- India will construct (a) a head regulator of 1,000 cusec capacity near the left undersluice of the Tanakpur Barrage and (b) intake portion of a canal upto Nepal-India international borders for the supply of water upto 150 cusec to irrigate the land of 4,000 to 5,000 ha in the Nepalese side. Release from the head regulator will be increased when Pancheshwar storage proposed upstream, or similar, is developed in the Mahakali River.

- Regarding the supply of power to Nepal from the Tanakpur Power Station, both sides agreed that 20 million units would be supplied annually, free of cost, to Nepal. The modalities for the supply of energy shall be worked out.

2.3 Present Status of River Training Works

2.3.1 Institutional Status

River Training Division is responsible for river training and flood protection works under the Department of Irrigation (DOI) of the Ministry of Water Resources. Its major task is to plan and arrange national budget and other external financial resources or commodity grant aid for river training works in Nepal.

There are five Regional Irrigation Directorates, which are headed by a regional directorate and composed of a construction monitoring section, a planning design and feasibility section, mobile supervisory team, and river training and monitoring section. Their responsibilities are mainly for irrigation development including river training works. The regional irrigation directorate has District Irrigation Office (DIO) in each district. As for the river training works, DIO has responsibilities of collecting river training requests, preparing necessary budget and executing river training works.

Villagers usually report river problems to DIO. Upon requests, engineers of DIO visit the site and judge whether the required river training works are able to be directly undertaken by villagers or done by DIO. When DIO judges that the river training works be done by itself, DIO prepares necessary budget and applies it to Regional Irrigation Directorate. Regional Irrigation Directorate collects budgetary requests from all DIOs and issues an annual river training programme to River Training Division for its approval. Some important and large scale ones, requiring relatively high budget, are undertaken as part of a central level project such as Mahakali Irrigation Project.

2.3.2 Types of River Training Works

A variety of river training works in Nepal includes revetments made of riprap or gabion, gabion spurs, retarding structures made of steel or timber members, levees and guide banks. Although the construction records of past river training works are not well reported to the central level, revetment made of gabions, that are filled with boulders and wrapped with iron wire, to reduce riverbank erosion is the most popular works. These gabion revetments are comparatively less expensive and can be constructed by using local materials and semi-skilled labours without heavy equipment. Gabion spurs are also popularly applied to deflect river flows away from eroding riverbanks at floods.

Galvanized iron wire (G.I.wire) for gabions has been distributed since 1988/1989 to DIOs under Commodity Grant by Japan in the five-year period to 1992/93. According to DOI, the quantity of weight of G.I.wire received from Japan totalled 18,104 ton as follows:

Unit : metric ton

Fiscal year	Weight of G.I.wire received from Japan
1988/89	5,222
1989/90	5,266
1990/91	2,555
1991/92	2,539
1992/93	2,522
Total	18,104

G.I.wire has been supplied to villagers free of charge upon their requests. However, costs required for the transportation of gabion wire, crating boulders and installation of gabions are under the budgetary constraint. In remote areas, the difficulty in transportation of G.I.wire has delayed the progress of river training works especially in the hill area.

2.3.3 Criteria of Design Floods for River Training Works

Two design manuals for river training works were prepared by WECS in order to provide a standardized design process for use by various government departments as well as by local consultants. One is " General Design Guidelines for River Training in Nepal " (Ref. VII-5) and the other is " Design Manual for River Training Works in Nepal" (Ref. VII-6).

The design manual includes the following design criteria for bank protection against erosion and flood protection with embankment as tabulated below:

Structure/ Purpose	Return period of design flood (years)
Bank protection against erosion	
- major , valuable property, potential loss of life	100
- minor	25 to 50
Flood protection with embankment	
- major , valuable property, potential loss of life	100
- minor	25

The design criteria for other structures are summarized in Table 2.3.1. Most of minor river training works are, however, designed to protect a limited area from floods in an experimental manner due to lack of hydrological data.

3 RIVER PROBLEMS AND RIVER TRAINING WORKS IN THE STUDY AREA

3.1 Present Status

(1) Institutional status

There are two Regional Irrigation Directorates controlling DIOs in Mid Western Development Region and Far Western Development Region. The former is located at Birendranagar in Surkhet District and the latter at Dhangadhi in Kailali District.

The Regional Irrigation Directorate is organized by a regional director, technical engineers, administrative officers and others. DIO is led by a senior divisional engineer, divisional engineers, oversees, assistant engineers, administrative staff and others. The Surkhet Regional Directorate, for example, has 80 staff and the Surkhet DIO has 25 staff, of which detailed staff component is shown in Table 3.1.1. A three-member committee, composed of a chief of DIO, an officer of District Administrative Office and an officer of District Development Board or Committee, holds meetings regularly, and request of river training works to the Regional Irrigation Directorate is also discussed.

The flood damage record and information required for planning of river training works have not well been accumulated so far. The reasons include

- difficulty of access to the site,
- lack of budget for surveying flood damage-prone areas by DIO,
- insufficiency of river topographic surveys,
- no installation of hydrological gauging equipment, and
- lack of standardized flood damage and flood problem reporting forms.

In October 1991, His Majesty's Government of Nepal (HMG/N) and the Government of Japan (GOJ) agreed that Water Induced Disaster Prevention Training Centre (DPTC) be established as a joint undertaking of concerned agencies of HMG/N with MWR as a leading agency, and GOJ would cooperate through JICA for the initial five years from

the date of the agreement. The objective of DPTC is to strengthen the capability of HMG/N to cope with water induced disasters through technical development, provision of training and establishment of data base. At present, DPTC has started its operation in the field of (a) Sabo (watershed management with emphasis on erosion control), (b) landslide prevention and (c) river training works.

(2) Financial status

The budget for river training works requested by districts of the Far Western and Mid Western Development Regions in 1990/91 is obtained from the River Training Division as shown in Table 3.1.2. This Table shows that the total requirement in 1990/91 was Rs. 29.4 million, of which the composition was 31 % for the nine districts located in the hill area and the remaining 69 % for three districts in the Terai area. The budget requested by each district in the hill area ranges from Rs. 0.2 to 0.8 million, which is a less amount compared to that in the Terai area.

Tables 3.1.3 to 3.1.5 show the allocation of district-wise expenditure for irrigation development under the Department of Irrigation for the three-year period, 1989 to 1991. In 1989, the expenditure for the river training works in Far Western and Mid Western Development Regions is reported at Rs. 2.9 million and Rs. 8.2 million respectively. In 1990 and 1991, the data on the expenditure for the river training works are not available, since it is included in the total expenditure for the irrigation development. It is reported that some DIOs have not received any budget in 1990 and 1991 in spite of requests, and the budget is not enough to carry out the required river training works.

(3) Flood damage records

Damage caused by floods or landslides is surveyed by District Headquarters Office and reported to Natural Disaster Relief Division of Ministry of Home. The damage records composed of such issues as the number of incidents and loss of lands of each district in Far Western and Mid Western Development Regions for the three-year period from 1989 to 1991 are shown in Tables 3.1.6 to 3.1.8 respectively.

(4) Progress of river training works

The weight of G.I.wire consumed for the river training works and the estimated length of river training works by district for the three-year period from 1988 to 1990 are shown in Table 3.1.9 and summarized below:

Summary of progress of river training works in Study Area from 1988 to 1990

Items	Unit	Quantity
- Total estimated length of river training works in the Mid Western and Far Western	m	19,600
: In the hill area	m	(3,400)
: In the Terai	m	(16,200)
- Total weight of G.I.wire consumed	ton	2,600
: In the hill area	ton	(800)
: In the Terai	ton	(1,800)

The above Table reveals that two thirds of the total G.I.wire have been consumed for the river training works in the Terai.

3.2 Existing Major River-related Structures

Existing major river-related structures in the Study Area are mentioned below.

(1) Barrages

There are two barrages in the Mahakali River, i.e. Sarda Barrage and Tanakpur Barrage. Since both the barrages have no flood regulating capacities and the spillway gates are fully opened at floods, no regulating effects are expected.

Sarda Barrage was constructed in 1928 by India 70 km downstream of Pancheshwar in the Mahakali River, consisting of a barrage with a crest length of 600 m having a maximum design discharge of 17,000 m^3/s, afflux bunds on both sides, and two diversion intakes for irrigation canals on the left bank in India and the right one in Nepal.

The 120 MW Tanakpur Hydroelectric Project is of a run-of-river type, being constructed by India nine km upstream of Sarda Barrage near Manarkot village. It involves construction of a 475 m long barrage, diversion of river water on the right bank through a channel to a powerhouse at Banbassa, and release of water through a

tailrace just upstream of Sarda Barrage. Tanakpur Barrage consists of 13 weir bays and nine under-sluice bays with a maximum discharge capacity of 19,900 m^3/s.

(2) Bridges

There are two large bridges on the road between Nepalganj and Birendranagar crossing the Babai and Bheri rivers. A large bridge is being constructed at Chisapani spanning over the Karnali River. There are a number of suspension bridges for footpath crossing the rivers in the hill area. On the East-West highway, tens of new bridges are being constructed between Mahendranagar and Chisapani, and some of them were already completed. It seems that there is much risk of damage of bridge piers due to scouring around its abutment.

(3) Irrigation facilities

A diversion weir named the Babai Diversion is being constructed in the Babai River. It is a concrete weir having a canal intake on the left bank with a settling basin. There are a number of minor scale irrigation intakes and canals. Such irrigation intakes are prone to be damaged or swept away by floods. Flood waters sometimes intrude the irrigation canals to cause inundation of agricultural land. In the hill area, small mills to mill cereals by harnessing hydro potential are also prone to be destroyed by floods.

3.3 River Problems in the Hill Area

As the results of the inquiry surveys, locations totalled 48 in number are identified as areas prone to flooding or riverbank erosion as plotted in Figures 3.3.1 to 3.3.13. Tables 3.3.1 to 3.3.21 show the information collected regarding the type of river problem, recent flood damage record and river training works constructed or required to be constructed. Primary river problems in the hill area are categorized as below:

Category of river problems	Number of locations
- Riverbank erosion	39 (58%)
- Inundation of cultivated lands	18 (27%)
- Contraction of river channels by deposition of land slide material	10 (15%)
* Total	67 (100%)

Note : In the above Table, 19 locations have multiple river problems, e.g. riverbank erosion with inundation.

Riverbank erosion is the most common river problem, and the total length of the riverbank prone to erosion is reported to be about 56 km. Inundation problems in the hill area form a smaller proportion than those in the Terai area, since most of cultivated areas are positioned at higher levels. Flood waters intrude into irrigation canals, causing inundation of lands. Damages caused by landslide are typical river problems in the hill area. Landslides sometimes occur along river channels due to intensive rainfall or scouring of toe portion of slopes by floods. Landslide material deposits to block river channels and decreases its discharge capacities. Decrease in discharge capacities often causes inundation of lands. Contraction of river channels leads to deflection of river flows, followed by erosion of the opposite side of riverbank.

No information has been made available at Humla, Mugu, Jumla and Dolpa districts since the District Irrigation Offices have been closed during the winter season and no engineers are present. Although the inquiry sheets were sent to those District Irrigation Offices through Regional Irrigation Directorate in the Phase II investigation period, their answers were not returned to the Study Team.

3.4 River Problems in the Terai Area

3.4.1 Dodhara and Chandani Areas along the Mahakali River

(1) Dodhara and Chandani areas

There is a flood-prone area in Kanchanpur District named Dodhara and Chandani areas some seven km downstream of Sarda Barrage. Dodhara and Chandani areas are encircled by the Mahakali River in the east and by the Jogbudha River in the west as shown in Figure 3.4.1.

A total land area is estimated to be some 5,000 ha, of which some 70 %, or 3,300 ha, is farm land at present. The agricultural land is fertile, and half of crop yield in Kanchanpur District is reported to be produced from this area. The total population in 1992 is estimated to be some 55,000 persons.

(2) Recent flood damage records

After flowing into the Terai area, the Mahakali River swings its course in a braided or meandering pattern without forming fixed river channels. The northern part of the left bank of the Mahakali River is adjacent to the Mahakali Irrigation Project Stage I command area. The southern part of the left bank forms a western boundary of the Shukla Phanta Reserve Forest. Erosion of the right bank is a serious problem. The Mahakali River has shifted its right bank by some 1,200 m towards Dodhara and Chandani areas during the 21-year period from 1965 to 1986 as shown in Figure 3.4.1, resulting in loss of 2,700 ha of land. The reduction of the area is tabulated below and plotted in Figure 3.4.2:

Year	Area (ha)	Loss of area (ha)	Annual average erosion rate (ha/year)
1965	7,670	-	-
1973	5,880	1,790	220
1986	4,950	930	70

In addition, some 25 % of the agricultural land area suffers from inundation in the monsoon period regularly. The recent severe flood damage was recorded in June 1981 with a peak discharge of some 11,000 m^3/s. The right bank was breached and some 12 houses in Chandani village were swept away. Another large flood occurred in August 1989 with a record of some 10,507 m^3/s at the Banbassa gauging station. This flood also breached the right bank some 200 m downstream of the 1981 flood breaching point, causing heavy damage. Such locations frequently prone to inundation are shown in Figure 3.4.1. It is noted severe flooding was caused by the torrential rainfall occurred in September 1993 in the Terai area of the Mahakari River basin.

(3) Flood mitigation works proposed to date

A proposal of the river training works for the areas was prepared in September 1991 by Mahakali Irrigation Project Office. It proposes to protect the 24 km long riverbank by such measures as spurs and bank pitching. The planned Pancheshwar Project is expected to mitigate inundation problems by creating a reservoir with a total volume of 6,800 million m^3.

3.4.2 Rajapur Area along the Karnali River

(1) Rajapur area

The Karnali River, as shown in Figure 3.4.3, bifurcates its river course at Chisapani, the Kauriyala River in the west and the Geruwa River in the east, making an alluvial fan of some 15,000 ha. The area is called Rajapur area, which is almost used as cultivated land. The Karnali River has shifted its main stem eastward from the Kauriyala River to the Geruwa after the 1983 flood due to a huge volume of sediment deposition in the river course downstream of Chisapani. River banks along the Kauriyala and Geruwa rivers are prone to erosion. According to the socio-economic survey by Agricultural Projects Service Centre in 1989, the total population and the number of households were estimated at 67,027 and 7,637, respectively.

(2) Recent flood damage records

This area is prone to flooding every year. Since no flood control structures have been constructed other than a number of minor gabion works, flood waters intrude into six irrigation canals and frequently inundate the agricultural area with a depth of 0.5 to 1.0 m. The 1983 flood with a peak flow of 21,700 m^3/s recorded at the gauging station No. 280 (Chisapani) was largest in the records for the last 25 years since 1962, which corresponds to a return period of 1 in about 150 years. The flood damages caused by the 1983 flood were studied in the feasibility study of the Karnali (Chisapani) Multipurpose Project, counting the inundation of 7,200 ha, which corresponds to about 35 % of the total cultivated land area as shown in Figure 3.4.4. It is estimated that death toll reached 35 to 40 people. Figure 3.4.5 also shows the inundated area of the 1988 flood with an estimated peak discharge of 11,900 m^3/s.

(3) Flood mitigation works proposed up to date

< Karnali Multipurpose Project >

A feasibility study of this project including the construction of a 270 m high dam was completed in 1989. This project is expected to bring flood mitigation effects to the downstream Terai area as well as flood-prone areas in India by creating a reservoir with a live storage of 16,200 million m^3, which corresponds to some 37 % of average annual runoff. Process to the further stage is under discussion.

< Rajapur Irrigation Rehabilitation Project >

A feasibility study was carried out under the technical assistance of ADB and completed in September 1990, aiming at rehabilitation of the existing irrigation system in the Rajapur area. The implementation of the project is expected to commence under the financial assistance of ADB in 1992. The Project includes such flood mitigation works as plug of all irrigation intakes, which caused flooding except for the Budi Kulo intake, embankments along Budi Kulo, raising the bank of approach channel and river bank protections. Although some flood mitigation alternatives are proposed, neither of the alternatives aims to complete control of floods. The structures are proposed in a manner to be re-constructed by farmers when damaged by floods.

< Karnali River Training Works >

A short report of the Karnali River Training Works was prepared by the Mid Western Regional Irrigation Directorate in 1983. The target area of the river training works covers the same area as that of the Rajapur Irrigation Rehabilitation Project. These works aim at flood mitigation by the construction of conventional river training structures such as spurs, revetments and levees at the places where immediate treatments are required.

3.4.3 River Problems of Other Rivers

There are a number of rivers lying between the Mahakali and Karnali rivers. Rivers originating from the southern slopes of the Siwaliks are characterized by high flash flow in the monsoon season, whilst a considerable number of dry river channels are observed in the dry season. Among them the Mohana, Donda, Kanara and Chaumala rivers are primary rivers causing riverbank erosion or inundation, of which locations are plotted in Figures 3.4.6 and 3.4.7.

Tributaries of the Mohana River originate on the southern slope of the Siwaliks and merge to its main stream downstream of the East-West highway. The main stem of the meandering Mohana River changes its river course estward near Dhangadhi and runs along the international border with India. It increases discharges by gathering river flows of such rivers as the Kanara River and meets the Kauriyala River.

There are two primary river problems along the Mohana River but no protection works have been constructed so far. One is the erosion on scattered locations along the left bank between Dhangadhi and the confluence point of the Kauriyala River, although the right bank in

the Indian territory is well protected by embankment. The other is the inundation of the area near Dhansinghpur village in Kailali District just upstream of the confluence with the Kauriyala River due to less discharge capacity of the river. This inundation is also reported to be caused by backwater effect of the Indian barrage located some 20 km downstream of the confluence point, which is being discussed between Nepal and India.

3.5 Influence of Flooding to India and Bangladesh

The Ganges River originates from the Gongotri glacier in the Himalayas near the India-China international border. The river flows initially in a south-easterly direction and changes its direction eastward in the lower reach to join the Yamuna River at Allahabad in the state of Uttar Pradesh as shown in Figure 3.5.1. The Mahakali River changes its name in the Indian territory to the Sarda River and the Karnali River to the Ghaghara River after crossing the southern India-Nepal international border, both of which join together and form the Great Ganges. The Great Ganges runs in the India plain and enters Bangladesh after joining the Gandaki and Kosi rivers. The influence of flooding of the Karnali and Mahakali rivers to India and Bangladesh is reviewed in this Study.

(1) Influence of flooding to India

The area liable to floods in India is broadly divided in four regions: (a) Ganga-Brahmaputra, (b) North-West, (c) Central India and (d) Deccan regions as shown in Figure 3.5.2. The Ganga-Brahmaputra region, including the states of Uttar Pradesh and Bihar, accounts for a large portion of flood-prone area in India as shown in the following Table:

Unit : Million ha

Name of state	Area of state	Flood prone area	Area protected up to March 1985
Uttar Pradesh	29.44 (100%)	7.34 (24.9%)	1.37 (4.7%)
Bihar	17.30 (100%)	4.26 (24.6%)	1.84 (10.6%)
India in total	328.78 (100%)	34.64 (10.5%)	13.01 (4.0%)

Source : " Flood Atlas of India, 1986 " by Central Water Commission, Ministry of Water Resources, Government of India

An international flood control programme was launched in 1954. According to the Flood Atlas of India (Ref. VII-7), an area of about 13 million ha has been provided with some protection works as of the end of March 1985, which is about 40 % of the area prone to floods in India. The flood-prone area in Uttar Pradesh, however, has not been well protected to compare with the lower reaches of the Ganges River in the state of Bihar.

According to the Feasibility Study of the Karnali Multipurpose Project, an area of 2,000 to 3,000 km^2 was partially flooded and waterlogged during the 1972 flood. An instantaneous discharge of some 14,000 m^3/s was recorded at Chisapani. The 1972 flood covered about 30 % of this total area along the Ghaghara River extending at least 130 km from the Nepal-India international borders as shown in Figure 3.5.3. It has been stated that most of this area is now protected with dikes by India and all of this area would be protected against floods up to a 50-year return period by the year 2000. The planned Karnali Multipurpose Project is expected to still provide flood control effect against floods larger than a 50-year return period.

Flood forecasting divisions totalling up to 22 and 145 flood forecasting sites have been set up in India by 1985. Out of them, eight forecasting divisions and 24 flood forecasting sites have been provided along the Ganges River. The implementation of a flood forecasting and warning system between the two countries is under process.

(2) Influence of flooding to Bangladesh

Most of Bangladesh is located within the flood plains of the three rivers, i.e. the Ganges, the Brahmaputra and the Meghna, of which the principal features are summarized below :

Name of river	Total catchment area (km^2)	Max. discharge in 1988 flood (m^3/s)	Mean annual discharge (m^3/s)	Name of stream gauging station
- Ganges	900,000	72,300	11,700	Hardinge Bridge
- Brahmaputra	580,000	99,500	12,900	Bahadurabad
- Meghna	77,000	19,800	3,500	Bhairab Bazar

The total catchment area of the Karnali and Mahakali rivers in Nepal territory is about 58,150 km^2, which corresponds to only four percent of that at the Goalundo stream gauging station located downstream of the confluence point of the Brahmaputra and Ganges rivers in Bangladesh.

The discharges of the Ganges and Brahmaputra rivers normally start increasing in April, reach peaks in August and last until October as shown in Figures 3.5.4 and 3.5.5 as well as those of the Karnali and Mahakali rivers. During the 1988 flood, the maximum discharge of the Brahmaputra River corresponded to a 100-year return period flood, and the Ganges River reached its peak discharge, a 40 year-return period flood, three days later. At the Goalundo stream gauging station, the maximum discharge of 132,000 m^3/s was measured. In the same flood period, the Karnali River recorded the peak discharge of 11,000 m^3/s at the gauging station No. 280 and the Mahakali River 4,079 m^3/s at the gauging station No. 150. Judging from the above, the flooding on the Karnali and Mahakali rivers constitutes a relatively small proportion of the total flood discharge in Bangladesh.

Besides the above, the Karnali multipurpose reservoir will be operated primarily for power generation and irrigation by storing runoff discharge in the rainy season. The 1988 flood in Bangladesh had a peak discharge of about 140,000 m^3/s or a total volume of about 50,000 million m^3 during the high flow period lasting for six days in September. The Feasibility Study of Karnali Multipurpose Project analyses that the Karnali reservoir will be able to hold back only about 12,000 to 18,000 m^3/s-day, or 1,000 to 1,500 million m^3 of water, which is small compared with the total flood water volume.

Judging from the above, it is found that the flood mitigation in Bangladesh will not be attained by the flood mitigation measures in the Karnali and Mahakali river basins. Much more comprehensive measures in all the river basins flowing into Bangladesh are necessary. From such a viewpoint, it is noted that Bangladesh has requested Nepal and India to join in the discussions on the solution of water distribution and flood management problems in the entire Ganges River basin. However, this has so far remained a bilateral subject between India and Bangladesh.

4. PRELIMINARY RIVER TRAINING WORK PLAN IN THE HILL AREA

4.1 Basic Concept

There have been only limited surveys of river training works in the hill area mainly due to the following two reasons, i.e. (a) lack of budget for surveying and (b) difficulty in access to the site for engineers of District Irrigation Offices. Such insufficient information has made it difficult to prepare a proper flood mitigation plan not only for the River Training Office but also for Regional Irrigation Directorate and District Irrigation Offices. In this Study, a preliminary river training work plan is, thus, prepared to aim at giving priority to river training work schemes out of the identified areas prone to flood damage. Priority is given to such areas where flood damages were judged serious, and that the past flood damage, the length of riverbank to be protected and types of river training works have been already surveyed by District Irrigation Offices.

Although minor river training works in the hill area are actually constructed by inhabitants with voluntary tasks, the areas given priority are judged to be too large to be done by voluntary labour. Therefore the construction cost of river training works for each area is estimated on a local contract basis. The unit price of each work item is referred to that applied, at present, for the existing river training works under the Mid Western Regional Irrigation Directorate.

4.2 Preliminary River Training Work Plan

Out of 48 flood damage-prone areas in the hill areas, 21 river training work schemes are given priority as listed in Table 4.2.1, whose locations are plotted in Figure 4.2.1. The length of riverbank to be protected varies from 180 m to 3,000 m as shown in Table 4.2.1 and the total length is estimated to be about 19,300 m.

River training works are planned to be constructed by revetment or spurs made of boulders crated in gabion boxes as having been practiced in the hill area. The unit price of each work item is shown in Table 4.2.2. The cost of G.I.wire required is included. Since the transportation cost of galvanized iron wire in the hill area accounts for a considerable proportion of total construction cost, the transportation cost from each Regional Irrigation Directorate to each river training work site is also considered. It is assumed that G.I.wire is transported by a truck from Nepalganj or Dhangadhi to the nearest terminal point of passable

roads and to the site by porters. The result of cost estimates for each scheme is shown in Table 4.2.1 and summarized below:

Summary of cost estimate of preliminary river training work in hill area

Items	Unit	Amount
- Total length of riverbank to be protected	m	19,300
- Total required weight of G.I.wire	ton	3,600
- Total cost of the preliminary river training work plan	Million Rs.	510
: Construction cost excluding G.I.wire	Million Rs.	(314)
: G.I.wire cost	Million Rs.	(130)
: Transportation cost of G.I.wire	Million Rs.	(66)

The total required weight of G.I.wire is estimated to be some 3,600 ton. This amount corresponds to that having been consumed in Mid Western and Far Western Development Regions for the three-year period since 1989, more than half of which, however, actually have been consumed for river training works in the Terai area. Since the total cost of Rs. 510 million includes the construction cost as well as the cost of G.I.wire, it is a large amount compared with the actual annual expenditure of about Rs. 11.1 million in 1989/90 as shown in Table 3.1.3, which was expended for the survey and transportation of G.I. wire only.

There is still need of collecting information by the District Irrigation Offices to mature the preliminary river training work plan in the hill area. It is recommended in the succeeding Chapter that priority be given to the preparation of topographic maps and design work for the selected 21 river training work schemes.

5. FLOOD MITIGATION PRIORITY SCHEME

5.1 Selection of Flood Mitigation Priority Scheme

The river training work scheme of Dodhara and Chandani areas is selected as a flood mitigation priority scheme in the Study Area taking into account the following: First of all, area losses due to the bank erosion have brought about a serious problem due to the fact that the agricultural production in Dodhara and Chandani areas greatly contributes to food supply in Kanchanpur District. Secondly, the field investigation and preliminary design for the work have been carried out by the Mahakali Irrigation Project Office well enough to proceed to further steps. High priority is, therefore, recommended to be given to this scheme.

5.2 Overview of Dodhara and Chandani Areas

5.2.1 Project Area

The Nepal-India international border forms the area boundary in the north, west and south, and the right bank of the Mahakali River in the east. Figure 5.2.1 is a topographic map of the area, which was prepared by Department of Survey in around 1990. The total land area is estimated to be some 5,000 ha ; 4 to 1 km in width and 22 km in length. Southern part of the areas is named Dodhara village and the northern one is called Chandani village respectively.

The climate is sub-tropical. Mean monthly temperatures in the nearest town, Mahendranagar, range from 14.1 ^{o}C in January and 30.6 ^{o}C in May. Monthly rainfall pattern in Dhangadhi varies distinctly between the wet season, from June to October, and the dry season, from November to May. The mean annual precipitation amounts to approximately 1,500 mm. Maximum monthly precipitation normally occurs in July, some 550 mm, and minimum in November, less than 10 mm.

People have access to the area in dry seasons by crossing a shoal of the Mahakali River. In rainy seasons people enter India by crossing Sarda Barrage and reach Dodhara and Chandani area through the forest. Sarda Barrage is situated in the Indian territory some seven km upstream of the area. It limits heavy transportation to 10-ton trucks.

These areas had initially been a forest land. In 1962, the Government decided to develop these areas as farm land. The forest have been cleared by people resettled from the hill area such as Darchula, Surkhet, Dailekh, Salyan and Bajura districts. At present, the forest

still covers some 10 % of the area and villages do some 20 %. The remaining 70 % of the area, or some 3,300 ha, is farm land, out of which some 1,000 ha is irrigated by shallow tube wells and the remaining is rain-fed farm land.

5.2.2 Social Situation

Kanchanpur District consists of 11 political regions, which are the unit to elect the representatives of district committee. Dodhara and Chandani area is one of the 11 political regions and consist of two village development committees, VDC. Each village is composed of nine wards. Although a population census is not available, a chairman of the village development committee reports that the population in 1992 is estimated to be some 27,000 persons with households of 4,000 in Dodhara village and 28,000 persons with households of 4,200 in Chandani. Most of people, 90 %, are engaged in agriculture. The average size of land holding is approximately one ha. Some of the remaining are engaged in marketing of daily goods. Production of vegetable oil from oilseeds and sugar from sugarcane by mills are also one of the business in this area.

Every ward in the area is accessible by motor vehicles. A 11 kV transmission line is connected from Mahendranagar. There are eight telephone facilities. One police post, one post office and one hospital are in service. As for formal schooling, one secondary school (high school), three lower secondary schools and 11 primary schools are established.

5.2.3 Agricultural Situation

The area is a food surplus region of Kanchanpur district. Sugarcane is the primary cash crop, followed by wheat, oilseeds and paddy. Main markets are Mahendranagar and its adjacent town, Gadda Chowki in India.

The cropping pattern in the area differs in the wet season and the dry season. Crop distribution, crop yield and farm gate price by season and by crop were surveyed based on interviews with local farmers as shown below:

Crops	Cropped area (%)	Crop yield (ton / ha)	Farm gate price (Rs./ ton)
< Wet season >			
- Paddy	85	3.5	4,500
- Maize	10	2.4	4,000
- Legumes	5	0.6	10,000
< Dry season >			
- Wheat	45	2.4	5,000
- Oilseeds	25	0.9	15,000
- Legumes	20	0.6	10,000
- Sugarcane	10	60.0	400

Although no surface water source is available at present, there exist 300 shallow tube wells for irrigation. A typical shallow well consists of (a) a galvanized iron pipe with 150 mm in diameter and nine meter in depth and (b) a five horsepower diesel pump. It can irrigate four hectare of farm land on an average. Top soil is silt or clay and subsoil is gravel mixed sand. No failure of construction of tube wells has been reported in the area. Pump irrigation is necessary at least for seven days for paddy in the wet season and six days for wheat in the dry season in one year. Farmers report that neither decrease in discharge nor decline in groundwater table has been observed even after five-day continuous pumping. Groundwater development seems to be prospective for future irrigation development in the area.

One-fourth of the total farmers have their own tube wells, and the remaining buy irrigation water from the owners. The construction of one tube well costs Rs. 20,000. Government grants a half of the cost, and Agricultural Development Bank provides the remaining money as loan to the farmer. Tube well owners sell water at a rate of Rs. 11.2 per hour excluding diesel oil charge or Rs. 22.4 per hour including diesel oil charge. One and a half liters of diesel oil are required for one-hour pumping.

As for irrigation development relying on a surface water source, a main irrigation canal with a length of 7.5 km is planned to be constructed to supply river water from the Maleriya Nala (Maleriya Creek) to the gross command area of 2,000 ha. The water source of the Maleriya Nala is seepage flow of the Sarda main irrigation canal. The minimum and maximum discharges are estimated to be 0.8 m^3/s and 20 m^3/s respectively. Although the construction of intake weir and the excavation of the main canal were completed with the expenditure of Rs. 7.0 million, the remaining construction works are interrupted due to the shortage of budget. The remaining works include (a) lining of the main canal, (b) 6 km long tertiary canals and (c) discharge regulating structures, which are to require the cost of Rs. 7.3 million.

As for alternative water sources, water supply from Sarda Barrage or direct intake from the Mahakali River is conceivable. Both the schemes, however, are subject to discussions related to the water right agreement with India.

5.3 River Training Works for Dodhara and Chandani Areas

5.3.1 Existing River Training Works

The Mahakali River has shifted its right bank towards Dodhara and Chandani areas. The northern part of the left riverbank of the Mahakali River has been protected by the construction of dykes and spurs. The right bank river training works have part by part been constructed since 1987 under the Mahakali Irrigation Project by means of gabion revetment, bank pitching and spurs as plotted in Figure 3.4.1. The total expenditure for the works amounted to some Rs. 13.04 million. Construction of the river training works in recent years has however been constrained due to the shortage of budget : Rs. 1.0 million in 1992 and Rs. 0.4 million in 1993.

5.3.2 Proposed River Training Works

(1) A proposal by Mahakali Irrigation Project

The proposed river training works aim not to control inundation by embankment but to mitigate a permanent loss of the land due to bank erosion, because the loss of land is considered more serious for local residents than damages caused by inundation. Figure 5.3.1 shows the proposed river training works. The total project cost was estimated to be Rs. 21.1 million including engineering service fee and physical contingencies but excluding the cost of G.I. wire for gabions.

(2) Pancheshwar Multipurpose Project

A field investigation of the Pancheshwar Multipurpose Project was completed in 1991. This project includes a 260 m high dam to be constructed 2.5 km downstream of the confluence of the Mahakali River and the Sarju River. This planned dam is expected to bring flood mitigation effects to the Terai area by creating a reservoir with a total volume of 6,800 million m^3. Process to the further step of this project is also under discussion with India at present.

5.4 Economic Evaluation for Dodhara and Chandani River Training Works

5.4.1 Review of Construction Cost

The total project cost, estimated at Rs. 21.1 million by the Mahakali Irrigation Project Office, is updated by (a) revising the unit rate of each work item and (b) including the cost of G.I.wire. The updated direct construction cost is estimated to be Rs. 48.79 million, in which indirect costs for administration work, further surveys and physical contingency are updated with a rate of 3%, 7% and 10% of the direct construction cost respectively, totalling Rs. 10.00 million. The total project cost is, therefore, estimated to be Rs. 58.58 million by accumulating the direct and indirect costs. Breakdown of the total cost is shown in Table 5.4.1.

5.4.2 Assessment of Flood Mitigation Benefit

(1) Area to be protected from loss due to bank erosion

Area decrease due to the bank erosion was estimated by referring to Figure 3.4.1 and a 1 in 10,000 scale topographic survey map surveyed in 1989. The Figure shows that Dodhara and Chandani areas will be decreased to some 4,000 ha in further 30 years if no further river training works are constructed. The proposed river training works are expected to protect the area of 300 ha in 10 years, 450 ha in 20 years and 500 ha in 30 years from loss due to the bank erosion.

(2) Annual flood mitigation benefit

The flood mitigation benefit in monetary terms that would be realized by the proposed scheme is defined as the differences in the value of flood damage without and with the proposed scheme. Although the flood damage normally includes crop losses, livestock losses, private property damages and public property ones, the crop losses are only considered conservatively as the flood damage caused by erosion at this preliminary stage. Since there in no irrigation system in the area along the riverbank to be protected by the proposed river training works, the average economic prices of the agricultural products in the rainy season is only assumed as the annual flood mitigation benefit.

Economic prices of the agricultural products as international tradable commodities were estimated by referring to the World Bank projections of world market prices for the year of 2000 at the 1992 price level. The forecast prices were adjusted to the 1993 price level by multiplying with factor of 1.032 on the basis of Manufacturing Unit

Value (MUV) index computed by the World Bank. The economic prices of crops per kg, therefore, were estimated at Rs. 9.7 for paddy, Rs. 10.4 for maize and Rs. 12.7 for legumes. The average annual unit flood mitigation benefit is assessed by multiplying the economic prices of crops by the crop distribution and yield in the rainy season. As a result, the annual unit flood mitigation benefit is assessed at Rs. 31,620 per hectare as shown in Table 5.4.2.

5.4.3 Preliminary Economic Evaluation

A preliminary economic evaluation is made to assess the economic viability based on the following assumptions :

- Economic project cost is arrived at by multiplying the project cost by an average economic conversion factor of 85 %. The total economic project cost is assessed to be Rs. 49.8 million.

- The total economic project cost is assumed to be disbursed into two-year construction period : 60 % for the first year and 40 % for the second one.

- Annual operation and maintenance costs are estimated to be Rs. 2.79 million by accumulating five percent of the construction cost related to the gabion work and ten percent of that related to the earth work on the basis of the Design Manual prepared by WECS in 1988. The economic annual operation and maintenance costs are assumed to be Rs. 2.37 million by multiplying the annual operation and maintenance costs by the average economic conversion factor.

- 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. The annual flood mitigation benefit is assessed to be Rs. 6.6 million in 10 years after the completion of the proposed river training works, Rs. 9.9 million in 20 years and Rs. 11.0 million in 30 years respectively.

- An evaluation period is set to 30 years after the completion of the construction on the basis of the Design Manual prepared by WECS in 1988. A cash flow prepared for the evaluation is shown in Table 5.4.3.

The economic internal rate of return is calculated to be 5.8 %, and the net benefit is negative value of Rs. 22.1 million by applying a discount rate of 10 %. Economic evaluation of the Dodhara and Chandani river training works was carried out under the condition that

crops are yielded only in the rainy season, i.e. without introduction of irrigation. This implies that the introduction of irrigation to the areas will increase the economic viability of the works.

5.5 Recommendations

(1) Implementation of Dodhara and Chandani Area River Training Work Scheme

In evaluating the Dodhara and Chandani area 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 records of floods and topographic maps of the area prone to flood damage. 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 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 on a long term basis:

- 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.

LIST OF REFERENCES

Ref. VII - 1 WECS. (1987). Erosion and Sedimentation in the Nepal Himalaya.

Ref. VII - 2 F.Zollinger. (1979). Analysis of River Problems and Strategy for Flood Control in the Nepalese Terai.

Ref. VII - 3 WECS. (1987). Preliminary Study of Glacier Lake Outburst Floods in the Nepal Himalaya, Phase 1 - Interim Report

Ref. VII - 4 WECS and JICA. (1991). Preliminary Work Report on Glacier Lake Outburst Flood in the Nepal Himalaya

Ref. VII - 5 WECS. (1987). General Design Guidelines for River Training in Nepal

Ref. VII - 6 WECS. (1988). Design Manual for River Training Works in Nepal

Ref. VII - 7 Central Water Commission Ministry of Water Resources Government of India. (1986). Flood Atlas of Insia

TABLES

Table 2.2.1 SUMMARY RECORD OF DISASTERS IN NEPAL

Fiscal year		Dead	Injured	Houses destroyed	Family affected	Land affected (ha)	Livestock lost
1983							
	Flood/Landslides	293	N.A.	N.A.	N.A.	N.A.	248
	Total	579	N.A.	42	N.A.	N.A.	248
1984							
	Flood/Landslides	363	N.A.	7,566	N.A.	12,418	3,114
	Total	941	N.A.	10,597	N.A.	12,418	3,547
1985							
	Flood/Landslides	420	N.A.	4,620	N.A.	13,544	3,059
	Total	1,387	N.A.	7,166	N.A.	13,544	3,059
1986							
	Flood/Landslides	315	N.A.	3,035	N.A.	13,158	1,886
	Total	1,512	N.A.	3,370	N.A.	13,158	6,566
1987							
	Flood/Landslides	391	162	33,721	96,151	188,579	1,431
	Total	881	162	36,220	97,036	188,579	1,852
1988							
	Flood/Landslides	328	198	2,396	4,113	N.A.	539
	Total	1,584	12,543	108,801	70,197	N.A.	2,789
1989							
	Flood/Landslides	680	0	6,024	N.A.	N.A.	1,512
	Total	1,716	3,014	18,974	N.A.	N.A.	4,210
1990							
	Flood/Landslides	307	26	3,060	5,165	N.A.	314
	Total	913	196	6,352	8,461	N.A.	867

Note : N.A. means that data is not available. Source : Ministry of Home

Table 2.2.2 LIST OF INUNDATION PROBLEM AREAS IDENTIFIED BETWEEN NEPAL AND INDIA

Village	District	Name of rivers	Area No. in Source
(1) Eastern Development Region			
1. Lagadi, Langadiyani	Siraha	Gagan	4
2. Govindpur, Lalpatti	Sapatari	Khando	5
3. Tilathi	Sapatari	Khando	6
4. Sahebganjanj	Sunsari	Burhi and Kaisali	7
5. Majhore	Morang	Lohindra	8
6. Bahundangi, Jamir, Kakarvitta	Jhapa	Mechi	9 & 20
7. Belhi, Tharhi, Balan	Saptari/Siraha	Balang	17
8. Bhairawa	Saptari	Drainage congestion and Kosi river	19
(2) Central Development Region			
9. Gaur Bazaar, Gaur	Rautahai	Bagmati/Lalbakiya	1
10. Raghunathpur, Balra, Hathiyol	Sarlahi/Mahottari	Manusmara	2
11. Phulburia, Musharia, Mukhiapatti	Dhanusha	Kamala	3(a) & 3(b)
12. Inaruwa	Parsa	Uriaiya	15
13. Amarpatti	Parsa		18
14. Raghunathpur	Mahottari	Maraha	30
(3) Western Development Region			
15. Rangpur, Tulsipur, Bijuwa	Kapilbastu	Siswa, Marethi, Bajaha and Siswa Sagar	11
16. Suata	Nawalparasi	Narayani	10
17. near Surajpur Powerhouse	Nawalparasi	Gandaki Western Main Canal	28
18. Jamuni	Dhanusha	Jamuni	16
19. Karaulia, Heradawa, Semari Itahawa	Kapilvastu	Banbanga	21
20. Pakhilhawa	Bhairawa	Danda	22
21. Bhiali		Ghagar	23
22. Parthahewa, Pajarbatti	Rupandehi	Rohini Nadi	24
23. Bhujehawa, Sankharpur, Kurthawal	Nawalparasi	Jharai	25
(4) Mid-western Development region			
24. Nepalgunj	Banke	West Rapti	13
25. Rajapur, Gulariya	Bardia	Karnali and Saryu	27 & 29
26. Dang Koilabash	Dang	Gurangena	12
(5) Far Western Development Region			
27. Chaugurdi, Dhansingh	Kailali	Karnali	26
28. Darchula	Darchula	Mahakali	14
29. Jogbura	Kanchanpur	Maraha Khola	31

Note: Locations of the problem areas are shown in Figure 2.2.3
Source: Itemwise Minutes of Standing Committee between Nepal and India on Inundation Problems, 1991

Table 2.2.3 SUMMARY OF INUNDATION PROBLEMS BETWEEN NEPAL AND INDIA IN THE STUDY AREA

Item No.	Location	River	Reported causes of inundations
14	Darchula District headquarter in Darchula area	Mahakali	- Owing to the construction of embankment and spurs by India side, pressure of the Mahakali waters towards the Nepalese territory has increased.
31	Jogbure area in Kanchanpur District	Mahakali	- Due to operation of escape channel damage is occurring in the Chandani area of Nepal.
26	Chaugurdi village and border area of Dhansingh village of Kailali District	Karnali	- Due to construction of the Girijapur barrage on Karnali (Ghagra) River by India, constricting the flow of rivers thereby affecting the Nepalese territory upstream.
27 & 29	Rajapur village and Gulariya village in Bardia District	Karnali and Babai	- Due to construction of barrage in Karnali (Ghagra) and saryu rivers by the Indian side, submergence occurs in Nepalese territory.

Source : River Training Division of Department of Irrigation

Table 2.3.1 DESIGN CRITERIA OF RIVER TRAINING WORKS IN NEPAL

Structure/ Purpose	Design Flood Return Period (years)
Bridge and associated works	
- major	100 to 200
- minor	50 to 100
Bank protection against erosion	
- major , valuable property, potential loss of life	100
- minor	25 to 50
Embankment flood protection	
- major , valuable property, potential loss of life	100
- minor	25
Irrigation canals	
- major	50
- minor	25
Road culverts	
- major	25
- minor	10
Construction of coffer dams	
- major	50
- minor	2 to 25

Source : Design Manual for River Training Works in Nepal in 1988, Water and Energy Commission Secretariat, Ministry of Water Resources

Table 3.1.1 STAFF COMPONENT OF SURKHET REGIONAL IRRIGATION DIRECTORATE AND DISTRICT IRRIGATION OFFICE

Surkhet Regional Directorate

	Position			Number of staff
(1)	Regional Irrigation Director			1
(2)	Gazetted	1st class	Technical engineer	2
(3)		1st class	Administrative	2
(4)		2nd class	Technical engineer	2
(5)		2nd class	Administrative	1
(6)		3rd class	Technical engineer	13
(7)		3rd class	Administrative	2
(8)	Nongazetted	1st class	Technical engineer	21
(9)		1st class	Administrative	11
(10)		2nd class	Technical engineer	4
(11)		2nd class	Administrative	4
(12)	Driver			3
(13)	Typist			5
(14)	Peon , sweeper			9
	Total			80

Surkhet District Irrigation Office

	Position	Number of staff
(1)	Senior Divisional Engineer	1
(2)	Engineer	2
(3)	Overseers	5
(4)	Junior Technician	1
(5)	Accountant	1
(6)	Sub-accountant	2
(7)	Clerk	2
(8)	Typist	1
(9)	Assistant	1
(10)	Field assistant	2
(11)	Driver	1
(12)	Guards, Peon, Sweepers	6
	Total	25

Note : Structural improvement is going to take place in a short period of time.

Table 3.1.2 **BUDGET FOR RIVER TRAINING AND FLOOD PROTECTION WORKS REQUESTED BY DISTRICT IN 1990/91**

Unit : thousand Rs.

	Name of district	Name of river / place	Estimated amount
1. Far-Western Irrigation Directorate			**16,746**
1.1	Darchula	- Mahakali	1,500
		- Kukure Garh	300
		- Dhap Irrigation Project	200
1.2	Kanchanpur	- Sanuwa	1,000
		- Dekhtamuli	1,000
1.3	Doti	- Gaira Gaon	300
		- Samugarh	300
		- Kandanando	300
		- Godaregarh	300
1.4	Dandeldhura	- Jogbudha	600
1.5	Bajura	- Pipalmora	200
		- Goigand	200
1.6	Baitadi	- Jamaligarh	1,100
1.7	Kailali	- Champ area	1,700
		- Khutia	300
		- Mohana	2,000
		- Kusum Ghat	5,446
2. Mid-Western Irrigation Directorate			**5,356**
2.1	Dailekh	- Karnali	570
		- Wire transportation to various districts	800
		- Guwar Khola	400
2.2	Rukum	- Various river training works	800
2.3	Pyuthan	- Various river training works	500
2.4	Mugu	- Various river training works	500
2.5	Bardiya	- Babai River	1,786
3. Mahakali Irrigation Project			**7,253**
3.1	Dodhara and Chandani areas		5,478
3.2	Jimuwa River training works		1,775
Total amount :			**29,355**

Source : River Training Division of Department of Irrigation

Table 3.1.3 ALLOCATION OF EXPENDITURE FOR IRRIGATION BY DISTRICT IN 1989/90

Unit : Thousand Rp.

Name of district	Total expenditure	Breakdown of expenditure		
		(a) District level **	(b) River training works ***	(c) Central level ****
< Far Western Development Region >				
(1) Bajhang	30,248	1,300	200	* 28,748
(2) Bajura	1,694	1,494	200	0
(3) Achham	1,500	1,394	106	0
(4) Doti	2,253	1,898	355	0
(5) Kailali	19,530	1,395	105	18,030
(6) Dadeldhura	3,720	3,568	152	0
(7) Baitadi	3,000	2,888	112	0
(8) Darchula	2,880	2,680	200	0
(9) Kanchanpur	74,915	7,815	1,500	65,600
(10) Far Western R.I.D	3,682	-	-	-
Total	143,422	24,432	2,930	83,630
< Mid-Western Development Region >				
(1) Rukum	9,293	8,893	400	0
(2) Dolpa	6,360	6,005	355	0
(3) Salyan	5,548	1,608	792	3,148
(4) Pyuthan	6,210	5,710	500	0
(5) Dang	27,630	1,094	406	26,130
(6) Jajarkot	9,130	8,253	877	0
(7) Dailekh	3,060	2,760	300	0
(8) Surkhet	8,113	7,440	673	0
(9) Banke	7,200	6,028	1,072	100
(10) Bardiya	37,478	1,628	892	34,958
(11) Dolpa	3,399	3,299	100	0
(12) Mugu	5,340	4,850	490	0
(13) Jumla	5,224	4,224	1,000	0
(14) Humula	3,460	3,199	261	0
(15) Kalikot	7,410	7,310	100	0
(16) Mid-Western R.I.D.	7,930	-	-	-
Total	152,785	72,301	8,218	64,336

Source : River Training Division of Department of Irrigation

Note * : Expenditure of Bajang District is spent to the Second Irrigation Project for for districts, namely Bhajhang, Bajura, Achham, and Doti.

** : Approximately 45% of expenditure of the district level is administrative cost.

*** : The expenditure of river training works does not include administrative cost.

**** : Approximately 20% of the expenditure of central level is administrative cost.

R.I.D. : Regional Irrigation Directorate

Table 3.1.4 ALLOCATION OF EXPENDITURE FOR IRRIGATION BY DISTRICT IN 1990/91

Unit : Thousand Rp.

Name of district	Total expenditure	Breakdown of expenditure		
		(a) District level **	(b) River training works ***	(c) Central level ****
< Far Western Development Region >				
(1) Bajhang	22,513	1,288	0	* 21,225
(2) Bajura	1,359	1,359	0	0
(3) Achham	1,055	0	0	0
(4) Doti	1,440	1,440	0	0
(5) Kailali	12,227	1,761	0	10,466
(6) Dadeldhura	3,121	3,121	0	0
(7) Baitadi	3,175	3,175	0	0
(8) Darchula	1,854	1,854	0	0
(9) Kanchanpur	100,018	4,983	0	95,035
(10) Far Western R.I.D	2,682	-	-	-
Total	149,444	18,981	0	105,501
< Mid-Western Development Region >				
(1) Rukum	2,367	2,367	0	0
(2) Dolpa	1,350	1,350	0	0
(3) Salyan	2,553	1,710	0	843
(4) Pyuthan	1,589	1,589	0	0
(5) Dang	10,453	1,018	0	9,435
(6) Jajarkot	1,647	1,647	0	0
(7) Dailekh	2,009	1,406	0	603
(8) Surkhet	3,792	2,965	0	827
(9) Banke	1,852	1,852	0	0
(10) Bardiya	113,229	1,744	0	111,485
(11) Dolpa	1,655	1,655	0	0
(12) Mugu	1,729	1,729	0	0
(13) Jumla	1,987	1,567	0	420
(14) Humula	1,884	1,884	0	0
(15) Kalikot	1,485	1,485	0	0
(16) Mid-Western R.I.D.	2,489	-	-	-
Total	152,070	25,968	0	123,613

Source : River Training Division of Department of Irrigation

Note * : Expenditure of Bajang District is spent to the Second Irrigation Project for for districts, namely Bhajhang, Bajura, Achham, and Doti.

** : Approximately 45% of expenditure of the district level is administrative cost.

*** : The expenditure of river training works is included in that of district level (a).

**** : Approximately 20% of the expenditure of central level is administrative cost.

R.I.D. : Regional Irrigation Directorate

Table 3.1.5 ALLOCATION OF EXPENDITURE FOR IRRIGATION BY DISTRICT IN 1991/92

Unit : Thousand Rp.

Name of district	Total expenditure	Breakdown of expenditure		
		(a) District level **	(b) River training works ***	(c) Central level ****
< Far Western Development Region >				
(1) Bajhang	48,618	8,058	0	* 40,560
(2) Bajura	1,387	1,387	0	0
(3) Achham	935	935	0	0
(4) Doti	2,494	1,966	0	528
(5) Kailali	35,065	2,588	0	32,477
(6) Dadeldhura	3,665	2,477	0	1,088
(7) Baitadi	1,963	1,963	0	0
(8) Darchula	1,885	1,885	0	0
(9) Kanchanpur	133,374	2,539	0	130,835
(10) Far Western R.I.D	2,616	-	-	-
Total	232,002	23,798	0	164,928
< Mid-Western Development Region >				
(1) Rukum	2,882	2,632	0	250
(2) Dolpa	1,475	1,475	0	0
(3) Salyan	2,136	2,136	0	0
(4) Pyuthan	1,360	1,360	0	0
(5) Dang	33,076	2,421	0	30,955
(6) Jajarkot	1,761	1,761	0	0
(7) Dailekh	1,434	1,434	0	0
(8) Surkhet	4,508	2,093	0	2,415
(9) Banke	4,367	2,820	0	1,547
(10) Bardiya	138,225	1,515	0	136,710
(11) Dolpa	1,404	1,404	0	0
(12) Mugu	1,470	1,470	0	0
(13) Jumla	1,312	1,312	0	0
(14) Humula	1,748	1,748	0	0
(15) Kalikot	1,510	1,510	0	0
(16) Mid-Western R.I.D.	2,815	-	-	-
Total	201,483	27,091	0	171,877

Source : River Training Division of Department of Irrigation

Note * : Expenditure of Bajang District is spent to the Second Irrigation Project for for districts, namely Bhajhang, Bajura, Achham, and Doti.

** : Approximately 45% of expenditure of the district level is administrative cost.

*** : The expenditure of river training works is included in that of district level (a).

**** : Approximately 20% of the expenditure of central level is administrative cost.

R.I.D. : Regional Irrigation Directorate

Table 3.1.6 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 3.1.7 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 3.1.8 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 3.1.9 **PROGRESS OF RIVER TRAINING WORKS FROM 1988 TO 1990**

	Name of district	Quantity of G.I. wire consumed in 1988 ton	Quantity of G.I. wire consumed in 1989 ton	Quantity of G.I. wire consumed in 1990 ton	Total quantity of G.I. wire consumed in 1988/ 89/ 90 ton	Estimated length of work in 1988/ 89/ 90 m
< Mid-Western Development Region >						
(1)	Surkhet	99	28	7	134	1,040
(2)	Rukum	13	15	0	28	210
(3)	Dailekh	0	23	0	23	180
(4)	Kalikot	0	0	0	0	-
(5)	Banke	6	0	0	6	50
(6)	Bardiya	300	1	0	300	2,340
(7)	Jajarkot	10	50	0	60	470
(8)	Dang	50	17	0	67	520
(9)	Salyan	80	70	0	150	1,170
(10)	Pyuthan	20	35	0	55	430
(11)	Dolpa	2	0	0	2	20
(12)	Jumla	0	3	0	3	20
(13)	Humula	0	3	0	3	20
(14)	Small hill irrigation projects	57	11	1	69	540
(15)	Gabion fabrication machine	0	95	56	152	-
*	Sub-total	636	349	64	1,049	7,010
< Far Western Development Region>						
(1)	R.I.D in Dhangadhi (Dipayal)	30	0	58	88	690
(2)	Bajhan	23	32	0	54	420
(3)	Baitadi	5	0	0	5	40
(4)	Bajura	9	3	0	12	90
(5)	Achham	30	0	0	30	230
(6)	Dadeldhura	39	20	9	69	540
(7)	Doti	30	24	0	54	420
(8)	Darchula	21	0	0	21	160
(9)	Kanchanpur	40	38	6	83	650
(10)	Kailali	76	123	0	199	1,550
(11)	Mahakali Irrigation Project	200	319	0	519	4,050
(12)	Mohana Irrigation Project	5	4	12	20	160
(13)	Small hill irrigation projects	12	81	2	95	740
(14)	V.D.C. Laxminagar, Doti	300	0	0	300	2,340
(15)	Other irrigation projects	6	3	0	9	70
(16)	Others	17	41	0	58	460
	Sub-total	812	687	29	1,528	12,610
	Total	1,448	1,036	93	2,578	19,620

Source : River Training Division, Ministry of Water Resources

Table 3.3.1 RIVER TRAINING WORKS IDENTIFIED IN SURKHET DISTRICT (1/2)

	Items	Unit	(a)	(b)	(c)
(1)	Name of area		Birendranagar Ward No. 8,10, 12	Birendranagar ward 11,12 & Jarbuta ward 1	Birendranagar ward 1 & 2, Unarganga
(2)	Name of river		Itram River	Neware River	Aamdali River
(3)	Type of river problem		Bank erosion/ Sedimentation/ Inundation	Bank erosion/ Sedimentation/ Inundation	Bank erosion/ Sedimentation/ Inundation
(4)	Recent outstanding flood damage				
	- Year of recent outstanding flood		August 1982	August 1982	August 1982
	- Length of riverbank eroded	m	2,000	3,000	2,000
	- Acreage of inundation	ha	200	200	200
	- Number of families affected	nos	40	60	50
(5)	River training works constructed				
	- Type of river training works		Removal of sediment & gabion revetment	Gabion revetment & spurs	No river training works
	- Length of riverbank protected				
	: by gabion revetment	m	400	1,000	-
	: by spurs	m	-	1,000	-
(6)	River training works to be required				
	- Type of river training works		Removal of sediment & gabion revetment	Gabion revetment & Spurs	Riverbed excavation & gabion revetment
	- Length of riverbank to be protected	m	500	1,500	2,000
	- Cost estimated by District Irrigat. Office	mill. Rp.	n.a.	n.a.	n.a.

Note : n.a. means that data is not available.

Table 3.3.2 RIVER TRAINING WORKS IDENTIFIED IN SURKHET DISTRICT (2/2)

Items	Unit	(d)	(e)	(f)
(1) Name of area		Kada, Simta, Cholpa, Bal takura, and Aali area	Cheapang	Birendranagar ward 4 & 8
(2) Name of river		Simta Khola	Sota Khola	Khorke Khola
(3) Type of river problem		Bank erosion / Inundation	Bank erosion / Inundation	Bank erosion / Inundation
(4) Recent outstanding flood damage				
- Year of recent outstanding flood		August 1982	July 1988	July 1988
- Length of riverbank eroded	m	20,000	1,000	10,000
- Acreage of inundation	ha	500	300	20
- Number of families affected	nos	700	50	7
(5) River training works constructed				
- Type of river training works		No river training works	Gabion revetment	Gabion revetment
- Length of riverbank protected				
: by gabion revetment	m	-	100	500
: by spurs	m	-	-	-
(6) River training works to be required				
- Type of river training works		Gabion revetment	Gabion revetment	Gabion revetment or levee
- Length of riverbank to be protected	m	20,000	1,000	7,500
- Cost estimated by District Irrigat. Office	mill. Rp.	n.a.	n.a.	n.a.

Note : n.a. means that data is not available.

Table 3.3.3 RIVER TRAINING WORKS IDENTIFIED IN RUKUM DISTRICT

Items	Unit	(a)	(b)	(c)
(1) Name of area		Beltapu	Jari Khola River Training Works	Dhaune Bagar
(2) Name of river		Sani Bheri River	Jari Khola	Sani Bheri River
(3) Type of river problem		Flood water intrusion to irrigation canals	Bank erosion	Bank erosion
(4) Recent outstanding flood damage				
- Year of recent outstanding flood		at floods	at floods	at floods
- Length of riverbank eroded	m	-	10,000	175
- Acreage of inundation	ha	40	n.a.	n.a.
- Number of families affected	nos	n.a.	n.a.	n.a.
(5) River training works constructed				
- Type of river training works		No river training works	Some gabion revetment	No river training works
- Length of riverbank protected				
: by gabion revetment	m	-	n.a.	-
: by spurs	m	-	-	-
(6) River training works to be required				
- Type of river training works		Gabion revetment / Spurs	Gabion revetment to protect irrigation canal	Gabion revetment
- Length of riverbank to be protected	m	3,000	scatteringly along 10,000 long bank	175
- Cost estimated by District Irrigat. Office	mill. Rp.	0.20	17.00	0.15

Note : n.a. means that data is not available.

Table 3.3.4 RIVER TRAINING WORKS IDENTIFIED IN SALYAN DISTRICT

	Items	Unit	(a)	(b)	(c)
(1)	Name of area		Sharda Khola	Marna Khola	Luhan Khola
(2)	Name of river		Sharda Khola	Marna Khola	Luhan Khola
(3)	Type of river problem		Bank erosion / Inundation	Bank erosion / Inundation	Bank erosion
(4)	Recent outstanding flood damage				
	- Year of recent outstanding flood		at floods	at floods	at floods
	- Length of riverbank eroded	m	n.a.	n.a.	n.a.
	- Acreage of inundation	ha	n.a.	n.a.	-
	- Number of families affected	nos	n.a.	n.a.	n.a.
(5)	River training works constructed				
	- Type of river training works		No river training works	Spurs	Gabion revetment and spurs
	- Length of riverbank protected				
	: by gabion revetment	m	-	-	45 nos. of gabion works
	: by spurs	m	-	50 nos. of spurs	n.a.
(6)	River training works to be required				
	- Type of river training works		Gabion revetment	Gabion revetment	Extention of gabion revetment and spurs
	- Length of riverbank to be protected	m	not surveyed yet	not surveyed yet	not surveyed yet
	- Cost estimated by District Irrigat. Office	mill. Rp.	n.a.	n.a.	n.a.

Note : n.a. means that data is not available.

Table 3.3.5 RIVER TRAINING WORKS IDENTIFIED IN DAILEKH DISTRICT (1/2)

	Items	Unit	(a)	(b)	(c)
(1)	Name of area		Rakam	Singouri	Dhamigaun
(2)	Name of river		Karnali River	Karnali	Paduka Kola
(3)	Type of river problem		Bank erosion	Bank erosion	Bank erosion / flood water intrusion to canal
(4)	Recent outstanding flood damage				
	- Year of recent outstanding flood		at floods	at floods	at floods
	- Length of riverbank eroded	m	500	n.a.	250
	- Acreage of inundation	ha	-	n.a.	n.a.
	- Number of families affected	nos	n.a.	n.a.	n.a.
(5)	River training works constructed				
	- Type of river training works		56 nos. of gabion boxes	135 nos. of gabion boxes	No river training works
	- Length of riverbank protected				
	: by gabion revetment	m	500	n.a.	-
	: by spurs	m	-	-	-
(6)	River training works to be required				
	- Type of river training works		Extension of gabion revetment	Gabion revetment	Gabion revetment and levee
	- Length of riverbank to be protected	m	500	not surveyed yet	250
	- Cost estimated by District Irrigat. Office	mill. Rp.	n.a.	n.a.	n.a.

Note : n.a. means that data is not available.

Table 3.3.6 RIVER TRAINING WORKS IDENTIFIED IN DAILEKH DISTRICT (2/2)

Items	Unit	(d)	(e)
(1) Name of area		Basai	Kotmandir
(2) Name of river		Chham Gad	Chhan Gad
(3) Type of river problem		Bank erosion	Bank erosion
(4) Recent outstanding flood damage			
- Year of recent outstanding flood		at floods	at floods
- Length of riverbank eroded	m	n.a.	n.a.
- Acreage of inundation	ha	-	-
- Number of families affected	nos	n.a.	n.a.
(5) River training works constructed			
- Type of river training works		No river training works	No river training works
- Length of riverbank protected			
: by gabion revetment	m	-	-
: by spurs	m	-	-
(6) River training works to be required			
- Type of river training works		Not surveyed yet	Some river training works
- Length of riverbank to be protected	m	n.a.	not surveyed yet
- Cost estimated by District Irrigat. Office	mill. Rp.	n.a.	n.a.

Note : n.a. means that data is not available.

Table 3.3.7 RIVER TRAINING WORKS IDENTIFIED IN KALIKOT DISTRICT

	Items	Unit	(a)	(b)	(c)
(1)	Name of area		Serijiula	Ramnakot & Lapha	Lapha Gad
(2)	Name of river		Serijiula Khola	Karnali River	Lapha Gad
(3)	Type of river problem		Bank erosion	Bank erosion	Bank erosion
(4)	Recent outstanding flood damage				
	- Year of recent outstanding flood		at floods	at floods	at floods
	- Length of riverbank eroded	m	500	1,000	200
	- Acreage of inundation	ha	10	-	15
	- Number of families affected	nos	n.a.	n.a.	n.a.
(5)	River training works constructed				
	- Type of river training works		No river training works	No river training works	No river protection works
	- Length of riverbank protected				
	: by gabion revetment	m	-	-	-
	: by spurs	m	-	-	-
(6)	River training works to be required				
	- Type of river training works		Gabion revetment	Gabion revetment	Gabion revetment
	- Length of riverbank to be protected	m	500	1,000	200
	- Cost estimated by District Irrigat. Office	mill. Rp.	n.a.	n.a.	n.a.

Note : n.a. means that data is not available.

Table 3.3.8 RIVER TRAINING WORKS IDENTIFIED IN JAJARKOT DISTRICT

Items	Unit	(a)	(b)	(c)
(1) Name of area		Punma	Junga Thaoachour	Japatipur
(2) Name of river		Bagdiya Khola	Vinus Gad	Kamali River
(3) Type of river problem		Bank erosion	Bank erosion	Bank erosion
(4) Recent outstanding flood damage				
- Year of recent outstanding flood		at floods	at floods	at floods
- Length of riverbank eroded	m	Annual erosion rate of 10m	n.a.	n.a.
- Acreage of inundation	ha	59	n.a.	-
- Number of families affected	nos	n.a	n.a.	n.a.
(5) River training works constructed				
- Type of river training works		Gabion revetment costed Rp. 0.34 million	Gabion revetment in 1987/88	5 nos. of spurs
- Length of riverbank protected				
: by gabion revetment	m	n.a.	3 ha	-
: by spurs	m	-	n.a.	n.a.
(6) River training works to be required				
- Type of river training works		Extention of river trainng works	-	Extention of river training works is required
- Length of riverbank to be protected	m	not surveyed yet	-	not surveyed yet
- Cost estimated by District Irrigat. Office	mill. Rp.	n.a.	-	n.a.

Note : n.a. means that data is not available.

Table 3.3.9 RIVER TRAINING WORKS IDENTIFIED IN BAJHANG DISTRICT (1/2)

	Items	Unit	(a)	(b)	(c)
(1)	Name of area		Chaughalli	Chopakhe and Deval areas	Dogad
(2)	Name of river		Taru Gad	Seti River	Bauli Gad
(3)	Type of river problem		Contraction of river flow by landslide mateial	Contraction of river flow by landslide material	Bank erosion
(4)	Recent outstanding flood damage				
	- Year of recent outstanding flood		Deposit of landslide material	Deposit of landslide materal at flood	at floods
	- Length of riverbank eroded	m	-	180	n.a.
	- Acreage of inundation	ha	-	-	-
	- Number of families affected	nos	16 houses were washed away	-	n.a.
(5)	River training works constructed				
	- Type of river training works		Spurs for bank erosion	Small spurs completed in 1991	No river training works
	- Length of riverbank protected				
	: by gabion revetment	m	-	n.a.	-
	: by spurs	m	n.a.	180 m costed Rp. 1.07 million	-
(6)	River training works to be required				
	- Type of river training works		Removal of landslide material	Extension of river training work is required	Gabion revetment
	- Length of riverbank to be protected	m	not surveyed yet	180	not surveyed yet
	- Cost estimated by District Irrigat. Office	mill. Rp.	n.a.	n.a.	n.a.

Note : n.a. means that data is not available.

Table 3.3.10 RIVER TRAINING WORKS IDENTIFIED IN BAJHANG DISTRICT (2/2)

	Items	Unit	(d)
(1)	Name of area		Rainabagar
(2)	Name of river		Seti River
(3)	Type of river problem		Contraction of river flow by landslide mateial
(4)	Recent outstanding flood damage		
	- Year of recent outstanding flood		at floods
	- Length of riverbank eroded	m	n.a.
	- Acreage of inundation	ha	n.a.
	- Number of families affected	nos	n.a.
(5)	River training works constructed		
	- Type of river training works		Some river training works
	- Length of riverbank protected		
	: by gabion revetment	m	n.a.
	: by spurs	m	n.a.
(6)	River training works to be required		
	- Type of river training works		Extention of river training works is required
	- Length of riverbank to be protected	m	not surveyed yet
	- Cost estimated by District Irrigat. Office	mill. Rp.	n.a.

Note : n.a. means that data is not available.

Table 3.3.11 RIVER TRAINING WORKS IDENTIFIED IN BAITADI DISTRICT

	Items	Unit	(a)	(b)	(c)
(1)	Name of area		Purchaundi Hat	Dung Gad	Jamari Gad
(2)	Name of river		Jamari Gad	Dung Gad	Jamari Gad
(3)	Type of river problem		Inundation / Bank erosion	Bank erosion	Bank erosion
(4)	Recent outstanding flood damage				
	- Year of recent outstanding flood		in 1989	at floods	at floods
	- Length of riverbank eroded	m	n.a.	1,500	2,500
	- Acreage of inundation	ha	n.a.	-	-
	- Number of families affected	nos	Some houses were washed away	-	n.a.
(5)	River training works constructed				
	- Type of river training works		No river training works	Gabion revetment	River training work was just started in 1992
	- Length of riverbank protected				
	: by gabion revetment	m	-	1,500	2,500 m to be protected
	: by spurs	m	-	-	-
(6)	River training works to be required				
	- Type of river training works		Gabion revetment	-	Gabion revetment
	- Length of riverbank to be protected	m	2,500	-	2,500
	- Cost estimated by District Irrigat. Office	mill. Rp.	n.a	-	n.a.

Note : n.a. means that data is not available.

Table 3.3.12 RIVER TRAINING WORKS IDENTIFIED IN BAJURA DISTRICT (1/3)

Items	Unit	(a)	(b)	(c)
(1) Name of area		Bauli	Chatabagar	Budhi Ganga
(2) Name of river		Bauli Gad	Budhiganga River	Tipata Gad
(3) Type of river problem		Flood water intrusion causing inundation	Flood water intrusion causing inundation	Bank erosion
(4) Recent outstanding flood damage				
- Year of recent outstanding flood		at floods	at foods	at floods
- Length of riverbank eroded	m	-	-	n.a.
- Acreage of inundation	ha	n.a.	n.a.	-
- Number of families affected	nos	n.a.	n.a.	n.a.
(5) River training works constructed				
- Type of river training works		Closure of water path / Spurs in 1989	Closure of tributary completed in 1989	Gabion revetment completed in 1989
- Length of riverbank protected				
: by gabion revetment	m	-	-	n.a.
: by spurs	m	n.a.	-	-
(6) River training works to be required				
- Type of river training works		Gabion revetment	Extension of gabion revetment	Extension of gabion revetment
- Length of riverbank to be protected	m	n.a.	n.a.	n.a.
- Cost estimated by District Irrigat. Office	mill. Rp.	0.031 million in 1989/90 fiscal year budget	0.023 million in 1989/90 fiscal year budget	0.043 million in 1989/90 fiscal year budget

Note : n.a. means that data is not available.

Table 3.3.13 RIVER TRAINING WORKS IDENTIFIED IN BAJURA DISTRICT (2/3)

	Items	Unit	(d)	(e)	(f)
(1)	Name of area		Kuldavmandu & Brahmatola	Kailashmandu	Simla
(2)	Name of river		Guhi Gad	Mala Gad	Kimuni Khola
(3)	Type of river problem		Contraction of river flow by landslide mateial	Bank erosion	Deposit of landslide material and erosion
(4)	Recent outstanding flood damage				
	- Year of recent outstanding flood		at floods	at floods	at floods
	- Length of riverbank eroded	m	-	n.a.	n.a.
	- Acreage of inundation	ha	-	-	-
	- Number of families affected	nos	-	n.a.	-
(5)	River training works constructed				
	- Type of river training works		No river training works	No river training works	No river training works
	- Length of riverbank protected				
	: by gabion revetment	m	-	-	-
	: by spurs	m	-	-	-
(6)	River training works to be required				
	- Type of river training works		Removal of landslide material	Spurs / gabion revetment	Landslide & bank erosion protection
	- Length of riverbank to be protected	m	not surveyed yet	not surveyed yet	not surveyed yet
	- Cost estimated by District Irrigat. Office	mill. Rp.	n.a.	n.a.	n.a

Note : n.a. means that data is not available.

Table 3.3.14 RIVER TRAINING WORKS IDENTIFIED IN BAJURA DISTRICT (3/3)

	Items	Unit	(g)	(h)
(1)	Name of area		Boldik	Pandusain
(2)	Name of river		Confluence of Karnali & Nuwad rivers	Tributary of Budhiganga
(3)	Type of river problem		Bank erosion	Deposit of landslide material
(4)	Recent outstanding flood damage			
	- Year of recent outstanding flood		at floods	at floods
	- Length of riverbank eroded	m	n.a.	n.a.
	- Acreage of inundation	ha	-	-
	- Number of families affected	nos	-	n.a.
(5)	River training works constructed			
	- Type of river training works		No river training works	No river training works
	- Length of riverbank protected			
	: by gabion revetment	m	-	-
	: by spurs	m	-	-
(6)	River training works to be required			
	- Type of river training works		Gabion revetment	Gabion revetment
	- Length of riverbank to be protected	m	not surveyed yet	not survey yet
	- Cost estimated by District Irrigat. Office	mill. Rp.	n.a.	n.a.

Note : n.a. means that data is not available.

Table 3.3.15 RIVER TRAINING WORKS IDENTIFIED IN ACHHAM DISTRICT

Items	Unit	(a)	(b)	(c)
(1) Name of area		Chipiya Khola River Training Works	Payal	Saphe
(2) Name of river		Chipiya Khola	Budhiganga River	Budhiganga
(3) Type of river problem		Bank erosion	Bank erosion	Contraction of river flow by landslide mateial
(4) Recent outstanding flood damage				
- Year of recent outstanding flood		at floods	at floods	at floods
- Length of riverbank eroded	m	n.a.	100	n.a.
- Acreage of inundation	ha	-	-	-
- Number of families affected	nos	n.a.	n.a	n.a.
(5) River training works constructed				
- Type of river training works		No river training works	No river training works	No river training works
- Length of riverbank protected				
: by gabion revetment	m	-	-	-
: by spurs	m	-	-	-
(6) River training works to be required				
- Type of river training works		Gabion revetment & 7 spurs	Gabion revetment	Some river training works are required
- Length of riverbank to be protected	m	n.a.	100	not surveyed yet
- Cost estimated by District Irrigat. Office	mill. Rp.	0.10	0.15	n.a.

Note : n.a. means that data is not available.

Table 3.3.16 RIVER TRAINING WORKS IDENTIFIED IN DADELDHURA DISTRICT

	Items	Unit	(a)
(1)	Name of area		Jogbudha
(2)	Name of river		Rangun Khola
(3)	Type of river problem		Bank erosion
(4)	Recent outstanding flood damage		
	- Year of recent outstanding flood		July 1989
	- Length of riverbank eroded	m	-
	- Acreage of inundation	ha	-
	- Number of families affected	nos	2 to 3 persons were washed away
(5)	River training works constructed		
	- Type of river training works		Gabion revetment & spurs
	- Length of riverbank protected		
	: by gabion revetment	m	500 m long scatteringly
	: by spurs	m	500 m long scatteringly
(6)	River training works to be required		
	- Type of river training works		Extention of protection works
	- Length of riverbank to be protected	m	500
	- Cost estimated by District Irrigat. Office	mill. Rp.	not surveyed yet

Note : n.a. means that data is not available.

Table 3.3.17 RIVER TRAINING WORKS IDENTIFIED IN DOTI DISTRICT

	Items	Unit	(a)	(b)	(c)
(1)	Name of area		Tarala	Laxminagad	Banedungrisairn, Gopghat, Talkot
(2)	Name of river		Seti River	Goguni Gad	Seti River
(3)	Type of river problem		Bank erosion	Inundation / Bank erosion	Bank erosion
(4)	Recent outstanding flood damage				
	- Year of recent outstanding flood		at floods	at floods	at floods
	- Length of riverbank eroded	m	500	-	n.a.
	- Acreage of inundation	ha	-	20	-
	- Number of families affected	nos	n.a.	n.a.	n.a.
(5)	River training works constructed				
	- Type of river training works		No river training works	No river training works	No river training works
	- Length of riverbank protected				
	: by gabion revetment	m	-	-	-
	: by spurs	m	-	-	-
(6)	River training works to be required				
	- Type of river training works		Gabion revetment	Gabion revetment	Gabion revetment
	- Length of riverbank to be protected	m	900	500	not surveyed yet
	- Cost estimated by District Irrigat. Office	mill. Rp.	n.a.	n.a.	n.a

Note : n.a. means that data is not available.

Table 3.3.18 RIVER TRAINING WORKS IDENTIFIED IN DARCHULA DISTRICT

	Items	Unit	(a)	(b)
(1)	Name of area		Banga Bagar	Noti Bazar
(2)	Name of river		Chamliya River	Mahakali River
(3)	Type of river problem		Bank erosion	Bank erosion
(4)	Recent outstanding flood damage			
	- Year of recent outstanding flood		July 1990	July 1990
	- Length of riverbank eroded	m	Retaining wall 25m long was washed away	n.a.
	- Acreage of inundation	ha	500	-
	- Number of families affected	nos	n.a.	n.a.
(5)	River training works constructed			
	- Type of river training works		Gabion revetment	No river training works
	- Length of riverbank protected			
	: by gabion revetment	m	n.a.	n.a.
	: by spurs	m	-	-
(6)	River training works to be required			
	- Type of river training works		Gabion revetment	Gabion revetment
	- Length of riverbank to be protected	m	200	300
	- Cost estimated by District Irrigat. Office	mill. Rp.	not surveyed yet	not surveyed yet

Note : n.a. means that data is not available.

Table 3.3.19 RIVER TRAINING WORKS IDENTIFIED IN KAILALI DISTRICT (1/2)

Items	Unit	(a)	(b)	(c)
(1) Name of area		Dhansingpur	Bhuinyaphata	Kanara River Traiing
(2) Name of river		Mohana River	Ligma river	Kanara
(3) Type of river problem		Inundation of cultivated area	Inundation of cultivated land	Bank erosion / Inundation
(4) Recent outstanding flood damage				
- Year of recent outstanding flood		at floods	at floods	at floods
- Length of riverbank eroded	m	-	-	n.a.
- Acreage of inundation	ha	n.a.	n.a.	n.a.
- Number of families affected	nos	n.a.	n.a.	n.a.
(5) River training works constructed				
- Type of river training works		No river training works	*No river training works*	*No river training works*
- Length of riverbank protected				
: by gabion revetment	m	-	-	-
: by spurs	m	-	-	-
(6) River training works to be required				
- Type of river training works		Levee	Bank embankment	Gabion revetment / spurs
- Length of riverbank to be protected	m	not surveyed yet	not surveyed yet	not surveyed yet
- Cost estimated by District Irrigat. Office	mill. Rp.	n.a.	n.a.	n.a.

Note : n.a. means that data is not available.

Table 3.3.20 RIVER TRAINING WORKS IDENTIFIED IN KAILALI DISTRICT (2/2)

Items	Unit	(d)
(1) Name of area		Mohan River
(2) Name of river		Mohan River
(3) Type of river problem		Bank erosion
(4) Recent outstanding flood damage		
- Year of recent outstanding flood		at floods
- Length of riverbank eroded	m	annual erosion rate of 20 to 30 m
- Acreage of inundation	ha	-
- Number of families affected	nos	n.a.
(5) River training works constructed		
- Type of river training works		No river training works
- Length of riverbank protected		
: by gabion revetment	m	-
: by spurs	m	-
(6) River training works to be required		
- Type of river training works		Gabion revetment / spurs
- Length of riverbank to be protected	m	not surveyed yet
- Cost estimated by District Irrigat. Office	mill. Rp.	not surveyed yet

Note : n.a. means that data is not available.

Table 3.3.21 RIVER TRAINING WORKS IDENTIFIED IN KANCHANPUR DISTRICT

	Items	Unit	(a)	(b)	(c)
(1)	Name of area		Dodhara & Chandani	Dekhat Bhali ward No.6 & 8	Baisi Bichwa
(2)	Name of river		Mahakali River	Donda River	Donda River
(3)	Type of river problem		Bank erosion / Inundation / Lateral bank shift	Bank erosion	Bank erosion and inundation
(4)	Recent outstanding flood damage				
	- Year of recent outstanding flood		June 1981, August 1989	at floods	at floods
	- Length of riverbank eroded	m	24,000 m long riverbank scatteringly	n.a.	n.a.
	- Acreage of inundation	ha	1,200	-	n.a.
	- Number of families affected	nos	12 houses were washed away	n.a.	n.a.
(5)	River training works constructed				
	- Type of river training works		Spurs, gabion revetment, crated boulder dyke	No river training works	No river training works
	- Length of riverbank protected		costed Rs. 13.043 million so far		
	: by gabion revetment	m	24,000 m long riverbank scatteringly	-	-
	: by spurs	m	24,000 m long riverbank scatteringly	-	-
(6)	River training works to be required				
	- Type of river training works		Spurs, gabion revetment, crated boulder dyke	Spurs and gabion revetment	Spurs and boulder crated dyke
	- Length of riverbank to be protected	m	24,000 m long riverbank scatteringly	5,000	not surveyed yet
	- Cost estimated by District Irrigat. Office	mill. Rp.	21.30	not surveyed yet	n.a.

Note : n.a. means that data is not available.

Table 4.2.1 **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 4.2.2 SUMMARY OF UNIT PRICES OF RIVER TRAINING WORKS IN THE HILL AREA

Unit : Rs.

	Work items	Unit	Unit prices
(a)	Transportation cost of G.I.wire including loading & unloading		
	- by porter	Rs. /kg/kosh	0.57
	1 kosh = 2 miles	Rs. /kg/km	0.16
	- by truck	Rs. /truck/day	1,800
		Rs. /kg/22 km	3.62
		Rs. /kg/km	0.17
(b)	Earthwork in excavation by ground condition		
	- Simple foundation	m3	45.76
	- Gravel and boulder mixed	m3	88.6
	- Medium rock	m3	167.13
	- Hard rock	m3	286.05
(c)	Boulder rate		
	- For 100m load collection including boulder	m3	168.40
	- Boulder filling rate	m3	67.62
	* Total crating boulder rate	m3	236.02
(d)	Netting G.I.wire	box	205
	- size 3m *1.5m *1m	m3	52
	- mesh 100mm * 100mm excluding wire cost		
(e)	Average cost on lump sum basis including G.I.wire	m3	700
	: Assumed box size	3*1.5*1m	
(f)	Assumed typical design sections of gabion works		
	- Design sect. area of gabion revetment per meter : 4m high, 7m long for apron	m2/m	22
	- Design sectional area of gabion spur per meter	m2/m	47
	- Bottom width of a spur	m	6
	- Design span of spurs	m	30

Source : Surkhet Regional Irrigation Directorate

Note : Improvement in the norms is going to take place soon.

Table 5.4.1 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 5.4.2 ANNUAL UNIT FLOOD MITIGATION BENEFIT IN DODHARA AND CHANDANI AREAS

Crops	Proportion of cropped area (%)	Crop yield (ton / ha) : A	Economic prices for major crops (Rs. / ton) : B	Economic prices per hectare (Rs. / ha) : C=A*B
- Paddy	85	3.5	9,660	33,810
- Maize	10	2.4	10,410	24,980
- Legumes	5	0.6	12,660	7,600
: Average unit flood mitigation benefit per annum				31,620

Note : Economic prices of the crops are referred to the World Bank projections of world market prices.

Table 5.4.3 CASH FLOW FOR ECONOMIC EVALUATION

: Unit: Rs. 1,000

Year	Capital cost : C1	O&M cost : C2	Total cost : C=C1+C2	Benefit : B	Net benefit : B-C
-2	19,920	0	19,920	0	-19,920
-1	29,880	950	30,830	550	-30,280
0	0	2,370	2,370	1,100	-1,270
1	0	2,370	2,370	1,650	-720
2	0	2,370	2,370	2,200	-170
3	0	2,370	2,370	2,750	380
4	0	2,370	2,370	3,300	930
5	0	2,370	2,370	3,850	1,480
6	0	2,370	2,370	4,400	2,030
7	0	2,370	2,370	4,950	2,580
8	0	2,370	2,370	5,500	3,130
9	0	2,370	2,370	6,050	3,680
10	0	2,370	2,370	6,600	4,230
11	0	2,370	2,370	6,930	4,560
12	0	2,370	2,370	7,260	4,890
13	0	2,370	2,370	7,590	5,220
14	0	2,370	2,370	7,920	5,550
15	0	2,370	2,370	8,250	5,880
16	0	2,370	2,370	8,580	6,210
17	0	2,370	2,370	8,910	6,540
18	0	2,370	2,370	9,240	6,870
19	0	2,370	2,370	9,570	7,200
20	0	2,370	2,370	9,900	7,530
21	0	2,370	2,370	10,010	7,640
22	0	2,370	2,370	10,120	7,750
23	0	2,370	2,370	10,230	7,860
24	0	2,370	2,370	10,340	7,970
25	0	2,370	2,370	10,450	8,080
26	0	2,370	2,370	10,560	8,190
27	0	2,370	2,370	10,670	8,300
28	0	2,370	2,370	10,780	8,410
29	0	2,370	2,370	10,890	8,520
30	0	2,370	2,370	11,000	8,630

FIGURES

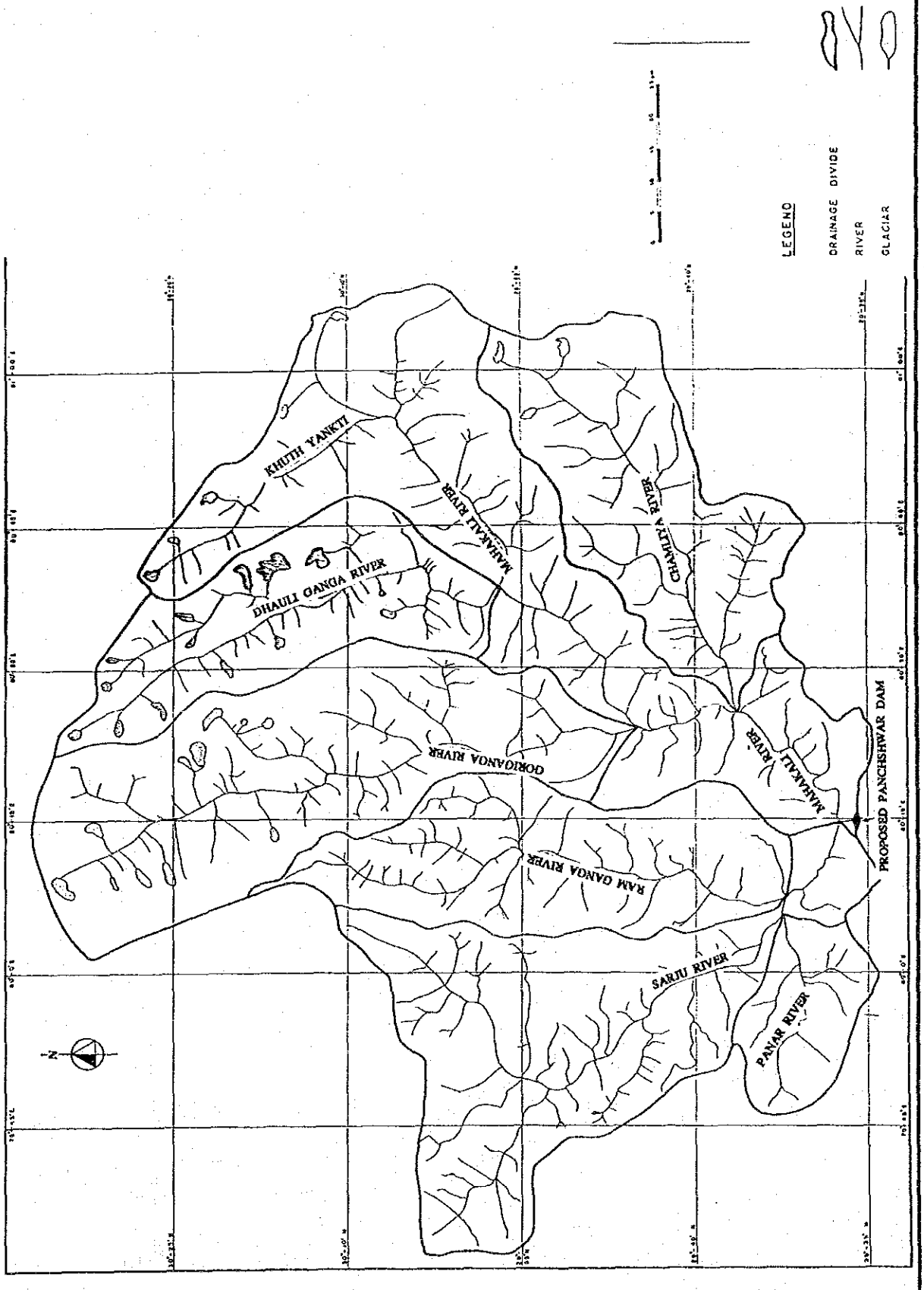


Figure 2.2.1 **Location Map of Glaciers in Upper Mahakali River Basin**

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

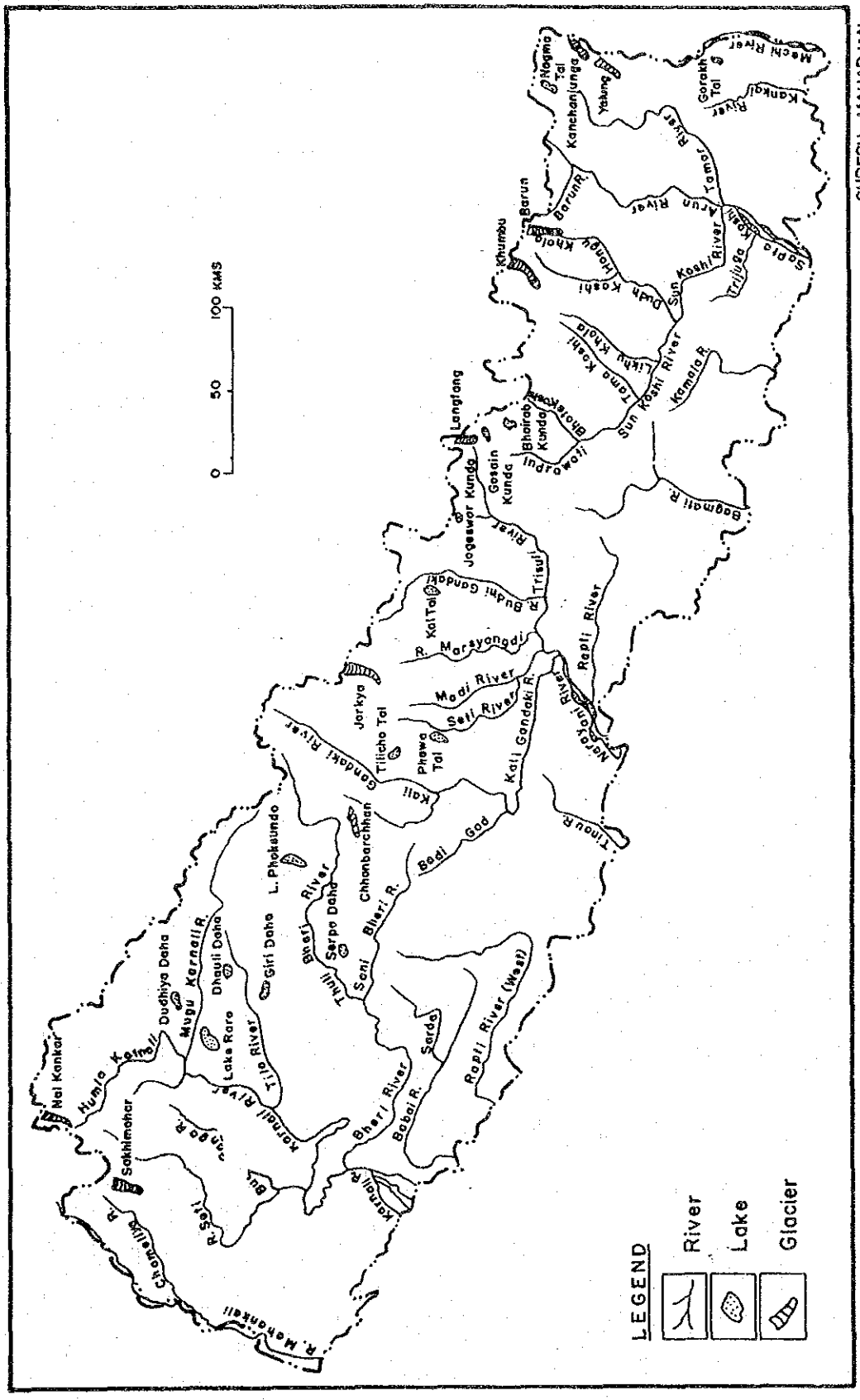


Figure 2.2.2 Location Map of Glaciers in Nepal

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

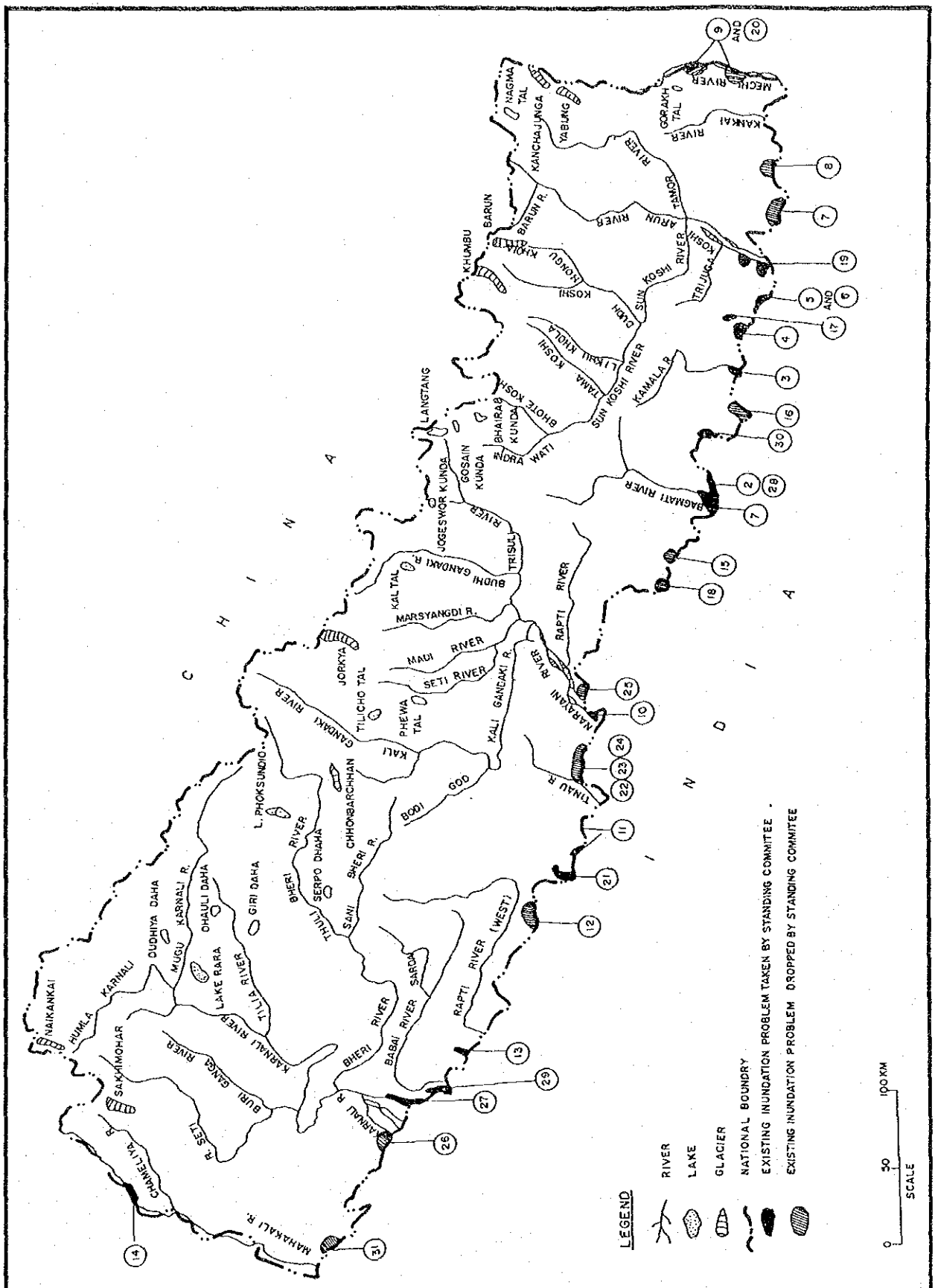
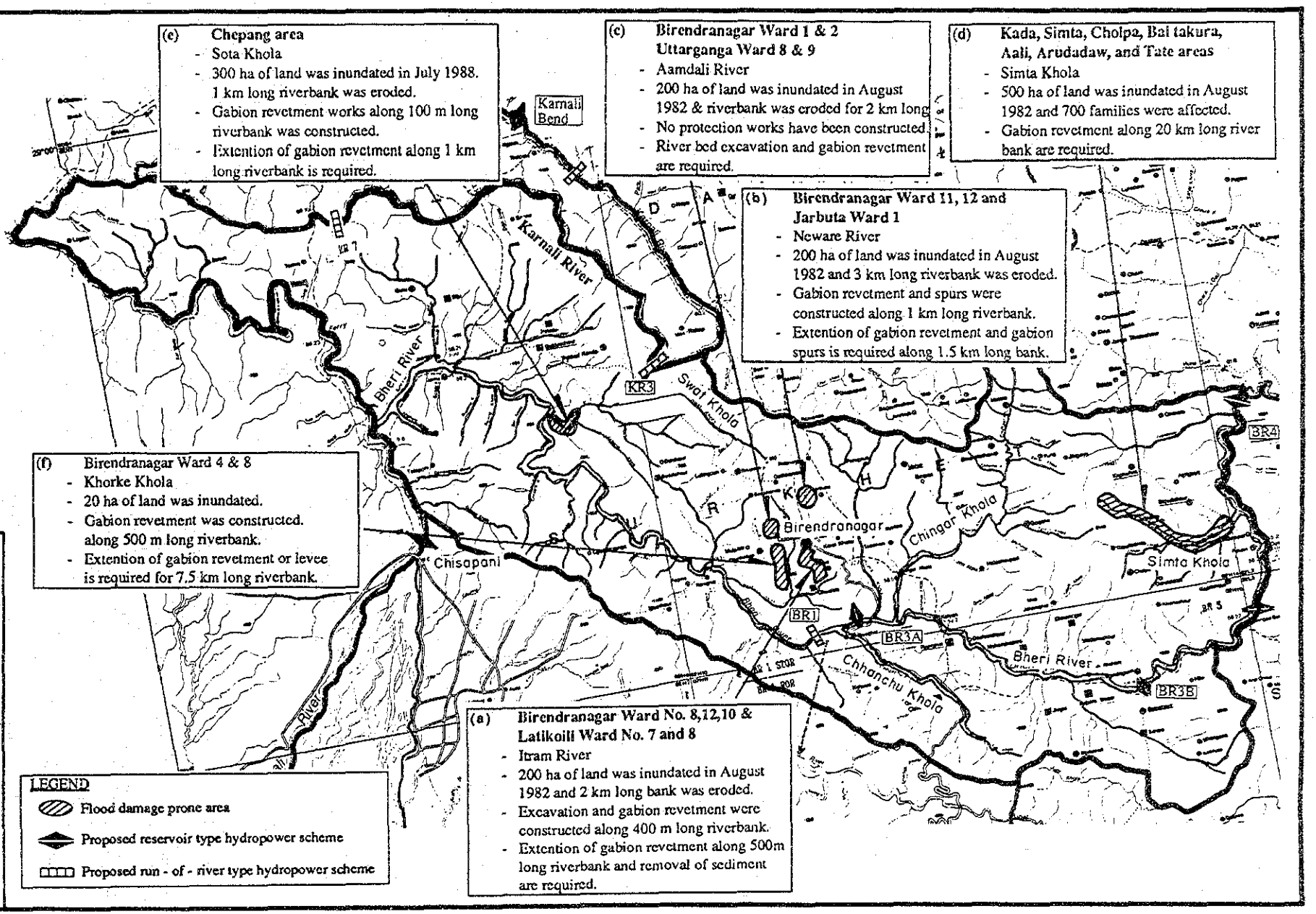


Figure 2.2.3 Location Map of Inundation Problems

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

Figure 3.3.1 River Problems and River Training Wors in Surkhet District



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

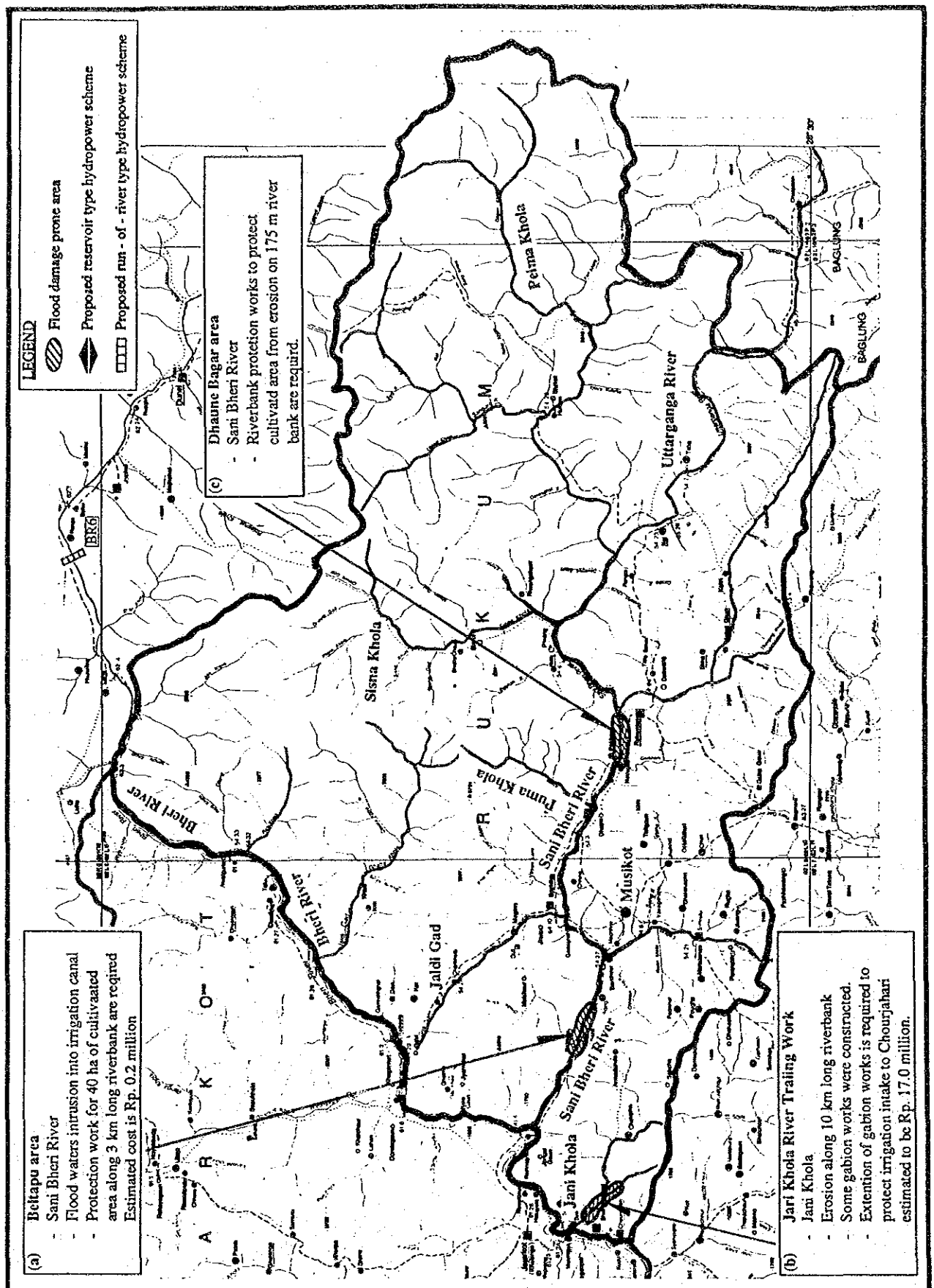


Figure 3.3.2 **River Problems and River Training Works in Rukum District**

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

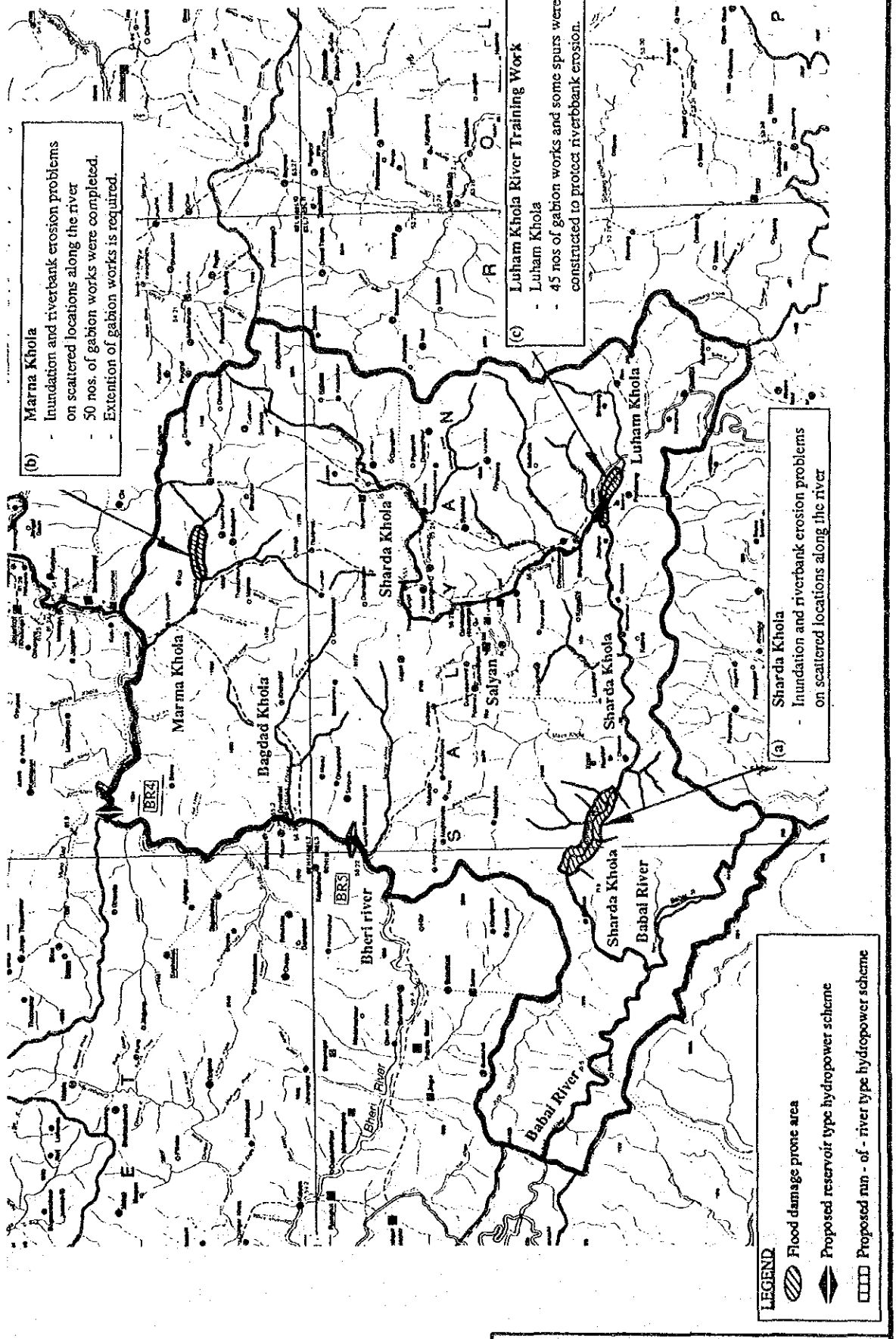


Figure 3.3.3 River Problems and River Training Works in Salyan District

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

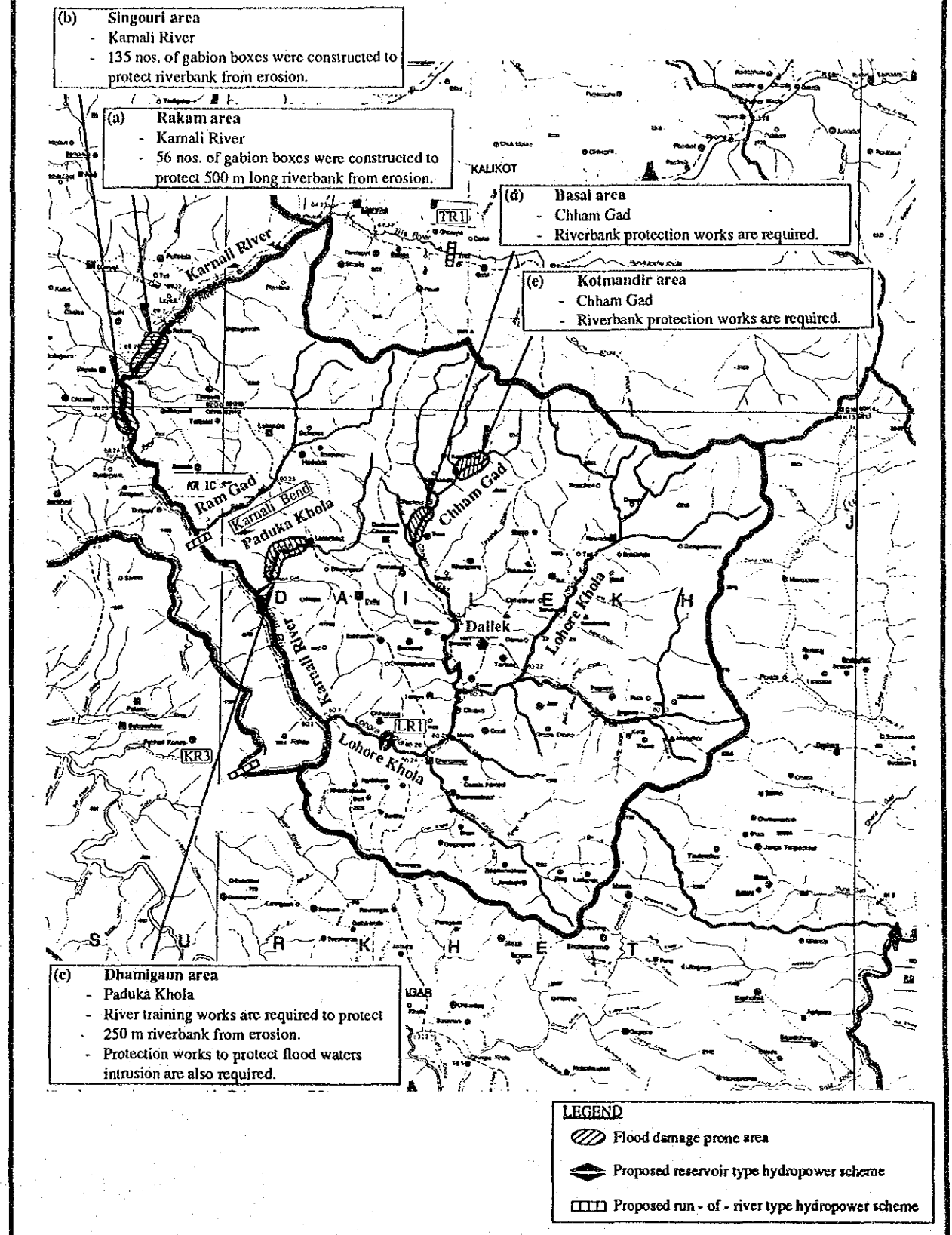


Figure 3.3.4 River Problems and River Training Works in Dailekh District

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

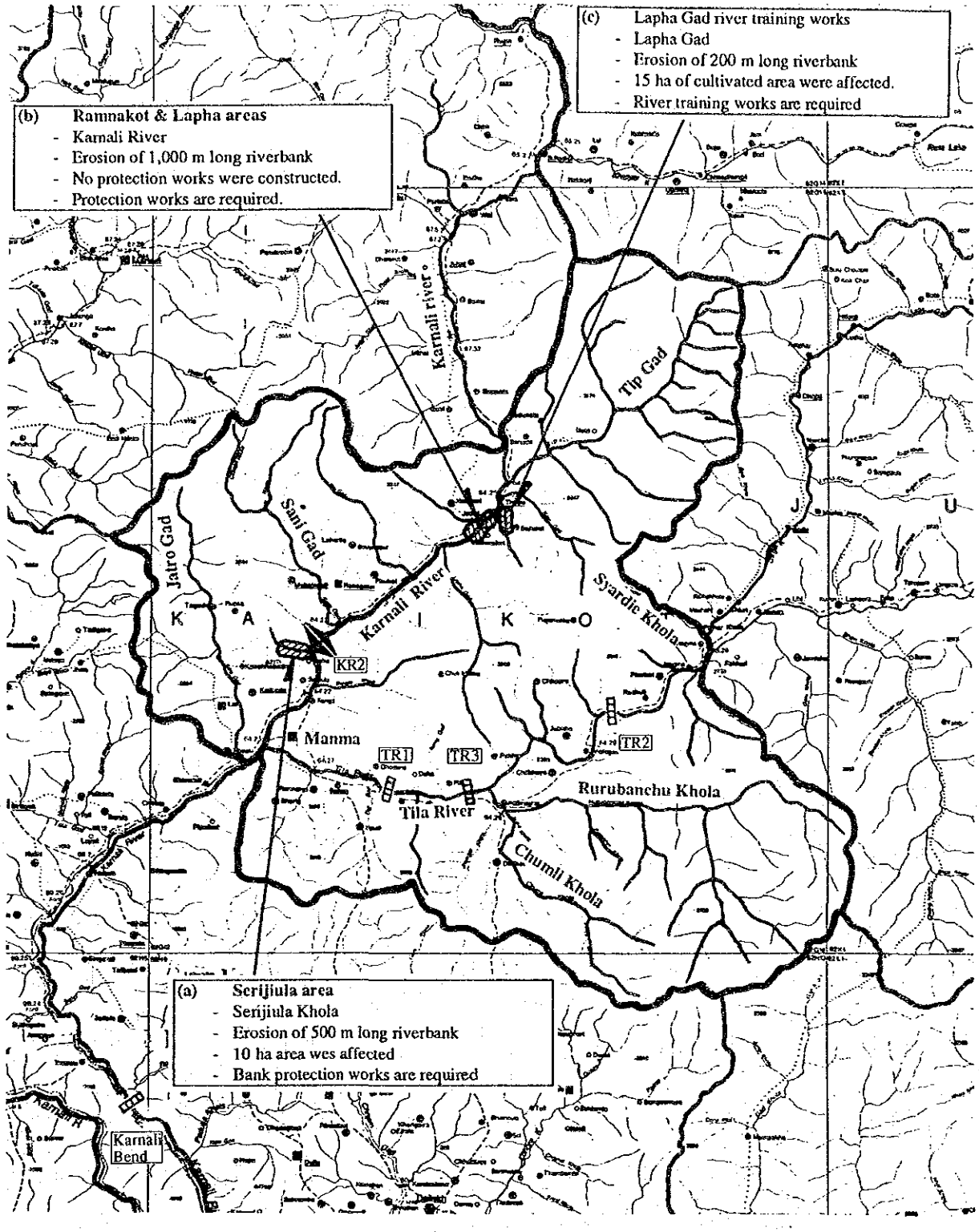


Figure 3.3.5 **River Problems and River Training Works in Kalikot District**

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

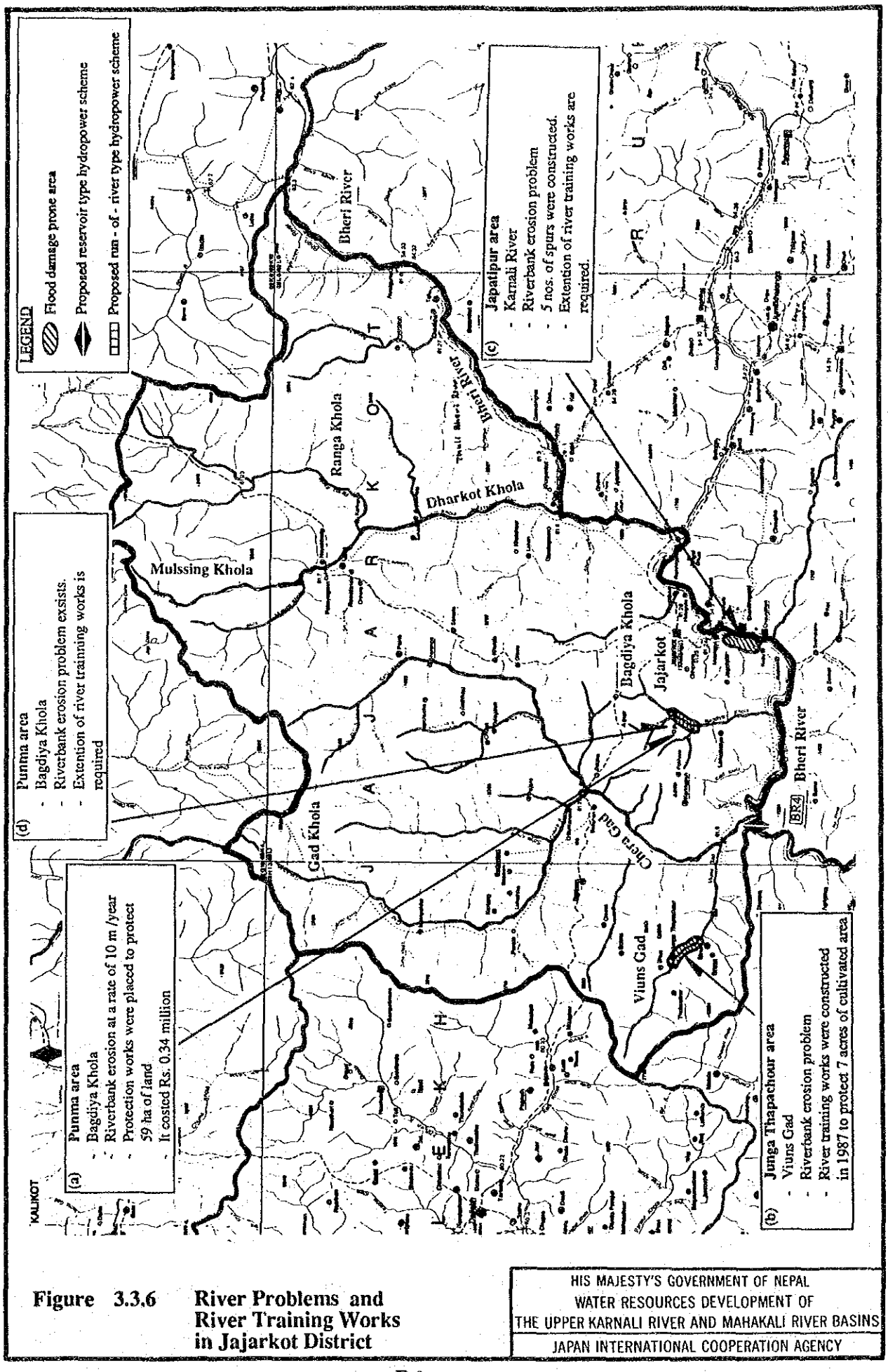


Figure 3.3.6 River Problems and River Training Works in Jajarkot District

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

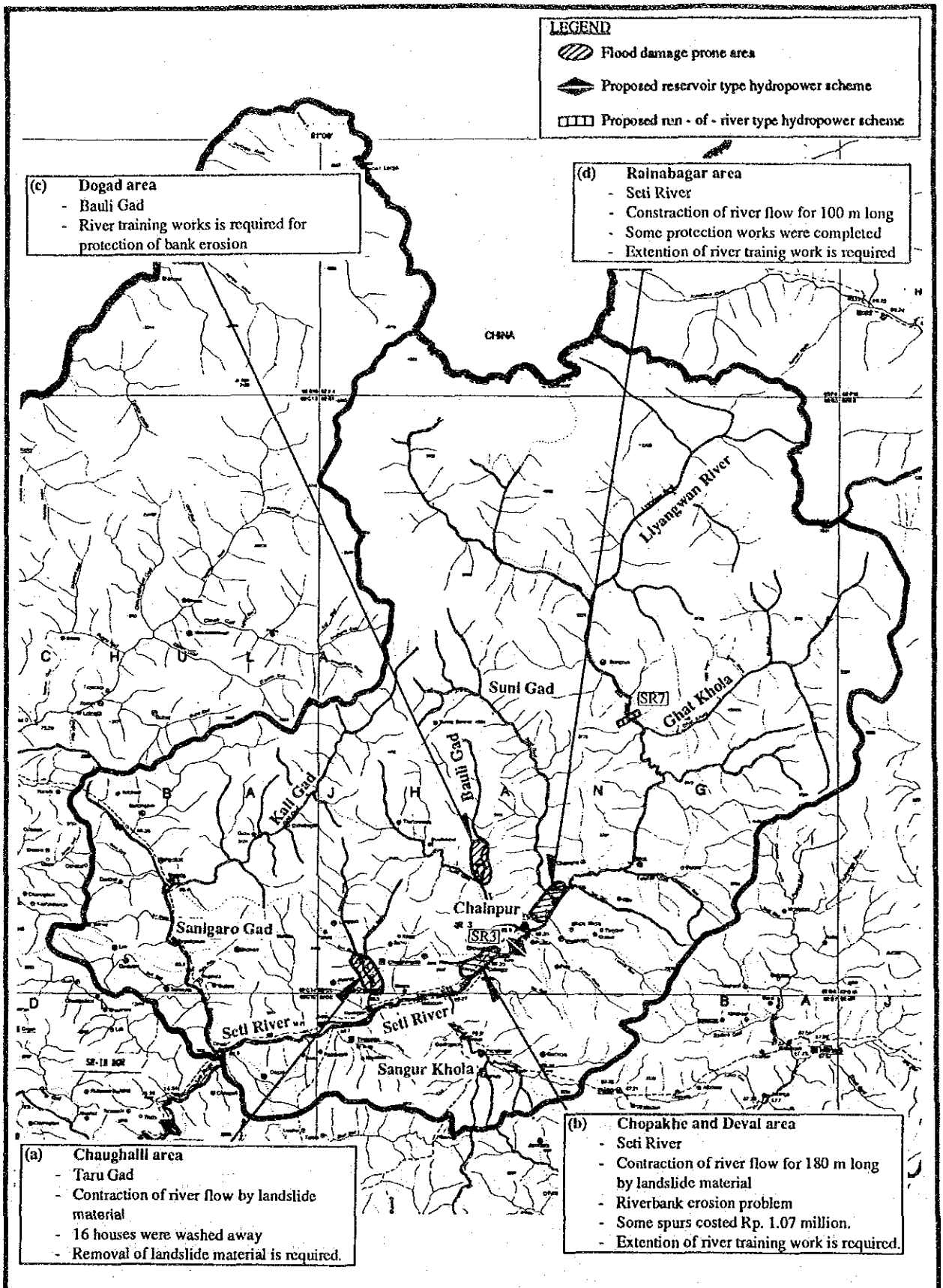


Figure 3.3.7 River Problems and River Training Works in Bajhang District

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

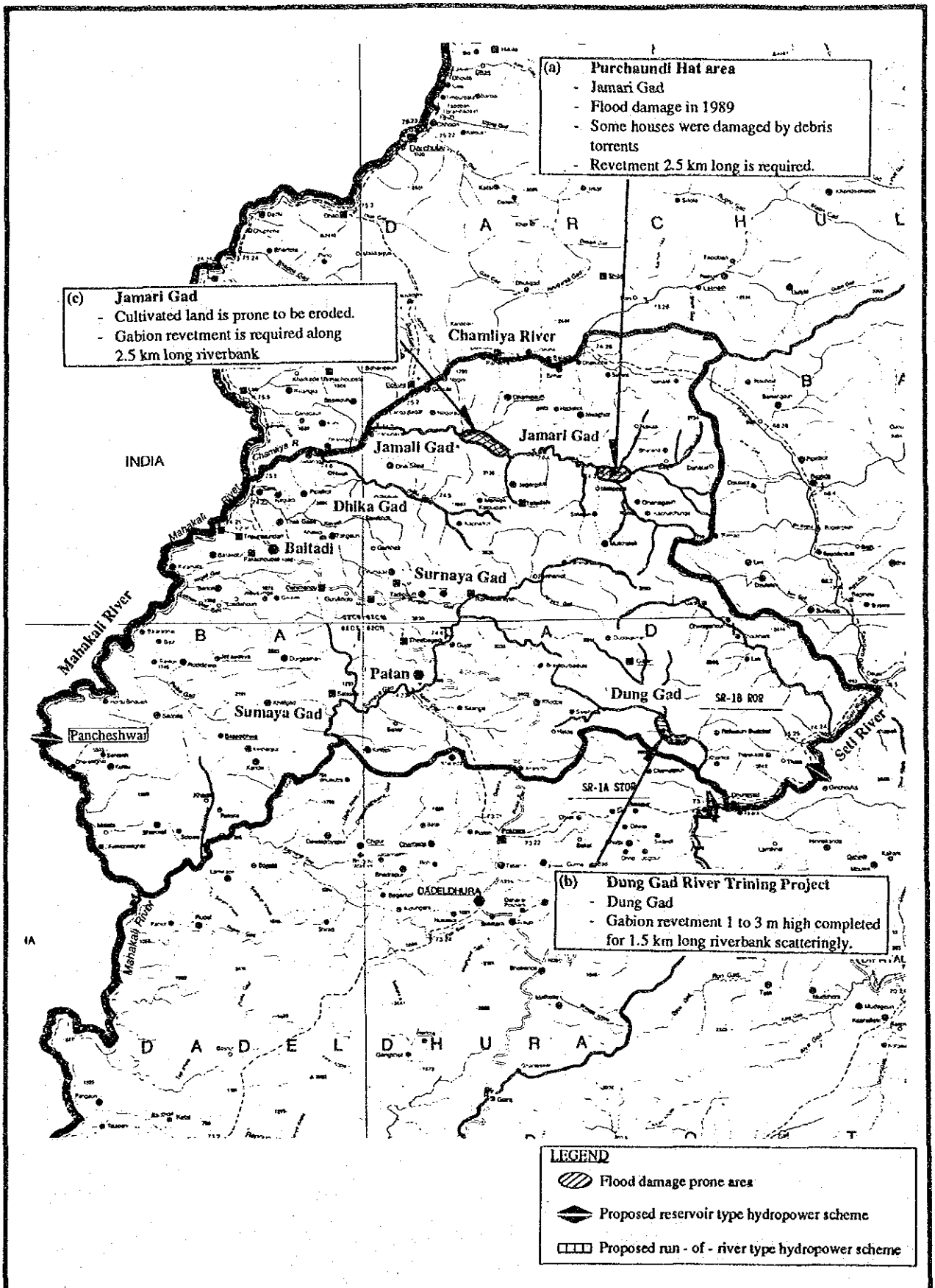


Figure 3.3.8 **River Problems and River Training Works in Baitadi District**

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

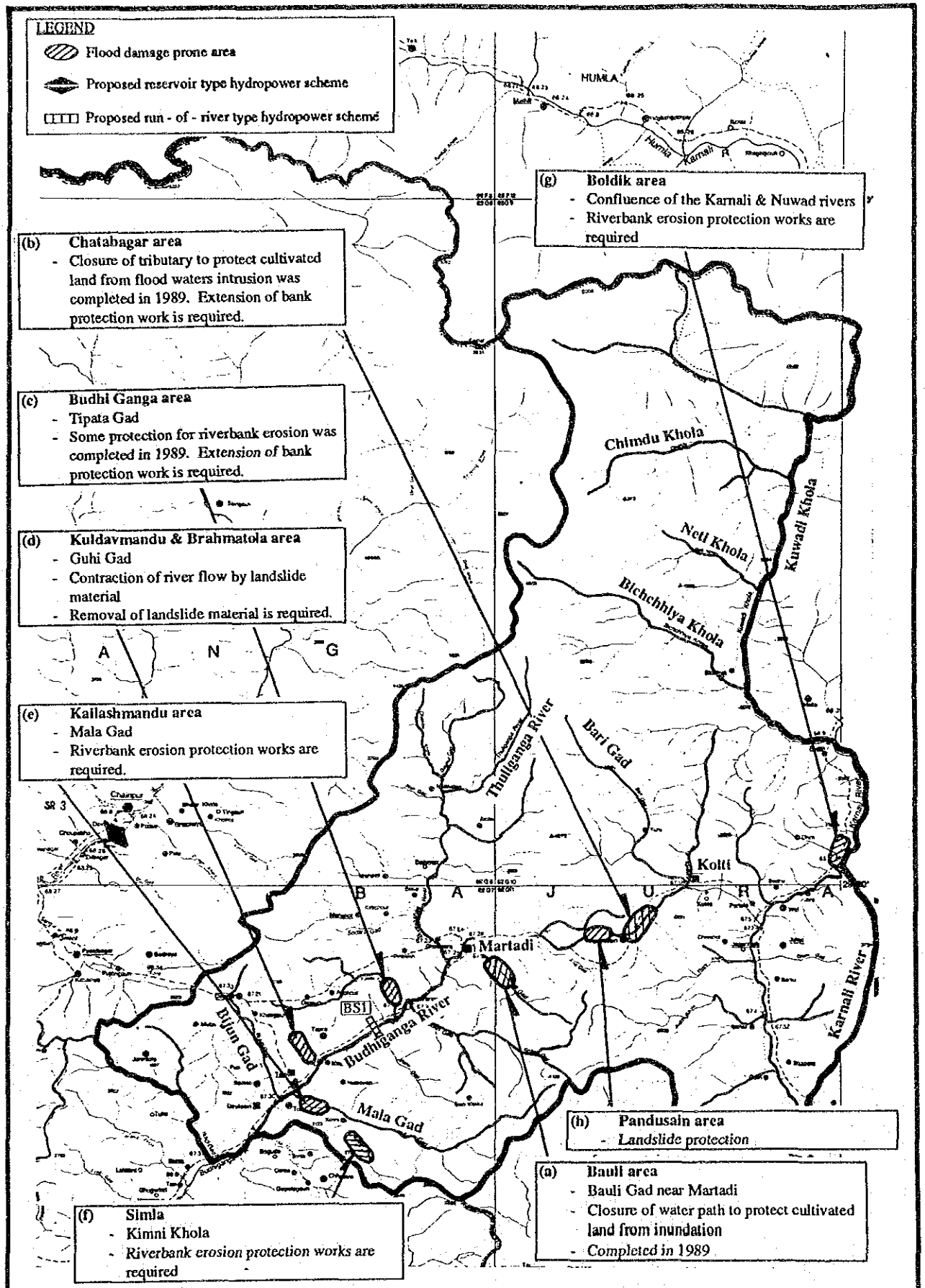


Figure 3.3.9 **River Problems and River Training Works in Bajura District**

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

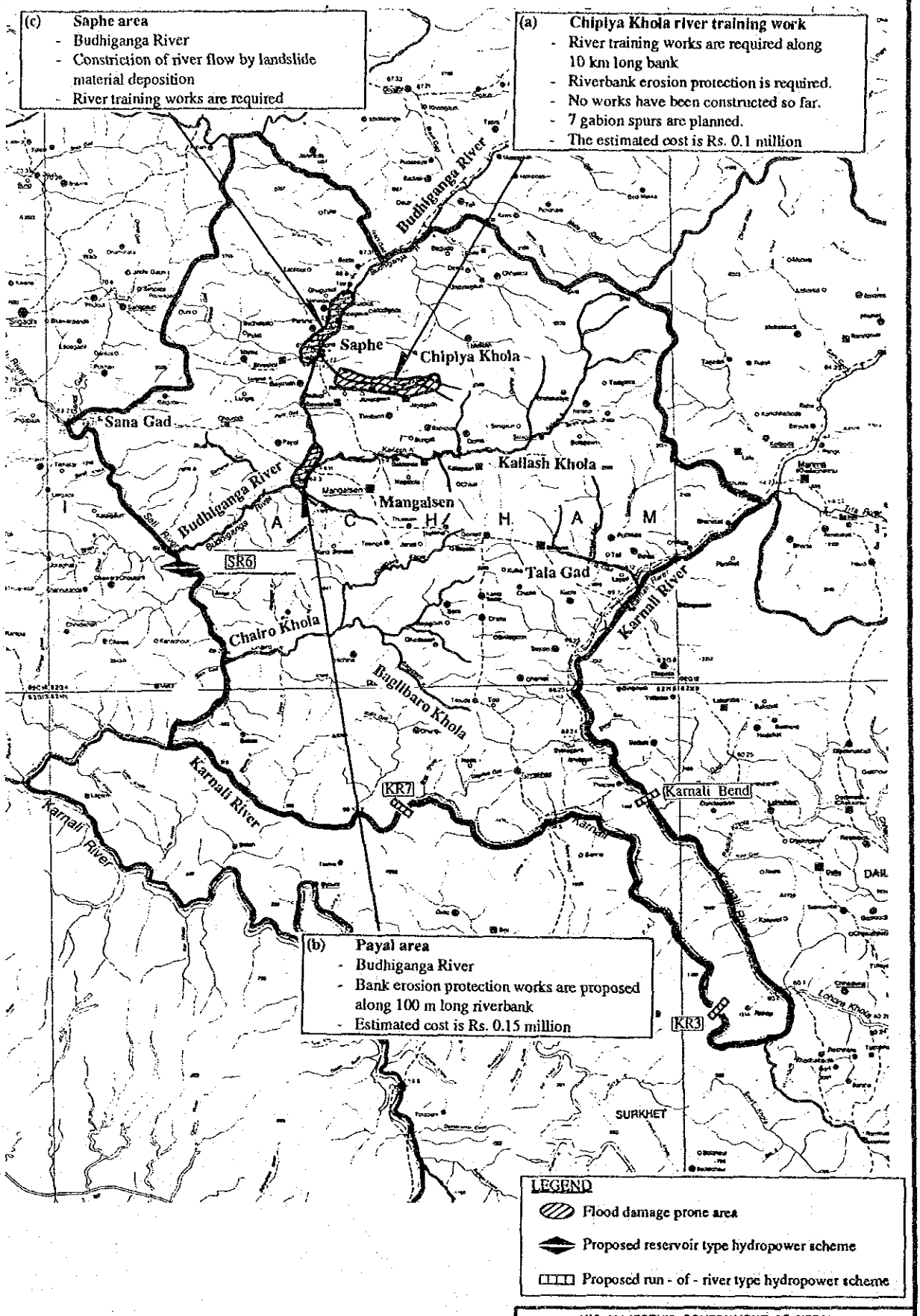


Figure 3.3.10 River Problems and River Training Works in Achham District

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

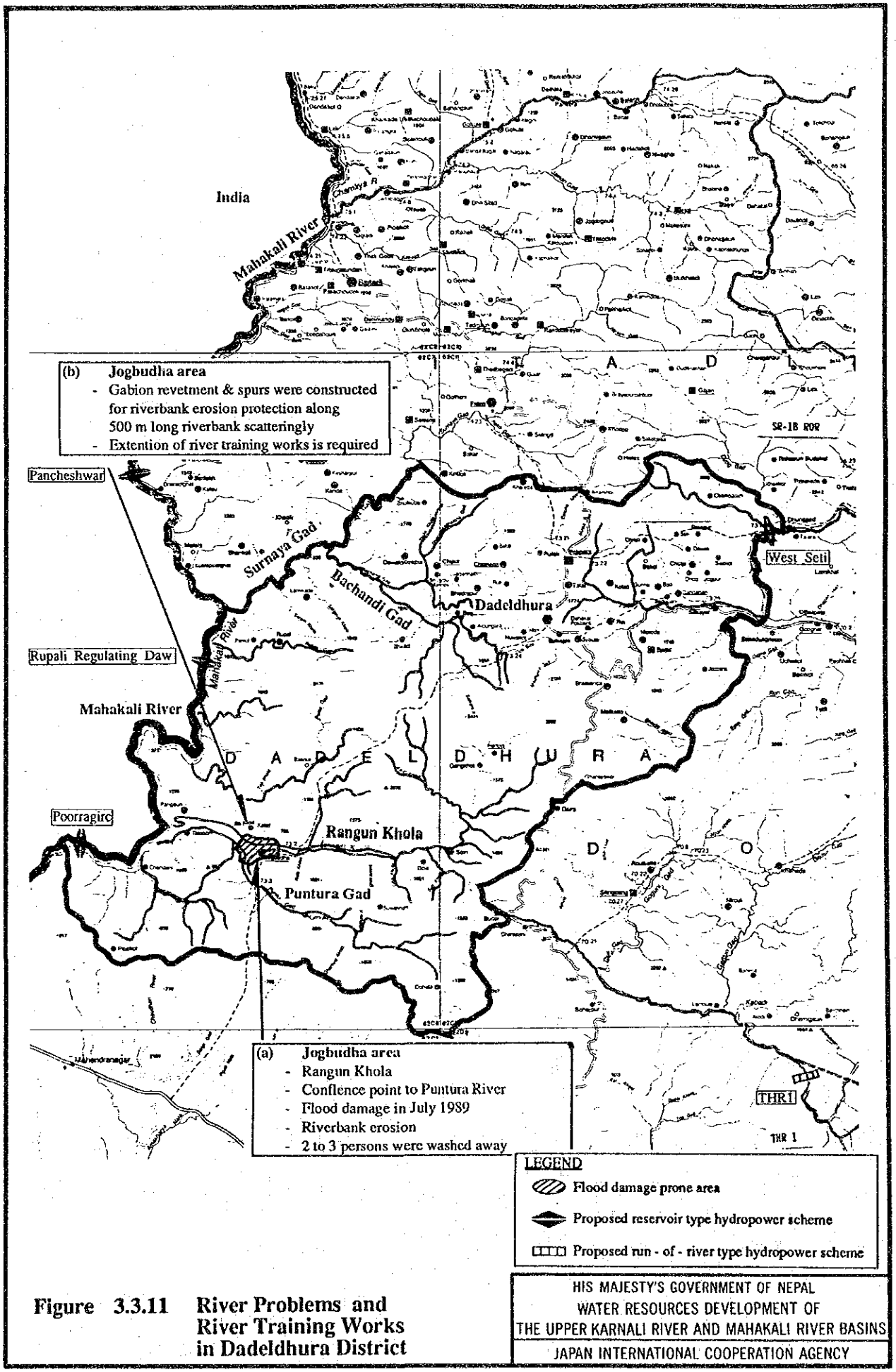


Figure 3.3.11 River Problems and River Training Works in Dadeldhura District

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

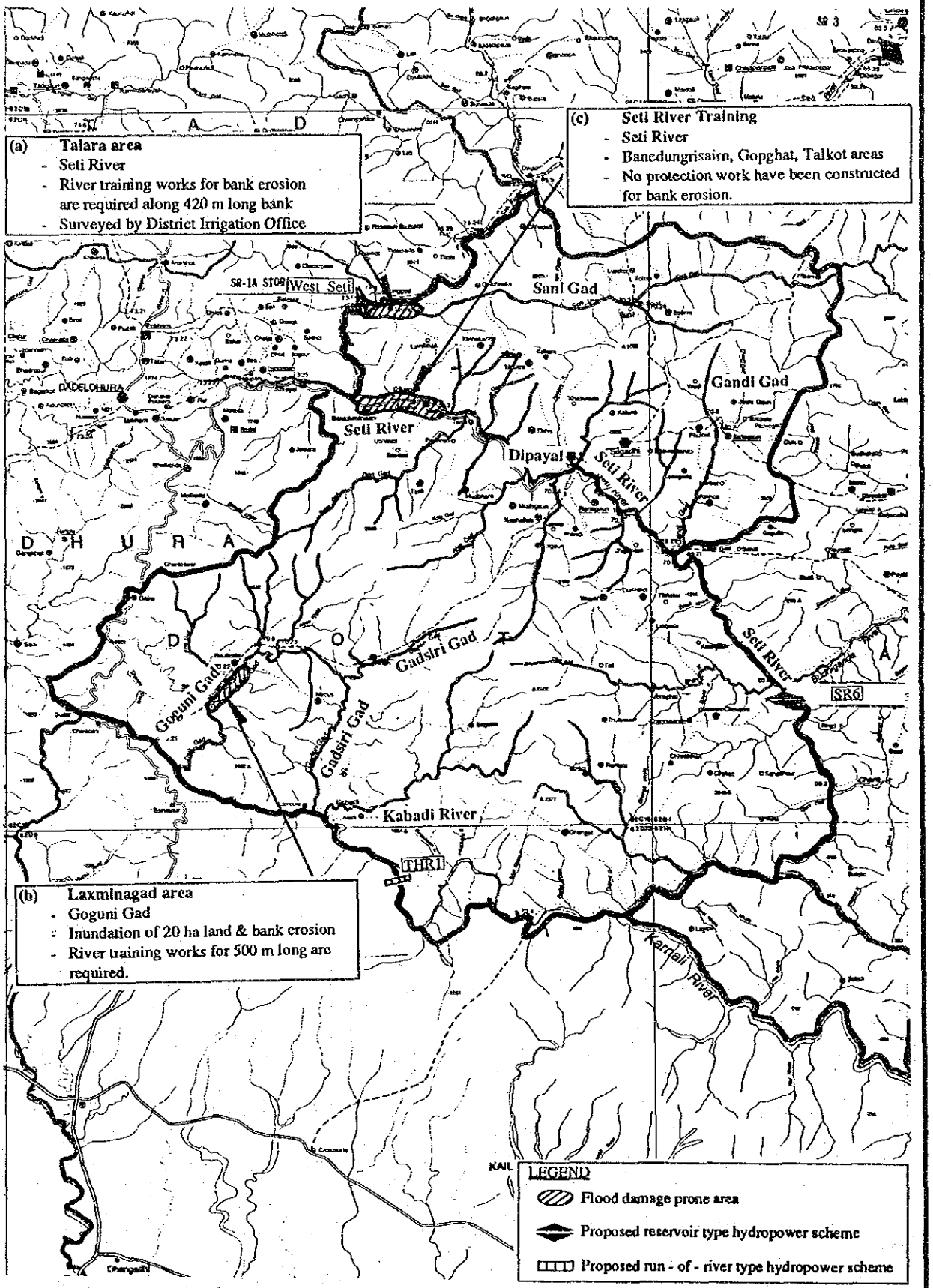


Figure 3.3.12 River Problems and River Training Works in Doti District

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

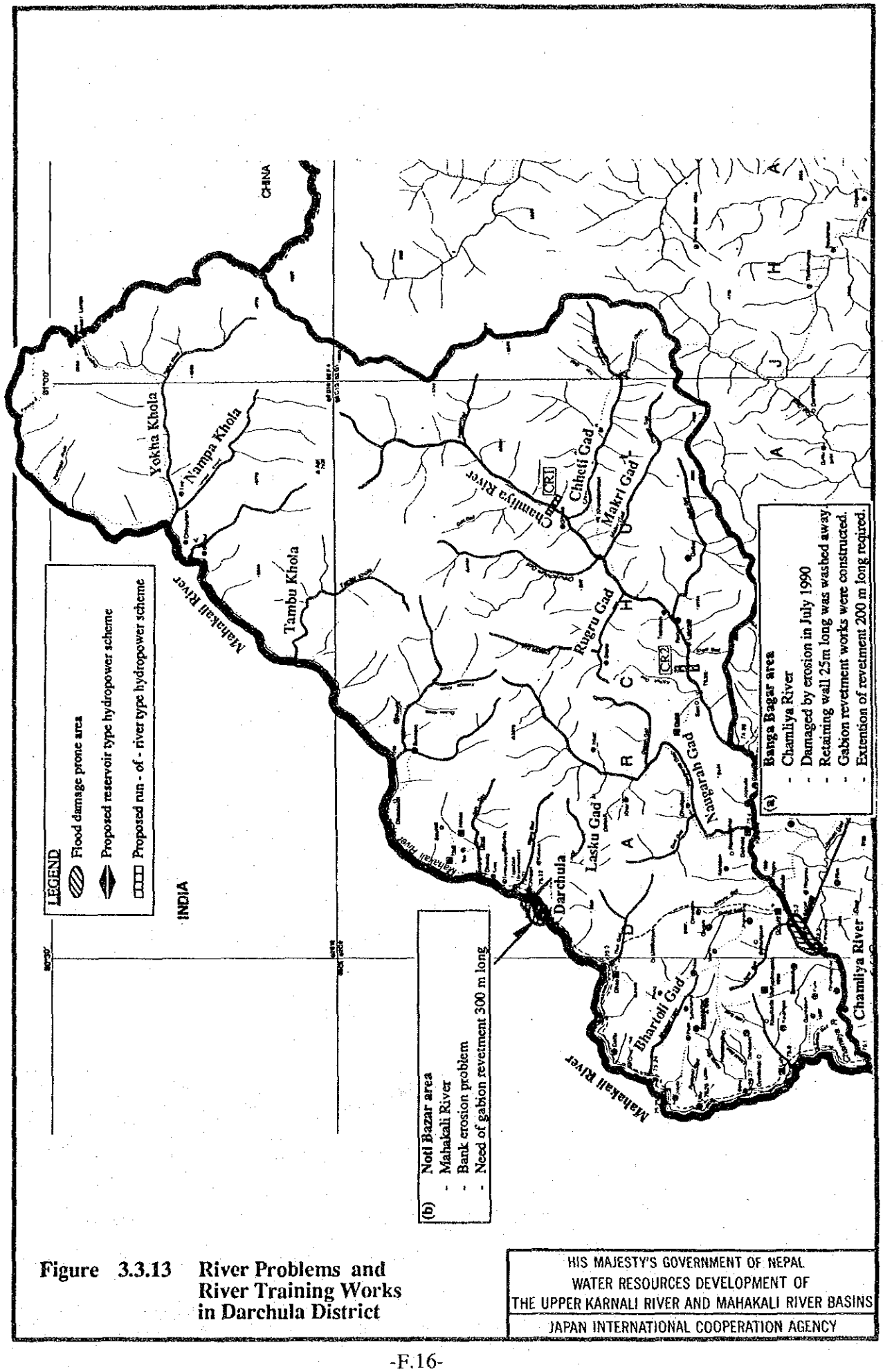


Figure 3.3.13 River Problems and River Training Works in Darchula District