
- ILO Convention concerning Indigenous and Tribal Peoples in Independent Countries (1989, No. 169)
- Convention on Biological Diversity (CBD) (1992)
- United Nations Framework Convention on Climate Change (1992)
- Kyoto Protocol to the United Nations Framework Convention on Climate Change (1998)
- Basel Convention the Montreal Protocol on Substances that Deplete the Ozone Layer
- International Treaty on plant Genetic Resources for Food and Agriculture (2001)

### 4.4 EIA and IEE requirement

There is no legal requirement for Strategic Environmental Assessment of Hydropower Project in Nepal. But Environmental Impact Assessment (EIA) or Initial Environmental Examination (IEE) will be required when projects move to feasibility study. The Environment Protection Act 1997 (EPA 1997) and Environment Protection Rules 1997 (EPR 2010 as amended) stipulates the projects which need EIA or IEE. All the hydropower projects which are more than 50MW are reqired to prepare EIA. Transmission line projects more than 132kV are required EIA. Followings are the requiring IEE/EIA projects in the EPR 1997.

Requireing IEE projects

1. Supply of electricity though the constructions of transmission lines of from 33 to 132 KV capacity.
2. Operation of rural electrification projects of 1 to 6 MW.
3. Operation of electricity generation projects from 5 to 50 MW capacity.

Requireing EIA projects

1. Supply of electricity through installation of transmission lines of more than 132kv.capacity.
2. Operation of more than 6 mva. Rural Electrification Projects.
3. Operation of electricity generation projects with a capacity of more than 50 MW.
4. Generation of more than 1mw. Diesel or the heat electricity.

Matters to be mentioned in IEE/EIA are also stipulated in EPR 1997 as follows.

Matters to be mentioned in IEE (EPR 1997, 2010 amended)

1. Name and address of individual or institution preparing the report:

2 Summery of the proposal: (To briefly mention the following matters in regard to the possibly impact of the implementation of the proposal on the environment):

(a) Objectives of the proposal,
(b) Impact on land-use.
(c) Adverse impact on the environment impact on human life, and population pressure,
(d) Damage to be suffered by local goods or objects,
(e) Other necessary matters.

3. The following matters must be explicitly mentioned in respect to the proposal:

(a) Type of proposal,
 (i) Processing,
 (ii) Manufacturing,
 (iii) Installation,
 (iv) Service delivery,
 (v) Others.
(b) If related to delivery, the nature and type of goods to be delivered.
(c) Proposal's
 (i) Installed capacity
 (ii) Number of hours to be operated per day or year.

(d) Materials to be used (quantity and year to be mentioned).

(e) Emission resulting from the implementation of the proposal (the time of operation and the consequent volume of emission to be specified)

(i) Solid
(ii) Liquid
(iii) Air,
(iv) Gas,
(v) Noise
(vi) Dust,
(vii) Others

(f) Energy to be used:

(i) Type,
(ii) Sources
(iii) Volume of consumption (per day and year)

(g) Human Resource requirements:

(h) Resources required for the implementation of the proposal:

(i) Total (Gross) capital
(ii) Working capital
(iii) Land area,
(iv) Building and their types,
(v) Machinery and tools
(vi) Others.

(i) Detailed particulars of the area where the project is to be implemented:

(i) Maps,
(ii) Population and condition relating to settlements in the area as well as in the nearby areas,
(iii) Particulars of any sensitive things or objects, if any, located close to the area where the proposal is to be implemented
(iv) Current situation
(v) Sources of water
(vi) Arrangement made for disposing or processing the waste
(vii) Paths for movement in the area where the proposal is to be implemented

(j) Manufacturing processes

(k) Details of the technology

(l) Other necessary matters.

4. Impact of the implementation of the proposal on the environment:

(a) Impact on the social, economic cultural spheres:

(i) Impact on human health,
(ii) Degradation of cultivable land,
(iii) Destruction of forests,
(iv) Changes in social, cultural and religious norms and value,
(v) Others.

(b) Biological Impact:

(i) Population,
(ii) Flora and fauna.
(iii) 'Natural habitat and communities

(c) Physical Impact:

(i) Land,
(ii) Atmosphere,

(iii) Water,
(iv) Noise,
(v) Man-made objects,
(vi) Others

5. Alternatives for the implementation of the proposal:
(a) Design
(b) Project site
(c) Processes, time-schedule,
(d) Raw materials to be used,
(e) Others

6. Alternatives to reduce or control the impact of the implementation of the proposal on the environment.

7. Matters to be monitored while implementing the proposal.

8. Other necessary matters.

## Matters to be mentioned in EIA (EPR 1997, 2010 amended)

1. Name and Address of the individual or intuition preparing the report:

2. Summary of the proposal: (to mention the following matters in regard to the possible impact of the implementation of the proposal on the environment.):
(a) Objectives of the proposal ,
(b) Impact on land-use,
(c) Adverse impact on the environment, impact on human life, and population pressure,
(d) Damage to be suffered by local goods or objects
(e) Other necessary matters.

3. Summary of the Report: Brief particulars of the matters mentioned in the report relating to the environmental impact assessment.

4. Particulars of the proposal:
(a) To specify the technical, geographical, environmental, economic, social, cultural and physical aspects of the proposal.
(b) To specify the objectives, working policies and work-schedule of the activities to be undertaken during each phase of the implementation of the proposal.

5. Basic information relating to the proposal: To mention basic information about the geo-physical, cultural, biological, and social and economic conditions of the area to be assessed, as well any possible change that may occur there before the implementation of the proposal. In case there are any data which may not be available or any Subject which may not be covered by the study, they too should be mentioned.

6. Identification of environmental Impact: To mention the possible positive and negative impact on the following spheres of the environment while implementing the proposal, and estimate and specify the volume of possible impart according to time and work schedules as far as possible.
(a) Geographical area likely to have positive or negative impact of the implementation of the proposal and thereof time-schedule.
(b) Impact of waste and pollution to be emitted through the implementation of the proposal.
(c) Direct or indirect and cumulative impact of the implementation of the proposal on the environment.

7. Analysis of the alternatives for the proposal: The following matters are to be analyzed:
(a) Matters concerning the design of the proposal, project site, technology, operation procedure, time –schedule and raw materials to be used.
(b) Comparison is to be made on the basis of the fixed and working capital, local suitability , institutional training and supervision needed for the implementation of the proposal, and the

environmental cost and returns and economic significance of each alternative measures are to be analyzed as far as possible.

(c) Short, medium and long – term adverse impact of the implementation of the proposal.

(d) Sources of energy to be used for the implementation of the proposal and measures to be adopted for saving such energy.

(e) Analysis of the consequences of the non- implementation of the proposal.

8. Measure to reduce environmental impact:

(a) To mention practical preventive measures to be adopted for all activities which could have a negative impact on the environment.

(b) In case the environmental impact cannot be fully avoided through preventive measures, arrangements made for payments of compensation shall be mentioned. The effectiveness of the preventive measures shall be analyzed from the view point of their cost on the basis of the comparison with other possible alternatives.

(c) The effectiveness of the preventive measures shall be analyzed from the viewpoint of their cost on the basis of a comparison with other possible alternatives.

9. To mentioned matters concerning environmental management plans.

10. Review of policy and Legal Provisions: To review the related policies, laws, and Rules on the basis of the nature and scale of the proposal. If any policy or legal provision, needs to e reformed, to specify the same.

11. Monitoring of the Proposal: To mention the procedure of monitoring the impact of the implementation of the proposal on the environment, as well as the monitoring agency, time-schedule, monitoring and evaluation Indicators etc.

12. To mention the format and relevancy of environmental examinations.

13. Reference materials: To make at list of publications quoted as references while preparing the report in the following manner:

(a) Author,

(b) Date of Publication,

(c) Title of the material quoted,

(d) Year volume, number, etc. (if any)

(e) Page number

14. To include the following particulars in the Annexes:

(a) Maps relating to the land structure, geographical location, land-use and land-capacity and other maps related to the study.

(b) Aerial photographs as far as possible of the proposal implementation site and the surrounding areas,

(c) Questionnaires or lists of Subject matters used for field research.

(d) Matters connected with the evaluation of the environmental impact such as charts and photographs.

(e) Hydrological and climatic data (by arranging them serially and chronologically)

(f) Data relating to flora and fauna of the proposal implementation site,

(g) Geological and risk evaluation data (if available),

(h) Information relating to the quality of air and water and the noise level before and after the operation of the project it available.

(i) Matrix or serial graphs relevant to the environmental impact assessment.

(j) Maps, slides records, video films and visual support equipments.

(k) Cropping techniques and data relating to livestock farming, soil features, and quantity of chemical fertilizers used.

(l) List of written reference materials used at the time of preparing the study report.

(m) List of invitees and participants and records of discussions, meetings and gathering among the

| |
|---|
| concerned agencies, and brief particular of monitoring operations.<br>(n) List of names of individuals and institutions comprising of the study team involved in the preparation of the environmental impact assessment report.<br>(o) Name, address and telephone number of the individuals and institutions contacted in the course of the study. |

# Chapter 5 Zero Option

If there are no hydroelectric power projects in Nepal, Solar Power, Wind Power, Thermal Power would be the alternative generation source. Followings show the possibility of the alternative source in Nepal. All of them can be the generation source to some extent, but cannot be stable and low cost energy supply to fulfill the energy demand.

## 5.1 Solar Power Generation

Since the generation cost by solar power is considerably high at the present time, construction of a number of large-scale solar power generation facilities that are connected to the integrated power system is considered to be unfeasible for the time being. On the other hand, it is suitable for electrification of each house/facility and the power source for street light. However, solar power generation facilities are not able to produce electricity during the night and their output fluctuate depending on the intensity of sunlight, electric storage devices like rechargeable batteries should be combined with them.

## 5.2 Wind Power Generation

Since there are many examples in many countries and its generation cost is relatively modest, wind power generation is one of promising power generation method as one of power sources that are to be connected to the integrated power system. However, since its output largely fluctuates depending on wind conditions and power generation responding the demand is difficult, the rate of its installed capacity in the power system has an upper limit. In addition, when it is used alone or in a small-scale rural power grid, electric storage devices like rechargeable batteries are required for stable power supply.

## 5.3 Thermal Power Generation (Diesel or Gas Turbine)

Thermal power generation is not affected by the nature and excellent in responding to the demand fluctuation, but it will be used only for the power source in emergency in Nepal. And generation cost would be high and $CO_2$ emission would be highest. It does not have any plan to construct a new thermal electric power plant at present.

**Table 5.3-1　Comparison of Electric Power Generation Methods in Nepal**

| | Hydropower | Solar Power | Wind Power | Thermal Power (Diesel, gas turbine) |
|---|---|---|---|---|
| Domestic potential | 42,000 MW | 2,100 MW [1)] (grid connected) | 3,000 MW [1)] | ― |
| Responsiveness to demand | Fair (ROR-type is inferior to storage-type) | Poor (Fair if electric storage devises are used) | Poor (Fair if electric storage devises are used) | Good |
| Generation Cost (Rs/kWh) | ROR (NEA): 3.1 [2)]<br>ROR (IPP): 5.4 - 6.5 [2)]<br>Storage (NEA): 5.0 [2)] | Household use: 28 - 32 [3)]<br>Mega solar: 20 - 40 [3)] | 8 - 15 [3)] | Diesel (NEA): 27 [2)] |
| Impact on Environment | Fair (Storage-type is inferior to ROR-type) | Good | Good | Poor |
| Expected Role | - Main power source for the national grid<br>- Rural electrification by mini/micro hydro | - Rural electrification of each household/public facility<br>- Street light, etc. | - Power source for the national grid<br>- Rural electrification | - Emergency power source |

1) Alternative Energy Promotion Centre, Nepal.
2) Estimated by JICA Study Team
3) National Policy Unit, Japan. 2010 price, on the assumption that JPY 1.0 = Rs. 0.85.

# Chapter 6　First Step

## 6.1　Project description

At the first step 67 Potential Projects (see Table 6.1-1) are examined. 65 projects were listed by NEA in December 2009 and two projects (C-19: Baghmati Multipurpose and W-27: Nisti-Panah) were added by NEA's request in January 2012. These are briefly examined on the desk study.

### Table 6.1-1 Potential Projects (67 projects) in 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.

## 6.2 Screening items and methods

First step aims to exclude projects deemed inappropriate as candidates of evaluation in the Study. Following three conditions are adopted for screening. The information used for the screening is NEA consultation, previous project report, and previous master plan study report given by NEA. Site survey and additional document survey was not conducted for the First Step.

(1) On-going Projects

The evaluation of the projects in Detail Design / Feasibility Study was deemed not useful. Then these projects were excluded from the project 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.

(2) Overlapped Project

The locations of some projects are about the same with other project. These duplicated projects were excluded.

(3) Not appropriate as Storage-type Hydroelectric Power Projects

From the viewpoints of installed capacity, dam height, project cost, regulating capacity of reservoir[3], number of submerging households, etc., projects that were deemed inappropriate as a storage-type hydroelectric power project in Nepal were excluded.

**Table 6.2-1 Screening Condition for Not Appropriate Projects**

| Items | Screening condition | Reason |
|---|---|---|
| Installed Capacity | More than 1,000 MW | It is too big because 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 NEA is about 3,700 MW. |
| Dam Height | Higher than 300m | It is too high because the maximum dam height in the world as of January 2012 was 300 m (Nurek dam in Tajikistan). |
| Project Cost | More than US$ 2 billion | It is too expensive because the national budget of Nepal 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. |
| Regulating Capacity [4] of Reservoir | Less than 5% | It will not work effectively for dry season energy. The main role of projects in this 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. |
| Number of Submerging Households | More than 5,000 households | It is too big, because resettlement issues might be biggest obstacles for development. |
| National Park and Protected Area | Projects that located in the area stipulated in “National Parks and Wildlife Conservation Act, 2029” | 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.” |
| World Heritage | Projects that located in world heritages | Ditto |

## 6.3 Screened projects

36 projects are excluded from 67 Potential Projects. All the excluded projects are summarized in Table 6.3-1.

(1) On-going Projects

Five projects which are in the stage of Detailed Design, Feasibility/Pre-Feasibility Study are excluded. Names of the projects are as follows.

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

4 In Japan, one of definitions of storage-type is the regulating capacity more than 20%. Regulating capacity of ROR-type is about 0%.

Project in Detailed Design Stage

C-07: Budhi Gandaki (600 MW)

Projects on which FS or Pre-FS is in progress

E-14: Tamor (Terahathum) (530 MW)
C-06: Kaligandaki-2 (660 MW)
C-19: Bagmati Multipurpose (140 MW)
W-27: Nisti-Panah (90.4 MW)

(2) Overlapped Project

Five projects are excluded because of duplication of the location. Followings are the name of the projects.

E-13: Tamor No. 1 (696 MW)
Tamor No. 1 was excluded and E-14: Tamor (Terahathum) (530 MW) was adopted because the study of Tamor (Terahathum) project was conducted later than Tamor No. 1.

E-18: Sun Koshi No. 3 (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 "Master Plan Study on the Koshi River Water Resources Development" (March 1985, JICA).

C-14: Seti (Gandaki) (230 MW)
This project was excluded because its location overlaps with Upper Seti projects that is now in the detailed design stage.

W-14: Thuli Gad (120 MW)
Thuli Gad was excluded and W-11: Thuli Gad -2 (119.7 MW) was adopted because the study of Thuli Gad -2 projects was conducted later than Thuli Gad.

W-15: LR-1 (98 MW)
LR-1 was excluded and W-26: Lohare Khola (67 MW) was adopted because the study of Lohare Khola project was conducted later than LR-1.

(3) Not appropriate Projects

36 projects are excluded from the viewpoints of installed capacity, dam height, project cost, regulating capacity of reservoir[5], number of submerging households, etc.

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

Installed Capacity

Projects whose installed capacity was more than 1,000 MW were excluded 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 NEA is about 3,700 MW. The projects excluded are as follows (see the column C of Table 6.3-1).

E-03: Dudh Koshi-3 (1,048.6 MW)
E-04: Dudh Koshi-4 (1,603 MW)
E-08: Mulghat (2,647.7 MW)
E-15: Sun Koshi No. 1 (1,357 MW)
E-16: Sun Koshi No. 2 (1,110 MW)
C-12: Kali Gandaki No. 1 (1,500 MW)
C-17: Trishulganga (1,500 MW)
W-07: Mugu Karnali (3,843.8 MW)
W-19: Lakarpata (1,200 MW)

Dam Height

Projects whose dam height was higher than 300 m were excluded taking into consideration that the maximum dam height in the world as of January 2012 was 300m (Nurek dam in Tajikistan). The projects excluded are as follows (see the column D of Table 6.3-1).

E-03: Dudh Koshi-3 (357m)
E-04: Dudh Koshi-4 (425m)
W-07: Mugu Karnali (694m)
W-08: Sani Bhari-1 (417m)
W-09: Sani Bhari-2 (330m)
W-13: Tila-3 (338m)

Project Cost

Projects whose project cost at the estimated point of time was more than US$ 2 billion were excluded taking into consideration that the national budget of Nepal 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. The projects excluded are as follows (see the column E of Table 6.3-1).

E-03: Dudh Koshi-3 (US$ 2.26billion)
E-04: Dudh Koshi-4 (US$ 2.87 billion)
E-08: Mulghat (US$ 2.37 billion)
W-07: Mugu Karnali (US$ 4.78 billion)

Regulating Capacity of Reservoir

Projects whose regulating capacity of reservoir was less than 5%[6] were excluded taking into consideration that the main role of projects in this 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 6.3-1).

E-05: Khimti (2.91%)
E-07: Likhu-1 (2.87%)
E-15: Sun Koshi No. 1 (0.19%)
C-04: Seti-Trisuli (2.56%)
C-15: Dev Ghat (0.32%)
C-16: Bhomichok (0.07%)
W-04: Humla-Karnali (2.73%)
W-13: Tila-3 (2.13%)

Number of Submerging Households

Since large number of relocation of households has a serious impact on the social environment of the project area, projects that required more than 5,000 households of submergence were excluded. The projects excluded are as follows (see the column G of Table 6.3-1).

E-21: Kankai (11,700)
C-06: Kaligandaki-2 (7,000)
C-13: Marsyangdi (5,170)
W-16: BR-3B: (9,270)
W-18: Surkhet (6,600)
W-19: Lakarpata (20,400)

National Park and Protected Area[7]

Projects that located in the area stipulated in “National Parks and Wildlife Conservation Act, 2029” were excluded. The projects excluded are as follows (see the column H of Table 6.3-1).

E-11: Sankhuwa-1 (Makalu-Barun Conservation Area)
C-09: Langtang Khola (Langtang National Park)
C-10: Uttar Ganga (Dhorpatan Hunting Reserve)

[6] In Japan, one of definitions of storage-type is the regulating capacity more than 20%. Regulating capacity of ROR-type is about 0%.

[7] 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.”

World Heritage

Projects that located in world heritages were to be excluded. However, there was no project in Table 6.3-1 that locates in a world heritage.

## Table 6.3-1 Screening of the Potential 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 the request by NEA.

# Chapter 7 Second Step

## 7.1 Project Description

At the second step, 31 Candidate Projects (See Figure 7.1-1 and Table 7.1-1) are examined. These 31 projects are selected from 67 Potential Projects. These are examined on the detail desk study.

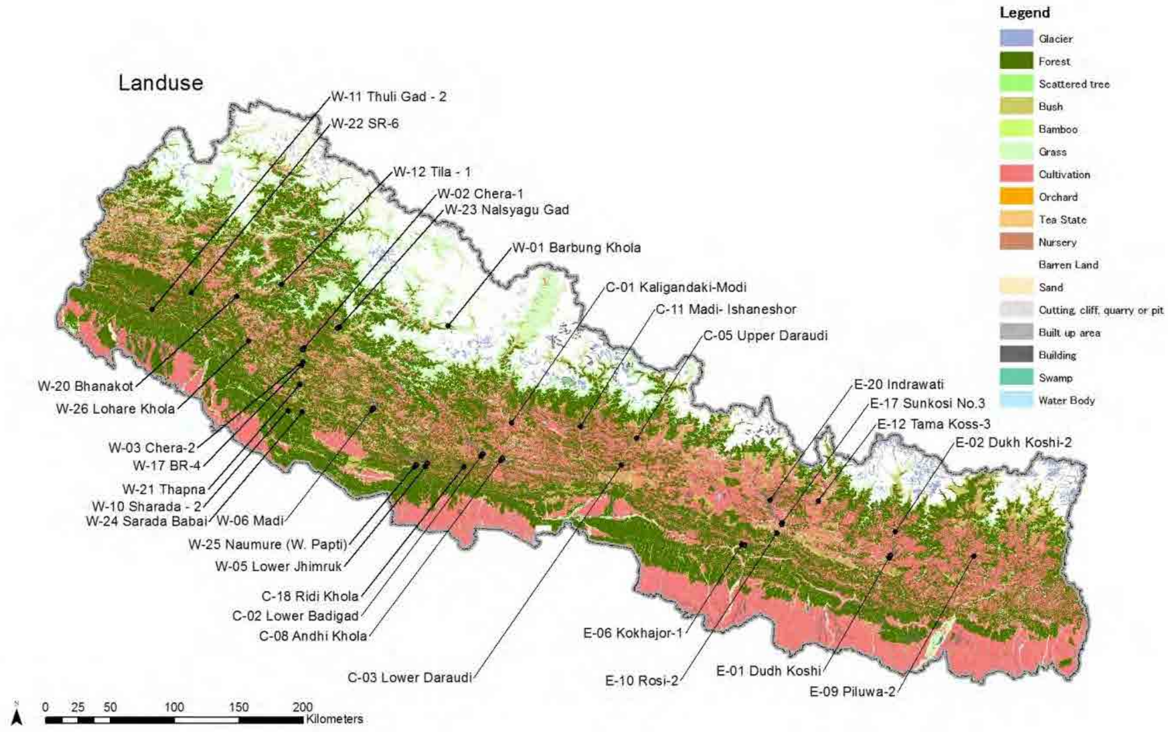



**Figure 7.1-1 Location of Candidate Projects on the Second Step**

**Table 7.1-1 Candidate Project 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. Rapti) | 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 |

## 7.2 Scoping and Evaluation Methods

The second step aims to select the Promising 10 projects from Candidate 31 projects. The Multi Criteria Analysis (MCA) was adopted for evaluation of the candidate projects in the second stage. 21 items are used for the evaluation. Sensitivity analysis is also done for other two cases. The data used for evaluation are existing project documents, geological map, topographical map, land-use map, Protected area map and so on. No site survey is conducted for the Second Step. Followings are evaluation methods and scoring criteria used for each items.

(1) Evaluation Items and Methods

1) Hydrology

***a. Reliability of Flow Data***

NEA has estimated the flow of the project by two kinds of methods. In the case 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 whole of the country.

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

Figure 7.2-1 shows the location of gauging stations reviewed. Table 7.2-1 show the specification of these gauging stations.

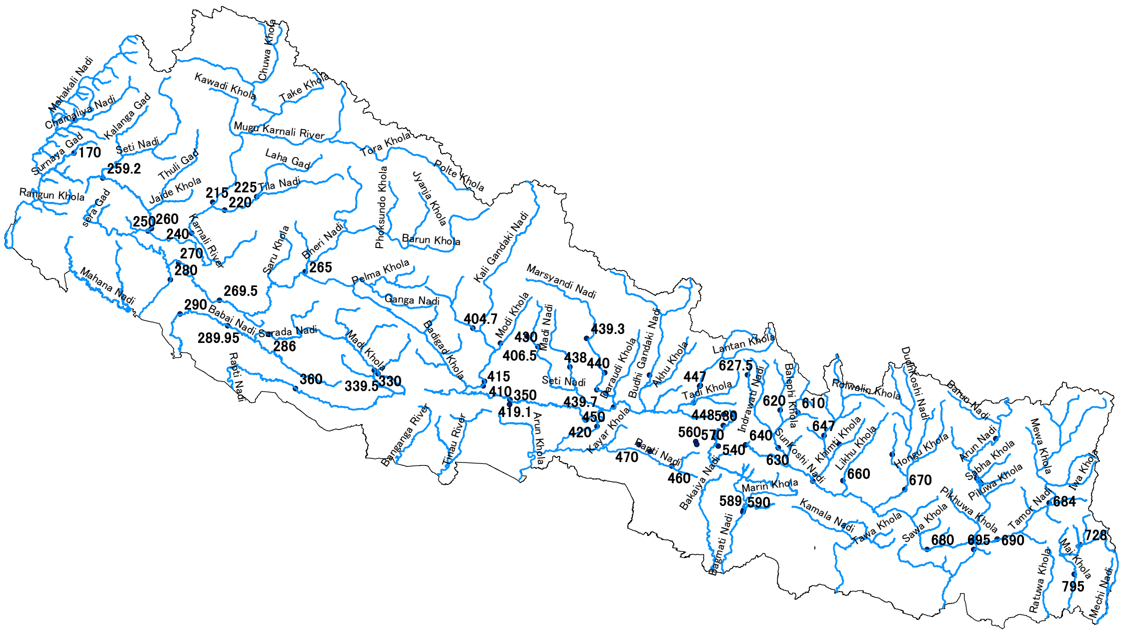



**Figure 7.2-1 Location of Gauging Stations Selected for Energy Calculation**

**Table 7.2-1 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 |

| 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

NEA has calculated the monthly flow data by Regional Analysis using the flow data before 1990 and the Monsoon Wetness Isolines based on the 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 7.2-2 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: $Q = 0.000995 \times A^{0.88672} \times MWI^{0.470822}$

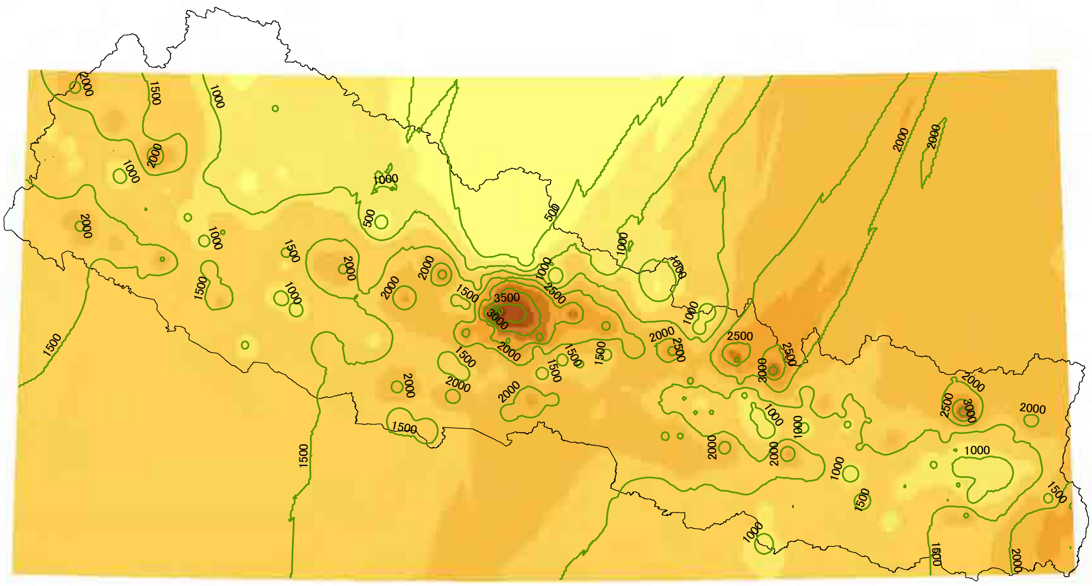


**Figure 7.2-2 Monsoon Wetness Index Isolines**

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 Table 7.2-2.

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

The project in which the flow data is gauged for 10 years but there are 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 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 7.2-2 Evaluation Criterion for Reliability of Flow Data**

| Flow Data | Estimated by the formula derived from the flow data gauged in the all gauging stations 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 |

### *b. Risk of GLOF*

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

As shown in the main report, according to the report by ICIMOD, 21 potentially critical glacial lakes in Nepal are identified.

Therefore, the Study Team decided the evaluation criterion for risk of GLOF to evaluate the potential projects by the number of potentially critical glacial lakes upstream of the project site as Table 7.2-3.

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 7.2-3 Evaluation Criterion for Risk of 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 |

### *c. Sedimentation*

Sediment phenomena progresses and it reduces effective storage capacity between FSL and MOL. In this stage, 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 the generation because of intrusion of sediment to the waterway.

Life of reservoir is an index to show the sediment impact to reservoir. It means how long years the reservoir become full by sediment yield. Life reservoir is equal to storage of reservoir divided by mean annual sediment yield.

Since the expected life of power station is 50 years, life of reservoir is required to be more than 50 years. The project in which life of reservoir is less than 50 years is considered as High Risk. Its score is 0. The life of reservoir of Low Risk project is decided to be 100 years. Its score is 100. The life of reservoir in the Medium Risk project is more than 50 years and less than 100 years. The score is calculated by proration. Table 7.2-4 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 3 areas of Nepal, such as the eastern area, the central area and the western area.

**Table 7.2-4 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

Here in this section describes the evaluation criteria for geology.

As discussed already, Nepal has numerous large active faults inside. Naturally earthquakes occur very frequent. Earth conditions including geology vary one area to another so rapidly. Storage hydroelectric power is 30-50 years structure that extreme cares should be paid to such Geology, Tectonic Faults, or Seismicity, in its site selection, as well as in its design. Hereby these geological evaluation criteria have been studied.

In the study, an each criterion is defined as “Geological conditions of the site,” “Natural hazard (earthquake)” and “Seismicity.” Each criterion is valued from “1” to “5” depending on each site condition. And thus “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 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 7.2-5.

# Table 7.2-5 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 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | Area | Acceleration | Epicenter |
| | | Formation | Area | Age | Rock Type | Large Tectonic Thrust | Faults | Land slides | Faults | Seismicity | Dam | Powerhouse | Reservoir | | 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 |

Source: compiled and modified from various sources.

## Table 7.2-5 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 | mode rate | | | 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. | mode rate | | | 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 | mode rate | 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 | mode rate | | | | | | | 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 | mode rate | | | | | | | 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 | mode rate | 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. | mode rate | 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 | mode rate | 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 | mode rate | 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 | mode rate | 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, | mode rate | 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 | mode rate | 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. | mode rate | 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. | mode rate | | | Late Cambrian, phyllite. | | | | LH | 270 | 13km, M5-6, N |

Source: compiled and modified from various sources.

## Table 7.2-5 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 |

Source: compiled and modified from various sources.

## Table 7.2-5 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 | mode rate | | | | | | | 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? | mode rate | 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 upsteream | mode rate | 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 | mode rate | 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 | mode rate | 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 | mode rate | 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 | mode rate | 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 | mode rate | 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 | mode rate | 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 | mode rate | 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 | mode rate | 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 | mode rate | 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? | mode rate | 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 | mode rate | 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 | mode rate | 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 | mode rate | | | 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 |

Source: and modified from various sources.

## Table 7.2-5 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 | moderate | | | | | | | 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 | moderate | | | | | | | 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. | moderate | | | | | | | 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. | moderate | | | 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 | moderate | | | | | | | 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 | moderate | | | | | | | 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 | moderate | | | | | | | 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 | moderate | 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 leagkage. | | 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 | moderate | 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 | moderate | 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 | moderate | | | 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 | moderate | | | 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 |

Source: compiled and modified from various sources.

### *a. Evaluation Criterion for Site Geology*

When considering the global 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.

NEA, in the past, also applied the similar methodology and provided "qualitative" geological point (score) to each candidate project. The methodology NEA applied is shown in Table 7.2-6.

**Table 7.2-6 Evaluation Criterion for Geology applied by 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 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 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 the more detailed data such as "rock types" and "ages" of each site both of which compose the 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 the discussion with NEA. The both parties discussed this based on the actual geologic and seismic dataset of the whole project sites. In other words, this criterion matrix is the outcome after it has been “tuned” so that the both parties have agreed upon.

For instance, there is a case that the criterion was revised after the discussion. Initially “limestone” was put inferior “point” as it was generally interpreted as one of problematic rocks. However, it has been suggested that a certain limestone in Nepal is less problematic when it is being “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 7.2-7 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 “general geologic feature.”

**(b) Modification (Subtraction of points) by “Landslides” or “Mines in operations”**

i) Landslides

As landslides in reservoir or dam axes have negative impacts from safety points of view as well as it may bring 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 subtraction of “20 point” from above (a) Criterion Matrix.

ii) Mines in Operations

The impacts of natural resource developments nearby on the potential planning (planned) sites of hydroelectric power are not geological issues but rather, they have much more political aspects of Nepal 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 is valued subtraction “20 point”.

Thus, the modification is:

i) Frequent landslides, subtract 20 point from (a) value
ii) Mines in operations etc., subtract 20 point from (a) value

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

The result is shown in Table 7.2-7.

**Table 7.2-7 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 Score.
In case of mines in operations etc., subtract “20 points” from Score.

### *b. Evaluation Criterion for Natural Hazard (Earthquakes)*

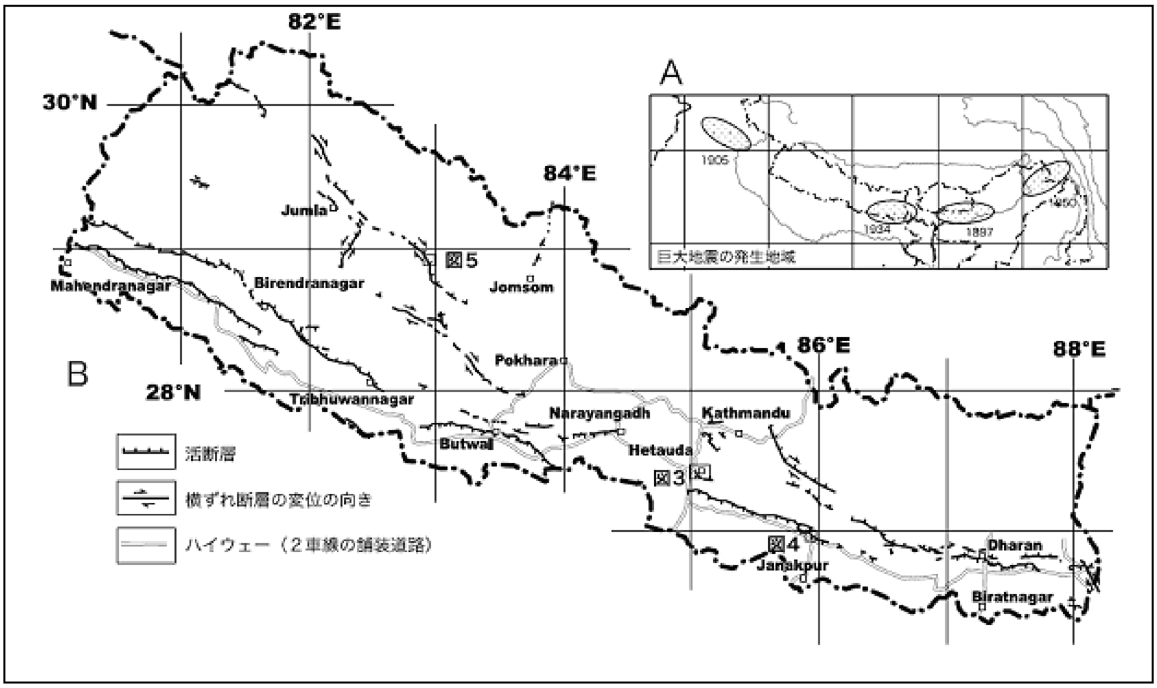
Considering the situation of seismicity and earthquake risks, it has been discussed and proposed to apply the Evaluation Criteria for that. It has been discussed to apply “Large Thrusts and faults” and “Seismicity (Earthquakes).”

First, the “Large thrusts and faults” criterion is considered. This evaluation is composed of 2 factors, such as the “proximity to large tectonic thrusts” and the “closeness to other faults,” and named after “Evaluation Criterion for Natural Hazard (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 not always earthquake faults are 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 affect serious damages to construction structures once surface faulting occur. In any case it is accepted that faults themselves are considered as weak thus not suitable for foundation. Considering these, such criterion 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 toward south, thus at present MBT can be more active causing large earthquakes over M8 than MCT which was once active in earlier stages of Himalayan orogenic movement. This indicates MCT and MBT are at present not equal in their effects. However, in considering the purpose of "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 risks of such faults other than large tectonic thrusts in general. Figure 7.2-3 shows the example of such faults map.




Source: Detailed mapping on active fault in developing region and its significance: A case study of Nepal, 2005.

**Figure 7.2-3 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 bears many faults till present. 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 Hazard (Earthquake)" 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 7.2-8) is decided from the distribution of actual data from the actual geologic and seismic dataset for all the project sites (Figure 7.2-4). "Threshold" used for closeness to other faults shown inTable 7.2-9 is decided through the discussions with NEA.

Table 7.2-8 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 |

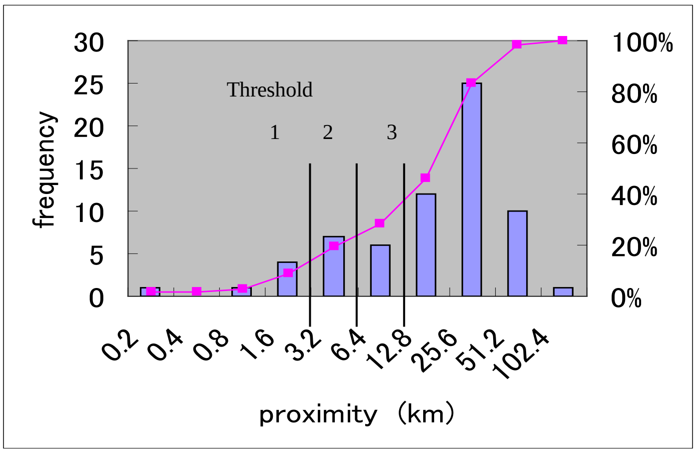



Figure 7.2-4 Actual Distribution of Proximity to Large Tectonic Thrusts for all Project Sites

Table 7.2-9 Closeness to Other Faults

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

Based on this criterion, the Study Team processed the actual geology and seismic dataset for all candidate sites (Table 7.2-5) and determined "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 7.2-10.

Table 7.2-10 Evaluation Criterion for Natural Hazard (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.

### c. *Evaluation Criterion for Seismicity (frequency, scale)*

The “Seismic hazard map” was prepared in Nepal as a reference for evaluation of seismic activities. This map indicates the horizontal acceleration ($cm/sec^2$), thereby seismic activities of each potential site are to be “screened” by putting relative “threshold” into such acceleration values from view of “design horizontal seismic coefficient.”

The Himalayas are the place for the collision of Indian subcontinent and Eurasia continent, thus inducing frequent earthquakes such as thrust types.

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, and HFT in terms of each seismic risk. But as we see M7.5 occurred in 1916 near MCT, so we decide all these thrusts may be better treated equally risky for seismic risks.

It should be noted that NEA study in the past just simply rules that the regional area such as Lesser Himalaya has a “same single” higher seismic risk than others such as Higher Himalaya.

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

Therefore in this study we determined “seismicity risk” based on the “Matrix” shown in Table 7.2-11. This is the combination of “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 10 km distance from site, which is considered the caution level in Nepal in general.

As agreed, the “threshold” of Figure 7.2-5 was determined after the evaluation of the actual distribution of the data in the actual geologic and seismic dataset for all the project sites.

**Table 7.2-11 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 the closeness to epicenters greater than M4 < 10 km, subtract 20.

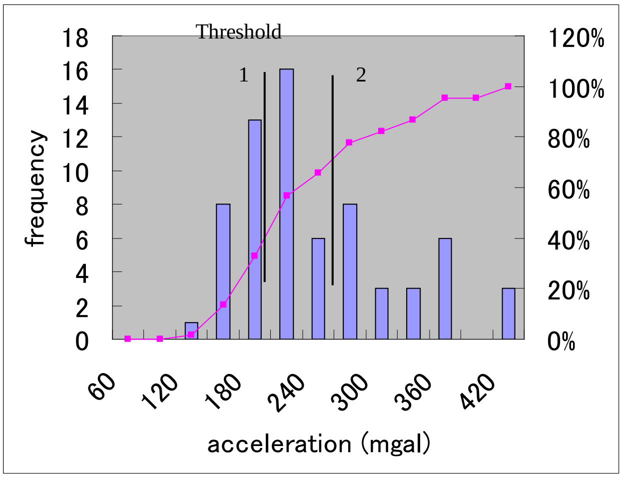
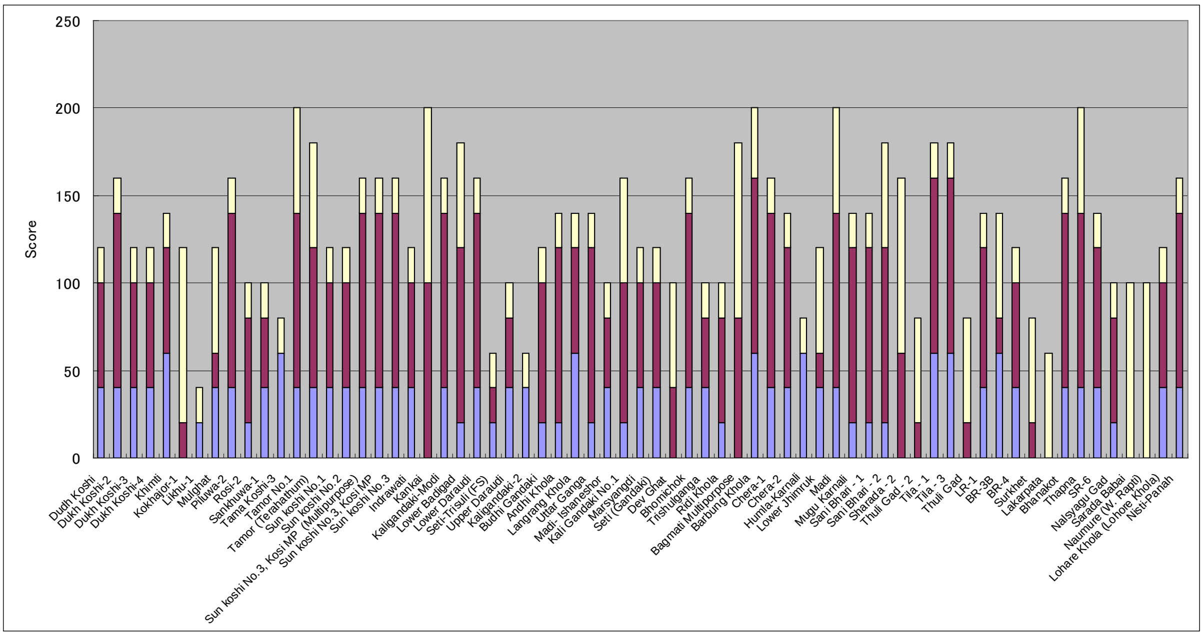



**Figure 7.2-5 Actual Distribution of Acceleration for All Project Sites**

All the outcome and result using these three criteria are compiled in Figure 7.2-6.




Source: based on the simple summation of all three criteria with equal weight.

**Figure 7.2-6 Geology Evaluation Outcome from All three Criteria for All Project Sites**

The discussion with NEA has concluded that the results above, in general, bear no problem. 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 landslides data)

It is also noted each “weighted percentage” for “Site Geology,” “Natural Hazard (Earthquakes)” and “Seismicity” is defined by the Study Team as discussed later. This is basically rooted upon the stakeholders, NEA, etc. But the weighted ratio is the present evaluation value and is fundamentally to be revised from time to time referring the various changing circumstances in the future that such ratio needs to be re-evaluated when required.

Incompleteness of geological maps

Figure 7.2-7 shows the available geological maps in Nepal for 1:50,000 (as of June 1, 2012). As clearly shown only 30 sheets are available for 1:50,000 which scales are usually required in this kind of study. Only 1:1,000,000 or 1:250,000 maps cover all the land. Especially the eastern and the western areas are lack of geological maps of 1:50,000.

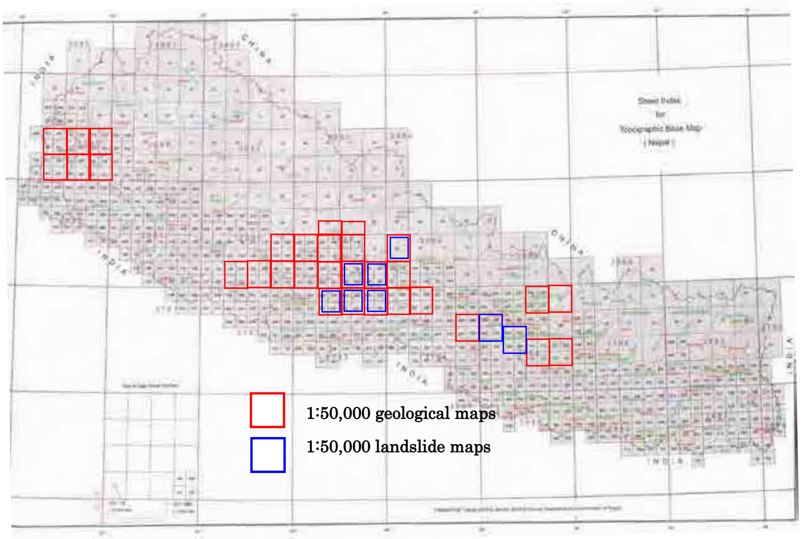



**Figure 7.2-7 Availability of Geological Maps in Nepal**

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 instead just carried out aerophoto interpretation for their analysis, without confirmation of the actual geology. Therefore, the possibility is that the actual geology differs from the descried geology in the existing materials. The confirmation of geology by visiting sites is necessary.

Lack of landslides data

As shown in Figure 7.2-7, there are only 8 sheets of "landslides" in Nepal. In conjunction with the unavailability of geological maps for 1:50,000, the data for collapses, landslides and other geological features are prepared far below sufficient. The actual analysis one by one in each prospective area is necessary.

It is well worth to note that Department of Survey does not have any stocks nor is able to publish those in time for them due to "load shedding."

3) Lead Time

***a. Length of Access Road***

The length of access road newly to be built for a project could influence at its construction period significantly. The length of access road 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 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 7.2-12)

**Table 7.2-12 Evaluation Criterion for Length of Access Road**

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

***b. Difficulty level of financing***

In general, the larger project requires the higher cost as well as the longer construction period. It takes longer time for financing for such project. 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 the various point of 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 US$ and 0 points set as the maximum project cost of 1,728.8 million US$ on quadratic interpolation in consultation with NEA. (See Table 7.2-13)

**Table 7.2-13 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 |

***c. Reliability of Development Plan***

In general, the more advanced study level a project has, the higher reliability the project has. Therefore, the reliability of develop plan was to be evaluated with study level of each project. The portions of study levels of 65 potential projects in the long list provided by NEA are as shown in Table 7.2-14.

**Table 7.2-14 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 on 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 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 the all collected information related to the studies for the projects. (See Table 7.2-15)

**Table 7.2-15 Classification of Study Level for Evaluation of Reliability**

| Study Level | Application |
|---|---|
| FS completed | Feasibility Study has been completed. |
| FS on going* | Feasibility Study is ongoing. |
| Pre-FS | Pre-Feasibility Study has been completed. |
| Preliminary Study | Additional investigations such as site reconnaissance, etc. have been conducted after desk study. |
| Desk Study | Desk study has been conducted. |
| Desk Study (few data) | Few data is available though 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 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. Pre-Feasibility Study is classified as Feasibility Study of which accuracy is beyond the required level to achieve above-mentioned purpose. The Desk Study is defined as a study conducted on available topographical maps without site survey. Further, a study for which additional survey such as site reconnaissance, etc. were conducted after Desk Study prior to conduct Pre-Feasibility Study is defined as 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 Desk study (few data) depending on study levels as shown in Table 7.2-16.

**Table 7.2-16 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 |

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

***a. Unit Generation Cost***

A unit generation cost is one of the important indices of economic efficiency of project, the smaller the unit cost is, the smaller 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 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 100 points, the project with the largest unit generation cost was scored 0 point, and other projects were scored a point obtained by linear interpolation with unit generation cost. (See Table 7.2-17)

**Table 7.2-17 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%

***b. 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 the import 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 several percent in FY2031/32[8], the last year of the study range of this study. Under these circumstances, projects with 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 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 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 7.2-18 taking the above-mentioned aspects into consideration.

**Table 7.2-18 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 |

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

### *c. Annual Energy Production*

Same 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 same calculation conditions.

In general, projects with large energy production are more preferable than those with smaller energy production. On the other hand, these projects have a tendency of having large installed capacity, and in some cases this may be contradictory to the evaluation of installed capacity described in the above. To avoid this contradiction, the score was determined that it linearly proportionate to annual energy production until 2,000 GWh and a constant value, the perfect score, for more than 2,000 GWh. (See Table 7.2-19)

**Table 7.2-19 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.

### *d. Energy Production in Dry Season*

One of the important roles of storage-type hydroelectric power project is energy production in the dry season. Same as the above-mentioned evaluation of annual energy production, the score was determined that it linearly proportionate to energy production until 850 GWh, the perfect score for more than that. (See Table 7.2-20)

**Table 7.2-20 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) Natural Environment

### *a. Impact on Forest Area*

Impact on the forest area 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 station), 0 point 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 large project area. Therefore, affected area per unit output is used for evaluation in order to minimize the total lost forest area to meet the demand. (See Table 7.2-21)

**Table 7.2-21 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 |

### *b. Impact on Protected Area*

The impact on the protected area is evaluated by the direct or indirect impact of reservoir area for the six protected areas described in Table 7.2-22. In downstream of reservoir area, according to the operation of reservoir, the flow rate may be increased in dry season and reduced during the rainy season. To account for this effect, one point is given for each category if the World Heritage, National Park including its buffer zone, Wildlife Reserve, Ramsar Convention or Key Biodiversity Area is located in the downstream of reservoir area. If the Key Biodiversity Area or one part of this area is located in the reservoir area, it counts 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 point for score of 3, 100 evaluation points for score of 0 and between them, the evaluation points are given by proportional distribution. (See Table 7.2-23)

**Table 7.2-22 Points for the Impact on Protected Area**

| 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.

**Table 7.2-23 Evaluation Criterion for Impact on Protected Area**

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

### *c. Impact on Fishes*

The impact on fishes is evaluated by the impact to water system where the following 18 species in Table 7.2-24 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 point for score of 0, 100 evaluation points for score of 10 and between them, the evaluation points are given by proportional distribution. (See Table 7.2-25)

**Table 7.2-24 List of Fishes used in the Evaluation**

| Scientific Name | English Name | Criteria | Lake and River system[9, 10] |
|---|---|---|---|
| *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 7.2-25 Evaluation Criterion for Impact on Fishes**

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

### *d. Impact on Conservation Species*

The impact on conservation species is evaluated by the impact to the seven rare land species shown in Table 7.2-26 for which the distribution map are available. If there is overlap in the distribution of rare species and the reservoir area, point of five levels is given by the habitat density. Total score of each project is the sum of scores of every 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 point 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 7.2-27)

[9] Coldwater fisheries in the trans-Himalayan countries (FAO, 2002)
[10] Coldwater Fish and Fisheries in Nepal (Jiwan Shrestha)

**Table 7.2-26 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 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 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 probably 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 7.2-27 Evaluation Criterion for Conservation Species**

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

6) Social Environment

***a. Impact of Construction for Transmission Line to the Social Environment***

As for the impact to the social environment by construction of new transmission line, longer transmission line has much influence to the scenery, acquisition of right of way and surrounding residents. Therefore, evaluation points were prorated between 100 points set as length of 30 km or less and 0 points set as length of 100 km or more. (See Table 7.2-28)

**Table 7.2-28 Evaluation Criterion for Impact of Construction for Transmission Line 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

### *b. Impact on Household*

The impact on household 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 report are not the same as the number on the map. However, in order to have a same evaluation level, only the number of building 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 point 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 7.2-29)

**Table 7.2-29 Evaluation Criterion for Impact on Household**

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

### *c. Impact on Agricultural Land*

The impact on agricultural land is evaluated by the agricultural land area per unit output (Agricultural land area inside of reservoir area (according to the map) / energy production of power station). 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 point 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. (See Table 7.2-30)

**Table 7.2-30 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 |

### *d. Impact on Ethnic Minority*

The impact on ethnic minority is evaluated by the number of affected ethnic minority. For this evaluation, the ethnic minority is determined by the 84 caste groups 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 ethnics and the minimum number is 0. Regarding these numbers the evaluation points are given for each project, 0 evaluation points for 26 ethnics, 100 evaluation points for 0 and between them, and the evaluation points are given by proportional distribution. (See Table 7.2-31)

**Table 7.2-31 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.

***e. Impact on Tourism***

The impact on tourism is evaluated by the impact to tourist area frequented by foreign tourists as well as trekking routes and the impact to temples, mosques and churches in reservoir area. Most of project does not affect the tourist area. Therefore, the projects affecting the tourist area are evaluated with 0 points and the others are evaluated with 100 points. (See Table 7.2-32)

**Table 7.2-32 Evaluation Criterion for Impact on Tourism**

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

(2) Weighting of the Second Step

The evaluation items described above were weighted depending on the importance in the objective of the Study, 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 project in question.

The Study Team prepared a draft of weighting taking into consideration the weighting used in other projects 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 7.2-34 to Table 7.2-36 were determined by reference to useful comments obtained from stakeholders.

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

- Same weight is attached to the technical and economic conditions and the impact on environment.
- In the technical and economic conditions, importance is placed on the effectiveness of project.
- In the impact on environment, same weight is attached to the impact on natural environment and the impact on the social environment.

**Table 7.2-33 Evaluation Items and Weight at the Second Stage (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 |

In the first stake-holder meeting, some attendees made comments that the technical and economical conditions were more important than the impact on environment when the power condition of Nepal was considered. 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.

**Table 7.2-34 Weight of Evaluation Item (Case 1)**

| Category | % | Subcategory | % | Evaluation Item | % | Point |
|---|---|---|---|---|---|---|
| Technical and Economical Conditions | 60 | Hydrological Conditions | 25 | Reliability of flow data | 25 | 3.75 |
| | | | | Risk of 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 road | 25 | 3.00 |
| | | | | Difficulty level of funding | 35 | 4.20 |
| | | | | Reliability of development plan | 40 | 4.80 |
| | | Effectiveness of 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 Environment | 40 | Impact on Natural Environment | 50 | Impact on forest | 25 | 5.00 |
| | | | | Impact on protected area | 30 | 6.00 |
| | | | | Impact on fishes | 20 | 4.00 |
| | | | | Impact on conservation species | 25 | 5.00 |
| | | Impact on Social Environment | 50 | Impact on locality by construction of transmission line | 20 | 4.00 |
| | | | | Impact on household | 25 | 5.00 |
| | | | | Impact on agriculture | 20 | 4.00 |
| | | | | Impact on ethnic minority | 20 | 4.00 |
| | | | | Impact on tourism | 15 | 3.00 |
| | | | | Total | | 100 |

**Table 7.2-35 Weight of Evaluation Item (Case 2)**

| Category | % | Subcategory | % | Evaluation Item | % | Point |
|---|---|---|---|---|---|---|
| Technical and Economical Conditions | 40 | Hydrological Conditions | 25 | Reliability of flow data | 25 | 2.50 |
| | | | | Risk of 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 road | 25 | 2.00 |
| | | | | Difficulty level of funding | 35 | 2.80 |
| | | | | Reliability of development plan | 40 | 3.20 |
| | | Effectiveness of 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 Environment | 60 | Impact on Natural Environment | 50 | Impact on forest | 25 | 7.50 |
| | | | | Impact on protected area | 30 | 9.00 |
| | | | | Impact on fishes | 20 | 6.00 |
| | | | | Impact on conservation species | 25 | 7.50 |
| | | Impact on Social Environment | 50 | Impact on locality by construction of transmission line | 20 | 6.00 |
| | | | | Impact on household | 25 | 7.50 |
| | | | | Impact on agriculture | 20 | 6.00 |
| | | | | Impact on ethnic minority | 20 | 6.00 |
| | | | | Impact on tourism | 15 | 4.50 |
| | | | | Total | | 100 |

## 7.3 Impact Assessment

Second Step is an evaluation for 31 Candidate projects based on the document survey. Evaluation is conducted from major six categories such as Hydrological Condition, Geological Conditions, Lead Time, Effectiveness of Project, Impact on Natural Environment, and Impact on Social Environment.

(1) Impact Evaluation

1) Hydrological Conditions

***a. Reliability of flow data***

Reliability of Flow Data is evaluated by the methods described in Section 7.2 (1) 1) a. The flow data of Lower Jhimruk (W05), Tila-1 (W12), Bhanakot (W20), Dudh Koshi (E01), Tama Koss-3 (E12), Sun Koshi No.3 (E17), Dudh Koshi-2 (E02), Andhi Khola (C08), Madi-Ishaneshor (C11), Thapna (W21), and Sarada Babai (W24) is relatively more reliable than the other projects.

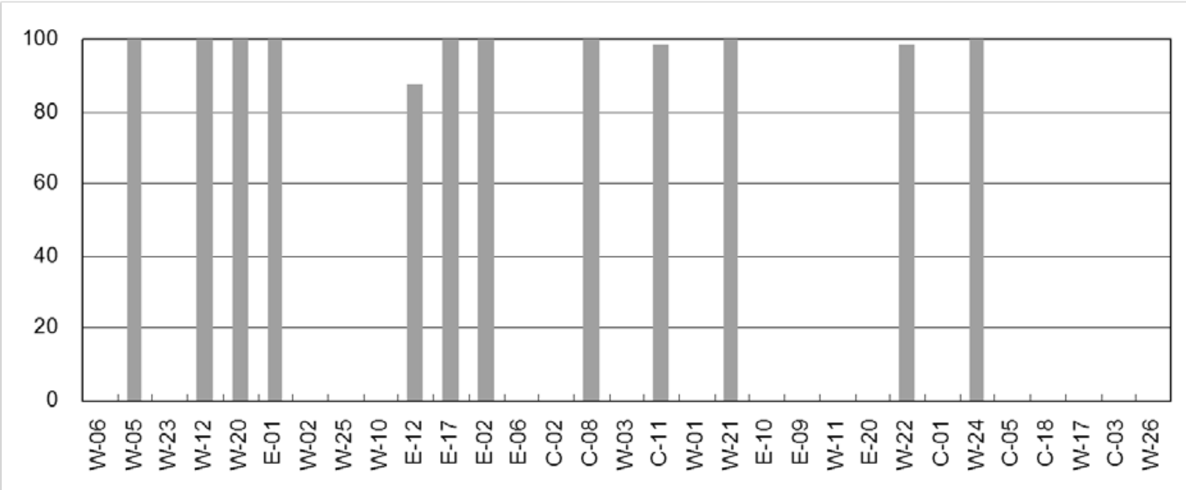



**Figure 7.3-1 Reliability of flow Data (Score)**

***b. Risk of GLOF***

The Risk of GLOF is evaluated by the methods described in Section 7.2 (1) 1) b. The risk is relatively higher in Dudh Koshi (E01), Dudh Koshi-2 (E02), and Kaligandaki-Modi (C01).

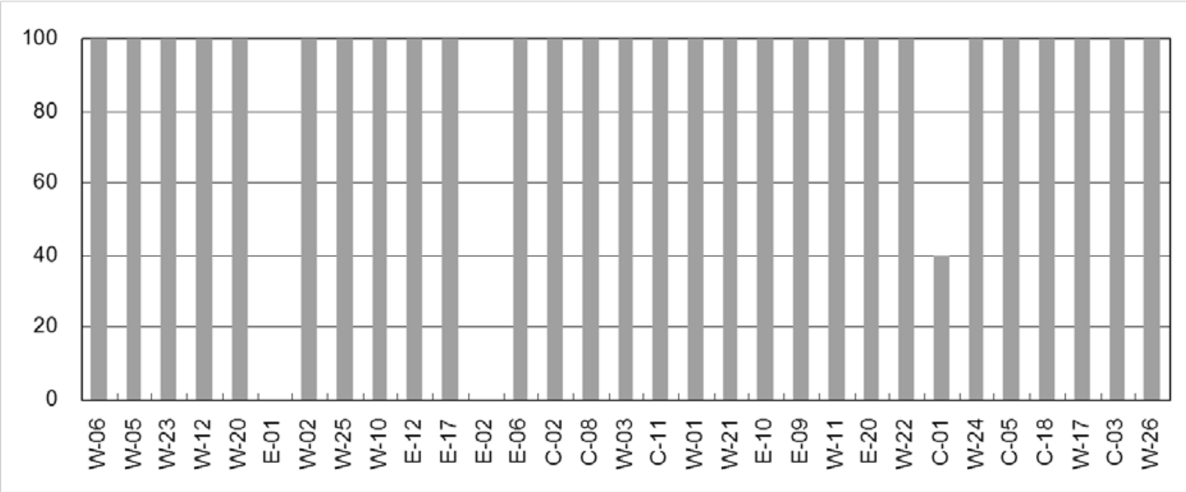



**Figure 7.3-2 Risk of GLOF (Score)**

### *c. Sedimentation*

The sedimentation risk is evaluated by the methods described in Section 7.2 (1) 1) c. Kokhajor-1 (E06), Piluwa-2 (E09), Upper Daraudi (C05), Lower Daraudi (C03), and Andhi Khola (C08) has relatively higher risk than the other projects.

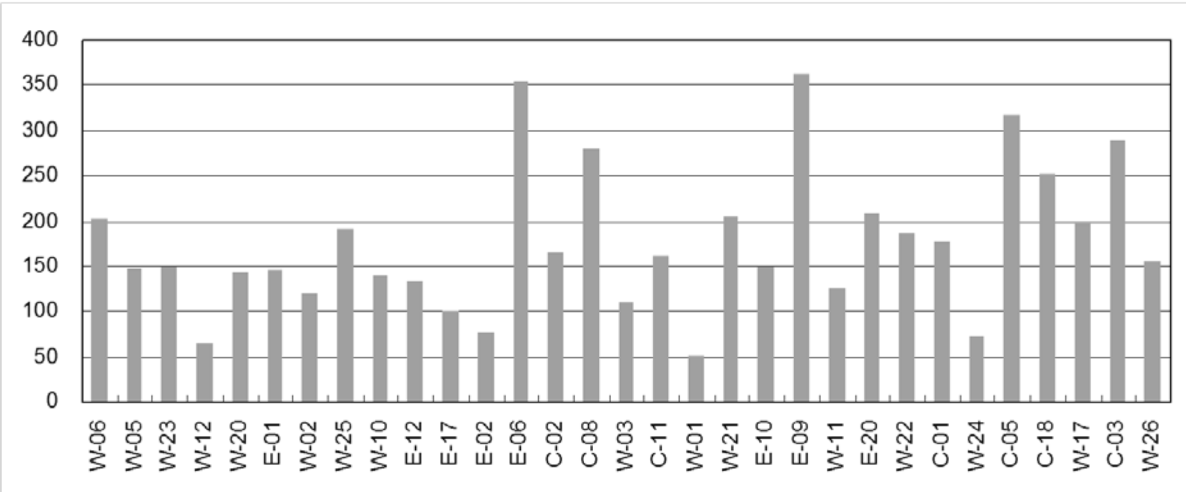



**Figure 7.3-3 Sedimentation (Life Time of Reservoir: Year)**

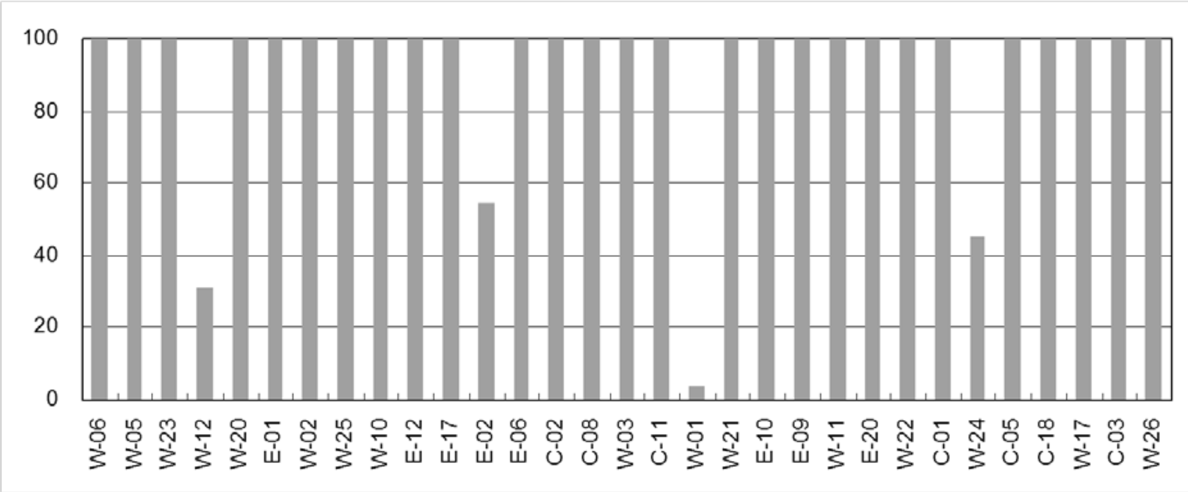



**Figure 7.3-4 Sedimentation (Score)**

2) Geological Conditions

***a. Seismicity***

Seismicity Risk is evaluated by the methods described in Section 7.2 (1) 2) c. Relatively lower risk projects are Naumure (W. Rapti) (W25), Sharada-2 (W10), Kokhajor-1 (E06), and Sarada Babai (W24).

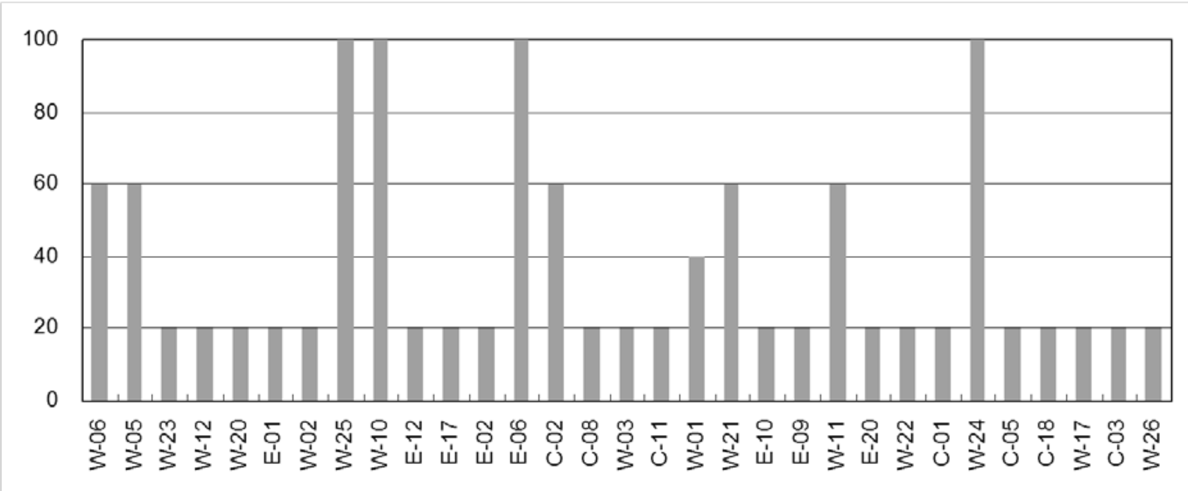



**Figure 7.3-5 Seismicity (Score)**

***b. Geological condition***

Geological Condition is evaluated by the methods described in Section 7.2 (1) 2) a. Relatively lower scored projects are Naumure (W. Rapti) (W25), Sharada-2 (W10), Kokhajor-1 (E06), Thuli Gad-2 (W11), and Sarada Babai (W24). Relatively higher scored projects are Tila-1 (W12), Tama Koss-3 (E12), Barbung Khola (W01).

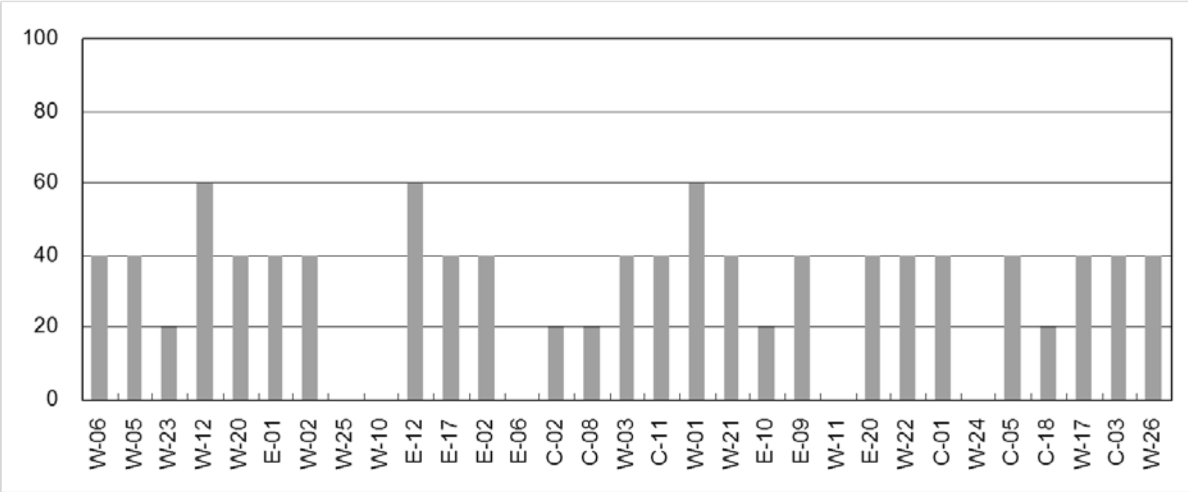



**Figure 7.3-6 Geological Condition of Site (Score)**

***c. Natural hazard***

Natural Hazard is evaluated by the methods described in Section 7.2 (1) 2) b. Relatively lower scored projects are Lower Jhimruk (W05), Naumure (W25), Tama Koss-3 (E12), Kokhajor-1 (E06), Thuli Gad-2 (W11), and Sarada Babai (W24).

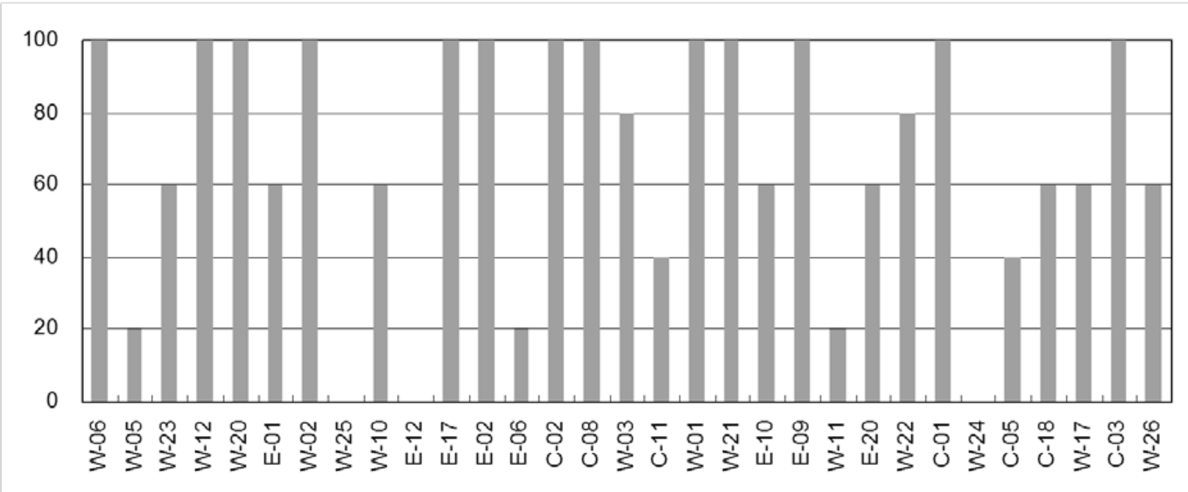



**Figure 7.3-7 Natural Hazard (Earthquake) (Score)**

3) Lead Time

***a. Length of access road***

Length of Access Road is evaluated by the methods described in Section 7.2 (1) 3) a. relatively lower scored projects are Dudh Koshi (E01), Barbung Khola (W01), and Tila-1 (W12).

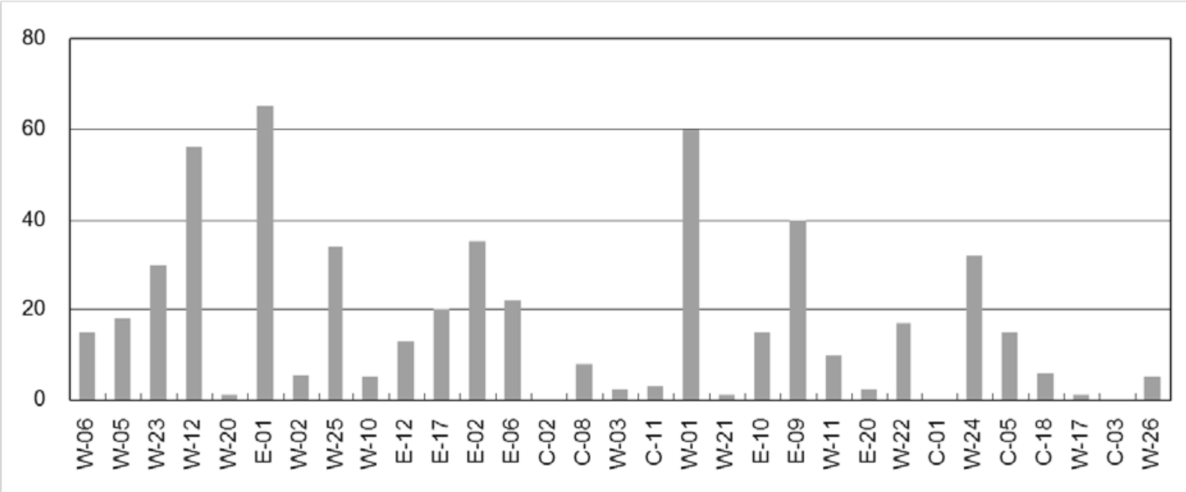



**Figure 7.3-8 Length of Access Road (km)**

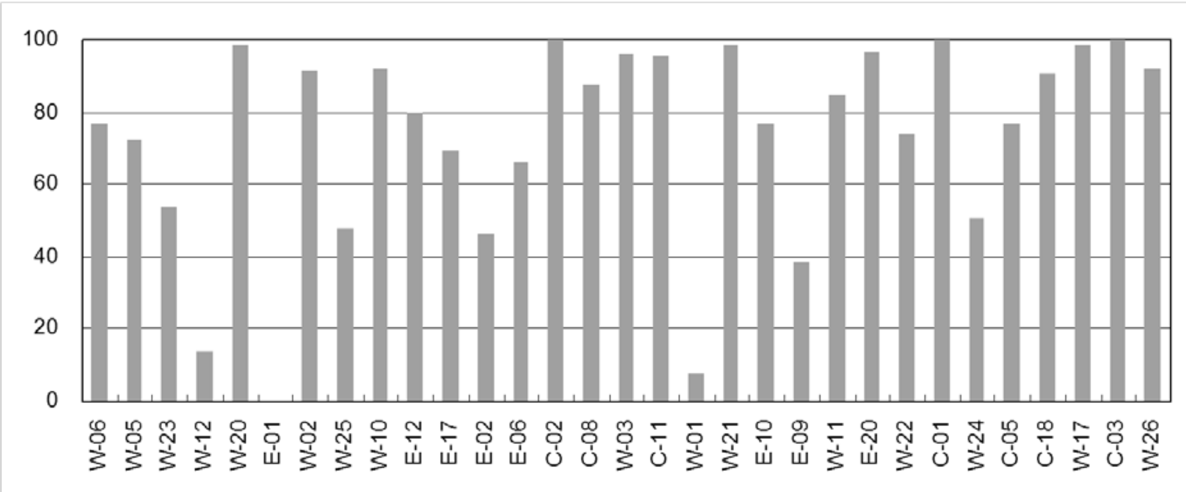



**Figure 7.3-9 Length of Access Road (Score)**

***b. Difficulty level of funding***

Difficulty Level of Funding is evaluated by the methods described in section 7.2 (1) 3) b. Relatively lower scored projects are BR-4 (W17), Bhanakot (W20), and Thapna (W21).

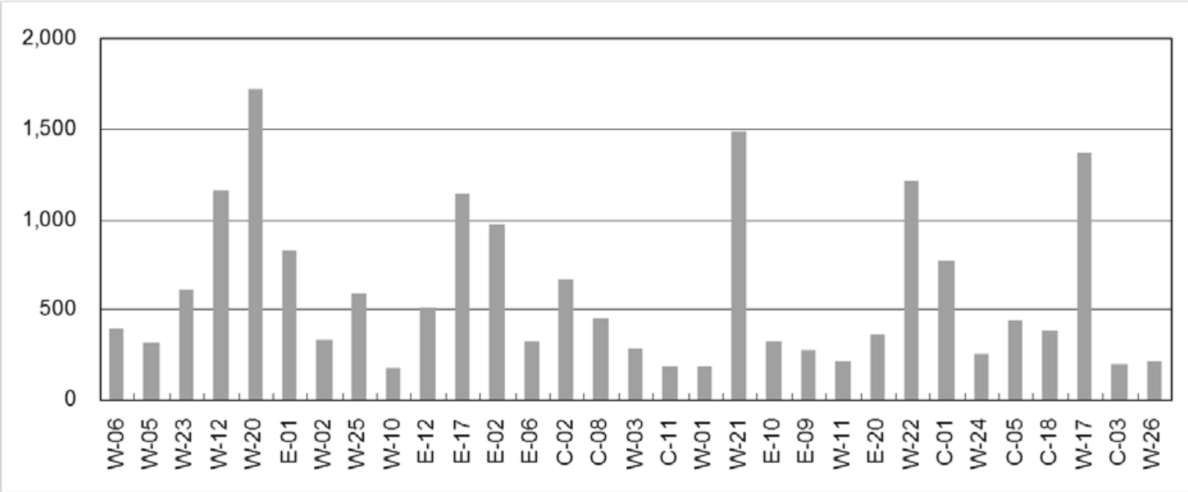



**Figure 7.3-10 Difficulty Level of Financing (2012 Project Cost: MUS$)**

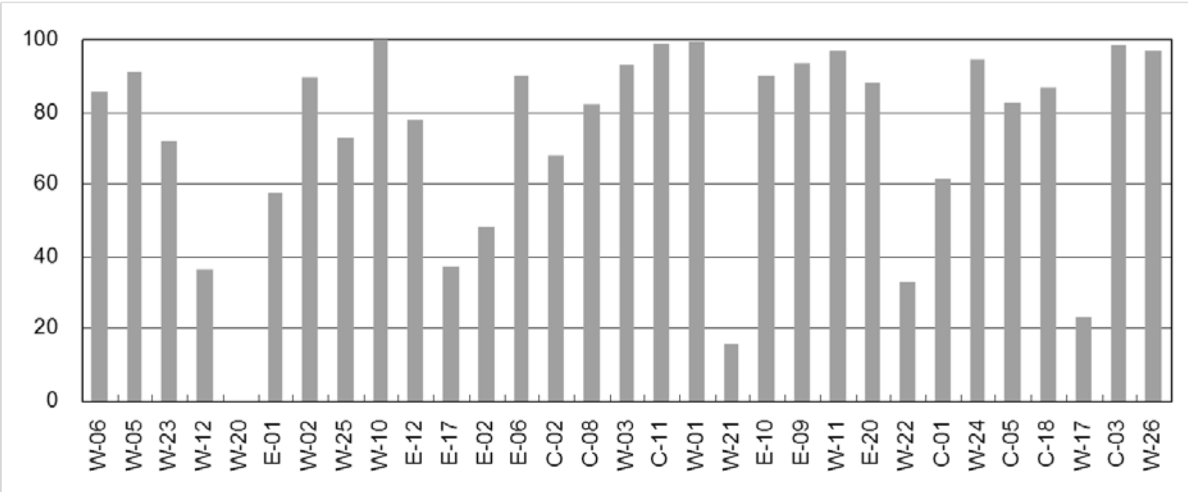



**Figure 7.3-11 Difficulty Level of Financing (Score)**

***c. Reliability of development plan***

Reliability of Development Plan is evaluated by the methods described in Section 7.2 (1) 3) c. Relatively higher scored projects are Dudh Koshi (E01), Andhi Khola (C08), Madi-Ishaneshor (C11), and Nalsyau Gad (W23).

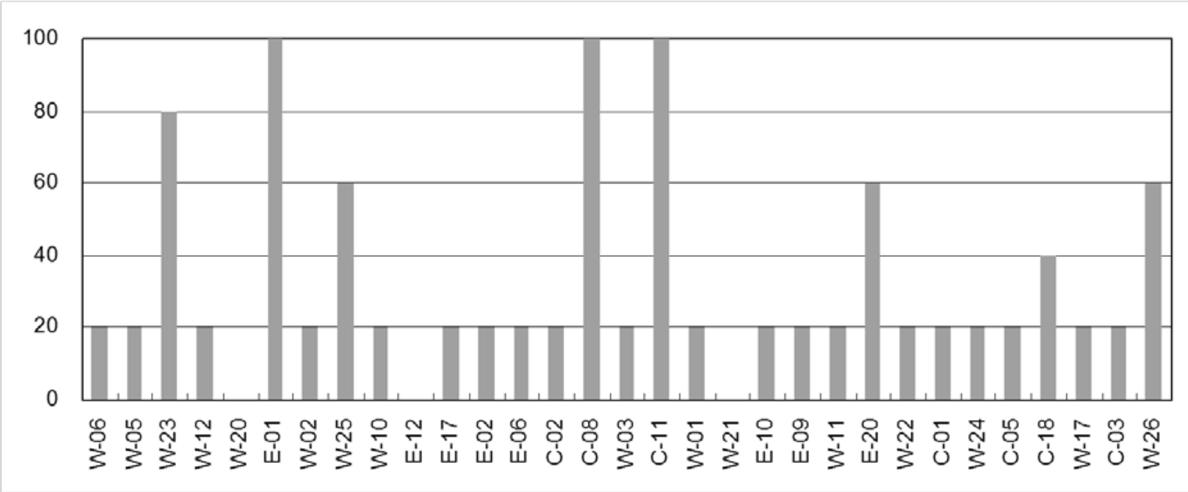



**Figure 7.3-12 Reliability of Development Plan (Score)**

4) Effectiveness of Project

***a. Unit generation cost***

Unit Generation Cost is evaluated by the methods described in Section 7.2 (1) 4) a. Relatively lower scored projects are Upper Daraudi (C05), Piluwa-2 (E09), Ridi Khola (C18), and Kokhajor-1 (E06).

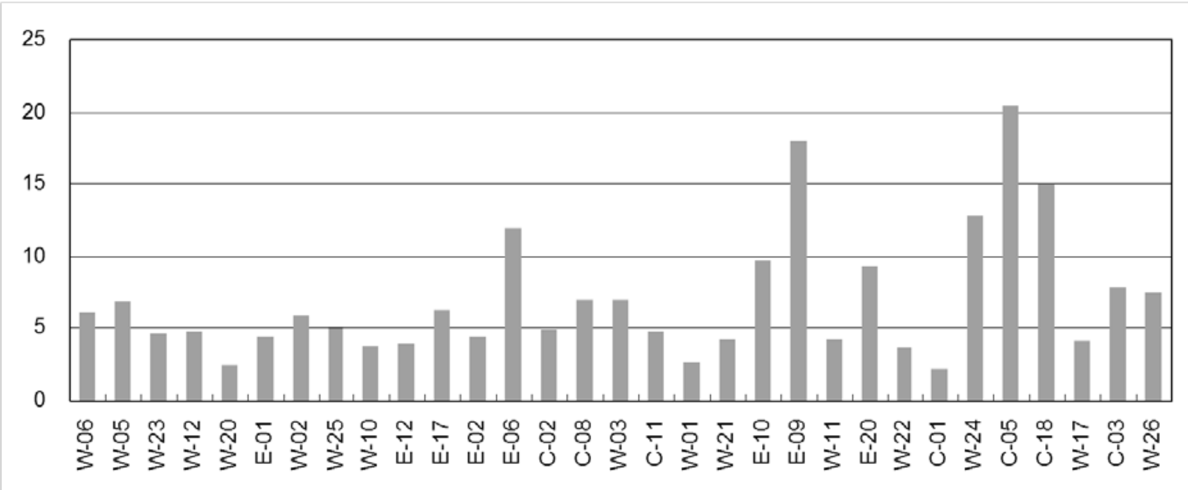



**Figure 7.3-13 Unit Generation Cost (US cent/kWh)**

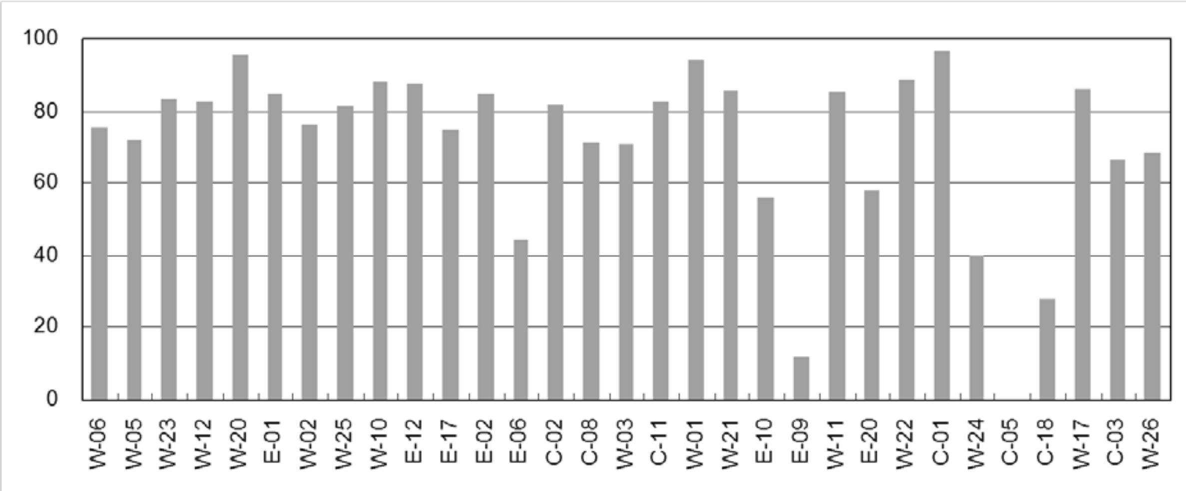



**Figure 7.3-14 Unit Generation Cost (Score)**

### *b. Installed capacity*

Installed Capacity is evaluated by the methods described in Section 7.2 (1) 4) b. Relatively lower scored projects are Bhanakot (W20), Kaligandaki-Modi (C01), BR-4 (W17), SR-6 (W22), and Tila-1 (W12).

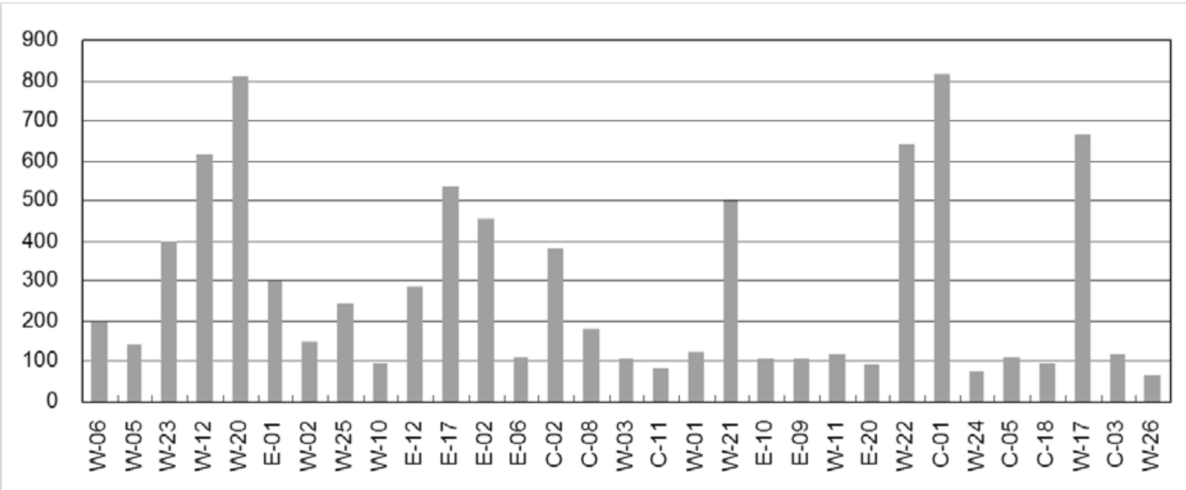



**Figure 7.3-15 Installed Capacity (MW)**

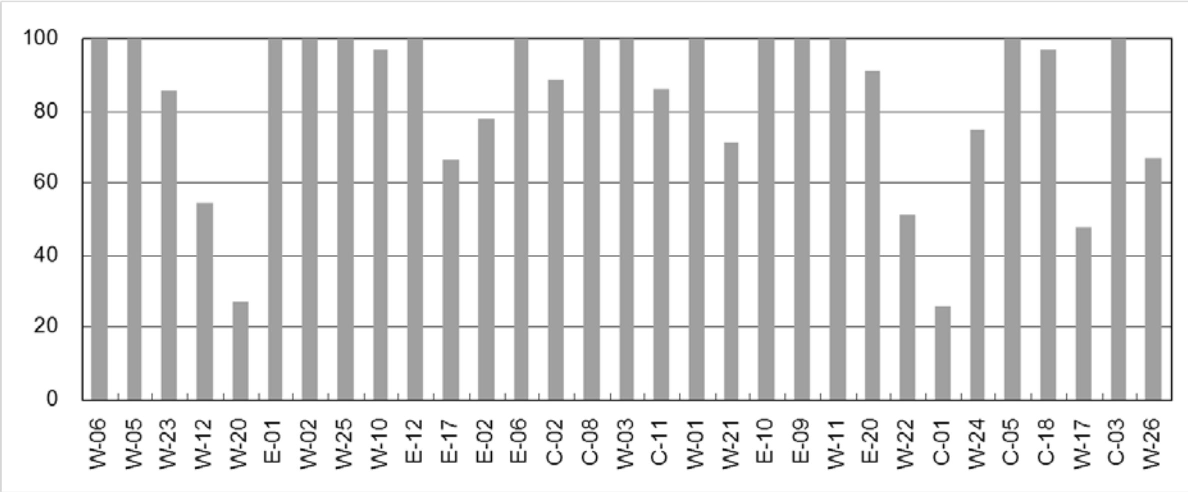



**Figure 7.3-16 Installed Capacity (Score)**

### *c. Annual energy production*

Annual Energy Production is evaluated by the methods described in Section 7.2 (1) 4) c. Relatively lower scored projects are Piluwa-2 (E09), Sarada Babai (W24), Upper Daraudi (C05), Ridi Khola (C18), Lower Daraudi (C03), Lohare Khola (W26), Kokhajor-1 (E06), Rosi-2 (E10), and Indrawati (E20).

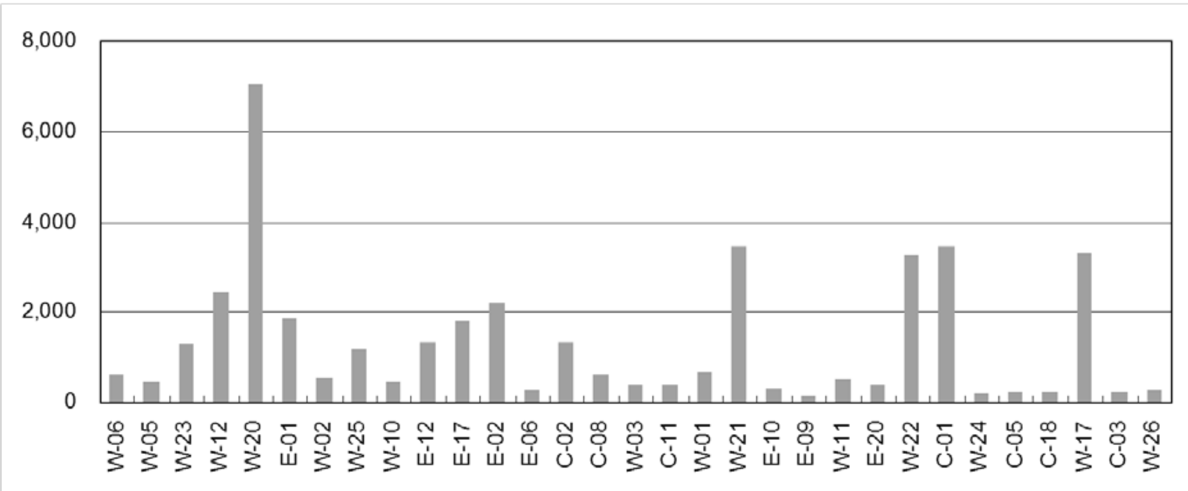



**Figure 7.3-17 Annual Energy Production (GWh)**

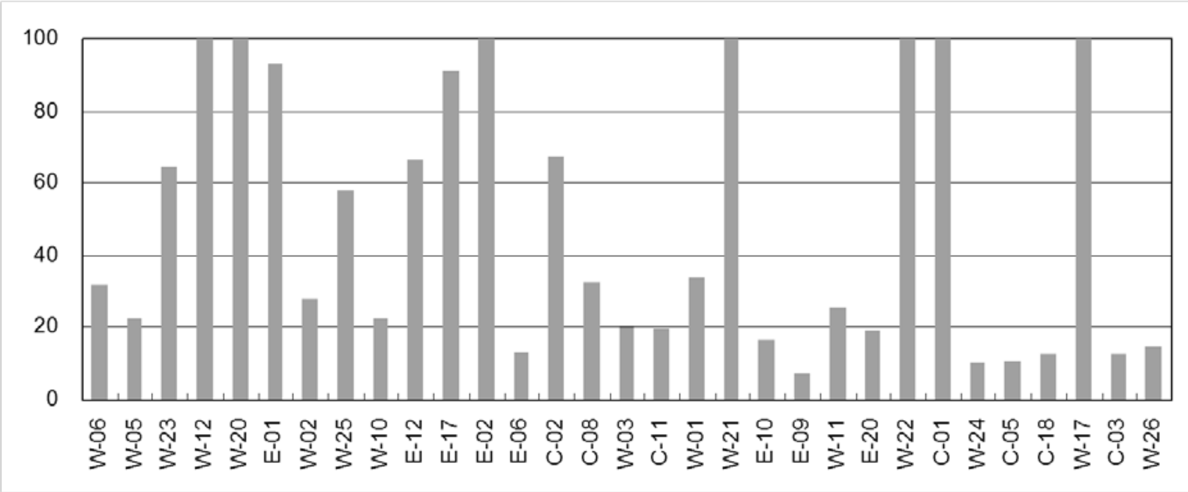



**Figure 7.3-18 Annual Energy Production (Score)**

### *d. Energy production in the dry season*

Energy Production in Dry Season is evaluated by the methods described in Section 7.2 (1) 4) d. Bhanakot (W20), Dudh Koshi (E01), Thapna (W21), SR-6 (W22), BR-4 (W17) are relatively higher scores than the other projects.

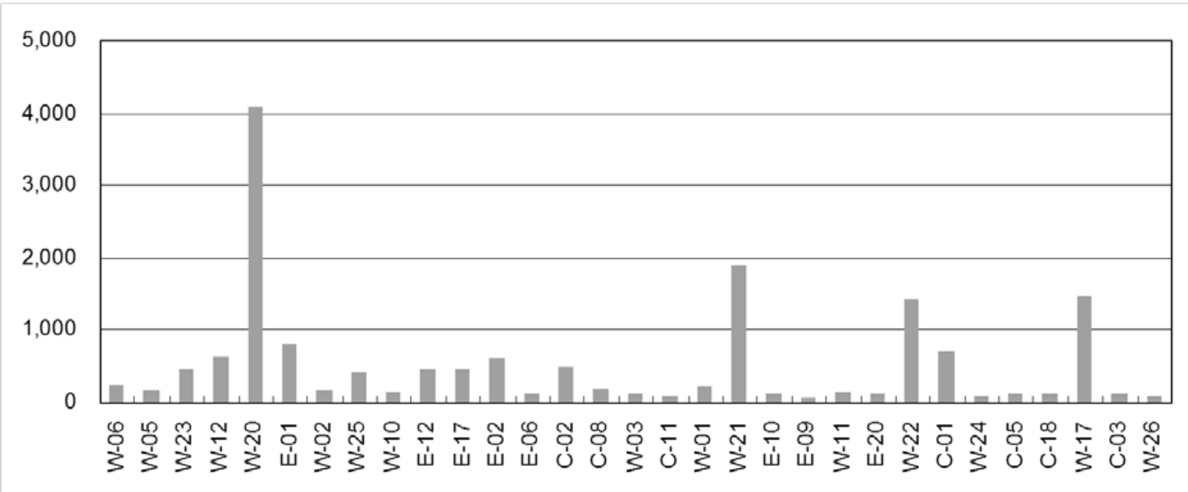



**Figure 7.3-19 Energy Production in the Dry Season (GWh)**

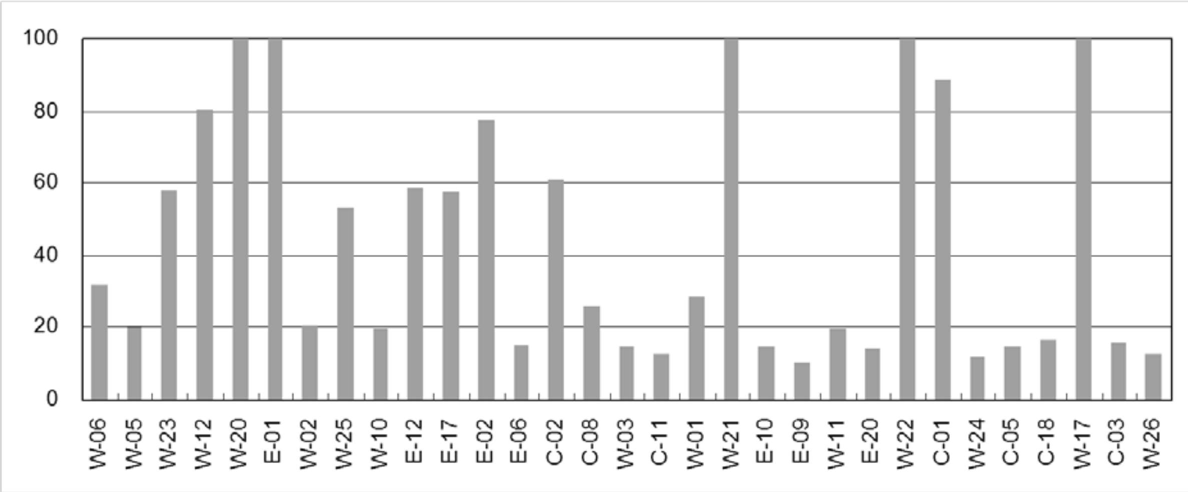



**Figure 7.3-20 Energy Production in the Dry Season (Score)**

5) Impact on Natural Environment

***a. Impact on forest***

Impact on forest is evaluated by the methods described in Section 7.2. BR-4 (W17), Thapna (W21), SR-6 (W22), Bhanakot (W20) are more than 1,000 ha which is relatively larger than the other projects. When it comes to unit forest are per MW, Lohare Khola (W26), BR-4 (W17), Kokhajor-1 (E06), Thapna (W21) are relatively bigger impact than the other projects.

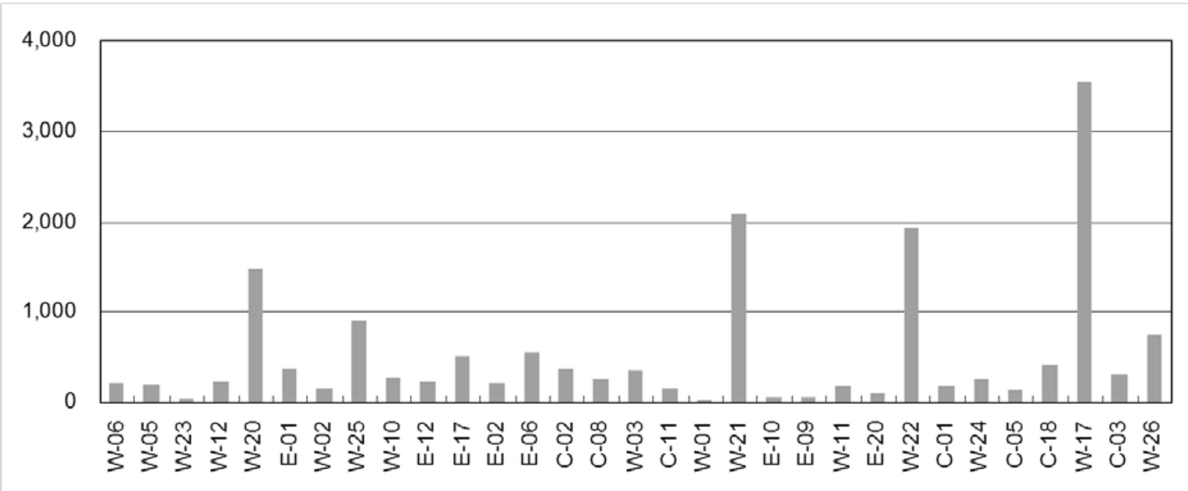



**Figure 7.3-21 Impact on Forest (Inundated Forest Area: ha)**

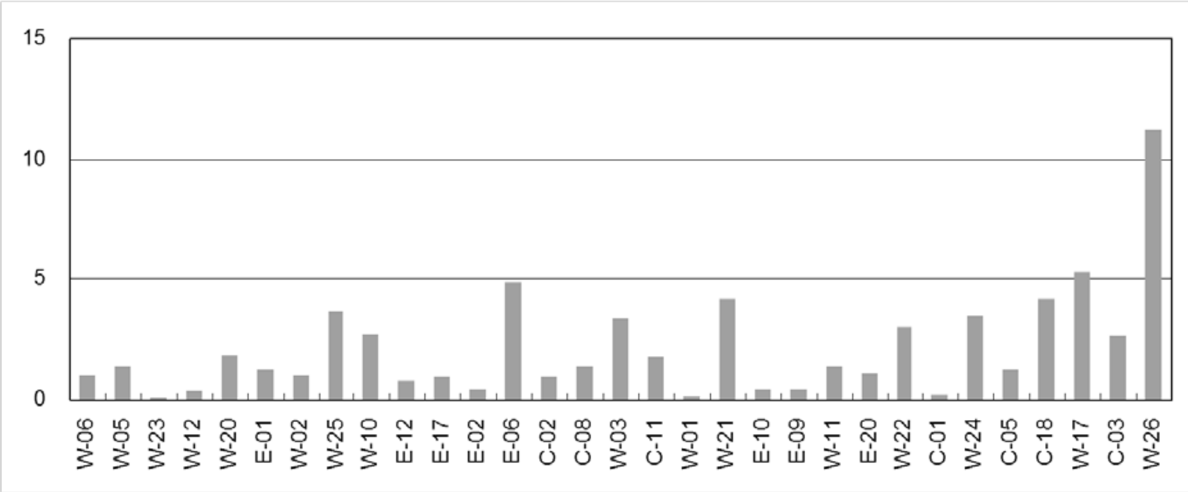



**Figure 7.3-22 Impact on Forest (Unit Inundated Forest Area: ha/MW)**

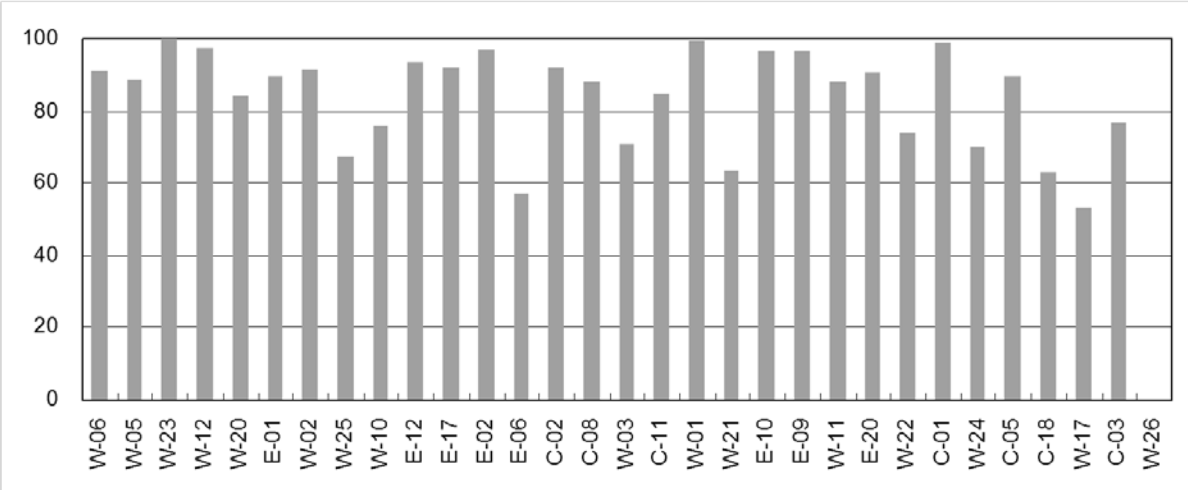



**Figure 7.3-23 Impact on Forest (Score)**

### *b. Impact on protected area*

Impact on Protected area is evaluated by the methods described in Section 7.2. The scores of Sharada - 2 (W10), Lower Badigad (C02), Andhi Khola (C08), Madi- Ishaneshor (C11), Kaligandaki-Modi (C01), Sarada Babai (W24), Upper Daraudi (C05), Ridi Khola (C18), and Lower Daraudi (C03) are relatively lower than the other projects.

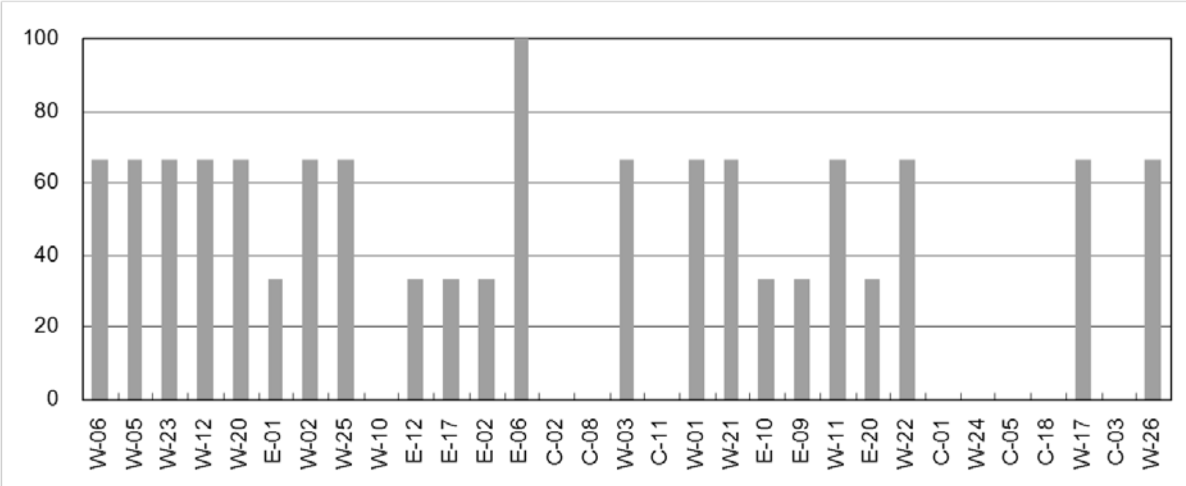



**Figure 7.3-24 Impact on Protected Area (Score)**

**Table 7.3-1 Impact on Protected Area**

| 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 |

### *c. Impact on fishes*

Impacts on fishes are evaluated by the methods described in Section 7.2. Relatively higher score projects are Madi (W06), Lower Jhimruk (W05), Naumure (W. Rapti) (W25), and Sarada Babai (W24).

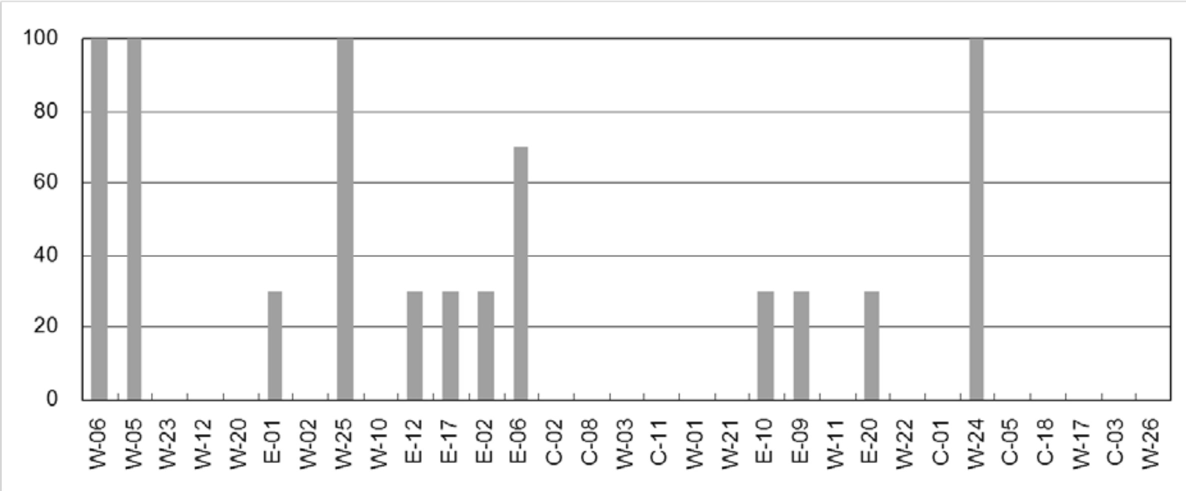



**Figure 7.3-25 Impact on Fishes (Score)**

***d. Impact on conservation species***

Impact on conservation species are evaluated by the methods described in Section 7.2 Relatively lower scored projects are Dudh Koshi (E01), Tama Koss-3 (E12), Sun Koshi No.3 (E17), Dudh Koshi-2 (E02), Kokhajor-1 (E06), Andhi Khola (C08), Madi- Ishaneshor (C11), Rosi-2 (E10), Piluwa-2 (E09), Thuli Gad-2 (W11), Indrawati (E20), SR-6 (W22), Upper Daraudi (C05), and Lower Daraudi (C03).

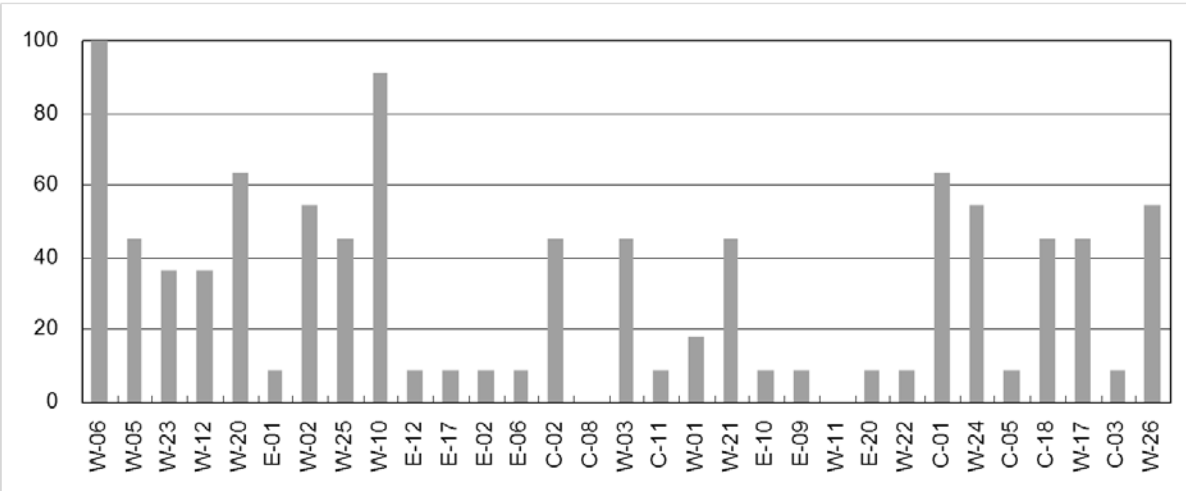



**Figure 7.3-26 Impact on Conservation Species (Score)**

## Table 7.3-2 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 |

6) Impact on Social Environment

***a. Impact on locality by construction of transmission line***

Impact on Locality by Construction of Transmission Line is evaluated by the methods described in Section 7.2. The length of transmission line needed for Bhanakot (W20), Tila-1 (W12), and Lohare Khola (W26) are more than 80 km which is relatively longer than the other projects.

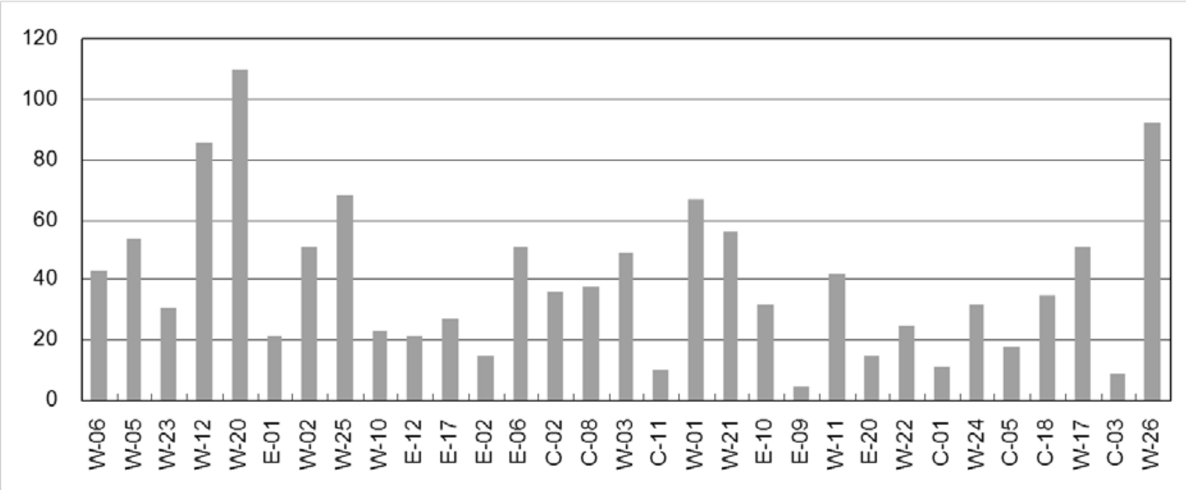



**Figure 7.3-27 Impact on Locality by Construction of Transmission Line (km)**

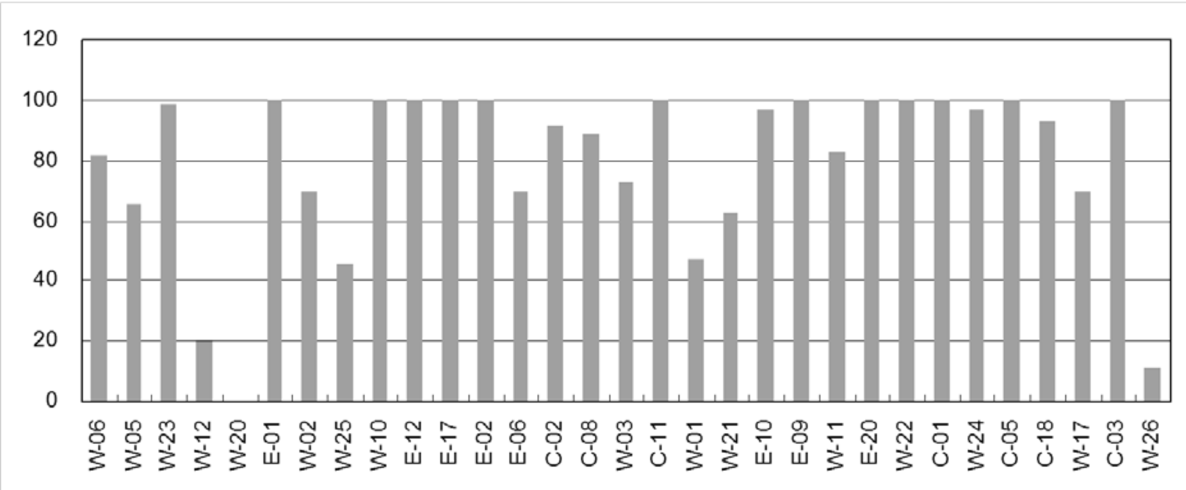



**Figure 7.3-28 Impact on Locality by Construction of Transmission Line (Score)**

***b. Impact on household***

Impact on household is evaluated by the methods described in Section 7.2. The number of buildings in the reservoir of BR-4 (W17), SR-6 (W22), and Thapna (W21) are more than 1,000 which are relatively higher than the other projects.

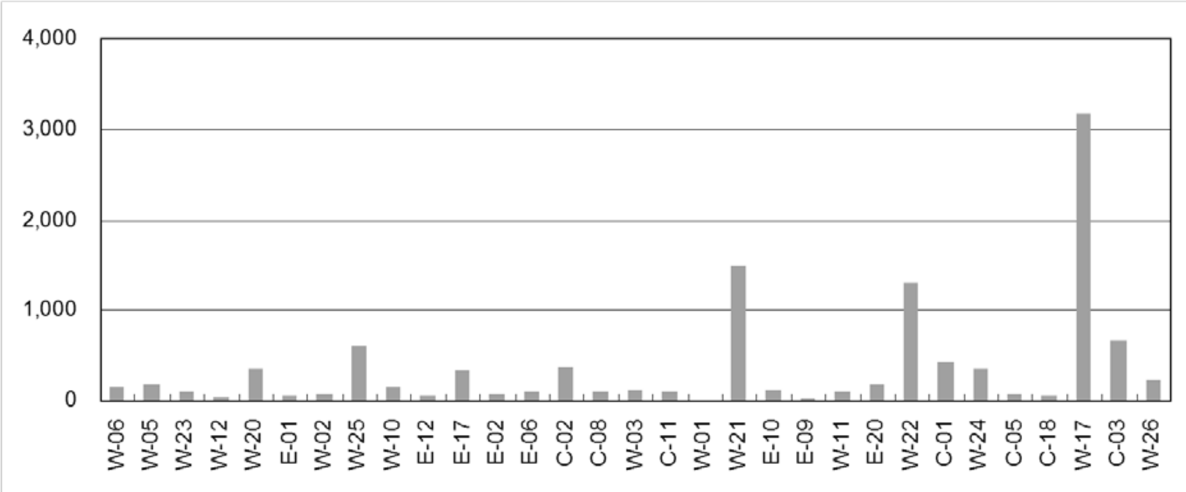



**Figure 7.3-29 Impact on Household (Households)**

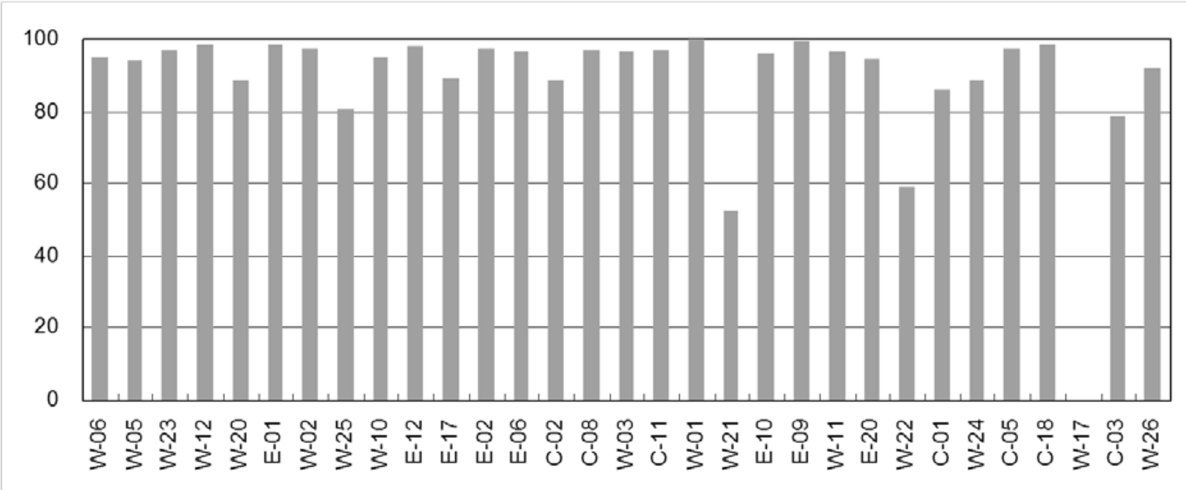



**Figure 7.3-30 Impact on Household (Score)**

### c. *Impact on agriculture*

Impact on Agriculture is evaluated by the methods described in Section 7.2. The impact on farm land of BR-4 (W17) and Thapna (W21) is more than 2,000 ha which is relatively higher than the other projects. When it comes to agricultural land per MW, impact of Lower Daraudi (C03), Lohare Khola (W26), BR-4 (W17), and Indrawati (E20) are more than 5 ha/MW which is relatively higher than the other projects.

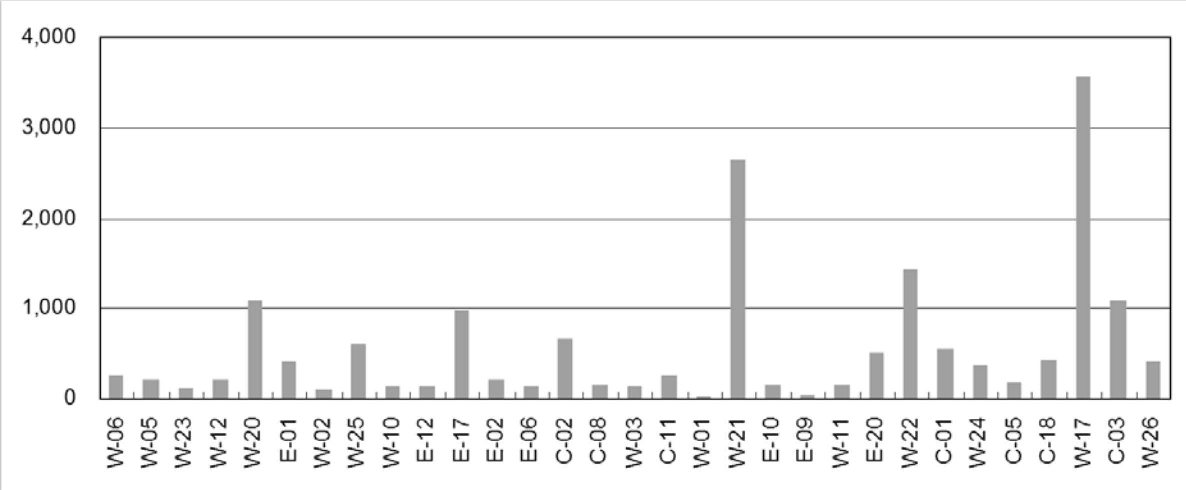



**Figure 7.3-31 Impact on Agriculture (Inundated Agricultural Land: ha)**

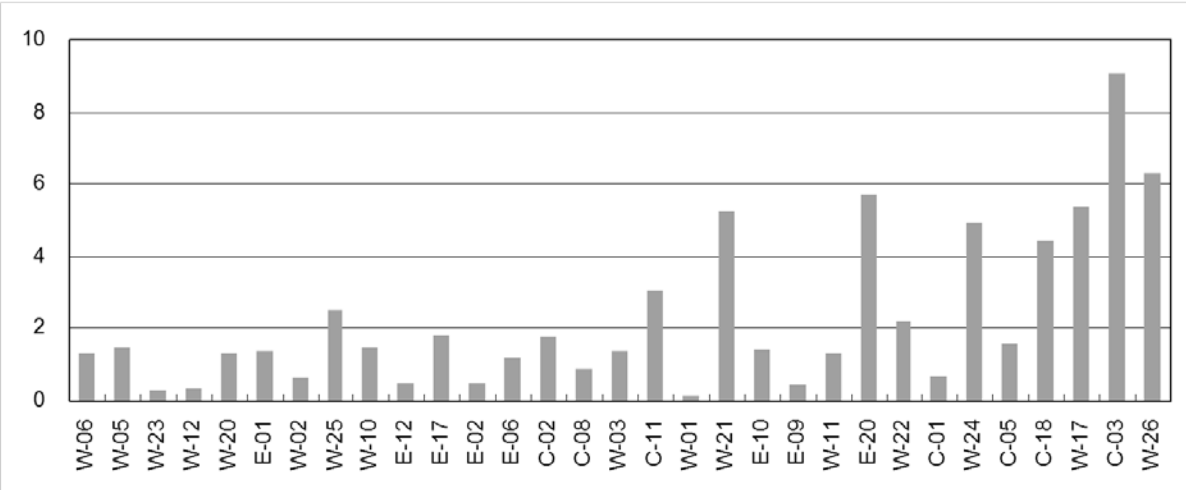



**Figure 7.3-32 Impact on Agriculture (Unit inundated Agricultural Land: ha/MW)**

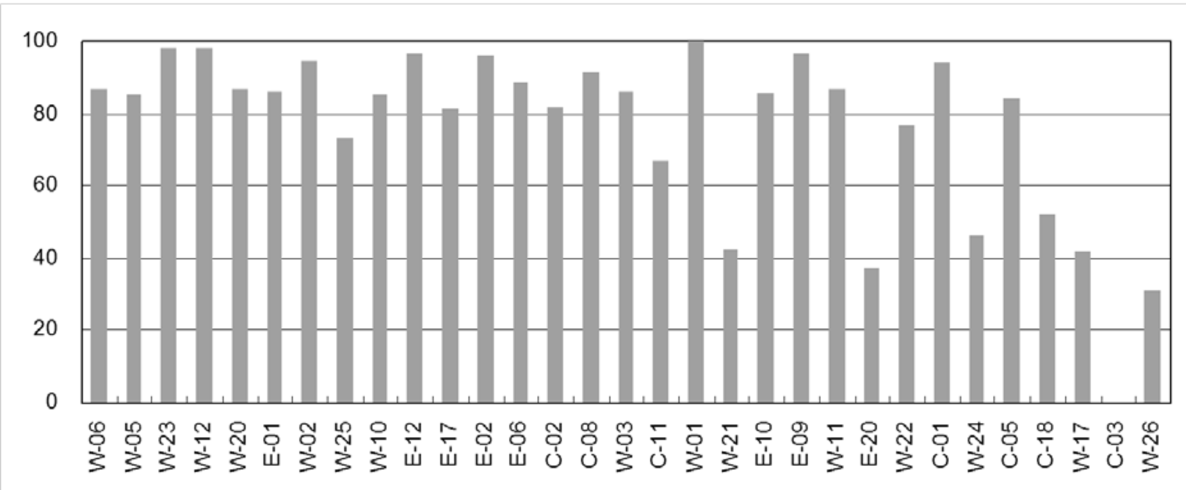



**Figure 7.3-33 Impact on Agriculture (Score)**

### *d. Impact on ethnic minority*

Impact on ethnic minority is evaluated by a method described in Section 7.2. SR-6 (W22), Thapna (W21), Kaligandaki-Modi (C01), and Tama Koss-3 (E12) are located in the VDCs which contains relatively higher number of ethnic minority groups.

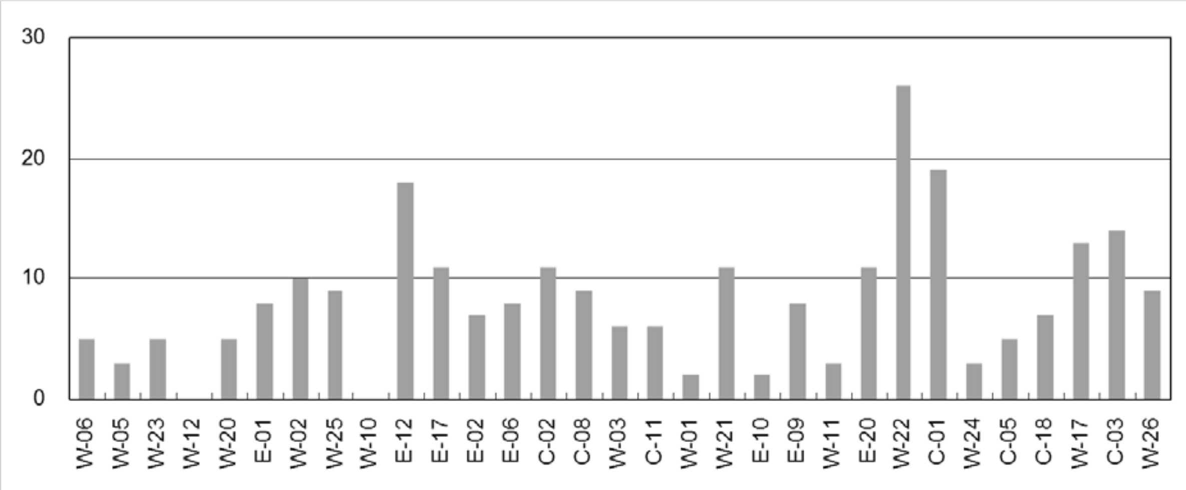



**Figure 7.3-34 Impact on Ethnic Minority (Number of Ethnic Minority Groups)**

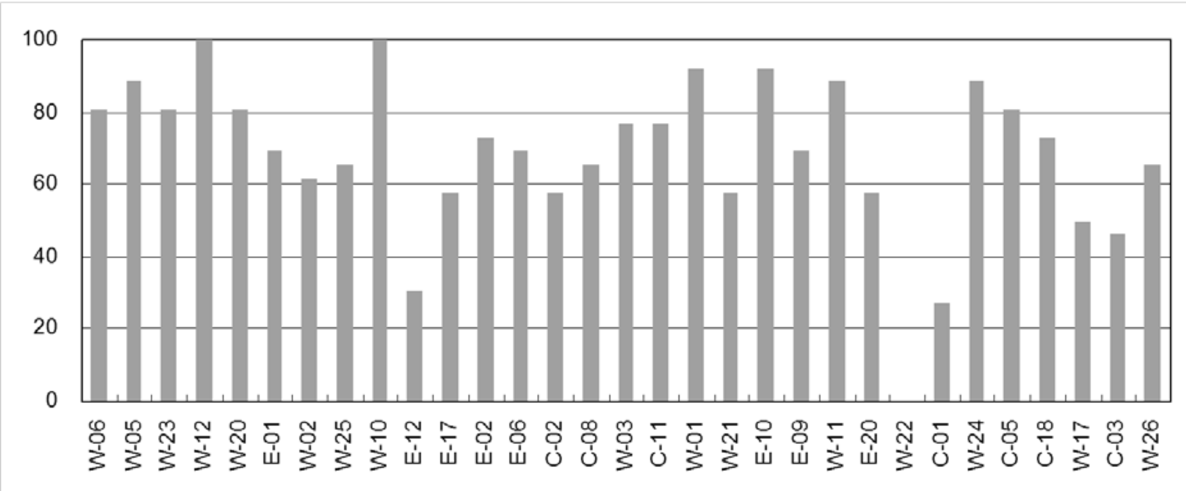



**Figure 7.3-35 Impact on Ethnic Minority (Score)**

### *e. Impact on tourism*

Impact on tourism is evaluated by a method described in Section 7.2. Relatively many temples are located in the reservoir of C01 Kaligandaki-Modi, W17 BR-4, W21 Thapna, and W22 SR-6. Then the scores of these projects are lower.

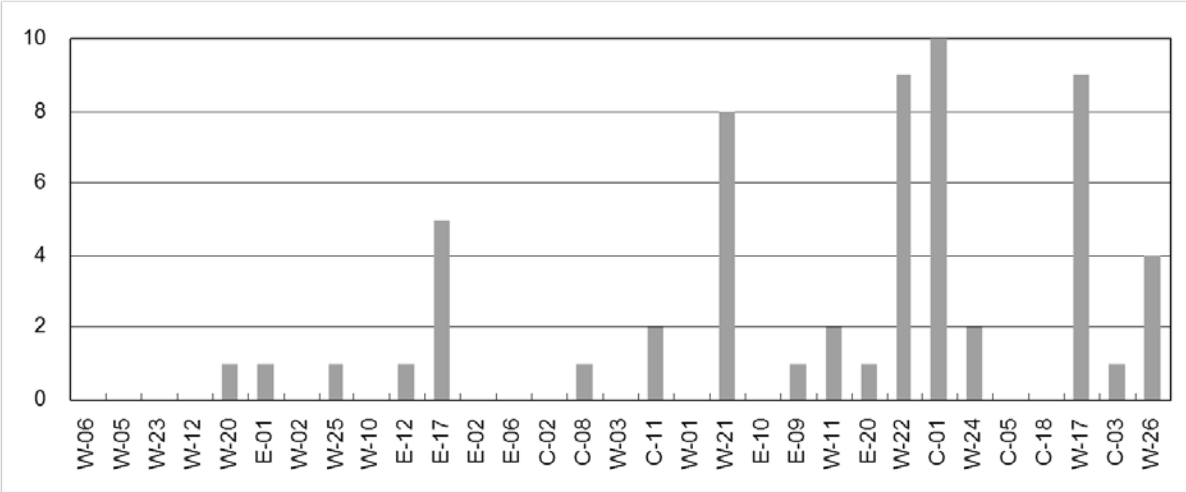



**Figure 7.3-36 Impact on Tourism (Number of Religious Asset and Trekking Route)**

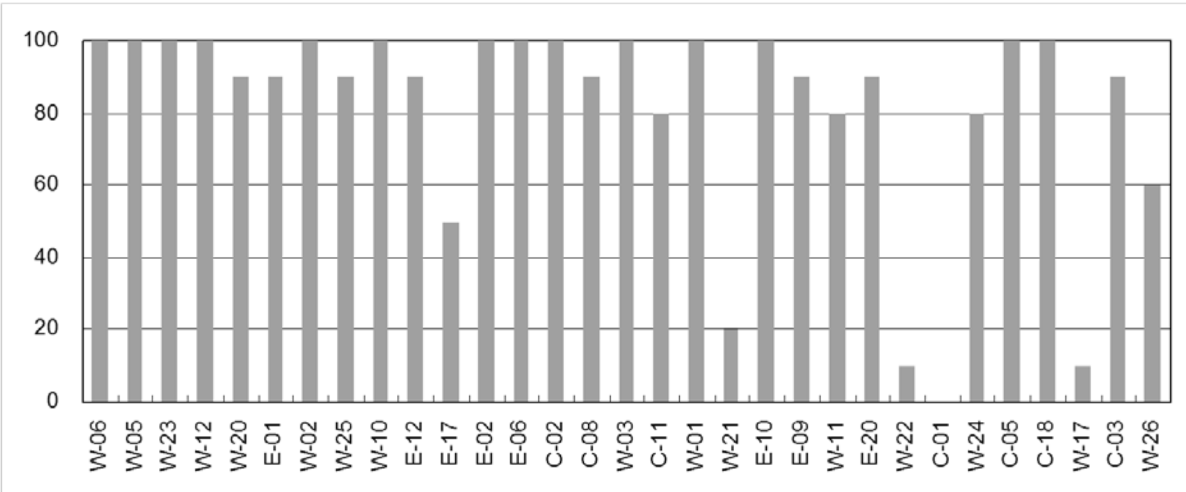



**Figure 7.3-37 Impact on Tourism (Score)**

## Table 7.3-3 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 |

(2) Sensitivity Analysis

The 31 candidate projects selected in Second Step (See Section 7.1) were evaluated by the evaluation method described in Section 7.2 (1), then the evaluation scores of each evaluation item were weighted with the weight described in Section 7.2 (2) and summed up, and evaluation scores of each candidate project were obtained. Numerical value or information of each evaluation item was obtained from existing project reports, topographical and geological maps, and other literature.

Table 7.3-4 shows the evaluation score and ranking of candidate projects, Table 7.3-5 shows the ranking of each case and Table 7.3-6 shows the detail of evaluation results.

## Table 7.3-4 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 7.3-5 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 7.3-6 (1) Evaluation Score and Ranking of Base Case (1/3)

| Category | | Technical and Economical Conditions | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subcategory | | Hydrological Conditions | | | | | | | | | Geological Conditions (See Table 8.4.1-5) | | | | | | 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 7.3-6 (2) Evaluation Score and Ranking of 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 8.4.3-6) | | | Impact on Fishes | | | Impact on Conservation Species (See Table 8.4.3-7) | | |
| 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 7.3-6 (3) Evaluation Score and Ranking of 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 8.4.3-8) | | | | |
| 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 |

## 7.4 Selection of Promising Project

As described in “7.2 Scoping and Evaliation Methods,” evaluation of technical/economical conditions and 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 positive and negative effects on local economy by implementation of power development projects and avoiding concentration of negative effects on environment and society.

(1) Total Installed Capacity of Promising Projects

In May 2012, when the total installed capacity of promising projects was studied, the required 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 Tanahu project (140 MW) and 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 Project in Each River Basin

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

However, as shown in Table 7.4-1, many projects in the western river basin were ranked near the top. Therefore, if promising projects were selected simply by the rank, seven or eight out of ten were in the western river basin that is far from Kathmandu. Taking into consideration these projects locate far from demand centers like Kathmandu, and 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 projects, the maximum number of promising projects in one river basin was decided to be five (5).

Table 7.4-1 shows the promising projects of each case when the number of projects in each river basin was limited to five.

## Table 7.4-1 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 License for Generation

As shown in Table 7.4-2, 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 private sector.

**Table 7.4-2 Issued Survey and Construction License 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

NEA and the Study Team checked the locations of projects ranked near the top against the survey and construction licenses (1 MW or more) issued as of May 13, 2012, and found that the locations of following four projects overlapped with the project areas of issued licenses. 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 license.

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, 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 7.4-3, the promising projects excluding the above-mentioned four projects (shaded projects) are shown.

## Table 7.4-3 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 7.4-4, for all cases, the total installed capacity of the promising projects was about 2,600 MW, 1.2 time of the required total installed capacity of promising projects.

There were 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 7.4-4) were selected as the promising projects.

**Table 7.4-4 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 7.4-5 shows the promising projects that were finally selected.

**Table 7.4-5 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 |

# Chapter 8 Third Step

## 8.1 Project Description

At the third step 10 Promising Projects (See Table 8.1-1 and Figure 8.1-1) are examined. These 10 projects were selected from 31 Candidate Projects. These are examined based on the data obtained by brief site survey.

**Table 8.1-1 Promising Projects on 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 |

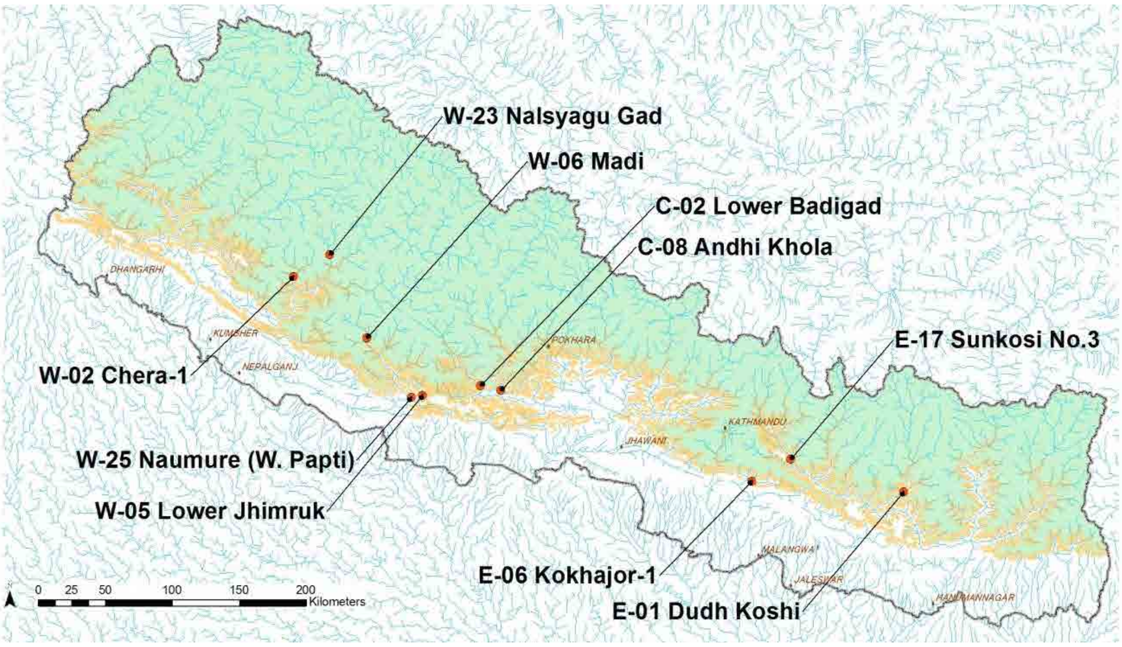



**Figure 8.1-1 Location of Promising Projects on the third Step**

The locations of promising projects are plotted in the isohyetal map and seismic hazard map of Nepal as follows. (See Figure 8.1-2 and Figure 8.1-3)

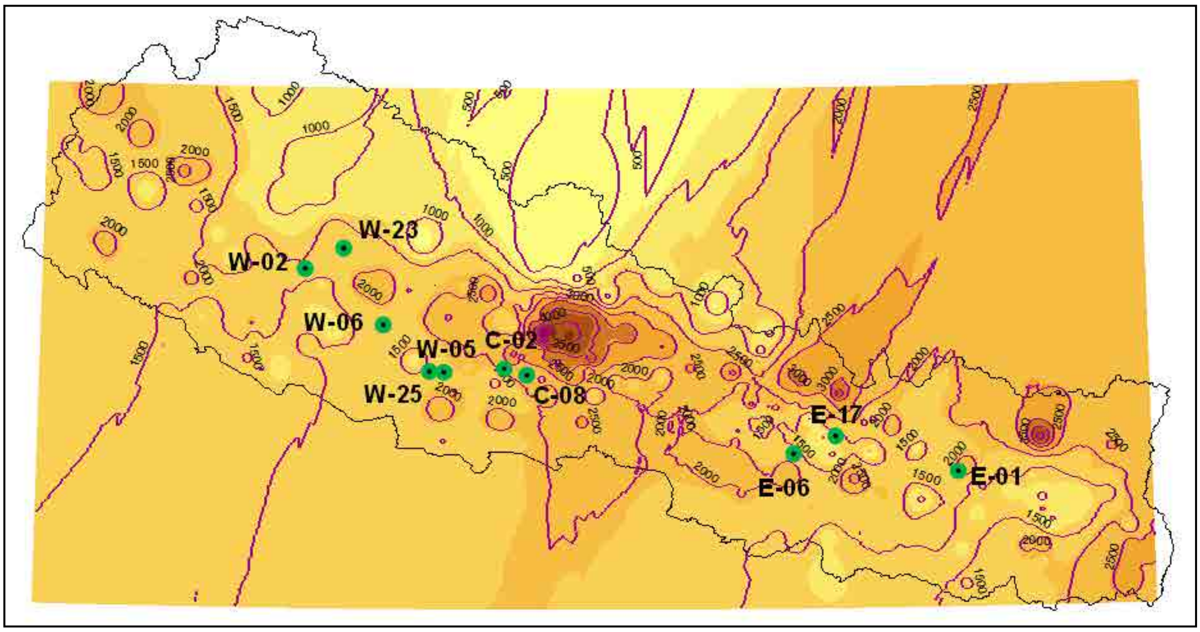



**Figure 8.1-2 Locations of Promising Projects in Isohyetal Map**

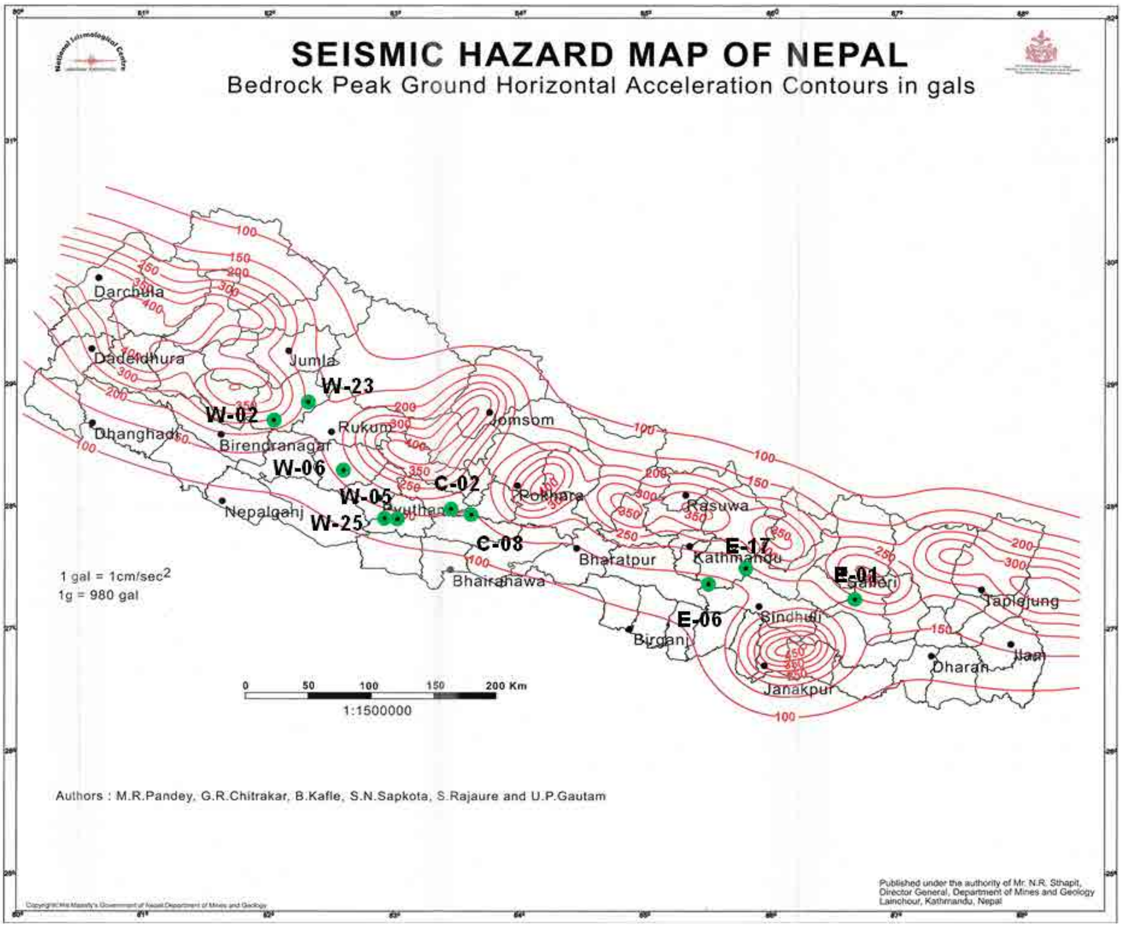



**Figure 8.1-3 Locations of Promising Projects in Seismic Hazard Map**

The salient features of the promising projects are summarized in Table 8.1-2.

## Table 8.1-2 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 8.1-3.

**Table 8.1-3 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 Hydroelctric 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 above, the following master plan studies have been conducted in terms of storage-type hydroelectric power projects.

- Identification and Feasibility Study of 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 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 Hydroelectric Project, 2011, NEA
- Detailed Survey on Tamor (Terathum) Project, 2010, NEA
- FS on Seti-Trisuli Project, 2005, NEA
- FS on -Ishaneshore Hydroelectric Project, 2002, NEA

- Pre-FS on Utter Ganga 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 next page.

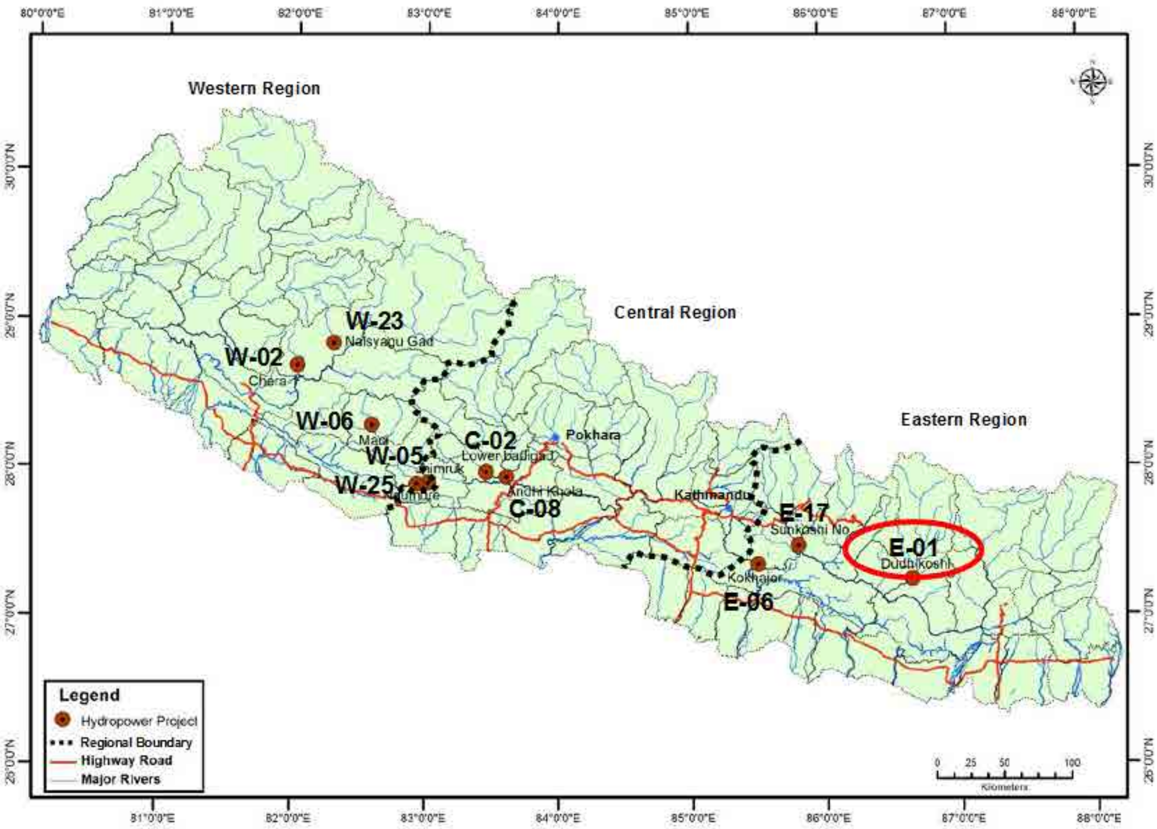



Figure 8.1-4 Location of Dudh Koshi Project (E-01)

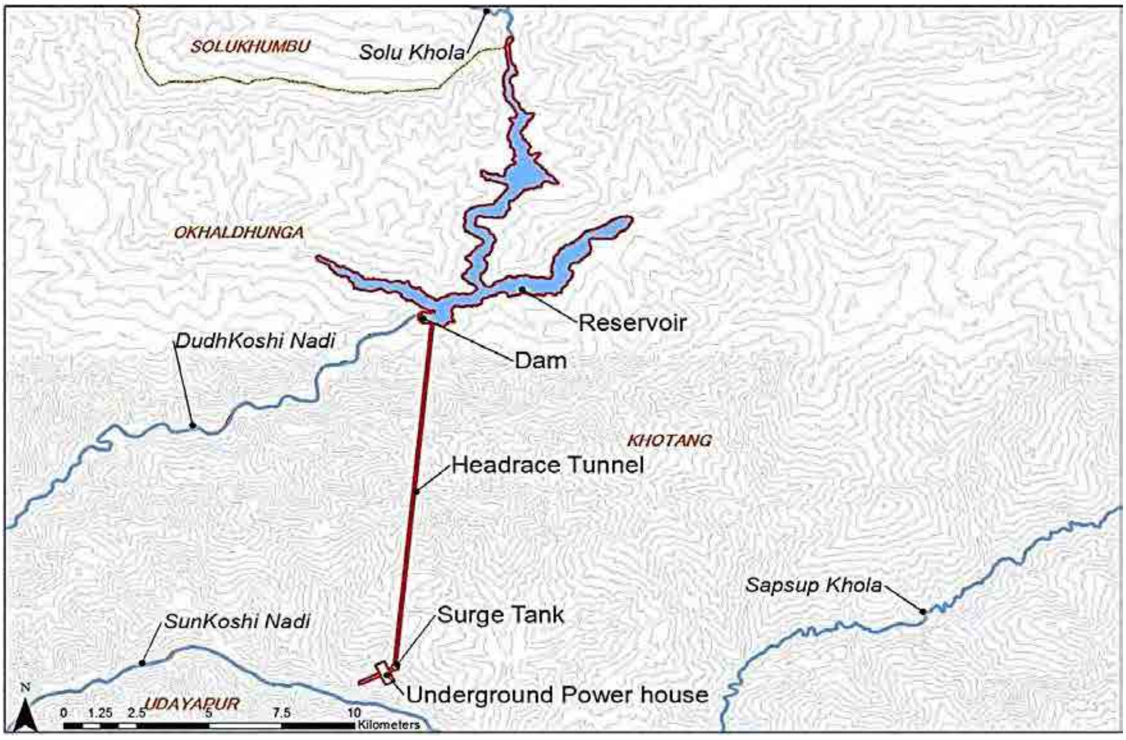



Figure 8.1-5 General Layout of the Dudh Koshi Project (E-01)

**Table 8.1-4 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 |

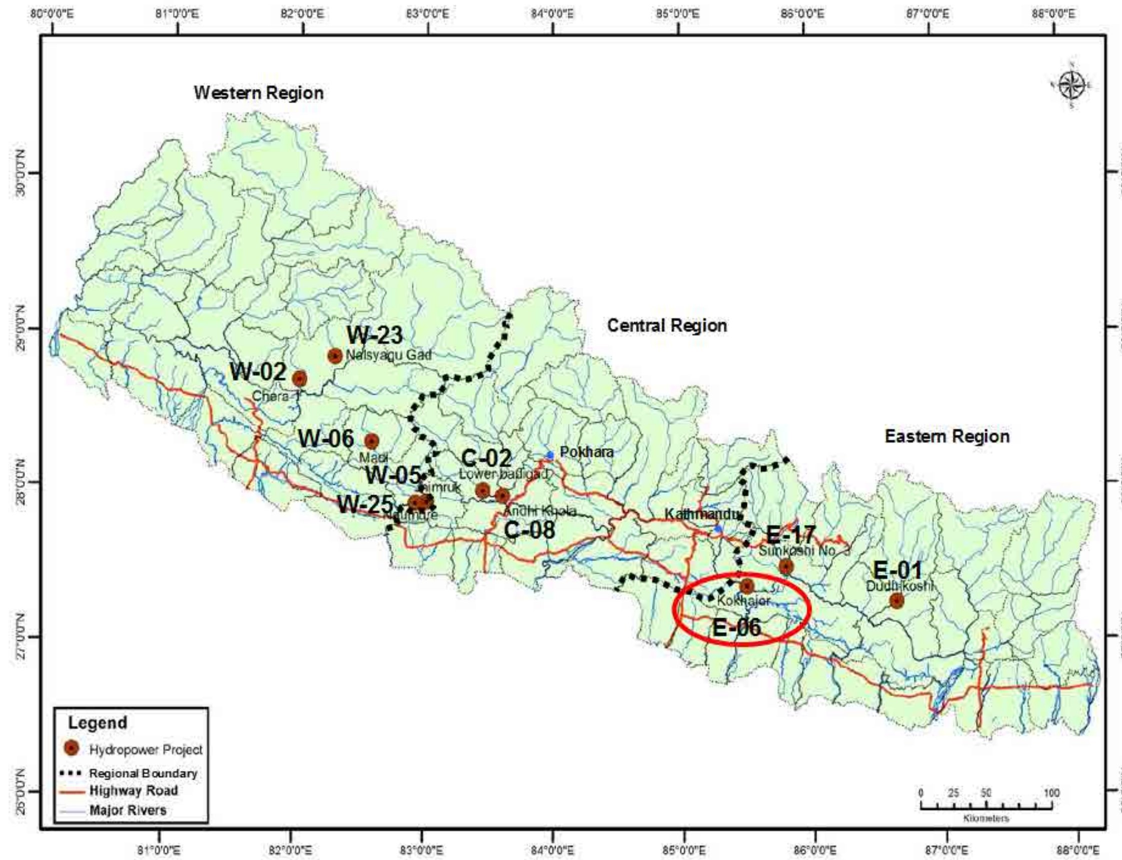



Figure 8.1-6 Location of Kokhajor-1 Project (E-06)

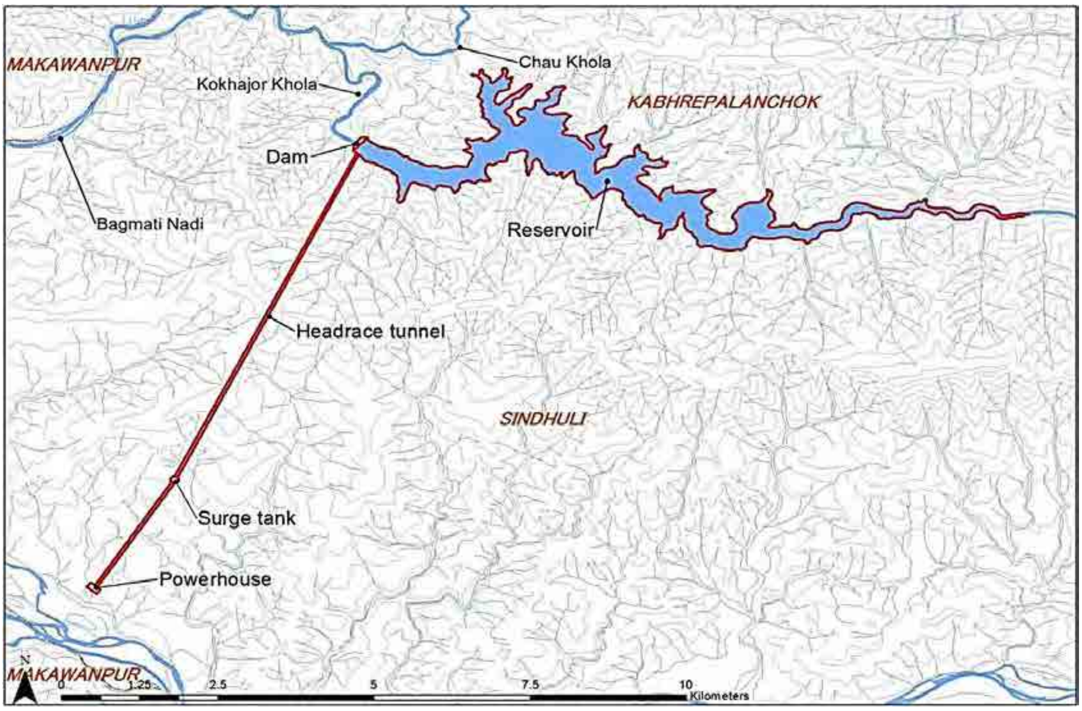



Figure 8.1-7 General Layout of the Kokhajor-1 Project (E-06)

**Table 8.1-5 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 | - |

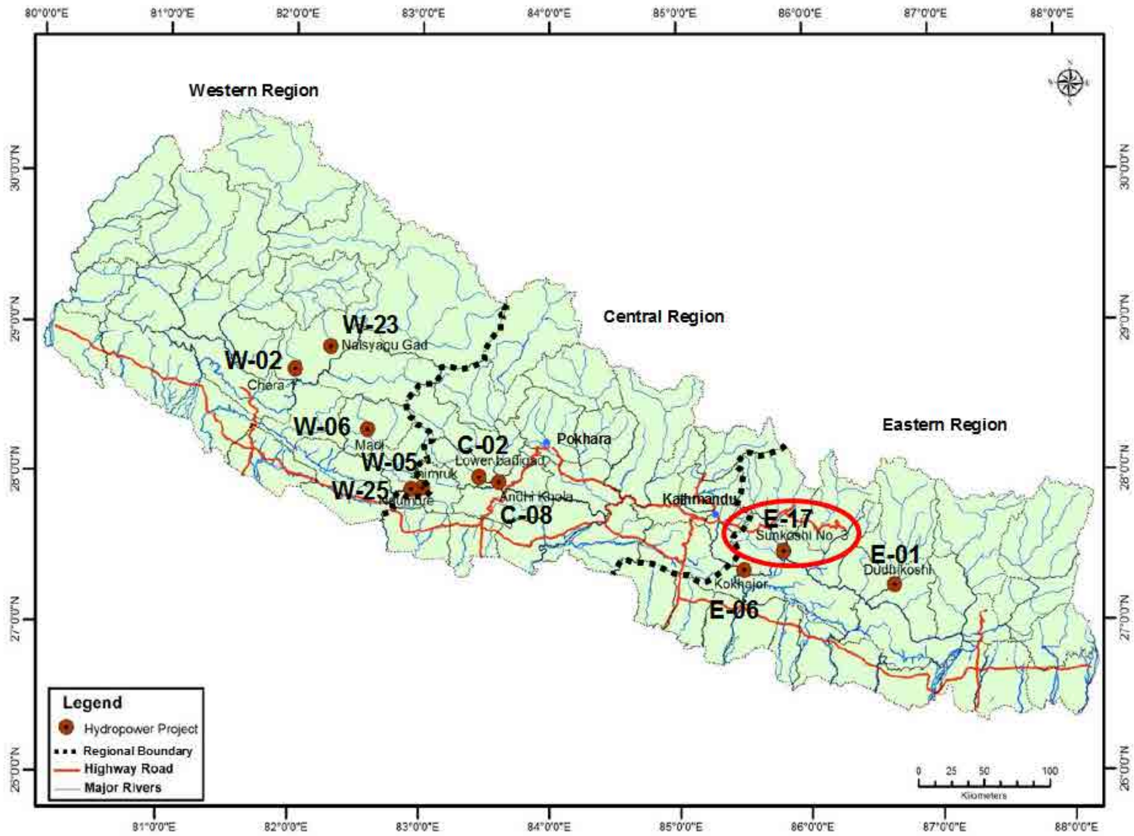



Figure 8.1-8 Location of Sun Koshi No.3 Project (E-17)

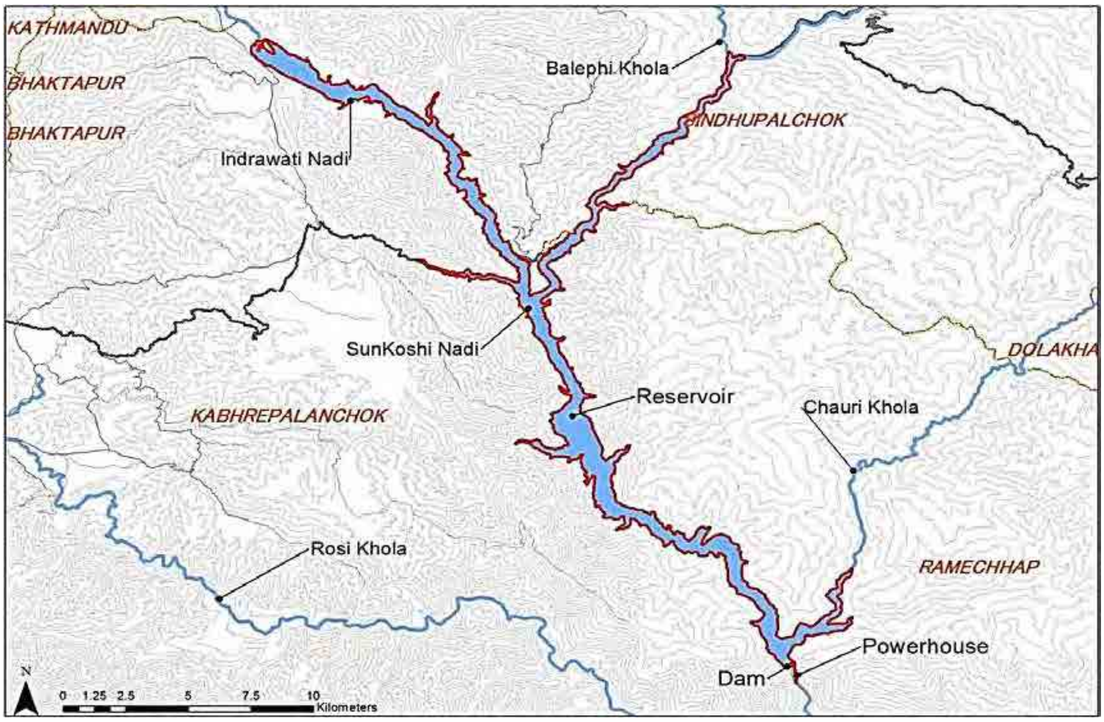



Figure 8.1-9 General Layout of the Sun Koshi No.3 Project (E-17)

## Table 8.1-6 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 |

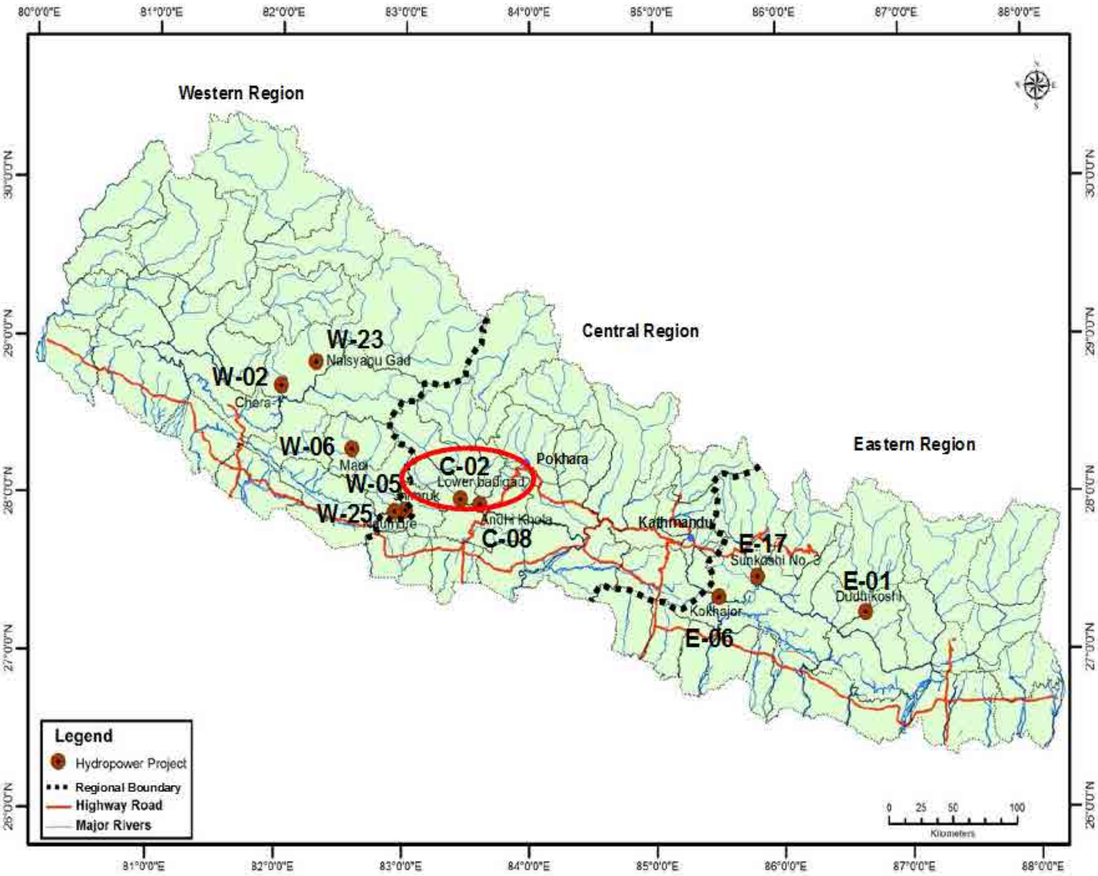



**Figure 8.1-10 Location of Lower Badigad Project (C-02)**

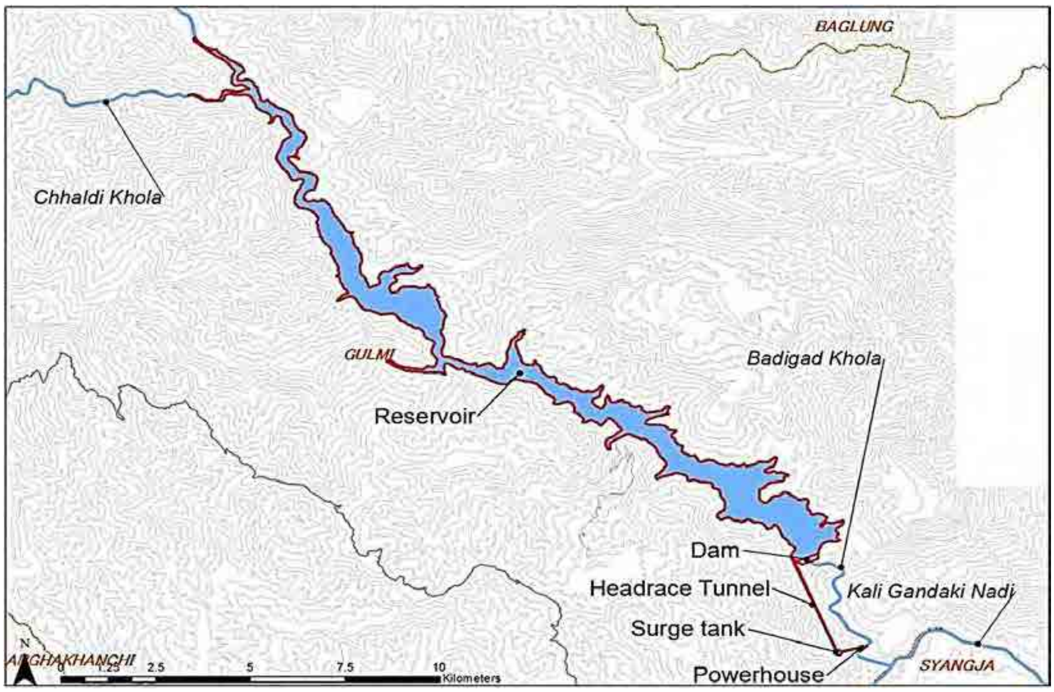



**Figure 8.1-11 General Layout of the Lower Badigad Project (C-02)**

**Table 8.1-7 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 |

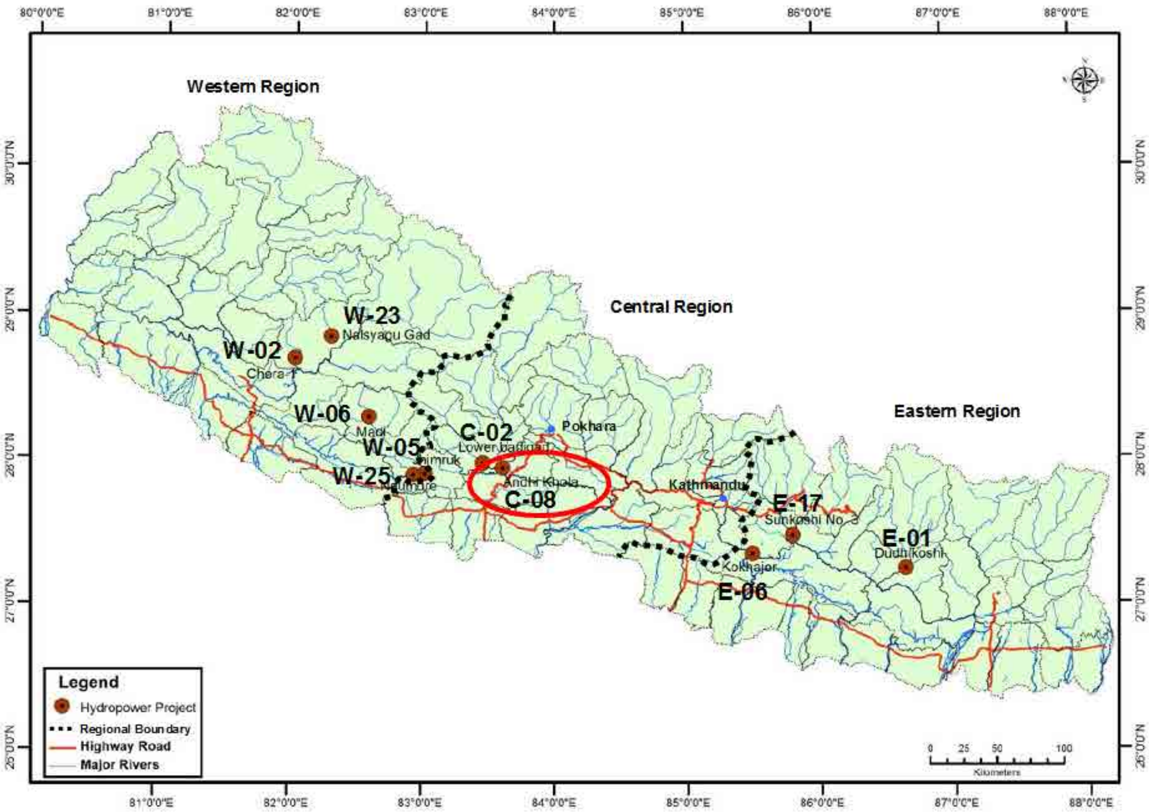



**Figure 8.1-12 Location of Andhi Khola Project (C-08)**

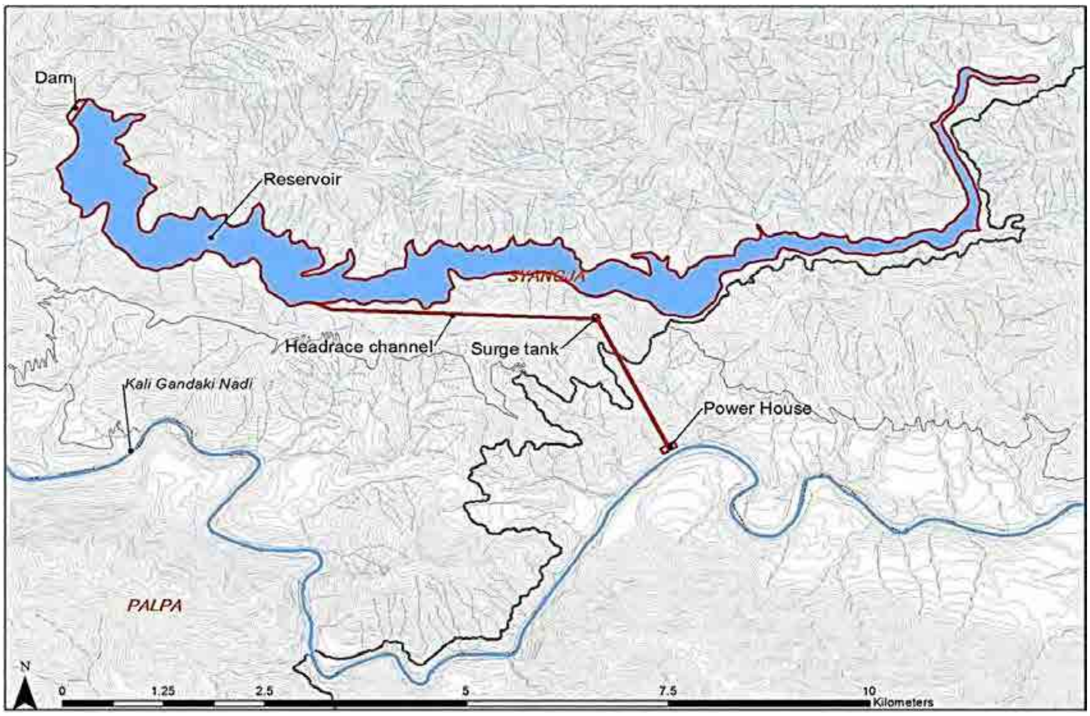



**Figure 8.1-13 General Layout of the Andhi Khola Project (C-08)**

**Table 8.1-8 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 |

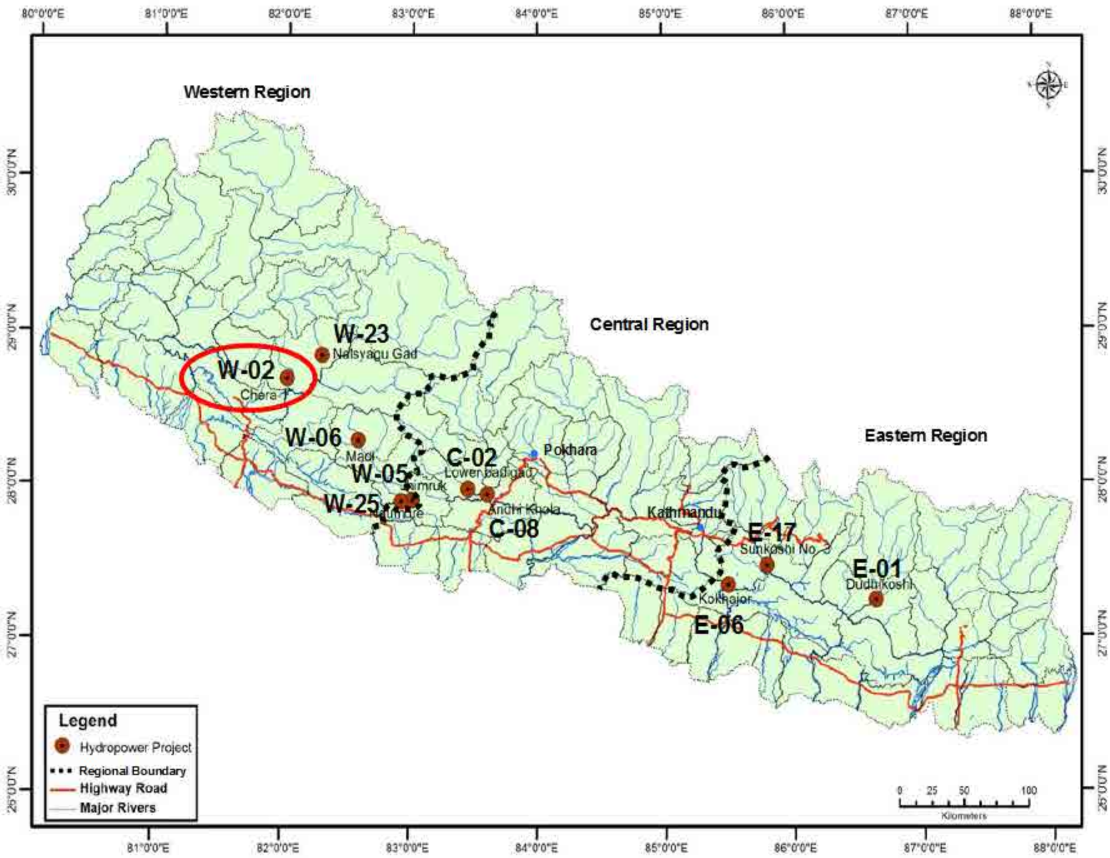



**Figure 8.1-14 Location of Chera-1 Project (W-02)**

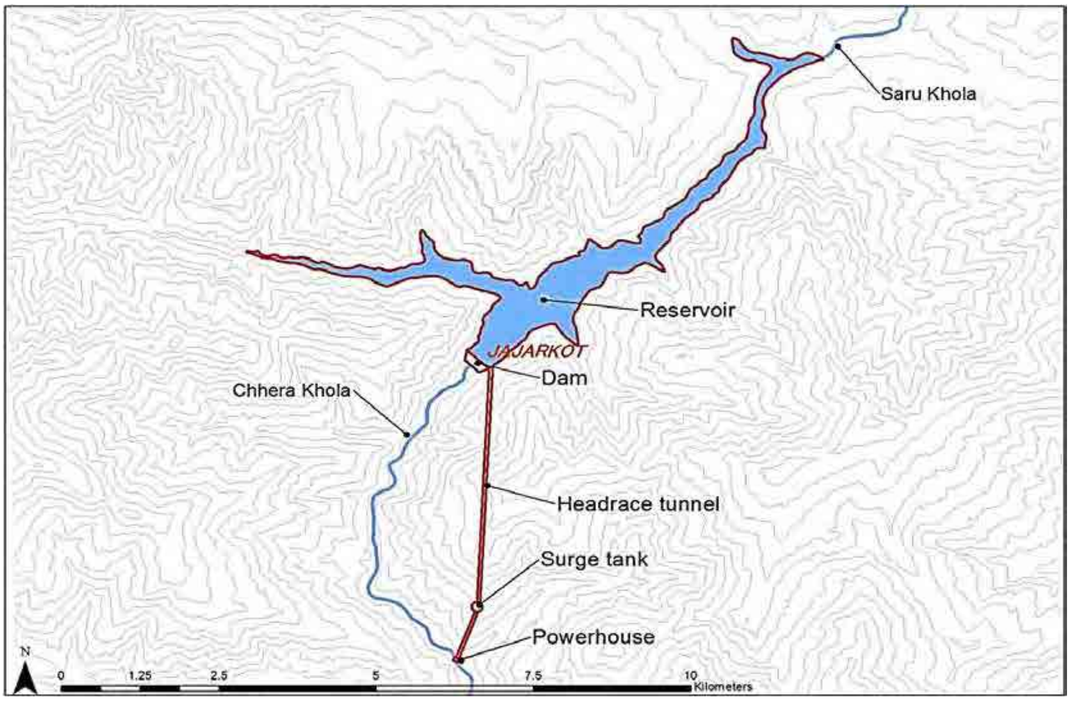



**Figure 8.1-15 General Layout of the Chera-1 Project (W-02)**

**Table 8.1-9 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 |

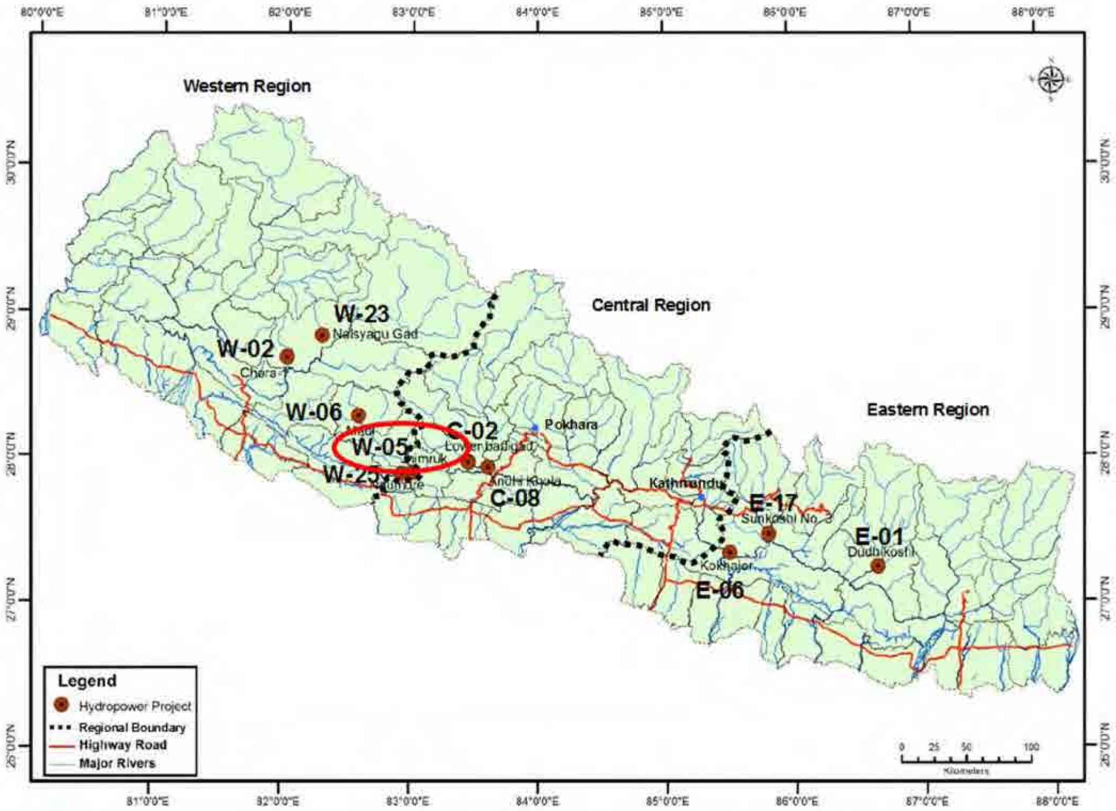



Figure 8.1-16 Location of Lower Jhimruk Project (W-05)

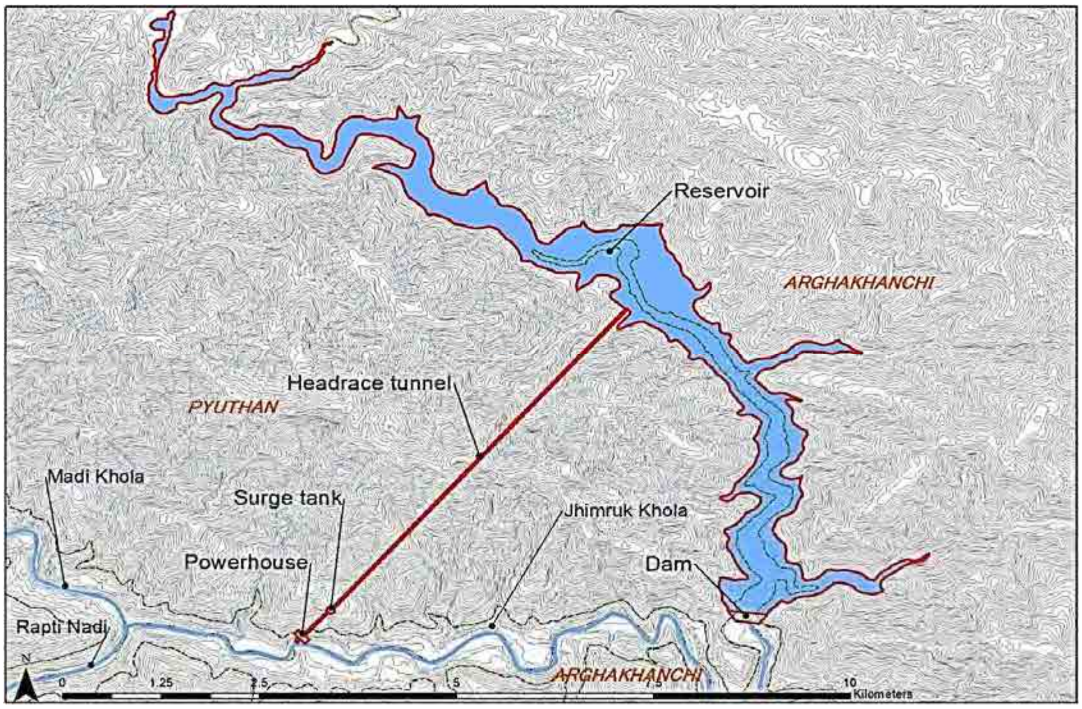



Figure 8.1-17 General Layout of the Lower Jhimruk Project (W-05)

**Table 8.1-10 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 |

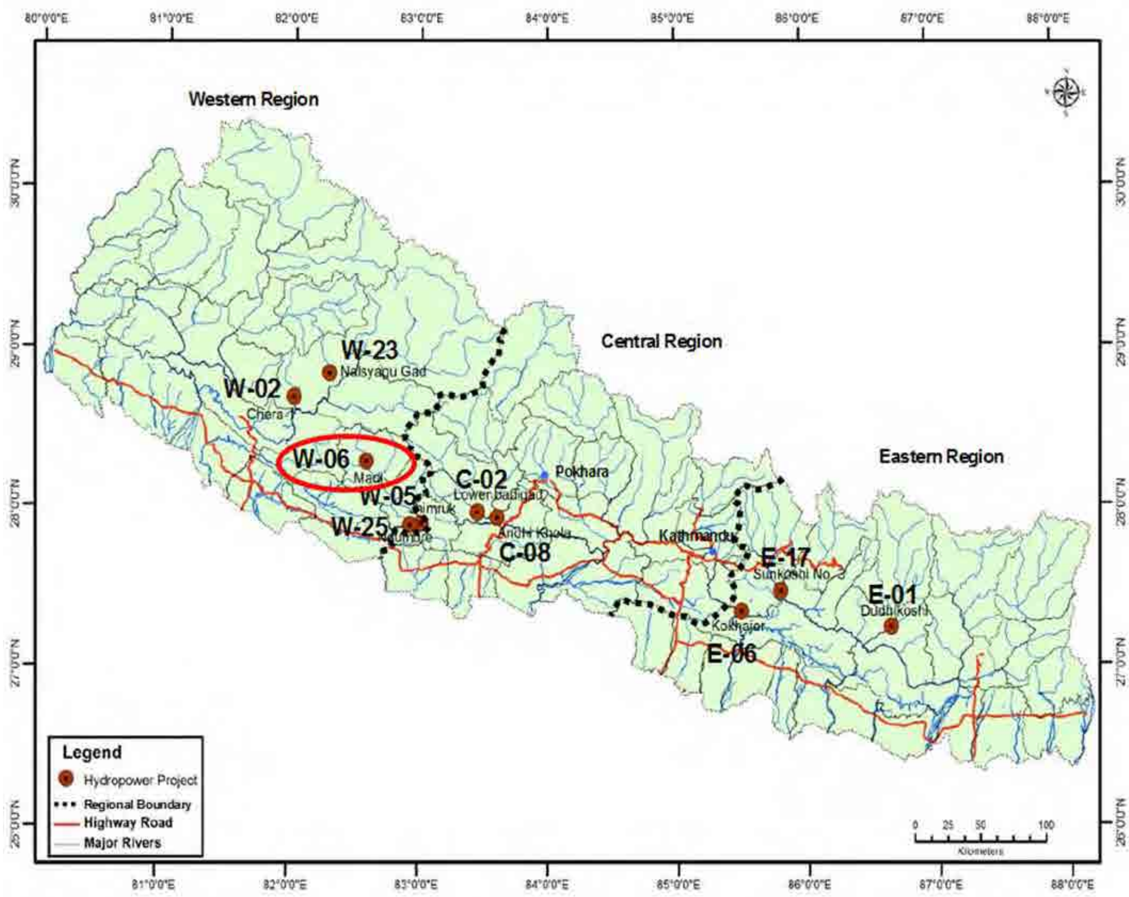



Figure 8.1-18 Location of Madi Project (W-06)

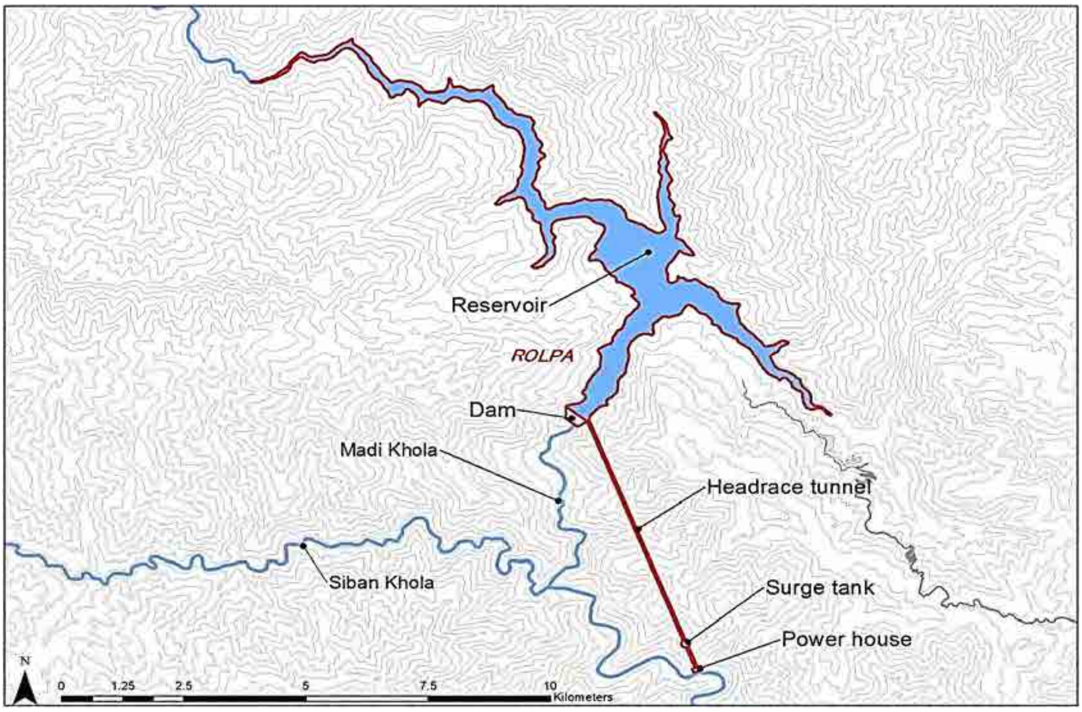



Figure 8.1-19 General Layout of the Madi Project (W-06)

**Table 8.1-11 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 |

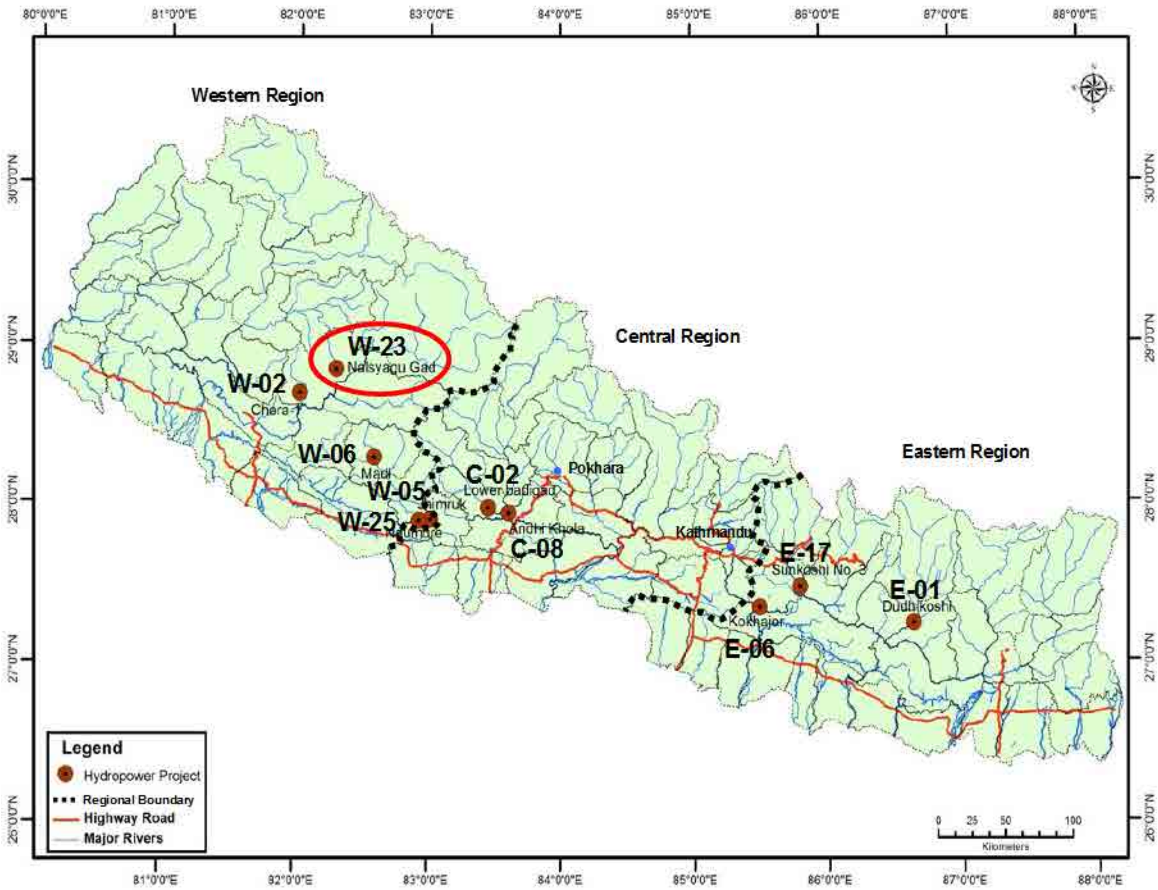



**Figure 8.1-20 Location of Nalsyau Gad Project (W-23)**

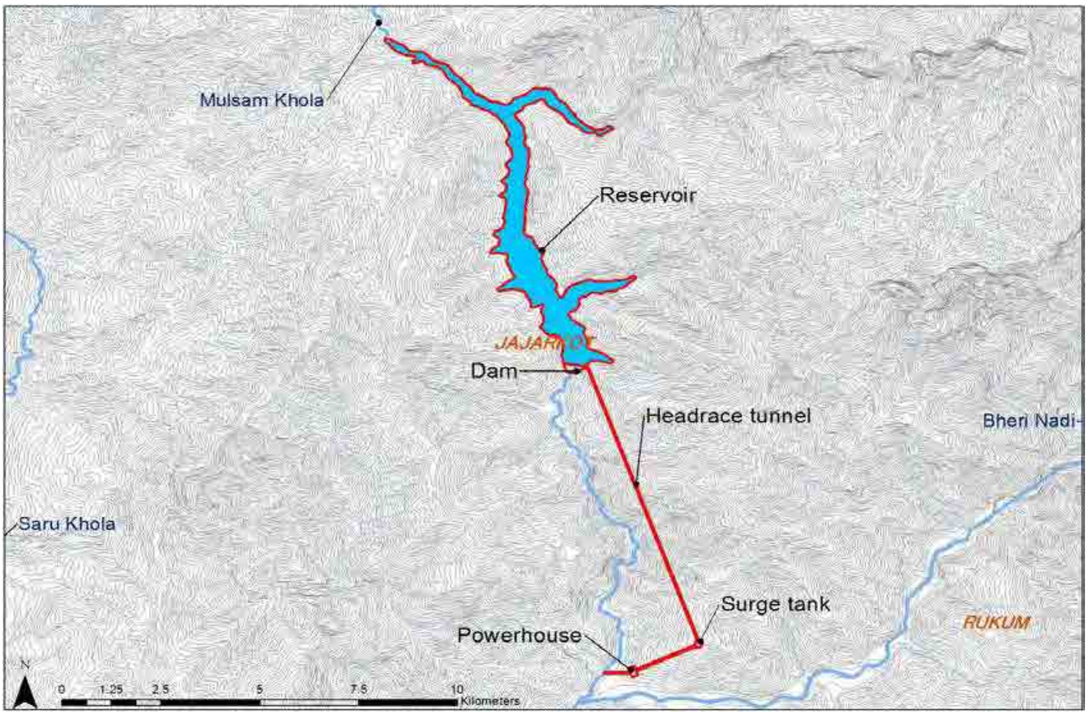



**Figure 8.1-21 General Layout of the Nalsyau Gad Project (W-23)**

**Table 8.1-12 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 | - |

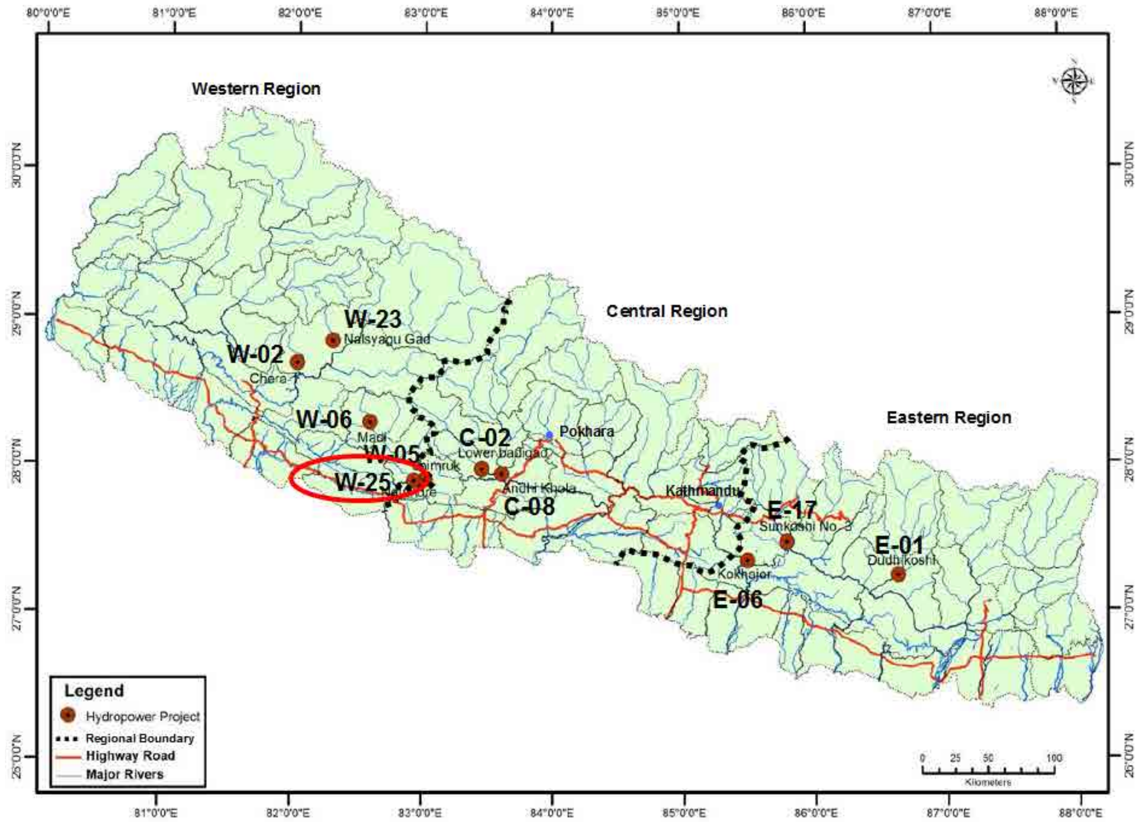



Figure 8.1-22 Location of Naumure (W. Rapti) Project (W-25)

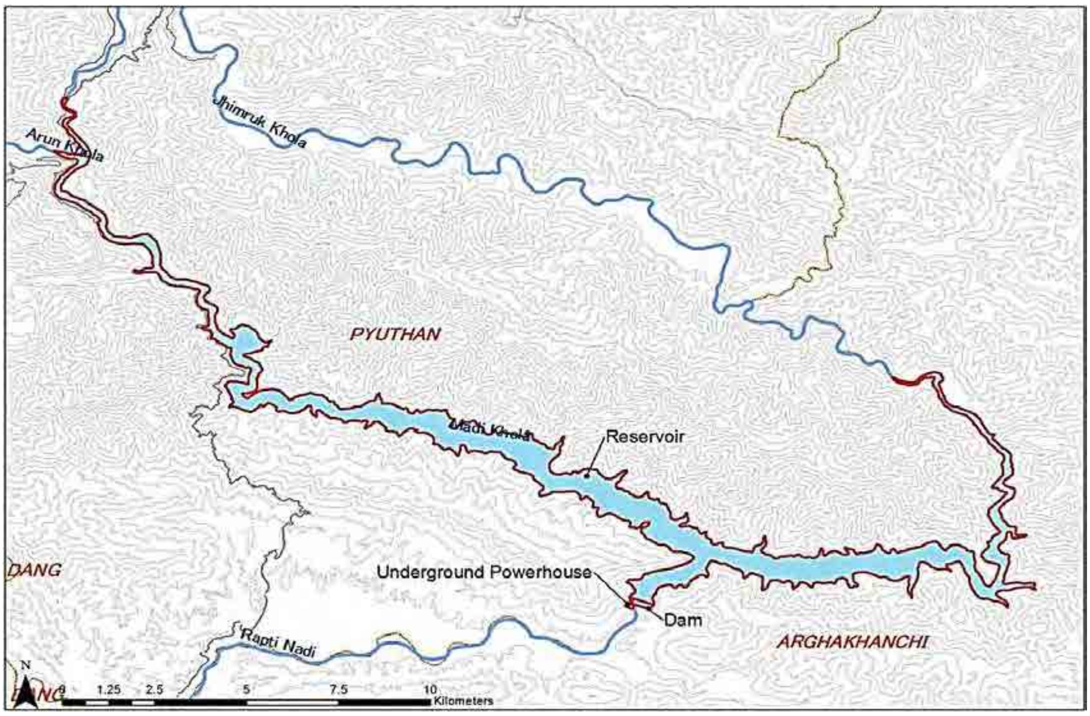



Figure 8.1-23 General Layout of the Naumure (W. Rapti) Project (W-25)

### Table 8.1-13 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 |

## 8.2 Scoping

The third step aims to evaluate 10 Promising projects from various points of view. Sixty three evaluation items are explained in this section.

(1) Evaluation Items and Methods

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 Clause 7.2. However, taking into account the comments obtained in the stakeholder meeting, some evaluation items were added and some modification was made in the evaluation criteria as described below.

Technical and Economical Conditions

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

    [1)]: The name of "Natural hazard (earthquake)" in Clause 7.2 was changed.
- Time to commencement of commercial operation [2)]

  [2)]: In Clause 7.2, this item was evaluated as "Lead Time to Implementation of Project" by "Length of access road," "Difficulty level of funding," and "Reliability of 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 forest, impact on flora [3)], impact on terrestrial fauna [3)], impact on protected area, impact on aquatic fauna, and impact of transmission line [4)].

    [3)]: Added items.

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

    [5)]: Added items.

1) Hydrology

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

***a. Reliability of flow data***

Evaluation method and point allocation of reliability of flow data are same as those that were used for evaluation of candidate projects, and the detail is described in Section 7.2 (1) 1) a.

The evaluation criterion for reliability of flow data is shown in Table 8.2-1.

**Table 8.2-1 Evaluation Criterion for 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 |

***b. Risk of GLOF***

Evaluation method and point allocation of risk of GLOF are same as those that were used for evaluation of candidate projects, and the detail is described in Section 7.2 (1) 1) b.

The evaluation criterion for reliability of flow data is shown in Table 8.2-2.

**Table 8.2-2 Evaluation Criterion for Risk of 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 |

***c. Sedimentation***

Evaluation method and point allocation of sedimentation are basically same as those that were used for evaluation of candidate projects, and the detail is described in Section 7.2 (1) 1) c. However, since nine out of ten projects have same score if the same point allocation is used, the point allocation was modified to obtain appropriate evaluation result.

The evaluation criterion for sedimentation is shown in Table 8.2-3.

**Table 8.2-3 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 hazard (earthquake)," and "Seismicity." The name of "Natural hazard (earthquake)" was changed to

"Thrust and fault." The detail of each evaluation method was described in Section 7.2 (1) 2).

***a. Geological conditions of the site***

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

Evaluation criterion for site geology is shown in Table 8.2-4.

.

### Table 8.2-4 Evaluation Criteria for Geological Conditions of 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 |
| | 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. |
| 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, ordinal rocks are shown for example. Observed rock and its condition should be described.

**Table 8.2-5 Evaluation Criteria for Geological Conditions of Site (Deduction of point)**

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

**Table 8.2-6 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 | | | | | | |

***b. Thrust and fault***

Evaluation method and point allocation of risk of thrust and fault are same as "Natural hazard (earthquake)" used for evaluation of candidate projects, and the detail is described in Section 7.2 (1) 2) b.

The evaluation criterion for reliability of flow data is shown in Table 8.2-7.

**Table 8.2-7 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.

***c. Seismicity***

Evaluation method and point allocation of risk of thrust and fault are same as those that were used for evaluation of candidate projects, and the detail is described in Section 7.2 (1) 2) c.

The evaluation criterion for reliability of flow data is shown in Table 8.2-8 to Table 8.2-10.

**Table 8.2-8 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 8.2-9 Evaluation Criterion for Seismicity (Class by Acceleration)**

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

**Table 8.2-10 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 length of access road, difficulty level of funding, and reliability of development plan as shown in Table 8.2-11. In the evaluation of promising projects, 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 8.2-11.

**Table 8.2-11 Time required for Each Stage**

| Stage | Time (Year) | Remark |
|---|---|---|
| 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, lead time of a project in desk-study level is the total time from pre-FS to construction, lead time of a project in pre-FS level is the total time from FS to construction.

The project with 10 years in lead time was scored 100 points, the project with 20 years in lead time was scored 0 points, and other projects were scored a point obtained by linear interpolation with lead time. (See Table 8.2-12)

**Table 8.2-12 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

***a. Unit generation cost***

Evaluation method is basically same one that was used for evaluation of candidate projects; 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 100 points, the project with the largest unit generation cost was scored 0 point, and other projects were scored a point obtained by linear interpolation with 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 8.2-13.

**Table 8.2-13 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%

***b. Installed Capacity***

In the evaluation of candidate projects described in Table 8.2-14, since the suitable development scale was expected 100 MW to 300 MW in the Scope of Work of this Study, the evaluation point was gradually decreased for projects more than 300 MW.

In the evaluation of promising projects, importance was put on large installed capacity because of its effect on mitigating load shedding. And since the maximum installed capacity among the promising projects is 536 MW, though there might be some minor difficulty of financing, etc., development of this scale of projects seems to have sufficient probability. Therefore, point allocation for evaluation of installed capacity was modified as shown in Table 8.2-14.

**Table 8.2-14 Evaluation Criterion for Installed Capacity**

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

***c. Annual Energy Production***

In the evaluation of candidate projects described in Section Table 8.2-15, 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 1,920 GWh, the evaluation point was determined proportional to annual energy production up to 1,910 GWh, the maximum value, as shown in Table 8.2-15.

**Table 8.2-15 Evaluation Criterion for Annual Energy Production**

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

*d. Energy Production in Dry Season*

Same to 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 8.2-16 .

**Table 8.2-16 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) Natural Environment

*a. Impact on Forest*

The impact on forest was evaluated by the total of evaluation scores of forest land per unit installed capacity, average crown coverage[11], and 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 was 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 point and the smallest number was evaluated at 100 points.

Table 8.2-17 shows the largest/smallest values and corresponding evaluation points.

**Table 8.2-17 Evaluation Criterion for Impact on Forest**

| Items | | | Min Impact | | Max impact |
|---|---|---|---|---|---|
| Impact on Forest | Forest land (km2)<br>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)<br>Number of trees (nos/MW) | *Value* | 9,776 | - | 520,608 |
| | | *Point* | 24.4 | - | 1980.1 |
| | | *Score* | 100 | Linear interpolation | 0 |

*b. 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

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

largest number was evaluated at 0 points, the smallest number at 100 points, and the other projects were evaluated by linear interpolation.

Table 8.2-18 shows the largest/smallest values and corresponding evaluation points.

**Table 8.2-18 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 |

### *c. Impact on Terrestrial Fauna*

The impact on terrestrial fauna was evaluated by the numbers of mammal/bird/herpetofauna species reported, 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 8.2-19 shows the largest/smallest values and corresponding evaluation points.

**Table 8.2-19 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 |

### *d. Impact on Protected Area*

Projects located in a protected area had already been excluded from the promising projects.

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 area/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 8.2-20 shows the largest/smallest values and corresponding evaluation points.

**Table 8.2-20 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 |

### *e. Impact on Aquatic Fauna*

The impact on aquatic fauna was evaluated by length of recession area, number of fish species reported, and number of fish species of conservation significance. Regarding the length of 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 8.2-21 shows the largest/smallest values and corresponding evaluation points.

**Table 8.2-21 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 |

### *f. Impact of Construction of Transmission Line*

The impact of construction of transmission line was evaluated by the length of transmission line. 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 8.2-22 shows the largest/smallest values and corresponding evaluation points.

**Table 8.2-22 Evaluation Criterion for Impact of Transmission Line**

| 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) Social Environment

***a. Impact on Household, etc.***

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

Table 8.2-23 shows the largest/smallest values and corresponding evaluation points.

**Table 8.2-23 Evaluation Criterion for Impact on Household, 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 |

***b. Impact on Ethnic Minority***

The impact on ethnic minority was evaluated by the number of ethnic groups under Disadvantaged, Marginalized, and Highly Marginalized. 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 8.2-24 shows the largest/smallest values and corresponding evaluation points.

**Table 8.2-24 Evaluation Criterion for Impact on Ethnic Minority Group**

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

***c. Impact on Agriculture***

The impact on agriculture was evaluated by the agricultural 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 8.2-25 shows the largest/smallest values and corresponding evaluation points.

**Table 8.2-25 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 |

### *d. 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, total income of fishermen, and length of recession area. 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 8.2-26 shows the largest/smallest values and corresponding evaluation points.

**Table 8.2-26 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 |

### *e. 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 8.2-27 shows the largest/smallest values and corresponding evaluation points.

**Table 8.2-27 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 |

### *f. Impact on Infrastructure*

The impact on infrastructure was evaluated by the length of road, the number of bridges, the number of water mills/turbines/hydroelectric power stations, 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 8.2-28 shows the largest/smallest values and corresponding evaluation points.

**Table 8.2-28 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 |

### *g. Impact on Rural Economy and Development Plan*

The impact on rural economy and development plan 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 8.2-29 shows the largest/smallest values and corresponding evaluation points.

**Table 8.2-29 Evaluation Criterion for Impact on 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 |

(2) Weighting of the Third Step

Same as the evaluation of candidate projects, the evaluation items described in 8.2 (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 item, and the total of weighted scores of all evaluation items is the evaluation score of project in question.

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

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

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

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

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

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

The weights of each evaluation item were determined by reference to other projects and based on knowledge of the study team.

Table 8.2-30 shows the weights and point allocations of each case.

## Table 8.2-30 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 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 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 Environment | 50 | Impact on 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 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, hydroelectric power station* | *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 8.2-31 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 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 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 Environment | 40 | Impact on Natural Environment | 40 | Impact on forest | (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 area | (16) | — |
| | | | | *Number of protected areas in the downstream* | *8* | *1.28* |
| | | | | *Number of protected species in the downstream* | *8* | *1.28* |
| | | | | Impact of transmission line | (6) | |
| | | | | *Length of transmission line* | *6* | *0.96* |
| | | Impact on Social Environment | 60 | Impact on household, etc. | (17) | — |
| | | | | *Number of estimated households* | *10* | *2.40* |
| | | | | *Number of schools* | *4* | *0.96* |
| | | | | *Number of industries* | *3* | *0.72* |
| | | | | Impact on ethnic minority | (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, hydroelectric power station* | *4* | *0.96* |
| | | | | *Impact on drinking water schemes* | *4* | *0.96* |
| | | | | Impact on rural economy and development plan | (8) | — |
| | | | | *Impact on market* | *4* | *0.96* |
| | | | | *Number of development plans* | *2* | *0.48* |
| | | | | *Previous issues* | *2* | *0.48* |
| | | | | Total | | 100 |

## Table 8.2-32 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 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 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 Environment | 60 | Impact on Natural Environment | 40 | Impact on forest | (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 area | (16) | — |
| | | | | *Number of protected areas in the downstream* | *8* | *1.92* |
| | | | | *Number of protected species in the downstream* | *8* | *1.92* |
| | | | | Impact of transmission line | (6) | |
| | | | | *Length of transmission line* | *6* | *1.44* |
| | | Impact on Social Environment | 60 | Impact on household, etc. | (17) | — |
| | | | | *Number of estimated households* | *10* | *3.60* |
| | | | | *Number of schools* | *4* | *1.44* |
| | | | | *Number of industries* | *3* | *1.08* |
| | | | | Impact on ethnic minority | (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, hydroelectric power station* | *4* | *1.44* |
| | | | | *Impact on drinking water schemes* | *4* | *1.44* |
| | | | | Impact on rural economy and development plan | (8) | — |
| | | | | *Impact on market* | *4* | *1.44* |
| | | | | *Number of development plans* | *2* | *0.72* |
| | | | | *Previous issues* | *2* | *0.72* |
| Category | | | | Total | | 100 |

## Table 8.2-33 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 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 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 Natural Environment | 40 | Impact on forest | (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 area | (16) | — |
| | | | | *Number of protected areas in the downstream* | *8* | *0.80* |
| | | | | *Number of protected species in the downstream* | *8* | *0.80* |
| | | | | Impact of transmission line | (6) | |
| | | | | *Length of transmission line* | *6* | *0.60* |
| | | Impact on Social Environment | 60 | Impact on household, etc. | (17) | — |
| | | | | *Number of estimated households* | *10* | *1.50* |
| | | | | *Number of schools* | *4* | *0.60* |
| | | | | *Number of industries* | *3* | *0.45* |
| | | | | Impact on ethnic minority | (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, hydroelectric power station* | *4* | *0.60* |
| | | | | *Impact on drinking water schemes* | *4* | *0.60* |
| | | | | Impact on rural economy and development plan | (8) | — |
| | | | | *Impact on market* | *4* | *0.60* |
| | | | | *Number of development plans* | *2* | *0.30* |
| | | | | *Previous issues* | *2* | *0.30* |
| | | | | Total | | 100 |

## 8.3 Impact Assessment

Third Step is an evaluation for the ten Promising Projects based on the site survey. 50 evaluation items of six categories are examined in detail. After Impact Evaluation, Sensitivity Analysis was conducted. Followings are the result of the Impact Evaluation and the Sensitivity Analysis.

(1) Impact Evaluation

1) Hydrological Data and Energy

***a. Hydrology***

As for hydrological data of the 10 promising projects, 3 items, namely, reliability of flow data, risk of GLOF, sedimentation of were researched and evaluated.

**(a) Reliability of Flow Data**

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

**Table 8.3-1 Summary of Study Result for Reliability on Flow Data**

| No. | Project Name | Reliability of Flow Data |
|---|---|---|
| E-01 | Dudh Koshi | The gauging station 670 is located at 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 | The gauging station 630 is located at 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 gauging station 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 | The gauging station 415 is located at 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 gauging station 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 | The gauging station 330 is located at 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 gauging station 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. |

| No. | Project Name | Reliability of Flow Data |
|---|---|---|
| W-23 | Nalsyau Gad | -ditto- |
| W-25 | Naumure (W. Rapti) | -ditto- |

### (b) Risk of GLOF

Similarly, the study result on risk of GLOF of each promising project is summarized in the following table.

**Table 8.3-2 Summary of Study Result on Risk of GLOF**

| No. | Project Name | Risk of 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 GLOF of the project is high. Imja Tsho is the highest risky glacial lake in terms of GLOF. |
| E-06 | Kokhajor-1 | There is no potentially critical glacier lake in term of GLOF upstream of the project site. |
| E-17 | Sun Koshi No.3 | There are nine potentially critical glacial lakes in term of 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 GLOF of the project is high. |
| C-02 | Lower Badigad | There is no potentially critical glacier lake in term of 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- |

### (c) Sedimentation

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

### Table 8.3-3 Summary of Study Result on Life of 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 |

#### *b. Energy Calculation*

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

#### (a) 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 to estimate maximized annual energy by optimizing 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 decision the optimum on conditions from primary decision to result for whatever primary conditions and decision of the system.

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

#### (b) Data for Calculation

The project parameters required for energy calculation such as Full Supply Level (FSL), Minimum Operational Level (MOL) and Water Level-Storage Volume Curve of 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 hydroelectric power station data around world. The installed capacities obtained from the result of this design review were used for the energy calculation.

The peak hour was established as 12 hours for energy calculation in consultation with NEA.

As for flow data, the data estimated in the hydrological analysis were used. The following table shows average monthly flows at dam sites of promising projects.

**Table 8.3-4 Summary of Flow 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 |

### (c) Calculation Result

The results of annual energy calculation for promising projects are summarized in the following table. Where, only for the Nalsyau Gad Project, the energy estimated in the feasibility study report is adopted as result since the feasibility study has just completed in 2012 in consultation with NEA.

### Table 8.3-5 Summary of Energy Calculation Result 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 |

2) Project Cost and Lead Time to Commencement of Operation

***a. Project Cost***

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

***b. 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 Inflation Rate of Consumer Price of Major advanced economies (G7) published in database of 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 works was divided into 3 parts, namely, cost for dam & reservoir, cost for waterway tunnel, cost for powerhouse. The ratio of contingency for cost of each work was determined based on the study level and the result of the geological investigation at site.

The idea for contingency ratios established for the FS or Pre FS-level projects in the source reports, such as 10% for open works, 15% for underground works, 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 & reservoir site, waterway tunnel site and powerhouse site based on the result of site investigations. Only for the Sun Koshi No.3 Project, the largest contingency ratio was applied because there was very limited information about civil structures though the geological evaluation was relatively good.

**Table 8.3-6 Physical Contingency Ratio of Civil Works 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 |

3) Cost of Promising Project

A price contingency established as 10% of each construction cost estimated with 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.

Where, only for the Nalsyau Gad Project, the construction cost estimated in the feasibility study report is used as it is except this price contingency and interest during construction since the feasibility study has just completed in 2012.

## Table 8.3-7 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 |

## Table 8.3-8 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 |

### *a. Lead Time to Commencement of Operation*

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

4) 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 8.3-9 Summary of Required Time to Commencement of Construction**

| Stage | Time (Year) | Remark |
|---|---|---|
| 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 | - | - |

5) Construction Period

The construction periods differ depending on project. The construction period of FS of Pre FS-level project established in the source report was maintained as it was. The construction period of desk study-level project was established considering the scale of dam and the length of waterway tunnel as major structure of project, and result of geological investigation at site as shown in the following table. Where, construction time for preparatory works 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 commencement of construction in Nepal.

**Table 8.3-10 Summary of Construction Period for Promising Projects**

| o. | 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 |

6) Lead Time to Commencement of Operation

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

**Table 8.3-11 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 |

**Table 8.3-12 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 |

7) Geological Issues

***a. Geological Investigation***

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

***b. Evaluation Method for Site Geology***

At the stage of evaluating promising project, evaluation for geology consists of 3 criteria, namely “Geological conditions of the site”, “Thrust and fault” and “Seismicity.” Evaluation method of “Geological conditions of the site” is changed according to abovementioned geological investigation and described in this section. The content of criterion of “Thrust and fault” is same of “Natural hazard (earthquake)” which was applied for selecting promising projects .There is no change in sub-criterion “Seismicity” which was also applied for selecting promising projects. Evaluation criteria of these two are shown in Section 7.2 (1) 2) b and c.

Hydroelectric project area composed of major structure sites, i.e. reservoir area, dam site, headrace tunnel route and power station site. Representing necessary conditions of these structure sites are as follows

- Reservoir area: water tightness, stability of surrounding slopes
- Dam site: stability of foundation rock, water tightness
- Headrace tunnel: stability of foundation rock
- Powerhouse: stability of foundation rock, stability of the slope behind

Evaluation of these structure sites are shown below

**(a) Reservoir Area**

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

Stability of surrounding slopes is evaluated based on the distribution and size of landslide and the distribution of dip slopes.

**(b) Dam Site**

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

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

**(c) Headrace Tunnel Route**

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

**(d) Powerhouse Site**

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

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

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

Evaluation criterion for site geology is compiled in Section 7.2 (1) 2) a.

### *c. Result of Evaluation for Site Geology*

Geological outline and result of evaluation of site geology are shown in Table 8.3-13~Table 8.3-22.

Score for each sub-item and that of structure site are shown with red letters in Table 8.3-13. Sub-items of low scores and with subtracts are those with disadvantages in engineering geological point of view.

**Table 8.3-13 Evaluation of Site Geology of the Dudh Koshi Project**

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

**a, b, c = 100 or 60 or 20 (60 and 20 show disadvantage)**
**d, e = 0 or -20 or lower score (-20 and lower score show disadvantage)**
**A= (b+c)/2+d B= (a+b)/2+d+e C=a+d D= (a+c)/2+d+e**

## Table 8.3-14 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 8.3-15 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 8.3-16 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 8.3-17 Evaluation of Site Geology of 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 8.3-18 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 8.3-19 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 8.3-20 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 8.3-21 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 8.3-22 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 | | | | slightly pervious and could pose threat of minor seepage | | |
| | Lower Siwaliks | sandstone with shale | | | | | | |
| | Sangram Formation | black shale | | | weakest unit | | | |
| | Syangja Formation | calcareous quartzites and quartzitic limestpne with shale | MBT | | . | | rocks near MBT are sheared and easily become unstable | |
| | 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 | | | 0 | 0 | 100 | 60 | | 80 |
| | Middle Siwaliks | sandstone and siltstones | no major fault | 20m thick by a boring | good to fair | slightly pervious and could pose threat of minor seepage、think careful for dam site | | |
| Headrace Tunnel Route | | | 0 | | 100 | | | 100 |
| | Middle Siwaliks | sandstone | no major fault | | overburden <60m | | | |
| Powerhouse Site | | | 0 | 0 | 100 | | 100 | 100 |
| | Middle Siwaliks | mudstone with sandstone | no major fault | about 20m thick | sound | | strikes of bedding plane are about perpendicular to slope | |

## Table 8.3-23 Evaluation Summary of Seismicity

| No. | Project | Area Class | Acceleration Class | Area - Acceleration Matrix | Basic score | Closeness to epicenters greater then M4 (km) / Subtraction | Project score |
|---|---|---|---|---|---|---|---|
| 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 8.3-24 Evaluation Summary of Geological Condition of 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 8.3-25 Evaluation Summary of Thrust and Fault**

| 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 |

8) Natural Environment

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

***a. Impact on Forest***

Comparing the forest area submerged in reservoir area, the impact on the Sun Koshi and the Naumure Projects are significant with more than 7 square kilometers of submerged forest area. More than 400,000 trees will be also affected. On the other hand, the submerged forest area of the Nalsyau Gad and the Chera-1 Projects are less than 1 square kilometers and the affected trees will be less than 40,000. Regarding the crown coverage, for the Kohajor-1 and the Dudh Koshi Projects are relatively high with more than 50%. I contrast, for the Madi and the Nalsyau Gad Projects are relatively low with less than 20 %. In comparison with the land use map of 1996 and the satellite image taken in 2010/2011, the forest land of the Naumure and the Andhi Khola Projects have decreased more than 1 square kilometer. By contrast, about the Sun Koshi Project, increase of forest land more the 3 square kilometers has been observed (see Table 8.3-26).

## Table 8.3-26 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 (km2)* | 1.46 | 1.87 | 1.64 | 0.76 | 7.85 | 3.304 | 1.51 | 4.10 | 2.89 | 8.16 |
| *Bush/Shrub land (km2)* | 0.72 | 0.51 | 2.02 | 0.89 | 1.22 | 0.589 | 0.38 | 0.32 | 0.02 | 2.57 |
| *Cultivated land (km2)* | 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. (km2)* | 0.71 | 0.89 | 1.04 | 0.54 | 4.27 | 2.930 | 1.07 | 3.03 | 1.04 | 9.49 |
| *Grass Land (km2)* | 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 (km2)* | 0.12 | -0.60 | -0.50 | -0.25 | -1.28 | -0.444 | -1.03 | 0.29 | -0.005 | 3.09 |
| *Bush/Shrub land (km2)* | -0.09 | 0.40 | 0.38 | -0.43 | 0.88 | 0.275 | 0.25 | -0.16 | 0.02 | -0.91 |
| *Cultivated land (km2)* | -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. (km2)* | 0.32 | 0.05 | 0.00 | -0.33 | 0.01 | 0.074 | -0.16 | 0.62 | -0.33 | -1.35 |
| *Grass Land (km2)* | -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 |

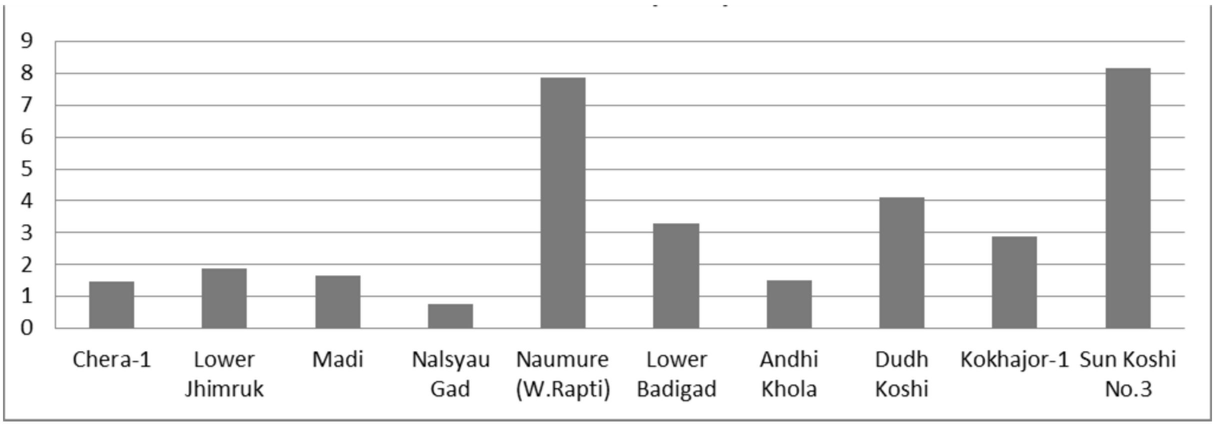



**Figure 8.3-1 Forest Land in the Reservoir Area**

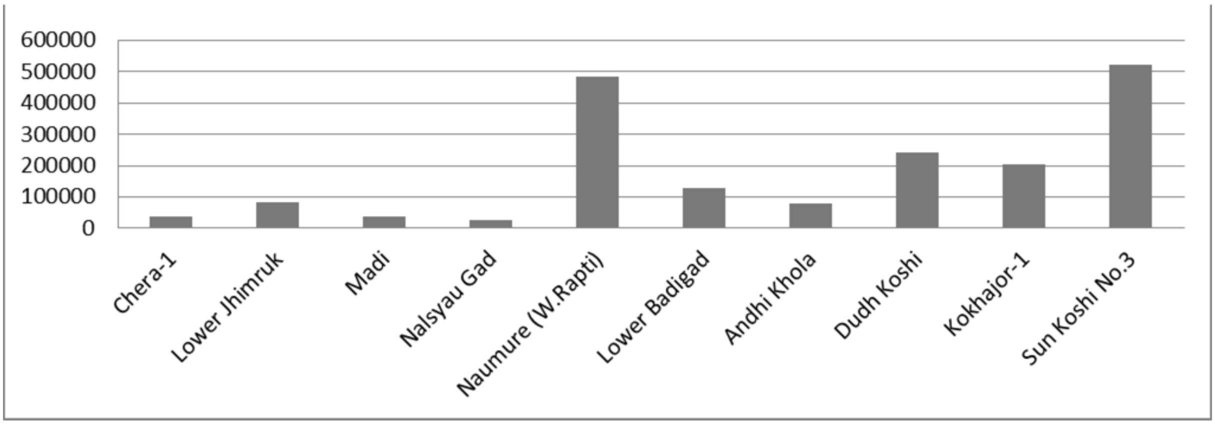



**Figure 8.3-2 Number of Trees in the Reservoir Area**

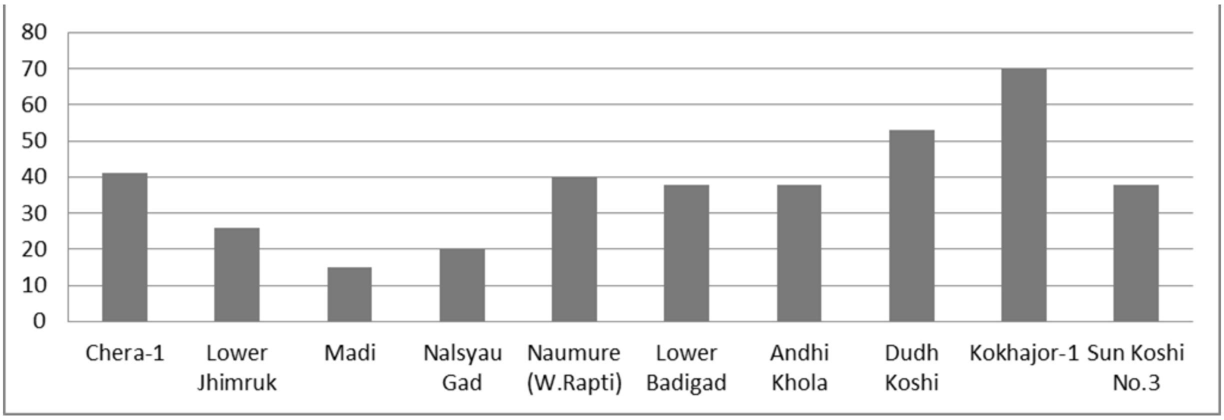



**Figure 8.3-3 Average of Crown Coverage in the Reservoir Area (%)**

***b. Impact on Flora***

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

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

## Table 8.3-27 Impact on Flora in the Reservoir Area

| No.<br>Project Name | W-02<br>Chera-1 | W-05<br>Lower Jhimruk | W-06<br>Madi | W-23<br>Nalsyau Gad | W-25<br>Naumure (W. Rapti) | C-02<br>Lower Badigad | C-08<br>Andhi Khola | E-01<br>Dudh Koshi | E-06<br>Kokhajor-1 | E-17<br>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 sal Forest | Mainly hill sal | Hill Sal Forest and Pine Forest | Mixed hardwood forest and Pine forest | Mainly Hill sal 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 NOS 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 OF TREES IN THE RESERVOIR AREA | 38088 | 83776 | 36982 | 24580 | 485130 | 129360 | 77312 | 242720 | 202300 | 520608 |

| No.<br>Project Name | W-02<br>Chera-1 | W-05<br>Lower<br>Jhimruk | W-06<br>Madi | W-23<br>Nalsyau<br>Gad | W-25<br>Naumure<br>(W. Rapti) | C-02<br>Lower<br>Badigad | C-08<br>Andhi<br>Khola | E-01<br>Dudh Koshi | E-06<br>Kokhajor-1 | E-17<br>Sun Koshi<br>No. 3 |
|---|---|---|---|---|---|---|---|---|---|---|
| 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 |

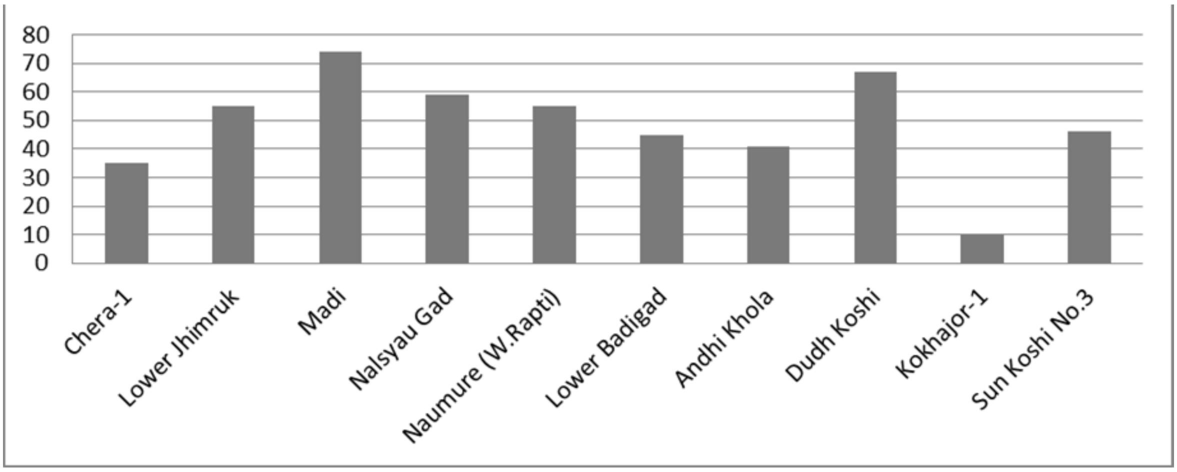



**Figure 8.3-4 Number of Plant Species Reported in the Reservoir Area**

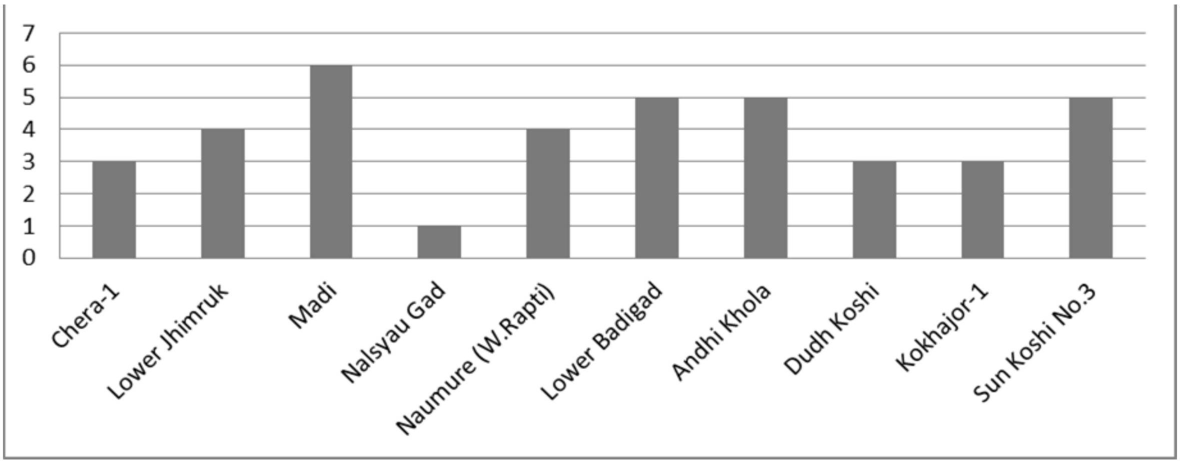



**Figure 8.3-5 Number of Plant Species of Conservation Significance in the Reservoir Area**

***c. Impact on Terrestrial Fauna***

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

## Table 8.3-28 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 encroachmen t | DEGRADE D AND FRAGMEN TED | high degree of human encroachmen t /degraded | Good habitat area for wildlife | Disturbed and fragmented due to human encroachmen t | Degraded and fragmented due to human encroachmen t | Disturbed by human interference | Fragmente d and degraded due to intervening of settlement fodder collection | Degraded and fragmented by human encroachmen t |
| **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 | 5 | 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** | 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** |
| **BIRD SPECIES REPORTED (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 |

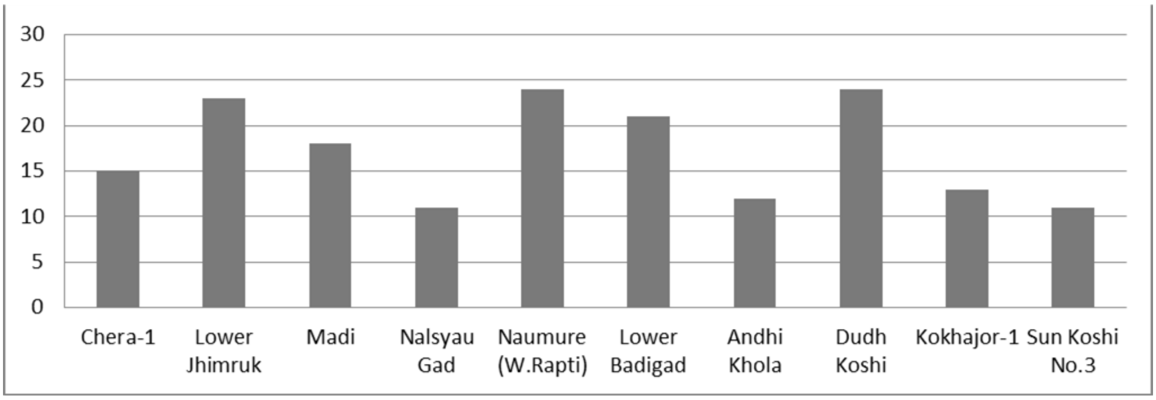



**Figure 8.3-6 Number of Mammal Species Reported in the Reservoir Area**

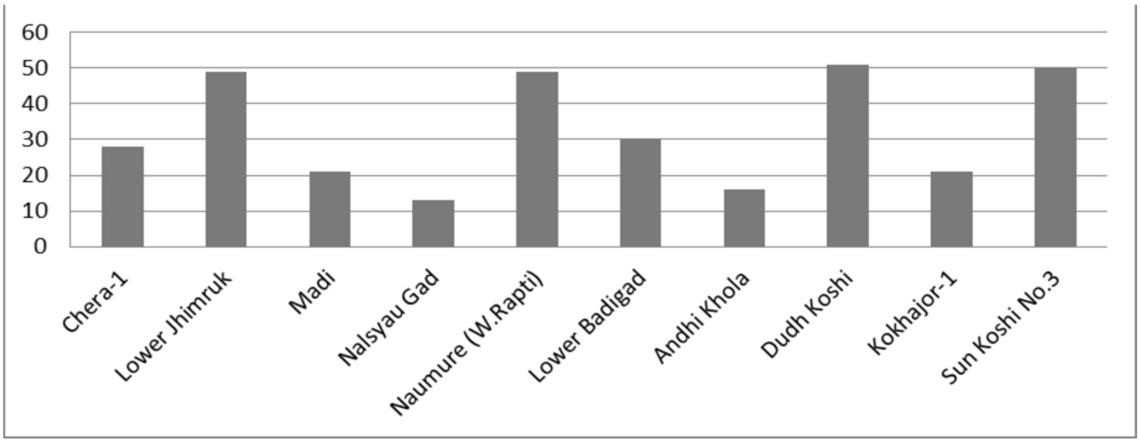



**Figure 8.3-7 Number of Bird Species Reported in the Reservoir Area**

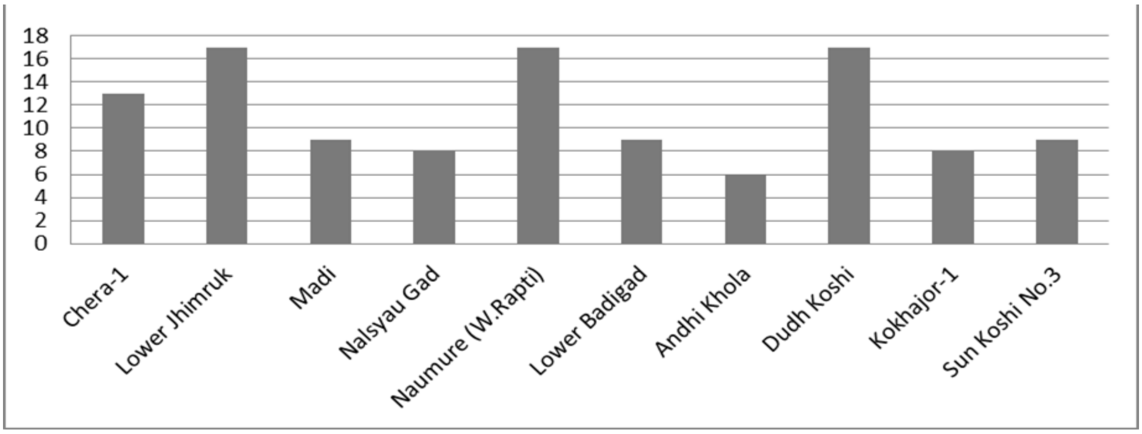



**Figure 8.3-8 Number of Herpetofauna Species Reported in the Reservoir Area**

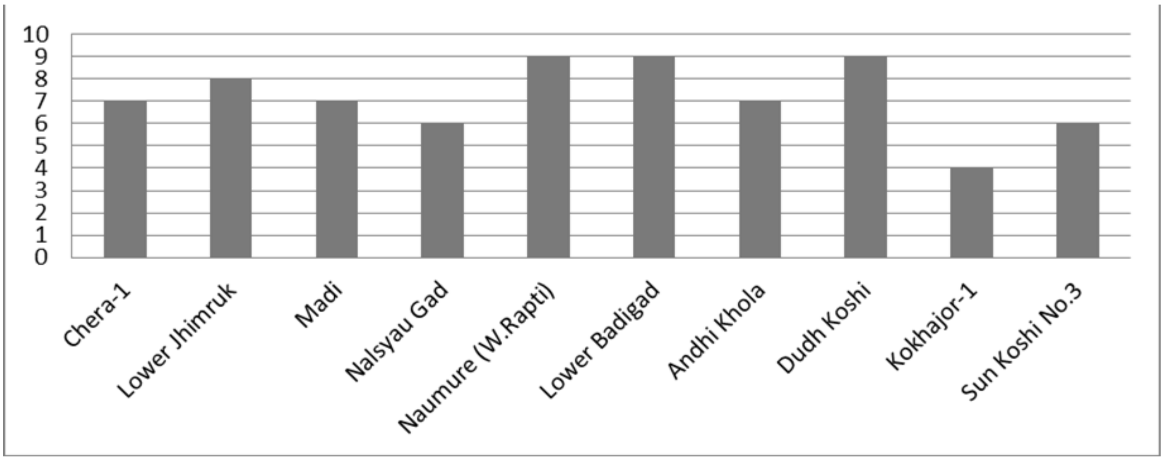



**Figure 8.3-9 Number of Conservation Mammalian Species Reported in the Reservoir Area**

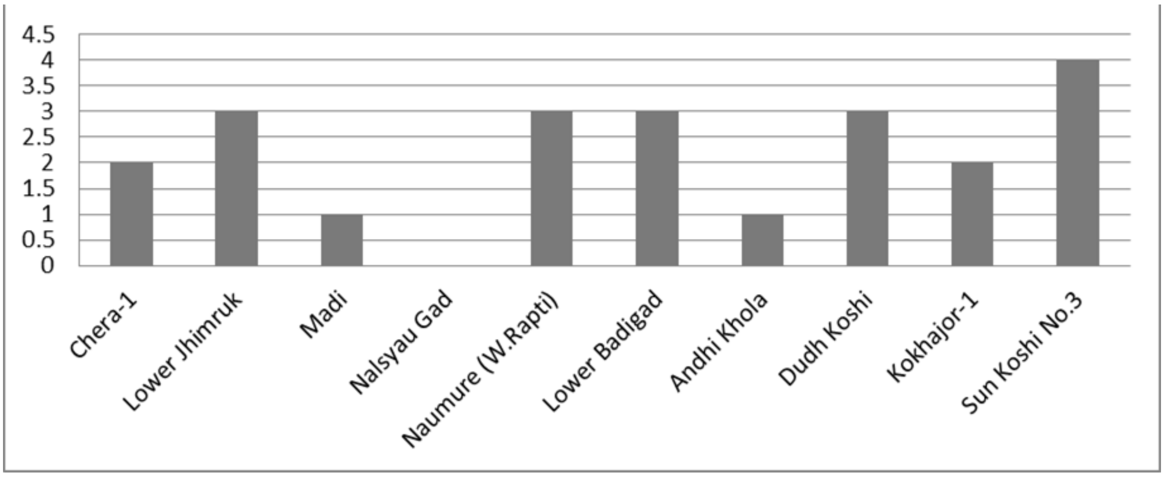



**Figure 8.3-10 Number of Conservation Bird Species Reported in the Reservoir Area**

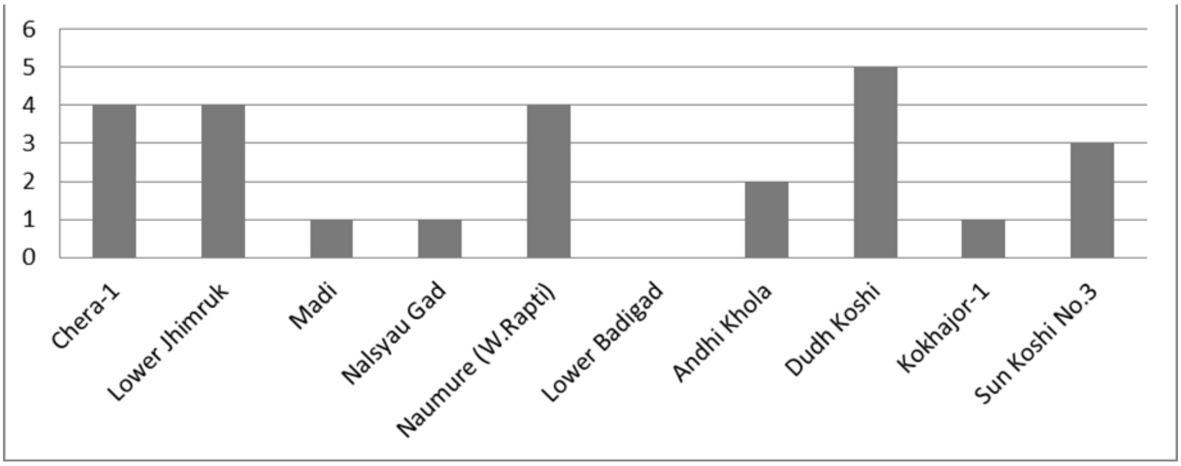



**Figure 8.3-11 Number of Conservation Herpetofauna Species Reported in the Reservoir Area**

### *d. Impact on Fish*

The impact on aquatic fauna has been evaluated taking into account fish species, number of fish species of conservation significance and the length or recession area. At the filed, interview with fisherman was conducted to collect the information and the length of recession area was measured on topographic maps. Regarding the number of fish species, the largest number of fish as 24 species was reported for the Dudh Koshi Project, relatively small number of fish species as 6 for the Andhi Khola Project and as 7 for the Kokhajor-1 Project were reported.

The Andhi Khola and the Dudh Koshi Projects have the longest recession area as 60 km. In contrast, the Sun Koshi No.3 and the Naumure (W. Rapti) Projects have the short recession are as less than 1 km. Table 8.3-29 show the results of Impact on aquatic fauna.

**Table 8.3-29 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 SPECIES 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 |

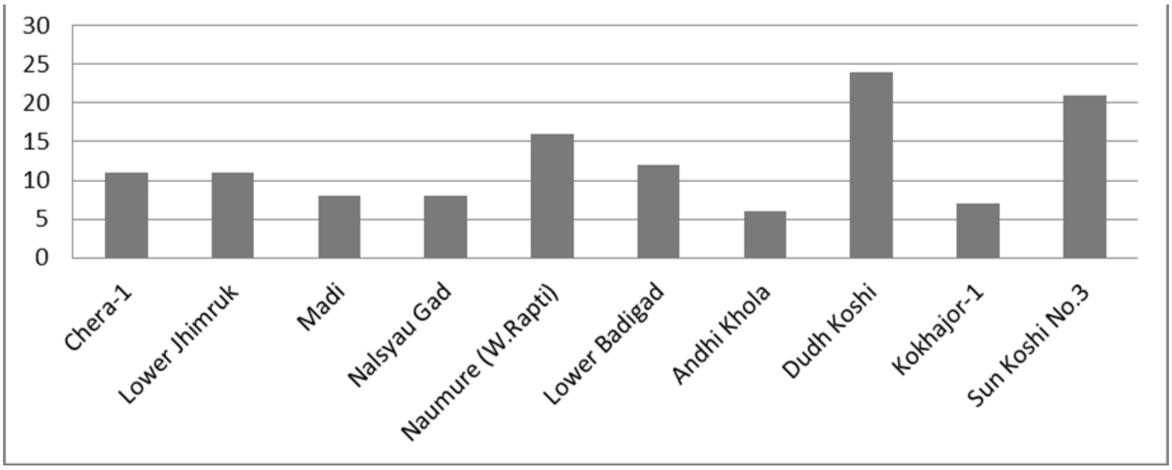



**Figure 8.3-12 Number of Fish Species Reported in the Reservoir Area**

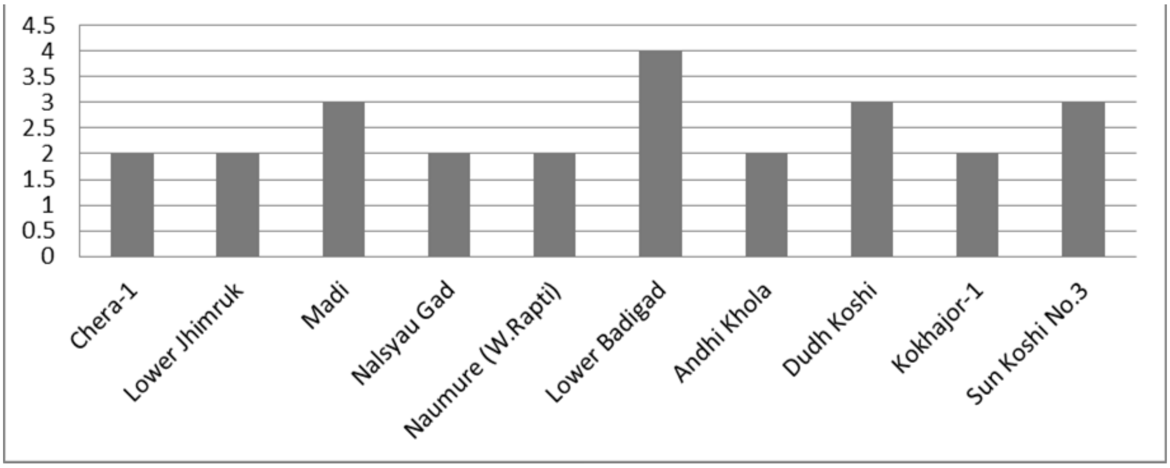



**Figure 8.3-13 Number of Fish Species of Conservation Significance in the Reservoir Area**

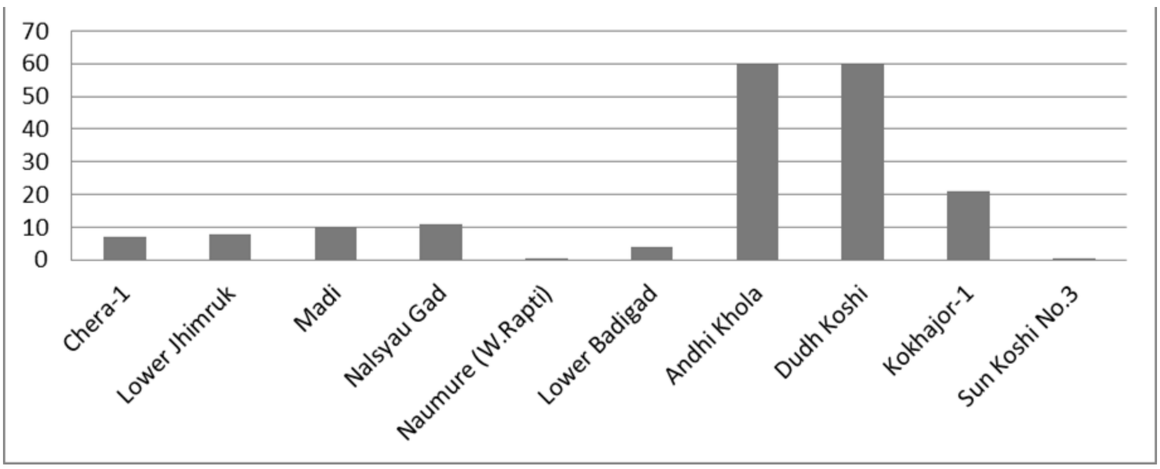



**Figure 8.3-14 Length of Recession Area (km)**

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

All the rivers on which the ten promising projects are located into India into India in their downstream, joint to 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. Also, studies were conducted on distribution of species listed in IUCN red list relatively clear of distribution in India. The largest number of protected areas is the 3 for the Chera-1 and the Nalsyau Gad Projects and the smallest is 1 for the Kokhajor-1 Project. The largest number of rare species is also reported for the Chera-1 and the Nalsyau Gad Projects as 6 species and the smallest is 3 for the Dudh Koshi, the Kokhajor-1 and the Sun Koshi No.3 Projects. Regarding Ganges River Dolphin, it is distributed to the downstream of all projects. Table 8.3-30 and Figure 8.3-15 show the results of the survey about the impact on rare species and protected area in the downstream.

**Table 8.3-30 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 | | | | | |

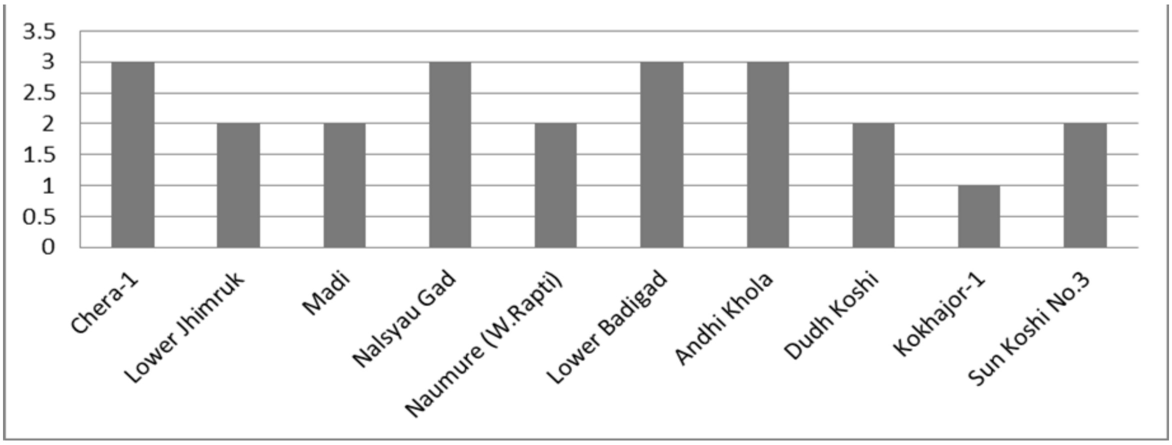



**Figure 8.3-15 Number of the Protected Area in the Downstream**

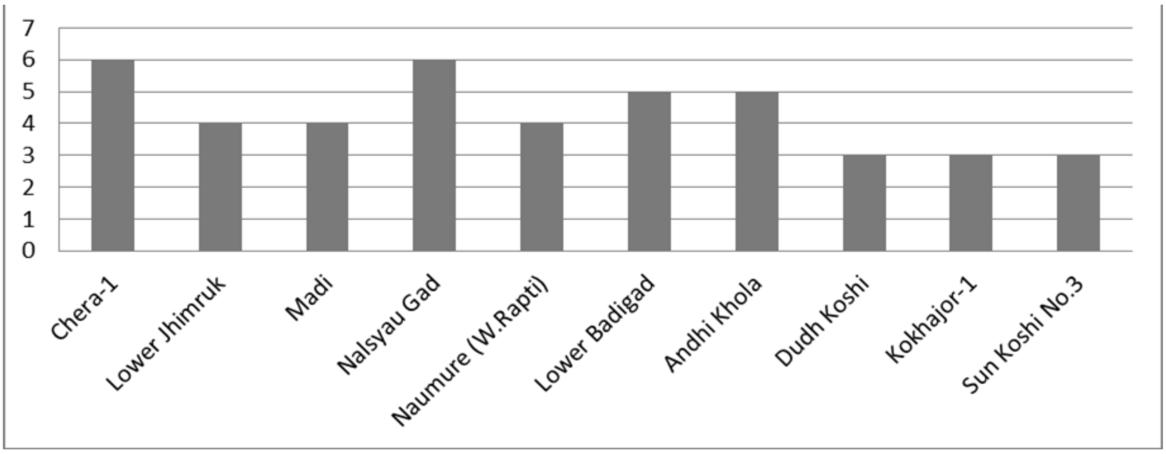



**Figure 8.3-16 Number of the Protected Species in the Downstream**

***f. Impact by Transmission Line***

Construction of new hydroelectric power station will be accompanied by not only an impact in the submerged area by reservoir area but also land acquisition and deforestation for the construction of transmission line. Construction of transmission line has also 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 route between planed substation and power stations were covered by forest land for almost all the promising projects. Therefore, the impact by transmission line was evaluated with its lengths which make an impact on forest land. The longest extension of transmission line was 112km for the Nalsyau Gad Project and the shortest was 35km for the Sun Koshi No.3 Project.

Table 8.3-31 and Figure 8.3-17 show the results of the impact by transmission line.

**Table 8.3-31 Length of Transmission Line**

| 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 |
| Length of Transmission Line (km) | 66 | 75 | 62 | 112 | 79 | 49 | 49 | 43 | 62 | 35 |

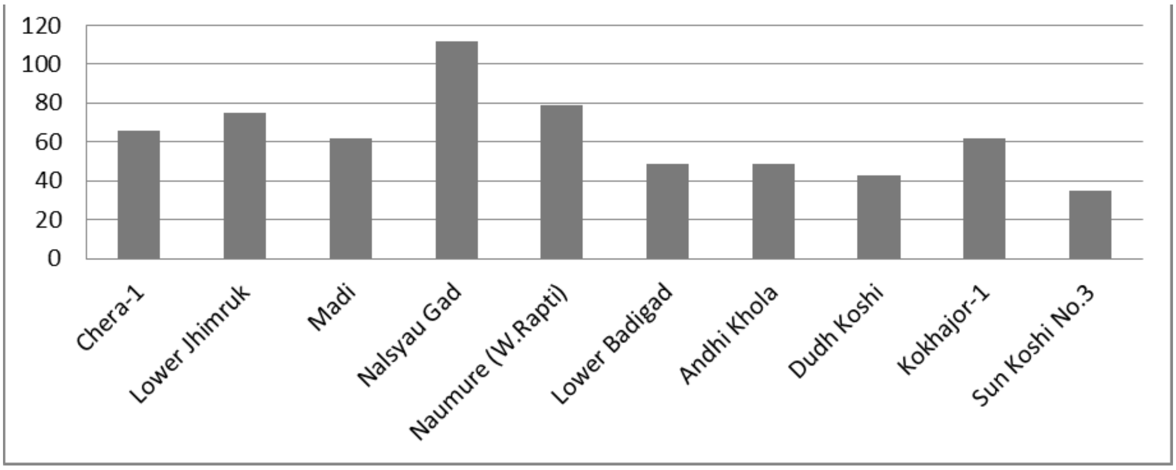



**Figure 8.3-17 Impact on Forest by Transmission Line**

9) Social Environment

The impact on social and environment was evaluated mainly by the impact on the buildings, ethnic minority groups, agriculture, fisheries, tourism and culture, existing infrastructure, and development plan for other sectors. The brief summary of each 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 structure that was counted from satellite image and placement and usage of households observed in the field. Regarding the number of schools and industries, these were studied by interview survey in the field. The estimated number of household is more than 1,500 in the place relatively close to the capital such as the Sun Koshi No.3 and the Lower Badigad Projects. On the other hand, only 63 household have reported for the Dudh Koshi Project. The number of schools and industries shows the similar trend.

Table 8.3-32, Figure 8.3-18, Figure 8.3-19 and Figure 8.3-20 shows the results of the impact on buildings.

**Table 8.3-32 Impact on Building**

| 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 HH reported in field Survey | 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) |

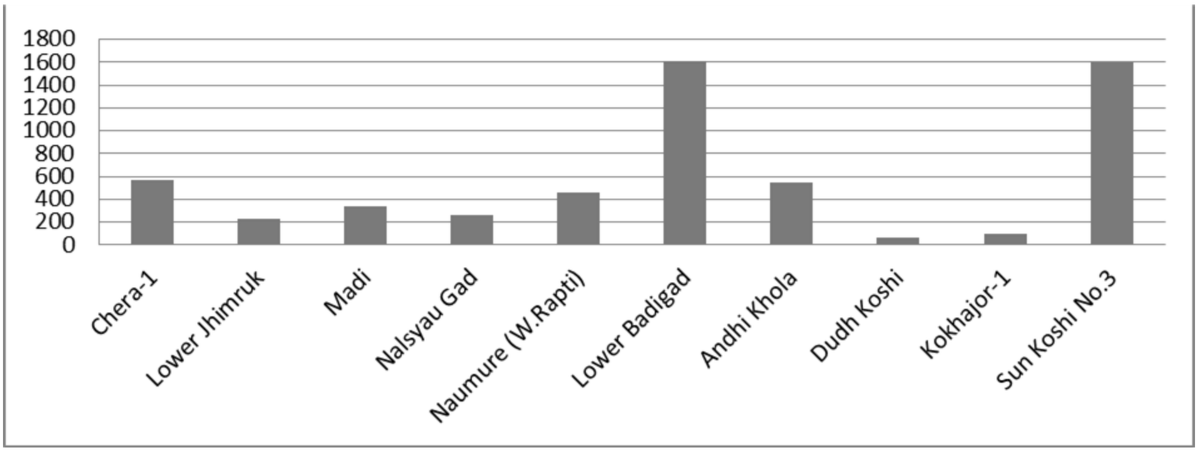



**Figure 8.3-18 Number of Household**

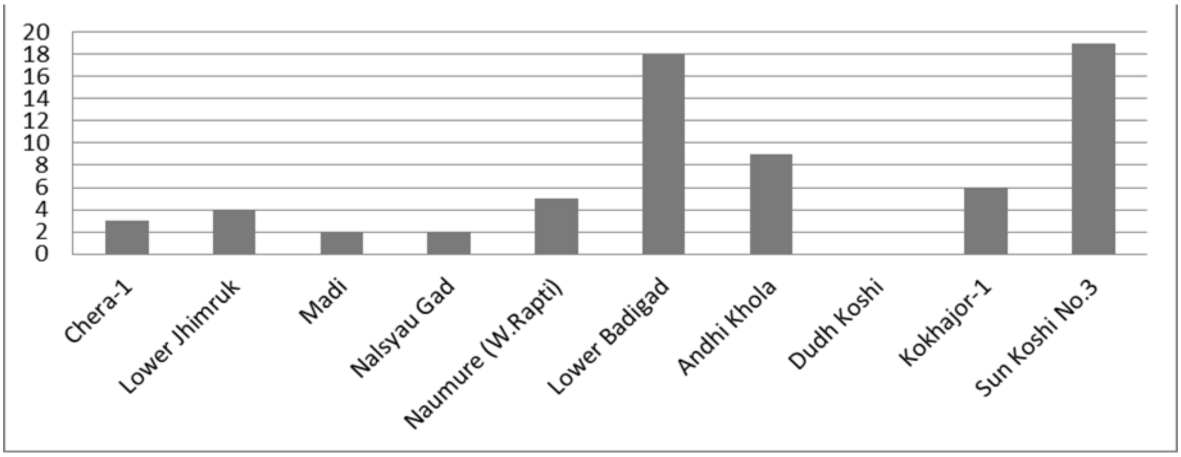



**Figure 8.3-19 Number of Schools**

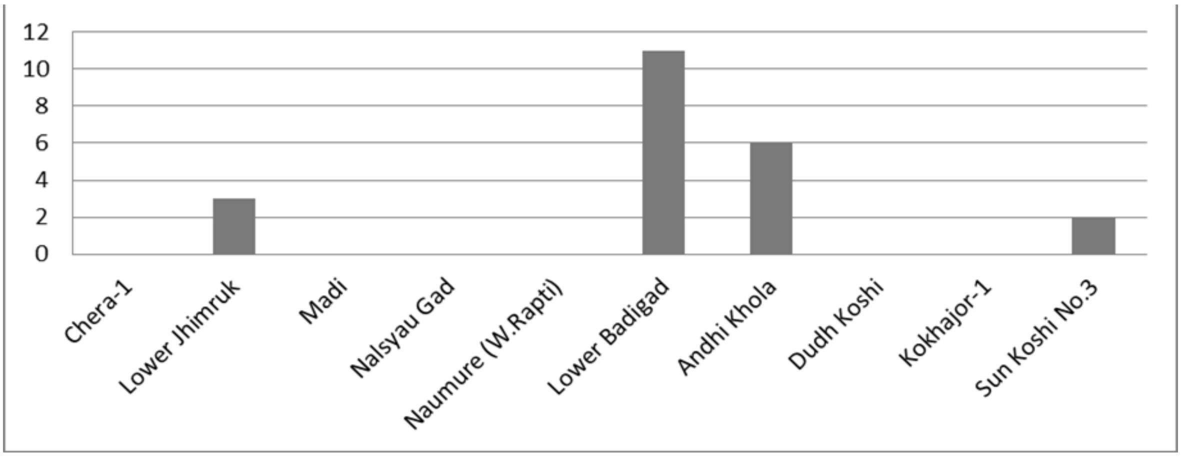



**Figure 8.3-20 Number of Industries**

### *b. Impact on Ethnic Minority Groups*

The impact on ethnic minority groups was evaluated with the number of minority groups from the ethnic groups observed with interview survey in the field. The largest number of minority groups observed in this survey was 5 groups for the Lower Badigad Project, the smallest number was 0 for the Nalsyau Gad Project. Table 8.3-33 and Figure 8.3-21 show the results of the impact on ethnic minority groups

| Table 8.3-33 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 |
| Brahmin | √ | √ | √ | √ | √ | √ | √ | × | × | √ |
| Thakuri/Chhetri | √ | √ | √ | √ | √ | √ | × | √ | × | √ |
| Dalit | √ | √ | √ | √ | √ | √ | √ | √ | × | √ |
| Newar ( Advanced) | × | √ | × | × | × | √ | √ | √ | × | √ |
| Thakali ( Advanced) | × | × | × | × | × | √ | × | × | × | × |
| Magar ( Disadvantaged) | √ | √ | √ | × | √ | √ | √ | √ | √ | √ |
| Gurung ( Disdavnataged) | × | √ | × | × | √ | √ | √ | × | × | × |
| Tamang ( Disadvantaged) | × | × | × | × | × | × | × | √ | √ | √ |
| Majhi ( Marginalised) | × | × | × | × | × | × | × | √ | × | √ |
| Kumal ( Marginalised) | × | √ | × | × | × | × | × | × | × | × |
| Tharu ( Marginalised) | × | × | × | × | × | √ | × | × | × | √ |
| Bote ( Highly Marginalised) | × | × | × | × | × | √ | × | × | × | × |
| Majhi( High Marginalised) | × | × | × | × | × | √ | × | × | × | × |

**NOTE: √ = Presence × = Absence**

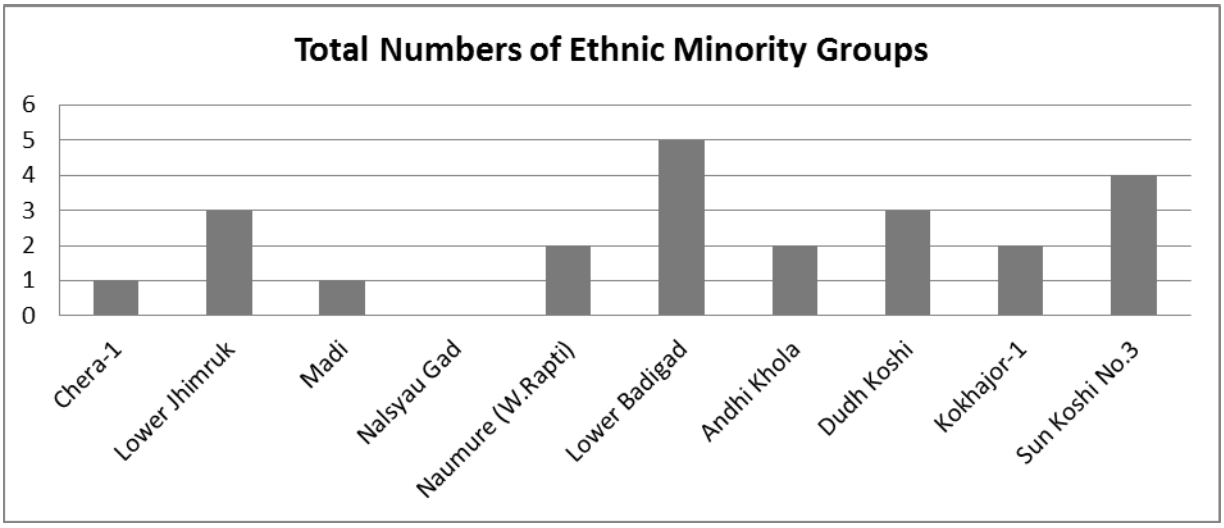



**Figure 8.3-21 Total Numbers of Ethnic Minority Groups**

### 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 the Sun Koshi No. 3 Project was the biggest as 9.4 km$^2$, the smallest was 1.1 km$^2$ for the Chera-1 Project. About the number of irrigation systems, relatively large number of irrigation systems were observed for the projects in a narrow valley such as the Lower Badigad, the Naumure (W. Rapti) and the Andhi Khola Projects. Relatively small for the Nalsyau Gad, the Dudh Koshi and the Kokhajor-1 Projects. Table 8.3-34, Figure 8.3-22 and show the results of the impact on agriculture.

**Table 8.3-34 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 (W. Rapti) | Lower Badigad | Andhi Khola | Dudh Koshi | Kokhajor-1 | Sun Koshi No.3 |
| Cultivated land (km2) | 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 (km2) | 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 |

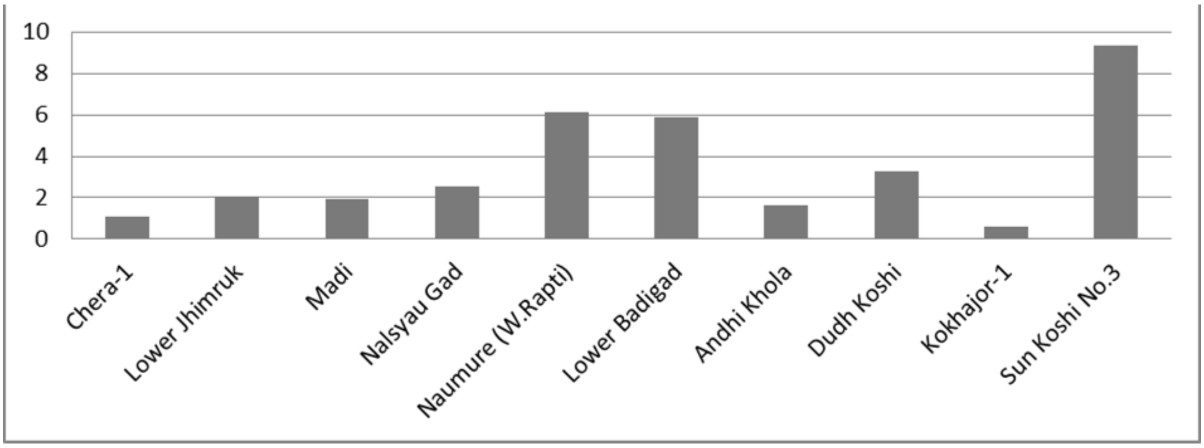



**Figure 8.3-22 Impact on Cultivated Land (km$^2$)**

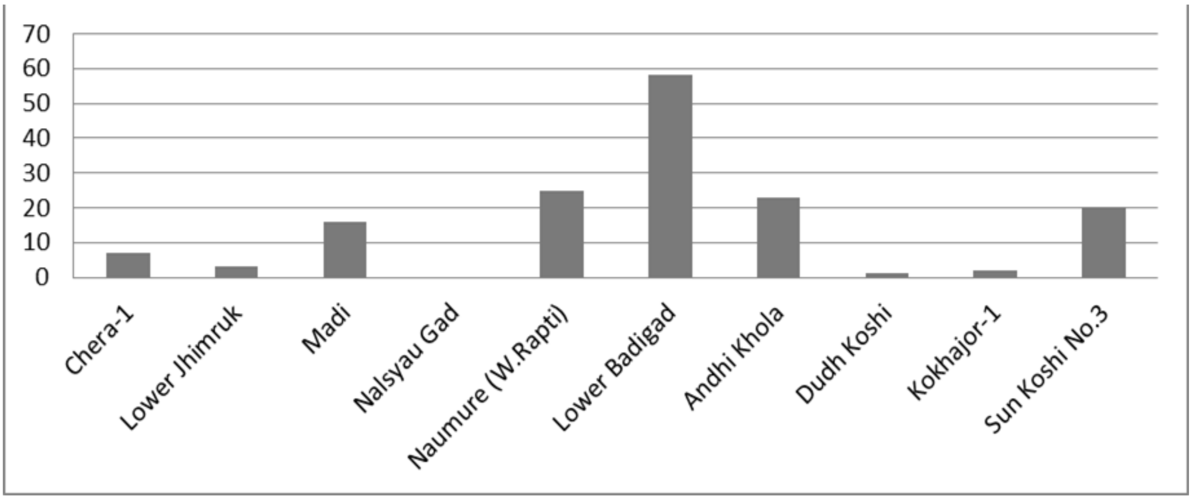



**Figure 8.3-23 Impact on the Number of Irrigation Systems**

### *d. Impact on Fisheries*

Interview survey with fisherman in the field was conducted for the survey about the impact on fisheries, and the 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 market, the average of total sales of fish market (Rs/day), the average cost of fish (Rs/kg), the average of 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 fisherman were calculated to compare the results between the projects. Regarding the number of fishermen, the largest number was more than 700 for the Sun Koshi No. 3 Project, any fisherman could not be observed for the Kokhajor-1 Project. About the number of fish markets, the relatively large number of 7 was observed for the Sun Koshi No.3, the Lower Badigad and the Dudh Koshi Projects. 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 large. Regarding the length of recession area, the Project and the Naumure Project are as short as 0.5 km, meanwhile the Dudu Project and the Project are as long as 60 km. Table 8.3-35, Figure 8.3-24, Figure 8.3-25, Figure 8.3-26, Figure 8.3-27 and Figure 8.3-28 show the above mentioned results. The amount of fish in recent years have shown basically decline by an increase in fishing pressure with the exception of the Lower Badigad Project which had shown the tendency of increase. Regarding the situation of the Lower Badigad Project, there are two reasons assumed: 1) the fishery regulation was enhanced about the fishing with dynamite and poison, 2) fish were run-up bypassing the block of run-up by Karigandaki A hydroelectric power plant.

## Table 8.3-35 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 (W. Rapti)** | **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/Man | 1.5 | 0 | 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 |

| 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** |
| 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 |

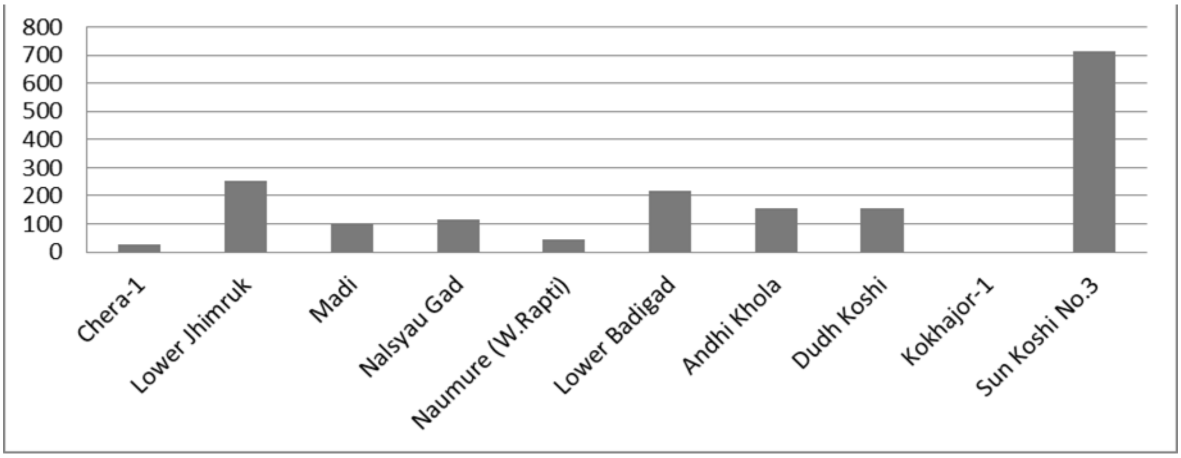



**Figure 8.3-24    Impact on Number of Fishermen**

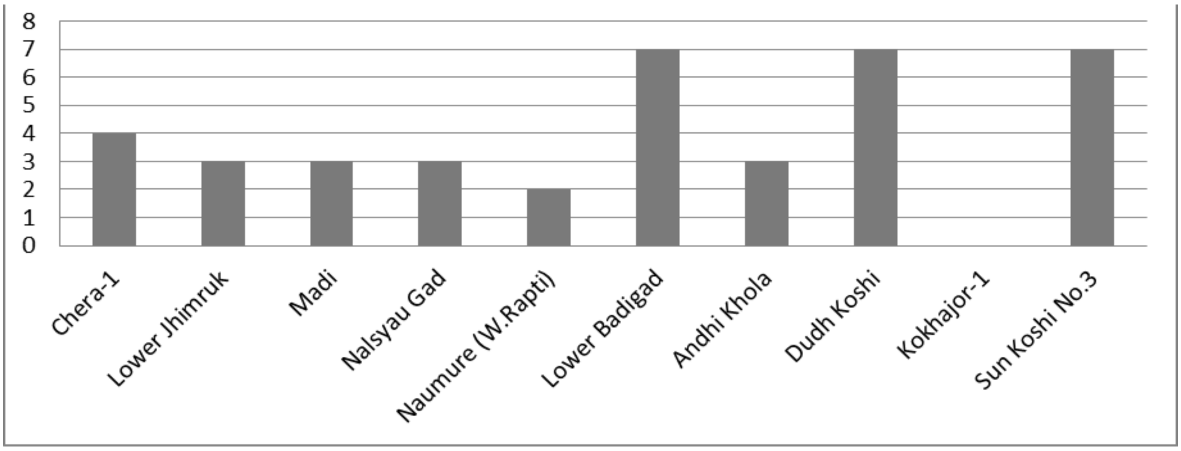



**Figure 8.3-25    Number of the Nearest Fish Markets**

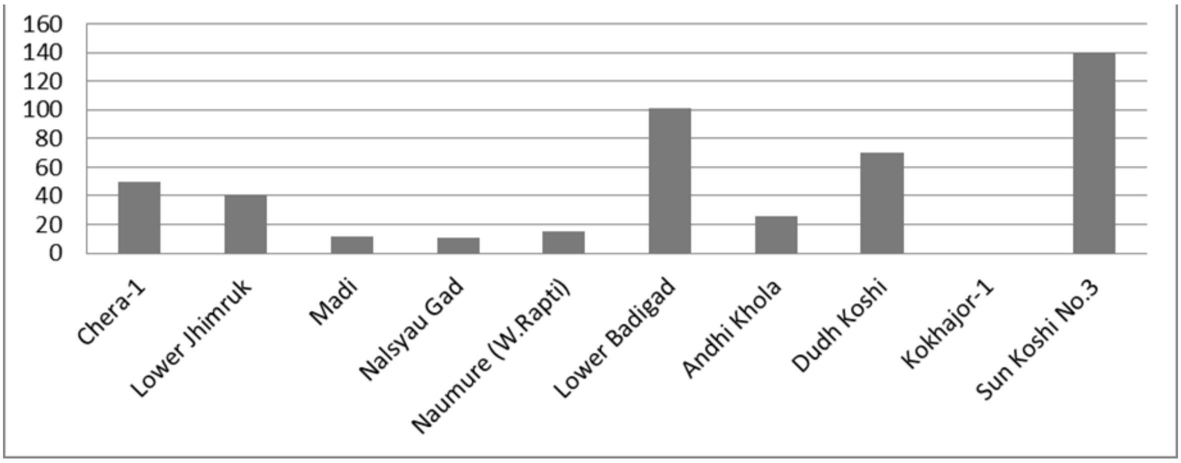



**Figure 8.3-26    Availability of Fish in the Market (kg/day)**

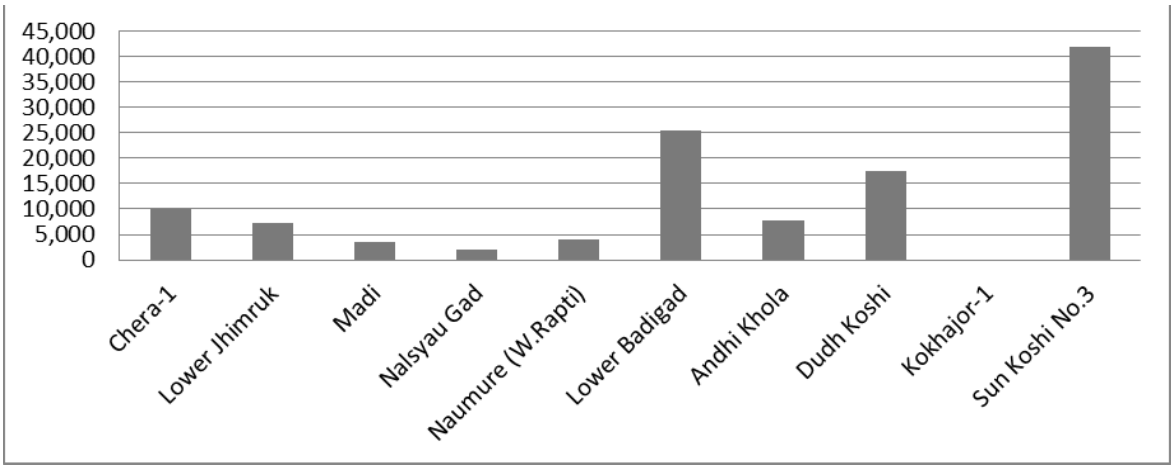



**Figure 8.3-27 Total Sales of Fish Market (Rs./day)**

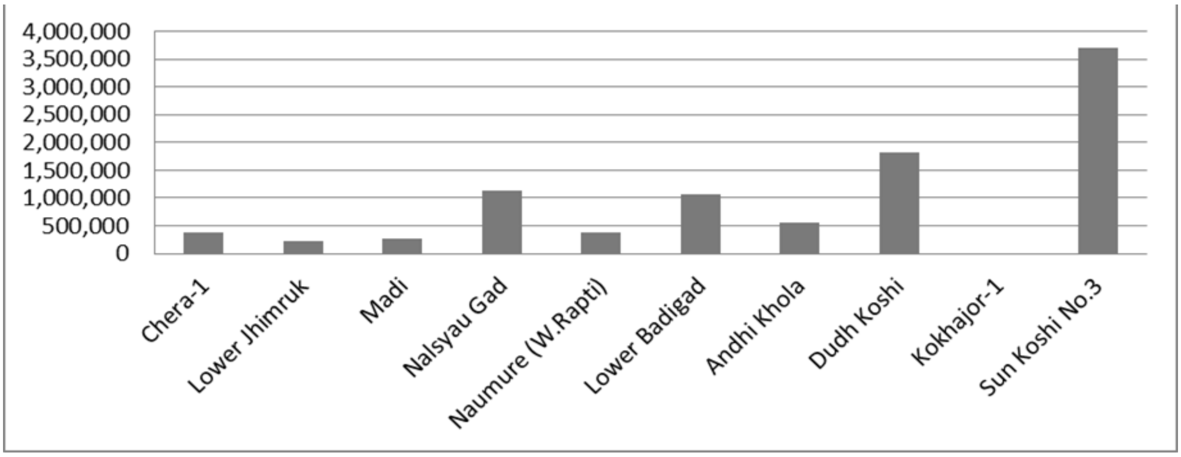



**Figure 8.3-28 Total Income of Fisherman (Rs./Year)**

***e. Impact on Tourism and Culture***

The information on the number of cultural structures (temples), unique handicraft, tourist facilities, tourists (pers./Ys), 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 festival and the pilgrimage. About the number of Temples, the largest number was 10 for the Sun Koshi No.3 Project, there was no reported temples for the Kokhajor-1 and the Nalsyau Gad Projects. Regarding handicraft, livingware such as straw matting (Gundri), bamboo basket (Doko) have been fabricating in the Lower Jhimruk Project. Products with goat hair in the Nalsyau Gad Project and bags in the Andhi Khola Project have been also fabricating. In the reservoir area of the Sun Koshi No.3 Project, there are a number of hotels which collect about 20,000 tourists in total by year. In the Dudh Koshi Project, rafting tourism has been carrying in two places. Table 8.3-36, Figure 8.3-29, Figure 8.3-30 and Figure 8.3-31 show the above mentioned results.

**Table 8.3-36 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 Handicraft | - | Gundri/Doko/ Mandro for self-use | - | Bakral from Goat wool | Mandal as per need | - | Nepali Bag and Woollen Products | - | - | - |
| **Tourism** | | | | | | | | | | |
| Number of Tourist Facilities | None | - | - | - | - | - | None | 2 (Rafting) | - | 10 |
| Number of Tourists/Yr | none | - | - | - | - | - | None | 10 | - | 20,000 |

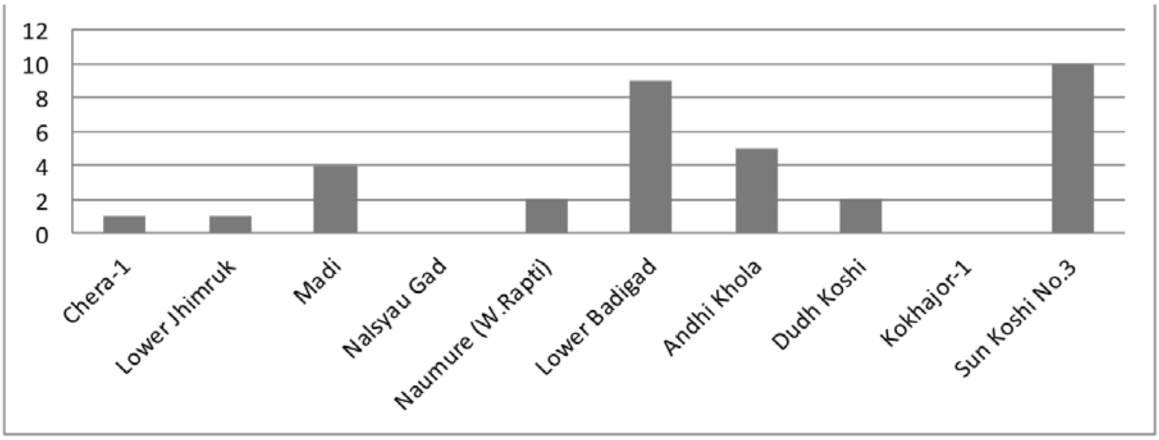



**Figure 8.3-29** Number of Cultural Structures (Temples)

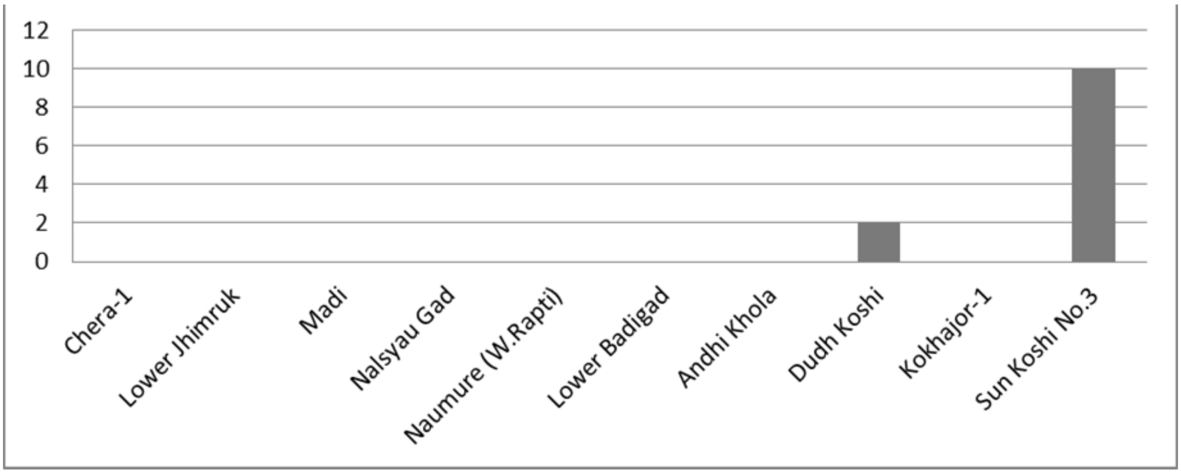



**Figure 8.3-30 Number of Tourist Facilities**

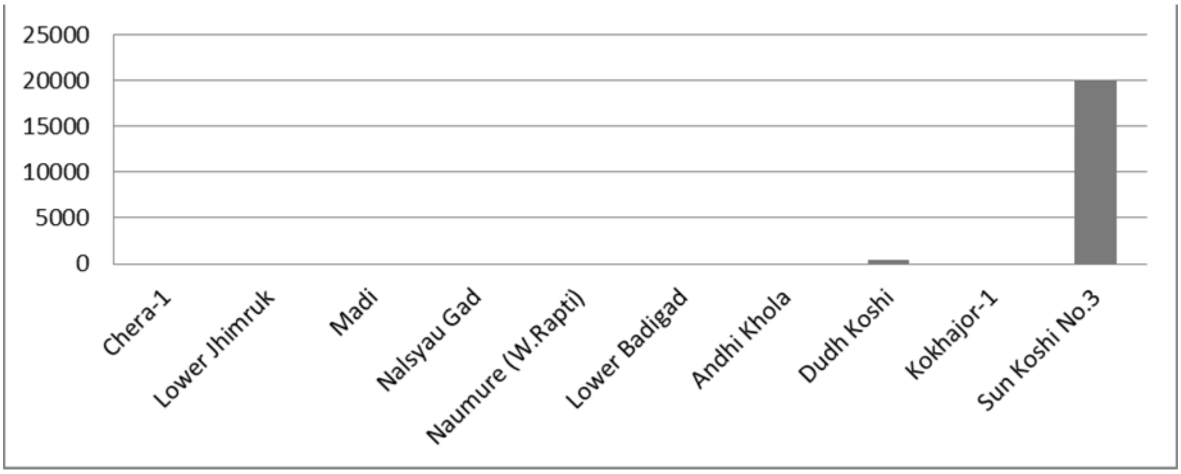



**Figure 8.3-31 Number of Tourist/Year**

### *f. Impact on Infrastructures*

Regarding the survey about the impact on infrastructures, it was conducted mainly about the length and type of road (paving road, gravel road), the number of bridges (suspension bridges, motorable bridges), existing water mill/turbine 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 hearing survey in the field. Regarding the impact on roads, the Sun Koshi No.3 Project where the national road leading to China will be submerged shows the impact relatively significant. Also the impact on the Lower Badigad Project will be significant because 20km of motorable road will be affected. On the other hand, the Nalsyau Gad and the Kokhajor-1 Projects will be almost unaffected. The Sun Koshi No.3 and the Lower Badigad Projects have more than 10 bridges which will be also affected. In the Lower Badigad and the Nalsyau Gad Projects, there are more than 20 micro hydro and small water turbine for agriculture will be affected. About the Andhi Khola Project, hydroelectric power plant with 5 MW exists in the reservoir area. The number of drinking water schemes were relatively large for the Lower Badigad, the Madi and the Sun Koshi No.3 Projects. Table 8.3-37, Figure 8.3-32, Figure 8.3-33, Figure 8.3-34 and Figure 8.3-35¥ show the above mentioned results.

**Table 8.3-37 Impact on Infrastructures**

| 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 Motorable Road (km) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 15.0 |
| Gravel motorable road (km) | 3.8 | 3.3 | 11.2 | 0.0 | 1.8 | 26.1 | 3.4 | 5.0 | 0.0 | 24.4 |
| Main Foot Trail (km) | 0.3 | 0.0 | 13.6 | 2.0 | 9.8 | 2.5 | 0.0 | 3.2 | 0.0 | 2.5 |
| Local Foot trail (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 |
| Motorable Bridges | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 1 |
| Fords | 2 | 0 | 2 |  | 5 | 3 | 0 | 2 | 1 | 32 |
| Water Mill/Turbine | 9 | - | 2 | 20 | - | 24 | - | -- | 10 | 15 |
| Hydroelectric power |  | - | 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 |

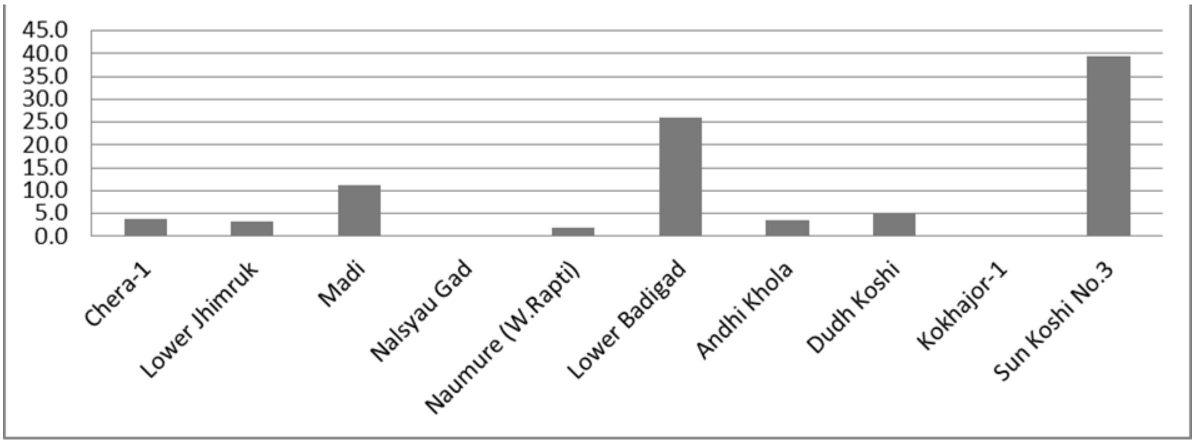



**Figure 8.3-32 Impact on Roads**

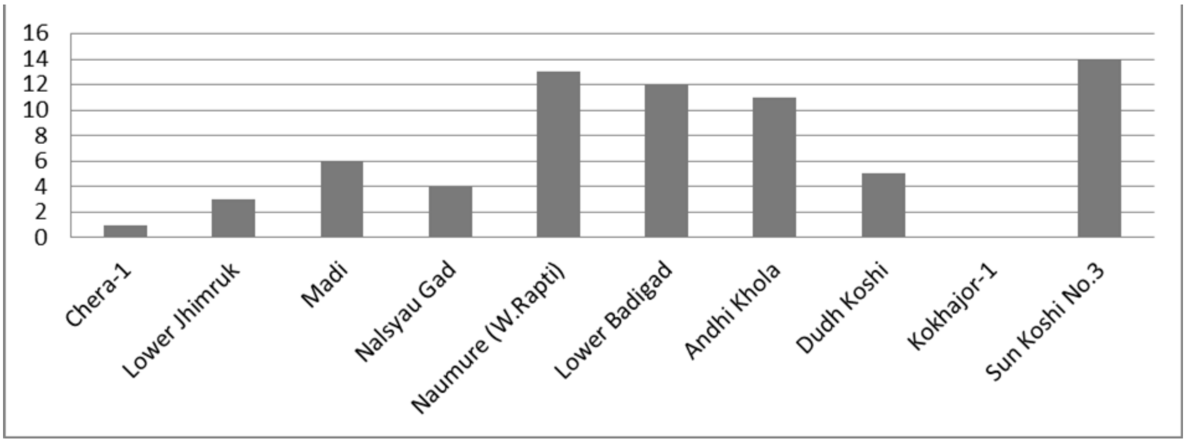



**Figure 8.3-33 Impact on Bridges**

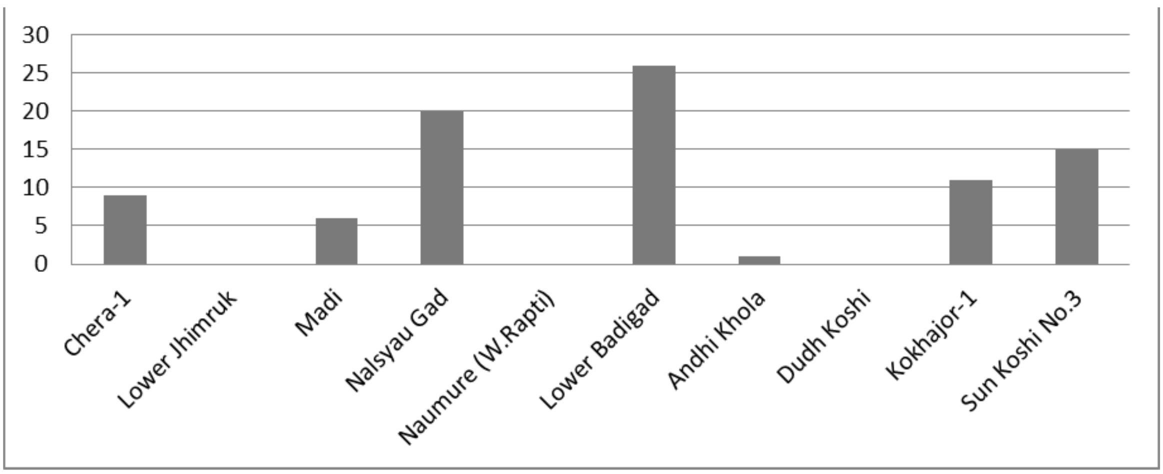



**Figure 8.3-34 Impact on Water Mill / Hydroelectric power**

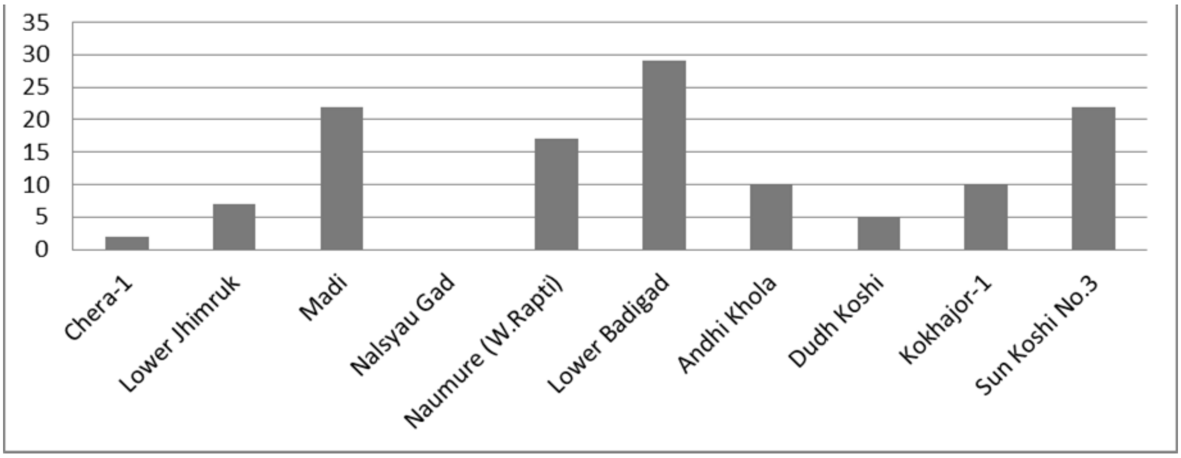



**Figure 8.3-35 Impact on Drinking Water Schemes**

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

Regarding the impact on the local economy and the existing development plans, the interview survey was conducted mainly about the number of markets, the ongoing and proposed development plans and the previous experience/issues. Relatively large number of markets was reported in the thickly populated place such as the Sun Koshi No.3, and the Lower Badigad Projects and the small numbers were reported in the thinly populated place such as the Kokhajor-1 and the Lower Jhimruk Projects. The largest number of existing development plans as 10 was reported for the Sun Koshi No. 3 Project and there were no observed development plan for the Dudh Koshi and the Chera-1 Projects. Regarding the previous experience/issues, some conflicts were reported: 1) small dispute with the extension of road for the Sun Koshi No. 3 Project, 2) dispute with the construction of a cement plant for the Kokhajor-1 Project. However, there was no reported conflict due to hydroelectric power development in the past. Table 8.3-38, Figure 8.3-36, Figure 8.3-37, and Figure 8.3-38 show the above mentioned results.

.

**Table 8.3-38 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 Andhi Khola Developmen t 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 |

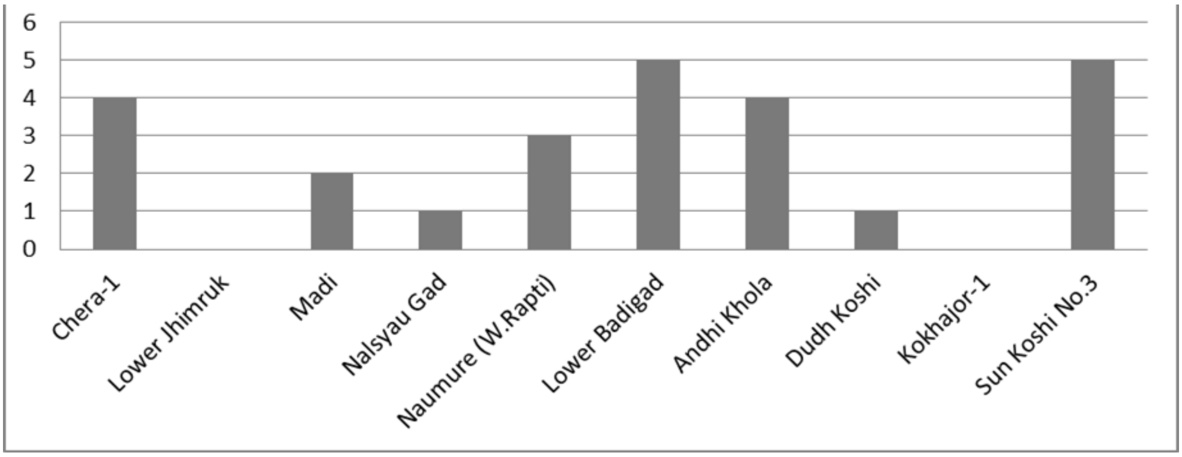



**Figure 8.3-36 Number of Markets**

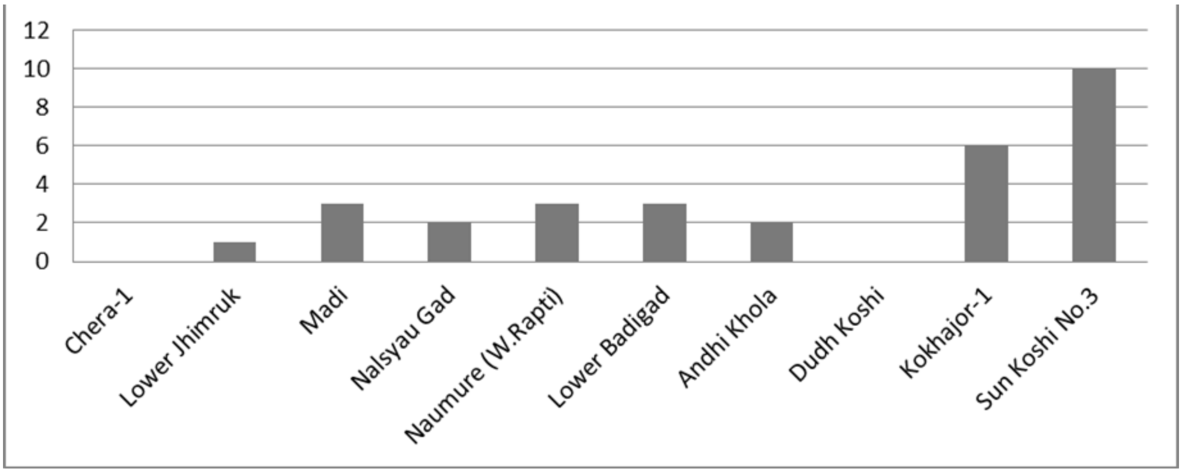



**Figure 8.3-37 Number of Existing Plans**

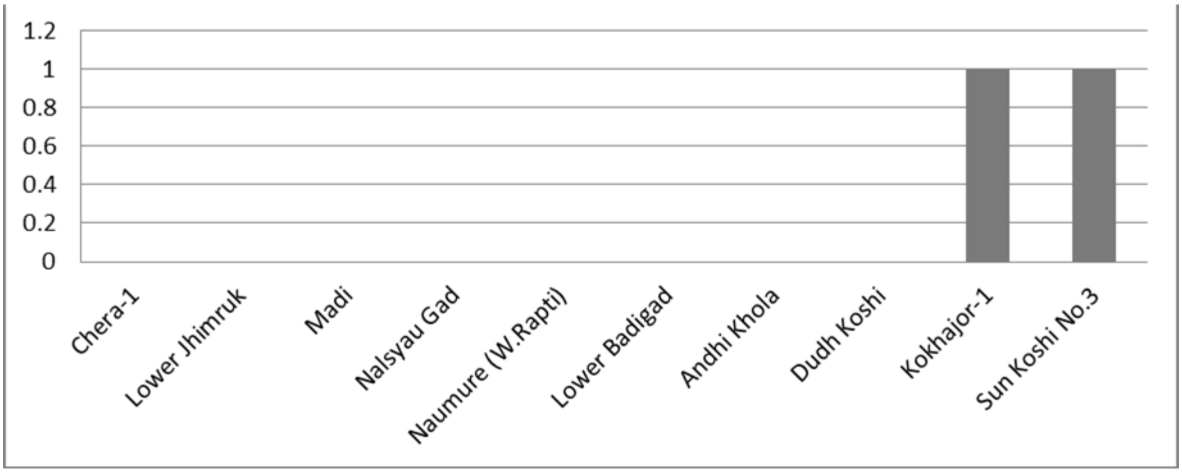



**Figure 8.3-38 Number of Previous Experience / Issues**

(2) Sensitivity Analysis

Ten promising projects selected in “7.4 Selection of Promising Projects” were evaluated by the evaluation method described in “8.2 (1) Evaluation Items and Methods”, and each evaluation point was weighted by the weight described in “8.2 (2) Weighting of the Third Step”, then evaluation score of each project was obtained by summing up all 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 result of evaluation, though the evaluation score is different case by case, the Nalsyau Gad Project obtained the highest score in the all cases. The Dudu , the Andhi Khola, the Chera-1, the Lower Jhimruk, and the Madi Projects obtained the second to the sixth scores. The Kokhajor-1, the Naumure (W. Rapti), the Sun Koshi No.3, and the Lower Badigad Projects were the seventh to the tenth places.

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

Table 8.3-39 shows the evaluation score and ranking of each project, their details are shown in Table 8.3-40. The characteristics of each subcategory of each project are shown in Figure 8.3-39 by setting the full score of each subcategory at 100 points.

**Table 8.3-39 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 | 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 Economic Conditions = 50%, Impact on Environment = 50%
Case 2: Technical and Economic Conditions = 60%, Impact on Environment = 40%
Case 3: Technical and Economic Conditions = 40%, Impact on Environment = 60%
Case 4: Technical and Economic Conditions = 75%, Impact on Environment = 25%

## Table 8.3-40 (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 8.3-40 (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 8.3-40 (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 8.3-40 (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 8.3-40 (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 | 2 | 60.0 | 1.44 | 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 8.3-40 (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 8.3-40 (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 8.3-40 (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 | 59.72 | 60 | 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 8.3-41 (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 8.3-41 (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 8.3-41 (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 8.3-41 (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 8.3-41 (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 | 2 | 60.0 | 1.15 | 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 8.3-41 (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 8.3-41 (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 8.3-41 (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 | 56.69 | 57 | 7 |
| 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 | 8 |

## Table 8.3-42 (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 8.3-42 (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 8.3-42 (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 8.3-42 (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 8.3-42 (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 | 2 | 60.0 | 1.73 | 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 8.3-42 (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 8.3-42 (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 8.3-42 (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 | 62.75 | 63 | 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 8.3-43 (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 8.3-43 (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 8.3-43 (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 8.3-43 (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 8.3-43 (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 | 2 | 60.0 | 0.72 | 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 8.3-43 (6) Evaluation Score and Ranking of Case 4 (6/8)

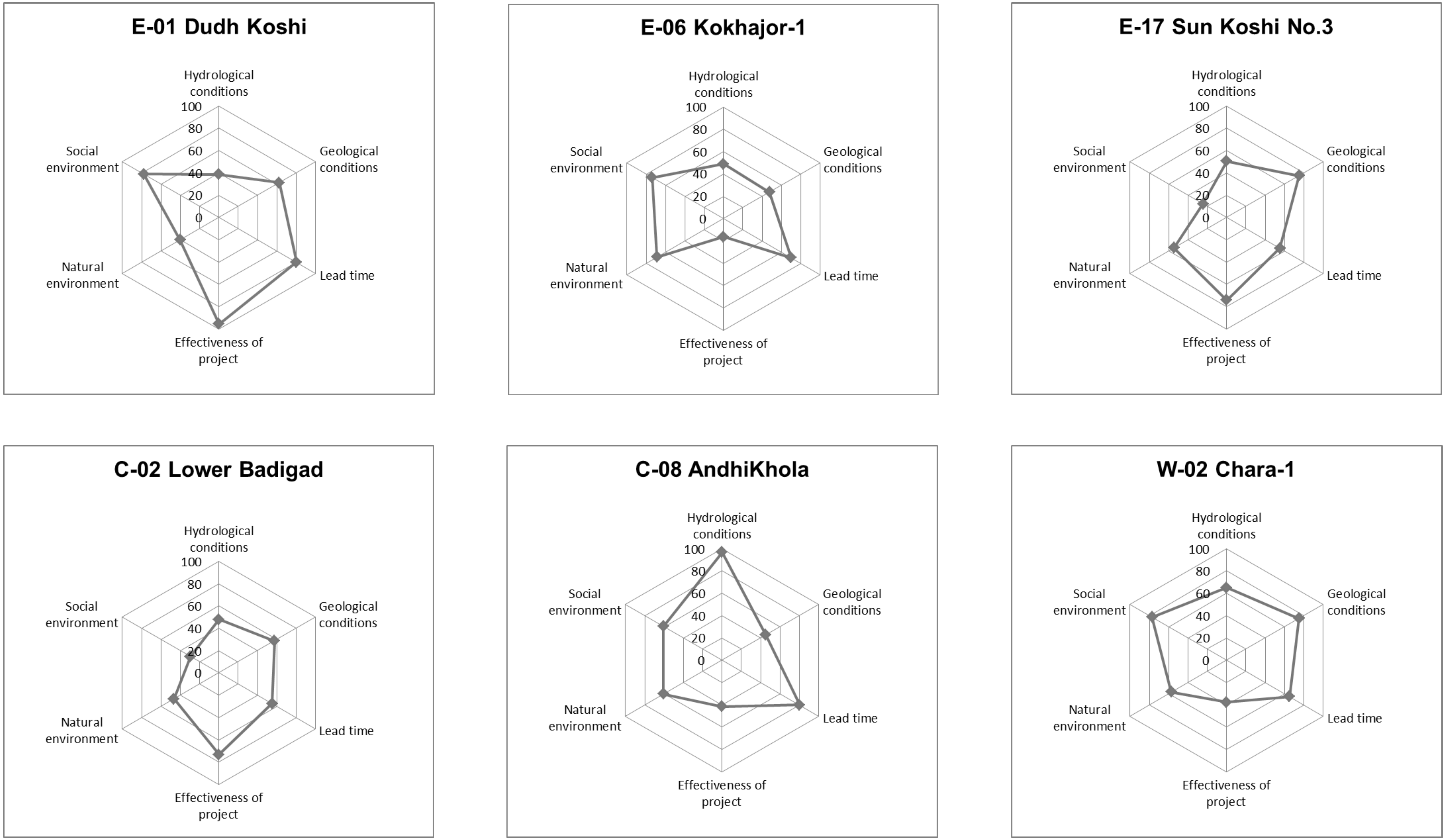
| Category | | Impact on Environment (cont.) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subcategory | | Impact on social environment (cont.) | | | | | | | | | | | | | | | | | |
| | | Impact on fishery | | | | | | | | | | | | | | | | | |
| 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 8.3-43 (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 |

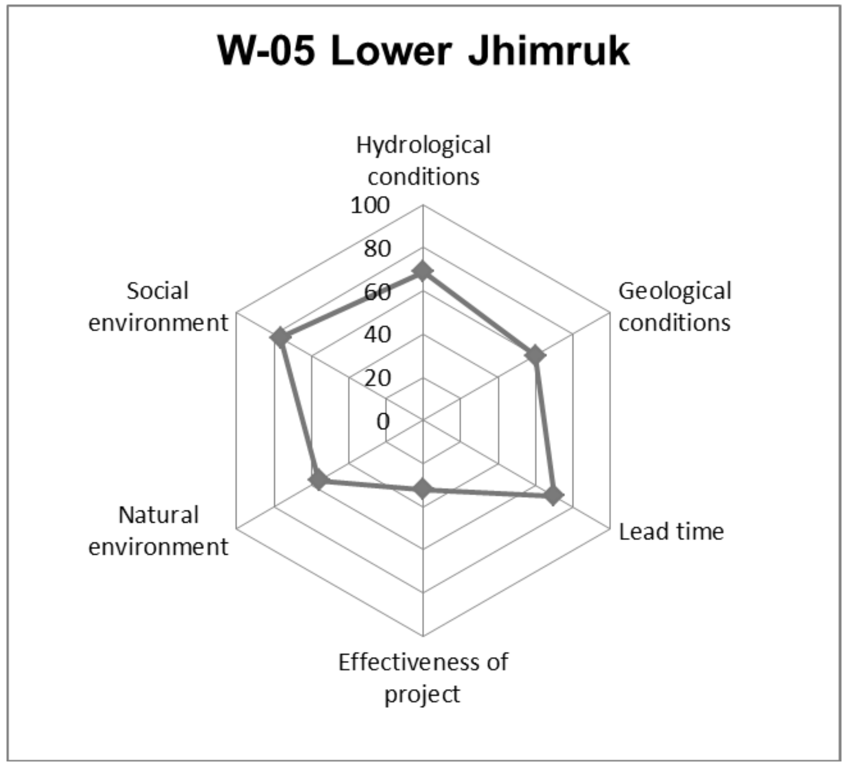
### Table 8.3-43 (8) Evaluation Score and Ranking of Case 4 (8/8)

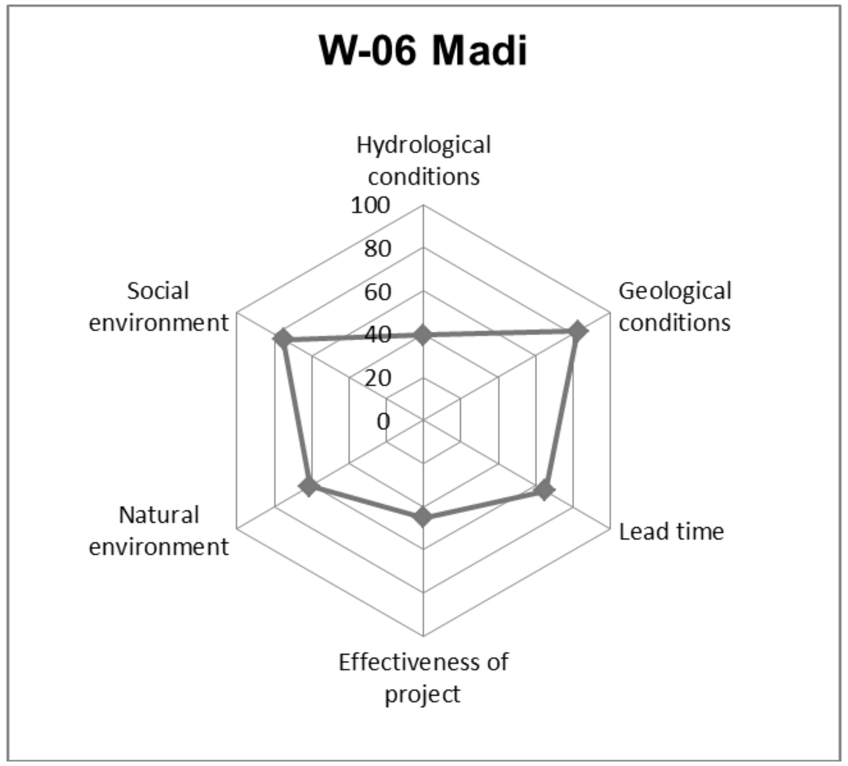
| Category | | Impact on Environment (cont.) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subcategory | | Impact on social environment (cont.) | | | | | | | | | | | |
| | | Impact on other sector's development | | | | | | | | | | | |
| Evaluation Item | | Impact 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 | 52.18 | 52 | 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 |

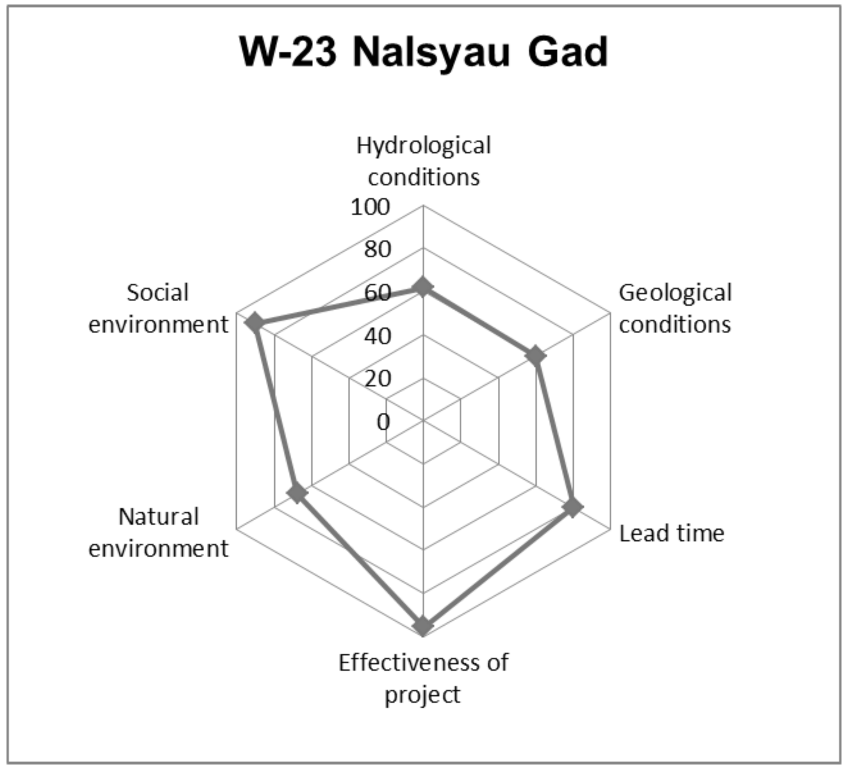


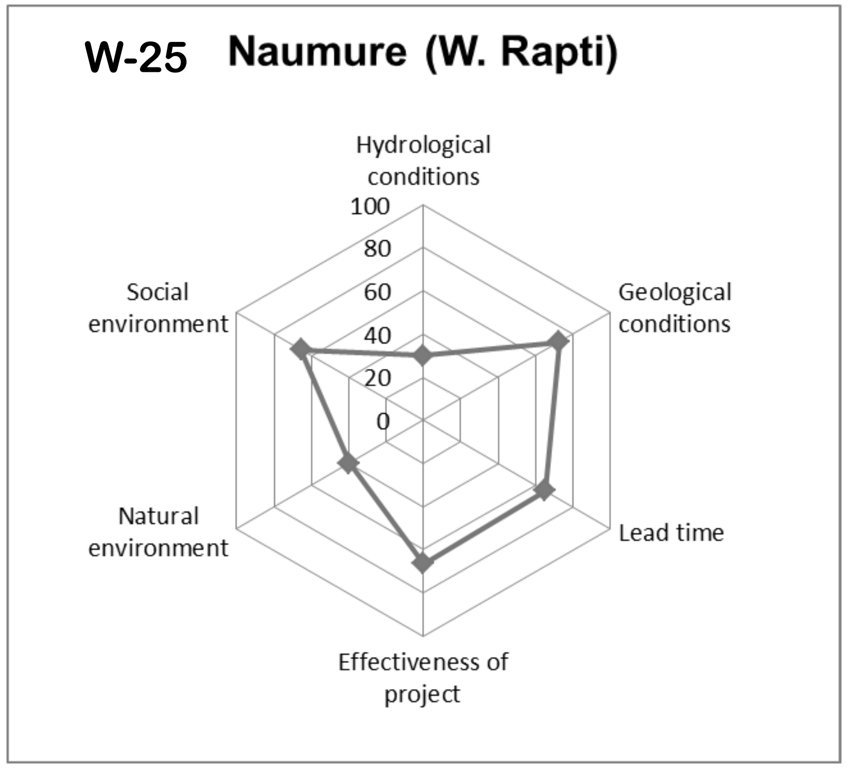

Note: The evaluation result of Case 1.

**Figure 8.3-39 (1) Characteristics of Promising Projects (1)**




Note: The evaluation result of Case 1.

**Figure 8.3-39 (2) Characteristics of Promising Projects (2)**

# Chapter 9 Cumulative Impact

## 9.1 Project Description

The information of the existing and planned Hydroelectric power plant, Irrigation, and Roads are collected to see the cumulative impact. In order to see the impact on downstream, the information in India are collected too.

(1) Existing Projects

1) Existing Hydroelectric Power stations and Irrigation Barrages

There are around 30 middle and large size hydroelectric power plants in Nepal. Five of them are under construction. Two of them are storage-type. 18 projects are in the Gandak river system, 7 projects are in Koshi river system, and 1 is in the Bagmati river system. Two of them are operating at the Irrigation barrages. The list is shown in Table 9.1-1 and the location is shown in Figure 9.1-1.

**Table 9.1-1 Operating and Constructing Major Hydro Power plants in Nepal**

| No. | Name | River | River System | Owner | Type | Capacity (KW) | Condition |
|---|---|---|---|---|---|---|---|
| 1 | Chamelia | Chamaliya Nadi | Chamaliya | NEA | ROR | 30,000 | Construction |
| 2 | Tinau (Butwal) | Tinau River | Danau | NEA | ROR | 1,024 | Operating |
| 3 | Jhimruk Khola | Jhimruk Khola | Rapti | Private | ROR | 12,000 | Operating |
| 4 | Andhikhola | Kali Gandaki Nadi | Gandaki | Private | ROR | 5,100 | Operating |
| 5 | Chilime | Trishuli River | Gandaki | Private | ROR | 22,000 | Operating |
| 6 | Devighat | Trishuli River | Gandaki | NEA | ROR | 14,100 | Operating |
| 7 | Gandak | Narayani (Sapta Gandaki) | Gandaki | NEA | ROR | 15,000 | Operating with Irrigation |
| 8 | KaliGandaki "A" | Kali Gandaki Nadi | Gandaki | NEA | ROR | 144,000 | Operating |
| 9 | Kulekhani III Headwork | Rapti Nadi | Gandaki | NEA | Storage | 14,000 | Construction |
| 10 | Kulekhani No. 1 | Bagmati | Bagmati | NEA | Storage | 60,000 | Operating |
| 11 | Kulekhani No. 2 | Rapti Nadi | Gandaki | NEA | ROR | 32,000 | Operating |
| 12 | Marsyangdi | Marsyandi Nadi | Gandaki | NEA | ROR | 69,000 | Operating |
| 13 | Middle | Marsyandi | Gandaki | NEA | PROR | 70,000 | Operating |

| No. | Name | River | River System | Owner | Type | Capacity (KW) | Condition |
|---|---|---|---|---|---|---|---|
| | Marsyangdi | Nadi | | | | | |
| 14 | Modi Khola | Modi Khola | Gandaki | NEA | ROR | 14,800 | Operating |
| 15 | Phewa (Pokhara) | Seti Nadi | Gandaki | NEA | ROR | 1,000 | Operating |
| 16 | Rairang | Thopal Khola | Gandaki | Private | ROR | 500 | Operating |
| 17 | Ridi Khola | Ridi Khola | Gandaki | Private | ROR | 2,400 | Operating |
| 18 | Seti (Pokhara) | Seti Nadi | Gandaki | NEA | ROR | 1,500 | Operating |
| 19 | Tatopani/Myagdi(i) & (II) | Kali Gandaki Nadi | Gandaki | NEA | ROR | 2,000 | Operating |
| 20 | Trisuli | Trishuli River | Gandaki | NEA | ROR | 24,000 | Operating |
| 21 | Upper Trisuli 3A | Trishuli River | Gandaki | NEA | ROR | 60,000 | Construction |
| 22 | Indrawati III | Indrawati Nadi | Koshi | Private | ROR | 7,500 | Operating |
| 23 | Khimti | Khimti Khola | Koshi | Private | ROR | 60,000 | Operating |
| 24 | Panauti | Rosi Khola | Koshi | NEA | ROR | 2,400 | Operating |
| 25 | Sunkosi | SunKoshi Nadi | Koshi | NEA | ROR | 10,050 | Operating |
| 26 | Upper Bhotekoshi | Bhotekoshi Nadi | Koshi | Private | ROR | 36,000 | Operating |
| 27 | Upper Tamakoshi Headworks | Tamakoshi Nadi | Koshi | NEA | ROR | 456,000 | Construction |
| 28 | Chatara | Koshi | Koshi | NEA | ROR | 3,200 | Operating with Irrigation |
| 29 | Puwakhola | Puwa Khola | Kankaimai | NEA | ROR | 6,200 | Operating |
| 30 | Mistri | Mistri | Gandaki | NEA | ROR | 140,000 | Construction |

There are around 6 large Irrigation barrages in Nepal and 6 large Irrigation barrages at downstream of the rivers from Nepal in India. The quantities of water or irrigation areas of four barrages located in the border of Nepal and India are stipulated by the international treaty or agreements. The name of the irrigation barrages are listed in Table 9.2-1 and the locations of the barrages are shown in Figure 9.1-1.

**Table 9.1-2 Operating Major Irrigation Barrage in Nepal and India**

| No | Name | River | River System | Country | International Treaty/ Agreement |
|---|---|---|---|---|---|
| 1 | Tanakpur Barrage | Mahakali Nadi | Rangun | India | Mahikali River Treaty 1996 |
| 2 | Banbasa Barrage | Mahakali Nadi | Rangun | India | Sarada Canal Project Agreement with British India, 1920: and the Mahikali Irrigation Project |
| 3 | Barrage (Sujauli) | Karnali River | Karnali | India | |
| 4 | Sikta headworks | Rapti Nadi | Rapti | Nepal | |
| 5 | Kakradari Barrage | Rapti Nadi | Rapti | India | |
| 6 | Babai headworks | Babai Nadi | Babai | Nepal | |
| 7 | Rupai Bararage | Tributary of Babai Nadi | Babai | India | |
| 8 | Bagmati Irrigation Project, headworks | Bagmati Nadi | Bagmat | Nepal | |
| 9 | Gandak Irrigation (same as Gandak HPP) | Narayani (Sapta Gandaki) | Gandaki | Nepal | Gandak Irrigation and Power Project Agreement, 1954 (revised 1964) |
| 10 | Bhardaha Barrage (same as Chatara HPP) | Koshi | Koshi | Nepal | Kosi Project Agreement, 1954<br>Agreement between Nepal and India for the construction of Chatra Canals Project,1964<br>Indo-Nepal Agreement on Renovation of Chandra Canal, Construction of Pump Canal and Western Kosi Canal in Nepal, 1978 |
| 11 | Kankai headworks | Kankaimai Nadi | Kankaimai | Nepal | |
| 12 | Farakka Barrage | Ganges River | Ganges | India | The Ganges River Treaty between India and Bangladesh, 1977, 1996 |

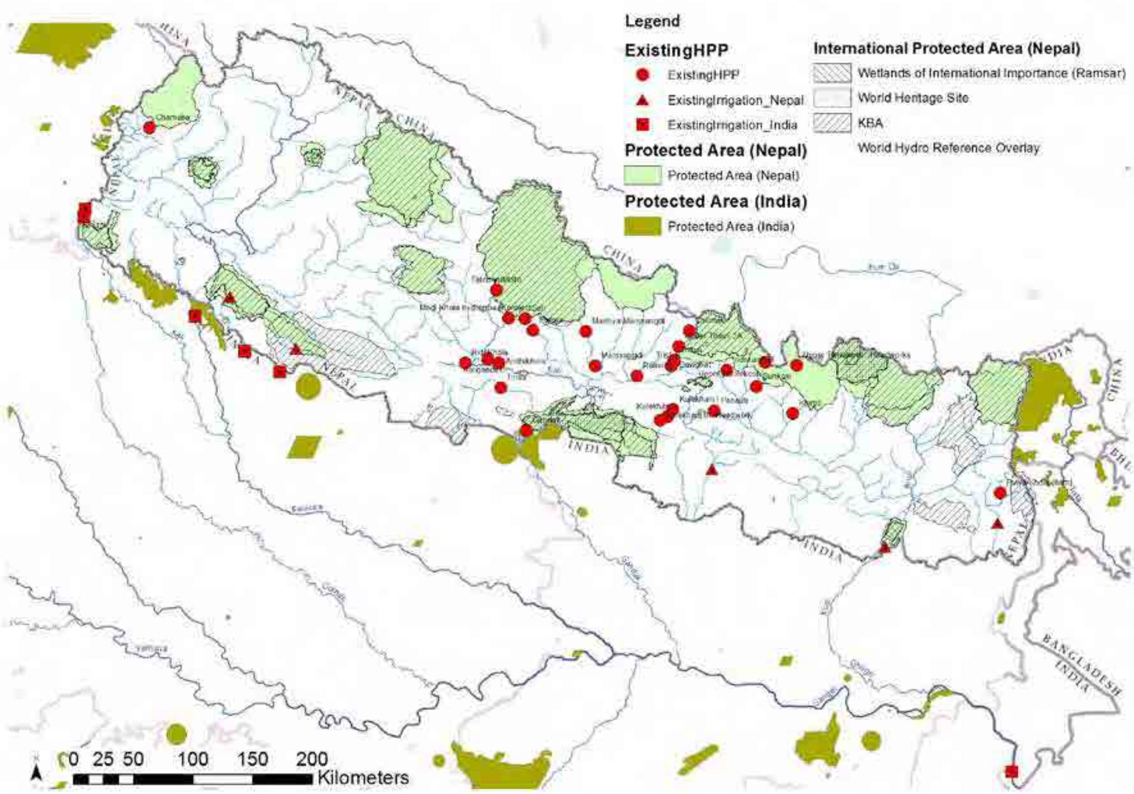



**Figure 9.1-1 Existing HPPs and Irrigation Barrage**

2) Existing Road

Road network is stretching widely in Nepal. Based on the Road Statistics 2006/2007, Black topped road is 4,258 km, Gravel road is 2,062 km, and Earthen road is 3,079 km. Black topped roads are connected from west to south in low land. Road density around the capital city is higher than the rural areas. Figure 9.1-2 shows the existing roads in Nepal.

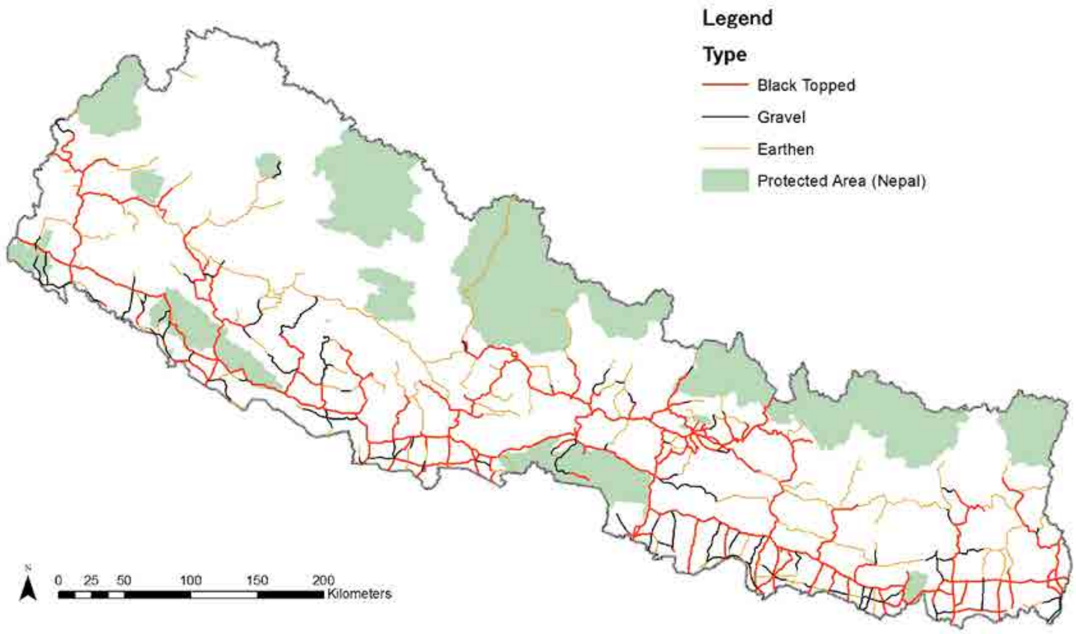



**Figure 9.1-2 Existing road network in Nepal**

Source: Strategic Road Network (2011/2012)

(2) Possible Projects

Possible Hydroelectric power plants, Irrigation Barrages and Roads in Nepal are examined.

1) Planned Hydroelectric Power Projects

There are many hydroelectric power development plans in Nepal both public and private. Accroding to the generation development plan in the main report, the major possible Hydroelectric power projects are categorized in two, such as Projects in preparation stage of construction and Candidate Projects. The projects in preparation stage of construction are 11 (See Figure 9.1-3) and Candidate projects are 9 (See Figure 9.1.4). 10 of them are a storage type project. 10 of them are in Gandak river system, 6 of them are in Koshi river system, and 2 of them are in Karnali river system.

In addition to that Ministry of Energy is issuing various types of licenses for possible HPPs, such as Construction licenses and Survey licenses. 74 Construction licenses, 29 Survey licenses above 100 MW, 52 Survey licenses for 25 to 100 MW, 175 Survey licenses for 1 to 25 MW, and 202 Survey licenses for below 1 MW are issued at the time of 2012 (See Figure 9.1-4). The valid periods of the licenses are limited. Then some licenses might be expired if no activities are taken for some time.

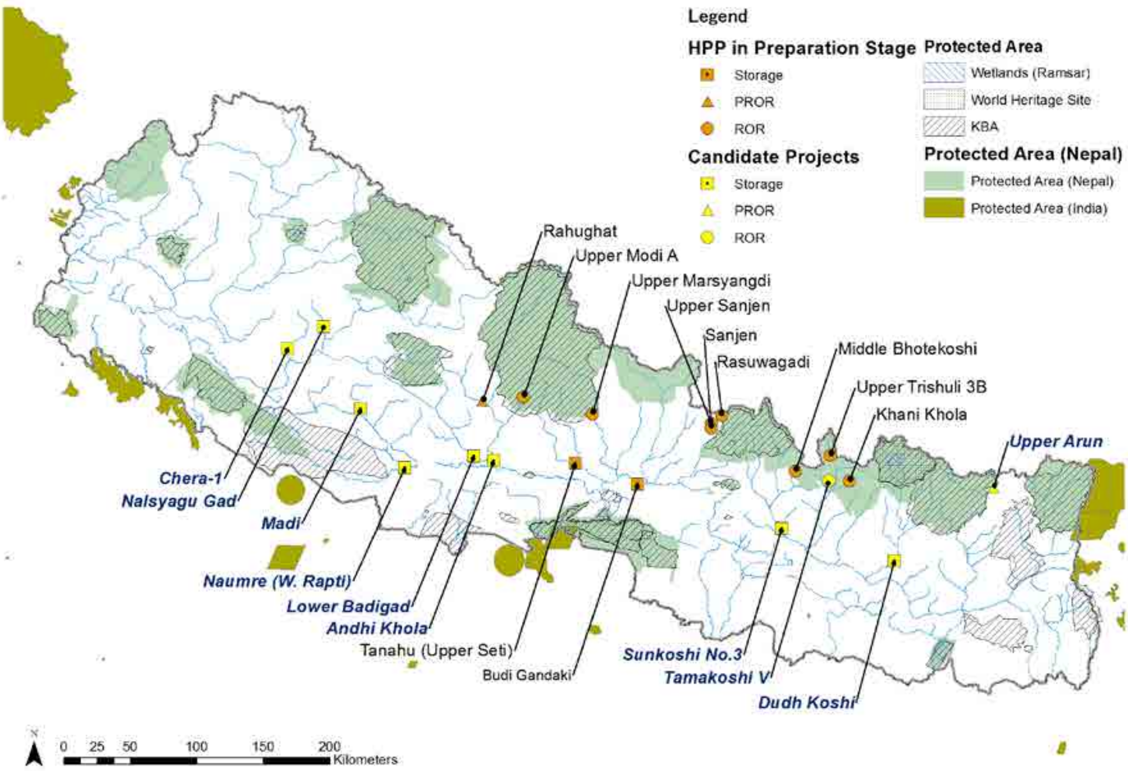



**Figure 9.1-3 HPPs in Preparation Stage and Candidate projects**

**Table 9.1-3 HPPs in Preparation Stage of Construction**

| No | Project Name | River System | Type | Installed Capacity (MW) |
|---|---|---|---|---|
| 1 | Khani Khola | Koshi | ROR | 25 |
| 2 | Upper Sanjen | Gandaki | ROR | 11 |
| 3 | Sanjen | Gandaki | ROR | 42.9 |
| 4 | Middle Bhotekoshi | Koshi | ROR | 102 |
| 5 | Rasuwagadi | Gandaki | ROR | 111 |
| 6 | Rahughat | Gandaki | PROR | 32 |
| 7 | Upper Marsyangdi | Gandaki | ROR | 50 |
| 8 | Upper Trishuli 3B | Koshi | ROR | 37 |
| 9 | Upper Modi A | Gandaki | ROR | 42 |
| 10 | Tanahu (Upper Seti) | Gandaki | Storage | 140 |
| 11 | Budhi Gandaki | Gandaki | Storage | 600 |

**Table 9.1-4 Candidate Projects**

| No. | Project Name | River System | Type | Installed Capacity (MW) |
|---|---|---|---|---|
| 1 | Upper Arun | Koshi | PROR | 335 |
| 2 | Dudh Koshi | Koshi | Storage | 300 |
| 3 | Nalsyau Gad | Karnali | Storage | 410 |
| 4 | Andhi Khola | Gandaki | Storage | 180 |
| 5 | Chera-1 | Karnali | Storage | 148.7 |
| 6 | Madi | Rapti | Storage | 199.8 |
| 7 | Naumure (W. Rapti) | Rapti | Storage | 245 |
| 8 | Sun Koshi No.3 | Koshi | Storage | 536 |
| 9 | Lower Badigad | Gandaki | Storage | 380.3 |

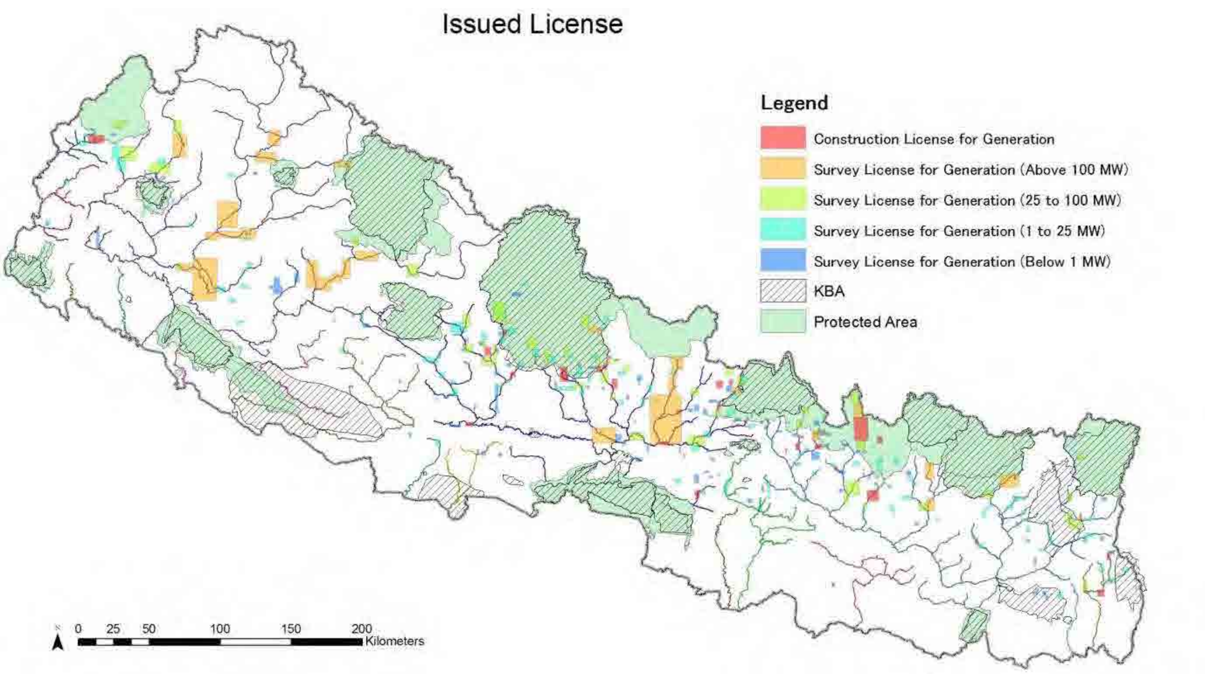



**Figure 9.1-4 Issued Licenses by Ministry of Energy (2012)**

2) Planned Irrigation Barrages

According to Department of Irrigation planned major irrigation systems in Nepal are Ramdi Irrigation project in Gnadak river system and Beni Ghat Irrigation project in Koshi river system. The possibility of the development is unclear at this time. In addition to that there are many other planned small size irrigation projects all over the country. Department of Irrigation seeks a possibility of irrigation use from the storage type generation projects such as the Naumure (W. Rapti) Project.

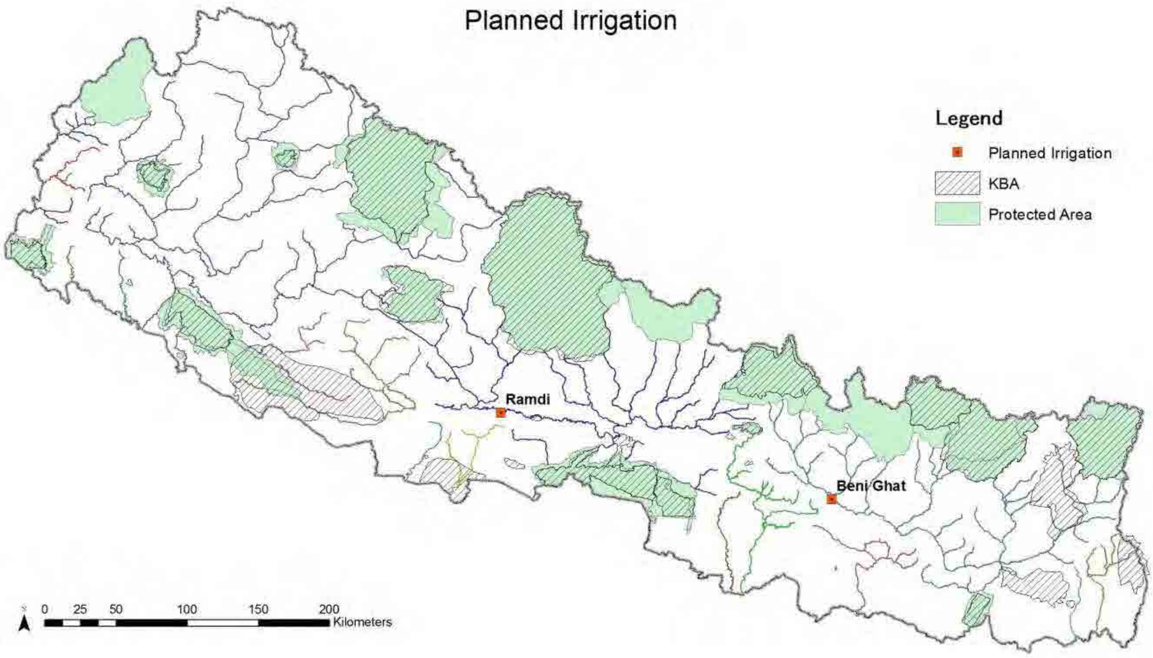
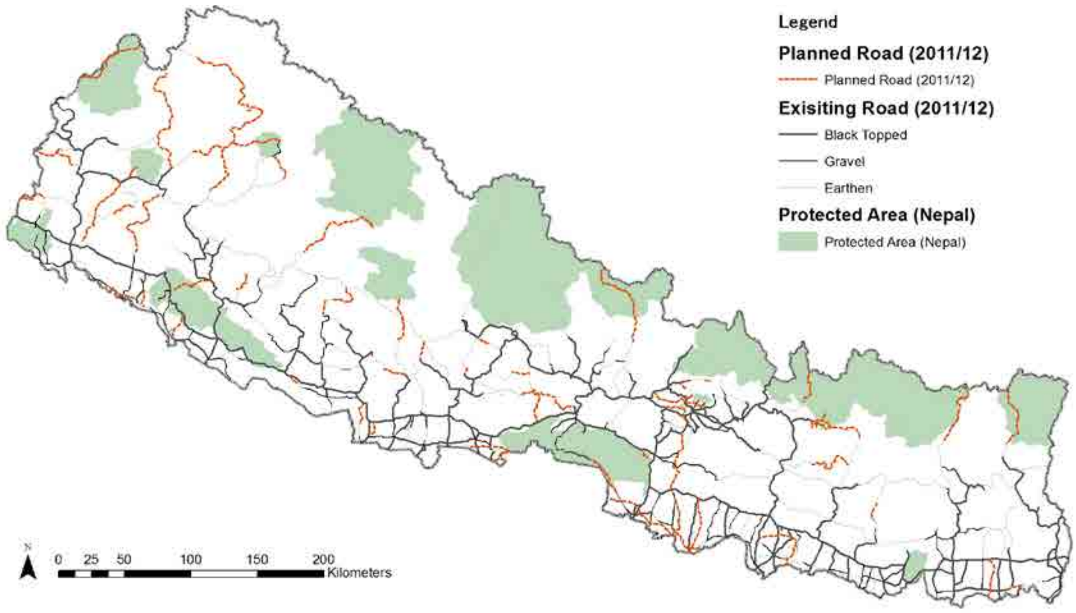



**Figure 9.1-5 Planned Major Irrigations in Nepal**

3) Planned Road Network

According to the Department of Road around 1,900 km are planned and under construction. In addition to that some upgrading projects such as Dhulikhel Sindhuli Bardibas Road Project, Kanti Lokpath Road Project, Road Network Development Project, and Road Sector Development Project are on going (See Table 9.1-5).




Source: Strategic Road Network 2011/2012 (DoR)

**Figure 9.1-6 Planned Road (2011/2012)**

**Table 9.1-5 Main road projects in Nepal**

| Name | Region | Length |
|---|---|---|
| Dhulikhel Sindhuli Bardibas Road Project | Central region | 158 km |
| Kanti Lokpath Road Project | Central region | 92 km |
| Kathmandu Valley Road Improvement Project | Central region | 3.23 km |
| Road Network Development Project | Eastern region | |
| East West Highway Pavement Strengthening Component | | 140 km |
| Road Improvement Component | | 168 km |
| Feeder Road Construction Component | | 96 km |
| Road Sector Development Project | Far western region and Mid western region | 297 km |

Source: Deartment of Roads

## 9.2 Scoping

Scoping table for the cumulative impact is prepared considering Hydroelectric power, Irrigation and road development. The Major impacts which would be accelerated by Hydroelectric power Projects are impact on water, forest, fishery and aquatic fauna (See Table 9.2-1). The water regulating effects accumulated by storage type HPP and Irrigations might cause serious impact on the wetland downstream. Because there are many protected area and protected species which depend on the wetland ecosystem near the Nepal and Indian border. The impact on migration fishes is also anxious by continued barriers in same river. Space crowning impact is also anxious because resettlement action itself might cause some impact on host communities and it will be accelerated by road construction. Noise and Global warming might be accelerated but they are excluded because main causes would come from road developments. Then (1) Water regulation effects, (2) Barrier effects on fish migration, and (3) Space crowning effects are selected for cumulative impact assessment.

**Table 9.2-1 Scoping Table for Cumulative Impact**

| Items | Existing | | | Planned | | | Total |
|---|---|---|---|---|---|---|---|
| | Hydropower | Road | Irrigation | Hydropower | Road | Irrigation | |
| Air quality | - | + | | + | ++ | + | + |
| Noise, Vibration | - | + | | + | +++ | | (+++) |
| Water | + | | + | +++ | | | +++ |
| Soil | - | + | | + | ++ | | (++) |
| Waste | - | - | | + | - | + | |
| Global Warming | - | ++ | | - | +++ | | (+++) |
| Resettlement | - | - | | ++ | + | + | ++ |
| Agriculture | - | - | | ++ | - | + | ++ |
| Fishery and Aquatic Fauna | ++ | - | + | +++ | - | + | +++ |
| Tourism | + | - | | ++ | - | + | ++ |
| Forest | - | + | | ++ | +++ | + | +++ |
| Protected Area | - | + | | ++ | ++ | + | ++ |
| Terrestrial Fauna | + | + | | ++ | ++ | + | ++ |

+++: Major impact, ++: Middle impact, +: Minor impact, -: No impact,

(   ): Main impactors are not Hydropower

## 9.3 Impact Assessment

(1) Water Regulation Effects on Eetland 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 9.3-1). The Karnali river system has two planned projects in different tributaries. If all 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 infract the Gandaki Irrigation and Power Project Agreement (1959) (Table 9.3-2) 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 infract the Kosi Project Agreement signed between Nepal and India. The Koshi Tappu Wildlife Reserve and 15 protected species might be also affected.

## Table 9.3-1 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)<br>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)<br>Asian Elephant (EN), Royal Bengal Tiger (EN), Fishing Cat (EN), Sambar (VU), Sloth Bear (VU), Smooth-coated Otter (VU), Himalayan Black Bear (VU) |
| | 5,150 | 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)<br>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)<br>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)<br>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) |

*: The figures in ( ) means that the area is included in Noumure’s catchmet area.

**Table 9.3-2 Schedule of Water Requirements of the Gandak Project in Cumecs**

(Vide clause 9 of the original agreement signed on December 4. 1959.)

| Month | Western Canal system and power house in Nepal | Eastern Canal system and power house in India | Total |
|---|---|---|---|
| January | 197 | 129 | 326 |
| February | 173 | 110 | 283 |
| March | 169 | 105 | 273 |
| April | 163 | 123 | 286 |
| May | 234 | 226 | 460 |
| June | 317 | 396 | 713 |
| July | 432 | 396 | 828 |
| August | 424 | 396 | 821 |
| September | 424 | 396 | 821 |
| October | 455 | 400 | 854 |
| November | 314 | 375 | 688 |
| December | 295 | 263 | 558 |

(2) Barrier Effects on Migration Fish

From ichthyological point of view, the rivers which have continuous barriers seem to be difficult for them to inhabit. Especially, the long distance migration fishes need access to the high mountain area 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 barrier free (See Table 9.3-3, Figure 9.3-1, Figure 9.3-2, and Figure 9.3-3). However, seven rivers of them are not reaching the high mountain area. Only the Karnali river system is reaching cold water area. Some of the existing barriers have fish ladders but some of them do not have any mitigation. Because of 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 serious impact on fish diversity in Nepal.

**Table 9.3-3 Number of Existing and Planned HPP in Each River Basin**

| *River System* | *Existing* | | *Planned* | | *Const. license* | *Survey License* | | | |
|---|---|---|---|---|---|---|---|---|---|
| | *HPP* | *Irrigation* | *HPP* | *Irrigation* | | *Over 100MW* | *25-under 100MW* | *1-under 25MW* | *Under 1MW* |
| Mahikali | 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 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| Gandaki | 19 | 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 |

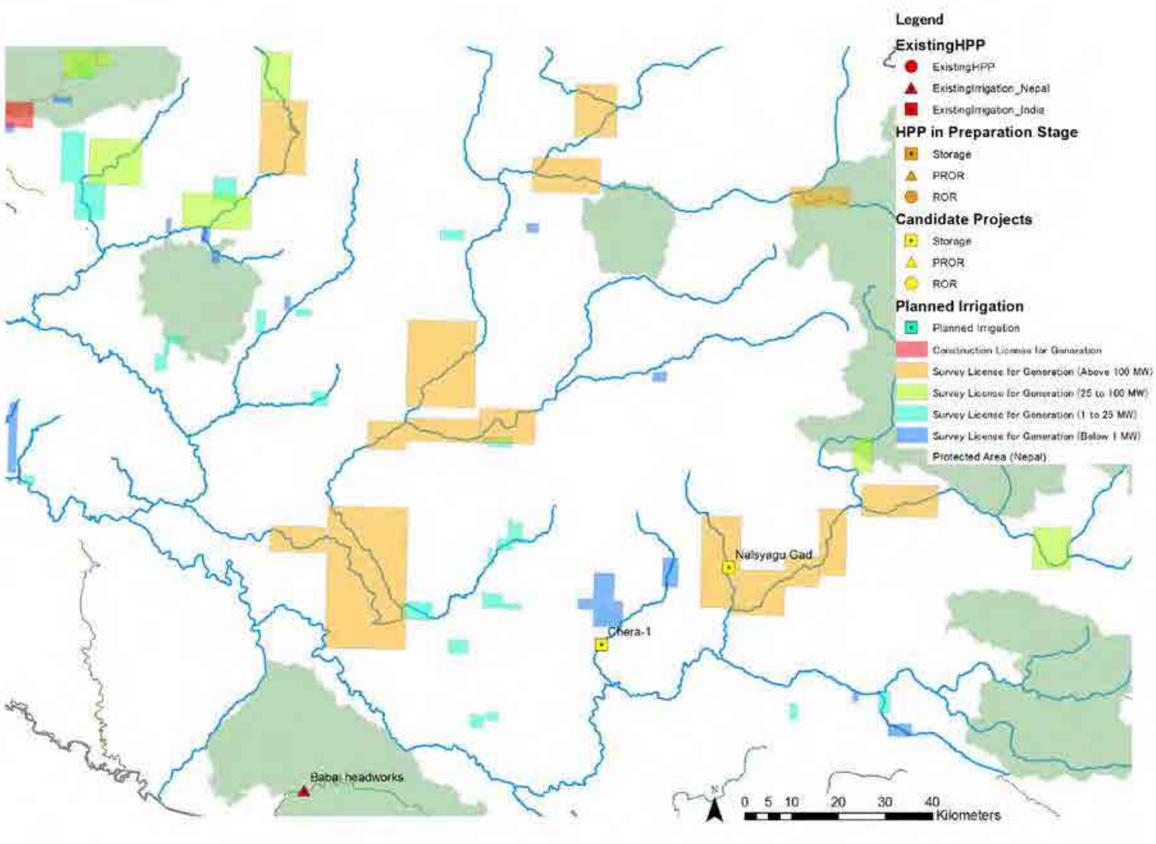



**Figure 9.3-1 Existing and Planned Barrier in Karnali River System**

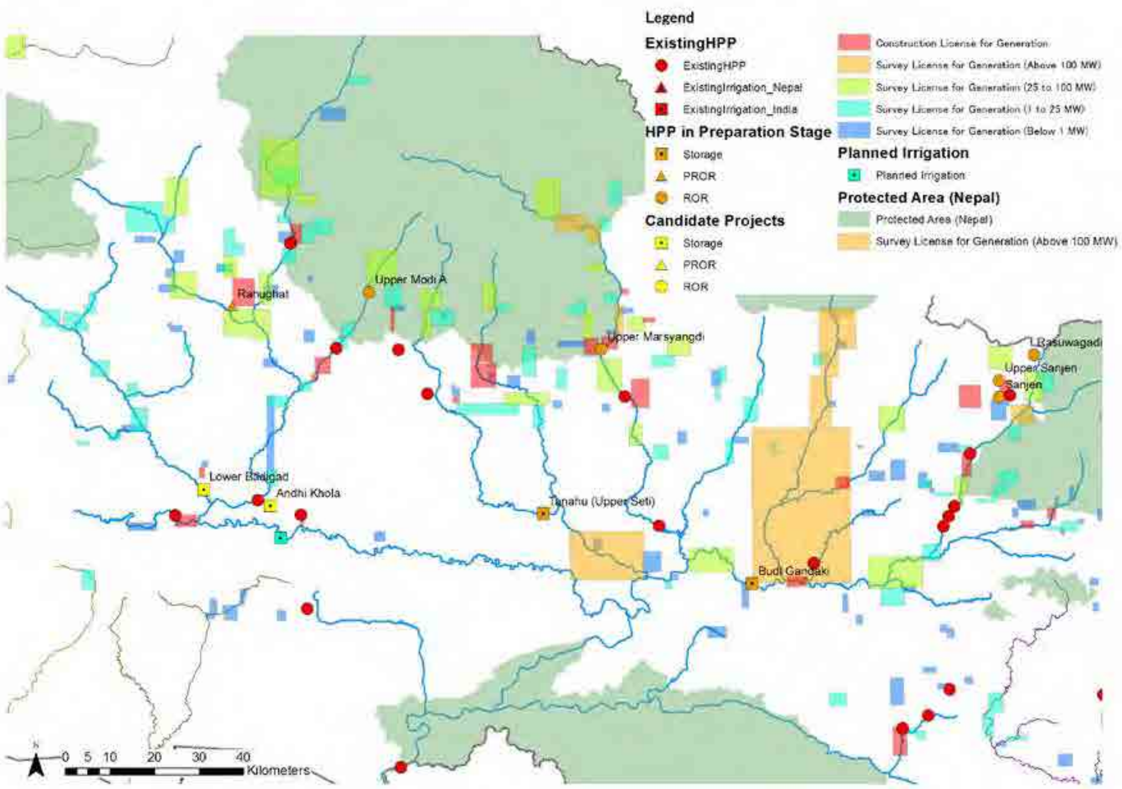



**Figure 9.3-2 Existing and Planned Barrier in Gandaki River System**

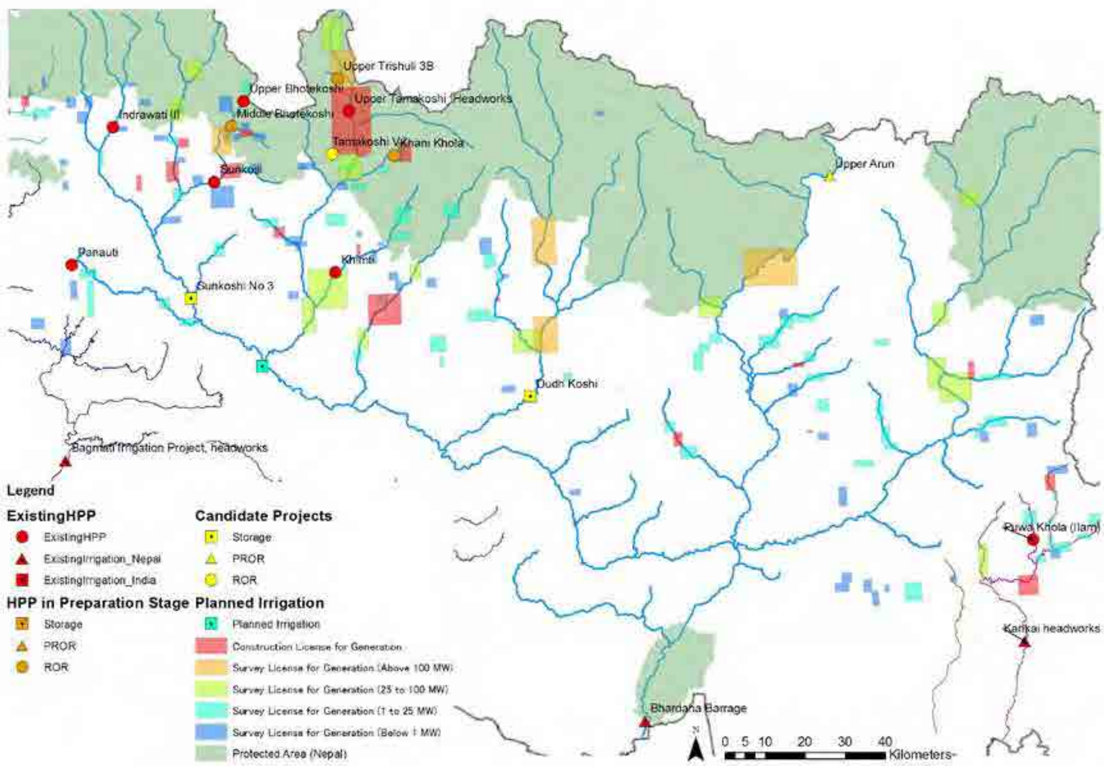



**Figure 9.3-3 Existing and Planned Barrier in Koshi River System**

(3) Space Crowning Impact on Forest Ecosystem

The impact on 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 Mid-Western region, Myagdi District, Kaski District, Lamjung District in Western region, Rasuwa District in Central region, and Solukhumbu District, Sangkhuwasabha District, Taplejung District in Eastern region. Without appropriate control, encroachment, irrigal logging, irrigal hunting, and irrigal fishing might expand around the projects concentrated area.

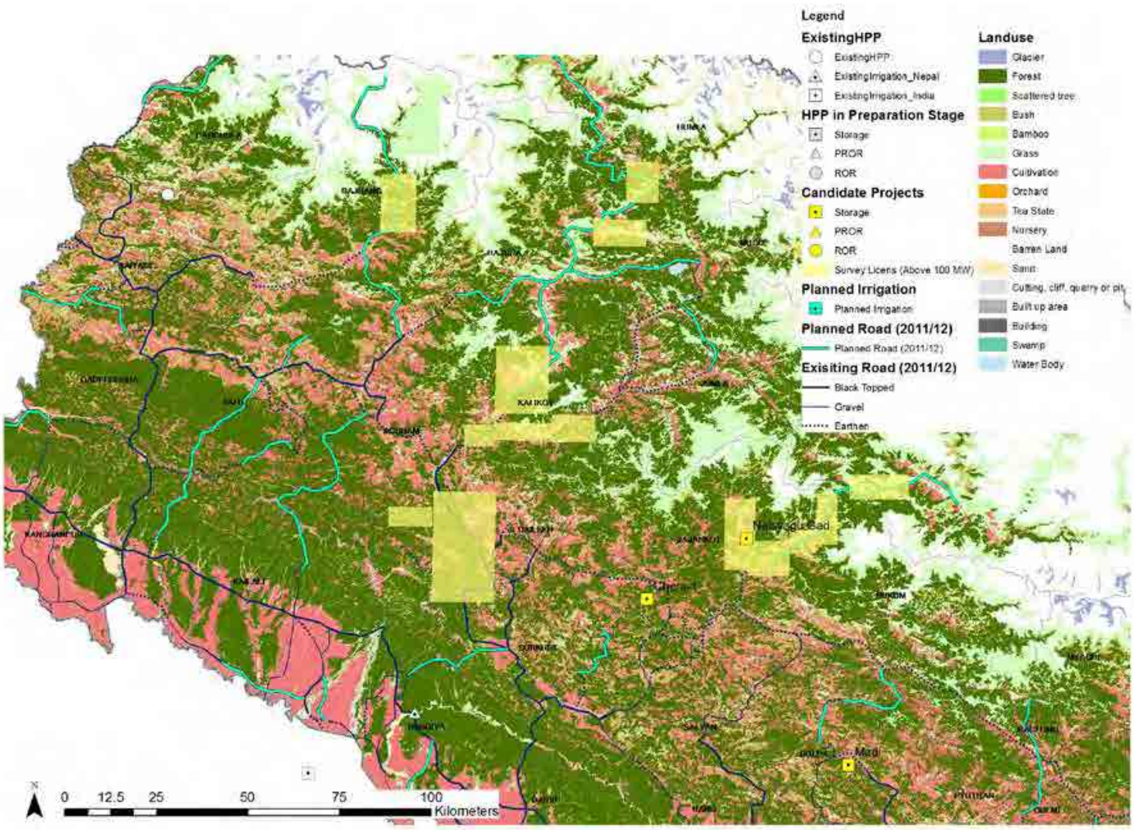



**Figure 9.3-4 Land Use and Existing and Planned Projects (West)**

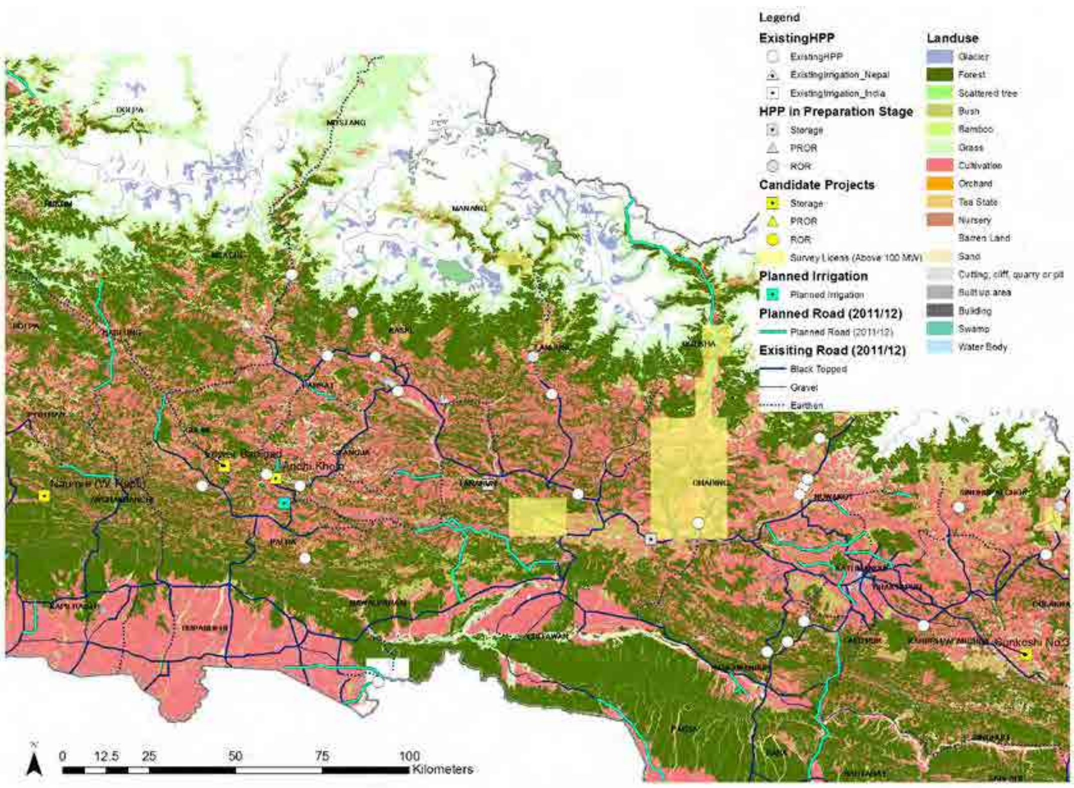



Figure 9.3-5 Land Use and Existing and Planned Projects (Center)

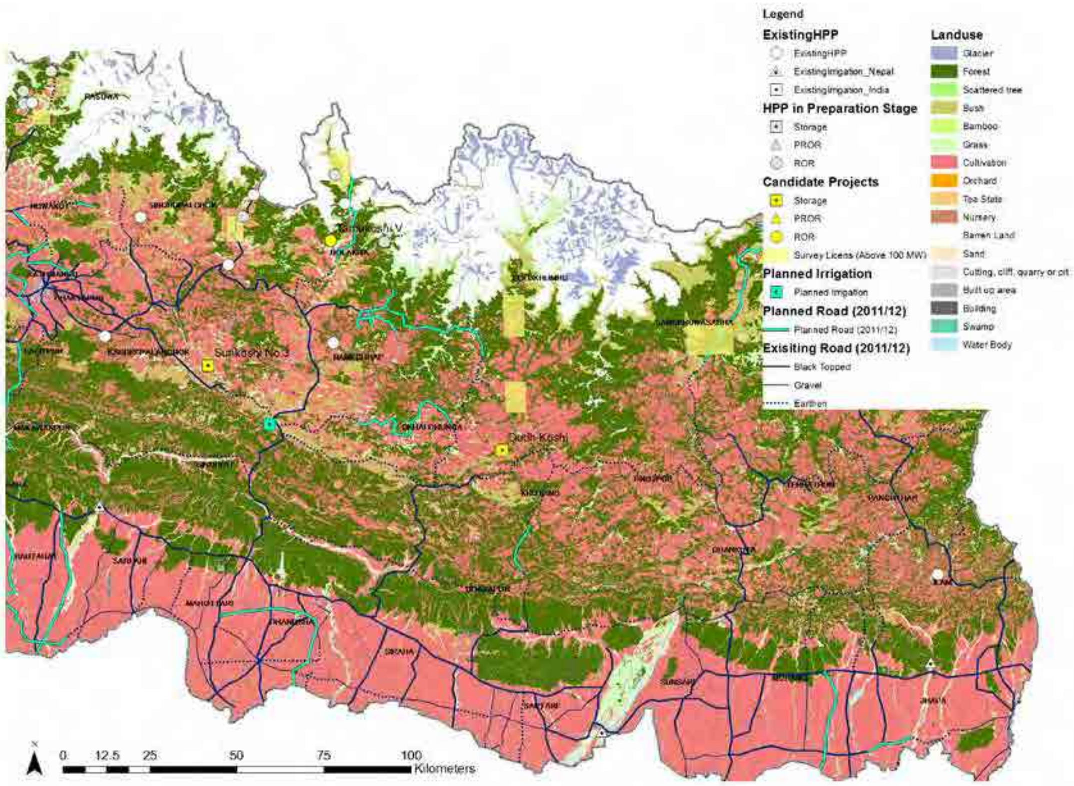



Figure 9.3-6 Land Use and Existing and Planned Projects (East)

# Chapter 10 Mitigation Measures

## 10.1 Mitigation for Individual Project

(1) Chera-1 Project

One of issues of concern in the Chera-1 Project is compensation for the resettlements. A survey should take enough time for more than 550 resettlements and be sure to equality for the people during negotiation. If possible, whole villagers will be able to move to same area with their culture. A survey for the 60 km transmission line should also take enough time.

(2) Lower Jhimruk Project

The Lower Jhimruk Project needs detail biological survey in EIA because a relatively high number of important species are identified. And important forest and grass land as habitat for the wild life should be identified. The negotiation process for the resettlement should be in a careful for the ethnic minority even if the number of resettlement is around 200. The compensation for the income from agriculture and fishery should be considered including vocational training.

(3) Madi Project

The Madi Project needs detail biological survey including fish survey and careful mitigation measures in EIA, because floral diversity and the number of important fish species are relatively high.

(4) Nalsyau Gad Project

Preliminary transmission survey will be required before EIA or IEE for the transmission line, because the route is around 112 km long. Water regulation plan during the rainy season and dry season should be carefully determined in order to minimize the impacts on the protected area and protected species. The household survey for the resettlement should take enough time because it counts around 300 households.

(5) Naumure (W. Rapti) Project

The Naumure Project needs detail biological survey in EIA, because 8 $km^2$ forest land will be submerged and it will cause habitat loss for the terrestrial fauna. Vocational training for the people who cannot live on farming might be required because more than 6 $km^2$ farm land will be lost.

(6) Lower Badigad Project

The Lower Badigad Project needs detail biological survey in EIA because a relatively large number of important mammals and fishes are identified. Relocation area for the 1,500 households should be considered in the early stage of designing. Water regulation in the rainy season and freshet rate in the dry season should be carefully examined considering the impact on protected area and protected species.

(7) 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 the local people should be considered. Not only provision of settlement area for more than 500 resettlements, but also some income compensation should be considered for the affected retailing store.

(8) Dudh Koshi Project

A bit wider area of mammals and birds survey will be required in order to identify the migration route in EIA study. The offset mitigation for fish should be considered at the early stage of the EIA study. The number of resettlement 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 the data of 1997 and it was not approved by the Ministry of Environment. Then EIA study should be conducted again and get certificate by the Ministry of Environment.

(9) Kokhajor-1 Project

Forest compensation should be considered carefully in EIA study. The study for resettlement should be taken care of each ethnic minority group, even if the number of resettlement is 200, which is relatively low.

(10) Sun Koshi No.3 Project

Compensation process would be critical for the Sun Koshi No.3 Project, because the number of resettlement will be more than 1,500. In addition, there are some accommodations for the tourists. The alternatives of the 15 km national highway which will be submerged in the reservoir area should be also prepared. Vocational supporting and entrepreneurial capability building might be needed for the farmers and fishermen who lose their income source.

## 10.2 Mitigation for Cumulative Impact

Mitigations for cumulative impact often involve a number of ministries and the mitigation that can be implemented on project-by-project basis is very few. Followings are the suggestions recommended for three impacts.

(1) Water Regulation Effects on Wetland Ecosystem

In case there are a number of projects in a 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 even a little such effect.

1) Re-regulating Reservoir

Re-regulating reservoir is one of the solutions to average daily variation of water discharge. It will maintain downstream aquatic ecology and avoid risk to human and wildlife. But it might be another barrier for fishes and it cannot control annual variation.

2) 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 concerned, it careful control of water regulation timing and rate are recommended.

3) 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.

(2) Barrier Effects on Migration Fish

Hydropower, irrigation, and water supply will block the fish migration. Many planned barrier will accelerate higher risk. Followings are some suggested mitigations.

1) Minimizing the Number of Barrier

The fewer number of barriers are better for fishes. Even if fish ladder or other mitigations are installed, they are not perfect mitigation which restore rivers to the original condition. To minimize the number of barrier, constructing limited number of storage type HPPs seems better than the construction of many small ROR type projects.

2) Barrier Free River

Keep at least one or two tributary river corridors in each of west, center and east areas for the maintenance of the key Himalayan fish species. For example the Thuli Gad and Barun Khola in the Karnali system, the Lundri Khola in the Rapti system, 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 hereinafter described.

3) Fish Ladders and Hatchery

Fish ladders/hatchery are not perfect mitigations but it is better than doing nothing at all. Legalizing provision of fish ladders for projects with less than 30m high dams (hydropower, irrigation, or water supply projects) not only for new projects but also existing projects is recommended. Legalizing fish hatchery for delivering affected fish resources for all the projects with above 30 m high dams is also recommended. If possible, delivering fish resource system from existing and planned fish hatchery might be effective after detailed examination of the genetic lineage between the rivers.

4) Fish Migrate-able Flashing Gate

Some new barrier will attach sediment flushing gates at the bottom to the middle level of the dam. If some additional device might be attached on the gate, fishes might be able to migrate after flushing.

5) 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 actual impact and effect of existing barriers. In order to identify hot spots for fish, a periodic nationwide fish census survey is highly recommended.

6) Fish Conservation Plan

Formulation of a fish conservation plan is required before Nepali fish diversity falls into critical situation. Not only the cumulative barrier effect but also invasion of exotic fishes to Nepal is anticipated. Based on the fish monitoring result, fish conservation plan should be prepared. This fish conservation plan might be useful for an appropriate watershed management. Formulating the fish conservation plan is necessary to accomplish sustainable development and the Directorate of Fisheries Development and international NGOs will take big roles for this formulation.

(3) Space Crowning Impact on Forest Ecosystem

1) 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 corridor and some high grade ecosystem remain sometimes. Such kind of places should be identified and informed to the development department.

2) Assured Tree Planting

The forest norm in Nepal is giving options to the developer; planting trees or paying compensation fee to the Department of Forest. But sometimes, the compensation fee is not correctly used to planting trees, because of lack of planting area. In order to assure the planting trees, developer should be responsible for tree planting from start to finish.

3) Construction Road Management

Construction of road and access roads for hydropower plant might become a trigger of illegal logging. In case the roads connect to high value forests, it should be controlled carefully.

4) Mitigation specialized organization

Installation of a mitigation organization might be useful. Many HPPs including small size will be developed in the few decades in Nepal. But it is a bit difficult to impose implementation of effective environmental mitigation on each project owner, because they are not a professional of biology. 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 organization specialized in mitigation which covers all the mitigation planning and monitoring works and which is paid by project owners is required. With this kind of organization, it can concentrate on rehabilitation of heavily damaged area effectively and efficiently.

# Chapter 11 Monitoring Methods

## 11.1 Environmental Monitoring for Individual Project

Environmental monitoring for existing projects were planned to be conducted by the project owner and audited by Ministry of Environment, Ministry of Energy, DOED, and NEA. These monitoring plans are documented and scheduled in the EIA and EMP (Environmental Management Plan) approved by Ministry of Environment. But unfortunately the actual monitoring and audits during construction are not so fully conducted in Nepal. It is very rare to see environmental monitoring report during operation. Some new mechanisms for the compliance should be established.

## 11.2 Environmental Monitoring for Cumulative Impact

There is no plan for the monitoring system for cumulative impact in Nepal. But fortunately most of the main watersheds have national parks down end of the river. Then periodically monitoring system on river flow, water quality, aquatic fauna, and wetland species communicating with watershed development would be promised.

# Chapter 12 Stakeholder Meeting

During the Study period, a total of three stakeholders meetings have been conducted at Kathmandu, inviting mass media, representatives of government agencies and political parties. At the second and third stakeholders meetings, holding of stakeholders meeting was informed to related districts in which promising projects are located. However, there were no participants from these districts.

In addition, interviews and hearing were conducted with a wide range of stakeholders such as the western regional office of Pokhara, ministries related to environment and forest, SEA report evaluation meeting members composed by NGOs, WWF, each related district offices and residents.

## 12.1 The 1st Stakeholders Meeting

On February 17, 2012, the first stakeholders meeting that was co-hosted by 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.

The main opinions and suggestions raised during the meeting are as follows.

**Table 12.1-1 Comment in the First Stakeholders Meeting and Reply or Action Taken by NEA and Study Team (Tentative)**

| No. | Name | Comment from Stakeholder | Reply by NEA / JICA Study Team |
|---|---|---|---|
| 1 | Mr. Ishwot Onta<br>Nepal Council for Arbitration / Jalsrot Vikas Sanstha | Positive aspects of storage-type hydroelectric projects should be included and clarity on benefit sharing aspects. | *[The Study Team understands that this comment is about multi-purpose storage-type projects.]*<br>Since this is a MP study on storage-type hydroelectric power development, only the benefit of hydroelectric power generation is considered. The Study Team understands that some projects will be able to be multi-purpose projects. Detail of each of these projects should be studied in another study and optimized as a multi-purpose project. |
| 2 | Dr. Rameshanada Vaidya<br>International Centre for Integrated Mountain Development | Analysis of change in snow and ice caps is essential under the proposed project. The issue of GLOF and change in snow cover due to climate change impact should not be overlooked. The impact of climate change on hydroelectric power and capacity of hydroelectric power stations must be assessed. The fluctuation of flow both up and down must be studied in depth. | Effects of climate change on GLOF, snow cover, river flow, etc. are not considered in this MP study. In the feasibility study, etc., of each project in the next stage, effects of climate change on them will be taken into consideration, if necessary and possible. |
| 3 | Mr. Ratneshwor Lal Kayastha<br>Madhesi Janadhikar Forum Nepal | The criteria for selection of candidate projects are normal. Since the situation of Nepal is different from other countries and we need urgent power, the criteria used in Nepal should be different from others considering this situation. Because of this reason, less weightage should be given on environmental and social aspects compared to technical and economic ones. | In the evaluation of 31 candidate projects and also in the evaluation of 10 promising projects, evaluation cases that have less weight for impacts on natural and social environment were also considered as alternative cases. |
| 4 | Mr. Surya Man Shakya<br>EIA Association of Nepal | SEA is very timely and urgent for Nepal. Some projects should be built in remote and less developed areas of Nepal. | The 67 candidate projects were located in the whole country, but the project location itself was not one of evaluation items. |

| No. | Name | Comment from Stakeholder | Reply by NEA / JICA Study Team |
|---|---|---|---|
| | | | As a result of evaluation, the locations of the ten promising projects are, one in the Eastern Region, two in the Central Region, two in the Western Region, two in both the Western and Mid-Western Regions, and three in the Mid-Western Region. |
| 5-1 | Mr. Rabin Shrestha<br>World Bank | The level of study in each stages varies, for example, some desk studies are more elaborative and in depth than feasibility study. So based on the level of study alone, criteria should not be fixed. The level and details of information in study are important aspect. | The level of study is used for evaluating the lead time to construction, not for evaluating the depth of study. |
| 5-2 | | For different hydroelectric power projects system and operative perspectives must be taken in consideration. | *[The gist of this comment is not clear.]* |
| 5-3 | | Export potential and power exchange between Nepal-India should also be taken for consideration. | Since the objective of this MP study is to meet the domestic demand, export to India is not considered. However, import from India is considered as one of power sources to meet the domestic demand. |
| 5-4 | | Though the storage master plan is proposed, the ROR master plan is not existence and it is necessary to integrate this master plan with ROR master plan. | In this study, RORs that are under construction or that are already committed are considered as specific projects. But other RORs are not considered as specific projects like as the storage projects in this study. MP of ROR will be prepared by another study in the near future, and then that will be integrated with the results of this study. |
| 5-5 | Mr. Rabin Shrestha (cont.) | The other usage of reservoir projects like irrigation, navigation, etc., is missing in selection criteria. | The Study Team understands reservoirs are able to be used for other purposes. However, since this is a MP study on hydroelectric power generation, importance was put on power generation in the evaluation criteria.<br>Possibility or detail of multi-purpose development of selected projects will be studied individually before the implementation of these projects, and they will be optimized as multi-purpose projects |
| 6 | Mr. Kul Man Ghising<br>Chilime Hydroelectric Project | Seasonal energy depends on the level of feasibility study, and plan load factor which should be taken in consideration by the Study Team for this study. | Monthly energy production was calculated, and then both the annual energy and the dry season energy were evaluated.<br>In the demand forecast, the load factor was estimated at 52% by consultation with NEA. |

| No. | Name | Comment from Stakeholder | Reply by NEA / JICA Study Team |
|---|---|---|---|
| | | | |
| 7 | Mr. Sanjeev Raj Rajbhandari NEA | Like master plan for storage hydroelectric projects, it is urgent to develop master plan for ROR. | [See 5-4] |
| 8 | Mr. Kiran Shrestha Chilime Hydroelectric Project | Cumulative impact assessment is important in storage-type projects. | Cumulative impact is considered in the SEA. |
| 9-1 | Mr. Shambhu Ghimire Ministry of Home Affairs | Safety and security are important aspects to be included in selection criteria. | Those of technical items like GLOF and geological conditions are considered in the criteria. |
| 9-2 | | Projects to be completed in short time should also be taken as criteria. | Lead time to implementation or commercial operation is used as one of evaluation criteria. |

The questionnaire survey was conducted on all participants about 1) criteria which were to exclude not appropriate project and to select the candidate projects and 2) the weightage of Evaluation Criteria with which candidate projects would be evaluated. Total of 32 participants answered to this questionnaire.

Regarding the criteria which were to exclude not appropriate project, the majority of respondents answered that all 7 items showed by Study Team were appropriate. In addition, impact on agriculture, on tourism and on other technical and economical criteria were suggested as criteria which should be considered.

Regarding the weightage of criteria with which candidate projects would be evaluated, the proportion between technical conditions, efficiency (economical conditions), natural environment and social environment were 38:25:16:15 respectively in response excluding NEA and the Study Team members. On the other hand, NEA assumed an appropriate proportion is as 42:23:14:16 respectively, it showed NEA put 65 % wight on technical and economical condition. The method of weightage was varied by respondents.

In response to the results described above, the Study Team decided to study about 3 cases putting different percent on technical/economical condition and natural/social environment. The sensitive analyses were conducted about the following three cases, 1) technical/economical condition: natural/social environment equal 50:50, 2) technical/economical condition: natural/social environment equal 60:40 and 3) technical/economical condition: natural/social environment equal 40:60.

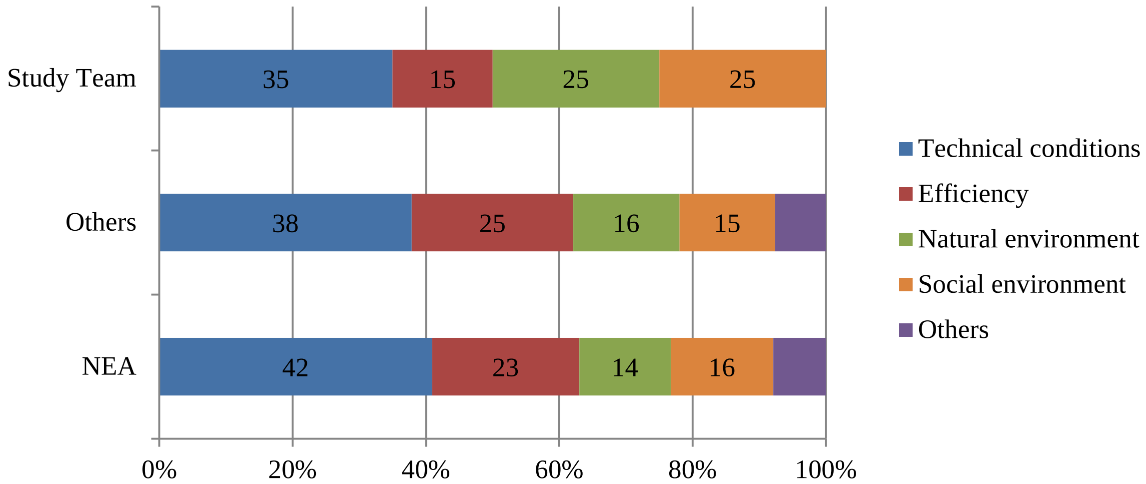



**Figure 12.1-1 Weightage of Evaluation Criteria**

In the questionnaire, rating of the evaluation criteria on a scale of 1 to 5 was requested about the criteria with which candidate projects would be evaluated. The scale of 5 represented very important and the scale of 1 represented less important.

The following figures are summary results of questionnaire.

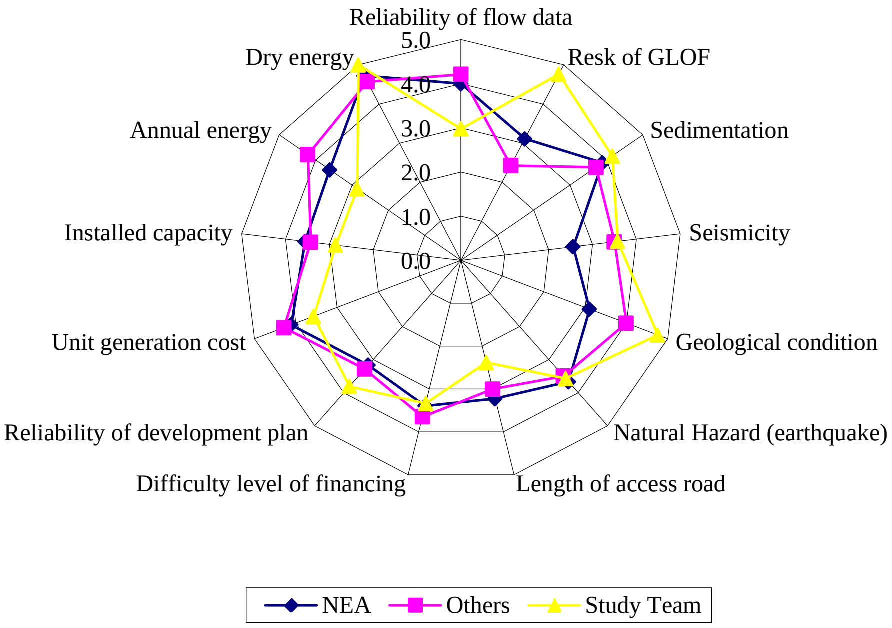



**Figure12.1-2 Summary Result about Technical and Economic Conditions**

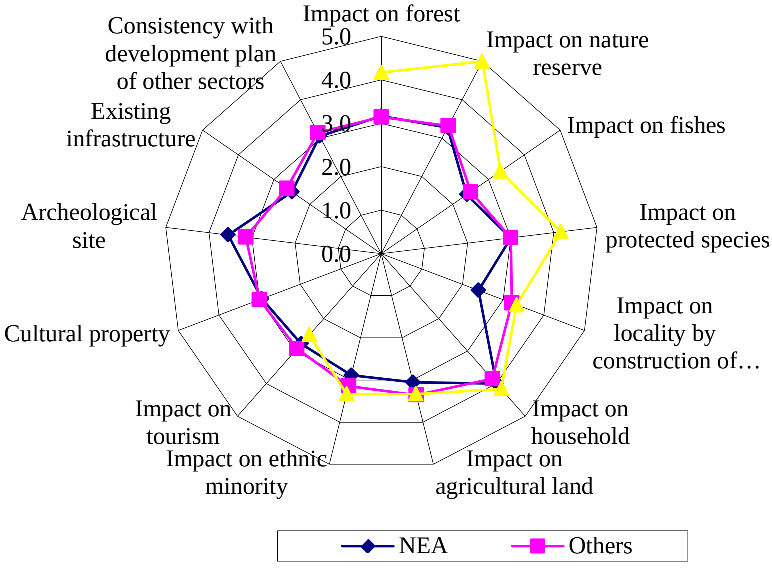



**Figure12.1-3 Summary Result about Social and Natural Environment**

The agenda and the list of participants of the 1st stakeholders meeting are attached as Table 12.1-2 and Table 12.1-3 at the end of this section.

**Table12.1-2 Program of the 1st Stakeholders Meeting**

| No. | Time | Program | Speaker/Presenter |
|---|---|---|---|
| 1 | 9:30-9:35 | Welcome address | Mr. U.D Bhatta,<br>GM, Project Development Division, NEA |
| 2 | 9:35-9:45 | Opening address | Mr. Hari Ram Koirala<br>Secretary, Ministry of Energy,<br>Government of Nepal (GoN) |
| 3 | 9:45-10:15 | Background of the project | Mr. Lila Nath Bhattarai<br>Director, PDD, NEA<br>Mr. Toshifumi Serizawa<br>JICA Study Team |
| 4 | 10:15-10:30 | Scope of the study and present status | Mr. Takashi Mimura,<br>Leader, JICA Study Team |
| 5 | 10:30-11:15 | SEA and Tentative Selection Criteria | Ms. Akiko Urago,<br>JICA Study Team<br>Ms. Keiko Otoguro,<br>JICA Study Team |
| 6 | 11.30-12:00 | Discussion | *All Participants* |
| 7 | 12:00-12:15 | Concluding Remarks | Mr. Yoshihiro Nomura,<br>Embassy of Japan in Nepal<br>Mr. Toru Kobayakawa<br>JICA Headquarters, Tokyo |
| 8 | 12:10-12.15 | Vote of Thanks | Mr. Tika Ram B.C<br>Officiating Managing Director, NEA |

## Table 12.1-3 Participant List of the 1st Stakeholders Meeting

| *Category* | *Name* | *Organization/Department* | *Position* |
|---|---|---|---|
| Ministry and relevant Organization | Shambu Ghimire | Ministry of Home Affairs | Under Secetary |
| | Hari Ram Koirala | Ministry of Energy | Secretary |
| | Sanjay Dhungel | WECS (Water and Energy Commission Secretariat) | Senior Divisional Engineer |
| | Dinesh Napit | DMG | |
| | Saroj Kumar Upadhaya | Cemeca HRA | Ex.Chairman |
| | Ishwor Onta | Cup NEPAC/JVs (Nepal Council for Arbitration / Jalsrot Vikas Sanstha) | Chairman |
| | Ram Sharma Poudel | Survey Dept | Chief Survey Officer |
| NGO | Ramehananda Vaidya | ICIMOD (The International Centre for Integrated Mountain Development) | Senior Advisor |
| | Dipak Aryal | NEFEJ / Radi Sagarmatha (Nepal Forum of Environmental Journalists) | Reporter |
| Association | Anuradha Sharma | Nepal Engineer Association | G.S |
| Institution | Surya Shrestha | SCHEMS | Professor |
| Media | Tamang A | Naya Nepal | Manager |
| | Ramesh Ghimire | Chanakya | Editor |
| | Durga Dhakal | NEON (National Employees Organization of Nepal) | |
| | Jguli Ram Thap | NEON | Treasurer |
| Donors | Gopal C Joshi Subedi | RERL/UNDP (Renewable Energy for Rural Livelihood / The United Nations Development Program) | Renewable Energy Advisor |
| | Dr. Narayan Chaulagain | GIZ | Deputy Program Manager |
| | Shyamal Shrestha | International Finance Corporation | Operations Analyst |
| | Rabin Shrestha | WB | Sr.Energy Specialist |
| Parties | Ratneshwor Lal Kayastha | MJF-N (Madhesi Janadhikar Forum-Nepal ) | |
| | Basanta man Singh | R.J. P (The Rastriya Janashakti Party ) | Asst. Secretary |
| Others | R.M Shrestha | Nepal Consult (P)Ltd | Sr. Engineer/ED |
| | M.L Shrestha | MZT | GM |
| Embassy | Yasuhiro Nomura | Embassy of Japan | Secretary |
| JICA | Toru Kobayakawa | JICA Tokyo | Advisor |
| | Kenichiro Iizuka | JICA Nepal Office | Representative |
| | Sourab Rana | JICA Nepal Office | Program Officer |
| | Yukiyoshi Ozaki | JICA | Expert |
| | Takashi Mimura | JICA Study Team | Leader |
| | Hiryoyasu Akaike | JICA Study Team | |
| | Madoka Harada | JICA Study Team | |
| | Akiko Urago | JICA Study Team | |
| | Kayoko Kurisaki | JICA Study Team | |
| | Eiji Tsuchiya | JICA Study Team | |
| | Toshifumi Serizawa | JICA Study Team | |
| | Keiko Otoguro | JICA Study Team | |
| NEA | Annu Rajbhandare | NEA | Deputy Manager |
| | Anil Raj Bhandary | NEA | Manager |
| | Bisme Dhij Joshi | NEA | Manager |
| | Buddha K. Manak | NEA | Director |
| | Damodar Bhakta | NEA | Manager |
| | G.K Lohie | NEA | Manager |
| | Jagadishwor Man Singh | NEA | Director |
| | Keshab Raj Bhatta | NEA | |
| | P.K Thakur | NEA | Manager |
| | Pradeep Manandhar | NEA | Manager |
| | Prem Chndra Gupta | NEA | Asst. Manager |
| | Sagar Sunal | NEA | Department manager |
| | Teeka Ram B.C | NEA | MD |
| | Upendra Dev Bhatta | NEA | General Manager |
| | Amogh Manandhar | NEA | Deputy Manager |

## 12.2 The 2nd Stakeholders Meeting

On November 28, 2012, the second stakeholders 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 its results were explained. Preliminary reports of site survey of these 10 promising projects, draft of 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 are evaluated.

The main opinions and suggestions raised during the meeting were as follows.

**Table 12.2-1 Comment in the Second Stakeholders Meeting and Reply or Action Taken by NEA and Study Team (Tentative)**

| No. | Name | Comment | Reply or action by NEA / JICA Study Team |
|---|---|---|---|
| 1-1 | Mr. S. Lacoul Ministry of Energy | How are the selected 67 projects justified? Are they from master plan studies of Koshi/Gandaki/Karnali-Mahakali basis? There seems to be additional projects as well. Are there any projects conflict with these master plan studies and/or conflict with the licensed projects? | The 65 projects were selected by NEA and two projects were added later.<br>These MP studies in the past are some of sources.<br>Some projects had conflicted with licensed projects, but they were excluded from this study. |
| 1-2 | | Other uses of regulated flow from reservoir have been ignored. But on the other hand, minor impacts such as fishery/tourism have been considered. Why major use such as irrigation has been ignored? In case of the Dudh Koshi and the Naumure Projects, irrigation use may be determining factor for implement ability of the project. | The Study Team understands reservoirs are able to be used for other purposes. However, in addition to that this is the MP study on hydroelectric power generation, it is not easy to evaluate each project quantitatively by the total benefits of power generation and other uses in the MP stage because it requires a lot of data and information. Accordingly, the benefit of promising projects were evaluated based on only hydroelectric power generation.<br>Possibility (or detail) of multi-purpose development of these projects will be studied individually by another study before implementation of these projects. |
| 1-3 | | The proposed alternative of Dudh Koshi by-passes Sun Koshi-Kamala diversion. So this alternative may not be acceptable form the point of view of irrigation because the irrigation use is very critical in these sites. | This alternative was selected from the viewpoint of power generation. Another alternative does not conflict with irrigation purpose, but its output is smaller. Coordination between power generation and irrigation should be necessary in the early stage to implement this project. |
| 1-4 | | Regional balance (in national development) has not been considered. No reservoir projects | The 67 candidate projects were located in the whole country, but the project location itself was not one of evaluation items. |

| No. | Name | Comment | Reply or action by NEA / JICA Study Team |
|---|---|---|---|
| | | in mid-western and far western region even by 2033. | As a result of evaluation, the locations of the ten promising projects are, one in the Eastern Region, two in the Central Region, two in the Western Region, two in both the Western and Mid-Western Regions, and three in the Mid-Western Region. |
| 2 | Mr. Sanjib Man Rajbhandari<br>NEA | It is important to include the watershed condition in the evaluation criteria since we are talking about the storage project. Individual ideas may be implemented but may not represent the overall watershed condition. | There are many items that form the watershed condition. In the evaluation of promising projects, the impact on rare species and protected area in the downstream were evaluated. They are part of consideration of the watershed condition. |
| 3 | Mr. Dilip K .Sadaula<br>Dept. of Forest and Soil Conservation | The study of watershed U/S of storage project is important and should be included in the evaluation criteria. | Effects of U/S watershed to the project like GLOF and sedimentation were included in the evaluation criteria. |
| 4-1 | Mr. Barna Bahadur Thapa<br>Dept. of National Parks and Wildlife Conservation | No PAS one inside 10 Pas. There is no impact. | *[The gist of the comment is not clear.]* |
| 4-2 | | What types of method do you use to take data around conservation area? | Data and information on National Parks, Important Birds Areas (IBA), Key Biodiversity Areas (KBA), etc. were obtained from published documents including websites. |
| 4-3 | | Monitoring is important during construction and operation phases. | *[Since this is common knowledge, It is not necessary to respond to this comment.]* |
| 5-1 | Mr. Jayandra Tamrakar<br>NEA | Seismicity and thrust/fault are interrelated. Therefore these can be taken as a single criterion. | Both the items are used for evaluating the effect of earthquake. Seismicity is evaluated by a matrix of area and seismic acceleration shown in the earthquake hazard map. Trust/fault is evaluated by the proximity to the location of project. In this study, the effect of earthquake is evaluated by these two criteria. |
| 5-2 | | However, the proximity to the active regional and local faults is important. Make a classification range by project location from the point of view of distance from active faults, e.g., less than 5 km, 5-10 km, 10-15 km, etc., and give the weightage accordingly to these classification ranges. | The proximity to regional active faults were evaluated by classifying it into 4 classes, they are less than 1.6 km, 1.6 to 3.2 km, 3.2 km to 12.8 km, and more than 12.8 km. Regarding local active faults, the proximity was classified into 2 classes, they are less than 100 m and less than 1 km, then deduced points from the evaluation score. |
| 5-3 | | Presence of calcareous rocks like limestone around the reservoir area should be considered. It can cause leakage from the reservoir. | Karstified calcareous rocks are permeable and cause leakage of reservoir water through reservoir area or dam site. In geotechnical evaluation of the 10 promising projects, water tightness was adopted as one of evaluation items for reservoir area and dam site. In |

| No. | Name | Comment | Reply or action by NEA / JICA Study Team |
|---|---|---|---|
| | | | evaluation of water tightness, distribution and feature of calcareous rocks are so important that they were investigated by field survey. When presence of calcareous rocks is confirmed, evaluation of water tightness was decreased except in case they are distributed in limited area and not karstified. |
| 5-4 | | Has distribution of landslide in the catchment area been considered? This can cause serious impact on the reservoir capacity. | Distribution of landslide in the catchment area was not considered in the evaluation. This should be studied in the next stage. |
| 6-1 | Mr. Rabin Shrestha<br>World Bank | The 10 promising projects should not be prioritizing problem in prioritize, but give an impression of good and bad. | Not only the ranking of projects themselves, but details of evaluation result of each evaluation item were described in the (draft) final report for all promising projects. |
| 6-2 | | In these 10 projects, identify problem areas based on complexity in geology. | A project area is composed of sites such as reservoir, dam, headrace tunnel and power house. Important physical characteristics for those sites are water tightness and slope stability, etc., which are affected by geology such as faults, calcareous rocks. In the evaluation of the promising projects, each site was evaluated by selected physical characteristics. Problem areas based on complexity in geology mean potentially problem areas. These areas correspond to sites of low evaluation in this study. Physical characteristics of low evaluation indicate the kind of problems and geology to be studied in later stages. |
| 6-3 | | Identify risk free projects and seek financial commitments. | The purpose of this evaluation is to identify projects with small risk. Seeking financial commitments is in the future stage of each project. |
| 6-4 | | Order of development would create confusion. | *[Since this is common issue in the implementation of projects of this kind, it is not necessary to respond to this comment.]* |
| 6-5 | | Financial plan of NEA in future revenue requirement. | *[Since this is out of scope of this Study, it is not necessary to respond to this comment.]* |
| 7 | Mr. Gyanendra Prasad Kayastha<br>NEA | On the screening criteria of exclusive of storage projects, the rating of sediment load must be mentioned and it should be one of the criteria to reject projects if annual sediment load exceeds the value of middle mountain and high mountain. | *[Definitions of “middle mountain” and “high mountain” are not clear.]*<br>The effect of sediment load should be evaluated by the lime of reservoir, not by the (rate of) sediment load itself. In the screening stage of this study, the life of reservoir was not considered, but in the evaluation of candidate project, it was one of evaluation items. |
| 8 | Mr. Sitaram Thapa<br>National | Why the regulated water is not mentioned on evaluation items for project selection? | *[Does “regulated water” mean the effects (both positive and negative) on the downstream area by regulating river flow, like* |

| No. | Name | Comment | Reply or action by NEA / JICA Study Team |
|---|---|---|---|
| | Employees Organization of NEA | | *effect on irrigation system and hydroelectric power stations (both existing and planned), on fishery, and other natural/social conditions?]* Effects of regulated water on the downstream area should be considered when a storage-type project is implemented. However, since a variety of data/information is required to evaluate these effects quantitatively, it is not easy to evaluate these effects in the MP stage in which a lot of projects have to be evaluated to select promising projects. Accordingly, these effects were not considered in this MP study. In the next stage, in the FS study of each project for example, the effects of regulated water should be studied quantitatively in some degree, and the project will be optimized including the effects on the downstream area. |
| 9-1 | Mr. Jayandra Shrestha NEA | Why regulating capacity of Naumure as 590 is taken as evaluation criteria for screening for storage project? River discharge is more than 1210 in dry season. Does not this mean against one basic purpose of storage project is making energy in dry season. The regulating capacity of 590 is less than river discharge and there is very few meaning as storage project. | *[The unit of these two values is not clear. Is it MCM?]* According to the result of our study, the effective storage capacity is 580 MCM and the annual inflow is 4,400 MCM, so the regulating capacity factor is 13%. The inflow for the four months (from mid-Dec. to mid-Apr. or from Paush to Chaitra) in the dry season is about 330 MCM. |
| 9-2 | | Should not one legally of T/L be considered as one of the important evaluation items, considering its availability is importance. | *[The gist of this comment is not clear.]* |
| 9-3 | | What is the purpose of considering three cases? How these case studies influence on selection or rating of projects? | There is no weight distribution which all people agree on. Accordingly, a technically oriented case and an environmentally oriented case were also considered. As a result, there was some difference in ranking but the effect was small for this degree of difference in weight distribution. |
| 9-4 | | How the rating and weight are taken or determined in evaluation frame work? | *[The gist of this comment is not clear.]* The evaluation items and their weight were determined by discussion in the Study Team and with NEA by reference to those in the other studied in the pars. |
| 9-5 | | It is suggested to have summary of socio economic parameters along with technical parameters. | *[What do "summary of socio economic parameters" and "summary of technical economic parameters" mean?]* |
| 9-6 | | Construction period is also estimated the time of completion period for decision making. | *[The gist of this comment is not clear.]* In the selection of promising project, construction period is not considered. In the |

| No. | Name | Comment | Reply or action by NEA / JICA Study Team |
|---|---|---|---|
| | | | evaluation of promising, however, the construction period of each project was estimated and used for estimation of lead time. Since time for decision making is required for all projects, it is not considered in the evaluation criteria. |

The Study Team collected stakeholders' opinions conducting a questionnaire survey. 45 participants answered to this questionnaire. According to its result, more than 75% of respondents confirmed that the evaluation criteria presented by the Study Team were appropriate.

In the questionnaire, rating of the evaluation criteria on a scale of 1 to 5 was also requested. The scale of 5 represented very important and the scale of 1 represented less important. In response to the results of the questionnaire, the rating was reviewed in the Study.

The following figures are summary results of rating.

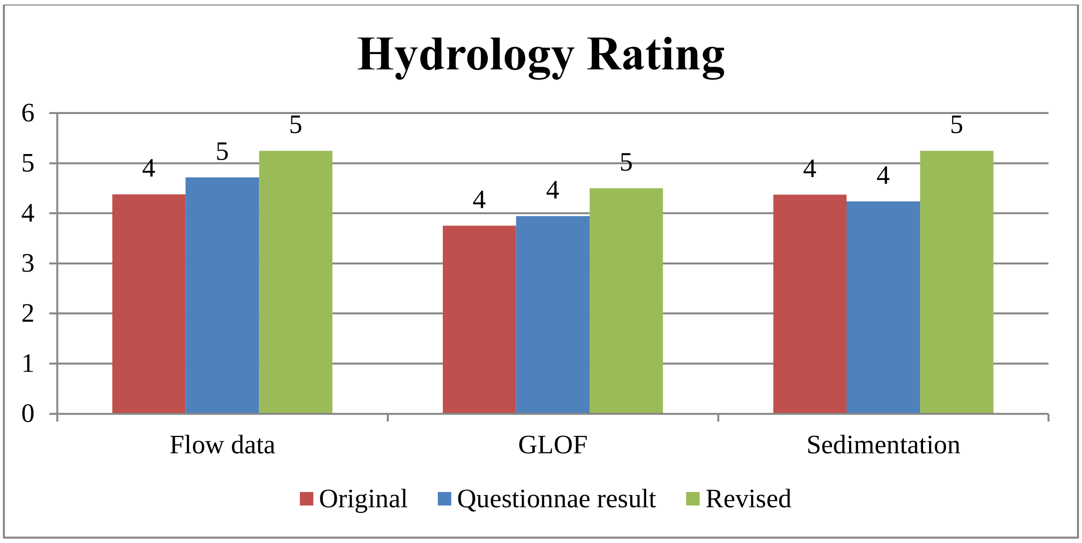



**Figure 12.2-1 Summary Result of Hydrology Rating**

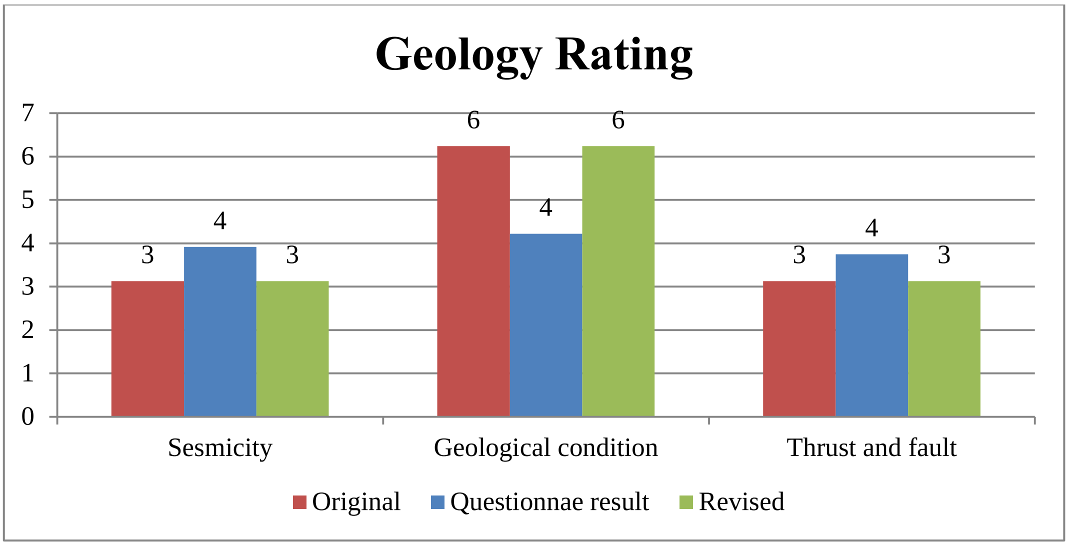



**Figure12.2-2 Summary Result of Geology Rating**

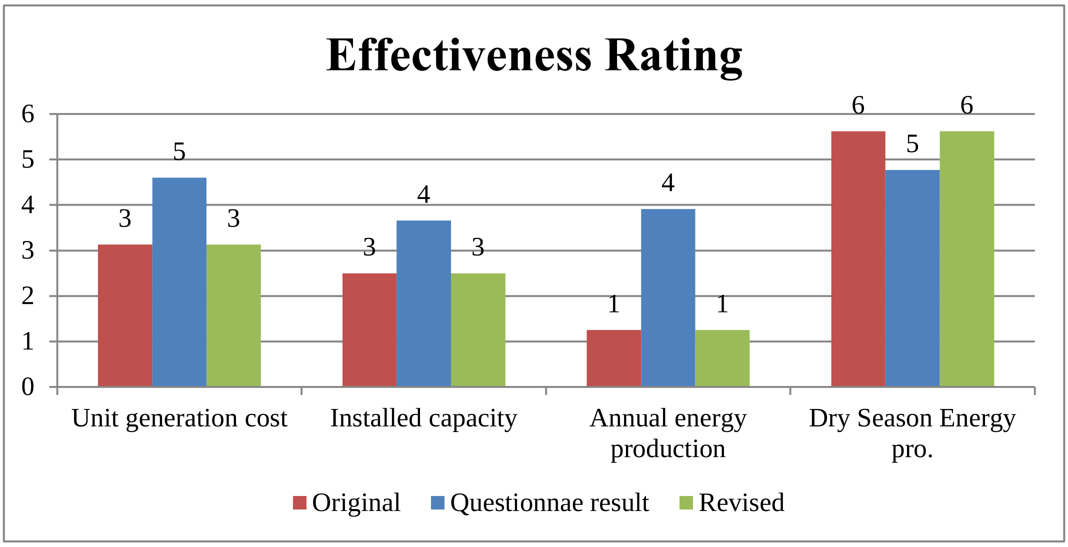



**Figure 12.2-3 Summary Result of Effectiveness Rating**

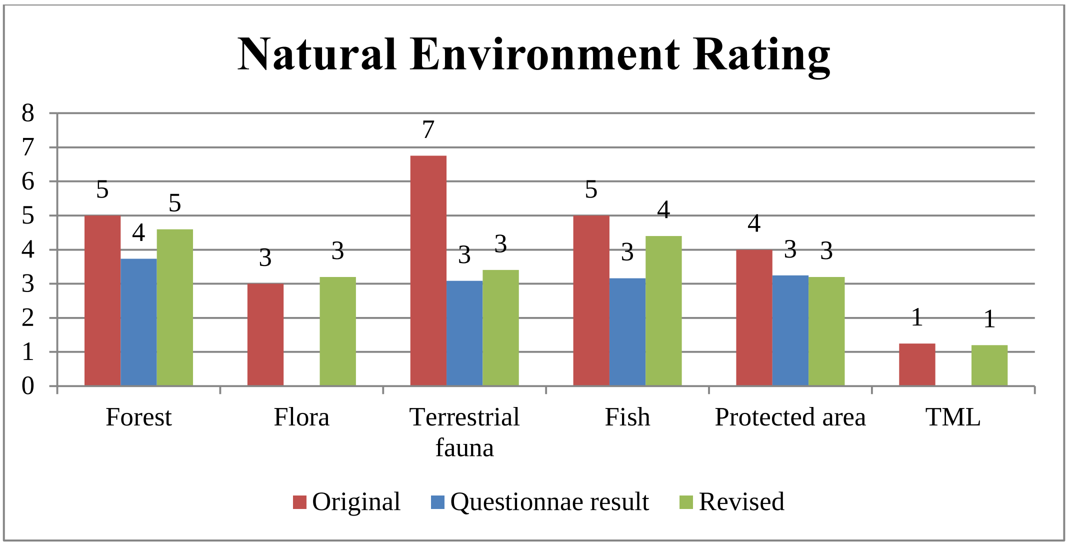



**Figure 12.2-4 Summary Result of Natural Environment Rating**

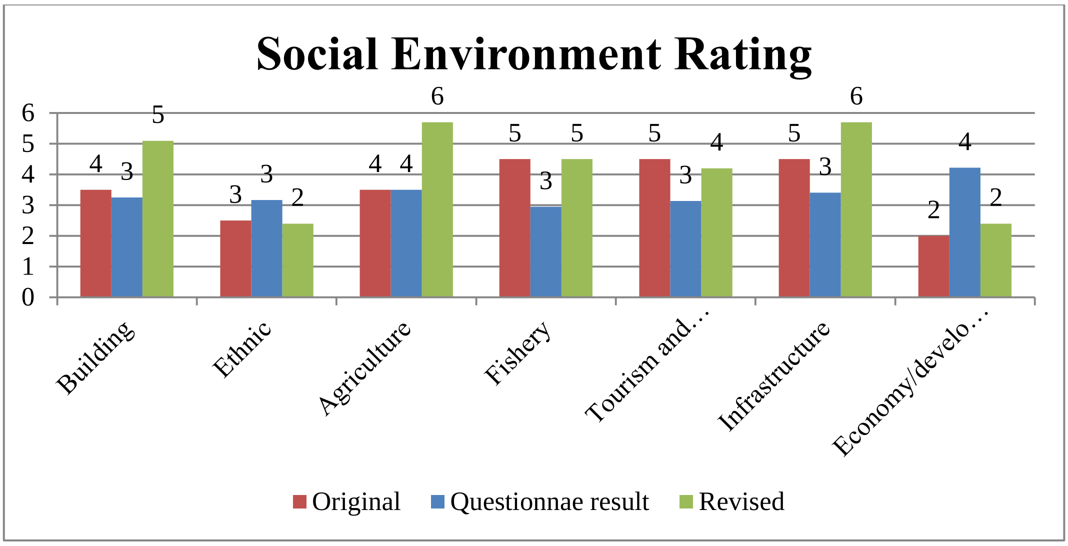



**Figure 12.2-5 Summary Result of Social Environment Rating**

In response to the above results, regarding the evaluation criteria with which promising project would be evaluated, the weightage for categories, subcategories and all evaluation items under subcategories were reviewed. As a result, the weightage were given to hydrological conditions, geological conditions, lead time and effectiveness as 30:25:20:25 respectively. About natural environment and social environment, the proportion of weightage between impact on natural environment and impact on social environment equal 40:60.

In addition, the Study Team decided to conduct sensitivity analyses for 4 cases. An equal weight as 50 % put on each technical/economical conditions and natural/social environment in case 1, weight as 60 % put on technical/economical conditions in case 2, weight as 60 % put on natural/social environment in case 3 and weight as 75 % put on technical/economical conditions in case 4.

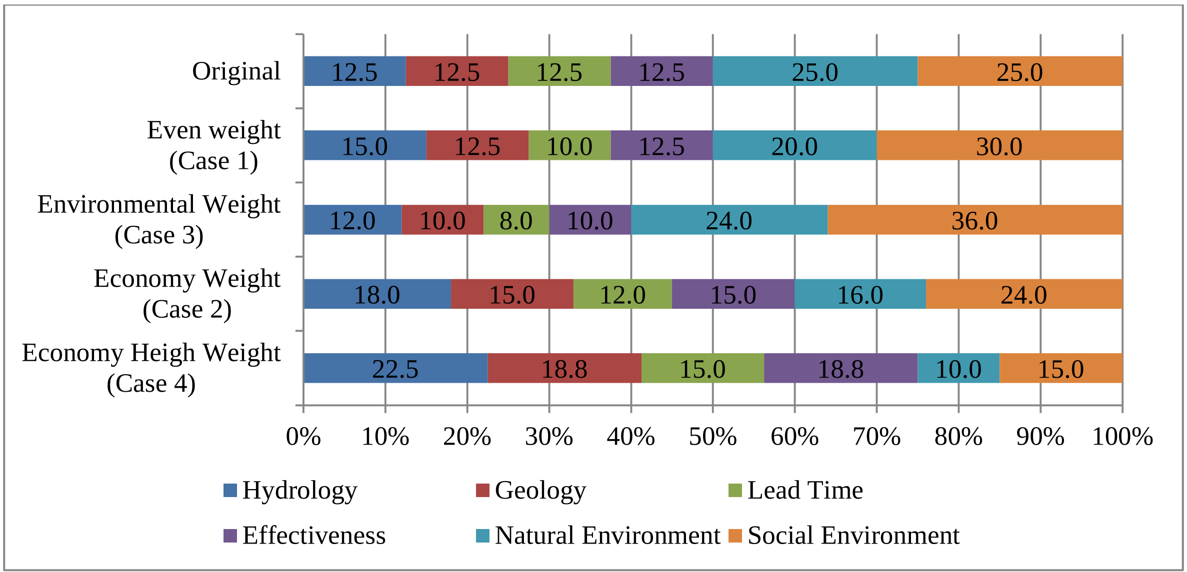



**Figure 12.2-6 Cases of Sensitive Analysis**

The agenda and the list of participants of the 2nd stakeholders meeting are attached as Table 12.2-2 and Table 12.2-3 at the end of this section.

**Table12.2-2 Program of the 2nd Stakeholders Meeting**

| No. | Time | Program | Speaker/Presenter |
|---|---|---|---|
| 1 | 9:30-9:35 | Welcome address | Mr. LilaNath Bhattarai<br>Director, NEA |
| 2 | 9:35-9:40 | Opening address | Mr. Hari Ram Koirala<br>Chief Guest |
| 3 | 9:40-9:55 | Background of the project | Mr. Sunil Kumar Dhungel<br>Project Development Division, NEA |
| 4 | 9:55-10:15 | Evaluation of potential projects and selection of promising projects | Mr. Takashi Mimura<br>JICA Study Team |
| 5 | 10:15-10:55 | Report on site survey at 10 promising projects | Mr. Hiroyasu Akaike, Mr. Nobuo Hoshino, and Ms. Akiko Urago<br>JICA Study Team |
| 6 | 11:10-11:30 | Assigning weightage of 10 promising projects | Ms. Keiko Otoguro<br>JICA Study Team |
| 7 | 11:30-12:00 | Discussion | *All Participants* |
| 8 | 12:00-12:20 | Concluding Remarks | Mr. Hisashi Hoshino,<br>First Secretary, Embassy of Japan in Nepal<br>Mr. Mitsuyoshi Kawasaki,<br>Chief Representative, JICA in Nepal |
| 9 | 12.30-12.40 | Vote of Thanks | Mr. U.D. Bhatta,<br>GM, NEA |

## Table 12.2-3 Participant List of the 2nd Stakeholders Meeting

| Category | Name | Organization/Department | Position |
|---|---|---|---|
| Ministry and relevant Organization | Hari Ram Koirala | Ministry of Energy | Secretary |
| | Moti B. Kunwar | Ministry of Energy | Joint. Secretary |
| | Srirajan Lamsal | Ministry of Science, Technology and Environment | Asst. Secretary |
| | Purna Ghimire | Ministry of Defense | Section Officer |
| | Jaya Kumar Katuwal | Ministry of Local Development | Account Officer |
| | Saroj Kumar Uphadya | Nepal Engineering Council | Vice Chairman |
| | Dhanbir Yadav | Department of Hydrology and Meteorology | Engineer |
| | Anupa Upadhya | Department of Electricity Development (DoED) | Director General |
| | Barna Bahadur Thapa | Department of National Park and Wildlife Conservation (DNPWC) | Under Secretory |
| | Dilip Sadank | Department of Soil Conservation and Watershed Management | SDEG |
| | Krishna Bahadur Katwal | Department of Local Infrastructure Development and Agriculture Roads | Engineer |
| | Damodar Bhakta | Trisuli 3B HEP | Project Manager |
| | Shailendra Lal | N/A | Deputy Manager |
| INGO | Ramesh Adhikari | World Wildlife Fund, Nepal | PO |
| Association | Rohini Paudel | Nepal Engineering Association | Member |
| Institutions | Surya Man Shakya | School of Environmental Management and Sustainable Development (SchEMS) | Director |
| Media | Dhurba Basnet | NEFEJ (Nepal Forum of Environmental Journalist) | GS |
| | Ashok Thapa | The Kathmandu Post (newspaper) | Sub – Editor |
| | Pitamber Sigdel | Annapurna Post (newspaper) | Sr Reporter |
| | Sitaram Bilashi | Gorkhapatra | Reporter |
| Donors | Dr. Narayan Chaulagain | GIZ | Deputy Program Manager |
| | Rabin Shrestha | World Bank | Sr. Energy Sp |
| | Shyamal Shrestha | International Finance Corporation | Operations Analyst |
| Parties | Basant Man Singh Adhikari | Rastriya Janasakti Party (R.J.P.) | Central committee member |
| Others | Ram Kumar Sharma | Nepal Environmenal and Scientific Services | Socio Economist |
| Embassy | Hisashi Hoshino | Embassy of Japan | First Secretary |
| | Kailash Man Pradhan | Embassy of Japan | Program Manager |
| JICA | Kenichiro Iizuka | JICA Nepal Office | Representative |
| | Sourab Rana | JICA Nepal Office | Program Officer |
| | Yukiyoshi Ozaki | JICA | Expert |
| | Takashi Mimura | JICA Study Team | Leader |
| | Hiroyasu Akaike | JICA Study Team | |
| | Nobuo Hoshino | JICA Study Team | |
| | Akiko Urago | JICA Study Team | |
| | Takatsugu Okabe | JICA Study Team | |
| | Toshifumi Serizawa | JICA Study Team | |
| | Keiko OTOGURO | JICA Study Team | |
| NEA | Biswa Dhoj Joshi | NEA | Manager |
| | Sunil Kumar Dhungel | NEA | Director |
| | Upendra Dev Bhatta | NEA | General Manager |
| | Rita Duwal | NEA | Civil Engineer |
| | Indra Prasad Neupane | NEA | Sr. Vice President |
| | Sagar Suwal | NEA | Dept. Manager |
| | Gyanendra P Kyastha | NEA | Manager |
| | Khagendra Shahi | NEA | |
| | Lila Nath Bhattarai | NEA | Director |
| | Hara Hansha Bajracharya | NEA | Asst. Manager |
| | D. S. Paudel | NEA | Director |
| | Birendra K. Pathak | NEA | General Manager |
| | Jayendra Shrestha | NEA | Director |
| | Pradeep Thike | NEA | Manager |

| Category | Name | Organization/Department | Position |
|---|---|---|---|
| | Rajeev Sharma | NEA | Director |
| | Bipnnanda Bijracharya | NEA | D. Manager |
| | Nireshwor Prasai | NEA | Dept. Manager |
| | Jagadishwor M Singh | NEA | Director |
| | Mahesh M. Shrestha | NEA | Deputy. Director |
| | Jayandra Man Tamrakar | NEA | Manager |
| | Uttam Amatya | NEA, | Manager |
| | Shanti Laxmi Shakya | NEA | Act. Director |
| | Amogh Manandhar | NEA | Dep. Manager |
| | Mohan Raj Panta | NEA | BOD |
| | Bhupendra Raj Gorkhali | NEA | Deputy Manager |
| | G. K. Lohia | NEA | Manager |
| | Tika Ram Paudel | NEA | Asst. Manager |
| | Keshab Raj Bhatta | NEA | Asst. General Manager |
| | Bishnu Malla | NEA | D. Manager |
| | Manju Lal Shrestha | NEA | Asst. Engineer |
| | Ishwori Prasad Khatiwoda | NEA | Act. DMD |
| | Gosai K. C. | NEA | Director |
| | Anil Rajbhandari | NEA | Manager |
| | Govind Raj Khanal | NEA | Director |
| | Mohan Shakya | NEA/ESSD (Environmental and Social Studies Department) | Director |
| | Raju Gyawali | NEA/ ESSD | Env. Specialist |
| | Lakshman Jha | NEA/PDD (Project Development Department) | Deputy Manager |
| | Ram Hari Gautam | NEA/ PDD | A.C. Officer |
| | Janak Mahat Chhetri | NEA/PDD | Asst. Admin Officer |
| | Ram Kumar Thebe | NEA /Employee Union | Vice President |
| | Rudra Bdr. Adhikari | NEA/Engineering Services | Assistant Director |
| | Durga Prasad Dhakal | NEA/Nepal Rastriya Karmachari Sangathan, | |
| | Sitaram Thapa | NEA /Nation Employee Organization | Chairman |

The 2nd Stakeholders Meeting received press coverage at least by 8 different newspapers in the next day of the Meeting. The following is one example of the press release in English-language newspaper.

The Rising Nepal

BUSINESS

2

# More projects must to solve power crisis

By A Staff Reporter
Kathmandu, Nov. 28

A study has suggested opting for 10 most viable reservoir-based hydropower projects in Nepal to address the widening difference between demand and supply of energy in the country during the dry season.

The study jointly conducted by the Nepal Electricity Authority (NEA) and Japanese International Cooperation Agency (JICA) has called for building 10 reservoir-based power projects that could be built at low cost within a short period.

JICA, which has been developing a master plan for the development of reservoir-based hydropower projects at the national level, had sorted out 10 most viable projects out of 67 reservoir-based projects in the country.

These projects were selected as most viable after conducting detail analysis of their geographical, environmental and social impacts.

According to the report, the proposed 10 projects will generate a total of 2643-MW electricity. The projects have individual capacity of around 200-400-MW.

However, the NEA is still in confusion in bringing investment for the implementation of these projects.

The selected projects are Dudhkoshi (300-MW), Kokhajor (111.5-MW), Sunkoshi-III (536-MW), Lower Badigadh (380.3-MW), Aandhikhola (180-MW), Chera-I (148.7-MW), Lower Jhimruk (142.5-MW), Madi (199.8-MW), Naksalgadh (400-MW) and Naumure (245-MW).

Out of these, the NEA has itself taken initiation for constructing Naksalgadh and Dudhkoshi projects.

Out of these projects, Canadian International Water and Energy Consultancy has carried out a preliminary feasibility study of the Dudhkoshi and JICA conducted the study of Sunkoshi, while NEA has carried out the preliminary feasibility study of rest of the projects.

Speaking at interaction in the capital, Energy Secretary Hariram Koirala said that the study would help in the development of the reservoir-based hydropower projects.

"The country will be free from the problem of load-shedding during the dry season if these projects materialise," Koirala said.

He said that the government would pay due attention towards implementing those projects.

| S.N. | Projects | Capacity (MW) | Cost (US$) in million |
|---|---|---|---|
| 1 | Dudhkoshi | 300 | 830.3 |
| 2 | Kokhajor | 111.5 | 624 |
| 3 | Sunkoshi-III | 536 | 1147 |
| 4 | Lower Badigadh | 380.3 | 572.8 |
| 5 | Asndhikhola | 180 | 450.3 |
| 6 | Chera-I | 148.7 | 332.2 |
| 7 | Lower Jhimruk | 142.5 | 312.4 |
| 8 | Madi | 199.8 | 394.5 |
| 9 | Naksalgadh | 400 | 741.3 |
| 10 | Naumure | 245 | 594.5 |

Domestic tourists enjo
Dhampus of Kas

**Figure 12.2-7 Example of Press Release about 2nd Stakeholders Meeting**

## 12.3 The 3rd Stakeholders Meeting

The Study team conducted the evaluation about the 10 promising project taking into consideration the comments raised in the 2nd stakeholders meeting and the result of site survey. With the purpose to sharing the results of the Study and the evaluation of 10 promising projects,

On February 13, 2013, the third stakeholders meeting that was co-hosted by NEA and the Study Team was held in Kathmandu. 107 participants including the Study Team were recorded for this meeting.

In this meeting, the result of power demand forecast and the evaluation results of promising projects taking into account the comments collected in the 2nd 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.

The main opinions and suggestions raised during the meeting were as follows.

**Table 12.3-1 Comment in the Third Stakeholders Meeting and Reply or Action Taken by NEA and Study Team (Tentative)**

| No. | Name | Comment | Reply or action by NEA / JICA Study Team |
|---|---|---|---|
| 1 | Mr. Sitaram Thapa NEA Employee Union | Value of regulated water was suggested to be considered as an evaluation indicator when ranking the project during the 2nd stakeholder meeting. But it seems that it has not been considered and without its consideration, the project cannot consider technically, legally and practically feasible. | As described in No. 8 in the Q&A of the 2nd SHM, the value of regulated water was not considered in this study because a variety of data and information is required to conduct quantitative evaluation. This evaluation should be conducted in the FS stage of each project. |
| 2-1 | Mr. Shriranjan Lakoul Ministry of Energy | Whether the INPS Plan is covered or not in Demand Forecast? | *[What is "Integrated Nepal Power System Plan"? What is the relation between the INPS plan and demand forecast?]* |
| 2-2 | | Hydro combination- is 100 % hydro system reliable? | It is the basic policy whether to rely about 100% on hydro power or to supply by thermal power to some degree. Currently, about 7.5% of the total installed capacity is thermal power (diesel), but it has been used very little because its generation cost is very high. Taking into consideration the fuel supply condition in the country, is it realistic to make a policy to develop a significant capacity of new thermal power generation in the next 20 years? Accordingly, the Study Team proposes that the power expansion plan in this study does not consider new thermal power generation but it adopts relatively large reserve margin or small LOLP.<br>Regarding wind power and solar generation, they are suitable for electrification in small areas, but they will be one of complementary power sources in the INPS. |
| 2-3 | | Value of irrigation water to be considered- also suggested in 2nd Stakeholder Meeting. | As described in No. 1-2 in the Q&A of the 2nd SHM, in addition to that this is the MP study on hydroelectric power generation, it is not easy to evaluate each project quantitatively by the total benefits of power generation and other uses in the MP stage because it requires a lot of data and information. Accordingly, the benefit of promising projects were evaluated based on only hydroelectric power generation.<br>Possibility (or detail) of multi-purpose development of these projects will be studied individually by another study before implementation of these projects. |
| 2-4 | | Issue of overlapping projects to be considered. | Since the power house of the Lower Jhimruk Project is planned in the reservoir of the Naumure Project, these two projects are not compatible. The study team recommends the Lower Jhimruk Project since this project has been ranked higher. |

| No. | Name | Comment | Reply or action by NEA / JICA Study Team |
|---|---|---|---|
| 2-5 | | Geological criteria are given heavy weightage, why? | Geological conditions have impacts on construction cost. In the DD (and FS) stage, they are considered in project costs, duration of construction, etc. In the MP stage, however, since it is difficult to consider them in project costs, etc., geological conditions were used for one of qualitative parameters to evaluate the degree of difficulty to realize a project. |
| 3-1 | Mr. Mohan Shakya NEA | Since Nalsyau Gad is already in initiation process by the government, it should be reduced from the 10 priority list. | When the Nalsyau Gad Project was selected as one of promising projects, this project was not in the initiation process by the government. |
| 3-2 | | GLOF risk project such as Dudh Koshi is ranked as 2nd, how? | In the FS of the Dudh Koshi Project in 1998, the impact of GLOF was evaluated. According this study, the peak discharge of GLOF are able to be controlled by the spillway designed for PMF. Further study should be conducted before implementing the project taking into consideration the latest data and information. |
| 4-1 | Mr. Subarnadash Shrestha SANIMA Hydropower | What is the proportion of Reservoir Consideration? | *[What is "Reservoir Consideration"?]* |
| 4-2 | | Harmonization with previous studies/target to be made such as 10,000 MW by ------23,000 MW (WECS) to achieve the actual results. | The targets of these studies include power export. But, since this MP study is for domestic demand, the target was put on the result of demand forecast, 4,300 MW in FY2031/32. |
| 4-3 | | Beneficial impacts to be highlighted by the study. | Both positive and negative impacts should be properly considered. |
| 4-4 | | Compensation mechanism to the affected families /institutions to be proposed in the report. | In this study, the compensation cost of each promising project was estimated and taken into consideration in the project cost. The study team understands the importance of compensation mechanism, but since this is a very big issue and not only for hydroelectric power projects, this mechanism should be proposed in the study on this issue. |
| 4-5 | | Tariff rate should also be proposed. | *[See the answer to comment No. 5.]* |
| 5 | Mr. Saroja Upadhyaya Nepal Engineering Council and HP Developer | The study should also analyze and indicate the investment potential / investor / development partners and recommend the tariff rate based on economic viability. | 1. The financial and economic analyses of each promising project were done based on assumed tariff rates. Their results are presented in the report to facilitate discussions on the feasibility of these projects and expected returns on investments in them. The analyses were done assuming |

| No. | Name | Comment | Reply or action by NEA / JICA Study Team |
|---|---|---|---|
| | | | that these projects would provide wholesale electricity to NEA. The rages of wholesale tariff rates for attractive returns on investments are calculated based on the financial analyses performed for all the promising projects.<br><br>Regarding the setting of NEA's retail tariff rates, the study teams considers the rates are subjects of policy and political considerations based on, for example, the economic and financial analyses of the promising power development projects. However, the study team prefers subsidy free retail tariff rates securing the financial viability of NEA business. The subsidy free tariff rates and better performance of the Nepali's economy without distorted power markets were assumed in the demand forecasting model.<br><br>2. The identification of candidate investors for the ten promising projects should include the assessment of such candidates' imbedded risks and performances. The team considers that these assessments are not included in the terms of reference of this study. |
| 6 | Mr. Dipak Rauniyar<br>Hydroelectricity Investment & Development Co., Ltd. | Investment aspects in JICA master plan study should be considered and analyzed. | *[See the answer to comment No. 5.]* |

Addition to the above mentioned opinion obtained during the meeting, some more comments were collected by questionnaire survey conducted in this meeting. 40 respondents gave their opinions about the points which should be carefully noted for making the master plan of storage type hydroelectric power development in their answer to the questionnaire. The respondents described various opinions, such as the necessity of urgent implementation of the selected project, the necessity of harmonization with other master plan or ongoing study and the necessity of the study about the impact in downstream of project area.

Considering all above comments in the Study, the Study Team decided to conduct more detailed study on cumulative impact and on mitigation for cumulative impact.

The agenda and the list of participants of the 3rd stakeholders meeting are attached as Table 12.3-2 and Table 12.3-3 at the end of this section.

**Table12.3-2 Program of the 3rd Stakeholders Meeting**

| No. | Time | Program | Speaker/Presenter |
|---|---|---|---|
| 1 | 10:00-10:10 | Welcome address | Mr. Birendra Kumar Pathak<br>General Manager, NEA |
| 2 | 10:10-10:30 | Background of project | Mr. Biswa Dhoj Joshi<br>Manager, NEA |
| 3 | 10:30-10:45 | Power Demand Forecast | Mr. Toshifumi Serizawa<br>JICA Study Team |
| 4 | 10:45-11:05 | Required Installed Capacity of Storage-type Hydroelectric Power Generation | Mr. Takashi Mimura<br>Leader, JICA Study Team |
| 5 | 11:05-11:15 | Evaluation Criteria and Weight | Ms. Keiko Otoguro<br>JICA Study Team |
| 6 | 11:30-12:20 | Evaluation Results of 10 Promising Projects | Dr. Toran Sharma<br>NESS<br>Ms. Akiko Urago<br>JICA Study Team |
| 7 | 12:20-13:00 | Discussion | *All Participants* |
| 8 | 13:00-13:10 | Concluding Remarks | Mr. Hisashi Hoshino<br>Embassy of Japan in Nepal<br>Mr. Toru Kobayakawa<br>JICA Tokyo |
| 9 | 13:10- 13:15 | Vote of Thanks | Mr. Rameshwar Yadav<br>Managing Director, NEA |

## Table12.3-3 Participant List of the 3rd Stakeholders Meeting

| Category | Name | Organization/Department | Position |
|---|---|---|---|
| Ministry and relevant Organization | Hari Ram Koirala | Ministry of Energy | Secretary |
| | Srijana Lama | Ministry of Energy | |
| | Ram Pd. Ghimire | Ministry of Energy | DMG Sect. |
| | Kabindra Karki | Ministry of Urban Development | SDE |
| | Divakar Kharel | Water and Energy Commission Secretariat (WECS) | SDE |
| INGO/NGO | Santim Nepal | World Wildlife Fund, Nepal | Director |
| | Dinesh Pariyar | Society for Sustainable Development (SSD) | Chairman, Pasture and Fodder Expert |
| Association | Subam Shah | Independent Power Producers' Association, Nepal (IPPAN) | President |
| | Narayan Parajuli | Power Producers Association of Nepal (PPAN) | Treasure |
| | Kumar Pandey | IPPAN | |
| Institutions | Kamala Kant Acharya | TU | Asst. Professor |
| | Subesh Ghimire | TU | Asst. Professor |
| | Sunil K. Dwivedi | TU | Asst. Professor |
| Media | Senchhelung Limbu | Ujyoalo 90 FM | Reporter |
| | Bishnu Belbase | Abhiyan | Reporter |
| | Bhavesh Adhikari | Kantipur | Journalist |
| | Bijaya | Kantipur | Journalist |
| | Rudra Pangeni | The Himalayan Times | Reporter |
| | Yogesh Pokharel | TRN | Reporter |
| | Ashok Thapa | Kathamandu Post | Sub Editor |
| | Laxaman Biyogi | Nepal Samachar Patra | Sr. Correspondent |
| | Sachen Gautam | Naya Patrika | Journalist |
| | Ram Pd. Pudasaini | Aarthik Daily | Reporter |
| Others | Sanjeeb Baral | Hydroelectricity Investment & Development Company Limited (HIDCL) | SDE |
| | Deepak Rauniar | HIDLC | |
| | Salil Devkota | NESS | Managing Director |
| | Toran Sharma | NESS | Technical Director |
| | Ram Kumar Sharma | NESS | Socio Economist |
| | Madan Koirala | NESS | Environmentalist |
| | Megh Raj Dhital | NESS | Geologist |
| Embassy | Hisashi Hoshino | Embassy of Japan | First Secretary |
| | Kailash Man Pradhan | Embassy of Japan | Program Manager |
| JICA | Toru Kobayakawa | JICA Tokyo | Advisor |
| | Kenichiro lizuka | JICA Nepal Office | Representative |
| | Sourab Rana | JICA Nepal Office | Program Officer |
| | Yukiyoshi Ozaki | JICA | Expert |
| | Takashi Mimura | JICA Study Team | Leader |
| | Hiroyasu Akaike | JICA Study Team | |
| | Nobuo Hoshino | JICA Study Team | |
| | Akiko Urago | JICA Study Team | |
| | Takatsugu Okabe | JICA Study Team | |
| | Toshifumi Serizawa | JICA Study Team | |
| | Keiko OTOGURO | JICA Study Team | |
| NEA | Amogh s. Manandhar | NEA | Dep. Manager |
| | Bharat Pd. Mainar | NEA | Asst. Manager |
| | UD Bhatta | NEA | GM |
| | BiswaDhoj Joshi | NEA | Manager |
| | Rajesh Sapkota | NEA | Engineer |
| | Sunil Kumar Dhungel | NEA | Director |
| | Rameshwor Yadav | NEA | MD |
| | Bharat Pd. Mainar | NEA | PM |
| | Damodar BS | NEA | |
| | Hari R. Shreestha | NEA | Director |
| | Sanjib Jha | NEA | Manager |
| | Sagar | NEA | Manager |
| | Gyanendra P Kyastha | NEA | Manager |
| | Santosh Maharjan | NEA | Engineer |

| Category | Name | Organization/Department | Position |
|---|---|---|---|
| | Bijaya Bajracharya | NEA | D. Manager |
| | Pradip Man Shrestha | NEA | Engineer |
| | Subindra Shrestha | NEA | Engineer |
| | Lila Nath Bhattarai | NEA | Director |
| | Krishna Pd. Ghimire | NEA | Engineer |
| | Surendra Chaudhary | NEA | Engineer |
| | Surya Narayan | NEA | Engineer |
| | Saroj Kumar | NEA | Vice Chairman |
| | D. S. Paudel | NEA | Director |
| | Preetam Pradhan | NEA | Dept. Manager |
| | Birendra K. Pathak | NEA | GM |
| | Shailendra | NEA | DM |
| | Deepak | NEA | |
| | Pradeep Kumar Thinke | NEA | Manager |
| | Rajeev Sharma | NEA | Director |
| | Tara Harsh Bajracharya | NEA | Asst. Manager |
| | Rajendra Thapa | NEA | A/c Officer |
| | Bikash Dongal | NEA | Engineer |
| | Lakshan Shah | NEA | Dept. Manager |
| | R.S Sayami | NEA | |
| | Surendra Acharya | NEA | Asst. Manager |
| | Jagadishwor M Singh | NEA | Director |
| | Mahesh M. Shrestha | NEA | Deputy. Director |
| | Pujan Piya | NEA | Asst. Manager |
| | Jayandra Man Tamrakar | NEA | Manager |
| | Lek Nath | NEA | Act. Director |
| | Shanti Laxmi Shakya | NEA | Act. Director |
| | Deepak Pd. Bhul | NEA | Engineer |
| | Mohan Shakey | NEA | Director |
| | Jhalak Ram Subedi | NEA | Asst. Manager |
| | G.opal Kumar Lohia | NEA | Manager |
| | Tika Ram Paudel | NEA | Asst. Manager |
| | Keshab Raj Bhatta | NEA | Director |
| | Lava Ghimire | NEA | |
| | Nass Man Pradhan | NEA | Manager |
| | Kuber lal Shrestha | NEA | Admn. Officer |
| | Pradeep Manandhar | NEA | Manager |
| | Anil Rajbhandari | NEA | Manager |
| | P.C Gupta | NEA | DM |
| | Dr. Dambar Bdr. Nepal | NEA/BOD | BOD |
| | Indra Prasad Neupane | NEA/EA | Sr. Vice President |
| | Amar Rajbhandari | NEA/ESSD | Deputy manager |
| | R. P Rimal | NEA/EU | President |
| | Ram Hari Gautam | NEA/ PDD | A.C. Officer |
| | Janak Mahat Chhetri | NEA/PDD | Asst. Admin. |
| | Bhupendra R. Gopal | NEA/PDD | D. Manager |
| | Puskar Amatya | NEA/PDD | Engineer |
| | Khagendra Shahi | NEA /NEON | President |
| | Kul Man Singh | NEA/Chilime | Managing Director |
| | Sitaram Thapa | NEA /Nation Employee Organization | Chairman |

The 3rd Stakeholders Meeting received press coverage in the next day of the meeting at least by 3 different newspapers such as The Rising Nepal, Himalayan Times and 1 Nepal newspaper. The following is the press release in English-language newspaper.

THE HIMALAYAN TIMES, THURSDAY, FEBRUARY 14, 2013 www.thehimalayantimes.com

BUSINESS

# Board to fast track hydro negotiations

Himalayan News Service
[Kath]mandu, February 13

Investment Board will fast track formal negotiations on Project Development Agreement (PDA) with three mega hydropower developers covering four projects.

After a meeting of the directors of Investment Board, chaired by caretaker prime minister Dr Baburam Bhattarai, today, in Kathmandu, the board has decided to fast track formal negotiations on each of the four hydropower projects — SN Power's Tamakoshi 3 (650MW), SJVN's Arun 3 (900MW), and GMR's Upper Karnali (900MW) and Upper Marsyangdi 2 (600MW).

The companies had reviewed a draft of the PDA template and commented on it in December.

"The comments have been taken into account by the Investment Board and it will engage in finalising the project specific PDAs," said Bhattarai, in the meeting.

"The number one economic priority of the government has always been to harness hydro resources for economic transformation," he said, adding the country now will move forward with negotiations. "We will conclude deals that ensure maximum benefits in terms of government revenue, local benefits for communities, maximising hydro spin offs for domestic industries and services sector, jobs for Nepalis, and solve loadshedding problem," he added.

The board will use PDA template as the basis for negotiations and tailor it to suit each of the four projects.

With an installed capacity of a total 3,050MW, four projects aimed at Indian market will first satisfy domestic power needs. Of the four projects, Arun 3 has committed to provide Nepal with 21.9 per cent free electricity while Upper Karnali has committed 12 per cent free electricity and 27 per cent free equity, in addition to paying royalties and taxes.

Has decided to speed up formal deals on Tamakoshi III, Arun III, Upper Karnali and Upper Marsyangdi II

"PDA template reflects several changes following a detailed feedback from developers and the international lender community," informed chief executive of the board Radhesh Pant.

"In addition to a team of world class commercial, technical and legal experts, the board will be working very closely with the Ministry of Energy and Nepal Electricity Authority to bring this PDA to fruition," he said, adding that with the board's endorsement of the negotiating mandate, PDA Negotiation Team will begin project specific negotiations with the developers immediately under the guidance of a PDA Coordination Committee chaired by the vice chair of National Planning Commission Deependra Bahadur Kshetry.

PDA Negotiation Team will be advised by relevant national and international legal, technical and commercial experts, said Pant, adding that an international team of experts has been appointed to provide input to the Investment Board in its assessment. "Negotiations on large-scale projects like these generally take several months to close."

Pant informed that the board has been conducting thorough financial analysis to assess economic benefits that would accrue to Nepal from the investment necessary to implement these hydro projects, each of which costs more than $1 billion (around Rs 85 billion).

"We have just appointed a leading engineering firm Lahmeyer International with assistance from World Bank through an open competitive process to review the four projects," he informed. "Their findings as well as our financial analyses will help inform Nepal's negotiating position."

"The board will sign deals that are balanced with terms that protect and benefit all parties," Pant said. Technical analysis will also ensure that these power projects are safe and sustainable.

The board also made decisions on other large infrastructure projects and gave the Office of the Investment Board the approval to move ahead with a Detailed Project Report of Kathmandu Valley Metro Rail project, mandated the Office of the Investment Board to form a six-member verification team to move forward with Kathmandu Valley Solid Waste Management project, and decided to conduct a feasibility study for a chemical fertiliser plant.

**Figure 12.3-1　Example of Press Release about 3rd Stakeholders Meeting**

## 12.4　Discussion at the Regional Office in Pokhara

**Visit Report of the Regional Offices in Pokhara**

### Introduction

The main purpose of visiting regional offices at Pokhara was to get information regarding developmental planning in the Western Development Region of Nepal with particular focus on the proposed storage types Hydroelectric power Project locations and to identify whether there will be major developmental conflict with concerned offices during project implementation. The visit was conducted to Regional Irrigation Office, Regional Agricultural Office and Regional Road Office on 13th June 2012. The Team Leader, Sub-Leader and Environmental and Social experts of the study team made visit to those offices. During the visit, meeting was held with the officials of the concerned offices informing them about the proposed projects that have been under study.

Team Leader Mr. Mimura highlighted the need of storage type projects in Nepal in the context of current power shortage. He also described about the proposed storage type projects at Western Developmental Region of Nepal with regards to the site, locations and features. He briefed about the projects like the Lower Badigad Project at Gulmi, the Andhi Khola Project at Syangja, the Lower Jhimruk Project at Arghakhanchi/Pyuthan and the Naumure (W. Rapti) Project at Arghakhanchi/Pyuthan that are located at Western Developmental Region of Nepal. After then, the concerns and issues raised by the officials were discussed and information regarding the developmental planning at such project sites was collected.

### Output of Visit

***Visit at Regional Irrigation Office***

During the visit at Regional Irrigation Office, meeting was held with Engineers Mr. Mahesh Yadav, and Mr. K.R. Baral. Mr. Baral and Mr. Yadav informed to the study team that the office is responsible mainly for construction and rehabilitation of irrigation projects. With regards to the irrigation plans at those project locations Mr. Baral informed that there are some farmers built small irrigation schemes in and around the Andhi Khola Project at Syangja. He also highlighted that there are no such major projects that are being planned in proposed project locations and added that although some minor irrigation schemes are there, the priority should be given to the storage type hydroelectric power development considering the current power shortage being faced by Nepal.

***Regional Road Office***

At regional road office, meeting was held with Mr. Subir Rai (Engg.), Mr. Bishwa Bijay Lal Shrestha (Engg.), Mr. Lilamani Sigdel and Ms. Ganga Kumari Thapa. They have informed to the team that under regional office there are five divisions. They suggested the study team to visit the respective division offices to get in depth information about the road development plans that are being proposed and under implementation at proposed storage hydroelectric power development sites. They also added that there are some road projects and RCC bridges that are planned and under construction at some locations of the proposed project sites. They also added that no major roads and bridges construction with the high national priority are being planned in the proposed storage hydroelectric power projects and emphasized for the development of mega hydroelectric power projects from rivers of Nepal in order to resolve the current energy crisis being faced by the nation.

***Regional Agriculture Office***

Meeting was held with Mr. Khem Narayan Chapagain (Agri. Extension Officer), Mr. Saroj Adhikari (Engg.), Mr. Matibar Yadav, Mr. Rammaya Kadariya and Ms. Menaka Liwali. Discussion was held regarding the proposed projects located at this region of Nepal. Mr. Chapagain highlighted that although small scale agricultural areas are available at some pocket areas of the proposed project sites of this region, no major large scale nationally important agricultural areas are available. He also informed that from the Regional Agriculture Office none of the mega agricultural development projects have been planned in such areas and also suggested the study team to visit the respective District Agricultural Offices to get in depth information about it. He added that District Agricultural Offices are responsible for preparation of the Agricultural Development Plans in coordination with the Regional Office. He made aware to the study team that Agricultural Service Center under respective District Agricultural Offices publishes a Pocket Profile mentioning about the agricultural productivity at various places of the district and suggested to collect that Profile in order to get the productivity status in the various project sites.

The team from the Regional Agriculture Office also provided the green signal for the development of proposed storage type hydroelectric power projects.

**Conclusion**

After meeting with the above mentioned regional offices located at Pokhara, it can be said that the proposed project sites are not having major nationally prioritized developmental plans with respect to irrigation, road, bridges and agriculture development that will create a major conflict for the development of proposed storage type hydroelectric power projects. All the officials that have been participated during the meeting were found positive for the development of proposed storage type hydroelectric power projects in Western Development Region in order to get rid from the power crisis being faced by Nepal.

## 12.5 SEA Report Evaluation Meeting

**Minutes of Meeting**
**on**
**Nationwide Master Plan Study on Storage-type Hydroelectric Power Development in Nepal**
**Strategic Environmental Assessment (SEA) Evaluation Meeting**

Date and Time: June 5, 2013, 11:30-13:30
Place: Ministry of Energy, Kathmandu, Nepal
Participants (28) (see Attached-1 for detail):

SEA Evaluation Team Members (13):

- Ministry of Energy (6)
- Ministry of Agriculture Development (1)
- Ministry of Irrigation (1)
- Ministry of Forest and Soil Conservation (1)
- Ministry of Science, Technology, and Environment (1)
- Tribhuvan University (1)
- WWF (2)

Others (15):

- Nepal Electricity Authority (NEA) (4)
- JICA / NEA (1)
- JICA Study Team (6)
- Nepal Environmental and Scientific Services (P) Ltd (4)

The meeting was chaired by Mr. Hari Ram Koirala, secretary, Ministry of Energy. He has welcomed all the participants for the meeting and requested to provide their valuable comments in the report. He has mentioned that the valuable comments and suggestions received from the participants of meeting will become valuable for JICA study team in finalizing the report.

After the opening of the meeting by the secretary, Ministry of Energy, Mr. Takashi Mimura, team leader of JICA study team presents the thanks for holding this meeting.

After, Ms. Keiko Otoguro of JICA study team presented the composition of the draft SEA report, project screening and evaluation criteria. She has explained how projects were selected from a long list of 67 potential projects. During the first phase of study, 36 projects are excluded from 67 potential projects giving rations. She further explained in second step how 10 promising projects were selected out of 31 projects selected in the First step. The technical, economical, and environmental parameters used for evaluation and weightage given for each parameter were explained by her. While explain the Third step, she has shown location of promising project sites and site specific details of each of the selected 10 projects in one by one basis. She has explained sub category of all the 10 projects. The sub categories of project briefed by her includes hydrological conditions, geological conditions, lead time, effectiveness of project, impact on natural environment, impact on social environment, and different loss that is going to take place in 10 promising projects.

After the presentation by Ms. Otoguro, Dr. Toran Sharma presented the mitigation measures to be followed in those 10 promising projects. He has explained the basis of cost estimations for physical, biological and socio-economic environment. He has further explained the comparison of various losses and likely cost for mitigation for all the 10 promising projects.

After the presentation by Dr. Sharma, Ms. Akiko Urago presented the Cumulative Impact Assessment (CIA). She has covered basic information about CIA and why such assessment is necessary in the context of Nepal. She has explained a brief CIA covering physical, biological and socio-economic impacts of all project sites. After that she did scoping of all project sites of three main impacts namely water regulation effects on wetland ecosystem. The next impacts identified are barrier effects on fish migration. Another important impact is space crowning impact on forest ecosystem. She has presented scoping table for Cumulative impact giving items and comparing it with existing and planned hydroelectric power in Nepal.

After the presentation by Ms. Urago, the floor was open for discussion. The name of participants participated in the discussion along with response from JICA study team is highlighted below.

1. Mr. Ashish Bhadra Khanal, Senior Divisional Engineer, Department of Irrigation, Ministry of Irrigation

In the maps shown by Ms. Urago, some of the ongoing projects are missing (example: Sikta Irrigation Project, Bheri-Babai Multipurpose Diversion Project).

Mr. Khanal has mentioned that the national water plan has emphasized in River Basin Development through Integrated Water Resource Management Plan. That is why his department is insisting JICA study team to use multiple use of water while evaluating projects.

*Ms. Urago mentioned that she couldn't get such information while preparing the report. Now she will include project sites of Bheri Babai and Sikta in final report.*

2. Mr. Bishwo Dhoj Joshi, PDD, NEA

He has mentioned that the water balance table should use small scale and range for small river and it should be compared with same scale used for large river.

*JICA study team acknowledges it.*

3. Mr. Raju Gyawali, Environment Specialist, Environment and Social Studies Department, NEA

The report has highlighted all the negative or adverse impacts while developing 10 promising projects. However, the beneficial impacts of reservoir projects should also be highlighted in the report.

*JICA study team mentioned that the potential and likely benefits of storage project are known.*

4. Mr. Ramesh Prasad Sapkota, Lecturer, Tribhuvan University

The report has identified flora and fauna in the upstream of dam. It is advisable that it should be considered downstream of dam and in other areas as well. Besides he further mentioned that Cumulative Impact Assessment (CIA) is an important tool that needs to be integrated at plan and policy level where as IEE/EIA is at project level. The CIA presented here is not detail and followed the standard format.

*Ms. Urago acknowledges it and she further added that this CIA is prepared based on the secondary information and information obtained from site during the field survey. Ms. Urago further mentioned that it is now the time for the government to think for initiating CIA in Nepal.*

5. Mr.Ashish Bhadra Khanal, Senior Divisional Engineer, Department of Irrigation, Ministry of Irrigation

Mr. Khanal has mentioned that National Water Plan has given priority for irrigation sector development so master plan study of storage type hydroelectric power study should also give priority for multipurpose use of water.

*Mr. Mimura has replied that irrigation sector development is important for the country. Benefit to irrigation is not taken in consideration during this study. We will mention this issue in a final report.*

6. Dr. Prabhakar Pathak, Joint Secretary, Ministry of Agriculture and Development

Dr. Pathak mentioned that the government has given high priority for the development of energy, infrastructure, and agriculture sector. For the development of Agriculture sector, irrigation is essential and this is highest priority of water use in Nepal. In such promising projects, when irrigation components are not addressed, there might create some controversy among ministries. While constructing these promising projects, we are losing cultivated land and if irrigation facilities are not provided in remaining land, we might have to face the problem of food security. So this aspect needs to be considered in report.

*Mr. Mimura acknowledges such issues will be dealt in a project selected for feasibility study.*

7. Mr. Ashok Bhattarai, Scientific Officer, Ministry of Science, Technology, and Environment

Mr. Bhattarai has mentioned that, developing a reservoir means opportunities for creating new habitat, niches and other beneficial uses (like fisheries).
The report should mention the sources of River like snow fed, rainfall etc. The report should also like with the present global issue of climate change not only about GLOF. He has suggested that protected areas in upstream of dam should be maintained. He further added that the protected flora and fauna from Government of Nepal’s list (National Report) should also be included in the report.

*JICA study team acknowledges the comments and suggestions.*

8. Shuva Sharma, Consultant, WWF

Mr. Sharma asked environmental expert's opinion of JICA study team regarding the ranking of 10 projects (if possible) from environmental and social perspective.

Before responding to Mr. Sharma's question by the Study Team, secretary of Ministry of Energy Mr. Koirala announce the closing of the session.

At the end, Mr. Hari Ram Koirala, thanked everyone for actively participating in the meeting. He believes that JICA study team will address the comments and suggestions raised by the participants in the final report.

**Participants**

SEA Evaluation Team Members

Ministry of Energy (6):
Mr. Hari Ram Koirala, Secretary
Mr. Keshab dhoj Adhikari, Jt. Secretary
Mr. Sriranjan Lakoul, Jt. Secretary
Mr. Anup Kumar Upadhyay, Director General, Department of Electricity Development
Mr. Chatur B. Shrestha, Senior Division Geologist, Environment Unit
Mr. Shyam Kishor Yadav, Senior Division Engineer, Environment Unit

Ministry of Agriculture Development (1):
Dr. Prabhakar Pathak, Jt. Secretary

Ministry of Irrigation (1):
Mr. Ashish Bhadra Khanal, Senior Divisional Engineer, Department of Irrigation

Ministry of Forest and Soil Conservation (1):
Mr. Madhu Ghimire, Environment Officer

Ministry of Science, Technology, and Environment (1):
Mr. Ashok Pd. Bhattarai, Under Secretary

Tribhuvan University (1):
Mr. Ramesh Sapkota, Lecturer

WWF (2):
Mr. Shuva Sharma, Consultant
Mr. Dipesh Joshi, Program Officer

Others

Nepal Electricity Authority (NEA) (4):
Mr. Sunil Kumar Dhungel, Director
Mr. Biswo Dhoj Joshi, Manager, Project Development Department
Mr. Raju Gyawali, Environmental Specialist
Mr. Gopal Kumar Lohia, Manager, Project Development Department

JICA / NEA (1):
Mr. Yutaro Mizuhashi, Expert

JICA Study Team (6):
Mr. Takashi Mimura, Team Leader
Mr. Hiroyasu Akaike, Sub-Leader/Hydropower Engineer
Mr. Nobuo Hoshino, Senior Consultant

Ms. Akiko Urago, Environmental Consultant
Mr. Takatsugu Okabe, Manager
Ms. Keiko Otoguro, Coordinator/Sub-Environmental Consultant

Nepal Environmental and Scientific Services (P) Ltd (4):
Mr. Salil Devkota, Managing Director
Mr. Toran Sharma, Technical Director
Mr. Ram Kumar sharma, Socio-Economist
Mr. Ram Chandra Poudel, Officer

## 12.6 Discussion at Ministry of Forests and Soil Conservation

**Minutes of Meeting**
**Meeting with Ministry of Forest and Soil Conservation in Nepal**

Date and Time: June 4, 2013
Place: Ministry of Forest and Soil Conservation (MFSC), Kathmandu, Nepal
Participants (3):
MFSC (1):
Mr. Babu Ram Yadav, Under Secretary
JICA Study Team (the Study Team) (2):
Ms. Akiko Urago
Ms. Keiko Otoguro

After explaining about the guideline of the "Nationwide Master Plan Study on Storage Type Hydroelectric Power Development in Nepal (hereinafter revered to as "the Study")" by the Study Team, the MFSC and the Study Team discussed and verified about the following points.

- The MFSC requested to utilize a new National Parks boundary to the Study Team to at the Joint Coordination Committee (JCC) Meeting held on 5th June 2013.
- MFSC and the Study Team confirmed that there is no Promising Projects of the Study in the new National Parks boundary.
- The Study Team requested for digital data on the new National Park boundary by GIS format to the MFSC, the MFSC introduced the contact address of the GIS personal to the Study Team.
- The Study Team asked about the revised proportion of forest compensation especially for hydropower projects, but the MFSC did not recognize about this revision.

## 12.7 Discussion at the WWF Nepal

**Minutes of Meeting**
**Meeting with WWF Nepal**

Date and Time: June 7, 2013, 10:45-11:30

Place: WWF, Kathmandu, Nepal

Participants (7):

WWF (5):

Mr. Santosh Mani Nepal, Director, Policy and Support

Ms. Judy Oglethorpe, Chief of Party – Hariyo Ban

Mr. Dipesh Joshi, Program Officer

Mr. Shuva Sharma, Consultant

Mr. RavindraTripathi, Research Assistant

JICA Stuey Team (2):

Ms. Akiko Urago

Ms. Keiko Otoguro

WWF explained their main activities such as about species conservation, forest conservation and protection of primary biodiversity. Closely related areas to the JCA Study Team's study are as follows.

- Chitwan: Important area for creation and conservation of corridor between Nepal and India, UNESCO World heritage site
- Gandaki: High biodiversity area
- Babai river: National park in which there is already dry area

WWF's concerns are as follows.

- WWF is concerned about the vegetation changes by the dam; tree invasion in the river bed by flood control can be occurred downstream of the dam site.
- If the storage water in the reservoir is used for irrigation, it may affect the habitat of a rare species in the downstream of the dam. Especially at Babai river, the flow has already become less at the end of the National Park in the downstream. If the flow reduces more, it will make a serious impact on the habitat.
- By new access road made through development project, impact on environment never occurred before such as increase of illegal hunters in the involved area will be concerned.

WWF's general suggestions are as follows.

- Developers consult government policy maker about their each development plan. It is also important to take into account not only the impact of each development but also the cumulative impact within other developments for developers and Nepal Government. Rivers in Nepal are flowing to India. Also, there are corridors for species between Nepal and India. It should be concerned the impact on the Indian side.
- New projects maybe create new possibility for development of ecosystem. Impact assessment should not stay only to evaluate whether the project is good or bad. It is also important to find an alternative plan (offset plan) if the serious impact is concerned.
- It would be useful if the impact studies for hydroelectric power schemes also include other infrastructures associated with it, including access roads, irrigation schemes downstream of the dams etc.

- Assessment of factors associated with activities upstream of the dams (including roads, deforestations, multiple water uses by communities etc.) would also be useful in better understanding impacts at landscape level.
- Linkages with climate change factors will also be useful.

Others
- WWF Nepal has not worked specifically in fish diversity projects and programs whereas it has updated information on river dolphins. WWF acknowledges that fish information for whole country of Nepal should be conducted. Otherwise, many fish species will extinct unknowingly.
- The Study Team lacks of the development information of the other sectors and distribution information of the important species. The study team requested WWF to share such kinds of information.
- WWF is now compiling a cumulative impact assessment through several projects conducted by them and this assessment will be finalized in a couple of months.

WWF will share its result with the Study Team once it finished.

## 12.8 Discussion at the IUCN Nepal

**Minutes of Meeting**
**Meeting with IUCN Nepal**

Date and Time: December 17, 2013, 11:45-12:15
Place: IUCN, Kathmandu, Nepal
Participants (5):
IUCN (2):
Mr. Yam Malla PhD, Country Representative
Mr. Rajendra Khanal, Programme Coordinator
JICA Stuey Team (2):
Ms. Akiko Urago
Ms. Keiko Otoguro

JICA Study Team explained the brief overview of National Master Plan Study on -type Hydroelectric Power Development in Nepal as well as the SEA conducted during the Study. Submitting the Draft SEA report to IUCN, JICA Study Team requested as follows.

- Advices on the development of about 10 promising projects
- Sharing GIS data of distribution maps of National Red List Mammals in Nepal

IUCN accepted to give advices requested by JICA Study Team focusing on Social & Natural Environment which is their specialty. IUCN will give their brief comment about 10 promising projects and detailed comment on Dudh Koshi Project, Nalsyau Gad Project and Andhi Khola Project. IUCN promised to JICA Study Team to give the comments within about 1 month.

IUCN also accepted to share the requested GIS data with JICA Study Team. IUCN introduced to JICA Study Team the person in charge of GIS data.

IUCN has an Ecosystem Base Adaptation (EbA) project near of the Andhi Khola Project. EbA is the use of biodiversity and ecosystem services, as part of an overall adaptation strategy, which helps people to adapt to the adverse effects of climate change. IUCN will analyze the Andhi Khola Project in consideration of the point of view or EbA.

Regarding the fish conservation, JICA Study Team explained the importance of overall fish survey in Nepal, also the intension of JICA to conduct the survey about fish distribution.

IUCN suggested to JICA Study Team to consult with Godabari Fishery Farm which is a fishery expert (government organization). This farm has detail information about distribution of fishes in Nepal.

## 12.9 Discussion at the Department of Forest under the Ministry of Forests and Soil Conservation

Draft SEA report was submitted to Department Forest for comments in December 2013. Department of Forest sent comments on January 2014. The comments are attached in Annex 22 in Appendix 5.

**Minutes of Meeting**

**Meeting with the Department of Forests under the Ministry of Forests and Soil Conservation in Nepal**

Date and Time: December 18, 2013, 13:00-13:30
Place: Ministry of Forests and Soil Conservation, Department of Forests, Kathmandu, Nepal
Participants (5):

Department of Forests (3):

Mr. Bishwa Nath Oli, Director General
Mr. Bala Ram Adhikari, Programme Co-ordinator
Mr. Kedarnath Sharma, Under Secretary

JICA Study Team (2):

Ms. Akiko Urago
Ms. Keiko Otoguro

JICA Study Team explained the brief overview of National Master Plan Study on -type Hydroelectric Power Development in Nepal. In the explanation, JICA Study Team added the following information.

- SEA was conducted during the Study.
- Stakeholders meetings were conducted three times during the Study in order to getting the opinions by stakeholders.

Submitting the Draft SEA report to the Department of Forests under the Ministry of Forests and Soil Conservation, JICA Study Team requested the following.

- Comments and advices on the development of about 10 promising projects especially on Dudh Koshi Project, Nalsyau Gad Project and Andhi Khola Project.

The Department of Forests principally accepted to give advices requested by JICA Study Team within about 1 month with a condition that NEA send an official letter to the Department of Forests which requests such kind of cooperation.

JICA Study Team apologized for the visit making an appointment without an official letter and promised to prepare the official letter through NEA.

The Department of Forests accepted the excuse from JICA Study Team and promised to give theirs comments by E-mail.

## 12.10 Discussion at the Directorate of Fisheries Development, National Inland Fisheries and Aquaculture Development Program

**Minutes of Meeting**
**Meeting with Directorate of Fisheries Development, National Inland Fisheries and Aquaculture Development Program in Nepal**

Date and Time: December 19, 2013, 13:45-14:15
Place: Central Fisheries Building, Kathmandu, Nepal
Participants (4):
Directorate of Fisheries Development (2):
Ms. Rama Nanda Mishra, National Program Chief
Mr. Raj Kapur Napit, Fisheries Development Officer
JICA Study Team (2):
Ms. Akiko Urago
Ms. Keiko Otoguro

JICA Study Team explained the brief overview of National Master Plan Study on -type Hydroelectric Power Development in Nepal as well as the SEA conducted during the Study. Submitting the Draft SEA report to Directorate of Fisheries Development, JICA Study Team requested advices and comments on the development of about 10 promising projects by 26th January 2014.

Directorate of Fisheries Development accepted the above request by JICA Study Team and promised to send their comments to JICA Study Team by E-mail.

The comments by Directorate of Fisheries Development during the meeting are as follows.

- In case there are a number of projects on 1 river, huge number of fish species might be affected. Mitigation measures should be important and carefully studied.

- Directorate of Fisheries Development agreed to the need for the Nationwide Fish census in the Draft SEA report.
- Directorate of Fisheries Development was highly appreciated if JICA would conduct the Nationwide Fish Study in the near term.

# Chapter 13 Suggestions for EIAs in FS stage

## 13.1 Required documents for Environmental and Social consideration

(1) Environment Impact Assessment (EIA/IEE)

EIA procedures in Nepal are stipulated on 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 output is 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 13.1-1 shows the required documents for hydropower and related projects.

**Table 13.1-1 Required documents for Transmission line and Hydropower plant**

| 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 (Here after referred to as JICA Guidelines) treat Environmental Management Plan (EMP) as a part of EIA. But if it requires updated EMP based on the detail design, it can be prepared independently.

(3) Resettlement Action Plan

JICA Guidelines are suggesting to follow OP 4.12, Annex A – Involuntary Resettlement Instruments when a large number of resettlement will happen. Table 13.1-2 shows the required information of RAP based on the OP 4.12, Annex A. All the possible projects for FS have to prepare RAP.

**Table 13.1-2 Required information of RAP**

1. Description of the project.
2. Potential impacts.
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 resettlers and host communities,
    - (a) a description of the strategy for consultation with and participation of resettlers 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 retaining 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.<br>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 the existence of indigenous people are confirmed. Table 13.1-3 shows the main contents of IPP based on the OP 4.10, Annex B (World Bank).

**Table 13.1-3 Required Information of IPP**

| |
|---|
| (a) A summary of the information referred to in the followings.<br>• A review, on a scale appropriate to the project, of the legal and institutional framework applicable to Indigenous Peoples.<br>• 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 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

## 13.2 Comprehensive Scoping in FS stage

It is difficult to conduct site specific scoping, because it is undecided which projects will be selected for 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. Risk of water accident would rise if there is no re-regulating pond. The low late of water rotation might cause eutrophication and dams without sedimentation flushing gate 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 environment; the animal migration will be inhibited and the land use of the ground under the transmission line will be limited.

The Table 13.2-1 shows scoping for hydropower plant and Table 13.2-2 shows scoping on transmission line.

**Table 13.2-1 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 pattern 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<br>Cumulative impact of ecosystem |
| | Aquatic ecosystem | Barrier on fish migration route | Habitat change by water flow, water temperature, water quality,<br>Increasing of the illegal fishing<br>Cumulative impact on the protected area downstream<br>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 13.2-2 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 | - |

## 13.3 Attentional issues of 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 not high air pollution area. If air quality survey is conducted as a baseline of monitoring, the dry season should not be excluded, day time of week day 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, 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: Alternative truck route can be considered, if there is not any effective mitigation.
- Suggestions for monitoring planning: Monitoring items should be included 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 fulfilled 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 impact on the river water quality by discharged water from the reservoir during operation. The risk would be high if it is expected population growth without sewage system. The impact on river water might affect not only on fish but also on water use downstream such as irrigation, drinking water supply, and/or industrial water supply.
- Suggestions for survey: Water sampling points should cover not only dam site and spillway but also future monitoring points and fish survey points. If possible the sampling timings should be same as fish survey hopefully four times a year, at least 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 implementability and 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 by analyzed items sampling points, 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 downstream of a dam and spillway. Monthly average river discharge will be changed by water storage. If there is no reregulating reservoir, river water downstream of the spillway will be increase rapidly by peak generation. River water volume will be changed by sand flush operation. Reduction of ground water or spring by tunneling is anticipated too. If some activities, such as irrigation, drinking water intake, industrial water intake, fishery, river bathing, cloth washing, rafting, exist in the wafer 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 confluences.

- Suggestions for survey: River crossing measurements at the 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 required, prediction result of sedimentation, river bed degradation by topography and geology expert could be used. The prediction result of water flow should be shared with 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: Mitigations should be selected feasible and practical ones 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 too.
- 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 woods, waste metal, waste plastics, domestic waste from construction site might be produced during construction. Floating waste captured by screen will be generated during operation whole year.
- Suggestions for survey: The exact volume of generated waste should be surveyed, , treatment methods should be studied, and management cost at the 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: The 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: Landform will be changed by quelling and dumping. The river bed level downstream of the spillway might be lowered by decreased sediment supply if there is no sand flush gate at the dam. The risk of land slide would be higher around the reservoir. Huge amount of sediment might flow in the reservoir when GLOF occurs. Landslides might be caused by Access road and/or Transmission line, if the civil works are inadequate.
- Suggestions for survey: Land slide survey should be done in the area above the minimum

operation level and high risk area should be identified. The survey result should be recorded in a survey slip format with latitude and longitude, photo shooting direction in order to use monitoring survey in later stage.

- Suggestions for impact assessment: Predicted points with high risk of land slide should be sent to social expert and used for the impact assessment on land use. The predicted result should be explained clearly to the affected land owners at the stakeholders meeting or other ways.
- Suggestions for mitigation planning: Feasible and practical methods in Nepal should be taken based on land use and impact extent discussion with civil engineers.
- Suggestions for monitoring planning: Monitoring points, report format, 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 vehicle, noise from rock quarry and plant operation, and building crack caused by blasting work might draw complaint.
- Suggestions for survey: If the survey is re-commissioned, survey time, location, timing, measurement methods should be clearly instructed, because survey methods is not strictly stipulated by the Nepal government. Working area, truck route, blasting points, location of buildings should be confirmed. The existing cracking and leaning of the buildings can be recorded before construction start, if required.
- Suggestions for impact assessment: Impact area should be identified based on the work layout maps. If there are any schools/hospitals in the impact area, alternative truck route should be examined with civil engineers. The possible extent of the impact, timing, and duration should be clearly explained to the possible 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. The reservoir without sand flushing gate might cause odor from sludge in the reservoir.
- Suggestions for 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 exact impact area and extent of the impact of odor, but if the odor risk cannot be excluded, the risk should be explained to the possible 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 the local houses.

- Suggestions for monitoring planning: Survey points, survey methods, reporting format should be instructed in detail.

(8) Sedimentation

- Anticipated impact: Reservoirs without sand flushing gate might be suffered from sedimentation.
- Suggestions for survey: Land use, terrain slope, land slide, water volume, 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 format should be examined.

## 13.4 Attentional issues of Natural Environment

(1) Protected Area

- Anticipated impact: Candidate projects are not located in 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 be cumulated. If it happens, the impact would affect the species and ecosystems in the protected area which depend on natural water flow and floods.
- Suggestions for survey: Major planned and existing irrigation facilities and storage type hydropower plant 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 by one project would be limited. Then cooperative mitigations with other projects would be recommended.
- Suggestions for monitoring planning: Monitoring plan should include compliance monitoring.

(2) Plants

- Anticipated impact: The vegetation loss around the river by hydropower project is inescapable. Even if the vegetation is common one but used by animals as migration route, the vegetation loss might affect the habitat of the migration species.
- Suggestions for survey: Not only the location of the protected species but also the vegetation

used highly by protected animals should be identified. The area of invasive species, degraded vegetation and erosion area should be identified too. The survey should be conducted at least two times a year in wet and dry seasons. The survey area should include Reservoir, Dam, Generation plant, Camp site, Quarry, Damping site, Access road, Construction road, and Transmission route. It should be expanded to the tree planting area for mitigation.

- Suggestions for impact assessment: Loss of 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 route for some terrestrial animals. And reservoirs, access roads, transmission lines might be barriers for migrations.
- Suggestions for survey: In order to raise the survey accuracy, Japanese professional surveyors are hopefully installed 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 whole habitat.
- Suggestions for impact assessment: Getting information about the vegetation change and land use change from plant expert and social expert, 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: Monitoring plan should include monitoring points, timing, methods, and reporting format in detail.

(4) Aquatic species

- Anticipated impact: Construction of barrier 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 the cold water fishes, the risk of extinction of the species would be extremely high. Changing of water environment such as water quality, water volume, and water temperature might cause serious impact on resident species too.
- Suggestions for 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 detail survey at the project site. Effectiveness of the mitigation of other hydropower projects in Nepal can be surveyed.
- Suggestions for impact assessment: Getting the prediction result from the expert of water quality and water flow, the extent of impact should be estimated by locations and by species in

detail.

- Suggestions for mitigation planning: Mitigation should be practical and sustainable one considering effectiveness of the other projects' mitigations.
- Suggestions for monitoring planning: Monitoring should include both compliance monitoring and impact monitoring.

### 13.5 Attentional issues of 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 database. In order to avoid deficiency of the survey, detail survey methods and arrangement methods should be taught to the re-commissioned survey company. Survey area should include a reservoir, power plant, quarry site, construction road, tentative working area, and resettlement area. In order to cover indirect impact, survey area should expand to houses and land around direct impact area. Not only house owners and land owners, but also tenant farmers, tenants of a house, servants, illegal land users, and non-registered land users should be surveyed. Elders, women, child, disabled, poverty household 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 too. The rules of the buffer zone around the reservoir should be clearly defined and boundary should be marked on the map. The predicted impact should be clearly explained in the SHM and considered to the illiterates.
- Suggestions for mitigation planning: Entitlement matrix should be prepared for all anticipated social impact based on the format or RAP. Caution for the compensation rate should be not to be far different from that of the similar projects around the area. Selectable compensations such as land or money would be preferable than 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, water use downstream of the spillway might be affected.
- Suggestions for survey: Locations and user location of the wells over the tunnel route and reservoir should be surveyed. Location, water right, of drinking water intake, irrigation water intake, industrial water intake, fish farming intake and their water discharge should be surveyed in the recession area. Fishery area, sand mining points, cloth washing, river bathing, river side camping site, rafting activity, religious activities should be surveyed at the dewatering area too. Water use timing should be examined too, because some activities might be done in only the wet season. The survey area would be up to the confluence with the bigger

river. If serious impacts are predicted at some points, surveyor should ask the water flow expert to add prediction points for river water level.

- Suggestions for impact assessment: Based on the predicted water flow impact, impact value, location, timing should be examined. The people affected should be explained clearly at the SHM or other ways.
- Suggestions for mitigation planning: If any impact on water use is confirmed, it should be added in Entitlement Matrix in RAP and prepare the compensation rules.
- Suggestions for monitoring planning: Monitoring should include both compliance monitoring and impact monitoring.

(3) Accident

- Anticipated impact: Accidents might happen on the community roads by construction vehicles and industrial injury at the site during construction. Flushing water from a dam and exponential increase in river flow by peak generation might cause water accidents downstream of the dam, if there is not any re-regulating reservoir.
- Suggestions for survey: School road and commuting road, camping site along the river, and river bathing site should be surveyed. If possible previous accidents near the project site or similar projects should be surveyed 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 other ways.
- Suggestions for mitigation planning: If serious impacts are predicted, alternative truck routs should be examined. Compliance of the Labor Act 2048 (1992), Some measures for workers environment 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: Not only the monitoring for probable accidents but also compliance monitoring for mitigation should be planned.

(4) Life and Livelihood

- Anticipated impact: Not only the people affected by resettlement or land acquisition but also the people affected on only water use might have difficulty in their life and livelihood. The people who have to release their cultivation land and/or the business which lose their customer might be affected even if they do not need to be relocated. Fish farming, fishery, sand mining and rafting business might be also decreased their income.
- Suggestions for 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, 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 the mitigation for who would like to change their jobs or the mitigation for who

would not like to change their jobs.

- Suggestions for monitoring planning: 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 by submerging.
- Suggestions for survey: Precise maps which show national maps and community forest might not exist. Then forest boundary 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, 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 construction license. Then compensation plan in EMP will be tentative one.
- Suggestions for monitoring planning: Monitoring plan should include compliance monitoring for the planned mitigation.

(6) Infrastructure

- Anticipated impact: Project might affect local infrastructures such as roads, suspension bridges, distribution lines, telephone lines, water supply facilities, sewerage systems, and so on. Impact on road might cause fragmentation of the communities.
- Suggestions for survey: The location of all the infrastructures 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 the user request.
- Suggestions for monitoring planning: Compliance monitoring for planned mitigation should be included.

(7) Culture

- Anticipated impact: Traditional buildings, buried cultural property, festival and traditional arts might be lost by inundation.

- Suggestions for survey: The survey area for intangible cultural properties should be expanded not only direct to impact area but also to whole village.
- Suggestions for impact assessment: Impact should be assessed whether the project might affect the sustainability of the traditional festival and/or traditional arts or not.
- Suggestions for mitigation planning: If serious cultural assets are identified, adequate mitigations including trans-building should be carefully examined.
- Suggestions for monitoring planning: Monitoring plan should include compliance monitoring.

(8) Landscape

- Anticipated impact: Landscape from viewpoints might be affected by existence of power plant facilities.
- Suggestions for 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 impacts on landscapes are 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 minotiries are confirmed at all the candidate projects sites. Then impact on these people is anticipated.
- Suggestions for survey: Required information for IPP should be gathered. More attention should be paid to language, culture, festival, traditional architecture and traditional natural resources. Not only the affected indigenous people but also whole distribution of the groups and distribution center should be examined. Traditional practice for relocations such as direction, timing, relationship between other groups, and land conditions should be examined. If required, the meeting in the group should be supported. If there are any conflicts and problems among or between groups, actual conditions should be surveyed. Survey in dry season would be effective because of road fragmentation by land slide in wet season.
- Suggestions for impact assessment: Whether the center of the ethnic groups will be affected or not should be assessed. Not only the resource of livelihood but also resource of the festival or custom should be examined if they are affected. The result of assessment should be informed not only to the affected people but also to whole ethnic groups if required.
- Suggestions for mitigation planning: Mitigation measures should be considered to avoid diaspora and fragmentation of the ethnic groups, and to sustain the 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 participatory way taking enough time. Take caution on the conflict and problems in the groups not be made worse.

- Suggestions for monitoring planning: Monitoring plan should be divided in owner's monitoring and audit monitoring. Adequacy of grievance adjustment should be monitored too.

(10) Working environment and work safety

- Anticipated impact: Labor accident, fight, food poisoning, communicable disease, and child labors are anticipated.
- Suggestions for survey: Hearing survey at near and similar projects are suggested and the previous work accident and diseases and their causes should be examined.
- Suggestions for impact assessment: Possibility of the occurrence of the 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: Monitoring plan should include both accident monitoring by project owners and compliance monitoring by audit organizations.

# Appendix 4

## Power Development Plan and Development Plan of Storage-type Hydroelectric Power Projects taking into consideration Candidate Projects proposed by NEA

# Table of Contents



# List of Tables

# List of Figures

# Appendix 4 Power Development Plan and Development Plan of Storage-type Hydroelectric Power Projects taking into consideration Candidate Projects proposed by NEA

## A.4.1 Introduction

The NEA proposes four projects listed in Table A.4.2.1-1 as candidate projects for the power development plan in addition to the candidate projects described in "8.9 Candidate Projects for Hydroelectric Power Generation" in the main report. In Appendix 4, these four projects were also considered as the candidate projects for "Power Development Plan" and "Development Plan of Storage-type Hydroelectric Power Projects."

## A.4.2 Power Development Plan

### A.4.2.1 Candidate Projects for Hydroelectric Power Generation

#### A.4.2.1.1 Candidate Projects proposed by NEA

The Utter Ganga project was excluded from the candidate projects because it became clear that this projects is located in conservation areas.

**Table A.4.2.1-1 Candidate Hydroelectric Power Projects by the NEA**

| Project Name | Type | Installed Capacity (MW) | Annual Energy (GWh) | Project Cost* (MUS$) | Commercial Operation** (FY) | Remarks |
|---|---|---|---|---|---|---|
| West Seti*** | STO | 750 | 3,636 | 1,483 | 2024 | |
| Utter Ganga | STO | 300 | 1,538 | 744 | 2027 | Excluded from the candidates in this study. (Hunting reserve) |
| Kaligandaki-2 | STO | 680 | 3,470 | 1,347 | 2027 | |
| Tamor | STO | 530 | 2,406 | 1,538 | 2028 | |

Source: NEA
*: FY2012/13 price
**: The earliest case. Estimated by the NEA and reviewed by the Study Team.
***: For power export.

#### A.4.2.1.2 Development of ROR-type Hydroelectric Power Generation and Power Imports from India

Development of ROR-type hydroelectric power generation and power imports from India were considered to be the same described in "8.9.2 Development of ROR-type Hydroelectric Power Generation" and "8.9.3 Power Import from India" in the main report.

### A.4.2.2 Key Parameters

As for the values of key parameters for formulating the power development plan, the values described in "8.10 Key Parameters" in the main report were used.

### A.4.2.3 Power Development Plan taking into consideration Candidate Projects proposed by the NEA

#### A.4.2.3.1 Practical Development Scenario

The projects under construction or with a high probability of being constructed listed in Table 8.8-1 (in the main report) commence commercial operation according to schedule. The candidate projects to be developed after these projects are the promising storage-type HPPs selected by the Study Team listed in Table 8.9.1-1 of the main report, ROR-type HPPs listed in Table 8.9.2-1, and the projects proposed by the NEA listed in Table A.4.2.1-1 in this appendix.

With these candidate projects, a power development plan that is able to resolve the load shedding as early as possible and then secure the required LOLP with the least total costs of construction and O&M costs in terms of present value is formulated.

#### A.4.2.3.2 Power Development plan

(1) Commencement of commercial operation

Table A.4.2.3.2-1 to Table A.4.2.3.2-3 show the power plants to be constructed and their commencement year of commercial operation for the base case, the high case, and the low case of demand forecast, respectively

For the base case, the total installed capacity of generation facilities that are put into operation for the 20 years from FY2012/13 to FY2031/32 is 4,177 MW (the increment in imports from India is included), and 2,214 MW of this is storage-type hydroelectric power generation.

For the high case, the total installed capacity of generation facilities that are put into operation for the 20 years from FY 2012/13 to FY2031/32 is 5,186 MW, which is 1,009 MW larger than that for the base case. In these generation facilities, storage-type hydroelectric power generation is 3,223 MW, which is 1,090 MW larger than for the base case.

For the low case, the total installed capacity of generation facilities that are put into operation for the 20 years from FY 2012/13 to FY2031/32 is 4,177 MW, which is the same as for the base case. In these generation facilities, storage-type hydroelectric power generation is 2,414 MW, which is also the same as for the base case.

## Table A.4.2.3.2-1 Generation Expansion Plan (Base Case) (Candidates proposed by NEA are considered)

| FY | | 2011/12 | 2012/13 | 2013/14 | 2014/15 | 2015/16 | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | 2025/26 | 2026/27 | 2027/28 | 2028/29 | 2029/30 | 2030/31 | 2031/32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Existing | —— | 850.1 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| **Kulekhani No. 3** | **STO** | | | | | **14.0** | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Chameliya | PROR | | | | | 30.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Khani Khola | ROR | | | | | 25.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Upper Sanjen | ROR | | | | | | 11.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Sanjen | ROR | | | | | | 42.9 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Upper Trishuli 3A | ROR | | | | | | 60.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Upper Tamakoshi | PROR | | | | | | 456.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Madhya (Middle) Bhotekosh | ROR | | | | | | | 102.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Rasuwagadi | ROR | | | | | | | 111.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Rahughat | PROR | | | | | | | 32.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Upper Marsyangdi | ROR | | | | | | | 50.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Mistri | ROR | | | | | | | 42.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| ROR-1 | ROR | | | | | | | | 100.0 | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Upper Trishuli 3B | ROR | | | | | | | | | 37.0 | → | → | → | → | → | → | → | → | → | → | → | → |
| ROR-2 | ROR | | | | | | | | | 100.0 | → | → | → | → | → | → | → | → | → | → | → | → |
| **Tanahu** | **STO** | | | | | | | | | | **140.0** | → | → | → | → | → | → | → | → | → | → | → |
| Upper Mode A | ROR | | | | | | | | | | 42.0 | → | → | → | → | → | → | → | → | → | → | → |
| ROR-3 | ROR | | | | | | | | | | 100.0 | → | → | → | → | → | → | → | → | → | → | → |
| Tamakshi V | ROR | | | | | | | | | | | 87.0 | → | → | → | → | → | → | → | → | → | → |
| **Budhi Gandaki** | **STO** | | | | | | | | | | | | **600.0** | → | → | → | → | → | → | → | → | → |
| ROR-4 | ROR | | | | | | | | | | | | | | 100.0 | → | → | → | → | → | → | → |
| ROR-5 | ROR | | | | | | | | | | | | | | | 100.0 | → | → | → | → | → | → |
| Upper Arun | PROR | | | | | | | | | | | | | | | 335.0 | → | → | → | → | → | → |
| **Dudh Koshi** | **STO** | | | | | | | | | | | | | | | | **300.0** | → | → | → | → | → |
| **Nalsyau Gad** | **STO** | | | | | | | | | | | | | | | | | | **410.0** | → | → | → |
| **West Seti** | **STO** | | | | | | | | | | | | | | | | | | | | **750.0** | → |
| Import from India | —— | 12.0 | → | → | → | 162.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Added Installed Capacity (MW) | | —— | 0.0 | 0.0 | 0.0 | 219.0 | 569.9 | 337.0 | 100.0 | 137.0 | 282.0 | 87.0 | 600.0 | 0.0 | 100.0 | 435.0 | 300.0 | 0.0 | 410.0 | 0.0 | 750.0 | 0.0 |
| Total Installed Capacity (MW) | | 862.1 | 862.1 | 862.1 | 862.1 | 1,081.1 | 1,651.0 | 1,988.0 | 2,088.0 | 2,225.0 | 2,507.0 | 2,594.0 | 3,194.0 | 3,194.0 | 3,294.0 | 3,729.0 | 4,029.0 | 4,029.0 | 4,439.0 | 4,439.0 | 5,189.0 | 5,189.0 |
| LOLP* (%) | | —— | **50.375** | **53.789** | **57.975** | **32.637** | **2.733** | **1.575** | **1.927** | **2.579** | **1.919** | **3.087** | 0.130 | 0.516 | 1.225 | 0.666 | 0.336 | 1.079 | 0.440 | 1.331 | 0.075 | 0.590 |

*: Critical LOLP is 1.375%, equivalent to 5 days/year.

Note: Projects in boldface are storage-type projects.
The total install capacity includes the import from India.

## Table A.4.2.3.2-2 Generation Expansion Plan (High Case) (Candidates proposed by NEA are considered)

| FY | | 2011/12 | 2012/13 | 2013/14 | 2014/15 | 2015/16 | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | 2025/26 | 2026/27 | 2027/28 | 2028/29 | 2029/30 | 2030/31 | 2031/32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Existing | —— | 850.1 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| **Kulekhani No. 3** | **STO** | | | | | **14.0** | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Chameliya | PROR | | | | | 30.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Khani Khola | ROR | | | | | 25.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Upper Sanjen | ROR | | | | | | 11.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Sanjen | ROR | | | | | | 42.9 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Upper Trishuli 3A | ROR | | | | | | 60.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Upper Tamakoshi | PROR | | | | | | 456.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Madhya (Middle) Bhotekosh | ROR | | | | | | | 102.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Rasuwagadi | ROR | | | | | | | 111.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Rahughat | PROR | | | | | | | 32.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Upper Marsyangdi | ROR | | | | | | | 50.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Mistri | ROR | | | | | | | 42.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| ROR-1 | ROR | | | | | | | | 100.0 | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Upper Trishuli 3B | ROR | | | | | | | | | 37.0 | → | → | → | → | → | → | → | → | → | → | → | → |
| ROR-2 | ROR | | | | | | | | | 100.0 | → | → | → | → | → | → | → | → | → | → | → | → |
| **Tanahu** | **STO** | | | | | | | | | | **140.0** | → | → | → | → | → | → | → | → | → | → | → |
| Upper Mode A | ROR | | | | | | | | | | 42.0 | → | → | → | → | → | → | → | → | → | → | → |
| ROR-3 | ROR | | | | | | | | | | 100.0 | → | → | → | → | → | → | → | → | → | → | → |
| Tamakshi V | ROR | | | | | | | | | | | 87.0 | → | → | → | → | → | → | → | → | → | → |
| **Budhi Gandaki** | **STO** | | | | | | | | | | | | **600.0** | → | → | → | → | → | → | → | → | → |
| Upper Arun | PROR | | | | | | | | | | | | | | 335.0 | → | → | → | → | → | → | → |
| ROR-4, -5 | ROR | | | | | | | | | | | | | | 200.0 | → | → | → | → | → | → | → |
| **Dudh Koshi** | **STO** | | | | | | | | | | | | | | | | **300.0** | → | → | → | → | → |
| **Nalsyau Gad** | **STO** | | | | | | | | | | | | | | | | | **410.0** | → | → | → | → |
| **West Seti** | **STO** | | | | | | | | | | | | | | | | | | | **750.0** | → | → |
| **Chera-1** | **STO** | | | | | | | | | | | | | | | | | | | **149.0** | → | → |
| **Andhi Khola** | **STO** | | | | | | | | | | | | | | | | | | | | | **180.0** |
| **Kaligandaki-2** | **STO** | | | | | | | | | | | | | | | | | | | | | **680.0** |
| Import from India | —— | 12.0 | → | → | → | 162.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Added Installed Capacity (MW) | | —— | 0.0 | 0.0 | 0.0 | 219.0 | 569.9 | 337.0 | 100.0 | 137.0 | 282.0 | 87.0 | 600.0 | 0.0 | 535.0 | 0.0 | 300.0 | 410.0 | 0.0 | 899.0 | 0.0 | 860.0 |
| Total Installed Capacity (MW) | | 862.1 | 862.1 | 862.1 | 862.1 | 1,081.1 | 1,651.0 | 1,988.0 | 2,088.0 | 2,225.0 | 2,507.0 | 2,594.0 | 3,194.0 | 3,194.0 | 3,729.0 | 3,729.0 | 4,029.0 | 4,439.0 | 4,439.0 | 5,338.0 | 5,338.0 | 6,198.0 |
| LOLP* (%) | | —— | **49.198** | **51.573** | **54.322** | **27.323** | **1.945** | **1.680** | **2.695** | **3.334** | **2.625** | **3.923** | 0.345 | 0.967 | 0.403 | 1.218 | 0.824 | 0.309 | 1.167 | 0.091 | 0.913 | 0.087 |

*: Critical LOLP is 1.375%, equivalent to 5 days/year.

Note: Projects in boldface are storage-type projects.
The total install capacity includes the import from India.

## Table A.4.2.3.2-3 Generation Expansion Plan (Low Case) (Candidates proposed by NEA are considered)

| FY | | 2011/12 | 2012/13 | 2013/14 | 2014/15 | 2015/16 | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | 2025/26 | 2026/27 | 2027/28 | 2028/29 | 2029/30 | 2030/31 | 2031/32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Existing | — | 850.1 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| **Kulekhani No. 3** | **STO** | | | | | **14.0** | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Chameliya | PROR | | | | | 30.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Khani Khola | ROR | | | | | 25.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Upper Sanjen | ROR | | | | | | 11.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Sanjen | ROR | | | | | | 42.9 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Upper Trishuli 3A | ROR | | | | | | 60.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Upper Tamakoshi | PROR | | | | | | 456.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Madhya (Middle) Bhotekosh | ROR | | | | | | | 102.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Rasuwagadi | ROR | | | | | | | 111.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Rahughat | PROR | | | | | | | 32.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Upper Marsyangdi | ROR | | | | | | | 50.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Mistri | ROR | | | | | | | 42.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| ROR-1 | ROR | | | | | | | | 100.0 | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Upper Trishuli 3B | ROR | | | | | | | | | 37.0 | → | → | → | → | → | → | → | → | → | → | → | → |
| ROR-2 | ROR | | | | | | | | | 100.0 | → | → | → | → | → | → | → | → | → | → | → | → |
| **Tanahu** | **STO** | | | | | | | | | | **140.0** | → | → | → | → | → | → | → | → | → | → | → |
| Upper Mode A | ROR | | | | | | | | | | 42.0 | → | → | → | → | → | → | → | → | → | → | → |
| ROR-3 | ROR | | | | | | | | | | 100.0 | → | → | → | → | → | → | → | → | → | → | → |
| Tamakoshi V | ROR | | | | | | | | | | | 87.0 | → | → | → | → | → | → | → | → | → | → |
| **Budhi Gandaki** | **STO** | | | | | | | | | | | | **600.0** | → | → | → | → | → | → | → | → | → |
| ROR-4 | ROR | | | | | | | | | | | | | | | 100.0 | → | → | → | → | → | → |
| Upper Arun | PROR | | | | | | | | | | | | | | | | 335.0 | → | → | → | → | → |
| ROR-5 | ROR | | | | | | | | | | | | | | | | 100.0 | → | → | → | → | → |
| **Dudh Koshi** | **STO** | | | | | | | | | | | | | | | | | **300.0** | → | → | → | → |
| **Nalsyau Gad** | **STO** | | | | | | | | | | | | | | | | | | | **410.0** | → | → |
| **West Seti** | **STO** | | | | | | | | | | | | | | | | | | | | | **750.0** |
| Import from India | — | 12.0 | → | → | → | 162.0 | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Added Installed Capacity (MW) | | — | 0.0 | 0.0 | 0.0 | 219.0 | 569.9 | 337.0 | 100.0 | 137.0 | 282.0 | 87.0 | 600.0 | 0.0 | 0.0 | 100.0 | 435.0 | 300.0 | 0.0 | 410.0 | 0.0 | 750.0 |
| Total Installed Capacity (MW) | | 862.1 | 862.1 | 862.1 | 862.1 | 1,081.1 | 1,651.0 | 1,988.0 | 2,088.0 | 2,225.0 | 2,507.0 | 2,594.0 | 3,194.0 | 3,194.0 | 3,194.0 | 3,294.0 | 3,729.0 | 4,029.0 | 4,029.0 | 4,439.0 | 4,439.0 | 5,189.0 |
| LOLP* (%) | | — | **51.054** | **55.341** | **60.972** | **36.845** | **3.802** | **2.389** | **2.716** | **2.678** | **1.453** | **2.135** | 0.017 | 0.144 | 0.621 | 1.338 | 0.712 | 0.370 | 1.117 | 0.435 | 1.275 | 0.081 |

*: Critical LOLP is 1.375%, equivalent to 5 days/year.

Note: Projects in boldface are storage-type projects.
The total install capacity includes the import from India.

(2) Supply-demand balance

Table A.4.2.3.2-4, Table A.4.2.3.2-5 and Table A.4.2.3.2-6, and Figure A.4.2.3.2-1, Figure A.4.2.3.2-2 and Figure A.4.2.3.2-3 show the supply-demand balance for the base case, the high case, and the low case of demand forecast respectively.

In these tables, some peak supply capacities are smaller than peak demand even though LOLP is within the allowable range, which is less than 1.375% and equivalent to less than 5 days/year of shortage in the supply capacity in a year. In general, shortage in the supply capacity of ROR-type HPPs concentrates in the dry season, and energy supply by ROR-type HPPs decreases significantly. To cope with that, a part of the storage-type HPPs are operated at the output lower than the installed capacity for a long time to supply base demand. Therefore, the shortage of peak supply capacity occurs for some days within the above-mentioned allowable range. Regarding energy, on the other hand, nearly 100% is supplied in years when LOLP is within the allowable range.

For the base case, though the Kulekhani No. 3 HPP (14 MW), the Chameliya HPP (30 MW), and the Khani Khola HPP (25 MW) will be put into operation in FY2015/16, the supply capacity is not able to meet the peak demand. The LOLP is improved by comparison with previous years. It is, however, a significantly large value, 33%. In FY2016/17, the Upper Tamakoshi HPP (456 MW), the Upper Sanjen HPP (11 MW), the Sanjen HPP (42.9 MW), and the Upper Trishuli 3A HPP (60 MW) are put into operation, and the LOLP becomes lower than 3%, however it is larger than 1.375%, the allowable upper limit. After then, between FY2017/18 and FY2021/22, the Nadhya (Middle) Botekoshi HPP (102 MW), the Rasuwagad HPP (111 MW), the Rahughat HPP (32 MW), the Upper Marsyangdi HPP (50 MW), the Mistri HPP (42 MW), the Upper Trishuli 3B HPP (37 MW), the Tanahu HPP (140 MW), the Upper Modi A HPP, and the Tamakoshi V HPP (87 MW) are put into operation. Other than these HPPs, ROR-type HPPs totaling 300 MW are also put into operation, and the LOLP fluctuates in a range between 1.5% and 3%.

In FY2022/23, commissioning of the Budhi Gandaki HPP (600 MW) makes the power demand and supply balanced, and the LOLP becomes lower than the allowable upper limit, 1.375%. Then the Upper Arun HPP (335 MW: PROR type) is put into operation in FY2025/26, the Dudh Koshi HPP (300 MW) in FY2026/27, the Nalsyau Gad HPP (410 MW) in FY2028/29, and the West Seti HPP (750 MW) is put into operation in FY2030/31. Other than these HPPs, ROR-type HPPs totaling 200 MW are also put into operation, stable supply-demand situation continues until FY2031/32. (See Table A.4.2.3.2-1)

The power development plan for the high case of the demand forecast is much the same as that for the base case until commissioning of the Budhi Gandaki HPP in FY2022/23. After then, the Upper Arun (PROR type), the Nalsyau Gad, and the West Seti HPPs are put into operation in FY2024/25, FY2027/28, and FY2029/30 respectively. Their commissioning are one year earlier than the base case. In addition, the Chera-1 HPP (149 MW) is put into operation in FY2029/30, and the Andhi Khola HPP (180 MW) and the Kaligandaki-2 HPP (680 MW) are put into operation in FY2031/32. These three HPPs are not put into operation in and before FY2031/32 in the power development plan for the base case of demand forecast. (See Table A.4.2.3.2-2)

The power development plan for the low case of demand forecast is also much the same as that for the base case until commissioning of the Budhi Gandaki HPP in FY2022/23. After then, commissioning of the Upper Arun, the Dudh Koshi, the Nalsyau Gad, and the West Seti HPPs are FY2026/27, FY2027/28, FY2029/30, and FY2031/32 respectively, one year later than for the base case of demand forecast. (See Table A.4.2.3.2-3)

**Table A.4.2.3.2-4 Balance of Demand and Supply, LOLP, and Reserve Margin (Base Case) (Candidates proposed by NEA are considered)**

| FY | Installed Capacity (MW) | Peak Demand (MW) | Supply Capacity (MW) | Supply – Demand (MW) | Energy Demand (GWh) | Supply Energy (GWh) | Supply / Demand (%) | LOLP (%) | Reserve Margin (%) |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d = c – b | e | f | g = f / e | h | i = a / b – 1 |
| 2012/13 | 862 | 1,231 | 479 | -752 | 5,607 | 4,707 | 84.0 | **50.375** | -30.0 |
| 2013/14 | 862 | 1,277 | 477 | -800 | 5,818 | 4,787 | 82.3 | **53.789** | -32.5 |
| 2014/15 | 862 | 1,328 | 476 | -852 | 6,049 | 4,865 | 80.4 | **57.975** | -35.1 |
| 2015/16 | 1,081 | 1,382 | 696 | -686 | 6,294 | 5,747 | 91.3 | **32.637** | -21.8 |
| 2016/17 | 1,651 | 1,439 | 1,224 | -215 | 6,556 | 6,527 | 99.6 | **2.733** | 14.7 |
| 2017/18 | 1,988 | 1,501 | 1,346 | -155 | 6,836 | 6,819 | 99.8 | **1.575** | 32.5 |
| 2018/19 | 2,088 | 1,575 | 1,375 | -200 | 7,176 | 7,154 | 99.7 | **1.927** | 32.5 |
| 2019/20 | 2,225 | 1,717 | 1,436 | -281 | 7,823 | 7,788 | 99.6 | **2.579** | 29.6 |
| 2020/21 | 2,507 | 1,867 | 1,617 | -250 | 8,504 | 8,481 | 99.7 | **1.919** | 34.3 |
| 2021/22 | 2,594 | 2,031 | 1,636 | -395 | 9,252 | 9,198 | 99.4 | **3.087** | 27.7 |
| 2022/23 | 3,194 | 2,169 | 2,236 | 67 | 9,881 | 9,880 | 100.0 | 0.130 | 47.3 |
| 2023/24 | 3,194 | 2,321 | 2,236 | -85 | 10,572 | 10,568 | 100.0 | 0.516 | 37.6 |
| 2024/25 | 3,294 | 2,513 | 2,265 | -248 | 11,447 | 11,428 | 99.8 | 1.225 | 31.1 |
| 2025/26 | 3,729 | 2,714 | 2,537 | -177 | 12,364 | 12,358 | 100.0 | 0.666 | 37.4 |
| 2026/27 | 4,029 | 2,925 | 2,837 | -88 | 13,325 | 13,320 | 100.0 | 0.336 | 37.7 |
| 2027/28 | 4,029 | 3,158 | 2,837 | -321 | 14,386 | 14,370 | 99.9 | 1.079 | 27.6 |
| 2028/29 | 4,439 | 3,410 | 3,247 | -163 | 15,531 | 15,526 | 100.0 | 0.440 | 30.2 |
| 2029/30 | 4,439 | 3,676 | 3,247 | -429 | 16,744 | 16,721 | 99.9 | 1.331 | 20.8 |
| 2030/31 | 5,189 | 3,966 | 3,997 | 31 | 18,066 | 18,066 | 100.0 | 0.075 | 30.8 |
| 2031/32 | 5,189 | 4,279 | 3,997 | -282 | 19,493 | 19,484 | 100.0 | 0.590 | 21.3 |

*: Critical LOLP is 1.375%, equivalent to 5 days/year.

## Table A.4.2.3.2-5 Balance of Demand and Supply, LOLP, and Reserve Margin (High Case) (Candidates proposed by NEA are considered)

| FY | Installed Capacity (MW) | Peak Demand (MW) | Supply Capacity (MW) | Supply – Demand (MW) | Energy Demand (GWh) | Supply Energy (GWh) | Supply / Demand (%) | LOLP (%) | Reserve Margin (%) |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d = c – b | e | f | g = f / e | h | i = a / b – 1 |
| 2012/13 | 862 | 1,216 | 479 | -737 | 5,537 | 4,682 | 84.5 | **49.198** | -29.1 |
| 2013/14 | 862 | 1,247 | 477 | -770 | 5,678 | 5,326 | 93.8 | **51.573** | -30.8 |
| 2014/15 | 862 | 1,284 | 476 | -808 | 5,851 | 5,498 | 94.0 | **54.322** | -32.9 |
| 2015/16 | 1,081 | 1,324 | 696 | -628 | 6,031 | 6,029 | 100.0 | **27.323** | -18.3 |
| 2016/17 | 1,651 | 1,381 | 1,224 | -157 | 6,290 | 6,287 | 99.9 | **1.945** | 19.6 |
| 2017/18 | 1,988 | 1,512 | 1,346 | -166 | 6,888 | 6,886 | 100.0 | **1.680** | 31.5 |
| 2018/19 | 2,088 | 1,649 | 1,375 | -274 | 7,512 | 7,505 | 99.9 | **2.695** | 26.6 |
| 2019/20 | 2,225 | 1,794 | 1,436 | -358 | 8,174 | 8,160 | 99.8 | **3.334** | 24.0 |
| 2020/21 | 2,507 | 1,949 | 1,617 | -332 | 8,880 | 8,851 | 99.7 | **2.625** | 28.6 |
| 2021/22 | 2,594 | 2,123 | 1,636 | -487 | 9,670 | 9,604 | 99.3 | **3.923** | 22.2 |
| 2022/23 | 3,194 | 2,270 | 2,236 | -34 | 10,342 | 10,229 | 98.9 | 0.345 | 40.7 |
| 2023/24 | 3,194 | 2,429 | 2,236 | -193 | 11,066 | 11,065 | 100.0 | 0.967 | 31.5 |
| 2024/25 | 3,729 | 2,629 | 2,265 | -364 | 11,974 | 11,962 | 99.9 | 0.403 | 41.9 |
| 2025/26 | 3,729 | 2,854 | 2,537 | -317 | 13,002 | 13,001 | 100.0 | 1.218 | 30.6 |
| 2026/27 | 4,029 | 3,093 | 2,837 | -256 | 14,089 | 14,082 | 100.0 | 0.824 | 30.3 |
| 2027/28 | 4,439 | 3,350 | 2,837 | -513 | 15,260 | 15,243 | 99.9 | 0.309 | 32.5 |
| 2028/29 | 4,439 | 3,635 | 3,247 | -388 | 16,557 | 16,545 | 99.9 | 1.167 | 22.1 |
| 2029/30 | 5,338 | 3,984 | 3,247 | -737 | 18,147 | 18,138 | 100.0 | 0.091 | 34.0 |
| 2030/31 | 5,338 | 4,389 | 3,997 | -392 | 19,993 | 19,983 | 100.0 | 0.913 | 21.6 |
| 2031/32 | 6,198 | 4,866 | 3,997 | -869 | 22,166 | 22,108 | 99.7 | 0.087 | 27.4 |

*: Critical LOLP is 1.375%, equivalent to 5 days/year.

## Table A.4.2.3.2-6 Balance of Demand and Supply, LOLP, and Reserve Margin (Low Case) (Candidates proposed by NEA are considered)

| FY | Installed Capacity (MW) | Peak Demand (MW) | Supply Capacity (MW) | Supply – Demand (MW) | Energy Demand (GWh) | Supply Energy (GWh) | Supply / Demand (%) | LOLP (%) | Reserve Margin (%) |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d = c – b | e | f | g = f / e | h | i = a / b – 1 |
| 2012/13 | 862 | 1,240 | 479 | -761 | 5,650 | 4,727 | 83.7 | **51.054** | -30.5 |
| 2013/14 | 862 | 1,297 | 477 | -820 | 5,907 | 4,818 | 81.6 | **55.341** | -33.5 |
| 2014/15 | 862 | 1,361 | 476 | -885 | 6,202 | 4,915 | 79.2 | **60.972** | -36.7 |
| 2015/16 | 1,081 | 1,430 | 688 | -742 | 6,514 | 5,857 | 89.9 | **36.845** | -24.4 |
| 2016/17 | 1,651 | 1,503 | 1,224 | -279 | 6,847 | 6,803 | 99.4 | **3.802** | 9.8 |
| 2017/18 | 1,988 | 1,579 | 1,346 | -233 | 7,192 | 7,165 | 99.6 | **2.389** | 25.9 |
| 2018/19 | 2,088 | 1,651 | 1,375 | -276 | 7,522 | 7,489 | 99.6 | **2.716** | 26.4 |
| 2019/20 | 2,225 | 1,728 | 1,436 | -292 | 7,869 | 7,834 | 99.6 | **2.678** | 28.8 |
| 2020/21 | 2,507 | 1,808 | 1,617 | -191 | 8,237 | 8,220 | 99.8 | **1.453** | 38.6 |
| 2021/22 | 2,594 | 1,918 | 1,636 | -282 | 8,738 | 8,712 | 99.7 | **2.135** | 35.2 |
| 2022/23 | 3,194 | 2,043 | 2,236 | 193 | 9,307 | 9,307 | 100.0 | 0.017 | 56.3 |
| 2023/24 | 3,194 | 2,178 | 2,236 | 58 | 9,922 | 9,921 | 100.0 | 0.144 | 46.6 |
| 2024/25 | 3,194 | 2,349 | 2,236 | -113 | 10,702 | 10,697 | 100.0 | 0.621 | 36.0 |
| 2025/26 | 3,294 | 2,533 | 2,265 | -268 | 11,538 | 11,521 | 99.9 | 1.338 | 30.0 |
| 2026/27 | 3,729 | 2,728 | 2,537 | -191 | 12,426 | 12,417 | 99.9 | 0.712 | 36.7 |
| 2027/28 | 4,029 | 2,939 | 2,837 | -102 | 13,390 | 13,386 | 100.0 | 0.370 | 37.1 |
| 2028/29 | 4,029 | 3,167 | 2,837 | -330 | 14,426 | 14,408 | 99.9 | 1.117 | 27.2 |
| 2029/30 | 4,439 | 3,408 | 3,247 | -161 | 15,524 | 15,519 | 100.0 | 0.435 | 30.3 |
| 2030/31 | 4,439 | 3,662 | 3,247 | -415 | 16,680 | 16,658 | 99.9 | 1.275 | 21.2 |
| 2031/32 | 5,189 | 3,934 | 3,997 | 63 | 17,921 | 17,921 | 100.0 | 0.081 | 31.9 |

*: Critical LOLP is 1.375%, equivalent to 5 days/year.

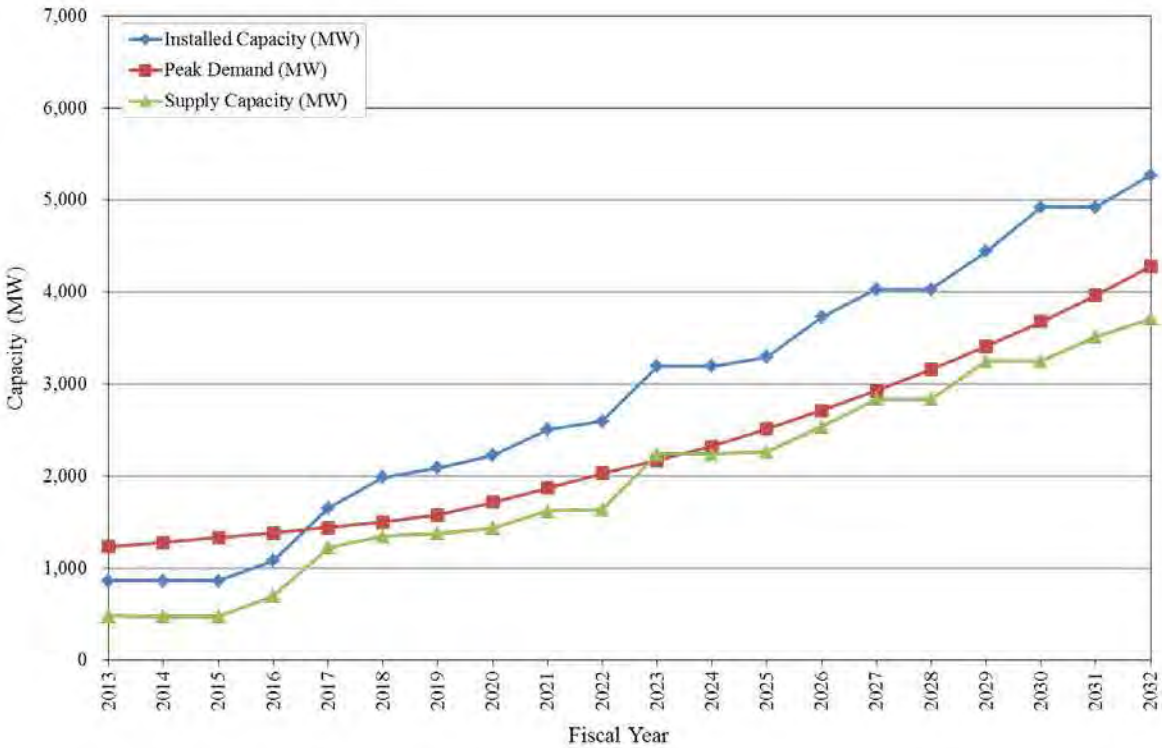



**Figure A.4.2.3.2-1 Balance of Peak Demand and Supply Capacity (Base Case) (Candidates proposed by NEA are considered)**

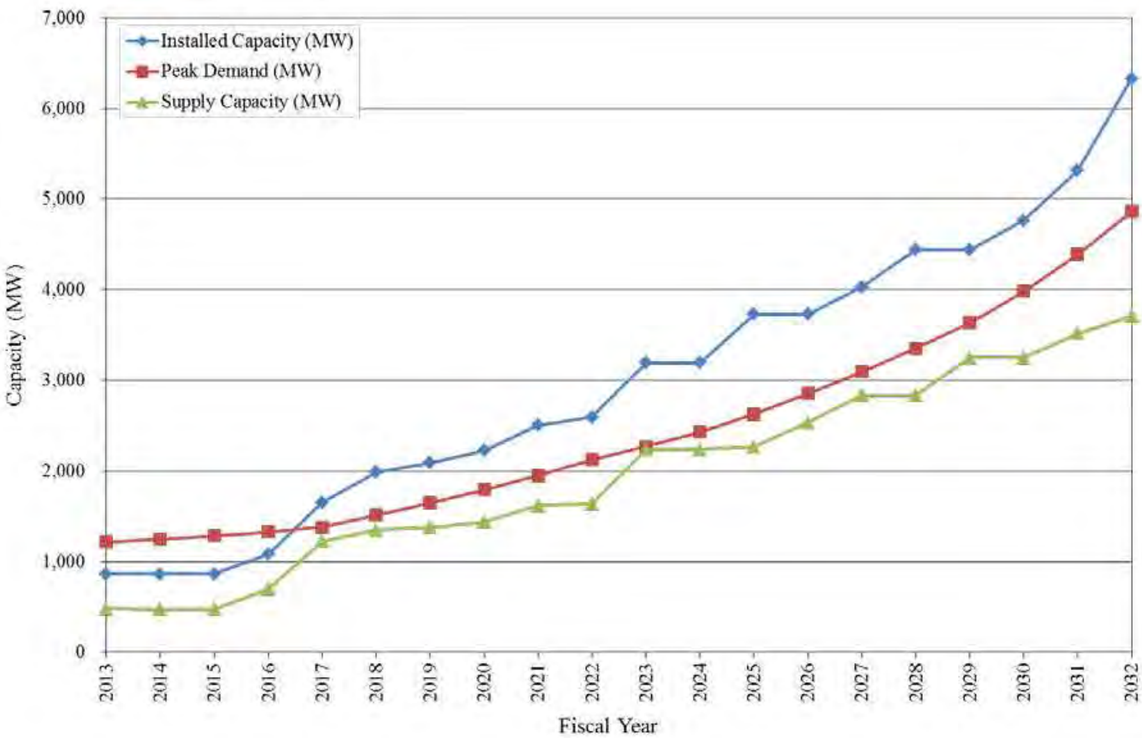



**Figure A.4.2.3.2-2 Balance of Peak Demand and Supply Capacity (High Case) (Candidates proposed by NEA are considered)**

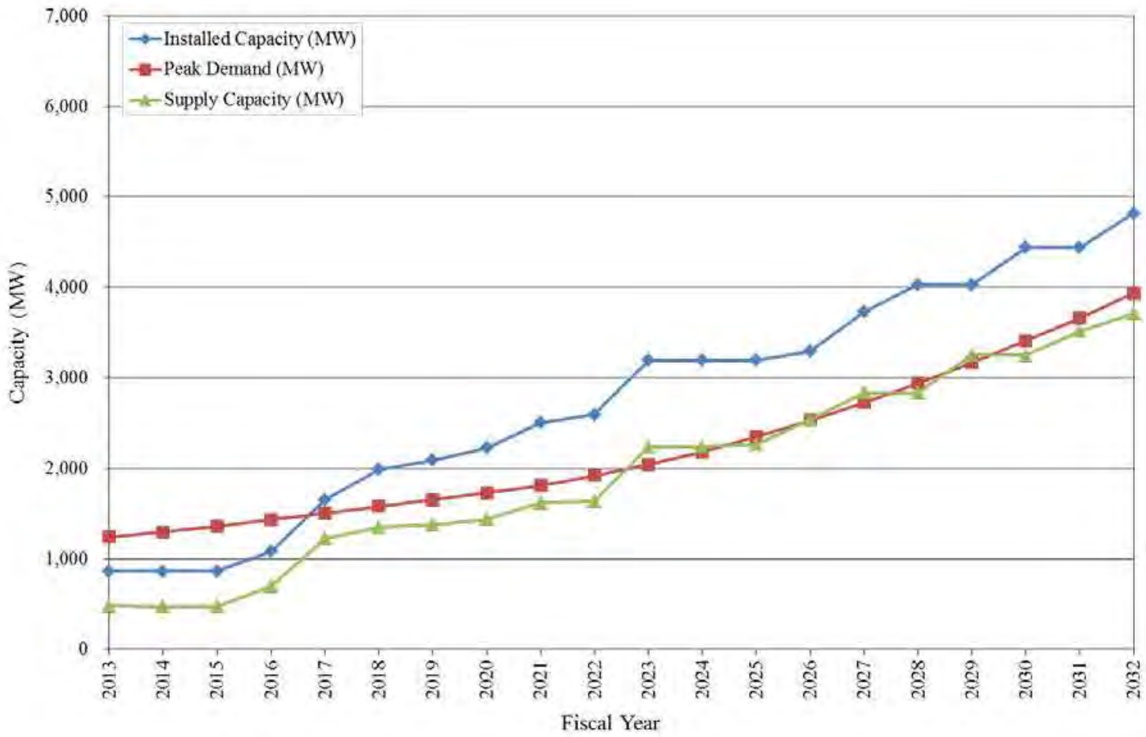



**Figure A.4.2.3.2-3 Balance of Peak Demand and Supply Capacity (Low Case)**
**(Candidates proposed by NEA are considered)**

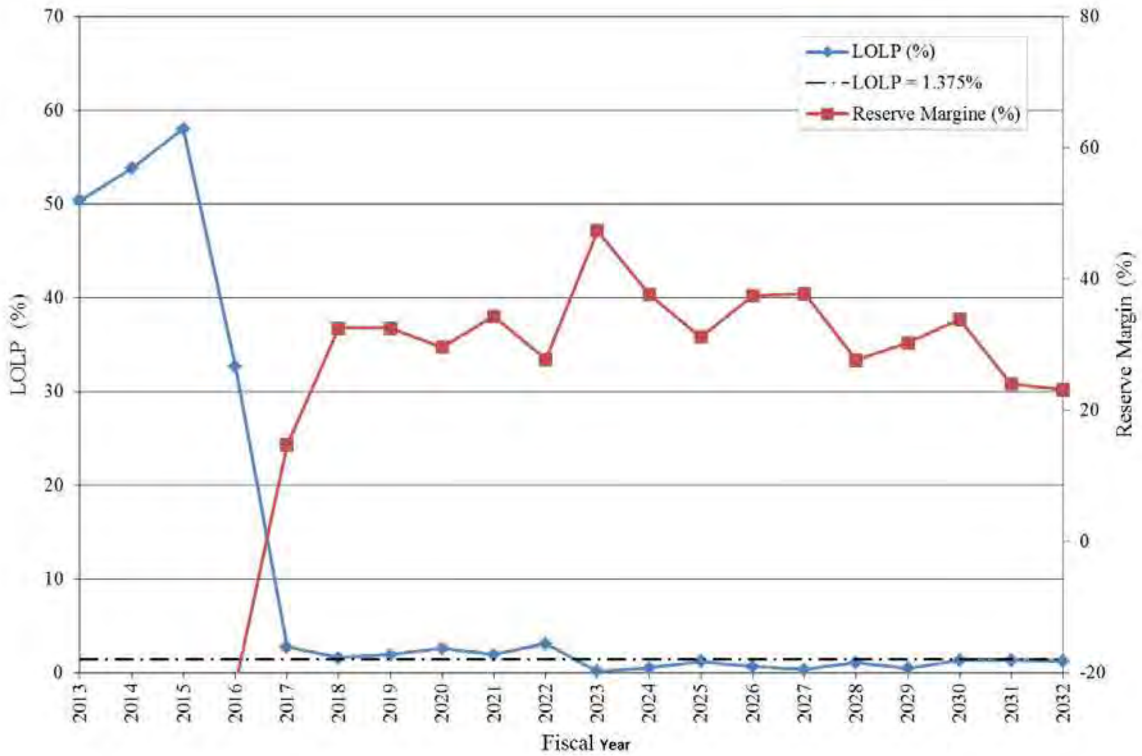



**Figure A.4.2.3.2-4 LOLP and Reserve Margin (Base Case)**
**(Candidates proposed by NEA are considered)**

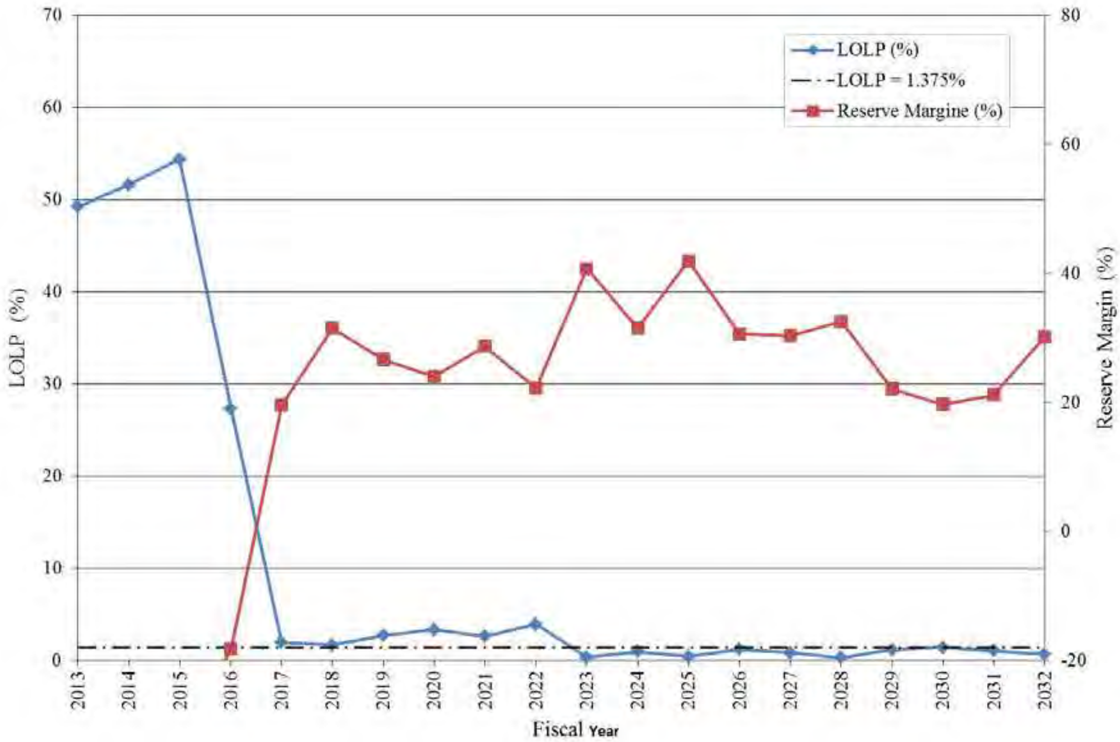



**Figure A.4.2.3.2-5 LOLP and Reserve Margin (High Case)**
**(Candidates proposed by NEA are considered)**

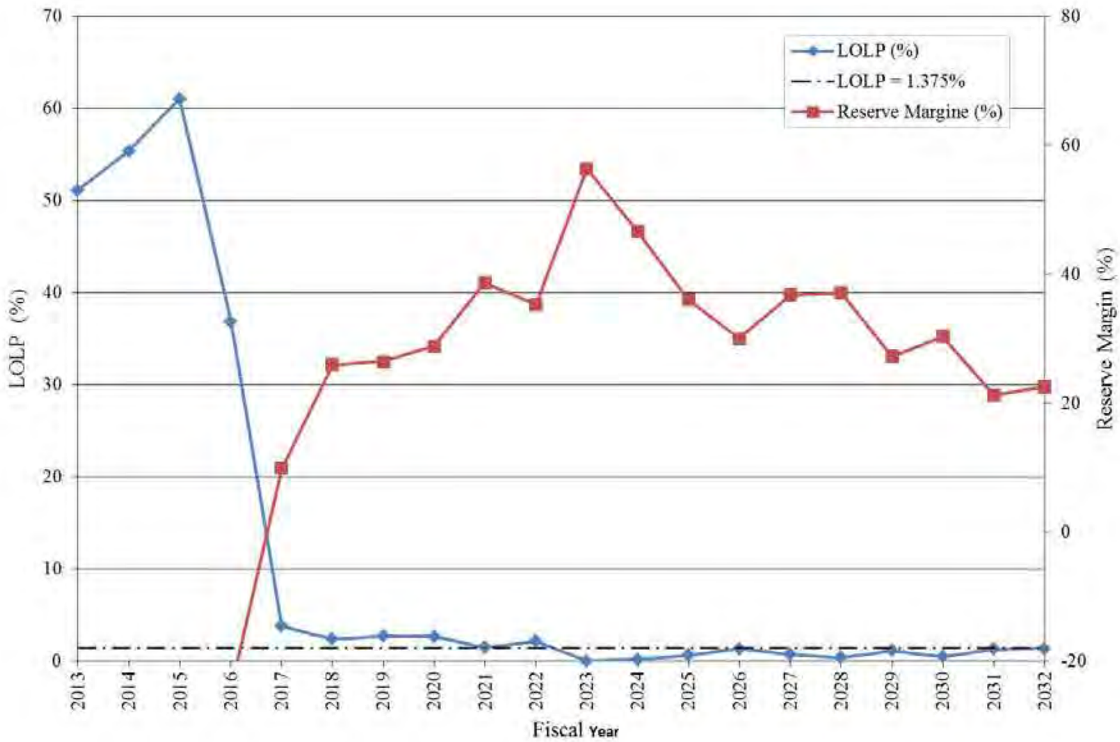



**Figure A.4.2.3.2-6 LOLP and Reserve Margin (Low Case)**
**(Candidates proposed by NEA are considered)**

## A.4.3 Development Plan of Storage-type Hydroelectric Power Projects

### A.4.3.1 Storage-type Hydroelectric Power Projects to be Implemented

In the power development plan described in “A.4.2 Power Development Plan,” the total installed capacity of hydroelectric power projects (including an increment in imports from India) that start commercial operation in the 20 years from FY2012/13 to FY 2031/32 including the increment in import from India is 4,177 MW for the base case of demand forecast, 5,186 MW for the high case, and 4,177 MW for the low case. The total installed capacity of storage-type hydroelectric power projects is 2,214 MW for the base case, 3,223 MW for the high case, and 2,214 MW for the low case.

Table A.4.3.1-1 shows the storage-type hydroelectric power projects to be implemented.

**Table A.4.3.1-1 Storage-type Projects to be Implemented (Candidates proposed by NEA are considered)**

| Project | Capacity (MW) | Commercial Operation (FY) | | | Remarks |
|---|---|---|---|---|---|
| | | Base Case | High Case | Low Case | |
| Kulekhani No. 3 | 14 | 2015/16 | | | Under construction |
| Tanahu | 140 | 2020/21 | | | LA has been concluded. |
| Budhi Gandaki | 600 | 2022/23 | | | DD is ongoing. |
| Dudh Koshi | 300 | 2026/27 | 2026/27 | 2027/28 | |
| Nalsyau Gad | 410 | 2028/29 | 2027/28 | 2029/30 | |
| West Seti | 750 | 2030/31 | 2029/30 | 2031/32 | |
| Chera-1 | 149 | ---- | 2029/30 | ---- | |
| Andhi Khola | 180 | ---- | 2031/32 | ---- | |
| Kaligandaki-2 | 680 | ---- | 2031/32 | ---- | |
| Total Capacity | ---- | 2,214 MW | 3,223 MW | 2,214 MW | |

In addition to the Kulekhani No. 3 project which is now under construction, the Tanahu project whose loan agreement has already been concluded, and the Budhi Gandaki project which is mow in the detailed design stage, the Dudh Koshi, the Nalsyau Gad, and the West Seti projects are implemented in the all cases.

For the base case of the demand forecast, the Dudh Koshi HPP (300 MW) is put into operation in FY2026/27, followed by the Nalsyau Gad HPP (410 MW) in FY 2028/29, and the West Seti HPP (750 MW) in FY2030/31. Since the West Seti HPP (750 MW) is put into operation in FY2030/21, the Andhi Khola, the Chera-1 and the Naumure projects that are put into operation by FY2031/32 in the power development plan drawn up in Chapter 8 of the main report are not necessary to be put into operation in or before FY2031/32, the last year of power development plan.

For the high case, the Nalsyau Gad and the West Seti HPPs are put into operation one year earlier than those for the base case, And the Chera-1 HPP is put into operation in FY2029/30, the Andhi Khola and the Kaligandaki-2 HPPs are put into operation in FY2031/32. These three HPPs are not put into operation in the base case are put into operation in FY2029/30, FY2031/32, and FY2031/32 respectively.

For the low case, the Dudh Koshi, the Nalsyau Gad and the West Seti HPPs are put into operation one year later than those for the base case..

Table A.4.3.1-2 shows the earliest possible years of commissioning and the commissioning years in each case of power demand forecast

**Table A.4.3.1-2 Commissioning Year of Commercial Operation (Candidates proposed by the NEA are considered)**

**Base Case**

| Project | Capacity (MW) | 2023/24 | 2024/25 | 2025/26 | 2026/27 | 2027/28 | 2028/29 | 2029/30 | 2030/31 | 2031/32 |
|---|---|---|---|---|---|---|---|---|---|---|
| Dudh Koshi | 300 | P | → | → | G | | | | | |
| Nalsyau Gad | 410 | P | → | → | → | → | G | | | |
| West Seti | 750 | P | → | → | → | → | → | → | G | |
| (Chera-1) | 149 | | | | | | | | | |
| (Andhi Khola) | 180 | | | | | | | | | |
| (Kaligandaki-2) | 680 | | | | | | | | | |

**High Case**

| Project | Capacity (MW) | 2023/24 | 2024/25 | 2025/26 | 2026/27 | 2027/28 | 2028/29 | 2029/30 | 2030/31 | 2031/32 |
|---|---|---|---|---|---|---|---|---|---|---|
| Dudh Koshi | 300 | P | → | → | G | | | | | |
| Nalsyau Gad | 410 | P | → | → | → | G | | | | |
| West Seti | 750 | P | → | → | → | → | → | G | | |
| Chera-1 | 149 | | | | | P | → | G | | |
| Andhi Khola | 180 | | | P | → | → | → | → | → | G |
| Kaligandaki-2 | 680 | | | | P | → | → | → | → | G |

**Low Case**

| Project | Capacity (MW) | 2023/24 | 2024/25 | 2025/26 | 2026/27 | 2027/28 | 2028/29 | 2029/30 | 2030/31 | 2031/32 |
|---|---|---|---|---|---|---|---|---|---|---|
| Dudh Koshi | 300 | P | → | → | → | G | | | | |
| Nalsyau Gad | 410 | P | → | → | → | → | → | G | | |
| West Seti | 750 | P | → | → | → | → | → | → | → | G |
| (Chera-1) | 149 | | | | | | | | | |
| (Andhi Khola) | 180 | | | | | | | | | |
| (Kaligandaki-2) | 680 | | | | | | | | | |

P : The earliest possible commissioning Year.
G : The commissioning year in the generation expansion plan.