prices of crops by the crop distribution and yield. As a result, the annual unit flood mitigation benefit is assessed at Rs. 31,620 per hectare.

(5) Preliminary economic evaluation

A preliminary economic evaluation was made to assess the economic viability. The total economic project cost is assessed to be Rs. 49.8 million by applying an average economic conversion factor of 85 %. Annual operation and maintenance costs are estimated to be Rs. 2.79 million and its economic value is assumed to be Rs. 2.37 million. Annual flood mitigation benefit is calculated by multiplying the annual unit flood mitigation benefit, Rs. 31,620 per hectare, by the expected acreage of the farm land to be protected, which corresponds to 70% of the area to be protected. An evaluation period is set to 30 years after the completion of the construction.

As a result, an economic internal rate of return is calculated to be 5.8 %, and the net benefit is a negative value of Rs. 22.1 million by applying a discount rate of 10 %. This economic evaluation was carried out under rain-fed condition. The introduction of irrigation will increase the economic viability of the works.

5.4.7 Recommendations

(1) Implementation of Dodhara and Chandani areas river training work scheme

In evaluating the Dodhara and Chandani areas river training work scheme, it should be considered that (a) the protection of the fertile land from erosion calls for urgent needs for the local residents and (b) the land use might be enhanced by extension of the irrigation system with groundwater development. Therefore, it is recommended that this flood mitigation priority scheme be proceeded to further studies for implementation. It is also recommended that the recession of the river bank and the high water level be monitored at floods.

(2) Recommendations regarding flood mitigation works in a short term

Presented hereunder are recommendations for immediately solving river problems in the Study Area :

- There are only limited discharge records at floods and topographic maps in the areas prone to flood damage, but no flood damage records have been accumulated so far. It is recommended that such information be (a) collected by

using standard forms through field surveys by engineers of District Irrigation Offices and (b) accumulated in Regional Irrigation Office and River Training Division.

- District Irrigation Offices have difficulties in carrying out field surveys due to lack of budgets. The budget for the river training works should be raised besides that for the irrigation developments. Some incentives may be necessary for engineers of District Irrigation Offices to carry out field surveys in the remote areas considering difficulties in access to sites.

- Since the Department of Irrigation gives a priority to flood mitigation works in allocating the limited budget, a proper implementation programme should be prepared on the basis of information on flood damages, cost and urgency of works from Regional Irrigation Office. It is recommended that Regional Irrigation Office be strengthened with technical staff in order to make an appropriate proposal of a flood mitigation work programme.

(3) Recommendations regarding flood mitigation works in a long term

Presented hereunder are recommendations for achieving goals of the flood mitigation works in the Study Area in a long term:

- It is recommended that each District Irrigation Office carry out field investigations for priority river training work schemes in the hill area out of the 21 schemes identified in this Study. Each field investigation is required to include assessment of flood damages, preparation of a topographic map, a preliminary design of proposed river training works and a preliminary cost estimate.

- District Irrigation Offices will submit the result of the field investigations to the Regional Irrigation Office. Regional Irrigation Office will submit to River Training Division a proposal of a region-wide programme by viewing the river basin as a whole. River Training Division will receive such proposals of the programmes from five Regional Irrigation Offices and establish a nation-wide river training programme.

- It is necessary to train technical engineers. Water Induced Disaster Prevention Training Centre under MWR is expected as a promising training centre.

- Functions of the existing river training works should periodically be monitored. In remote areas, participation of local people in monitoring work is indispensable. Therefore, local people should be trained to accustom the monitoring work as well as simple construction and maintenance works.

- A meteorological and hydrological observation net work is required to be established in the Karnali and Mahakali river basins.

- Although the surveys on possibility of Glacier Lake Outburst Floods have been attempted in Eastern, Central and Western Development Regions, those in Mid Western and Far Western Development Regions will also be required.

5.5 Watershed Management

5.5.1 Present Condition

Rivers in Nepal, all draining south to the Ganges plain, are characterized by their transportation of tremendous quantities of sediment material. A major force is the geotectonic movement caused by subduction of the Indian plate under the Himalayan mountains, resulting in the uplift and distortion of land, which form unstable steep slopes in the mountain zone. The other is the effect of human activities on forest, shrub, grazing and agricultural lands.

The upper reaches of the Karnali and Mahakali rivers are geologically composed of gneisses, schists, shales, sandstones, conglomerates, quartzites and carbonaceous rocks of Pre-Cambrian to Mesozoic, which are folded, sheared and faulted. These meta-sedimentary bedrocks are often intensely slacked in the area to even more than 30 metres of depth from the ground surface due to stress relief on the steep slopes. The bedrocks are intersected by frequent faults of varied sizes, of which most are minor but may contribute to increasing the potential of slope failure or landslide. According to the analysis of LRMP, the slope classified as moderate to steep, which is marginal for landslide, occupies almost 90% of the land area in the districts of the Study Area, except for five districts in the Terai zone.

Carson (1985) discussed in his study of erosion and sedimentation in the Nepalese Himalayas that mass wasting or massive production by slope failure of mud/debris flows accounts for a large part of sediment yield. C.K. Sharma (1988) argued that deforestation, cultivation and construction works, which are three main human activities, accelerate the erosion by natural activities.

Among the forces to mobilize the mass wasting, earthquake will work mainly as an agent to start the movement. It triggers the slope failures in the short duration of its action by disturbing the mechanical balance of slopes or old landslides once stabilized. The earthquake, by itself, can be the cause of localized quick landslips or rock failures than slow-moving landslides. Nepal is in a well-known active seismic zone with two major active thrust faults running in the east-northeasterly direction, i.e. the Main Central Thrust separating the high Himalayas from the midland and the Main Boundary Thrust through the foothills. Minor earthquakes of 3 to 5 in magnitude (Richter Scale) are frequent but destructive event occurs only a few times in a century (Sharma 1988). Even in varied magnitude, earthquakes are an important natural factor in generating slope instability. On the other hand, human activities such as deforestation are the cause of surface erosion.

5.5.2 Watershed Management Activities

(1) Government strategy

The Department of Soil Conservation and Watershed Management (DSCWM) has recognized the importance of soil conservation and watershed management and has set the following targets for them:

(a) Arresting watershed degradation and ecological deterioration,

(b) Reducing human pressure on land through better and integrated land management, and

(c) Helping to attain a better quality of life for the people through higher land productivity and environmental balance.

There are three countermeasures in order to achieve the above-mentioned targets; (i) preventive measures, (ii) rehabilitative measures and (iii) disseminative and educational measures (Master Plan for Forestry Sector). There is, however, no sole ministry which can handle all these work. In practice, the responsibility for implementing these three measures is shared by different ministries under the leadership of the DSCWM as follows:

(a) Ministry of Forest and Environment: management and protection of upstream watersheds and grazing land,

(b) Ministry of Agriculture: extension of management expertise in agricultural areas, and

(c) Ministry of Water Resources: construction and protection of water conveyance systems and control of water flows in downstream valleys.

(2) Evaluation of watershed

Shrestha, B.D. et al (1983) ranked watershed condition by district, using a relative rating method classified into five categories based on the idea of Nelson, D. et al (1980)as follows:

Class 1 Excellent : Where the watershed is in or near 'pristine' condition; natural or geological erosion may be present. Area in this class is 71,400 sq km (51 %).

Class 2 Good: Where minor amounts of disturbance from land use exist; productivity of land is not impaired. Area in this class is 50,432 sq km (36 %).

Class 3 Marginal: Where significant disturbance exists; productivity is impaired. Area in this class is 15,360 sq km (11 %).

Class 4 Poor: Where impact of accelerated erosion is serious; land productivity is reduced. Area in this class is 1,410 sq km (1 %).

Class 5 Very poor: Where erosion is advanced; agricultural and forage production is absent or greatly reduced. High sediment yield due to flashing flow after rainfall has destroyed the natural characteristics of the stream. Area in this class is 1,410 sq km (1%).

For the numerical evaluation of watershed, the following points are given to each class; nil point for Classes 1 and 2, one point for Class 3, two points for Class 4 and three points for Class 5. Multiplying the share ratio (percent in area) of each class by respective points, all the districts in Nepal were evaluated as given in Figure 5.5.1 and Table 5.5.1. Further details of the Study Area are given in Table 5.5.2. According to this, Surkhet District is classified into Class 5 and requires urgent countermeasures to protect the watershed. Three districts, Dolpa, Rukum and Dailekh, are in a marginal condition, and thus the proper corresponding measures should be taken.

(3) Watershed management

As a recent trend for soil conservation and watershed management, emphasis is placed on integrated rural development projects and community forest projects. This shift of trend is caused by understanding the importance of socio-economic factors in the degradation and banishment of forest land. Since local people do not have any alternative for energy source other than cutting forest trees, emphasis is given Integrated Rural Development Project (IRDP) for watershed management to establish a sustainable ecosystem, which balances the requirements of people's lives and land productivity by increasing the productivity of cultivated land as well as forest.

(4) Community and private forestry programme

The Master Plan of the Ministry of Forestry and Environments prioritized the six major programmes administered by the Department of Forest. Among them, the Programme of Community and Private Forestry is the most important one, occupying half of the sector investment.

The central policy of this programme is to develop and manage forest resources through the active participation of individuals and communities to meet their basic needs. The strategy to achieve this is described in the following statement:

> "phased handing over of all accessible hill forests to the communities to the extent that they are able and willing to manage them".

In other words, while old legislation aimed to keep people out of the government forests, new legislation intends to delegate to the community the authority and responsibility to protect, manage and utilize the government forests.

The main components of the community and private forestry programme are:

- to encourage planting of degraded forests and management of natural forests as community forests,
- to distribute free or subsidized seedlings to encourage the establishment of private forestry, and
- to establish and manage community forestry in open and degraded areas.

Among the various activities of the programme, the accumulated area of afforestation over the period of year 1980 to 1988 is approximately 31,000 ha in 29 districts of the country. The districts involved in the programme in the Study Area are Darchula, Baitadi, Dadeldhura, Bujhang, Doti, Bajura and Achham in the Far Western Development Region and Jajarkot in the Mid Western Development Region as of year 1988. The achievement of the community and private forestry programme for the fiscal year 1990/91 in the country as a whole and in the two development regions concerned is shown in Table 5.5.3. The area covered in each region is only 1,000 hectares, which is still negligible compared with the total area of the two.

5.6 Studies on the Bheri-Babai Diversion Scheme

The implementation of the Karnali multipurpose project would be viable with no doubt, but it will require much time, say at least 25 years, before starting the construction of the project for tackling such issues as the agreement on energy sale with India, the displacement of people in the reservoir area, financial arrangement for the implementation and so on.

The delay of implementing the Karnali project implies that the project will lose the opportunities to earn the benefits originally planned by selling generated energy. The earlier implementation of the Bheri/Babai diversion scheme prior to that of the Karnali would make up for a part of benefits which are gained from the Karnali project in economic terms. This section deals with the possibilities of earlier implementation of the Bheri/Babai diversion scheme in economic terms by dividing into two parts. The first part discusses the potentiality to extend the irrigation command areas lying downstream of the Babai River. The second part deals with the economic viability to implement the Bheri/Babai diversion scheme as the hydropower generation scheme prior to the Karnali project.

(1) Development Potential of Irrigation by the Bheri/Babai Diversion Scheme

A 10-year drought discharge of the Babai River after receiving the flow released from the Bheri/Babai power plant was computed based on simulation to grasp the general idea for extending the irrigation command areas lying in the lower reaches of the Babai River.

A main condition given to the simulation is the maintenance flow of the Bheri River, which will mainly be required for protecting aquatic fauna, terrestrial animals and flora and for sustaining fishery among others. Environmental studies to determine the

amount required as maintenance flow have not been carried out so far. Thus, river maintenance flow of the Bheri River was at this moment assumed at 48 m^3/sec, which is the historical minimum discharge at the BR-1 site.

As discussed in the preceding Section 5.1.4, design discharges of BR-1 were selected at 29.1, 38.3 and 58.2 m^3/sec. A 10-year drought discharge of the Babai with the diversion from the Bheri was computed through the simulation, ensuring 30.4 for 29.1 m^3/sec diversion flow, 32.7 for 38.3 m^3/sec and 33.8 for 58.2 m^3/sec as summarized in Figure 5.6.1.

Further detailed simulation studies were carried out to delineate the irrigable areas for the given cropping patterns. The conditions given for the simulation are 58.2 m^3/sec as the design discharge of BR-1 and 16-year runoff data. Maintenance flow of 48 m^3/sec for the Bheri River is of course included as a condition of simulation. As a conclusion, paddy cropping in the monsoon season is possible for the entire irrigation area of 74,270 ha, whilst upland crops such as wheat and sugarcane can be planted for an area of 33,270 ha in the winter season.

(2) Assessment of Economic Viability for the Earlier Implementation of the Bheri-Babai Diversion Scheme

The diversion of the Bheri River water to the Babai River naturally reduces energy generation from the Karnali project, even if the Bheri-Babai diversion scheme makes up for some of it. Figure 5.6.2 shows the relationship between the reduced energy generation of the Karnali project and the make-up energy generation of the Bheri-Babai diversion scheme.

Without introducing the Bheri-Babai diversion scheme, the Karnali project produces average annual energy of 21,128 GWh/year. With the diversion of 29.1 m^3/sec, the Karnali project reduces its energy generation to a level of 20,575 GWh/year, whilst 20,424 GWh/year for 38.3 m^3/sec and 20,141 GWh/year for 58.2 m^3/sec. Introduction of the Bheri-Babai diversion scheme recovers the energy generation to a level of 20,912 GWh/year for 29.1 m^3/sec, 20,852 GWh/year for 38.3 m^3/sec and 20,736 GWh/year for 58.2 m^3/sec. That is to say, net energy decrease of the Karnali project by introducing the Bheri-Babai diversion scheme is 216 GWh/year for 29.1 m^3/sec diversion, 276 GWh/year for 38.3 m^3/sec diversion and 392 GWh/year for 58.2 m^3/sec diversion.

The economic viability of the Bheri-Babai as a hydropower project was evaluated by assessing the trade-off between the early energy generation from the Bheri-Babai power plant and the net energy loss in the Karnali project, which is induced by diverting the Bheri River water to the Babai River through the Bheri-Babai power plant without passing the Karnali Power plant. A time lag of 25 years was assumed for the implementation of the Bheri-Babai and the Karnali, i.e. 25-year early installation of the former scheme. The net energy loss of the Karnali project was treated as the negative benefits of the Bheri-Babai diversion scheme, which consecutively appear after the implementation of the Bheri-Babai diversion scheme. Assumptions and conditions applied for economic evaluation are referred to Appendix IV, Hydroelectric Power Generation.

The viability of the Bheri-Babai diversion scheme taking into consideration the conditions mentioned above revealed in terms of economic internal rate of return (EIRR) and the net present value (NPV) as follows:

Design discharge of diversion, m^3/sec	EIRR, %	NPV, million US$
29.1	10.0	0.3
38.3	11.3	10.6
58.2	12.1	21.6

Since the above three cases gained the EIRR greater than 10%, the earlier implementation of the Bheri-Babai verified its viability. It is noted that since the above economic evaluation does not include the irrigation benefits, the economic viability of the Bheri-Babai diversion scheme will be higher, if such benefits are included in the economic evaluation. A discount rate of 10% was applied for the calculation of NPV.

A sensitivity test was carried out by changing the installation timing of the Karnali project to a 30-year delay resulting in the EIRR of 10.7 % for 29.1 m^3/sec diversion discharge, 11.8 % for 38.3 m^3/sec and 12.6 % for 58.2 m^3/sec.

5.7 Studies of Hydropower Scheme as a Multipurpose Scheme

In planning water resources development, full attention should be given to forming multipurpose projects for the effective utilization of limited water resources so far as it is practicable. The incorporation of some single purpose schemes considered separately possibly

forms one multipurpose project, which results in reduction of construction cost to be required when each single purpose scheme is implemented separately.

Possibilities of involvement of other purposes to each hydropower scheme identified in the Study Area were studied. Other development objectives added to the hydropower schemes may possibly include irrigation development, flood mitigation and rural electrification by harnessing planned reservoir storage or hydropotential. The Karnali Multipurpose Project, as a good example, is planned to fulfill such objectives as hydroelectric generation, increase in irrigated agriculture production in both Nepal and India, flood mitigation and navigation in the proposed reservoir. At this stage, such possibilities were examined by using the 1 to 50,000 scale topographic maps and the information obtained from reconnaissance.

The irrigation development described in Section 5.2, Irrigation, plans to construct a weir on the nearby tributary for the supply of irrigation water to command areas by gravity flow. Where the command areas are situated near the identified hydropower scheme, there is a possibility to seek the water source to the scheme. One alternative is to use water to be stored in a planned reservoir and to supply irrigation water to downstream command areas by gravity flow. In the case that a planned reservoir is not high enough above command areas to provide water by gravity, another alternative is to pump up river water from the neighbouring main stream directly, where river flow is more ample and stable than the tributary in dry seasons, by receiving electricity for pumping from the planned power station. Conceivable irrigation schemes to be developed together with the hydropower as one scheme are summarized below:

	Scheme Name	NCA (ha)	Water Source	Power for Pumping (kW)	Possibility of Gravity Irrigation	Accessibility
1.	Gatte Khola	58	Sani-Bheri	800	no dam site available upstream	not good
2.	Korelli Khola	368	Bheri	550	no dam site available upstream	good
3.	Nepgad	48	Thuri-Bheri	210	no dam site available upstream	not good
4.	Natharpur	60	Humla-Karnali	130	possible from MKR-1	not good
5.	Karai-Melgad	65	Sumaya-Gad	280	no dam site available upstream	not good

The Natharpur scheme exhibits the physical possibility of gravity irrigation (from the hydropower project site); however, the construction of a lengthy driving canal from Humla-Karnali is not recommendable from the standpoints of economy, and operation and maintenance. Accordingly, all the five schemes are considered for lift irrigation.

As for the flood mitigation, a reservoir has a function to regulate flood water. In the Terai, the planned Pancheshwar Multipurpose Project is expected to mitigate flood damage in the Dodhara and Chandani areas, whilst the Karnali Multipurpose Project is expected for the Rajapur area. In the hill area, most of identified flood-prone areas are located not downstream of the reservoir type hydropower schemes but along the riverbanks of tributaries where no reservoir type hydropower schemes are identified (refer to Figure 5.4.1 as an example). As an exception, Banedungrisairn area in Doti district (refer to Figure 5.4.12) is located on the Seti River about 10 km downstream of the proposed West Seti Hydropower Project. The flood damage of this area is expected to be mitigated by this Project.

6. PROPOSED WATER RESOURCES DEVELOPMENT IN THE STUDY AREA

6.1 Importance of Water Resources Development in the Study Area

Water resources in the Study Area are abundant, but their immediate use by local people has been quite limited because of deep valley. Years ago when the spatial structure of Nepal was very weak and the Study Area was almost isolated, development of hydroelectric power and its export to India have been main concerns of water resources development in the Karnali and Mahakali river basins. Since that time, the implementation of the Karnali Multipurpose Project and Pancheshwar Hydroelectric Project is being considered between HMG/N and the Government of India.

The development axis of Nepal has gradually expanded from the Kathmandu valley to the west through Terai Ecological Belt, owing to the eradication of malaria and the infrastructure development such as the construction of East-West highway and extension of 132 kV power transmission lines. Now the water and land resources in the Study Area can be developed for the country-wide use; that is, hydroelectric power potential in large rivers and land productivity in Terai Ecological Belt can contribute to the national economic development and food self-sufficiency.

People in Hill and Mountain Ecological Belts in the Study Area are particularly under a low quality of life. Priority will be set on the development of rural infrastructure such as roads, trails, suspension bridges, irrigation system, drinking water, communication, schools and health centres with the objective of rural development and regional balance of the Eighth Plan. Water resources will be essential for the rural infrastructure development in productive use such as irrigation, domestic water supply and mini hydropower generation, and also in protective aspects such as watershed management and flood mitigation.

6.2 Objectives for Development and Time Frame

The objectives of water resources development in the Study Area are set to develop mega scale hydroelectric power potential for the energy export to India, to develop medium/small scale hydroelectric power potential for domestic, agricultural and industrial uses within Nepal, to utilize large rivers for irrigated agriculture in Terai Ecological Belt, to contribute to the development of rural infrastructure in Hill and Mountain Ecological Belts, to

protect flood-prone areas in the hill area from flooding and to manage the watershed in protecting land resources in Hill and Mountain Ecological Belts.

Water resources development is a continuous process, and requires a systematic development based on availability of resources. Time frame for this Study is stipulated for 20 years, which correspond to the year 2012/13 (end of the Eleventh plan period).

6.3 Strategies for Development

The mega scale hydroelectric power scheme will need a long lead time, before its operation starts, and particularly so if it involves international negotiations. Other than the Karnali Multipurpose Project and Pancheshwar Hydroelectric Project, no mega scale scheme is assumed to be committed whithin the time frame of this Study.

Medium/small scale hydroelectric power schemes with an appropriate size will be selected in view of volume, spatial distribution and other characteristics of load up to year 2012/13, from among potential schemes in the Karnali and Mahakali river systems within the territory of Nepal.

The idea of the proposed Bheri-Babai Multipurpose scheme envisions a transfer of the Bheri River to the Babai River in order to develop a medium scale hydroelectric power and to irrigate 70,000 ha in Terai Ecological Belt. This scheme as well as other hill irrigation schemes, if feasible, will be taken up to meet country's needs before the Karnali Multipurpose Project is commissioned.

Development of domestic water supply system, mini hydroelectric power scheme, irrigation system and river improvement works as well as watershed management will be contemplated at strategic areas in Hill Ecological Belt.

6.4 Strategic Areas for Development in the Study Area

Hill and Mountain Ecological Belts in the Study Area are in deficit of food grain, although the grain production per capita in Terai Ecological Belt as a whole stands at the national average level. It is assumed that food grain is imported from Terai Ecological Belt to Hill and Mountain Belts.

Daily necessaries and industrial products such as salt, kerosene, metal products, etc. are mostly imported from the state of Utter Pradesh of India into the Study Area across the southern and western international borderlines.

Some crop, livestock and their products are exported from Hill and Mountain Ecological Belts to Terai Ecological Belt and the state of Utter Pradesh. They are ghee, ginger, chili, fruits, honey, Nepali paper, handicraft, sheep, horse, goat, hide, woolen products and so on.

The above-mentioned trades of commodities are conducted at markets located in the border towns as well as those scattered in the Study Area. With the development of transportation facilities such as trails, bridges and roads, some market places have gradually grown in terms of town facilities and urban activities.

These market places interlinked by transportation facilities are cores of regional development that absorb population and also induce socio-economic development in neighbouring areas.

The strategies for development proposed in the preceding Section 6.3 include the development of water resources facilities in the cores of regional development in Hill and Mountain Ecological Belts in order to encourage urbanization of the core areas as strategic areas intending to promote socio-economic development of the Study Area as a whole.

The spatial structure as a system of development cores and transportation facilities in the Study Area can be illustrated as shown in Figure 6.4.1. Border towns of Mahendranagar, Dhangadhi and Nepalganj are the development cores in the Terai Ecological Belt. They are centres of trade with Tanakpur, Lucknow and Kanpur in the state of Utter Pradesh in India. Their inter-relationship and trades with other towns in Nepal will be strengthened with the completion of the East-West highway. Four development cores are located in Hill and Mountain Ecological Belts, being connected with the above-mentioned development cores in the Terai Ecological Belt by motorable road. They are herein identified as the strategic areas and outlined hereunder.

Jumla, which is the headquarters of the Karnali Zone and the commercial centre in the region, will be the development core in the Upper Karnali Area, which is the most remote area in the Study Area. The horticultural products such as apples yielded in the area will be brought to Surkhet, Nepalganj, India and so on seeking markets. The town zone included in the Jumla strategic area is defined to be Chandannath, Mahatgaun and Depalgaun Village Development Committees, VDC, (refer to Figure 6.4.2).

Surkhet, which is the headquarters of the Mid Western Development Region and the commercial centre of the region, will be not only the development core in the Bheri Zone, but also the transit point to and from the Upper Karnali Area. The Bheri Zone is promising with tree crops such as oranges, peaches and so on besides food grain, which is mainly produced in the Surkhet valley. The town zone included in the Surkhet strategic area is defined to be Birendranagar municipality and Uttraganga and Latikoili VDC (refer to Figure 6.4.3).

Dipayal-Silgadhi-Rajpur, which is the headquarters of the Far Western Region and the commercial centre in the region, will be the development core in the Seti Zone, which includes Achham, Bajura and Bajhang districts besides Doti district itself. This Seti Zone is also promising with tree crops such as oranges besides food grains. A strong cohesion with Dhangadhi is expected, because the road to link Dipayal and Dhangadhi was completed. The town area included in the Dipayal-Silgadhi-Rajpur strategic area is defined to be Dipayal-Silgadhi municipality and Tikha VDC (refer to Figure 6.4.4). It is noted that Dipayal and Silgadhi has been amalgamated in a municipality by the law enforced in April 1992.

Baitadi, which is the headquarters of Baitadi District, Far Western Development Region, will be the development core in the Upper Mahakali Area. The area is furthermore prosperous in trading with India and visits of devotees and holy men to Tripura Sundari as well as promising with tree crops such as oranges and cottage industry to make carpets. The completion of Baitadi-Dhangadhi road would make cohesion in the region stronger. The town area included with Baitadi strategic area is defined to be Thaligada, Tripura Sundari, Khalanga and Dashrath Chand in the Baitadi zone and Patan and Basantpur in the Patan zone (refer to Figure 6.4.5).

7. SELECTION OF PRIORITY SCHEMES FOR DEVELOPMENT

As discussed in the preceding Section 5.1.3, Power Demand in the Study Area, the Study Area needs electric power sources with an installed capacity of 50 to 100 MW. The balance calculation between supply and demand on five main food grains (refer to Section 5.2.1) identifies the Study Area as the one with food deficit in the nation.

The Government launched a programme to provide safe drinking water throughout the nation by year 2000. To meet this programme, the Mid Western Development Region in the Study Area requires to develop an amount of 24,134,906 litre per day by year 2000, for which 417 water supply schemes should be implemented, whilst 24,327,645 litre per day and 735 schemes for the Far Western Development Region in the Study Area (refer to Sections 5.3.2 and 5.3.3).

River bank erosion which requires river training works is raised as a main issue of river-related problems as well as inundation in the Study Area. In particular, losing of lands after such large rivers as the Karnali and the Mahakali debouch in the Terai plain is considered to be a serious problem requiring urgent countermeasures (refer to Section 5.4). Degradation and deterioration of watershed are severe in Nepal including the Study Area, probably being in an alarming state. Countermeasures to maintain and sustain the watershed shall be proposed and implemented by people's endeavours (refer to Section 5.5).

Schemes with development potential of water resources, called potential schemes, were identified in the Study Area through the work of Phases I and II as discussed in Chapter 5. The identified potential schemes cover the study categories of hydropower, irrigation, domestic water supply, flood mitigation and watershed management.

Priority schemes, for which further detailed studies are undertaken, are selected from among the identified potential schemes taking into consideration not only economic viability and spatial distribution of the schemes and balanced development among the sectors, but also the necessity of mobilizing the available water resources for the improvement of the life of local people, which is at present under the subsistence level.

Taking into consideration the above matters, four hydropower, four irrigation and one flood mitigation schemes were selected as priority schemes. Selected four hydropower schemes are as follows:

Scheme	Type	Installed Capacity MW	Construction Cost, million US$	EIRR, %
BR-1	Run-of-river	82.0	184.4	13.0
SR-3	Run-of-river	75.2	166.1	12.3
CR-2	Run-of-river	23.5	68.3	10.2
LR-1	Reservoir	58.0	118.3	9.1

Figure 7.1.1 shows the locations of the above four schemes. It is noted that further considerations were given to less financial burden to the implementing agency besides economic viability and reasonable development scale in comparison with the demand in the region in selecting the four hydropower priority schemes.

For irrigation, following four schemes were selected as the priority schemes considering the food self-sufficiency in the region:

Scheme	District	Net Command Area, ha
Large scale		
Bheri-Babai	Bardiya and Banke	Monsoon season : 72,000 Winter season : 33,000
Small scale		
Surkhet Valley Korelli Khola	Surkhet	2,700
Basin Lift Irrigation	Surkhet	368
Garjyangkot	Jumla	200

Figure 7.1.2 depicts the locations of the above four schemes. Further considerations for the above selection are given to the high economic efficiency and the stage of scheme, i.e. the exclusion of studied and on-going schemes, for the large scale irrigation schemes and accessibility to the site besides the food self-sufficiency issue in the region for the small scale irrigation schemes.

For flood mitigation, river training works of Dodhara and Chandani areas (refer to Figure 5.4.21) were selected taking into consideration (i) Area losses due to the bank erosion have brought a serious problem due to the fact that agricultural production in these areas greatly

contributes to food supply in the Kanchanpur district and (ii) Field investigation and preliminary design for the works have been carried out by the Mahakali Irrigation Project Office well enough to proceed to further studies.

Domestic water supply and watershed management were not included in the selection of priority schemes due to the scale and number of schemes for domestic water supply and the nature of the study for the watershed management. However, further discussions of domestic water supply are given for the four strategic areas, whilst watershed management is dealt with in the river basin of LR-1 scheme and in the four strategic areas.

8. SUGGESTED WATER RESOURCES DEVELOPMENT FOR THE STRATEGIC AREAS

8.1 Jumla Strategic Area

8.1.1 Natural Conditions

The Jumla strategic area, lying on 82° 11' east longitude and 29° 17' north latitude, extends in the valley bottom of the Tila River just downstream of the confluence between the Chandanbise River and the Babila River. The area, lying at an altitude of 2,350 m above mean sea level, forms a narrow and long flat terrain along the Tila River.

According to the record of meteorological station 303 (refer to Figure 8.1.1), average monthly air temperature varies in a small range from 3.8° C in January to 19.7° C in June with a mean value of 12.7° C. However, the lowest air temperature, although there is a slight difference in each year, reaches -5 to -6° C in January, whilst the highest one goes beyond 27 to 28° C in June.

Rainfall in the area is relatively small with an average value of 778.4 mm a year probably because the area lies on the lee side of the south-east monsoon, which prevails in the period of June to August. The ratio of the rainfall fallen in the period of June to August to the annual rainfall is 55%.

8.1.2 Socio-economic Conditions

The Jumla strategic area includes the Jumla town zone, which is the headquarters of the the Karnali Zone, one of three Zones in the Mid Western Development Region. The Village Development Committees (VDC), belonging to this strategic area, are Chandannath, Mahatgaun and Depalgaun (refer to Figure 6.4.2).

According to the population census, the population of the District was 68,797 persons in year 1981 and 76,305 persons in year 1991, resulting in an annual increase rate of 1.04%. Occupying an area of 2,531 km^2, the District has a sparse population density of 27.18 persons/km^2 in year 1981 and 30.15 persons/km^2 in year 1991. On the other hand, the population of the strategic area consisting of Chandannath, Mahatgaun and Depalgaun VDCs was 10,075 persons in year 1991.

The production of food grain in the District was 2, 560 ton for paddy, 2,010 ton for wheat and 1,190 ton for maize in year 1989. The cultivated area for those grains is 1,600 ha for paddy, 1,750 ha for wheat and 1,190 ha for maize.

Motorable roads are at present undeveloped in the District, although there is a plan to extend the road from Dungeswar (refer to Figure 4.3.1). On the other hand, air access by the Royal Nepal Airlines Corporation is available to the area from four destinations, Kathmandu, Nepalganj, Surkhet and Simikot.

8.1.3 Electricity Supply

Electric power in the area is at present supplied by a small hydro plant (Jumla) with an installed capacity of 200 kW. Electric power demand was projected to year 2013, which is the target year of this master plan study, for assessing electric power to be developed in the strategic area as follows:

Unit: kW

Demand	1991	1995	2000	2005	2010	2013
Domestic	229.5	250.2	278.4	308.7	341.7	362.7
Industrial and Commercial	88.3	87.6	97.4	108.0	119.6	126.9
Public	45.9	50.0	55.7	61.7	68.3	72.5
Total	363.7	387.8	431.5	478.4	529.5	562.1

The area has an installed capacity of 200 kW. The balance of power, which is 362.1 kW between the demand in year 2013 and the supply capacity, is required to be developed by year 2013 to meet the electric power demand in the area. Power sources will be sought in a hydropower scheme to use water of the Garjyangkot Irrigation Project (refer to Figure 6.4.2).

8.1.4 Irrigation Development

Wheat is cultivated as a main crop, along with barley, millet and paddy. However, amounts of grain production are insufficient. In addition, major fruit crops including apple, peach, apricot, etc. are produced. Nevertheless, farms are without systematic cropping, and instead fruit trees grow at random, scattering locations around the farm house. Cultivation of vegetables such as pumpkin, gourds, radish, potatoes, etc. is extremely limited due to lack of irrigation facilities, and low amounts of sunshine.

Crops are produced primarily for local consumption in the area, with surplus marketed in nearby villages. The Garjyangkot Irrigation Project with an area of 200 ha proposed for the

area targets the production of staples such as paddy, wheat, barley and potato to the exclusion of fruit crops. In the future, however, it is proposed that an irrigated nursery bed for fruit crops be established to introduce cash crops into the area.

8.1.5 Domestic Water Supply

Among three VDCs in the Jumla strategic area, Chandannath is the only VDC which is at present receiving water supply. Two water supply schemes are now under construction for supplying drinking water to two VDCs, Mahatgaun and Chandannath, whilst one water supply scheme for Depalgaun is now being planned under the finance of the ADB.

The population of three VDCs is 10,075 persons in year 1991, being expected to reach 10,795 persons in year 2000 and 11,935 persons in year 2013. A total of supply capacity of four schemes mentioned above is 306,720 litre per day with the design population of 4,789 persons.

The balance between the population in year 2000 and 2013 and the design population of water supply schemes is required to be developed for meeting the demands of respective target years, amounting to 263,700 litre per day by year 2000 and 302,940 litre per day by year 2013. A water source to meet the demand in Chandannath and Mahatgaun was identified in the Rini Khola, requiring costs of US$ 58 thousand for conveying water to the demand centres (refer to Figure 6.4.2). Depalgaun is not expected to have water deficits by year 2013.

8.1.6 Watershed Management

The Jumla Strategic Area is located in a narrow valley at an altitude higher than 2,500 m. These areas are evaluated to be erosion-prone in a medium level, but high erosion-prone areas spread at higher altitude. Ten years ago there were many coniferous forests. These forests were degraded seriously, especially the lower parts of the slopes are now bare land.

Under reforestation activity of the District Forest Office (DFO), 18 ha was reforested with Himalayan ceder, Blue pine, etc., and 75,000 seedlings for reforestation activities were produced in 1991.

8.2 Surkhet Strategic Area

8.2.1 Natural Conditions

The Surkhet strategic area lies in the centre of the Surkhet valley, which extends in the downstream reaches of the Bheri River with an area of some 18,000 ha. The area is characterized by little undulation, warm climate and fertile soils suitable for agriculture. But, the fact that the area is located at the considerably higher elevation compared with the river bed of the Bheri River is a main constraint in developing agriculture by irrigation.

According to the record of meteorological station 406 (refer to Figure 8.1.1), average monthly air temperature varies in a range from 11.9° C in January to 27.5° C in June with an average value of 21.2° C. The lowest air temperature, although there is a slight difference year by year, reaches 3 to 4° C in January, whilst the highest one goes beyond 35° C in May.

Rainfall in the area is ample with an average value of 1,926.5 mm a year. The rainfall brought by the south-east monsoon, which prevails from June to August, is dominant, accounting for 71% of annual rainfall.

The Surkhet strategic area is located at 81° 38' east longitude, 28° 35' north latitude and 73 m above mean sea level.

8.2.2 Socio-economic Conditions

The Surkhet strategic area includes the Surkhet town zone, which is the headquarters of the Mid Western Development Region. The municipality and the Village Development Committees, VDC, belonging to this strategic area, are Birendranagar (municipality) and Uttraganga and Latikoili (refer to Figure 6.4.3).

According to the population census, the population of the District was 166,196 persons in 1981 and 225,296 persons in 1991, resulting in an annual increase rate of 3.09%, which is great compared with 2.22% in the Study Area. Occupying an area of 2,451 km^2, the District has a population density of 67.81 persons/km^2 in year 1981 and 91.92 persons/km^2 in year 1991, which is compared with the national average; 102 persons/km^2 in year 1981 and 126 persons/km^2 in year 1991. On the other hand, the population of the strategic area was 38,627 persons in year 1991 as the sum of Birendranagar municipality and two VDC, Uttraganga and Latikoili.

The production of food grain in the District, which is well developed as one of granaries of the Study Area, was recorded at 17,260 ton for paddy, 22,430 ton for wheat and 23,280 ton for maize in 1989. The cultivated area for those grains is 9,020 ha for paddy, 16,860 ha for wheat and 14,550 ha for maize.

The area is linked to the East-West highway by the road extended from Kohalpur, which is a gravelled one with a single lane (refer to Figure 4.3.1). It is planned for the entire section of this extension road to be black-topped. On the other hand, air access is available to the area from two destinations; Kathmandu and Jumla.

8.2.3 Electricity Supply

The area at present receives electric power supply not only from the national power grid (refer to Figure 5.1.1) but also from the small hydropower plant (Surkhet) with an installed capacity of 345 kW.

Electric power demand in the strategic area was projected by year 2013 for assessing the capacity of electric power to be developed as follows:

Unit: kW

	1991	1995	2000	2005	2010	2013
Domestic	947.1	1,189.8	1,578.0	2,087.1	2,753.1	3,247.5
Industrial and Commercial	331.5	416.4	552.3	730.5	963.6	1,136.6
Public	189.4	238.0	315.6	417.4	550.6	649.5
Total	1,468.0	1,844.2	2,445.9	3,235.0	4,267.3	5,033.6

The area has a hydro plant with an installed capacity of 345 kW as mentioned above. The balance between electric power demand and supply capacity will be supplied from the national grid through the Birendranagar sub-station (refer to Figure 5.1.1).

8.2.4 Irrigation Development

Development of the Surkhet valley with a net irrigation area of 2,700 ha is considered to be the highest priority. At present, paddy, summer vegetables, wheat, potato and mustard are cultivated in the area. Incremental benefit under irrigation development of the area as described the preceding Section 5.2 is estimated at Rs 56,541,000 a year with annual crop production increase of 12,275 t.

8.2.5 Domestic Water Supply

There are three existing water supply schemes for distributing domestic water to Birendranagar and Uttraganga, whilst two water supply schemes are under construction for Birendranagar and Latikoili.

The population of three VDCs in the Surkhet strategic area is 38,627 persons in 1991, being expected to reach 58,424 persons in year 2000 and 106,855 persons in year 2013. The comparison between the population in year 2000 and 2013 and the supply capacity of five existing and on-going schemes mentioned above, totalling 4,755,891 litre per day, results in requiring the development of 270,639 litre per day by year 2000 and 962,154 litre per day by year 2013. A potential source for the water supply scheme of Uttraganga was identified in the Khorke Khola (refer to Figure 6.4.3), whilst Latikoili could be served with wells. Construction costs for the Uttraganga and Latikoili schemes are estimated at US$ 43 thousand in total.

8.2.6 Watershed Management

The southern half of the Surkhet Strategic Area is evaluated as a low erosion-prone area due to the flat wetland paddy area. On the other hand a matured sal forest located north of the strategic area decreased its crown density from more than 70% to 10 - 40%.

The Surkhet district watershed was evaluated at very poor and the population pressure on the agricultural land is high. The demand for fuelwood is high, and thus the degradation of forests in the surrounding areas seems to continue at a high speed.

Under these conditions the proper watershed management is urgently required for the provision of ample water supply and fuelwood to the strategic area.

8.3 Dipayal-Silgadhi-Rajpur Strategic Area

8.3.1 Natural Conditions

The Dipayal-Silgadhi-Rajpur strategic area lies in the middle reaches of the Seti River. Rajpur lies on the hilly area of its right bank, whilst Silgadhi stands on the ridge four km far from Dipayal.

According to the record of meteorological station 203 (refer to Figure 8.1.1), average monthly air temperature changes in a range from 11.8°C in January to 25.7°C in June with an

average value of 20.4°C. The lowest air temperature reaches 5 to 6°C in January and the highest one goes beyond 30°C in May and June.

Average annual rainfall in the area is 1,281.6 mm. The share of the monsoon rainfall, which is dominant from June to August, to annual rainfall is 58%. The coordinates of Dipayal are 80° 56' east longitude and 29° 15' north latitude, and its altitude is 518 m above mean sea level. On the other hand, the altitude at Silgadhi is 701 m above mean sea level with the altitude difference of 183 m with Dipayal.

8.3.2 Socio-economic Conditions

The Dipayal-Silgadhi-Rajpur strategic area includes the commercial zone of Silgadhi and the government quarters zone of Dipayal and Rajpur, which is the headquarters of the Far Western Development Region. The municipality and the Village Development Committee, VDC, belonging to this strategic area are Silgadhi-Dipayal, which is the new municipality, and Tikha (refer to Figure 6.4.4).

According to the population census, the population of the District was 153,135 persons in 1981 and 167,469 persons in 1991, resulting in an annual increase rate of 0.90%. Occupying an area of 2,025 km^2, the District has a population density of 75.62 persons/km^2 in year 1981 and 82.70 persons/km^2 in year 1991. On the other hand, the population of the strategic area was 19,861 persons in year 1991.

The production of food grain in the District was 11,500 ton for paddy, 11,320 ton for wheat and 6,380 ton for maize in year 1989. The cultivated area for those grains is 6,730 ha for paddy, 10,290 ha for wheat and 4,200 ha for maize.

The area is linked to the Dhangadhi-Baitadi highway, which has a single lane with black top pavement between Budar and Dadeldhura and earthen road between Dadeldhura and Baitadi, by the road branched off from Bhatkada, which is an earthen one with a single lane (refer to Figure 4.3.1). On the other hand, air access by the Royal Nepal Airlines Corporation is available to the area from three destinations; Nepalganj, Dhangadhi and Mahendranagar. Of them, the air flights between Mahendranagar and Dipayal are available only in winter seasons.

8.3.3 Electricity Supply

The area is at present supplied with electricity from the hydro plant (Doti) with an installed capacity of 200 kW, but is suffering from power shortage. To meet the growing

demand, the area is expected to be linked to the national power grid with a 33 kV transmission line in year 1993/94 (refer to Figure 5.1.1).

Electric power demand in the strategic area was projected to year 2013 for assessing the capacity of electric power to be developed as follows:

Unit: kW

	1991	1995	2000	2005	2010	2013
Domestic	455.9	518.4	572.7	630.9	693.0	732.6
Industrial and Commercial	159.6	181.4	200.4	220.8	242.6	256.4
Public	91.2	103.7	114.5	126.2	138.6	146.5
Total	706.7	803.5	887.6	977.9	1,074.2	1,135.5

Electric power to meet the demand will be supplied from the 33 kV transmission line which will be linked to the national grid in year 1993/94 (refer to Figure 5.1.1) as mentioned above, even if supplementary supply is received from the Doti existing hydro plant with an installed capacity of 200 kW.

8.3.4 Irrigation Development

Cropped area is 1,029 ha, of which only 200 ha is irrigated. The Dware Khola, Dipayal Khola, Mallo Amalakhet Khola and Kher Khola on the left bank of the Seti River comprise main water sources of the area.

Irrigation facilities under the Dipayal West and East Irrigation Project with an area of 100 ha completed in 1987, FMIS, etc. exist in the vicinity, and no new irrigation project is planned. In the future, it will be necessary to utilize these existing irrigation facilities to expand agricultural production in the area.

8.3.5 Domestic Water Supply

There is only one scheme to supply domestic water to the area, whilst four water supply schemes are under construction for Silgadhi and Tikha.

The population of Dipayal-Silgadhi and Tikha is 19,861 persons in 1991 and is expected to increase to 21,461 persons in year 2000 and 24,004 persons in year 2013. Even with the supply capacity of 1,221,216 litre per day by five water supply schemes mentioned above, the Dipayal-Silgadhi-Rajpur strategic area requires to develop an amount of 286,300 litre per day by year 2000 and 378,398 litre per day by year 2013. Potential sources for the

water supply schemes of Tikha and Dipayal except for Silgadhi, where no water deficits are expected by year 2013, are identified in the Ritha Khola and the Godre Khola, respectively (refer to Figure 6.4.4). Construction costs required for the implementation of both schemes are estimated at US$ 34 thousand.

8.3.6 Watershed Management

The levelled and sloping terraces occupy most of the Strategic Area. The levelled terraces are well maintained. Two protected forest areas which existed on the map of LRMP are now in fact treeless. Shrub land is being transformed to bare land due to overgrazing.

The degraded shrub and forest area can be concluded to be highly erodible, and therefore engineering and rehabilitative countermeasures are essential for watershed management.

8.4 Baitadi Strategic Area

8.4.1 Natural Conditions

The Baitadi strategic area, which is developed along the Mahakali River some 5 km downstream of its confluence with the Chamliya River, includes Tripurasundari, Jhulaghat and Patan besides Baitadi itself. Baitadi and Patan are developed on the ridge, whilst Tripurasundari lies at the foothill and Jhulaghat stands at the riverside of the Mahakali River.

According to the observation record at meteorological station 103 (refer to Figure 8.1.1), average monthly air temperature varies in a range from 10.1° C in January to 24.1° C in June with an average value of 18.7° C. The lowest air temperature reaches 4 to 5° C in January and the highest one goes beyond 30° C in June.

Average annual rainfall in the area is ample with a value of 1,393.8 mm. The monsoon rainfall is dominant in June to August, accounting for 63% of annual rainfall. The coordinates of Baitadi are 80° 26' east longitude and 29° 33' north latitude, and its altitude is 1,219 m above mean sea level.

8.4.2 Socio-economic Conditions

The Baitadi strategic area includes Baitadi, Patan, Tripurasundari and Jhulaghat. Baitadi is the headquarters of the Baitadi District, whilst Patan is the town for the Baitadi

Multiple Campus and also for some government offices, Tripurasundari attracts the visits of devotees and holy men, and Jhulaghat is the gate way of trades with India. The Village Development Committees; VDC, belonging to this strategic area are Khalanga, Thaligada, Tripurasundari and Dashrath Chand in the Baitadi zone and Patan and Basantpur in the Patan zone (refer to Figure 6.4.5).

According to the population census, the population of the District was 179,136 persons in 1981 and 200,229 persons in 1991, resulting in an annual increase rate of 1.12%. Occupying an area of 1,519 km^2, the District is well populated with a density of 117.93 persons/km^2 in year 1981 and 131.82 persons/km^2 in year 1991, which are greater than the national average; 102 persons/km^2 in year 1981 and 126 persons/km^2 in year 1991. On the other hand, the population of the strategic area was 20,481 persons in year 1991.

The production of food grain in the District was 7,650 ton for paddy, 6,530 ton for wheat and 8,450 ton for maize in year 1989. The cultivated area for those grains is 4,500 ha for paddy, 7,100 ha for wheat and 5,150 ha for maize.

This area is linked to the East-West highway by the road branched off from Atariya, which is a single lane with black top pavement between Budar and Dadeldhura and earthen road between Dadeldhura and Baitadi (refer to Figure 4.3.1). On the other hand, air access by the Royal Nepal Airlines Corporation is available to the area, where the airport lies in Patan and Gokuleshwar from three destinations; Nepalganj, Bajura and Mahendranagar. Of them, Mahendranagar is the seasonal airport, which is operated only in winter seasons.

8.4.3 Electricity Supply

The area at present receives the power from the hydro plant (Surnaiya) with an installed capacity of 200 kW.

Electric power demand in the strategic area was projected by year 2013 for assessing the capacity of electric power to be developed as follows:

Unit: kW

	1991	1995	2000	2005	2010	2013
Domestic	408.0	446.7	498.9	555.3	616.8	656.4
Industrial and Commercial	142.8	156.3	174.6	194.4	215.9	229.7
Public	81.6	89.3	99.8	111.1	123.4	131.3
Total	632.4	692.3	773.3	860.8	956.1	1,017.4

There is a small hydro plant (Surnaiya) with an installed capacity of 200 kW as mentioned above. It would be appropriate to meet the balance between the demand and the supply capacity by extending the transmission line from Dadeldhura to Baitadi (refer to Figure 5.1.1), since there would be no small hydropower schemes, which is economically viable with a development scale of some 800 kW, in the vicinity. An alternative is to construct the transmission line from the power plant site of CR-2 to Dadeldhura through Baitadi area, when CR-2, the scheme in the Chamliya River, is implemented.

8.4.4 Irrigation Development

Small scale irrigation projects comprising Dananigad Irrigation Project (A = 24 ha), Udaya Irrigation Project (A = 10 ha) and Simile Irrigation Project (A = 8 ha) are currently under construction in the vicinity of Baitadi town.

In addition, the Surnayagad Irrigation Project (A = 120 ha) was constructed near Patan airport in 1988. Major crops cultivated under the above projects are paddy, wheat, barley, maize, millets and potato. Horticulture crops include pear, peach, apricot, apple, etc. Irrigation is primarily targeted at lowland paddy to the exclusion of upland maize.

Since there is no large scale irrigation project planned for the area, increased farm production must be accomplished through effective use of existing irrigation facilities, pest control measures and fertilizer use.

8.4.5 Domestic Water Supply

The area is supplied with domestic water by 26 schemes, the supply capacity of which is 423,010 litres per day. On the other hand, nine schemes with a total capacity of 304,480 litres per day are under construction to meet the growing demands.

The population of the Baitadi strategic area is 20,481 persons in year 1991, being expected to increase to 23,114 persons in year 2000 and 27,667 persons in year 2013. The area will require to develop 344,125 litres per day by year 2000 and 517,525 litres per day by year 2013 to meet the growing demands in spite of the total capacity of 727,490 litres per day by existing and on-going schemes. A potential water source was identified in the Gwalek Khola to distribute water to Khalanga, Thaligada, Tripurasundari and Dashrath Chand in the Baitadi zone, whilst water for Patan and Basantpur in the Patan zone can be obtained from Surnaya Khola and Dhadaun Khola, respectively (refer to Figure 6.4.5). Costs required for the implementation of those three schemes are estimated at US$ 61.8 thousand.

8.4.6 Watershed Management

The Baitadi Strategic Area is composed of two zones, namely Baitadi and Patan.

(1) Baitadi Zone

The levelled terraces are well maintained and evaluated as a low erosion-prone area. Many shrub areas, however, have transformed to bare land at present. The forest areas of hardwood and mixed species have also been severely degraded. Fuelwood collection must be a difficult task, since forest area is left only far from towns.

(2) Patan Zone

The levelled and sloping terraces in the Patan Zone are well maintained and evaluated as low erodible area. The forest and shrub areas are relatively well maintained, but still deteriorating.

The grazing land west of Patan town is highly erosion-prone, and thus an afforestation project is urgently required.

TABLES

Table 2.2.1 POPULATION OF NEPAL BY DEVELOPMENT REGION (1981 - 1991)

Development Region	1981 Census	1991 Census	Annual Growth Rate (%)
Far Western	1,320,089	1,681,453	2.45
Mid Western	1,955,611	2,406,095	2.09
Western	3,128,859	3,751,922	1.83
Central	4,909,357	6,174,237	2.32
Eastern	3,708,923	4,448,374	1.83
Total	15,022,839	18,462,081	2.08

Source : Four Monthly Statistical Bulletin, 1991

Table 2.2.2 GROSS DOMESTIC PRODUCT (GDP)

Unit : Million Rs.

Items	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
Nominal GDP ^1	50,428	59,246	68,858	78,259	88,711	100,628
Agriculture	26,819	30,759	35,825	42,148	50,032	56,346
Non-Agriculture	23,609	28,487	33,033	36,111	38,679	44,282
Real GDP ^2	24,645	25,617	27,475	28,538	29,560	30,745
Growth Rate (%)	4.30	3.94	7.25	3.87	3.58	4.01
Agriculture	14,705	14,789	15,993	17,194	18,444	18,998
Non-Agriculture	9,940	10,828	11,482	11,342	11,116	11,747

Annul Growth Rate (1985/86-1990/91)	
Real GDP (Annual Average)	4.52 %
Agriculture (Annual Average)	5.26 %
Non-Agriculture (Annual Average)	3.40 %

Source : Economic Survey, Ministry of Finance, 1991

Remark : ^1 GDP at market price

^2 GDP at 1974/75 price

Table 2.2.3 PRODUCTION OF MAJOR FOOD CROPS IN NEPAL

Unit of production : ton

Year	Paddy			Maize		
	Area (ha)	Production	Yield (ton/ha)	Area (ha)	Production	Yield (ton/ha)
1984/85	1,376,860	2,709,430	1.968	578,720	819,850	1.417
1985/86	1,391,040	2,804,490	2.016	614,680	873,850	1.421
1986/87	1,333,360	2,372,020	1.779	626,710	868,350	1.386
1987/88	1,423,290	2,981,780	2.095	673,810	901,500	1.338
1988/89	1,450,470	3,283,210	2.264	721,870	1,071,610	1.484

Year	Millet			Wheat		
	Area (ha)	Production	Yield (ton/ha)	Area (ha)	Production	Yield (ton/ha)
1984/85	134,370	124,430	0.926	451,890	53,720	1.181
1985/86	151,050	137,940	0.913	482,820	598,000	1.239
1986/87	150,780	137,590	0.913	535,530	701,040	1.309
1987/88	164,770	150,130	0.911	596,750	744,600	1.248
1988/89	182,560	183,090	1.003	599,290	830,050	1.385

Year	Barley			Pulses		
	Area (ha)	Production	Yield (ton/ha)	Area (ha)	Production	Yield (ton/ha)
1984/85	27,390	23,460	0.857	228,020	131,680	0.577
1985/86	29,320	23,430	0.799	253,660	146,160	0.576
1986/87	28,560	24,670	0.864	262,940	166,090	0.632
1987/88	29,110	24,290	0.834	264,570	139,490	0.527
1988/89	29,450	27,020	0.917	265,730	156,680	0.590

Source : Agricultural Statistics of Nepal, 1990

Table 3.3.1 LAND SYSTEMS IN THE STUDY AREA

Physiographic Region	Land System	Land Unit	Far-Western Dev. Region		Mid-Western Dev. Region		Total Study Area		Nepal	Total
			(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
Terai	1	1a, 1ab, 1b, 1c, 1d	23,035	1.2	31,820	0.7	54,855	0.9	230,296	1.6
	2	2a, 2b, 2c, 2d	130,316	6.7	102,983	2.4	233,300	3.7	1,151,408	7.8
	3	3a, 3b, 3c, 3d	184,205	9.5	123,497	2.9	307,702	4.9	740,382	5.0
Siwaliks	4	4a, 4b, 4c, 4Com	3,473	0.2	40,824	1.0	44,297	0.7	163,754	1.1
	5	5a, 5b, 5c, 5d	8,513	0.4	99,564	2.3	108,077	1.7	308,742	2.1
	6	6a, 6b, 6c, 6d	0	0.0	39,594	0.9	39,594	0.6	57,230	0.4
	7		20,361	1.0	18,973	0.4	39,334	0.6	88,793	0.6
	8		165,702	8.5	370,191	8.6	535,894	8.6	1,260,482	8.5
Middle Mount.	9	9a, 9b, 9c, 9Com	6,588	0.3	13,622	0.3	20,211	0.3	136,775	0.9
	10	10a, 10b, 10Com	10,923	0.6	12,304	0.3	23,227	0.4	123,633	0.8
	11		243,094	12.5	306,971	7.2	550,064	8.8	1,853,680	12.6
	12		420,608	21.6	456,747	10.7	877,355	14.1	2,236,410	15.2
High Mount.	13	13a,13b,13c,13d,13com	5,683	0.3	14,793	0.3	20,476	0.3	32,477	0.2
	14	14a, 14b	263,765	13.6	646,179	15.1	909,945	14.6	1,471,396	10.0
	15	15a, 15b	168,530	8.7	469,883	11.0	638,413	10.3	1,395,699	9.5
High Himalayan	16	16a,16b,16c,16d,16Com	24,700	1.3	237,833	5.6	262,533	4.2	478,416	3.2
	17	17a, 17b	264,792	13.6	1,287,952	30.1	1,552,743	24.9	3,007,823	20.4
Others	18		0	0.0	6,473	0.2	6,473	0.1	11,237	0.1
Total			1,944,287	100.0	4,280,205	100.0	6,224,492	100.0	14,748,631	100.0
High Agricultural Potential Area			265,726.9	13.7	400,997	9.4	666,724	10.7	2,194,968	14.9
Terai		2, 3a	176,652	9.1	138,268	3.2	314,920	5.1	1,423,356	9.7
Siwaliks		4c, 5a, 6a, 6b, 6c	3,487	0.2	76,557	1.8	80,044	1.3	216,386	1.5
Mid. Mount.		9b, 9c	4,283	0.2	6,859	0.2	11,142	0.2	59,526	0.4
High Mount.		13b,13c,13Com,13d,14a	81,305	4.2	179,313	4.2	260,618	4.2	495,698	3.4
Low Agricultural Potential Area			377,962	19.4	530,100	12.4	908,062	14.6	2,765,343	18.7
Terai		3b, 3c	93,186	4.8	63,739	1.5	156,925	2.5	358,619	2.4
Siwaliks		4b, 5b, 5c, 5Com	6,025	0.3	48,545	1.1	54,570	0.9	184,615	1.3
Mid. Mount.		9Com, 10a, 11	248,855	12.8	315,316	7.4	564,171	9.1	1,935,678	13.1
High Mount.		15a	29,897	1.5	102,500	2.4	132,397	2.1	286,431	1.9
Non-Agricultural Potential Area			1,300,598	66.9	3,349,108	78.2	4,649,706	74.7	9,788,320	66.4
Terai		1a,1ab,1b,1c,1d,3d	67,719	3.5	56,294	1.3	124,013	2.0	340,111	2.3
Siwaliks		4a,4Com,5d,6d,7,8	188,537	9.7	444,045	10.4	632,583	10.2	1,477,998	10.0
Mid. Mount.		9a, 10b, 10Com, 12	428,075	22.0	467,469	10.9	895,544	14.4	2,353,593	16.0
High Mount.		13a, 14b, 15b	326,776	16.8	849,042	19.8	1,175,818	18.9	2,117,443	14.4
High Himal.		16, 17	289,491	14.9	1,525,785	35.6	1,815,277	29.2	3,487,939	23.6
Others		18	0	0.0	6,473	0.2	6,473	0.1	11,237	0.1

Source : Land Resources Mapping Project, 1986

Table 3.4.1 LIST OF PROTECTED AREAS

	Unit :km2
National Park	10,144
In the Study Area	3,886
Shey Phoksundo National Park	3,555
Rara National Park	106
Khaptad National Park	225
Out of the Study Area	6,258
Royal Bardiya National Park	968
Royal Chitwan National Park	932
Langtang National Park	1,710
Sagarmatha National Park	1,148
Makalu-Barun National Park	1,500
Wildlife Reserve	974
In the Study Area	
Royal Suklaphanta Wildlife Reserve	155
Out of the Study Area	819
Parsa Wildlife Reserve	499
Koshi Tapu Wildlife Reserve	175
Shivapuri Conservation and Wildlife Reserve	145
Hunting Reserve	1,325
In the Study Area	
Dhorpatan Hunting Reserve	1,325
Conservation Area	3,490
Out of the Study Area	
Annapurna Conservation Area	2,660
Makalu-Barun Conservation Area	830
Total Protected Area in the Study Area	5,366
Total Protected Area out of the Study Area	10,567
Total Protected Area	15,933

Source : MFE "Master Plan of the Forestry. Sector, Nepal" and IUCN Protected Areas in Relation to the Pysiographic Zones of Nepal.

Table 3.4.2 LIST OF ANIMAL SPECIES PROTECTED BY ACT IN NEPAL

Mammalia

SPECIES		LOCAL NAME	ENGLISH NAME	Listed in Red Data Book
Macaca	assamensis	Assami rato bandar	Assamese macaque	
Manis	crassicaudata	Salak	Pangolin	
Manis	pentadactyla	Salak	Indian pangolin	
Caprolagus	hispidus	Hispid Kharayo	Hispid hare	√
Platanista	gangetica	Sons	Gangetic dolphin	√
Canis	lupus	Bwanso	Wolf	√
Ursus	arctos	Himali rato bhalu	Himalayan brown bear	
Ailurus	fulgens	Habre	Red panda	√
Pridnodon	pardicolor		Linsang	
Hyaena	hyaena	Hundar	Hyena	
Felis	bengalensis	Chari bagh	Leopard cat	
Felis	lynx		Tibetan lynx	
Neofelis	nebulosa	Dhwanse chituwa	Clouded leopard	√
Panthera	tigris	Bagh	Tiger	√
Panthera	uncia	Hiun chituwa	Snow leopard	√
Eiephas	maximus	Jangali hatti	Wild Elephant	√
Rhinoceros	unicornis	Gainda	Rhinoceros	√
Sus	salvanus	Pudke bandel	Pygmy hog	√
Moschus	chrysogaster	Kasturi mriga	Musk deer	√
Cervus	duvauceli	Barhasingha	Swamp deer	√
Bos	gaurus	Gauri gai	Gaur bison	
Bos	mutus (gruniens)	Yak and nak	Wild yak	
Bubalus	bubalis	Arna	Water buffalo	√
Ovis	ammon	Nayan	Tibetan argali	
Pantholops	hodgsoni	Chiru	Chiru	
Antilope	cervicapra	Krishnasar	Blackbuck	
Tetraceros	quadricornis	Chauka	Four horned antelope	

Aves

SPECIES		LOCAL NAME	ENGLISH NAME	Listed in Red Data Book
Ciconis	nigra	Kalo sarus	Black stork	
Cionia	ciconia	Seto sarus	White stork	
Brus	grus	Sarus	Common crane	
Catreus	wallichii	Cheer	Cheer pheasant	√
Lophophorus	impeyanus	Danphe	Impeyan pheasant	
Tragopan	satyra	Monal	Satyr tragopan	
Houbropsis	bengalensis	Khar mujur	Bengal florican	
Sypheotides	indica	Sano khar mujur	Lesser florican	
Buceros	bicornis	Thulo dhanesh	Great hornbill	

Reptilia

SPECIES		LOCAL NAME	ENGLISH NAME	Listed in Red Data Book
Python	spp.	Ajingar	Python	√
Gavialis	gangeticus	Gharial gohi	Gharial	√
Varanus	flavescens	Sun gohoro	Monitor lizard	

Source: Master Plan for the Forestry Sector Nepal, and 1988 IUCN Red List of Threatened Animals, IUCN

Table 3.4.3 WATER QUALITY IN THE DRY SEASON

No.	1	2	3	4	5	6	7	8
River	Bheri	Bheri	Babai	Lake Rara	Lake Rara	Karnali	Seti	Mahakali
Site	Jajarkot	BR 1	Babai Barrage	Tap Water	Lakeside	KarnaliBend	West Set/SR1	Pancheshwar
Date	Dec. 08,	Dec. 08,	Dec. 08,	Dec. 09,	Dec. 09,	Dec. 9,	Dec. 10,	Dec. 10,
Time	13:50	14:30	15:35	10:12	11:00	13:00	8:55	11:03
Weather	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Water Tem (°C)	12	14	20	8	11	10	10	12
Air Temp. (°C)	23	23	20	12	12	18	11	19
EC (µS/cm)	200	200	330	220	170	150	230	220
pH	9.1	8.7	8.5	8.4	8.5	8.6	8.7	8.8
DO (mg/l)	6	5	6	5	6	5	7	5
COD (mg/l)	1	1	1	-	2	1	2	2
Turbidity	0	1	2	1	1	1	1	1
Water Color	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Smell	No	No	No	No	No	No	No	No
General Fungi	not found	a lot	a lot	-	1 spot	not found	a lot	a lot
Remarks	Wide river Many people live nearby	Deep valley Few people	Storage water SS found		Most polluted water in the lake		Sampling site is downstream of village	

Methods of measurement

EC : DIST 3 EC meter by HANNA Instruments
PH : pHep pH Meter by HANNA Instruments
DO : CHEMets self-filling ampolues for colorimetric analysis
COD : by oxidization with Alkaline KMn 04 at room temperature
Turbidity : Turbidity and Colorimeter WA-PT-4 by Kyoritsu Chemical-Check Lab., Corp.
General Fungi : Test Pater for General Fungi by Fuji Chemical Co. Ltd.

Table 3.4.4 WATER QUALITY IN THE RAINY SEASON

Description	Unit	Karnali at Chisapani	Bheri upstream at Ghatgaon	Karnali upstream Thuligad
SO4	mg/l	8.3	10.8	14.1
PO4	mg/l	0.5	0.5	1.5
TDS	mg/l	264.0	208.0	264.0
SS	mg/l	112.0	744.0	304.0
TS	mg/l	376.0	952.0	568.0
TH	mg/l	90.2	78.2	95.2
pH		8.0	7.8	8.1
DO	mg/l	10.5	9.3	8.6
Eletrical condutivty	micromho/cm	183.0	210.0	208.0
BOD	mg/l	1.5	1.1	1.8
Na +	mg/l	1.5	1.9	1.8
K +	mg/l	1.3	1.3	1.4
Fe +	mg/l	*	*	*
Mn +	mg/l	*	*	*
Ca ++	mg/l	27.2	26.0	26.0
Mg ++	mg/l	5.3	3.9	7.3
CO3 --	mg/l	18.0	12.0	12.0
Mco3 --	mg/l	109.8	85.4	97.6
C1-	mg/l	0.8	1.0	0.6

Abbrevations :
- TDS = Total Dissolved Solids
- SS = Suspended Solids
- TS = Total Solids
- TH = Total Hardness
- DO = Dissolved Oxygen
- BOD = Biological Oxygen Demand

Note : * Denotes less than 0.1

Source : The Karnali Multipurpose Project, Environmental and Socio-Economic Situation Report prepared by New ERA, 1987

Table 4.1.1 ADMINISTRATIVE DIVISIONS IN THE STUDY AREA

Development Region	Zone	Number of District	No. of Development Unit		
			Municipality	Village	Total
Far Western	Seti	5	2	244	246
	Mahakali	4	1	152	153
Sub-Total		**9**	**3**	**396**	**299**
Mid Western	Rapti	5	1	226	227
	Karnali	5	0	132	132
	Bheri	5	2	230	232
Sub-Total		**15**	**3**	**588**	**591**
Total		**24**	**6**	**984**	**890**

Source : Central Bureau of Statistics

Table 4.1.2 POPULATION DENSITY IN THE STUDY AREA
(1981 and 1991)

Zone/ District	Area (km2)	Population (1981)	Population (1991)	Density (1981)	Density (1991)	Annual Population Increase, %
Karnali						
Humla	5,655	20,303	34,640	3.59	6.13	
Mugu	3,535	43,705	36,445	12.36	10.31	
Kalikot	1,741	87,638	88,781	50.34	50.99	
Jumla	2,531	68,797	76,305	27.18	30.15	
Dolpa	7,889	22,043	25,075	2.79	3.18	
Sub-total	21,351	242,486	261,246	11.36	12.24	0.75
Rapti						
Rukum	2,877	132,432	155,017	46.03	53.88	
Salyan	1,462	152,063	182,145	104.01	124.59	
Pyuthan	1,309	157,669	173,893	120.45	132.84	
Rolpa	1,879	168,166	179,904	89.50	95.74	
Dhang	2,955	266,393	352,237	90.15	119.20	
Sub-total	10,482	876,723	1,043,196	83.64	99.52	1.75
Bheri						
Dailekh	1,502	166,527	187,820	110.87	125.05	
Jajarkot	2,230	99,312	114,267	44.53	51.24	
Surkhet	2,451	166,196	225,296	67.81	91.92	
Bardia	2,025	199,044	281,840	98.29	139.18	
Banke	2,337	205,323	284,430	87.86	121.71	
Sub-total	10,545	836,402	1,093,653	79.32	103.71	2.72
Mahakali						
Darchula	2,322	90,218	101,614	38.85	43.76	
Baitadi	1,519	179,136	200,229	117.93	131.82	
Dadeldhul	1,538	86,790	104,449	56.43	67.91	
Kanchanp	1,610	168,971	258,508	104.95	160.56	
Sub-total	6,989	525,115	664,800	75.13	95.12	2.39
Seti						
Bajhang	3,422	124,010	139,178	36.24	40.67	
Bajura	2,188	74,649	92,083	34.12	42.09	
Doti	2,025	153,135	167,469	75.62	82.70	
Achham	1,680	185,212	197,888	110.25	117.79	
Kailali	3,225	257,905	420,035	79.97	130.24	
Sub-total	12,540	794,911	1,016,653	63.39	81.07	2.49
Total	59,892	3,275,637	4,079,548	53.00	66.00	2.22

Source : (1) Statistical Year Book of Nepal, 1991
(2) Four Monthly Statistical Bulletin, 1991

Table 4.2.1 CROP PRODUCTION AND RANKING BY DEVELOPMENT REGION (1988/89)

Unit: Production in thousand tons

		FWDR	MWDR	WDR	CDR	EDR
Paddy	Production	245.84	312.62	614.41	1138.71	971.63
	Ranking	5.00	4.00	3.00	1.00	2.00
Maize	Production	68.60	188.70	274.01	305.75	234.51
	Ranking	5.00	4.00	2.00	1.00	3.00
Millet	Production	12.25	18.54	78.35	30.57	43.38
	Ranking	5.00	4.00	1.00	3.00	2.00
Wheat	Production	94.09	155.75	158.73	287.51	133.97
	Ranking	5.00	3.00	2.00	1.00	4.00
Barley	Production	4.65	11.33	4.52	4.34	2.18
	Ranking	2.00	1.00	3.00	4.00	5.00
Oilseeds	Production	17.37	27.03	10.88	30.12	13.79
	Ranking	3.00	2.00	5.00	1.00	4.00
Potato	Production	44.41	66.97	77.10	256.24	196.19
	Ranking	5.00	4.00	3.00	1.00	2.00
Tobacco	Production	0.40	0.70	0.50	3.01	2.21
	Ranking	5.00	3.00	4.00	1.00	2.00
Sugarcane	Production	43.31	6.50	286.03	459.56	107.61
	Ranking	4.00	5.00	2.00	1.00	3.00
Pulses	Production	24.78	26.25	19.13	58.49	28.03
	Ranking	4.00	3.00	5.00	1.00	2.00
Fruits	Production	35.12	54.08	67.23	117.57	65.04
	Ranking	5.00	4.00	2.00	1.00	3.00

Source : Agricultural Statistics of Nepal, 1990

Remark :
- FWDR = Far Western Development Region
- MWDR = Mid Western Development Region
- WDR = Western Development Region
- CDR = Central Development Region
- EDR = Eastern Development Region

Table 4.2.2 PRODUCTION OF LIVESTOCK PRODUCTS AND RANKING BY DEVELOPMENT REGION (1988/89)

Unit : Production in tons

		FWDR	MWDR	WDR	CDR	EDR
Cow Milk	Production	29,560	34,899	42,453	66,873	70,094
	Ranking	5	4	3	2	1
Buffalo Milk	Production	56,104	77,047	181,883	161,943	113,035
	Ranking	5	4	1	2	3
Mutton	Production	185	1,505	468	368	471
	Ranking	5	1	3	4	2
Chicken	Production	277	985	1,205	2,529	1,299
	Ranking	5	4	3	1	2
Buffalo Meat	Production	8,231	11,971	21,195	32,606	19,925
	Ranking	5	4	2	1	3
Goat Meat	Production	2,678	7,260	4,897	7,130	6,413
	Ranking	5	2	4	1	3
Duck Meat	Production	12	7	30	80	92
	Ranking	4	5	3	2	1
Pig Meat	Production	506	1,556	1,333	1,373	4,631
	Ranking	5	3	4	1	2
Wool	Production	43	423	132	84	91
	Ranking	5	1	2	4	3

Source : Agricultural Statistics of Nepal, 1990

Remark : FWDR = Far Western Development Region
MWDR = Mid Western Development Region
WDR = Western Development Region
CDR = Central Development Region
EDR = Eastern Development Region

Table 4.4.1 CAMPUSES IN THE MID WESTERN AND FAR WESTERN DEVELOPMENT REGIONS

Mid Western Development Region

Zone	District	Name of Campus	Course	Education Level
Karnali	Jumla	- Jumla Campus in Jumla	Education Management	Certificate Certificate
Rapti	Rukum	- Musikot Khalanga Campus in Musikot	Humanities	Certificate
Bheri	Jajarkot	- Bheri Gyanodaya Campus in Khalanga	Humanities	Certificate
	Surkhet	- Birendranagar Multiple Campus in Birendranagar	Management Humanities	Bachelor Bachelor
		- Surkhet Campus in Birendranagar	Law Education	Certificate Certificate

Far Western Development Region

Zone	District	Name of Campus	Course	Education Level
Mahakali	Darchula	- Darchula Campus in Darchula	Humanities	Certificate
	Baitadi	- Baitadi Patan Multiple Campus in Patan	Law Humanities	Certificate Bachelor
		- Jayanath Campus in Baitadi	Humanities	Certificate
	Dadeldhura	- Dadeldhura Multiple Campus in Dadeldhura	Management Humanities	Certificate Certificate
Seti	Bajhang	- Jaya Prithivi Campus in Bhopur	Humanities	Certificate
	Doti	- Doti Multiple Campus in Doti	Law Humanities	Certificate Bachelor
	Achham	- Achham Campus in Mangalsen	Management	Certificate
		- Janta Campus in Mangalsen	Management	Certificate

Table 5.1.1 EXISTING AND UNDER-CONSTRUCTION POWER PLANTS IN THE NATIONAL GRID

Name	Type	In-service Date	Installed Capacity (MW)	Effective Capacity (MW)	Potential Annual Energy Output, (GWh)
Existing					
Trisuli	ROR ^1	1962	21.0	14.0	115
Sunkosi	ROR ^1	1973	10.1	5.8	57
Gandaki	ROR ^1	1979	15.0	9.4	44
Kulekhani I	RES ^2	1982	60.0	60.0	163
Devighat	ROR ^1	1983	14.1	14.1	92
Kulekhani II	ROR ^3	1986	32.0	32.0	95
Marsyangdi	ROR ^1	1990	69.0	64.0	462
Andhi Khola	ROR ^1	1990	5.1	5.1	27 ^4
Small Hydro			6.0	6.0	15
Hetauda	Diesel		10.0	10.0	53
Other Diesel			15.0	7.0	37 ^4
Duhabi	Multi-fuel	1991	26.0	26.0	137 ^4
Sub-total			283.3	253.4	1,297
Under-construction					
Jhimruk Piuthan	ROR ^1	1994	12.5	12.5	66 ^4
Sub-total			12.5	12.5	66
Total			295.8	265.9	1,363

Notes :
^1 Hydro plant of the run-of-river type
^2 Hydro plant of thr reservoir type
^3 Cascade development with Kulekhani I
^4 The plant factor is assumed at 0.6.

Table 5.1.2 PRESENT CONDITION OF RURAL ELECTRIFICATION IN THE STUDY AREA (1/2)

Mid Western Development Region

Name of Towns	Name of District	Name of Plant	Installed Capacity, kW	Type of Plant	Installation Status	Remarks
Karnali Zone						
Simikot	Humla	Simikot	50	Solar	Existing	Maintenance problem
Gamgadhi	Mugu	Gamgadhi	50	Solar	Existing	Maintenance problem
Manma	Kalikot	Manma	500	Hydro	Planned	Feasibility study has been done. ^1
Jumla	Jumla	Jumla	200	Hydro	Existing	
Dunai	Dolpa	Dolpa	160	Hydro	Planned	Feasibility study has been done. ^2
Rapti Zone						
Jumlikhalanga	Rukum	Syarpudaha	200	Hydro	Existing	
Bheri Zone						
Dailekh	Dailekh	Dailekh	360	Hydro	Planned	Feasibility study has been done. ^3
Jajarkot	Jajarkot	Chaurjhari	150	Hydro	Existing	
Birendranagar	Surkhet	Surkhet	345	Hydro	Existing	

Table 5.1.2 PRESENT CONDITION OF RURAL ELECTRIFICATION IN THE STUDY AREA (2/2)

Far Western Development Region

Name of Town	Name of District	Name of Plant	Installed Capacity, kW	Type of Plant	Installation Status	Remarks
Mahakali Zone						
Darchula	Darchula	Darchula I	50	Hydro	Existing	
		Darchula II	250	Hydro	Under-construction	Completion in 1992
Baitadi	Baitadi	Surnaiya Gad	200	Hydro	Existing	Service in 1991
Dadeldhura	Dadeldhura	Rupal Gad	100	Hydro	Existing	
		Dadeldhura	112	Diesel	Existing	Irregular Service
Mahendranagar	Kanchanpur		500	Imported		
Seti Zone						
Chainpur	Bajhang	Bajhang	200	Hydro	Existing	Worn out
Martadi	Bajura	Bajura	200	Hydro	Existing	
Dipayal and Silgadhi	Doti	Doti	200	Hydro	Existing	Power deficit
Mangalsen	Achham	Achham	400	Hydro	Under-construction	Completion in 1994

Notes : ^1 Kalikot Small Hydel Project, NEA , June 1990
^2 Dolpa Small Hydel Project, NEA, June 1990
^3 Dailekh Small Hydel Project, NEA, October 1988

Table 5.1.3 HYDROPOWER POTENTIAL SCHEMES
IDENTIFIED IN THE STUDY AREA IN THE PAST STUDIES

Name of Scheme	Tributary	Type of Scheme	Catchment Area km2	Remarks
Karnali River Basin				
Karnali/Chisapani ^1	Karnali	Reservoir	43,679	Feasibility
KR 7^2	Karnali	Run-of-river	21,314	Reservoir type alternative
KR 3/Lakharpata ^2	Karnali	Run-of-river	21,291	
Karnali Bend/KR 1A^3	Karnali	Run-of-river	20,120	Pre-feasibility
KR 2^2	Karnali	Run-of-river	15,739	
KR 4^2	Karnali	Run-of-river	13,238	
TR 1^2	Tila	Run-of-river	3,326	
TR 2^2	Tila	Run-of-river	2,840	
MKR 1^2	Mugu	Run-of-river	6,008	
HKR 1^2	Humla	Run-of-river	5,964	
BR1/Bheri/Babai ^2	Bheri	Run-of-river	11,815	Reservoir type alternative
BR3/Surkhet ^2	Bheri	Reservoir	11,554	
BR5/Thapna ^2	Bheri	Reservoir	10,757	
BR 4^2	Bheri	Reservoir	10,305	
BR 6^2	Bheri	Run-of-river	1,367	
SR 6^2	Seti	Reservoir	7,213	
West Seti/SR 1^4	Seti	Reservoir	4,250	Feasibility
SR 3^2	Seti	Run-of-river	2,421	
THR 1^2	Thuli Gad	Run-of-river	626	
Mahakali River Basin				
Pancheshwar ^5	Mahakali	Reservoir	12,600	F/S level field investigation
Rupali Regulating dam ^6	Mahakali	Reservoir		
Poornagiri ^5	Mahakali	Reservoir	15,000	
Chamliya ^6	Chamliya	Reservoir	1,570	Plant factor of 0.2

Sources :
^1 Karnali (Chisapani) Multipurpose Project, Himalayan Power Consultants, December 1989
^2 The Upper Karnali Hydroelectric Projet, Himalayan Power Consultants, December 1987.
^3 The Upper Karnali Hydroelectric Project, Prefeasibility Study of th Karnali Bend Site KRIA, Himalayan Consultants, December 1989.
^4 West Seti Hydroelectric Project, Sogreah, March 1987.
^5 Pancheshwar Project, Water Power Consultancy Service, India, November 1971.
^6 Pancheshwar Multipurpose Project, Field Investigations whthin

Table 5.1.4 NEWLY PROPOSED HYDROPOWER POTENTIAL SCHEMES

Name of Scheme	Tributary	Type of Scheme	Catchment Area km2	Remarks
Karnali River Basin				
TR3	Tila	Run-of-river	3,105	SG240*
TR4	Tila	Run-of-river	513	SG240
MKR2	Mugu	Run-of-river	5,773	SG240
MKR3	Mugu	Run-of-river	4,251	SG240
HKR2	Humla	Run-of-river	5,654	SG240
HKR3	Humla	Run-of-river	4,144	SG240
HKR4	Humla	Run-of-river	3,807	SG240
BR3B	Bheri	Reservoir	10,910	SG270
BR7	Bheri	Run-of-river	628	SG270
BR8	Bheri	Run-of-river	2,438	SG270
LR1	Lohore	Reservoir	733	SG240
BS1	Buriganga	Run-of-river	853	SG260
SR7	Seti	Run-of-river	978	SG260
Mahakali River Basin				
CR1	Chamliya	Run-of-river	280	SG120
CR2	Chamliya	Run-of-river	785	SG120

Notes: * Stream gauge number used for the calculation of power output and annual energy output.

Table 5.1.5 POWER AND ENERGY GENERATION OF THE RESERVOIR TYPE SCHEMES

	Draft Rate	Plant Discharge (m3/sec)	FSL (EL m)	MOL (EL m)	RWL (EL m)	TWL (EL m)	Installed Capacity (MW)	Firm Energy (GWh/yr)	Secondary Energy (GWh/yr)	Total Energy (GWh/yr)
BR3A	0.6	648	556	519	544	415	660	1,874	796	2,670
	0.7	756	563	519	548	415	797	2,274	754	3,028
	0.8	864	574	519	556	415	961	2,747	686	3,433
BR3B	0.6	590	682	615	660	488	801	2,243	988	3,231
	0.7	688	701	615	672	488	1,003	2,775	1,006	3,781
	0.8	786	712	615	680	488	1,192	3,407	911	4,318
BR4	0.6	527	794	752	780	620	667	1,900	800	2,700
	0.7	615	802	752	785	620	804	2,245	779	3,024
	0.8	703	814	752	793	620	964	2,757	679	3,436
BR5	0.6	570	726	681	711	516	880	2,512	1,047	3,559
	0.7	665	732	681	715	516	1,048	2,939	968	3,907
	0.8	760	750	681	727	516	1,269	3,624	888	4,512
SR6	0.6	434	603	557	588	401	642	1,841	799	2,640
	0.7	507	613	557	594	401	776	2,240	752	2,992
	0.8	579	639	557	612	401	966	2,809	690	3,499
LR1	0.6	62	800	766	789	693	47	135	71	206
	0.7	72	808	766	794	693	58	166	70	236
	0.8	83	824	766	805	693	73	210	66	276

Table 5.1.6 POWER AND ENERGY GENERATION OF THE RUN-OF-RIVER TYPE SCEMES

Scheme	Firm Discharge (m3/sec)	Plant Discharge (m3/sec)			FSL	TWL	Firm Power (MW)	Power (MW)			Firm Energy (GWh/yr)	Secondary Energy (GWh/yr)			Total Energy (GWh/yr)		
		8-hr	12-hr	16-hr				8-hr	12-hr	16-hr		8-hr	12-hr	16-hr	8-hr	12-hr	16-hr
Karnali River Basin																	
KR2	60.4	181.1	120.7	90.6	1,050	762	137.6	412.8	275.2	206.4	1,198	1,695	909	487	2,893	2,107	1,685
KR3/Lakharpata	98.3	294.9	196.6	147.5	586	400	144.7	434.1	289.4	217.0	1,260	1,782	956	512	3,042	2,215	1,772
KR4	45.0	134.9	89.9	67.4	1,240	1,158	29.2	87.5	58.3	43.8	254	359	193	103	613	447	357
KR7	98.4	295.2	196.8	147.6	525	421	81.0	243.0	162.0	121.5	705	998	535	287	1,703	1,240	992
TR1	19.3	57.8	38.5	28.9	1,110	712	60.7	182.1	121.4	91.1	529	748	401	215	1,276	929	743
TR2	15.6	46.8	31.2	23.4	1,830	1,330	61.8	185.3	123.5	92.7	538	761	408	219	1,299	946	757
TR3	17.6	52.7	35.1	26.4	1,330	1,079	34.9	104.7	69.8	52.3	304	430	230	124	734	534	427
TR4	2.4	7.2	4.8	3.6	2,530	2,345	3.5	10.5	7.0	5.2	30	43	23	12	73	53	43
MKR1	17.6	52.9	35.3	26.5	1,451	1,235	30.2	90.5	60.3	45.3	263	372	199	107	634	462	369
MKR2	15.6	46.8	31.2	23.4	1,855	1,705	18.5	55.6	37.1	27.8	161	228	122	66	390	284	227
MKR3	9.0	27.1	18.1	13.6	2,865	2,285	41.5	124.4	82.9	62.2	361	511	274	147	872	635	508
HKR1	23.3	69.9	46.6	34.9	1,643	1,320	59.5	178.6	119.0	89.3	518	733	393	211	1,251	911	729
HKR2	21.8	65.5	43.7	32.7	1,855	1,705	25.9	77.7	51.8	38.9	226	319	171	92	545	397	317
HKR3	17.1	51.4	34.3	25.7	2,066	1,890	23.9	71.6	47.7	35.8	208	294	158	84	502	365	292
HKR4	15.8	47.4	31.6	23.7	2,362	2,066	37.0	111.1	74.1	55.5	322	456	245	131	778	567	453
BR1/Bheri/Babai	19.4	58.2	38.8	29.1	437	259	27.3	82.0	54.7	41.0	233	361	195	103	595	428	337
BR6	7.6	22.7	15.2	11.4	1,919	1,646	16.4	49.1	32.8	24.6	142	187	100	54	329	242	196
BR7	1.7	5.1	3.4	2.5	2,620	1,890	9.7	29.2	19.5	14.6	85	111	60	32	196	144	117
BR8	4.1	12.4	8.3	6.2	2,590	2,285	10.0	30.0	20.0	15.0	87	114	61	33	201	148	120
SR3	13.2	39.6	26.4	19.8	1,307	1,067	25.1	75.2	50.1	37.6	217	280	152	91	497	369	308
SR7	4.9	14.7	9.8	7.3	1,975	1,524	17.5	52.4	34.9	26.2	151	195	106	63	347	257	215
THR 1	1.1	3.3	2.2	1.7	729	401	2.9	8.6	5.7	4.3	25	40	21	11	65	46	36
BS1	6.0	18.2	12.1	9.1	850	760	4.3	12.9	8.6	6.5	37	48	26	16	86	63	53
Mahakali River Basin																	
CR1	2.1	6.4	4.3	3.2	1,860	1,675	3.1	9.4	6.3	4.7	27	35	19	11	62	46	38
CR2	7.2	21.7	14.5	10.9	882	765	6.7	20.1	13.4	10.1	58	75	41	23	134	99	81

Table 5.1.7 ECONOMIC EVALUATION OF POTENTIAL SCHEMES (RESERVOIR TYPE)

Scheme	Draft Rate	Installed Capacity (MW)	Firm Energy (GWh/y)	Secondary Energy (GWh/y)	Construction Cost (US$1,000)	Net Benefit (US$1,000)	EIRR (%)	(US¢/KWh)
LR1	0.6	47.0	135	71	105,078	-11,899	8.5%	5.10
	0.7	58.0	166	70	118,259	-7,807	9.1%	5.01
	0.8	73.0	210	66	144,540	-12,277	8.8%	5.24
BR3A	0.6	660.0	1,874	796	820,923	256,488	13.9%	3.07
	0.7	797.0	2,274	754	914,306	311,548	14.2%	3.02
	0.8	961.0	2,747	686	1,060,168	348,304	14.1%	3.09
BR3B	0.6	801.0	2,243	988	816,255	427,034	16.2%	2.53
	0.7	1,003.0	2,775	1,006	911,115	538,775	16.9%	2.41
	0.8	1,192.0	3,407	911	1,005,558	653,871	17.6%	2.33
BR4	0.6	667.0	1,900	800	1,046,339	115,391	11.4%	3.88
	0.7	804.0	2,245	779	1,216,106	107,230	11.2%	4.02
	0.8	964.0	2,757	679	1,373,534	140,560	11.3%	4.00
BR5	0.6	880.0	2,512	1,047	1,028,160	386,903	14.6%	2.89
	0.7	1,048.0	2,939	968	1,123,183	440,035	14.8%	2.87
	0.8	1,269.0	3,624	888	1,311,537	513,275	14.8%	2.91
SR6	0.6	642.0	1,841	799	926,363	176,302	12.4%	3.51
	0.7	776.0	2,240	752	997,620	244,535	13.1%	3.33
	0.8	966.0	2,809	690	1,175,156	292,445	13.1%	3.36

Note: US¢ means US cents.

TABLE 5.1.8 ECONOMIC EVALUATION OF POTENTIAL SCHEMES (RUN-OF-RIVER TYPE) (1/2)

Scheme	Operation (Hours)	Installed Capacity (MW)	Firm Energy (GWh/y)	Secondary Energy (GWh/y)	Construction Cost (US$1,000)	Net Benefit (US$1,000)	EIRR (%)	(US¢/KWh)
KR2	8	412.8	1,198	1,695	810,044	277,590	14.2%	2.80
	12	275.2	1,198	909	666,503	171,941	13.2%	3.16
	16	206.4	1,198	487	594,236	112,015	12.4%	3.53
KR3	8	434.1	1,260	1,782	689,299	399,762	16.8%	2.27
	12	289.4	1,260	955	515,387	304,022	16.9%	2.33
	16	217.0	1,260	512	404,524	264,567	17.6%	2.28
KR4	8	87.5	254	359	332,577	-83,372	6.3%	5.43
	12	58.3	254	193	278,825	-74,041	6.1%	6.24
	16	43.8	254	103	254,471	-72,183	5.8%	7.13
KR7	8	243.0	705	998	386,925	223,407	16.8%	2.27
	12	162.0	705	535	325,049	146,038	15.4%	2.62
	16	121.5	705	287	288,747	106,704	14.5%	2.91
TR1	8	120.3	349	494	340,586	10,818	10.4%	4.04
	12	80.2	349	265	289,082	-13,456	9.4%	4.71
	16	60.2	349	142	255,233	-22,361	8.8%	5.20
TR2	8	52.6	153	216	314,818	-106,008	4.8%	8.53
	12	35.1	153	116	273,169	-103,805	4.0%	10.15
	16	26.3	153	62	251,963	-103,474	3.4%	11.72
TR3	8	104.7	304	430	290,474	13,486	10.6%	3.96
	12	69.8	304	230	248,230	-9,543	9.5%	4.65
	16	52.3	304	123	229,182	-24,238	8.5%	5.37
TR4	8	10.5	30	43	64,683	-24,573	4.5%	8.86
	12	7.0	30	23	58,522	-25,393	3.4%	11.04
	16	5.2	30	13	53,916	-24,737	2.9%	12.54
MKR1	8	90.5	263	371	282,801	-9,643	9.5%	4.46
	12	60.3	263	199	250,871	-32,389	8.2%	5.43
	16	45.3	263	106	231,977	-43,599	7.3%	6.29
MKR2	8	55.6	161	229	272,091	-71,560	6.1%	6.98
	12	37.1	161	123	244,489	-80,282	5.0%	8.61
	16	27.8	161	66	229,646	-84,972	4.2%	10.12
MKR3	8	124.4	361	511	331,076	25,375	11.0%	3.80
	12	82.9	361	274	300,594	-14,998	9.3%	4.73
	16	62.2	361	147	282,426	-49,536	7.5%	5.56
HKR1	8	178.6	518	733	411,916	78,549	12.4%	3.29
	12	119.0	518	393	354,395	29,847	11.1%	3.89
	16	89.3	518	211	325,096	2,780	10.1%	4.46
HKR2	8	77.7	226	319	354,653	-82,843	6.6%	6.51
	12	51.8	226	171	319,855	-97,520	5.4%	8.06
	16	38.9	226	91	298,353	-103,655	4.6%	9.41

TABLE 5.1.8 ECONOMIC EVALUATION OF POTENTIAL SCHEMES (RUN-OF-RIVER TYPE) (2/2)

Scheme	Operation (Hours)	Installed Capacity (MW)	Firm Energy (GWh/y)	Secondary Energy (GWh/y)	Construction Cost (US$1,000)	Net Benefit (US$1,000)	EIRR (%)	(US¢/KWh)
HKR3	8	71.6	208	294	360,684	-99,047	5.9%	7.18
	12	47.7	208	157	331,128	-114,409	4.7%	9.07
	16	35.8	208	84	313,184	-121,128	3.9%	10.73
HKR4	8	111.1	322	456	415,744	-57,799	8.0%	5.34
	12	74.1	322	245	367,532	-79,659	6.9%	6.48
	16	55.5	322	131	341,503	-91,483	6.0%	7.54
BR1	8	82.0	233	362	184,369	44,219	13.0%	3.10
	12	54.7	233	196	146,507	26,975	12.4%	3.42
	16	41.0	233	104	132,146	12,993	11.3%	3.92
BR6	8	49.1	142	187	154,001	-9,494	9.2%	4.68
	12	32.8	142	100	137,381	-20,685	7.9%	5.68
	16	24.6	142	54	125,515	-24,553	7.2%	6.40
BR7	8	29.2	85	111	138,552	-36,910	6.1%	7.07
	12	19.5	85	59	129,270	-44,035	4.8%	8.98
	16	14.6	85	32	123,693	-47,228	4.0%	10.57
BR8	8	30.0	87	114	189,910	-69,822	4.2%	9.45
	12	20.0	87	61	170,743	-70,597	3.3%	11.54
	16	15.0	87	33	161,353	-71,499	2.7%	13.45
SR3	8	75.2	217	280	166,124	30,269	12.3%	3.34
	12	50.1	217	152	137,463	16,616	11.6%	3.73
	16	37.6	217	91	118,304	13,785	11.5%	3.84
SR7	8	52.4	151	196	152,659	-3,407	9.7%	4.40
	12	34.9	151	106	115,410	-1,572	9.8%	4.49
	16	26.2	151	64	103,891	-4,648	9.4%	4.83
THR1	8	8.6	25	40	48,762	-14,117	5.8%	7.50
	12	5.7	25	21	43,730	-15,944	4.5%	9.51
	16	4.3	25	11	40,372	-16,408	3.7%	11.21
BS1	8	8.6	37	49	98,866	-42,497	3.2%	11.50
	12	6.5	37	26	86,278	-40,151	2.5%	13.69
	16	4.3	37	16	79,047	-37,898	2.2%	14.91
CR1	8	9.4	27	35	79,859	-36,635	2.6%	12.88
	12	6.3	27	19	74,089	-37,099	1.7%	16.11
	16	4.7	27	11	70,303	-36,698	1.1%	18.50
CR2	8	23.5	68	88	68,258	894	10.2%	4.38
	12	15.7	68	48	57,931	-3,139	9.3%	4.99
	16	11.8	68	27	51,317	-4,421	8.8%	5.40

Note: US¢ means US cents.

Table 5.2.1 SUMMARY OF PRESENT DOI (Including SHIP), FMIS AND AMIS IRRIGATION PROJECTS IN THE STUDY AREA

District	Total		Existing		On-Going		Planned		Cancelled	
	Nos.	NCA(ha)	Nos.	NCA(ha)	Nos.	NCA(ha)	Nos.	NCA(ha)	Nos.	NCA(ha)
Salyan	301	4,811	298	4,646	3	165				
Rukum	116	3,289	109	2,914	4	N.A.	3	375		
Surkhet	300	17,678	294	12,981	2	1,672	4	3,025		
Jajarkot	145	4,414	132	3,232	6	617	7	565		
Dailekh	234	3,653	232	3,150	1	477	1	26		
Total for Hill	1,096	33,845	1,065	26,923	16	2,931	15	3,991		
Dolpa	12	595	5	460			7	135		
Jumla	19	375	4	100	2	40	13	235		
Kalikot	11	1,168					10	953	1	215
Mugu	5	416	1	20	2	195	2	201		
Humla	6	520	2	65			3	385	1	70
Total for Mountain	53	3,074	12	645	4	235	35	1,909	2	285
Total for Mid West.	1,149	36,919	1,077	27,568	20	3,166	50	5,900	2	285
Achham	229	3,367	219	2,645	5	242	5	480		
Doti	236	4,676	220	3,610	7	625	6	179	3	262
Dadeldhura	162	1,511	157	943	4	398	1	170		
Total for Hill	627	9,554	596	7,198	16	1,265	12	829	3	262
Baitadi	13	628	6	286	6	277	1	65		
Bajura	8	647	1	50	5	382	2	215		
Bajhang	28	2,195	7	658	8	747	12	730	1	60
Darchula	12	1,034	1	40	8	559	3	435		
Total for Mountain	61	4,504	15	1,034	27	1,965	18	1,445	1	60
Total for Far West.	688	14,058	611	8,232	43	3,230	30	2,274	4	322
Total for Mid-Western and Far Western	1,837	50,977	1,688	35,800	63	6,396	80	8,174	6	607

Note : Not included Large Scale Potential Irrigation Projects

Table 5.2.2 LARGE SCALE POTENTIAL IRRIGATION PROJECTS

Unit: Net ha

Name	District	Existing		New Scheme	Total
		DOI	FMIS		
Run-of-River Project					
Sikta	Banke	1,250	2,890	31,930	36,070
Babai	Bardiya		5,308	8,192	13,500
Khutiya II	Kailai		1,000	2,500	3,500
Mahakali II	Kanchanpur		703	6,099	9,800
Multipurpose Project					
West Rapti	Kapilbastu	800	4,996	24,704	30,500
	Dangdeukhuri	435	7,396	1,669	9,500
	Banke	1,250	2,890	31,930	36,070
	Total	2,485	15,282	58,303	76,070
Karnali	Banke	1,250	2,430	32,471	36,151
	Bardiya	960	23,527	39,682	64,169
	Kailali	3,633	28,653	58,344	90,630
	Total	5,843	54,610	130,497	190,950
Bheri-Babai	Bardiya	960	11,312	27,728	40,000
					636,910

Remarks: DOI: Irrigation system managed by DOI
FMIS: Farmer managed irrigation system

Source: MPID2 Annexes-Volume 1

Table 5.2.3 SUMMARY OF THE SMALLER IDENTIFIED POTENTIAL IRRIGATION PROJECTS (1/2)

<MID WESTERN DEVELOPMENT REGION>

Unit : ha

District	Number of Projects	Net Command Areas		
		Overall Scheme	Existing Scheme	New Scheme
Dangdeukhuri	8	3,125	480	2,645
Banke				
Bardiya	1	290		290
Total For TERAI	9	3,415	480	2,935
Pyuthan	3	1,000		1,000
Polpa	1	100		100
Salyan	1	70		70
Rukum	5	425		425
Surkhet	4	943	200	743
Jajarkot	4	109	67	42
Dailekh	1	477		477
Total For HILL	19	3,124	267	2,857
Dolpa	2	110		110
Jumla	2	250		250
Kalikot	2	315		315
Mugu	2	201		201
Humla	2	90		90
Total For MOUNTAIN	10	966		965
Total For MID WEST	38	7,505	747	6,757

Source: MPID2, Table A3-3

Table 5.2.3 SUMMARY OF THE SMALLER IDENTIFIED POTENTIAL IRRIGATION PROJECTS (2/2)

<FAR WESTERN DEVELOPMENT REGION>

Unit : ha

District	Number of Projects	Net Command Areas (ha)		
		Overall Scheme	Existing Scheme	New Scheme
Kailai	1	649		649
Kanchanpur	1	1,800		1,800
Total For TERAI	2	2,449		2,449
Achhan	1	142		142
Doti	9	1,102	313	789
Dadeldhura	4	305		305
Baitadi	5	227		227
Total For HILL	19	1,776	455	1,321
Bajura	3	295	45	250
Bajhang	16	1,381	965	416
Darchurla	4	629	90	539
Total For MOUNTAIN	23	2,305	1,100	1,205
Total For FAR WEST	44	6,530	1,555	4,975
Total For MID+FAR	82	14,035	2,302	11,732

Source: MPID2, Table A3-3

Table5.2.4 PRESENT SITUATION OF MPID2 IDENTIFIED SMALL PROJECTS (In the Study Area)

District	Number of Projects	Existing or on-going	Planned
Salyan	1	1	
Rukum	5	2	3
Surkhet	4	2	2
Jajarkot	4	2	2
Dailekh	1	1	
Total for Hill	15	8	7
Dolpa	2		2
Jumla	2	1	1
Kalikot	2		2
Mugu	2	2	
Humla	2	1	1
Total for Mount.	10	4	6
Total for Mid West.	25	12	13
Achham	1	1	
Doti	9	6	3
Dadeldhura	4	3	1
Baitadi	5	4	1
Total for Hill	19	14	5
Bajura	3	2	1
Bajhang	16	13	3
Darchula	4	3	1
Total for Mount.	23	18	5
Total for Far West.	42	32	10
Total for Mid+Far West.	67 (100%)	44 (66%)	23 (34%)

Table 5.3.1 WATER SUPPLY SCHEMES IN THE STUDY AREA

Mid Western Development Region

District	Exisitng Water Supply Sheme		On-going/Planning Water Supply Scheme		Total Water Supply Scheme		Population in 1991	Service Ratio(Design Population/Population in1991), %	
	Number	Design Population	Number	Design Population	Number	Design Population		Existing Scheme	Total Scheme
Karnali Zone									
(1) Humla	19	9,627	49	24,167	68	33,794	34,640	27.8	97.6
(2) Mugu	6	4,009	14	10,112	20	14,121	36,445	11.0	38.7
(3) Kalikot	9	22,010	65	80,650	74	102,660	88,781	24.8	115.6
(4) Jumla	6	3,959	22	15,127	28	19,086	76,305	5.2	25.0
Sub-total	46	44,950	179	140,195	225	185,145	261,247	17.2	70.9
Rapti Zone									
(1) Rukum	50	61,230	25	52,212	75	113,442	155,017	39.5	73.2
Sub-total	50	61,230	25	52,212	75	113,442	155,017	39.5	73.2
Bheri Zone									
(1) Dailekh	28	16,669	37	39,601	65	56,270	187,820	8.9	30.0
(2) Jajarkot	31	31,917	12	36,757	43	68,674	114,267	27.9	60.1
(3) Surkhet	48	113,848	16	69,641	64	183,489	225,296	50.5	81.4
Sub-total	107	162,434	65	145,999	172	308,433	527,383	30.8	58.5
Total	203	268,614	269	338,406	472	607,020	943,647	28.5	64.3

Far Western Development Region

District	Exisitng Water Supply Sheme		On-going/Planning Water Supply Scheme		Total Water Supply Scheme		Population in 1991	Service Ratio(Design Population/Population in1991), %	
	Number	Design Population	Number	Design Population	Number	Design Population		Existing Scheme	Total Scheme
Mahakali Zone									
(1) Darchula	59	23,661	73	32,536	132	56,197	101,614	23.3	55.3
(2) Baitadi	117	44,588	98	60,455	215	105,043	200,229	22.3	52.5
(3) Dadeldhura	32	39,505	40	63,581	72	103,086	104,449	37.8	98.7
Sub-total	208	107,754	211	156,572	419	264,326	406,292	26.5	65.1
Seti Zone									
(1) Bajhang	21	19,860	44	40,589	65	60,449	139,178	14.3	43.4
(2) Bajura	30	17,405	33	38,853	63	56,258	92,083	18.9	61.1
(3) Doti	21	35,488	126	109,733	147	145,221	167,469	21.2	86.7
(4) Achham	50	47,372	184	109,463	234	156,835	197,888	23.9	79.3
Sub-total	122	120,125	387	298,638	509	418,763	596,618	20.1	70.2
Total	330	227,879	598	455,210	928	683,089	1,002,910	22.7	68.1

Table 5.3.2 FUTURE DEMAND OF DOMESTIC WATER

Zone	District	Population in1991	Annual Increase Rate, %	Population in 2000	Water Demand in 2000, lpd	Population in2013	Water Demand in 2013, lpd
Mid Western Development Region							
Karnali	Humla	34,640	1.05(5.49)	41,655	1,874,475	56,012	2,520,540
	Mugu	36,445	1.05(-1.80)	39,704	1,786,680	45,280	2,037,600
	Kalikot	88,781	0.13	100,083	4,503,735	119,399	5,372,955
	Jumla	76,305	1.04	83,557	3,760,065	96,787	4,355,415
	Dolpa	25,075	1.30	26,903	1,210,635	31,463	1,415,835
Rapti	Rukum	155,017	1.59	177,246	7,976,070	216,023	9,721,035
Bheri	Dailekh	187,820	1.21	209,557	9,430,065	253,279	11,397,555
	Jajarkot	114,267	1.41	134,070	6,033,150	162,429	7,309,305
	Surkhet	225,296	3.09	296,408	13,338,360	461,138	20,751,210
	Sub-total	943,646		1,109,183	49,913,235	1,441,810	64,881,450
Far Western Development Region							
Mahakali	Darchula	101,614	1.20	108,007	4,860,315	126,702	5,701,590
	Baitadi	200,229	1.12	224,714	10,112,130	267,909	12,055,905
	Dadeldhura	104,449	1.87	134,027	6,031,215	192,519	8,663,355
Seti	Bajhang	139,178	1.16	161,067	7,248,015	207,319	9,329,355
	Bajura	92,083	2.12	107,875	4,854,375	136,762	6,154,290
	Doti	167,469	0.90	198,040	8,911,800	227,104	10,219,680
	Achham	197,888	0.66	211,198	9,503,910	235,282	10,587,690
	Sub-total	1,002,910		1,144,928	51,521,760	1,393,597	62,711,865
	Total	1,946,556		2,254,111	101,434,995	2,835,407	127,593,315

Note: The annual population increase rate of the Humla and Mugu Districts is estimated as one district due to the change of boundary between them.

Table 5.3.3 WAER SUPPLY CONDITION IN THE STUDY AREA

Zone	District	Number of Municipality	Number of VDC	Population in 2000	Population in 2013	Number of Exisiting Schemes	Supply Capacity of Existing Schemes, lpd	Number of On-going/ Planning Schemes	Supply Capacity of On-going/ Planning Schemes,lpd	Deficits in 2000,lpd	Dificits in 2013,lpd
Mid Western Development Region											
Karnali	Humla		26	41,655	56,012	19	433,215	49	1,080,255	565,312	1,126,962
	Mugu		24	39,704	45,280	6	311,310	14	1,213,920	1,079,712	1,262,610
	Kalikot		29	100,083	119,399	9	1,065,881	65	4,805,186	926,750	1,444,005
	Jumla		29	83,557	96,787	6	194,648	22	812,817	2,808,168	3,399,399
	Dolpa		23	26,903	31,463	6	284,080	29	625,314	532,396	655,484
Rapti	Rukum		43	177,246	216,023	50	3,013,364	25	3,191,453	3,121,161	4,532,080
Bheri	Dailekh		59	209,557	253,279	28	1,717,370	37	2,910,398	6,336,496	7,611,091
	Jajarkot		30	134,070	162,429	31	1,238,982	12	1,827,058	3,140,088	4,307,119
	Surkhet	1	49	296,408	461,138	48	7,627,301	16	3,410,437	5,624,823	10,870,841
	Sub-total	1	312	1,109,183	1,441,810	203	15,886,151	269	19,876,838	24,134,906	35,209,591
Far Western Development Region											
Mahakali	Darchula		38	108,007	126,702	59	1,142,580	73	1,582,836	1,896,361	2,666,480
	Baitadi		68	224,714	267,909	117	1,897,616	98	3,413,768	5,674,193	7,403,856
	Dadeldhura		25	134,027	192,519	32	2,275,837	40	4,345,643	1,994,863	3,837,918
Seti	Bajhang		46	161,067	207,319	21	853,787	44	2,034,819	4,858,391	6,660,796
	Bajura		27	107,875	136,762	30	798,732	33	1,940,707	2,474,535	3,605,452
	Doti	1	53	198,040	227,104	21	2,473,359	126	6,550,638	3,200,690	3,882,665
	Achham		75	211,198	235,282	50	1,930,567	184	6,674,150	4,228,612	4,954,691
	Sub-total	1	332	1,144,928	1,393,597	330	11,372,478	598	26,542,561	24,327,645	33,011,858
	Total	2	644	2,254,111	2,835,407	533	27,258,629	867	46,419,399	48,462,551	68,221,449

Table 5.4.1 DAMAGE RECORDS CAUSED BY FLOODS OR LANDSLIDE BY DISTRICT IN 1989

Name of District	Incident nos.	Injured nos.	Dead toll persons	Livestock loss nos.	Personal house loss nos.	Personal land loss ha	Public land / others ha	Estimated damages Rp.	Affected nos. of families nos.
Far Western Region			**11**	**61**	**322**	**107.3**		**12,512,129**	-
Darchula	-	-	4	2	4	-	-	103,950	-
Doti	-	-	1	4	1	-	-	144,408	-
Dadeldhura	-	-	2	6	16	-	-	122,650	-
Kanchanpur	-	-	-	-	13	55.6	-	240,000	-
Kailali	-	-	2	27	237	25.8	4 bridges and 1 school	4,216,872	-
Achham	-	-	-	-	23	-	1school	195,619	-
Bajura	-	-	-	-	25	19.2	4 local bridges	7,114,640	-
Baitadi	-	-	1	-	-	-	-	-	-
Bajhang	-	-	1	22	3	6.7	-	373,990	-
Mid-Western Region			**47**	**563**		**134**		**30,738,600**	-
Kalikot	-	-	25	14	106	-	16 mills and 19 bridges	1,686,000	-
Humla	-	-	-	-	25	-	-	380,550	-
Jumla	-	-	5	396	16	-	40 canals and 43 mills	7,389,850	-
Mugu	-	-	-	-	1	-	-	311,760	-
Rukum	-	-	6	-	1 house and 43 mills	132.3	2 schools and 9 local bridges	20,714,440	-
Salyan	-	-	7	46	9 houses and 53 mills	-	1 suspension bridge 12 canals and 2 timber bridges	-	-
Dailekh	-	-	-	-	-	-	-	-	-
Surkhet	-	-	3	-	-	-	-	-	-
Dolpa	-	-	-	-	-	-	2 local bridges	-	-
Bardiya	-	-	-	4	3	-	1 local bridge	6,000	-
Jajarkot	-	-	1	13	1	1.9	-	50,000	-
Banke	-	-	-	90	98	-	3 local bridges	200,000	-

Source : Natural Disaster Relief Division of Ministry of Home

Table 5.4.2 DAMAGE RECORDS CAUSED BY FLOODS OR LANDSLIDE BY DISTRICT IN 1990

Name of District	Incidents nos.	Injured nos.	Dead toll persons	Livestock loss nos.	Personal house loss nos.	Personal land loss ha	Public land / others ha	Estimated damages Rp.	Affected nos. of families nos.
Far Western Region	**48**		**31**	**38**	**851**	**280**		**13,870,352**	**1,420**
Darchula	2	-	1	-	-	0.4	0.7	110,000	30
Doti	4	-	1	2	1	-	1-school	61,550	31
Dadeldhura	1	-	-	-	1	0.1	-	30,000	6
Kanchanpur	12	-	3	-	579	233.2	-	3,100,000	596
Kailali	2	-	-	-	61	39.4	-	25,000	75
Achham	4	-	-	4	12	-	2-houses	160,502	9
Bajura	19	-	16	32	168	7.3	1 timber bridge 1 house and 1 canal	10,249,600	582
Baitadi	2	-	-	-	28	-	-	-	91
Bajhang	2	-	10	-	1	-	1 bridge (local) & 3 turbines	133,700	-
Mid-Western Region	**39**	**6**	**53**	**31**	**124**	**4**		**1,525,320**	**380**
Kalikot	3	-	-	-	4	-	3 bridge	292,560	3
Humla	11	-	-	4	95	2.2	1 local bridge	570,560	308
Jumla	4	-	-	-	3	-	1 canal	68,420	2
Mugu	-	-	-	-	-	-	-	-	-
Rukum	3	-	8	4	5	-	-	43,850	5
Salyan	5	-	4	11	7	-	3.5	298,400	26
Dailekh	4	-	15	10	5	-	-	196,030	13
Surkhet	2	-	-	-	3	-	-	-	3
Dolpa	-	-	-	-	-	-	1 local bridge	-	-
Bardiya	1	-	15	-	-	-	-	-	-
Jajarkot	6	6	11	2	2	1.5	15 houses, 1 timber bridge 0.4 ha	55,500	20
Banke	-	-	-	-	-	-	-	-	-

Source : Natural Disaster Relief Division of Ministry of Home

Table 5.4.3 DAMAGE RECORDS CAUSED BY FLOODS OR LANDSLIDE BY DISTRICT IN 1991

Name of District	Incidents nos.	Injured nos.	Dead toll persons	Livestock loss nos.	Personal house loss nos.	Personal land loss ha	Public land / others ha	Estimated damages Rp.	Affected nos. of families nos.
Far Western Region		**1**	**4**	**3**		**4**		**3,350,000**	**150**
Darchula	-	-	-	-	26 local mills	0.2	-	314,000	60
Doti	-	-	-	-	-	-	-	-	-
Dadeldhura	-	-	-	-	-	-	-	-	-
Kanchanpur	-	-	-	-	-	-	-	-	-
Kailali	-	-	-	-	-	3.1	-	320,000	32
Achham	-	1	3	-	4	0.6	-	1,466,000	54
Bajura	-	-	1	-	-	-	-	-	-
Baitadi	-	-	-	-	-	-	-	-	-
Bajhang	-	-	-	3	1	0.1	13 local bridges	1,250,000	4
Mid-Western Region			**3**		**5**			**100,000**	**2**
Kalikot	-	-	-	-	-	-	-	-	-
Humla	-	-	-	-	-	-	-	-	-
Jumla	-	-	-	-	-	-	-	-	-
Mugu	-	-	-	-	-	-	-	-	-
Rukum	-	-	-	-	3	-	-	100,000	1
Salyan	-	-	-	-	-	-	-	-	-
Dailekh	-	-	-	-	-	-	-	-	-
Surkhet	-	-	-	-	-	-	-	-	-
Dolpa	-	-	-	-	-	-	-	-	-
Bardiya	-	-	-	-	-	-	-	-	-
Jajarkot	-	-	3	-	2	-	-	-	1
Banke	-	-	-	-	-	-	-	-	-

Source : Natural Disaster Relief Division of Ministry of Home

Table 5.4.4 LIST OF PRIORITY RIVER TRAINING SCHEMES IN THE HILL AREA

Name of districts	Name of areas	Length of riverbank to be protected m	Type of river training works	Cost of river training works incl. G.I.wire Million Rs.
1. Surkhet				**128.3**
(a)	Birendranagar ward No. 8,10, 12	500	Sediment removal & revetment	11.9
(b)	Birendranagar ward 11,12 & Jarbuta ward 1	1,500	Revetment & spurs	44.2
(c)	Birendranagar ward 1 & 2, Uttarganga	2,000	Sediment removal & revetment	47.6
(e)	Cheapang	1,000	Revetment	24.6
2. Rukum				**119.8**
(a)	Beltapu	3,000	Revetment & spurs	91.4
(b)	Jari Khola River Training Works	1,000	Revetment on scattered spots	24.1
(c)	Dhaune Bagar	170	Revetment	4.3
3. Dailekh				**19.0**
(a)	Rakam	500	Revetment	12.8
(c)	Dhamigaun	250	Revetment and levee	6.2
4. Kalikot				**44.8**
(a)	Serijiula	500	Revetment	13.0
(b)	Ramnakot & Lapha	1,000	Revetment	26.5
(c)	Lapha Gad	200	Revetment	5.3
5. Bajhan				**4.7**
(b)	Chopakhe and Deval areas	180	Revetment	4.7
6. Baitadi				**129.8**
(a)	Purchaundi Hat	2,500	Revetment	65.4
(c)	Jamari Gad	2,500	Revetment	64.4
8. Achham				**2.6**
(b)	Payal	100	Revetment	2.6
9. Dadeldhura				**14.5**
(a)	Jogbudha	500	Revetment & spurs	14.5
10. Doti				**33.5**
(a)	Tarala	900	Revetment	22.0
(b)	Laxminagad	500	Revetment	11.5
11. Darchula				**13.0**
(a)	Banga Bagar	200	Revetment	5.1
(b)	Noti Bazar	300	Revetment	7.9
	Total	**19,300**		**510.0**

Table 5.4.5 ESTIMATED COST OF RIVER TRAINING WORKS OF DODHARA AND CHANDANI AREAS

	Work items	Unit of work quantity	Work quantity	Original estimate		Revised estimate	
				Unit prices Rs.	Amount 1,000 Rs.	Unit prices Rs.	Amount 1,000 Rs.
< Direct construction cost >							
(1)	G.I.wire crate weaving works	m2	244,500	13.41	3,280	13.41	3,280
(2)	Collection and transportation of boulders	m3	52,038	145.34	7,560	185.75	9,670
(3)	Boulder filling in crate	m3	52,038	42.26	2,200	67.60	3,520
(4)	River bed material dowla inspection track : Loading, unloading & transp. of river bed material	m3	55,000	68.90	3,790	180.00	9,900
(5)	Earthwork in excavation for catch drain & construction of dowla	m3	22,400	76.60	1,720	76.60	1,720
(6)	Masonry terminal structure to inlet drain water to the river	nos	25	25,000	630	40,000	1,000
(7)	Sod facing on bank slope	m2	90,000	2.17	200	4.00	360
(8)	RBM dykes and core of sours with riverbed material	m3	1,200	68.90	80	180.00	220
(9)	Sod facing for catch drain slope	m2	40,000	2.17	90	4.00	160
(10)	Earthwork in excavation in gravel mixed soil for foundation of masonry terminal structures	m3	10,000	73.56	740	79.09	790
(11)	Cost of G.I. wire	kg	499,200		-	36.00	17,970
(12)	Transportation of G.I. wire from Dhangadhi by truck(up to 70 km) incl. loading and unloading	Rs/ kg	499,200		-	0.40	200
(13)	Installation of water level measurement with staff gages		3			10,000.00	30
*	Total direct construction cost				20,290		48,820
< Indirect construction cost >							
(14)	Administration expenses : 3% to direct cost				50		1,460
(15)	Engineering services : Survey, design, contracting : 7% of direct cost				170		3,420
(16)	Physical contingency : 10% of the total direct cost				600		4,880
*	Total indirect construction cost				820		9,760
** Grand total of direct and indirect costs					21,110		58,580

Note : Original estimate was made by Mahakali irrigation Project Office in 1991 and its unit prices are reviewed by this Study.

Table 5.5.1 WATERSHED CONDITIONS AND NUMBER OF DISTRICTS

Class	Evaluation	Numerical Value	Number of Districts Included in Each Class	Number of Districts in the Study Area
Class I	Excellent	less than 500	25	7
Class II	Good	500 - 1500	25	11
Class III	Marginal	1500 - 3000	13	4
Class IV	Poor	3000 - 4500	5	0
Class V	Very Poor	over 4500	7	2

Source : Shrestha, B.D. et al, Watershed Condition of Districts of Nepal, 1983.

Table 5.5.2 DISTRICTS IN ORDER OF WATERSHED CONDITION

	District Name	Value
1	Surket	5,118
2	Dang	4,944
3	Piuthan	2,341
4	Dolpa	1,990
5	Rukum	1,854
6	Dailekh	1,544
7	Baitadi	1,449
8	Salyan	1,294
9	Bajhang	1,159
10	Rolpa	1,144
11	Jajarkot	1,036
12	Doti	944
13	Darchula	823
14	Kalikot	812
15	Jumla	636
16	Banke	627
17	Bajura	623
18	Achham	471
19	Bardia	246
20	Dadeldhura	219
21	Kailali	170
22	Mugu	138
23	Humla	0
24	Kanchanpur	0

Source : Shrestha, B.D. et al, Watershed Condition of Districts of Nepal, 1983.

Table 5.5.3 HILL COMMUNITY FORESTRY DEVELOPMENT PROGRAMME
(Achieved)

Fiscal Year - 1990/1991

Programme (Activities)	Whole Country	Far-Western	Mid-Western
1. User's Group Initiation and Formation	680 Nos	116 Nos	29 Nos
2. Management			
2.1 Management Plan Preparation	1,485.83 ha	174.57 ha	0
3. Nursery			
3.1 Operation	542 Nos	98 Nos	24 Nos
3.2 Seedling Production	13,033,722 Nos	2,033,289 Nos	548,500 Nos
3.3 Seedling Purchase	894,773 Nos	98,075 Nos	0
4. Community Plantation			
4.1 Survey & Handover	1,533.4 ha	129.9 ha	100 ha Survey
4.1.1 Pitting	1,233.01 ha	135 ha	50 ha
4.2 Plantation	747.91 ha	105 ha	42 ha
5. Plantation Protection & Maintenance			
5.1 Weeding	2,855.73 ha	488.3 ha	228.2 ha
5.2 Replacement	498,477 Nos	49,744 Nos	54,000 Nos
6. Seeding Distribution for Private Forest Est.	2,262,559 Nos	210,000 Nos	46,456 Nos
7. Improved Stove Distribution	2,899 Nos	51 Nos	0
8. Demonstration Plot Operation	2 Nos	0	0
9. Training & Extension			
9.1 Workshop/Seminar (District/Ranger)	13 Nos	2 Nos	2 Nos
9.2 Training (Nursery Naike/Watchers)	16 Nos	3 Nos	2 Nos
9.3 Study Tour (CFA/User's Group)	7 Nos	0	0
10. Total Budget Expenditure (including Administrative Expenditure)	32,397,632 Rs.	5,026,439 Rs.	1,830,081 Rs.
11. Total Progress Achievement	76.38%	75.30%	54.49%

Source : HMG/DNDP/FAO Community Forestry Development Project, Annual Progress Report for 1990/1991

FIGURES

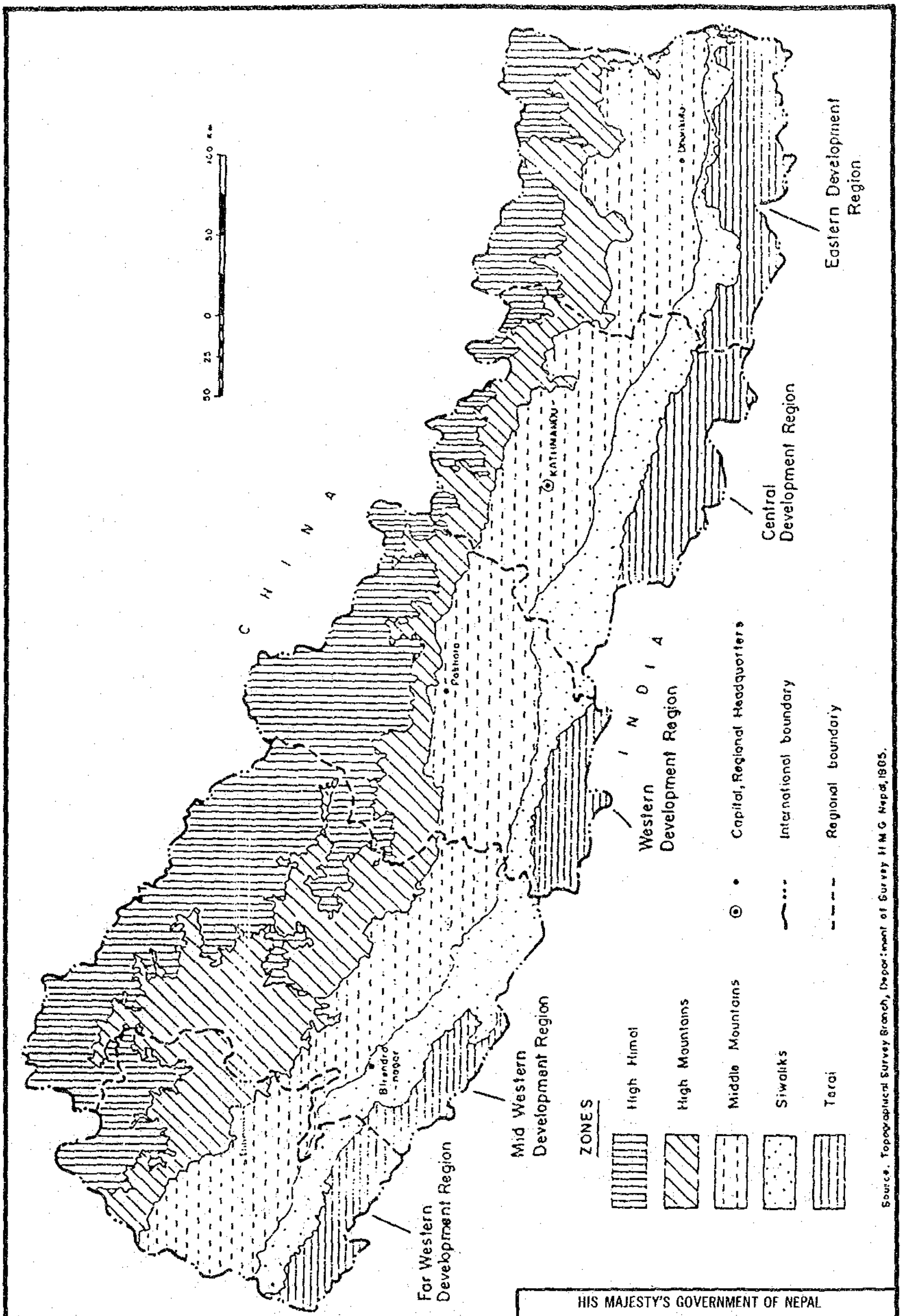

Figure 2.1.1 Physiographic Zones and Development Regions

HIS MAJESTY'S GOVERNMENT OF NEPAL WATER RESOURCES DEVELOPMENT OF THE UPPER KARNALI RIVER AND MAHAKALI RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY

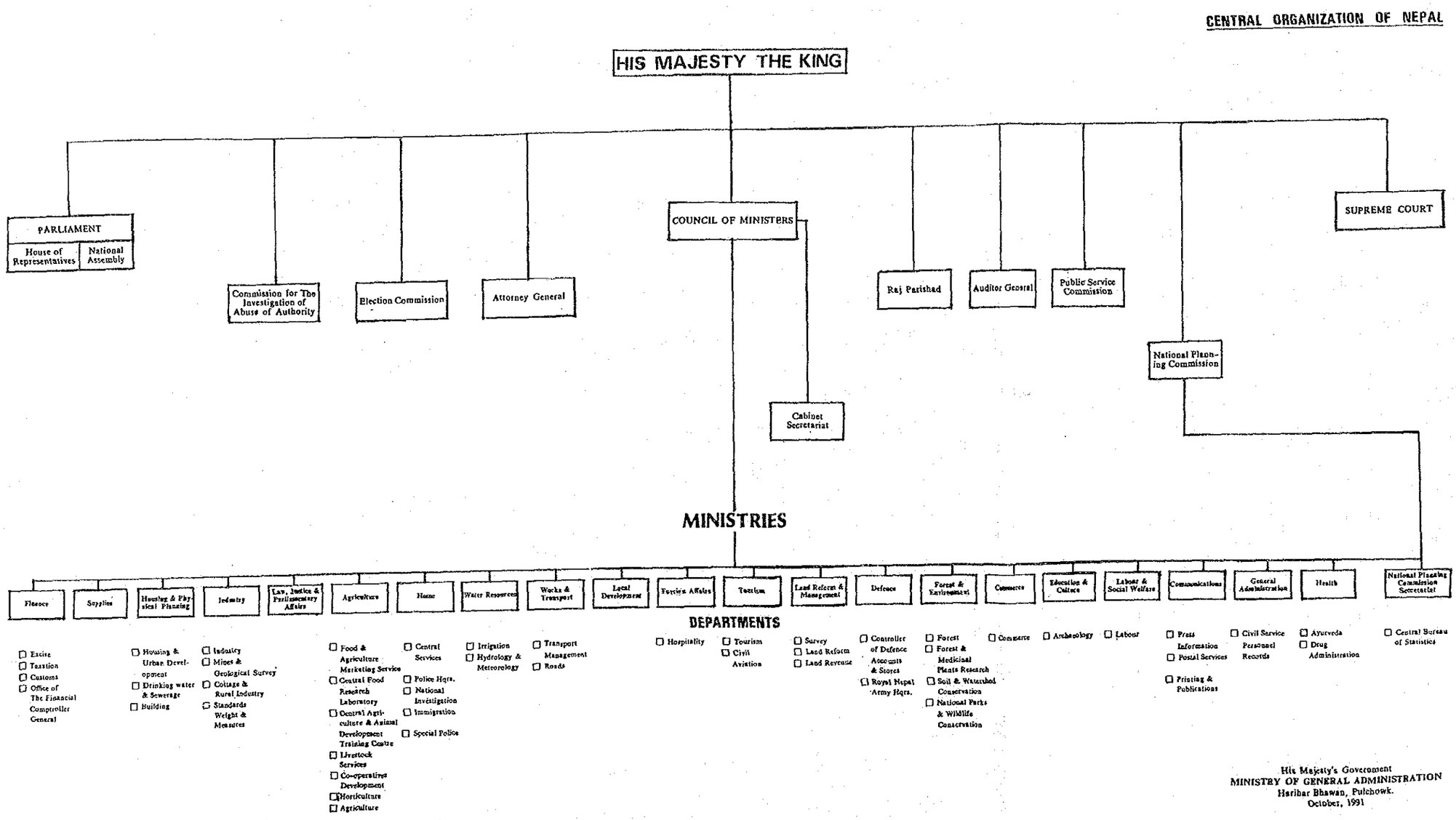

Figure 2.3.1 Organization Chart of Central Government

HIS MAJESTY'S GOVERNMENT OF NEPAL
WATER RESOURCES DEVELOPMENT OF
THE UPPER KARNALI RIVER AND MAHAKALI RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY

HIS MAJESTY'S GOVERMENT OF NEPAL

MINISTRY OF WATER RESOURCES

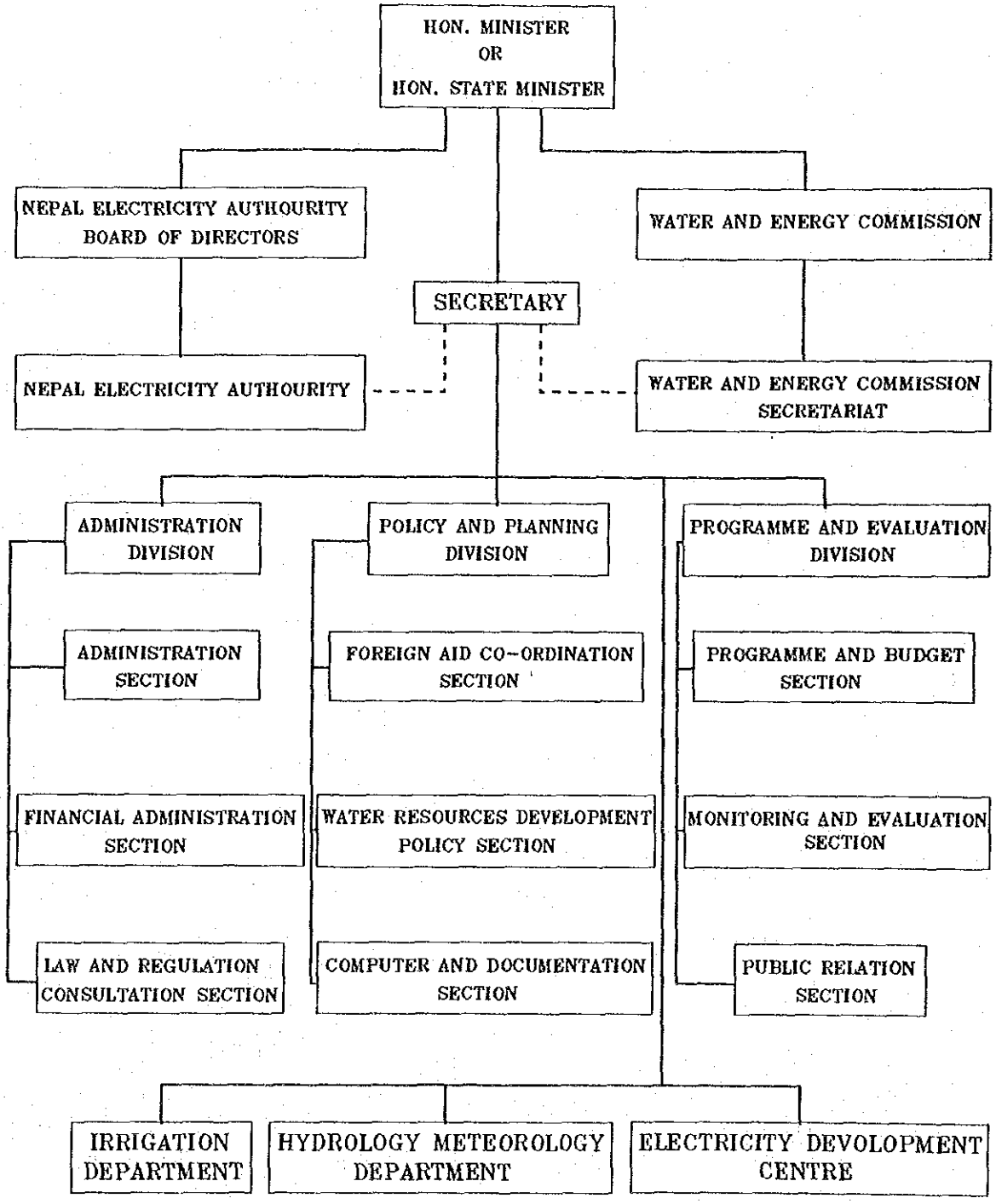

Figure 2.3.2 Organization Chart of Ministry of Water Resources

HIS MAJESTY'S GOVERNMENT OF NEPAL
WATER RESOURCES DEVELOPMENT OF
THE UPPER KARNALI RIVER AND MAHAKALI RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY

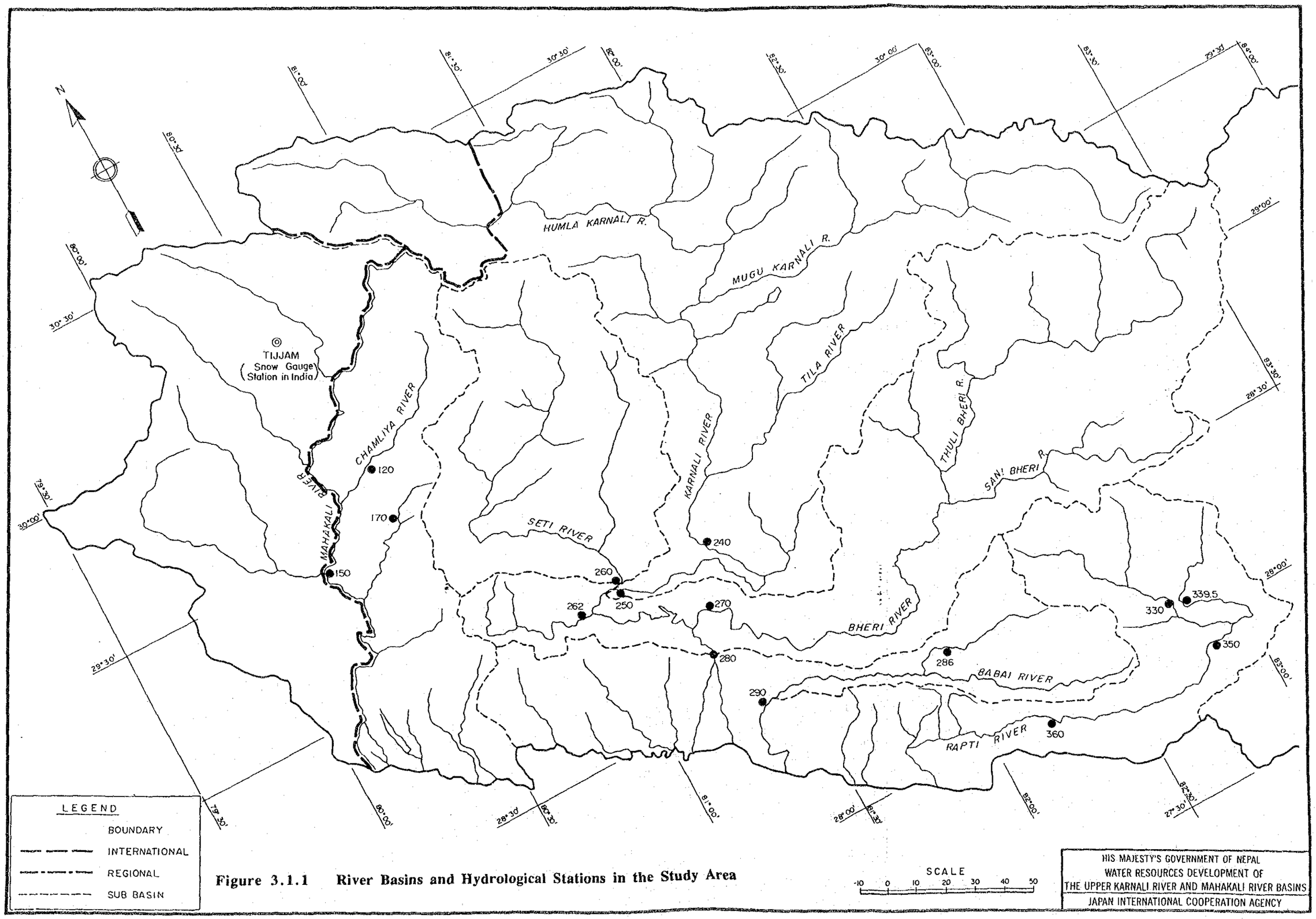

Figure 3.1.1 River Basins and Hydrological Stations in the Study Area

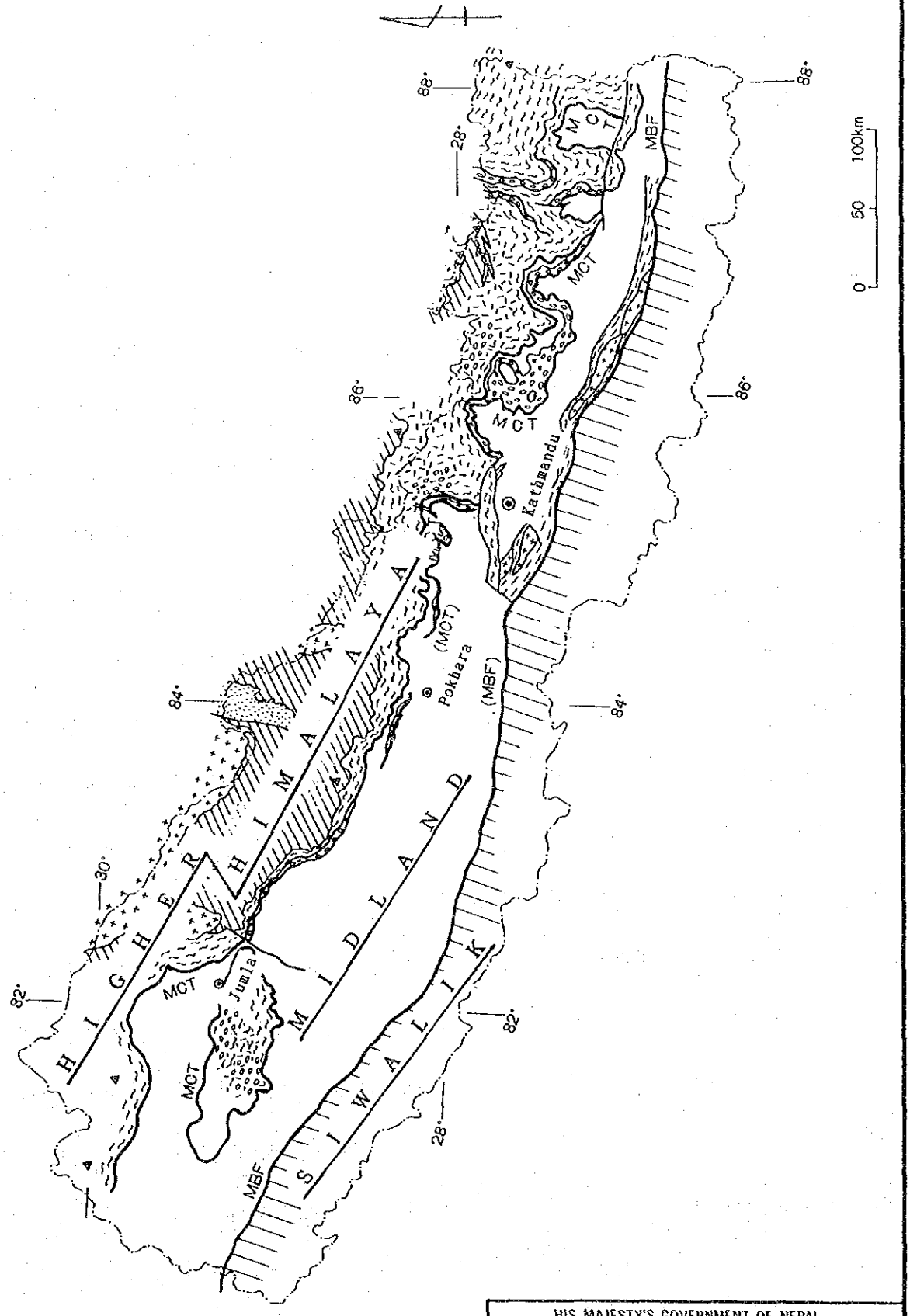

Figure 3.1.2 General Geologic Map of Nepal Showing the Three Zones

HIS MAJESTY'S GOVERNMENT OF NEPAL
WATER RESOURCES DEVELOPMENT OF
THE UPPER KARNALI RIVER AND MAHAKALI RIVER BASINS
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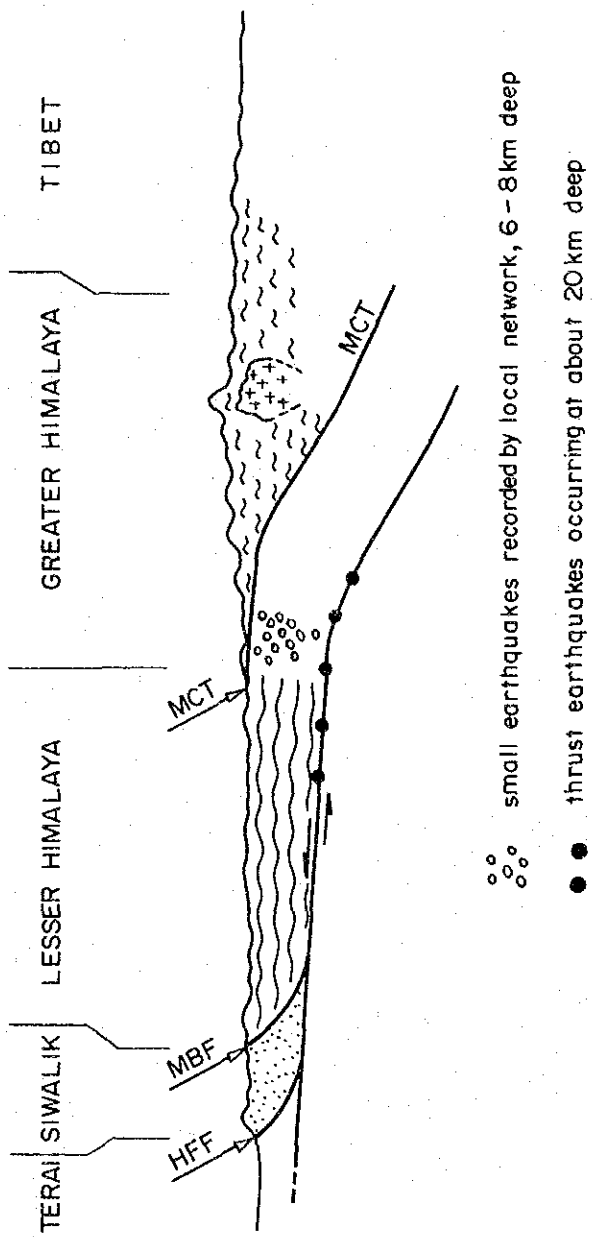

Figure 3.1.3 Schematic Geo-Structural Profile of Nepal

HIS MAJESTY'S GOVERNMENT OF NEPAL
WATER RESOURCES DEVELOPMENT OF
THE UPPER KARNALI RIVER AND MAHAKALI RIVER BASINS
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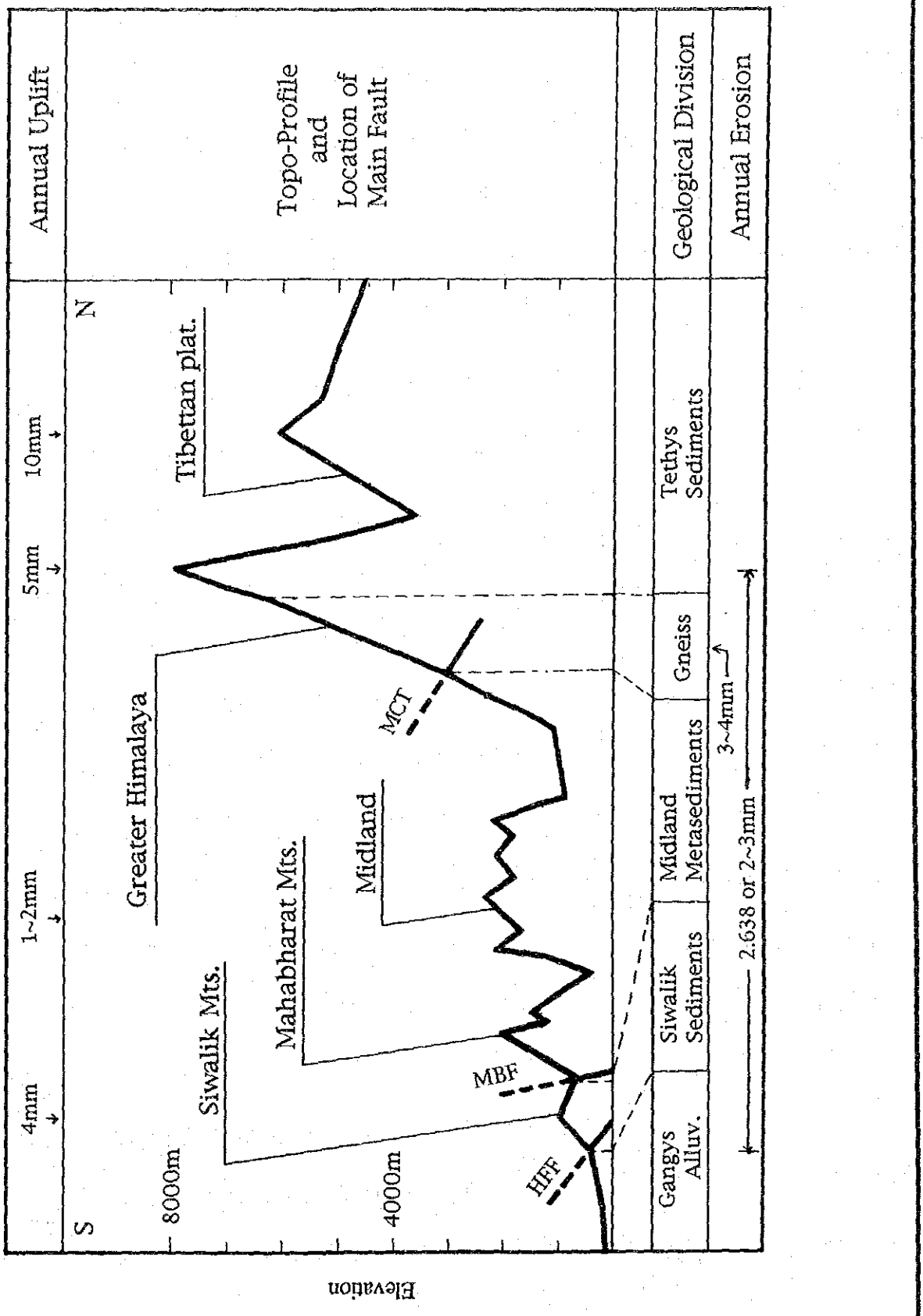

Figure 3.1.4 Schematic Profile

HIS MAJESTY'S GOVERNMENT OF NEPAL
WATER RESOURCES DEVELOPMENT OF
THE UPPER KARNALI RIVER AND MAHAKALI RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY

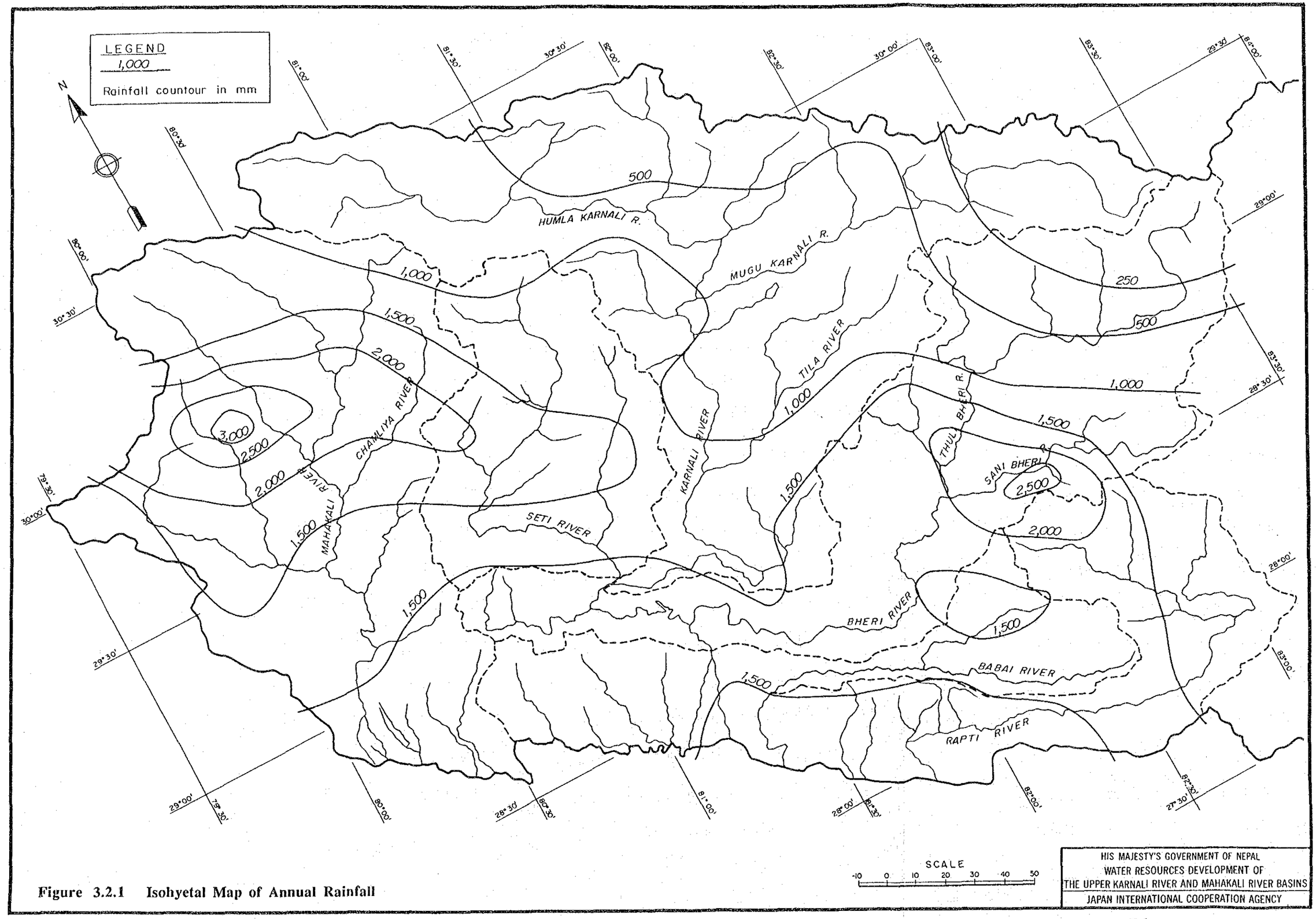

Figure 3.2.1 Isohyetal Map of Annual Rainfall

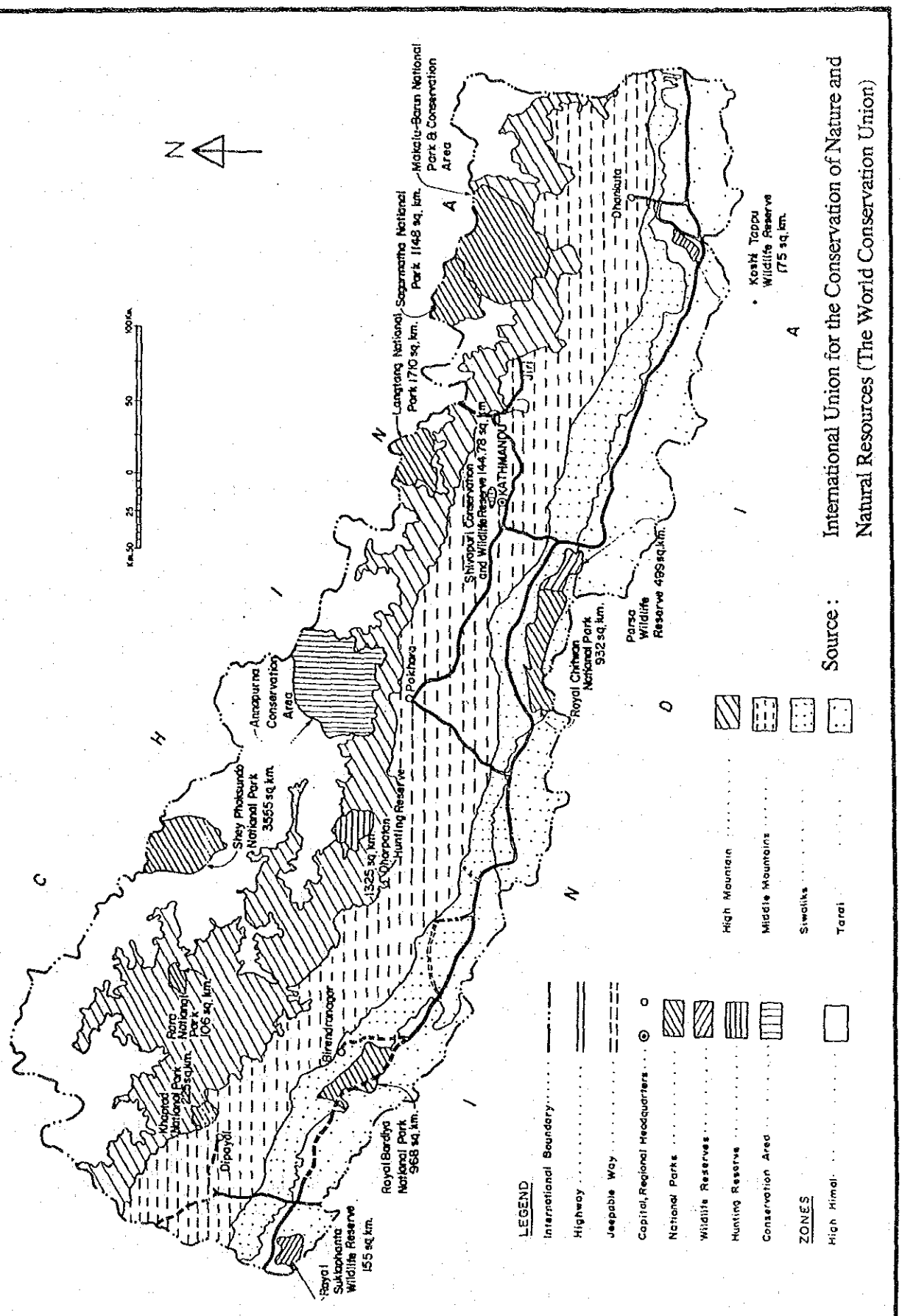

Figure 3.4.1
Protected Areas in Relation to the Physiographic Zone of Nepal

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WATER RESOURCES DEVELOPMENT OF
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Figure 4.1.1 Administration Division of the Study Area

HIS MAJESTY'S GOVERNMENT OF NEPAL
WATER RESOURCES DEVELOPMENT OF
THE UPPER KARNALI RIVER AND MAHAKALI RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY

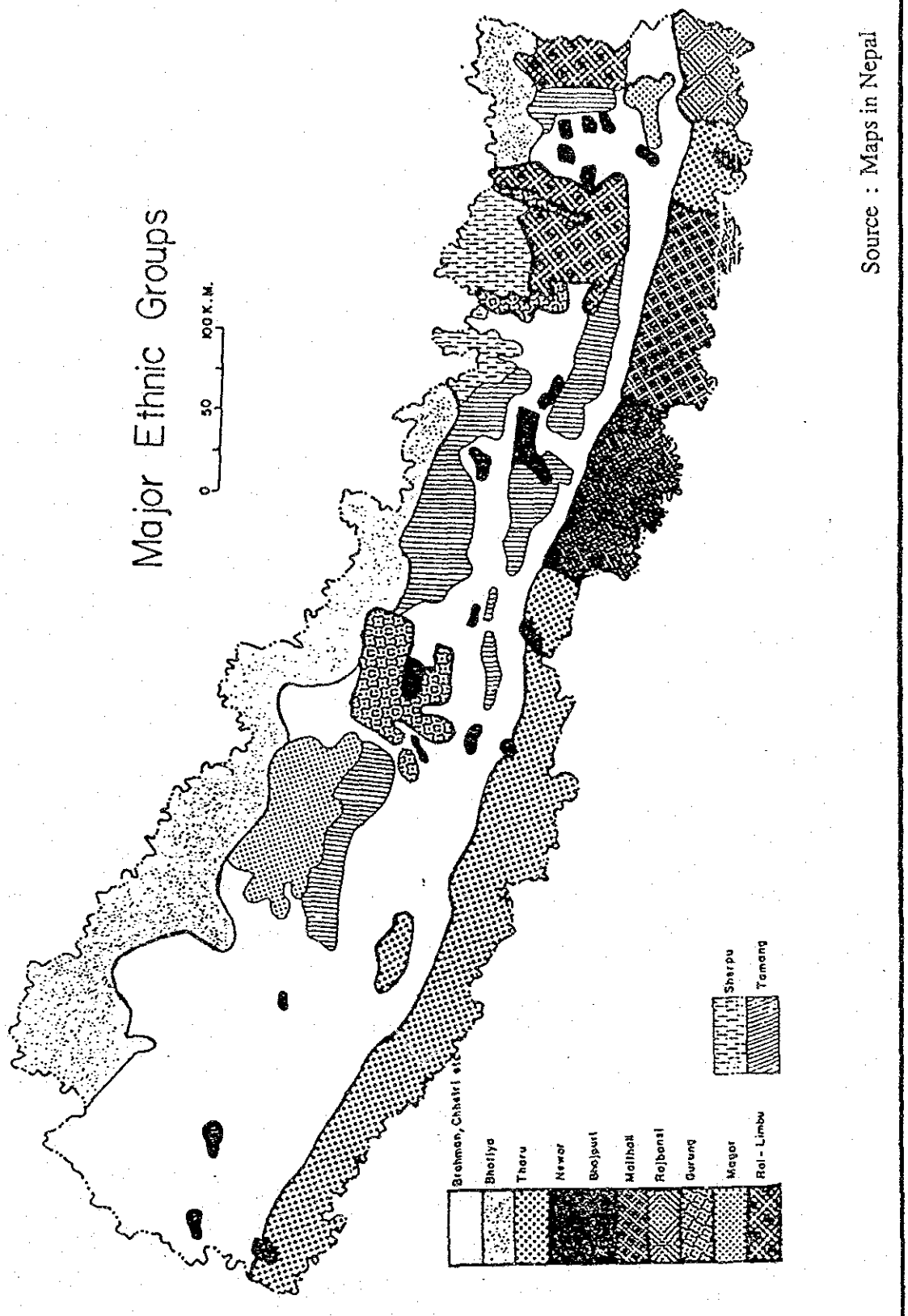

Figure 4.1.2 Major Ethnic Groups in Nepal and the Study Area

HIS MAJESTY'S GOVERNMENT OF NEPAL
WATER RESOURCES DEVELOPMENT OF
THE UPPER KARNALI RIVER AND MAHAKALI RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY

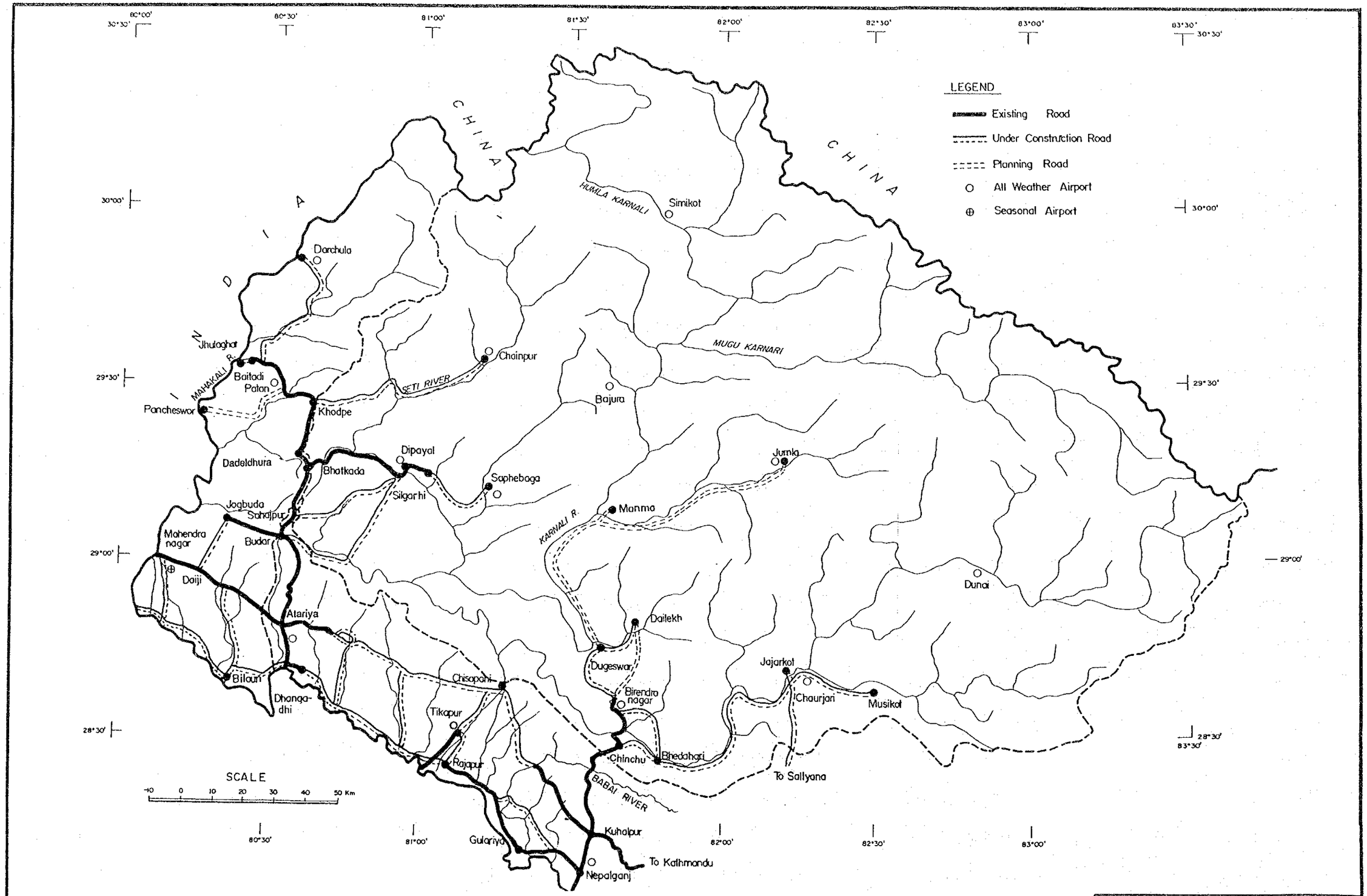

Figure 4.3.1 Road Networks and Airports in the Study Area

HIS MAJESTY'S GOVERNMENT OF NEPAL
WATER RESOURCES DEVELOPMENT OF
THE UPPER KARNALI RIVER AND MAHAKALI RIVER BASINS
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NEPAL

KM.40 20 0 40 80 120 160KM.

DADELDHURA
DIPAYAL SINGADHI
MAHENDRANAGAR
KANCHANPUR
DHANGADHI
DAILEKH
BIRENDRA NAGAR
GULARIA
KOHALPUR
TULSIPUR
NEPALGUNJ
GHORKI
LAMAHI
TANGHAS
DILI BAZAR
TANSEN
ANDIKHOLA P/S
DAMAULI
POKHARA
GORKHA
MARSYANGDI P/S
DEVIGHAT P/S
TRISULI P/S
JINK & LEAD MINE
DHUNCHE
NEW CHABEL
BHAKTPUR P/S
SUNKOSI
BUTWAL
SHIVAPUR
KRISHNA NAGAR
AMUWA
LUMBINI
BHAIRAHWA
SURAIPURA P/S
DUMKIBAS
BHAKTAPUR
SIACHUATAR
KULEKHANI NO1 P/S
KULEKHANI NO2 P/S
PATAN
DHULIKHEL
JIRI
KHOPASI P/S
HETAUDA
AMALEKHGUNJ
PURWANI PUR
SIMARA
BIRGUNJ
KALIYA
KATHERYA
GAUR
DHALKEBAR
MALANGWA
JALESWAR
JANKPUR
BISHNUPUR
RAJBIRAJ
LAHAN
DHANKUTTA
DHARAN
DUHUBI
BIRATNAGAR
KANAYAM
DAMAK
SHIVGURS
BHADRPUR
BHULABARI

LEGEND

- 132 KV Transmission Line
- 132 KV Transmission Line Under Construction
- 66 KV Transmission Line
- 66 KV Transmission Line Under Construction
- 33 KV Sub Transmission Line
- 33 KV Transmission Line Under Construction
- 33 KV Sub Transmission Line Under Planning

Note : As of August 1993, the 132 kV line between Kohalpur and Mahendranagar has been completed.

Figure 5.1.1 Transmission Line Network in Nepal

HIS MAJESTY'S GOVERNMENT OF NEPAL
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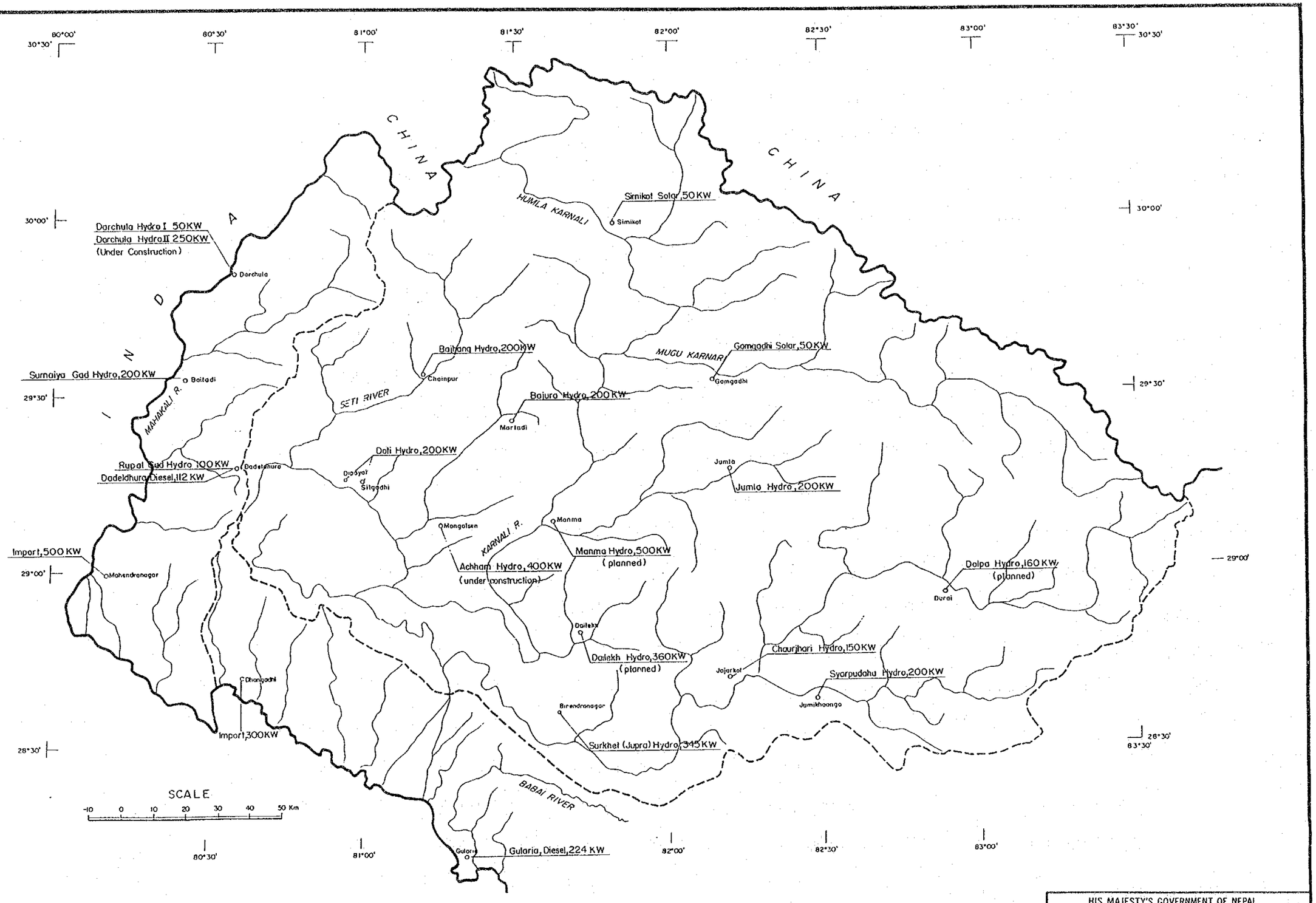

Figure 5.1.2 Rural Electrification in the Study Area

HIS MAJESTY'S GOVERNMENT OF NEPAL
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JAPAN INTERNATIONAL COOPERATION AGENCY

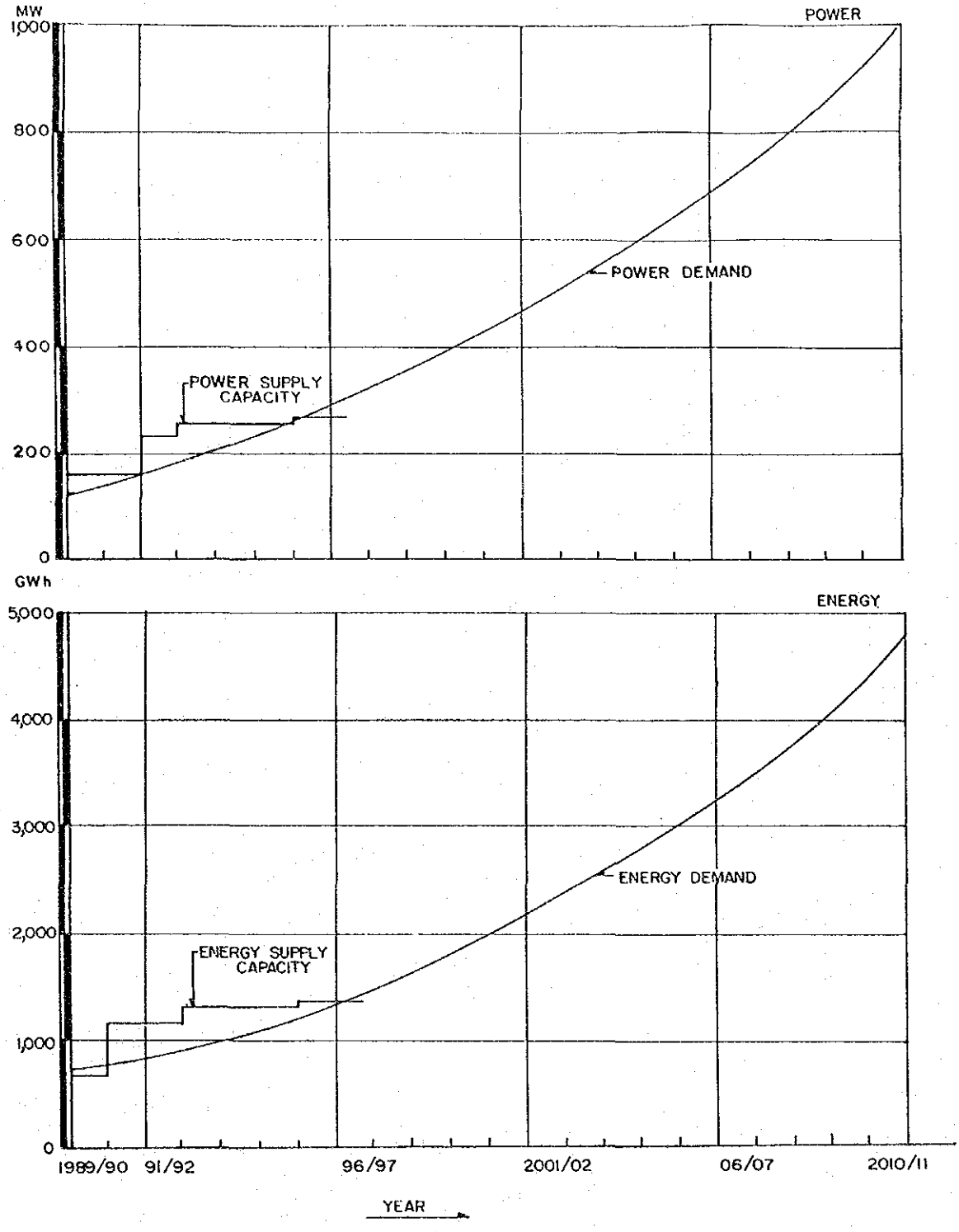

Figure 5.1.3 Relationship between Power Supply Capacity and Demand

HIS MAJESTY'S GOVERNMENT OF NEPAL
WATER RESOURCES DEVELOPMENT OF
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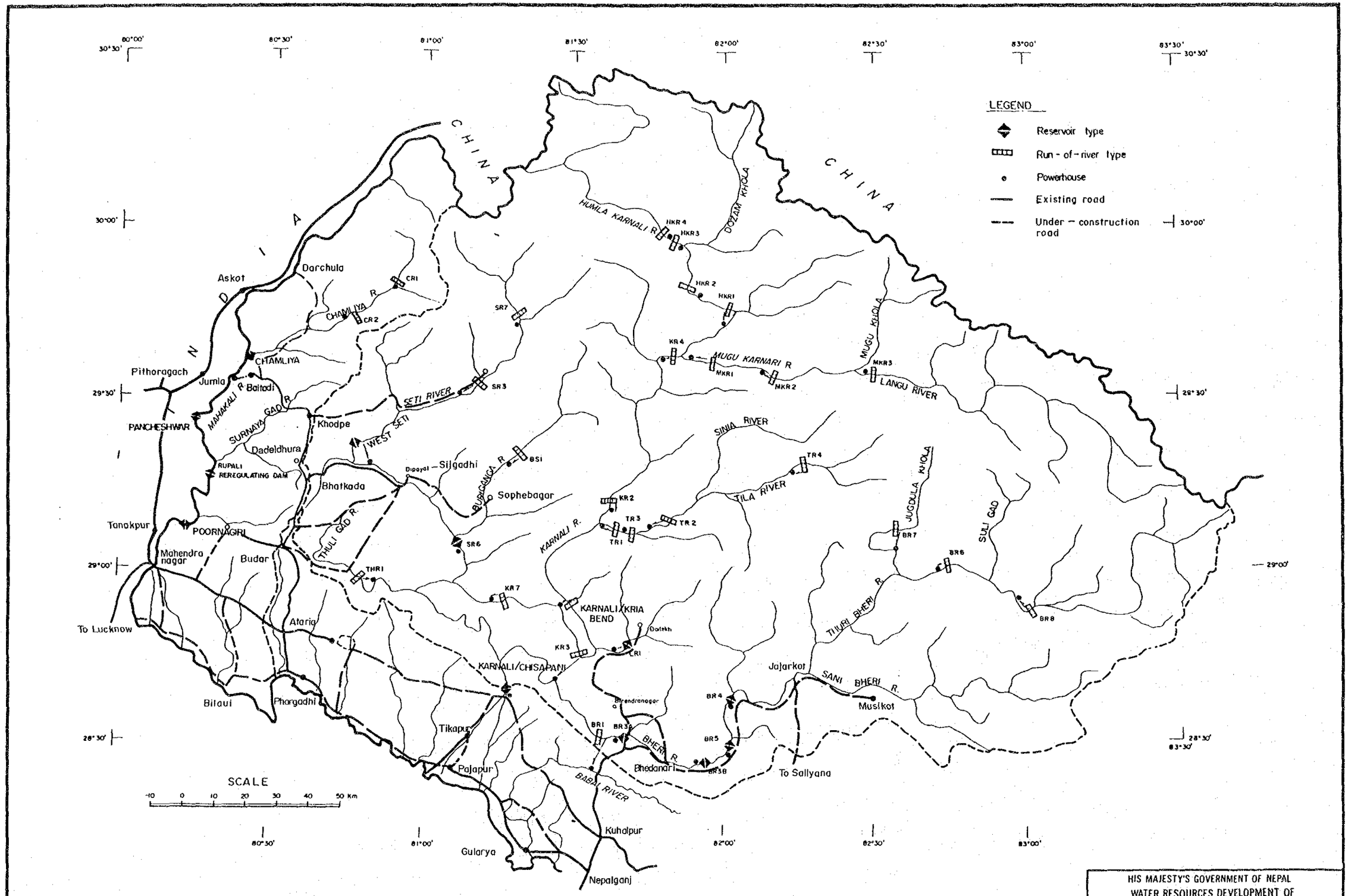

Figure 5.1.4 Hydropower Potential Scheme Sties

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