HKKH Partnership
for ecosystem management

View of a High Place

Natural and Cultural Landscape of Sagarmatha National Park

Lhakpa Norbu Sherpa and Birendra Bajracharya

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About ICIMOD

The International Centre for Integrated Mountain Development, ICIMOD, is a regional knowledge development and learning centre serving the eight regional member countries of the Hindu Kush-Himalayas – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – and based in Kathmandu, Nepal. Globalisation and climate change have an increasing infl uence on the stability of fragile mountain ecosystems and the livelihoods of mountain people. ICIMOD aims to assist mountain people to understand these changes, adapt to them, and make the most of new opportunities, while addressing upstream-downstream issues. We support regional transboundary programmes through partnership with regional partner institutions, facilitate the exchange of experience, and serve as a regional knowledge hub. We strengthen networking among regional and global centres of excellence. Overall, we are working to develop an economically and environmentally sound mountain ecosystem to improve the living standards of mountain populations and to sustain vital ecosystem services for the billions of people living downstream – now, and for the future.

Cover Photo

Sagarmatha, Lhotse and Ama Dablam peaks with Buddhist stupa in the foreground.
(Birendra Bajracharya)

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Preface

Khumbu is the seat of the world's highest mountain (Mt. Everest/Sagarmatha/Jomolangma) and a sacred hidden valley of the Sherpa people. It was declared as Sagarmatha National Park (SNP) in 1976 by the Government of Nepal and inscribed into the World Heritage Sites list by UNESCO in 1979. Sagarmatha National Park was selected as one of the project sites of the Hindu Kush-Karakoram-Himalaya (HKKH) Partnership Project funded by the Government of Italy and implemented by IUCN, ICIMOD, CESVI and Ev-K2-CNR. The aim of the HKKH Partnership Project was to develop institutional capacities for systemic planning, management and research in protected areas of the Hindu Kush-Karakoram-Himalaya mountain complex. The project conducted applied research, compiled databases and developed a Decision Support Toolbox (DST) to support the management of SNP. The "View of a High Place" has been put together as a means to disseminate the information compiled by the project in the form of Geographic Information System (GIS) and satellite-based maps for general users. The unparalleled mountain scenery, high-altitude ecosystem and culture of Sagarmatha National Park and its Buffer Zone (SNPBZ) attract visitors from many different countries. In 2008 alone, the Park received 30,000 visitors from over 90 different countries. We hope that this book will of interest to the visitors from all over the globe wanting to know more about this magical place. The book will also be equally useful to researchers and students interested in the region who need a quick overview before they initiate their work. Keeping in mind that "a picture tells a thousand words," this book integrates maps and photographs as much as possible and keeps the written text to a minimum.

Photographs integrated in the book come from different sources that are acknowledged. We express our special thanks to Gauri Shanker Dangol from ICIMOD who has been instrumental in preparing the maps and layout design of the book. We are thankful to Yuko Maskay, Miranda Weinberg and Helen Sherpa for their editorial assistance. We also thank Basanta Shrestha, Division Head of Mountain Environment and Natural Resources' Information System (MENRIS) and all the colleagues at ICIMOD and the HKKH Partnership Project who supported us in creating this book.

We hope that this book will in some way help conserve the ecosystem and culture of the highest place on the earth's surface by generating greater understanding and appreciation of its unique natural and cultural values.

Lhakpa Norbu Sherpa and Birendra Bajracharya

Mane stones and stupa along the Everest trail. People pass by these sacred structures by keeping them to their right.

Birendra Bajracharya

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1. Rise of the Himalaya

1.1 Top of the World

The Himalayas is one of the highest and youngest mountain ranges in the world. Himalaya in Sanskrit means "house of snow." The range extends from Afghanistan to Myanmar for approximately 3,000 kilometers (km). This long mountain chain is divided into different sections such as the Assam Himalaya, Nepal Himalaya, Kumaon-Garhwal Himalaya and Kashmir-Punjab Himalaya. The highest point of the Himalayan range lies along the nearly 800 km-long Nepal Himalaya, which rises from the Indo-Gangetic lowlands to the summits of some of the earth's highest peaks. As a result, the Himalayan region in Nepal is often referred to as the "Top of the World."

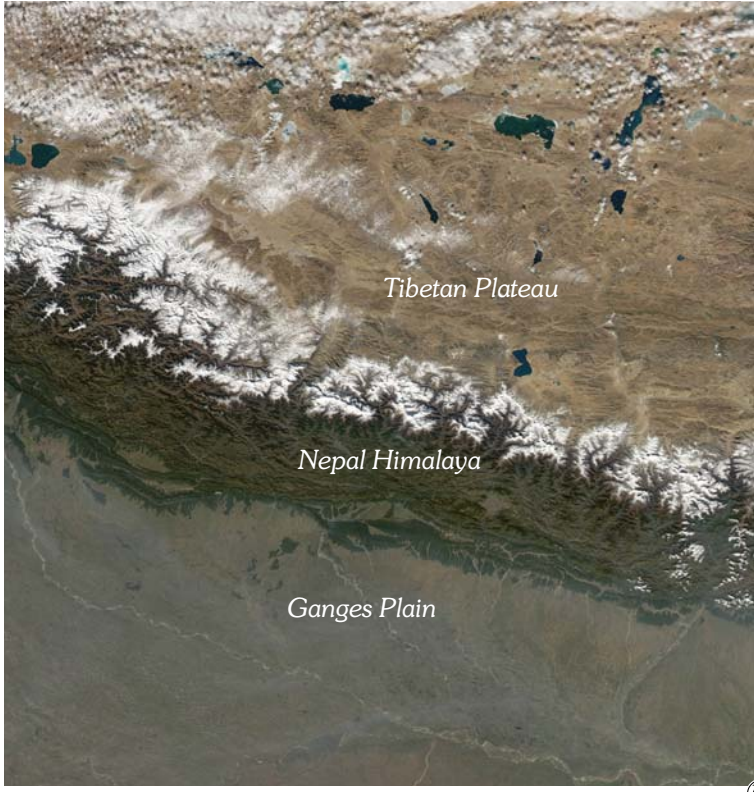
The rise of the Himalaya can be traced back to collision of two continental land masses - India and Eurasia - many millions of years ago. The Indian plate, which was originally part of a southern continent known as Gondwanaland which also included Australia, came detached and drifted northwards to collide with the Eurasian continent. This event took place more than 50 million years ago. When the two land masses collided, the Indian plate slid under the Eurasian land mass. The Eurasian landmass pushing against the Indian plate buckled and began to rise to form the Himalayan Range and high mountains such as Sagarmatha (8,850 m), Kanchanjunga (8,586 m) and Makalu (8,463 m). Scientists believe that the Himalayan peaks are still rising but this is counter-balanced to some extent by erosion.

1.2 The Sloping Country

Nepal is a country located on a slope on the south side of the Himalaya between Tibet Autonomous Region (PRC China) and India. It resembles a sloping riser between two terraced fields - the plateau of Tibet being the upper terrace and Ganges plains of India the lower fields. The 147,480 square kilometers (sq km) country is approximately 870 km long, east to south, north to south. Along its northern border with Tibet lie the high Himalayan peaks. A mountaineer standing on one of these lofty peaks of the great Himalayan range can trace the southern border with India only 130 km away in the low hazy horizon. Along this line of sight, the mountaineer can view silhouettes of a series of mountain ranges that progressively decrease in height, starting with the Mahabharat Range and finally ending with the Siwaliks that merge into the Ganges plain. Within this short distance of 130 km, the altitude drops from more than 8,000 m to less than 100 m above sea level. This dramatic change in elevation also affects the temperature and precipitation regime. For example temperature can increase from -40 degree Celsius at the summit to +40 degree Celsius in the Tarai. These changing climatic conditions along the elevation gradient support a diversity of biological and cultural features that sets Nepal apart from many other countries.

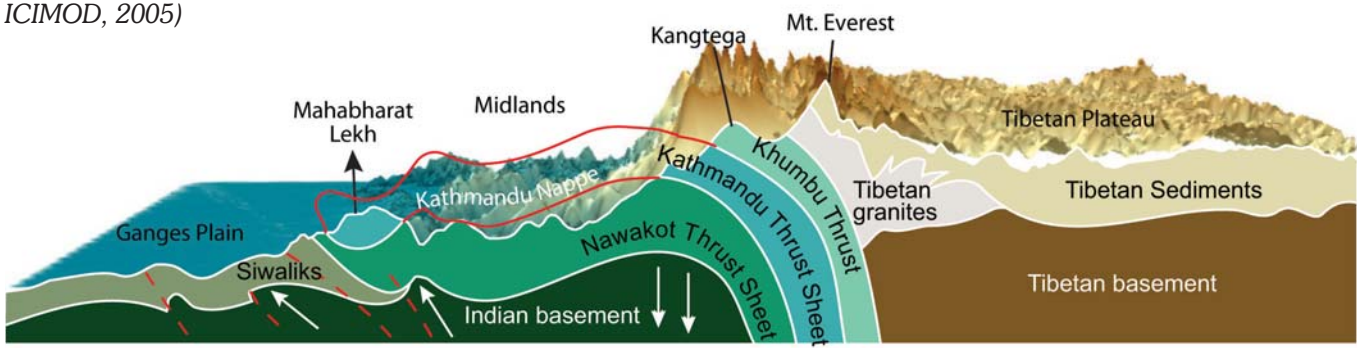
1.3 Discovering the Highest Mountain

Just one and a half centuries ago, no one knew where the highest point of the earth surface was. It was in 1852 when surveyors from the Great Trigonometrical Survey team of India began to take measurements of the heights of the Himalayan peaks that they stumbled onto Mt. Everest. They did not travel through the rugged unknown territories of Nepal to look for it. Instead they took measurements



Himalaya range from space
Source: Moderate Resolution Imaging Spectroradiometer (MODIS) image from NASA

Geologic cross-section along 87 ° longtude through Mt. Everest. (Source: Atlas of the Himalaya, ICIMOD, 2005)



Jomo Miyo Langsangma or Jomolangma - the goddess of Mt. Everest and provider of wealth and food to humans

from the plains of India using the triangulation method. The measurements were recorded in a logbook to be calculated later. The peaks without known names were labeled with roman numerals. A peak in northern Nepal was labeled as Peak XV and calculation of its height three years later revealed that it was the highest mountain in the world. The Bengali Chief Data Analyst rushed into the office of Surveyor General Sir Andrew Waugh and reported with excitement: "Sir, I have discovered the highest mountain in the world." The height was calculated to be 29,002 feet (Howard-Bury 1921).

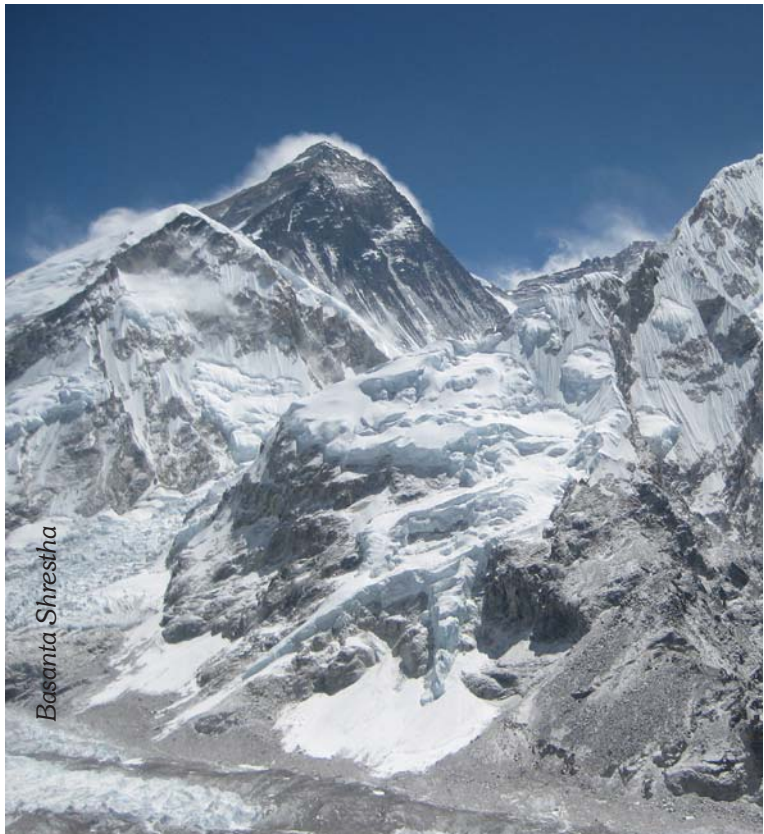
1.4 Naming of the Highest Mountain

The surveyors did not know the local name of Peak XV, just proven to be the highest mountain in the world. They communicated with the authorities of Nepal to find out its local name. In 1865, after having failed to find a local name from Nepal, the then Surveyor General of India named it Mount Everest after his predecessor, Sir George Everest who initiated the surveys. Ever since, the world's highest mountain became famous internationally as Mt. Everest. Realizing its significance, the Nepalese government coined its own official name, Sagarmatha, meaning "forehead of the sky.'' According to Harka Gurung, a well-known mountain geographer of Nepal, the naming took place around 1956.

1.5 The Elusive Native Name

Little did the Nepali authorities knew that for hundreds of years the mountain was known as Jomolangma[1] to the indigenous communities living around its base. Jomolangma is an abbreviated version of the name of a benevolent goddess - Jomo Miyo Langsangma, who is believed to reside on the mountain. Unfortunately, this native name eluded the attention of the decision-makers and surveyors, and remained overshadowed by Everest and Sagarmatha. Sherpa people believe that Jomolangma has four other sister goddesses. Jointly they are called Tsering-che-nga or five long life sisters. Tashi Tseringma, the oldest sister, resides on a mountain in Rolwaling commonly known Tseringma. The Great Trigonometrical Survey team of India renamed it as Gauri-Shankar because its twin peaks resembled the Hindu god couple Gauri and Shanker. The residences of the three other sisters of Jomolangma - Tingi Shalsangma, Tekar Donsangma and Chopen Dinsangma, have not yet been revealed. However, it is believed that each of these sister goddesses have special power to bestow longevity, wealth, food, telepathic and other powers to humans. Jomolangma is the goddess of wealth and food.

Mt. Everest (8850 m) known as Sagarmatha in Nepal and as Jomolangma in local language



1 Jomolangma, Sagarmatha and Mt. Everest will be considered the local, national and international name for the world's highest mountain and will be used interchangeably for the purpose of this book. The Chinese spelling of Jomolangma is Qomolangma.

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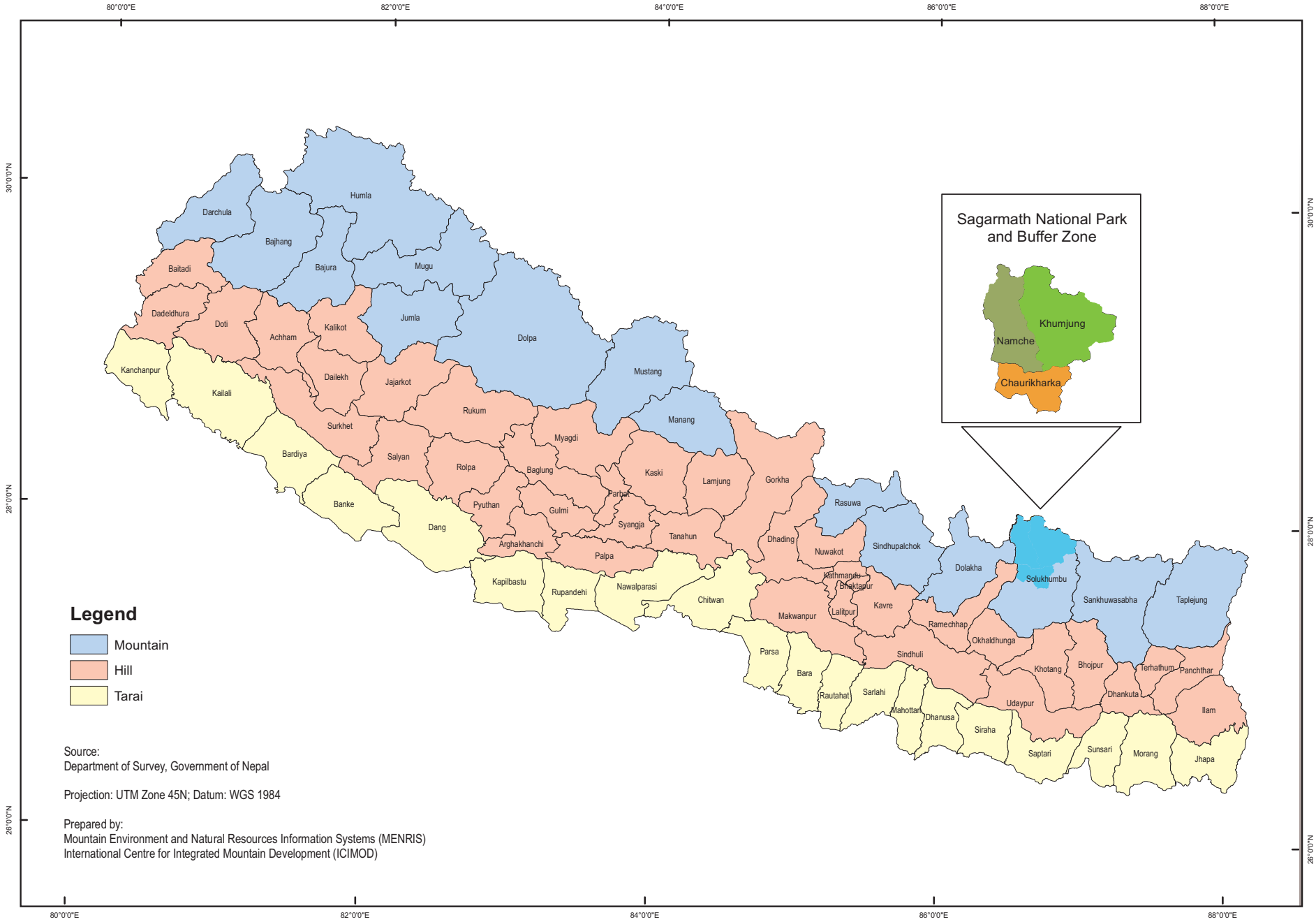
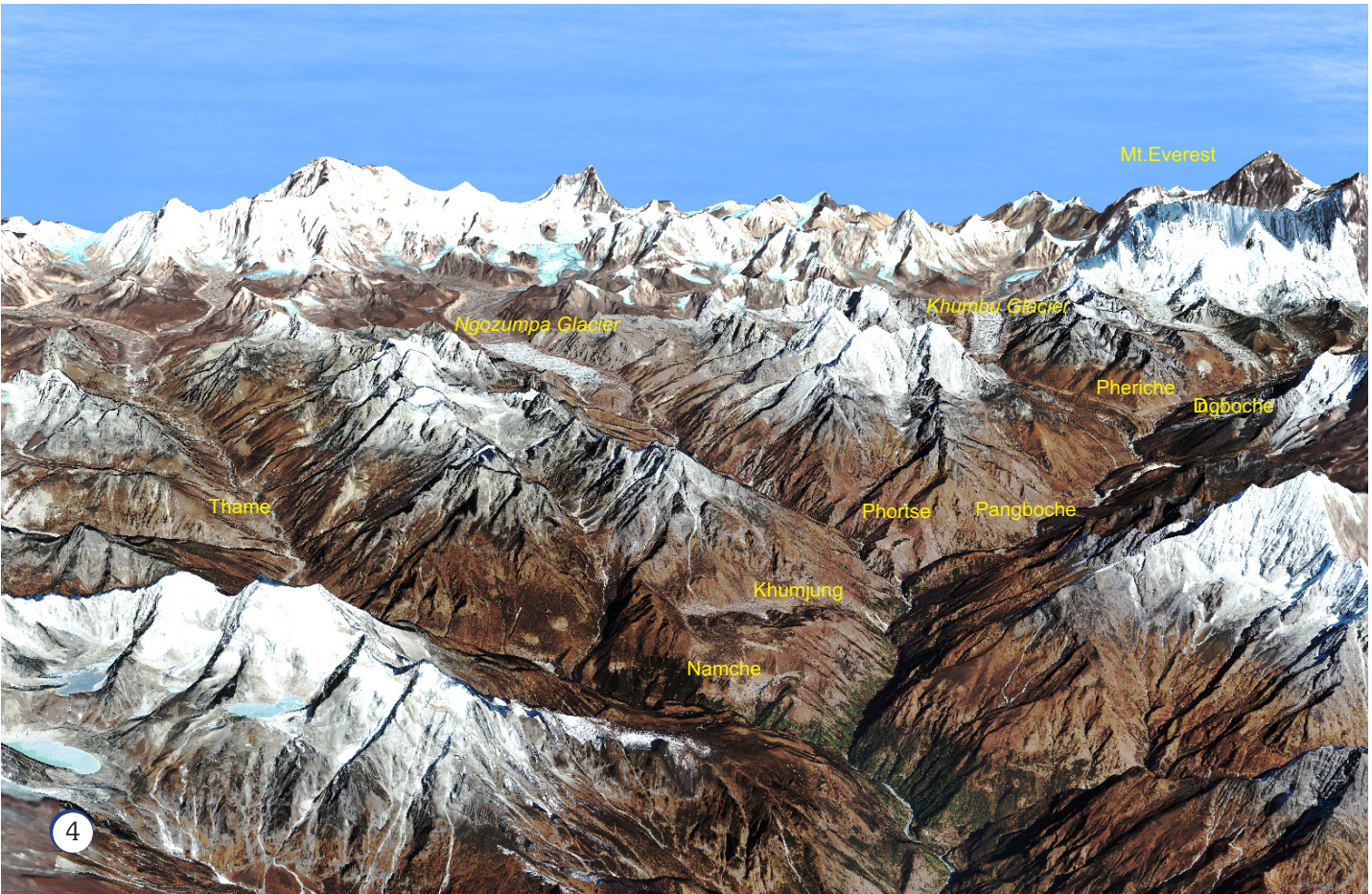


2. The Physical Environment

2.1 Location

The Khumbu Region or Sagarmatha National Park is located in northeast Nepal about 140 km east of Kathmandu. The park is located at the base of the world's highest peak - Jomolangma/Sagarmatha/Mt.Everest. Administratively, the Park and Buffer Zone cover the three northern Village Development Committee areas - Chaurikharka, Namche and Khumjung - of Solukhumbu District. These VDCs also form the basis for the SNPBZ Committee jurisdictions. To conserve the world's highest ecosystem, the Nepal government designated the 1,148 sq km Khumbu area as a national park in 1976. The 275 sq km area of Chaurikharka VDC to the south was added as a buffer zone in 2002. Recognising the global importance of Sagarmatha as the world's highest mountain, the park was declared a UNESCO World Heritage Site in 1979.

Landscape of Sagarmatha National Park
(IKONOS image draped over the digital elevation model)



2.2 Extreme Elevation

Like other areas of the globe with extreme characteristics, the hottest deserts, wettest rain forests and the deepest oceans, the Sagarmatha National Park is unique and fascinating because of its extreme elevation as one of the highest landscapes on the surface of the earth.

The elevation rises from 1,800 m to 8,850 m at the top of Everest within a distance of less than 50 km. There is no other place in the world where the altitude of the land rises so high so quickly. The change in altitude influences temperature, solar radiation and air density. For example, air temperature lapses at the rate of approximately 1 degree centigrade per 1,000 m altitude gain. Changes in these climatic factors affect vegetation growth, animal survival and human livelihoods. Under natural conditions, different plants and animals can be found at different elevations. These biological and climatic changes along the elevation gradient are expressed in terms of bioclimatic zones.

2.3 Bioclimatic Divisions

The landscape of Sagarmatha National Park and Buffer Zone (SNPBZ) roughly falls into five ecological zones based on altitude. These include nival, alpine, sub-alpine, cool-temperate and warm-temperate bioclimatic zones.

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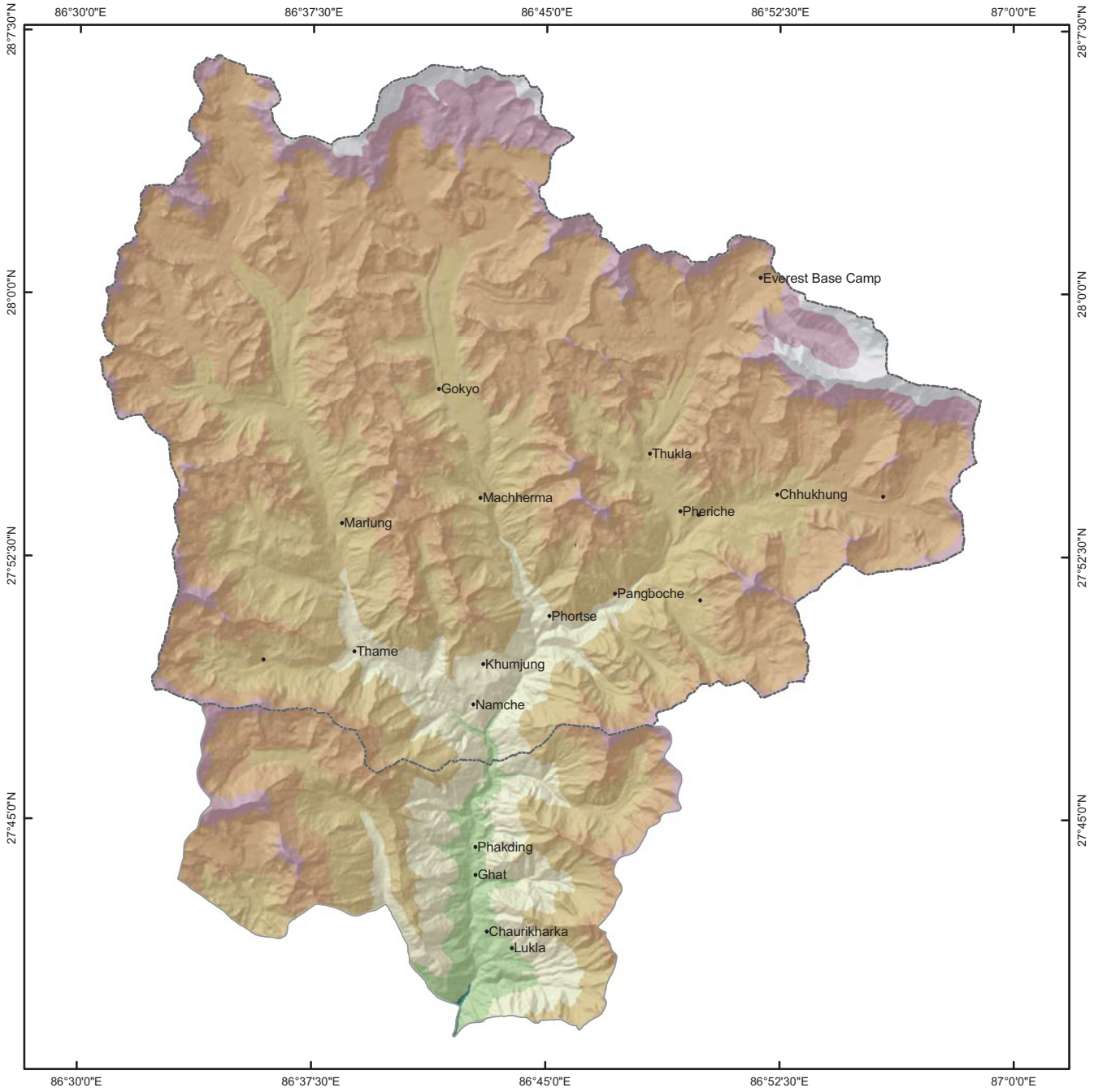

Sagarmatha National Park and Buffer Zone

Elevation Zone

The elevation rises from 1,800 m to 8,850 m at the top of Everest within a distance of less than 50 km. The landscape roughly falls into five ecological zones based on altitude. These include nival, alpine, sub-alpine, cool-temperate and warm-temperate bioclimatic zones.

Legend

- Major places
- Park boundary

Elevation

- Above 7,000 (1.86%)
- 6,001 - 7,000 (7.71%)
- 5,001 - 6,000 (48.31%)
- 4,001 - 5,000 (30.79%)
- 3,001 - 4,000 (8.72%)
- 2,001 - 3,000 (2.57%)
- Below 2,000 (0.03%)

0 2.5 5 10 15
Kilometres

Source:
Department of Survey, Government of Nepal
Projection: UTM Zone 45N; Datum: WGS 1984

Prepared by:
Mountain Environment and Natural Resources Information Systems (MENRIS)
International Centre for Integrated Mountain Development (ICIMOD)

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Nival environment near Gorakshep

Alpine Zone is an important area for grazing high-altitude yaks and naks

Nival Zone (>5,000 m)

This is the zone of bare soil, rocks, snow and ice and has very limited vegetation. Many active glaciers are located in this zone. Hence, it is also known as the periglacial zone. This zone lies mostly above 5,000 m elevation. Nearly 58% of the total area of the Park and Buffer Zone falls within the Nival Zone. Temperatures remain below freezing point in most winter months. The permanent snowline may descend down to 5,000 m elevation on the cold slopes and on warmer and sunny slopes, the snowline is higher.

Freeze and thaw action, frost shattering and soil creeps are common because of the extreme temperature differential between winter and summer months making the ground highly fragile and sensitive to disturbance. Down slope movement of soil (0-1.5 mm/year) can occur in most places. High-altitude plant species such as Rhododendron nivale, Androsace, Primula, Delphinium, Rodiola, Poa and Festucca grasses may be found on more stable sites. Himalayan snow cock, snow partridge, snow leopard and gray wolf are seasonal visitors to these heights. The winter snow acts as a protective cover that provides shelter for small plants and animals that live in this extreme environment. Human use of the Nival Zone is limited to mid-summer grazing, trekking and mountaineering. The Nival Zone is one of the most important fresh water reservoirs stored in the form of ice and snow.

Alpine Zone (4,000-5,000 m)

The Alpine Zone, located between 4,000 to 5,000 m elevations above sea level, is one of the harshest environments. About 31% of the total area of the Park is occupied by the treeless Alpine Zone. Much of the vegetation found in this zone is stunted and cold-tolerant species such as Rhododendron anthopogon, Rhododendron setosum, Juniperus wallichiana; Salix calyculata and Cassiope fastigiata grow here. The lower winter temperature and lesser precipitation limit tree growth in this zone. Xeric species such as Cotoneaster, Juniperus, Poa, Festucca, Mayricaria, and Arenaria and Saussureas are found on sunny slopes. Despite cold winter conditions and lack of vegetation, the Alpine Zone is an important area for grazing high-altitude yaks and naks and more recently for tourism and mountaineering businesses - two land uses that are the major pillars of the local economy. Many of the alpine seasonal herding settlements have now become booming sites for tourist lodges and camping areas. Pheriche, Lobuche and Gokyo are prime examples of this change in land use.

Sub-Alpine Zone (3,000-4,000 m)

The Sub-Alpine Zone covers a narrow band between 3,000 to 4,000 m elevations above sea level. Only about 9% of the area falls within this zone. The Sub-Alpine Zone is generally covered with forests of Abies, Pinus, Juniperus, Betula, Rhododendron campanulatum, and

Rhododendron campylocarpum. The upper limits of sub-alpine forest extend to 3,900 m on cool slopes and on warmer slopes this line is not clearly discernible due to the influences of fire, grazing and harvesting. The species composition on the warm and cool slopes is different because of differing environmental conditions and level of human disturbances. The Sub-Alpine Zone is one of the most disturbed landscapes because it is an ideal area for raising yaks and naks and cultivating potatoes and buckwheat. The climate is a little warmer and drier and all the major villages of Khumbu including Namche, Khumjung, Khunde, Thame, Phortse and Pangboche are located in this zone. Despite the heavy human presence, wildlife such as Himalayan tahr, musk deer, snow leopard, wolf, jungle leopard, red fox and yellow-throated marten are commonly sighted. A number of very important birds such as danphe, kaliz pheasant and blood pheasant are found in the sub-alpine forests and fields.

Cool-Temperate Zone (2,000-3,000m)

The Cool-Temperate Zone is an ideal area for growing productive forest. Only 3% of the Park and its Buffer Zone falls within the Cool-Temperate Zone. The flora and fauna diversity is naturally high because of warmer and moister conditions. The majority of the Cool-Temperate Zone falls outside the park in the Chaurikharka Buffer Zone. The major temperate tree species are Tsuga, Pinus, Quercus, and Rhododendron arborium. Wildlife commonly found here are Himalayan black bear, jungle leopard, red panda, barking deer, Himalayan palm civet, jackal, yellow-throated marten, porcupine, squirrel and bat.
The Cool-Temperate Zone is also suited for agriculture. Therefore, moderately sloping areas are converted to agriculture and pastures under private and community ownership. Common crops include potato, wheat, maize, millet, beans and various vegetables. Cattle, goat and yak-cattle crosses are raised in this warmer region. Small numbers of poultry are also kept. Forest fires are common on the dry slopes. Heavy livestock grazing and timber harvesting in the past have depleted and altered the forests. Regeneration of early successional species such as pine is taking place in many areas where grazing and farming pressure have been reduced.

Warm-Temperate Zone (<2,000 m)

The area of Warm-Temperate Zone within SNPBZ is negligible. A small area restricted to the lower gorge of the Dudh Koshi below Chaurikharka falls within this zone. The species of vegetation and wildlife found in this area are not very different from the lower belt of the Cool-Temperate Zone. The greatest difference is that snow rarely falls in this zone.

Temperate forest in Dudh Koshi Valley in Chaurikharka area

Sub-Alpine forest of pine, fir, birch and rhododendron in Imja valley

Birendra Bajracharya

2.4 Slopes Matter

Mountains are defined as an elevation of the earth's surface rising abruptly and to a larger height then the surrounding level areas. The sides of these rising mountains facing different directions are its slopes. The steepness of these slopes dictates vegetation growth, wildlife habitat quality and human use of the land. Slope is usually measured as percent slope or degrees. In degrees, they range from >0 to 90 degrees. The lower elevation and gently sloping areas are highly sought after for agriculture and human settlement. However, in mountainous landscapes, flat areas are limited. Only about 23% of the land in SNPBZ has slopes less than 15 degrees. Many of the gently sloping areas are located in high altitude glacial valleys. These include landforms such as glacial terraces, former lake beds and river terraces along the valley floor. At lower elevations below 4,000 m, all the gently sloping areas that are reasonably safe from hazards are occupied by settlements and cultivated fields (Phortse, Thame, Khumjung and Dingboche). The forests around the villages are generally degraded and modified because of centuries of grazing and harvesting pressure.

About 38% of the area has slopes ranging from 16 to 35 degrees. These steeper slopes are generally less suited for settlements and agriculture. Limited terraced farming is possible on warm and moist slopes. The steep slopes are also less favorable for forest growth because these slopes have less moisture and less developed soils. Livestock grazing is the most common use of these steeper slopes. They offer ideal pastures for both domestic stock and wild ungulates such as Himalayan tahr and musk deer. Another 38% of the SNPBZ has slopes ranging from 36 to 60 degrees. These areas are too steep for productive agriculture. Limited grazing by agile livestock such as yaks and naks are possible. These areas offer good habitat for wildlife because they are relatively less disturbed. Land areas with slopes steeper than 60 degrees are rare. Only about 2% of area consisting of vertical mountain slopes fall in this category. These landforms are supported by solid rocks. Vegetation cover is limited because soils do not accumulate. Verticality makes these areas vulnerable to all kinds of disturbances including slumping, mass wasting, avalanche and rock falls. The disintegration of the rock faces forms talus slopes, debris cones and avalanche fans at the bases. The awe-inspiring topography attracts tourists and mountaineers. Vertical slopes are also sanctuaries for birds and animals.

Slope determines the location of settlements and land uses

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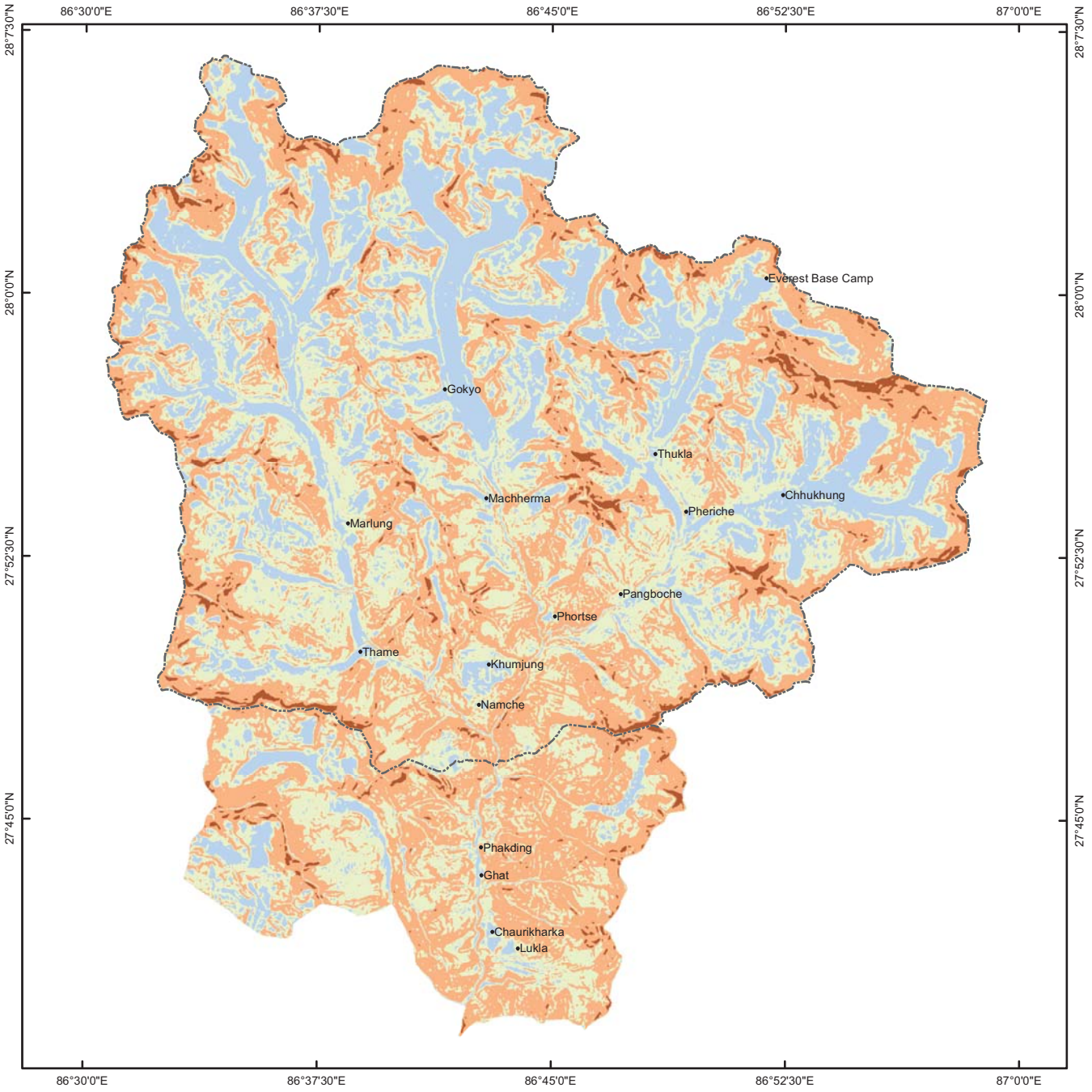
Sagarmatha National Park and Buffer Zone



Slope

The landscape of SNPBZ is characterized by steep slopes. Over 75% of the area has slopes ranging from 15 to 60 degrees. Only 23% of the area has gentle slopes suited for settlement and agriculture.

Legend

- Major places
- Park boundary

Slope in degree

- 0 - 15 (22.27 %)
- 16 - 35 (37.41 %)
- 36 - 60 (37.95 %)
- 61 - 76 (2.37 %)

0 2.5 5 10 15
Kilometres

Source:
Derived from Digital Elevation Model, MENRIS, ICIMOD
Projection: UTM Zone 45N; Datum: WGS 1984

Prepared by:
Mountain Environment and Natural Resources Information Systems (MENRIS)
International Centre for Integrated Mountain Development (ICIMOD)

ICIMOD

2.4 Mountain Faces

Mountains have sides that face a particular direction. These are called aspects. Different aspects of a mountain receive different levels of incoming solar radiation, and have different soil temperature, moisture and evaporation rates. These environmental factors have a strong influence on establishment, growth and survival of vegetation. Aspect along with slope and altitude influences people's land use choices. In the northern hemisphere, southerly aspects are warmer sides of a mountain. At higher elevation, warmer aspects remain snow-free for longer periods, providing winter grazing opportunities. Soils on southerly aspects also warm up earlier in spring and provide a longer growing season. These aspects are preferred locations for settlements; for example, the Khumbu villages of Namche, Phortse, Pangboche, and Thame Gonpa are on south facing slopes. Nearly 60% of the total land area of SNPBZ has warm southerly aspects and the remaining 40% of the land area can be classified as cool aspects. There are significant temperature differences between warm and cool aspects. Cooler aspects have more forests and vegetation cover than warm aspects although the growth potential is better on warmer slopes. This is because warmer aspects are particularly vulnerable to drought and frequent fires. Warm aspects are also places where human settlements, harvesting, grazing and farming are concentrated which discourage forest establishment and growth. As a result the vegetation covers on warmer slopes are patchy consisting of species such as dwarf rhododendrons, and junipers.

Warm Slope and Cool Slope Comparison

Thamo Village (3,500 m), located on a warm southwest-facing slope below Kapsale Mountain is surrounded by an almost pure forest of Juniperus recurva which is tolerant of drought, fire and animal browsing. The cool slope on the opposite side has luxurious mixed forests of Abies and Betula with an under storey of Rhododendron, Acer, Layonia and Viburnum. The difference in vegetation cover type appears to be mainly due to temperature and moisture differences that regulate natural and human disturbances.

Birendra Bajracharya

Warm and cool aspects exhibiting distinct vegetation cover types

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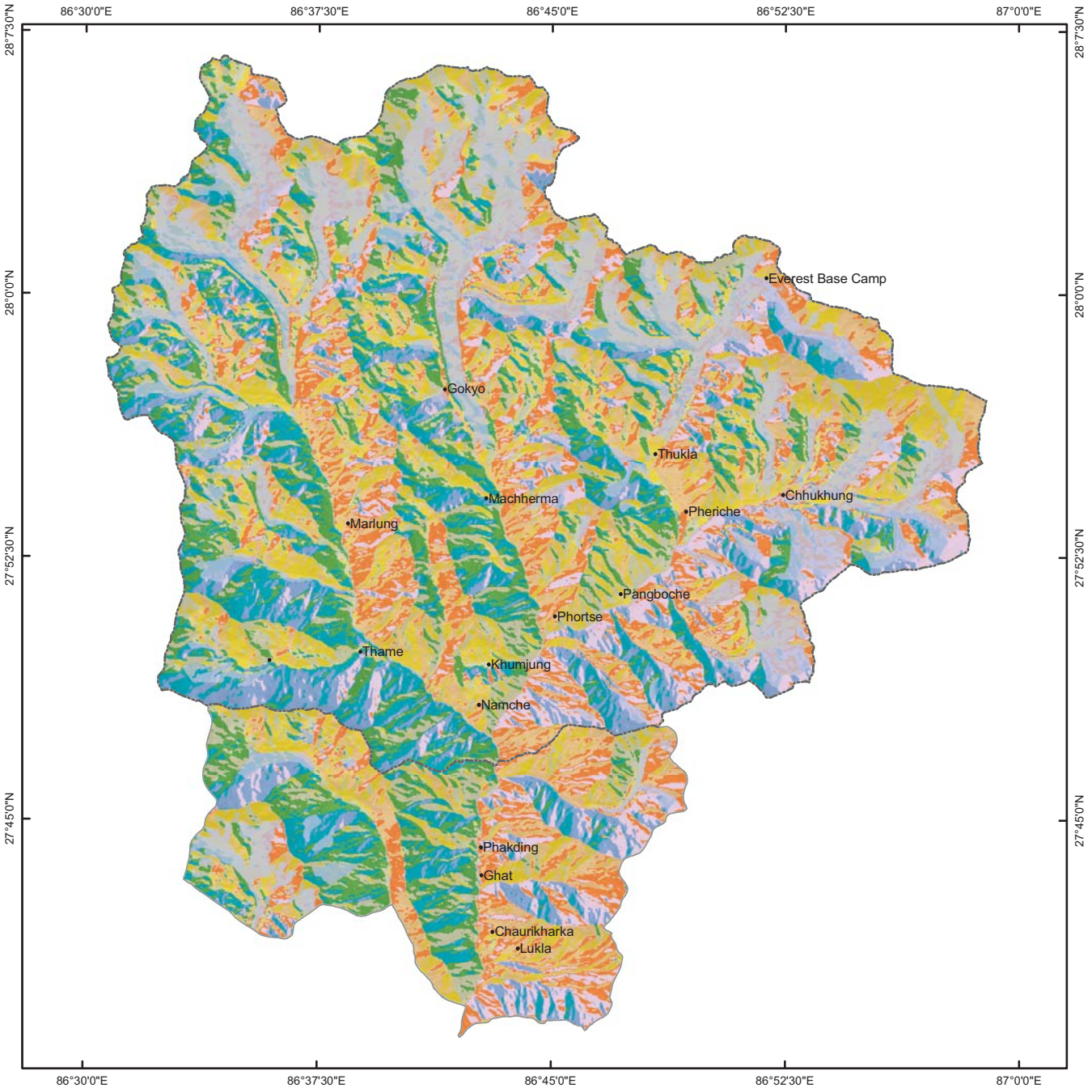
Sagarmatha National Park and Buffer Zone



Aspect

Aspect determines the levels of incoming solar radiation, soil temperature, moisture and evaporation rates. These factors have a strong influence on plant growth, habitat quality and land use. Being located on the southern slope of the Himalaya, nearly 60% of the area has warm southerly aspect which makes the land much more accessible for human use.

Legend

- Major places
- Park boundary

Aspect

- Flat
- North (337-22.5) (8.81%)
- Northeast (22.5-67.5) (11.20%)
- East (67.5-112.5) (12.77%)
- Southeast (112.5-157.5) (13.78%)
- South (157.5-202.5) (14.76%)
- Southwest (202.5-247.5) (16.84%)
- West(247.5-292.5) (12.52%)
- Northwest (292.5-337.5) (9.30%)
- North (337.5-360)

0 2.5 5 10 15
Kilometres

Source:
Derived from Digital Elevation Model, MENRIS, ICIMOD
Projection: UTM Zone 45N; Datum: WGS 1984

Prepared by:
Mountain Environment and Natural Resources Information Systems (MENRIS)
International Centre for Integrated Mountain Development (ICIMOD)

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2.6 Peaks and Valleys

The Khumbu is almost completely surrounded by high mountains. The global giants such as Everest (8,850m), Lhotse (8,501m), Cho Oyu (8,188 m) and Nuptse (7,864m), and lesser peaks such as Pumori (7,165m), Khumbutse (6,665m), Lingtren (6,749 m), and Gyachung Khang (7,922m) stand to the north forming a formidable climatic and physical barrier that protects the area from cold northern winds from the Tibetan plateau. The range also traps the monsoon moisture advancing from the south in summer and makes the area moister than that of adjacent Tibet just across the range. Khumbu valley is also enclosed by a series of mountain peaks from the south, east, and west. These include Chho Pula (6,695m), Baruntse (7,168m), Amphu Latse (5,663m), Amadablam (6,814m) and Malaphula (6,573m). The Khang Taiga (6,783m), Thamserku (6,618m), Kongde (6,187m), Teng Khangmoche (6,500m) and Paniyo Tippa (6,696m) ranges stand to the south-east and south-west. These ranges partially screen Khumbu from the full force of monsoon rain creating slightly drier inner valley conditions.

The Dudh Koshi gorge is the only entry point that allows movement in and out of the park in all seasons. The high mountain pass of Nangpa La (5,716m) is used for conducting trans-Himalayan trade that is open only for local-level, cross-border trading between peoples who reside within 30 km of the border. The next pass that provides limited access in and out of the Park is the Tashi Labtsa pass (5,722m) that links Khumbu with the adjacent Rolwaling Valley. The western range includes peaks such as Jobo Rabsang (6,666m), Pangbug (6,716m), Dingjung (6,249m), Dragnag (6,801m), Langmoche (6,611m), Tingirigi Tau (6,940m), Phacharmo (5,756m) and Pigphera Go (6,696m) that separate Khumbu from Rolwaling Valley.

Between these mountain ranges lie several north-south aligned upper valleys—Nangpa, Gokyo and Imja. These valleys have wide upper U-shaped profiles because they were formed by glacial activity. Lower down, the valleys take V-shaped profiles because of river cutting. These main valleys have many side-valleys, some of which are deep and gentle while others may be short and steep. Between the valleys are ridges with peaks such as Khumbi Yullha (5,761m), Kabsale (5,319m), Kyajo Ri (6,186m), Machermo Peak (6,237m) and Ama Yutsoma (5,949m) that separate the Nangpa and Gokyo valleys. The Tawoche (6,542m), Arkamtse (6,423m) and Chholatse (6,440m) ranges separate the Gokyo valley from the adjacent Imja valley.

Bird's eye view of Khumbu surrounded by high mountains.

Birendra Bajracharya

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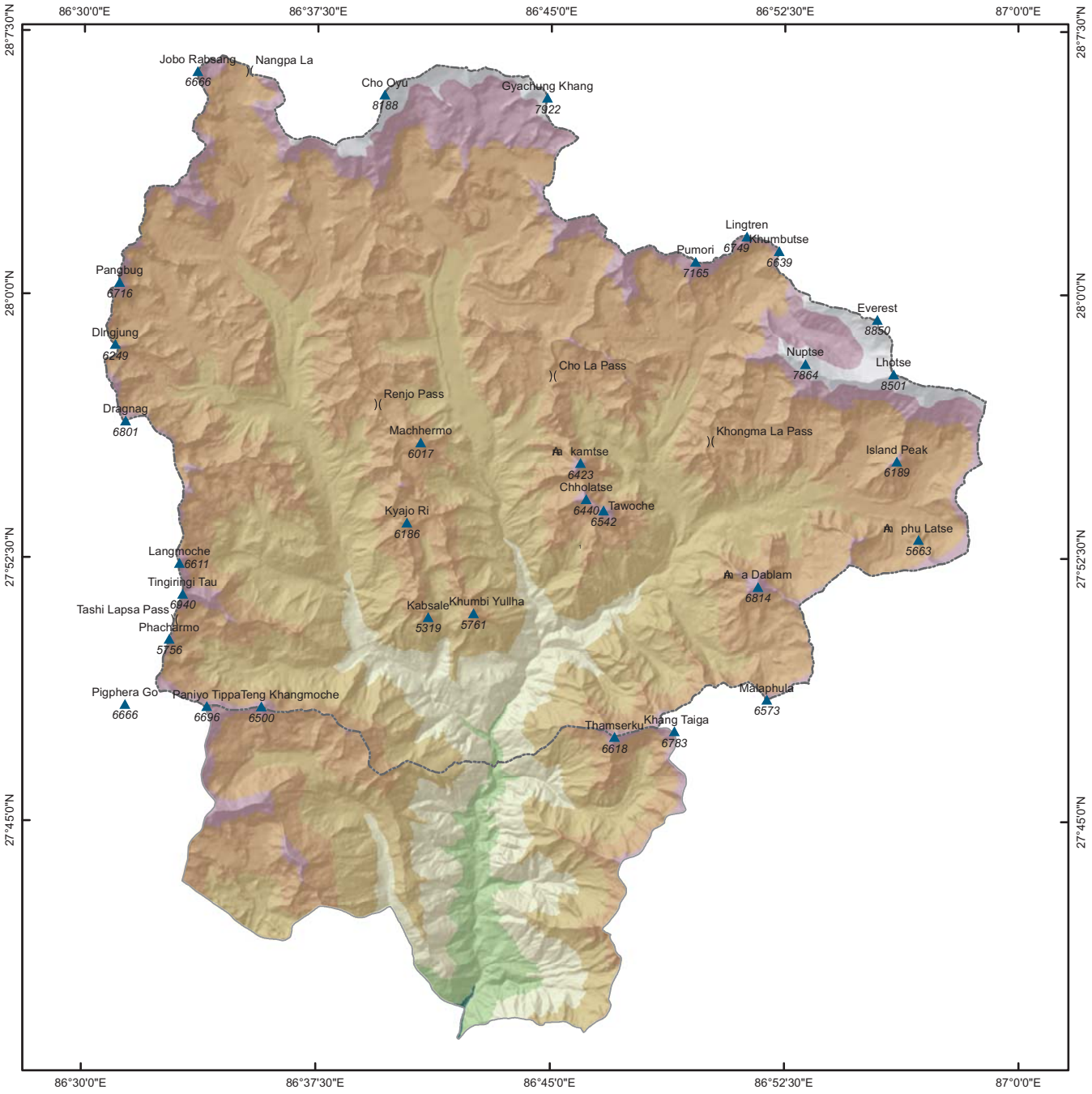

Sagarmatha National Park and Buffer Zone

Peaks

SNPBZ is completely surrounded by high mountain peaks of which Everest, Lhotse and Cho Oyu are over 8000 m high. These mountains not only attract tourism but also regulate the climatic conditions of the area.

Legend

- Peak name
- Pass
- Park boundary

0 3 6 12 18
Kilometres

Source:
Department of Survey, Government of Nepal
Projection: UTM Zone 45N; Datum: WGS 1984

Prepared by:
Mountain Environment and Natural Resources Information Systems (MENRIS)
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2.7 Glaciers, Rivers and Lakes

The upper parts of the Khumbu valley have a very high concentration of glaciers which are at various stages of recession. The Nangpa, Ngozumpa, Khumbu and Imja glaciers are the larger glaciers of the park. Ngozumpa is nearly 32 km long. The second-longest Khumbu glacier is 10 km long. These glaciers are fed by a number of side-valley glaciers and hanging snow and ice-fields. The glaciers of Khumbu are mostly covered by rock debris and clean ice surfaces are rarely seen. They are, therefore, described as "debris-covered" glaciers. The glaciers of Khumbu ebbed and flowed at different times. The most recent advances took place during the Little Ice Age which ended around 1850. Most Himalayan glaciers are believed to be receding rapidly because of global warming. The surfaces of the glaciers are dotted with lakes and exposed vertical ice cliffs. Some of these water bodies are jade-green whereas others are dirty grey. The melting of the glaciers often leads to formation and expansion of glacial lakes. The lakes formed on active glaciers are mostly temporary in nature. They form, change and vanish. However, those on more stable grounds last longer such as Gokyo Lake.

Imja Lake at the head of the Imja valley, for example, did not exist prior to the 1960s and grew rapidly since then to become one of the biggest glacial lakes in Khumbu. The sudden discharge of this lake could cause catastrophic damage to the area and could have a tremendous impact on humans. The process known as Glacial Lake Outburst Flood (GLOF), which is generally triggered by earthquakes, ice avalanche and excessive pressure and weakening of the ice or moraine dams, and has taken place repeatedly in the past. The most significant recent GLOF took place in 1985 from Dig Tso Lake.

Melting glaciers are also the source of rivers that nourish the downstream communities. These rivers are fed by many side streams. Dudh Koshi drains the Khumbu valley, joins the Sun Koshi further downstream and flows down to the Bay of Bengal. Along the way, these rivers provide water for drinking, bathing, fishing, agricultural irrigation, hydropower generation and transportation for millions of people. The land cover change analysis conducted by ICIMOD indicated that surface areas of glaciers have been shrinking and water bodies such as lakes have been gaining in size in the Khumbu Himal. The rapid melting of stored glacial ice combined with reduced accumulation of snow is leading to gradual reduction in glacial ice mass which is of a great concern for future water availability.

View of Khumbu Glacier from Kalapatthar with Mt. Everest in the background.

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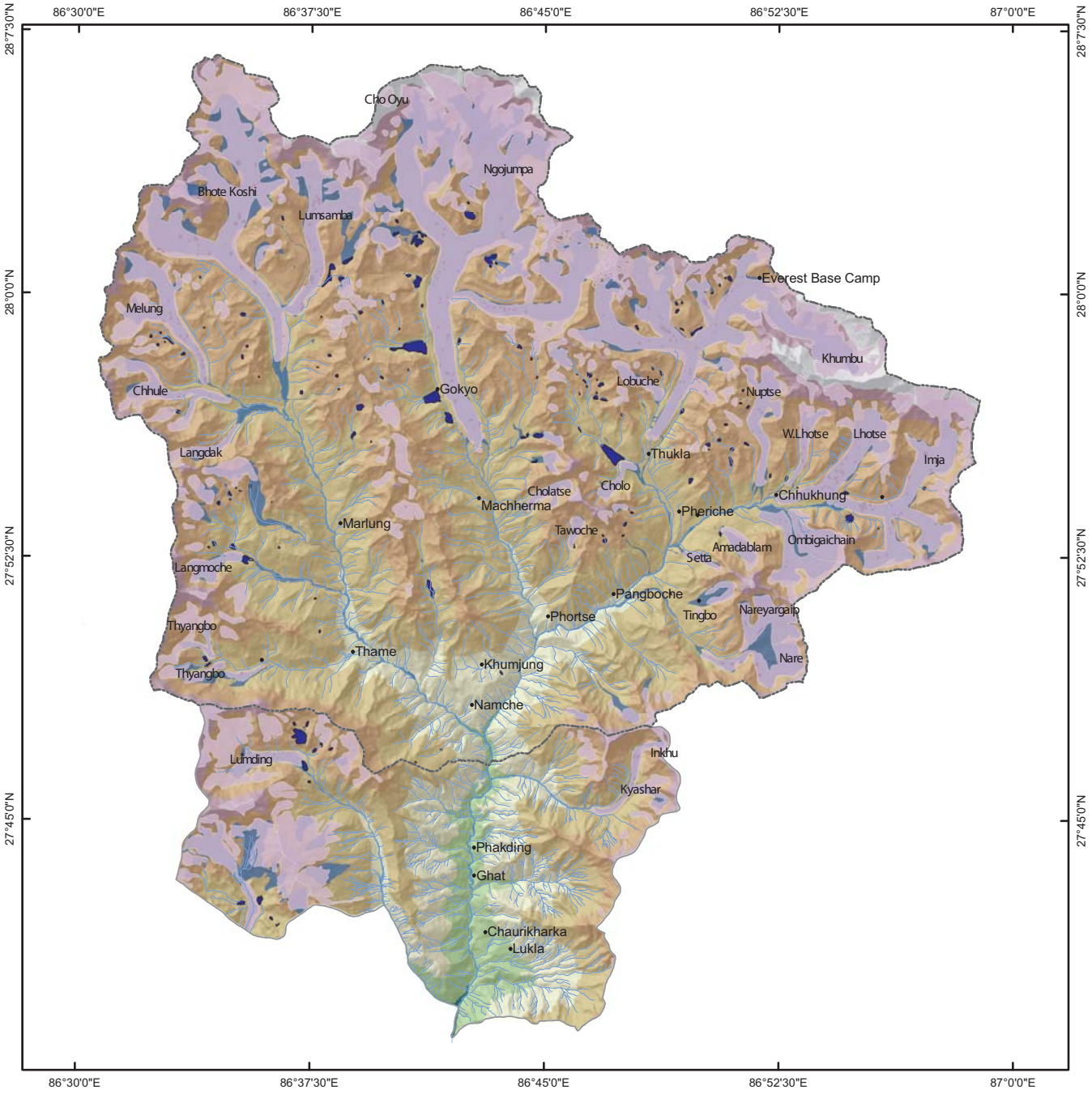
Sagarmatha National Park and Buffer Zone

Glacier, River and Lake

The SNPBZ has the highest concentration of glaciers in Nepal. The rapid decrease of glacial ice and snow due to global climate change is becoming a major concern for future water availability and aesthetic beauty of the region.



Legend

- Major places
- River
- Glacier
- Glacier lake
- Park boundary

0 2.5 5 10 15
Kilometres

Source:
Department of Survey, Government of Nepal
Projection: UTM Zone 45N; Datum: WGS 1984

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Lhakpa Sherpa

3. Cultural Landscape

3.1 The People

The landscape of SNPBZ has been shaped by centuries of human activity. Oral history has it that the ancestors of the Sherpa people have been settled in the area for more than 500 years. In the past, people moved in and out of the valley freely under the influence of social and economic push and pull factors. Hari Ram, one of the first outsiders to enter Khumbu noted 55 tax-paying households in Namche in 1855. This population has increased threefold over the last 150 years. It is suspected that the resident population grew substantially after the introduction of the potato around 1850. This also coincided with the termination of Little Ice Age cooling, which may have made the climate more amenable to farming. There is little reliable historical data on population changes in Khumbu. Recent survey data suggests an average household size of 4.3 persons and population growth rate of 10% over the ten year period between 1991 and 2001. This does not account for temporary and semi-permanent migrants. A survey by Khunde Hospital carried out in 2003 recorded 7,000 people in the Park and its Buffer Zone area of which 5,781 were local residents. Over 90% of the population is Sherpa. The other 10% are from the Rai, Tamang, Brahmin and Chhetri ethnic groups who recently migrated to the area to work in the tourism sector.

3.2 Sacred Values and Spiritualism

One Buddhist text describes Khumbu as a wild valley surrounded by snowy mountains located about fifteen days walk south of the holy mountain of Tsibri. The valley was considered as beyul, a sacred hidden valley reserved by Padmasambhava for the purpose of providing refuge for his followers in times of famine, disease, and persecution. The pioneers were mostly hermits on pilgrimages who gradually settled and formed communities. With them came the tradition of worshipping mountains as the abode of deities such as Khumbi Yullha, Jomolangma, and Tseringma. Under the watchful gaze of these mountain deities, the people conducted their livelihood activities with sensitivity and care. Efforts were made to protect wildlife and forests, and land was not disturbed unnecessarily. The Buddhist values promoted compassion, kindness and honesty and the strength to survive in one of the world's highest ecosystems came from this deep sense of spirituality. Over 95% of the local population is Buddhist and hunting wildlife and slaughtering livestock is still discouraged in Khumbu.

The three sons of an early inhabitant of Khumbu, Buddha Tsenchen, established the three main religious centres of Khumbu. Sangwa Dorje established Pangboche Gonpa; Ralpa Dorje established the Thame Gonpa; and Khenpa Dorje established the Rimijung Gonpa. It is believed that Buddha Tsenchen was reborn as Lama Gulu, the founder who built Tengboche Monastery. There are also many private and village Gonpas that are heart of the communities and the foundation of local culture and religion. The majority of the Sherpa Gonpas belong to the Nyingmapa School. They celebrate festivals such as Dumji (Buddha's birthday), Mani Rimdu (for peace and security) and Nyingne (fasting) ceremonies. Sherpa people also maintain a tradition of respecting natural landscapes such as mountains, lakes, trees and rocks as abodes of spirits and deities.

A masked dancer getting ready for performance

Facing page:
(1) Thame Gonpa located at 3900 m elevation on the slope of Sumdur peak (2) Statue of Padmasambhava inside the Khumjung Gonpa (3) Devotees praying at Mani Rimdu ritual in Thame Gonpa (4) People gathered at Tshogchen festival in Kyarok Gonpa


Lhakpa Sherpa
1


2
Birendra Bajracharya


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Lhakpa Sherpa


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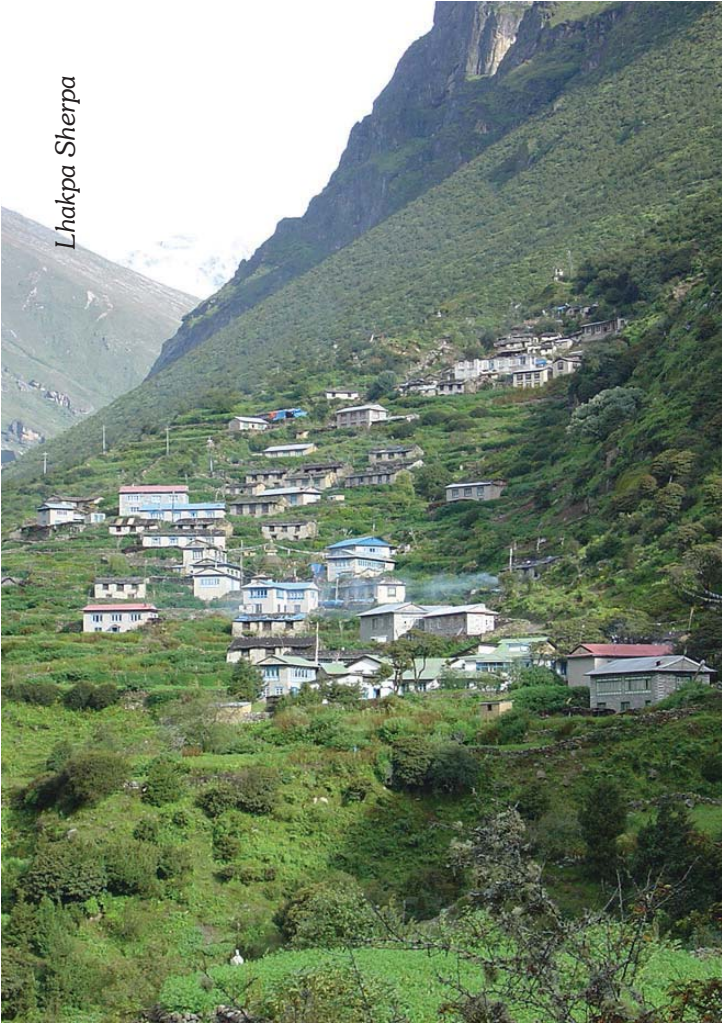
Lhakpa Sherpa



Lhakpa Sherpa

Thamo Village located in the Nagpa Valley

3.3 Settlement

There are nearly one hundred large and small settlements scattered throughout the Park. These settlements are located at different elevations, aspects and slopes. They range from small seasonal yak herding camps with a few huts to large commercial tourist centers with multi-storey lodges. Historically, the settlements at different altitudes were used in different seasons for herding livestock and growing crops as part of the transhumance system. In the transhumance system, some settlements are used more frequently than others. The most frequently used settlements are those in the mid-elevation regions that have gradually become the main villages. They are generally located at elevations between 3,500-4,000 m.

The high-altitude settlements above 4,000 m elevation were used mainly as summer grazing grounds (phu) and those located at lower valleys (rong) were used as wintering grounds. Sites of most settlements were carefully selected away from mountain hazards such as floods, avalanches and landslides. In the absence of flat areas, warm southerly slopes (Thamo, Mende, Namche, Phortse and Pangboche) were chosen for settlement establishment. The farming villages are not crowded because homesteads are established on sizeable plots of fields. Traditional houses were simple ground-floor huts that were easy to build and maintain. Traditional houses are built out of locally available rock, timber and earth. They generally face southeast for maximum sunlight. With their natural colors, the traditional houses blend in well with the surrounding landscape.

Over the years, houses have become more sophisticated and multi-storey. Village architecture began to evolve with changing demands and opportunities. The main drivers of this change are demand for large tourist accommodations and opportunities for tourism businesses. The availability of alternative building materials such as metal roofing, cement and plywood have made construction of large tourist lodges possible. Prior to 1965, all the houses of Namche had roofs made of a combination of shakes, rock slates and bamboo mats. By 1975, around 25% of the homes had changed to aluminum roofing. By 1985 nearly 50% had changed to aluminum roofing and by 1995, nearly all the roofs had converted to aluminum. While the use of aluminum roofing altered the architecture of the village, the availability of the alternative roofing material has saved huge amounts of forests. Tourism also influences settlement growth and expansion patterns. Tourism encourages new expansion and development of houses mostly along the main trails resulting in an increasingly linear pattern of development that is noticeable at places such as Lukla, Phakdingma and Ghat. Since major tourist trails tend to follow direct routes along the rivers, development along these trails makes settlement vulnerable to natural hazards such as floods, fires and landslides. The availability of nearby water sources (springs and streams) was a major consideration for settlement in the old days. Nowadays, water can be piped from faraway places.

Most historic villages have their own unique history and peculiarities. Villages are often grouped into communities. Sharing cultural festivals such as Dumji is the unifying factor for these communities. The villages in the Nangpa valley beyond Namche are considered one community known as Thramichhowa. People of Khumjung and Khunde villages are considered a single community. Similarly, although quite a distance apart, the people of Phortse and Pangboche villages are considered one community and Namche stands on its own. In Pharak, the main traditional villages are Dungete (Chaurikharka), Lhawo (Ghat), Sewongma/Tate, Rimejung, Phakdingma, Phemkaro and Monjo.

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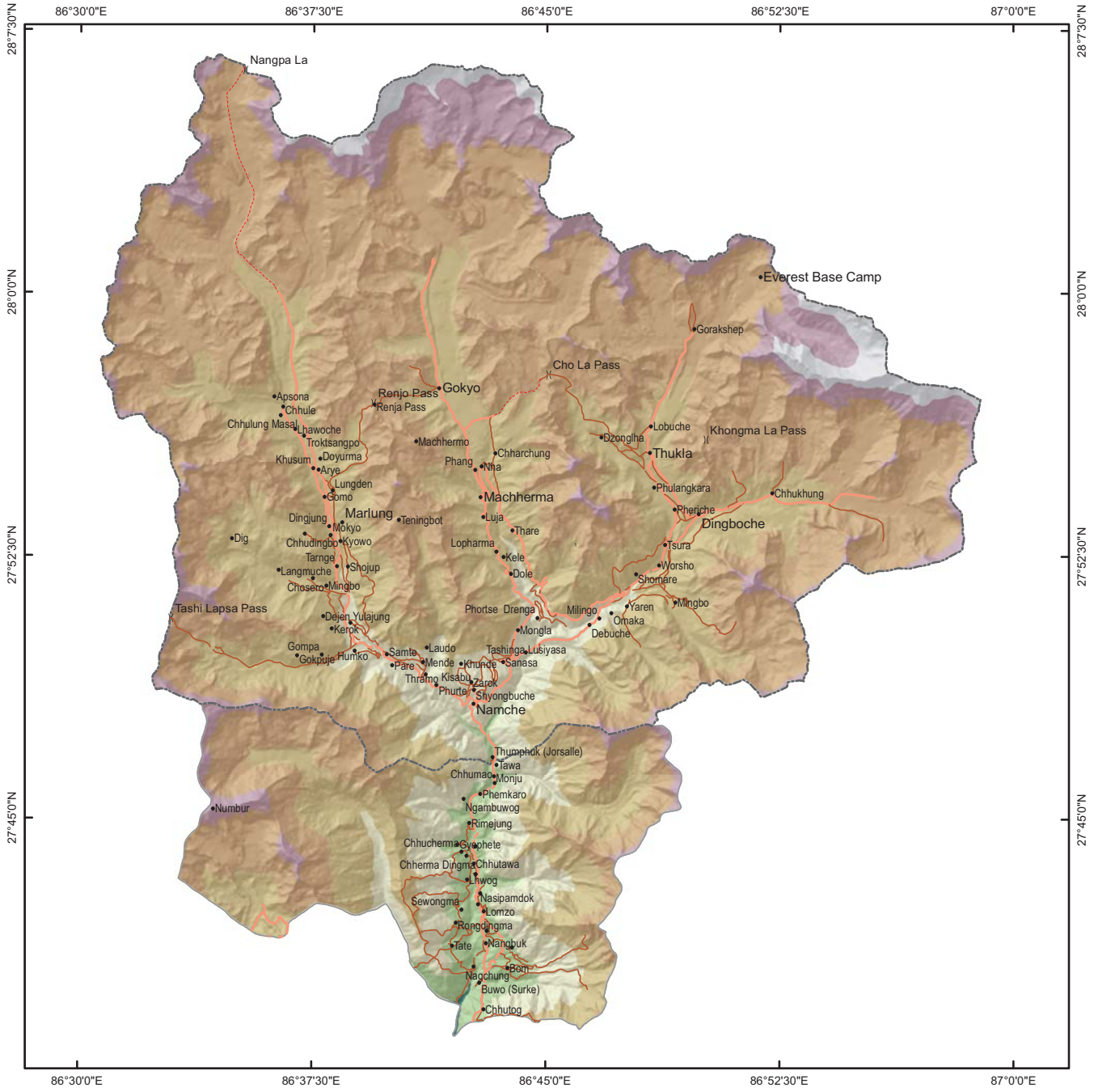
Sagarmatha National Park and Buffer Zone

Settlement

The SNPBZ has more than 100 settlements located at different elevations. These settlements range from small seasonal yak herding camps with a few huts to large commercial tourist centers with multi-storey lodges.



Legend

- Major places
- Pass
- Main trail
- Scondary trail
- Seasonal trail
- Park boundary

0 2.5 5 10 15
Kilometres

Source:
Department of Survey, Government of Nepal
Projection: UTM Zone 45N; Datum: WGS 1984

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International Centre for Integrated Mountain Development (ICIMOD)

ICIMOD

Traditional villagescape of Thangmite Village

Lhakpa Sherpa

Thame and Thangmite Villages

The twin villages of Thame and Thangmite located at 3,750 m elevation are the main settlements in the Nangpa Valley. This valley is the ancient migration and cross-border trading route to Tibet across the Nangpa La. The valley also connects Khumbu with adjacent Rolwaling Valley to the west across the Tashi Labtsa pass. The villages of Thame and Thangmite are on former glacial lake beds and separated by a ridge formed by a glacial side moraine. These villages are located at the upper limit of the sub-alpine forests. The valleys beyond these villages are gentle and are covered with alpine scrublands.

Oral history has it that the settlements in the Nangpa Valley are some of the oldest in Khumbu. There are several monasteries in the valley of which Thame and Kyarok are the oldest. The salt trade decreased in the early 1960s but Nangpa Valley residents could not take advantage of the emerging tourism economy as much as other villages. One reason was that the government kept the upper Nangpa Valley closed for tourist travel until recently for border security reasons. As a result, local people have maintained traditional farming and livestock herding as their dominant economic activities. Many men from the area go away in search of mountaineering and trekking jobs elsewhere. The world's most famous Everest veterans such as Tenzing Norgay, Ang Rhita Sherpa, Apa Sherpa and Tsewang Nyima Sherpa, have their roots in the area.

Sagarmatha National Park
and Buffer Zone

Thame and Thangmite

The twin villages of Thame and Thangmite are located along the the Nangpa river. The scar of the 1985 Dig Tsho GLOF is still distinctly visible.

0 85 170 340 510
Metres

Image Source: IKONOS 2001

Prepared by:
Mountain Environment and Natural
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Settlements of Dingboche and Pheriche on two sides of a hill

Tengboche Monastery

Dingboche and Pheriche

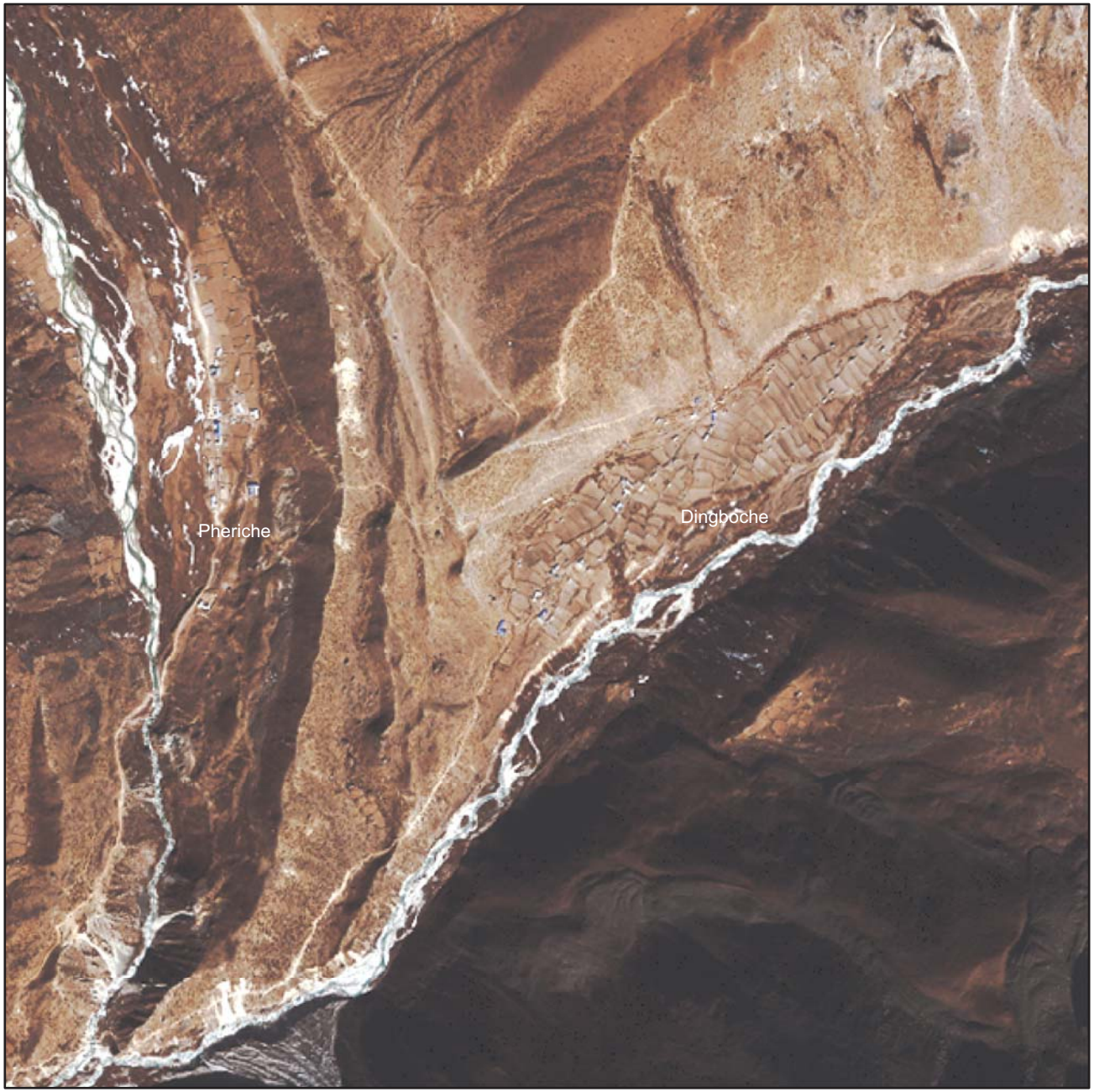
Dingboche is one of the highest (4,530 m) agricultural settlements in Khumbu. Located on a gently-sloping terrain, the settlement receives plenty of sunshine and has good access to water. Dingboche is one of the few places in Khumbu where Tibetan barley is cultivated. In recent years, Dingboche has become a popular junction for tourists.

Many lodges have mushroomed in the village. The village offers fantastic views of Amadablam, Khang Taiga, Tawoche and Imjatse. Namkhar Dzong, one of the revered religious sites of Khumbu, is located on the mountain slope above the village.

During the height of the crop growing season, the villagers impose a very strict form of customary agriculture protection rules where people are not allowed to light fire, cook food or spend nights in the village. Herders and farmers vacate the village and move further up valley in camps. At the head of the valley beyond Dingboche lie several glaciers. One of the largest glacial lakes of the region, the Imja Tso, is formed on the Imja glacier. Immediately to the west of the village lies the sister village of Pheriche, another traditional herding settlement that has become a tourist village. There are many tourist lodges in Pheriche where tourists often spend a night or two before heading up towards Mt. Everest.

Tengboche

Tengboche is not a village. It is the seat of a monastic institution, located on a hill (3,867 m) that was part of the former terminal moraine of a glacier. Its name originates from a boulder with hollow depressions that resembles an imprint of a human heel (tingpije). The boulder can still be seen in front of the monastery. Oral history has it that Lama Sangwa Dorje stood on this rock and left his imprint. Tengboche Monastery was established on this site in 1919 by Lama Gulo. His incarnation, the present abbot, Nawang Tenzing Jangpo, is one of the most respected spiritual leaders in Khumbu.



Sagarmatha National Park
and Buffer Zone

Dingboche and Pheriche

Located above 4000 m elevation, the Dingboche and Pheriche are some of the highest settlements in the Park. They are traditionally agro-pastoral settlements used mostly in summer but now being converted to tourist villages.

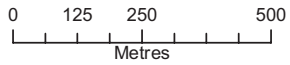


Image Source: IKONOS 2001

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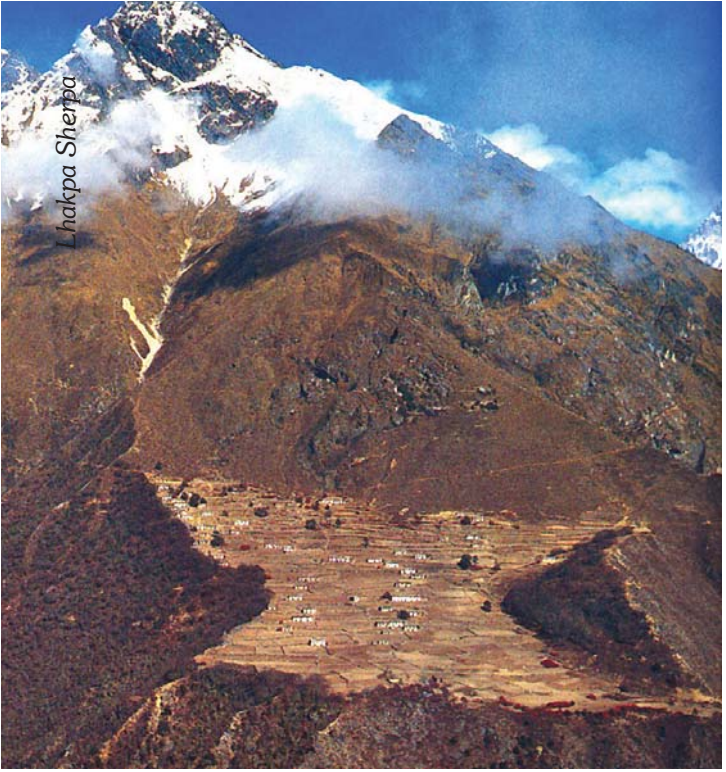

Lhakpa Sherpa

Phortse village located on a unique landscape

Sanu Raja Maharjan

Upper and lower settlements of Pangboche

With the opening of Mt. Everest to mountaineering and then tourism, this isolated religious site has become a major attraction on the tourist route. It has splendid views of mountain and forests. Jomolangma, Lhotse, Nubtse, Ama Dablam. Khang Taiga and Tham Serku tower over it. There are a limited number of lodges and the monastery protects the forests around it.

These forests are home to important alpine plants and animal species and are also a source of firewood and timber for the monastery and surrounding villages.

Phortse and Pangboche

Pangboche and Phortse villages are located nearly five kilometers apart and use different valleys for their summer rangelands. Yet, these two villages are traditionally considered part of the same community because they shared the Pangboche Gonpa to celebrate the annual dumji festivals. In 2001, the Phortse community built its own village monastery and now celebrates the festival locally. Nevertheless, Phortse and Pangboche communities have similar socio-economic characteristics. They both practice mixed farming and tourism as their main sources of income. The big difference is that Pangboche is located directly on the main trail to Everest. Their summer settlements such as Pheriche, Lobuche , Dingboche and Chhukhung have become very profitable places to operate tourist lodges and restaurants. The impact of growing tourism pressure on the alpine environment is also visible. Phortse, on the other hand, receives fewer tourists because it is located off the main trekking trail. Most young people from Phortse go away to work as mountaineering and trekking guides. The village is located on a unique landscape and the community is one of the most cohesive in region, which still enforces customary regulations to protect crops and forests.

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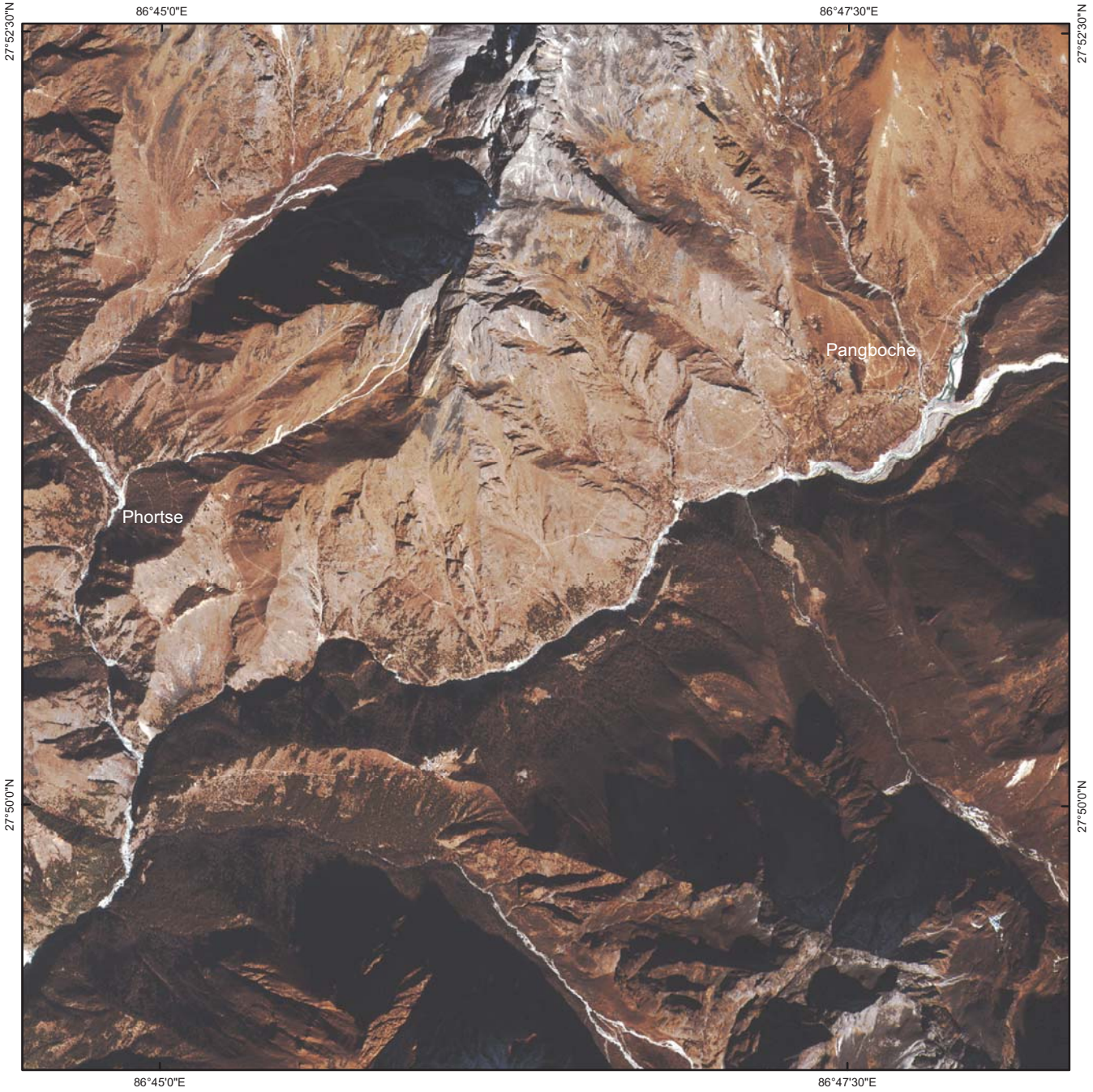

Sagarmatha National Park
and Buffer Zone

Phortse and Pangboche

Phortse and Pangboche villages are among the half a dozen permanent settlements enclaves in the Park. Being located on the main Everest trail, Pangboche has become one of the major tourist places while Phortse receives very few tourists.

0 0.25 0.5 1 1.5
Kilometres

Image Source: IKONOS 2001

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International Centre for Integrated Mountain
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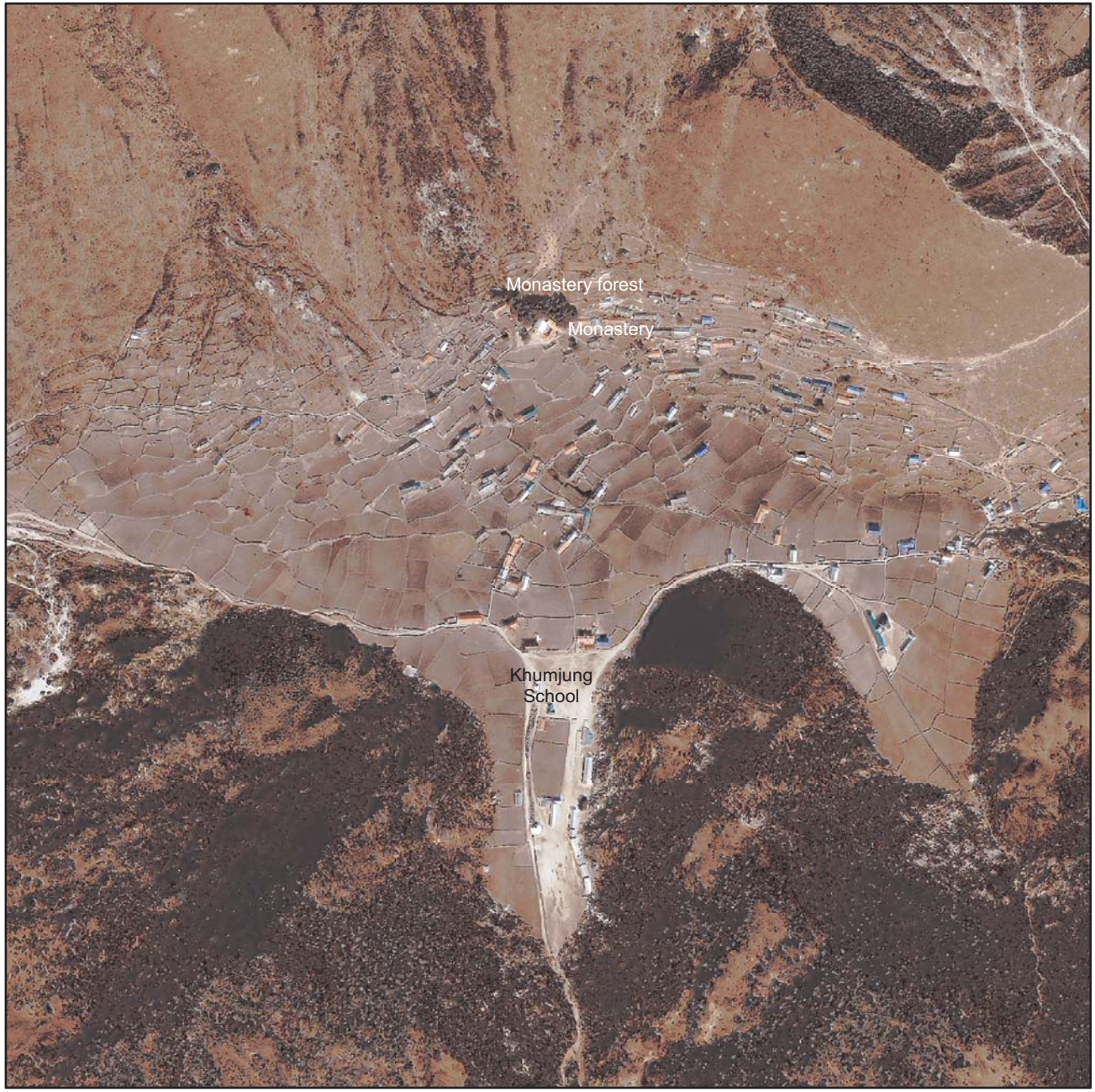
Khumjung-Khunde

Khumjung and Khunde are twin villages located on the lap of Khumbi Yullha—a 5,761 m sacred mountain and home to Khumbu's protector deity. The two villages are located about a kilometer apart separated only by a landslide-prone area. Khumjung and Khunde are some of the Khumbu's most picturesque villages. Located in a quiet valley and protected from the south by forested hills, theses villages enjoy picturesque views of Ama Dablam and Khang Taiga. Khumjung and Khunde villagers share the Gokyo and Imja valleys as their summer pasture and to run tourist businesses. Sir Edmund Hillary built a school in Khumjung in 1961 and a hospital in Khunde in 1964 to improve the health and education facilities of the area. Khumjung High School is one of the best in the region with over 200 students and 17 teachers. The Khunde hospital provides basic health services for local people as well as visitors. Being located at the cross-roads of Nangpa and Gokyo Valleys, Khumjung also receives substantial tourist traffic.

Khumjung village with the roof of the houses having a uniform colour

Alton C. Byers



Sagarmatha National Park
and Buffer Zone

Khumjung

Khumjung Village is located in a quiet valley on the lap of Khumbi Yullha, the mountain on which the protected deity of the area resides. In the early texts, Khumjung and its twin village of Khunde (not visible in the image) are described as resembling a horse facing west. From the space, it looks more like a dinosaur.

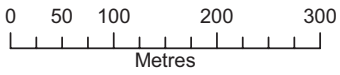


Image Source: IKONOS 2001

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Alton C. Byers

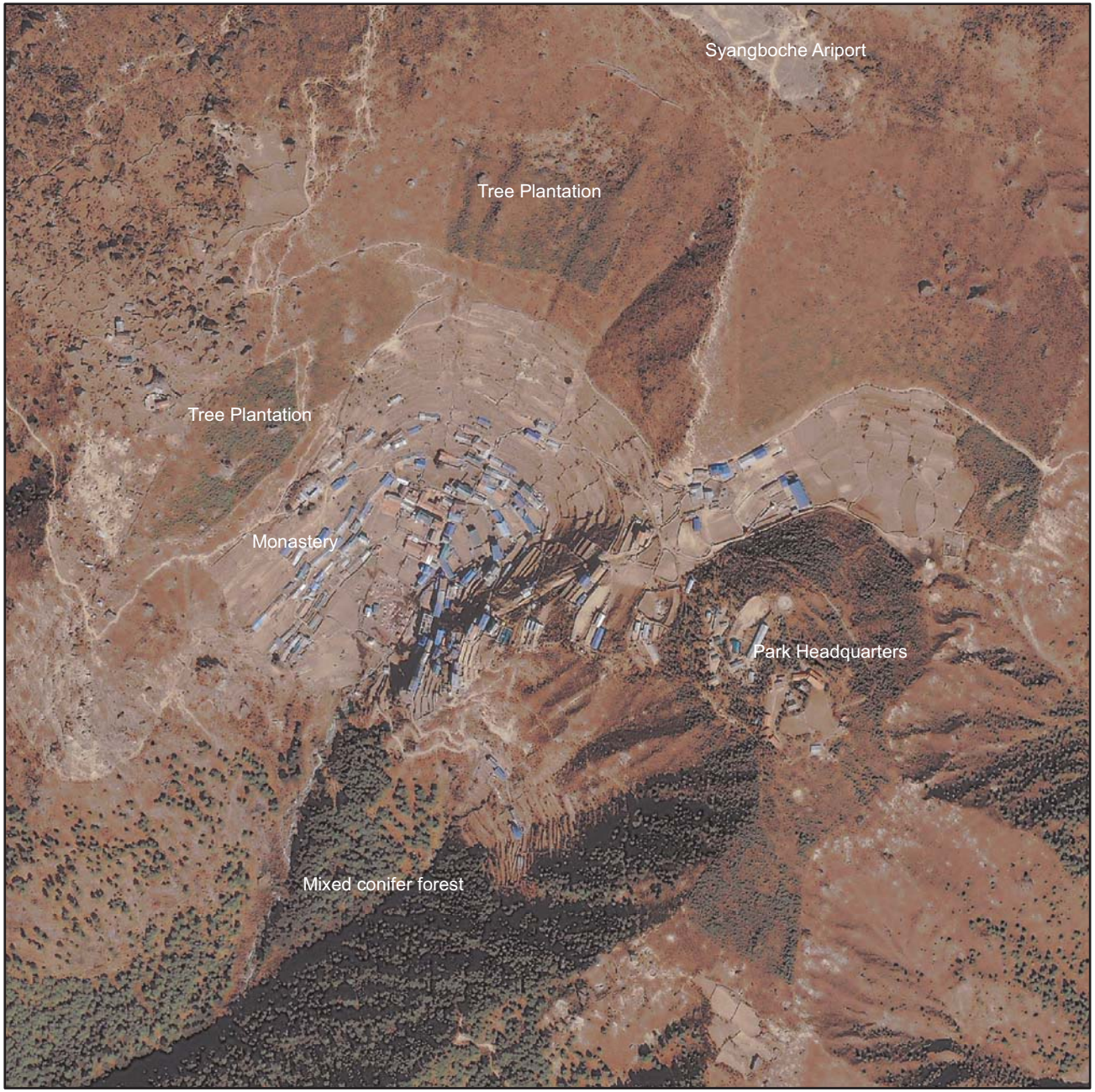
Namche (Nauje)

Namche (Nauje) is one of the youngest and economically most vibrant settlements in Khumbu because of its strategic location at the confluence of two rivers and trails. Namche has become the entry and exit point of Khumbu. This village is said to have been established less than 150 years ago. People from different Khumbu villages moved here seeking trading opportunities. According to oral tradition, the bowl-shaped basin of Namche was once covered with huge old-growth forests of juniper and fir and so was called Nagchhe meaning "the big forest." People cleared the forest and settled to conduct barter trade. One of the earliest trading commodities was Tibetan salt that was bartered with grains from lowland Nepal.

Today, Namche still maintains its importance as a commercial center of Khumbu with its booming tourism businesses. Most of the traditional homes have been converted to tourist lodges. The Namche community is one of the most prosperous in Khumbu with living standards many times higher than that of adjacent farming communities. The town has piped water, a library, internet kiosks, banks, post office, markets, shops, restaurants and other modern amenities. There are also a number of government offices including the headquarters of the Sagarmatha National Park.

The village is now surrounded by forest plantations established jointly by the park and the villagers which will restore Nauje to its former glory as the site of a big forest. Historically, the Namche community celebrated Dumji festival at Khumjung Gonpa. Namche now has its own village monastery and celebrates Dumji festival locally.

Settlement of Namche (Nauje) located in a bowl shaped basin



Sagarmatha National Park
and Buffer Zone

Namche (Nauje)

The local name is Nauje. t was so named because of a big forest that existed in the areas before people settled there. Much of the forests have been removed over last hundred years of settlement. t is one of the youngest and most vibrant commercial and administrative centre ofKhumbu.

0 50 100 200 300
Metres

Image Source: IKONOS 2001

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Changing architecture of Sherpa village in Phakding

Phakdingma (Phugdingma)

Phakdingma is named after phug (a cave) and a dingma (flat areas). It is a small settlement in the Pharak valley that is now within the Buffer Zone of Sagarmatha National Park. The Pharak region is located in the main Dudh Koshi gorge. Like many other Pharak villages, Phakdingma is located on an old river terrace. As the river cut deeper channels, people settled on the elevated terrace to farm and raise animals. Located at an elevation of 2,800 m, Phakdingma enjoys a temperate climate with ample forests. It has good potential for agriculture, especially vegetable farming. People of Phakdingma originally relied heavily on forest products and subsistence farming. Houses were simple ground floor wooden structures. Phakdingma has now transformed into a sizeable tourist village because of its location between Lukla and Namche. Most tourists traveling on foot to Lukla airport from Namche or vice versa arrive at Phakdingma for the night. As lodges developed along the sides of the trail many new settlers have gravitated into the area to take advantage of tourism work.

Lukla

Lukla means "sheep corral". Lukla was an isolated livestock-herding village only 45 years ago, before Sir Edmund Hillary selected the long and gently-sloping farming areas for an airstrip in 1964. Sir Edmund Hillary first built this mountain airport to transport his school building supplies. This airstrip has become the main gateway to Khumbu. For many years, it only operated during the dry season and remained closed during monsoon. In 2001, the runway was blacktopped and became fit for landing a wider range of aircraft in all weather conditions. The business potential of Lukla grew with the increase in visitor flow. Entrepreneurs and workers from other parts of Nepal have migrated to Lukla for the business opportunities. This once isolated livestock-herding settlement has now become a multi-cultural settlement and a major centre for tourist businesses. Land prices rose sharply and the township grew and expanded organically without much planning. Much of the growth and development is along the main tourist thoroughfare. Lukla has an ideal climate for vegetation growth. Before the airport was built, the village was surrounded with dense forests of mature oak and hemlock. The sudden increase in timber and firewood demand led to rapid destruction of the surrounding forests. Today, the forests of Lukla area are characterised mostly by young regeneration. Lukla has a monastery, hospital and a high primary school.

The fast growing Lukla village

Sagarmatha National Park and Buffer Zone

Lukla

Historically, Lukla was a small herding and farming village. It grew rapidly after Sir Edmund Hillary built the airport in 1964. It is now the main gateway to Khumbu and a growing tourist town.

0 50 100 200 300
Metres

Image Source: IKONOS 2001

Prepared by:
Mountain Environment and Natural Resources Information Systems (MENRIS)
International Centre for Integrated Mountain Development (ICIMOD)

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3.4 Agriculture Practices

In the Sagarmatha National Park, traditional agriculture is still practiced by the local people. The cultivated areas are considered part of the Park Buffer Zone. Much of the park land is located above 4,000 m which supports limited agriculture. The young mountain soils, short growing season and steep topography exclude productive agriculture. Cultivated areas make up less than 1% of the total land area of the park. Potato is the main high-altitude crop that is grown skillfully up to 4,000 m elevation. In some areas, buckwheat and barley are also grown. In the lower valleys of Pharak where the climate is warmer and wetter, a wider range of crops such as wheat, maize, beans and some millet can be grown. Agriculture in Khumbu and Pharak is largely dependent on monsoon rain and irrigation and terracing is uncommon. Cultivated fields are mostly found on level areas and are fenced by stone walls to keep the livestock away. Most village homes are built amidst agricultural fields. Fields are fertilized once a year with composted livestock manure and human waste.

Yak resting on alpine pasture after transporting heavy loads over the Nagpa pass

People harvesting potatoes in Tham

Agricultural activities take place between April and September. The mountainous topography and small plot size makes mechanisation difficult and farming activities are carried out manually in a very labor-intensive manner. Agriculture and herding activities are vulnerable to farm labor shortages. As a significant portion of active labor has shifted to work in tourism, farming is left with inadequate manpower that affects its productivity and sustainability. Only about 22% of the households are entirely dependent on agriculture and about 37% are said to be partially involved. The higher elevation areas above 4,000 m are used for grazing livestock. During the heavy snowfall in mid-winter, herders move down to lower settlement (gunsa). This transhumance practice is vital for the sustainability of agriculture and pastoral systems in the mountains. This ensures crop protection and rotational grazing that is important for rangeland quality. This system was enforced by the community through a customary regulation known as dee and appointing an enforcer known as nawa. In some settlements, this practice is still active but it is disappearing in others due to changing socio-economic demands.

3.5 Livestock Herding

Livestock farming is strongly linked to the agricultural system. One of the commonly cited reasons for keeping livestock is to supply manure for agriculture, so livestock and agriculture are inseparable parts of the same system. Along with growing crops for human consumption, farmers also manage hay fields for producing supplementary winter fodder for their livestock. The main livestock found in the area are yaks and naks, cows and bulls, and dzo and zom. Sheep, goats and horses are few in numbers. Pigs and chickens are traditionally not raised by Sherpas.

Yaks and naks are the male and female of the same species Bos grunniens and are well adapted to high altitudes. They are found throughout the highlands of the Himalayas, Tibetan plateau, and Pamir and Altai Mountains of central Asia. In the Himalayas, they are found only above 3,000 m elevation as being heavily coated, they are intolerant of hot conditions. In the summer they range up to 5,000 m elevation. In 2008, there were about 5,000 large livestock in Khumbu and Pharak of which only 50% were yaks and naks. The other 50% were yak-cow cross breeds, horses and mules. The number of herding families has been declining in recent years because many traditional herding families have opted for off-farm occupations such as in tourism. In the past, people kept more female animals for breeding, milking and wool production. Nowadays, demand has shifted to more male animals (dzos and yaks) for transporting goods. This demand is also encouraging introduction of non-traditional animals such as mules and donkeys.

3.6 Trade

Historically, the trans-Himalayan salt trade with the neighboring Tibetan regions was a major economic activity of Khumbu people. The main item of trade was Tibetan rock salt. The trans-Himalayan trade still continues but it has changed drastically. Tibetan salt is no longer imported because of the decline in demand due to competition from Indian salt. Now, salt has been replaced by manufactured items from China (clothing, blankets, electronics, food and beverages). Traditional Tibetan products such as salt, dry mutton, fat, barley, tea and wool are also brought but only in limited quantities. Payments for these products are made mainly in cash earned from tourism. The trans-border trade with Tibet is still very important for the Khumbu residents as the cost of transportation of goods and supplies from Kathmandu is becoming prohibitive.

Tibetan traders selling Chinese products in Thame

Weekly haat bazaar in Namche

4. Mountain Tourism

4.1 Climbing of Everest

The discovery that Jomolangma was the highest mountain in the world started a race to the summit. Explorers and mountaineers from many countries began to mount expeditions. For many it became an issue of national prestige and so they wanted to reach the summit by any means. A British pilot is known to have planned a crash landing on the slope of the mountain followed by a walk up to the summit. Luckily, this plan was aborted. For many years, the sheer remoteness and the unwelcoming attitude of the Nepalese and Tibetan governments kept many mountaineers at bay. The indigenous people who lived around the mountain's base were not keen to see outsiders climb all over their sacred mountain. They believed that such activities would offend the deities and cause misfortune. Despite the negative local sentiment, an Everest reconnaissance team arrived in Tibet in 1920. British Army Officer Lieutenant Colonel Francis Edward Younghusband stated that, "it stands to reason that men with any zest for mountaineering could not possibly allow Mt. Everest to remain untouched" (Haward-Bury 1921). Zatrul Rinpoche, the abbot of Rongphu Monastery located near the base of Everest was hospitable and kind to foreign climbers but privately he was not pleased with mountaineering. He confided to his monks that Jomolangma would not be climbed during his lifetime but predicted that once it was climbed things would not be the same. The abbot of Rongphu passed away in 1940. Explorers and climbers from all over the world continued to attempt to reach its summit. Edmund Hillary and Tenzing Norgay became the first to reach the summit in 1953. This ascent was made by approaching the mountain from the south slope from the Khumbu valley. More than 2,500 people from 78 countries have reached its summit more than 4,000 times since then.

Edmund Hillary and Tenzing Norgay, the first men to reach the summit of Mt. Everest in 1953.
Source: Royal Geographical Society, London

4.2 Growing Tourism

The climbing of Everest drew much international attention to the area. The news captured the imaginations of many young people around the world. As a result, the number of people wanting to climb Everest or just see the mountain increased. Prior to the 1960s, the visitors spent long periods of time trying to reach the destination and climb the mountains. The remoteness and sheer difficulty of getting in and out kept the number of trekkers low. Those who chose to visit had to walk for many days on the trail. The establishment of several mountain airstrips suddenly changed this situation as air access dramatically increased the number of visitors. Khumbu became the main access to Everest especially due to the closure of Tibet during the Cultural Revolution from 1950-1980. Visitors traveling to the Everest region became known as trekkers and providing services to trekkers became a new commercial venture. More visitors started to flock to the area as trekking agencies promoted the region. Records show that Khumbu received only 20 foreign visitors in 1963 and this number swelled to 30,000 in 2008. However, the visitor numbers did drop during the height of Maoist insurgency from 1996 to 2004 because of security concerns. The most popular destinations are Namche, Tengboche, Dingboche, Lobuche, Kalapatthar and Gokyo Lake. Only about 25% of the visitors visit the Nangpa Valley. Most trekkers spend 10-14 days in the area and mountaineering expeditions are allowed to stay up to two months. Most visitors hire at least one person as a porter or a guide. Of the hundreds of mountaineering expedition groups that arrive in Nepal from all over the world, the majority go to Khumbu to climb the large and small peaks of the area. Climbing permits are issued by the government of Nepal upon payment of a fee, which varies according to the heights of the mountains. Smaller peaks below 6,000 m elevation may cost less and permits for these peaks are issued through the Nepal Mountaineering Association.

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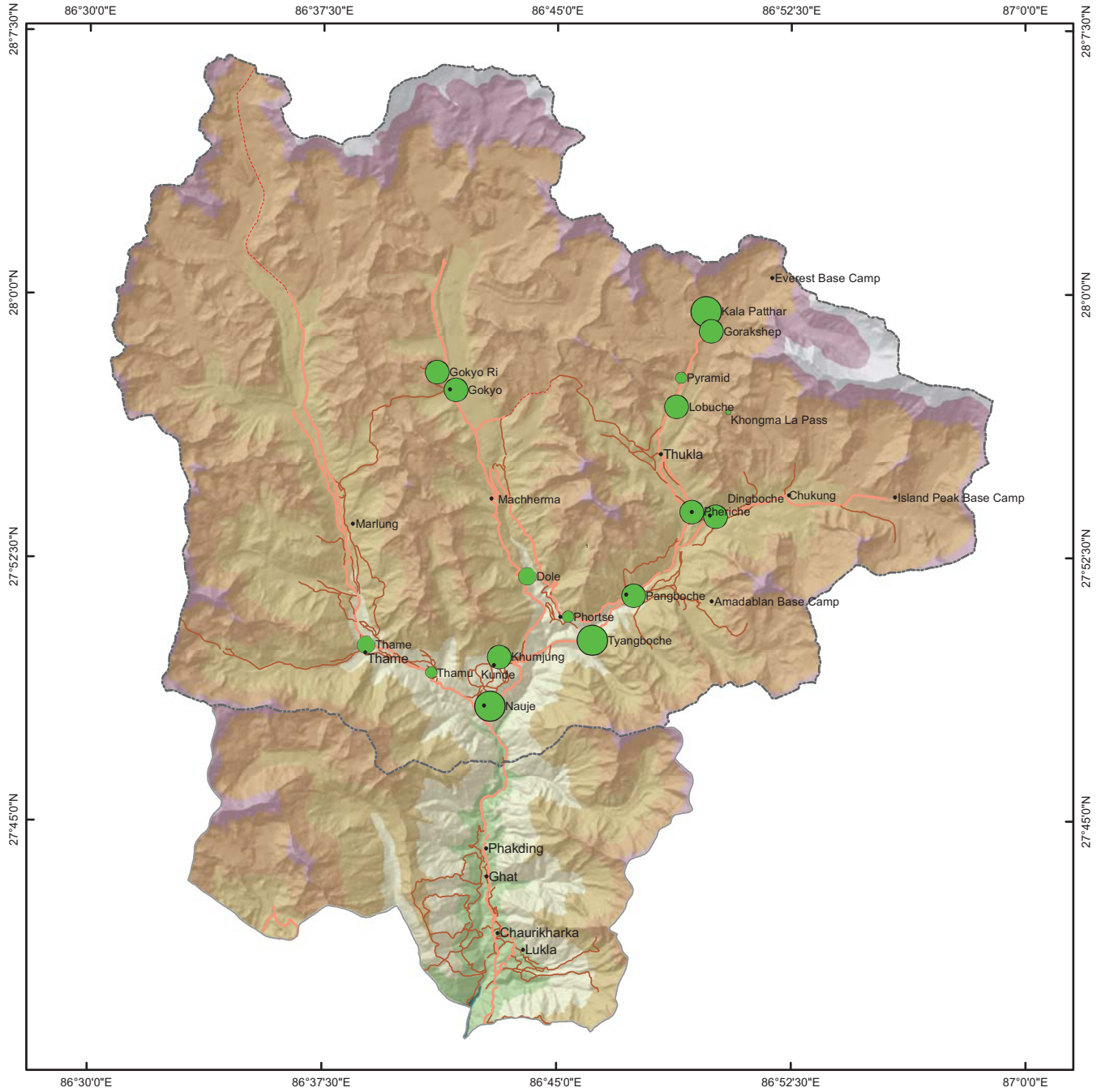
Visitors by Location (Percent)

A survey conducted by HKKH Project showed that majority of the people visiting Sagarmatha National Park visit Namche, Tengboche, and Kala Patthar in the Imja Valley. The Nangpa Valley to the west receives very little visitors and remains culturally intact.



Legend

- Major places
- Park boundary
- Main trail
- Scondary trail
- Seasonal trail

In percent

- Up to 5
- 6 - 20
- 21 - 30
- 31 - 50
- Above 50

0 2.5 5 10 15
Kilometres

Source:
Visitor survey, CESVI, 2007
Projection: UTM Zone 45N; Datum: WGS 1984

Prepared by:
Mountain Environment and Natural Resources Information Systems (MENRIS)
International Centre for Integrated Mountain Development (ICIMOD)

ICIMOD

4.3 Seasonality of Tourist Flow

The most challenging aspect of visitor management in SNPBZ is its seasonality. Both mountaineering and trekking activities are currently concentrated during the spring and fall seasons. The numbers drop drastically during the summer and winter months because of unfavorable weather conditions. Winter months are a little too cold for most visitors. In monsoon Khumbu is green, lush and extremely pleasant but the cloudy and rainy conditions make air travel uncertain. Besides, most visitors come for the mountain scenery and cloudy monsoon conditions can obstruct mountain views. Most visitors arrive during the spring and autumn with over 80% of the visitors arriving in these seasons. As a result, periodic overcrowding has been experienced along the popular trekking trails during the peak season, usually only for a brief period during October. In the longer term the visitor numbers to Khumbu are expected to grow. The high demand for accommodation and services during the peak season is driving overdevelopment of tourist hotels and lodges. These facilities remain full only during the peak seasons.

About 30,000 tourists visited the park in 2008

Lhakpa Sherpa

4.4 Socio-Economic and Environmental Concerns

Tourism is the strongest driver of socio-economic change in Khumbu. Operating lodges and restaurants and working as a guide or porter are the most common ways to make a living from tourism. These alternative economic opportunities are beginning to replace other more traditional economic activities such as agriculture, livestock management and trade. Because switching to lodge and hotel operation and working as guides brings quick cash income many of the homes and yak herding shelters are being converted to profitable tourist accommodation. The first tourist lodge opened in Namche in 1971 and by 1978 there were 17 lodges. Now, there are now nearly 500 lodges and more are being added every year. Tourism businesses and employment bring cash income to families and an increased standard of living. It has improved people's ability to educate children, pay for healthcare, and go for religious pilgrimage. It has also helped build friendships and connections internationally enabling local to seek opportunities elsewhere in the world. Nevertheless, there are also challenges associated with the tourism economy. The reliability and sustainability of the tourism business is in question. It is vulnerable to all kinds of internal and external factors such as global economic recession, conflicts and fuel crisis. Tourism also tends to displace other locally based livelihood strategies such as farming, herding and trading. This makes the region dependent on imported commodities and supplies and causes inflation. There is a genuine concern that a sudden collapse of the tourism industry could create major economic adjustment problems. Returning to agriculture, livestock and traditional skills would be challenging.

According to the local people, only about 20% of the total money a tourist spends on a trip to the Everest region actually stays in the region. The remaining 80% goes to pay for international and local air travel, commercial trekking and mountaineering outfitters, purchase supplies and products and hire outside staff. This demonstrates the positive role of Sagarmatha National Park in benefiting the economy beyond its boundary. It also shows that the

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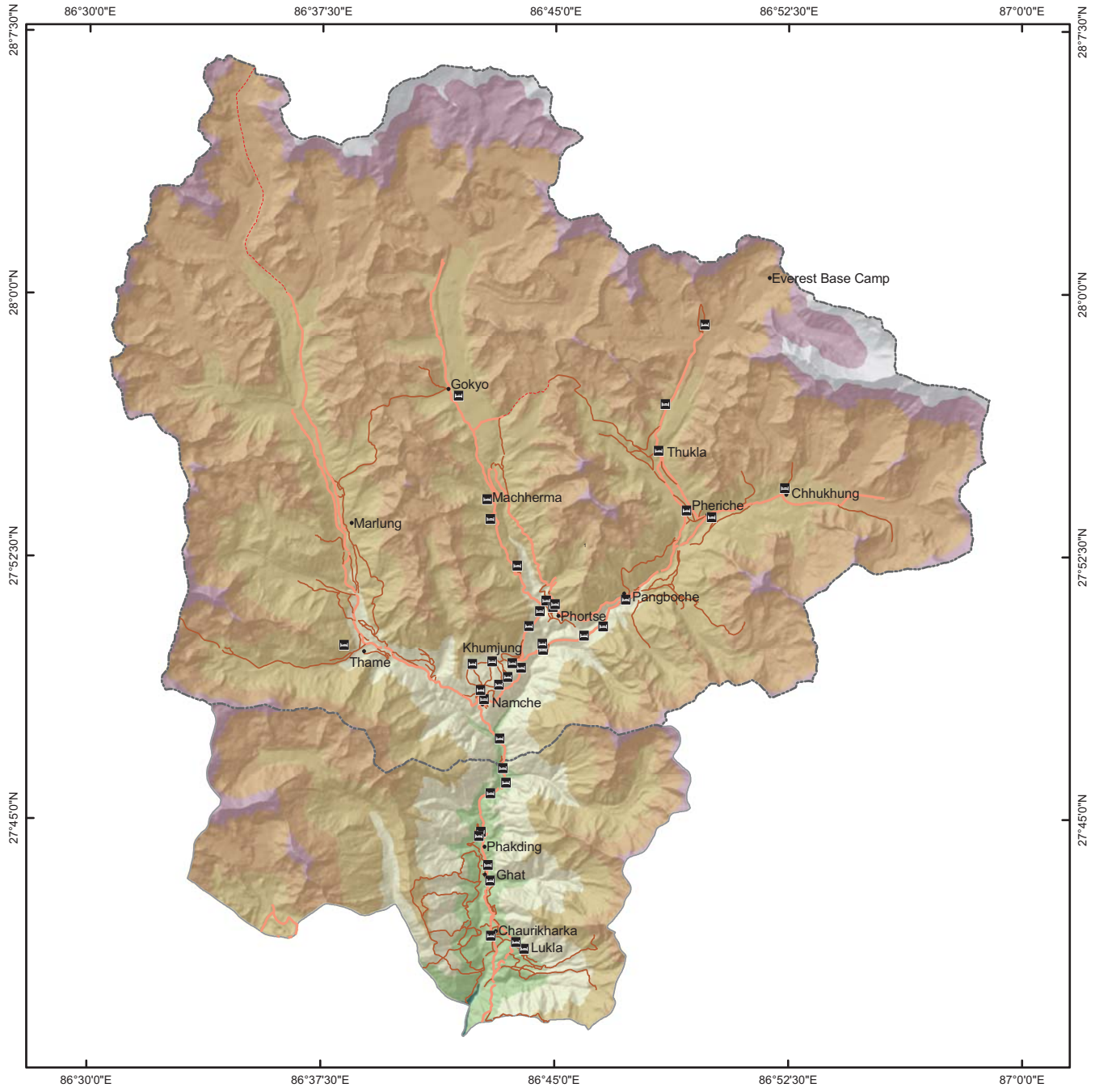
Hotels

The hotels and lodges are concentrated mainly between Lukla and Everest Base Camp where most visitors go. Gokyo Valley is also popular. The Nangpa Valley is developing very fast as visitors seek less crowded destinations.



Legend

- Main Trail
- Scondary trail
- Seasonal
- Major places
- Hotel
- Park boundary

0 2.5 5 10 15
Kilometres

Source:
Department of Survey, Government of Nepal
Projection: UTM Zone 45N; Datum: WGS 1984

Prepared by:
Mountain Environment and Natural Resources Information Systems (MENRIS)
International Centre for Integrated Mountain Development (ICIMOD)

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benefits to local communities are only marginal compared to the impacts. There are concerns ranging from negative impact on the environment, cultural erosion, and perceived loss of local identity and language. Since tourism incomes are not equitably distributed within the community, there are widening gaps between rich and poor households.

When managed well, tourism can be one of the most environmentally friendly economic ventures. Uncontrolled and poorly managed tourism can bring negative environmental consequences including deforestation, wildlife poaching, land encroachment, uncontrolled development, pollution, and landscape damage through mining and infrastructure construction. In Khumbu, establishment of the Park was a proactive measure in the right direction to mitigate the environmental impacts of tourism. Before the Park was established, trekkers and mountaineers mostly camped and freely used firewood collected from the surrounding forests for cooking, heading and campfires. Litter around camp sites and trails were common sights. Timber for building tourist facilities was harvested in the local forests. The establishment of the Park and its regulatory measures, helped curb impact of deforestation and pollution.The tourist impact at the local level can be managed through good planning and management.

Global warming is an emerging environmental concern because almost 60% of the park's land falls under an extremely high-elevation zone where a mixture of snow, ice, water and bare rock covers the landscape. The accelerated melting of glaciers and snow on mountain tops is likely to affect the water availability, biological diversity and aesthetic quality of the Park in the future.

Massive constructions taking place in Namche

Narendra Byanchanya

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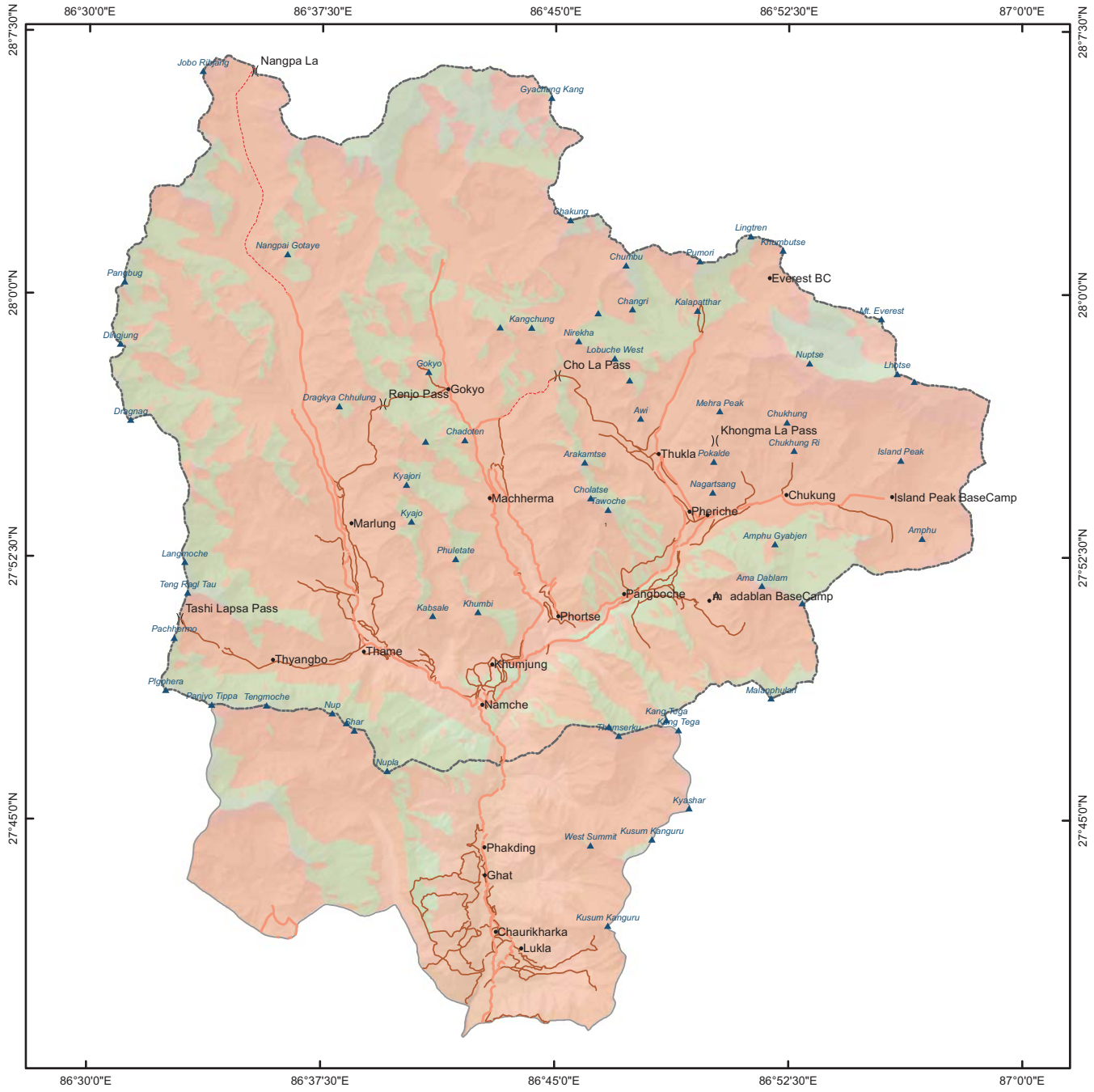
Visibility of Mt. Everest

Mt. Everest is the main attraction for visitors in SNP. The map has been generated by using a digital elevation model and shows the areas from where Mt. Everest can be seen.



Legend

- Main trail
- Scondary trail
- Seasonal trail
- Peaks
- Pass
- Major places
- Park boundary

Visibility of Mt. Everest
- Not Visible
- Visible

0 2.5 5 10 15
Kilometres

Source:
Derived from Digital Elevation Model, MENRIS, ICIMOD
Department of Survey, Government of Nepal
Projection: UTM Zone 45N; Datum: WGS 1984

Prepared by:
Mountain Environment and Natural Resources Information Systems (MENRIS)
International Centre for Integrated Mountain Development (ICIMOD)

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List of schools in SNPBZ

S. No	School Name and Location	Buildings	Teachers	Boys	Girls	Total
1	Khumjung High School	17	14	141	147	288
2	Pangboche Primary School	3	3	23	22	45
3	Phortse Primary School	2	3	17	26	43
4	Tengboche Gonpa School	0	1	12		12
5	Himalaya Primary School, Namche	3	3	49	38	87
6	Namche Primary School, Thamo	2	3	9	8	17
7	Thame Lower Secondary School	4	7	41	33	74
8	Thame Gonpa School			16		16
9	Jansewa Primary School, Gumela	3	4	55	62	117
10	Karma Jansewa Primary School, Sewongma	1	1	6	8	14
11	Lukla Primary School	3	5	149	153	302
12	Mahendra Jyoti High School, Chaurikharka	9	11	173	210	383
13	Pema Choling Primary, Rimejung	2	1	29	35	64
14	Sagarmatha Primary School, Surke	1	4	20	10	30
15	Yubabarsha Primary School, Monjo	3	8	40	32	72
16	Lukla Gonpa School			25		25
17	Pema Chholin Gonpa School, Gumela			15		15
	Total	**53**	**68**	**820**	**784**	**1604**

Sir Edmund Hillary's statue at Khumjung High School, Khumjung

5. Development Infrastructure

5.1 School

Prior to the development of modern schools, monasteries were the only educational institutions. Since only the students ordained to become monks joined the monasteries, the majority of the laypersons were left without any formal education. Some children received rudimentary instruction at home in Sambhota script from their elders. The first initiative to teach local people Nepali language and Devanagari script in Khumbu began in 1960 when the government assigned teachers to start schools in Namche and Chaurikharka villages but the initiative lacked proper facilities. Establishment of schools with proper classrooms and qualified teachers began in 1961 when Sir Edmund Hillary established the Khumjung School. This was followed by more requests for help by the neighboring villages of Thame, Pangboche, Phortse, and others in Pharak. There are now eleven primary, two higher secondary schools, and four Gonpa schools in SNPBZ. Finding trained teachers is a major challenge in these mountain schools so many children are sent to schools in Kathmandu and elsewhere. This exodus, along with effective birth control measures, is having an impact on student numbers in these remote schools.

Since there were no local people literate in Nepali and English, Sir Edmund Hillary initially recruited teachers from Sherpa communities in Darjeeling. However, the government education policies of the time forbade the local language and script being taught in schools. The teaching of Nepali and English in schools led to broadening of opportunities in business and the travel industry. The literacy rate among Solukhumbu Sherpa is comparable to the national average of 54%. The literacy rate among males is slightly higher than that of females. However, the number of Sherpas with college and university degrees is still extremely low. Formal education without mother tongue use has led to rapid decline in Sherpa language and culture. This process still continues despite the post-1990 changes in government policy towards indigenous languages. Like many other ethnic groups of Nepal,

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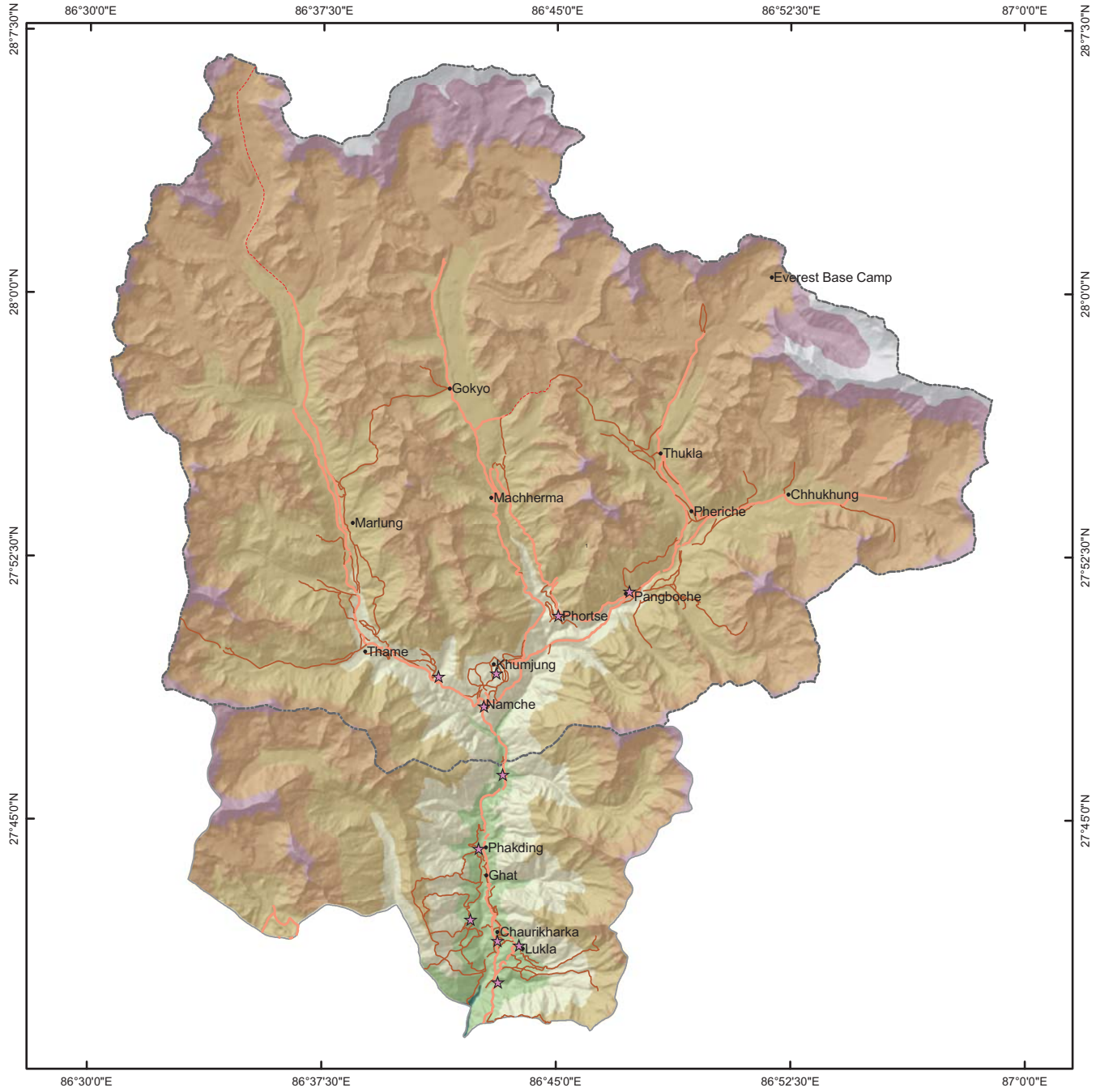
Sagarmatha National Park and Buffer Zone

Schools

Formal education started in 1961 with the establishment of Khumjung School by Sir Edmund Hillary. Presently, there are 13 village schools and four Gonpa Schools.



Legend

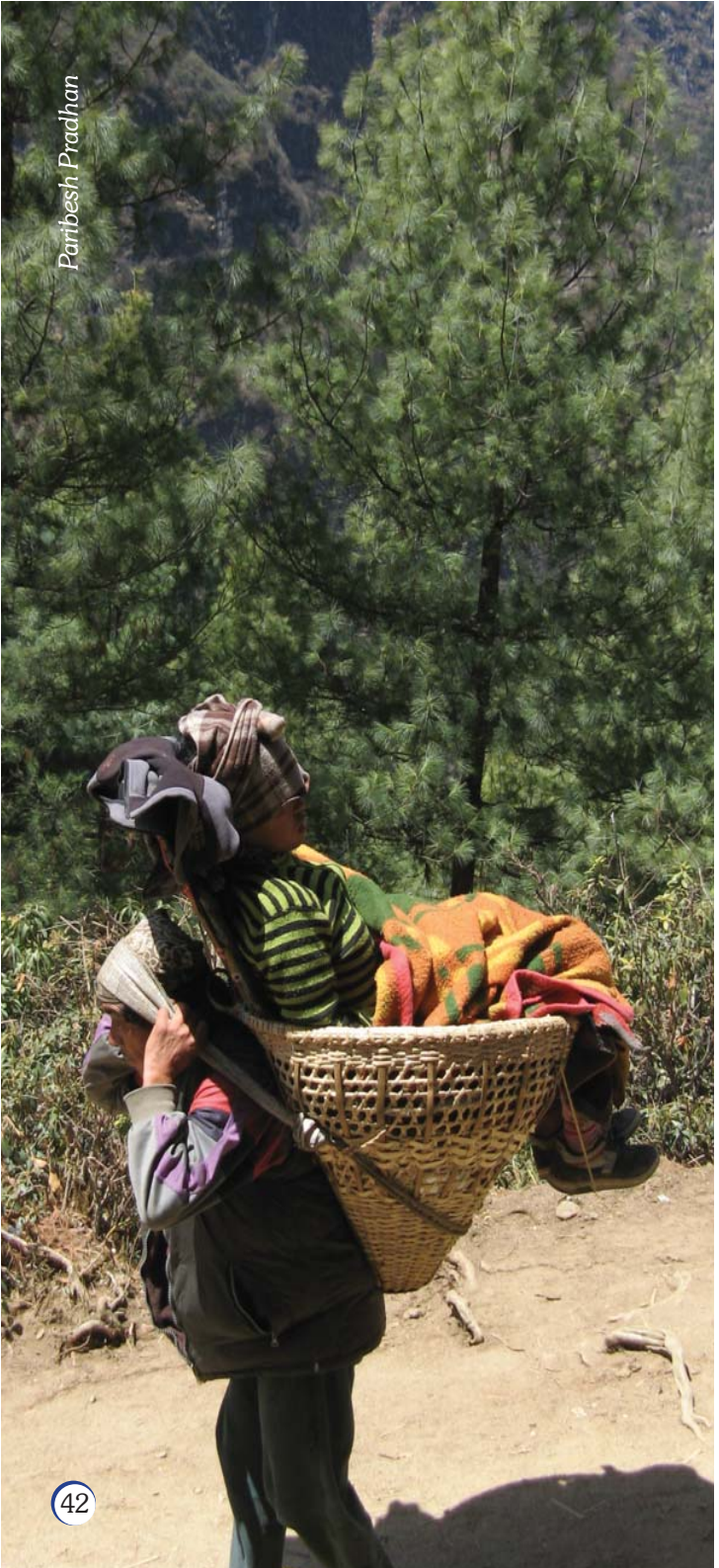
- Main trail
- Scondary trail
- Seasonal trail
- Major places
- School
- Park boundary

0 2.5 5 10 15
Kilometres

Source:
Department of Survey, Government of Nepal
Projection: UTM Zone 45N; Datum: WGS 1984

Prepared by:
Mountain Environment and Natural Resources Information Systems (MENRIS)
International Centre for Integrated Mountain Development (ICIMOD)

ICIMOD



Paribesh Pradhan

A sick woman being carried to health post

Sherpas are now seeking to reverse this trend of language loss by integrating Sherpa language in schools.

5.2 Hospital and Health Posts

Compared to many other remote mountain regions, Khumbu has relatively well-developed health facilities. There are two hospitals and half a dozen village clinics in the area. Prior to establishment of these facilities, local people relied on traditional herbal medicine of Amchis, spirit mediums and religious practitioners for cure. Although the traditional healers are believed to be effective in treating certain psychosomatic problems, not all physical ailments respond to traditional healing methods. Local people were known to approach passing explorers and mountaineers for western medicines long before modern hospitals were ever established. Nevertheless, traditional ways of healing are still popular. The people also make use of the network of hospitals and clinics established in the area for basic health services.

Khunde Hospital was established in 1966 by Sir Edmund Hillary. It was run by volunteer doctors from New Zealand and Canada for many years but is now staffed entirely by local doctors and nurses. Khunde provides regular medical services to the local communities at a very low cost. Trekkers and visitors can also seek basic treatments for a fee. The hospital has an outpatient clinic, short and long stay wards, ultrasound, laboratory, oxygen concentrator for treating altitude sickness and a pharmacy that sells common pharmaceuticals. The doctors at Khunde Hospital also supervise a network of village clinics located at Thame, Phortse, Monjo and Debuche villages. These clinics are staffed by locally trained health workers and provide simple treatments. The hospital is financially supported by the Himalayan Trust and Sir Edmund Hillary Foundation of Canada.

Namche Dental Clinic supported by the American Himalayan Foundation and Everest Marathon organizers was established in 1991 to address the problem of increasing tooth decay among Sherpa children along the trekking trails because of change in food habits. The clinic is run by a trained local dental hygienist. The clinic offers both preventive and curative services to the local community and schools as well as to trekkers.

Government Health Post at Namche was established in the early 1970s and operated from a rented house for many years. It recently built its own building with support from the local community. The other two government health posts are located in Chheplung and Pangboche villages. Ensuring adequate medicines and dedicated staff has always been a challenge in government-operated health posts in remote areas and these suffer similar problems.

High Altitude Clinics respond to the needs of trekkers and mountaineers, Acute Mountain Sickness (AMS). Visitors from around the world who are not used to high altitudes often fall ill in Khumbu if not properly acclimatised. This also includes porters and guides originating from lower parts of Nepal. Rapid ascent without giving adequate time to physically adjust to the rising altitude is said to be the main cause of AMS. AMS kills quickly if not detected and treated in time. According to Khunde Hospital sources, an estimated 200 people have died in Khumbu from high-altitude sickness over the last 25 years. Dr. Peter Hackett responded to this need and the Himalayan Rescue Association (HRA) of Nepal started a high-altitude clinic at Pheriche in 1973. The clinic provides emergency assistance to trekkers suffering from AMS. However, the clinic operates only during the peak trekking seasons and is staffed by volunteer doctors from overseas and supported by local staff. More recently, a clinic was also established at Machermo village in Gokyo valley to assist porters suffering from high-altitude sickness.

Lukla Hospital (The Pasang Lhamu - Nicole Niquille Hospital) was built in 2005. The construction of this hospital was funded by a private donor - Nicole Niquille in collaboration with the Pasang Lhamu Foundation. Nicole

Niquille is a Swiss national and a professional guide who suffered paralysis from a climbing accident in 1994. She donated part of the money she received from her insurance to build the 12-bed hospital equipped with maternity, dental, emergency, surgery and family health care facilities. It is intended to serve the population of Chaurikharka and Kharikhola VDC that are not accessible to other hospitals. The hospital is currently staffed with volunteer doctors from overseas and local Nepali graduates.

Namche Healing Centre is a non-profit social service venture supported by the Sacred Land Initiatives. It was conceived in 1988 to re-establish the Tibetan herbal medical tradition and offer herbal treatments. Medicine is given at a subsidized cost to those who can not afford care. The clinic also has an exhibit of Himalayan herbal medicines. The centre is staffed by an Amchi who also gives advice on healthcare, diet, meditation and relaxation techniques. Associated with the Namche Healing Centre is an initiative to grow medicinal herbs on farms to prevent depletion of wild stocks from continuous collection.

5.3 Airports and Landing Strips

Among Nepal's 75 districts, Solukhumbu is known as the district with highest number of airfields. These are located in Lukla, Phaplu, Shyangboche, Kangel and Mingbo. Out of the five airfields in the district, three are located within the boundary of SNPBZ.

Tenzing-Hillary Airport of Lukla was built in 1964 by Sir Edmund Hillary. The initial purpose was to transport supplies for his development projects. Located about 15 km south of the Everest Base Camp at a moderate elevation of 2,800 m, the Lukla airport has become the main entry point to Khumbu. It has a short 527 m long and 20 m wide runway built on land with a 12% slope from bottom to top. This airport now lands over 50 flights a day during peak tourist seasons and delivers more than 500 people on a busy day. The Lukla airport was named Tenzing Hillary Airport in 2003 on the occasion of the 50th anniversary of the climbing of Everest to honor Sir Edmund Hillary and Tenzing Norgay. Over 90% of the people visiting the region arrive by air at this airport.

Mingbo Airstrip was built long before Lukla by Hillary to transport mountaineering gear for a research expedition on Ama Dablam. The strip was built at Mingbo, close to Mt. Ama Dablam base camp. A pre-fabricated aluminum structure was flown to Mingbo, carried to Khumjung and installed as the first Khumjung school building in 1961. The building is still being used as a classroom but the Mingbo airstrip never became popular.

Shyangboche Airport is located at 3,600 m elevation between villages of Namche and Khumjung. It was built in 1974 by a Japanese business to access the Everest View Hotel, located in Khumjung VDC. The airport was not only used for transporting hotel guests but also by the general public. It is rarely operational now because of a lack of suitable aircraft. Although there are no regular flights, the airport still is valuable for transporting cargo and rescue helicopters. A plan to expand the airport was thwarted in 1992 because of objections from business interests.

Staff of Khunde Hospital and its village healthpost

Lukla airport - gateway to Sagarmatha National Park


Lhakpa Sherpa

5.4 Trails and Bridges

Trails and bridges are the most important development infrastructure in Khumbu and are the lifeline of economic development. Historically, trails and bridges were built and maintained by local communities on a voluntary basis. In many places, these were not adequate for pack animals. With support from the government and international aid agencies and availability of better tools and technology, significant improvements have been made to trails and bridges. Metal suspension bridges and explosives to cut trails across rock faces have improved trails. Trails and bridges suitable for pack animals and horses have increased the flow of materials and supplies resulting in improved livelihoods. Maintaining trails and bridges is a constant challenge in the mountains because of landslides, floods and avalanches. Encroachment by development along the sides the trails undermines the trekking experience. Construction of lodges too close to the trails prevents future trekking trail expansion and improvements. Protection and improvement of public trails is one of the highest priorities for the future.

5.5 Communication Facilities

Prior to 1970, Khumbu was not properly linked with the outside world. Only security agencies such as police and army were allowed to have radios which were not accessible for to the general public. The private sector including businesses, were not permitted to use radio frequencies. Sagarmatha National Park acquired radios and for a few years the park's radio became an important emergency communication link for visitors and local people alike. The communication situation changed dramatically in 1994 after the electrification of the major villages in the park and installation of telephone lines and mobile phone stations. Nepal Telecommunication installed land lines in most homes in Namche and Khumjung villages, and further extension is planned for the Thame Valley in 2009. Satellite-based internet technology was introduced to Namche by private entrepreneurs. Mobile phone companies have now established their services in the area, although signal coverage is difficult because of the complex mountain topography. Despite these challenges, the value of communication facilities in mountain areas cannot be overemphasized. It saves time and energy, stimulates business and ensures safety in the mountains.

5.6 Hydropower and Energy

The installation of the 600 kilo watt (kW) hydroelectricity facility in SNP is one of the most significant development efforts that took place in Khumbu. The project financed by the Austrian Government initially began its construction below Thamo in 1975. After 10 years of planning and construction, it was washed away by GLOF from Dig Tso in 1985. The construction started at a new site further upstream on the Thame Khola and was completed in 1994. It currently supplies electricity to 11 villages including Namche, Khumjung-Khunde and Thame. Availability of electricity for cooking, lighting and heating saves at least 35% of the firewood use. Power cables and high tension lines are buried underground wherever possible to preserve the aesthetics of the Park. The facility is now run by the Khumbu Bijuli Company, which is owned by the local users.

Trails and bridges suitable for pack animals and horses have increased the flow of materials and supplies

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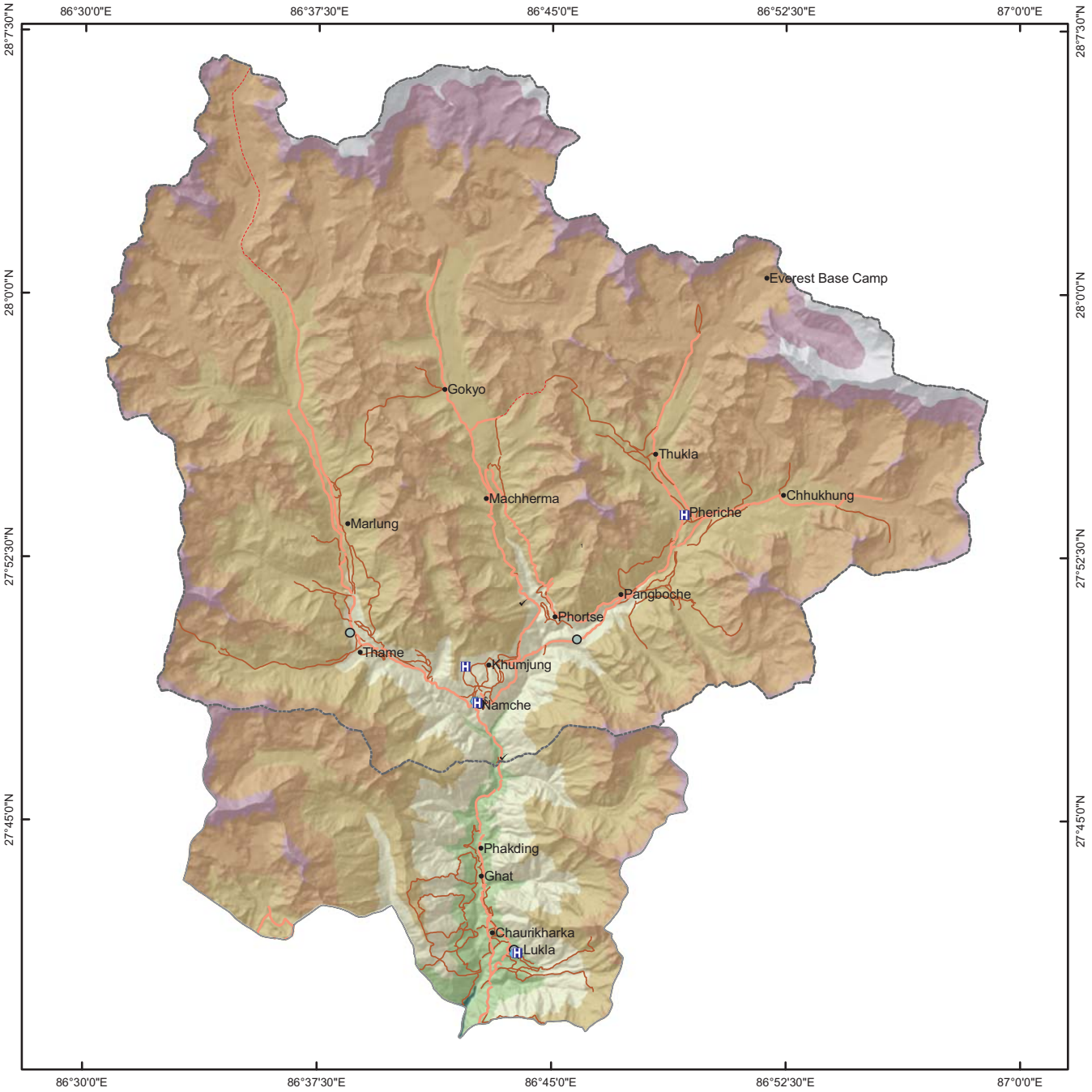
Sagarmatha National Park and Buffer Zone

Services

Facilities such as banks, post office, health posts, park guard posts and police stations are also mostlylocatedalongthemaintrekkingroutefrom LukatoEverestBaseCamp.



Legend

- Main trail
- Scondary trail
- Seasonal trail
- Check Post
- Health Post
- Police Post
- Post Office
- Major places
- bank
- Park boundary

0 2.5 5 10 15
Kilometres

Source:
Department of Survey, Government of Nepal
Projection: UTM Zone 45N; Datum: WGS 1984

Prepared by:
Mountain Environment and Natural Resources Information Systems (MENRIS)
International Centre for Integrated Mountain Development (ICIMOD)

ICIMOD


Buddhi Ratna Dangol


Paribesh Pradhan

Himalayan Tahr


Buddhi Ratna Dangol

Primula


EvK2CNR

Snow leopard


Buddhi Ratna Dangol

Thermopsis barbatum


Govinda Joshi

Musk deer

6. Conservation and Management

6.1 Environmental Services

Nepal's Himalaya provides a series of environmental services to the region. They offer an effective barrier against the cold and arid winds of Tibetan plateau. They also block the moist air from the Bay of Bengal and force it to precipitate to create the monsoon climate which supports much of the agriculture in Nepal and India. The Himalayan Ranges are also reservoirs of water stored in the form of snow, ice and lakes. These water reservoirs feed the rivers that provide drinking and irrigation water for millions of people downstream. The Himalayas are also considered sacred and a source of inspiration for many people. a mountain such as Kailash (Khang Rinpoche) is considered sacred by four major religions in the world (Buddhist, Hindus, Jain and Bön). Many Himalayan valleys are also sacred beyul to Buddhists in Nepal, Tibet and India. Recreational visitors and climbers are inspired by these mountain ranges because of their beauty and tranquility. They provide a space where many people can escape the rigor of their daily lives. The most amazing feature of the Himalayas is the overwhelming vertical gradients and topographic variations that create conditions that support biological and cultural diversity.

6.2 Indigenous Resource Management Systems

The Sherpa of Khumbu like many other Himalayan communities have an age-old tradition of respecting their land as sacred hidden valley (beyul). Within this broader sacred landscape, specific components such as mountains, springs and lakes are considered dwellings of deities and spirits with whom human beings have to share the natural world. These beliefs shape people's attitude towards the environmental resources. From a traditional perspective, humans do not have complete rights over natural resources and unnecessary exploitation is avoided. Sherpas traditionally performed rituals to appease the known and unknown protectors of the land

before occupying, cultivating, developing or disturbing wild lands. These values and beliefs, although eroding rapidly, are still having an impact on how resources are managed in Khumbu.

Sherpa aversion to wildlife hunting and livestock slaughter-ing is an important example of the impact of the indigenous faith-based conservation practices. This practice still continues despite the recent cultural changes. The community-appointed nawa system for forests and crop protection and are also linked with the traditional belief systems. They perform many rituals to ensure safety, security and harmony in the human and supernatural community.

6.3 National Park

In addition to the indigenous system, Khumbu was declared a national park in 1976 to add another layer of protection. The setting up of parks in Nepal was encouraged by the global environmental movement of the early 1970s. The first park established was the Chitwan National Park in 1970. Nepal now has 16 parks and protected areas covering nearly 19% of the total land area of the country. The parks of Nepal were seen as a conservation success in the developing world. Many of them are located in the Himalayan region. Sagarmatha National Park was established to conserve one of the world's highest ecosystems including Mt. Everest. It was a visionary step considering the emerging impacts of unregulated tourism. The park's challenge is to continue to provide protection of high altitude forests and wildlife and address irresponsible encroachment with participation of the local communities.

6.4 Buffer Zone Management

Sagarmatha became one of Nepal's first national parks to recognise the local people's rights to continue to reside in the park and practice customary land use. Following its establishment, the government was able to collect substantial amounts of revenue from park entry permits and mountaineering levies. But these resources went directly to the national treasury and were not effectively shared with the communities living in and around the park. The Buffer Zone concept was introduced later as a way to expand the area of the park and at the same time to share the park revenue directly with the local communities. The expected outcome was to make the local people stronger partners in conservation. Buffer Zone Regulations allow local communities to receive up to 50% of the park revenue for community development, infrastructure improvement and conservation. Projects can address water, energy, trails, schools and conservation of culture and environment issues. The buffer zone program has made local people more aware and interested in conservation issues and they are now seeking greater involvement in the park's decision-making processes.

Time series photo of SNP Headquarters, Mendalpu Hill

6.5 Pollution Control and Sanitation

Preventing littering and pollution of water sources is the next most urgent problem of the park after halting deforestation and curbing wildlife poaching. This was also the main reason behind creation of the park. Due to lack of effective control mechanisms, littering and pollution is still a challenge. Garbage at high altitude decays slower and stays longer in the environment compared to lower elevations. The litter dumped on the slopes of Mt. Everest for example stays unchanged for a long period of time and it was once called " the world's highest junkyard." National Park status was proposed mainly to address the problems of deforestation and pollution. The participation of many national and international cleaning groups and the establishment of a local NGO (Sagarmatha Pollution Control Committee-SPCC) in 1991 greatly helped control the problem. SPCC hired cleaning staff, collected garbage along the trails and placed it in designated pits. It is reported that in 1999 alone, 56,000 beer bottles were airlifted from the park. The use of bottled beer was later banned by the park. While cleaning played a major role in improving the situation, the problem of pollution needs strong regulatory measures and awareness campaigns.

Paribesh Pradhan

Cleaning campaign at the Everest Base Camp during Eco-Everest Expedition 2008

6.6 Linking with Surrounding Landscapes

Sagarmatha National Park is not an isolated conservation island. It is linked with the 2,300 sq km Makalu-Barun National Park and Buffer Zone immediately to the east, and the huge (34,480 sq km) Qomolangma Nature Preserve (QNP) of the Tibet Autonomous Region of China to the north. These contiguous parks jointly form one of the largest blocks of protected areas in the heart of the Himalayas. The large size creates opportunities to protect wide-ranging species and communities of plants and animals species. The survival chances of carnivores such as snow leopards, wolves and brown bears are greatly increased by having a large transboundary protected area. Active cooperation and collaboration between the managers and administrators of these transboundary protected areas is important to increase its effectiveness. Organisations such as The Mountain Institute, ICIMOD and WWF have facilitated a series of transboundary conservation workshops, meetings and visits to promote conservation cooperation and linkages across protected area boundaries. Continuation of these efforts is essential to ensure improved collaboration for effective conservation of the Himalayan ecosystem.

6.7 Research on Change

Managing a national park ecosystem requires scientific understanding of dynamic natural phenomena and processes. The drivers of change may be natural factors such as fire, flood, disease and competition between species and communities. The human factors such as harvesting of natural resources, their management and conservation can also influence ecosystem dynamics. Global warming is becoming a major concern as the consequences for conservation and livelihood are unknown. Ecosystem management requires sophisticated tools for research, monitoring, and making management decisions. This information needs to be available for managers and decision makers in readily understandable forms.

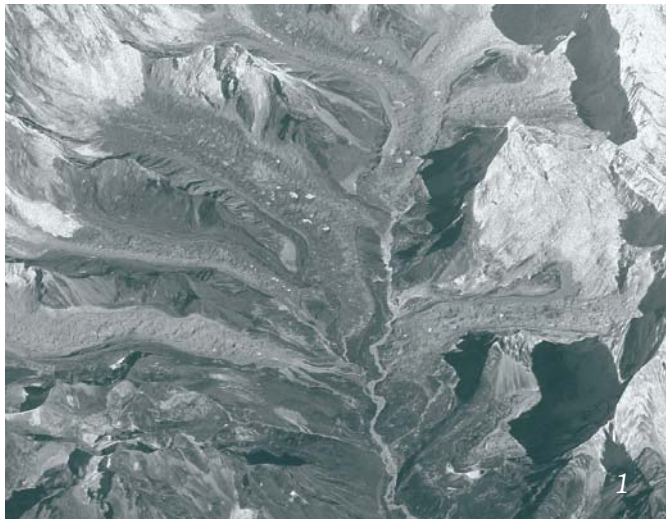
The high altitudes and unique ecosystem of SNP have attracted many short term researchers from all over the world. The EvK2CNR established The Pyramid International Laboratory/Observatory at Lobuche and is one of the few research initiatives that is permanently based within the Park. It has facilitated over 550 scientific research missions and has published many papers. However, the research on ecosystem management is relatively small. The Hindu Kush-Karakoram Himalaya (HKKH) Partnership Project was launched in 2004 to support the development of institutional capacities for systemic planning, management and research in protected areas of the high mountain regions of Asia. The project partners include International Union for Conservation of Nature (IUCN), International Centre for Integrated Mountain Development (ICIMOD), EvK2CNR Committee and an Italian NGO - CESVI. The project selected three mountain protected areas of Asia including Sagarmatha National Park in Nepal, Central Karakoram National Park (CKNP) in Pakistan and Qomolangma Nature Preserve (QNP) in Tibet Autonomous Region of China. The project focused on turning research results into information that supports management.

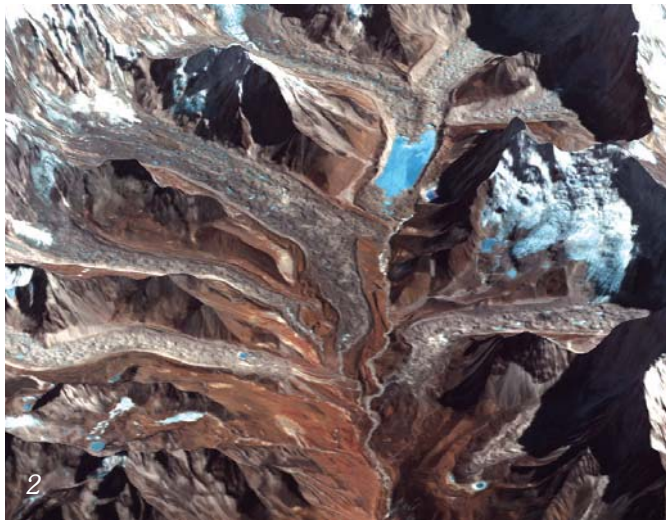
Land Cover Change Analyses

Detecting land cover change over time is perhaps one of the most important sources of research information for making ecosystem level management decisions. Land cover is a fundamental variable that impacts and links many aspects of the social and physical environments. It is also used to predict changes in availability of habitats and resources and is used as a baseline for monitoring ecosystem dynamics. Under the HKKH Partnership Project, ICIMOD carried out a land cover change study of SNP using satellite images of different years (1992, 2000 and 2006). The study estimated that more than

Pyramid International Laboratory at Lobuche (5050 m)

(1) Imja Glacier as seen in Corona image of 15 Dec. 1962 draped over the DEM (digital elevation model). Note that there was no lake.
(2) Imja Tsho as seen in ASTER image of 1 Feb. 2006 draped over the DEM.
(3) Field photograph of Imja Tsho (15 Oct 2006)



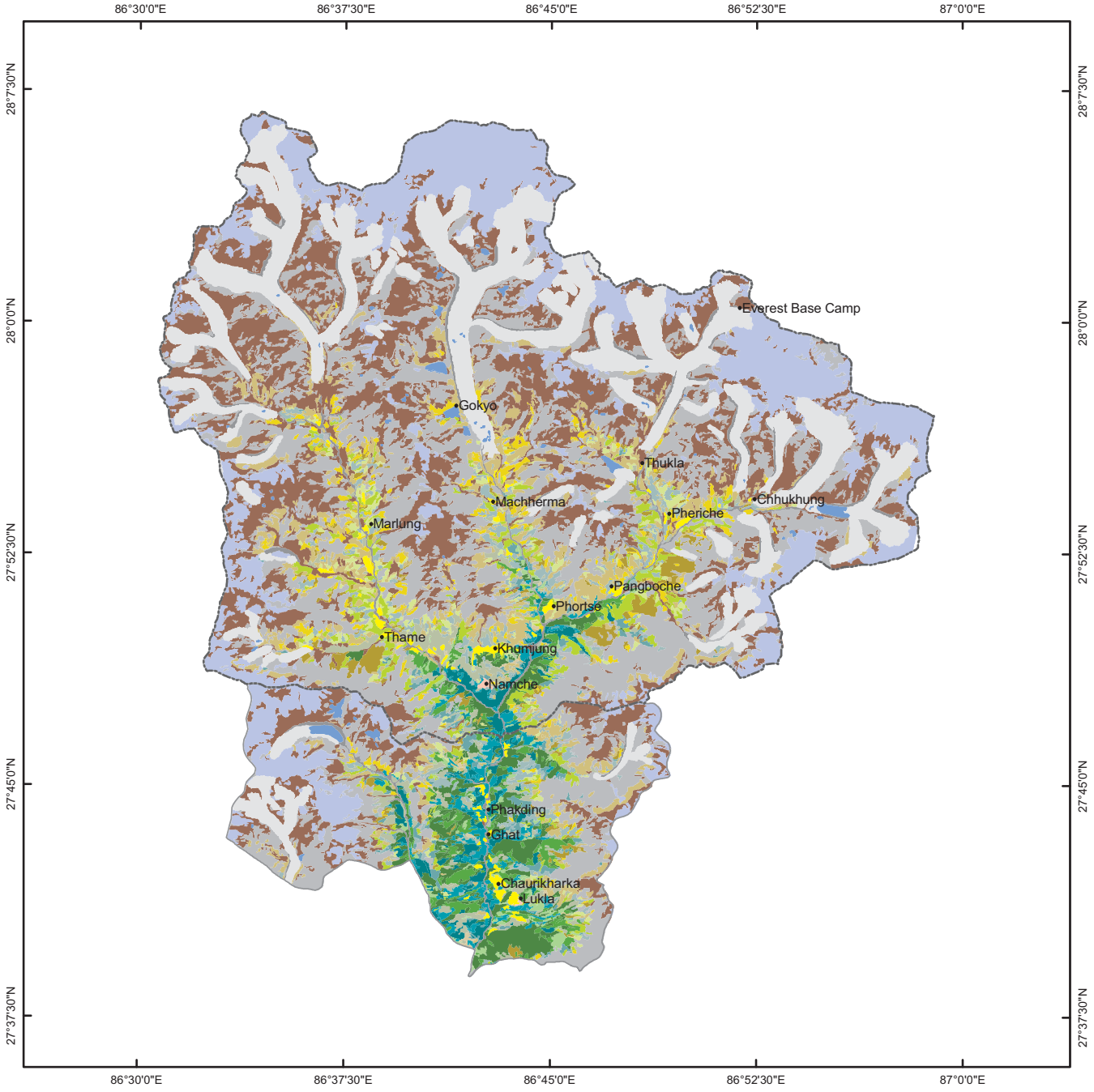


70% of the SNPBZ area is currently covered by snow, ice, glaciers, bare rocks and bare soil. The aspect and slope have important influences on vegetation cover types but the altitude has a greater influence because it regulates temperature, precipitation and solar radiation.

Between 1992 and 2006, the forest areas of SNP decreased by 387 hectare (ha) and shrub area gained by 220 ha over the 15-year period. The forest reduction and increase in shrub cover took place mainly between 3,000 m to 4,000 m elevations. In comparison there has been a reduction in shrub cover in the higher alpine region. Grass cover and bare area increased slightly at all elevation ranges. An increase in built up areas was detected whereas cultivated areas decreased slightly. It will be useful to discover the drivers of these changes and predict what kind of consequences it may have on the socio-ecosystem of the park in the long term.

Climate change is one of the most urgent contemporary research topics. The impact of climate change on Himalayan protected areas is not well understood. Global level climate studies show that the earth's average surface temperature has been increasing since the end of the Little Ice Age. Over the last century, the temperature has increased by 0.3 to 0.6 degrees Celsius. It is predicted that the rate of temperature rise may increase much faster in future. The biggest concern is the melting of the snow and ice cover. They act as barometers of climate change. There are many anecdotal stories about disappearance and shrinking of glacial ice and snow in the mountains. The SNP environments are particularly sensitive because temperature changes are more pronounced at higher altitudes. Studies show that Himalayan glaciers have been melting at unprecedented rates in recent decades. The land cover analysis study conducted by ICIMOD showed that the surface area of glacial lakes in SNPBZ has increased by 236 ha between 1992 and 2006. With the melting of glacial ice, new lakes have been forming on glaciers and those lakes that were already in existence have been expanding. The land cover study also shows that most large glacial lakes in the Himalayas are recent in origin (created within last 50 years). Many lakes have burst

HKKH Partnership
for ecosystem management



Sagarmatha National Park and Buffer Zone

Land Cover 2006

Legend

- Major places
- Park boundary
- Bare Rock (22.47%)
- Bare Soil (19.50%)
- Broadleaved Closed Forest (1.36%)
- Broadleaved Closed Shrubland (2.35%)
- Broadleaved Open Forest (0.54%)
- Broadleaved Open Shrubland (1.15%)
- Built Up Area (0.03%)
- Closed to Open Herbaceous Vegetation (5.81%)
- Cultivated Area (0.63%)
- Dwarf Closed Shrubland (1.54%)
- Dwarf Open Shrubland (1.55%)
- Glacial Lake (0.58%)
- Glacier (15.40%)
- Gravels, Stones and Boulders (1.64%)
- Mixed Closed Shrubland (Thicket) (0.93%)
- Mixed Open Shrubland (2.29%)
- Multilayer Mixed Forest (2.60%)
- Needleleaved Closed Forest (1.19%)
- Needleleaved Closed Shrubland (1.92%)
- Needleleaved Open Forest (1.24%)
- Needleleaved Open Shrubland (0.08%)
- River
- Snow (15.19%)

0 2.5 5 10 15
Kilometres

Image Source: ASTER (1 Feb 2006)
Projection: UTM Zone 45N; Datum: WGS 1984

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ICIMOD

Sumary of land cover change by elevation zones between 1992 to 2006
(Source: Land Cover Mapping in the HKKH - Cases from Three Mountain Protected Areas, ICIMOD 2009)

Change from 1992 to 2006 (aggregated) in hectares	< 2000	2000 – 3000	3000 - 4000	4000 - 5000	> 5000	Total
Forest	-2	-77	-186	-122	0	-387
Shrub	3	157	272	-227	14	220
Grass	-6	-3	146	1132	605	1874
Bare area	0	-64	-234	257	9361	9320
Built Up Area	0	2	9	0	0	10
Cultivated Area	0	-17	-8	-5	0	-29
Glacial Lake	0	0	0	43	193	236
Glacier	0	0	0	2	-11	-9
Snow	0	0	0	-1073	-10271	-11344

in the past causing floods of all sizes. Khumbu has been identified as a hotspot of glacial lake activity. Studies also show that the total number of glacial lakes in the Himalayas has decreased by 37% but the area of existing lakes has increased by 21% indicating expansion and merging of adjacent lakes. A lake, Imja Tso, has been growing rapidly over last 50 years and the risks of breaching the unstable moraine dams and causing catastrophic floods (GLOF) are high. The terminus of the glacier retreated at the rate of 42 m per year between 1962 and 2000. This rate increased to 74 m per year between 2001 and 2006. The retreat of the glacier leads to expansion of the lake. The hazard assessment indicates that bursting of Imja Tso could affect the lower river terraces through out the Dudh Koshi Valley. The awareness of the risk of GLOF is important. ICIMOD along with a number of partner organizations have initiated "Eco-Everest Expedition" as an awareness raising campaign in 2008.

Climate change will continue to be a pressing concern both at the local and global level for the foreseeable future. Melting of glaciers warrants special research efforts to improve our scientific understanding. Although research has been carried out in Khumbu, there is still a gap in long-term monitoring and information sharing. At times, knowledge generated is not being use for making policy decisions because of the lack of institutional capacity and mechanisms.

Climate change and global warming is a reality. It is also proven beyond doubt by many scientific works that the drivers of climate change are human use of fossil fuels. Mitigation at the source is urgently needed while in the high Himalayas natural and human populations will need to adapt to a changing environment.

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Parbesh Pradhan

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Building partnerships for the HKKH region

The project "Institutional Consolidation for the Coordinated and the Integrated Monitoring of Natural Resources towards Sustainable Development and Environmental Conservation in the Hindu Kush-Karakoram-Himalaya Mountain Complex" (HKKH Partnership project) is a regional initiative aimed at consolidating institutional capacity for systemic planning and management of socio-ecosystems at the local, national and regional levels in the HKKH region. The project, supported by the Italian Cooperation, is implemented by International Union for Conservation of Nature (IUCN), CESVI, Ev-K2-CNR Committee and International Centre for Integrated Mountain Development (ICIMOD).

Web links:
http://www.hkkhpartnership.org
http://www.iucn.org
http://www.cesvi.org
http://www.evk2cnr.org
http://www.icimod.org