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## CHAPTER III

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### Study area

#### 3.1. Sikkim

The Himalaya is the youngest and structurally most complicated mountain system of the world that extends from the Indus in the west to the Brahmaputra in the east measuring about 2500 km in length and width ranging from 240 to 340 km. It has a great variation in eco-biogeography, giving rise to different eco-climatic zones that harbours a large number of biological wealth. India is one of the 12-megadiversity countries in the world with 45,000 species of plant (the total may be closer to 60,000 as several parts of India are still unexplored) and 81,000 species of animal with about 400,000 un-described organisms (Anonymous 1998, Khoshoo 1991, Mohan Ram 2000). Out of the 18 biodiversity *Hotspots* that feature exceptional concentration of species with high level of endemism and faced exceptional threats of destruction, two are located in India. Of these, 'Eastern Himalayas' is one of the two such *Hotspots* of India (Myers 1990).

The Eastern Himalaya is considered as the stretch of extremely rugged mountains between 26°30' to 28° north latitude and 87° to 97°30' east longitude. It covers the area between Singalila Ridge in the west to eastern part of Arunachal Pradesh

including Bhutan. The region supports a wide biodiversity due to complex physiography, bioclimatic zonations and their location at the convergence of the Palaearctic and Oriental Zoogeographical Realms (Ives & Messerli 1989).

Sikkim is a small Indian state, belonging to the Eastern Himalaya. It is situated at the western edge of the Eastern Himalaya that falls between 27°4'46" to 28°7'48" north latitude and 88°58" to 88°55'25" east longitude covering an area of 7,069 sq km. Nepal encircles it in the west, Bhutan and Chumbi Valley of Tibetan Autonomous Region of the People's Republic of China in the east, Darjeeling Gorkha Hill Council of West Bengal in the south and Tibetan plateau of Tibetan Autonomous Region of the People's Republic of China in the north. The abounding forest of Sikkim exhibits bewildering diversity of plants and animals with 43% forest covering (Anonymous 1994). About 29% of the total geographical area of the state is reserved as protected areas with one Biosphere Reserve and five Wildlife Sanctuaries. Tista and Rangit are the two main rivers of the state.

### **3.2. Khanchendzonga Biosphere Reserve**

Khanchendzonga Biosphere Reserve (KBR) lies in northwestern part of Sikkim (Fig. 3.1). Owing to high possession of flora and fauna, Khanchendzonga National Park (KNP) was commissioned

on 26<sup>th</sup> August 1977 with an initial area of 850 sq km. This was later expanded to 1784 sq km in May 1997 on account of its intact continuous tract of mountain land reserved for conservation of native wildlife with many rare and endangered species (Lepcha 1997). The park occupied as much as 25.11% of the total geographical area of the state with a range of elevation from 1829 to 8550 m amsl. Recently, on 7<sup>th</sup> February 2000, the Ministry of Environment and Forests, Government of India notified KNP as Biosphere Reserve. The erstwhile KNP area came under conservation management category II with a National Geographical Province 2.38.12, covering Himalayan highlands (Sharma 1997). The newly notified KBR area includes settlement at Bakhim and Tshoka within the conservation area. Other settlements such as Sakyong, Chungthang, Menshithang, Lachung, Monguthang and Yuksam surround the area. Yuksam, a major settlement, and Yuksam-Dzongri trekking corridor within KBR have been the focus area for the present study, which come under the most popular tourism destination in Sikkim (Fig. 3.2).

### **3.3. Yuksam and Yuksam-Dzongri trekking corridor**

Sikkim, as a whole, is considered to be sacred by the Sikkimese Buddhists. The cultural fabric of the Sikkimese society is dependent on the conservation of the entire sacred landscape of the interacting ecosystems. According to the sacred text "Neysol",

the area below Mount Khanchendzonga in West Sikkim (*De-mo-dzong* or present Yuksam) is the most sacred of all, being the abode of the Sikkimese deities. The air, water, soil and biota are all raised to the people of Sikkim, because of their interconnection that are perceived to exist between them (Ramakrishna 1996).

Yuksam-Dzongri trekking corridor of west district (Fig. 3.2), the major trekking trail of Sikkim, is unique of its kind. This corridor is a stretch of forest that lies between two destinations that is Yuksam and Dzongri. The term 'corridor' was used following definition provided by Nicholls & Margules (1991) as "a narrow strip, stepping steps of hospitable territory traversing inhospitable territory providing access from one area to other". The corridor is 26 km long in distance from temperate to alpine zone and passes through Sachen, Bakhim, Tshoka and Phitang (Fig. 3.2). Its diverse tropical mixed broad-leaved forest, sub-alpine conifer-rhododendron forest, alpine meadows, cascading streams, sacred lakes, a wide variety of birds and flowering plants and panoramic view of the World's third highest mountain Mount Khanchendzonga provides all kinds of joy to the tourists. Ultimately the trail leads to Goecha La, a paradise of panoramic view of Mt Khanchendzonga surrounded by Mt. Pandim, Mt. Kabur, Mt Narsing and many other snow-capped mountains. Heterogeneity in culture and tradition, rich biodiversity, scenic

beauty and historic religious places like Norbu Gang and Dubdi Monastery (Plate 5) have made this area an attractive place for tourists. Ecologists and environmentalists, earth scientists and nature lovers, botanists and zoologists, all are equally fascinated.

### **3.4. Physical features**

#### ***3.4.1. Location and topography***

Yuksam and Yuksam-Dzongri trekking corridor have been selected for the present study. Yuksam, a settlement and Yuksam-Dzongri trekking corridor lies within the KBR in the west district of Sikkim. The area extends from 27°19'13" to 27°29'4" north latitude and 88°9'18" to 88°15' east longitude (Fig 3.1). Yuksam village (Plate 1), a base for the trekkers and trailhead and the trail upto Dzongri in the KNP was designated as tourism zone (Lepcha 1997).

The corridor lies along the extensive forest areas with many pristine patches. Tshoka and Dzongri are situated at the ridge lifted out from Onglathang and Tekep La valleys (Plate 1). These two valleys nurture two main tributaries merging into Rathong River, which is one of the two main rivers of Sikkim. The general slopes of this corridor have directions from southwest, southeast and northwest. The area has diverse altitudinal variation starting from 1780 m (Yuksam) to 4000 m (Dzongri). A rise in altitude

along the trail is mild upto Prek Chu and it increases abruptly thereafter. The rock is chiefly made up of Darjeeling Gneiss and comprised of high-grade gneiss containing quartz and feldspar with streaks of biotite (Geological Survey of India, 1984).

### 3.4.2. *Climate*

Climatic data (rainfall, temperature and humidity) were collected at three locations namely at Yuksam (1780 m), Tshoka (3000 m) and Dzongri (4000 m) during the study period (1997-99). The data revealed that temperate conditions prevailed at Yuksam, sub-alpine at Tshoka and alpine at Dzongri. The climate is moist, rain occurs almost round the year and divisible into three season viz., rainy (June to September), winter (October to February) and mild summer/spring (March to May). Mean annual rainfall was highest at Yuksam (3760 mm) followed by Tshoka (3648 mm) and Dzongri (2312 mm). At Yuksam, in an average 85% of annual rainfall occurred during the rainy season (Fig. 3.3). Similarly, at Tshoka it was 87% and at Dzongri 90.2%.

Minimum temperature of -3°C, 8°C and 4.4°C were recorded respectively at Dzongri, Tshoha and Yuksam in January. Summer temperatures at these halting places were mild ranging from 20°C to 24°C at Yuksam, 15°C to 16°C at Tshoka and 11° C to 13°C at Dzongri. The study area remained humid throughout year with

>90% humidity during the rainy season (Fig. 3.3). Great variation of temperature was observed along the corridor even on the same day due to extensive physiographic differences. The trail is unique that start from temperate climate passing through sub-alpine and reaching alpine zone in its 26 km stretch.

### 3.4.3. *Vegetation types*

Floristic wealth of the trekking corridor is rich and diverse, both in composition and value. Forests represent a variety of plant communities that include diverse vegetation types corresponding to variation in climate and edaphic factors. According to classification by Champion & Seth (1968), the area broadly comes under the sub-type 11b of northern montane temperate forest type and the group 12 of Himalayan moist temperate forest, sub-alpine scrub and pasture land. The corridor broadly has three forest types viz., temperate forest (1780-2730 m amsl), mixed conifer forest/sub-alpine (2730-3650 m) and alpine scrub and grasses (above 3650 m). Temperate broadleaf forest (Plate 2) is represented by *Quercus* spp, *Castanopsis* spp, *Acer* spp., *Juglans regia*, *Machilus edulis*, *Cinnamomum* spp. associated with *Rosa* sp., *Rubus* spp., *Berberis* sp. and *Viburnum* sp. as shrubs. There are a few patches of relatively pure stands of oak (*Quercus lamellosa*) with dense under storey of *Viburnum cordifolia*, *Eurya acuminata* and *Symplocos ramosissima* with mosses and epiphytes. Major part of the trekking

corridor has mixed type of vegetation with well-marked strata of tree layers of different species. *Q. lamellosa* and *C. tribuloides* are the top canopy layer trees followed by *M. edulis*, *Acer* sp. and *S. ramosissima*. The range of forest at higher elevation of temperate belt has broad leaf tree species such as *Magnolia* spp, *Quercus* spp, and *Acer* spp. Some areas have pure top canopy stands of *Magnolia* associated with second storey species like *Rubus* sp, *E. acuminata* and tall forms of rhododendrons.

In mixed coniferous forest, the lower elevation range of sub-alpine belt is dominated by Himalayan hemlock (*Tsuga dumosa*) mixed with rhododendrons and *Betula*. As the elevation increases, the hemlock is replaced by silver fir (*Abies densa*) with dense undergrowth of rhododendrons associated with *Viburnum*, *Daphne* and *Eurya*. Most part of the forests have *A. densa* as dominant species, attaining height of 30-40 m with luxuriant undergrowth of rhododendrons (Plate 2). This forest is extensive with more species of rhododendrons at elevations above 3400 m.

Above 3650 m in the alpine condition (Plate 1), tree growth is completely arrested with bushy vegetation of xeromorphic species. A few stunted bushy species of rhododendrons mixed with tough clumps of *Juniperus.*, *Berberis* and *Rosa* are common. Dzongri (4000 m) gives clear picture of dry alpine pasture (Plate 1). The vegetation in this zone is practically of scattered scrubs, often

barren at higher elevation. Most of the species are stunted, thorny and scrub type. Two most dominating genera are *Juniperus* and dwarf forms of rhododendrons. The wide flattened area within the altitudinal range from 3800 to 4400 m represents alpine meadows with *Cyperus*, *Potentilla*, *Juniperus* and also comprising of a wide variety of flowering plants. Further above, areas are with completely arrested growth of vegetation and often-barren rocky cliffs. Most of these areas are covered by snow perpetually.

#### 3.4.4. *Wildlife*

Documentation of wildlife in the Sikkim Himalaya has not been updated after the works of Ali (1989) for birds, Avasthe & Jha (1999) for mammals and Haribal (1992) for butterflies. A wide variety of wildlife, including many threatened and endangered species inhabit KBR (Lepcha 1997). Some of these are shown in Plate 3. Incidental animal sighting records by the villagers have mentioned at least 19 species of noted wildlife, including endangered species such as snow leopard, red panda, musk deer and few rare and endangered birds (Table 3.1). According to villagers, commonly sighted animals in the area are Himalayan barking deer, Himalayan black bear, ghoral, clouded leopard and leopard cat. Other than these, Wildlife Section, Department of Forest, has reported Shapi from high altitude areas of KBR (Lachungpa, personal communication) and Lepcha (1994). Wildlife

reports on KNP have brought about the presence Kiang (*Equus kiang polyodon*) and many rare and endangered species (Ganguli-Lachungpa 1994, Lepcha personal communication).

Yuksam-Dzongri trekking corridor houses a wide variety of bird species (Appendix A). The most common birds are bulbuls, warblers, magpies and thrushs. The state bird of Sikkim 'blood pheasant' was also recorded from the trail area. Rare birds like Satyr tragopan and monal were confirmed with sightings at about 2500 m on the way to Dzongri (Table 3.1). Some of the less sighted bird species at temperate locations are whitetailed nuthatch, Nepal parrotbill, redtail minla, spectacled barwing, Himalayan snowcock, eastern solitary snipe, yellowbellied fantail flycatcher, Nepal cutia, sultan tit etc (Appendix A).

#### ***3.4.5. People and their livelihood options***

Sikkim is unique in its cultural heterogeneity. Many distinctive ethnic groups with their exclusive tradition and culture live in harmony. Lepchas are the aboriginal race of Sikkim (Plate 4). They are short people with fair complexes and charming face. They have culture and traditions of their own. Basically hunting and gathering are their tradition and have been living in the wild for ages. This way of life has enriched their knowledge on indigenous flora and fauna. They have their own nomenclature for

almost all the flora and fauna of the locality. Bhutias are another ethnic race living in Sikkim (Plate 4). Buddhism is their religion and they follow different culture and traditions. Worship in Monastery is typical for the race. Another race is the Nepali, who arrived the province in late nineteenth century. Majority of Nepalis are Hindus and are dominant group representing 70-75% of the total population of Sikkim. They brought agriculture as their tool for livelihood and settled in different areas.

#### *3.4.5.1. Community composition*

A mixture of ethnic groups inhabits Yuksam. Literarily, ethnics of Sikkim are Lepchas, Bhutias and Nepalis. The dominant races in the Yuksam area were Nepalis with higher proportion of Subbas, followed by Bhutias, Lepchas and Tibetan Refugees who live mainly at Tshoka. Firewood, fodder and timber collections, interior forest grazing, non-timber forest produce (NTFP) collection and leaf litter collection for farm use are common practices among these ethnic groups (Plate 4). Beside these, tourism has been increasing in the area at rapid rate and more people are engaged in this profession.

Yuksam has 12 settlements including Tshoka with 274 families and 1572 population. Yuksam, with mixed ethnic groups, is the biggest settlement having 55 households with a population of 293

individuals (Table 3.2). This is followed by Tshong and Khongtay in which Nepalis are the dominant group. One settlement with 9 families resides at Tshoka on the trail occupying 13 ha area in the KBR. About 51% of the total households are dependent on forest found along the trail.

#### **3.4.5.2. Livelihood**

Primary occupation of the communities in the study area is farming while some are associated with tourism enterprise in the form of lodge operators, porters, yak men, cooks and naturalist guides. More than 81% of the inhabitants are engaged in agriculture. Involvement in government sector as a service holder accounts only 3% of the total population. Tourism, being secondary but substantial source of income for the local community, this sector bears extensive burden on the utilisation of natural resources of the area. About 15% of the total population of this area are involved in tourism sector (Maharana 1997-98, personal communication). Annually, about 2000 domestic as well as foreign tourists visit this corridor. More than 150 support staff, 140 Dzogs (cross of cow and yak) and a dozen of horses are engaged in the corridor on an average of six times a year. Moving from one locality to another with yak and sheep herd is a traditional profession of some locals (Plate 5). Himalayan Mountaineering Institute (HMI) trainees also use locals as support staff and a large

number of pack animals engaged generate additional income for the locals (Plate 5).

#### 3.4.5.3. *Land use and land holding*

Land use demarcation along the corridor (Fig 3.4), estimated from Survey of India topo-sheets (1:50,000) and IRS-IA LISS II satellite data of 1988, shows that about 79% of corridor area is covered with forest. About 24% of the forest cover has been found as dense forest, 25% open forest, 45% degraded and pure rhododendrons, alpine scrubs and forest blank account for about 6%. Higher proportion of open forest and degraded land was recorded in temperate region compared to alpine region. Historically, Yuksam has been known as *Dema-zong*, meaning the land of paddy. Earlier, extensive areas were under paddy cultivation. In recent years more sustainable practice of large cardamom cultivation in agroforestry systems has replaced paddy fields. Based on Land Revenue Department record (1988) of 204 households, land possession and land holding size of different ethnic groups showed that 47% land belongs to Nepali community (Limbu, Chettri and Gurung) among 114 households. Bhutias, with 53 households had 37% and Lepcha with 37 households occupy only 15% land. It has been noted that about 3% of agricultural land are paddy field compared to 15% cardamom cultivation in agroforestry. Bhutias on an average have the highest landholding

size (4.54 ha per family), followed by Nepalis (2.62 ha per family) and the lowest by Lepchas (2.59 ha per family).

#### 3.4.5.4. *Livestock*

Income of the Yuksam people mostly comes from composite source of agriculture, horticulture, tourism and animal husbandry. Livestock rearing was mainly done to produce milk, meat, manure, cheese and to use as pack animals along the trekking corridor. The animals include cattle (26%), goat (18%), sheep (7%), dzo (7%), yak (3%), horses (1%) and pigs (15%) in the study area (Table 3.3). Livestock size depends upon the farm size, family size and involvement in tourism. The collected data on livestock reveal that more number of sheep belonged to Gurung community, and yak and Dzo to Tibetan refugees and Bhutias.

In the recent years (1996-1998), the number of cattle, sheep and dzos has increased by 85%, 5%, and 27%, respectively (Table 3.3). This attributes to growing tourism activities in the area in which these animals provided high economic benefits to the local people. On the other hand, the number of yaks, horses and pigs decreased by 6%, 29% and 5% respectively (Table 3.3). Horse number has decreased substantially as this is not a suitable pack animal at high altitude trekking compared to Dzoes whose number has increased.

### 3.5. History

The aboriginal inhabitants of Sikkim are the Lepchas. Their origin is obscure, due to lack of documentation on their entity in Sikkim. It was thought that they migrated to the present abode along the foothills of Himalaya from the east and not from Tibet across this range (Dozey 1989). The Lepchas (Plate 4) with small clans came under the protection of the descendent of Khye Burmsa who lived in Sikkim sometime in the 13<sup>th</sup> century.

Buddhism is the state religion and introduction of Buddhism among the Lepchas in Sikkim certainly dates back to Lha-tsum's arrival, about in the middle of the seventeenth century AD (Foning 1991). The next race to enter Sikkim was the Tibetans, who came over in two waves. The first hailed from Tibetan monasteries of Sakya and Ralung and settled as ruling race, and is now dominating over the effeminate Lepchas. Due to the unrest going on in Tibet, the followers of the Nyingma sect have fled south towards Sikkim. The prominent saints who came to Sikkim in the 17<sup>th</sup> century were Lama Lhatsun Chempo, Gnadak Rinzing Chempo and Kathok Sempa chempo. 'Yuksam' was a meeting place of these learned monks who came to Sikkim from three different directions with an intention to establish Buddhism. These monks searched a fourth person as vision by Padma Sambhava and were brought to Yuksam and was consorted as the religious

king of Sikkim in 1642 at Norbugyang (Plate 5) with the title of "chogyal" meaning "the king who rules with righteousness or dharma raja". The construction of Dubdi monastery (Plate 5) also took place someway around the same time. The Lama and the local people of Sikkim and Tibetans implicitly believe that Saint Padma Sambhava (Guru *Rim-bo-che*), found Sikkim during his journey to Tibet and personally consecrated every sacred spot including Yuksam in Sikkim (Waddell 1993).

Yuksam is an area, which the people of Sikkim perceive as the very basis of their present culture. Padma Sambhava, who is highly revered and worshiped by the Sikkimese Buddhists is considered to have blessed Yuksam and surrounding landscape, by having placed within it a large number of hidden treasures *ters* and it is believed that (*ters*) will only be slowly revealed to enlighten Lamas and discovered at appropriate time. Yuksam region is considered to have 109 hidden lakes. Both the visible and less obvious notional lakes identified by religious visionaries are said to be presiding deities, representing good and evil. Propitiating these deities with different ceremonies is considered to be the path for conservation in all respects (Ramakhrisnan 1996). Conserving and protecting these treasures from polluting and disturbing influences is considered to be vitally important for

human welfare. Any major disruption to the river system would disturb the entire system of the area.

Later, the yak and sheepherder used the Yuksam-Dzongri corridor and Dzongri pasture for grazing. Since 1960s, the Himalayan Mountaineering Institute (HMI) started to use the trail for basic and advance training in Rathong Glacier. Later, a nine-house Tibetan settlement established at Tshoka in the late 1960s. The magnificently diverse landscapes and rich cultural heritage of Sikkim have contributed to rapid growth of adventure tourism since 1990. After relaxation of government rules, there has been a tremendous increase in visitor number to this small trekking corridor causing disturbances to both physical environment and biological resources (Rai & Sundriyal 1997).

Table 3.1. Important wildlife of Yusam-Dzongri corridor reported by the community of Yuksam and their threat categories from IUCN data.

Common Name	Scientific Name	Ecological zone	Local name	Schedule/ part	Status
Barking Deer	<i>Muntiacus muntjak</i> Zimmermann	ST	Ratwa	III	T
Bharal	<i>Pseudois nayaur</i> (Hodgson)	AL	Nervati	I	V
Clouded leopard	<i>Neofelis nebulosa</i> Griffith	ST	Nigalay Chituwa	I	E
Common Langur	<i>Presbytis entellus</i> Dufresae	TE	Hanuman Bander	II/1	C
Ghoral	<i>Nemorhaedus goral</i> Hardwicke	TE	Himal ko goral	III	R
Great tibetan sheep	<i>Ovis ammom hodgsoni</i> Blyth	AL	Tibet ko Bheran	I	E
Hill fox	<i>Vulpes v. montana</i> Linn.	AL			
Himalayan Black Bear	<i>Selenarctos thibetanus</i> (Cuvier)	TE	Konthe Bhalu	II/2	V
Himalayan thar	<i>Hemitragus jemlahicus</i> Smith	AL	Thar	I	E
Himalayan yellow throated marten	<i>Martes flavigula</i> Boddaert	ST		II	E
Indian porcupine	<i>Hystrix indica</i> Kerr	ST	Dumsi	IV	C
Indian wild pig	<i>Sus scrofa</i> Linn.	ST	Bandel	III	IK
Marbled Cat	<i>Felis marmorata</i> Martin	TE	Jungali Biraloo	I	E
Musk deer	<i>Moschos charysogaster</i>	AL	Kasturi	I	E
Orange belled squirrel	<i>Dremomyths lokhriah</i> Hodgson	ST	Lotharkay	IV	C
Red Panda	<i>Ailrus fulgens</i> Cuvier	TE	Kudo	I	E
Serow	<i>Capricornis sumatraensis</i> (Bechstein)	AL	Thar	I	V
Snow leopard	<i>Uncia uncia</i> Schreber	AL	Semu	I	E
Tibatan wolf	<i>Canis lupus</i> Chanko	AL		II/2	V

Contd...3.1

Birds: Common name	Species	Ecological zone	Local name	Schedule/part	Status
Blood pheasant	<i>Ithagenus cruentus</i> (Hardwick)	AL	Chilimen	I	V
Crimson horned pheasant	<i>Tragopan satyra</i> (Linn.)	AL	Daphe	I	R
Forest eagle owl	<i>Budo nepalensis</i>	ST	Lat Kusyal	I	E
Himalayan golden eagle	<i>Aquila chrysaetos daphanea</i>	AL	Sunaulo Giddha	I	E
Lammergeier	<i>Gypaetus barbatus</i>	AL	Budo Giddha	I	E
Monal pheasant	<i>Lophophorus impejanus</i> (Latham)	AL	Monal	I	E
Snow partridge	<i>Lerwa lerwa</i>	AL	Larewa		T
Snow pigeon	<i>Columba leuconata</i>	ST			T
Sparrow hawk	<i>Accipiter niscus</i>	ST		I	E
Tibetan snowcock	<i>Tetraoalpus tibetanus</i>	AL		1	E
White breasted dipper	<i>Cinclus cinclus</i>	AL		I	R

AL = alpine, ST = sub-tropical, TE = temperate, E = endangered, V = vulnerable, T = threatened, C = common, R = rare

Table 3.2. Settlement wise households and population in the Yuksam – Dzungri trekking Corridor

Settlements	Number of Households	Total Population
Tshoka*	9	57
Geychen *	18	120
Norbugang*	21	122
Khongtay*	38	242
Yuksam*	55	293
Kopchey	12	67
Mantabong	22	138
Tshong	42	171
Topsing	21	135
Gufa Danra	6	35
Dostang	12	78
Mangsabong	18	114
<b>Total</b>	<b>274</b>	<b>1572</b>

\* Settlements dependent on corridor forest for resources

Table 3.3. Livestock numbers during 1996-1998 in Yuksam and Yuksam-Dzongri trekking corridor.

Livestock	Years			Increase (%)
	1996	1997	1998	
Dzo	96	101	122	27
Yak	83	70	78	-6
Horse	31	31	22	-29
Cattle	245	267	454	85
Goat	361	399	311	-14
Sheep	441	435	461	5
Pig	273	254	260	-5
<b>Total</b>	<b>1530</b>	<b>1557</b>	<b>1708</b>	<b>63</b>

# LEGENDS

-  Core zone
-  Buffer zone

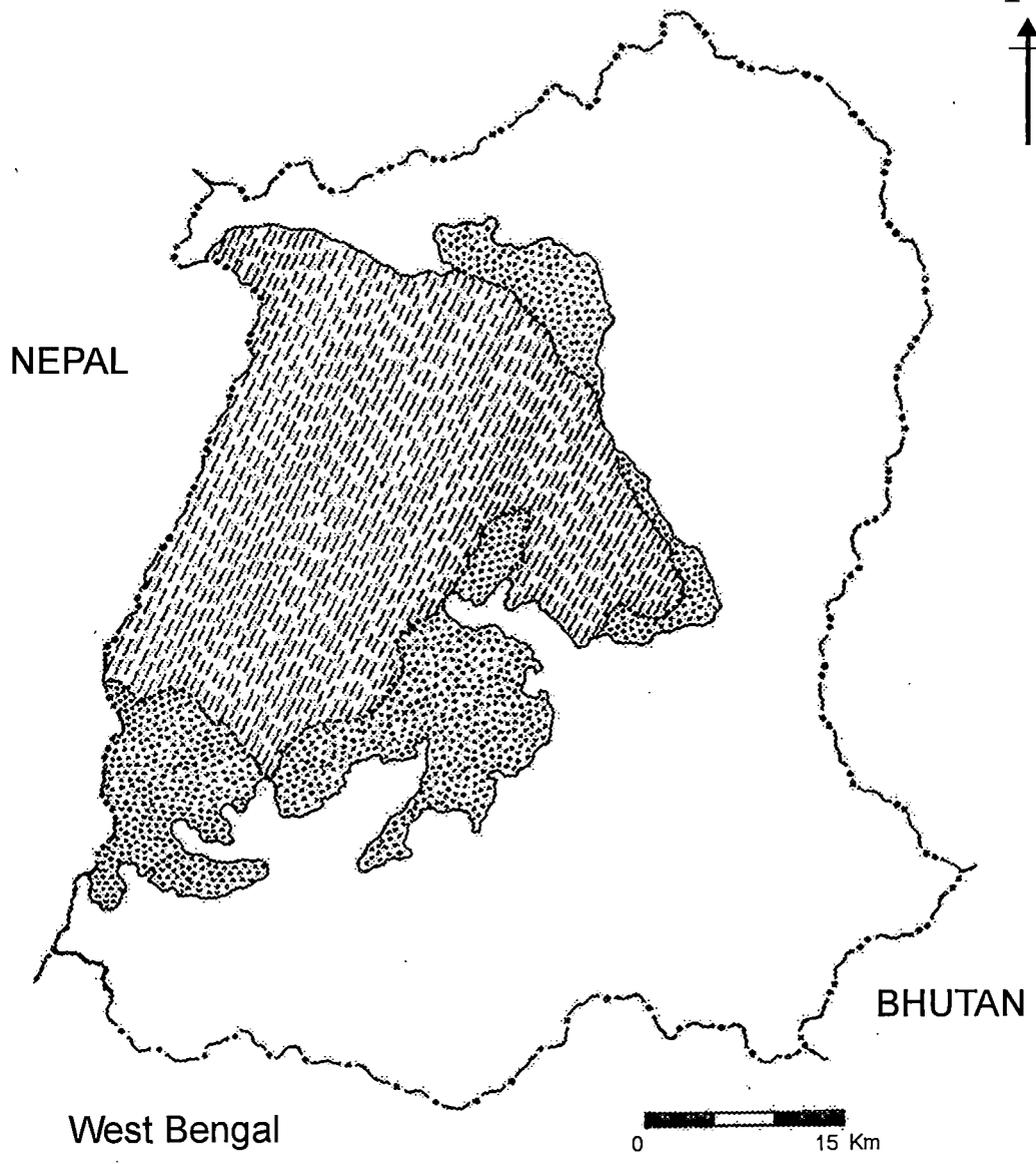


Fig. 3.1. Location map showing the Khanchendzonga Biosphere Reserve in Sikkim

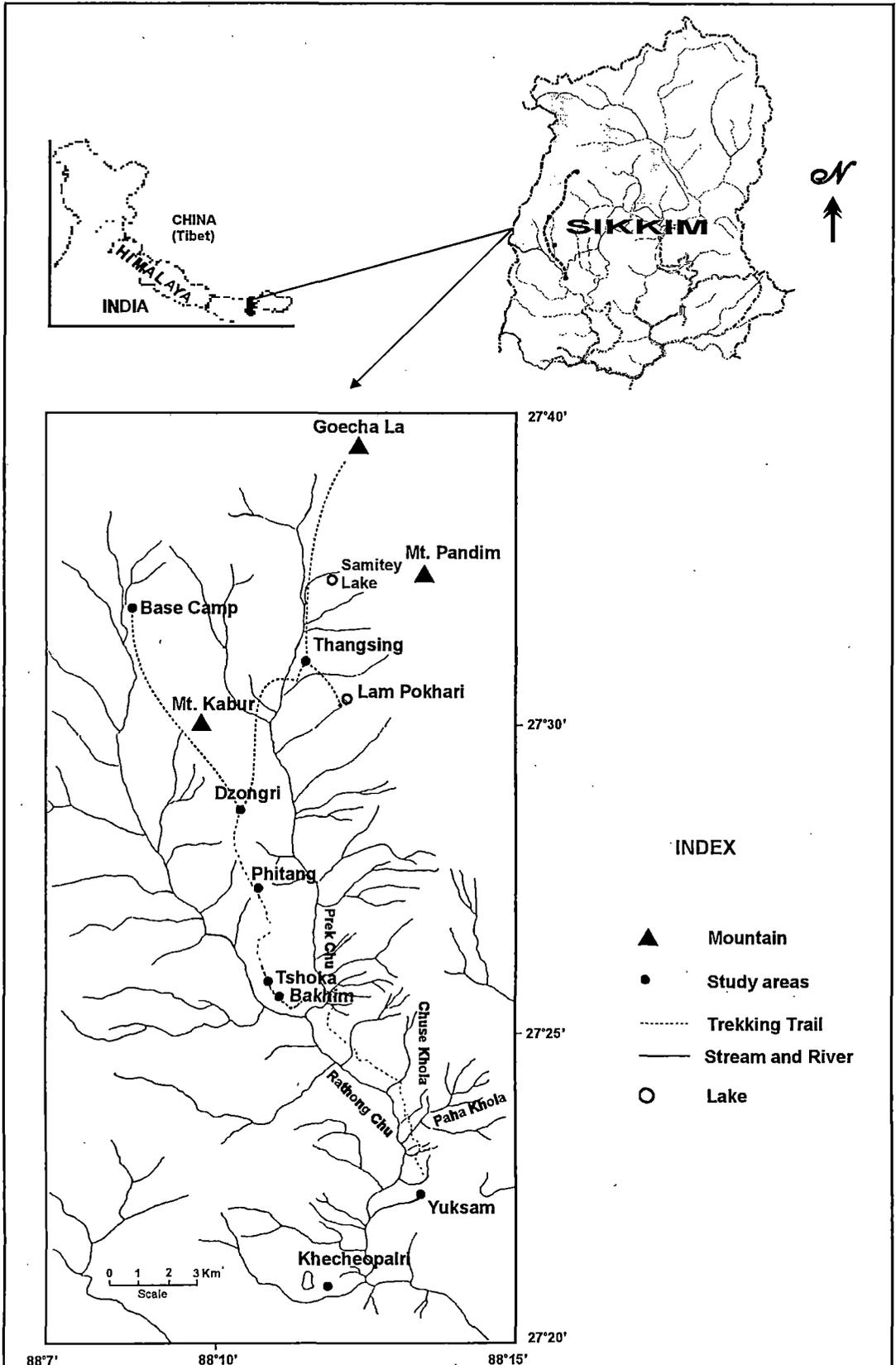
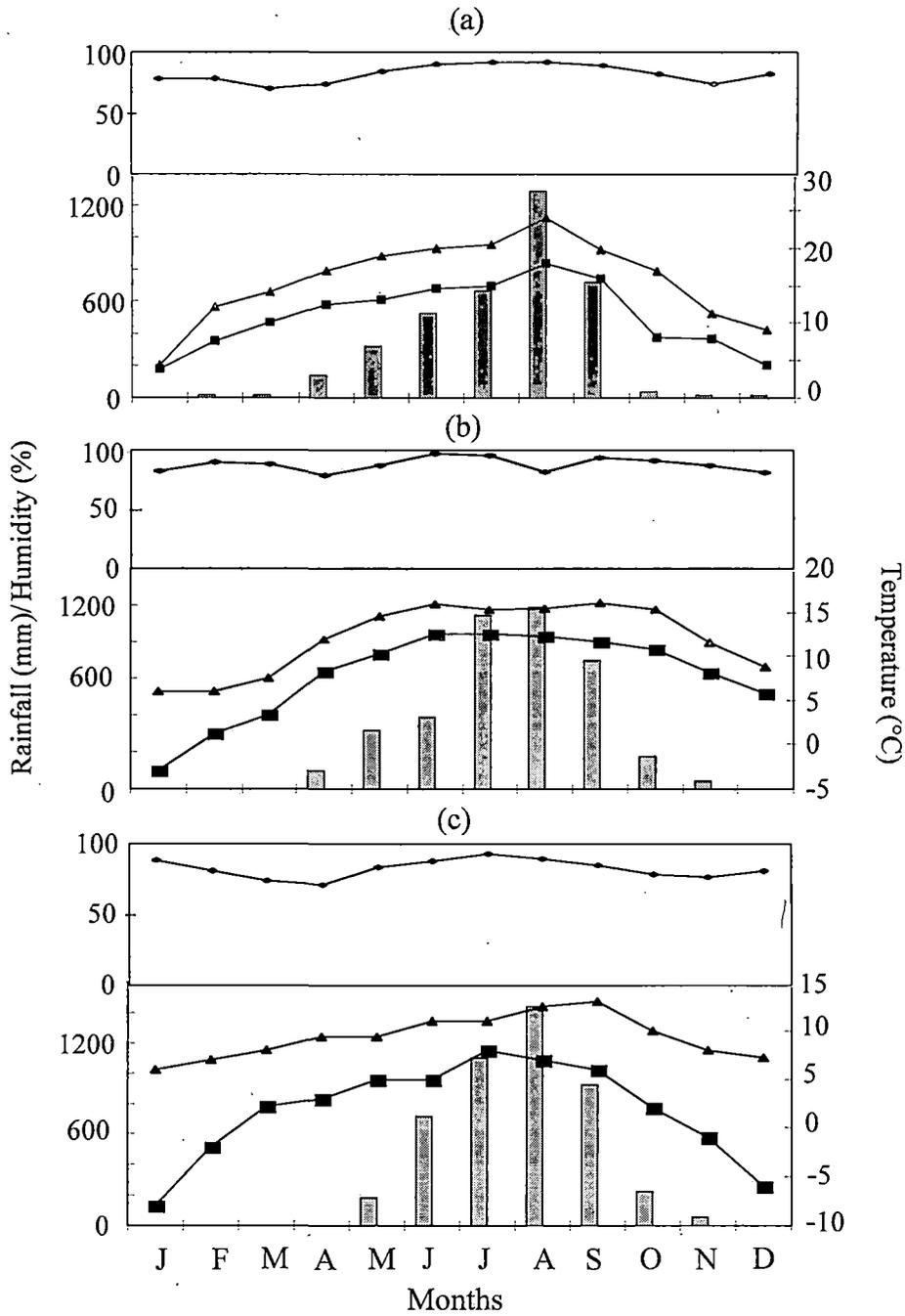


Fig.3.2. Location map of Yuksam-Dzongri trekking corridor in the Khanchendzonga Biosphere Reserve



Rainfall
  Minimum temperature
  Maximum temperature
   
 Humidity

Fig. 3.3. Temporal variation of temperature, rainfall and humidity at three major halting places (a = Yuksam, b = Tshoka, c = Dzongri).

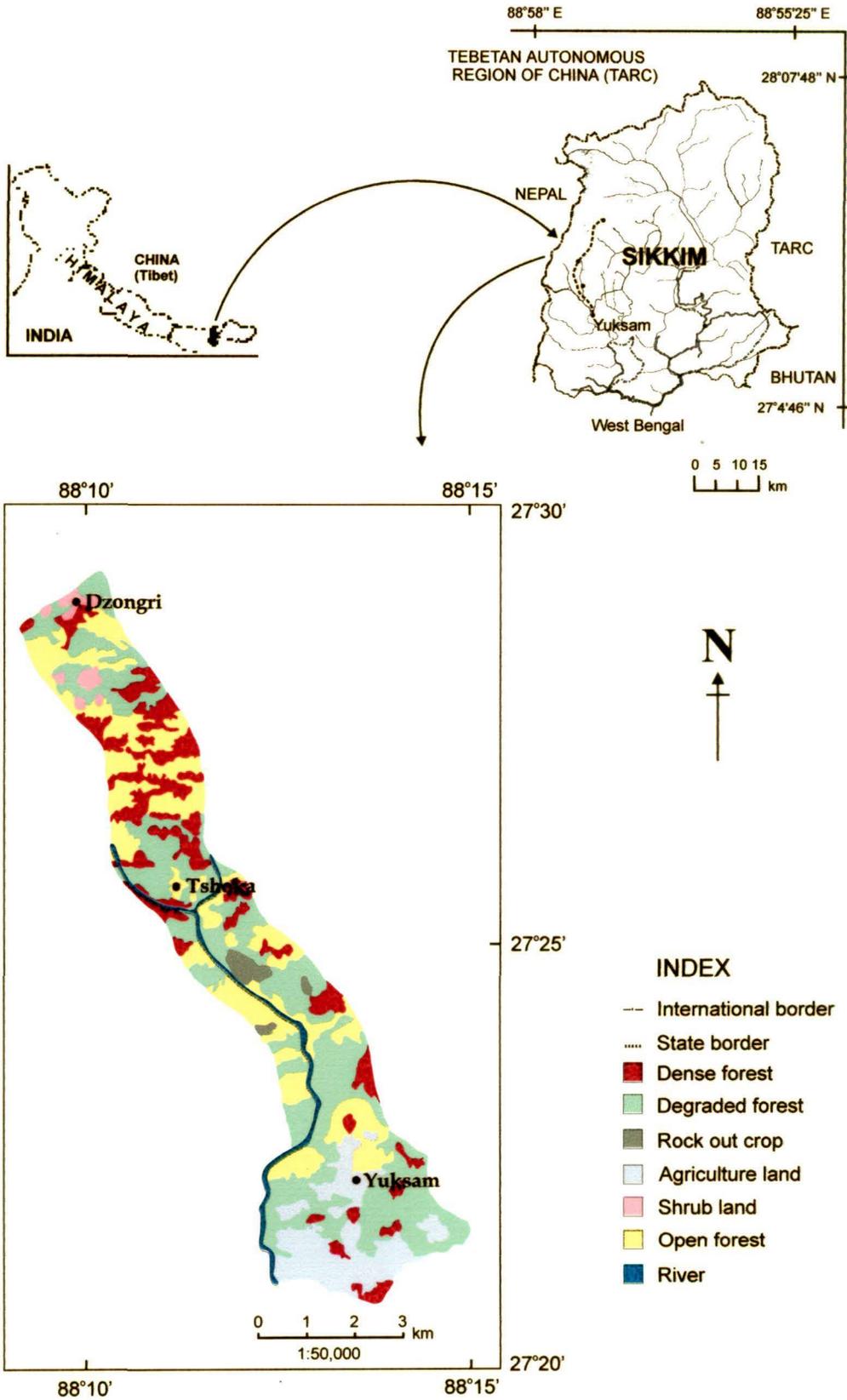


Figure 3.4. Map showing land use area of Yuksam-Dzongri trekking corridor.