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Implementing the Rural Access Programme Nepal

District Environmental Brief
Bhojpur
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WSP International Management Consulting

in association with

ODG DEV — OXFORD POLICY MANAGEMENT — GE — helvetas Nepal

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WORKING DRAFT

1 INTRODUCTION

This environmental brief of Bhojpur district has been prepared largely on the basis of readily available information gathered from the secondary sources. The aim of the brief is to present district level general situation with regard to the environment and environmental resources, and to highlight the opportunities and risks linked with the situation. This is expected to help in designing RAP components and activities in the district by considering the environmental sensitivity in a sensible manner and in timely fashion. General findings of the desk review were presented and discussed in a one-day workshop on *Environmental Situation of Bhojpur* organised jointly by Bhojpur DDC and RAP. The inputs from the workshops were utilised to refine the desk findings.

Location –Bhojpur is a hill district in the eastern development region of Nepal. It is a generally north-south elongated district. The length and width of the district are on average 93 km (north-south) and 35 km (east-west) respectively with an area of about 1520 sq. km (see annexed Topographical Map of Bhojpur). Latitude and longitude of the district varies from respectively $26^0$53'to $27^0$46'N and $86^0$53'to $88^0$17'E.

Almost all of Bhojpur falls within the Middle Mountain (between 700 and 2000 m elevation) physiographic region except a small belt, forming the north and north-western district boundaries, which falls in the High Mountain region (2,000-2,500m). This belt adjoins Sankhuwashava, Solukhumbhu and Khotang districts. The southern boundary areas around the Sun Koshi River touches the Siwalik region. The altitude of the district ranges from about 115 m at the confluence of the Arun River and the Sunkoshi River to 4155 m at the northwest corner of the district at Siliche Danda, which is the boundary point of four districts Solukhumbu, Sankhuwashabha, Khotang and Bhojpur. The aspect and degree of natural slope varies widely. Geologically, the district predominantly lies in the Lesser Himalaya and a part of the Higher Himalaya (see Annex II).

According to the1991 AD (2048 BS) census, the total population of the district is 198,784 (96,037 male and 102,747 female) making the population density 131.9 people per square kilometer. The population growth rate is very low (at about 1%) compared to other parts of the country due probably to the high rate of out migration.

This document describes the environmental situation of the Bhojpur district under five separate headings viz; *Precipitation and Climate, Geology and Instability, Forest and Biodiversity, Renowned and Potential Areas, and Water Body*. The natural environmental setting of an area is in fact a combination of all of those aspects as they are linked in multiple ways. Superimposition of human actions, including development efforts, make environmental issues further complicated and multi-disciplinary. The division is, therefore, an arbitrary one meant only for the ease of discussion and presentation.

2 PRECIPITATION AND CLIMATE

2.1 RAINFALL PATTERN

Rainfall/precipitation in the district follows a pattern of approximately equal rainfall bands/zones that run roughly east-west (see annexed Climate Map). A relatively low rainfall band runs roughly east-west through approximately the middle of the district. Mean annual precipitation in this band is expected in the range of 1200 to 1400 mm. In the south-eastern part of this low rainfall band there is a rain shadow area where rainfall is the lowest in the district, with annual precipitation in the range of 1000 mm to 1200 mm. According to the observations of the people at district level, the rain shadow area approximately comprises of the VDCs of Hasanpur, Homtang, Ranibas, Manebhanjyang, Sano Dumma, Dhulo Dumma, Jarayotar, Charambi and south-eastern part of Yaku. Information obtained from secondary sources such as the Department of Hydrology and Meteorology indicate that the rain shadow area is comprised of Sanodumma, Chyangre, Yakubirta, Jarayotar, and Charambi VDCs.

The precipitation gradually increases towards both the north and the south of the middle low rainfall band. The northern band receives the highest amount of rain. Mean annual rainfall is expected to reach up to 3000 mm in the northern part of the district and up to 1800 mm in the southern part. Mean monsoon rainfall follows almost the same pattern as the mean annual precipitation. During the monsoon, the high precipitation zone in the north receives about 1800 mm of rain, the middle band receives 800 mm and southern-most band receives 1600 mm. The rain shadow in the south-eastern area receives the lowest amount of monsoon rain.

The highest 24-hour precipitation in the district is generally expected to be in the range of 200 to 250 mm. The highest 24-hour precipitation gradually increases towards the south with 350 mm of rain in 24-hours in the southern-most part of the district that borders with Udayapur. The highest 24-hour rainfall in the lowest rainfall area/ rain shadow is in the range of 150 mm.

2.2 TEMPERATURE

Temperature in different parts of the district varies according to the altitude. The altitude generally increases from south to north and from east to west. River valleys with lower altitudes have warm temperatures compared to ridges with higher altitudes. Areas in the Sun Koshi valley within the Bhojpur district have temperatures similar to the Tarai. The valleys of the Arun, Sun Koshi, Pikhuwa and other streams are warm. Ridges, particularly in the north-western part of the district adjoining Khotang and Solukhumbhu, are cool. May and April are the hottest months with mean monthly maximum temperatures in the range of 33 to 36^0C along the river valleys, and 15 to 18^0C in the higher altitudes. January is the coldest month with mean monthly temperatures of 6 to 9^0C in the river valleys and 0 to -3^0C in the higher altitudes in the north-western ridges of the district.

2.3 CLIMATIC ZONES

Based on the altitudinal guidelines, Bhojpur district may be divided into the following climatic zones:

- Sub-tropical Zones (below 1,000 m) – Sub-tropical climatic zones are found along the river valleys. They occupy approximately 515 sq km of area.
- Warm Temperate Zones (between 1,000 to 2,000 m) – Slopes between ridges and valleys experience warm temperate climates and they occupy approximately 749 sq. km. of area.
- Cool Temperate Zones (between 2,000 to 3,000 m) – North-Western territories of the district have cool temperate and this occupy something like 233 sq. km.
- Alpine Zone (3,000 to 4,000 m) – Alpine climate (areas above 3,000 m msl) can be found only in a small north-western part of the district (the ridge forming the border between Bhojpur, Khotang, Solukhumbu, and Sankhauwasabha). The total area of this zone within Bhojpur district is about 23 sq. km. only.

The factual information mentioned above reveals that 33.9 %, 49.3%, 15.3 %, and 1.5 % of the Bhojpur district area falls into the sub-tropical, warm temperate, cool temperate and alpine zones respectively. It reveals that most parts of the district have either sub-tropical or warm temperate climates. Temperate climates (both warm and cool combined) exist in 64.6 % of the district area. This implies that Bhojpur district is neither too hot nor too cold in general. The eastern and southern parts of the district fall into one of these climatic zones. It should be noted that the divisions based on the altitude only provide an indication about the climate. Local climate varies significantly due to effects of aspects, topography, regional influences and local valley influences.

3 GEOLOGY AND INSTABILITY

General Geology of the Bhojpur Area – Bhojpur district predominantly lies in the Lesser Himalaya with a part in the Higher Himalaya[1]. Geomorphologically from south to north, the area falls on the Mahabharat Range, the Midlands and Fore-Himalayas respectively. The southern boundary of the Bhojpur, the Sun Koshi River flows almost along the Main Boundary Thrust (MBT) and separates the northern Lesser Himalayan rocks from the southern Siwaliks.

The geology of the district is complicated by many faults, folds, metamorphisms and intrusions. The rock units of the district are comprised of rocks from the Nawakot Complex® [2] and the Kathmandu Complex as well as crystalline rocks. The rocks of the Kathmandu Complex override the Nawakot Complex along the Mahabharat Thrust®. The main rock units of the complexes that exist in the district are briefly described below.

3.1 ROCK UNITS

Kuncha Formation of the Nawakot Complex is exposed around the southern part of the district and the upstream section of the Arun valley as a part of the Arun Tectonic Window®. It contains grey greenish chloritic phyllite with bands of light brown fine-grained quartzite. Generally the bedrock is covered by soils in the area due to the high weathering potential of phyllite. In the southern part of the district, the beds are dipping moderately due north.

Benighat Slate of the Nawakot Complex is exposed around the southern margin of the district, along the MBT and along the right bank of the Arun River, mainly on upstream side. It consists of grey to black slaty phyllite, phyllitic slate intercalated with limestone and calcareous slate. Slate covered areas are relatively more prone to weathering, erosion and landslides.

Robang Formation mainly contains greenish grey coloured chloritic phyllite with garnets and intercalated with grey quartzitic phyllite, quartzite, amphibolite and pockets of talc. The rocks of the Robang Formation are exposed around east of Bhojpur. Due to the high quartz content, the phyllite of this formation is relatively resistant to weathering and erosion and is also relatively less prone to landslides.

Lesser Himalayan Gneiss is exposed along the southern margin of the district as well as to the east of Bhojpur bazaar, and is sandwiched in the Kuncha Formation. Due to high mica content, lesser Himalayan gneiss has more potential for landslides and deep weathering. The high landslide prone area around Thulodumma falls on this gneiss.

Raduwa Formation and *Bhainsedobhan Marble* of the Kathmandu Complex are exposed around the east of Bhojpur bazaar. The desk study was not suffiecient to differentiate these two formations in the district. They consist of grey to greenish muscovite biotite schist with garnets, chlorite-muscovite schist, pink-fleshy-white-light brown quartzite and coarse-grained grey crystalline limestone and marble. The garnetiferous schist of the Raduwa Formation is susceptible to high levels of weathering, erosion and landslides.

Kalitar Formation is also exposed around east of Bhojpur Bazaar. It contains grey to steel grey garnetiferous muscovite biotite schist, feldspathic muscovite biotite schist with interbedding of quartzite and lenses of granitic gneiss and pegmatite. The Kalitar Schist is also susceptible to landslides and erosion.

Kulikhani Formation is the most dominant rock unit in the district and is exposed around Bhojpur bazaar and to its south-west. It consists of fine-grained white quartzite, garnetiferous schist,

[1] See Annex II and annexed Geological Map for further explanation.
[2] Definition of the term marked with superscript ® is included in the Annex I Glossaries.

micaceous schist, kyanite schist, and granitic gneisses. High quartz content schist and gneiss are more stable whereas the micaceous schist and gneiss are prone to weathering and erosion. Patchy exposures of granitic gneiss that interrupt the rocks of the Kathmandu Complex are comprised of pegmatite veins which is the host rock of some economic minerals such as muscovite and beryl.

Higher Himalayan Crystalline is exposed around the northern part of the District and mainly contains garnet-biotite gneiss with a distinct banded structure. The garnets are usually 3-4 mm in diameter. This rock unit also represents a relatively stable area in the district, however; the steep slopes are prone to high rockslides and rock falls.

3.2 GEOLOGICAL STRUCTURES

Thrusts®, faults®, folds® and lineaments® are the major geological structures that exist in the district. MBT and MCT are the major thrusts. There are other local thrusts and faults. The MBT is considered to be still active and in Bhojpur district it almost coincides with the Sunkoshi River. About 3 km north of the MBT there is another thrust that runs almost parallel to the MBT. The MCT is considered to be inactive at present and there is debate over its exact location (described as mystic by many authors). In Bhojpur district, the MCT is believed to run through the northern margin of Bhojpur Bazaar (see geological map) gently dipping due north. The Mahabharat Thrust (MT) that runs almost parallel to the MBT separating the rocks of the Kathmandu Complex from the Nawakot Complex is another major thrust located in southern part of the district. Several local thrusts and faults, which are associated with major MBT and MCT, exist in the district (see annexed Geological Map).

Several lineaments exist in Bhojpur district. Presence of a lineament indicatea a possible weak zone. Instabilities, mainly landslides and gully erosion, are often aligned along the lineaments indicating faults, thrusts and other discontinuities. There are many wedge failures in the district trending obliquely to the two lineaments and they are probably due to the intersection of discontinuities. Most commonly the lineaments in the district are trending NE-SW. The remaining lineaments are either trending N-S or NW-SE. There are few lineaments that trend east-west. The major drainage of the area flows along the lineaments. For instance, in the central south part of the area, the Siktel Khola, Behare Khola, and Makuwa Khola flow almost parallel to the lineaments.

Folds are common throughout the district. There are also minor anticlines® and synclines® in the district. The river valleys are often found along the anticlinal axis and the ridges along the synclinal axis. For example, the Behare Khola flows along an anticlinal axis.

Joints® and foliation® are other important geological structures in the district.

3.3 SOIL DEPOSITS

Although there are micro-level variations, the district exhibits three distinct soil types in a broad sense. They are alluvium®, colluvium® and residual® soil.

The residual soils occur along the flat ridges, spurs and upper hill slopes of the area. They are deposited around Dingla, Ranibas, Manebhanjyang and other ridges. Their composition and thickness generally vary with the parent materials, the topography and the geological structure. The most common residual soils that occurs in the Himalayan hill slopes are silty-clayey-sand (SW-SC), silty sand (SM) and poorly graded sand (SP). In the district, most areas with residual soil are dry cultivated or forest covered.

The colluvial deposit represent the most widespread surface cover in the district area. These are mainly distributed along the hill slopes and are thick towards the base. Their composition and

thickness usually vary with the parent materials and slope inclination. The colluvium soils in the hill slope are predominantly silty-sandy-gravel.

Alluvial soil and debris deposits are distributed along the Rivers forming many terraces viz; Arun valley, Sun Koshi valley, Pikhuya Khola and their major sub-drainages. The river terrace along the Arun and Sunkoshi Riverbanks are older and relatively thick. Most of the river terraces in the district are wet cultivated.

3.4 GEOMORPHOLOGY

The main geomorphic features of the district include talus® deposits, alluvial fans®, river terraces, erosion fronts, recent riverbeds, active gullies, landslides, bare rock cliff, colluvial deposits, residual soils and debris® fan deposits. The geomorphic features are related to geological structures and rock type. Steep slopes exist along the riverbanks. The counter dip slopes and lateral dip-slopes® exist in the hard rocks, for example quartzite, gneiss, limestone and marble are generally steep. The ridges that have gentle and smooth slopes are often associated with the dip slopes of phyllite that are covered with thick soil due to high weathering and low transportation. Most of the drainage follows the trend of the lineaments. The drainages that flow along the lineaments meander less than the others. Several of these streams have high gradients and therefore high erosion and transportation activity. They carry debris and deposit it at the mouth forming debris fans. The Pikhuya Khola is a moderately meandered river with many point bar deposits. In general, the drainage pattern® in the district is dendritic®. Some sub-drainage systems exhibit other types of drainage patterns, for example, Kawa Khola has a trellis® pattern. The trunk Arun River flows from north to south and finally merges with the Sunkoshi River that flows from west to east along the southern border of the district. The Pikhuwa Khola, which is a tributary of the Arun River, is the largest stream draining entirely from the district. Its catchment covers half the district area mostly from the central part of the district.

Generally speaking the south facing slopes, in the southern half portion of the district, are relatively gentler than the north-facing slopes. The north facing slopes are generally steep and have many scarps and talus cone deposits at their base. The overall topography of the district is rugged although some isolated areas with smooth and gentle topography do exist. The topography is particularly rugged in the southern part of the district around Dummama and Pancha VDCs, and in the central-eastern part of the district around Yakubirta and Helaucha VDCs.

3.5 UNSTABLE ZONES

Landslides – Landslide together with gully erosion are the major mass wasting processes in the district and cause problems particularly during the monsoon rain. The distribution of landslides in the Bhojpur district is shown on the geological map of Bhojpur. These problems are primarily linked with geological condition, topography/slope and rainfall as well as with vegetation cover, soil type and human activities. Landslides are mainly concentrated around the soft rock and along geologically weak zones such as faults thrusts and other lineaments. Soil erosion is mainly concentrated along gullies on hill slopes and along weak lineaments.

According to the observations and experiences of district people, Hasanpur, Dummana, Pangcha, Debantar, Pawala and some parts of Patlepani VDCs suffer most from recurring landslides and slope failures. The other distinct area of high landslide occurrence in their observation is along Irkhuwa Khola from Dovane to Kulung VDCs. The observations also support the findings of the desk review in general. Other localities where district people report frequent landslides are from Bhojpur Bazar to Tumlingtar, the Kereunipani VDC area, and areas around Nagi and Tyamke.

Broad Landslide Hazard Zones – The desk level analysis of the secondary information indicates that Bhojpur district can be classified boardly into four zones. The desk assessment was made by considering the geology, land use, hill slope and aspect, drainage density, landslide distribution, soil type and lineaments in the area. The division into different zones is very rough and indicative only,

with the possibility of micro-level variation in the hazard level within each zone. The zones are the Southern Marginal Zone, Eastern Marginal Zone, Central and western zone, and Northern Marginal Zone.

3.5.1 SOUTHERN MARGINAL ZONE

This zone approximately includes Dummana, Pangcha, Hasanpur and Patalepani VDCs and the southern part of Pawala and Devantar VDCs. The topography of this zone is very rugged. Soft slate and phyllite are the dominant rock types in this zone. Many faults including the MBT have disrupted the geology. Drainage density is very high and gullies are active. The dominant soil type is colluvium and the hill slopes are mainly facing due south. Dip slopes are observed in north facing slopes. Consequently, landslides are frequent in the area. This zone, therefore, represents an unstable and very high hazard zone. Construction activities in this zone demand extreme caution with slope protection. Activities such as road construction might further escalate the existing problems of landslides and slope instabilities and raise the level of hazard even further. It is always desirable, if possible, to avoid construction on the landslides and weak slopes in this zone and it is very difficult to find a good site particularly for linear projects such as roads.

3.5.2 EASTERN MARGINAL ZONE

This zone extends north-south along the Arun River and is a part of the Arun Window. The zone approximately inclludes the following VDCs: Homtang, Thullodumma, Sanodumma, Bastim, Chyangre, Yaku, Jarayotar, Charambi, Tiwaribhanjyang, Pyauli, Champe, Yangpang, Deurali, and Kyorenipani. Rock type changes abruptly from place to place within this zone. Commonly found rock types are slate, phyllite, schist, gneiss, quartzite and marble. The soft rocks (especially slate and phyllite) are the dominant ones. The slope aspect of this zone is generally east and rocks are moderately dipping due west. Hill slope angle varies from gentle at the terraces along the Arun River to steep towards the west. Many faults and lineaments have disrupted the continuity of the rocks. The topography of this zone is rugged to very rugged. Gullies and streams are active and carry high sediment loads. This zone can be considered a medium to high landslide hazard zone. Areas around Homtang, Thullodumma, Sanodumma and Bastim VDCs appear riskier as landslide distribution is denser in this area. Although less problematic than the southern zone, this area also requires caution during the planning and development of roads. Careful selection of the alignment, balancing cut and fill combined with structures for the protection of slopes are desirable if roads are to be developed.

3.5.3 CENTRAL AND WESTERN ZONE

This is almost a geologically monotonous zone occupying the large portion of central and western Bhojpur. The zone includes Thidinkha, Bhubal, Basingharpu, Basikhor, Baikunthe, Manebhanjyang, Bhulake, Dhodhalekhani, Lekharka, Okhre, Dalgaun, Taksar, Gogane, Khawa, Amtek, Shyamshilla, Bhojpur, Bhaisipankha, Bokhim, Siddheshwar, Annapurna, Nagi, Chhinamakhu, Guptewhwar, Heloucha, Timma, Boya, Sangpang, Tungechha, Kimalung, Mulpani, and Khartamchha VDCs. The zone contains a repetitive rocktype, mainly schist, gneiss and granite. In general this zone has moderately steep hill slopes with predominantly residual and colluvial soils. The dip direction and dip angle of the rocks varies from place to place forming many folds. The zone exhibits very few landslides. A few rock cliffs exist around Chhapgaun and east of Tyamke. Although lineamants exist, the rocks of this zone are less crushed along large faults. The Pikhuwa Khola, which carries a relatively low sediment load, is the major drainage of this zone. The zone is relatively more stable than other zones in the district, and may be categorised as a zone of medium hazard in terms of slope instability and landslides. Construction of roads in this zone could lead to minor instabilities. Careful selection of the alignment and use of simple structures combined with vegetative methods for slope protection may be sufficient to control landslides and slope instabilities. However, it is desirable to avoid construction in the rock cliff or soil cliff areas.

3.5.4 NORTHERN MARGINAL ZONE

This zone occupies the steep terrain of the northern part of the district and includes Dobhane, Khatamma, Choukidanda and Kulung VDCs. Many lineaments, which indicate weak geology, exist in this zone. There are many existing landslides. Rock fall and rockslides are frequent and likely to recur due to steep slopes (see Slope Map) and rock discontinuities. Soil covered steep slopes have more potential for soil erosion. The zone can be categorised as a zone of high slope instability and landslide hazard. Like the southern zone, construction activities in this zone are also very difficult and demand extreme caution with slope protection. Construction activities may trigger the slope instabilities.

3.6 EROSION

Steep slopes, high rainfall and weak soil are the critical factors that determine the risk of erosion due to overland flow of water. In Bhojpur district, the high erosion potential areas appear to more or less overlap with the high landslides and slope instability areas described above. The southern band along the district border and the north-western corner of the district show high risk of erosion during monsoon rain. Similarly stream corridors also exhibit a high risk of soil erosion. The north-eastern parts of the district, except the stream valleys, have low erosion risks. An east-west band running approximately through the centre of the district shows intermediate erosion potential. A substantial part of this area also happens to be relatively stable with respect to landslides and slope stability. (The central and western zones have already been discussed above in the landslide zones). The erosion status map of Bhojpur district prepared by DoSCWM on the basis of Land Utilisation, Land System Maps of LRMP, and Population data also arrive at more or less similar conclusions.

3.7 BRIEF REVIEW OF NATURAL DISASTER

Landslides and floods are the major disaster sources in the district. Review of the recent natural disasters occurring in the Bhojpur district due to landslides and floods suggest that the district is situated in a relatively low disaster prone zone in comparison with the other hill districts of Nepal. Such comparison, however, provides only a relative picture. The loss of properties and life in Bhojpur is not so low that it can be ignored. Furthermore, there are certain areas/pockets, particularly in the southern and northern zones, that suffer from recurring landslides, floods and instability related disasters. If only those areas were considered, they would probably fall into the high disaster prone spots for hills of Nepal. The table below highlights the loss of life and property in Bhojpur district between 1992 and 1997 due to floods and landslides.

Table 1 Damage due to flood and landslides in Bhojpur district, between 1992 and 1997

Year		1997	1996	1995	1994	1992
Death		5	34	0	-	-
Injured		0	7	3	-	-
Affected Family		179	2096	54	55	8
House Destroyed	Completely	1	23	53	20	3
	Partially	0	252	-	-	-
Loss of land (ha.)		2.5	185	-	-	-
Livestock		0	111	21	3	-
Estimated Loss (NRs.)		418,400	50,648,037	295,550	680,971	331,950

According to the local sources, several landslides occurred along Irkhuwa Khola from Dovane VDC to Kulung VDC during the rain of July 1997 (2054 Sraban). Similarly, a belt in the south that includes

Pawala to Ranibas VDCs suffered from landslides and erosion during the rainy season of 1996 (2053 BS). These events damaged houses, settlements, fertile irrigated lands (Khet) as well as good forests. Bare rocks and boulders are exposed in the areas now. During the August –September 1999 (2056 BS) rainy season an uncommon event occurred. An area of about 10 to 12 Ropanis of land including a house subsided by approximately 30 feet at Chamtang village (on the border of Chyangre and Bastim VDCs). This may have been due to erosion in calcareous rock (marble). About 15 houses were adversely affected in addition to the one that completely subsided.

Other possible sources of natural disasters are Glacial Lake Outburst Flood (GLOF) and earthquakes. The Arun River is a snow fed antecedent® river and many glacial lakes lies in its catchment that extends to Chinese territory. GLOFs have occurred in the Arun River in the past and studies have indicated probability of them reoccurring in the future. Eastern Nepal in general has experienced more earthquakes than the rest of Nepal in the past, indicating higher chances of earthquakes in the region, which includes Bhojpur, in the future. However, one hypothesis is that the past great earthquakes in eastern Nepal (1833, 1834, 1934 and 1988), and epicentre concentration of other minor earthquakes, may have released the accumulated strain and therefore reduced the probability of an imminent event.

4 FORESTS AND BIO-DIVERSITY

4.1 FORESTS

4.1.1 GENERAL

According to information/data from the Department of Forest Research and Survey (DoFRS), 81539 ha (54%) of the Bhojpur district area is covered by vegetation (Table 2). The DoFRS vegetation data was prepared by interpretation of satellite images (1991). It included all types of vegetation without differentiating between dense and open/degraded forests. The forests in Bhojpur district are under the management responsibility of the District Forest Office, while Forest Users Groups (FUGs) are responsible for the management of their respective community forests.

Table 2: Land Use (in ha.)

Area covered by vegetation in the given elevation range						Agriculture and other	Snow	Water body	Total Area
Below 1000m	1000 to 2000	2000 to 3000	3000 to 4500	More than 4500 m	Total				
29,424	35,771	15,220	1,124	0.0	81539	67,866	0.9	1,434	150839.9
(19.51)	(23.71)	(10.09)	(0.75)	(0.00)	(54.06)	(44.99)	(0.00)	(0.95)	(100.00)
(36.09)	(43.87)	(18.66)	(1.38)	(0.00)	(100)	<-- % of Total Forest Vegetation Area			

Note: Figures in parenthesis are expressed in %. Source: DoFRS 1999.

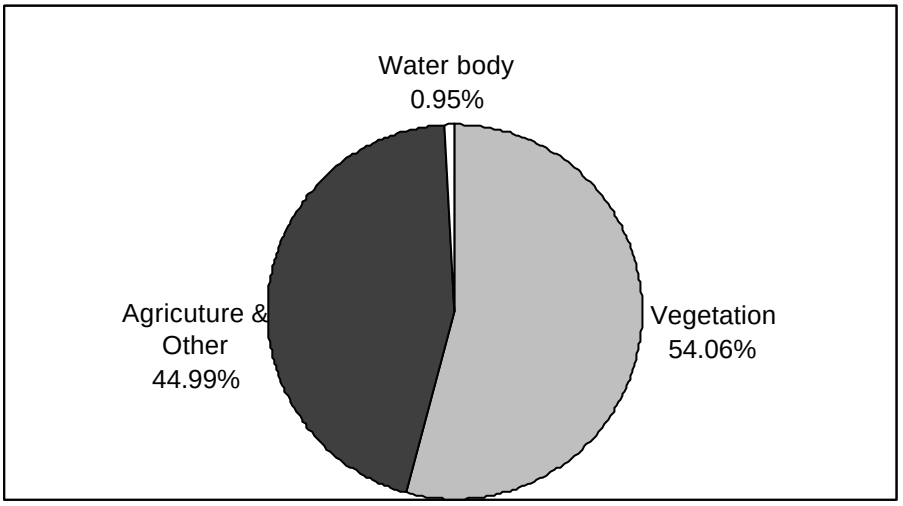


Figure1 : Land Use in Bhojpur District

Forests types – On the basis of altitude and dominant species, the forests in the district may be classified as:

- Hill Sal Forest – (Sal - *Shorea robusta*). This type of forest generally occurs in main river valleys which drop below 1000m msl. It occurs on dry south faces.
- Riverine forests of *Cedrela – Albizia* (Tuni and Siris) – Tall trees of Cedrela toona in association with Albizia spp. occur in sub-tropical foothills along the Arun River. Occasionally, *Duabanga sonneratioides* and *Eugenia* spp. are associated in this type of forest in the damp habitats of north - facing slopes.
- Lower Slope Mixed Hardwood Forest (*Schima -Castanopsis* Forest) – Known as Chilaune - Katus Forest, this type of forest is found in between 600m and 1700m. It does not form a continuous belt. *Schima wallichii* is mostly associated with *Castanopsis indica*, *C.tribuloides and C.hystrix.*

- *Pinus roxburghii* (Khote Salla Forest) – This type of forest is particularly found in between 1200 – 2000 m on south facing slopes.
- Upper Slope Mixed Hardwood Forest – Forests of *Quercus* spp. (Banjh or Oak) and Rhododenron spp. (Lali Gurans) are found at about 2000 – 3000m. *Quercus lamellosa, Q.spicata, Q.incana, Q.lanuginosa, Q,dilalata* are the common species of *Quercus* in this type of forest in the district and are found in association with *Sorbus* spp., *Symplocos* spp., *Prunus* cornuta, *Vaccium* spp., and *Acer* spp.
- Conifer and Rhododendron forests – At altidudes of about 2000 m to 4000 m. forests of *Pinus excelsa, Tsuga dumosa* and *Abies spectabilis* are found in the district. Some associated species of these forests are *Quercus* sps. and *Rhododendron* spp.

Crown Cover –The crown cover based classification that provides information about the existing major and significant forest areas in the district is however more useful for the purpose of planning road development. On the basis of crown cover, the forest in the district can be classified as Dense Forest, Closed Forest and Open Forest (see annexed Forest Map). Desk review and analysis of secondary information/sources, such as the Land Utilisation Map produced by LRMP and the 1:25,000 topographical maps produced by the Topographical Survey Branch, reveal that the district has:

- 8.32 km^2 Dense forest (crown cover more than 75 %) covering 0.55 % of the district area.
- 330.95 km^2 Closed forest (crown cover between 40 % and 75 %) covering 21.77 % of the district area.
- 600.08 km^2 Open forest (crown cover between 10 and 40 %) covering 39.24 % of the district area, and
- 580.76 km^2 of other land uses covering 38.21 % of the district area.

Only a few small blocks of Dense forests, occupying about 0.55 % of district area, appear to be in existence in the district (See annexed Forest Map). These Dense forests are generally surrounded by the Closed forests, which occupy larger areas. The Closed forests occupy about 21.77 % of the district area. Parts of the large Closed forests, especially the portion at the interior, are quite dense with more than 60 % crown cover. These parts closely resemble Dense forest. Similarly, parts of the periphery of the Closed forests with a crown cover close to 40% resemble Open forests. The Dense and Closed forests appear in the north-western part of the district, particularly in Dobhane, Timma, Kimalung, and Khartamcha VDCs. Heloucha, Boya, Dalgaun and Mane Bhanjyang VDCs at the central and Basikhora, Ludin, Pangcha and Odane VDCs in the southern part of the district have large blocks of Closed forests.

Distribution of Forests –Forests are scattered in different parts of the district. However, the north - western part of the district has the largest block of forests and the central part of the district has the least forested areas. Forests are located either on the ridges of the hills or along the rivers and streams. HMG has a policy to maintain forest belts to at least double the width of the rivers and streams. The DoFRS data suggests that vegetation cover in the Bhojpur district is largely located above 1000m, with a maximum cover (43.87% of the total vegetation area) being between 1000m - 2000m (see table 1). The forests on the ridges and uphill areas play a vital role in conserving rain water and releasing it to the downhill areas where villages and farmlands are generally located. It is also interesting to note from the forest map of the district that the forest patches are generally wider from east to west than from north to south.

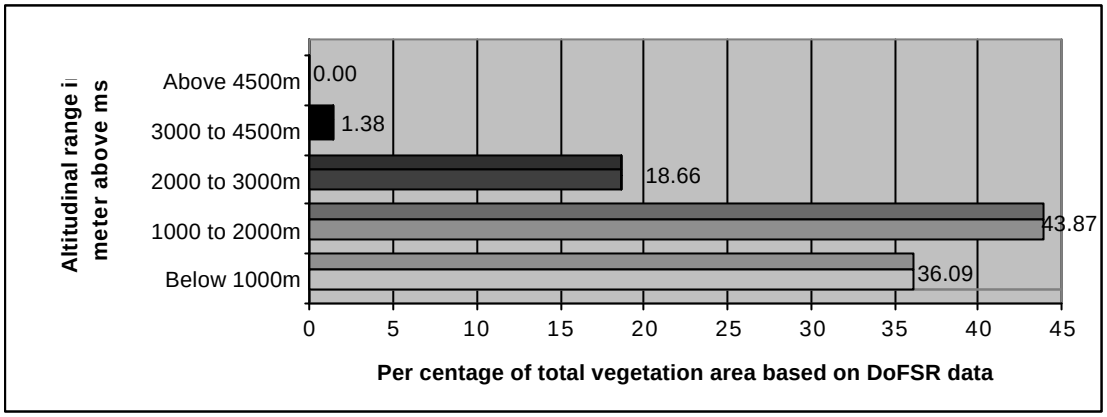


Figure 2: Altitudinal distribution of vegetated areas (as a percentage of total vegetated area)

Significant Forest Areas – The desk review and analysis also provided a birds-eye view of the existing forest situation in the district. The desk study showed that major and significant forest areas are concentrated in the following localities:

- Northwestern part of the district (mainly the ridge areas of Chhinamakhu, Timma and Dovane VDCs adjoining Khotang district).
- The ridge that forms the upper catchment of the Malebu and Yanguwa Kholas. This is a ridge area comprising of parts of Timma, Gupteshwor, Sidheswaor, Helauchha, Boya, Kimalung and Sangpang VDCs. The main trail linking Bhojpur Bazar and Dingla passes through this forest. According to local people, it takes about 4 hours to walk through this forest and it is rich in wildlife.
- River/stream valleys such as the Arun River and its tributaries, the Sunkhosi and its tributaries, and the Pikhuwa Khola and its tributaries. The forest along the Pikhuwa Khola is thin, degraded and mostly contain shrubs. This forest however is linked with the forests in the north-western part of the district.
- Tyamke ban - Protected Area is in the Mid Hills of Nepal rather than the High Mountains or the Terai. Areas with rich biodiversity in the Mid Hills need to be protected. Large blocks of forests in Bhojpur district are considered as biodiversity rich forests. Among them is the block of forest surrouding Tyamke Danda peak which extends to the adjoining forests of the Khotang district. This area is to be protected for boidiversity conservation as the local people of Bhojpur and Khotang districts have shown their interest in conserving these forests.

According to the views expressed by the participants at the district workshop, the forests in the north-west (Chhinnamakhu to Dovane) and the ridge which forms the upper catchment of the Malebu and Yanguwa Kholas are very dense, undisturbed virgin forests. The most significant forests in the district are located in these localities. Moreover, these forests are very close to the Makalu Barun National Park and Conservation area. The workshop participants identified the following renowned forests in the district: Dovane Ban, which is probably the biggest forest in the district and is rich in bio-diversity and undisturbed; Raniban of Helauchha which is big and dense; Tyamke Ban which is quite big, and has a high biodiversity including herbs/medicinal plants; Deurali Ban which is an excellent Sal forest in the Arun valley and Ghur Bise Ban which is dense, virgin forest.

Forests in the northern and southern part of the district need to be protected from a soil and water conservation point of view. The areas are unstable and also have relatively higher rainfall than the central part of the district.

4.1.2 COMMUNITY FORESTS

The District Forest Office (DFO) is responsible for the protection, conservation and management of all the state forests in the district. Community forestry refers to the situation where forests are controlled and managed by groups of rural people who agree to use them to support their farms and households. The promotion of community and private forestry has the highest priority in HMG's

Forestry Sector Policy. CFUGs are given the responsibility for protecting, harvesting and regenerating the national forests close to their villages. So long as provision is made for forest regeneration, CFUGs can sell forest products to raise funds and use 75% of the income from the community forests for community development activities. The other 25% of the income must be used for community forestry development activities.

In Bhojpur district, Nepal UK Community Forestry Project (NUKCFP) and the DFO have been supporting community forestry programmes. The community forestry programme in Bhojpur started in 1989/90 and is considered as one of the best in the country. In the first three years, the formation of CFUGs was below 10 per year. They gained momentum in the fourth year reaching over 35 per year. Observations by district representatives and line agencies indicate that forest cover in the district has increased in the past ten years, probably due to successful community forestry activities. By March 2000, there were over 360 CFUGs who are responsible for the protection and management of something like 30,000 ha of forests. A large number of CFUGs are expected to be formed in future. This indicates the increasing interest that local people have for taking management responsibility for the national forests near their settlements. The most common species in community forests in Bhojpur district is Schima- castanopsis (Chinalune-Katus), followed by Shorea robusta (Sal) or other subtropical forest species and Pinus roxburghii (Khote Salla).

The community forests in the central portion of the district are relatively better protected and managed than in other parts of the district as the CFUGs there are more capable here. According to the views expressed by the participants of the District Workshop on Environmental Situation, CFUGs are generally weaker in the south and consequently community forests in the south are not as good as in central areas. The probable reasons for these weaker CFUGs are, the relative difficulty of access from the District Forest Office which makes technical support difficult , general poverty in the area which reduces the time local people have available to look after the forests, and low levels of awareness regarding the importance of and need for forest conservation. RAP can have a positive influence on this by improving accessibility, implementing complimentary activities and taking environmental mitigation/enhancement measures.

It is important to bear in mind that there are some cases elsewhere in Nepal in which CFUGs have been blamed for the destruction of community forests by having secret deals with the timber dealers. This has been reported particularly from the Tarai and Siwalik areas which are accessible by road. The are some common factors which appear in these community forests. They all have easy or motorable access, the community forests were handed over without full compliance with the procedures and hence the process was non-transparent to the users, and there are low levels of user awareness regarding the rules for the conservation and use of the forest. It is important for RAP to take into consideration these facts whilst planning the development of rural roads.

4.2 WILDLIFE AND BIODIVERSITY

In the eastern Nepal, the Arun valley is renowned for both floral and faunal diversity and almost all areas of Bhojpur district, except a small area near the southern border that drains into Sun Koshi River, falls within the Arun River basin. The species of wildlife, birds, fishes and plants (herbs and other) found in the district are generally the same as those found elsewhere in the hills of the region including Khotang, Dhankuta, Terhathum and Sangkhuwasabha districts. The forests which have potentially the highest biodiversity are the forests of Dovane, Tyamke Danda, Ghurebise and Helauchha. Therefore, these forests need protection and should not have road access. The desk study and district workshop information was not sufficient to prepare an elaborate list of species found in each separate forest. An indicative list of species of wildlife, birds and fishes which are common in the district are however presented below.

- Wildlife found in the higher altitudes: Kharaayo-Rabbit (*Caprolaus hispidus*), Mriga - stag (*Aixis axis*), Harin (*Axis axis*), Chituwa - Leopard (*Panthera pardus*), Chittal - Spotted deer, Ghoral- Goral (*Nemorhaedus goral*), Rukha Bhalu-Bear cat (*Arctictis binturong*), Bhui Bhalu -

Sloth bear (*Melurus ursinus*), Sarpa - Snake, Ajingar - Asiatic rock python (*Python molurus*), Bandel - Wild boar *(Sus serofa*)

- Wildlife found in the lower altitudes: Chituwa (*Panthera pardus*), Mriga-Stag, Dumsi-Porcupine (*Hystrix indica*), Shyal-Jackal (*Canis aurecus*), Baandar-Monkey (*Primates spp*.), Dhedu (*Macaca mulata*), Malsapro, Oot -Otter (*Aoynyx cinera*)
- Birds found in the higher altitudes: Danphe - Impeyan pheasant (*Lophophorus impejanus*), Munal- Crimson-horned pheasant (*Tragopan satyra*), Kalij- Pheasant (*Lophura leucomelana*), Piura, Ban Kukhura - Jungle fowl (*Gallus gallus*)
- Birds found in the low altitudes: Mayur-Peacock (*Pavo cristatus*), Koili -Cuckoo *(Eudynamys scolopacea*), Kag- Crow (*Corous macrorhynchos*), Pani Hans - *Duck (Anas sps*), Lampuchchre - Drongo (*Dicrurus paradiseus*)
- Fishes found in the district, the dominant species found are Asala-Trout (*Schizothorax spp*.) and Katle (*Catla catla*). Other fishes found are Buduna (*Garra annandalei; Chrossocheilus latus*), Tite (*Psilorhynus pseudo chensis*) etc. Fishes are generally found in the Pikuwa, Akhawa and Sera Kholas.

Ajingar - Asiatic rock python (*Python molurus*), Danphe - Impeyan pheasant (*Lophophorus impejanus*), Munal- Crimson-horned pheasant (*Tragopan satyra*) are protected species of Nepal.

The above list is not a comprehensive one and furthermore the biodiversity is not limited to wild animals alone, it includes various other things such as species of wild plants, cultivated crops, livestock etc. In that sense, discussion on biodiversity is incomplete and attempts should be made to obtain more information about various aspects of biodiversity in the district as RAP design and implementation proceeds. Some additional information related to biodiversity is described subsequently under the headings of Non-timber forest products.

4.3 NON-TIMBER FOREST PRODUCTS

The importance of non-timber forest products (NTFPs) is increasingly being recognised in recent times. They have a very important linkage with rural livelihoods in the hills of Nepal. NTFPs commonly found in Bhojpur are briefly described in the following paragraphs.

- **Lokta** – Lokta is a plant that provides the raw material for producing traditional Nepali paper. Lokta grows in the upper temperate zones and prefers shady places (undergrowth in the forest) and north-facing terrain. Two shrubs of the genus *Daphne* are harvested to provide bast fibre for the local manufacture of hand-made Lokta paper. *Daphne bholua* grows under the forest canopy at altitudes of 1800 - 3100m and *Daphne papyracea* from 1500-2100m. Plenty of lokta is available in Dovane and Khatamba VDCs and there is a paper industry in each of these VDCs. The plant is also available in the forests of Tyamke, Khartamchha, Kudakaule, Kimalung, Timma and Helamcha VDCs. In 1984, it was estimated that 5.4 % of the total gross stock of lokta in the country was in Bhojpur district. Excessive or improper extraction of lokta bark can destroy the plant. Regeneration takes place from seed and root suckers. Rotational cropping (ten to fifteen years) is required to maintain a steady supply of bark. The 1984 study approved extraction of 15 mt of lokta bark annually for 5 years from Bhojpur. Lokta bark is extracted during the periods of mid-March to mid –September. An established market for the paper exists in Kathmandu.

  There is an opportunity to incorporate lokta management into community forestry in the district. It should be noted that lokta processing requires considerable amounts of fuelwood. Through forest user group formation, there may be greater incentive for communities to manage fuelwood and lokta for making paper.

- **Allo (Himalayan nettle)** – Allo (*Giradinia diversifolia*) is a naturally growing shrub which likes forest shade in gullies and damp land by rivers. It prefers an altitude of between 1200 - 3000m and north facing slopes. It regenerates naturally both from seed and root suckers. In Bhojpur district allo is generally found in all areas where lokta is found. The area particularly

renowned for allo is the north-eastern part of the district along the Arun River where it borders Sankhuwashabha district. Other known areas for allo are in the west and north of the district. Allo is also found in Yu VDC in the south. The fibre from the inner bark of allo is traditionally used for making bags, cloths, fishing nets, rope, sacks etc.

- **Rudrakshya** (*Elaeocarpus sphaericus*) – Followers of the Hindu religion consider rudrakshya to be a holy tree (Lord Shiva). It is a wild fruit, usually 10-15 m high. Its seed is hard like nut and popularly used by the Hindus for religious purposes. It is an exotic species, believed to be introduced by Swami Sadananda in the Dingla area which is now famous for rudrakshya (particularly Guthi Ban and Jageda Ban in the Arun valley). It grows in relatively warm valley areas in the hills and can be cultivated in other suitable places also. Due to religious reasons people generally do not cut this tree. As the seeds have religious value, there is a demand and market for it. Some people collect the seeds in the months of November and December to sell or export. This activity is a source of income for some households in the area. The price of rudrakshya seed depends on the number of grooves (mukh). Ek Mukhi Dana (seeds with one groove) are considered invaluable. Seeds with four, five and six grooves are found easily and widely, and thus have a low price.

- **Bamboo** – Bamboo is widely cultivated in Bhojpur. It is found almost everywhere in the district. Bamboo has multiple uses in rural livelihoods such as for poles, sheds, bridges, fences, mats, roofs, baskets and partitions. The shoots can be used as vegetables and the leaves as fodder. Large bamboo species are widely cultivated below 2600 m and used for construction purposes. The smaller bamboo species such as nigalo and malingo are grown naturally in gullies and on shady slopes, and are also found in the forests and pasture land.

  Strength and durability contribute to the wide use of bamboo for households items e.g. *nanglos* (round trays) *dokos* (head baskets), *thunches* (finely woven headbasket used for grains), *tokaris* (round wide baskets) and *dalos* (small vegetable baskets with short legs). Bamboo culms are split and woven into mats. Bamboo is also used as pillars, roof beams, fencing, panelling, and scaffolding. Young bamboo shoots are eaten by man.

- **Amliso (***Thysanolyen maxima***)**– Amliso is grown in most parts of the district. It grows naturally and is plentiful in Patlepani, Simarang, Devtar VDCs and the nearby areas. The naturally grown Amliso is traditionally collected and exported from the area. Recently, some farmers have started Amliso cultivation in Timma VDC.

- **Wild edible fruits, nuts and vegetables** – Some wild edible fruits and nuts commonly available in Bhojpur district are Kattus (*Castnopsis tribuloides*), Ainselu (*Rubus ellipticus*), Bayer(*Zizyphus mauritiana*), Sati Bayar (*Rhus parviflora*), *Okhar (Juglans regia*), Harro (*Termenalia chebula*), Barro(*Terminala bellirica*.), Amala (*Emblica officinalis*), Kafal (*Myrica esculenta*), Phanir (*Syzygium cumini*), Jamun (*Syzygium cumini*), Mallido *(Ischaemum rugosum*), Bhakimilo (*Rhus javanica*), Gidda Bhyagur (*Dioscorea bulbifera*), Ban Tarul (*Dioscorea deltoidea*), Lapsi (*Choerospondias axillaris),* Chiuri (*Bassia butyracea*), *Badahar (Artocarpus lakoocha*), Khaniu (*Ficus cunia*), Mel (*Pyrus pashia*), Bel (*Aegle marmelos*) etc. Similarly, the wild edible vegetables found are Niuro (*Dryopteris cochleata*), Sisnu (*Urtica dioca*), Jaluko (*Eichnomia crassipes*), Chinde Sag (*Amaranthus* sps), Sim Sag (*Amaranthus* sps), (Lajime Sag), Pudinha (*Mentha arvensis*), Tanki (*Bauhinia purpurea*), Chyau (*Agaricus* sps.), Jimmu (*Allium wallichii*) etc. Rural people have a taste for these wild edibles and it is a common practice that the local people freely collect these fruits, nuts and vegetables from the forests when they are in season. They are mainly collected for domestic consumption, but are occasionally sold in the weekly markets or Bazaar areas such as at Bhojpur Bazaar. Wild edibles are not part of the main diet of the Bhojpur people. However, the edibles from the forests are important food/ nutrient supplements to the rural people, especially the poor.

- **Herbs and medicinal plants** – Titepati (*Artemisia vulgaris*), Ritha (*Sapindus mukrossi*), Ban Tulashi (*Ocimum* sps.), Majhito(*Rubia manjith*), Kukur Daino (*Smilax macrophilla*), Chabo (*Piper chaba*), Gurjo *(Tinospora cordifolia*), Thinngre Salla (*Tsuga dumosa*), Louth Salla

(*Taxus baccata*), and Ban Lasun (*Allium* sps.) are available in different parts of Bhojpur. In addition, the following plants and herbs are available in the respective zones.

Tropical and sub-tropical zone	Temperate zone	Sub-alpine and Alpine Zone
Khayer (*Acacia catechui*), Asuro (*Adhatoda vasica*) Sarpagandha (*Rauwolfia serpentina*), Barro, Harro, Amala, Chhatiwan (*Alstonia scholaris*), etc.	Chiraito (*Swertia chirata*), Bojho (*Acorus calamus*), Chutro (*Berberis aristata),* Pakhanved (*Bergenia ciliata*), Tejpat (*Cinamomum tamala*), Padampuskar(*Iris decora*), Angeri (*Lyonia ovalifolia*), Nagbeli (Lycopodium sps.), Timur (*Zanthoxylum armatum*), etc.	Bikhma (*Aconitum ferox)*, Bikh *(Aconitum* sps.), Dhupi (*Juniperus* sps.) , Jatamansi (*Nardostachys grandiflora*), Panch-aunle (*Dactylorhiza hatagiera*), Kutki (*Picrorhiza kurroa*), Padamchal (*Rheum emodi*), Nirmasi (*Delphium denudatum*), etc.

The north-western high altitude areas of the district are famous for herbs and medicinal plants, except for Khayer which grows in the warmer places.

4.4 PROTECTED AREAS

There are no national parks, reserved areas, conservation areas or other nationally protected areas in Bhojpur district. Some of the forests in the north, however, adjoin the Makalu Barun National Park and Conservation Areas located in Solukhumbhu and Sankhuwasava districts. These forests exhibit many similarities in terms of the type and nature of forest, and the floral and faunal diversity with the forests of Makalu Barun areas.

5 RENOWNED AND POTENTIAL AREAS

5.1 TOURISM POTENTIAL AREAS

Sites that possess any one or a combination of the following values or attributes: historical, religious, natural - scenic beauty, lakes, rivers, waterfalls, biodiversity rich areas, caves etc. are considered as tourism potential areas.

Salpa Pokhari and Silichung Danda – Salpa Pokhari, a high altitude lake, is located in Dovane VDC at an altitude of 3410 m. It is the biggest natural lake in the district and it takes about 15 minutes to walk around its periphery. It is in a beautiful area that has a pristine rhododendron forest in excellent condition. It is a renowned tourist attraction in the region and situated on a tourist trekking route to Mount Everest from Tumlintar. According to the district people, it was the first route followed by Tenzing and Hillary to Mount Everest. Silichung Danda, which forms the catchment boundary of the Pokhari, is the highest point adjacent to the Salpa Pokhari. According to the information provided at the district headquarters, the Danda, with an approximate altitude of 4150 m, offers an excellent view of the high Himalayan peaks from Makalu to Mount Everest. The peak has a white rhododendron forest.

Salpa Pokhari is also famous as a religious place in the region. Every year on the day of Mangsir Purnima (second week of December) pilgrims visit the Pokhari for a holy bath. The Janai Purnima Mela, a religious fair, is organised on this occasion.

Salpa Pokhari and Silichung Danda jointly offer excellent potential for tourism development.

Tyamke Danda (peak) – Tyamke Danda is an unique view point located at the border of Khawa and Nagi VDCs. It is a renowned view point from where the Terai, Himalayan peaks, sun rises and sun setscan be seen. From this point, Mount Everest and a whole range of mountain peaks are visible. Bhojpur Bazaar, Hile, Dhankuta, Terai, and Diktel Bazaar can all be seen from Tyamke Danda on a clear day. Its altitude is 3010 m above msl. The peak is a part of the ridge that divides Bhojpur and Khotang districts. The area surrounding the peak has quite good forest which is rich in bio-diversity. The western slope of the Danda falls into Khotang district. The Danda is an important viewpoint and tourist attraction for Khotang district as well. According to local people from Bhojpur and Diktel Bazaars, during the Panchayat time the local people and authorities recommended the Tyamke Danda area as a National Park or Conservation Area. The DFO of Bhojpur has a programme for this year to study the biodiversity in the Tyamke Danda area. Tyamke Danda is also a local religious place. Tyamke Danda is recognised as a potential tourist destination within the district.

Nag Chhanga and Golma Raja Golma Rani – Nag Chhanga is a beautiful waterfall on the Behere Khola at Kanne Daha Village in Baikunthe VDC. The waterfall is approximately 100 feet. As the waterfall runs over limestone rock shapes like moving snakes are created. These images can be viewed from the water pool at the bottom. Golma Raja Golma Rani is located close to Nag Chhanga. It is an area characterised by unique cliff landscape. There are several legends related with the place. It is considered to be a good site for rock climbing. Nag Chhanga and Golma Raja Golma Rani can be combined to form a tourist destination in the district.

Chirkhuwa Chhanga and Maiyum Danda (3336m) – Chirkhuwa Chhanga at approximately 300m high is probably the highest water fall in the district. It is located at Chhange Gaun in Khatemchha VDC at the head water of the Chirkhuwa Khola. The waterfall combines with the Shyam Khola and becomes the Chirkhuwa Khola. The Maiyum Danda (3336 m high) is located in Kimalung and Timma VDCs at the upper ridge of the Chirkhuwa Chhanga. It is a good view point in the middle of dense forest. These two can be promoted as another tourist attraction in Bhojpur.

Other tourist areas – There are a number of sites in the district that are attractive or offer good views of the mountains, for example, Nag Daha at Amtek (Bhaisepakha, Akhuwa khola), Chyangre Pokhari at Chyangre VDC, Arun Danda at Shyamsila (Mahadevsthan), and Suntale.

Arun River has rafting potential which would benefit not only Bhojpur but also the adjoining districts.

5.2 HISTORIC, RELIGIOUS AND CULTURAL SITES

Bhojpur Bazar and Taksar – Bhojpur Bazar is the headquarters of Bhojpur district. It is located at a height of about 1600 m. It is an important administrative, service, trade and education centre in the district. The *Sidhdha Kali Temple* of Bhojpur Bazaar is well known not only in the district but also in the region. The *Khukuri*, the Gorkha knife, produced in Bhojpur is famous throughout the country. Taksar is a little historic town south of Bhojpur Bazaar established by the Rana rulers for the purpose of minting metal coins. The name Taksar is actually derived from this activity. It is also famous for metal crafts. Skilled people from Kathmandu valley were encouraged to migrate and settle here. The architecture, stone and wood carving of Taksar town therefore resembles those of Kathmandu valley. There is a *Sarswati Temple* in Taksar. The cave at the Sidhdha Kali is believed to be linked with the cave at Taksar Sarswati temple. The only air strip in Bhojpur district is also located in Taksar.

Dingla – Dingla is a historic town settlement with a beautiful landscape located in Keurenipani VDC. It is also an important market, trade and commerce centre serving the locality. Dingla is famous for Rudrakhya (holy beads for Hindu). The famous Swami Khadananda took the initiative to establish a Sanskrit School at Dingla in 1932 BS (around 1875 AD). It was the first school established by people in Nepal. Now, it has developed into the Khadananda Higher Secondary School and offers formal education upto level 10+2. Dingla is a popular stop over place for trekkers trekking on the Tumlingtar-Salpa Pokhari-Everest trail. There is also a Ram Janaki Temple in Dingla. Religious fairs such as the Ramnawami fair and the Balachaturdashi fair are organised in Dingla. Dingla is therefore an historic, religious and touristic place, as well as being a local trading centre.

Chandi Than –Chandi dance is the famous dance of the Kirat people in eastern Nepal. The Chandi Than located at Nagi VDC is believed to be the main place where religious rituals are performed and the dance is organised.

Hatuwa Gadhi and Ghodetar –This is an historic and archeological place. There is a story that King Atal Singh used to live in the palace at Hatuwa Gadhi (Gadhi meaning fort). The palace or fort remnants can still be seen. Archeological study has not been undertaken yet. There is a story that the rulers used to organise horse races in Ghodetar (Ghoda means horse in Nepali) . Ghodetar is now a local trading centre. Hatuwa Gadhi and Ghodetar are located at Ranibas VDC.

Other sites – There are a number of religious and cultural sites in the district. For example, Majhuwa Besi at Nepale Danda VDC. Pashupati temple situated at the border of Timma and Chhinnamakhu VDCs, Behereshwor at Dhotale Khani village, Golmaharaja Temple in Mane Bhanjyang and Tilahar Temple in Aamtek.

5.3 AGRICULTURE POTENTIAL AREAS

Rice – Rice is generally cultivated all over the district. The areas that are renowned for rice cultivation and production are those located adjacent to the Arun River in the Kulung, Nepale Danda, Chouki Danda, Deurali down to Pyauli VDCs in the north-eastern part of the district. Extensive paddy fields can be seen in those areas. According to the participants of the Workshop on Environmental Situation of Bhojpur, this area has a rice surplus which is exported to the rice deficient areas of Solukhumbhu and Sankhuwashaba. The other important rice production areas are adjacent to Siktel and Behere Kholas.

Tangerine – There are three distinctly identified pockets which have good potential for tangerines. Pocket one is located in the north-west and includes Chhinnamakhu, Timma, Khawa, Annapurna, Nagi and Gupteshwor VDCs. Pocket two is located in the south and includes Homtang VDC and parts of Ranibas and Baikunthe VDCs. Pocket three is located in the north-west and includes Sangpang, Deurali, Kurakauli and Pyauli VDCs. Tangerines seem to flourish on east facing slopes at 800 to 1400 m. It may be possible to promote growing tangerines on most of the east facing slopes mentioned, so long as they are at the right altitude range.

Tea - Successful cultivation of tea in parts of Dhankuta, and Terhathum districts, which have similarities with Bhojpur district, suggest that tea cultivation could be possible in different parts of Bhojpur. A study conducted by the District Agricultural Office of Bhojpur reveals that Balankha, Yu, Annapurna, and Chhinnamakhu VDCs have suitable climates and soils for tea cultivation. Other possible areas include Suntale, Shyamsila, Tiwaribhanjyang, Lekharka, and Nagi VDCs.

Alaichi (Cardamom) – Cardamom cultivation seems possible in most parts of the district. Especially in Gupteshowor, Timma, Chhinnamakhu, Sangpang, Khawa, Annapurna, Champe, Deurali, Basikhora, Yu, Kudakaule, Helauchha, and Dhulo Duma VDCs.

Uttis (*Alnus nepalesis*) – Plantation of uttis trees is possible in most parts in the middle mountains. Uttis grows very fast ensuring fast financial return by selling timber. It is good for providing shade to cardamom and is also suitable in landslide prone areas.

Amliso (*Thysanolaena maxima*) – see section 4.1.4.

Aduwa (Ginger) – Although, ginger cultivation is common in most parts of district, it is the southern parts of the district, including Homtang, Sinrang, Ranibas VDCs, that are traditionally known for ginger cultivation. Ginger cultivation is popular in the south maybe because the area is relatively dry which is unfavourable for the cultivation of crops like rice.

Ground nuts and Tobacco – Tobacco and Ground Nuts (Badam) are popular in the relatively dry area of the district in the south-east . This includes Jarayotar, Homtang, Sano Duma, and Dhulo Duma VDCs.

Vegetable – High quality vegetable cultivation is possible in most parts of the district. Bokhim, Shyamshila and Taxar VDCs are currently renowned for vegetable growing, maybe due to closeness to the district headqurters where there is a market for the produce. Potato is commonly cultivated all over the district. Winter potato can be grown in valleys and summer potato on ridge areas. Scus yield is high in the ridge areas (cool climate). Chilli is another item that grows very well in most parts of the district and fetches a good price. Chilli is also popular in the south.

Other fruits – Lichi and Mango that grow in warm climates (sub-tropical) grow in the Arun and Sun Koshi River Valley areas in the east and south parts of the district.

5.4 MINERAL POTENTIAL AREA

Studies in the past reported the existence of a few non-metallic as well as metallic mineral resources and precious stones in the district. None of them were, however, considered as of high enough economic importance to exploit. The major mineral resources recorded from Bhojpur district are summarised in the table below and shown in the geological map.

Table 3: Mineral deposits and occurrences in Bhojpur district (source: ESCAP, 1993)

Locality	Latitude (North)	Longitude (East)	Commodity / Minerals	Symbol	Host Geology	Economic Status
Bhojpur	27 ^{0} 10' 00''	87^0 04' 00''	Muscovite	Mc	Pegmatite	Occurrence
Sikryatar(Jagre)	27 ^{0} 08' 00''	87^0 13' 30''	Talc	Ta	Schist	Occurrence
Ikhu Khola	26 ^{0} 58' 00''	87^0 01' 30''	Beryl	Be	Pegmatite	Occurrence
Chirling Khola	26 ^{0} 57' 00''	87^0 06' 00''	Copper	Cu	Disseminated along fault	Small-tonnage
Sirise	27 ^{0} 05'	87^0 02'	Copper	Cu	Quartzitic Schist	Old audit*
Khakuwa Khola	27 ^{0} 19' 30''	87^0 09'	Copper	Cu	Kuncha Phyllite	Not known*

* Source: Department of Mines and Geology

The LRMP Geology Report has mentioned existence of copper deposits at Dingla (Lon: 87^0 37'E, Lat: 27^0 24'N) just below the MCT in garnet mica gneiss.

Besides these, other mineral resources of the area include dimension stone, block stone, and sand and gravel. Local people have been traditionally exploiting these for their use. Good quality sand and gravel may be found in the trunk Arun River, Sunkoshi River, Pikhuwa Khola and their major tributaries. Quartzite, gneiss, quartzitic schist and marble are the major sources of block-stone and gravel and available almost all over the district. Slate and phyllite, which are useful for roofing and riprap, occur on southern part of the district and along the Arun Valley.

In the Workshop on the Environmental Situation of Bhojpur (March 22, 2000), the participants provided some information on the mines. The information may not be fully relied on because it is not based on any scientific exploration or studies. It does however provide clues for further exploration. According to the workshop participants Selme (in Lekharka VDC) and Tyamke (in Annapurna /Khawa VDCs) have traditionally operated copper and iron mines which are now abandoned. According to them, the other mines that exist in the district are: a copper mine at Khani Gaun (at the border of Champe and Yangpang VDCs), an iron mine at Falam Khani Gaun of Okhre VDC-3, a mica mine at the ridge slope of Bhir Thapla on the way to Dingla in Boya VDC, and a copper mine at Bachimle Khola (in Khawa, Nagi, and Annapurna VDCs). There are limestone mines being locally used at Taksar, Amtek, and Chyangre VDCs. Limestone is also available at Kawa Khola in Ranibas VDC. Silidhunga is available in Shyamsila VDC.

6 WATER BODY

Bhojpur district falls within the catchment of two major rivers in eastern Nepal, the Arun and Sun Koshi Rivers both of which form the district boundary in the east and south respectively. In fact, a very high proportion of the area comes under the Arun River's catchment. The only not in this catchment is the area near southern boundary that drains into the Sun Koshi River. The catchment of these two big rivers extends to Tibet across the Himalaya. The proportion of the catchment areas of these rivers within Bhojpur district is very small in relation to their total catchment areas.

The perennial tributaries draining from Bhojpur district to these two major rivers, particularly the Arun River, are the main sources of water for the people of the district. The main streams that flow into the Arun River are the Irkhuwa, Chirkhuwa, Khakuwa, Yangguwa, Leguwa, Hanaryo, and Pikhuwa Kholas. Pikhuwa is the biggest stream draining within the district. The main streams that flow into the Sun Koshi are Ikhuwa and Majhuwa Kholas. The valley floors of the Arun River in the east, and Siktel and Behere Kholas in the west are the major rice producing areas of the district, and have extensive irrigated lands. The tributary streams have been traditionally utilised for irrigation and other purposes. The stream characteristics are summarised in table 4 and table 5 below. Studies on micro-hydropower showed a number of potential sites on these streams (Table 6). A mini-hydropower station developed on Siktel Khola has been supplying power to the district headquarters. Springs are the major sources of drinking water in the district.

There are waterfalls in the perennial tributaries. The Chirkhuwa Khola Chhanga (biggest fall in the district) and Nag Chhanga are the famous waterfalls in the district (see section 5.1).

There are a number of lakes and Pokharis in the district. Salpa Pokhari is the biggest among them (see section 5.1). Other such water bodies are Panchakanya Pokhari, Hansa Pokhari, Chyangre Pokhari (at Chyangre VDC), Bhabisyabakta Pokhari (at Rani Bas VDC) etc.

Table 4: Characteristics of River in Bhojpur District

River System	Length (km)		Elevation Within District (m)		Mean slope within District (%)	Catchment Area (Km^2)			
	Total	Within District	Highest Pt.	Lowest Pt.		Total	Within District	Forest (%)	Agr. (%)
Arun River	368.0	77.5	366.0	91.5	0.35	36,533	1323.0	54	46
Irkhuwa	26.0	26.0	3596.5	352.4	12.50	205.45	205.45	73	27
Kakuwa	6.0	6.0	1311.0	610.0	11.70	10.75	10.75	18	82
Benkuwa	8.70	8.7	2896.0	823.0	23.80	16.025	16.025	40	60
Badahare	2.75	2.75	786.0	28.0	18.10	1.033	1.033	58	42
Khisiya	2.25	2.25	695.0	289.0	18.00	0.82	0.83	60	40
Benkhuwa	2.625	2.625	670.73	359.1	11.80	1.705	1.70	10	90
Chirkhuwa	19.00	19.0	3396.8	335.3	15.90	76.625	76.625	37	63
Shyam Khola	11.50	11.5	3109.7	884.1	19.40	9.675	9.675	62	38
Chaulane	5.00	5.0	853.7	341.56	10.20	2.650	2.650	82	8
Semeng	3.50	3.5	871.95	335.4	15.30	2.470	2.470	6	94
Khakuwa	10.50	10.50	2123.7	259.0	17.90	40.075	40.075	82	18
Yanguwa	17.50	17.50	2682.1	250.0	14.30	124.23	124.23	55	45
Bharse	9.25	9.25	1981.7	548.8	15.50	21.38	21.38	52	48
Nakhuwa	13.50	13.50	2500.0	426.8	15.40	34.65	34.65	80	20
Leguwa	10.00	10.00	2072.5	246.90	18.25	24.425	24.425	45	55
Sapa	6.50	6.50	1676.3	243.80	22.22	12.625	12.625	44	56
Jogarne	3.25	3.25	1219.6	223.41	30.60	2.97	2.97	60	40
Hangrayo	15.50	15.50	1950.6	213.35	11.11	57.10	57.10	65	35
Alaiche	6.00	6.00	1829.3	195.10	27.60	10.96	10.96	65	35
Pikhuwa	40.50	40.50	1636.3	167.60	3.22	588.20	588.20	58	42

Akhuwa	18.50	18.50	2439.0	426.82	10.90	52.325	52.325	40	60
Khesang	9.25	9.25	2134.1	609.30	16.50	57.10	57.10	25	75
Sere	8.75	8.75	2408.5	792.30	18.50	27.05	27.05	20	80
Lyangtang	7.50	7.50	2439.0	1128.0	17.50	10.650	10.650	32	68
Khunge	10.50	10.50	2621.9	1006.0	15.40	27.025	27.025	65	35
Siktel	15.00	15.00	2591.5	854.00	11.60	71.300	71.300	58	42
Bere	13.50	13.50	2195.0	518.30	12.40	52.55	52.55	46	54
Makhuwa	18.75	18.75	2378.0	366.00	10.70	33.50	33.50	75	25
Chukawa	6.50	6.50	2073.0	548.70	23.50	11.90	11.90	55	45
Kawa	13.50	13.50	2134.0	548.70	11.70	32.825	32.825	43	57
Chichuwa	7.50	7.50	1463.1	274.40	15.80	11.35	11.35	52	48
Jabepahra	2.50	2.50	1981.7	789.60	47.60	3.42	3.42	75	25
Habirang	3.00	3.00	1981.7	786.60	39.80	3.97	3.97	66	33
Porobong	2.00	2.00	914.60	179.80	36.70	2.70	2.70	25	75
Langkonsha	1.25	1.25	304.80	176.80	10.24	2.90	2.90	5	95
Pakhuwa	7.50	7.50	1676.3	167.60	20.00	25.475	25.475	45	55
Paire	2.13	2.13	945.10	163.10	36.70	1.85	1.85	35	65
Roktang	4.00	4.00	1128.0	168.30	23.90	6.50	6.50	78	22
Nangkhwa	5.25	5.25	1219.5	158.50	20.20	6.95	6.95	60	40
Sunkishi	220.0	24.00	163.10	91.50	0.30	1923.0	162.58	48	52
Ikhuwa	18.70	18.70	1676.3	167.60	8.10	109.07	55.00	45	
Charling	8.50	8.50	1768.3	259.10	17.70	35.65	35.65	58	52
Khumbe	7.00	7.00	1829.3	426.80	20.00	13.65	13.65	55	45
Findurang Renchang	32.50	32.50	1493.9	853.65	19.70	2.125	2.125	48	52
Ebuwa	5.50	5.50	1703.3	731.70	17.70	10.625	10.625	58	42
Dimalung	4.25	4.25	518.29	190.50	7.70	3.46	3.46	30	70
Chhehare	3.15	3.15	609.75	182.90	13.50	3.70	3.70	34	66

Table 5: Mean Monthly Discharge for Streams in Bhojpur District (m^3/sec)

River	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max.	Min.
Arun River System														
Irkhuwa	2.56	2.07	1.79	1.83	2.38	10.48	27.65	34.06	25.85	12.10	5.75	3.51	66.76	0.797
Kakuwa	0.15	0.12	0.11	0.11	0.13	0.63	1.46	1.99	1.41	0.68	0.36	0.21	4.16	0.037
Benkhuwa	0.22	0.18	0.16	0.16	0.19	0.92	2.18	2.92	2.09	1.00	0.52	0.31	6.06	0.046
Badahare	0.02	0.01	0.01	0.01	0.01	0.07	0.14	0.21	0.14	0.07	0.04	0.02	0.46	0.003
Khisiya	0.01	0.01	0.01	0.01	0.01	0.05	0.11	0.17	0.11	0.06	0.03	0.02	0.37	0.003
Chirkhuwa	1.00	0.81	0.71	0.71	0.89	4.09	10.35	13.17	9.77	4.61	2.26	1.37	26.41	0.285
Shyam	0.14	0.11	0.10	0.10	0.11	0.57	1.32	1.80	1.27	0.61	0.32	0.19	3.77	0.033
Benkhuwa	0.03	0.02	0.02	0.02	0.02	0.11	0.23	0.34	0.23	2.11	0.06	0.04	0.74	0.005
Chaulane	0.04	0.03	0.03	0.03	0.03	0.16	0.36	0.52	0.35	0.17	0.10	0.06	1.12	0.009
Semena	0.04	0.03	0.03	0.03	0.03	0.15	0.34	0.48	0.33	0.16	0.09	0.05	1.04	0.008
Khakuwa	0.54	0.44	0.39	0.38	0.47	2.20	5.43	7.06	5.15	2.45	1.23	0.74	14.35	0.145
Yanguwa	1.58	1.28	1.12	1.13	1.44	6.48	16.75	20.98	15.74	7.40	3.55	2.17	41.59	0.472
Bharse	0.30	0.24	0.22	0.21	0.25	1.21	2.90	3.85	2.77	1.32	0.68	0.41	7.95	0.075
Nakhuwa	0.47	0.38	0.34	3.33	0.40	1.92	4.69	6.13	4.47	2.12	1.07	0.64	12.52	0.125
Leguwa	0.34	0.27	0.24	0.23	0.29	1.37	3.31	4.38	3.16	1.51	0.77	0.46	9.01	0.087
Sapa	0.18	0.14	0.13	0.12	0.15	0.73	1.72	2.32	1.65	0.79	0.42	0.25	2.84	0.044
Jogarne	0.04	0.04	0.03	0.03	0.03	0.18	0.41	0.58	0.40	0.19	0.11	0.06	1.24	0.010
Hangrayo	0.75	0.61	0.54	0.53	0.66	3.09	7.72	9.92	7.31	3.46	1.71	1.04	20.02	0.210
Alaiche	0.16	0.13	0.12	0.11	0.13	0.64	1.49	2.02	1.43	0.69	0.36	0.21	4.24	0.038
Pikhuwa	6.98	5.64	4.80	5.06	6.79	28.59	78.87	93.82	72.96	33.86	15.3	9.58	179.5	2.385
Akuwa	0.69	.056	0.50	0.49	0.61	2.84	7.08	9.12	6.71	3.18	1.58	0.95	18.45	0.192
Khesang	0.75	0.61	0.54	0.53	0.66	3.09	7.72	9.92	7.31	3.46	1.71	1.04	20.02	0.210
Sere	0.37	0.30	0.27	0.26	0.32	1.51	3.67	4.83	3.50	1.67	0.85	0.51	9.92	0.096
Lyangtang	0.15	0.12	0.11	0.11	0.12	0.62	1.45	1.97	1.39	0.67	0.35	0.21	4.13	0.036
Khunge	0.37	0.30	0.27	0.26	0.32	1.51	3.66	2.83	3.49	1.66	0.85	0.51	9.91	0.096
Siktel	0.93	0.75	0.66	0.66	0.83	3.80	9.59	12.24	9.06	4.28	2.10	1.28	24.58	0.264
Bere	0.70	0.56	0.50	0.49	0.61	2.85	7.11	9.16	6.73	3.19	1.59	0.96	18.52	0.192
Makuwa	0.45	0.37	0.33	0.32	0.39	1.86	4.54	5.94	4.32	2.05	1.04	0.62	1.13	0.120
Chukawa	0.17	0.14	0.12	0.12	0.14	0.69	1.62	2.19	1.56	0.75	0.39	0.23	4.58	0.041
Kawa	0.44	0.36	0.32	0.31	0.38	1.82	4.45	5.82	4.23	2.01	1.02	0.61	11.90	0.118
Chichuwa	0.16	0.13	0.12	0.11	0.13	0.66	1.54	2.09	1.49	0.71	0.38	0.22	4.38	0.039
Jabepahara	0.05	0.04	0.04	0.04	0.04	0.21	0.47	0.660	0.45	0.22	0.12	0.07	1.42	0.011
Habirang	0.06	0.05	0.04	0.04	0.05	0.24	0.54	0.76	0.53	0.25	0.14	0.08	1.63	0.013
Porohong	0.04	0.03	0.03	0.03	0.03	0.17	0.37	0.53	0.36	0.17	0.10	0.06	1.14	0.009
Lungkonsha	0.04	0.04	0.03	0.03	0.03	0.18	0.40	0.56	0.39	0.19	0.10	0.06	1.21	0.009
Phakuwa	0.35	0.28	0.25	0.24	0.30	1.43	3.45	4.56	3.30	1.57	0.80	0.48	9.37	0.091
Paire	0.03	0.02	0.02	0.02	0.02	0.12	0.25	0.36	0.25	0.12	0.07	0.04	0.80	0.006
Poktang	0.09	0.08	0.07	0.07	0.08	0.39	0.89	1.22	0.86	0.41	0.22	0.13	0.59	0.022
Nangkhwa	0.10	0.08	0.08	0.07	0.08	0.41	0.95	1.31	0.92	0.44	0.24	0.14	2.76	0.023
Sunkoshi River System														
Ikhuwa	1.40	1.13	0.99	0.99	1.27	5.72	14.71	18.51	13.84	6.52	3.15	1.92	36.80	0.412
Charling	0.48	0.39	0.35	0.34	0.42	1.97	4.83	6.30	4.59	2.18	1.10	0.66	12.86	0.128
Khumbe	0.19	0.16	0.14	0.13	0.16	0.79	1.86	2.50	1.78	0.85	0.45	0.26	5.21	0.047
Findurang & Rencheng	0.03	0.03	0.02	0.02	0.03	0.13	0.29	0.42	0.28	0.14	0.08	0.04	0.91	0.007
Ebuwa	0.15	0.12	0.11	0.10	0.12	0.662	1.45	1.96	1.39	0.67	0.35	0.21	4.12	0.036
Dimalung	0.05	0.04	0.04	0.04	0.04	0.21	0.47	0.67	0.46	0.22	0.12	0.07	1.43	0.011
Chhehare	0.06	0.04	0.04	0.04	0.04	0.23	0.51	0.71	0.49	0.24	0.13	0.08	1.53	0.012

Table 6: Some potential sites for micro-hydropower development

Site/ Scheme	Source	Design output (KW)	Remarks
Dawa	Sere Khola	8.7	Existing mill.
Chhinamakhu	Hingkhuwa K.	7.5	
Annapurna (Dilpa)	Wachingle K.	11	New Site
Salleni (Gogane)	Siktel K.	17	New Site. Load centre scattered
Jimigaon	Juke K.	4.4	Existing mill.
Jhyaupokhari	Nakhuwa K.	13	New Site
Baluwa Besi	Chirkhuwa K.	19	Existing mill. Lies on tourist route.
Chaukidanda	Benkhuwa K.	5	Existing mill.
Salpa Phedi	Sanu K.	12	New site. Lies on tourist route (to Nemche)
Kudak Kaule	Chirkhuwa K.	14	Existing mill. Owners interested.
Yangpang	Yanguwa K.	17	New site.
Bhulke	Bere K.	12	Possible water right problem. Scattered load centre.
Leguwa K.	Leguwa K.	2.3	Low winter flow. Stream bed seepage
Kavre (Lekharka)	Siktel K.	7	New site. Remote and poor area.
Pittim	Nakhuwa K.	5	Existing mill. Load centre far and scattered.

7 CONCLUSION AND RECOMMENDATION

Forests in the upper reaches, where population density is less, are generally in a pristine state. These forests also contain abundant wildlife, birds and plant species. The most significant forests in the district are the forests in the north west (Chhinnamakhu to Dovane VDC) and on the ridge forming the upper catchment of the Malebu and Yanguwa Kholas. These forests are extensive, dense, pristine and rich in bio-diversity containing many varieties of wildlife and plants including herbs. They may also have important sub-regional and local ecological functions although their significance is unknown at this stage. These forests should be given a high priority for protection. Roads are not desirable through the middle of, or providing access to, the interiors of the above mentioned forests. Other important forests in the district that need careful consideration while planning roads and other RAP components are the forest around Tyamke Danda, Deurali Sal forest in Arun valley, and Ghur Bise forest.

Forests along the river/stream valleys may be relatively narrow but they are important because they link otherwise isolated forests and provide important movement routes for wildlife and birds. The forests along the stream valleys are also important from a slope stability point of view as the valleys are generally steep and unstable.

Non-timber Forest Products (NTFPs) are very important resources for the local people, especially for the poor and disadvantaged people. There is a need to work in partnership with DFO, CFUGs, NUKCF or other agencies active in the field, to assess the prospects for NTFPs in the road influence corridors and to explore ways of promoting forest conservation as well as sustainable and equitable forest usage.

Although complete avoidance of the forest areas is desirable while planning and constructing roads, it may not always be possible to achieve. In this situation, the roads may be conditionally acceptable through the forest boundaries or peripheral areas of some less significant forests. It will not however be desirable through the middle of forests.

If a rural road has to pass through community forest(s), a close consultation and coordination with local consumers and communities, as well as with Users Committee is required. Possibility of cooperation and partnership between RAP and the communities or CFUGs in protecting and enhancing the community forests in the road influence corridor should be explored. Supporting awareness programmes targeted at the forest users in the road influence corridor can be an effective environmental mitigation strategy.

The level of environmental awareness at the district level through to the community level is found to be generally very low. Specially designed environmental awareness programmes for the communities in the road influence corridor as well as the decision-makers at district and village levels are recommended. This combined with support for forest and soil conservation activities in the corridors will play a vital role for the conservation/protection of the local resources and their sensible use in sustaining livelihoods and in the maintenance of roads/ infrastructures.

Soil is another important natural resource in the hills. There is a need to work in partnership with the local communities in the road influence corridor in the field of soil conservation.

The southern and northern parts of the district are conspicuous due to their instability. These areas are particularly sensitive and have been experiencing a large numbers of landslides and instability incidents. The natural topography of these areas suggests that these incidents will continue in the future. The southern part of the district around Thulodumma, Cheduwa, Homtang and Hasanpur VDCs also appear to be problematic, unstable and riskier than the rest of the district. The probable reasons for this are that the rocks of the southern part are highly faulted along the Mahabharat Thrust, the MBT and other faults which are considered still active, and that the area (including Thulodumma, Homtang and Cheduwa VDCs) contain biotitic gneiss and biotitic schist that are soft and weak and have high weathering and erosion potential. A combination of these factors with the

rainfall, slopes and soil types make the southern part of the district a highly landslide prone zone. This is demonstrated by the large number of existing or past landslides in the area. The high landslide incident area in the extreme north, includes areas around Kulung, and Chaukidanda VDCs. Both the areas also happen to be the high rainfall zones in the district. The landslides on the southern part of the district are mainly soil slides and more likely to recur in future where as the northern belt is more likely to experience rockslides, rock fall, and avalanches.

The above conclusions are based on secondary information. Also they are broad in nature, highlighting only a general situation in the district. They are expected to be useful for desk level work for defining road corridors and for planning road networks and individual roads. Micro-level variations are bound to be present and need to be looked at once a corridor is defined. A careful selection of road alignment by considering the landslide and instability aspects is critical for the long-term maintenance of the road. Roads seem to be extremely difficult to build and maintain in the southern and northern parts of the district.

From the point of view of the two major environmental aspects (forests and landslides), the north-western parts (from Chhinnamakhu to Dovane and nearby areas), and area around the ridge forming the upper catchment of Malebu and Yanguwa Kholas are found to be the most sensitive in the district. Furthermore, population density in these areas are also less. Road development providing access to these areas is undesirable.

Except in those areas that are highlighted in the above paragraphs because they sensitive due to forest and slope stability considerations and therefore undesirable areas for road construction, roads may be planned and built in the district as long as due consideration is given to the following aspects:

- careful selection of alignment to avoid or minimise occupation of forest areas and irrigated fertile lands (Khet)
- careful selection of the alignment considering landslides and instability,
- design the road for balancing cut and fill (if not possible manage excess mass making terraces or deposit in safe place)
- designing a good locally maintainable water management strategy and integrating the concept from the early stage of road planning,
- integrated use of vegetation and simple engineering structures for the protection of slopes in the road corridor,
- a locally sustainable system for protection of forest, soil and slope in the road vicinity, and
- partnership with immediate road neighbours and communities in the road influence zone for the maintenance of the road and for the protection of local resources.

ANNEX I: GLOSSARIES

Alluvium - The general term for river or stream deposits. It consists of gravel, sand, silt, clay and often organic materials that make it a fertile soil.

Antecedent - Established before the onset of some remoulding event, such as uplift, and maintaining its course unaffected by that event.

Anticline – The arch or crest of a fold in rock strata.

Badlands - Characterised by a fine drainage network and short steep slopes with little or no vegetative cover. They develop in regions of erodible sediments where vegetation has been destroyed, e.g. by cattle grazing, or where vegetation is lacking.

Colluvium - Unconsolidated material at the bottom of a cliff or slope, generally moved by gravity alone. It lacks stratification and is usually unsorted; its composition depends upon its rock source, and its fragments range greatly in size.

Complex - An assemblage of related groups or formations is called a complex.

Debris - Any surface accumulation of rock fragment and soil detached from the rock mass by disintegration, also called rock waste.

Dendritic, Trellis Drainage Pattern - The particular arrangement or configuration that is collectively formed by the individual stream courses in an area. Drainage pattern reflect the influence of factors such as initial slopes, inequalities in rock hardness and structural control, and the geological and geomorphic history of the drainage basin. The ***dendritic pattern*** characterised by the irregular branching of tributary streams in many directions at almost any angle, but usually less that 90^0. A ***trellis pattern*** shows an arrangement of sub-parallel streams.

Dip-slope - The slope of the land surface that more or less conforms with the inclination of the underlying rocks.

Fan-deposit - A fan shaped mass of rock fragments and soil, mainly alluvial and debris.

Fold - A bend in rock strata caused by movements in the earth's crust. The strata are bent in a series of arches (anticlines) and troughs (synclines).

Formation - Fundamental geological unit used in the local classification of strata or rocks. Formations are not classified by geological time but rather by distinctive physical and chemical features of the rock. The names of formations are often taken from geographical names of places where they were originally described. These are combined with the names of the predominating rock comprising the build of the formation, e.g. Chandragiri Limestone.

Group - The formal stratigraphic rock unit next in order above formation. It includes two or more geographically associated formations with notable features in common.

Joints – Cracks in rock masses, formed along a plane of weakness (the joint plane) and where there has been little or no movement, unlike a fault.

Lineament - The lineaments are linear topographic features on plan that generally are expressions of buried geological structures. Faults, thrusts, fold axes, prominent joints, shear zones etc. may look like linear features on plan *(lineament).* Presence of a lineament indicates a possible weak zone.

Nappes - A large sheet-like body of solid rock that has moved a long distance (generally a mile or more) at low angles over the underling rocks either by over-thrusting or recumbent folding.

Residual - Soil produced in *situ* by weathering of rock.

Syncline - The trough or inverted arch of a fold in rock.

Talus - A heap of coarse debris, as a result of weathering (mainly physical), at the foot of a cliff.

Thrust - A contraction fault which cuts up-section.

Window - When erosion breaks through the over-thrust sheet exposing the rock beneath the thrust/fault, a window is formed. The name applies because it is possible to look through the upper sheet to the lower.

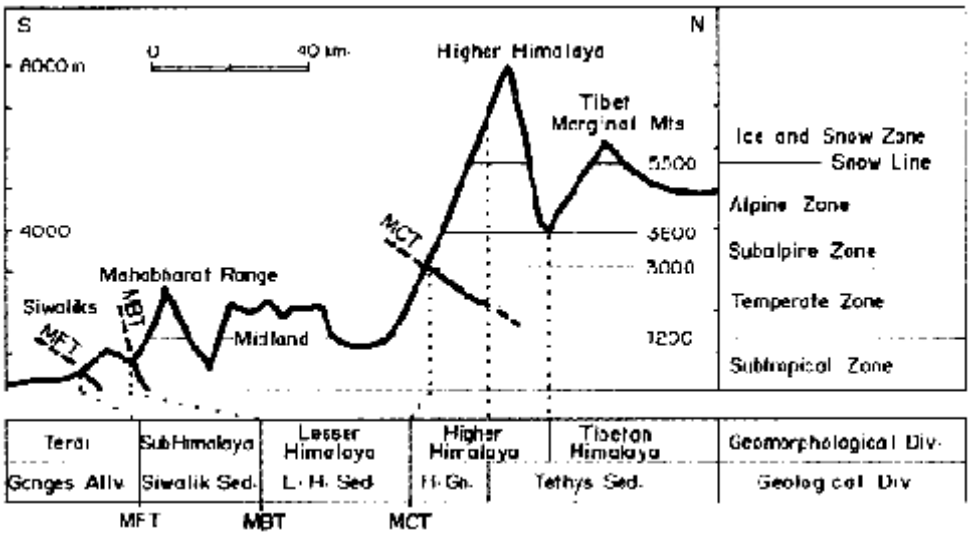
ANNEX II: GENERAL GEOLOGICAL FRAMEWORK OF THE HIMALAYA

It is generally agreed that the Himalaya were generated as a result of the collision of the northward moving Indian continent with the Asian landmass. That orogenic (mountain building and deformation of rocks) process continues, and mountains are still being formed. Continued activity is manifested in the present day northward movement of India at a rate of ~5 cm a year and in the occurrence of frequent seismic events along the mountain range and in its surroundings (Upreti B. N., 2000). Most of the convergence is accommodated within the Himalaya by movement on various thrusts and folds. Nepal occupies the central sector of the southward convex Himalayan mountain arc and nearly one third of the 2400 km long Himalayan range lies within Nepal. Like other parts of the Himalaya, the Nepal Himalaya can be divided into five latitudinal morpho-tectonic zones as follows (see Geological Map).

1. The Gangetic Plain (Terai)
2. The Sub-Himalaya (Churia Hills or Siwaliks)
3. The Lesser Himalaya (Mahabharat/Midland Zone)
4. The Higher Himalaya (Central Crystalline axis)
5. The inner Himalaya (Tibetan Sedimentary zones)

Gangetic plain represents the great alluvial tract of the Himalayan Rivers. The almost monotonous deposits of this plain belong to the latest chapter of the Himalayan upheaval and conceal beneath them the older rocks. The MFT separates the Gangatic plain from the northern foothills of the Sub-Himalayan Siwalik belt. **Sub-Himalayan or Siwaliks** extends up to MBT in north from the southern terai. The Siwaliks is characterized by rugged young topography and comprised more than 6 km thick fluvial deposits, mainly mudstone, sandstone and conglomerate. **Lesser Himalayan** comprises of largely unfossiliferous meta-sedimentary sequence and high-grade metamorphic succession along the structural depressions confined within the limits of the MBT in south and Main Central Thrust (MCT) in north. The belt is 60 to 100 km wide and consists of more than 30 km thick meta-sedimentary and metamorphic rocks; mainly schist, phyllite, gneiss, quartzite, limestone and granite. Various magmatic rocks occur within this zone that interrupt stratigraphic sequences in many places. **Higher Himalaya** extends from the MCT to the transitional contact with the northern Tibetan sedimentary zone. The Higher Himalayan zone comprises of high-grade metamorphic rocks; mainly gneiss, schist, marbles and granites. Due to controversies in identification and location of MCT, it is quite difficult to trace the southern boundary of this zone. **Inner Himalaya or Tibetan Tethys** sediments succeed the Higher Himalayan crystallines transitionally. Owing to the terrain conditions, this zone is relatively less studied. Its expansion in eastern Nepal is very limited and confined only along the summit line of 8000 m peaks. It comprises mainly of fossiliferous sedimentary rocks such as shale, limestone, and sandstone.

These almost parallel, east-west extending zones differ in their lithology, structure, and geological history. Generally, instabilities in the Himalayas are controlled by the textural and structural characteristics of the rocks and soils within the zone. There are many discontinuities generally associated with major thrusts and faults. Landslides and topographic depressions are often aligned along active faults.



Simplified Cross Section of the Himalayas (after Kizaki, 1994)

ANNEX III: ENGINEERING SIGNIFICANCE OF ROCKS

The Bhojpur area mainly comprised of quartzite, limestone, marble, slate, phyllite, schist, gneiss, amphibolites and granite rocks. These rocks differ in texture as well as composition and accordingly the rock strength changes. The strength of rocks also differ with rock weathering grade and discontinuity characteristics of rock mass. In general, the area comprised mainly of moderate to high strength rocks. The distribution of various types of rocks in the area is shown in the geological map of Bhojpur with geological formations.

Quartzite: This rock dominantly composed of quartz mineral, a highly stable mineral and therefore less likely to deep weathering and erosion. Generally, it has high bearing capacity and thick-bedded quartzite forms barren cliffs. In the area, the Kuncha Formation and the Robang Formation comprised of subordinate amount of quartzite bands. Highly fractured quartzite is more permeable and more likely to occur landslides on that slope. It is also useful to moderate to high quality construction materials mainly block stone. Thick exposure excavation generally needs blasting.

Limestone/Marble: These are calcareous rocks and chemically weak but physically strong. Deep chemical weathering is possible in such terrain. More likely to develop cast topography such as cave, cavern and depression due to subsidence. The Benighat Slate and Bhainsedobhan Marble consist limestone and marble. Generally, high bearing capacity on massive limestone and marble. Completely weathered calcareous rock form good land for dry cultivation on gentle slopes and forest on steep slopes. Fresh is good source of construction materials such as block-stone and gravel.

Slate: Slate is a fine-grained metamorphic rock with perfect rock cleavage. The Benighat Slate dominantly consists of slate. It is more likely to deep weathering, erosion and landslides. Weathered slate has low to moderate bearing capacity. It can be excavated quite comfortably. Fresh exposure is mainly useful for dimension stone mining for roofing purpose.

Phyllite: Grains in phyllite are coarser than in slate and occasionally difficult to distinguish it from slate. It is also more likely to deep weathering, erosion and landslides but it has low permeability. It can be excavated quite comfortably but harder than slate. This is the dominant rock type of the area in the Nawakot Complex. The Kuncha Formation, Benighat Slate and Robang Formation consist dominantly of phyllite. Low to moderate bearing capacity in weathered phyllite. Useful for construction material mainly dimension stone for pavestone and roofing purpose.

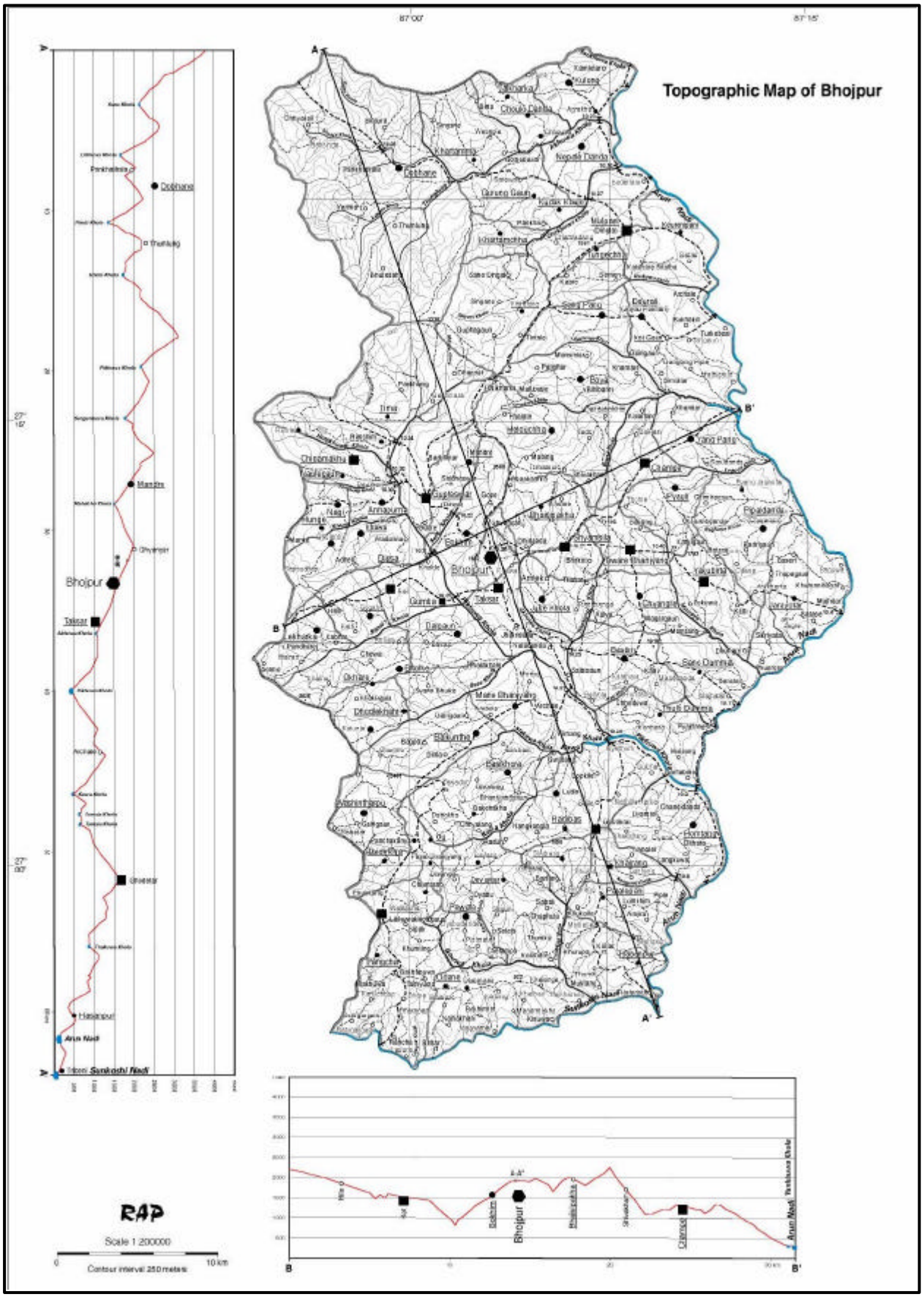
Schist: It is a coarse grained metamorphic rock. Risk to landslides on slopes with deep weathering. Fresh quartzitic schist possesses high bearing capacity whereas weathered and high mica content one possess low to moderate bearing capacity. Foundations stable on fresh. In the area, schist is mainly the constituent of the Raduwa Formation, Kalitar Formation and Kulikhani Formation.

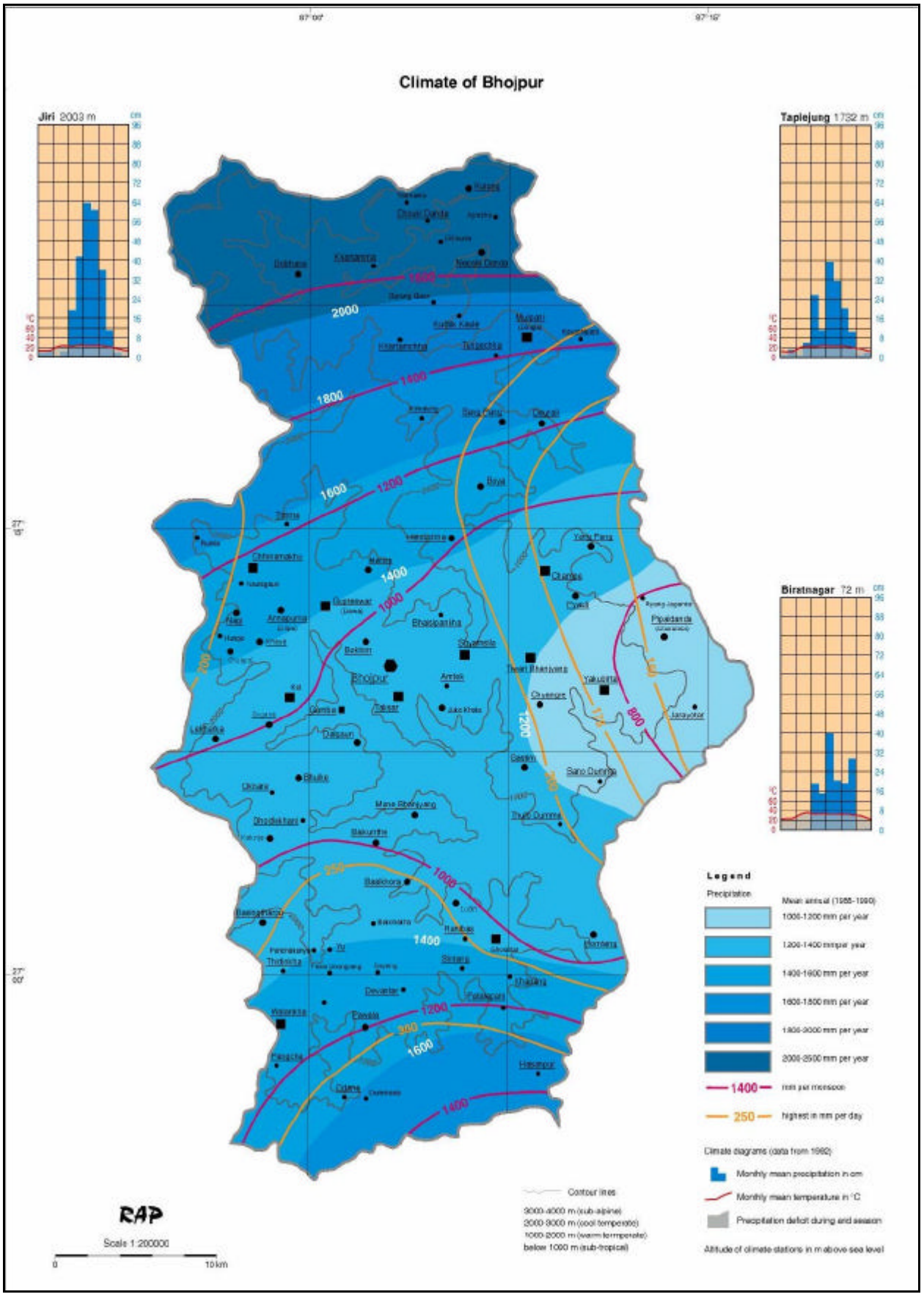
Gneiss: It is quartz-feldspar-mica dominant coarse grained and coarse crystalline metamorphic rock. The rock strength and weathering potentiality vary with mineral composition. High mica content is more likely to weathering and erosion. Highly prone to landslide and badlands® development under weathered condition. This is the most dominant rock around north of the Bhojpur bazaar, such as the Higher Himalayan crystalline gneiss and patchy gneissic exposure on all over the area. High bearing capacity in fresh rocks but low to moderate in weathered ones. Medium to high permeability in weathered condition at or near the surface. Fresh rock can be used for block-stone.

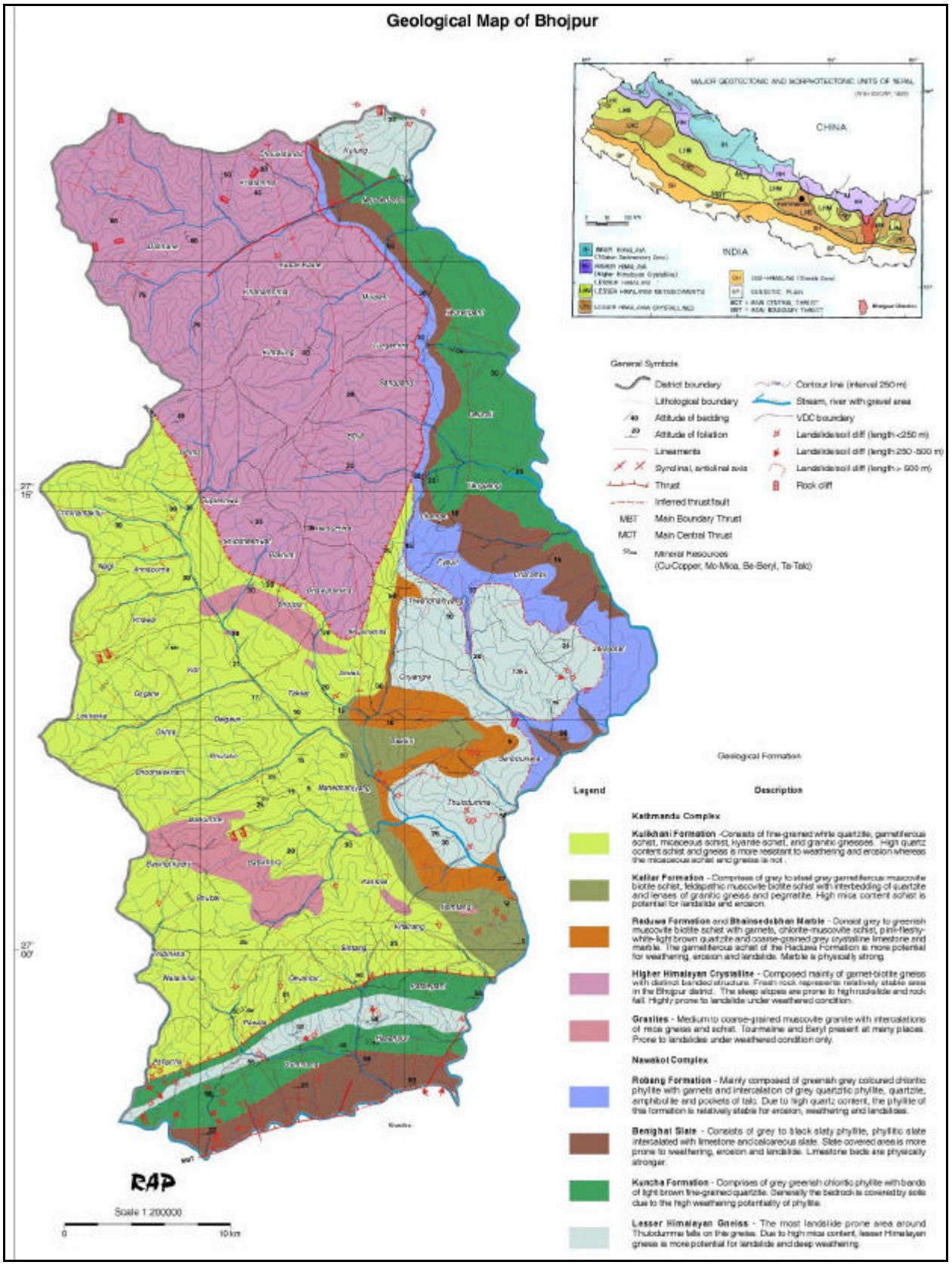
SUMMARY OF GEO-TECHNICAL PROPERTIES OF SOILS

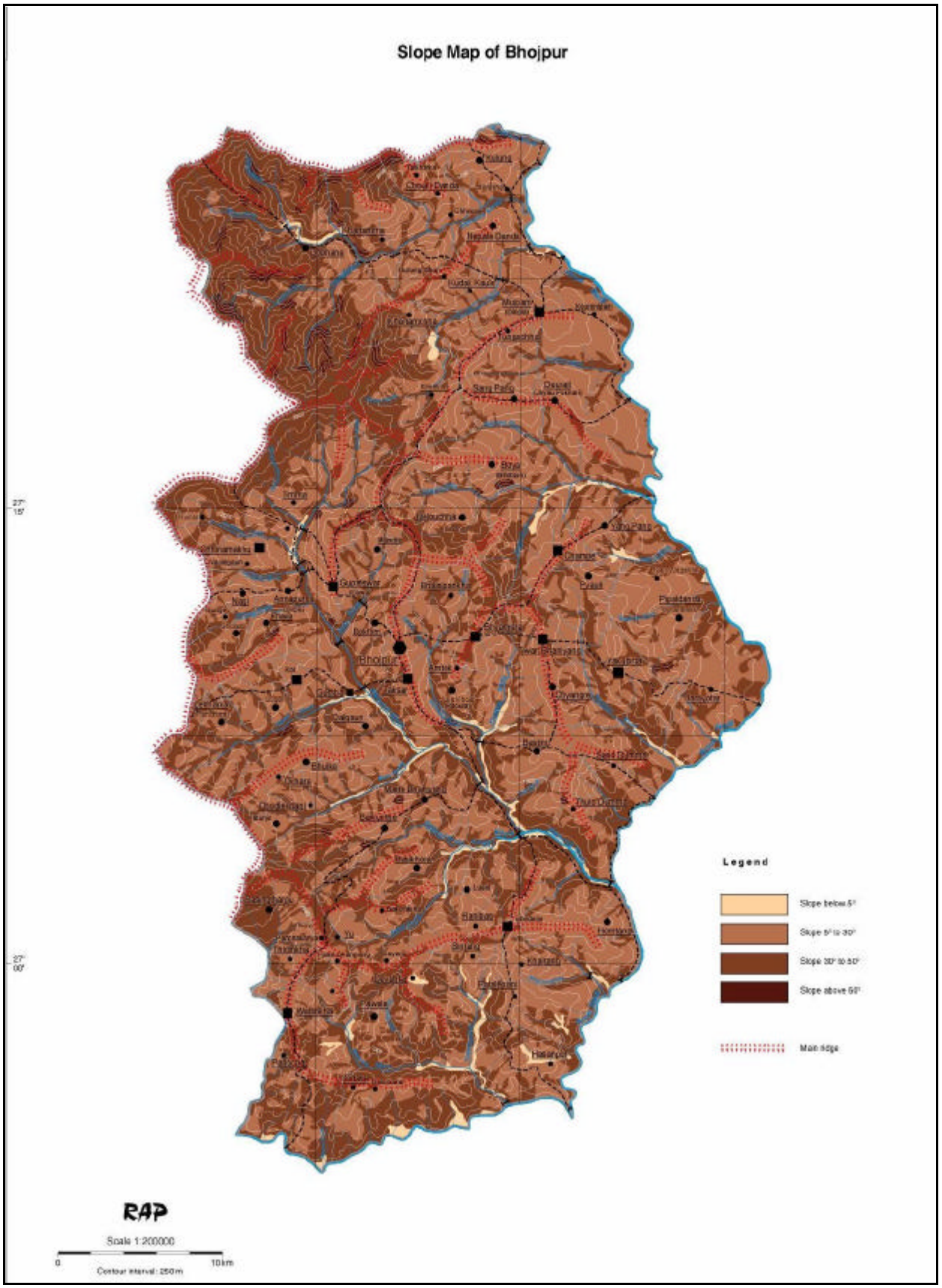
Soil type	Friction angle	Cohesion
Coarse alluvium	35^0	Non-cohesive
Fine alluvium	30^0	Non-cohesive
Colluvium	32^0 - 36^0	Non-cohesive
Residual	26^0 - 31^0	Slightly cohesive

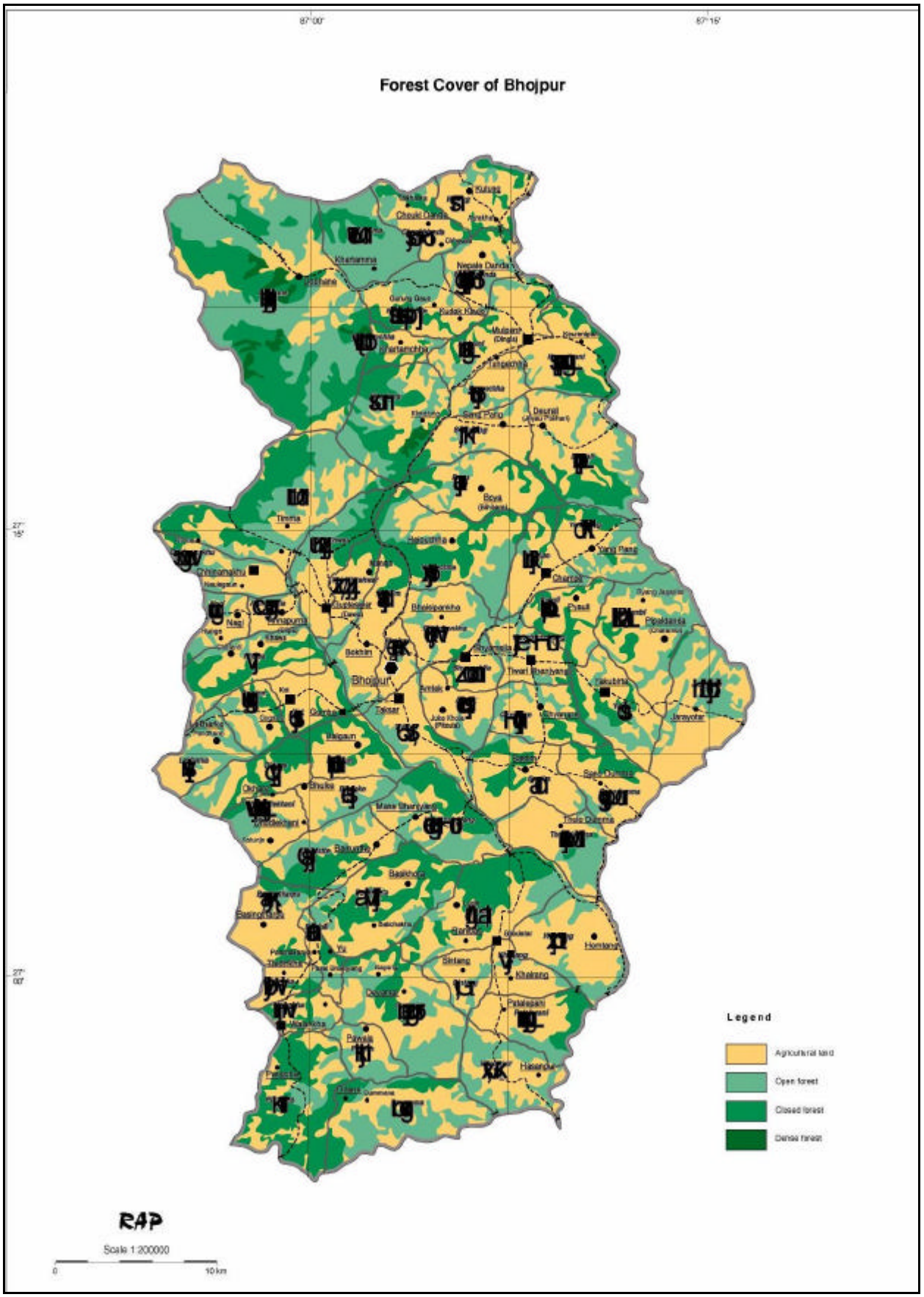
ANNEX IV: BHOJPUR MAPS

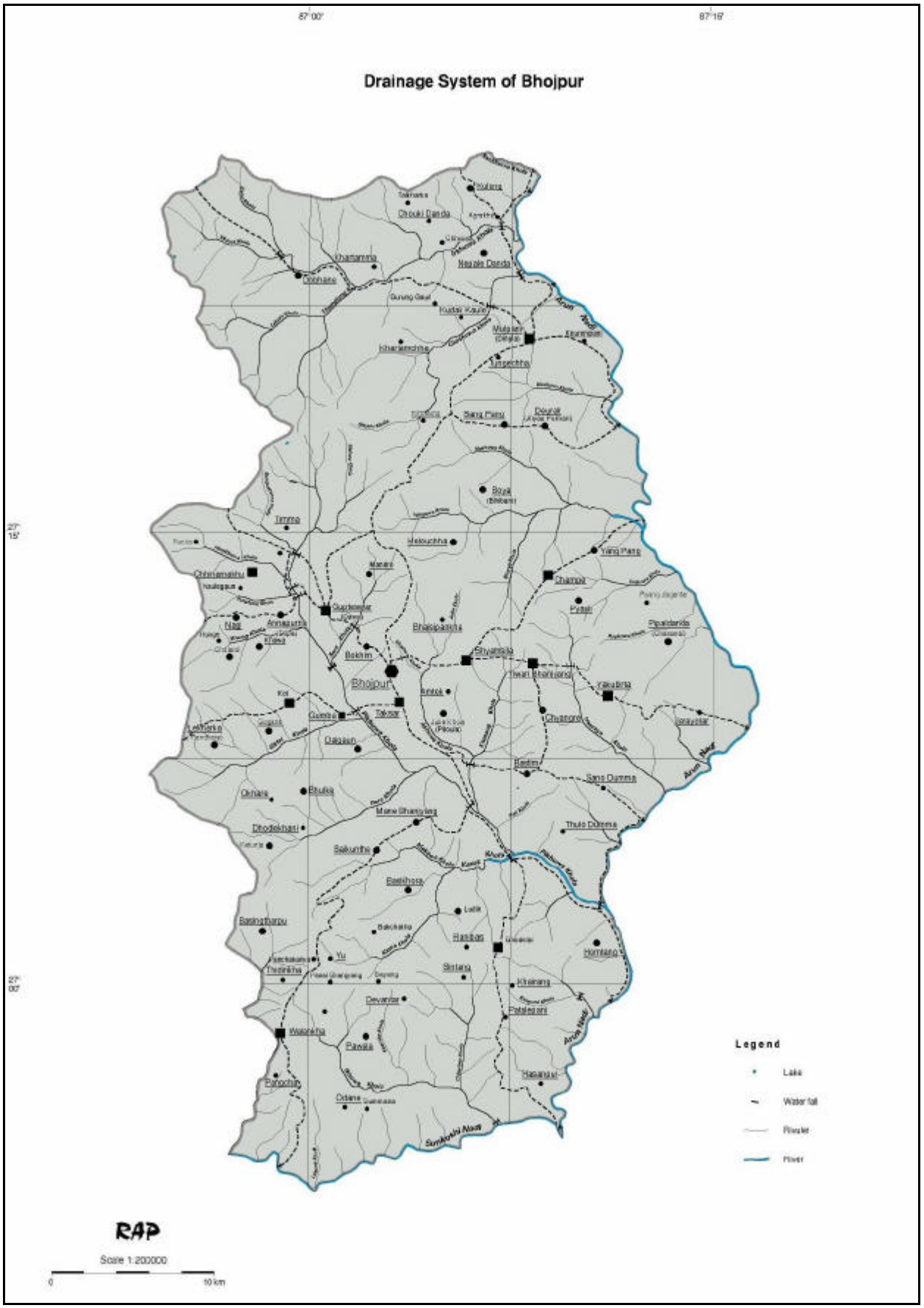


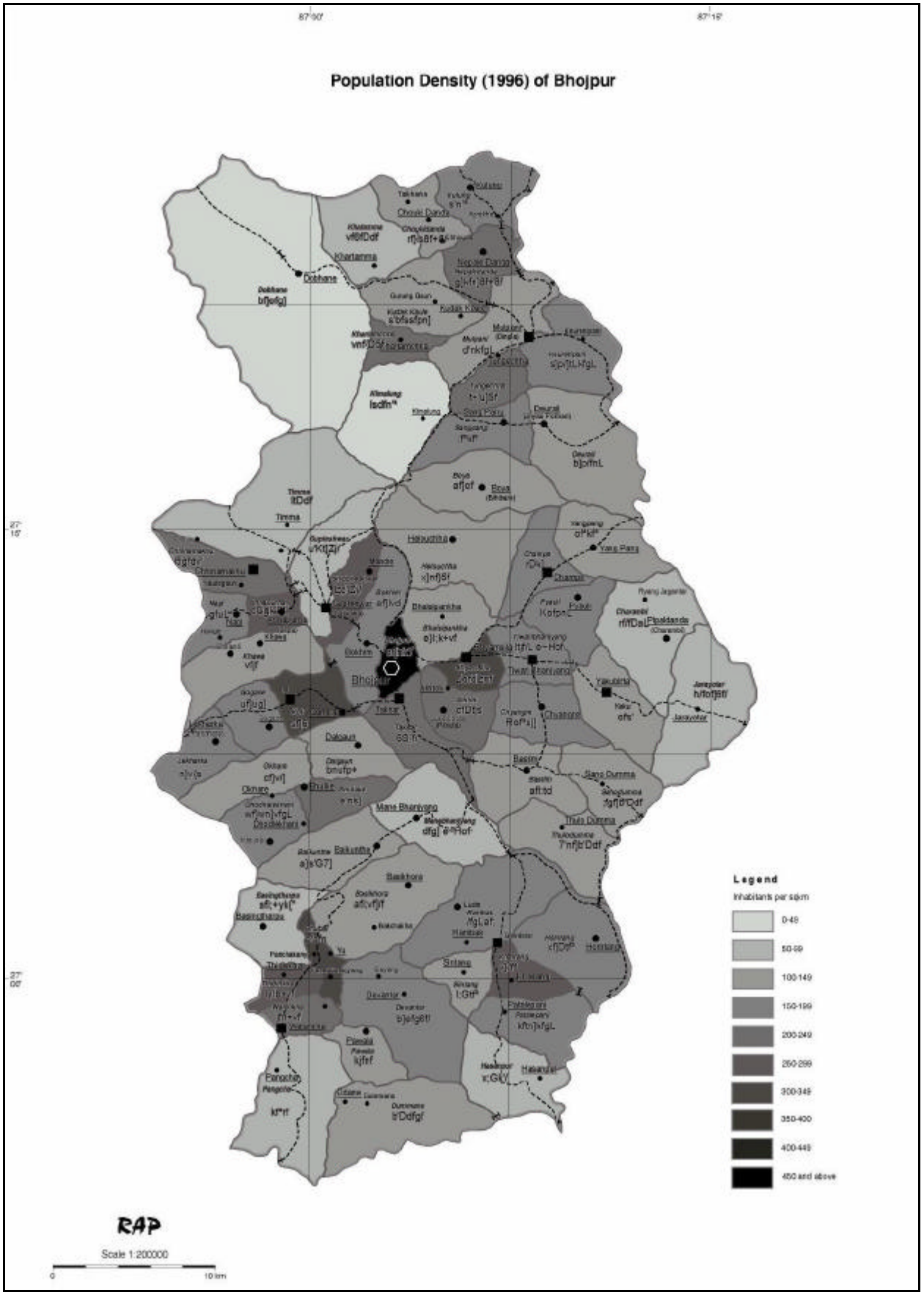

Climate of Bhojpur
Jiri 2003 m
Taplejung 1732 m
Biratnagar 72 m
Legend
Precipitation
Mean annual (1988-1998)
1000-1200 mm per year
1200-1400 mm per year
1400-1600 mm per year
1600-1800 mm per year
1800-2000 mm per year
2000-2500 mm per year
1400 mm per monsoon
250 highest in mm per day
Climate diagrams (data from 1992)
Monthly mean precipitation in cm
Monthly mean temperature in °C
Precipitation deficit during arid season
Altitude of climate-stations in m above sea level
Contour lines
3000-4000 m (sub-alpine)
2000-3000 m (cool temperate)
1000-2000 m (warm temperate)
below 1000 m (sub-tropical)
RAP
Scale 1:200000
0
10 km
87°00'
87°15'
27°
00'


Geological Map of Bhojpur
MAJOR GEOTECTONIC AND MORPHOTECTONIC UNITS OF NEPAL
CHINA
INDIA
General Symbols
District boundary
Lithological boundary
Attitude of bedding
Attitude of foliation
Lineaments
Synclinal, anticlinal axis
Thrust
Inferred thrust/fault
MBT Main Boundary Thrust
MCT Main Central Thrust
Mineral Resources (Cu-Copper, Mc-Mica, Be-Beryl, Te-Talc)
Contour line (interval 250 m)
Stream, river with gravel area
VDC boundary
Landslide/soil diff (length <250 m)
Landslide/soil diff (length 250 -500 m)
Landslide/soil diff (length > 500 m)
Rock cliff
Geological Formation
Legend
Description
Kathmandu Complex
Kulikhani Formation -Consists of fine-grained white quartzite, garnetiferous schist, micaceous schist, kyanite schist, and granitic gneisses. High quartz content schist and gneiss is more resistant to weathering and erosion whereas the micaceous schist and gneiss is not .
Kalitar Formation - Comprises of grey to steel grey garnetiferous muscovite biotite schist, feldspathic muscovite biotite schist with interbedding of quartzite and lenses of granitic gneiss and pegmatite. High mica content schist is potential for landslide and erosion.
Raduwa Formation and Bhainsedobhan Marble - Consist grey to greenish muscovite biotite schist with garnets, chlorite-muscovite schist, pink-fleshy-white-light brown quartzite and coarse-grained grey crystalline limestone and marble. The garnetiferous schist of the Raduwa Formation is more potential for weathering, erosion and landslide. Marble is physically strong.
Higher Himalayan Crystalline - Composed mainly of garnet-biotite gneiss with distinct banded structure. Fresh rock represents relatively stable area in the Bhojpur district. The steep slopes are prone to high rockslide and rock fall. Highly prone to landslide under weathered condition.
Granites - Medium to coarse-grained muscovite granite with intercalations of mica gneiss and schist. Tourmaline and Beryl present at many places. Prone to landslides under weathered condition only.
Nawakot Complex
Robang Formation - Mainly composed of greenish grey coloured chloritic phyllite with garnets and intercalation of grey quartzitic phyllite, quartzite, amphibolite and pockets of talc. Due to high quartz content, the phyllite of this formation is relatively stable for erosion, weathering and landslides.
Benighat Slate - Consists of grey to black slaty phyllite, phyllitic slate intercalated with limestone and calcareous slate. Slate covered area is more prone to weathering, erosion and landslide. Limestone beds are physically stronger.
Kuncha Formation - Comprises of grey greenish chloritic phyllite with bands of light brown fine-grained quartzite. Generally the bedrock is covered by soils due to the high weathering potentiality of phyllite.
Lesser Himalayan Gneiss - The most landslide prone area around Thuladurmma falls on this gneiss. Due to high mica content, lesser Himalayan gneiss is more potential for landslide and deep weathering.
RAP
Scale 1:200000
0
10 km


Slope Map of Bhojpur
Legend
Slope below 5°
Slope 5° to 30°
Slope 30° to 50°
Slope above 50°
Main ridge
Bhojpur
RAP
Scale 1:200000
0
10km
Contour interval: 250 m


Forest Cover of Bhojpur
87°00'
87°15'
27° 15'
27° 07'
Legend
Agricultural land
Open forest
Closed forest
Dense forest
RAP
Scale 1:200000
0
10 km


87°00'
87°15'
Drainage System of Bhojpur
27° 15'
27° 00'
Bhojpur
Legend
Lake
Water fall
Rivulet
River
RAP
Scale 1:200000
0
10 km


Population Density (1996) of Bhojpur
87°00'
87°15'
27°15'
27°00'
Legend
Inhabitants per sq.km
0-49
50-99
100-149
150-199
200-249
250-299
300-349
350-400
400-449
450 and above
RAP
Scale 1:200000
0
10 km