

JAPAN INTERNATIONAL COOPERATION AGENCY
DEPARTMENT OF IRRIGATION
MINISTRY OF WATER RESOURCES
THE KINGDOM OF NEPAL

THE STUDY
ON
FLOOD MITIGATION PLAN
FOR
SELECTED RIVERS IN THE TERAI PLAIN
IN
THE KINGDOM OF NEPAL

FINAL REPORT
VOLUME III (9/9)
SUPPORTING REPORT
(B,C AND D)

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**THE STUDY
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FINAL REPORT

VOLUME I : EXECUTIVE SUMMARY

VOLUME II : MAIN REPORT

VOLUME III : SUPPORTING REPORT

A1: FLOOD MITIGATION PLAN/RATUWA RIVER

A2: FLOOD MITIGATION PLAN/LOHANDRA RIVER

A3: FLOOD MITIGATION PLAN/LAKHANDEI RIVER

A4: FLOOD MITIGATION PLAN/NARAYANI RIVER

A5: FLOOD MITIGATION PLAN/TINAU RIVER

A6: FLOOD MITIGATION PLAN/WEST RAPTI RIVER

A7: FLOOD MITIGATION PLAN/BABAI RIVER

A8: FLOOD MITIGATION PLAN/KHUTIYA RIVER

B : OVERALL DESCRIPTION OF STUDY AREA

C : BASIC INVESTIGATIONS AND STUDIES

D : OTHER DOCUMENTS

VOLUME IV : DATA BOOK



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US\$ 1.00=NRs.67.93

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B. OVERALL DESCRIPTIONS OF STUDY AREA



SUPPORTING REPORT
B. OVERALL DESCRIPTIONS OF STUDY AREA

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1. TOPOGRAPHY AND GEOLOGY

1.1 Location and Topography

Nepal with an area of 147,181 km² is a landlocked country situated at a distance of about 500 km from the nearest sea. It extends from 26°22'N to 30°27'N and from 80°04'E to 88°12'E. It stretches for about 900 km in an east-west direction and for about 200 km in a north-south one, being sandwiched between China on the north and India on the south.

Nepal is a mountainous country. About 77% of its total area is covered by mountainous lands. In general, the topographic altitude decreases from Himalayan range on the north end towards south. At the southern end, there exists the Terai plain.

The Terai plain whose elevation ranges from about 50 m to 300 m,MSL covers some 14% of the total area of Nepal.

1.2 Geohistory and Geomorphology

The Himalayas stretch from the Nanga Parbat peak in the northwest to the Namche Barwa massif in the east. Its length is approximately 2,400 km from west to east, and varies in width from 150 to 300 km.

The Himalayas are believed to have originated in a broad sea basin bordering a land mass. This sea lay between Gondwana land in the south and the Eurasian plate in the north.

In the Eocene (65 million years ago), the Indian sub-continental plate divided from Gondwana land and abutted against the Eurasian plate. The meeting line or zone of the two plates called as the Indus-Tsangpo suture line or zone is located in the north of Tibet and the Tethys sea lay between both plates.

The top of the Indian shield (plate) is hidden under the Eurasian plate. Geological record shows that the Himalayas were formed from the Tethys sea, and this sea was nearly filled up with sediment during the Cretaceous period. This organic process started lifting the seabed to shape the mountain. With the creation of the mountains, natural forces started their influence. Antecedent rivers like the Kosi, Gandaki, Karnali, and Mahakali, which were contemporaneous to the Himalayas, started eroding the

mountains to draining southwards. Since the Mahabharat mountains and Siwalik hills did not exist at the initial stage, these rivers flowed straight to the south. Later, with the rise of the Himalayas, the Mahabharat range was formed and the rivers flowing toward south were blocked, except the rivers whose erosion prevailed against rise of hills. These intercepted rivers started following parallel to the Mahabharat range in search of the exit at the weak points, like faults, folds, or low elevations. This led to the formation of longitudinal valley.

More recently, the Siwalik (Churia) hills and Indo-Gangetic basin was thrust into existence, and the river started filling up with detritus from the north. The Indo-Gangetic basin consisting of nearly 1,600 meters deep alluvium was filled with clastics derived from the Himalayas over a period of 1 to 10 million years. Finally, these natural forces located the present topographical features and geological formations. Figure B1.1 shows the general geomorphologic view of the Nepal Himalayas and its neighborhood.

Figure B1.2 shows the topographic feature by contour lines, and Fig. B1.3 depicts the geological map of Nepal and its main tectonic zones. The topographical features of the Study Area are influenced by (1) tectonics, (2) rock types, and (3) climate.

(1) Tectonics

The Himalayas extend east-west direction mostly being at right angle to the compressive force of orogeny. The major faults or thrusts also have east-west direction in parallel to the Himalayas. Some exceptions are Kali Gandaki fault and Arun anticline, which extend toward right angle to the Himalayas.

The principal tectonics in the Study Area is composed of Main Central Thrust (MCT), Main Boundary Thrust (MBT), and Himalaya Frontal Fault (HFF).

(2) Rock Types

After the rise of the Himalayas, rock types have played a vital role in shaping the topographic corrugation. Hard rocks like granite and gneiss stand higher when compared to the softer rocks. Snow clad peaks and adjoining mountain ranges in the north mostly consist of gneiss, quartzite and granite and, in few cases, limestone.

The granitization and magmatization has added to the strengthening the rocks. In the

midland part where the hard rock is absent, the topography consists mostly of low-lying hills and valleys. At Tansen near the upper Tinau river where soft rocks are exposed, the Mahabharat range is not conspicuously developed. Where the limestone and dolomite are exposed, the chemical weathering creates a serrated topography. This feature is dominant in the central to western part of Nepal.

The Siwalik hills in the south consist of sandstone and shale beds in a cyclic formation. Some of the sandstone beds in the upper parts are loosely cemented. In this zone the dip of the bed is towards the north, and escarpment structures are visible in central Nepal. In the eastern Nepal the sandstone beds of Siwalik hills are soft, so that it shows the heavily weathered land topography.

(3) Climate

Temperature and humidity help in the weathering and disintegration of rocks, and rainwater helps in washing out the weathered material. In Nepal as rocks are generally found dipping toward north and faults extend to east west direction, the steep slope is found on the southern side. As sunshine mostly hits the southern slope, the temperature on the southern slope is higher than the northern one. In the areas like the Siwalik hills and Mahabharat range the southern slope is mostly dry. In contrast, numerous springs and seepage are found on the northern slope.

In the higher mountains, the southern slope is covered with more vegetation as compared to the northern slope where vegetation growth is limited due to the lack of sunshine. Chemical weathering is accelerated during the daytime on the southern slope. Physical weathering (temperature) is dominant during the summer, and chemical weathering in the rainy season and winter.

As rainfall is heavy on the southern slope of the Mahabharat range, the erosion in the southern slope is active and hence a very small amount of weathered material is retained. In such places rock falls are more common than slides, whereas, on the northern slope where rain water is retained as spring water, chemical weathering is much more pronounced, hence slides which may be due to rock avalanche or talus creep occur frequently.

1.3 Topographical and Geological Zone

Topography and geology of Nepal can be divided into major six zones. The eight river

basins for the Study fall under the following zones (Fig.B1.4):

(Zones)	(Related river basins)
• Inner Himalayan valleys	: Narayani river
• Higher Himalayan zone	: Narayani river
• Lesser Himalayan zone	
• Midland range	: Narayani and West Rapti rivers
• Mahabharat range	: Narayani, Tinau, West Rapti and Babai rivers
• Siwalik (Churia) hills	: All the eight rivers
• Dun valleys	: Narayani and West Rapti rivers
• Terai plain	: All the eight rivers

(1) Inner Himalayan Valleys

North of the Higher Himalayan zone and south of Tibetan plateau are called as Inner Himalayan valleys including Mustang and Langu. In these valleys the amount of annual rainfall is small below 250 mm. The rocks are of Tethys sediments with recent alluvium covering.

(2) Higher Himalayan Zone

Snow covered peaks and deep and "U" shaped glacial hanging valleys are the main topographic features in the Higher Himalayan zone. The mountains above 3,800 m,MSL are mostly barren of vegetation and above 4,800 m,MSL snow occurs at most places. Higher peaks are mostly located in east Nepal as compared to the west. On mountain slopes, glacial moraines are found. Sometimes the moraines form glacial lakes which are found mostly in northern Nepal.

The topographic slope in this zone varies from vertical to 740 m/km. This slope makes rocks unstable. In Nepal the dip of rock is generally towards the north east. In places where river makes bend and dip is towards the valleys, exposed bedrock slips due to the load pressure exceeding frictional force. The load increases with erosion of the valley and decreases with erosion of surface layer.

Rivers have gradient of 200 to 740 m/km and flow velocity increases at summer night when the snow-melt water reaches the river channel. Snow melts during the day and it takes about 5 to 6 hours to reach the river channel. In this zone, rockslides or mountain slides often happen. Gravity slides occur in the bed dips of 30° to 60°. Below or above this dip rocks are mostly stable, unless they are fractured.

(3) Lesser Himalayan Zone

Lesser Himalayan zone occupies the central part of the Himalayan Mountains. It consists of a series of mountain ranges rising abruptly above its low rolling hills.

The Lesser Himalayan zone is divided into two sub-ranges, namely the Midland and Mahabharat ranges from north.

Midland Range

The Midland range consists of low hills, river and tectonic valleys. The slope ranges from 100 to 400 m/km. In this range, generally the rocks consist of fissile phyllite and schist (Fig. B1.5(a)). The dip of the bed in this part is generally towards the north. In the areas where rivers have east-west course, landslides are seen on the southern bank of the river. Since the phyllite is a soft rock, the exposed bed in the bottom section of hill is found to be crushed in most places, indicating that the load is beyond its bearing capacity.

The Midland range is composed of soft rocks (phyllite, slate and dolomite) and thick soil covers this area, hence it is heavily populated. Because soft rocks weather easily, the Midland range forms low and mild slope hills. Nearly all the hill slopes are found to be formed from the talus of landslide and rock fall. Generally the hill slope appears to be stable for a period of 8 to 10 years after the slide till the talus is washed away by under-cutting of the river, and at the same time, this causes the development of gullies and erosion throughout valleys. Slowly the topography changes from flat to steeper terrain and sliding occurs again.

Mahabharat Range

The Mahabharat range consists of comparatively harder rock than the midland range. The number of slides is found to be less even though the topography is steep. The topography is steeper on the southern slope comparing to the northern one of about 100 to 200 m/km. Slides take place on the northern slope and rock falls on the southern slope. The steep of the topography can be attributed to the Main Boundary Fault (MBF) which lies mostly at the southern foot of this range.

The Mahabharat range is the first set of high mountains facing the Terai plain, and

affects much to the climate of Nepal during the monsoon.

(4) Siwalik (Churia) Hills

The Siwalik (Churia) hills are the lowest hills bordering the Indo-Gangetic plain in the north. Mostly it consists of rocks of alternating beds of clay, sandstone, sand and pebble. The rocks generally dip northwards. Alternately loose and hard rock beds have produced the escarpment feature. In many places rugged land with numerous gullies and mound of talus are found. The topographic slope varies from 200 to 400 m/km on the average. The Siwalik hills are divided into three layers, i.e., upper, middle and lower Siwaliks.

Upper Siwalik

The upper Siwalik is mainly conglomerate with pebbles and boulders of pale schistose quartzite, purple and white quartzite, dark phyllites, purple and dark pebbly quartzite, and silt brown sandstone. The depth of upper Siwalik is about 2,000 to 3,000 meters.

Middle Siwalik

The layers of middle Siwalik are found in the form of thick deposits of sandstone. These are characterized by their feldspar and mica content. Apparently the sandstone has been derived from granite rocks. Calcareous concretions and seams of coal are found in the basal part. In many sections, the sandstone forms vertical cliffs. The depth of middle Siwalik is about 2,000 to 2,500 meters.

Lower Siwalik

The lower Siwalik is an alteration of brown, weathered sandstone and chocolate colored clays. The alternation of beds is not thick as the sandstone. Beds of impure limestone also occur within the lower Siwalik. The depth of lower Siwalik is about 1,200 to 1,500 meters. All pebbles except those found in the brown sandstone are derived from rocks of Pre-tertiary age.

Figure B1.5 (b) shows the stratum profile of the Siwalik hills near the Arun river. The figure indicates the composition of each layer and the state of rising Siwalik hills.

(5) Dun Valleys

The Siwalik hills make separate ranges from east to west except in some places where it merges with Mahabharat range. The separate ranges form Dun Valleys as seen in Trijunga, East Rapti-Nawalpur, Deokhuri (West Rapti), Dang Valley, Surkhet Valley, etc. The Dun Valleys are fertile and are similar to the Terai plain in nature. Hence they are sometimes classified as a part of the Terai plain.

(6) Terai Plain

The Terai plain is the continuation of Indo-Gangetic plain having an elevation from 50 to 300 m,MSL. Its width varies between 10 to 30 km with one exception at Koitabash narrow, and extends from east to west Nepal for about 900 km.

The Terai slopes toward south with steeper slope at the foot hill region and nearly flat at the southern end.

In the Terai plain the changes of river stream are often seen in places by the lateral erosion incorporated by much sediment from the mountainous area. On such rivers, artificial structure works such as bridge, roads and irrigation facilities have to be given careful consideration.

The Terai plain is divided into three zones, i.e., (1) Bhabhar zone (foot of hill), (2) Marshy area (spring line), and (3) Southern Terai (Indian border).

Bhabhar Zone

The Bhabhar zone lies at the foot of Siwalik hills and is about 12 km in width (Charkose Jhadi). It is composed of boulder, pebble, cobble and sand of Siwalik hills or Mahabharat range deposited by the present rivers. In most cases the rocks are sandstone, quartz or cherty dolomite. The foot of hills is covered with evergreen forest.

Soils are mainly alluvium consisting of sand, silt, clay looms and silty clay. In the dry season almost all rivers in this zone have no flow on the surface and water flow underground only.

Geological formation of this zone is shown below taking a sample at the Tarhara farm (East Nepal):

(Depth from surface)	(Description)
1.8 meters	Top Soil
3.3 meters	Fine Sand
7.5 meters	Coarse gravel, pebbles and cobbles.

Marshy Area

The marshy area is found in the south of Bhabhar zone where two lithological units having different porosity and permeability meet or inter finger along with the change of elevation mainly resulting in spring lines, ponds, lakes, etc. The lithology is mostly composed of pebbles and sandy bed with a few clay partings. The lithology of the pebbles is similar to the boulder zone and sand beds are loose, brownish to greenish with black and red shale fragments. The clay is mostly blackish gray where a thick sequence is found, but yellow one is also observed at some places where there was a temporary hiatus in its deposition or because of a flood at that time. This is particularly true in Lumbini zone.

Geological formation of this area is shown below taking a sample at Sunsari (East Nepal):

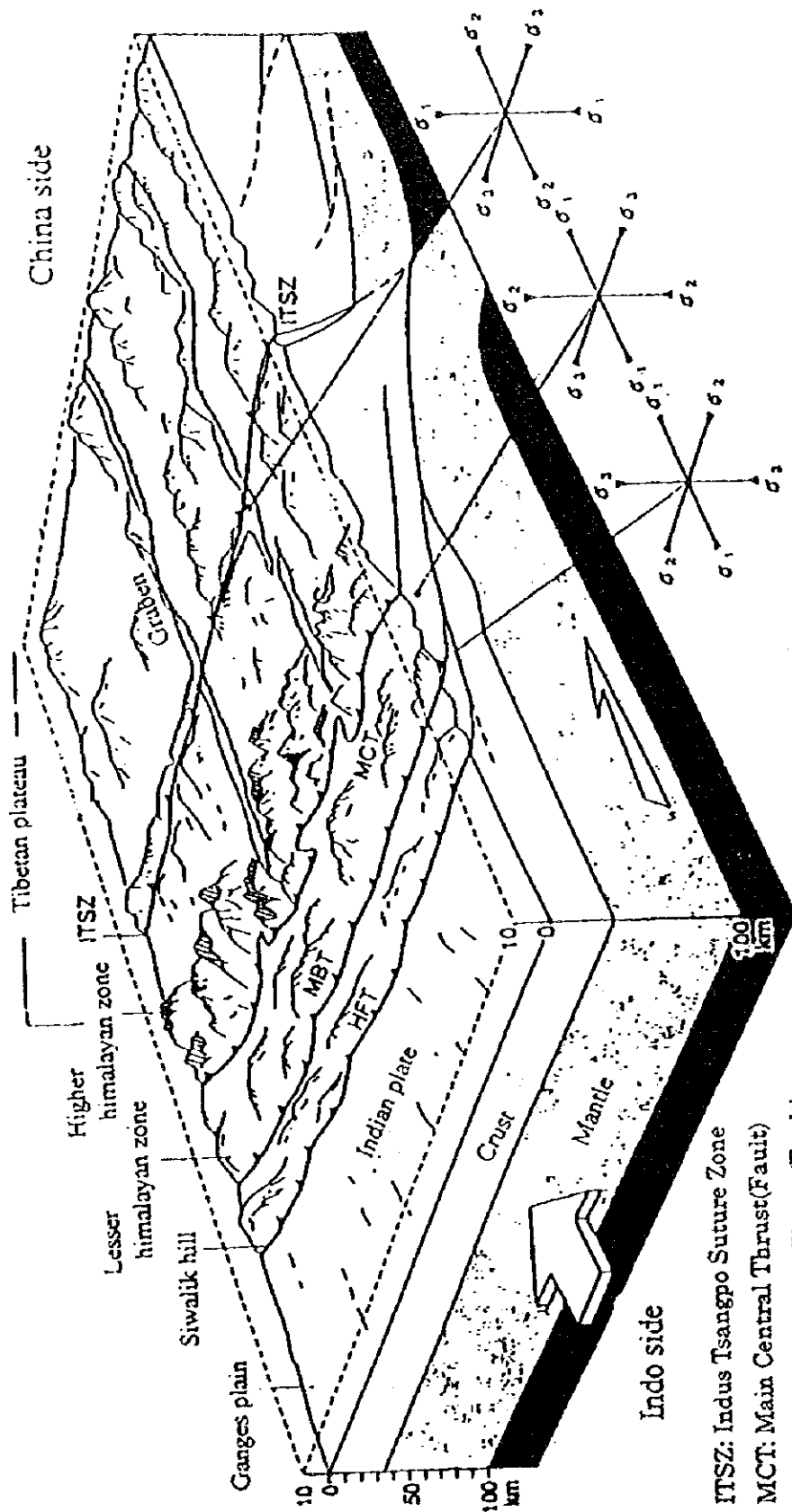
(Depth from surface)	(Description)
1.5 meter	Top soil silt
5.1 meters	Fine to coarse sand
6.6 meters	Yellow silt
7.5 meters	Coarse sand to fine gravel
8.1 meters	Yellow clay
12.3 meters	Fine to medium gravel
20.4 meters	Yellow clay

Southern Terai

This nearly flat and not well-drained area is found between middle Terai and the Indo-Nepal border. The area is composed of sand, clay and silt with less pebble.

Geological formation of this area is shown below taking a sample at Sakhara (East Nepal):

(Depth from surface)	(Description)
1.5 meter	Top surface soil
7.2 meters	Clay, gray
17.7 meters	Sand, gray
24.0 meters	Gravel, gray

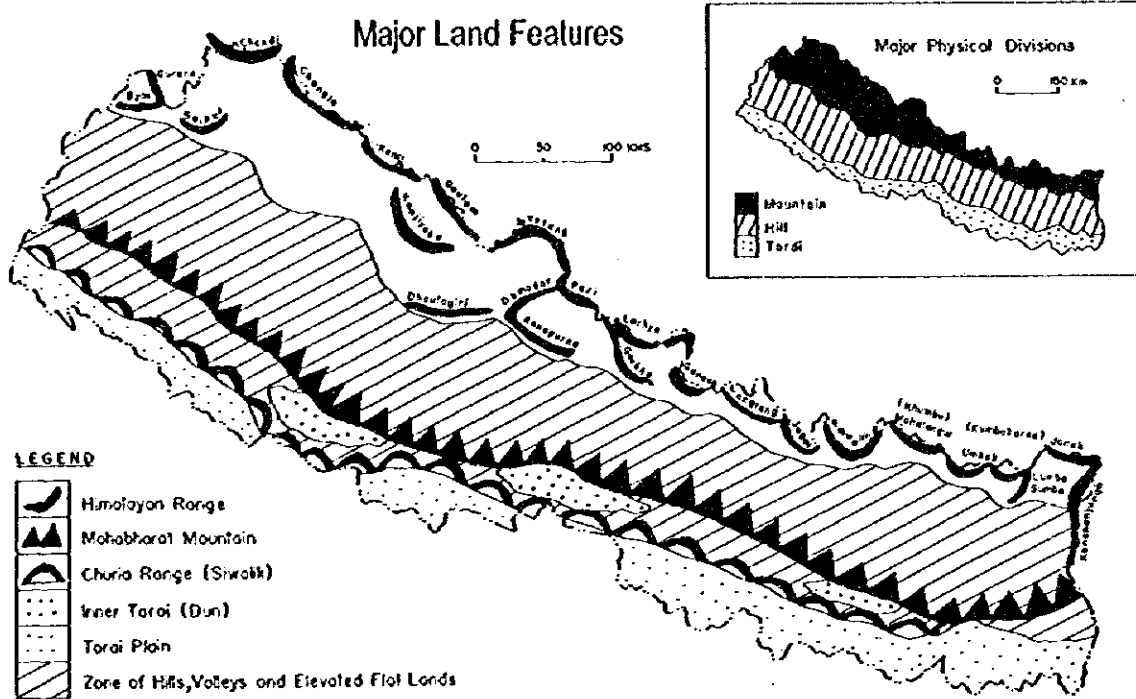
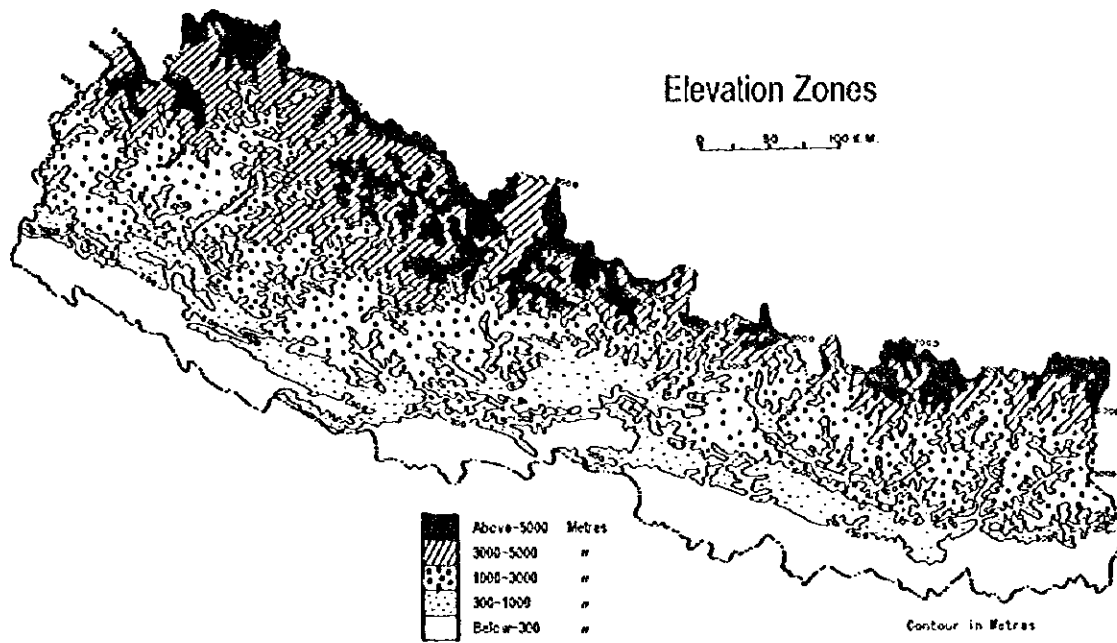


Direction of main stress
 σ_1 : Maximum stress σ_2 : Medium stress σ_3 : Minimum stress

ITSZ: Indus Tsangpo Suture Zone
 MCT: Main Central Thrust(Fault)
 MBT: Main Boundary Thrust(Fault)
 HFT: Himalayan Frontal Fault

GEOMORPHOLOGICAL VIEW OF NEPAL HIMALAYA

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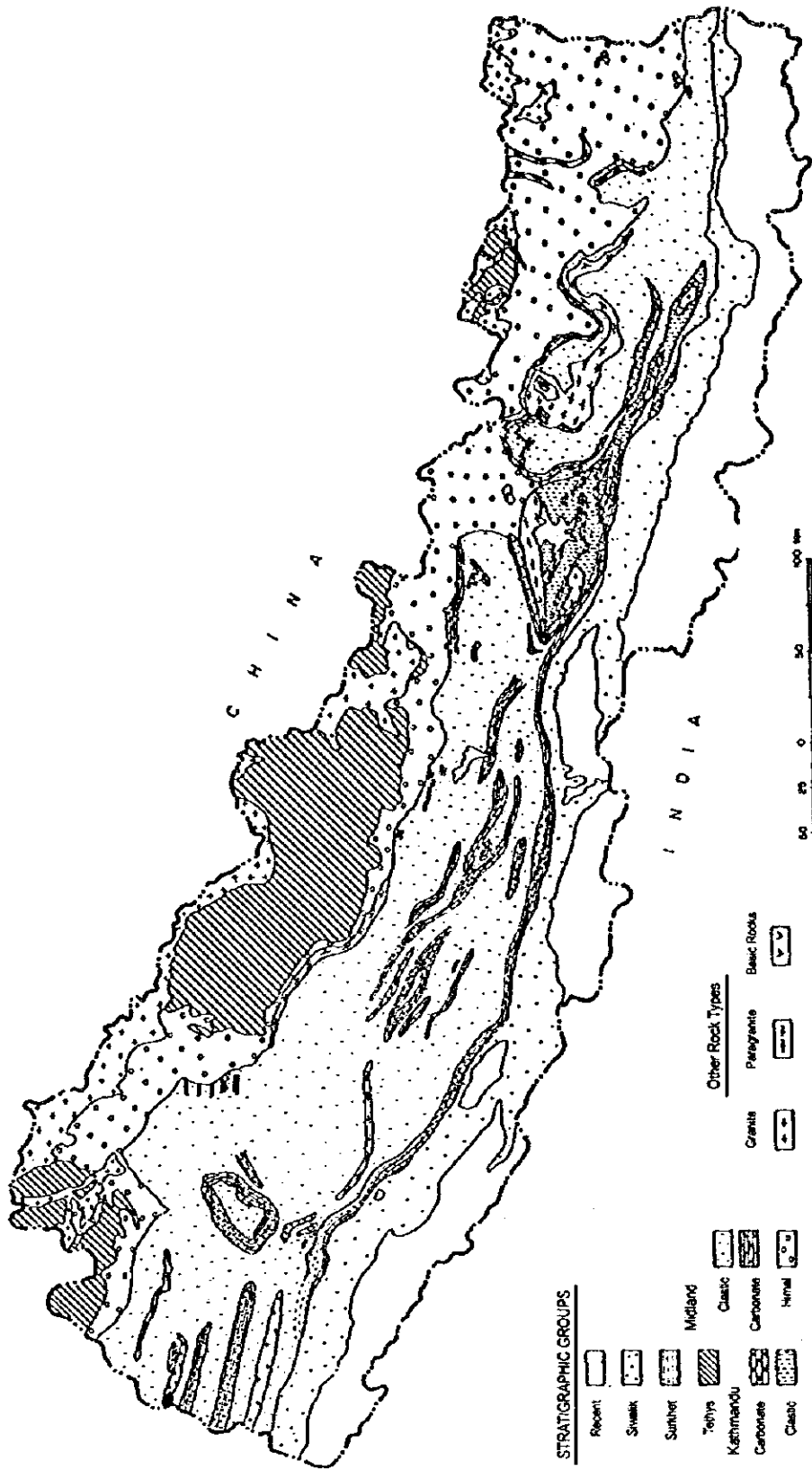


Source: Nepal in Maps, 1988

TOPOGRAPHIC FEATURES

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**THE STUDY ON FLOOD MITIGATION PLAN
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Fig. B1.3

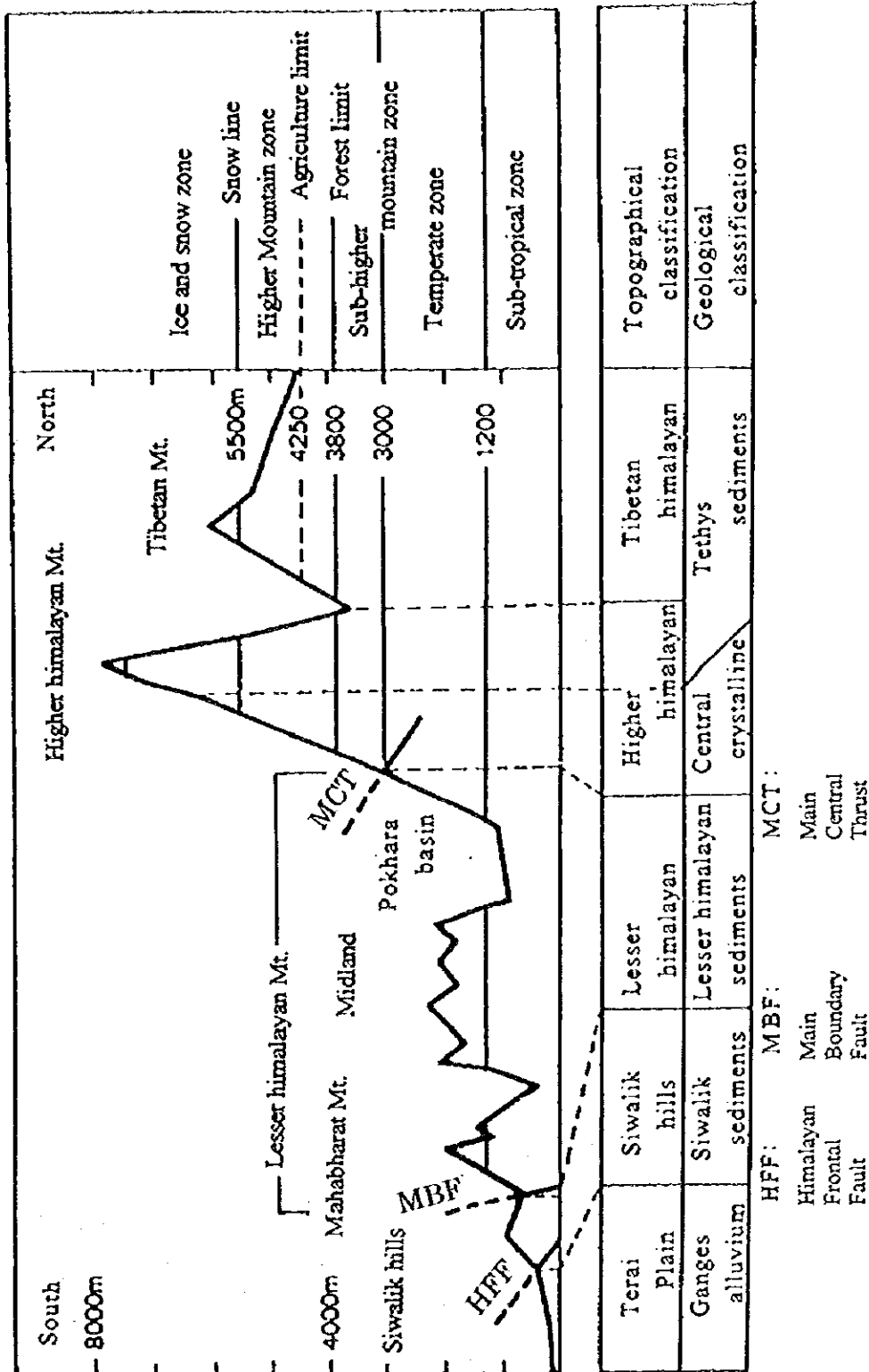


- STRATIGRAPHIC GROUPS**
- Recent
 - Sivalik
 - Sunher
 - Tejhs
 - Kathmandu
 - Carbonate
 - Quaternary
 - Midland
 - Quaternary
 - Carbonate
 - Normal
- Other Rock Types**
- Granite
 - Phengyante
 - Basic Rocks

Source: Nepal in Maps, 1988

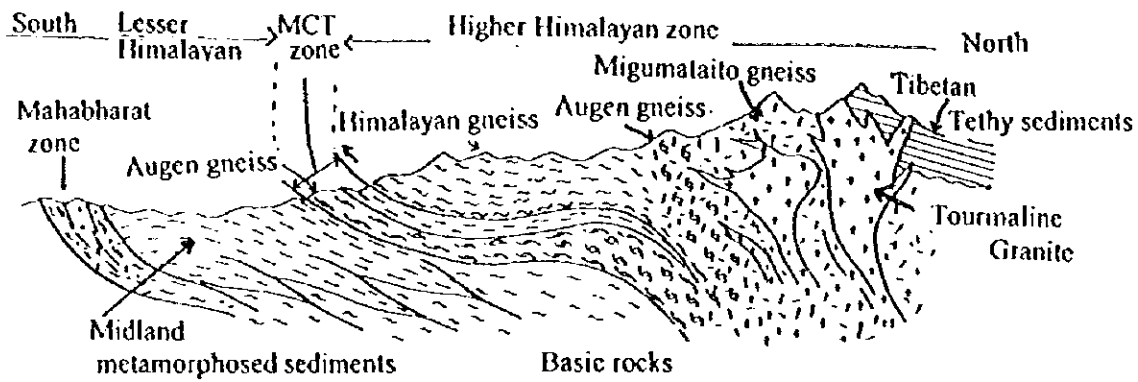
GEOLOGY OF NEPAL

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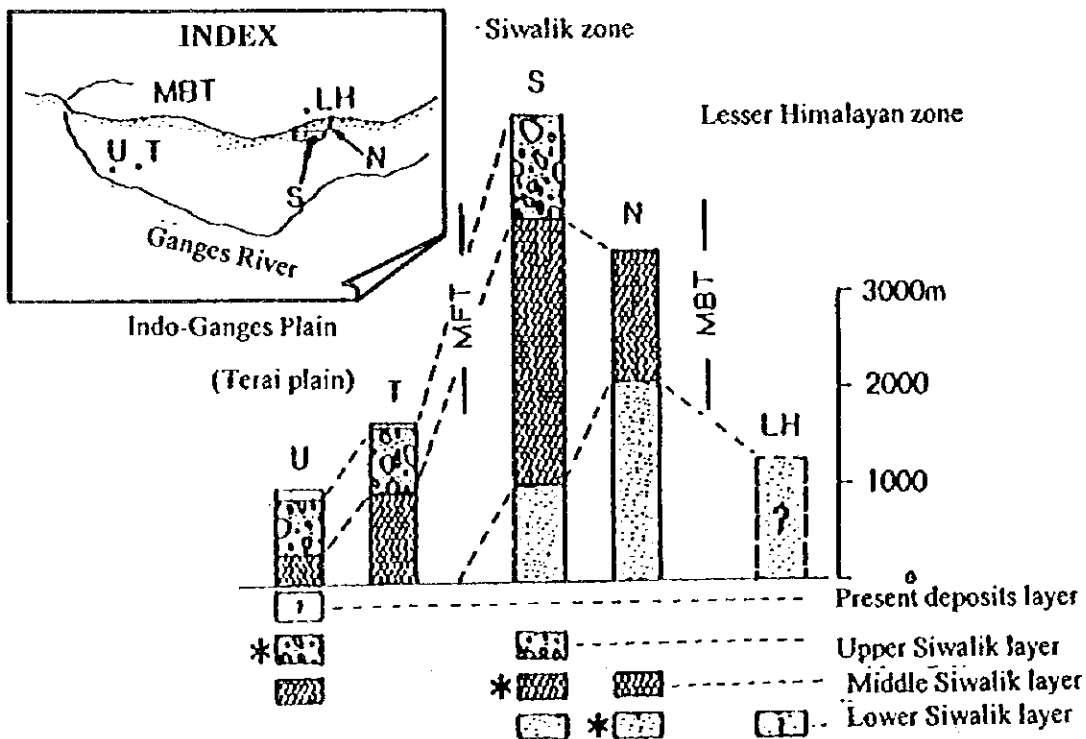


TOPOGRAPHICAL AND GEOLOGICAL CLASSIFICATION (N-S PROFILE)

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(a) GEOLOGICAL FEATURE OF HIMALAYA



(b) PROFILE OF SHIWALIK HILLS

GEOLOGICAL PROFILES OF HIMALAYA AND SIWALIK HILLS

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2. METEOROLOGY AND HYDROLOGY

2.1 Meteo-Hydrological Observation

(1) Meteo-Hydrological Data of Nepal

Responsibilities for meteo-hydrological data collection and analysis in Nepal have been born mainly by the Department of Hydrology and Meteorology (DHM), the Ministry of Science and Technology. Other authorities such as the Department of Irrigation (DOI), Nepal Electricity Authority (NEA), and International Center for Integrated Mountain Development (ICIMOD) also conduct meteo-hydrological observations. In principle, all of these observed data are sent to the DHM. The DHM publishes data in yearbooks after basic checking has been completed.

Meteorological Data

The Meteorology Section in the DHM is responsible for compilation and analysis of meteorological observation records such as precipitation, temperature, humidity, vapor pressure, sunshine, wind, evaporation and soil temperature. These observed data are processed at their computer center. Monthly meteorological data are compiled in the yearbooks of "Climatological Records" and "Precipitation Records" published by the DHM. Unpublished data, such as daily and hourly precipitation, are also available through official procedures.

Hydrological Data

The Hydrology Section in the DHM is responsible for compilation and analysis of hydrological observation records such as water level, discharge and sediment. These observed data are processed at their computer center. Discharge data on a monthly basis are compiled in the yearbooks of "Hydrological Records" published by the DHM. Unpublished daily and hourly discharge data are also available through official procedures. Sediment sample data are not published because the compilation is not completed yet.

Meteorological and Hydrological Stations

Based on the DHM's data, a list of meteorological and hydrological stations is summarized in Tables B2.1 and B2.2, and their locations are shown in Figs. B2.1 and B2.2.

(2) Installation of Recording Rain Gauges

Site Selection

Three (3) recording rain gauges were installed by the Study Team. The installation sites shall be selected based on the following criteria:

- Gauges shall be installed for the Study Area.
- Continuous operation and maintenance shall be secured.
- New gauges shall complement the existing rainfall stations network.

The following sites were selected for the installation of the rain gauges based on the above criteria (Fig. B2.3):

- 1) Bagmati Irrigation Project Office for the Lakhadei river basin: One (1) set. This office is under the direct control of DOI. An ordinary rain gauge (Index No.1121 under DHM) has been installed here.
- 2) Chitwan District Irrigation Office in Bharatpur for the Narayani river basin: One (1) set. This office is under the direct control of DOI.
- 3) Banke District Irrigation Office in Nepalganj for the lower Babai and West Rapti river basin: One (1) set. This office is under the direct control of DOI. An ordinary rain gauge (Index No.0416 under DHM) has been installed here.

Observation

The recording rain gauge consists of two parts, the rain gauge and the recorder. The rain gauge is placed outdoors on open ground or on a flat roof of the building, while the recorder is kept indoors. The assigned caretaker will undertake periodic maintenance of the rain gauge and recorder. Details of the equipment installed at each site are summarized below:

River basin	Caretaker	Serial Number
Lakhadei	Bagmati Irrigation Project Office (Karmaiya, Sarlahi)	Gauge: 232734 Recorder: 244190
Narayani	Chitwan District Irrigation Office (Bharatpur)	Gauge: 232746 Recorder: 244191
Babai/West Rapti	Banke District Irrigation Office (Nepalganj)	Gauge: 232717 Recorder: 244189

(3) Installation of Water Level Gauges

Site Selection

The Study Team installed six (6) water level gauges. The installation sites shall be selected based on the following criteria:

- Gauges shall be installed in the Study Area.
- The site shall be selected at the outlet of mountainous basin.
- The site shall be convenient for installation and measurement.
- Continuous operation and maintenance shall be secured.

The following sites were selected for the installation of water level gauges (Fig. B2.3):

- 1) Highway bridge at Damak for the Ratuwa river (2 sites)
 - Ratuwa River: Left side pier of the East-West Highway bridge
 - Ratuwa River: Right side pier of the East-West Highway bridge
- 2) Highway bridge at Lalbhitti for the Lohandra river (1 site)
 - Lohandra River: Left side pier of the East-West Highway bridge
- 3) Hulaki road near Malangawa for the Lakhandei river (2 sites)
 - Lakhandei River: Left side abutment of the road bridge near the Malangawa
 - Lakhandei River: Left side pier of the road bridge near the Malangawa
- 4) Barrage site for the Babai river (1 site)
 - Babai River: Downstream of Babai barrage for rehabilitation of the existing staff gauge.

Observation

The assigned caretaker at each site will undertake observation of water level and maintenance of staff gauge. The readings of water level are made daily at 8:45 and 17:00. During the flood period, the water level should be observed continuously except at nighttime. Locations of the equipment installed at each site are summarized below:

River	Caretaker	Remarks
Ratuwa	Jhapa District Irrigation Office (Chandragadhi)	Left bank bridge pier: 5 m Right bank bridge pier: 5 m
Lohandra	Morang District Irrigation Office (Biratnagar)	Left bank bridge pier: 5 m
Lakhandei	Sarlahi District Irrigation Office (Malangawa)	Left bank bridge abut: 4 m Left bank bridge pier: 3 m
Babai	Babai Irrigation Project Office (Babai, Bardiya)	Repair of downstream staff gauge: 8 m

2.2 Meteo-Hydrological Features of Nepal

The variation in altitude leads to a variety of climatic conditions from tropical to tundra in Nepal. In addition to the tremendous variations in altitude, dry and rainy (monsoon) seasons also give rise to extreme climatic contrast. The vertical variations and monsoon cause the contrasts in the Nepalese meteorological features such as temperature, moisture, winds and precipitation.

The latest yearbooks for the 10-year period from 1985 to 1994 were examined and the meteorological data for 29 stations in Nepal are summarized in Tables B2.3 and B2.4. Table B2.3 shows a summary of meteorological conditions and Table B2.4 gives details of average monthly rainfall and air temperatures. The locations of these 29 meteorological stations are shown in Fig. B2.4.

(1) Air Temperature and Humidity

Altitude affects the temperature. The higher the altitude the cooler the climate. As such, lowlands like the Terai, the Inner Terai and the midlands are warmer, and the hilly and the Himalayan regions are cooler. In the altitude below 600 m,MSL, the climate is tropical with a hot and moist atmosphere.

Among the 29 stations the highest annual mean maximum temperature is 31.2°C at Manusmara (sta. code No: 1118) in Sarlahi district with a elevation of 100 m,MSL, The lowest annual mean minimum temperature is -1.3°C at Mustang (0612) in Mustang district at elevation 3,705 m,MSL. An increase in altitude leads to a decrease of air temperature. Figure B2.5 shows the relationship between air temperature and elevation.

The coldest month is in January and the hottest month in June and July. The temperature rises from March to June/July while it decreases from October to January. Temperature rises from eastern to western Terai in general, but in the hills due to the effect of altitude the temperature is variable.

The annual mean relative humidity ranges from 75% to 85% at the 29 stations. Relations between relative humidity and elevation are plotted in Fig. B2.6. No significant relation was found between relative humidity and elevation.

(2) Rainfall

Nepal receives the southeast monsoon during the months from June to September. The monsoon air-stream is forced to rise as it meets the Himalayas and causes heavy rainfall on south facing slopes. The highest rainfall is recorded along the Churia/Mahabarat hills on the southern margin of the mountain zone. In the lee of these zones, the rainfall is reduced. Rainfall zones tend, therefore, to run parallel with the main mountain ridges. The monsoon has little effect above 3,000 m,MSL.

Rainfall distribution varies according to topography. As the rain-bearing wind approaches to Nepal from the southeast in the summer monsoon season, it increases altitude due to the existence of Siwalik hills and heavy rainfall occurs in on the hill slopes. Pokhara region is one of the heaviest rainfall areas in Nepal. On the contrary, the foothills of the Great Himalayas receive less rainfall located on the lee. Figure B2.7 shows the isohyetal maps of annual rainfall and that during monsoon period over the country.

The annual rainfall ranges from 100 mm to 3,800 mm for the 29 stations. Relationships between annual rainfall and elevation are plotted in Fig. B2.8. According to this figure, the annual rainfall depth is less than 50 mm in the mountainous area over 2,500 m in altitude and about 1,000 mm to 3,000 mm in the Terai plain with an altitude less than 500 m,MSL. The annual rainfall increases from 1,000 mm to 2,500 mm as elevation increases from 500 m to 2,500 m,MSL. Most rainfall is recorded in July to August and the least rainfall occurs in November to January at every station.

(3) Hydrology

In the mountain and midland zones, the geology tends to promote rapid run-off due to dense network of small steep streams draining into the major rivers. In contrast, in the Siwalik hills, the geology promotes groundwater storage.

Melted snow contributes to the run-off mainly from March to July and increases the river flow before the monsoon rains. In the catchments lying below 3,000 m,MSL, there is no significant contribution of snow. In these catchments, no rise of flow is found before the monsoon rains, and run-off is concentrated in the monsoon season.

Figure B2.9 shows the monthly flows at the flow observation stations of the major rivers.

Table B2.1 (1/5)

LIST OF METEOROLOGICAL STATIONS

Station No.	Station Name	Type of Station	Reg.	Latitude		Longitude		Elevation (m)	Start of Record	Remarks		
				°	'	°	'					
0101	Kakerpalha	Precipitation	FW	29	39	00	80	30	00	842	05-1956	
0102	Baitadi	Precipitation	FW	29	33	00	80	25	00	1,635	02-1973	
0103	Patan (West)	Climatology	FW	29	28	00	80	32	00	1,266	05-1956	
0104	Dandeldhura	Synoptic	FW	29	18	00	80	35	00	1,865	05-1956	
0105	Mahendra Nagar	Agrometeorology	FW	29	02	00	80	13	00	176	02-1971	
0106	Belauri Santipur	Precipitation	FW	28	41	00	80	21	00	159	02-1971	Khutiya+
0107	Darchula	Climatology	FW	29	51	00	80	34	00	1,097	02-1974	
0108	Satbanj	Precipitation	FW	29	32	00	80	28	00	2,370	06-1976	
0201	Pipalkot	Precipitation	FW	29	37	00	80	52	00	1,456	06-1956	
0202	Chainpur (West)	Climatology	FW	29	33	00	81	13	00	1,304	06-1956	
0203	Silgadi Doti	Climatology	FW	29	16	00	80	59	00	1,360	06-1956	
0204	Pajura	Precipitation	FW	29	23	00	81	19	00	1,400	01-1976	
0205	Katai	Precipitation	FW	29	00	00	81	08	00	1,388	12-1957	
0206	Asara Ghat	Precipitation	FW	28	57	00	81	27	00	650	03-1963	
0207	Tikapur	Climatology	FW	28	30	00	80	57	00	140	03-1976	
0208	Sandepani	Precipitation	FW	28	45	00	80	55	00	195	12-1957	Khutiya+
0209	Dhangadhi	Climatology	FW	28	41	00	80	36	00	170	06-1956	Khutiya
0210	Bangga Camp	Climatology	FW	28	58	00	81	07	00	340	03-1963	
0211	Khaptad	Precipitation	FW	29	23	00	81	12	00	3,430	04-1976	
0212	Sitapur	Precipitation	FW	28	34	00	80	49	00	152	02-1971	Khutiya+
0214	Kola Gaun	Precipitation	FW	29	07	00	80	41	00	1,304	02-1971	Khutiya+
0215	Godavari (West)	Climatology	FW	28	52	00	80	38	00	288	06-1975	Khutiya
0217	Mangalsen	Precipitation	FW	29	09	00	81	17	00	1,345	01-1979	
0218	Dipayal (Doti)	Synoptic	FW	29	15	00	80	57	00	617	12-1981	
0219	Dhangadhi	Synoptic	FW	28	41	00	80	36	00	170	*	
0301	Mugu	Precipitation	MW	29	45	00	82	33	00	3,803	06-1958	
0302	Thirpu	Precipitation	MW	29	19	00	81	46	00	1,006	12-1956	
0303	Jumla	Synoptic	MW	29	17	00	82	10	00	2,300	12-1956	
0304	Guti Chaur	Precipitation	MW	29	17	00	82	19	00	3,080	06-1976	
0305	Sheri Ghat	Precipitation	MW	29	08	00	81	36	00	1,210	02-1966	
0306	Gam Shree Nagar	Precipitation	MW	29	33	00	82	09	00	2,133	10-1970	
0307	Rara	Climatology	MW	29	33	00	82	07	00	3,048	10-1970	
0308	Nagma	Precipitation	MW	29	12	00	81	54	00	1,905	10-1970	
0309	Bijayapur (Raskot)	Precipitation	MW	29	14	00	81	38	00	1,814	12-1956	
0310	Dipayal Gaun	Climatology	MW	29	16	00	82	13	00	2,310	06-1974	
0311	Simikot	Climatology	MW	29	58	00	81	50	00	2,800	05-1976	
0312	Dunai	Climatology	MW	28	56	00	82	55	00	2,058	06-1958	
0313	Darna	Precipitation	MW	29	41	00	82	06	00	1,950	09-1979	
0401	Pusma Camp	Climatology	MW	28	53	00	81	15	00	950	03-1963	
0402	Dailekh	Climatology	MW	28	51	00	81	43	00	1,402	01-1957	
0403	Janu (Tikuwa Kuna)	Precipitation	MW	28	47	00	81	20	00	260	05-1963	
0404	Jajarkot	Precipitation	MW	28	42	00	82	12	00	1,231	12-1956	
0405	Chisapani (Karnali)	Climatology	MW	28	39	00	81	16	00	225	01-1963	
0406	Surkhet (Birendra Nagar)	Synoptic	MW	28	36	00	81	37	00	720	01-1957	
0407	Kusum	Precipitation	MW	28	01	00	82	07	00	235	11-1956	West Rapti
0408	Gulariya	Precipitation	MW	28	10	00	81	21	00	215	01-1957	Babai
0409	Khajura (Nepalgunj)	Agrometeorology	MW	28	06	00	81	34	00	190	01-1968	West Rapti
0410	Bale Budha	Precipitation	MW	28	47	00	81	45	00	610	05-1965	
0411	Rajapur	Precipitation	MW	28	26	00	81	06	00	129	02-1971	
0412	Naubasta	Precipitation	MW	28	16	00	81	43	00	135	02-1971	West Rapti
0413	Shyalo Shree	Precipitation	MW	28	27	00	81	35	00	302	02-1971	Babai
0414	Baijapur	Precipitation	MW	28	03	00	81	54	00	226	02-1971	West Rapti
0415	Bargadaha	Precipitation	MW	28	26	00	81	21	00	200	11-1967	Babai
0416	Nepalgunj (Reg Off.)	Climatology	MW	28	04	00	81	37	00	144	02-1973	West Rapti
0417	Rani Jaruwa Nursery	Climatology	MW	28	23	00	81	21	00	200	12-1975	Babai
0418	Maina Gaun (D.bas)	Precipitation	MW	28	59	00	82	17	00	2,000	05-1975	
0419	Sikta	Agrometeorology	MW	28	02	00	81	47	00	195	05-1978	West Rapti
0501	Rukumkot	Precipitation	MW	28	36	00	82	38	00	1,560	07-1957	
0502	Shera Gaun	Precipitation	MW	28	35	00	82	49	00	2,150	07-1957	
0504	Libang Gaun	Precipitation	MW	28	18	00	82	38	00	1,270	07-1957	West Rapti
0505	Bijuar Tar	Precipitation	MW	28	06	00	82	52	00	823	08-1957	West Rapti
0507	Nayabasti (Dang)	Precipitation	MW	28	13	00	82	07	00	698	12-1970	Babai
0508	Tulsipur	Climatology	MW	28	08	00	82	18	00	725	12-1970	Babai
0509	Ghorahi (Masina)	Precipitation	MW	28	03	00	82	30	00	725	12-1970	Babai
0510	Loilabas	Precipitation	MW	27	42	00	82	32	00	320	02-1971	
0511	Salyan Bazar	Climatology	MW	28	23	00	82	20	00	1,457	11-1956	Babai

Table B2.1 (2/5)

LIST OF METEOROLOGICAL STATIONS

Station No.	Station Name	Type of Station	Reg.	Latitude			Longitude			Elevation (m)	Start of Record	Remarks
				°	'	"	°	'	"			
0512	Luwamjula Bazar	Precipitation	MW	28	18	00	82	17	00	885	11-1971	Babai
0513	Chaur Jhari Tar	Climatology	MW	28	32	00	82	01	00	910	06-1975	
0514	Musikot (Rukumkot)	Climatology	MW	28	38	00	82	29	00	2,100	07-1973	
0515	Ghorai	Synoptic	MW	28	03	00	82	30	00	725	*	
0601	Jomsom	Climatology	W	28	47	00	83	43	00	2,744	07-1957	Narayani
0604	Thakmarpha	Agrometeorology	W	28	45	00	83	42	00	2,566	12-1966	Narayani
0605	Baglung	Climatology	W	28	16	00	83	36	00	984	05-1969	Narayani
0606	Tatopani	Precipitation	W	28	29	00	83	39	00	1,243	05-1969	Narayani
0607	Lete	Precipitation	W	28	38	00	83	36	00	2,384	05-1969	Narayani
0608	Ranipauwa (M.Nath)	Precipitation	W	28	49	00	83	53	00	3,609	05-1969	Narayani
0609	Beni Bazar	Climatology	W	28	21	00	83	34	00	835	02-1956	Narayani
0610	Ghani (Mustang)	Precipitation	W	29	03	00	83	53	00	3,465	11-1972	Narayani
0612	Mustang (Lomangtang)	Climatology	W	29	11	00	83	58	00	3,705	09-1973	Narayani
0613	Karki Neta	Precipitation	W	28	11	00	83	45	00	1,720	02-1977	Narayani
0614	Kushma	Climatology	W	28	13	00	83	42	00	891	05-1969	Narayani
0615	Bobang	Precipitation	W	28	24	00	83	06	00	2,273	12-1977	Narayani
0616	Gurja Khani	Precipitation	W	28	36	00	83	13	00	2,530	12-1978	Narayani
0619	Ghorapani	Precipitation	W	28	24	00	83	44	00	2,742	03-1975	Narayani
0620	Tribeni	Precipitation	W	28	02	00	83	39	00		*	Narayani
0621	Darbang	Precipitation	W	28	23	00	83	24	00		*	
0622	Rangkhani	Precipitation	W	28	09	00	83	34	00		*	
0701	Ridi Bazar	Precipitation	W	27	57	00	83	26	00	442	07-1956	Narayani
0702	Tansen	Climatology	W	27	52	00	83	32	00	1,067	07-1956	Tinau
0703	Butwal	Climatology	W	27	42	00	83	28	00	205	07-1956	Tinau
0704	Beluwa (Girwari)	Precipitation	W	27	41	00	83	03	00	150	02-1957	Narayani
0705	Bhairhawa Airport	Agrometeorology	W	27	31	00	83	26	00	109	09-1966	Tinau
0706	Dunkauli	Agrometeorology	W	27	41	00	84	13	00	154	10-1965	Narayani
0707	Bhairhawa (Agric)	Agrometeorology	W	27	32	00	83	28	00	120	01-1968	Tinau
0708	Parasi	Precipitation	W	27	32	00	83	40	00	125	05-1971	
0710	Dumkibas	Precipitation	W	27	35	00	83	52	00	164	05-1970	Narayani
0715	Khanchikot	Climatology	W	27	56	00	83	09	00	1,760	11-1970	Narayani
0716	Taulihawa	Climatology	W	27	33	00	83	04	00	94	11-1970	
0721	Pattharkot (West)	Precipitation	W	27	46	00	83	03	00	200	03-1973	
0722	Musikot	Precipitation	W	28	10	00	83	16	00	1,280	06-1956	Narayani
0723	Bhagwanpur	Precipitation	W	27	41	00	82	48	00	80	01-1975	
0724	Paklihawa	Precipitation	W	27	29	00	83	27	00	100	01-1970	
0725	Tamghas	Climatology	W	28	04	00	83	15	00	1,530	11-1979	Narayani
0726	Gagarkot	Precipitation	W	27	52	00	83	48	00	500	11-1979	Narayani
0727	Lumbini	Precipitation	W	27	28	00	83	17	00	95	10-1980	Tinau
0728	Simari	Climatology	W	27	32	00	83	45	00	154	04-1981	Narayani
0801	Jagat (Setibas)	Precipitation	W	28	20	00	84	54	00	1,334	07-1957	Narayani
0802	Khudi Bazar	Climatology	W	28	17	00	84	22	00	823	07-1957	Narayani
0803	Pokhara (Hospital)	Precipitation	W	28	14	00	84	00	00	866	06-1956	Narayani
0804	Pokhara Airport	Agrometeorology	W	28	13	00	84	00	00	827	10-1965	Narayani
0805	Syangja	Climatology	W	28	06	00	83	53	00	868	11-1972	Narayani
0806	Larke Sando	Precipitation	W	28	40	00	84	37	00	3,650	06-1978	Narayani
0807	Kunchha	Precipitation	W	28	08	00	84	21	00	855	06-1956	Narayani
0808	Bandipur	Precipitation	W	27	56	00	84	25	00	965	06-1956	Narayani
0809	Gorkha	Agrometeorology	W	28	00	00	84	37	00	1,097	06-1956	Narayani
0810	Chapkot	Climatology	W	27	53	00	83	49	00	460	02-1957	Narayani
0811	Malepatan (Pokhara)	Agrometeorology	W	28	13	00	83	57	00	856	04-1966	Narayani
0813	Bhadaure Deurali	Precipitation	W	28	16	00	83	49	00	1,600	05-1969	Narayani
0814	Lumle	Agrometeorology	W	28	18	00	83	48	00	1,740	11-1969	Narayani
0815	Khairini Tar	Agrometeorology	W	28	02	00	84	06	00	500	03-1969	Narayani
0816	Chame	Climatology	W	28	33	00	84	14	00	2,680	07-1974	Narayani
0817	Damauli	Precipitation	W	27	58	00	84	17	00	358	01-1974	Narayani
0818	Lamachaur	Precipitation	W	28	16	00	83	58	00	1,070	01-1972	Narayani
0820	Manang Bhot	Precipitation	W	28	40	00	84	01	00	3,420	06-1975	
0821	Ghandruk	Precipitation	W	28	23	00	83	48	00	1,960	05-1976	Narayani
0822	Khuldi	Precipitation	W	28	26	00	83	50	00	2,440	09-1973	
0823	Gharedhunga	Precipitation	W	28	12	00	84	37	00	1,120	07-1976	Narayani
0824	Siklesh	Precipitation	W	28	22	00	84	06	00	1,820	06-1977	Narayani
0825	Begnas Tal	Precipitation	W	28	12	00	84	06	00	900	07-1981	
0826	Walling	Precipitation	W	27	59	00	83	46	00	750	*	
0827	Rumjakot	Precipitation	W	27	52	00	84	08	00	660	*	
0902	Rampur	Agrometeorology	C	27	37	00	84	25	00	256	01-1967	Narayani

Table B2.1 (3/5)

LIST OF METEOROLOGICAL STATIONS

Station No.	Station Name	Type of Station	Reg.	Latitude			Longitude			Elevation (m)	Start of Record	Remarks
				°	'	"	°	'	"			
0903	Jhawani	Precipitation	C	27	35	00	84	32	00	270	02-1957	Narayani
0904	Chisapani Gadhi	Precipitation	C	27	33	00	85	08	00	1,706	05-1956	Narayani
0905	Daman	Climatology	C	27	36	00	85	05	00	2,314	09-1965	Narayani
0906	Hetaunda N.F.I	Climatology	C	27	25	00	85	03	00	474	08-1966	Narayani
0907	Amlekhganj	Precipitation	C	27	17	00	85	00	00	396	06-1955	
0909	Simara Airport	Agrometeorology	C	27	10	00	84	59	00	130	09-1965	
0910	Nijgadh	Precipitation	C	27	17	00	85	10	00	244	06-1955	
0911	Parwanipur	Agrometeorology	C	27	04	00	84	58	00	115	01-1967	
0912	Ramoli Bairiya	Precipitation	C	27	01	00	85	23	00	152	01-1956	
0915	Karkhu Gaun	Precipitation	C	27	37	00	85	09	00	1,530	12-1971	
0917	Hetaunda (Ind Dis)	Precipitation	C	27	26	00	85	02	00	466	01-1974	Narayani
0918	Birgunj	Precipitation	C	27	00	00	84	52	00	91	02-1974	
0919	Makwanpur Gadhi	Precipitation	C	27	25	00	85	10	00	1,030	12-1974	Narayani
0920	Beluwa	Precipitation	C	27	30	00	84	45	00	274	12-1974	Narayani
0921	Kalैया	Precipitation	C	27	02	00	85	00	00	140	02-1976	
0922	Gaur	Climatology	C	26	46	00	85	18	00	90	03-1983	
1001	Timure	Precipitation	C	28	17	00	85	26	00	1,900	06-1957	Narayani
1002	Aru Ghat D.Bazar	Precipitation	C	28	03	00	84	49	00	518	06-1957	Narayani
1003	Trishuli	Precipitation	C	27	55	00	85	09	00	595	12-1955	Narayani
1004	Nuwakot	Climatology	C	27	55	00	85	10	00	1,003	05-1956	
1005	Dhading	Precipitation	C	27	52	00	84	56	00	1,420	05-1956	Narayani
1006	Gumthang	Precipitation	C	27	52	00	85	52	00	2,000	07-1947	
1007	Kakani	Agrometeorology	C	27	48	00	85	15	00	2,064	01-1962	Narayani
1008	Nawalpur	Precipitation	C	27	48	00	85	37	00	1,592	06-1959	
1009	Chautara	Precipitation	C	27	47	00	85	43	00	1,660	07-1947	
1011	Kathmandu (US AID)	Precipitation	C	27	42	00	85	20	00	1,335	01-1954	
1012	Sundarijal (Pwr House)	Precipitation	C	27	45	00	85	25	00	1,364	05-1940	
1013	Sundarijal (Water Res.)	Precipitation	C	27	47	00	85	26	00	1,576	05-1940	
1014	Kathmandu (I.E.)	Precipitation	C	27	44	00	85	20	00	1,324	01-1921	
1015	Thankot	Precipitation	C	27	41	00	85	12	00	1,630	09-1966	
1016	Sarmathang	Climatology	C	27	57	00	85	36	00	2,625	11-1970	
1017	Dubachaur	Precipitation	C	27	52	00	85	34	00	1,550	11-1970	
1018	Baunepati	Precipitation	C	27	47	00	85	34	00	845	11-1970	
1020	Mandan	Precipitation	C	27	42	00	85	39	00	1,365	07-1947	
1022	Godavari	Climatology	C	27	35	00	85	24	00	1,400	05-1952	
1023	Dolal Ghat	Precipitation	C	27	38	00	85	43	00	710	07-1947	
1024	Dhulikhel	Climatology	C	27	37	00	85	33	00	1,552	06-1947	
1025	Dhap	Precipitation	C	27	55	00	85	38	00	1,240	12-1976	
1027	Bahrabise	Precipitation	C	27	47	00	85	54	00	1,220	12-1965	
1028	Pachuwar Ghat	Precipitation	C	27	34	00	85	45	00	633	01-1966	
1029	Khumaltar	Agrometeorology	C	27	40	00	85	20	00	1,350	05-1967	
1030	Kathmandu Airport	Agrometeorology	C	27	42	00	85	22	00	1,336	06-1949	
1035	Sankhu	Precipitation	C	27	45	00	85	29	00	1,449	09-1970	
1036	Panchkhal	Agrometeorology	C	27	41	00	85	38	00	865	11-1970	
1038	Dhunibesi	Climatology	C	27	43	00	85	11	00	1,085	04-1971	Narayani
1039	Panipokari (Kathmandu)	Climatology	C	27	44	00	85	21	00	1,335	04-1971	
1043	Nagarkot	Climatology	C	27	42	00	85	31	00	2,163	05-1971	
1047	Pharping	Precipitation	C	27	37	00	85	18	00	1,500	05-1971	
1049	Khopasi (Panauti)	Precipitation	C	27	35	00	85	31	00	1,517	06-1971	
1052	Bhaktapur	Precipitation	C	27	44	00	85	25	00	1,330	05-1971	
1054	Thamachit	Precipitation	C	28	10	00	85	19	00	1,847	11-1971	Narayani
1055	Dhuncha	Climatology	C	28	06	00	85	18	00	1,982	11-1971	Narayani
1056	Tokha	Precipitation	C	27	48	00	85	26	00	1,790	12-1972	
1057	Pansayakhola	Climatology	C	28	01	00	85	07	00	1,240	01-1973	
1058	Tarka Ghyang	Precipitation	C	28	00	00	85	33	00	2,480	01-1974	
1059	Changu Narayan	Precipitation	C	27	45	00	85	25	00	1,543	05-1974	
1060	Chapa Gaun	Precipitation	C	27	36	00	85	20	00	1,448	10-1975	
1061	Lubhu	Precipitation	C	27	39	00	85	23	00	1,341	11-1975	
1062	Sangachok	Climatology	C	27	42	00	85	43	00	1,327	05-1979	
1063	Thokarpa	Precipitation	C	27	42	00	85	47	00	1,750	07-1979	
1071	Buddhanilakantha	Climatology	C			00			00	1,360	*	
1072	Paigutang	Climatology	C	28	13	00	85	11	00	4,091	*	
1101	Nagdaha	Precipitation	C	27	41	00	86	06	00	850	01-1977	
1102	Chariket	Precipitation	C	27	40	00	86	03	00	1,940	06-1959	
1103	Jiri	Agrometeorology	C	27	38	00	86	14	00	2,003	08-1961	
1104	Melung	Precipitation	C	27	31	00	86	03	00	1,536	06-1959	

Table B2.1 (4/5)

LIST OF METEOROLOGICAL STATIONS

Station No.	Station Name	Type of Station	Reg	Latitude		Longitude		Elevation (m)	Start of Record	Remarks		
				°	'	°	'					
1106	Ramechhap	Precipitation	C	27	19	00	86	05	00	1,395	01-1918	
1107	Sindhuli Gadhi	Climatology	C	27	17	00	85	58	00	1,463	06-1955	
1108	Bahun Tilpung	Precipitation	C	27	11	00	86	10	00	1,417	05-1958	
1109	Paubharkot (East)	Precipitation	C	27	05	00	85	40	00	275	01-1956	Lakhandehi
1110	Tulsi	Precipitation	C	27	02	00	85	55	00	457	12-1955	
1111	Janakpur Airport	Climatology	C	26	43	00	85	58	00	90	06-1968	
1112	Chisapani Bazar	Precipitation	C	26	55	00	86	10	00	165	07-1955	
1114	Haridnath	Precipitation	C	26	48	00	85	59	00	93	11-1968	
1115	Nepal Thok	Precipitation	C	27	27	00	85	49	00	1,098	04-1918	
1116	Haridharpur Gadhi	Precipitation	C	27	20	00	85	30	00	880	06-1955	
1117	Haridharpur Gadhi Valley	Precipitation	C	27	20	00	85	30	00	250	03-1978	
1118	Manusmara	Climatology	C	26	53	00	85	25	00	100	02-1979	
1119	Gausala	Precipitation	C	26	53	00	85	47	00	200	02-1979	
1120	Malangwa	Precipitation	C	26	52	00	85	34	00	150	03-1983	Lakhandehi
1121	Karmaiya	Climatology	C	27	07	00	85	28	00	131	08-1983	
1122	Jalesore	Climatology	C	26	39	00	85	47	00		03-1989	
1201	Namche Bazar	Precipitation	E	27	49	00	86	43	00	3,450	04-1971	
1202	Chaurikhark	Precipitation	E	27	42	00	86	43	00	2,619	01-1918	
1203	Pakamas	Precipitation	E	27	26	00	86	34	00	1,982	12-1947	
1204	Aisealukharh	Precipitation	E	27	21	00	86	45	00	2,143	05-1918	
1206	Okhaldhunga	Synoptic	E	27	19	00	86	30	00	1,720	12-1917	
1207	Name Bhanjyang	Precipitation	E	27	12	00	86	25	00	1,576	11-1917	
1208	Dwarpa	Precipitation	E	27	13	00	86	51	00	1,829	05-1959	
1210	Kunle Ghat	Precipitation	E	27	08	00	86	25	00	497	12-1917	
1211	Khotang Bazar	Precipitation	E	27	02	00	86	50	00	1,295	05-1959	
1212	Phatepur	Climatology	E	26	44	00	86	51	00	100	07-1976	
1213	Udayapur Gadhi	Climatology	E	26	56	00	86	31	00	1,175	07-1917	
1215	Lahan	Climatology	E	26	44	00	86	30	00	138	11-1955	
1216	Siraha	Precipitation	E	26	39	00	86	13	00	102	06-1917	
1217	Khumjung	Precipitation	E	27	49	00	86	43	00	3,750	05-1966	
1218	Tengboche	Precipitation	E	27	50	00	86	46	00	3,857	05-1966	
1219	Salleri	Precipitation	E	27	30	00	86	35	00	2,378	12-1917	
1220	Chialsa	Agrometeorology	E	27	31	00	86	37	00	2,770	05-1966	
1222	DiAtel	Precipitation	E	27	13	00	86	48	00	1,623	06-1973	
1223	Rajbiraj	Climatology	E	26	33	00	86	45	00	91	12-1971	
1224	Sirwa	Precipitation	E	27	33	00	86	23	00	1,662	05-1959	
1225	Syangboche	Precipitation	E	27	49	00	86	43	00	3,700	05-1973	
1226	Barmajhiya	Precipitation	E	26	36	00	86	54	00	85	09-1973	
1301	Num	Precipitation	E	27	33	00	87	17	00	1,497	06-1959	
1303	Chainpur (East)	Climatology	E	27	17	00	87	20	00	1,329	07-1917	
1304	Pakhribas	Agrometeorology	E	27	03	00	87	17	00	1,680	01-1976	
1305	Leguwa Ghat	Precipitation	E	27	08	00	87	17	00	410	07-1917	
1306	Munga	Precipitation	E	27	02	00	87	14	00	1,317	07-1917	
1307	Dhankuta	Synoptic	E	26	59	00	87	21	00	1,445	06-1917	
1308	Mulghat	Precipitation	E	26	56	00	87	20	00	365	06-1917	
1309	Tribeni	Precipitation	E	26	56	00	87	09	00	143	05-1918	
1310	Barahshetra	Precipitation	E	26	52	00	87	10	00	145	03-1917	
1311	Dharan Bazar	Precipitation	E	26	49	00	87	17	00	441	06-1917	Ratua / Lohendra
1312	Haraincha	Precipitation	E	26	37	00	87	23	00	152	04-1956	Ratua / Lohendra
1313	Biratnagar (City)	Precipitation	E	26	28	00	87	17	00	67	05-1918	Ratua / Lohendra
1314	Termathum	Climatology	E	27	08	00	87	33	00	1,633	04-1966	
1316	Chatara	Precipitation	E	26	49	00	87	10	00	183	06-1918	
1317	Chepuwa	Precipitation	E	27	46	00	87	25	00	2,590	06-1959	
1318	Paripalle (Horti)	Precipitation	E	27	01	00	87	18	00	1,364	11-1966	
1319	Biratnagar Airport	Agrometeorology	E	26	29	00	87	16	00	72	07-1968	Ratua / Lohendra
1320	Tarahara	Agrometeorology	E	26	42	00	87	16	00	200	07-1968	
1321	Tumlingtar	Precipitation	E	27	17	00	87	13	00	303	05-1977	
1322	Machuwaghat	Precipitation	E	26	58	00	87	10	00	158	05-1918	
1323	Dharan British Camp	Climatology	E	26	47	00	87	17	00	400	08-1969	Ratua / Lohendra
1324	Bhojpur	Agrometeorology	E	27	11	00	87	03	00	1,595	06-1954	
1325	Dingla	Precipitation	E	27	22	00	87	09	00	1,190	05-1918	
1401	Ofangchung Gola	Precipitation	E	27	41	00	87	47	00	3,119	07-1917	
1402	Pangthung Doma	Precipitation	E	27	41	00	87	49	00	2,818	12-1917	
1403	Lungtang	Precipitation	E	27	33	00	87	47	00	1,780	07-1917	
1404	Taplethok	Precipitation	E	27	29	00	87	47	00	1,383	07-1917	
1405	Taplejung	Synoptic	E	27	21	00	87	40	00	1,732	07-1917	

LIST OF METEOROLOGICAL STATIONS

Station No.	Station Name	Type of Station	Reg.	Latitude			Longitude			Elevation (m)	Start of Record	Remarks
				°	'	"	°	'	"			
1406	Memeng Jagat	Precipitation	E	27	12	00	87	56	00	1,830	07-1947	
1407	Ham Tea Estate	Agrometeorology	E	26	55	00	87	54	00	1,300	03-1956	
1408	Damak	Precipitation	E	26	43	00	87	40	00	163	03-1956	Ratus / Lohendra
1409	Anarmani Birta	Precipitation	E	26	38	00	87	59	00	122	03-1956	
1410	Himali Gaun	Precipitation	E	26	53	00	88	02	00	1,654	02-1968	
1411	Soktim Tea Estate	Climatology	E	26	48	00	87	54	00	530	06-1966	
1412	Chandra Gadhi	Precipitation	E	26	34	00	88	03	00	120	02-1971	
1413	Khamachin	Precipitation	E	27	44	00	87	59	00	4,242	12-1948	
1414	Nup	Precipitation	E	27	43	00	87	52	00	4,000	06-1948	
1415	Sanishare	Precipitation	E	26	41	00	87	58	00	168	01-1972	
1416	Kanyam Tea Estate	Climatology	E	26	52	00	88	04	00	1,678	04-1972	
1417	Jaubari	Precipitation	E	27	04	00	88	00	00	3,050	06-1973	
1418	Angbung	Precipitation	E	27	16	00	87	43	00	1,219	07-1947	
1419	Phidim (Panchther)	Climatology	E	27	09	00	87	45	00	1,205	07-1978	
1420	Dovan	Precipitation	E	27	21	00	87	36	00	763	07-1947	
1421	Gaida (Kankai)	Climatology	E	26	30	00	87	54	00	143	02-1984	

(Note) Reg. FW: Far Western, MW: Mid Western, W: Western, C: Central and E: Eastern Region

LIST OF HYDROMETRIC STATIONS

Station No.	Name of River	Name of Site	Latitude			Longitude			Elevation (m)	Drainage Area (km ²)	Instrument	Start of Record	End of Record	Remarks
			°	'	"	°	'	"						
120.	Chamelia	Karkale Gaon	29	40	20	80	33	30	-	1.150		01/01/65		
150.	Mahakali	Pancheshwor	29	26	45	80	15	30	-	12.236	C R	01/01/62		
169.8	Sumagad	Gujar Gaon	29	31	00	80	35	00	-	(66)	C	-		
170.	Sumagad	Patan near Baitadi	29	27	30	80	33	10	1.110	1.18	C	01/01/66	01/04/88	
190.5	Kandr Khola	Amsara	28	36	00	80	56	00	-	(313)		-		
190.8	Khutiya Khola	Boladevi Gaon	28	53	00	80	44	00	-	-		-		Khutiya
205.	Kharpu Khola	Kharpu	29	57	00	81	52	00	-	1.310		14/05/78		
206.	Humla Karnali	Bihi Chhara	29	38	00	81	52	00	-	(8.447)		17/06/79		
208.	Mugu Karnali	Surkhet	29	37	00	81	52	00	-	5.300	C	15/06/79		
209.	Kawadi Khola	Kawadi Ghat	29	36	16	81	45	28	-	795		17/01/89		
210.	Rara Daha	Nizal	29	31	00	82	04	00	-	1.150		08/11/65		
215.	Humla Karnali	Thuldada	29	09	00	81	36	00	-	15.200	C	06/02/66		
220.	Tila Nala	Nagina	29	12	00	81	55	00	-	1.870	C	19/03/64		
225.	Sinja Khola	Diware	29	12	00	81	55	00	-	824	C	17/03/64		
230.	Tila Nadi	Seti Ghat	29	08	00	81	36	00	-	3.470	C	08/03/64		
240.	Karnali	Asara Ghat	28	57	10	81	26	30	629	19.260	C R S	01/01/61		
241.	Lohare Khola	Tallo Dungsawat	28	41	00	81	36	00	-	1.060	C	24/05/65		
245.	Chhamghat Khola	Gitachaur	28	56	00	81	41	30	-	(108)	C	20/03/78		
250.	Karnali	Benighat	28	57	40	81	07	10	320	21.240	C R	01/02/63		
251.	Seit	Chainpur	29	33	30	80	12	40	-	2.040	C	-		
255.	Bhadi Ganga	Kakarsant	29	11	00	81	13	00	-	1.340	C	28/04/78		
259.2	Seit	Gopaghat Gaon	29	18	00	80	46	30	-	4.420	C	-		
260.	Seit	Banga near Belgaon	28	58	40	81	08	40	328	7.460	C R S	06/02/63		
262.	Tuli Gad	Khanayata!	28	56	00	80	54	00	314	896	C R	17/06/65		
265.	Thulo Bheri	Rimna	28	42	30	82	17	30	-	6.720	C	18/06/72		
267.	Sano Bheri	Simji Ghat	28	39	30	82	21	30	-	2.620	C	18/06/76		
269.5	Bheri Nadi	Samaiji Ghar							-	-	C PR	16/12/89		
270.	Bheri	Jamu	28	45	20	81	21	00	246	12.290	C R S	23/01/63		
280.	Karnali	Chisapani	28	38	40	81	17	30	191	42.890	C R S	01/01/62		

LIST OF HYDROMETRIC STATIONS

Station No.	Name of River	Name of Site	Latitude			Longitude			Elevation (m)	Drainage Area (km ²)	Instrument	Start of Record	End of Record	Remarks
			°	'	"	°	'	"						
284.	Sarda Khola	Shyalpani-Sita Pail	28	22	50	82	11	45	-	295		17/06/77		Babai
285.	Mohana	Kalakunta	28	27	00	81	00	50	-	(623)		22/04/76		
286.	Sarada Khola	Daradhunga	28	17	58	82	01	30	-	316	C R S	01/01/72		Babai
287.	Kauriala Karmali	Sattar Farm	28	24	30	81	05	00	-	-		17/03/80		
288.	Geruwa Karmali	Kothiya Ghat	28	22	30	81	12	00	-	(14.853)		18/03/80		
289.	Babai River	Gangate Gaon	28	15	00	81	57	00	-	-		06/01/72		
289.5	Gohar Khola	Sirchaur Gaon	28	09	15	82	22	45	-	-	C	21/06/77		Babai
289.9	Babai Nadi	Gangata	-	-	-	-	-	-	-	-		-		Babai
289.95	Babai Nadi	Chepang	-	-	-	-	-	-	-	-	C R	01/10/89		Babai
290.	Babai	Bargadha	28	25	20	81	22	10	192	3,000	C R	16/07/66	13/04/89	Babai
291.	Babai Nadi	Bhada	-	-	-	-	-	-	-	-		-		Babai
327.	Lungri Khola	Khungree Gaon	28	13	50	82	42	50	-	467	C	26/12/76		West Rapti
330.	Mari Khola	Nayagaon	28	04	20	82	48	00	536	1,980	C	01/01/64		West Rapti
333.	Arun Khola	Devistan	28	02	00	82	45	30	-	136	C	--/68		West Rapti
339.5	Jhimruk Khola	Tigra Gaon	28	03	00	82	49	40	-	683	C	22/05/71		West Rapti
340.	Jhimruk Khola	Kalimati Ghat	28	02	10	82	53	00	692	696	C	01/01/65	21/05/71	
350.	Rapti	Bagasoti Gaon	27	54	00	82	51	00	381	3,380	C R S	08/05/75		West Rapti
350.5	Rangsing Khola	Tinkhanne Gaon	27	47	30	82	49	00	-	(92)	C	03/01/83		West Rapti
360.	Rapri	Jalkundi	27	56	50	82	13	30	218	5,150	C R S	08/04/64		West Rapti
380.	Rapti River	Sinchania	28	01	00	81	44	45	-	-		06/03/83		
385.2	Rapti River	Faninda	-	-	-	-	-	-	-	-		-		West Rapti
387.4	Dumre Khola	Kalimati	27	47	47	83	32	09	595	90	C	18/06/80		Tinau
387.5	Madi Tinau	Charchare	27	47	29	83	33	08	570	103	C R	17/06/80		Tinau
387.8	Jhumsa Khola	Dumahi Bari	27	45	00	83	30	46	335	99	C	15/02/85		Tinau
390.	Tinau Khola	Butwal	27	42	10	83	27	50	184	554	C	09/12/63		Tinau
405.	Kali Gandaki	Jomsom	28	47	30	83	45	00	-	(3,060)		07/06/69		Narayani
405.5	Kali Gandaki	Tatopani	28	29	00	83	39	00	1,239	-	R	--/03/92		
404.6	Kali Gandaki	Kalipul Beni	28	21	30	83	34	30	-	(4,581)		05/04/71		Narayani
404.7	Myagdi Khola	Mangia Ghat	28	21	30	83	32	00	-	(1,112)	C	19/05/75		Narayani

LIST OF HYDROMETRIC STATIONS

Station No.	Name of River	Name of Site	Latitude		Longitude		Elevation (m)	Drainage Area (km ²)	Instrument	Start of Record	End of Record	Remarks	
			°	'	°	'							
406.	Kali Gandaki	Modi Beni	28	12	00	83	42	00	667	-	R	--/03/92	
406.5	Modi Khola	Nayapul	28	15	30	83	42	15	-	(635)	C	25/05/75	Narayani
409.5	Seti Khola	Seti Beni	28	00	40	83	37	10	-	(138)		22/02/76	Narayani
410.	Kali Gandaki	Seti Beni	28	00	30	83	36	10	546	6,630	C R S	21/02/64	Narayani
413.2	Danab Khola								-	-	C	27/05/90	
414.1	Darun Khola	Anjun Chaupari							-	-		01/01/90	
415.	Andhi Khola	Dumrichaur Andhimuhan	27	58	20	83	35	20	543	476	C	06/04/89	Narayani
416.2	Daram Khola	Wamitaksar	28	11	45	83	18	15	-	(239)	C	18/12/78	Narayani
417.	Badigad Khola	Rudrabeni Gulmi	27	58	20	83	28	10	-	1,990	C	24/05/67	Narayani
419.1	Kali Gandaki	Ansigh-AndhiGhat							-	-	C	13/04/89	Narayani
420.	Kali Gandaki	Kotagaon Shringe	27	45	00	84	20	50	198	11,400	C R	15/04/64	Narayani
428.	Mardi Khola	Lahachok	28	18	50	83	55	50	-	160	C	07/06/70	Narayani
430.	Seti Khola	Phoolbari	28	14	00	84	00	00	830	582	C	01/01/89	Narayani
438.	Madi	Shisa Ghat	28	06	00	84	14	00	-	858	C	08/02/73	Narayani
439.3	Khudi Khola	Khudi Bazar	28	17	15	84	21	45	-	(151)	C	04/07/81	Narayani
439.4	Dordi Khola	Amote Bazar-Sera Besi	28	10	45	84	27	50	-	(341)	C	09/02/76	Narayani
439.7	Marsyangdi	Bimal Nagar	27	57	00	84	25	48	354	(4,088)	C R S	31/03/87	Narayani
439.8	Marsyangdi	Gopling Ghat	27	55	55	84	29	42	320	3,850	C R S	01/06/73	21/05/88
440.	Chepe Khola	Garam Besi	28	03	41	84	29	23	442	308	C PR	20/11/63	Narayani
441.	Daraundi Khola	Nayasanghu Gorkha	28	01	00	84	35	15	-	386	C	13/10/67	Narayani
441.5	Daraundi Khola	Ramdi										26/12/86	
445.	Burhi Gandaki	Arughat	28	02	37	84	48	59	485	4,270	C R S	28/11/63	Narayani
445.3	Ankhu Khola	Ankhu Bridge	27	58	20	84	49	10	-	768	C	--/--/67	Narayani
446.1S	Lirung Khola	Kyangjin										-	
446.2	Langrang Khola	Shyaprubesi	28	09	30	85	20	45	-	(540)	C	-	Narayani
446.2S	Bhote Kosi	Syaprubesi							-	-		-	
446.5	Trisuli Khola	Dhunchu	28	07	10	85	17	40	-	49	C R	--/--/63	Narayani
446.8	Phalankhu Khola	Betrawati	27	58	25	85	11	15	650	162		24/04/69	Narayani
447.	Trisuli	Betrawati	27	58	08	85	11	00	600	4,110	C R S	01/04/67	Narayani

LIST OF HYDROMETRIC STATIONS

Station No.	Name of River	Name of Site	Latitude			Longitude			Elevation (m)	Drainage Area (km ²)	Instrument	Start of Record	End of Record	Remarks
			°	'	"	°	'	"						
447.4	Tadi Khola	Rautar Nuwakot	27	55	00	85	17	10	-	254		-		Narayani
447.9	Likhu Khola	Pattawari Nuwakot	27	53	30	85	14	45	-	(145)		-		Narayani
448.	Tadi Khola	Tadipul Belkot	27	51	35	85	08	18	475	653		14/06/68		Narayani
449.9	Trisuli	Mugling	27	51	00	84	34	30	-	-		-		Narayani
449.91	Trishuli	-	-	-	-	-	-	-	-	-		-		-
449.95	Trisuli	Bhorletar	27	49	00	84	26	45	-	(14,500)	C	26/02/82		Narayani
450.	Narayani	Narayan Ghat	27	42	30	84	25	50	180	31,100	C R S	10/02/62		Narayani
460.	Rapti	Rajaiya	27	26	30	84	58	15	332	579	C	01/01/63		Narayani
465.	Manahari Khola	Manahari	27	53	00	84	48	10	305	427	C R	13/06/63		Narayani
470.	Lothar Khola	Lothar	27	55	40	84	43	00	336	169	C	30/11/63		Narayani
505.	Bagmati	Sundarjial	27	46	30	85	25	40	1,600	17	C R	07/12/62		
507.	Nagmati	Sundarjial	27	46	20	85	26	10	1,660	13		00/11/63		
510.	Sialimati	Syamdado	27	46	10	85	25	10	1,660	3		00/11/63		
511.	Dhawal Khola	Gagalgau	27	44	45	85	26	15	-	-		-		
520.	Bagmati River	Gokarna	27	43	45	85	23	30	-	56		-		
525.5	Manahara River	Shakyu Salmutar	-	-	-	-	-	-	-	-		04/03/00		
530.	Bagmati	Gauri Ghat	27	42	30	85	21	00	1,300	68		15/11/64		
536.2	Bishumati Khola	Budhanilikantha	27	46	49	85	21	32	1,454	4		27/05/68	27/08/98	
540.	Nakhu Khola	Tika Bhairab	27	34	30	85	18	50	1,400	43		23/11/62		
548.	Nakhu Khola	Nakhu Jati Near Patan	27	39	40	85	18	30	-	56		01/01/87		
550.	Bagmati River	Chovar	27	39	40	85	17	50	1,280	585	C R S	01/07/62	-/-/80	
550.05	Bagmati	Khokana	27	16	00	85	13	00	1,255	607	PR	01/06/91		
550.1	Bagmati River	Sampkhel	27	33	30	85	15	45	-	-	C R S	15/06/85		
565.	Kulekhani Khola	Lamichaur	27	56	13	85	09	39	1,514	122	C R	01/07/75	09/12/78	
570.	Kulekhani Khola	Kulekhani	27	35	10	85	09	30	1,480	126	C R S	01/12/62	15/11/77	
586.	Bagmati	Rai Gaon	-	-	-	-	-	-	-	-		01/02/88		
589.	Bagmati	Pandhera Dobhan	27	06	20	85	28	30	180	2,700	C R S	28/01/79		
590.	Bagmati	Karmaiya - Mangalpur	27	06	20	85	28	30	177	2,720	R S	21/06/64	17/10/84	
592.	Bagmati	Bramhapuri	26	45	30	85	20	00	-	(13,790)		-		

LIST OF HYDROMETRIC STATIONS

Station No.	Name of River	Name of Site	Latitude			Longitude			Elevation (m)	Drainage Area (km ²)	Instrument	Start of Record	End of Record	Remarks
			°	'	"	°	'	"						
595.	Jamuni	Chyutaha	26	57	00	85	20	00	-	-	19/03/92			
598.	Kamala	Chisapani	26	55	15	86	10	30	-	(1,595)	-			
599.	Kamala	Inarawa	26	36	45	86	09	00	-	-	-			
600.05	Barun Khola	Seksila Hatiya	27	41	00	87	21	00	1,500	552	22/12/86			
600.1	Arun	Uwa Gaon	27	36	00	87	20	06	1,294	26,750	C R S	11/05/72		
601.8	Pangtha Khola	Kurle Besi	27	24	00	87	13	30	-	(26)	-	01/09/98		
601.9	Pangma Khola	Kurle Besi	27	24	00	87	12	45	-	(58)	-	01/09/98		
602.	Sabhaya Khola	Tumlingtar	27	18	20	87	13	15	-	375	C R	02/01/74		
602.5	Himwa Khola	Pipletar	27	17	45	87	13	30	-	110	C	-		
604.	Arun	Leguwa Ghat	27	09	00	87	16	30	-	(4,183)	-	01/06/68		
604.5	Arun	Turkeghat	27	20	00	87	11	30	414	28,200	C R	23/05/75		
605.	Pikhuwa Khola	Parapani Phedi	27	05	00	87	07	00	-	557	-	0/0/64		
606.	Arun	Simle	26	55	30	87	09	30	-	30,380	Br	-		
610.	Bhote Kosi	Barabise	27	47	10	85	53	20	840	2,410	-	17/02/65		
612.	Sun Kosi	Barabise	27	46	30	85	54	30	-	(84)	-	-		
620.	Balephi Khola	Jalbire	27	48	20	85	46	10	793	629	C	25/12/63		
625.	Sun Kosi	Dolaighat	27	38	30	85	43	00	-	(1,375)	C	-		
627.5	Melamchi Khola	Helambu	28	02	30	85	32	00	-	-	-	-		
627.55	Melamchi Khola	Sajhaya	-	-	-	-	-	-	-	-	-	-		
629.1	Indrawati	Dolaighat	27	38	20	85	42	30	-	1,225	C	17/09/72		
630.	Sunkosi	Pachuar Ghat	27	33	30	85	45	10	589	4,920	C	26/03/64		
640.	Rosi Khola	Panauti	27	34	50	85	30	50	1,480	87	-	17/10/63		
641.	Rosi Khola	Lold Khola	-	-	-	-	-	-	-	-	-	-		
647.	Tamakosi	Busti	27	38	05	86	05	12	849	2,755	C R	14/01/70		
650.	Khimti Khola	Rasnal Village	27	34	30	86	11	50	1,520	513	C	06/04/64		
652.	Sunkosi	Khurkot	27	20	00	86	00	00	455	10,000	C	01/07/67		
660.	Likhu Khola	Sanghu Khola	27	20	10	86	13	10	543	823	C	24/03/64		
665.	Sun Kosi	Ahrkapur (Toksseighat)	27	10	30	86	22	00	-	(8,736)	C	20/02/86		
668.4	Taktor Khola	Beni	27	31	45	86	33	30	2,350	(87)	Br	-		

LIST OF HYDROMETRIC STATIONS

Station No.	Name of River	Name of Site	Latitude		Longitude			Elevation (m)	Drainage Area (km ²)	Instrument	Start of Record	End of Record	Remarks
			°	'	''	°	'						
668.5	Soluwa Khola	Saimc	27	30	30	86	33	15	1,800	Br	-	-	
669.5	Rawa Khola	Gaikhure	27	16	00	86	40	30			-	-	
670.	Dudh Kosi	Rabuwa Bazar	27	16	00	86	39	50	460	C R S	10/03/64		
680.	Sun Kosi	Kampughat	26	52	30	86	49	20	200		28/06/65		
681.	Sun Kosi	Hampuachuar	26	55	15	87	08	45	-	C	-	-	
684.	Tamur	Majhitar	27	09	30	87	42	45	-	C	-	-	
685.3	Maiwa Khola	Maiwa Dovan	27	22	10	87	36	50	194		-	-	
685.9	Hima Khola	Thapatar (Phidim)	27	09	45	87	46	15			0/0/74		
688.5	Madhu Khola	Dhankuta	26	59	30	87	22	15			-	-	
688.6	Banchare Khola	Dhankuta	26	59	00	87	22	30	13		-	-	
688.7	Nibuwa Khola	Dhankuta	26	59	00	87	23	15	(28)		-	-	
689.	Tankhuwa Khola	Biretar Near Dhankuta	26	58	30	87	22	15	-		--/--/64		
690.	Tamur	Mulghat	26	55	50	87	19	45	276	Br PR S	11/03/65		
691.	Tamur	Tribeni	26	55	00	87	10	00	-	(6.146) C	-	-	
695.	Sapta Koshi	Chatara-Kothu	26	52	00	87	09	30	140	54,100 C	S	01/01/77	
698.	Sardu Khola	Mathilo Sardu-Dharan	26	51	00	87	18	05	7			0/0/71	
715.	Mai Khola	Mai Beni	26	53	25	87	57	20	210			0/0/71	
720.	Jog Mai Khola	Mai Beni	27	53	40	87	59	20	140			0/0/67	
728.	Mai Khola	Rajdwail	26	52	45	87	55	45	377	C	S	01/01/83	
750.	Puwa Khola	Sajbote (Ilam)	26	55	00	87	54	40	802	107 C		18/01/65	
738.	Deo Mai Khola	Angdang	26	54	00	87	46	15	-	(199) C		-	Ratuwa ?
795.	Kankai Mai	Mainachuli	26	41	12	87	52	44	125	1,148 C R		01/05/71	
799.	Kankai	Kumarkhod-Jhapa							-			30/10/87	
848.4	Siddhi Khola	Kajeni	26	51	15	88	07	00	-			-	

Note:

- C: Cable way for discharge measurement
 Br: Bridge available for discharge measurement
 R: Recording gauge for water level observation
 PR: Pressure type gauge for water level observation

SUMMARY OF METEOROLOGICAL CONDITIONS

No.	Station Code	Station Name	Type of Station	District	Latitude N	Longitude E	Elevation (m)	Mean Monthly Maximum Temperature (°C)	Mean Monthly Minimum Temperature (°C)	Mean Monthly Relative Humidity (%)	Mean Annual Rainfall (mm)	Maximum Mean Monthly Rainfall (mm)	Remarks
1	0209	Dhangadhi	Climatology	Kailali	28°41'	80°36'	170	30.6	17.3	79.6	1,648.0	525.2	Jul Khusiya Basin
2	0215	Godavari (West)	Climatology	Kailali	28°52'	80°38'	288	30.2	19.8	74.8	2,279.4	700.1	Jul Khusiya Basin
3	0218	Dipaval (Doti)	Synoptic	Doti	29°15'	80°57'	617	30.7	14.8	77.9	1,078.8	249.0	Jul
4	0402	Dallekh	Climatology	Dallekh	28°51'	81°43'	1,402	23.7	12.9	73.9	1,743.9	483.6	Jul
5	0406	Surkhet (Birendra Nagar)	Synoptic	Surkhet	28°36'	81°37'	720	27.9	15.5	75.8	1,569.3	474.0	Jul
6	0416	Nepalkunj (Reg.O&E)	Climatology	Barke	28°04'	81°37'	144	30.9	19.2	82.7	1,337.6	425.8	Jul West Rapti Basin
7	0417	Rani Januwa Nursery	Climatology	Bardiya	28°23'	81°21'	200	30.9	17.9	82.7	1,279.1	370.2	Jul Babai Basin
8	0508	Tulsipur	Climatology	Dangdekhuri	28°08'	82°18'	725	28.8	16.6	78.5	1,458.1	402.9	Aug Babai Basin
9	0601	Jomsom	Climatology	Mustang	28°47'	83°43'	2,744	17.8	4.9	63.6	212.6	40.9	Jul
10	0612	Mustang (Lomanthang)	Climatology	Mustang	29°11'	83°58'	3,705	12.5	-1.3	82.9	118.3	45.0	Jul
11	0702	Tansen	Climatology	Palpa	27°52'	83°32'	1,067	25.1	15.1	80.1	1,677.0	477.1	Jul Tinau Basin
12	0705	Bhairahwa Airport	Agrometeorology	Rupandehi	27°31'	83°26'	109	30.9	18.4	79.7	1,608.9	508.6	Jul Tinau Basin
13	0706	Dunkauli	Agrometeorology	Nawalparasi	27°41'	84°13'	154	30.7	18.6	82.9	2,216.8	641.0	Jul Narayani Basin
14	0804	Pokhara Airport	Agrometeorology	Kaski	28°13'	84°00'	827	26.5	15.2	80.9	3,784.9	928.9	Jul Narayani Basin
15	0809	Gorkha	Agrometeorology	Gorkha	28°00'	84°37'	1,097	25.9	15.7	79.5	1,683.9	468.7	Jul Narayani Basin
16	0906	Hetauda N.F.I	Climatology	Makwanpur	27°25'	85°03'	474	29.2	16.9	77.9	2,282.9	565.6	Aug Narayani Basin
17	1030	Kathmandu Airport	Agrometeorology	Kathmandu	27°42'	85°22'	1,336	25.3	11.6	85.6	1,347.2	323.9	Jul
18	1103	Jiri	Agrometeorology	Dolakha	27°38'	86°14'	2,003	20.4	8.0	82.7	2,216.9	581.3	Jul
19	1111	Janakpur Airport	Climatology	Dhanusa	26°43'	85°58'	90	30.6	19.4	75.5	1,474.6	415.0	Jul
20	1118	Manusmara	Climatology	Sarlahi	26°53'	85°25'	100	31.2	18.7	83.8	1,369.1	416.9	Aug Bairmati Basin (Lakhandei Basin)
21	1121	Karmaliya	Climatology	Sarlahi	27°07'	85°28'	131	30.7	20.3	75.0	1,718.3	443.1	Aug Bairmati Basin (Lakhandei Basin)
22	1206	Oxhaldhunga	Synoptic	Oxhaldhunga	27°19'	86°30'	1,720	20.4	12.8	75.7	1,764.1	469.8	Jul
23	1307	Dhankuta	Synoptic	Dhankuta	26°59'	87°21'	1,445	21.8	14.5	74.0	1,047.8	232.9	Aug
24	1319	Biratnagar Airport	Agrometeorology	Morang	26°29'	87°16'	72	30.1	18.5	80.4	1,892.8	454.9	Jul
25	1323	Dharan British Camp	Climatology	Sunsari	26°47'	87°17'	400	28.2	20.3		2,187.3	541.0	Aug
26	1324	Rhojpur	Agrometeorology	Rhojpur	27°11'	87°03'	1,595	20.4	12.5	78.4	1,214.1	258.8	Jul
27	1405	Taplejung	Synoptic	Taplejung	27°21'	87°40'	1,732	20.4	11.7	77.4	1,961.6	415.0	Aug
28	1407	Ilam Tea Estate	Agrometeorology	Ilam	26°55'	87°54'	1,300	22.4	15.9	76.0	1,787.9	424.0	Jul
29	1421	Gaida (Kantai)	Climatology	Jhapa	26°30'	87°54'	143	30.3	30.3	76.5	2,852.6	683.2	Aug

Table B2.4 (1/8)

METEOROLOGICAL CONDITIONS

Code: 0209
Station: Dhangadhi

Latitude: 28°41'
Longitude: 80°36'
Elevation: 170 m

Air Temperature, Mean

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	-	-	22.3	27.0	30.0	31.4	28.9	29.2	27.9	24.5	19.7	16.6	-
1986	15.2	16.9	21.8	26.1	27.8	30.3	28.8	28.7	28.7	24.8	20.6	16.2	23.8
1987	15.5	18.5	22.6	26.1	28.6	32.6	29.9	29.5	29.4	25.6	20.5	16.4	24.6
1988	15.6	18.3	21.5	27.4	30.4	30.6	29.4	29.3	29.5	25.5	20.7	17.4	24.6
1989	14.3	15.9	21.3	25.7	30.8	30.0	29.4	29.0	28.6	25.9	19.4	15.3	23.8
1990	14.7	16.4	19.9	26.2	28.1	31.0	28.6	29.3	28.6	24.4	20.2	15.7	23.6
1991	13.4	17.5	21.6	26.4	30.8	30.7	30.1	29.1	28.0	24.8	18.8	15.2	23.8
1992	14.4	15.3	21.6	27.2	29.1	31.0	29.5	29.1	28.3	24.5	19.8	15.2	23.7
1993	13.2	17.8	19.7	25.9	30.3	31.0	29.6	29.0	27.8	25.1	20.0	15.8	23.7
1994	15.0	16.1	22.2	25.6	31.4	31.8	30.1	29.1	28.5	24.6	19.2	15.4	24.1
Ave.	14.6	17.0	21.3	26.3	29.7	31.0	29.5	29.1	28.6	25.0	19.9	15.8	24.0

Relative Humidity, 08:45

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	82	81	65	50	56	66	84	86	83	83	84	90	75.8
1986	96	94	76	55	59	71	85	85	85	76	93	95	80.8
1987	95	88	64	58	52	64	82	82	83	79	83	95	77.1
1988	95	86	74	56	55	69	86	86	81	81	87	94	79.2
1989	95	91	77	47	44	75	84	83	86	80	87	94	78.8
1990	96	95	81	48	72	76	88	82	83	82	87	97	82.3
1991	96	92	83	53	51	72	84	89	90	82	89	94	81.3
1992	96	93	67	42	47	61	78	82	85	86	90	97	77.0
1993	96	91	74	52	56	69	82	88	86	81	90	95	80.0
1994	95	93	79	56	45	68	82	87	82	84	90	96	79.8
Ave.	95.6	91.4	75.0	51.9	53.4	69.4	83.4	85.1	84.6	81.2	88.4	95.2	79.6

Precipitation, Total

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	10	0	0	8	89	117	396	450	438	214	0	46	1,778
1986	4	40	2	63	77	232	498	197	227	37	15	52	1,414
1987	7	17	3	16	69	154	648	282	193	0	0	6	1,395
1988	8	3	36	25	65	206	729	350	207	1	0	30	1,660
1989	74	15	32	0	12	248	571	593	235	8	15	20	1,824
1990	0	130	28	1	265	203	860	410	330	0	0	76	2,303
1991	16	49	24	51	61	154	395	504	541	0	10	31	1,836
1992	18	18	0	9	70	127	293	547	279	68	8	0	1,437
1993	8	13	72	4	45	207	359	547	409	0	0	0	1,664
1994	24	67	0	33	16	222	374	500	33	0	0	0	1,269
Ave.	17.7	39.1	21.9	22.4	75.6	194.8	525.2	435.7	272.7	12.7	5.4	23.9	1,648.0

Dhangadhi (0209)

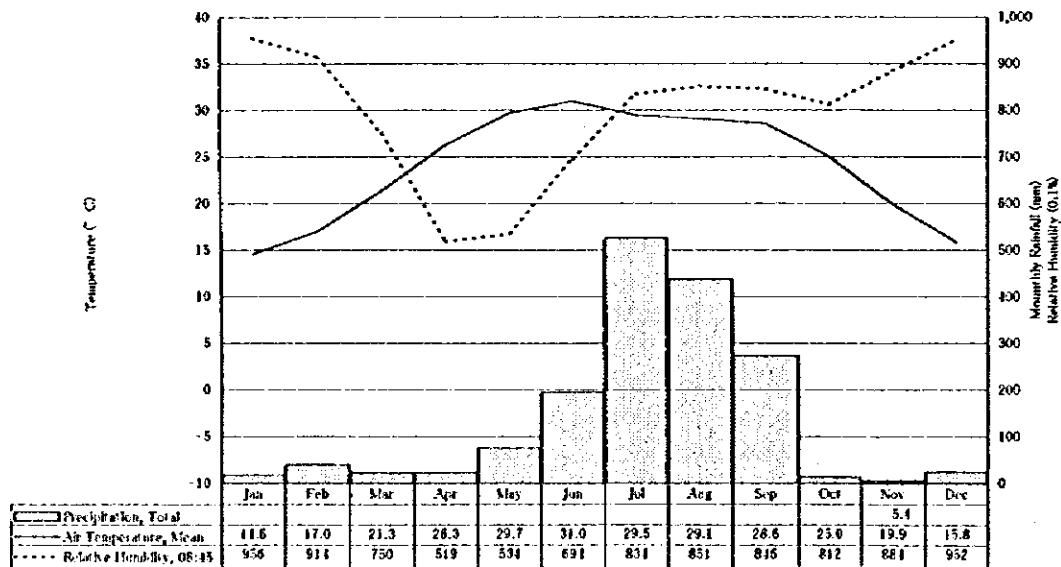


Table B2.4 (2/8)

METEOROLOGICAL CONDITIONS

Code: 0416
Station: Nepalgunj (Reg.Off.)

Latitude: 28°04'
Longitude: 81°37'
Elevation: 144 m

Air Temperature, Mean

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	15.8	17.9	24.6	29.5	32.0	31.6	29.1	29.7	28.1	25.3	21.1	17.3	25.2
1986	15.8	18.2	23.5	28.0	29.6	31.6	29.5	29.9	28.7	25.5	22.1	17.5	25.0
1987	16.5	20.8	24.3	28.4	30.0	33.7	29.6	29.6	29.3	26.2	21.2	17.1	25.5
1988	16.0	19.2	22.8	29.0	31.7	31.1	29.5	29.0	29.2	26.1	22.0	-	-
1989	14.4	16.6	22.5	27.5	31.6	29.9	29.4	29.4	28.6	26.4	21.2	17.1	24.5
1990	15.4	17.7	21.7	27.4	29.3	31.2	29.0	29.9	29.0	25.4	21.6	17.3	24.5
1991	14.8	19.0	23.6	28.0	32.5	31.6	30.8	29.5	28.8	26.1	19.8	16.3	25.0
1992	15.0	16.1	23.2	29.1	30.8	32.1	32.0	29.7	28.9	26.2	21.7	16.5	25.1
1993	14.0	19.4	21.4	27.5	30.5	31.1	30.1	29.6	28.5	26.8	22.7	18.0	25.0
1994	16.3	17.8	23.9	28.1	32.5	32.4	30.6	29.5	29.1	25.9	21.5	17.1	25.4
Ave.	15.3	18.3	23.0	28.1	30.9	31.6	30.0	29.5	28.9	26.0	21.5	17.1	25.0

(Unit: °C)

Relative Humidity, 08:45

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	92	84	65	49	54	72	87	87	90	89	87	92	79.0
1986	91	91	73	52	53	69	86	86	86	87	87	91	79.6
1987	92	86	72	55	57	65	89	87	87	88	88	91	79.8
1988	94	83	70	52	63	75	89	91	91	89	85	92	81.2
1989	93	81	78	48	55	82	89	90	94	93	91	92	82.4
1990	96	93	82	60	77	84	91	89	93	88	88	90	85.9
1991	93	84	78	60	62	77	85	91	92	86	90	92	82.5
1992	94	92	77	62	63	71	88	90	94	91	91	91	83.9
1993	95	89	77	67	77	84	92	91	92	90	92	91	86.7
1994	93	89	82	57	59	78	86	91	89	87	84	89	82.0
Ave.	93.4	87.9	76.6	57.0	62.9	76.1	88.3	89.9	90.9	88.8	88.4	91.7	82.7

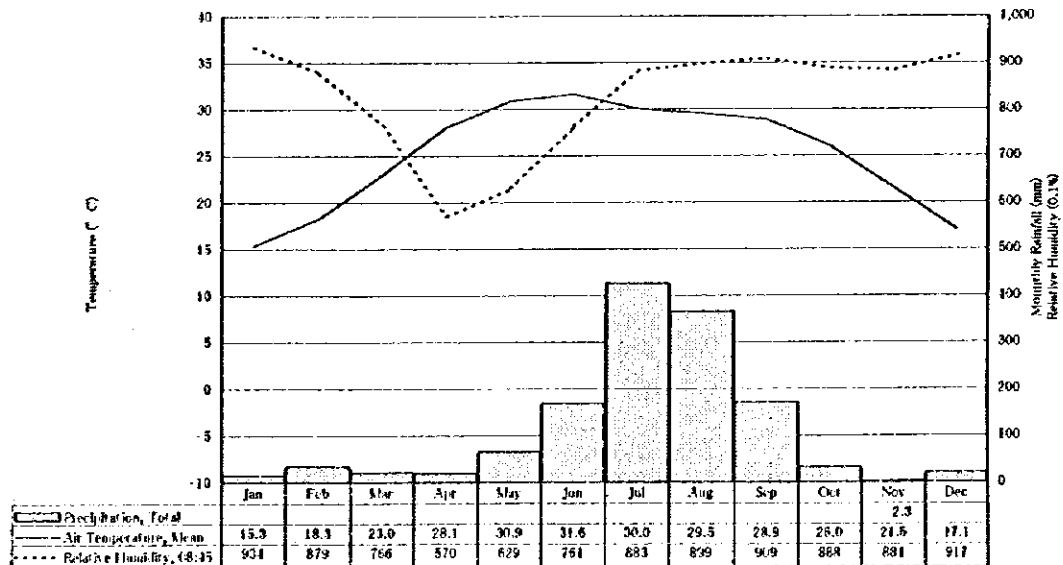
(Unit: %)

Precipitation, Total

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	5	2	0	4	37	218	295	481	447	157	0	11	1,657
1986	3	46	6	24	45	96	212	274	190	53	3	56	1,009
1987	4	24	0	31	102	58	684	139	196	48	0	8	1,294
1988	15	10	20	22	63	157	834	679	106	23	0	32	1,911
1989	45	20	27	0	47	133	613	269	268	58	12	19	1,511
1990	0	100	95	0	146	293	510	210	158	19	0	34	1,565
1991	13	26	10	25	29	112	174	453	132	0	0	36	1,010
1992	9	12	0	8	20	125	201	432	230	88	6	0	1,131
1993	8	4	31	56	90	427	369	557	196	0	0	0	1,738
1994	33	65	0	0	37	115	235	326	58	0	0	0	869
Ave.	14.4	34.1	21.0	18.4	64.4	163.4	425.8	365.4	170.4	32.1	2.3	20.6	1,337.6

(Unit: mm)

Nepalgunj (Reg. Off.) (0416)



METEOROLOGICAL CONDITIONS

Code: 0612
 Station: Mastang (Lomangtang)

Latitude: 29°11'
 Longitude: 83°58'
 Elevation: 3,705 m

Air Temperature, Mean

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	-6.0	-0.8	6.5	5.8	8.2	11.5	12.6	12.7	11.9	5.7	2.4	0.4	5.9
1986	-2.8	-1.9	0.9	4.5	7.8	13.0	14.0	13.5	11.2	5.2	2.8	-3.6	5.4
1987	-3.5	-1.4	2.9	4.7	6.5	13.4	14.6	13.9	12.4	5.3	3.3	-0.5	6.0
1988	-1.3	-0.8	-0.1	6.3	10.1	12.3	14.1	13.2	11.2	6.1	1.2	-	-
1989	-4.9	-1.9	2.1	4.4	8.7	10.5	13.0	13.0	11.2	6.1	1.3	-2.0	5.1
1990	1.3	-1.9	-0.7	5.1	10.4	14.6	14.0	13.7	12.0	5.3	1.8	-0.7	6.2
1991	-	-	5.5	5.0	9.9	12.6	14.5	14.3	11.5	5.2	1.0	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	0.4	5.4	9.7	13.0	14.4	14.7	12.6	7.2	2.2	-1.3	-
1994	-0.3	0.4	2.7	3.0	10.1	13.5	14.2	13.6	12.1	5.8	0.0	-	-
Ave.	-1.9	-1.2	1.7	4.8	9.1	12.8	14.1	13.7	11.8	5.8	1.7	-1.6	5.7

(Unit: °C)

Relative Humidity, 08:45

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	-	88	84	78	85	83	82	95	77	85	91	92	-
1986	-	-	-	64	54	71	74	67	70	68	83	88	-
1987	95	97	83	74	80	60	69	77	83	66	82	91	79.8
1988	95	94	91	67	64	63	70	79	81	70	95	96	80.4
1989	92	98	94	87	78	70	70	97	95	97	97	92	89.0
1990	96	95	96	65	61	80	76	75	85	72	94	95	82.5
1991	-	-	90	63	87	77	85	77	65	81	90	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	84	72	63	67	76	97	94	60	74	93	-
1994	94	96	77	79	81	61	66	72	62	54	91	-	-
Ave.	94.4	96.0	87.9	71.4	71.0	68.6	73.4	80.1	79.5	71.0	88.3	92.5	82.9

(Unit: %)

Precipitation, Total

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	14	1	0	0	4	9	103	53	5	67	0	20	276
1986	1	10	0	17	0	0	103	36	9	2	0	31	209
1987	0	3	0	0	10	0	5	27	8	80	0	18	151
1988	2	5	9	9	2	20	38	29	0	0	0	0	114
1989	2	2	3	0	30	0	28	21	0	0	1	0	87
1990	0	14	1	0	1	1	34	7	24	0	10	3	95
1991	-	-	1	0	2	0	23	48	0	0	5	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	27	0	0	0	0	0	0	0	0	0	-
1994	4	3	2	0	0	0	45	0	0	0	0	0	54
Ave.	1.5	6.2	5.4	3.3	5.6	2.6	34.5	21.0	5.1	10.3	2.0	7.4	118.3

(Unit: mm)

Mastang (Lomangtang) (0612)

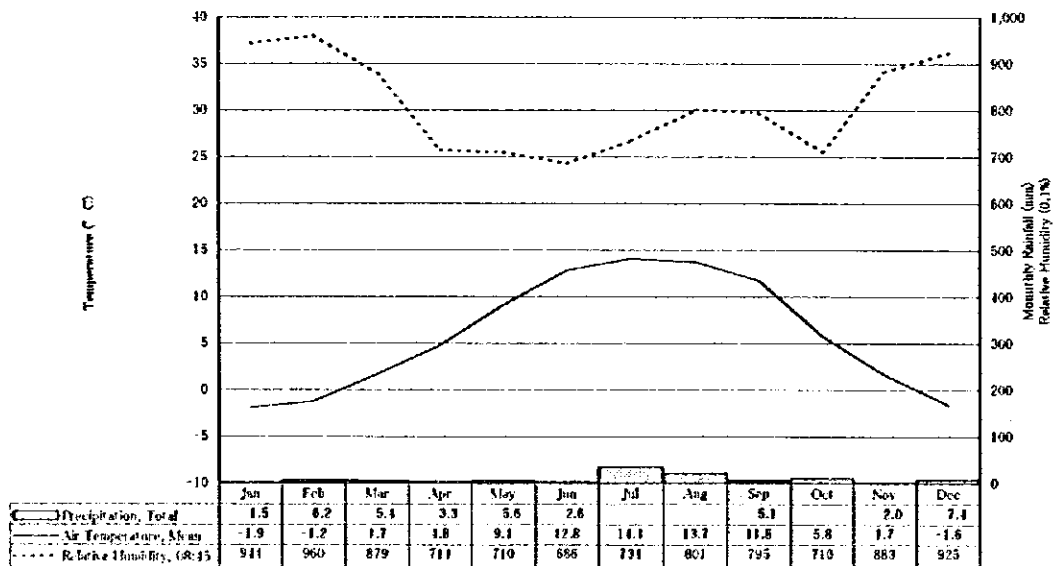


Table B2.4 (4/8)

METEOROLOGICAL CONDITIONS

Code: 0705
Station: Bhairawa Airport

Latitude: 27°31'
Longitude: 83°26'
Elevation: 109 m

Air Temperature, Mean

(Unit: °C)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	16.0	17.8	24.8	29.1	30.2	30.8	28.6	30.2	28.3	26.2	21.5	17.9	25.1
1986	16.0	18.1	23.4	27.6	28.6	31.5	29.4	30.0	28.3	25.6	22.3	17.9	24.9
1987	16.3	20.0	23.7	27.7	29.7	31.8	28.3	28.5	28.3	26.0	21.9	17.7	25.0
1988	16.2	19.3	22.3	27.6	29.8	29.5	28.7	28.4	28.9	26.4	21.6	18.2	24.7
1989	14.6	16.7	22.2	27.4	30.2	29.8	28.1	29.5	-	26.5	21.0	16.3	-
1990	15.2	17.8	21.8	26.7	28.6	30.2	28.7	29.8	28.7	25.3	22.3	17.6	24.4
1991	14.9	18.9	23.3	27.6	30.4	29.9	29.8	29.1	28.9	26.0	20.1	16.5	24.6
1992	15.4	16.2	23.0	28.7	29.2	30.8	29.1	28.8	28.7	25.8	21.9	17.0	24.5
1993	13.7	19.0	20.9	26.6	29.4	30.3	30.2	28.9	27.7	26.4	22.1	18.0	24.4
1994	16.4	17.3	23.7	27.7	30.7	30.7	30.1	29.7	28.3	25.4	21.1	17.1	24.8
Ave	15.4	18.1	22.7	27.5	29.6	30.5	29.1	29.2	28.5	25.9	21.6	17.4	24.7

Relative Humidity, 08:45

(Unit: %)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	95	87	64	50	60	72	86	82	84	85	86	92	78.6
1986	95	88	67	53	60	68	84	84	85	86	87	91	79.3
1987	94	86	73	52	49	64	85	81	85	82	84	96	77.6
1988	97	85	69	56	64	73	85	87	85	81	79	91	79.3
1989	95	86	70	38	54	75	88	80	-	84	87	92	-
1990	96	89	69	55	67	77	84	81	84	83	84	93	80.2
1991	94	87	72	50	63	75	82	84	88	84	90	93	80.2
1992	96	92	64	41	59	66	79	82	86	88	89	97	78.3
1993	97	90	69	60	68	75	82	88	88	84	92	95	82.3
1994	96	92	72	52	56	79	82	85	87	83	89	95	80.8
Ave	95.6	88.3	69.4	50.8	60.0	72.4	83.4	83.7	86.4	83.9	85.8	93.7	79.7

Precipitation, Total

(Unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	12	5	0	14	51	148	389	234	468	182	0	37	1,540
1986	1	21	0	87	53	309	416	323	419	131	27	62	1,849
1987	1	2	4	41	20	73	599	344	193	124	0	8	1,409
1988	0	9	21	64	37	210	894	703	99	15	28	49	2,129
1989	34	10	40	0	63	263	1,072	207	312	4	2	18	2,025
1990	0	63	15	10	125	237	655	295	169	263	0	3	1,835
1991	27	10	33	11	64	200	215	445	314	0	1	42	1,362
1992	6	13	0	4	69	142	350	270	163	160	5	0	1,182
1993	3	1	84	28	90	246	130	444	447	5	0	0	1,478
1994	21	37	0	6	34	248	246	336	278	0	0	5	1,211
Ave	10.3	18.4	21.9	27.9	61.7	214.2	508.6	374.1	266.0	78.0	7.0	20.8	1,608.9

Bhairawa Airport (0705)

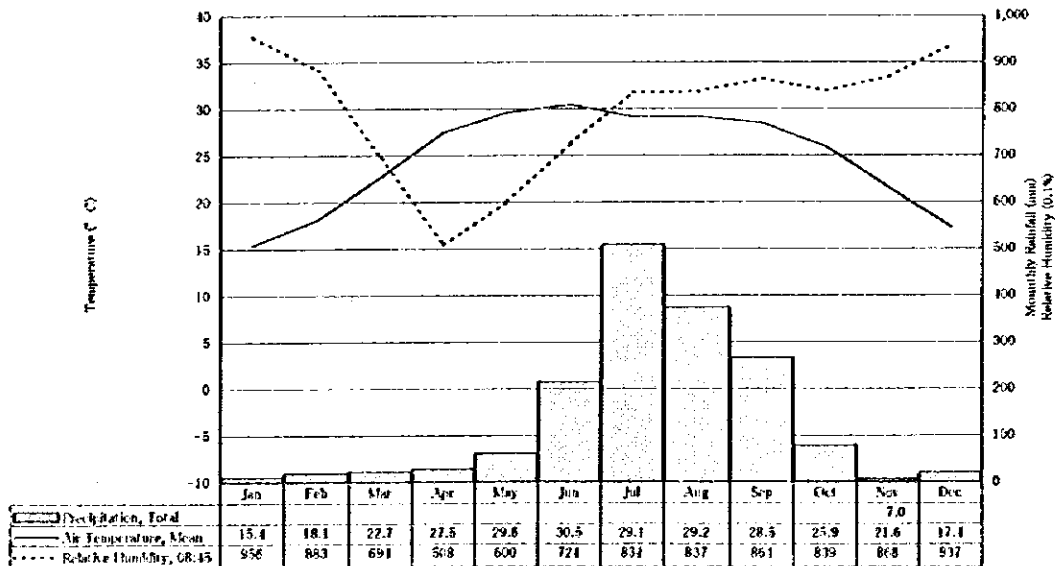


Table B2.4 (5/8)

METEOROLOGICAL CONDITIONS

Code: 0804
 Station: Peshara Airport

Latitude: 28°13'
 Longitude: 84°00'
 Elevation: 827 m

Air Temperature, Mean

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	13.3	15.7	21.8	24.4	23.8	25.9	25.0	26.3	24.6	21.4	17.2	14.1	21.2
1986	13.3	15.3	19.2	21.3	22.7	25.9	25.8	26.2	24.2	21.2	18.1	13.5	20.5
1987	13.8	16.0	19.0	22.0	23.8	26.1	25.3	25.5	25.4	21.8	18.2	15.0	21.0
1988	14.3	16.3	19.0	23.1	24.7	25.8	26.1	25.8	25.4	22.4	17.8	15.4	21.3
1989	12.6	14.2	18.9	22.7	25.2	25.5	24.8	25.5	25.0	22.0	17.3	13.4	20.6
1990	15.0	15.2	17.2	21.7	23.9	26.1	25.7	25.7	25.1	21.4	18.3	14.6	20.8
1991	12.9	16.4	19.8	22.4	24.5	25.5	26.4	26.0	25.3	22.3	17.0	13.6	21.0
1992	13.0	13.8	20.6	24.3	23.4	25.8	25.8	26.0	25.3	21.8	17.8	13.6	20.9
1993	13.5	16.4	17.6	21.7	23.8	25.8	26.3	25.7	24.3	22.2	18.5	15.2	20.9
1994	13.7	14.4	20.1	22.0	24.9	25.8	26.4	26.4	25.1	21.3	16.8	13.6	20.8
Ave.	13.5	15.3	19.0	22.3	24.1	25.8	25.8	25.8	25.0	21.8	17.7	14.2	20.9

(Unit: °C)

Relative Humidity, 08:45

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	86	83	66	57	73	80	89	87	87	86	86	90	80.8
1986	89	87	72	74	75	85	88	87	89	84	88	87	83.8
1987	88	85	76	63	61	76	88	85	87	79	80	85	79.4
1988	89	85	72	60	71	80	87	88	84	75	73	87	79.3
1989	91	83	70	52	63	79	88	85	86	76	84	90	78.9
1990	93	86	76	66	72	83	86	87	86	77	75	86	81.1
1991	90	79	69	61	75	83	87	88	85	82	85	91	81.3
1992	94	89	67	43	71	74	82	86	80	85	84	92	79.3
1993	93	86	69	65	77	82	86	91	90	87	88	86	83.3
1994	89	84	81	63	70	81	85	88	89	84	81	87	81.8
Ave.	90.7	84.9	72.4	61.3	70.6	80.3	86.3	87.2	86.2	81.0	82.0	87.9	80.9

(Unit: %)

Precipitation, Total

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	22	26	27	63	299	373	905	525	696	204	51	58	3,249
1986	1	47	64	191	159	726	768	574	1,164	130	14	69	3,907
1987	3	63	86	117	311	656	1,213	742	728	167	5	28	3,919
1988	2	26	73	136	241	783	1,094	811	794	15	4	55	4,034
1989	68	14	66	12	518	594	974	872	807	58	44	43	4,070
1990	0	60	115	45	361	932	733	743	530	100	0	3	3,622
1991	10	22	78	64	358	496	798	603	994	57	1	35	3,516
1992	13	25	1	54	247	469	794	799	397	246	2	26	3,073
1993	9	20	56	205	358	652	956	1,168	479	295	9	0	4,211
1994	35	50	73	60	381	687	1,020	794	524	98	2	0	3,724
Ave.	15.7	36.3	68.0	98.2	303.8	666.1	928.9	789.6	713.0	129.6	9.0	28.8	3,786.9

(Unit: mm)

Peshara Airport (0804)

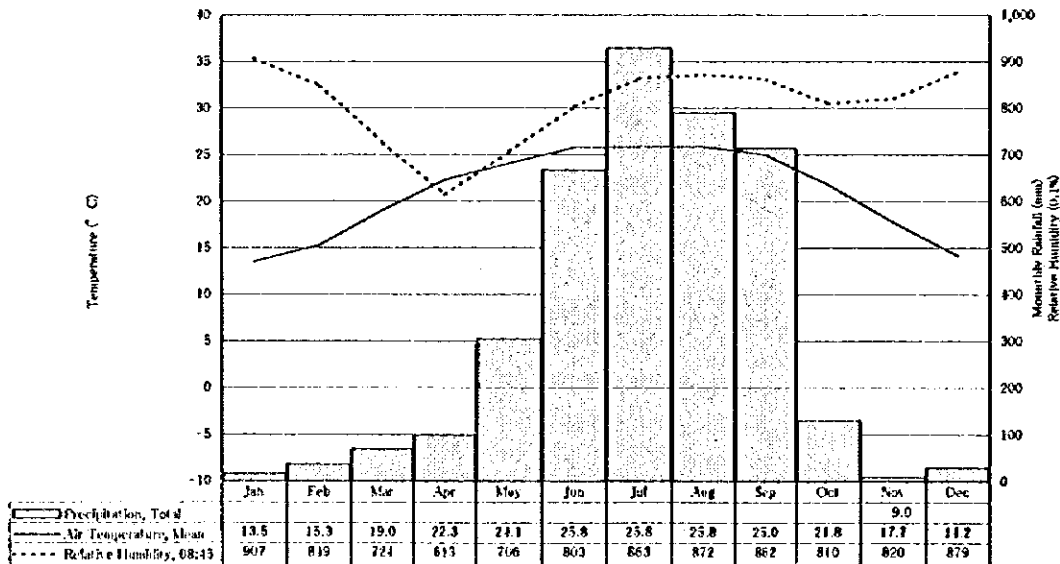


Table B2.4 (6/8)

METEOROLOGICAL CONDITIONS

Code: 1030
Station: Kathmandu Airport

Latitude: 27°42'
Longitude: 85°22'
Elevation: 1,336 m

Air Temperature, Mean

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	10.3	11.9	17.7	20.4	21.8	24.1	23.4	24.5	22.5	19.1	14.6	12.1	18.5
1986	10.5	11.8	15.9	18.8	20.5	23.9	24.2	24.1	22.5	18.6	15.2	10.8	18.0
1987	10.5	13.0	15.5	19.0	21.2	23.9	23.8	23.5	22.9	19.3	15.6	12.4	18.4
1988	11.1	13.5	15.7	19.9	22.4	23.4	24.2	23.9	23.8	20.9	15.4	12.7	18.9
1989	10.1	11.9	16.3	19.3	22.6	24.2	23.8	24.4	23.8	21.0	14.9	11.3	18.6
1990	12.7	12.5	14.6	18.5	21.5	24.5	23.8	23.8	23.0	19.3	15.9	12.0	18.5
1991	9.9	13.4	16.8	19.1	22.1	23.4	24.3	23.8	23.1	19.6	13.9	10.8	18.3
1992	10.0	11.1	17.6	20.8	20.8	23.7	23.7	24.0	23.1	19.3	15.0	11.1	18.3
1993	10.7	13.6	14.5	18.7	21.7	23.7	24.3	24.0	22.8	20.2	15.8	12.5	18.5
1994	11.4	12.1	17.4	19.5	22.6	24.4	24.7	24.4	23.4	19.2	14.9	11.3	18.7
Ave.	10.7	12.5	16.0	19.3	21.7	23.9	24.1	24.0	23.1	19.7	15.2	11.6	18.5

(Unit: °C)

Relative Humidity, 08:45

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	94	90	74	65	72	76	84	84	87	91	98	97	84.3
1986	97	96	79	74	73	79	84	84	87	93	97	98	86.8
1987	97	96	93	74	64	77	86	87	87	92	96	96	87.1
1988	95	91	86	70	75	80	83	88	87	91	92	93	86.0
1989	95	91	82	60	69	75	83	85	85	89	94	94	83.8
1990	97	95	87	76	75	77	84	85	87	87	92	95	86.5
1991	96	88	84	72	78	82	85	88	87	91	93	95	86.6
1992	98	92	71	56	75	77	81	85	85	90	91	96	83.1
1993	97	91	80	72	74	79	85	87	89	89	95	95	86.1
1994	95	92	83	61	69	83	83	85	87	89	90	96	84.5
Ave.	96.7	92.8	82.8	68.3	72.4	78.8	83.8	86.1	86.8	90.1	93.3	95.3	85.6

(Unit: %)

Precipitation, Total

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	10	3	4	25	133	161	418	434	376	167	0	55	1,786
1986	0	23	16	93	97	316	381	219	221	80	0	49	1,495
1987	3	43	36	34	58	116	499	256	171	159	0	19	1,394
1988	1	19	68	42	153	240	397	279	134	18	12	79	1,442
1989	47	11	32	4	149	136	328	206	197	42	0	1	1,133
1990	0	42	60	116	108	365	346	309	188	79	0	3	1,616
1991	21	11	45	106	145	114	190	281	128	0	0	25	1,066
1992	6	17	0	45	70	233	224	220	209	51	16	3	1,024
1993	10	15	42	87	185	204	296	294	156	15	2	0	1,306
1994	27	19	14	8	142	414	254	446	243	0	12	0	1,579
Ave.	12.8	22.2	32.6	59.4	123.0	237.6	323.9	278.9	183.0	49.3	4.7	19.9	1,347.2

(Unit: mm)

Kathmandu Airport (1030)

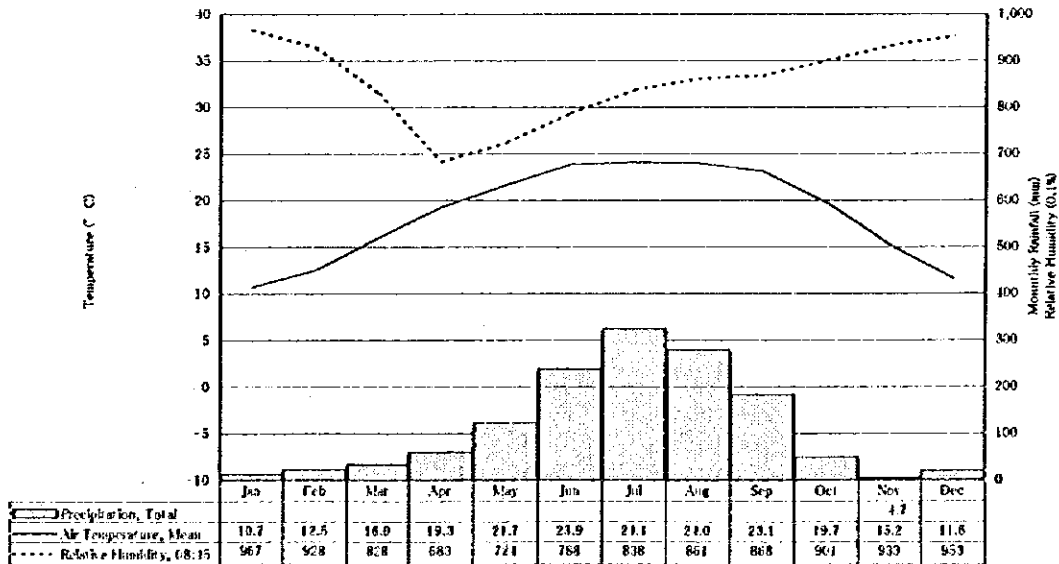


Table B2.4 (7/8)

METEOROLOGICAL CONDITIONS

Code: 1118
Station: Manusmara

Latitude: 26°53'
Longitude: 85°25'
Elevation: 100 m

Air Temperature, Mean

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	18.0	23.1	26.9	27.8	31.1	29.2	29.8	28.2	25.4	22.3	17.7	-
1987	16.1	19.7	23.1	26.9	29.2	31.6	29.1	29.2	29.1	26.8	22.5	18.8	25.2
1988	16.9	19.5	23.1	27.0	29.8	30.1	30.0	29.3	-	-	22.8	19.0	-
1989	15.0	17.1	22.3	26.7	29.3	30.5	29.0	29.6	28.9	27.6	21.5	16.7	24.5
1990	16.4	18.5	22.1	26.7	29.1	31.1	29.6	30.2	29.0	26.0	22.6	18.2	24.9
1991	15.3	18.9	23.8	27.1	30.4	30.5	30.3	30.0	29.3	26.9	20.7	17.1	25.0
1992	15.8	16.5	23.0	28.2	28.8	31.2	30.2	30.4	29.5	27.2	22.7	17.5	25.1
1993	14.8	19.5	21.1	26.0	29.3	30.2	30.3	29.4	28.8	27.4	23.0	18.7	24.8
1994	17.4	18.0	23.5	27.2	30.6	31.3	30.9	30.4	29.1	26.1	22.0	17.1	25.3
Ave	15.9	18.4	22.8	26.9	29.3	30.8	29.8	29.8	29.0	26.7	22.2	17.8	25.0

(Unit: °C)

Relative Humidity, 08:45

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	88	70	60	63	69	82	80	80	82	83	91	-
1987	94	81	71	71	74	81	90	88	83	77	79	91	81.7
1988	93	86	67	66	71	77	85	85	-	-	76	87	-
1989	92	84	72	53	70	80	87	84	89	82	85	91	80.8
1990	91	86	75	68	78	81	87	82	86	83	84	85	82.4
1991	89	83	72	67	73	80	84	85	87	88	87	89	82.0
1992	87	85	75	57	78	79	87	87	89	90	88	88	82.5
1993	87	88	83	82	87	90	90	91	92	90	89	87	88.0
1994	88	90	88	83	86	89	91	91	93	92	91	90	89.3
Ave	90.5	85.7	74.8	67.4	75.6	80.7	87.0	85.9	87.4	85.5	84.7	88.8	83.8

(Unit: %)

Precipitation, Total

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	33	1	62	99	115	429	335	138	167	16	60	-
1987	0	3	3	114	24	100	519	1,097	320	302	0	4	2,436
1988	0	39	35	113	89	165	379	439	-	-	0	14	-
1989	11	14	21	0	159	84	407	70	244	50	0	1	1,061
1990	0	32	5	32	171	85	450	333	258	14	0	0	1,380
1991	28	2	3	33	30	124	257	433	107	105	0	6	1,128
1992	1	11	0	39	158	31	278	222	178	82	5	0	1,005
1993	7	4	29	85	44	141	406	542	158	7	0	0	1,423
1994	24	16	0	3	124	30	337	281	284	2	0	0	1,101
Ave	8.9	17.1	19.8	53.4	99.8	97.2	384.7	416.9	210.9	91.1	2.3	9.1	1,369.1

(Unit: mm)

Manusmara (1118)

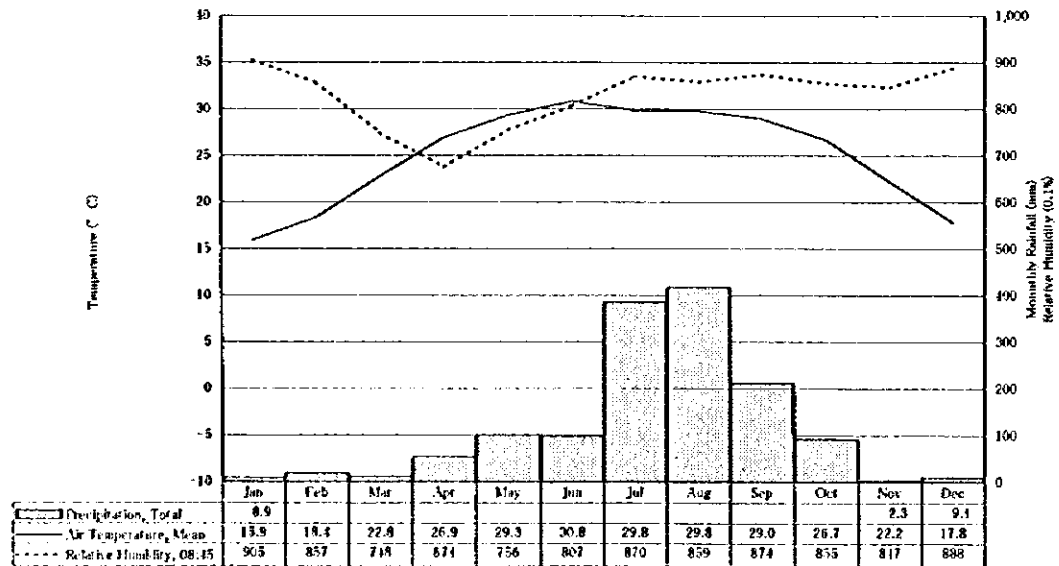


Table B2.4 (8/8)

METEOROLOGICAL CONDITIONS

Code: 1319
 Station: Biratnagar Airport

Latitude: 26°29'
 Longitude: 87°16'
 Elevation: 72 m

Air Temperature, Mean

(Unit: °C)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	16.1	18.2	24.7	28.8	27.8	29.0	27.7	29.5	28.1	26.0	21.3	18.0	24.6
1986	16.6	18.4	23.6	26.6	26.4	29.3	28.7	29.4	27.4	24.8	22.5	17.9	24.3
1987	17.0	19.4	23.1	26.2	28.2	29.1	27.7	27.8	27.7	25.8	22.6	18.9	24.4
1988	17.1	19.6	22.4	26.1	27.8	28.6	28.9	28.3	29.2	27.1	22.5	19.3	24.7
1989	15.4	17.0	22.4	27.0	27.6	28.1	27.7	28.1	26.4	26.3	21.5	16.9	23.7
1990	16.5	18.6	21.6	25.6	27.3	28.7	28.5	29.2	28.3	25.4	22.5	17.9	24.1
1991	15.5	19.1	23.5	26.8	27.9	28.0	28.4	28.6	27.9	26.2	20.8	17.1	24.1
1992	15.9	16.4	23.6	28.4	27.6	29.6	28.8	29.1	28.9	26.0	21.7	16.8	24.4
1993	14.4	19.2	21.4	25.4	27.5	28.4	29.4	28.5	28.0	26.5	22.8	18.8	24.2
1994	17.0	17.7	23.6	27.6	30.2	29.4	30.1	29.6	28.8	25.8	21.8	17.5	24.9
Ave.	16.1	18.4	22.8	26.6	27.8	28.8	28.1	28.7	28.0	26.0	22.1	17.9	24.3

Relative Humidity, 08:45

(Unit: %)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	89	79	62	61	74	83	88	85	86	82	83	90	80.2
1986	96	85	59	58	71	77	85	83	84	81	81	86	78.9
1987	92	84	72	56	64	79	87	83	85	79	78	87	78.8
1988	93	84	63	63	70	74	87	87	79	75	71	87	77.8
1989	91	76	65	50	68	81	85	85	88	81	85	89	78.7
1990	95	85	72	66	80	85	89	84	85	80	79	91	82.7
1991	94	87	70	62	74	83	84	85	87	83	85	90	82.0
1992	95	85	59	52	74	77	85	87	86	84	81	94	80.0
1993	96	87	69	64	75	82	86	89	85	84	88	90	82.9
1994	97	90	73	59	69	82	82	85	85	85	82	90	81.6
Ave.	94.3	85.1	66.9	58.9	71.7	80.0	85.6	85.3	84.9	81.3	81.1	89.3	80.4

Precipitation, Total

(Unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	1	2	24	0	184	179	632	189	286	217	9	16	1,239
1986	0	2	1	39	216	210	487	218	362	151	1	25	1,712
1987	0	6	36	58	120	325	647	749	480	138	12	1	2,572
1988	0	67	23	127	118	129	512	724	121	107	38	4	1,970
1989	15	32	5	0	327	346	685	491	791	59	0	5	2,666
1990	0	16	15	109	313	467	692	510	301	23	0	0	2,356
1991	35	4	22	51	108	153	285	290	411	70	0	26	1,455
1992	2	3	0	2	187	147	396	201	189	291	0	1	1,419
1993	21	1	35	91	130	308	357	699	346	49	9	0	2,046
1994	28	31	9	3	81	165	123	225	160	1	3	0	829
Ave.	11.2	18.0	16.2	53.3	177.8	251.1	454.9	446.3	351.2	98.8	7.0	6.9	1,892.8

Biratnagar Airport (1319)

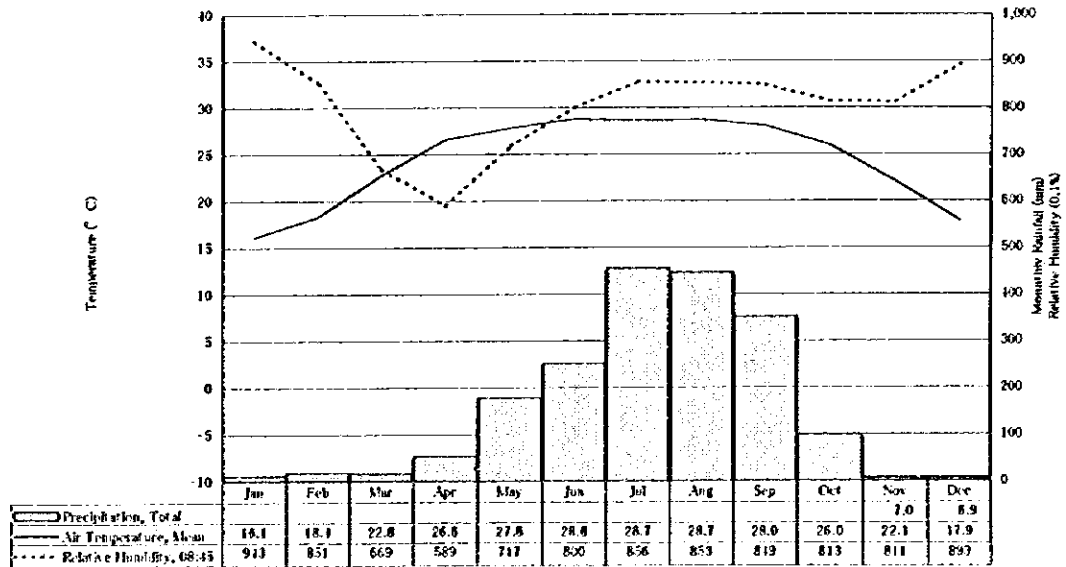


Fig. B2.1

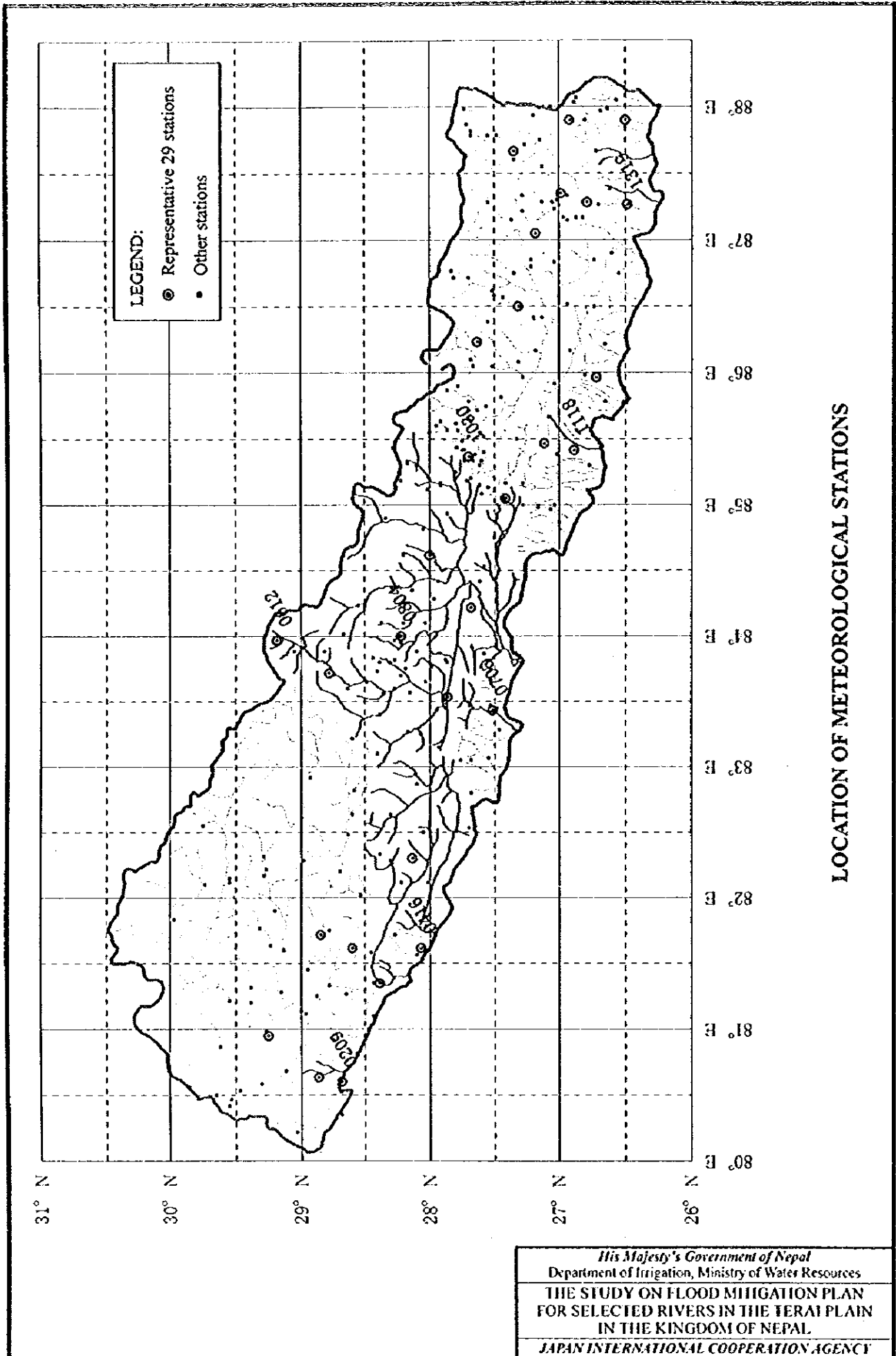


Fig. B2.2

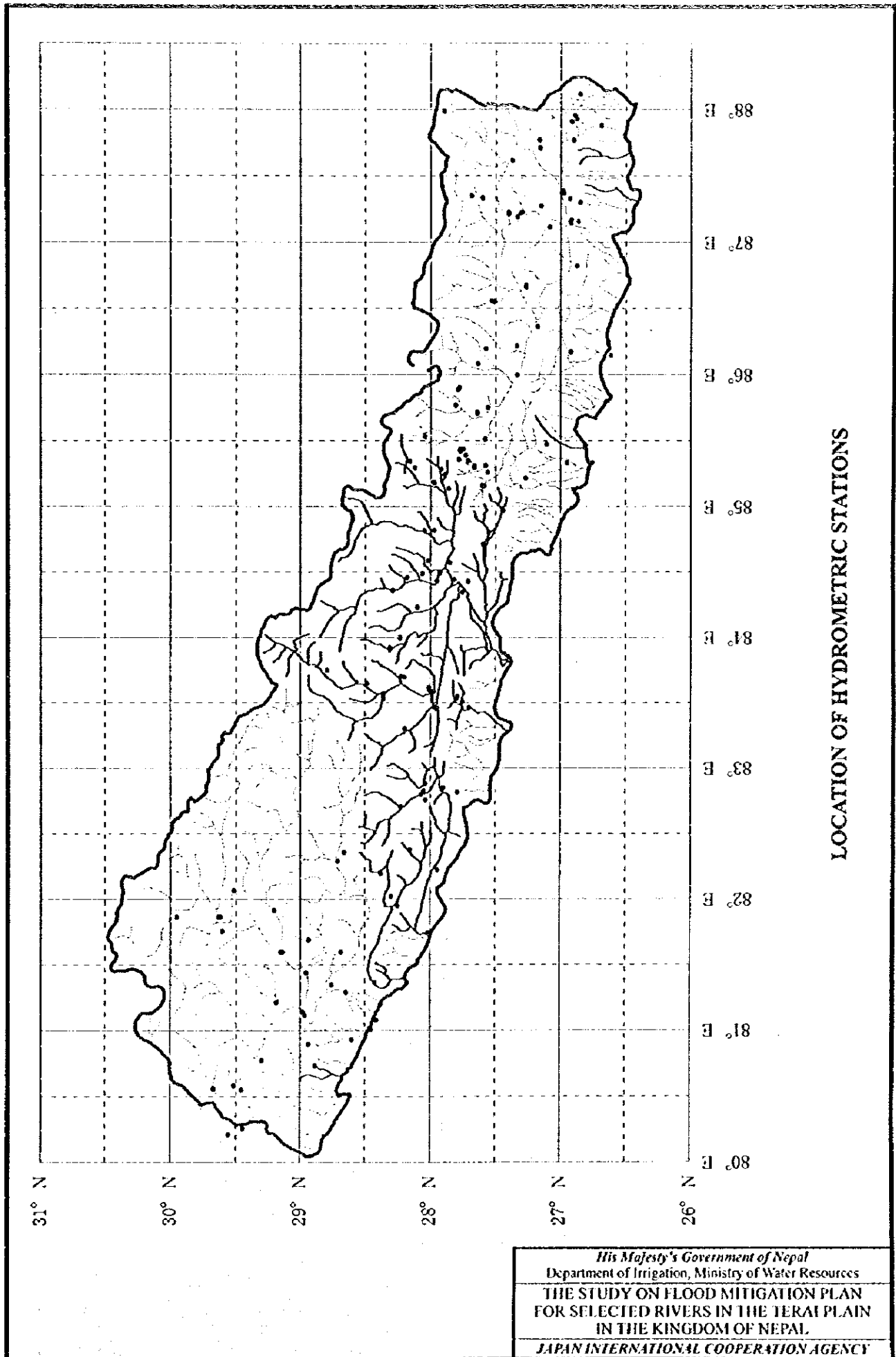
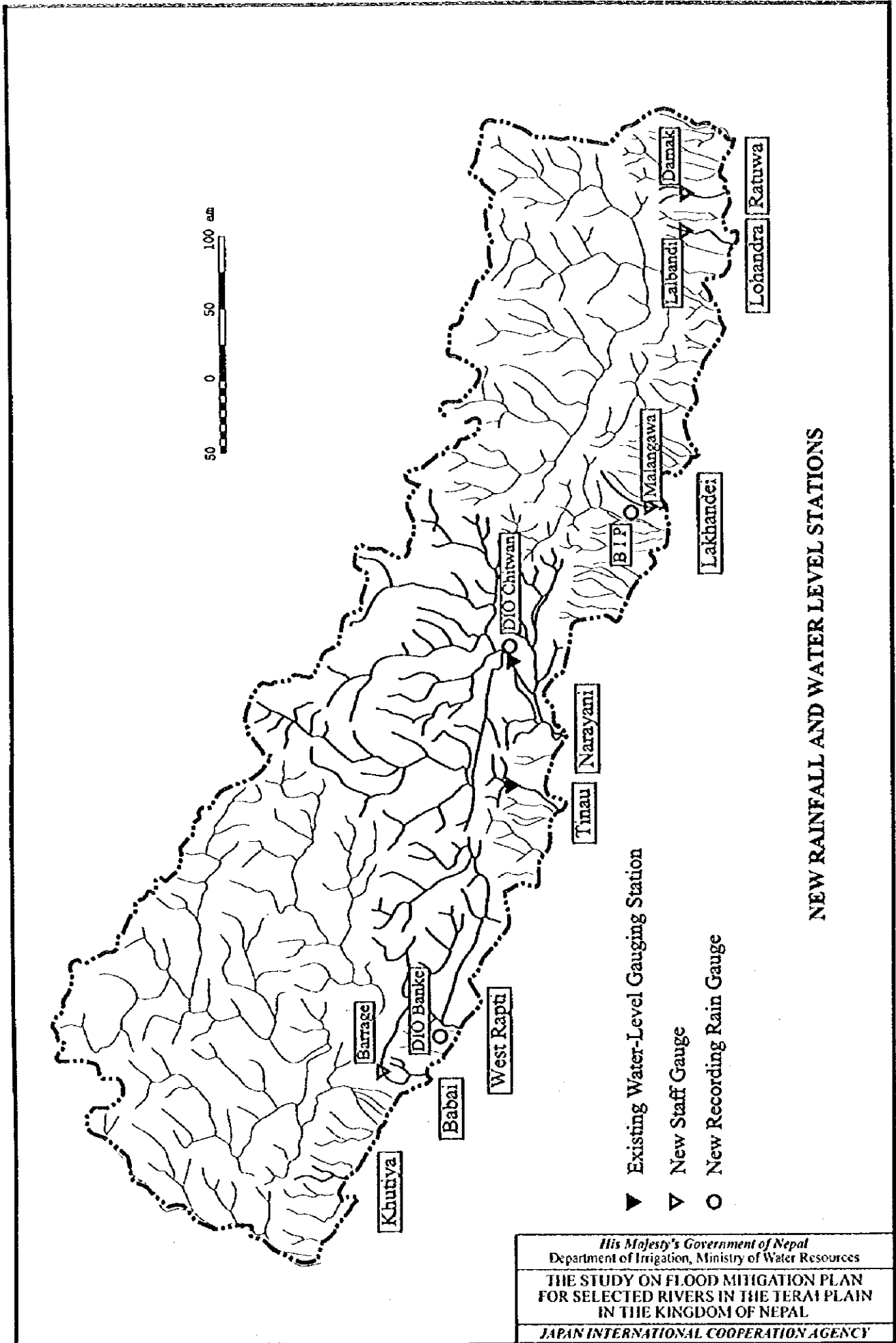
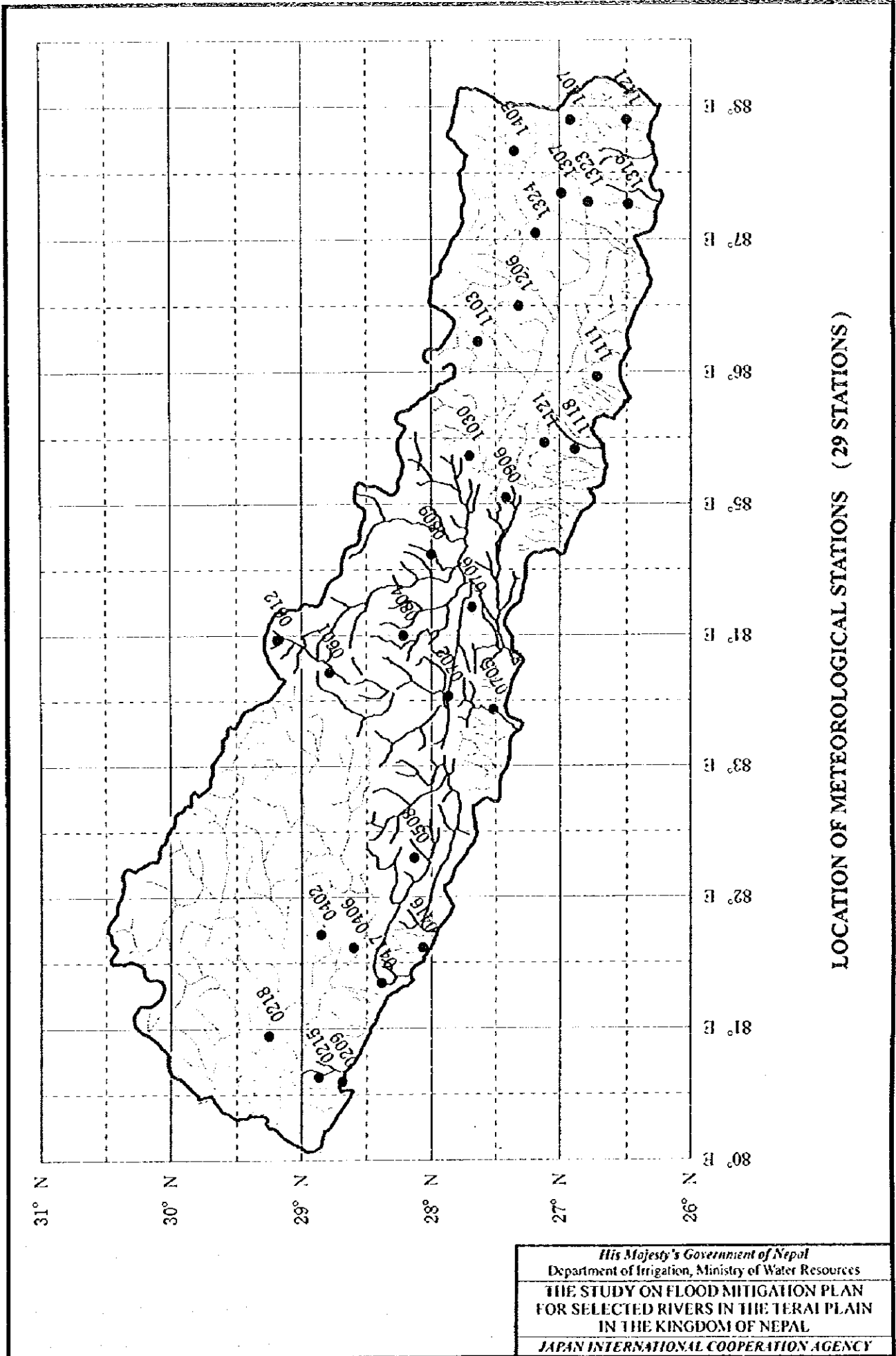


Fig. B2.3

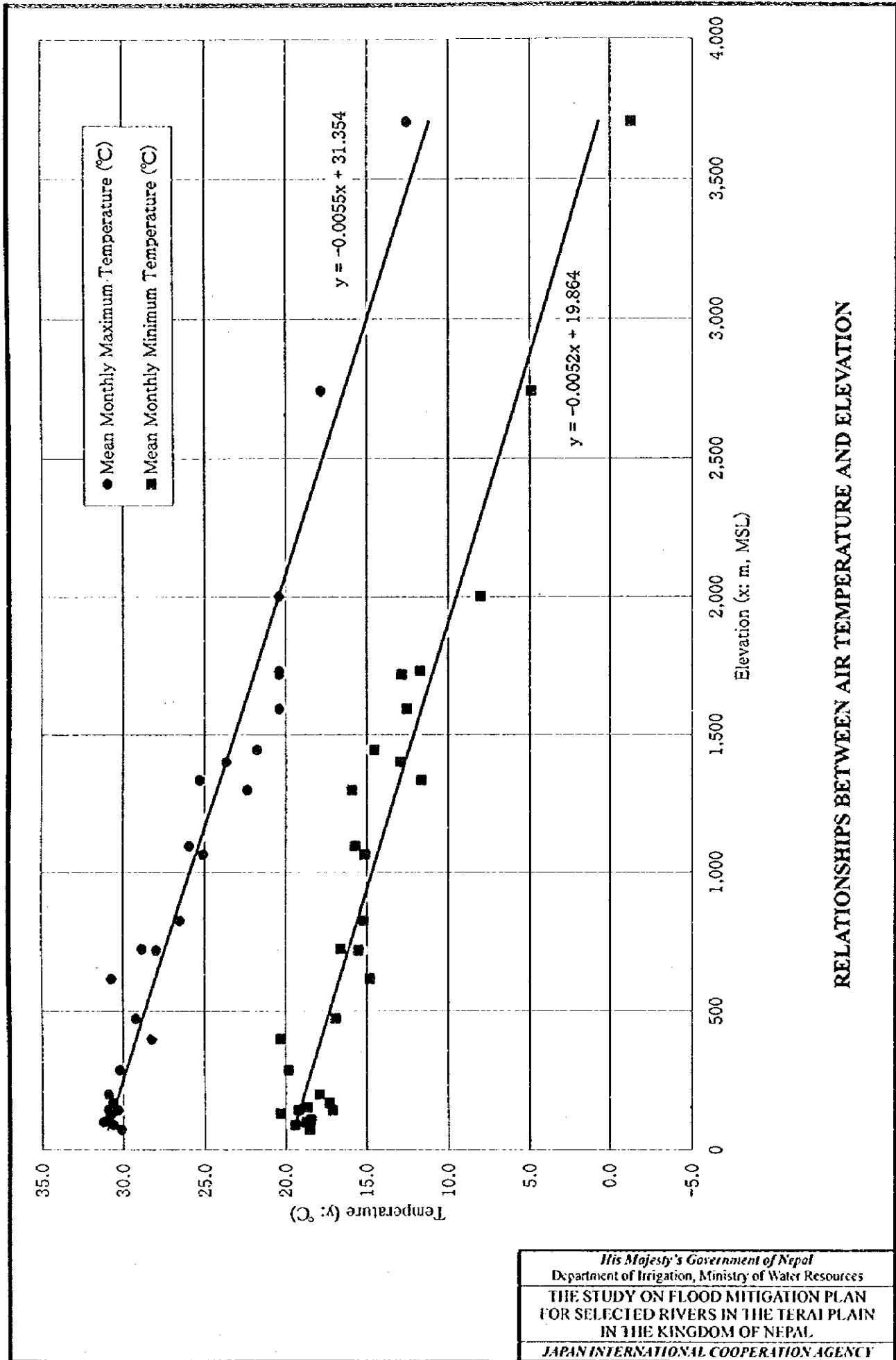




LOCATION OF METEOROLOGICAL STATIONS (29 STATIONS)

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 IN THE KINGDOM OF NEPAL**
 JAPAN INTERNATIONAL COOPERATION AGENCY

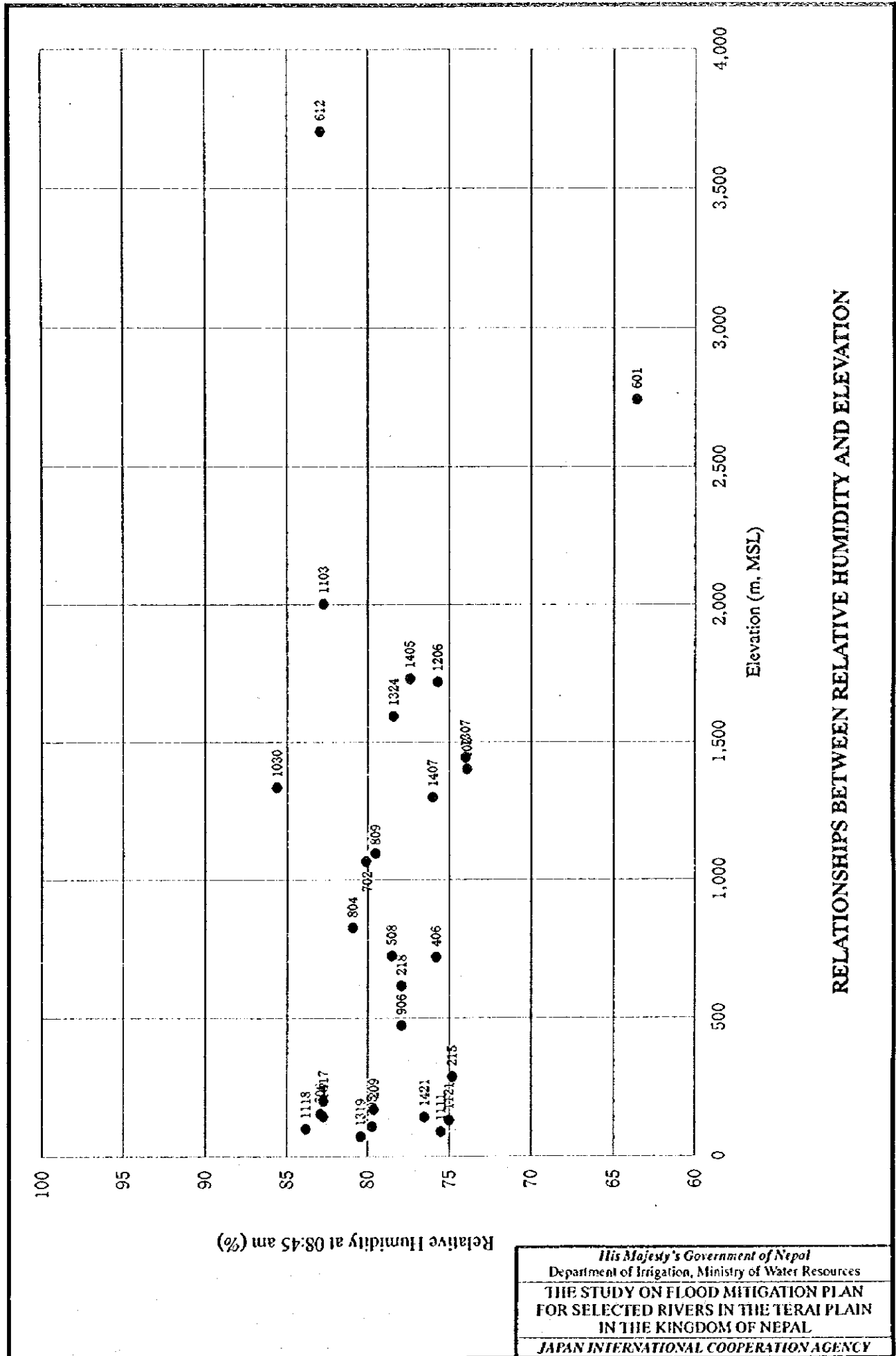
Fig. B2.5



RELATIONSHIPS BETWEEN AIR TEMPERATURE AND ELEVATION

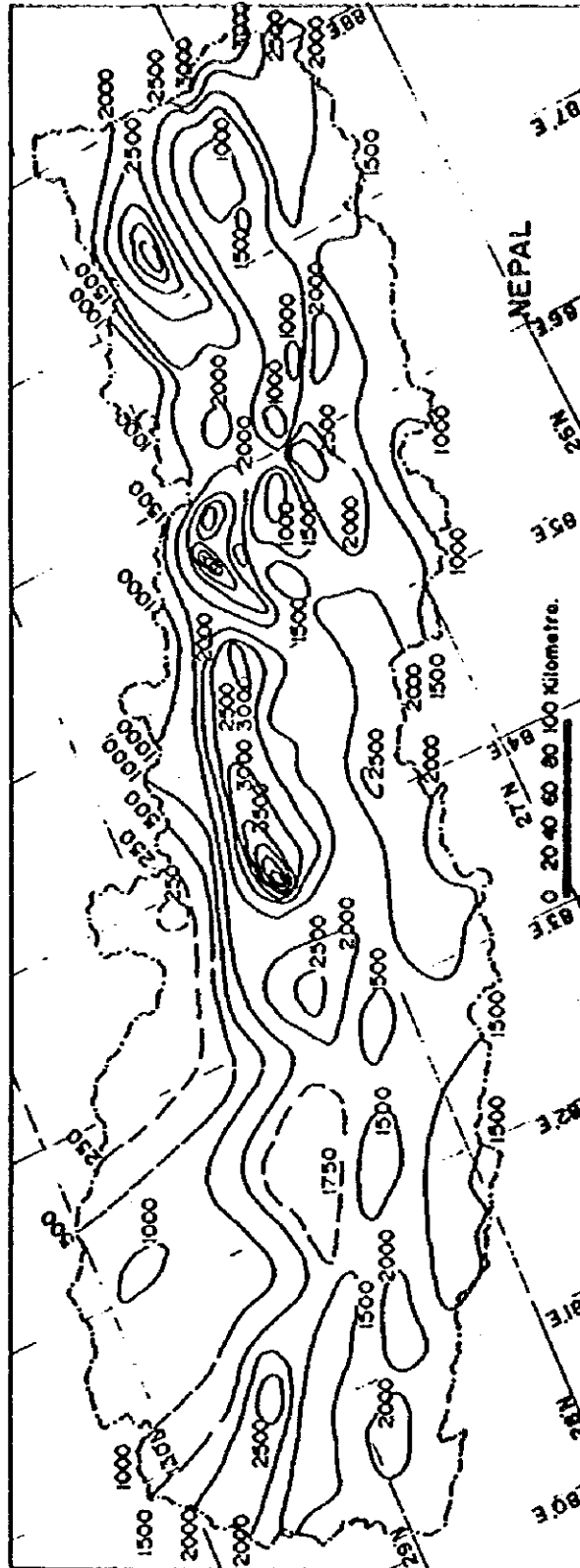
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Fig. B2.6



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MEAN ANNUAL PRECIPITATION (mm) 1971-1985

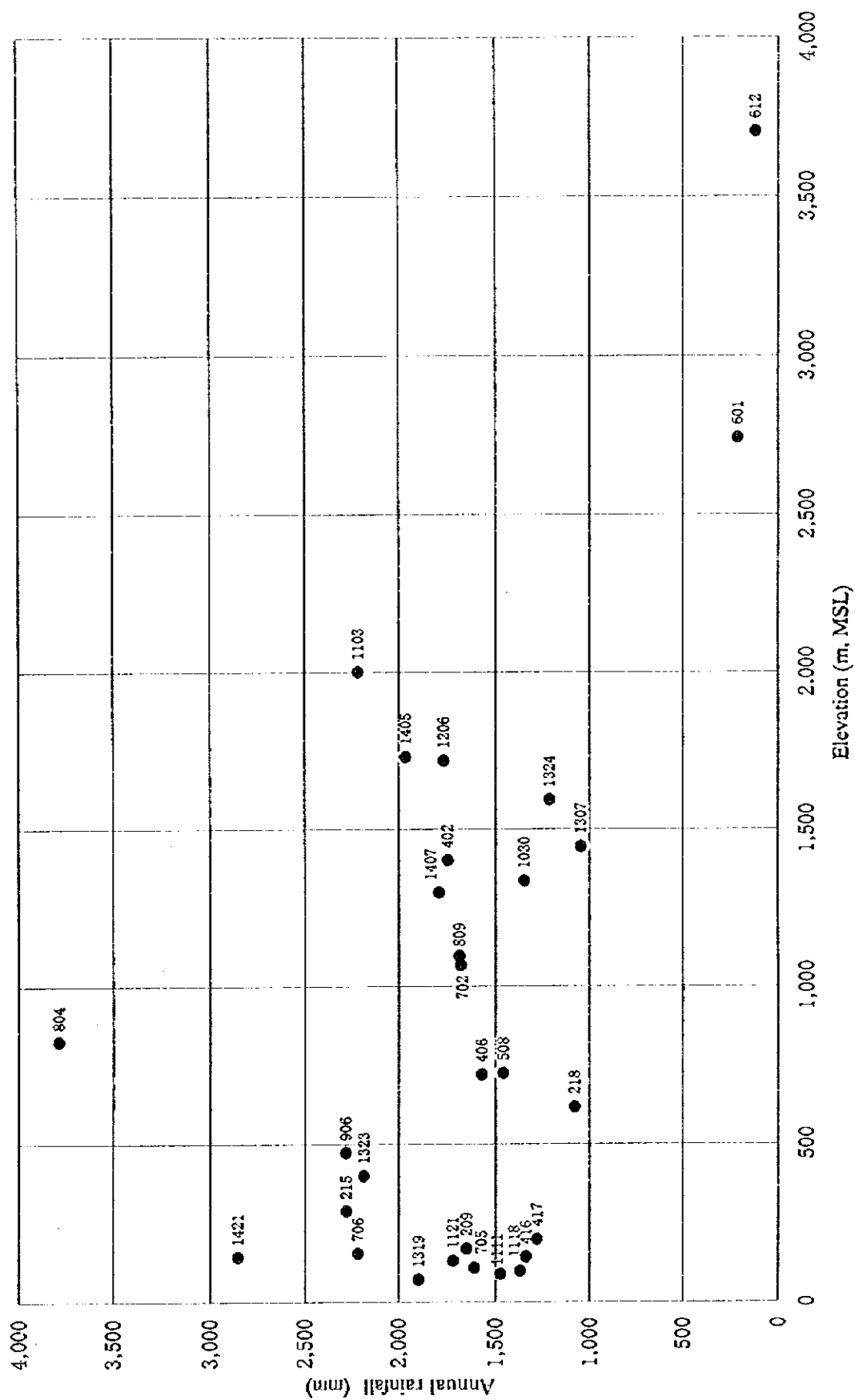


Source: Natural Hazards and Man Made Impacts in The Nepal Himalaya, C.K.Sharma, 1988

ANNUAL RAINFALL
DISTRIBUTION OF NEPAL

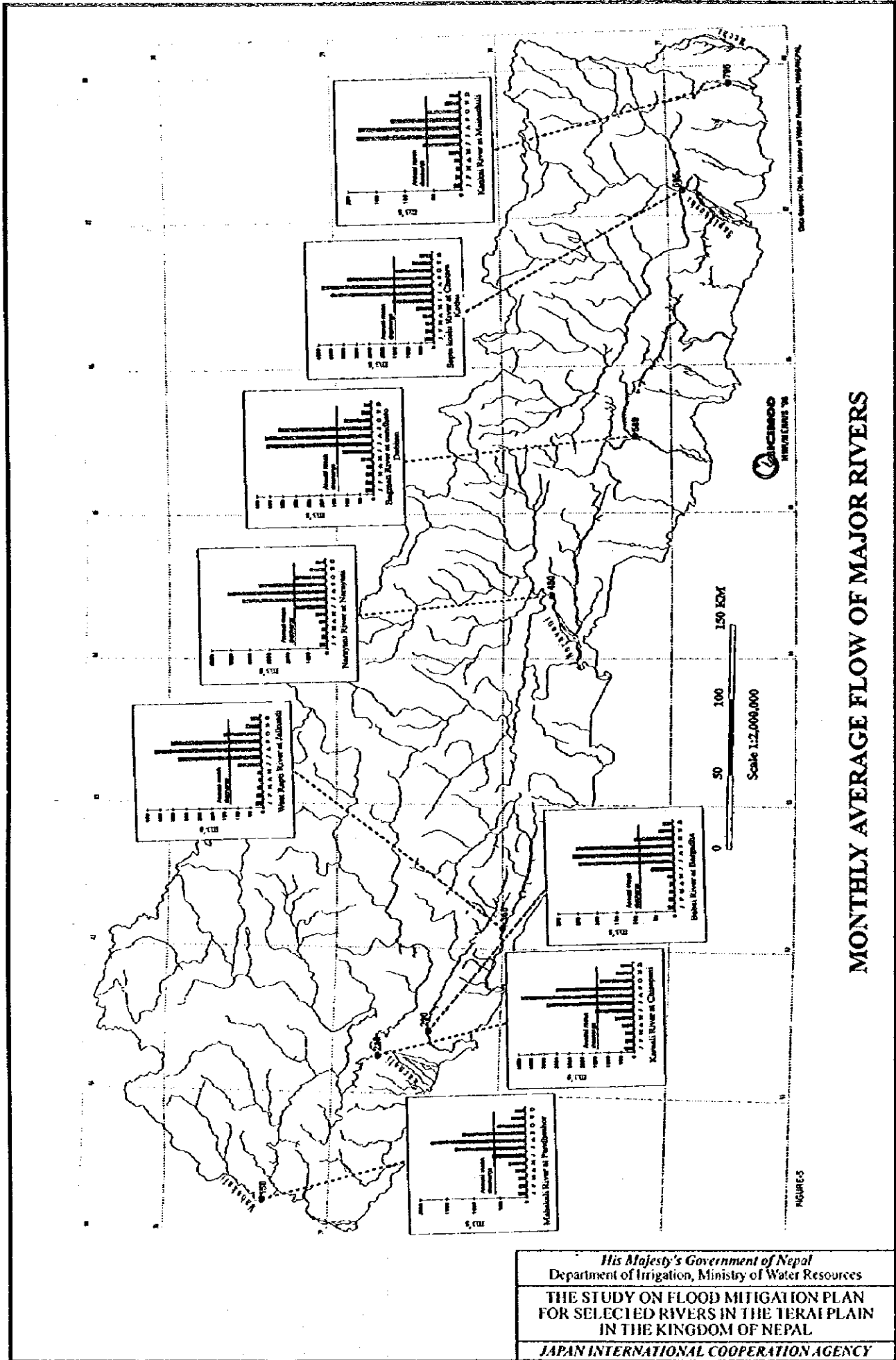
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Fig. B2.8



RELATIONSHIPS BETWEEN ANNUAL RAINFALL AND ELEVATION

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3. RIVER SYSTEM AND RIVER BASIN

3.1 Rivers in Nepal

(1) River Systems in Nepal

Major river systems in Nepal and their principal features are shown in Fig. B3.1 and Table B3.1. Four major rivers, i.e., the Kosi, Narayani (Gandaki), Karnali and Mahakali rivers, drain about 71% of the total area of Nepal. Other individual rivers originating from the Mahabharat ranges include the Kankai, Kamala, Bagmati, Tinau, West Rapti, and Babai rivers.

Aside from the above, numerous rivers of small scale originate from the Siwalik hills, among which included are the Ratuwa, Lohandra, Lakhandei and Khutiya rivers selected for the present study.

All of these rivers, running in a southwest direction in the Terai plain, flow into the Ganges river in India. The Ganges river finally empty into the Bay of Bengal passing through Bangladesh. Since all rivers in the Terai plain flow into India, modifications to river flow in Nepal would influence the flow conditions in India.

(2) Classification of Rivers

Based on the origin of the basin, rivers in the Terai plain are classified into three as follows:

- 1) Class I: Rivers flowing from the Himalayas and Tibet such as the Kosi, Narayani, Karnali and Mahakali rivers.
- 2) Class II: Rivers originating in the midlands or in Mahabharat range such as the Kankai, Kamala, Bagmati, Tinau, West Rapti, and Babai rivers.
- 3) Class III: Rivers coming from southern slope of the Siwalik hills. The Ratuwa, Lohandra, Lakhandei and Khutiya rivers fall under this class.

The criteria for river classes in Terai are shown in Table B3.2 according to the DOSWC Report (source: Analysis of River Problems and Strategy for Flood Control in the Nepalese Terai, 1979, DOSWC).

3.2 Rivers in Study Area

(1) Principal Basin Features

Eight river basins have been selected for the study from the river classes I, II and III as follows:

- 1) Class I river : Narayani river
- 2) Class II river : Tinau, West Rapti and Babai rivers
- 3) Class III river: Ratuwa, Lohandra, Lakhandei and Khutiya rivers

Systems of these rivers are schematically shown in Fig. B3.2. Basin areas of these rivers are shown below.

River	Mountain (km ²)	Plain (km ²)	Total (km ²)
1.Ratuwa R.	133	250	383
2.Lohandra R.	140(31)	279	419(310)
3.Lakhandei R.	106	194	300
4.Narayani R.	35,075	705	35,780
5.Tinau R.	669	412	1,081
6.West Rapti R.	5,800	618	6,418
7.Babai R.	3,054	371	3,425
8.Khutiya R.	175	150	325

(Remarks) Areas in () for the Lohandra river basin indicate those excluding mountainous basin of the Chisan river.

(2) Characteristics of River Channel

Basic features of the existing river from the Indian border to the upper end of the Terai plain are outlined as shown below.

River	Class	Length(km)	Slope	Width
1. Ratuwa R.	III	43.7(33.4)	1/170~1180	200~690
2. Lohandra R.	III	67.5(51.9)	1/80~2000	50~520
3. Lakhandei R.	III	51.4(40.9)	1/240~1240	50~900
4. Narayani R.	I	83.0(80.6)	1/720~1/1560	400~2500
5. Tinau R.	II	59.5(57.7)	1/110~3180	100~940
6. W. Rapti R.	II	53.0(163.5)	1/540~1920	200~1700
7. Babai R.	II	48.0(48.0)	1/320~3000	200~1300
8. Khutiya R.	III	35.0(28.6)	No map	50~650

Note: River length in () indicates that downstream from E-W Highway

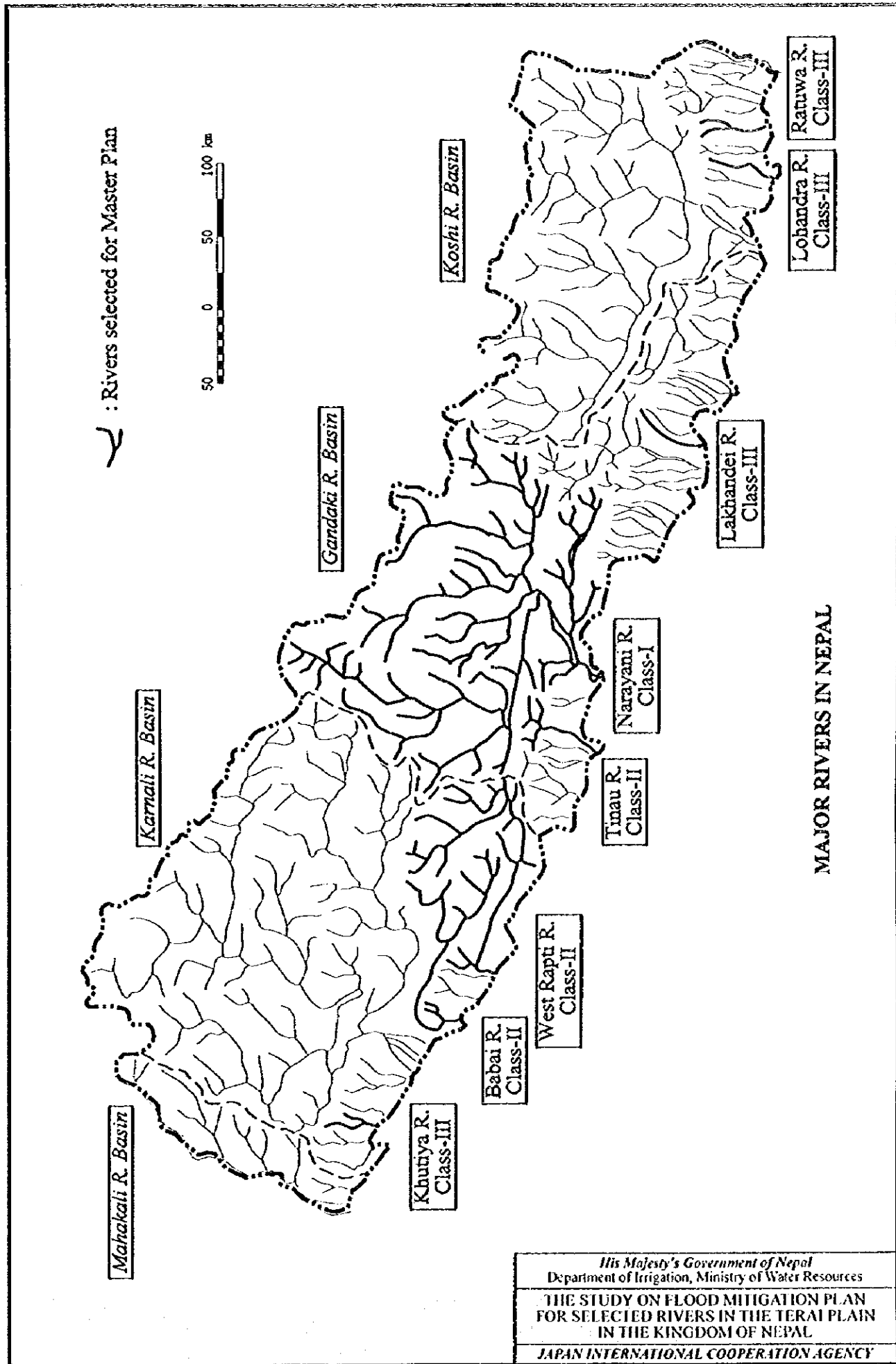
MAJOR RIVERS IN NEPAL

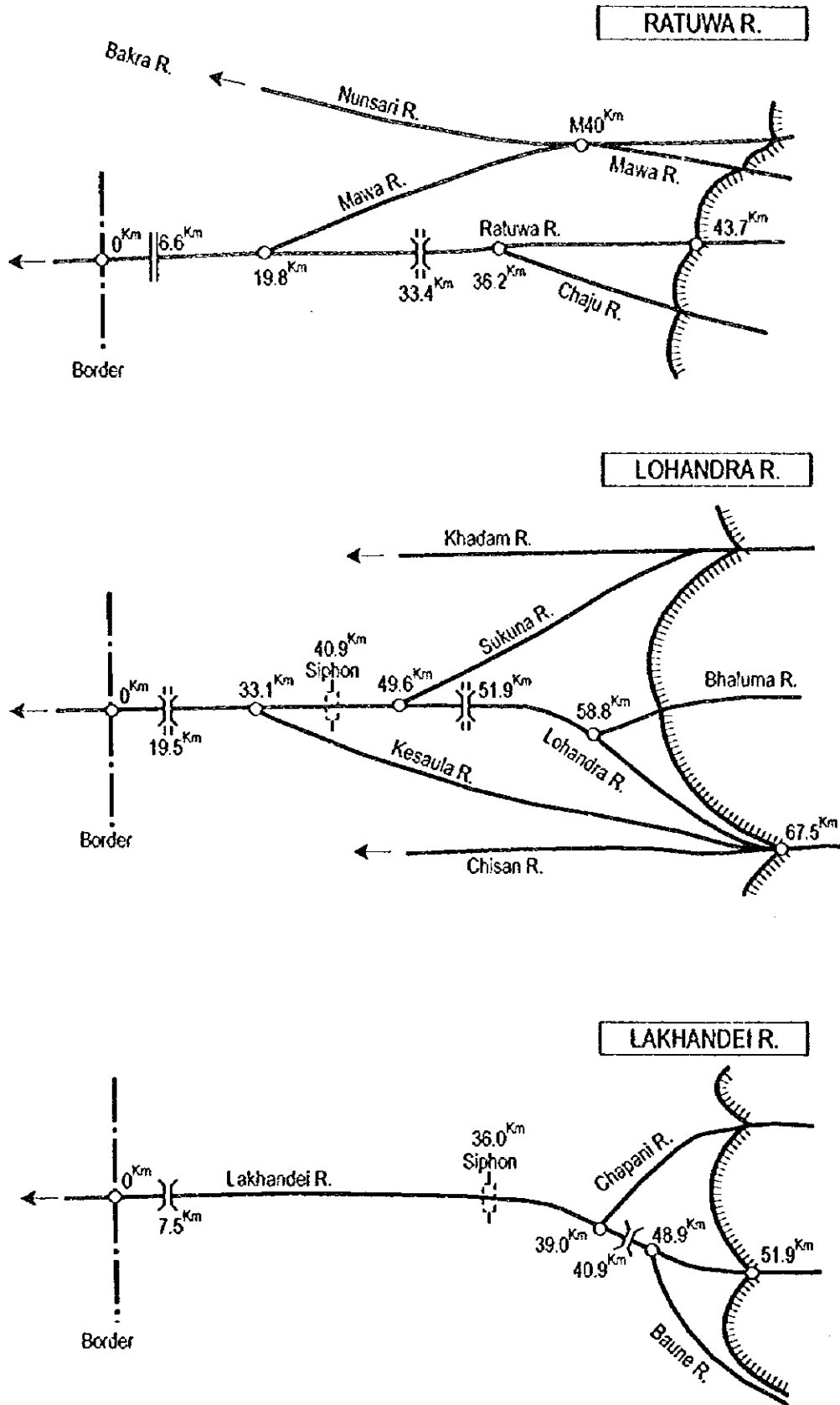
Name of river	Catchment area			Length of main river		
	Total (km ²)	Area in Nepal		Total (km)	Length in Nepal	
		(km ²)	(%)		(km)	(%)
1 Koshi River Basin	60,400	27,784	46	534	187	35
1-1 Tamar River	6,125	6,125	100	198	198	100
1-2 Arun River	34,000	5,100	15	481	135	28
1-3 Sunkoshi River	19,220	16,145	84	336	255	76
2 Narayani River Basin	34,960	31,114	89	451	451	100
2-1 Trisuli River	19,700	15,366	78	270	159	59
2-1-1 Budhi Gandaki River	4,960	3,621	73	154	100	65
2-1-2 Marshandi River	4,819	4,819	100	153	153	100
2-1-3 Seti River	2,843	2,843	100	125	125	100
2-2 East Rapti River	2,993	2,993	100	122	122	100
2-3 Kaligandaki River	11,600	11,600	100	316	316	100
3 Karnali River Basin	44,000	41,360	94	550	435	79
3-1 Humla Karnali River	8,500	5,525	65	243	129	53
3-2 Mugu Karnali River	6,155	6,155	100	195	195	100
3-3 Tila River	3,252	3,252	100	109	109	100
3-4 Seti River	7,103	7,103	100	202	202	100
3-5 Bheri River	13,867	13,867	100	264	264	100
4 Mahakali River	15,260	5,188	34	223	223	100
5 Kankai River	1,317	1,317	100	108	108	100
6 Kamala River	1,786	1,786	100	117	117	100
7 Bagmati River	3,681	3,681	100	163	163	100
8 Tinau River	550	550	100	100	100	100
9 West Rapti River	6,215	6,215	100	257	257	100
10 Babai River	3,252	3,252	100	190	190	100

RIVER CLASSIFICATION IN TERAI PLAIN

Items	Class-I	Class-II	Class-III
Catchment area:			
1 Location	Up to and beyond the Himalayas	Up to Midland or areas of Mahabharat	Southern slopes of Siwaliks hill
2 Basin area (km ²)	15,000 to 60,000	500 to 5,000	less than 300
3 Formation	Antecedent	Consequent	Consequent
Discharges:			
4 In dry season	Perennial flow	Perennial flow	Ephemeral or small flow
5 Ratio of discharge: Q _{max} /Q _{min}	40 to 100	100 to 1,000	More than 2,000
6 Duration of ± 100 % changes from Q _{max}	One day	One hour	A few minutes
Sediment:			
7 Erosion in watershed	High	Very high	Extreme
8 Bedload at the mouth of the hills	Sand and silt	Gravel and sand	Boulders and gravel
9 Endangered areas in the Terai	Small	Medium	Large
10 Effect of soil conservation in watershed on river in the Terai	Low	Medium	High
Others:			
11 Flood warnings in the Terai	Possible	Problematic	Not applicable
12 Project costs for river control	Very big amount	Big amount	Not beyond the capacity of

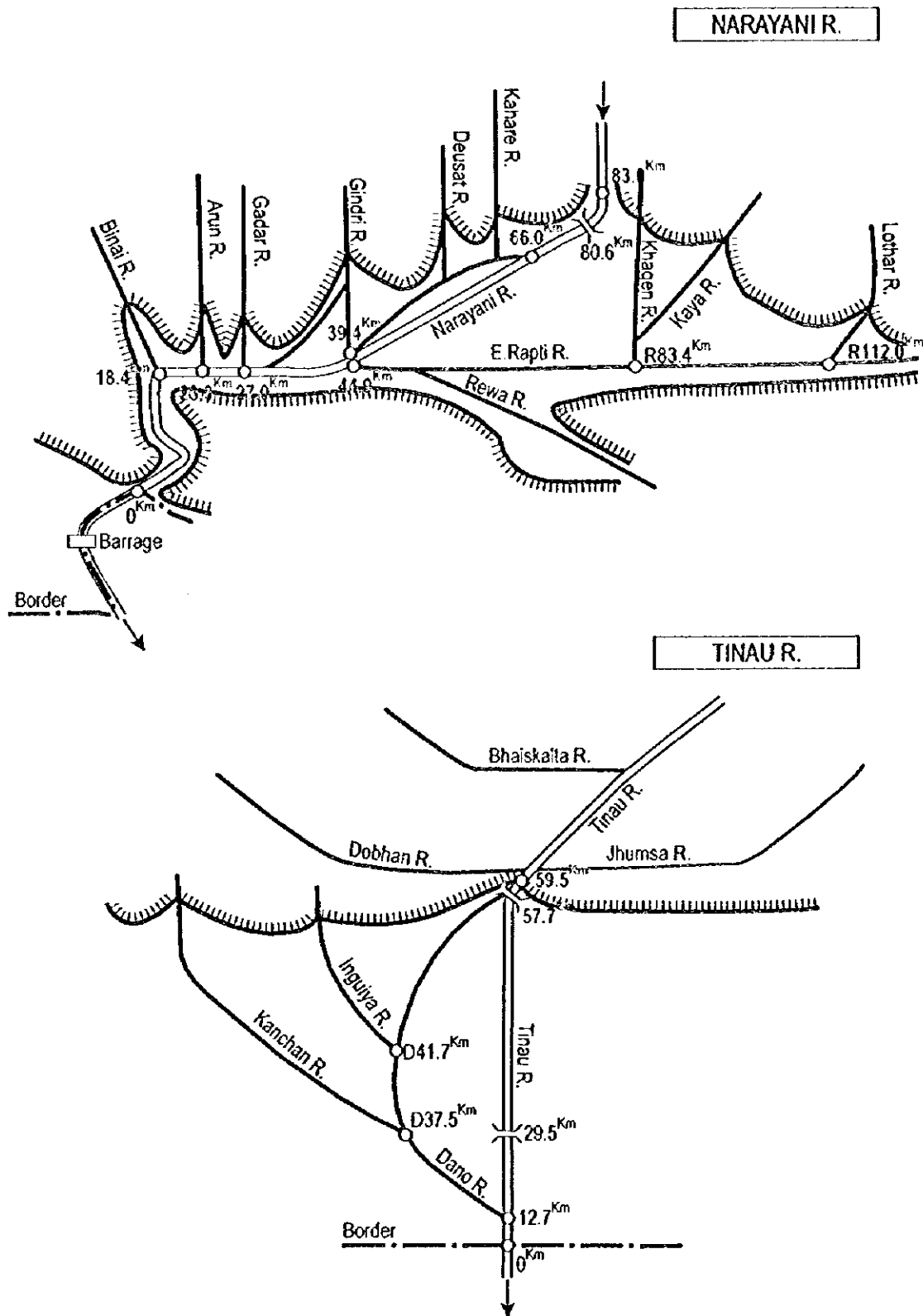
Source: Analysis of River Problems and Strategy for Flood Control in the Nepales Terai, 1979, DOSWC





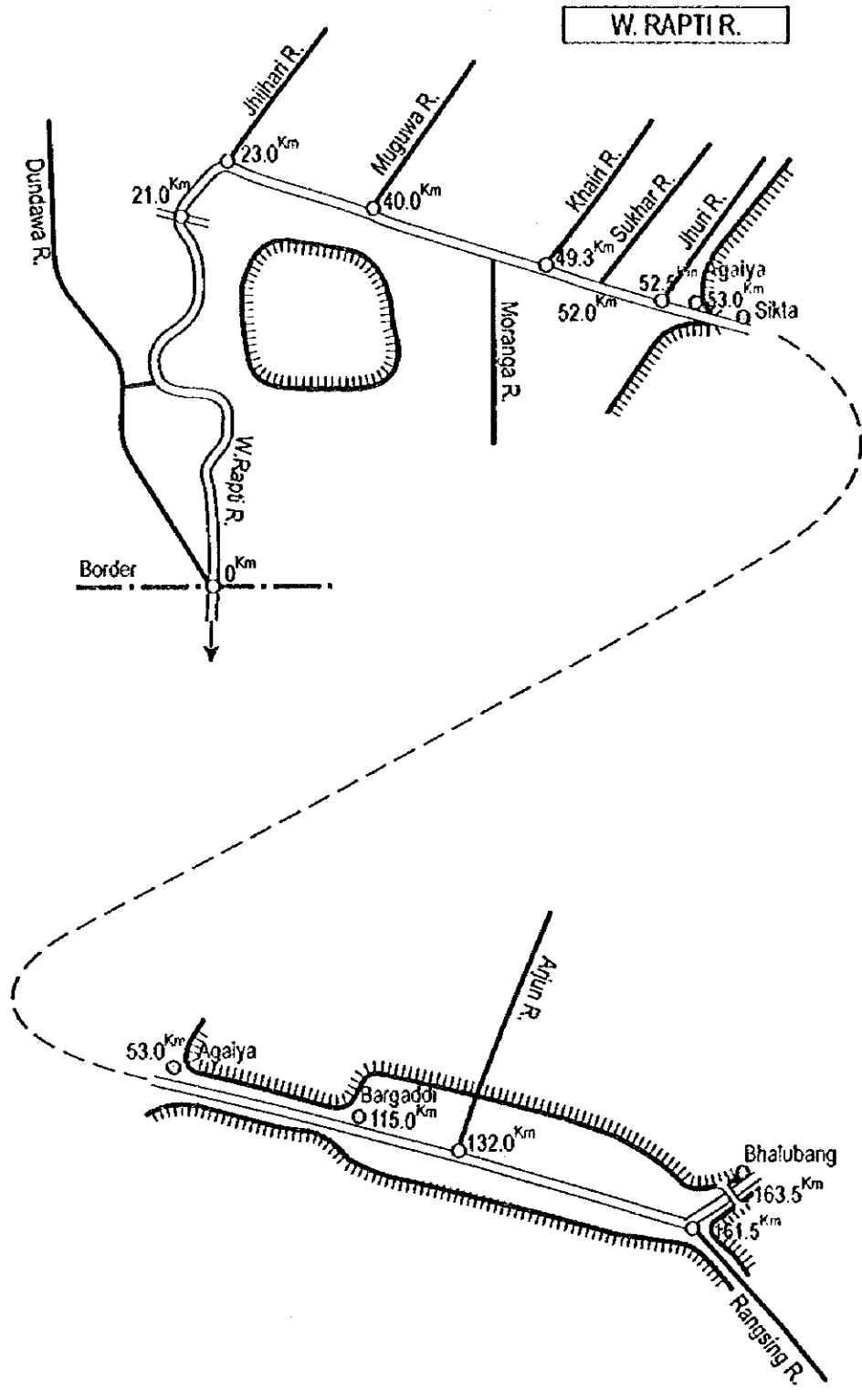
SCHEMATIC RIVER SYSTEMS OF EIGHT RIVERS(I)

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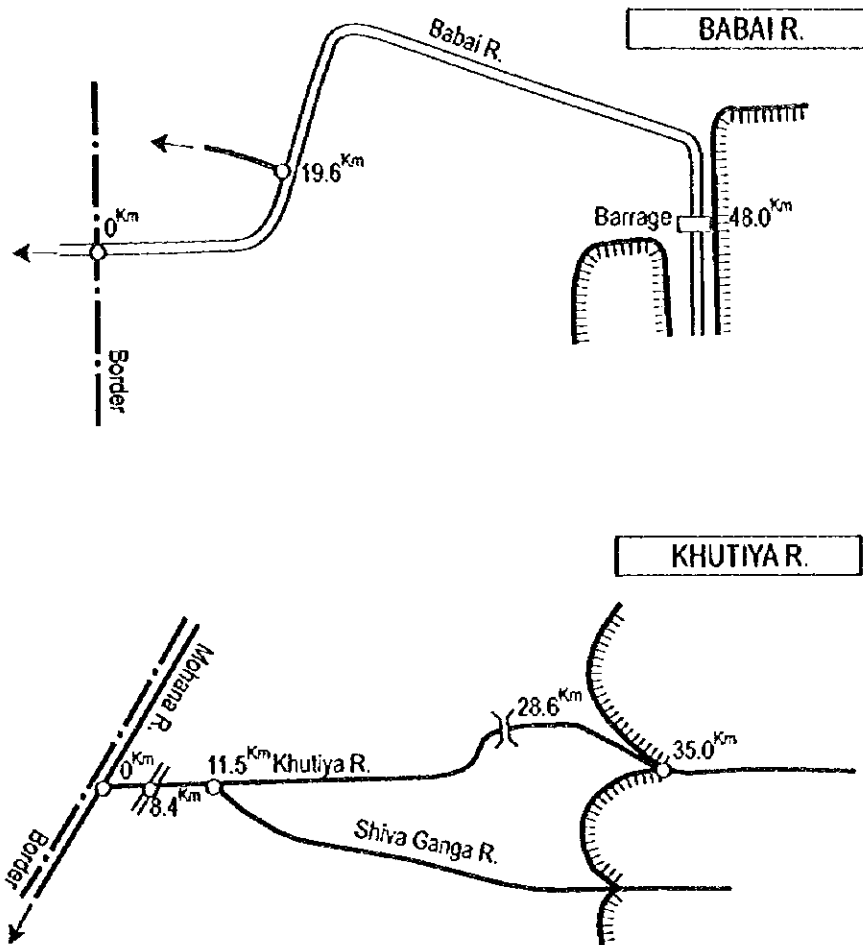
SCHEMATIC RIVER SYSTEMS OF EIGHT RIVERS(2)

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SCHEMATIC RIVER SYSTEMS OF EIGHT RIVERS (3)

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**SCHEMATIC RIVER SYSTEMS
OF EIGHT RIVERS (4)**

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