ICIMOD

ATLAS of the HIMALAYA

David Zurick
Julsun Pacheco
Basanta Shrestha
Birendra Bajracharya

Regional Setting

Physical Environment

Society

Resources and Conservation

About ICIMOD

The International Centre for Integrated Mountain Development (ICIMOD) is an independent 'Mountain Learning and Knowledge Centre' serving the eight countries of the Hindu Kush-Himalayas – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – and the global mountain community. Founded in 1983, ICIMOD is based in Kathmandu, Nepal, and brings together a partnership of regional member countries, partner institutions, and donors with a commitment for development action to secure a better future for the people and environment of the greater Himalayan region. ICIMOD's activities are supported by its core programme donors – the Governments of its regional member countries and of Austria, Denmark, Germany, Netherlands, Norway, and Switzerland – along with over thirty project co-financing donors. The primary objective of the Centre is to promote the development of an economically and environmentally sound mountain ecosystem and to improve the living standards of mountain populations.

ATLAS of the HIMALAYA

by

David Zurick
Julsun Pacheco
Basanta Shrestha
Birendra Bajracharya

Copyright © 2005

International Centre for Integrated Mountain Development (ICIMOD)

All rights reserved

This edition has been prepared for distribution in the Hindu Kush-Himalayan region only.

A subsequent edition will be published by David Zurick and Julsun Pacheco for distribution and sale in the rest of the world.

Published by

International Centre for Integrated Mountain Development (ICIMOD)

G.P.O. Box 3226

Kathmandu, Nepal

Photos

All photographs by David Zurick unless otherwise noted.

Cover: Nepal Himalaya from Manaslu to Langtang, Siklis village, Sutlej river, Swayambhu Stupa and Baspa Valley

ISBN 92 9115 224 2

ICIMOD Editorial Team

Greta M. Pennington Rana (Former Senior Editor)

Harka Gurung (Consultant Editor)

Punam Pradhan (Desktop Publisher and Designer)

Gauri Dangol (Graphic Designer)

Printed and bound in Nepal by

Hill Side Press (P) Ltd.

Kathmandu, Nepal

The views and interpretations in this publication are those of the authors. They are not attributable to the International Centre for Integrated Mountain Development (ICIMOD) and do not imply the expression of any opinion concerning the legal status of any country, territory, city or area of its authorities, or concerning the delimitation of its frontiers or boundaries.

FOREWORD

The Himalaya pierces the sky of Asia, creating a continuous chain of high mountain ranges that stretches over 4,000 kilometres from Afghanistan in the west to China and Myanmar in the east. With all 14 of the world's highest mountains looming over 8,000 metres, the Himalaya is literally the 'abode of snow' from which its name derives. The Himalaya is a beacon for clouds of moisture, which generously bestow its slopes with precipitation and through rapidly growing mountain torrents create the great rivers of Asia: the Indus, the Ganges, the Yarlung Tsangpo/Brahmaputra, the Salween, the Lancang Jiang/Mekong, and the Yangtze. The tributaries of these Himalayan rivers water the rangelands, fields, forests, and wetlands that sustain over 150 million mostly poor mountain residents and over 500 million people downstream. These rivers offer a tremendous potential for hydropower and irrigation, as well as supplying drinking water and supporting industrial production throughout their length.

With its high ridges, deep valleys, and extreme weather conditions, the Himalaya has also ensured that the peoples, flora, and fauna that it nurtures have a varied and relatively isolated multitude of ecosystems in which to develop and live. The result is a rich landscape of both cultural and biological diversity. Speaking hundreds of languages, the peoples of the Himalaya are nestled in clothes and houses that provide outward manifestations of the rich cultural heritage they have created and maintained for thousands of years of movement and settlement.

These spectacular mountains have also been beacons for outsiders. With thousands of locally important sacred sites, the Himalaya is full of peaks, valleys, caves, rivers, and lakes that draw pilgrims from all of Asia's major religions: Buddhism, Chinese religions, Hinduism, Islam, and the extraordinarily varied indigenous shamanic religions. The Himalaya also lure the modern day mountaineering and trekking pilgrims who journey from all over the world to test and renew their bodies and souls.

A spectacular and varied source of life for Asia, the Himalaya also buries its share of humans. The moving tectonic plates that created the mountains, still erupt in massive earthquakes such as that which occurred in the Kashmir region on the 8th of October 2005. Annually there are floods, glacial lake outbursts, landslides, avalanches, and blizzards that can cause devastating damage to humans, their settlements, and their livelihoods. More slowly, but perhaps with an even greater impact, global warming is melting the glaciers and snow packs that provide dry season water to the thirsty millions downstream. And simultaneously, the Himalaya is serving as a barrier to the gigantic cloud of aerosols - both natural and manmade - that builds up over the South Asian subcontinent in the winter and spring.

The International Centre for Integrated Mountain Development (ICIMOD) was established in 1983 to help provide means to improve the livelihoods of the poor and vulnerable peoples who live in this extraordinary and changing part of the world. Designed to provide a regional forum for the extended Himalayan region, ICIMOD is an independent intergovernmental mountain learning and knowledge centre focusing on research, training, and knowledge sharing for integrated mountain development at local, national, regional, and global levels. As knowledge of the geographic landscape is fundamental for devising appropriate policies and programmes in the region, ICIMOD, through its Mountain Environment and Natural Resources Information Systems (MENRIS), is using state-of-the-art geographic information and communications technology (Geo-ICT) tools and methods to enhance understanding of the mountain ecosystem and its services. Presenting this type of information in the form of maps is an effective medium for increasing understanding, and supports the making of sound decisions that will have a lasting and positive impact on peoples and their environments.

This Atlas of the Himalaya is the outcome of a collaboration between the University of Eastern Kentucky, USA, and ICIMOD. The Atlas is designed for use by researchers and practitioners, as well as the many people interested in the region in general. The spatial information provided in the maps is complemented by textual descriptions and photographs. The maps have been drawn with both accuracy and aesthetic principles in mind and presented without international boundaries, both to underline the continuous nature of the landscape and to avoid potential controversies. The Atlas provides information on the characteristics of physical geography, geology, climate, and natural hazards. It also includes descriptions of the sociocultural and historical dimensions of the region. Finally, the Atlas highlights the Himalaya as an important resource base and underscores the need for conservation of the mountain ecosystem to go hand in hand with development.

Readers familiar with the larger Himalayan region, sometimes termed the Hindu Kush-Himalaya, that ICIMOD uses in its own maps to designate the area in which we work, will note that this Atlas covers a more restricted area of the classically defined Himalaya from the South Asian perspective. We hope that the Karakoram, Pamir, and Hindu Kush in the western Himalayan system and the mountain ranges in China, Myanmar, and Bangladesh in the northern and eastern end of the system that are missing from this Atlas can form the basis for future work.

We hope you will find this Atlas both useful and enjoyable.

Dr. J. Gabriel Campbell
Director General
ICIMOD

ACKNOWLEDGEMENTS

The authors would like to express deep gratitude to Dr. Harka Gurung, a renowned geographer of Nepal, for his meticulous review of the Atlas in its draft form and providing a succinct introduction. The authors would like to express deep gratitude to Dr. J. Gabriel Campbell, Director General of ICIMOD for his encouragement for collaboration between ICIMOD and Eastern Kentucky University to produce an atlas of this form and providing useful insights with his vast knowledge and experience in the Himalayas. The authors would like to deeply acknowledge the support and valuable editorial inputs by Ms. Greta Rana and Dr. A. Beatrice Murray, and Ms. Punam Pradhan for her inputs in desktop support. The authors would like to express sincere thanks and appreciation to Mr. Gauri Shankar Dangol for his dexterous graphics inputs and formatting in numerous iterations of atlas preparation. The authors are grateful for the assistance of the Mountain Environment and Natural Resources Information Systems (MENRIS) Division staff and especially Mr. Govinda Joshi and Mr. Anirudra Man Shrestha at ICIMOD in providing useful inputs and spatial data for mapping purposes. Special thanks go to Eastern Kentucky University for providing institutional support during the research and compilation of the Atlas. The authors wish to thank their families for their moral support during this endeavor.

INTRODUCTION

The term 'Himalaya' is a combination of two Sanskrit words *'hima'* (snow) and *'alaya'* (abode). This imagery as the abode of snow is epitomised by Mount Kailash (6,856 m) or Kang Rimpoche (king of the mountains) within whose 150 kilometer radius originate five major rivers. These are the Indus to the north-west, the Sutlej to the west, the Ganges and Karnali to the south, and the Yarlung-Tsangpo to the east.[1] Therefore, the Himalaya is a veritable water tower that sustains the perennial rivers which in turn define and shape the mountain configuration. The main range extends over 2,400 kilometers in a vast southerly arc between the deep gorges of the Indus in the west and Dihang (Brahmaputra) in the east with Nanga Parbat (8,126 m) and Namcha Barwa (7,755 m) respectively as its extremeties.[2]

The Himalayan range is a singular entity of immense physical dimension. It is the loftiest mountain complex on earth with 31 peaks exceeding 7,600 meters in elevation.[3] The extreme elevation and rugged relief are the result of orogenic forces and vigorous erosion processes. The crest-line of the main range rarely falls below 5,500 meters. In places, it is traversed by extremely deep river gorges that present a landscape of great vertical contrast within a short horizontal distance. The Himalaya extends over 9 degrees of latitude and 22 degrees of longitude. It lies, therefore, at the convergence of four floristic regions: Indian, Malay, Sino-Japanese, and Central Asian. Vertical zonation of vegetation types is a common phenomenon in the Himalaya, but there are also horizontal differences across the length of the range.[4] Thus, the humid east has tropical luxuriance while the drier west has a greater variety of plant associations.

The Himalaya, wedged between the centers of two Asiatic civilisations – Indic and Sinic, has been both a region of refuge and a frontier for colonisers. The peopling of the area was the outcome of waves of Caucasoid migration from the west and south as well as Mongoloids from the east and north. Owing to their respective migration routes, the zone of Caucasoid-Mongoloid interface became tangent to the Himalayan crest-line whereby the former are spread across the Western Himalaya and the latter proliferate east of the Karnali basin.[5] With the migrants and colonisers also came the higher religions: Brahmanism from the tropical plains, Lamaism from the high plateau and Mohammedanism from the arid west. However, the spiritual faith of Himalayan peoples is still moulded by their inherent Shamanistic belief. Their cultural vitality remains preserved in at least 51 distinct languages across the Himalaya.[6] Of these, 33 belong to the Tibeto-Burman and 16 to the Indo-Aryan language families.

The Himalayan region supports a high density of population compared to other mountain areas. The 1991 estimate of its total population is 50 million, half of which was added in the last five decades.[7] If the low-lying territories such as the Nepal Terai are excluded, the total highland population would be about 40 million. Therefore, the average population density of the Himalaya comes to 68/km^2. The density of population is progressively higher westwards: 90 per sq. km in the western section, 87 in the central section, and only 19 in the eastern section. The important aspect in present day population dynamics of the Himalaya is the migration factor in which the dominant trajectory is that of descent to the adjacent lowlands for land settlement and economic opportunity.

The people residing in the Himalaya remain poor and their per capita income is said to average US$157 (per annum) compared to US $ 970 for the developing countries.[8] The estimate of the population living below the poverty line ranges from over one-fourth in western mountain districts of India to nearly a half in the Nepal highlands. Generally, the degree of poverty tends to conform to the elevation zone, e.g., the higher the elevation, the greater the extent of poverty. The persistence of poverty in the Himalaya is due to both physical constraints and policy neglect owing to their remote location. Inaccessibility remains the main constraint. Road extension in the Himalaya has been more a result of border conflict among states than of economic rationale. Yet, mountain areas can be developed based on their comparative advantage in product diversity, ranging from horticulture to immense hydropower and unique tourism resources.

Most books on the Himalaya are of the tourism genre with a focus on the mountain scenery. Some recently published books are preoccupied with environmental concerns. There is a lack of publications describing the situation and problems of the Himalaya in their regional context. This book, *Atlas of the Himalaya*, is a bold attempt with a broad multi-dimensional scope. Area studies conventionally have a three-fold schema that describe physical, cultural, and economic aspects. This volume has a different approach. It commences with the regional setting for orientation and then covers physical and social environments. The final part deals with resource conservation and refers to the potential of protected areas in mountain ecology and economy. The maps and diagrams are complemented with descriptive text and numerous photographs. This Atlas is a useful contribution towards a better understanding of Himalayan geography and development activities there.

Harka Gurung

---

1 Blanche C. Olschak, Augusto Gansser & Emil M. Biuhrer. *Himalayas: Growing Mountains, Living Myths, Migrating Peoples.* Lucerne, 1987, pp. 38-39

2 Kenneth Mason. *Abode of Snow: A History of Himalayan Exploration and Mountaineering.* London: Rupert Hart-Davis, 1955, p. 6 (Fig. 1)

3 Harka Gurung. *Mountains of Asia: A Regional Inventory.* Kathmandu: ICIMOD, 1999

4 Carl Troll. "Die klimatische und vegetations-geographische Gliederung des Himalaya-Systems", *Khumbu Himal.* Berlin, No. 1, 1967, pp. 353-388

5 Harka Gurung. "The Himalaya: Perspective on change", *South Asia Forum.* No. 3, Summer 1982, pp. 9-21

6 Ronald J-L. Breton. *Atlas of the Languages and Ethnic Communities in South Asia.* New Delhi, 1999

7 David Zurick & P.P. Karan. *Himalaya: Life on the Edge of the World,* Baltimore, 1999, p. 138. This population also includes 8.6 million of the Nepal Terai

8 Zurick & Karan, op. cit., p. 194

CONTENTS

Note: In this Atlas, the area termed 'Himalaya' has been taken as the area stretching from the Indus river in the west to the Brahmaputra river in the east. The northern boundary has been defined using mainly the administrative boundaries, reflecting the availability of most of the datasets, whereas the southern boundary has been taken from the Hindu Kush-Himalayan region boundary adopted by ICIMOD. In general, ICIMOD uses 'Himalaya' to describe a larger regional area that includes the Karakoram, Pamir, and Hindu Kush in the western Himalayan system and the mountain ranges in China, Myanmar, and Bangladesh in the northern and eastern end of the system. We hope to cover these additional areas in future work.

List of Maps

List of Plates

List of Tables, Figures and Boxes

Reference Map Legend

Physical feature

- Pass
- K2 (8611) ▲ Mountain peak
- Lahaul Valley — Physical feature
- Road
- Mahakali — River
- Lake

Urban area

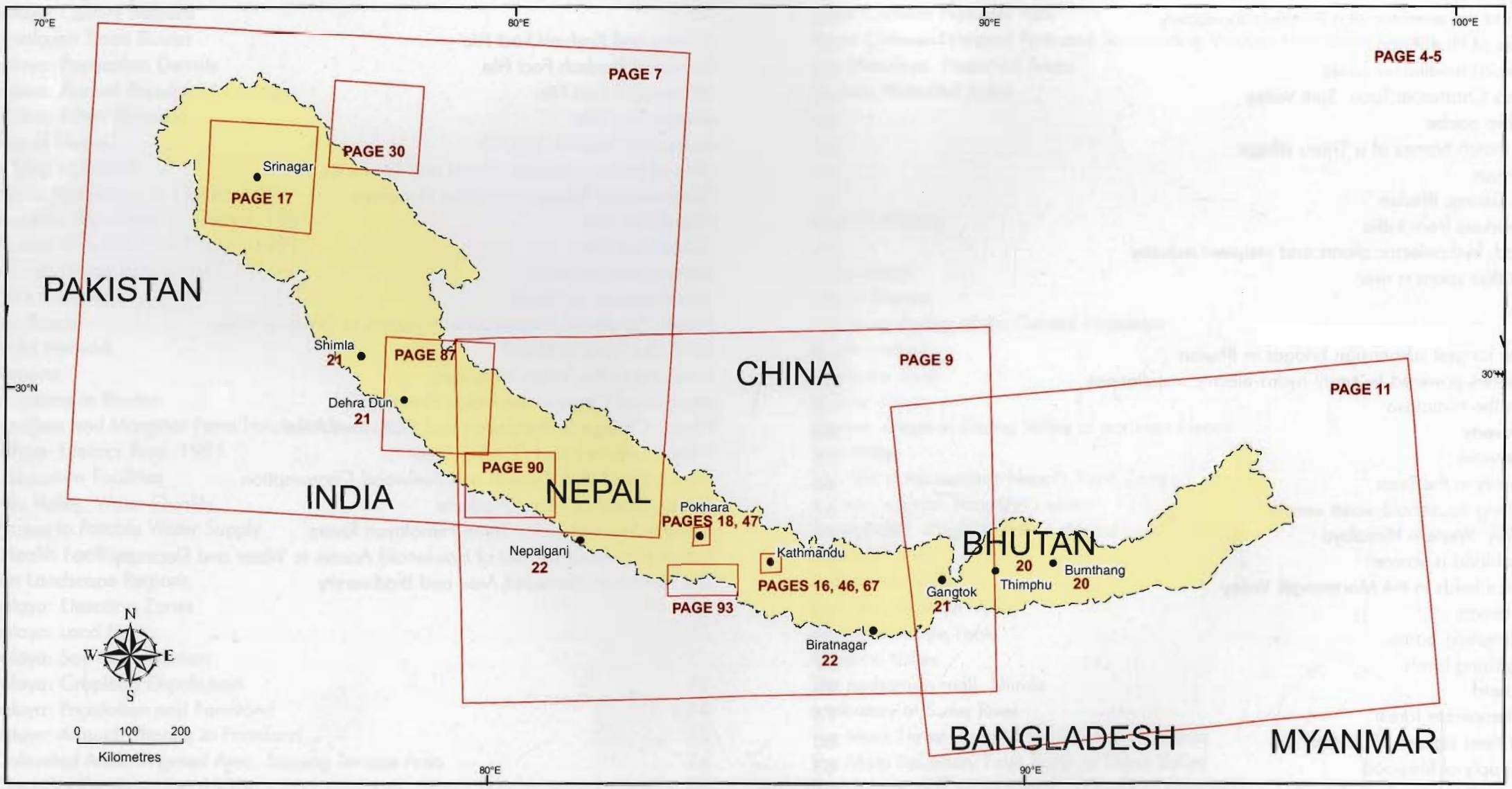
- **Kathmandu** ★ Capital city
- **Srinagar** ● Major city
- **Anantnag** ● Secondary city
- **Chamba** ● Town
- **Arakot** ● Settlement area
- **Chandigarh** ● Selected city

Elevation (meters)

8,850

0

Key Reference Map



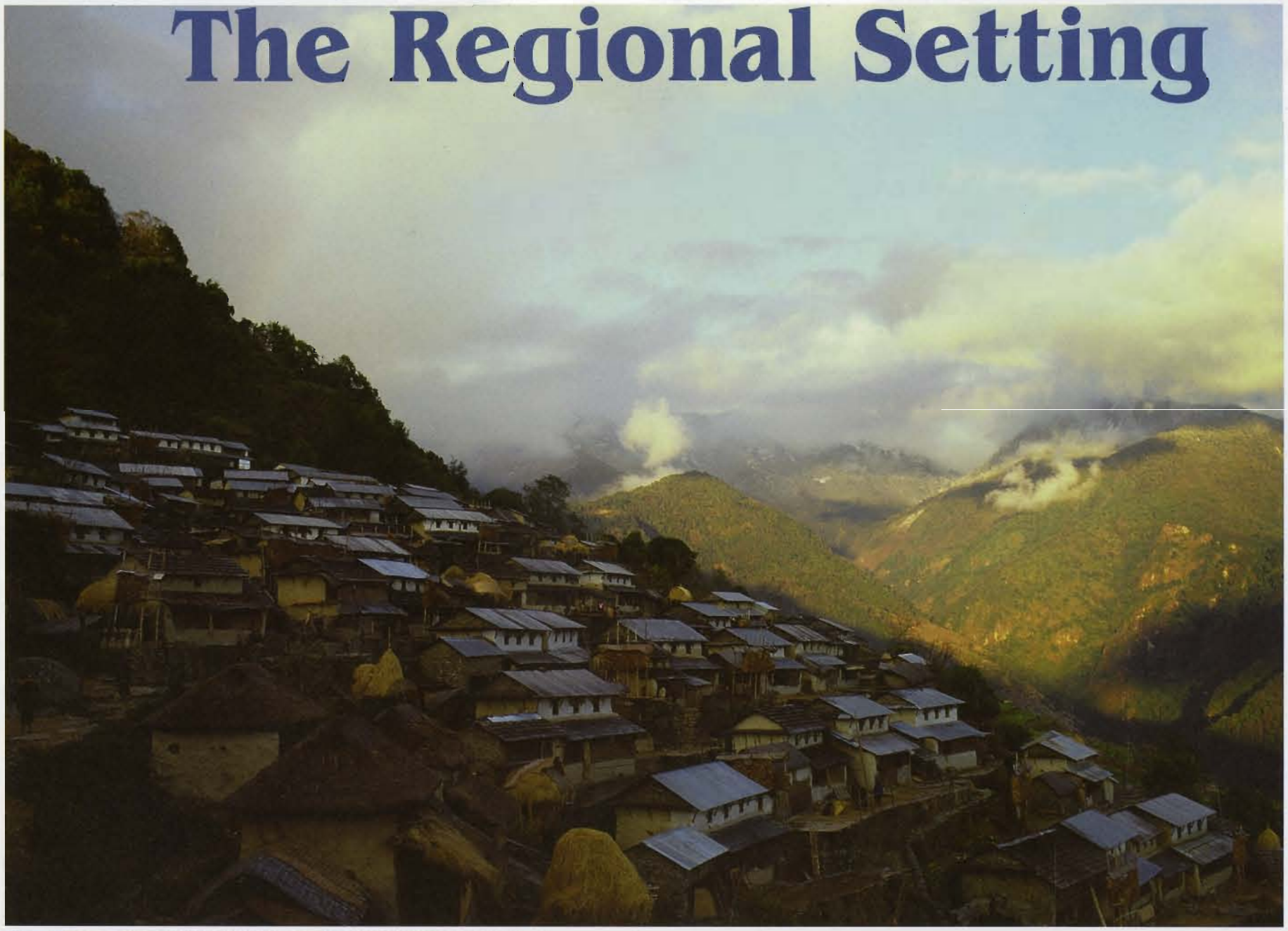
Source: compiled by the authors from various sources including government published maps, National Geographic maps, atlases, global data sets

Part One

The Place of the Himalaya in the World

Part One

The Regional Setting



Siklis village, located on the southern slopes of Annapurna, is inhabited by Gurung people.

THE HIMALAYA: The Regional Setting

Source: Compiled by the authors from various sources, including government published maps, National Geographic maps, atlases, tourist maps, global data sets, U.S. National Aeronautics and Space Administration (NASA) satellite data

Mount Everest. (8,850 m)

The HIMA' ALAYA: (Abode of Snow)

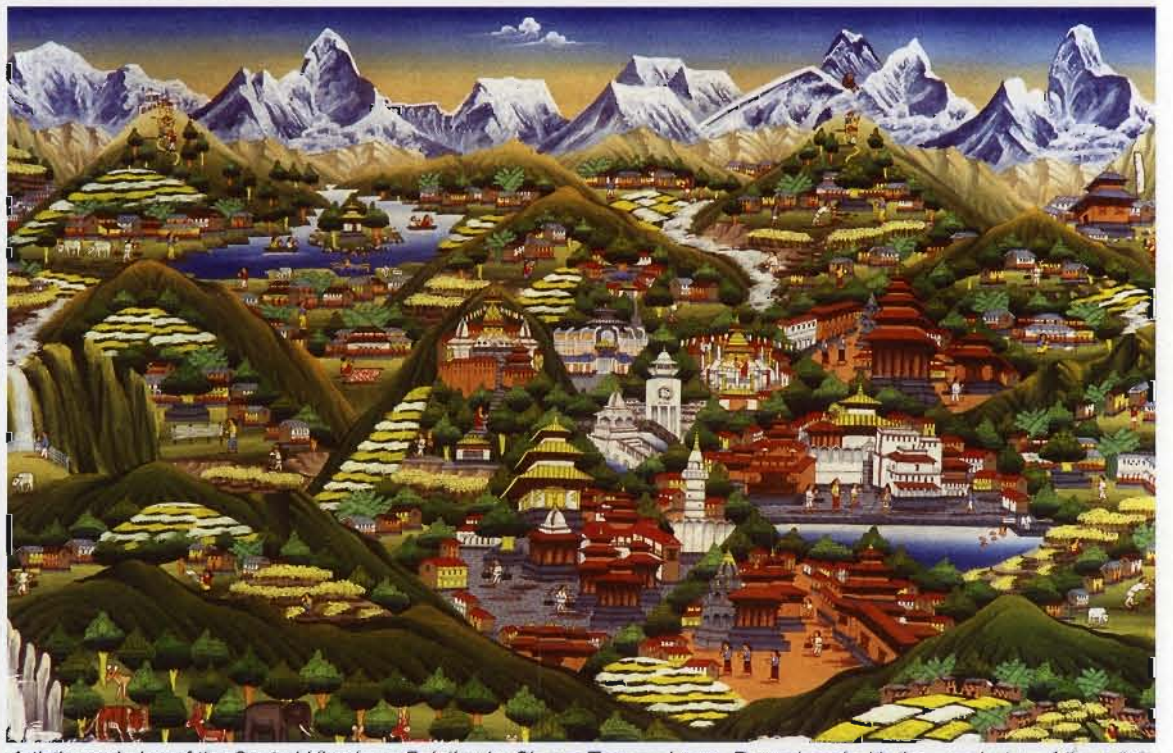
The slow, inexorable drift northward of the Gondwana continent, beginning about 130 million years ago in the Cretaceous period and continuing into the present day, resulted in the collision of the Indian and Asian continental plates, lifting up huge sections of old, compressed sea floor, creating the Himalaya - an extraordinary range of mountains that stands high above all other places on earth. Evidence of this cataclysmic event, and the 60 million-year old roots of the mountains, can be found in the landscape, among the twisted strata of exposed rock that show the enormous pressures of buckling and folding, and in the fossilized brachiopods, corals, and skeletal fish that are trapped at the foot of glaciers several miles high. They demonstrate the oceanic origins of the mountains; seashells are found even near the summit of Mt. Everest. Among the remnants of the ancient Tethys Sea, which intervened between the earth plates during much of their geological convergence, are the ammonites, whose spiraling shape represents for Hindus (Vishnu's chakra) and for Buddhists (cosmic mandala) symbols of diversity. They are especially esteemed by pilgrims as talismans for the power that comes from the curious mix of geology and mythology.

From the southern plains, the mountains appear as an impossible line of white peaks stretching across the horizon, as if they are a physical rampart separating entire worlds. Peoples living both north and south of the Himalaya believe them to be the abode of the gods, and the great deities of Tibet and India are thought to reside there and to intermingle in one another's affairs. For this reason, the Himalaya are held to be holy by native people, and to be animated with divinity. The religious view ascribes the celestial heights of the mountains to the *axis mundi*, which symbolically links the secular and spiritual realms of life in a conjunction of heaven and earth, and populates the mountainous landscape with mythical creatures, treasure places, monastic settlements, and auspicious settings that are filled with inexplicable powers. Magic and belief thus have secured for people an enduring place in the rugged and majestic terrain of the Himalaya.

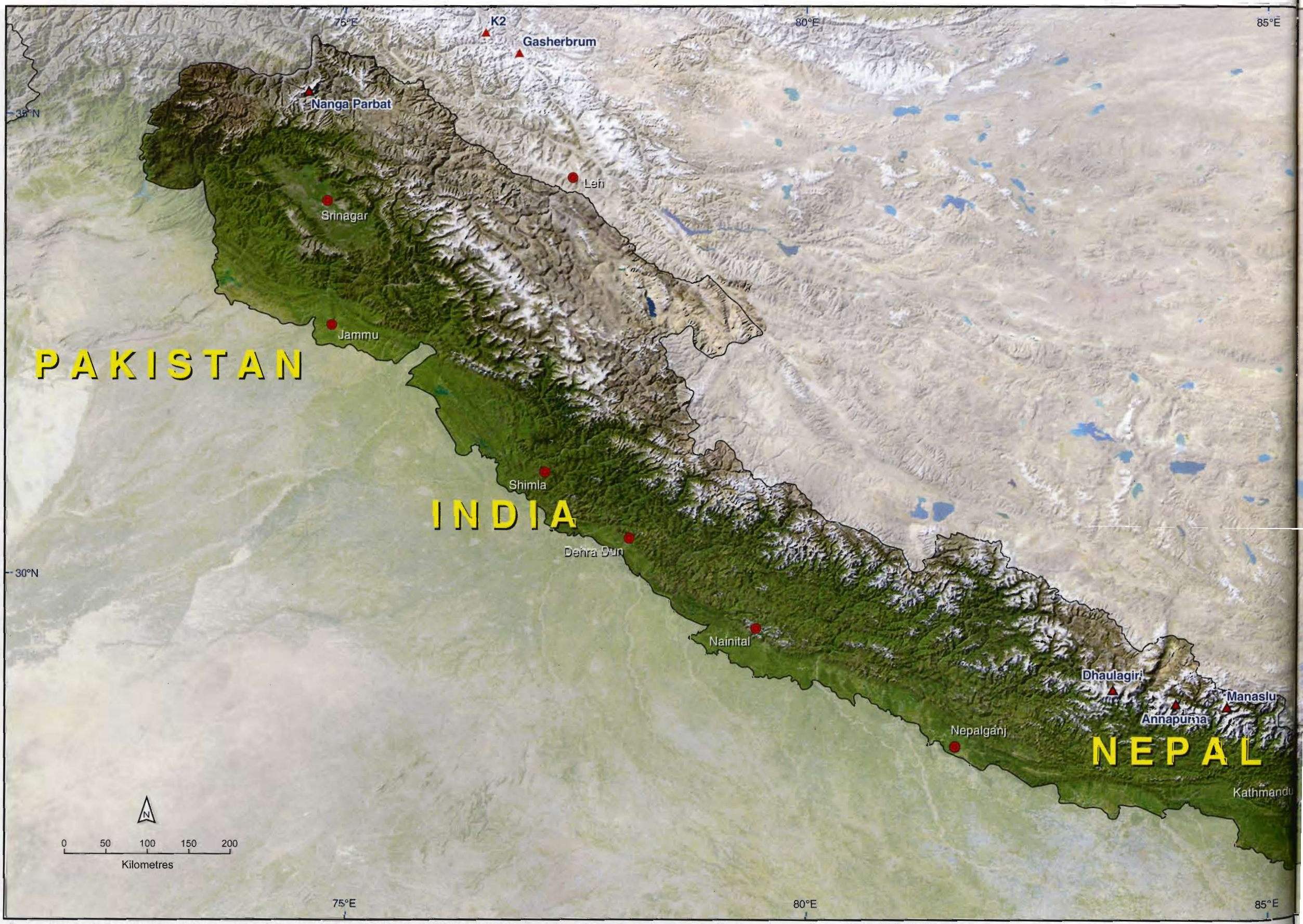
A geographical view of the mountains celebrates its stunning physical qualities. When the Karakoram peaks are included, the Himalayan range contains all fourteen of the Earth's summits over 8,000 meters, including Mt. Everest, which at 8,850 meters is the world's highest mountain. The deepest canyon in the world - the Kali Gandaki Gorge - is also located there, as are numerous other world class valleys, including some, such as the Dihang gorge, that are so remote they have been discovered only recently. In a regional setting, the Himalaya form the topographic showpiece of a huge highland area stretching from Afghanistan to Myanmar, and encompassing the Pamir, Hindu Kush, and Karakoram ranges, as well as the Himalaya proper. These ranges coalesce into a contiguous ridge of folds and thrust up along a 4,000-kilometer crescent. In a strict geographic sense, the Himalaya proper are more narrowly defined. They occupy the territory between 75 degrees East Longitude and 95 degrees East Longitude, and 27 degrees North Latitude and 35 degrees North Latitude, extending from the Indus River in the west to the Brahmaputra River in the east, anchored by the summits of 8,125-meter Nanga Parbat and 7,756-meter Namcha Barwa, respectively, and encompassing a geographic relief from the rolling high plateau of Tibet in the north to the outer foothills above the Ganges Plain in the south. According to this

The Asian highlands extend from Afghanistan to Myanmar and encompass the Hindu Kush, Karakoram, and Himalayan ranges (the HKH region). To the north of the HKH region is high Central Asia, which includes the Pamir mountains, as well as the massive Tibet Plateau. This entire area is the loftiest place on Earth. South of the mountains are the Indian peninsula and the adjoining countries of Pakistan and Bangladesh. All the countries of continental South Asia are geographically tied to the Himalaya, either directly by territory located in the mountains, or indirectly because the alpine system fundamentally interacts with the land and water systems within their political reach. The shaded area on the map represents the geographic constituency of the International Centre for Integrated Mountain Development (ICIMOD), an inter-governmental organization based in Kathmandu whose mandate is to promote poverty alleviation and environmental conservation in the HKH region.

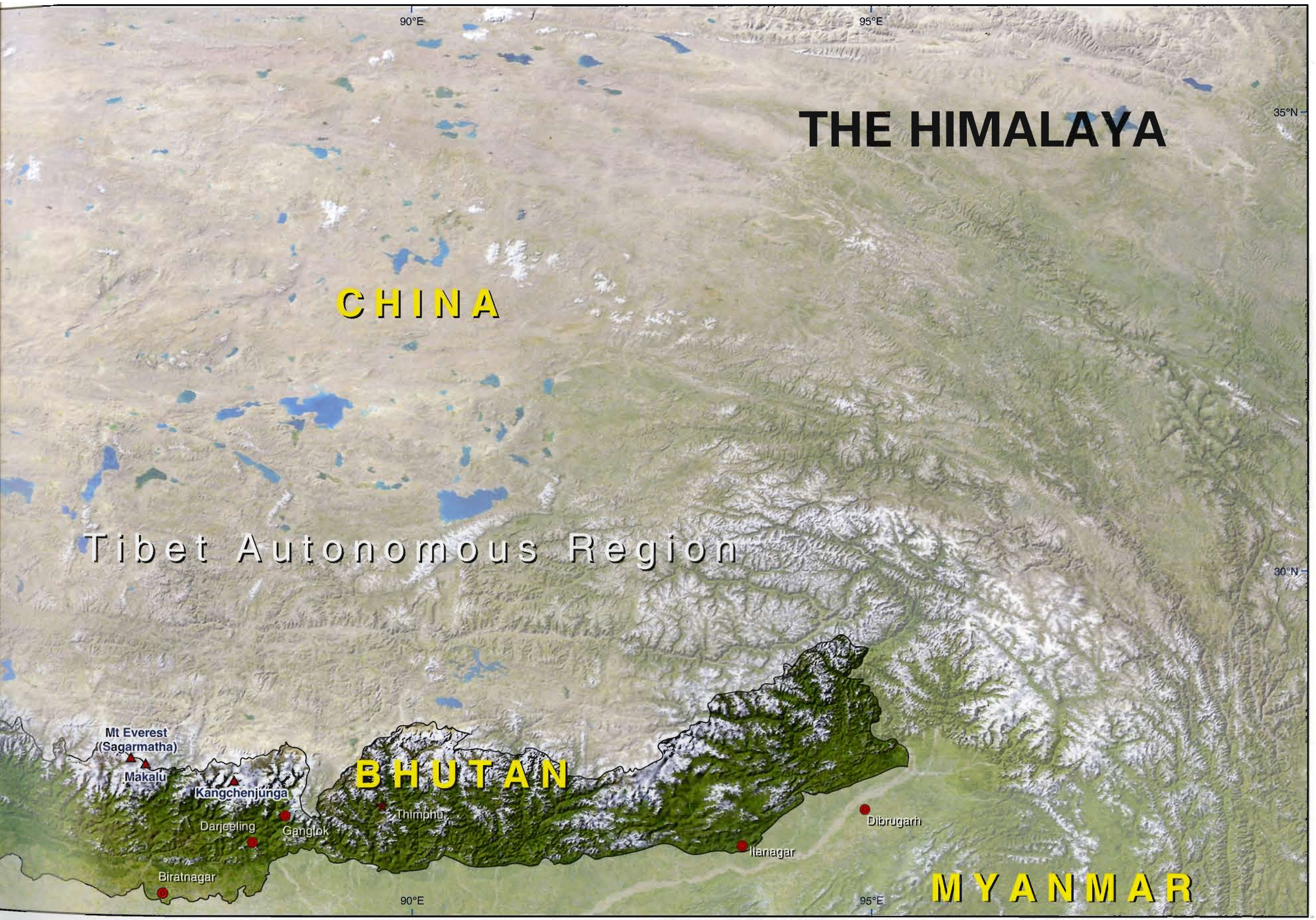
In this Atlas, the area termed 'Himalaya' has been taken as the area stretching from the Indus river in the west to the Brahmaputra river in the east. The northern boundary has been defined using mainly the administrative boundaries, reflecting the availability of most of the datasets, whereas the southern boundary has been taken from the Hindu Kush-Himalayan region boundary adopted by ICIMOD. In general, ICIMOD uses 'Himalaya' to describe a larger regional area that includes the Karakoram, Pamir, and Hindu Kush in the western Himalayan system and the mountain ranges in China, Myanmar, and Bangladesh in the northern and eastern end of the system. We hope to cover these additional areas in future work.



Artistic rendering of the Central Himalaya. Painting by Shyam Tamang Lama. Reproduced with the permission of the artist.



Source: Compiled by the authors from various sources, including government published maps, National Geographic maps, atlases, tourist maps, global data sets, U.S. National Aeronautics and Space Administration (NASA) satellite data


90°E
95°E
35°N
THE HIMALAYA
CHINA
Tibet Autonomous Region
30°N
Mt Everest
(Sagarmatha)
Makalu
Kangchenjunga
Darjeeling
Gangtok
Thimphu
BHUTAN
Dibrugarh
Itanagar
Biratnagar
MYANMAR
90°E
95°E

JAMMU AND KASHMIR FACT FILE

Form of Government:	Federal Republic (state of the Indian Union)
Capital:	Jammu (winter), Srinagar (summer)
Area:	222,236 square kilometers
Population:	7,718,700
Population Density:	34.7 /km²
Life Expectancy:	no data
Infant Mortality:	no data
Official or Principle Language:	Hindi, Kashmiri, Dogri-Kangri
Literacy Rate:	no data
Religions:	Muslim, Hindu, Buddhist
Currency:	Indian rupee
GNP per capita:	no data
Climate:	Temperate to alpine
Highest Point:	Nunkun 7,135 meters

Nilgiri summit (7,061 m)

definition, the Himalaya run about 2,400 kilometers long, contain 600,000 square kilometers, and have a population of over 47 million persons.

In capturing such a huge tract of the earth of immense geographical proportions, the Himalaya are distinguished by a great variety of terrain, climate, and human culture. The

HIMACHAL PRADESH FACT FILE

Form of Government:	Federal Republic (state of the Indian Union)
Capital:	Shimla
Area:	55,673 square kilometers
Population:	6,177,248
Population Density:	111 /km²
Life Expectancy:	60
Infant Mortality (per 1000):	121.92
Official or Principle Language:	Pahari, Hindi
Literacy Rate:	63.50%
Religions:	Hindu 96%; Muslim 1.6%, Buddhist 1.2%
Currency:	Indian rupee
GNP per capita:	US$375
Climate:	Temperate to alpine, monsoon
Highest Point:	Leo Pargyal 6,790 meters

western regions of Ladakh and Zanskar are dry, north of the main summits is desert, and the temperature is cold much of the year. The eastern edge of the Himalaya, meanwhile, in the watershed of the Brahmaputra River where it disgorges from the highlands in Tibet, is subtropical and one of the wettest spots on earth, with recorded precipitations in excess of fourteen meters a year. From west to east, north to south, exist enormous gradients of both precipitation and temperature. To the extent that regional climate organizes the distribution of natural vegetation, we also find great complexity in the type and range of Himalayan plants. The eastern region of Bhutan and the upper Assam Valley form a global biodiversity hotspot with a tremendous variety of plants and animals, a third of which are found nowhere else in the world.

More striking, perhaps, than even the horizontal space occupied by the Himalaya is the vertical aspect of the mountains. Simply put, changes in elevation result in the formation of different climatic and vegetation zones along the flanks of the mountains. On average, the temperature difference with altitude change is 6.4 degrees C / kilometer (3.5 degrees F /1000'). With elevation changes of almost 8,000 meters possible, the temperature gradient discovered in the heights of the Himalaya is comparable to whatever may be encountered by traveling from the tropical latitudes to the polar ice fields. Add to the vertical gradient the fact that slope aspects determine solar receipts and windward versus leeward localities witness extreme differences in precipitation, and the possibilities for natural diversity over short distances become great. This complex environmental model confuses most attempts to describe the Himalayan environment in monolithic terms. On the ground, however, the diversity is most easily seen: the terrain falls away from the icy peaks in terraces and deep green valleys, rolling across ridge upon ridge in cascading descents before spilling onto the lowland plains. Water follows the contours of the land, gushing from glacial lakes and snowmelt in torrents, carving shadowy gorges, and nourishing agricultural fields that are carved into the sides of the mountains. The surface of the land, in response to the diverse circumstances imposed by the terrain and climate, is a bewildering patchwork of glaciers, forests, pastureland, rivers, and farms. This natural diversity, moreover, is accentuated by the complex cultural geography of the Himalaya, which weds human society to the physical circumstances of the mountains.

Three great civilizations converge on the Himalaya: Buddhist tradition from Tibet, Islamic in the western region,

UTTARANCHAL FACT FILE

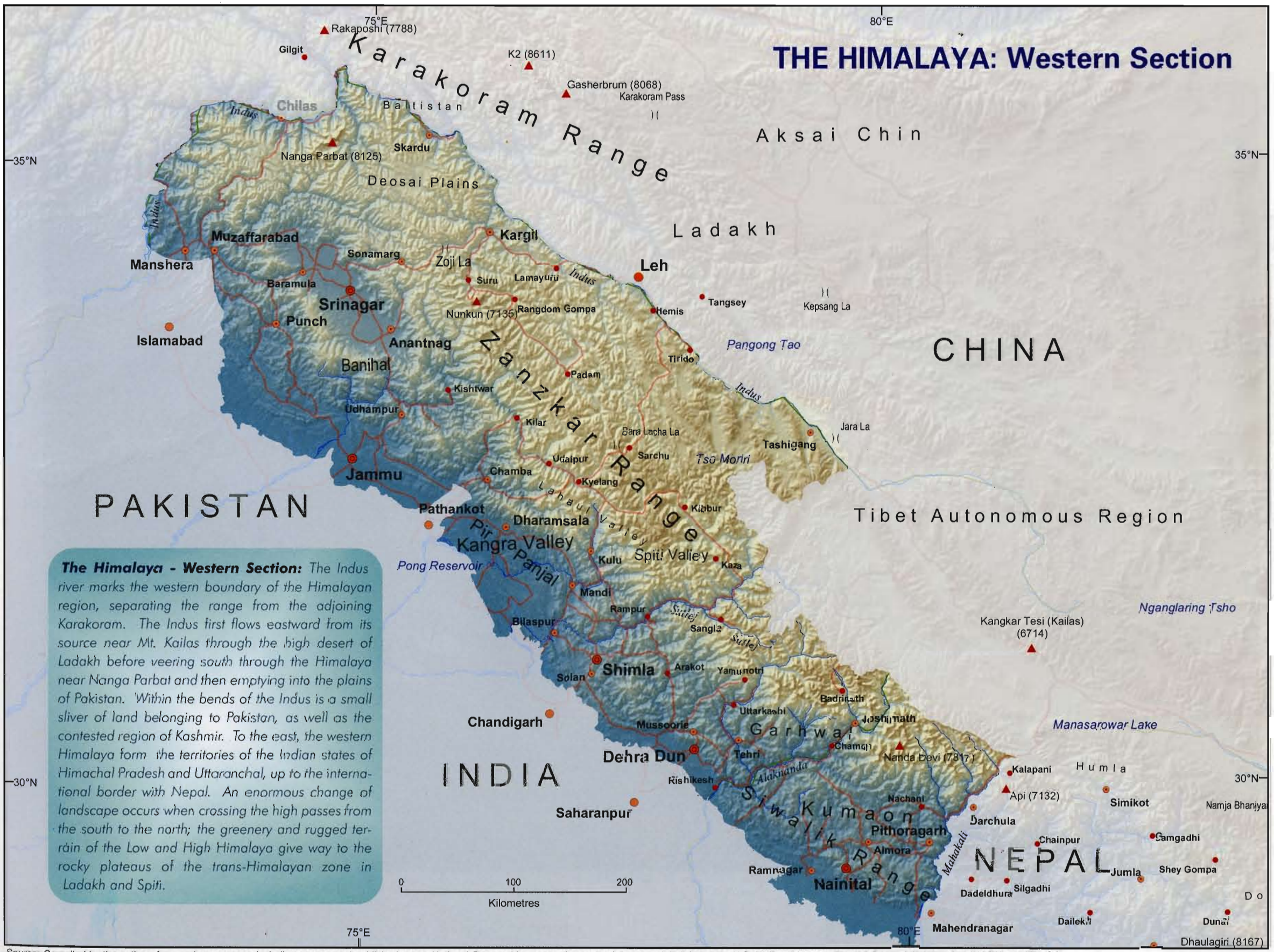
Form of Government:	Federal Republic (state of the Indian Union)
Capital:	Dehradun (interim)
Area:	51,125 square kilometers
Population:	7,000,000
Population Density:	125 /km²
Life Expectancy:	55
Infant Mortality:	113
Official or Principle Language:	Pahari, Garhwali, Hindi
Literacy Rate:	58%
Religions:	Hinduism
Currency:	Indian rupee
GNP per capita:	US $240
Climate:	Temperate to alpine
Highest Point:	Nanda Devi 7,824 meters

The Indus River cuts through the arid mountains of Baltistan to form a deep gorge that defines the northern boundary of the Himalaya.

and Hindu culture from India. These societies overlay the numerous tribal settings, from the pastoral and semi-nomadic communities in the trans-Himalayan valleys to the shifting cultivation farmers in the subtropical forests, so that an extraordinary assemblage of local cultures results from the blending of traditions. The kaleidoscopic human face of the Himalaya attests to the unique and compelling ways in which people have adapted to these cultural as well environmental influences. Anthropologists have provided ethnographic profiles of Himalayan peoples, showing them to be resilient and tenacious in the midst of the demands imposed by local environmental conditions. It is less clear, though, how the traditional lifestyles will help people to navigate the future, when the pressures of limited resources combine with the social demands of globalization.

In modern times, the peoples of the Himalaya are forced to accommodate the needs of much larger societies,

THE HIMALAYA: Western Section



The Himalaya - Western Section: *The Indus river marks the western boundary of the Himalayan region, separating the range from the adjoining Karakoram. The Indus first flows eastward from its source near Mt. Kailas through the high desert of Ladakh before veering south through the Himalaya near Nanga Parbat and then emptying into the plains of Pakistan. Within the bends of the Indus is a small sliver of land belonging to Pakistan, as well as the contested region of Kashmir. To the east, the western Himalaya form the territories of the Indian states of Himachal Pradesh and Uttaranchal, up to the international border with Nepal. An enormous change of landscape occurs when crossing the high passes from the south to the north; the greenery and rugged terrain of the Low and High Himalaya give way to the rocky plateaus of the trans-Himalayan zone in Ladakh and Spiti.*

Source: Compiled by the authors from various sources, including government published maps, National Geographic maps, atlases, tourist maps, global data sets, U.S. National Aeronautics and Space Administration (NASA) satellite data

Nakho village, western Himalaya

THE HIMALAYA: Central Section

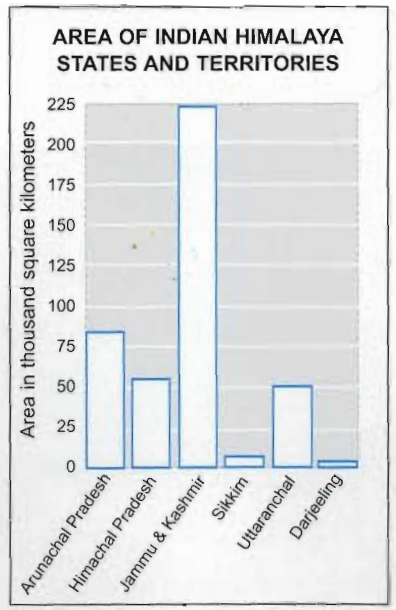
Himalaya - Central Section: *Nepal and Sikkim compose the central Himalaya, where the highest peaks of the range are found. The monsoon climate dominates this region. High population density and poverty are common, and some of the most severe instances of environmental degradation occur here. Much of the interior regions of the central Himalaya remain without roads, and barring the few airstrips capable of handling small aircraft, the mountainous terrain is accessible only by foot. The narrow strip of land along the Nepal-India border, known as the Terai, is one of the most rapidly-developing zones in the entire Himalaya.*

Source: Compiled by the authors from various sources, including government published maps, National Geographic maps, atlases, tourist maps, global data sets, U.S. National Aeronautics and Space Administration (NASA) satellite data

BHUTAN FACT FILE

Form of Government:	Monarchy
Capital:	Thimphu
Area:	47,000 square kilometers
Population:	1.2 million
Population Density:	25.8 /km²
Life Expectancy:	52.8
Infant Mortality (per 1000):	109.3
Official Language:	Dzongkha
Literacy Rate:	41.10%
Religions:	Lamaistic Buddhist 75%, Hindu 25%
Currency:	Ngultrum
GNP per capita:	US $420
Climate:	Tropical to alpine, monsoon
Highest Point:	Kula Kangri 7554 meters

which conventionally view the mountains as sovereign territory and important resource frontiers. The Asian countries bordering the Himalaya have carved the mountainous territory into respective political possessions, albeit with great uncertainty in some places. Kashmir, for example, is contested by India and Pakistan, whereas many Kashmiri people would prefer an independent state. India and China differ over the ownership of an inhospitable stretch of cold desert north of Ladakh known as Aksai Chin. India initially claimed the land and put it on its maps, but discovered in 1958 that China had already built roads through the region. Tiny Sikkim, wedged between Nepal and Bhutan, was an independent kingdom until it became the twenty-second state of India in 1975. Chinese maps include about 300 square kilometers of territory that belong to Bhutan, but the matter is not pursued because China wishes to maintain cordial relations with Bhutan. Much of the eastern region of the Himalaya, now occupied by the Indian state of Arunachal Pradesh, is claimed by China. These contested divisions of Himalayan territory, long a part of the region's political history, continue in the present day; most recently in 2000, the Himalayan state of Uttaranchal was formed by assembling 13 mountain districts of Uttar Pradesh into India's twenty-seventh state.



The demarcation of political areas in the mountains results in the boundaries that commonly appear on the Himalayan maps. In the western region, the Pakistan districts of Mansehra, Abbottabad, and Kohistan share the Indus watershed and lie in the shadows of Nanga Parbat. This part of Pakistan is known as Azad Kashmir, meaning 'free Kashmir,' and suggests Pakistan's viewpoint that much of the rest of Kashmir is illegally occupied by India. Arcing eastward, the Himalayan range leaves Pakistan sovereign territory and enters the Indian state of Jammu and Kashmir. The border area is tumultuous, and poorly defended despite a heavy military presence from both Pakistan and India. Over 200,000 square kilometers of mountain terrain is circumscribed by the boundaries of Jammu and Kashmir, including the plateau region of Ladakh. With almost 8 million persons, Jammu and Kashmir has the largest population of any Indian state in the western Himalaya. To the east of Kashmir is the state of Himachal Pradesh, which lies entirely within the Himalaya and encompasses 55,000 square kilometers. Its population of over 6 million makes it a densely settled region (110/km²) surpassed in that regard only by the new neighboring state of Uttaranchal, which has an area of 51,125 square kilometers and a total population of just over 7 million (125/km²). Uttaranchal encompasses the traditional regions of Garhwal and Kumaon, which are still locally known by their historic titles rather than by the new district names.

Administrative Regions of Indian Himalaya

Himalayan State	Area (sq. km)	% of Area of Indian Himalaya
Jammu & Kashmir	222,236	41.83
Arunachal Pradesh	83,743	15.76
Himachal Pradesh	55,673	10.48
Uttaranchal	51,125	9.62
Sikkim	7,096	1.34
Darjeeling	3,149	0.59

The remote and arid Spiti Valley lies north of the crest of the Himalaya in Himachal Pradesh.

In the central part of the Himalaya, Mahakali river forms the boundary between India and the Kingdom of Nepal, and bisects a territory that shares similar cultural traits and environmental conditions. The dialects of people on both sides of the international border are remarkably similar, even though their respective national languages are different. Moreover, the early political history of this region, prior to the independence of India and the consolidation of Nepal's frontier, suggests a common origin for both nationalities. Nepal to the east encompasses 147,181 square kilometers with a population of 23, 214,000 persons (2000 Census). Nepal's territory is commonly thought to occupy the central zone of the geological Himalaya, and, indeed, most of the

Jharkot village in Dzong Valley of northern Nepal, near the border with Tibet, Mustang

ARUNACHAL PRADESH FACT FILE

Form of Government:	Federal Republic (state of the Indian Union)
Capital:	Itanagar
Area:	83,743
Population:	1,091,117
Population Density:	13 /km²
Life Expectancy:	44
Infant Mortality:	no data
Official or Principle Language:	Dafla, Abori, Mishmi
Literacy Rate:	no data
Religions:	Animistic tribal, Buddhist
Currency:	Indian rupee

THE HIMALAYA: Eastern Section

88°E 90°E 92°E 94°E 96°E

30°N 28°N 26°N

CHINA

Tibet Autonomous Region

INDIA

BHUTAN

Lhasa
Shigatse
Yarlung Tsangpo
Salween
Tunga Pass
Mipi
Miging
Asonli
Brahmaputra
Mishmi Hills
Riga
Mara
Malinan
Kula Kangri (7554)
Thanza
Lhedang
Chomo Lhan (7327)
Gasa
Kangto (7090)
Daporijo
Pasighat
Teju
Chumbi Valley
Tista
Sikkim
Yangothang
Thunkar
Lhuntshi
Tashi Yangtse
Tawang
Subansiri
Assam Valley
Paro
Wangdi Phodrang
Tongsa
Bumthang
Ziro
Dibrugarh
Gangtok
Thimphu
Bumtang
Bomdila
Mangan
Chuzom
Black Mountains
Mongar
Tashingang
Seppa
North Lakhimpur
Kalimpong
Shemgang
Kalaktang
Sangbay
Manas
Darjeeling
Sarbhang
Pemagatsel
Itanagar
Siliguri
Phuntsholing
Sarkhang
Geylegphug
Samdrup
Tezpur
Jalpaiguri

Himalaya - Eastern Section: The eastern stretch of the Himalaya covers the Kingdom of Bhutan and the Indian state of Arunachal Pradesh. The international boundaries remain contested in this region, with China claiming much of the area now occupied by India, as well as a small part of northeast Bhutan. This region receives the greatest amount of rainfall and good forest cover exists throughout the eastern Himalaya. Population densities are lowest in Arunachal Pradesh, where mountain towns are few, and the majority of people practice a form of nomadic agriculture called jhum, or shifting cultivation. Large sections of this part of the Himalaya remain off limits to foreigners, and the almost constant cloud cover hides the landscape from even the penetrating technology of global satellite systems.

0 50 100
Kilometres

Source: Compiled by the authors from various sources, including government published maps, National Geographic maps, atlases, tourist maps, global data sets, U.S. National Aeronautics and Space Administration (NASA) satellite data

The hills in far western Nepal's Rapti Zone. This beautiful region, that spawned the Maoist insurgency, is one of the poorest socioeconomic zones .

highest summits, such as Everest, Annapurna, and Dhaulagiri, are located there. The eastern border of Nepal is dominated by Mt. Kangchenjunga, the third-highest summit in the world at 8,598 meters and one of the most beautiful. Along its western and southern flanks, Kangchenjunga comprises a good share of the territory of Sikkim, a former kingdom tightly wedged between Nepal and Bhutan that is now an Indian state. Sikkim's total area is 7,096 square kilometers, much of it high mountains, and its population is 406,500 persons.

The eastern region of the Himalaya includes the Kingdom of Bhutan and the northeastern Indian state of Arunachal Pradesh. Bhutan encompasses 47,000 square kilometers, with a population of 2 million persons, making it one of the less densely-populated regions in the Himalaya. To the east of Bhutan is the range's most sparsely inhabited area, the subtropical mountain region of Arunachal Pradesh. Bhutan is mainly agrarian, over 90% of its population are farmers, and the country seeks to maintain its strong Buddhist tradition by limiting the numbers of tourists. Arunachal Pradesh, similarly, is closed to much of the world, with the central Indian government restricting foreigners to only a few spots for reasons of border security and the frequent uprisings that occur among its tribal populations. Both Bhutan and Arunachal Pradesh also share a wealth of natural beauty and diversity, and this entire zone is considered to be a world-class biodiversity hot spot. The extreme eastern edge of the Himalaya is formed by the bend of the Brahmaputra River, where it shifts southward from the Tibet Plateau (where the river is known as the Yarlung Tsangpo) at the 95 degree East Longitude line. There, it cuts a deep gorge in the Himalaya before emptying into the Assam valley near the river town of Dibrugarh.

NEPAL FACT FILE

Form of Government:	Constitutional monarchy
Capital:	Kathmandu
Area:	147,181 square kilometers
Population:	24,302,653
Population Density:	172.6 /km²
Life Expectancy:	58.4 years
Infant Mortality (per 1000):	73.6
Official Language:	Nepali
Literacy Rate:	27%
Religions:	Hindu 90%, Buddhist 5%, Muslim 3%, other
Currency:	Nepalese rupee
GNP per capita:	US$200
Climate:	Subtropical to alpine; monsoon
Highest Point:	Mount Everest 8,850 meters

In sum, the Himalaya encompasses a remarkable mosaic of landscapes and cultures, organized in part according to the political territories described above, but also in accordance with longstanding heritages that predate the modern nation-states. The naming of Himalayan places, which gives rise to the titles that appear on the maps, also highlights the juxtaposition of old settlement titles and modern names derived from contemporary nation building. In some cases, the old and new names are used interchangeably, such as Everest and Sagarmatha, but most often the ancient topynyms, which hearken back to linguistic dialects that may no longer even exist, have given way to their modern equivalents in the national language or in English. The word 'dzong', for example, which still appears on the Himalayan maps in reference to distinct places from Ladakh in the west to Bhutan in the east, reflects early Tibetan dialect usage and refers to a fortress, or a fortress-like settlement. Commonly, a prefix locates the fortress in a specific geographic locality. For example, Baragaon Dzong in Nepal refers to a valley of 12 fortress-like villages north of the Annapurna range, while Paro Dzong in Bhutan refers to an old historical center of the

SIKKIM FACT FILE

Form of Government:	Federal Republic (state of Indian Union)
Capital:	Gangtok
Area:	7096 square kilometers
Population:	406,457
Population Density:	57.3 /km²
Life Expectancy:	no data
Infant Mortality:	no data
Official Language:	Gorkhali/Nepali, Hindi
Literacy Rate:	56.94%
Religions:	Hinduism, Buddhism
Currency:	Indian rupee
GNP per capita:	US $215
Climate:	Subtropical to alpine
Highest Point:	Kangchenjunga 8,586 meters

A Tharu woman harvesting wheat in a tectonic (dun) valley in the outer foothill zone. The Siwalik Hills loom to the north in the background.

Sermathang village in Helambu (Yolmo), Sindhupalchok, Nepal

kingdom. The term 'dzong,' however, is rarely used outside Bhutan on the maps, with only a few Nepalese exceptions. The names of mountain summits, likewise, commonly appear in multiple ways. The world knows the name of the highest mountain on earth to be Mt. Everest, which commemorates the British surveyor Sir George Everest, but the summit, located in northeastern Nepal, is locally known by the Nepalese as Sagarmatha, and by the Tibetans as Chomolungma which means 'Mother Goddess'.

In its general overview, the Himalayan range exhibits unparalleled grandeur. North of the high peaks are remote sections of arid plateau and valleys. In Ladakh, the Tibetan Plateau extends for several hundred kilometers, and shapes a 60,000 square kilometer landscape of arid steppe and valleys similar to that found further east in Tibet. Much of this area is windy and cold, projecting a stark beauty, but containing little water and few places suitable for human settlement. Other minor extensions of the plateau occur in isolated regions of Nepal, notably in Dolpo and Mustang, which lie north of the 8,167-meter Dhaulagiri and 8091-meter Annapurna mountains, respectively, in Sikkim along the upper Tista River, and in Bhutan north of 7,554-meter Kula Kangri.

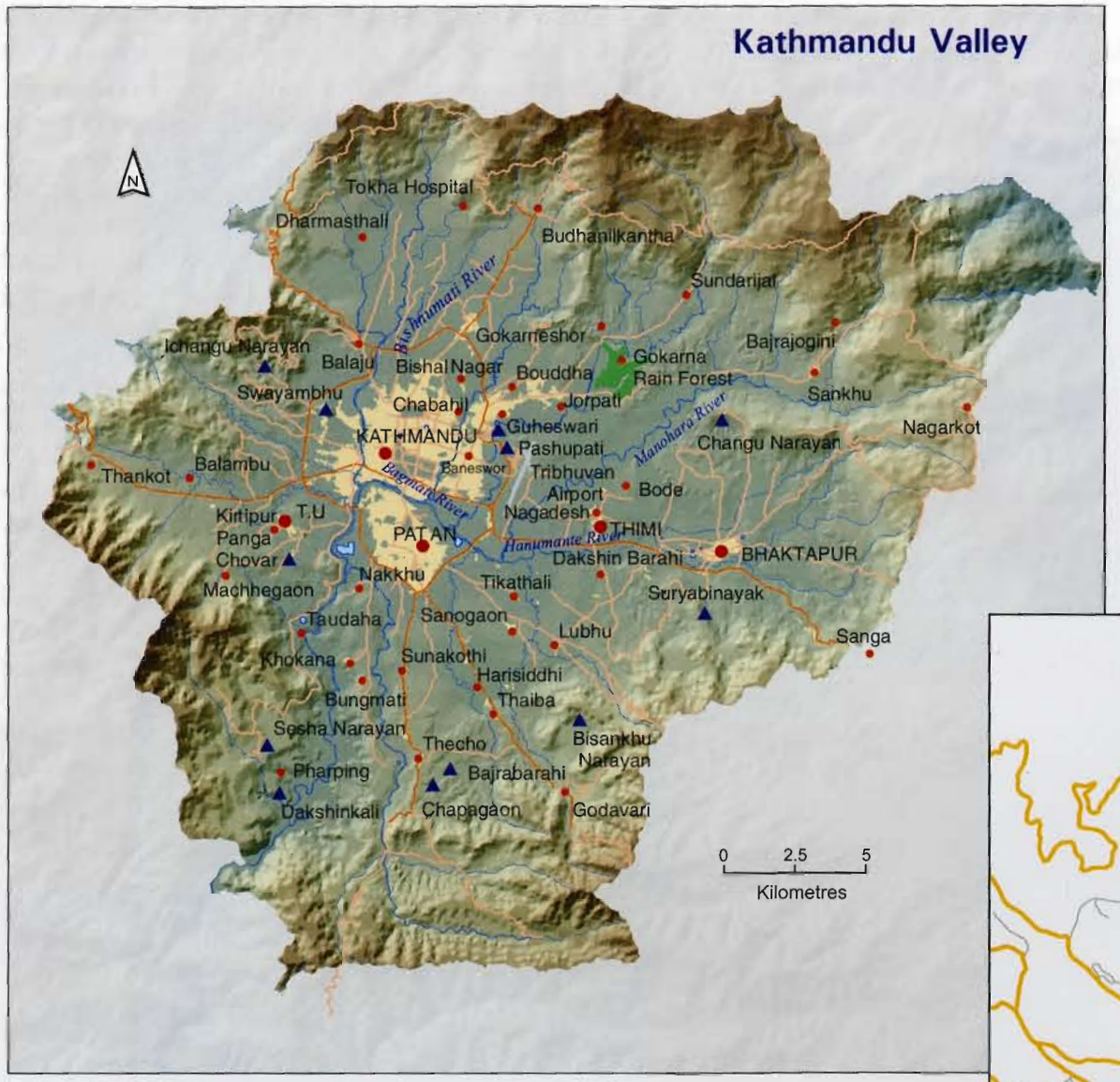
The remote plateau region lies in the rainshadow of the great Himalayan peaks and is, therefore, arid, with surface water originating mainly in the melting of snowfields and glaciers. The terrain and isolation make communication and travel across this zone difficult. In the western Himalaya, the Indian government has built a number of military roads in Ladakh and in the adjoining plateau regions of Spiti and Lahul. Many of these roads are now open to civilian traffic, and their presence in these localities has considerably opened the plateau to regional transportation. Elsewhere in the Himalaya, though the plateau areas generally remain devoid of vehicular traffic. Several passes, called 'la', enter the zone from the south, crossing the Great Himalaya at heights ranging from 4,000 to 6,000 meters. The major passes include the 4,373-meter Jelep La in the Chumbi Valley of Sikkim, the 5,150-meter Laitsawa Pass in Bhutan, numerous important routes in Nepal in the areas of Dolpo, Khumbu (Mt. Everest region), and Mustang, and the crossings of the Zanskar and Ladakh ranges in India at 4,650-meter Baracha La and 4,276-meter Kun Zum La.

South of the plateau zone, extending west to east across the length of the range, lie the summits of the Great Himalaya. This highland zone composes an almost contiguous rampart of ice, snow, and rock, and in the minds of most people conjures the strongest images of the Himalaya. Here, in the ancient Tethys Sea deposits of over 15 kilometers thick have been uplifted to expose the crystalline core of the mountains. Amid the high peaks are deep gorges, secluded tributary valleys, and passes, providing difficult avenues for travel and remote places for scattered human settlements. The altitude, climate, and harsh terrain preclude the possibility of many people living in this zone. In the Zanskar and Spiti valleys of India and in the upper Kali Gandaki Valley of Nepal, where clear skies prevail much of the year, abundant sunshine makes agriculture possible where irrigation water is available. In these places, small villages, with mud and stone houses, are cloistered around old Buddhist monasteries.

During the long winters, snow in the high passes isolates many of the valley settlements and makes travel difficult or impossible. It is feasible to leave Zanskar in the winter only by walking for a week or more across the dangerous frozen surface of the Zanskar river, moving from the interior of the Zanskar valley to the road head near Padam in Ladakh along a treacherous canyon trade corridor that is many centuries old. In Nepal and in Bhutan, the Great Himalayan zone is used primarily as a summer grazing area for the semi-nomadic peoples who live for most of the year in villages located at lower altitudes. The upper flanks of such great massifs as Dhaulagiri, Annapurna, Everest, and Kangchenjunga host significant populations of seasonal herders - the Magar, Gurung, and Sherpa, for example - but provide few resources for permanent villages. In recent years, the Great Himalayan zone has become a popular destination for mountaineers and trekkers, and a number of national parks are newly established there. The bulk of the human population in the Himalaya resides in the intermediate hill zone, which falls south away from the Great Himalaya in terrain ranging from 1,500 meters to 4,500 meters in elevation. The hill zone landscape is heavily dissected by rivers flowing down from the higher mountains and contains numerous ridges and valleys in a complex rugged topography. Several prominent and discrete ranges occur in

Ganesh Himal (7,110 m) Gorkha District, Nepal

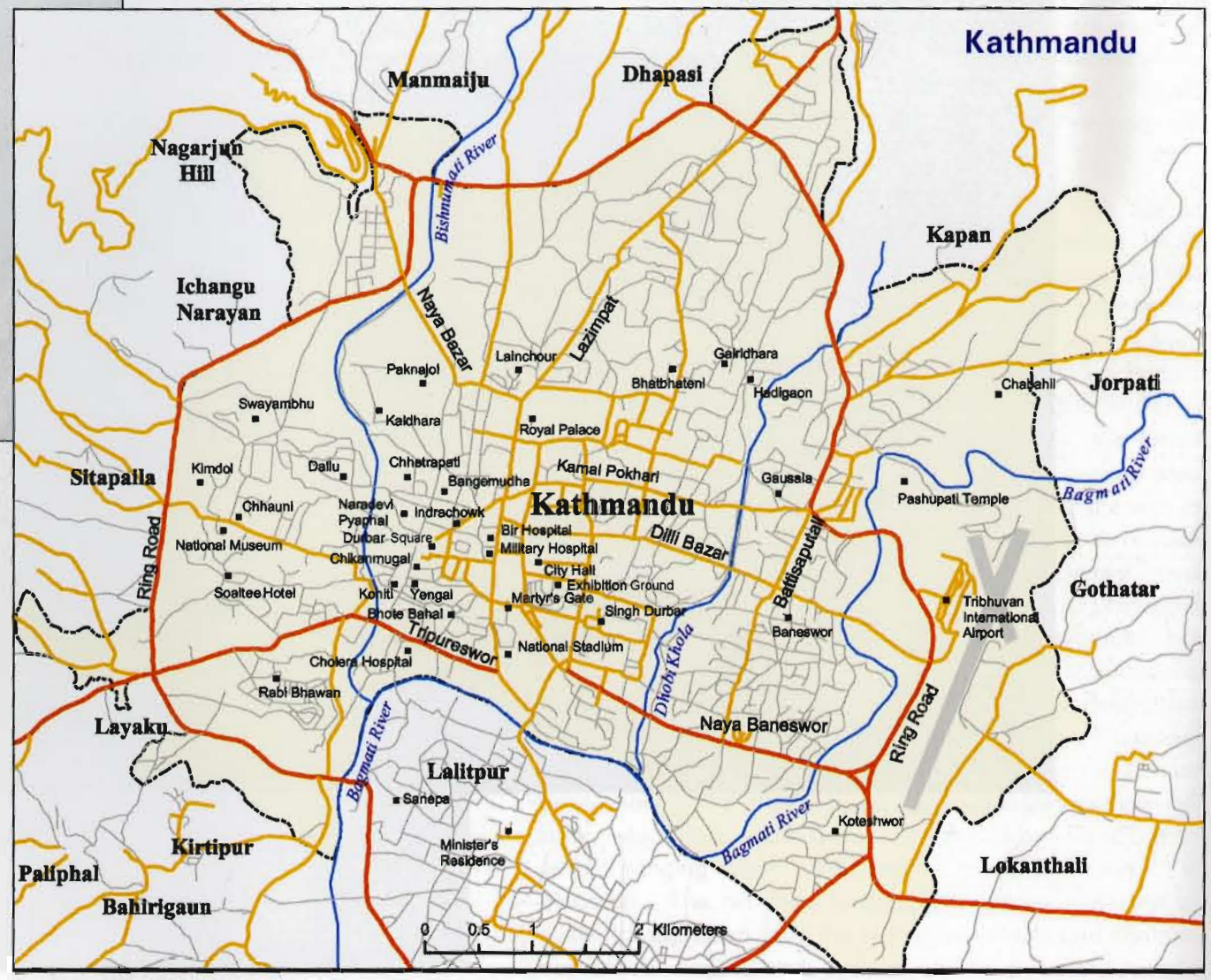
Kathmandu Valley, Nepal



Source: ICIMOD, MENRIS data compiled from various sources

this zone, including Pir Panjal in the northwestern Indian Himalaya, Mahabharat Lekh in Nepal, and the Black Mountains of Bhutan. These ridges, by virtue of their greater height, stand above much of the rest of the hill zone, but the entire zone is mountainous and in full view of the high peaks of the Great Himalaya. Numerous rivers fed by the melting snow and glaciers converge in the hill zone to form the great river systems: The Indus-Sutlej in the westernmost region; the Alaknanda-Bhagirathi in the Garhwal region; Nepal's Karnali, Narayani, and Kosi rivers; the Tista in Sikkim, the Amo-Sankosh and Manas in Bhutan; and the Brahmaputra in Arunachal Pradesh, which forms the eastern boundary of the Himalaya. These river systems play a vital role in shaping the topography of the hill zone, provide water for irrigation, and signify potential energy for hydropower development.

One of the most striking aspects of the hill zone landscape is how intensively it is managed by human society, to the point of exhaustion in places. Farm communities dot the ridges and spread across the lower slopes, interspersed by areas of forest and cultivation. The forests are most intact where the population densities are low, but even in the heavily settled areas, the forests occur as conservation areas, religious sanctuaries, and village common lands where fodder is collected and livestock taken to graze. The cultivated lands are widespread in the river valleys where water for irrigation water is available to grow a rice crop and alluvial terraces provide fertile soils. The hill slopes, meanwhile, have been carved out over centuries into cascades of level terraces, so that in places over a mile of vertical mountain relief is covered in carefully managed farm fields. If one knows how difficult it is to hoe a small garden by hand, then it is possible to imagine the labor required to



Source: ICIMOD, MENRIS data compiled from various sources

Source: Compiled by the authors

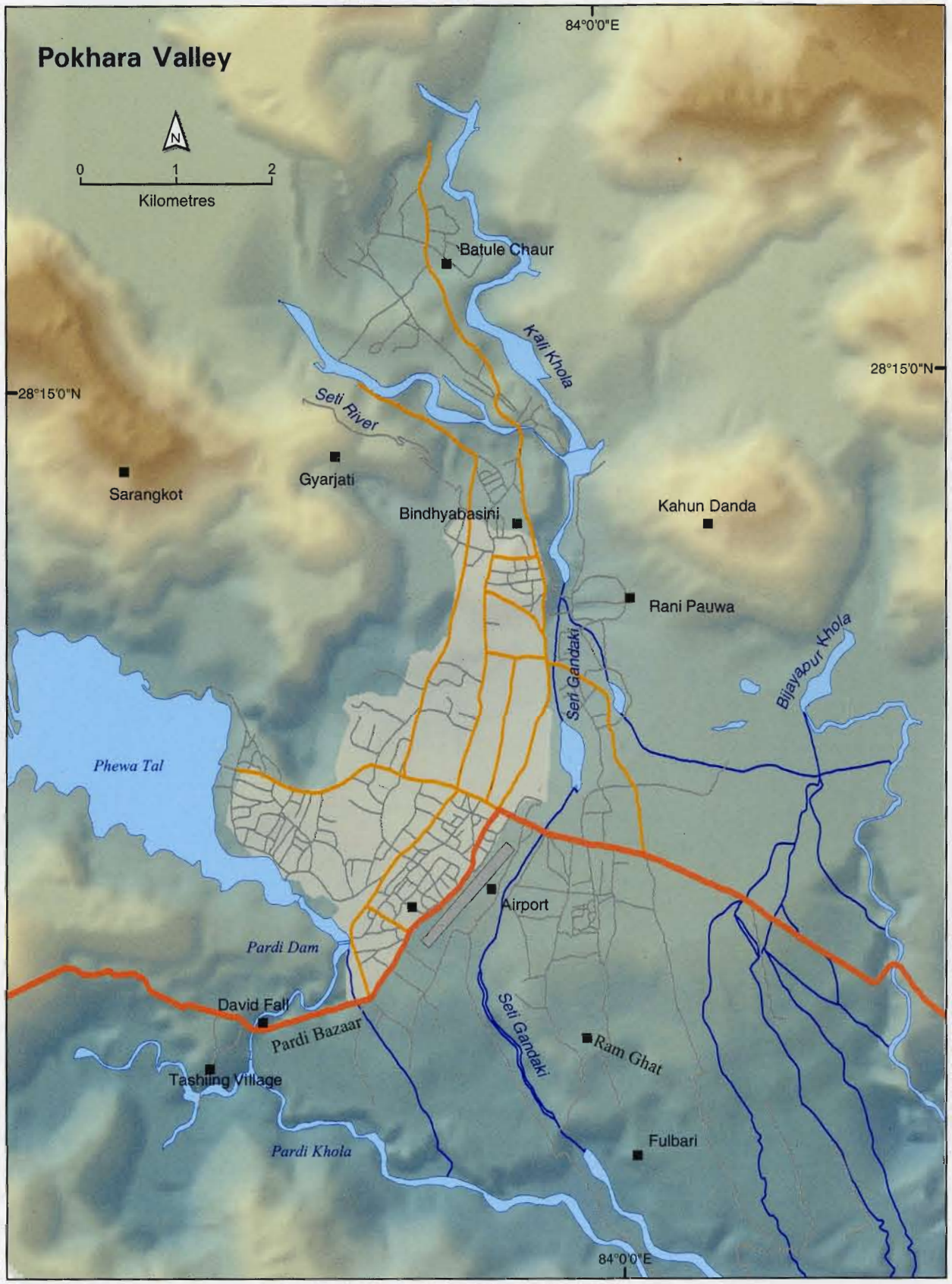
Dal Lake, Kashmir Valley

Source: Based on Dubey, M. and T. Sinclair, 1992. Insight Guides - Western Himalaya. Singapore: APA Publications

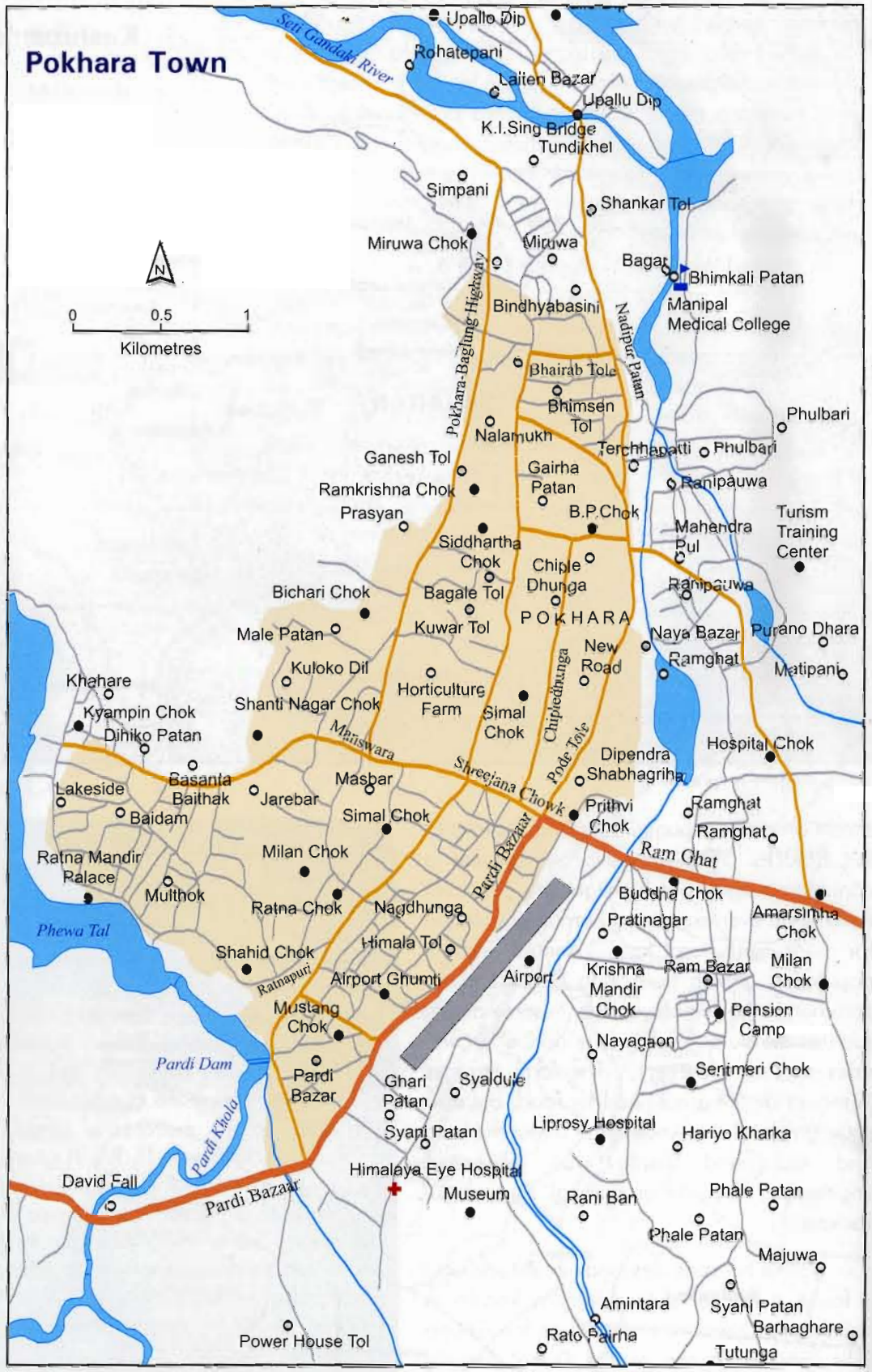
shape an entire mountainside into a series of flat surfaces. The extensive terraces are a compelling sight, but highlight the continual need of an ever-expanding human population for more agricultural land. Annual rates of population growth from 2 to 3 percent are common in the Himalaya, and, in some areas, such as the outer foothills, the annual growth rates exceed 4 percent. The farm terraces demonstrate the great need for food, but also show a remarkable knowledge about the land and soil, and display the advanced engineering skills of traditional agricultural societies.

The hill zone descends in altitude until it forms a line of outer foothills, known in India as the Siwaliks, in Nepal as the Churia Hills, and in Bhutan as the Duars (literally meaning 'gateway'). The foothills, in turn,

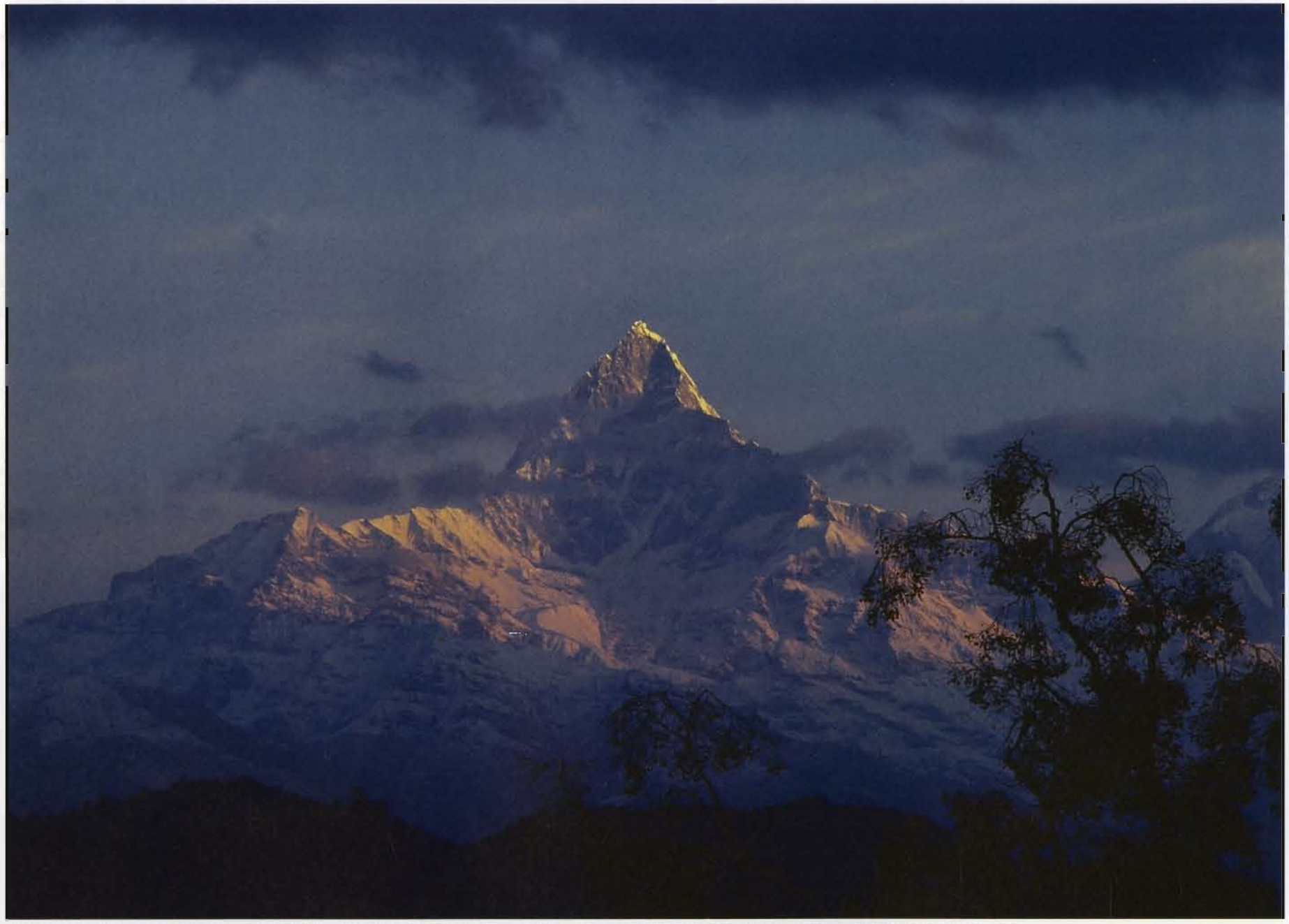
Major Valleys and Cities: *Kashmir Valley in the western Himalaya and Kathmandu Valley and Pokhara Valley in Nepal are all tectonic depressions. In Kashmir, several small remnant lakes, including the Dal Lake, Nagin Lake, and Wular Lake, are distinctive features of the present-day valley floor. Kathmandu Valley is drained by the Chobhar gorge. Both valleys also contain sizeable settlements, including two of the largest cities in the Himalaya - Srinagar (710,000 pop. est. metropolitan area; 1991 Census) and Kathmandu (1,093,414 pop. est. metropolitan area; 2001 Census). Kathmandu is growing at an exceedingly fast rate (4.8% per annum) due to in-migration from the hills. Kathmandu Valley also contains two additional traditional city-states: Patan and Bhaktapur. Pokhara, Valley in central Nepal contains Phewa Tal, the town of Pokhara and rich agricultural land.*



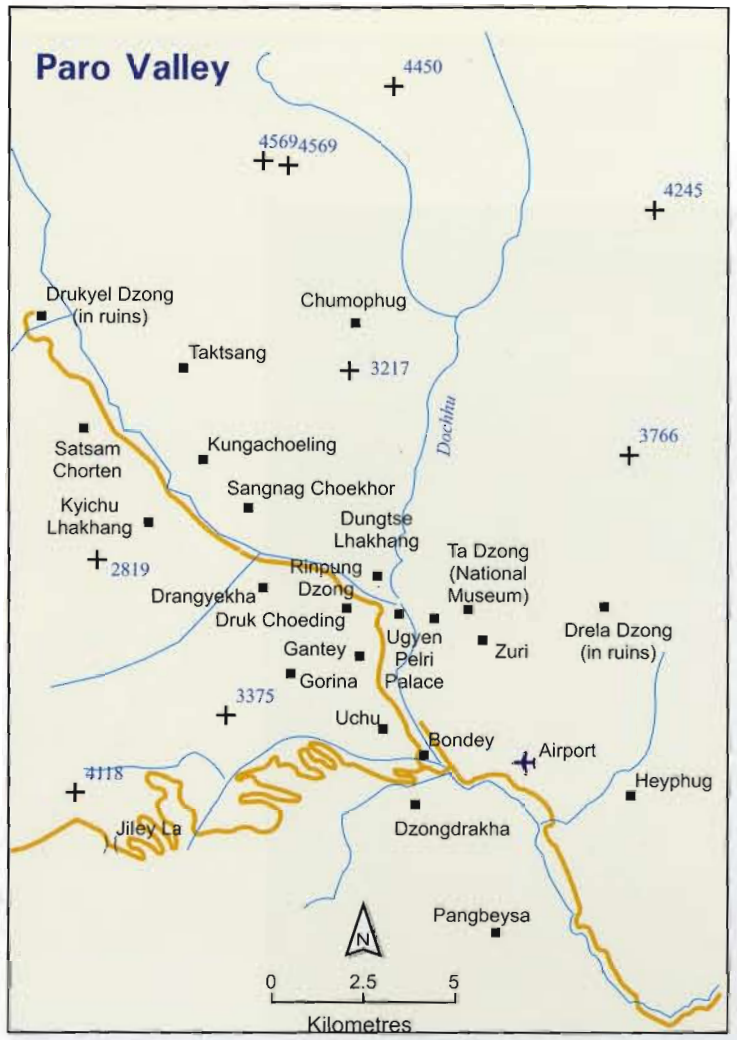
Source: ICIMOD, MENRIS data (Compiled from Dept. of Survey, Topographic Maps 1:25000 scale, 1995)

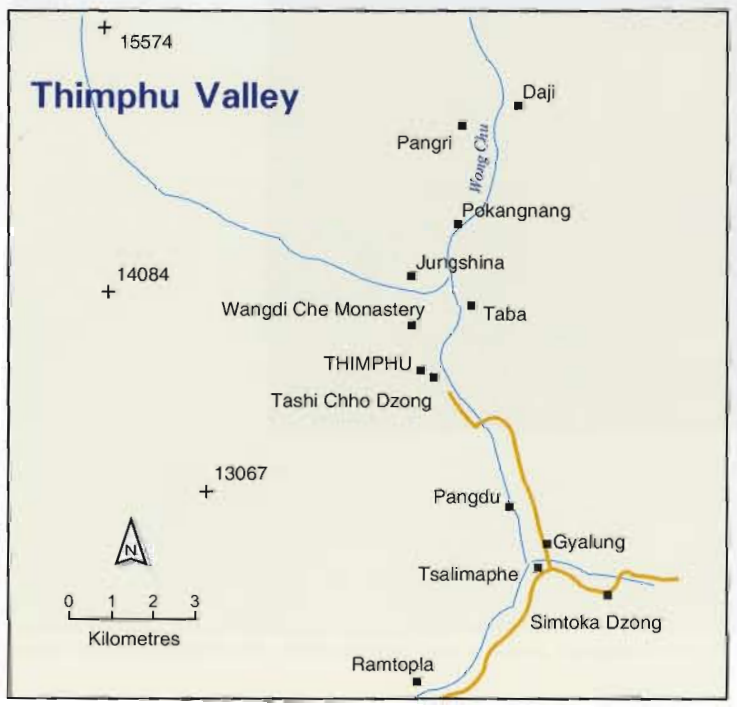


Source: ICIMOD, MENRIS data (Compiled from Dept. of Survey, Topographic Maps 1:25000 scale, 1995)



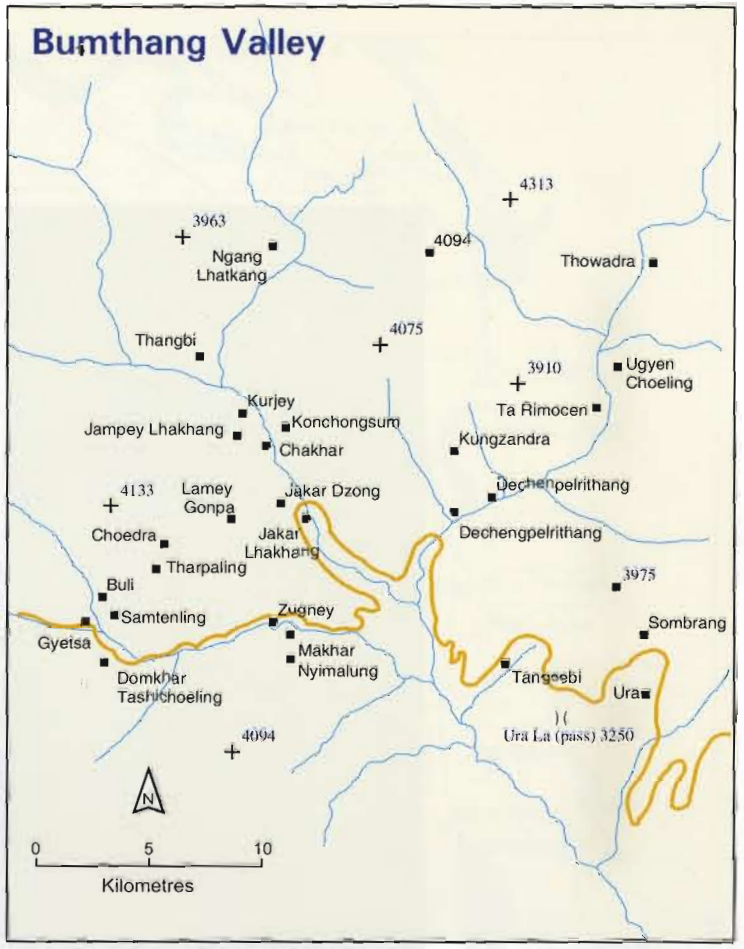
Machhapuchhre Peak (6,997 m), located in central Nepal north of Pokhara Valley, is one of the few Himalayan summits still banned for climbers.





give way to a southward sloping piedmont plain (in Nepal known as the Terai), which forms the northern extension of the Ganges-Brahmaputra plain. A system of tectonic depressions, called dun valleys, in the foothills, are filled with alluvium deposited by the rivers and make good farming areas (for example, the Dang Valley in Nepal). Significant forest areas remain in the foothill zone, mainly because this area historically has avoided intensive human settlement, but these forests are now threatened due to logging operations and to large migration flow from the mountains. The outer foothills and plains are viewed as resource and settlement frontiers by many of the Himalayan countries, and agricultural, industrial, and urban expansions occur there at a rapid rate. The many new towns and roads that have sprung up in this zone provide convenient access to once remote regions in the high mountains. The gateway towns are developing at a rapid rate

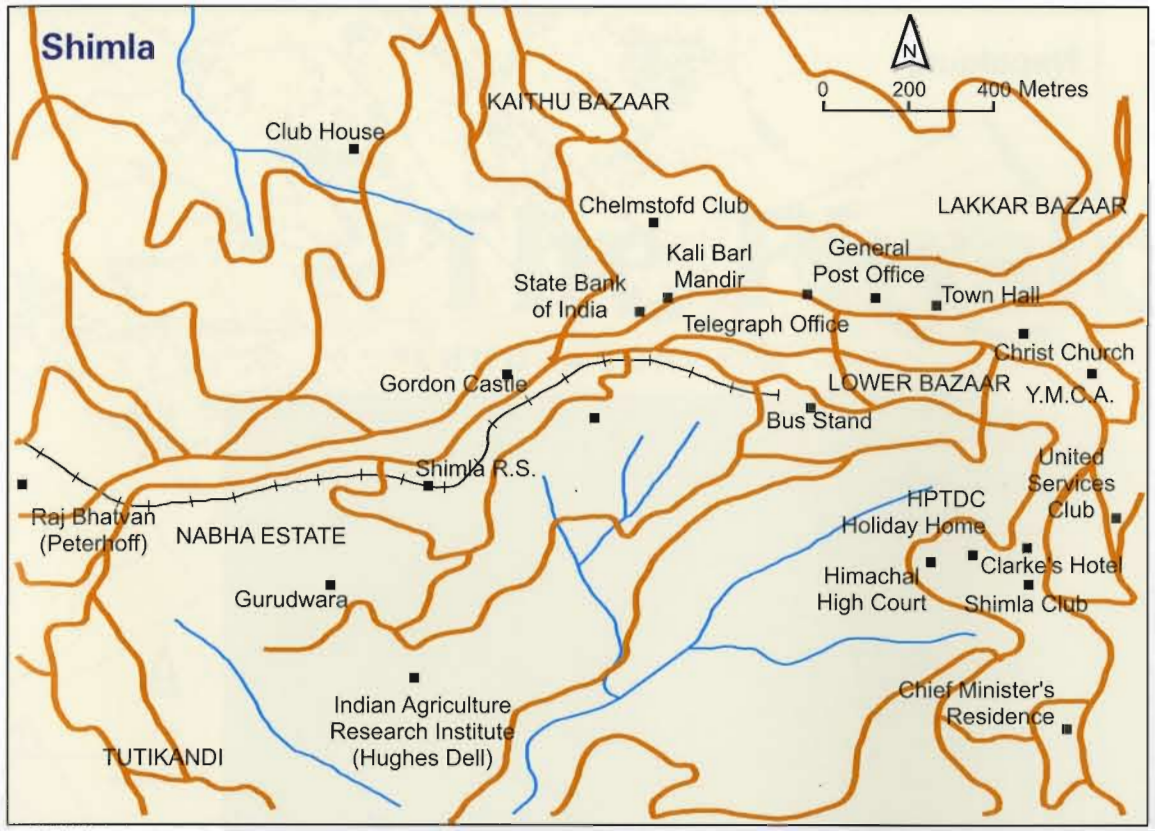
Bhutan Valley Settlements: *Paro Valley, Bumthang, and Thimphu. Overall, Bhutan has lower population densities than those found in the western and central sections of the Himalaya: but, in the broad, fertile valleys of the middle mountain zone, some high population densities exist, reflecting the agricultural potential of the valleys as well as their historical-political importance. The presence of dzongs - or fortress settlements, signifies the historic feudal arrangement of Bhutanese society and the overwhelming presence of monastic communities.*



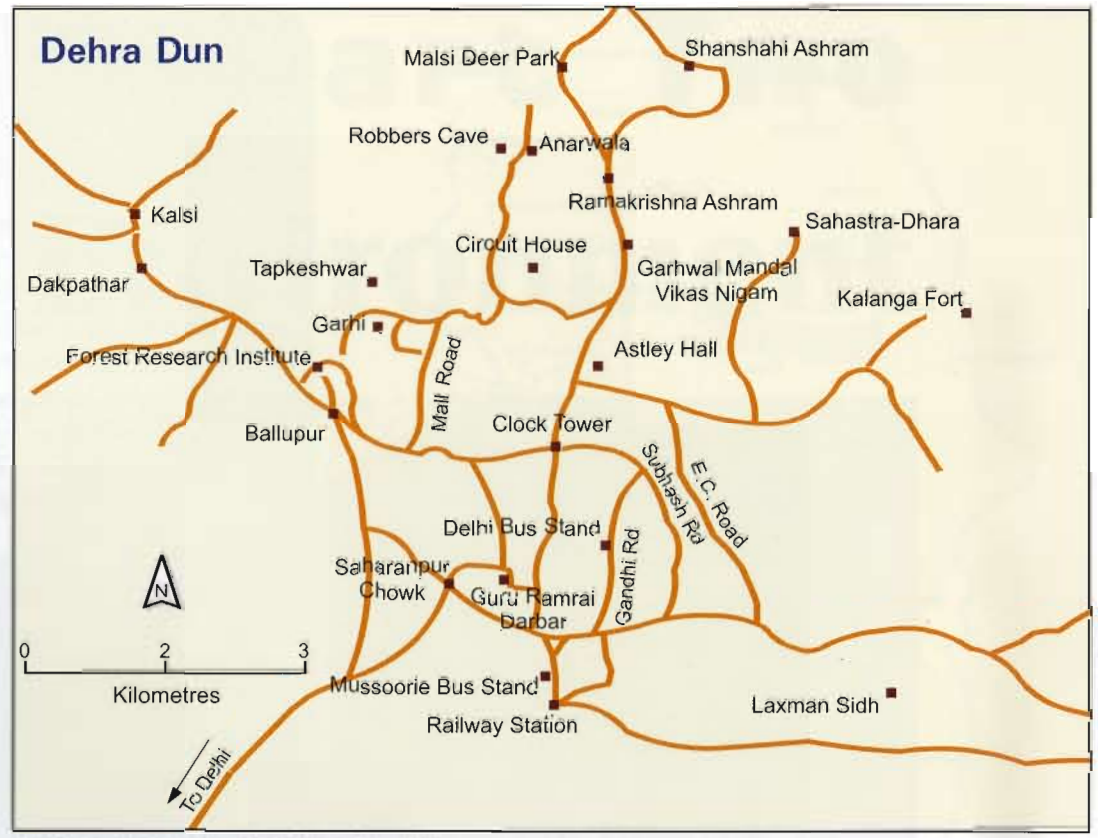
Source Bumthang, Paro Valley, Thimphu Valley maps: Karan, P.P., 1967. Bhutan. Lexington, KY: University of Kentucky Press; Pommaret, 1991. Introduction to Bhutan. Geneva: Editions Olizane S.A

Thimphu Valley, Bhutan

Birendra Bajracharya



Source: Based on Dubey, M. and T. Sinclair, 1992. Insight Guides - Western Himalaya. Singapore: APA Publications; Sud, O.C., 1992. The Simla Story, Simla: Maria Brothers



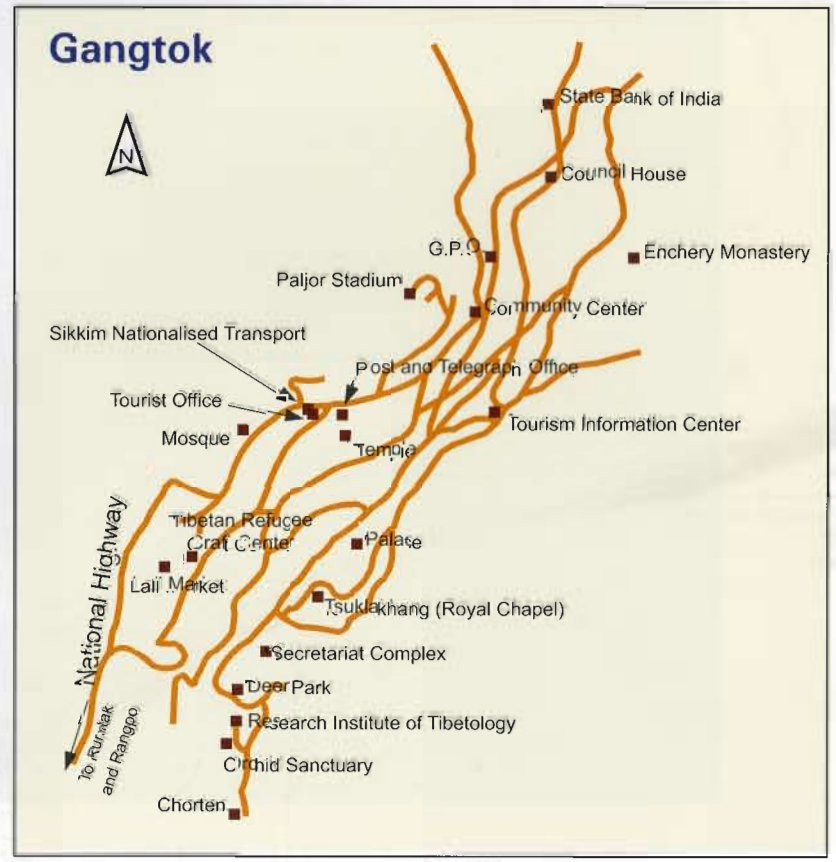
Source: Indian Himalaya Tourism Map - Dehra Dun

all across the southern perimeter of the Himalaya, giving rise to an urban and industrial look in the lowland landscape.

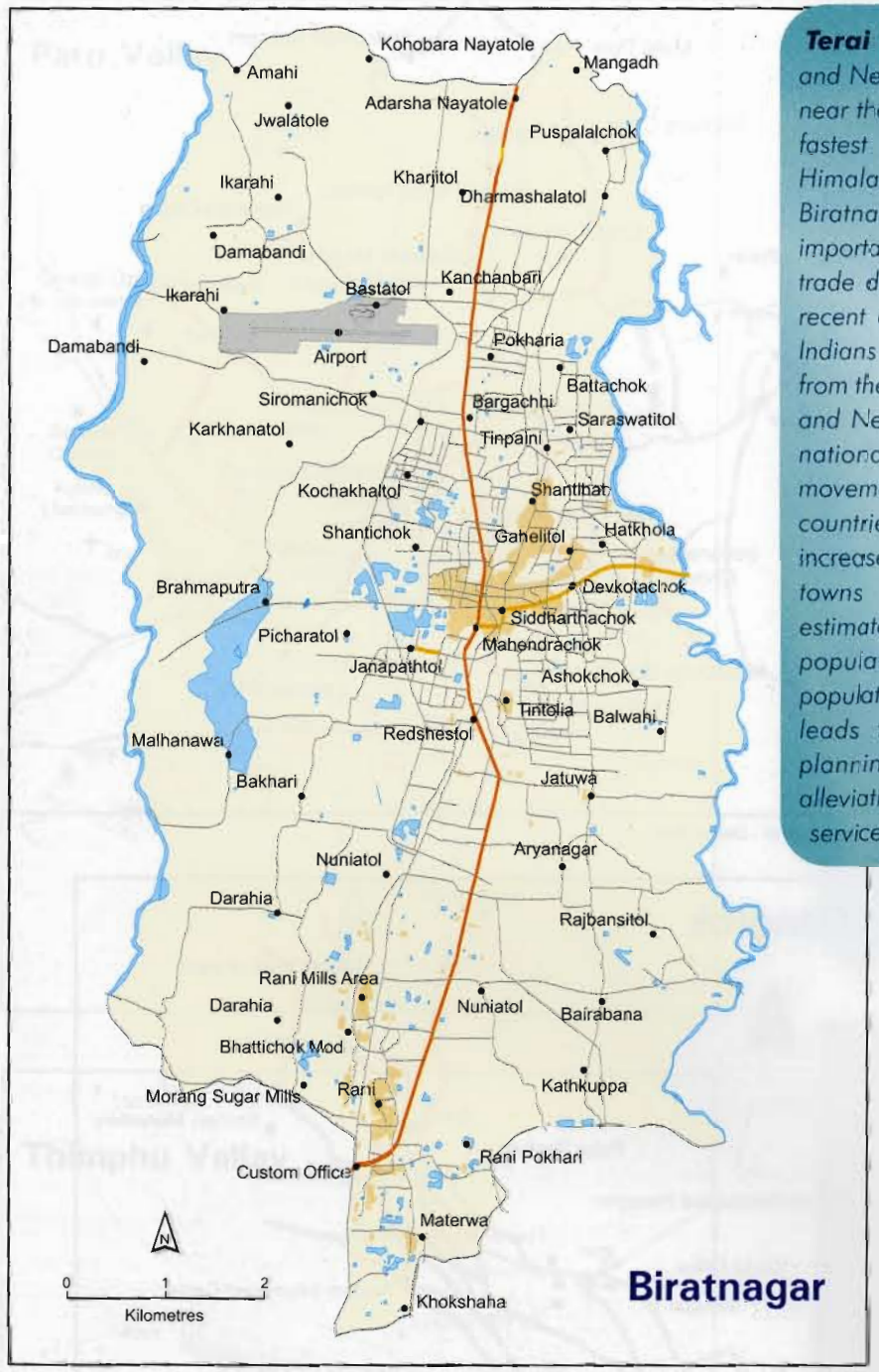
There is much interest in the current state of the Himalayan environment, with diverse scenarios proposed about the levels of land degradation and the reasons for them. Amid this uncertainty, it is clear that the extraordinary diversity of nature and culture in the Himalaya eliminates any

The pedestrian mall, Shimla

Towns of the Himalaya: *Dehra Dun, Shimla, Darjeeling, and Gangtok. Urbanization is a relatively recent phenomenon in the Himalaya, where most populations remain rural and agrarian. Some of the Himalayan towns, such as Shimla and Darjeeling, owe their prominence to the British, who developed the settlements as summer retreats during the colonial period. English colonial officers and their families, as well as military, clerical, and business people, escaped the hot months in the plains by fleeing to the higher altitudes of the Himalaya. Shimla became prominent as the summer capital of the British Raj. Other Himalayan towns have more recent origin, their growth stemming from the tides of human migration that flow from the countryside to the city. In Nepal, for example, where rural-urban migration rates are high, the percent of urban population increased from 3.6% in 1961 to 12.7% in 2001. The urbanization rate in Nepal for the period from 1991-2001 was about 3.5%. Wherever roads are built in the Himalaya, towns spring up, so that there is a close correlation between accessibility and town development.*

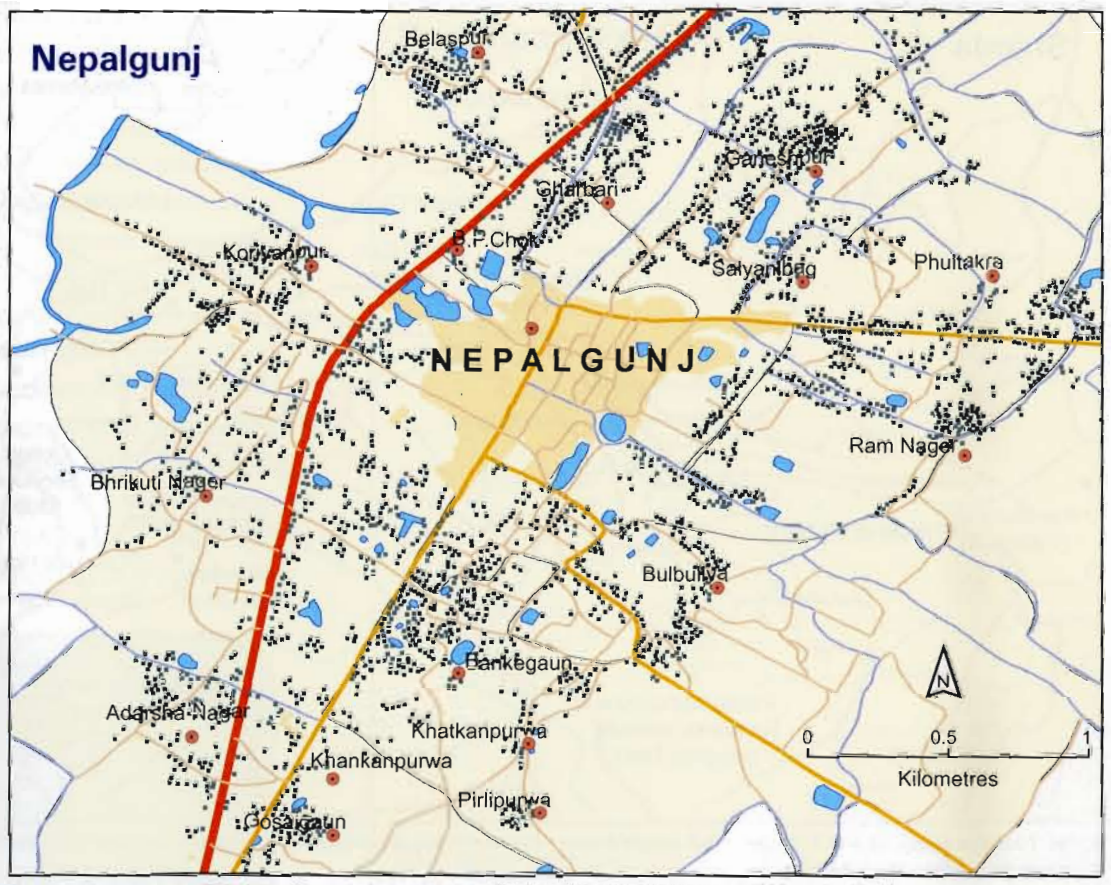


Source: Sikkim Department of Tourism - Gangtok city map



Source: ICIMOD, MENRIS data (Compiled from Dept. of Survey, Topographic Maps 1:25000 scale 1995)

Terai Towns of Nepal: *Biratnagar and Nepalganj. The lowlands of Nepal near the Indian border are some of the fastest growing regions in the entire Himalaya. Border towns, such as Biratnagar and Nepalganj, play important roles as transit routes and trade depots and have been settled in recent decades by a large number of Indians as well as Nepalese migrants from the hills. The border between India and Nepal is effectively open for both nationalities, allowing freedom of movement and trade between the two countries. This has led to a rapid increase in the populations of Terai towns (Biratnagar 2001 population estimate 222,279; Nepalganj 2001 population estimate 83,111). The population increases in the Terai towns, leads to serious management and planning issues related to poverty alleviation, infrastructure, and urban services.*



Source: ICIMOD, MENRIS data (Compiled from Dept. of Survey, Topographic Maps 1:25000 scale, 1995)

single proposition from explaining ecological conditions across the entire range. In many places we can witness almost catastrophic levels of soil and water degradation, declining farm productivity, and increasing human impoverishment. These trends have been in place for a number of decades and their resolution remains distant. Elsewhere, we can find a careful husbandry of natural resources, progressive and sustainable local economies, and a natural landscape that remains largely intact. In general, though, the combination of geological instability, expanding subsistence demands on the environment, and accelerating resource extraction promoted by national development results in a greater vulnerability of natural and human ecosystems. The most serious land degradation occurs notably in places where local communities have lost authority over managing their own resource environment, where people are most impoverished such that their livelihoods become acts of desperation, and where infrastructures supporting the industrial economy are the strongest. Under such circumstances, it is difficult to imagine a sustainable future. However, in light of the deteriorating environmental trends, many new conservation initiatives are proposed that range from grassroot-level economic strategies to large national parks.

A common feature of most successful Himalayan conservation programs is the fact that environmental preservation must be tied to appropriate economic and social opportunities, whereby people can manage their most basic needs as well as their cultural aspirations on a sustainable basis. In this vein, maintaining cultural diversity is absolutely necessary for managing biological diversity. Most people recognize that the Himalayan environment is unique, its size and diversity are over whelming , yet it is the rich assemblage of cultures that reside there which transforms the wild and scenic beauty of the mountain landscape into a place of human dimension and ensures its continued presence in the face of inevitable change. Nature and society together in the Himalaya compose an elegant and challenging landscape and shape one of the most stunning places on earth.

Part Two

The Physical Environment

A tributary of Sutlej River flows through a narrow gorge in the western Himalaya

GEOLOGY

The Himalaya form one of the youngest mountain ranges on earth. Their geological history properly begins 60 million year ago, when the Gondwana plate first collided with Asia, but most of their altitude has been gained during the last 2 million years. The mountains continue to grow today amid widespread and frequent earthquakes. The seismic tremors signify geological forces that have produced not only the spectacular highland terrain but also a tectonically dangerous place to live. The mountains' propensity for seismic disturbances, their steep terrain, gravity, and the forceful movement of water across the rugged slopes, combine to create what geologists call a 'high energy' environment. The kinetic potential contained within the contours of the Himalaya is enormous. The summits and gorges, the long lines of undulating ridges, and the diverse terrain that we see as the actual mountains are merely the outer skin of a geological plate up to 75 kilometers thick that underlies the region. It is the movement of this crustal fragment during the past 60 million years, with the South Asia plate submerging beneath that of the Asian continent and lifting the oceanic crust of the ancient Tethys Sea along the way, that has caused the mountains to form. They continue to grow because the Indian plate maintains its northward drift into Eurasia, at a speed of movement today of about 2 centimeters per year.

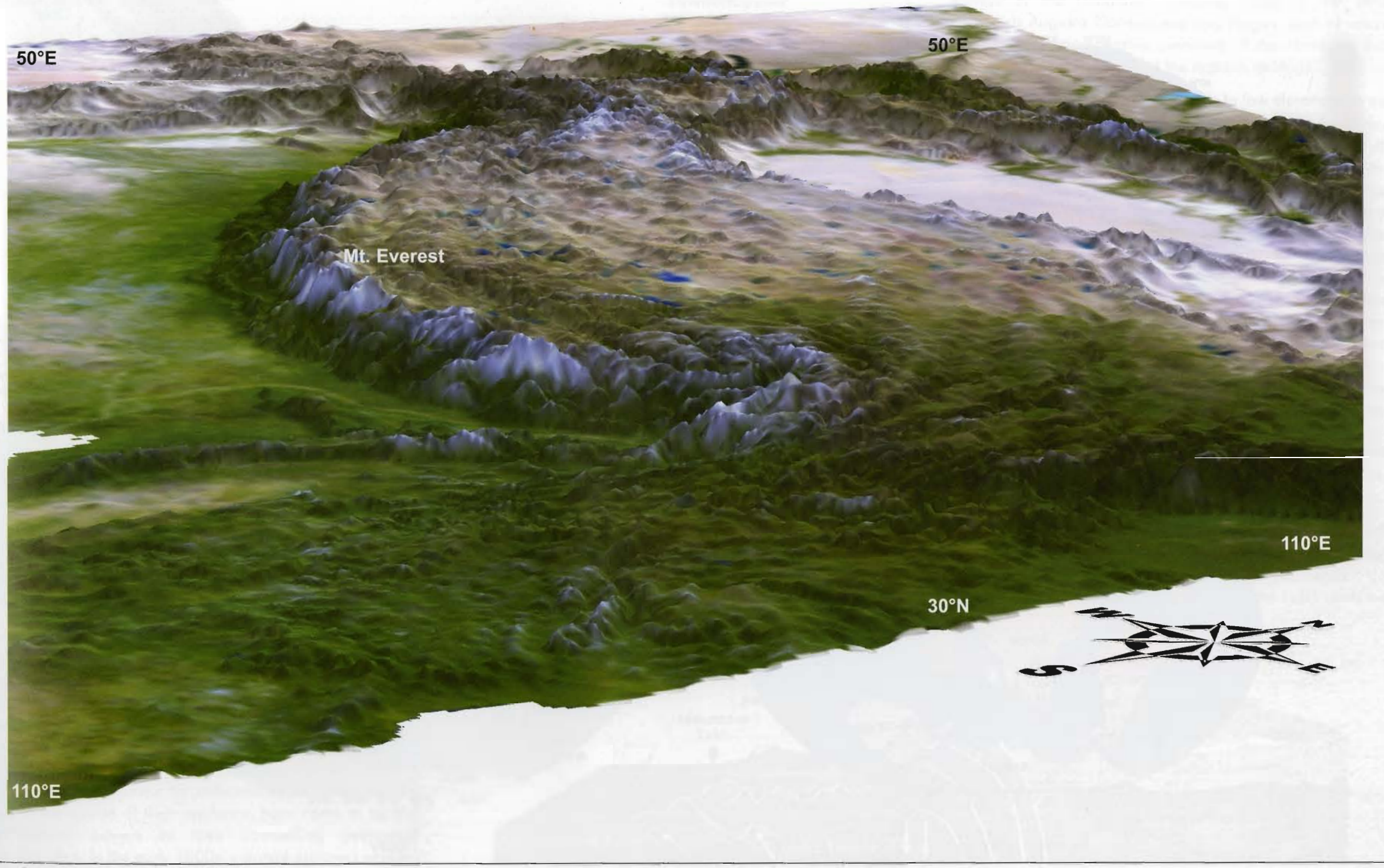
Our knowledge of the physical development of the Himalaya is tied to the theory of continental drift, which explains the world's landforms according to the break up of primordial super continents and the historical movements of the Earth's lithosphere. In the case of the Himalaya, the break up of Gondwanaland over the past 500 million years contributed fragments of crust that slowly drifted northward toward the Siberian shield, eventually colliding with the Asian continent and causing massive upthrusts along the advancing edge of the Indian plate (see figure on page 26.) The northward movement of India toward Eurasia began about 130 million years ago, contracting the intervening Tethys Sea, and the actual collision of India and Asia began some 60 million years ago during the early Tertiary period. As a result of this collision, the oceanic crustal rocks and sediments of the Tethys Sea were thrust upward along an interface known as the Indus-Yarlung suture zone. The present-day Indus and Yarlung-Tsangpo (Brahmaputra) rivers follow this alignment and wrap the tectonic Himalaya in a geological embrace that stretches west to east for 2,600 kilometers. The fact that these two rivers demarcate the tectonic rendering of the Himalaya provides a useful reference for the geographical boundaries of the mountains. To the west of the Indus River, at the juncture of the Nanga Parbat uplift, is the Shyok suture zone, named after an important tributary of the Indus River. Geologically speaking, this zone separates the Himalaya from the Karakoram mountains, although the two ranges commonly are joined in the rendering of a pan-South Asia highland system.

When the Karakoram is included in the Himalayan chain of mountains, the system includes all fourteen of the earth's peaks over 8,000 meters, and hundreds of others greater than 7,000 meters in elevation. Eight of the 8,000-meter peaks are in Nepal, including the world's highest mountain, Mount Everest, at 8,850 meters. The world's second highest peak, located in the Karakoram range in Pakistan, is K2, at 8,611 meters. Nepal contains all or part of seven other 8,000-meter peaks: Kangchenjunga (8,586 meters), Lhotse (8,516 meters), Makalu (8,463 meters), Dhaulagiri (8,167 meters), Cho Oyu (8,201 meters), Manaslu (8,163 meters), and Annapurna (8,091 meters). The four remaining peaks above 8,000 meters are in the Karakoram: Nanga Parbat (8,125 meters), Gasherbrum I (8,068 meters),, Gasherbrum II (8,035 meters), and Broad Peak (8,047 meters). The smallest of the 8,000 meter peaks, Shisha Pangma (8,013 m) is located north of the Nepal border in Tibet. These prominent mountains are recognizable massifs on the Himalayan skyline, and represent the highest elevation of the huge crystalline masses that compose the High Himalaya.

The tectonic Himalaya extend in a northwest to southeast direction from the Indus River in present-day Pakistan, near the Nanga Parbat summit, to the Brahmaputra River in India's northeastern mountains, near the Namcha Barwa summit. West and east of these summits, the Himalaya join with the other lineaments of the circum-Indian mountains to create the highest places on Earth. It is likely that the Indian plate first struck Eurasia in the northwestern part of the

The Main Thrust Zone of the Central Himalaya contains numerous deep valleys hemmed in by high peaks

The Himalaya and Tibetan Plateau from the South-East



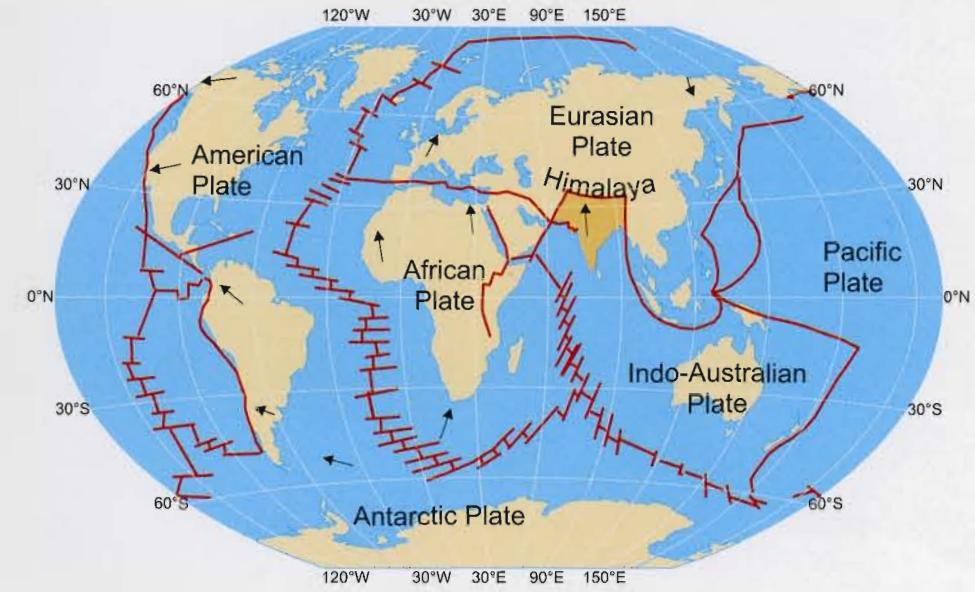
Source: Compiled by Julsun Pacheco using NASA data

The Drifting of Continents and Formation of the Himalaya

200 million years ago

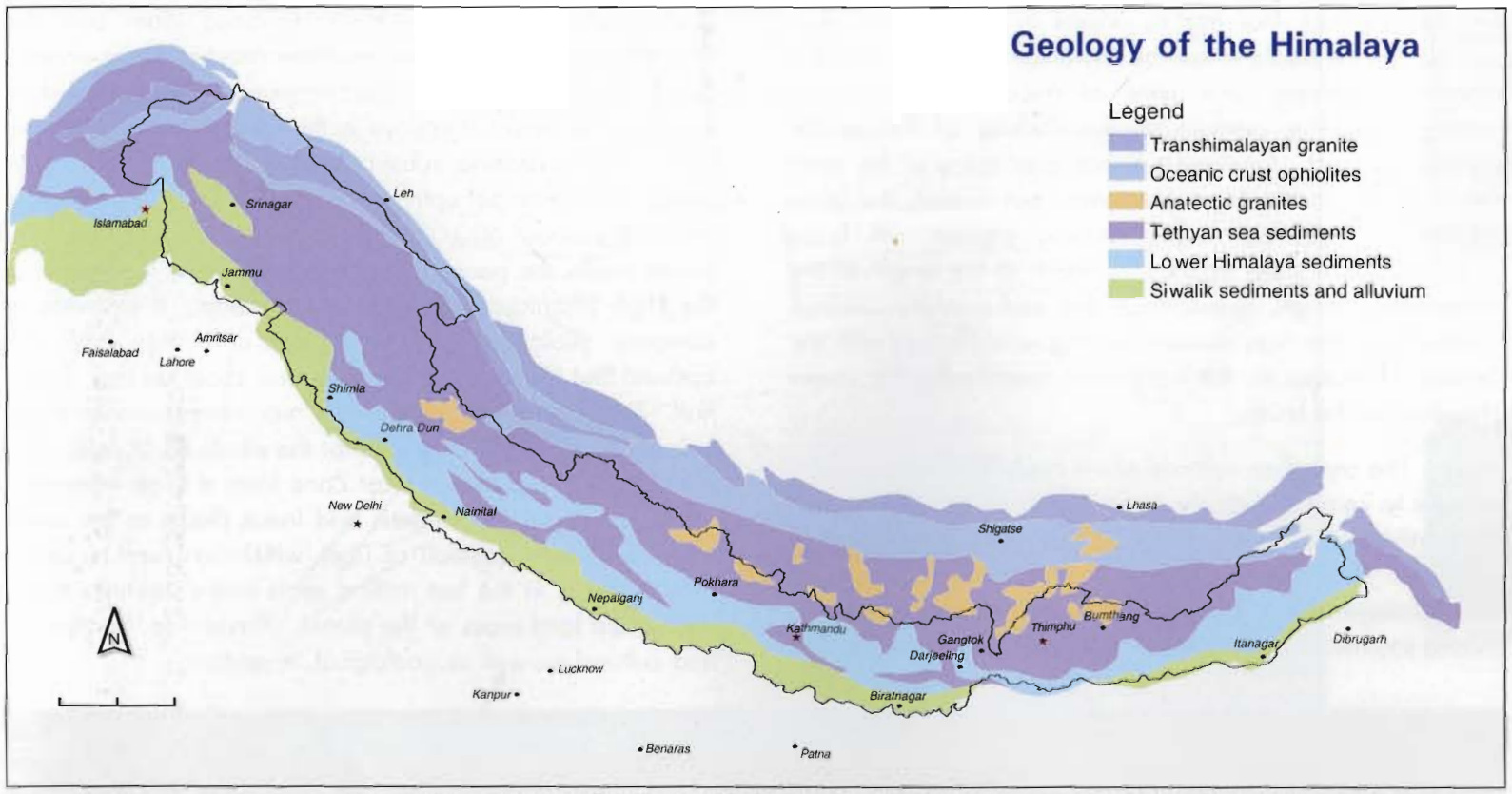
135 million years ago

65 million years ago



Today

Source: Compiled by Julsun Pacheco. Assembled from various sources, including Getis, A. et al., 2000. Introduction to Geography. Boston: McGraw Hill



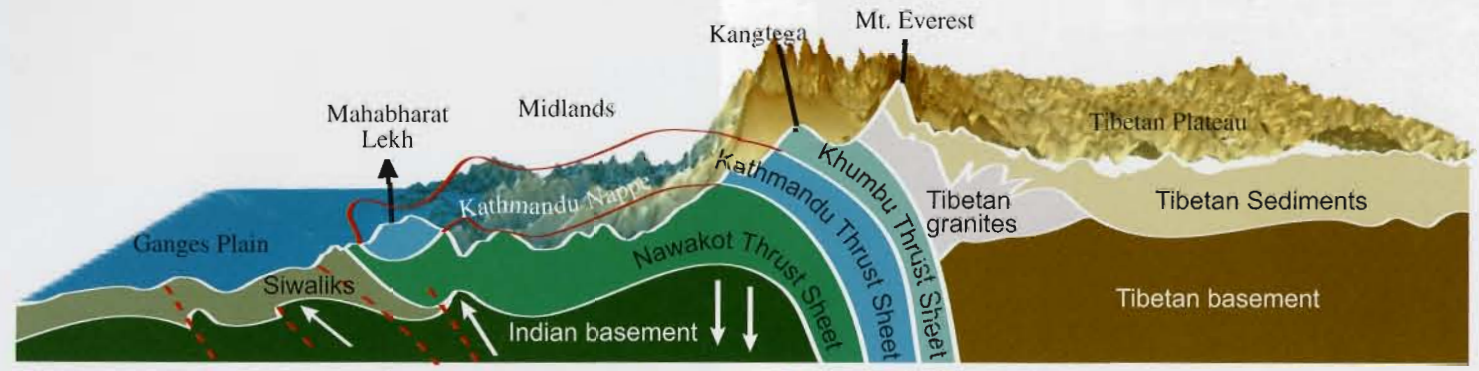
Source: Simplified from MacFarlane, A. et al. (eds.), 1999. Himalaya and Tibet. Boulder, CO: The Geol. Soc. of America; Gansser, A., 1964. Geology of the Himalayas. London: Wiley Interscience

Generalized Geology of the Himalaya: *A simplified overview of the complex geology of the Himalaya reveals a regional structure of tectonic zones from north to south: The Indus Suture Line, the Tibetan or Tethys Himalaya, the Great or High Himalaya, the Lower Himalaya, and the Outer Himalaya or Siwalik Foothills. These zones result from the tectonic processes of uplift, are distinguished by contrasting rock layers and mineral content, and are separated by faults and thrust boundaries, including the Main Central Thrust separating the trans-Himalaya and Tibetan zone from the High Himalaya, and the Main Boundary Fault separating the Lower Himalaya and the outer Siwalik zones. The prominent rocks of the Himalaya originate in the sediments of the ancient Tethys Sea and the crystalline structures of the central upthrust zone where tremendous heat and pressure metamorphosed the rock layers. The distribution of rock types shown on the map reflects the underlying tectonic structures.*

Himalaya, where the mountains bend southward around Nanga Parbat, and (not until 20 million years later) in the eastern sector near Namcha Barwa where the syntaxis of the Himalaya joins with the highlands of northern Myanmar. This would help to account for the directional strike of the range as well as for the distribution of differing rock types and ages and tectonic structures. The remote areas of this highland region have been known for millennia by its native peoples who, in the course of their residence, have come to ascribe supernatural powers to their compelling geological characteristics. In the early 1800s, colonial explorers working for the East India Company began preliminary mapping of the Himalayan frontier for the British Empire. In 1851, with the establishment of the Geological Survey of India in Calcutta, a series of systematic geological studies was undertaken. In 1907, a comprehensive geological map of the Himalaya was created by the geologists Burrard and Hayden and published by the Government of India Press. These efforts laid the initial foundation for the more recent surveys of the Himalaya, including those of the Swiss geologists Augusto Gansser and Toni Hagen, both of whom contributed comprehensive overviews of the Himalaya that remain benchmark studies of the region's geology.

The range of relief from high to low elevations in the Himalaya is unsurpassed by other mountains in the world, but the geological formation of its structures is still not fully understood. The earliest geological inquiries relied upon the dating of exposed rock layers based upon fossil findings. More recent investigations consider the underlying structure of the main thrust sheets of the Himalaya to explain the geological divisions of the range. They distinguish four main zones, from north to south: The thick-crusted Tibetan or Tethyan zone, sometimes called the trans-Himalaya, which comprises a small part of the Himalaya proper but constitutes an important outer margin of the extensive plateau of Tibet; the Great Himalaya, which caps the complicated geology of the main thrust zone in a series of lofty peaks and snow summits; the Lesser Himalaya which occupy a 65-kilometer band of intermediate hills striking across the mid-section of the range; and the Outer Himalaya, or Siwalik foothills zone, which are made up of a series of low-altitude ridges separated by alluvium-filled tectonic basins.

The complex geology of the Lower and High Himalaya is partially attributed to the great rock sheets, called nappes, that have been displaced many kilometers. The nappes essentially represent scrapings of the India continent



Geologic Cross-Section Along 87° Longitude

Source: Adapted from Hagen, T., 1980. Nepal: Kingdom in the Himalayas. Berne: Kummerly and Frey Publishers

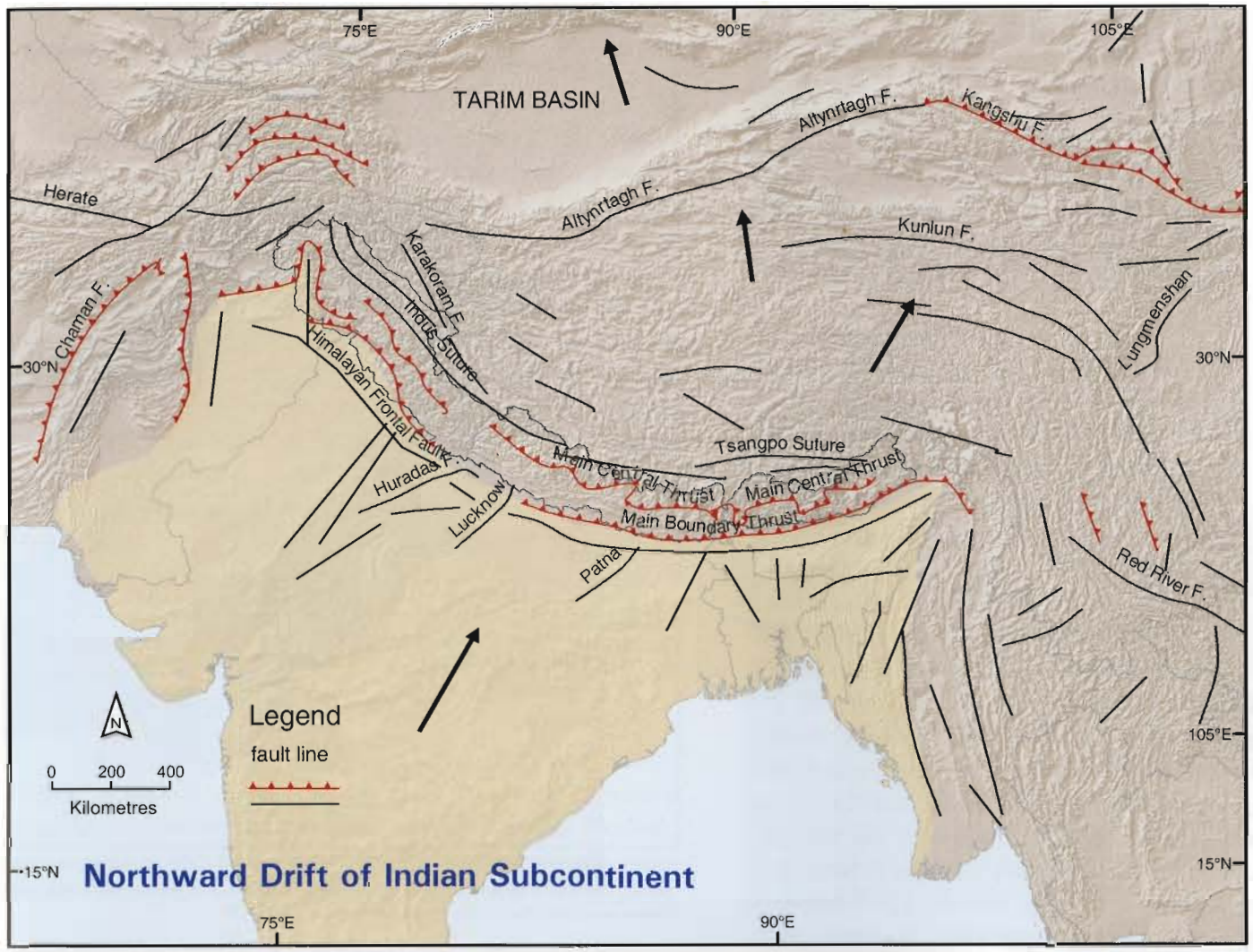
that have been forced backward (south) atop the forward (north) - moving plate as India passes beneath Asia. The mountains are crossed by rivers that cut through the strike of the range, producing some of the deepest gorges in the world. The rivers that cut the great transverse valleys predate the uplift of the Himalaya and originate in the Tibetan zone; thus they have been continually eroding the mountains all the while they have grown. Important rivers breaching the Himalaya include the Indus River (1,200 meters above sea level and 22 kilometers from Nanga Parbat), Sutlej, Kali Gandaki (1,500 meters above sea level and 7 kilometers from Dhaulagiri), and the Trishuli River (1,800 meters above sea level and 13 kilometers from the 7,225-meter Langtang Lirung Himal). These rivers, in turn, are fed by melting glaciers. Some of the world's largest glaciers are located in the Karakoram mountains: Siachen Glacier (72 kilometers), Hispar Glacier (61 kilometers), Baltoro Glacier (58 kilometers).

Geological studies show the Himalaya to be composed of an exceedingly complex structure of diverse origin struck through with faults and fissures and hotspots, twisted by folds and thrust belts, and overfilled in places with sediments and surface deformations. These local irregularities, which occur on a mammoth scale in the Himalaya, conform to a fairly consistent overall geological structure. They contribute to the mountains' overwhelming size as well as to their compelling beauty and rich mineral resources. The age of the Himalaya generally diminishes from north to south. The oldest geological structures and rock materials occur along the axis of the main crystalline thrust sheet, which is located in the High Himalaya south of the Indus-Yarlung suture, often underlying the sedimentary deposits of the northernmost Tibetan or Tethys Himalaya. Where the high peaks join the uplifted plateau of Tibet, the Himalaya are covered by sedimentary rocks that originate in the uplift, compression, and erosion of the Tethys Ocean. The tectonic boundary between India and Asia, the so-called 'Indus Suture Line' is characterized by a mix of sedimentary, metamorphic, and volcanic rocks. The adjoining Tibetan Himalaya are about 15 kilometers thick and contain fossil-laden marine rocks that once constituted the northern margin of the Indian continent.

South of the Tibetan Himalaya, in the High Himalaya, are located the world's highest mountain peaks. They tower above the geological substrata of this zone as skyward extensions of a crystalline sheet over 10 kilometers thick and 100 kilometers from north to south. Stretched over much of this inner core crystalline mass, like a thick skin, is a layer of sedimentary rock that has its origins in the Tethys Ocean seabed. In the north, where the crystalline structures meet the Tibetan Himalaya, is a zone of mica and tourmaline outcroppings - a product of the melting of the Indian continental crust. Geologists puzzle over many of the local deformations in the High Himalaya, but overall the zone provides a relatively simple tectonic picture. A huge crystalline thrust sheet extends for much of the length of the Himalayan range, supporting the sedimentary surface landforms of the high mountains, and is in contact with the Tethyan Himalaya in the north and overthrusts the Lower Himalaya in the south.

The crystalline upthrust of the High Himalayan zone is thought to coincide with the huge horizontal compression of the northern edge of India as it drifted northward in contact with Asia. This compressed rock, known as the 'root zone' of the Himalaya, actually uplifted as a great nappe sheet and moved southward overlaying the intervening materials, so that geologically speaking the High Himalaya loom over the Lesser Himalayan zone. The southern reaches of the original nappe sheets eroded as India continued its northward drift, exposing the Lesser Himalaya in the foreground and leaving behind the crystalline substructure of the High Himalayan peaks. The principal upthrust occurred quickly in geological reckoning, about 600,000 to 1 million years ago, and this phase marks the period when the present-day landscape of the High Himalaya took most of its shape. If we were to compare geological time to a year of human time, the upthrust that formed the Himalaya took about an hour and a half. The scale of this upheaval is monumental nonetheless, with geographical implications for the whole all of Asia. The high peaks of the Main Thrust Zone form a huge watershed divide between the Gangetic and Indus plains to the south and the northern plateau of Tibet, which has risen by about 4,500 meters in the last million years and constitutes today the highest land mass on the planet. This divide has climatic and cultural, as well as geological, importance.

The Main Boundary Fault north of Doon Valley is located approximately where the hill zone meets the outer foothills. This is one of the most tectonically active zones in the Himalaya.

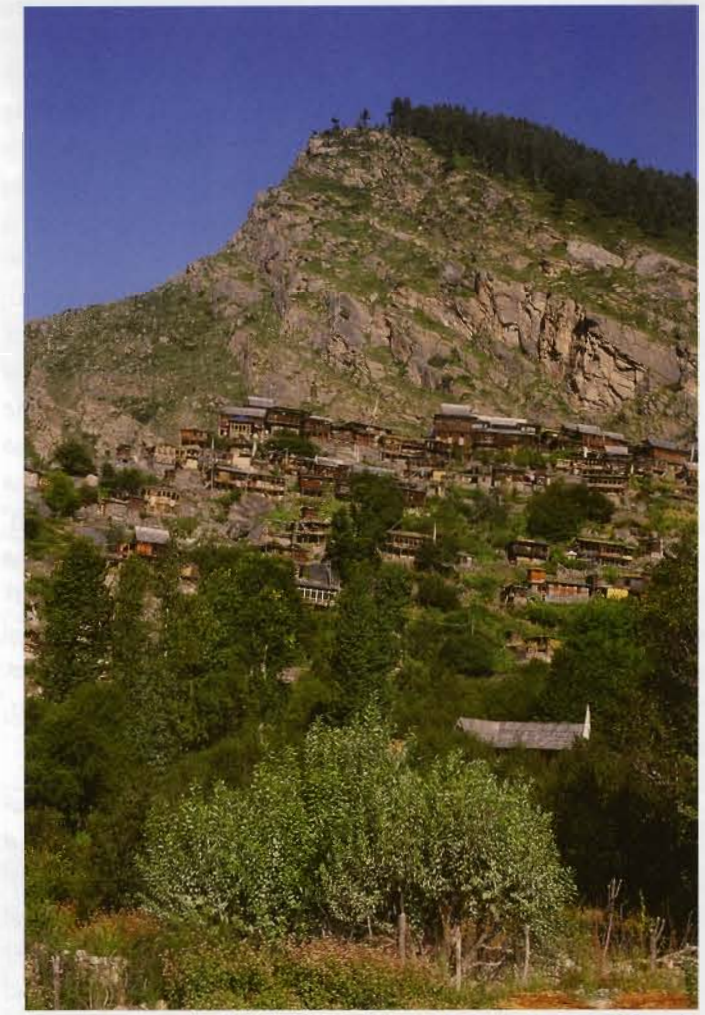


Source: Assembled from various sources: Gansser, A. 1964. Geology of the Himalayas. London: Wiley Interscience; MacFarlane, A. et al. (eds), 1999. Himalaya and Tibet. Boulder, CO: The Geological Society of America; and Gaur V., 1994. Earthquake Hazard and Large Dams in the Himalaya. New Delhi: INTACH

The granitic and schist peaks of Garhwal Himalaya

Many of the rocks found in the High Himalaya, including the precious gemstones associated with the crystalline structures, have their origin in the heat and pressure created by this upheaval. In addition to the quartzite rocks, the zone contains immense deposits of granites, including those having a high mineral content and value (for example the leucogranites, which include tourmaline), micas, marbles, and gneisses. Young granite intrusions are especially prominent in this zone. They often form the highest peaks, their flanks imbedded with striations of contrasting color denoting the extrusion of minerals through geological fissures. The vertical uplift continues in the Himalaya at a rate ten times faster than that of the European Alps, and their exposed strata bear testimony to its ancient low-altitude origins: flora and fauna fossils found at elevations above 6,000 meters indicate a tropical climate.

During the latest phase of mountain-building, about 40,000 years ago, the Himalaya experienced an Ice Age. The glaciers gained in size at the high elevations and scoured the mountain slopes into the dramatic ridges, cirques, and hanging valleys we see today. Numerous lakes formed from the glacial melting that followed the last Ice Age, many of which have since dried in the desert-like conditions north of the main peaks. In Tibet, the evaporating lakes left behind huge salt pans, which the Tibetans traditionally mine for export to India along the great Himalayan salt route. The depositional hills of glacial till, called moraines, form dams in the High Himalaya and create lakes from the melting glaciers. The natural walls of glacier debris occasionally burst, allowing the impounded water to escape in cataclysmic floods that threaten life and land downstream at lower altitudes. These Glacial Lake Outburst Floods (GLOFs) constitute a significant hazard in the high mountains.



Wooden houses in Chitkul village cling to the uplifted strata of Sangla Valley, Indian Himalaya

Alluvial river terraces along the Sharada River provide fertile land for growing rice

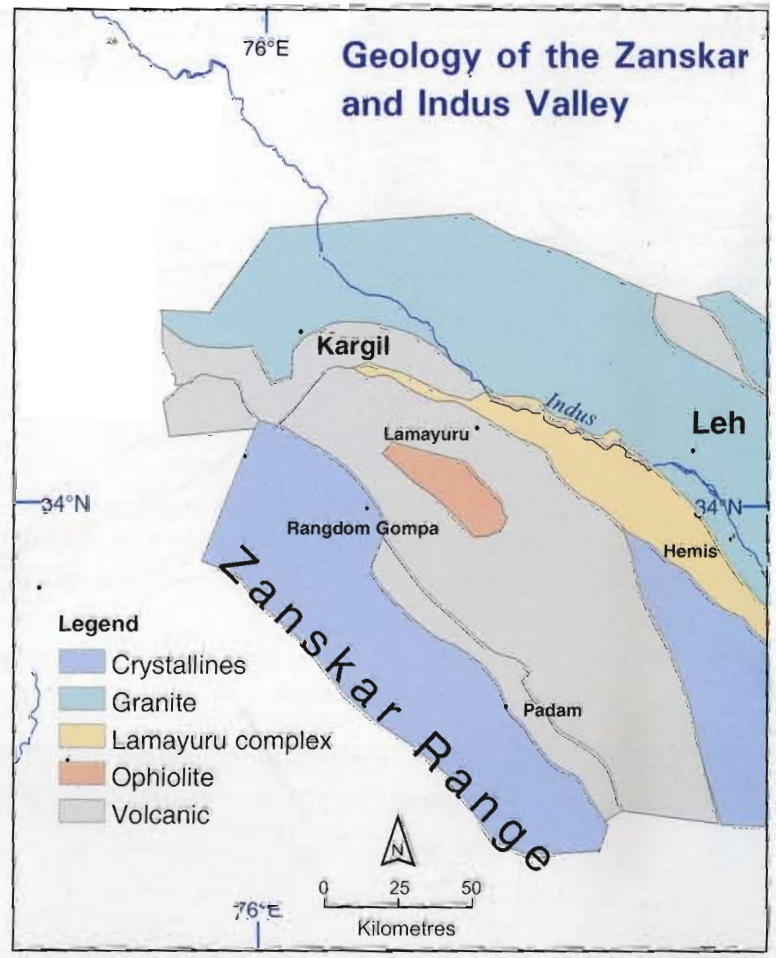
Located south of the High Himalayan zone, between the Main Central Thrust in the north and the Main Boundary Fault in the south, are the Lower or Lesser Himalaya. This region is commonly referred to as the Hill zone, suggesting its intermediate altitude. Much of the geology of the zone is composed of compressed shield material from India and sediments from the Tethys Sea. In keeping with the general chronology of Himalayan geology, which shows the age of thrusting to diminish from north to south, the Lesser Himalaya are of more recent formation than the High Himalaya. The Main Boundary Fault marking the southern boundary of the Lesser Himalaya corresponds to where the thrust sheets of the High Himalaya made contact with the outermost Himalaya. Two important ranges appear in this contact zone - the Mahabharat Lekh range in the Hill zone and the Siwalik Range in the Outer Himalaya foreland. Independent thrust sheets also formed in some places in the Lesser Himalaya, and these, too, overthrust the outermost sub-Himalaya, creating a zone of high tectonic activity.

There exists a great deal of variation in the geology of the Lower Himalayan zone, but in many places the inner thrust sheets dip steeply to the north creating formidable natural barriers in the terrain. With the exception of the Mahabharat Lekh, which consists of hard rocks and steep slopes, the Lower Himalaya generally contain rocks that are less resistant than those found in the High Himalaya, hence the hillsides tend to erode easier and be more gentle with deeper soils. The Mahabharat Lekh, however, composes such a formidable rock barrier that many rivers flowing south from the High Himalaya are forced west or east before breaching the range and continuing south. The entire Lower Himalayan zone continues to be uplifted at a geologically fast rate; the Kathmandu Valley in Nepal, for example, has risen over 200 meters in the past 200,000 years.

South of the Main Boundary Fault is the so-called Outer Himalaya or Siwalik zone, which is associated with some of the most active tectonics in the region. This zone consists of sediments derived from the uplift and erosion of the main Himalaya. It straddles the Himalayan Frontal Thrust, which marks the outermost boundary of the Himalaya, and overlooks the alluvial tracts of the Gangetic Plain. Much of the Outer Himalayan zone is occupied by the Siwalik range, which is a series of foothills formed from faulting and folding, interspersed with sediment-filled tectonic basins. These basins, for example Dang Valley in Nepal and Dehra Dun in India, are called dun valleys and constitute agriculturally rich alluvial deposits. Whereas the southern edge of the Outer Himalaya gradually declines in altitude to meet the Indian plains, the northern boundary of the zone is distinguished by the 25-kilometer wide Main Boundary Fault, which is a steep north-dipping fault and thrust zone. Much like the dendritic tributary patterns of a watershed, the Main Boundary Fault zone constitutes a hierarchy of subsidiary faults and thrust branches. These diverge in the west and converge onto the main fault in the east, exposing the tectonic origins of the Outer Himalaya. The tectonic movements of the Siwalik zone are especially active and the zone overall is characterized by numerous tremors and earthquakes.

Western Section

In the western section of the Himalaya, situated between the Indus and Sutlej rivers, is a 500-kilometer stretch of mountains that constitutes much of the Indian states of Kashmir and Himachal Pradesh, as well as a tiny portion of Pakistan. The western sector is dominated by Nanga Parbat, at 8,125 meters the highest peak in the Kashmir Himalaya and the ninth highest peak in the world. Nanga Parbat geologically, as well as visually, anchors the western Himalaya, and is the northernmost outcrop of the Indian continental crust. A great deal of geological investigations, mainly by Italian scientists, have centered on Nanga Parbat, in part because it is a very young mountain that prominently displays in its exposed strata the quintessential traits of mountains, which intrigue so many Himalayan geologists. Perhaps most importantly, though, Nanga Parbat is the pivot point for the western Himalayan syntaxis, wherein the mountains bend from northeast to southwest along the Indus



Source: Assembled from Crook, J. and H. Osmaston (eds.), 1994. Himalayan Buddhist Villages. New Delhi: Motilal Banarsidass Publishers; and Gaur, V. K. (ed.), 1993. Earthquake Hazard and Large Dams in the Himalaya. New Delhi: INTACH

Geology of the Zanskar and Indus Valley: *The Indus River marks an important suture zone which defines the geological boundary of the Himalaya. The western regions of Zanskar and Ladakh straddle the Indus valley region and are marked by the juncture of the high, dry trans-Himalayan plateau of Ladakh and the Great Himalaya of Zanskar, with its icy peaks and high valleys. The geology of this region reflects its position in the crystalline thrust belt.*

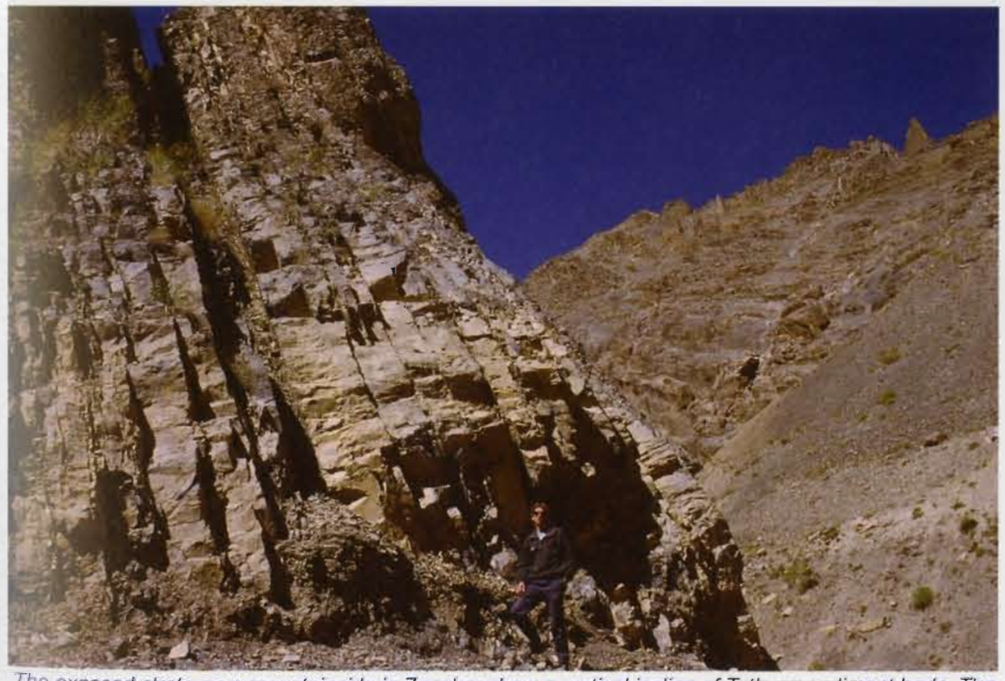
Suture. It thus occupies a critical position in the tectonic structure of the entire Himalayan range.

The base of Nanga Parbat consists of metamorphosed gneisses, with compositions that include muscovite, garnet, cordierite, as well as other leuco-granites. The most recent phase of the Nanga Parbat uplift has produced tourmaline-bearing granites. The gemstones of Nanga Parbat are of commercial interest, but the massif is best known for its dramatic and isolated silhouette amid the terrain of the western Himalaya. Outside the Karakoram Range, it is the only 8,000-meter Himalayan peak west of Dhaulagiri in Nepal, a distance of about 1,100 kilometers. To the north is the Indus Valley, which, at 1,300 meters above sea level, provides a striking topographic contrast to the altitudes of Nanga Parbat. The mountain is bounded by the Ladakh and Kohistan formations, which constitute much of the western Himalayan region and appears conspicuously at the juncture of the mountain arc of the High Himalaya, Kohistan-Ladakh, and the Karakoram, a circumstance that is tectonically accounted for by the Indus-Tsangpo Suture and the Shyok Suture zones located nearby.

South of Ladakh and in direct contact with Nanga Parbat is the crystalline backbone of the High Himalaya extending eastward through Kashmir and Himachal Pradesh. This region, particularly the eastern end of the Kashmir basin, marks the beginning of the patterns that give a truly regional

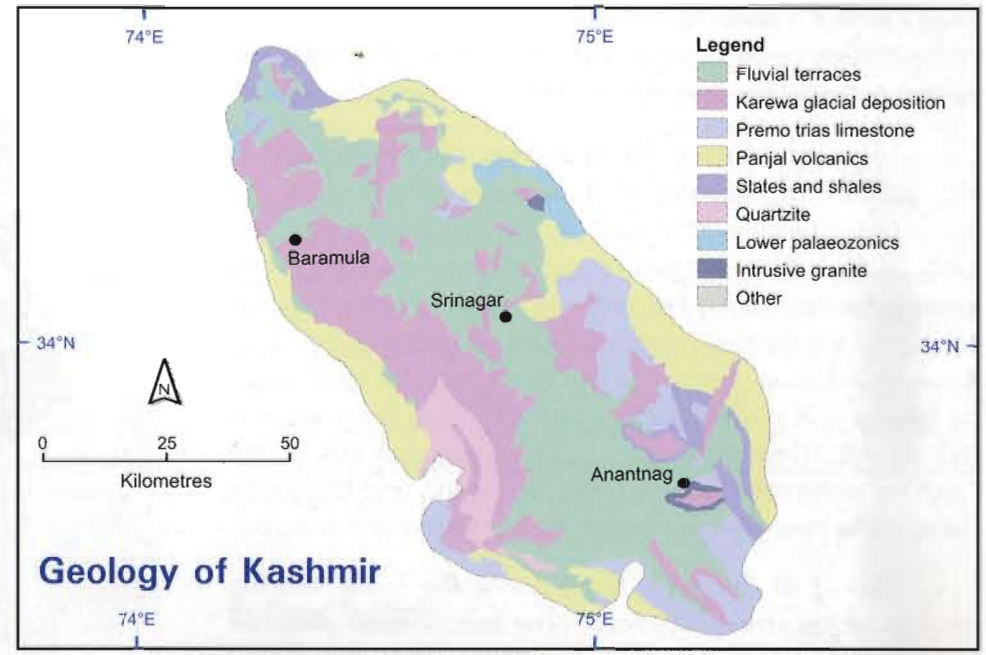
Geology of Kashmir: *The Kashmir Valley is a tectonic basin located north of the Pir Panjal range (which forms its southern ramparts) in the Lower Himalayan zone. The basin is characterized by the important Karewa glacial depositions which show the young formations in the valley to date to a late Pleistocene uplift (10,000-20,000 years ago).*

structure to the geology of the Himalaya (see map on page 33). A large crystalline uplift occurs east of the basin and west of the Zanskar Shear Zone, with primary granite characteristics. To the east, in the Beas River basin of Himachal Pradesh, the crystalline belt thrusts in a southwestward direction between the towns of Kulu and Rampur. North of Rampur, in the famous Spiti Valley, are extensive extrusions of quartzite similar to what is found in the Kashmir Valley. Much of Spiti, though, is overlain by sediments, shales, pebbles, and conglomerates. The black shales, in particular, are common markers of the boundary between the High Himalaya and the Tibetan Himalaya where Spiti is located. These dark shales and pebbly terrain give Spiti its characteristic stark and gray outlook.

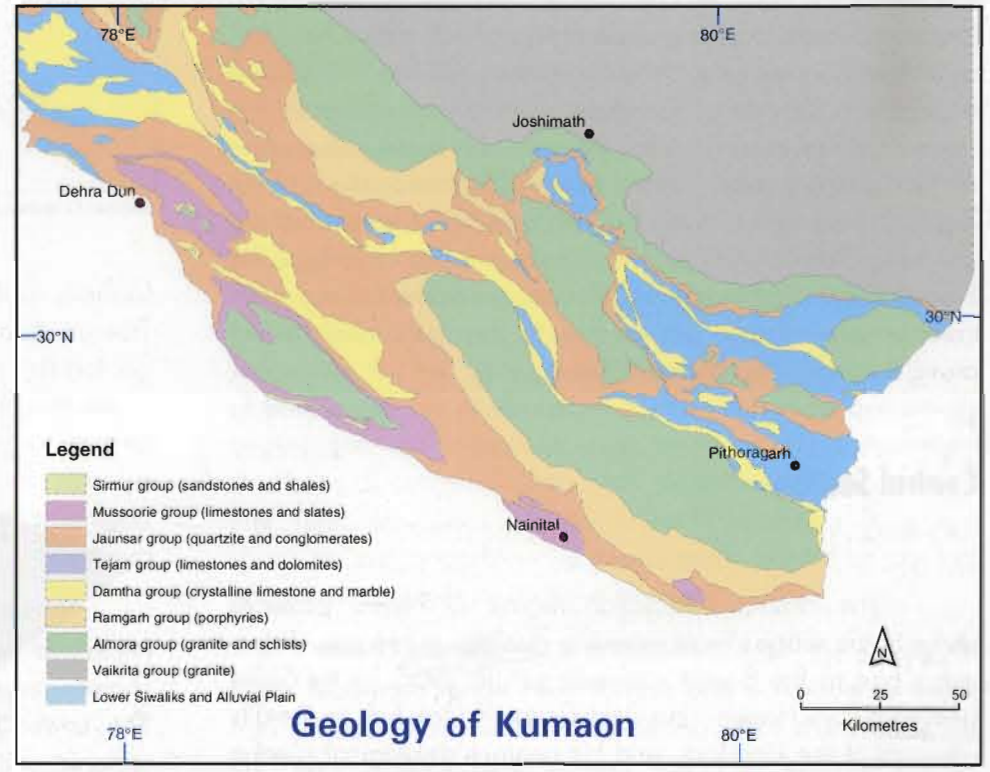


The exposed strata on a mountainside in Zanskar show a vertical incline of Tethyan sediment beds. The angle of repose suggests the powerful seismic history of the Himalaya.

To the east of Himachal Pradesh is a section of the western Himalaya, commonly referred to as Kumaon - the term referring to both a geographic area and a sub-range of mountains. The Kumaon Himalaya consists of the 320-kilometer stretch of highlands between the Sutlej River and the Nepal border (defined by the course of the Mahakali River). Structurally, from north to south, this region includes the fourfold division noted early: the Tibetan trans-Himalaya, including the famous Mount Kailas, High Himalaya, Lower Himalaya, and Outer Himalaya or



Source: Assembled from various sources: Gansser, A. 1964. Geology of the Himalayas. London: Wiley Interscience; and Malinconico, L. and Lillie R. (eds.) 1989. Tectonics of the Western Himalaya. Boulder, CO: The Geological Society of America



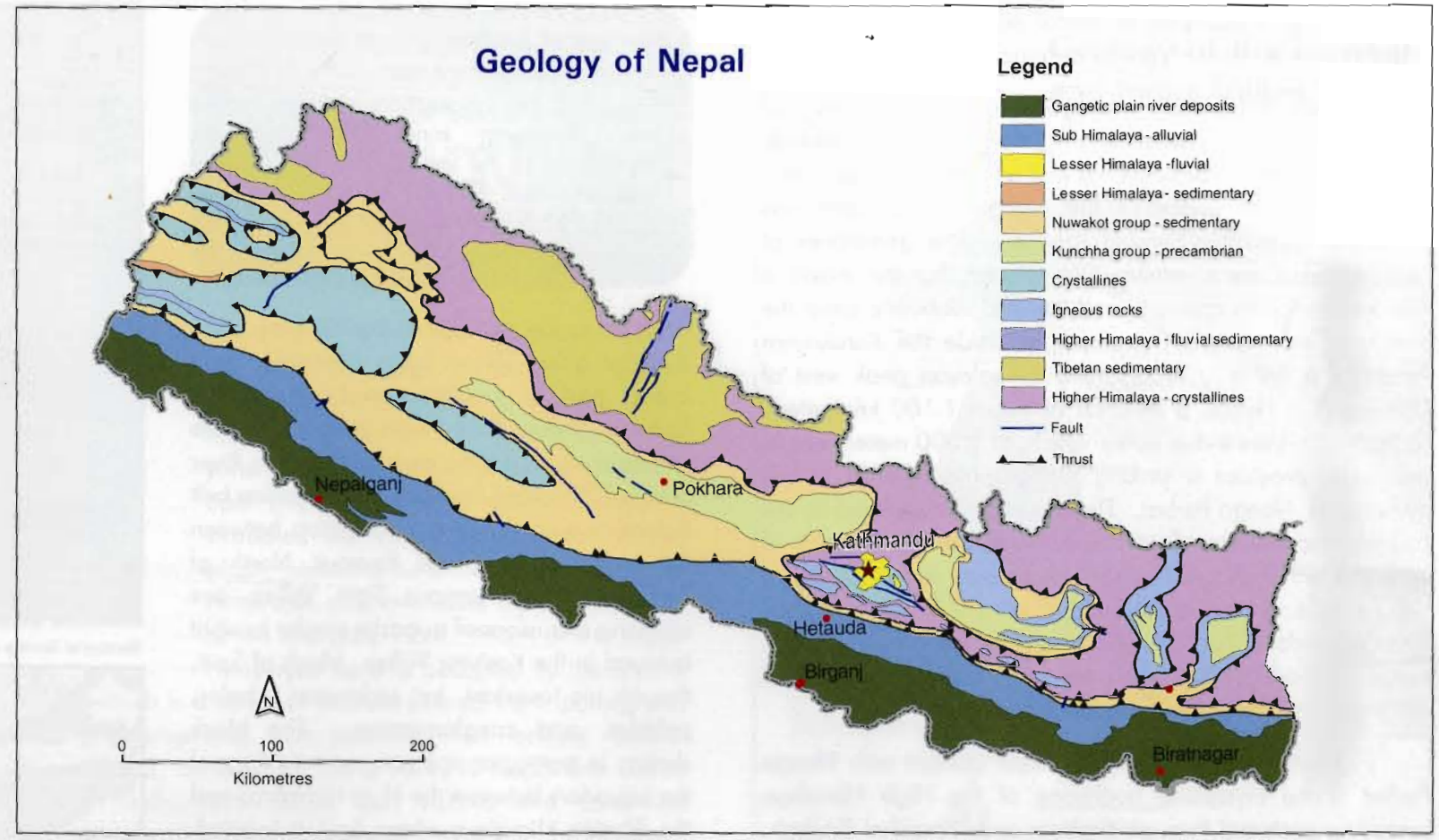
Source: Based upon materials provided by the Wadia Institute of Himalayan Geology, Dehra Dun

Geology of Kumaon: *The Kumaon Himalaya contain a 320 kilometer stretch of mountains between the Sutlej and Mahakali rivers. The geological structure of the Kumaon region is a continuation of the western Himalayan system that runs through Kashmir and Himachal Pradesh. A distinguishing feature of the Kumaon region lies in the trans-Himalayan zone where the existence of numerous exotic blocks resulted from huge volcanic explosions in Tibet.*

Siwalik zone. Of particular interest in this sector is the occurrence of the Vaikitra Thrust, north of the Baspa Valley, which splits the crystalline belt of the Kumaon Himalaya into two distinct parts.

The Main Central Thrust is especially well outlined in the geology of Kumaon, and is easily discerned in the landscape looking northward from the hill zone toward the high peaks. This juncture is evident, for example, when viewing Api Peak along the northwest Nepal - Kumaon border zone, and the famous pilgrimage sites of Garhwal, including those at Shivaling, Gangotri, and Badrinath, are overlooked by granite and phyllite peaks which constitute the crystalline belt of the Himalayan zone. The upper stretches of the Garhwal waterways, including the Alaknanda and Bhagirathi rivers, carve deep gorges through the hard rocks of this region.

South of the High Himalaya is the more intricate geology of the Lower Himalaya. The lack of fossil evidence leaves much of the stratigraphy unanswered, but recent tectonic investigations indicate sedimentary zones of limestone and sandstone separated by a crystalline belt. The Krol Belt of limestone, slates, and sandstone, named after the Krol mountains located near Shimla, stretches between Shimla and Nainital and is one of the most prominent structures in the Lower Himalayan zone. Near the town of Nainital occur some of the oldest outcrops, and the relatively high mountains of the region lay along a tectonic fault separating the zone from the low-lying Outer Himalaya. As elsewhere in the Himalaya, the Siwalik Zone in Garwhal and Kumaon comprises a region of considerable tectonic activity due to the faults and folding along the Himalayan Frontal Thrust.



Source: Simplified from Amatya, K.M. and B.M. Jnawali, 1994. Geological Map of Nepal. Kathmandu: KAAAS Consultancy and His Majesty's Government, Survey Department

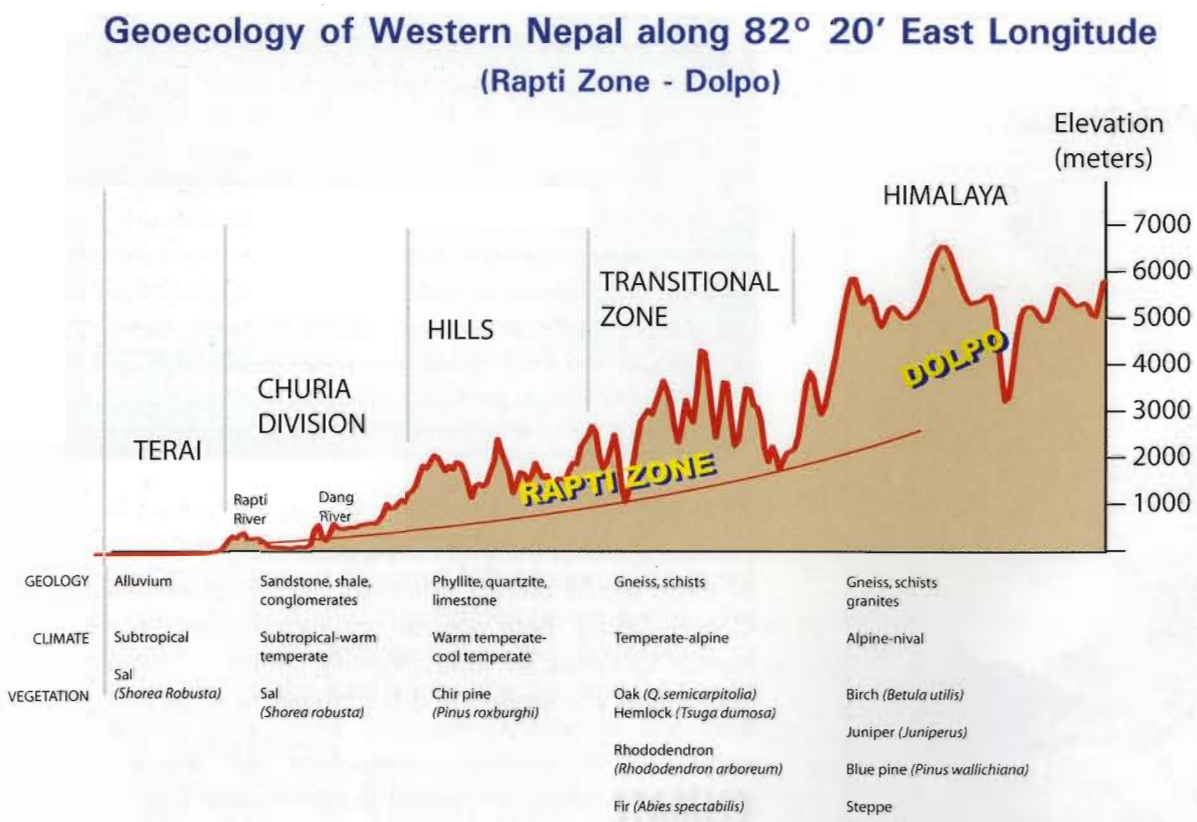
Central Section

The central Himalayan region of Nepal provides some of the range's most extensive geological records, due in great part to the 8-year survey begun in 1950 by the Swiss geologist Toni Hagen. His field research took him to literally all parts of the kingdom, and his copious geological surveys and notes contribute to baseline knowledge about the geology of this central Himalayan region. Geologists often accompany the summit assaults on Nepal's highest peaks and provide detailed surveys of the specific massifs. All eight of Nepal's 8,000-meter peaks are located in the massive Main Central Thrust zone. The Everest region, in particular, has seen a great deal of geological exploration, beginning formally in the 1920s with expeditions originating from the Tibetan side of the mountain. It was not until 1952 that geologists first visited the southern side of Everest. The base of the mountain is composed of granites, which give way with altitude to gneisses, schists, and phyllites, and then, near the summit, to limestone. The calcareous cap of Everest originates from the ancient Tethys seabed which was once overlain by coral reef and sediments.

The great thrust sheets that compose the High Himalaya of the central region overshadow the Lower Himalayan zone which occupies much of the terrain of Nepal. The Lower Himalaya, in turn, are divided into two main tectonic units - a lower sedimentary group and a higher, mostly crystalline, formation called the Kathmandu unit. Each of these units is subdivided into numerous individual thrust sheets, so that overall the geology of the Lower Himalaya in Nepal is quite complicated. Topographically, though, the Lower Himalaya are well defined by the Mahabharat range, which runs parallel to the Main Boundary Fault and forms the southern boundary of the zone, and by the Central Thrust peaks to the north. A few large basins intervene, notably the Kathmandu Valley and Pokhara Valley which are important settlement areas. Common rock types in the Lower Himalaya include granitized schists, gneisses, quartzites, and phyllites.

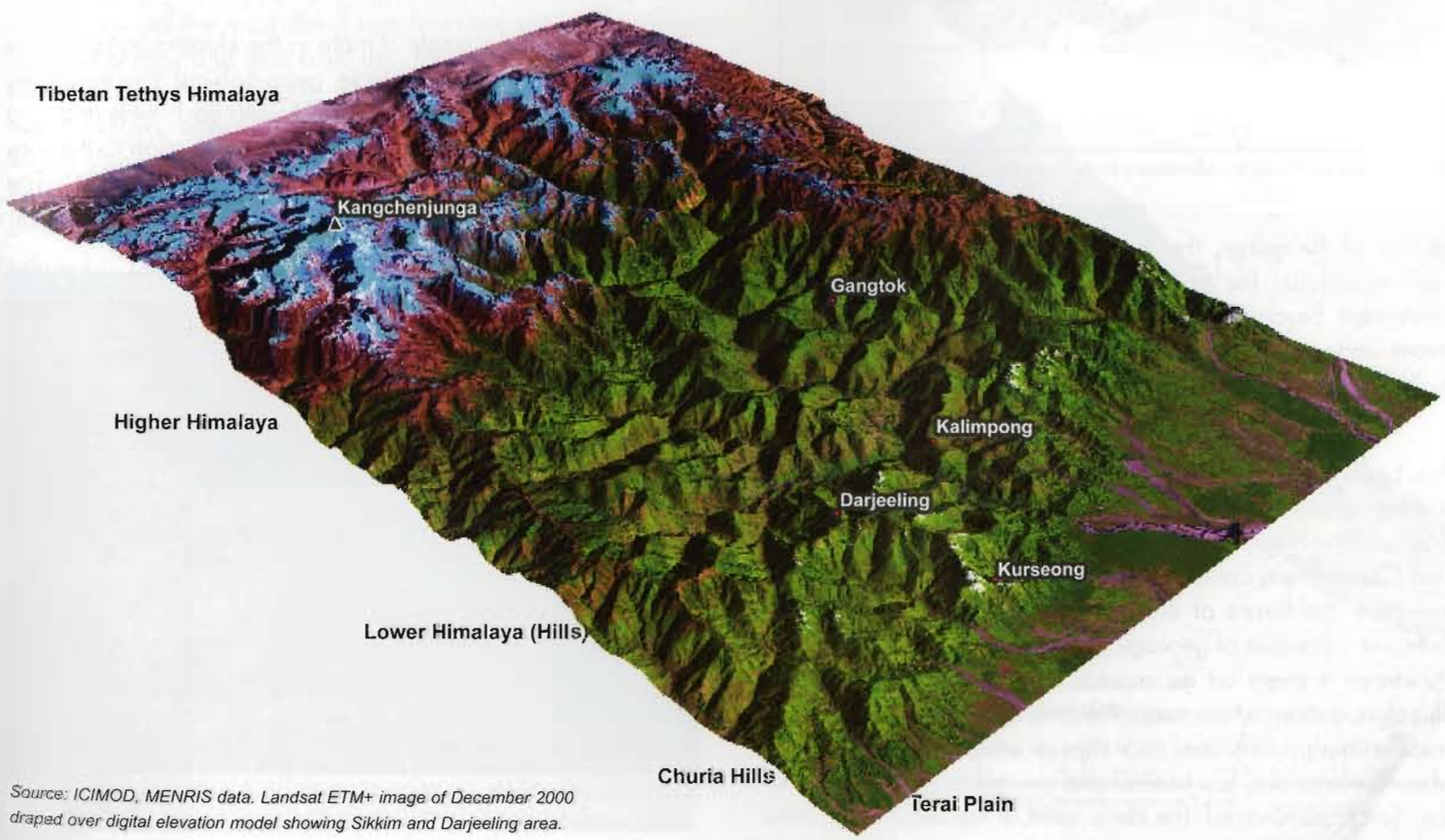
The low-lying Outer Himalaya of Nepal contain the Siwalik range as well as adjoining areas of alluvium deposits. Much of the Nepalese Siwaliks are composed of

Geology of Nepal: *Much of what is known about the geology of Nepal stems from the pioneering work of Swiss geologist Toni Hagen, who surveyed almost all of the country in a series of explorations beginning in 1950. Broadly speaking, the regional geology of Nepal is explained by major thrusting and folding of rock sheets, with the crystalline rocks of the High Himalaya being transported south along the Main Central Thrust zone. In the northern Tibetan zone are primarily sedimentary rocks, and the southern foothills are formed from conglomerates and sediments deposited by the rivers emptying out of the mountains. Numerous faults are observed on satellite images and indicate the most active zones are in the Lower Himalaya and Siwalik Foothills.*



Source: Adapted from Zurick, D., 1988. Resource Needs and Land Stress in Rapti Zone, Nepal. The Professional Geographer, 40(4):428-444

Geoecology of Western Nepal along 82 Degrees East Longitude: *A transect of western Nepal shows the correspondence of geology, elevation, climate, and vegetation. The zonation of life zones by altitude is a premier characteristic of the Himalayan environment and adds greatly to the immense complexity of the mountain landscape.*



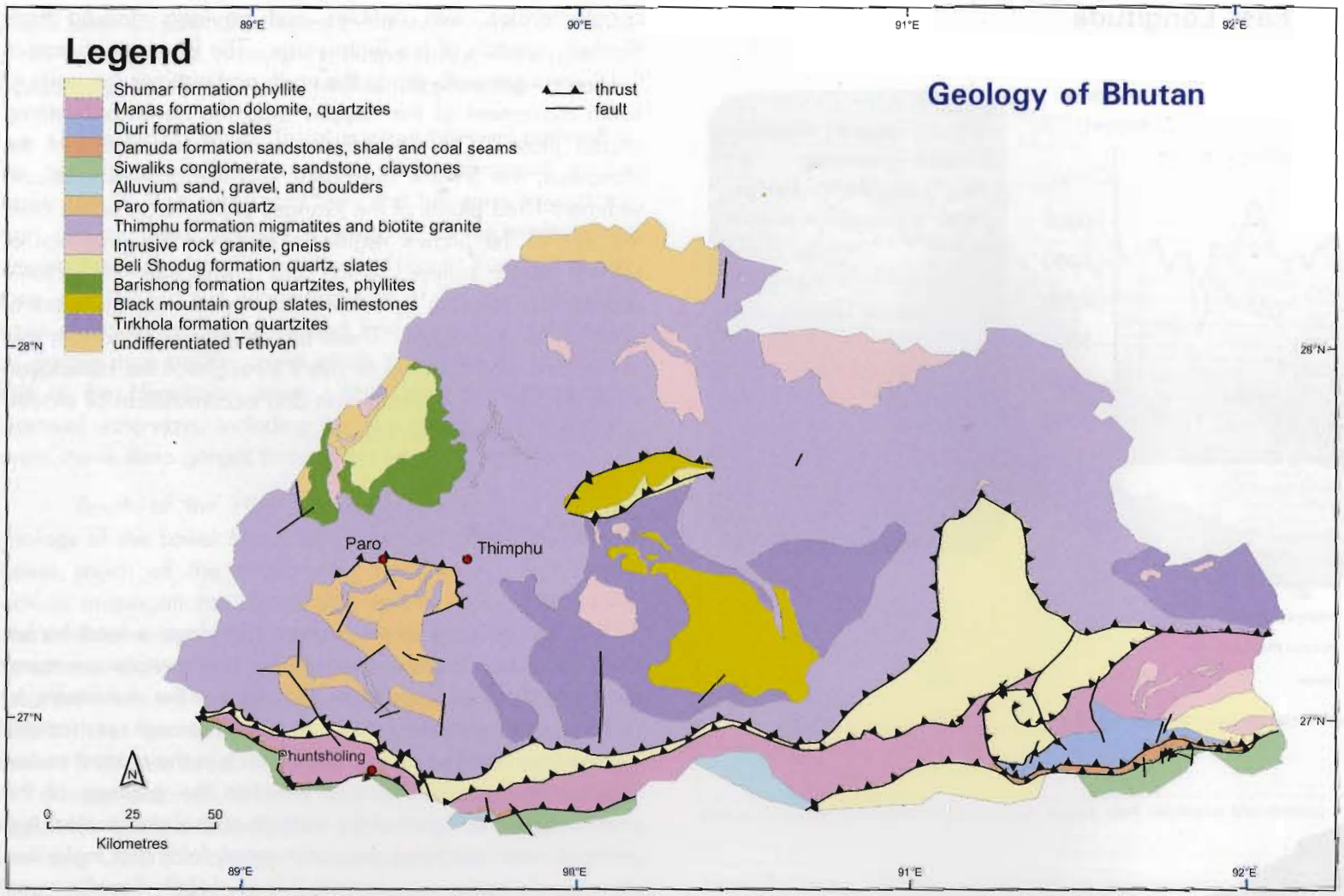
Source: ICIMOD, MENRIS data. Landsat ETM+ image of December 2000 draped over digital elevation model showing Sikkim and Darjeeling area.

conglomerates, with pebbles and boulders derived from eroded materials of pre-Tertiary age. The folds and thrusts of the Siwalik generally dip to the north and indicate the north to south movement of the nappes atop the northward-drifting crustal plate. On the extreme southern boundary of the Himalaya, the Siwalik disappear into the alluvial fans and sediment-filled plains of the Ganges plain. One of the chief features of the Silawik region in Nepal is the presence of several large valleys, which are comprised of tectonic depressions overlain by sediments eroded from the general uplift of the mountains. These basins play an important role in the flow and flooding of rivers throughout the Himalayan foreland and in the distribution and accumulation of eroded sediments carried downstream.

Eastern Section

The geology of the eastern Himalaya is least known because of the challenges posed by severe monsoon rains, the thick cloak of vegetation that covers the mountains to considerable altitudes, and the government restrictions imposed on travel and scientific research in the eastern sector. One of the main differences between the geology of the eastern region and that of the western and central sectors is a series of cross structures and sedimentary folds that make less clear the distinction between the Zones of High Himalaya and the Lower Himalaya. For example, the thrust boundary separating the two zones is not clearly disclosed in the strata of Bhutan, so the demarcation of the High Himalaya simply begins with the crystalline mass north of the sedimentary structures of central Bhutan. No clear thrust line is evident. The high elevations of the Great Himalayan zone are characterized by granite and gneiss peaks carved by glaciers into serrated ridges and cirque slopes.

The Lower Himalaya in Bhutan contain the prominent Black Mountain range near Tongsa and a number of large river valleys whose wide floors distinguishes them from the narrower gorges and valleys found elsewhere in the Himalaya. The broad valleys in Bhutan result from the erosive power of the rivers, which contain a high level of water discharge from monsoon rains, and the less resistant underbelly of sedimentary rocks. The bedrock of the Lower Himalaya becomes less metamorphosed to the east, so that the rivers in eastern Bhutan tend to create wider valleys than in the western part of the kingdom. In contrast to the poorly



Source: Simplified from Geological Map of Bhutan. United Nations Economic and Social Commission for Asia and the Pacific in cooperation with the Department of Geology and Mines, Thimphu, Bhutan.

defined thrust boundary between the High Himalaya and the Lower Himalaya, the Main Boundary Fault separating the latter from the Outer Himalaya is well established in Bhutan. The low-lying foothills show severe tectonic deformation, with successive faults and thrust sheets along a west-east strike. As elsewhere in the Himalaya, this zone poses some of the most serious prospects for earthquakes and other seismic action.

To the east of Bhutan, in the Indian state of Arunachal Pradesh, the geology of the Himalaya is largely unknown. Overall, the elevations of the mountains are lower with the exception of Namcha Barwa (7,756 meters), which anchors the southward bend of the Tsangpo (Brahmaputra) River where it empties from Tibet into India. Across the Tsangpo River is the peak of Gyala Peri (7,150), and the intervening gorge has only recently been explored. The steep gradient of the river as it cuts through this eastern sector of the Himalaya suggests a very young uplift of the mountains. In a remote section of the gorge, the river gradient captures a series of high waterfalls, the presence of which was only recently confirmed. Beyond the Brahmaputra region, major fault and thrust zones separate the Himalayan from the adjoining highland regions in Myanmar and China.

The geological formation of the youthful Himalaya has been a steady process, characterized not so much by sudden upheavals as by a relentless movement of the earth's crust and the steady rise of land where the continents of South and Central Asia collide. As the mountains have grown, so too have the forces of erosion acted upon them to reduce their size. The rate of geological erosion or denudation of the Himalaya is every bit as impressive as its geological uplift. This denudation, which takes the form of surface erosion and mass wasting (landslides, rock slips or other mass movements of earth materials), is a natural and inevitable characteristic of the Himalaya. Indeed, the steep relief of the mountains, their

Geology of Bhutan: *Despite the pioneering work of the Swiss geologist Augusto Gansser and the more recent surveys carried out jointly by the Survey of India and the Department of Geology and Mines of the Royal Government of Bhutan, less than 30 percent of Bhutan has been mapped geologically. Mineral exploration began only in the 1960s. The tectonic structures of Bhutan follow the general pattern of the entire Himalaya, with less well-defined divisions between the High Himalaya and the Lower Himalaya and the presence of broad erosional valleys in the eastern parts of the kingdom. The northern border of Bhutan, in the trans-Himalayan zone, is marked by a series of marginal or axial mountains that protrude from the Tibetan plateau.*

youth and rapid rate of uplift (1,500 meters in the last 20,000 years), as well as the weathering potential of the monsoon; all of these would predict extremely high rates of denudation. Compounding these natural occurrences are the effects of human activities in land clearing, which in severe cases accelerates soil erosion and contributes to slope instability.

CLIMATE

There is no single climate in the Himalaya; rather the mountains create such diverse geographical circumstances that climate becomes kaleidoscopic, with each twist and turn in the terrain the changing altitude, and orientation to the sun, resulting in a plethora of individual climate segments. The major controls on climate in the Himalaya include their

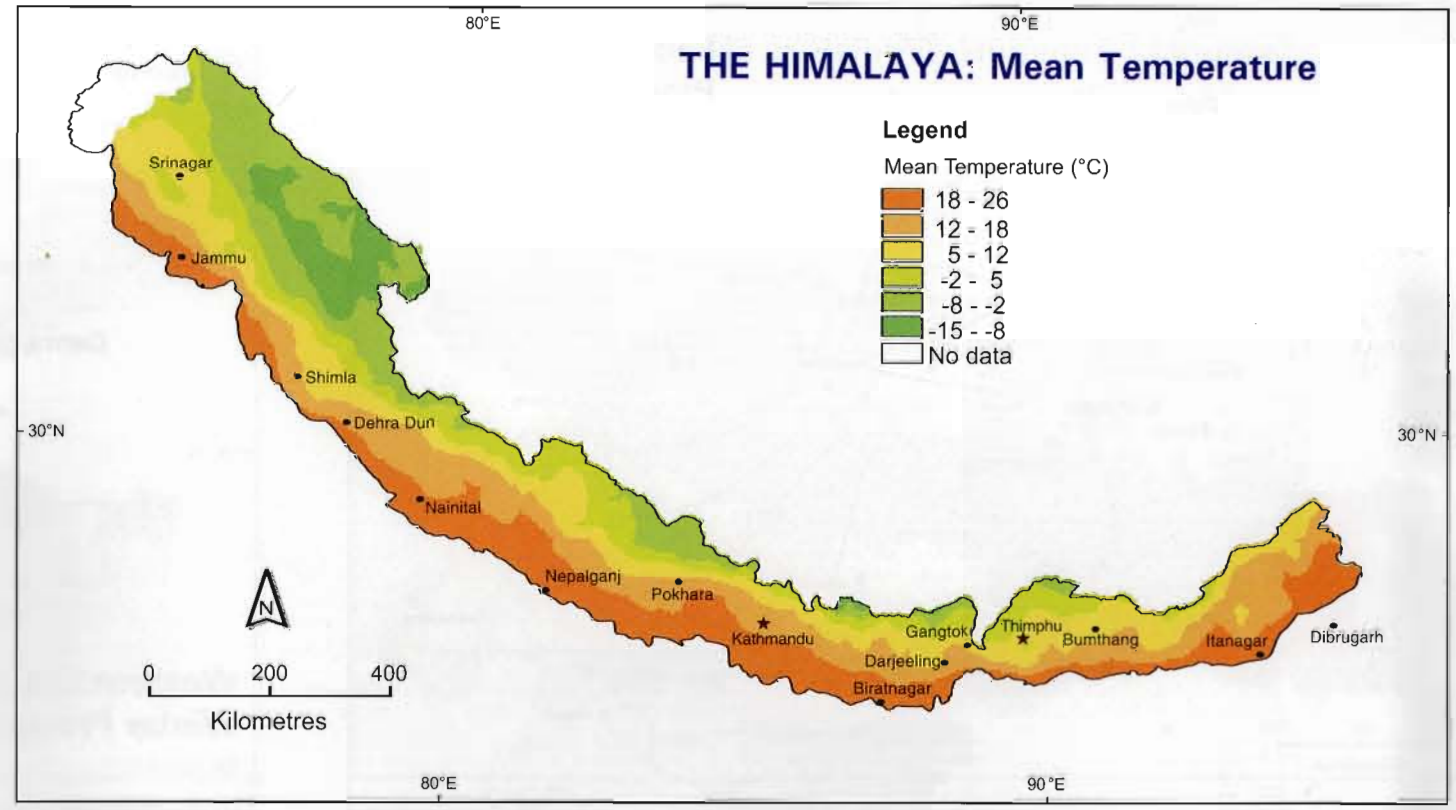
The extreme climate of Manang Valley is modified by the nearby Annapurna massif.

latitudinal position, altitude, and location relative to the Asian monsoon airflow. From north to south, the mountains cover a range of latitudes greater than eight degrees, spanning temperate to subtropical zones, equivalent in North America to the span of the Appalachian Mountains from Pittsburgh to Atlanta. Moreover, the topographic barrier of the Himalaya permits the tropical climate zone to extend farther north in South Asia than it does anywhere else in the world. This factor is most pronounced in the eastern sector of the range where the Brahmaputra valley funnels warm air from the Bay of Bengal into the mountains toward Namcha Barwa and northward into eastern Tibet.

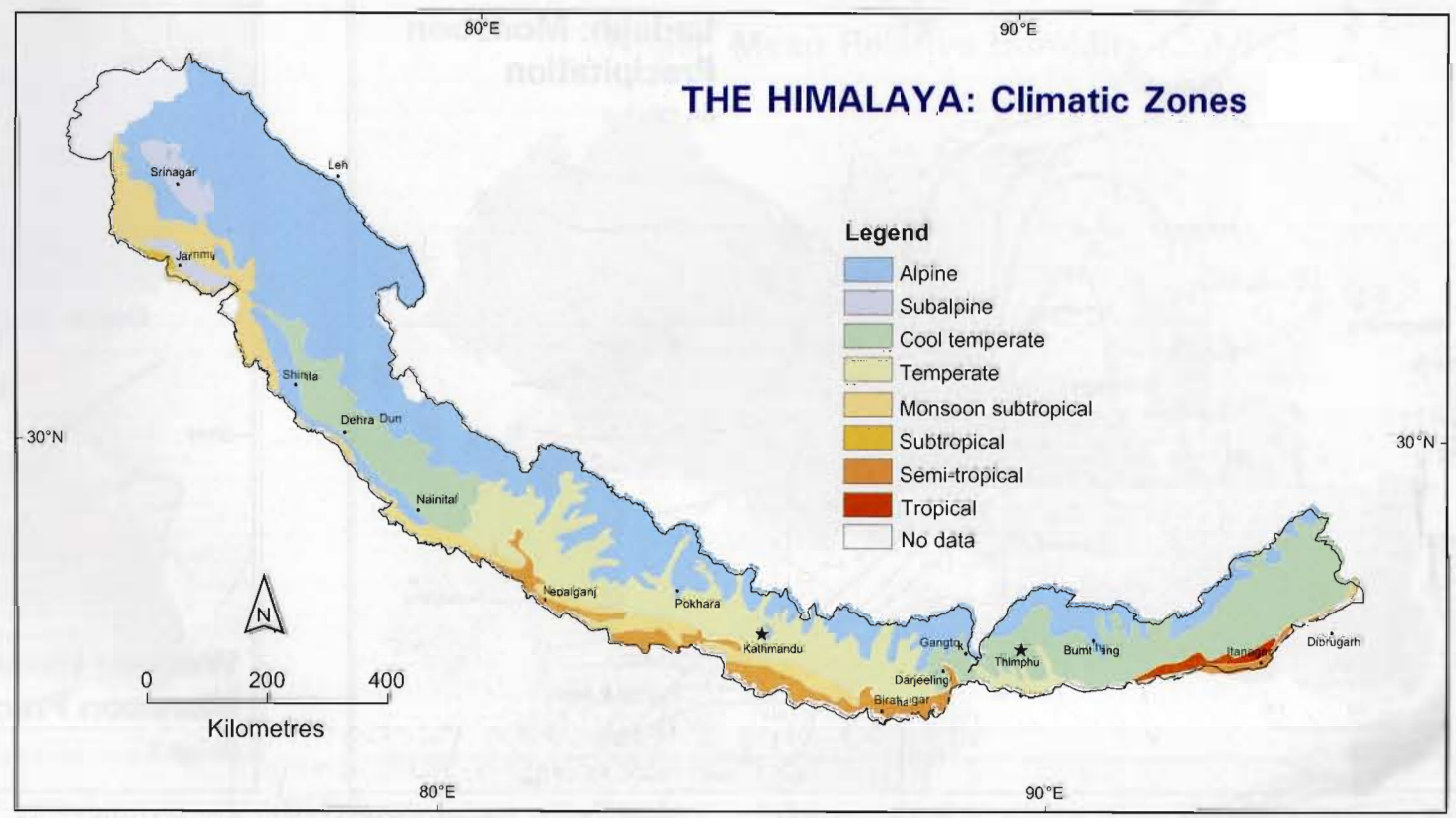
Temperatures in the Himalaya vary inversely with altitude at a rate of about 2 degrees C. (3.6 degrees F.) per 300 meters (1,000 feet) of elevation loss or gain. Due to the rugged terrain, wide ranges in temperature are found over short distances. Local temperatures also correspond to season, orientation of the land toward the sun, and the size of the mountain mass. The seasonal differences are most pronounced in the northwestern regions of the Indian Himalaya and western Nepal where the winter months are characterized by temperate or frigid weather. Since temperature is directly related to solar radiation, the mountain slopes that get the most direct rays from the sun also receive the most energy and heat build up. This effect becomes more pronounced with increasing elevation. In the topography of the Himalaya, where steep-walled valleys are common, two facing slopes may be only a stone's throw distance from one another, but their opposing aspects produce significantly different weather. The southern exposure may well provide an additional month of growing season. The overall size of the mountain mass influences temperature because it acts as a heat island and therefore influences the energy budget. The immense scale of the Himalayan peaks means that the summits create their own climate, which may be radically different from that of nearby plateaus or valleys.

One of the most influential factors affecting the Himalayan climate is the Asian monsoon. The monsoon is not a rain but a wind that carries rain in the summer months.

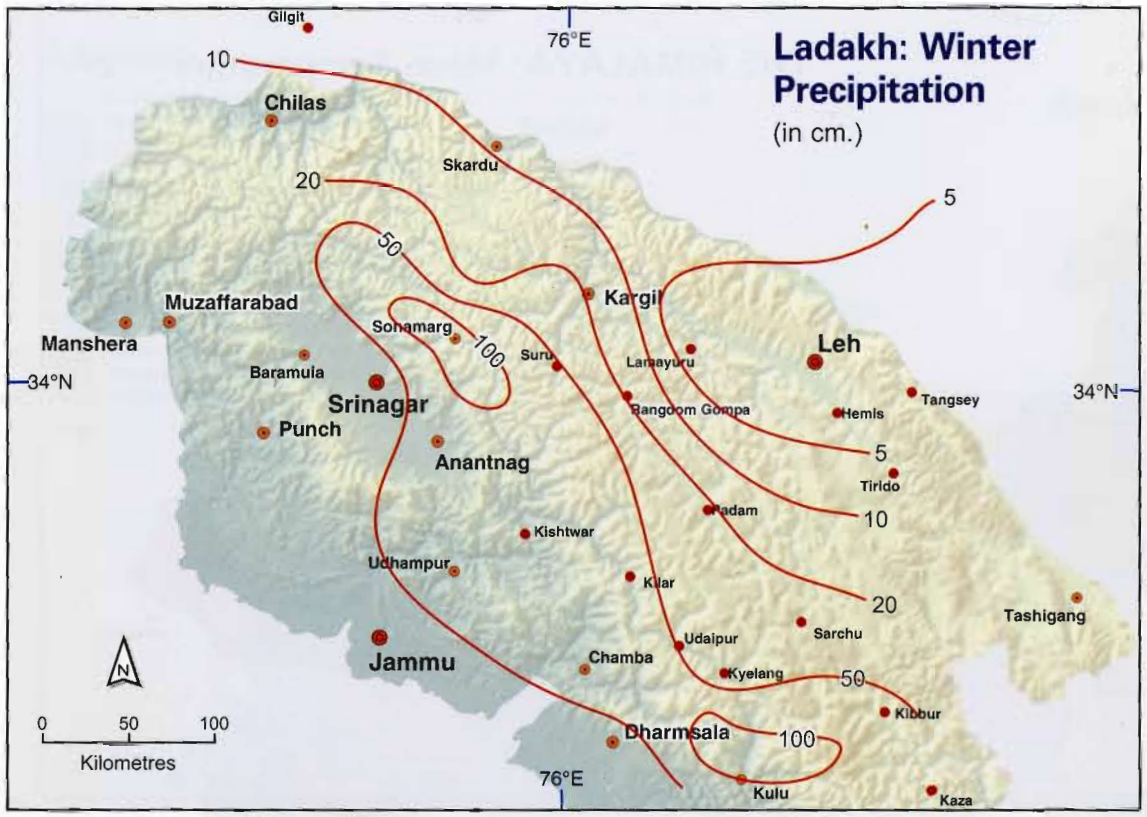
The Himalaya - Mean Temperature: *Altitude and latitude are the greatest influences on temperature in the mountains. The gradient of temperature change with altitude, known as the environmental lapse rate, coupled with latitudinal influences on temperature, produces generalized climate patterns in the Himalaya that range from tropical to frigid alpine.*

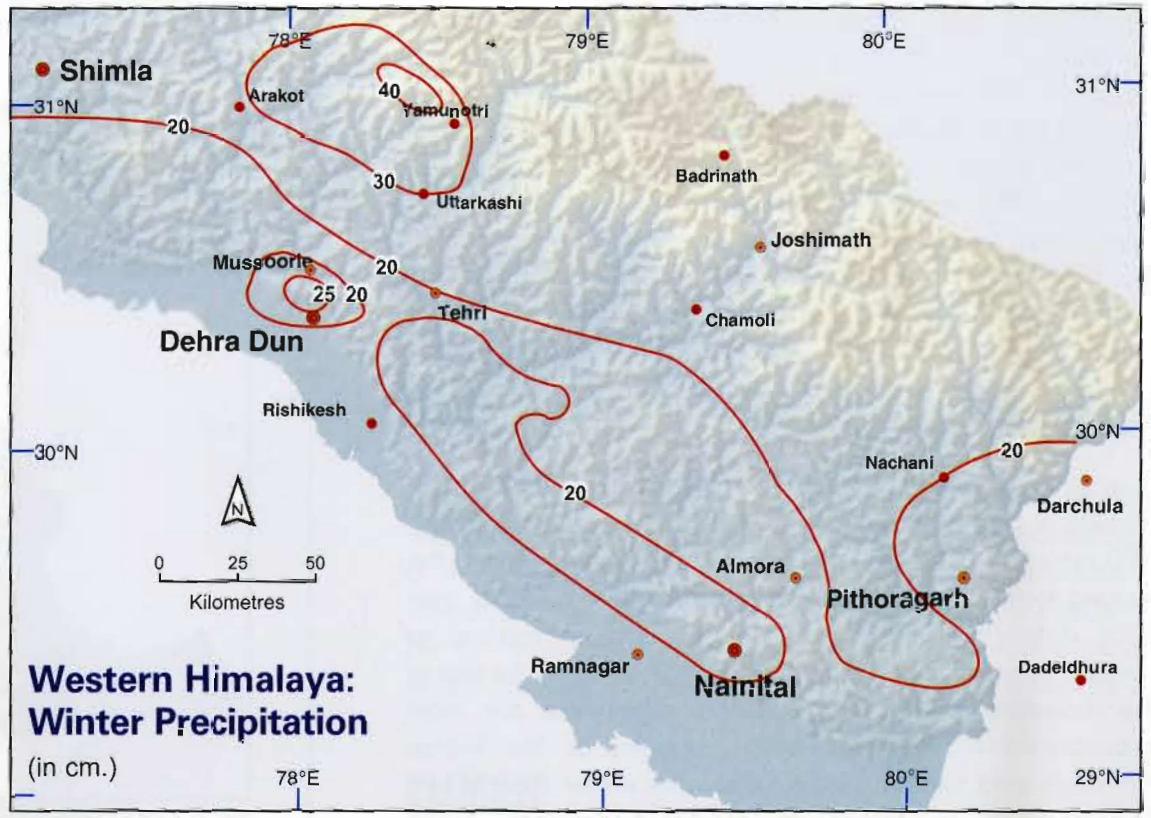


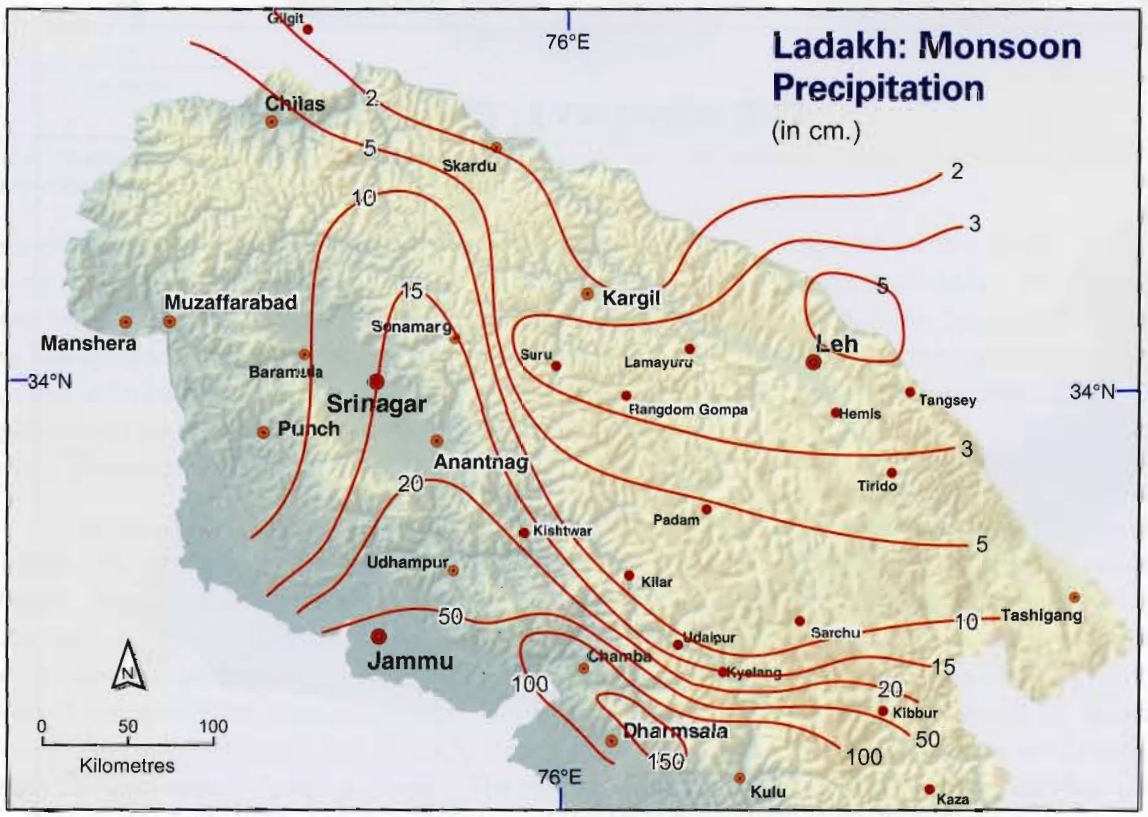
Source: ICIMOD, MENRIS compiled from FAO data

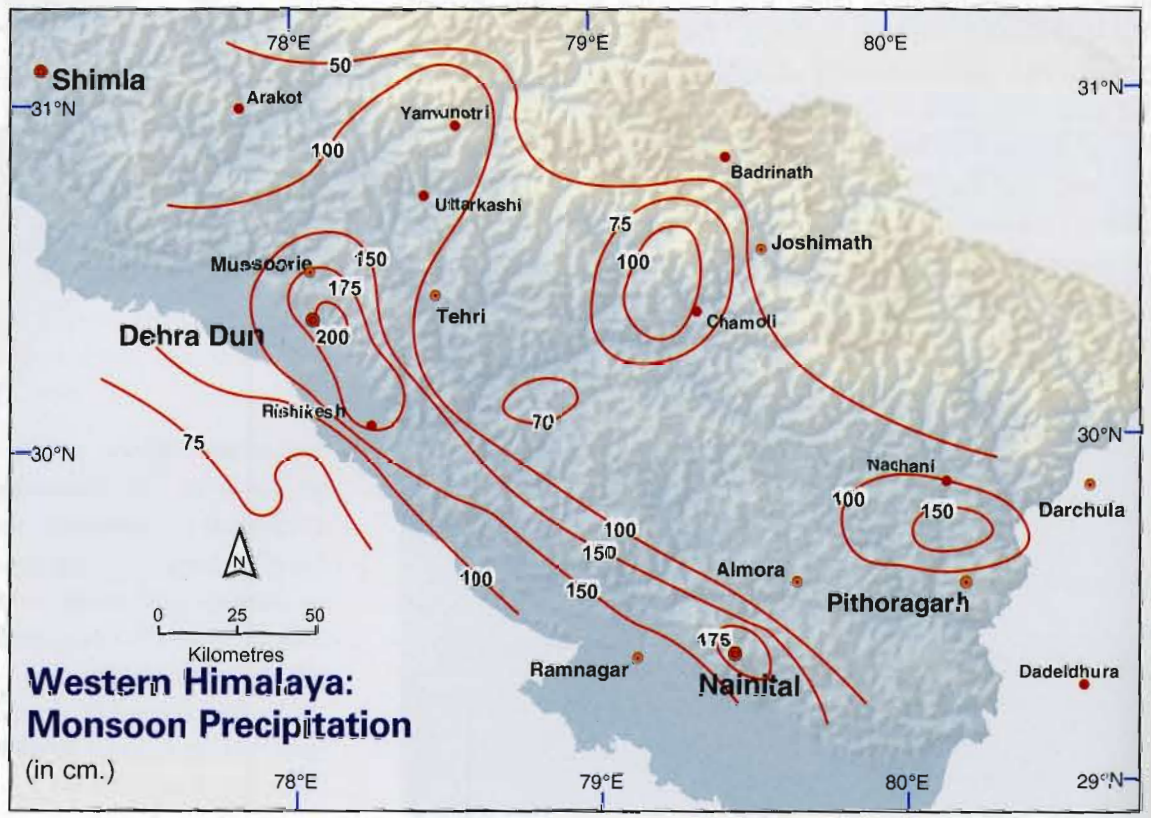


Source: ICIMOD, MENRIS compiled from FAO data



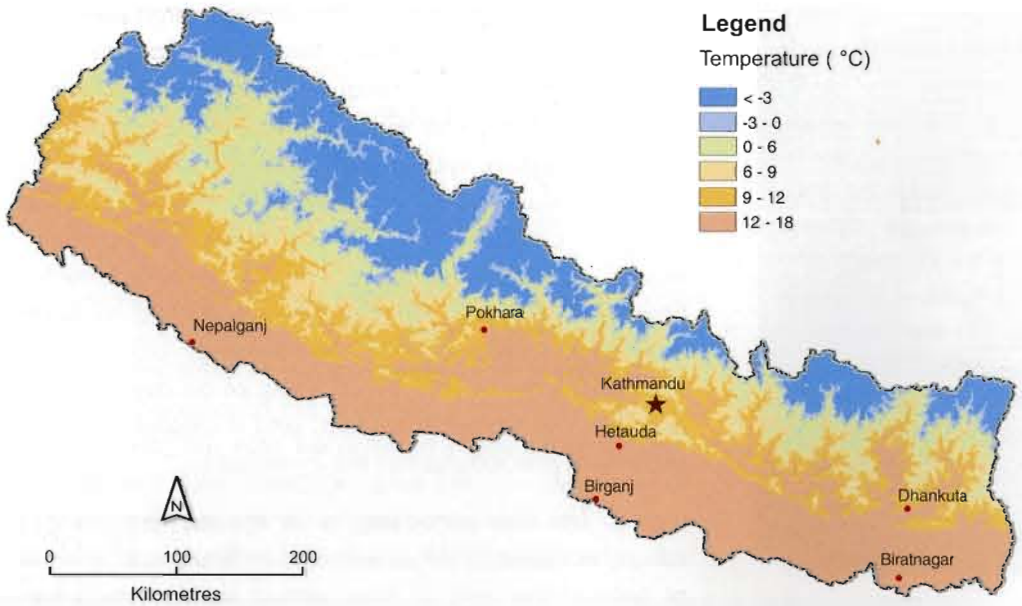




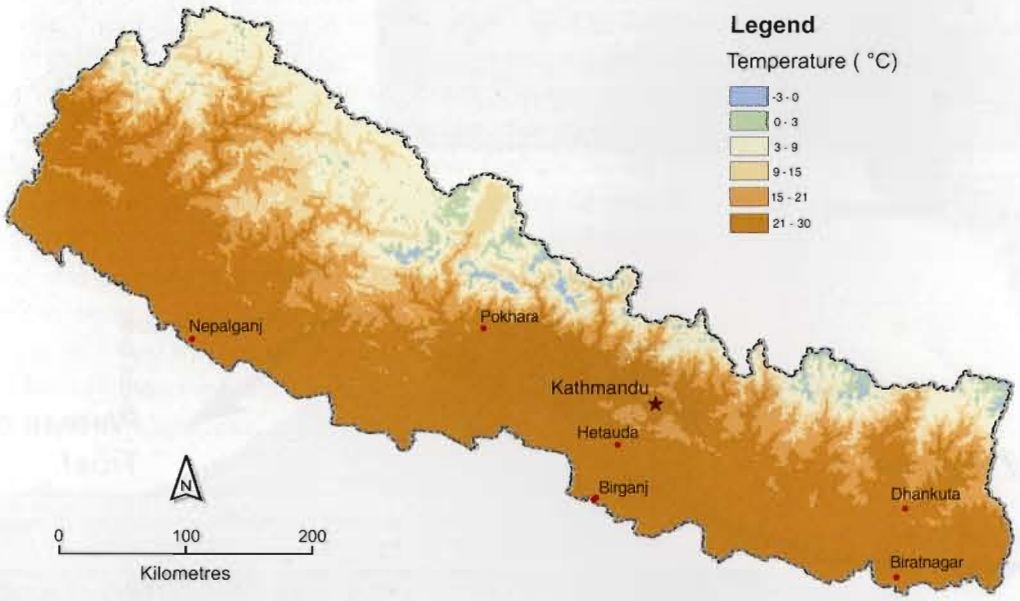


Source: Adapted from Pangtey, Y.P.S. and S.C. Joshi (eds.), 1987. Western Himalaya, Vol. 1: Environment. Nainital: Gyandaya Prakashan

Nepal: January Temperature

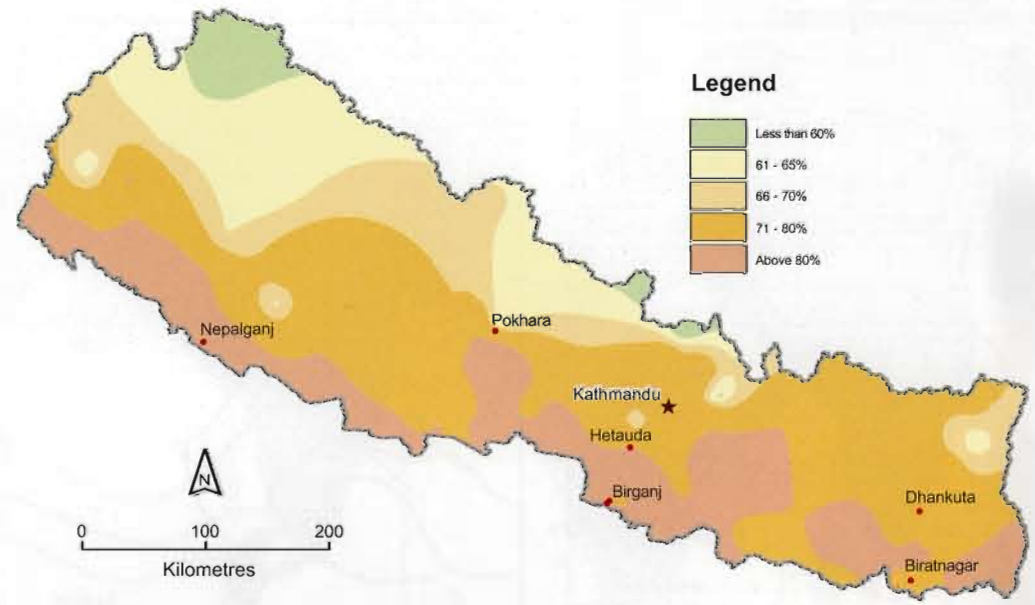


Nepal: July Temperature

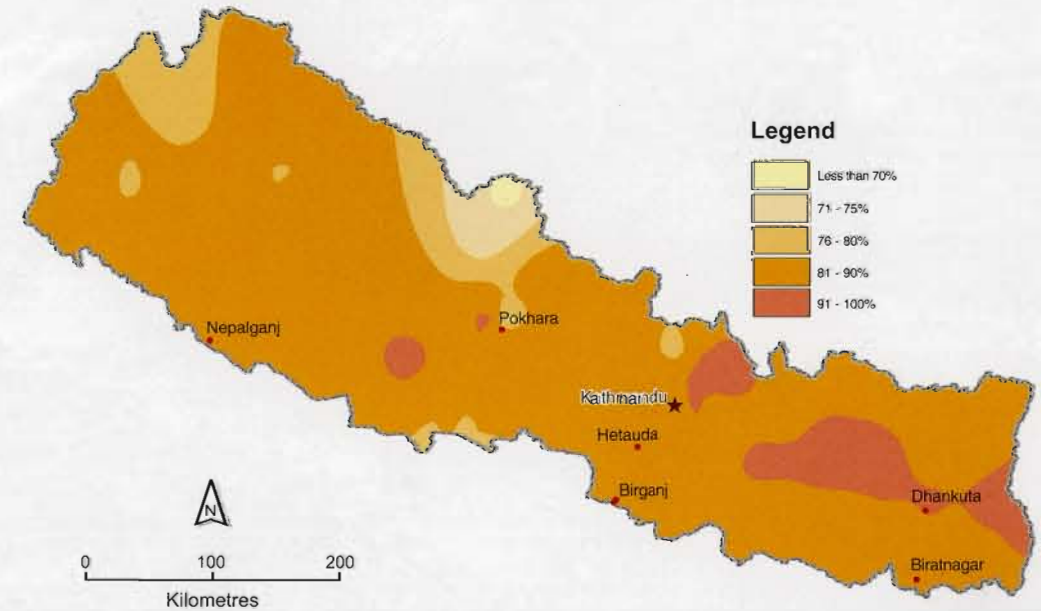


Source: ICIMOD, 1996. Climatic and Hydrological Atlas of Nepal. Kathmandu: ICIMOD

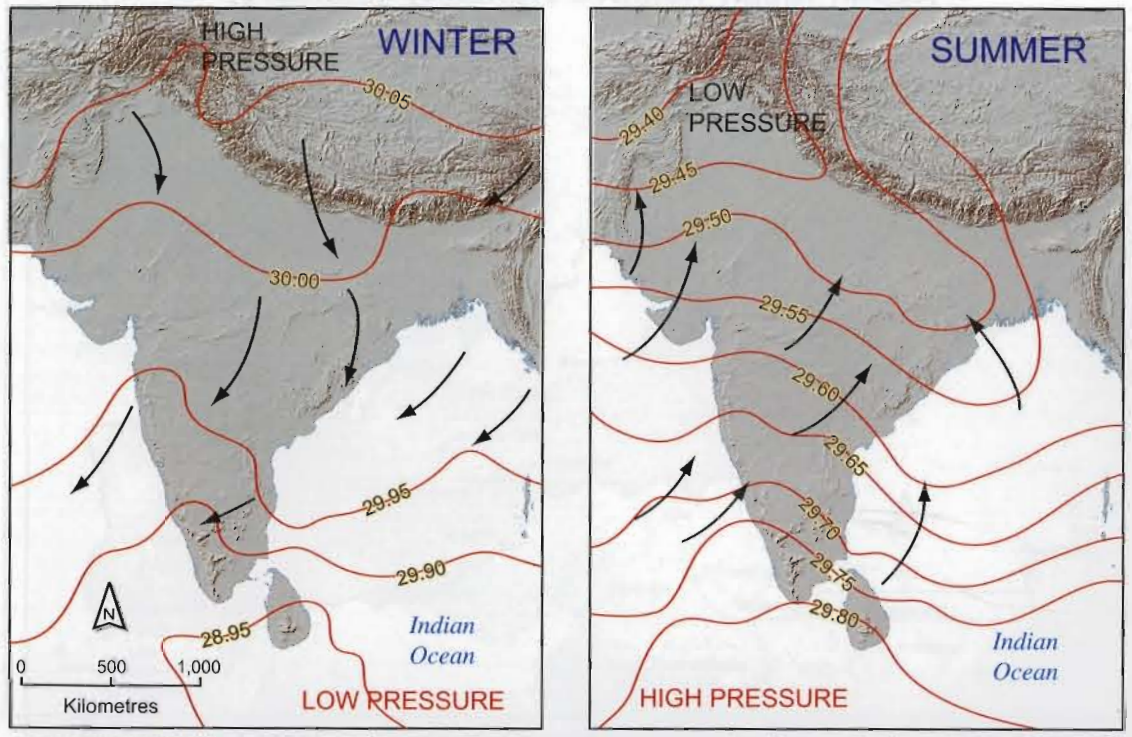
Nepal: Mean Relative Humidity (January)



Nepal: Mean Relative Humidity (July)



Seasonal Pressure Systems and Airflow (mb)



Source: Adapted from Wallen, R.N., 1992. Introduction to Physical Geography. Iowa: Wm. C. Brown Publishers

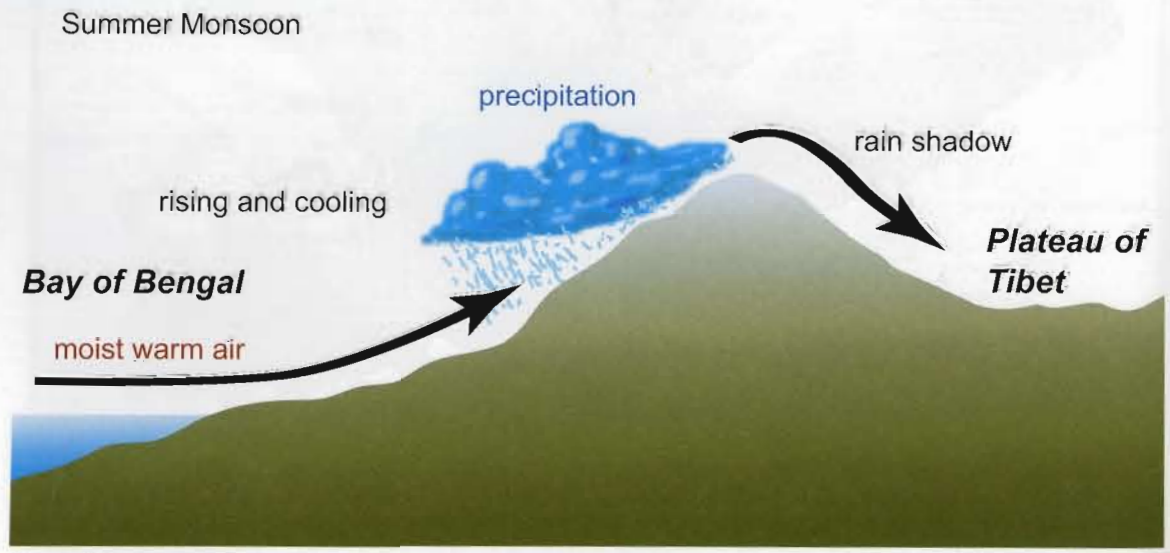
Monsoon clouds rise with the warm morning air in Helambu valley, Sindhupalchok, Nepal

Seasonal Pressure Systems and Airflow: *In the winter months a high pressure system builds over central Asia, causing air to flow south. This is the winter monsoon (monsoon means 'wind'), and it is a dry season due to the lack of moisture sources in central Asia. In the summer, a low pressure system builds over central Asia, drawing air from the Indian Ocean. This moist air produces the precipitation associated with the summer monsoon.*

The wind is triggered by enormous air pressure differences between central and southern Asia, which form as a result of the differential heating and cooling of the inner continent and the surrounding oceans. In the winter, a high pressure system hovers above central Asia, forcing air to flow southward across the Himalaya. Because there is no significant source of moisture, the winter winds are dry. In the summer, however, the high pressure system forms over the Indian Ocean, and it drives moisture-laden air northward. The wet summer winds cause precipitation in India and along the tiered, southern slopes of the Himalaya. The water-laden monsoon air flowing north over the Himalaya is forced to ascend the mountains and to cool, condensing, and releasing its moisture as rain. This forced lifting of air over the mountains is called the orographic effect, and it creates a concentrated pattern of precipitation in the Himalaya.

The monsoon begins in the eastern sector of the range, in Arunachal Pradesh and in Bhutan, in early summer at around the end of May, and it slowly moves westward, reaching Kashmir in the western Himalaya by late June or early July. As it moves westward, the monsoon also becomes drier. In the eastern region, the famous weather station at Cherrapunji in Assam records an annual rainfall of 10,871 mm (428 inches), with a single day record of 1,041 mm (41 inches). This spot is second only to Mt. Waialeale in Hawaii, which receives an average annual rainfall of 12,344 mm (486

Orographic Precipitation: *Moist warm air from the Indian Ocean flows northward in the summer months and rises over the Himalaya. The rising air cools, condenses to form clouds, and precipitation occurs, mainly along the southern slopes of the mountains. As the airflow continues to move over the main crest of the Himalaya it has lost much of its moisture and, as it descends, it warms. The result is a rain shadow where precipitation levels are low and the climate is arid. This phenomenon results in the dry conditions of the Tibetan plateau.*



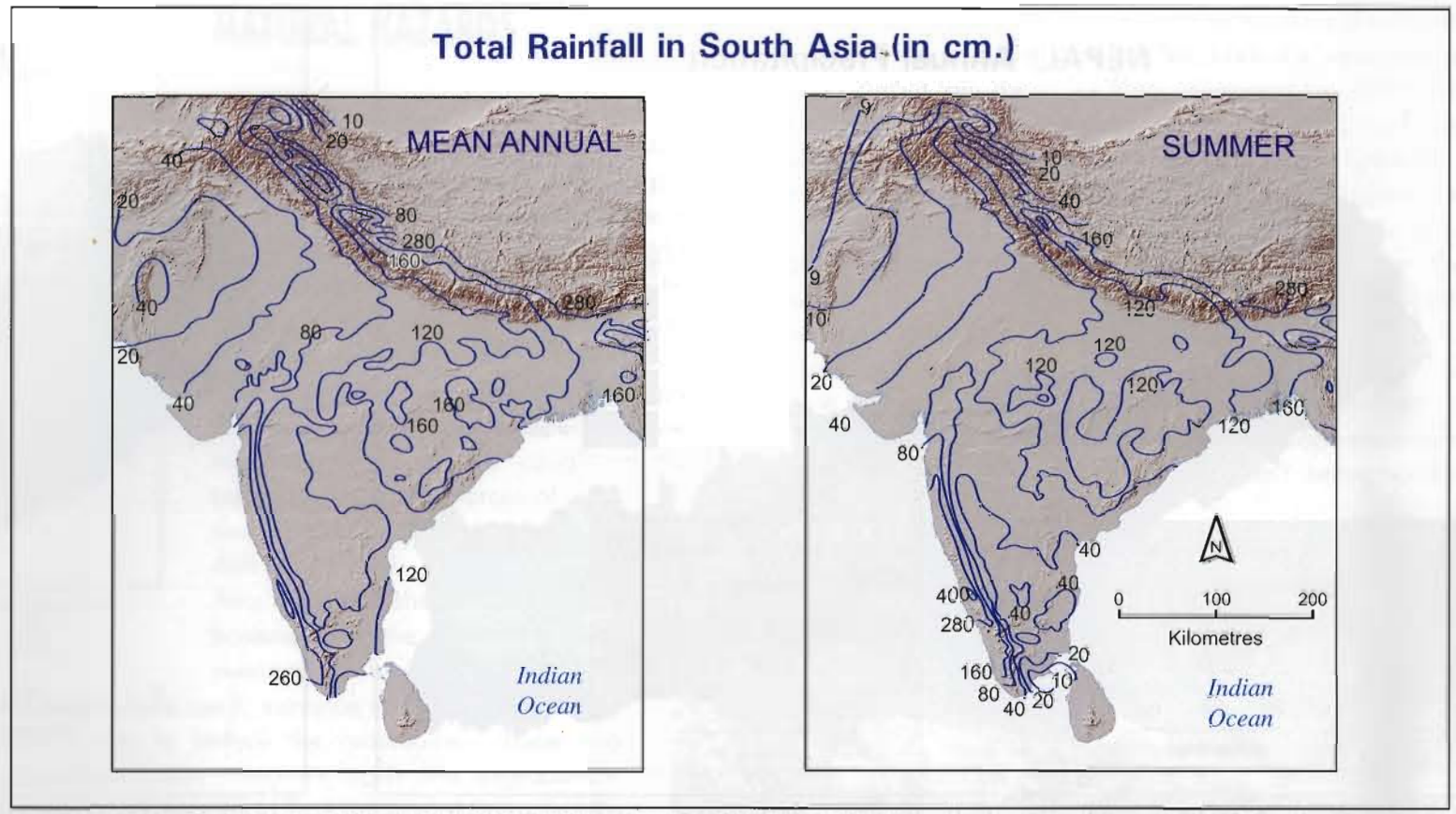
Orographic precipitation

inches), as the wettest place in the world. But whereas the rainfall on Mt. Waialeale occurs throughout the year, Cherrapunji receives almost all its annual precipitation only in the few monsoon months.

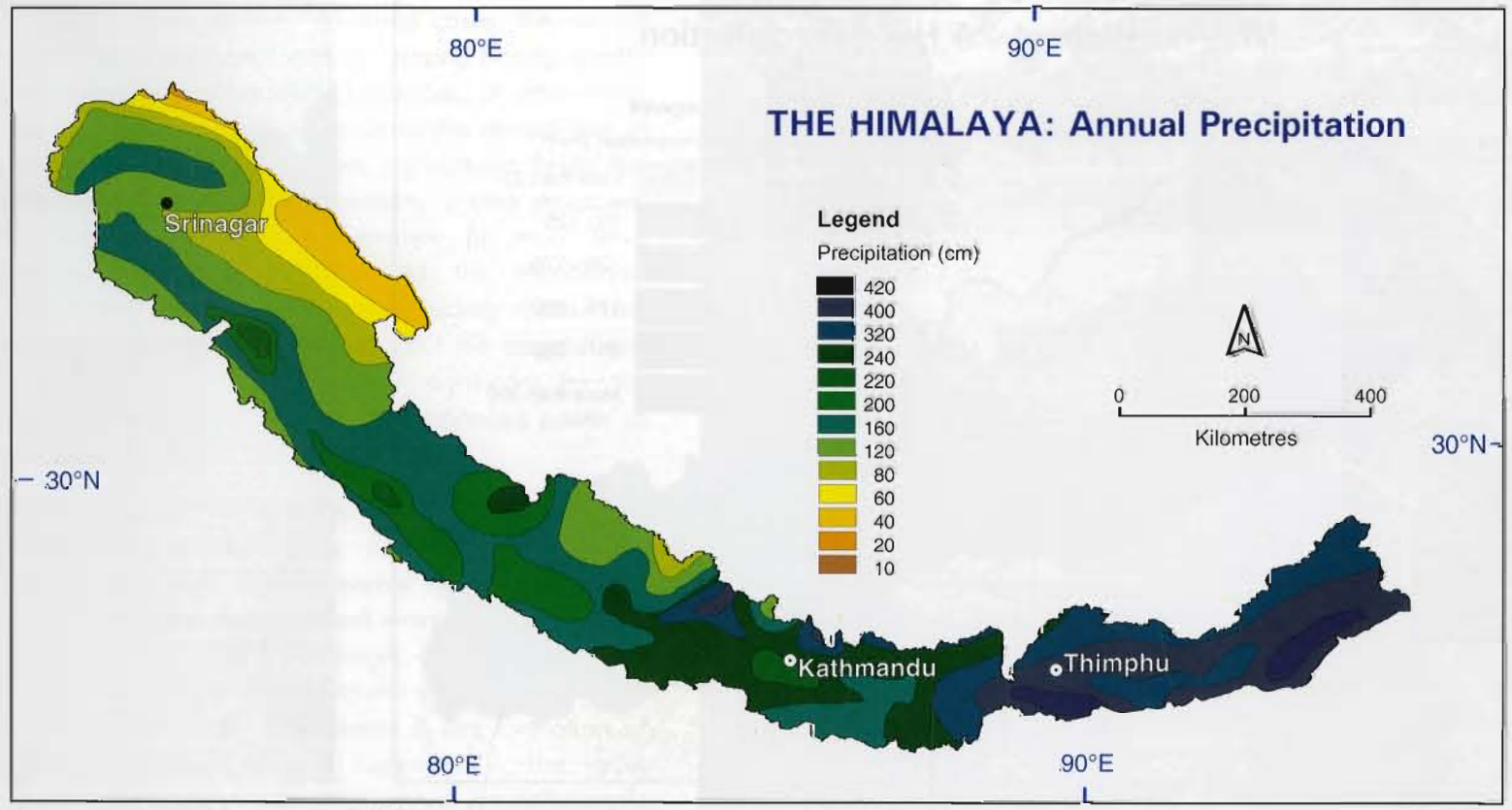
The monsoon precipitation drops progressively in the westward direction, with annual receipts in Darjeeling of 3,122 mm (123 inches), in Kathmandu of 1,688 mm (66 inches), and in Jammu of 1,096 mm (43 inches). A vertical gradient in rainfall receipts exists in addition to the longitudinal shift. An increase in rainfall occurs with altitude up to a maximum precipitation zone, which in the Himalaya occurs around 2,000 meters, after which it then begins to drop again. The precise measurement of this gradient is difficult, in part because of the absence of recording stations at high elevations, but also because so many other factors, such as wind and solar direction, play critical roles in local temperature and precipitation accounts, but in certain circumstances the elevation factor actually supercedes the east to west longitudinal gradient.

When the wet wind from the south is carried over the High Himalaya it has already lost much of its moisture, and that amount which remains is locked up as vapour when the air subtly warms as it descends onto the Tibet plateau. Consequently, the trans-Himalayan zone, in the lee of the high peaks, is dry. This is the so-called rainshadow effect. The climate barrier of the Himalaya results in startling contrasts of climate. Precipitation in Nepal, for example, diminishes from 5,202 mm (205 inches) in Lumle, located on the southern side of Annapurna in central Nepal, to 174 mm (7 inches) on the north side of the same mountain. In Leh in Ladakh, which is located north of the Main Central Thrust of the western Himalaya, annual precipitation is only 76 mm (3 inches) (see map on page 36). In the eastern and central regions, it is possible to walk in only a few days from lush, wet forests to stark and cold high deserts. Such transects make clear the fact that the regional patterns of climate are often less important than the local ones, which vary in extreme ways over quite short distances.

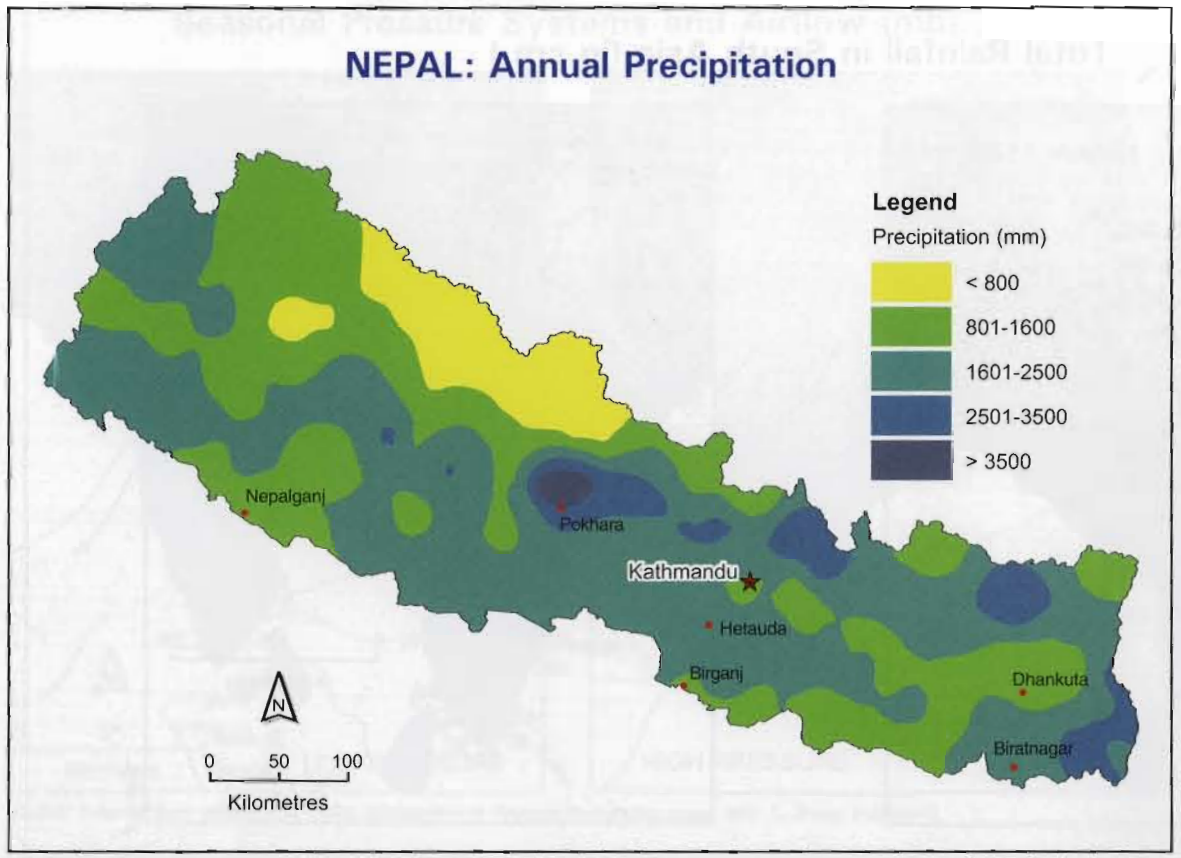
Additional factors affecting the climate of the Himalaya include wind and glaciers. Mountains, which protrude into the high atmosphere, are some of the windiest places on the planet. They modify the normal circulation of air and create their own winds by setting up regional and local pressure systems. Mountain and valley breezes interlock in a diurnal circulation that can become so strong as to create gale-force winds. In the Kali Gandaki valley of central Nepal,

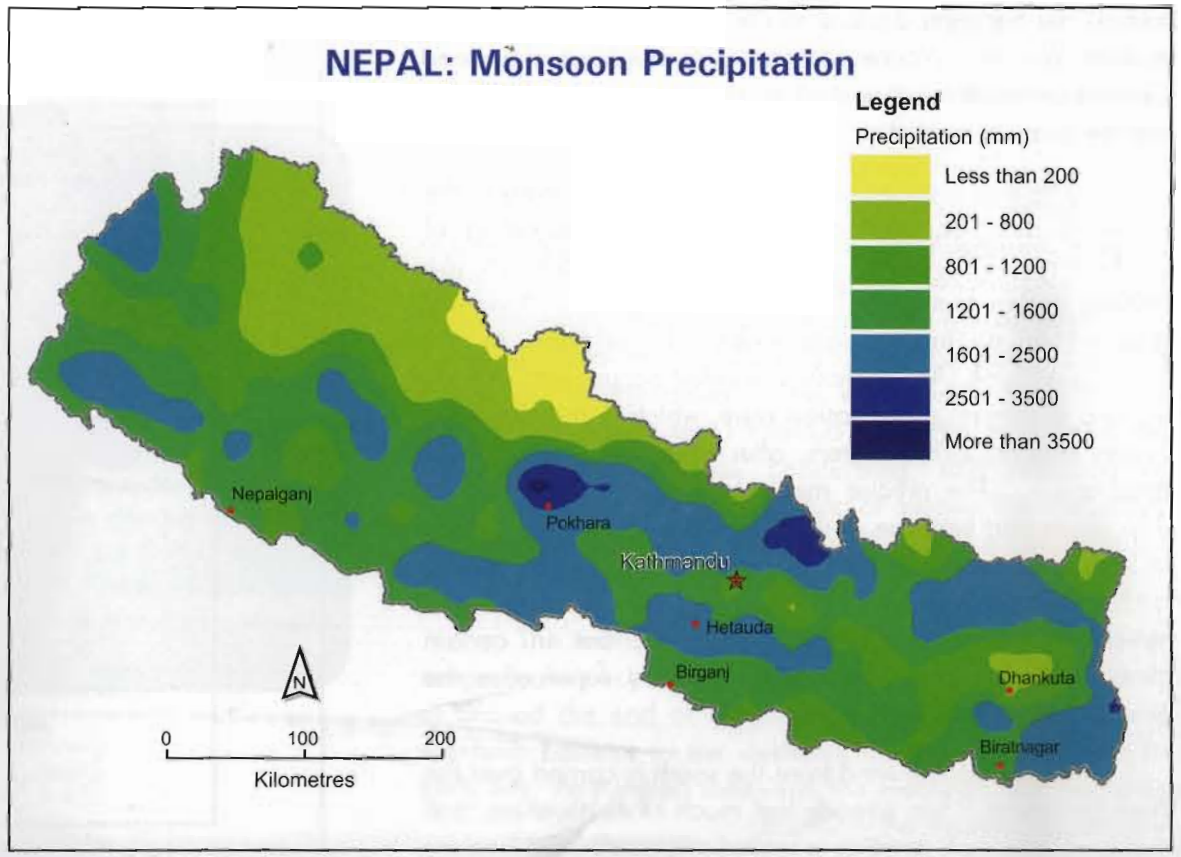


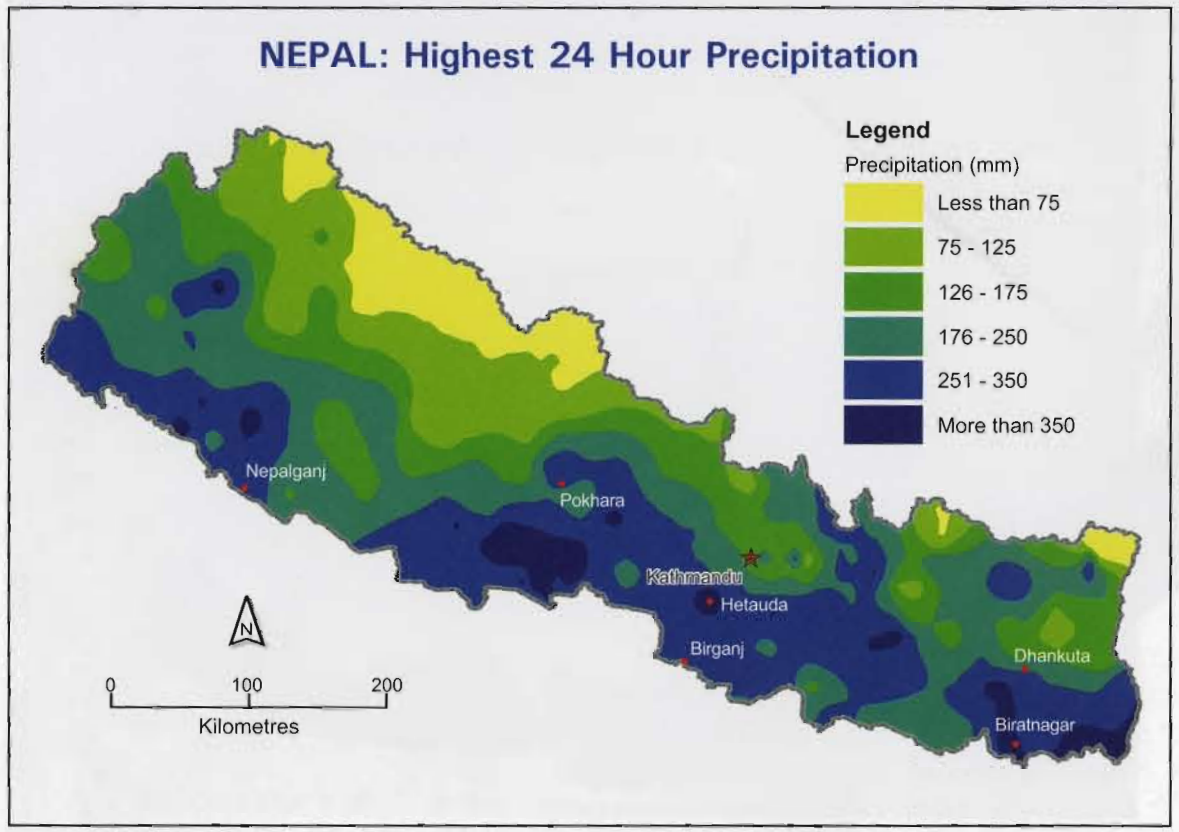
Source: Adapted from Bruijnzeel L. A. and Bremmer C. N., 1989. Highland-Lowland Interactions in the Ganges-Brahmaputra River Basin. Kathmandu: ICIMOD, Occasional Paper No. 11



Source: ICIMOD, MENRIS compiled from FAO data



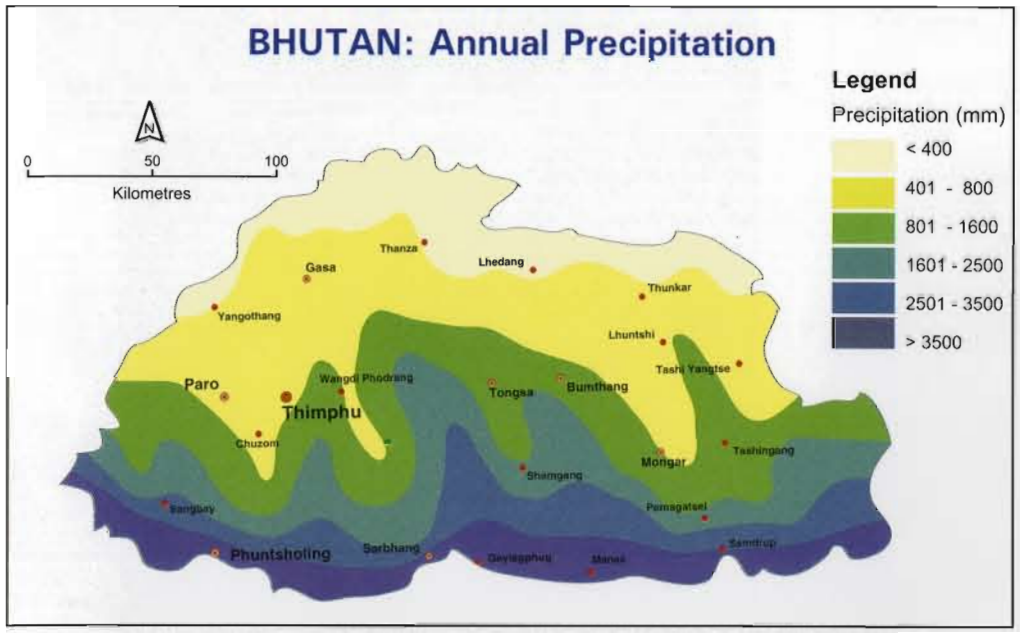




Sourc: ICIMOD, 1996. Climatic and Hydrological Atlas of Nepal. Kathmandu: ICIMOD

Mandira Shrestha

Floods are a regular feature during the monsoon rains



Source: Adapted from Royal Government of Bhutan, 1992. Seventh Five Year Plan (1992-1997), Vol. 1 Main Plan Document. Thimphu: RGOB, Planning Commission

the pressure gradients become especially powerful. The valley winds that blow through Jomsom village begin in the late morning and by noon may reach speeds of 80-100 kilometers per hour! These daily winds blow sand and grit through the valley in gale-like conditions until late afternoon, when they taper off, leaving the air once again calm and the sky clear. Small valleys located below glaciers receive cool air moving downslope, which may rush like a torrent at times. Such glacier winds are generally thin, extending only a few hundred feet above the land, but the cold temperatures they bring to the places downwind can make them inhospitable indeed.

In the eastern and central Himalaya, most precipitation falls in the summer, and overall the amount declines with altitude at elevations above 2,000 meters. The relatively low amount of rainfall received at the higher elevations partially explains why the glaciers there are not as vast as one might imagine. Their formation suggests they are fed mainly by avalanches dropping snow from the peaks above, and not directly by precipitation. In the western Himalaya and in the adjoining Karakoram Range, however, we find some of the world's largest glaciers, and their presence is attributed to the local topography, with its large basins, as well as to the fact that the western sectors of the High Himalaya receive considerably more precipitation from winter storms tracking from the west and producing locally severe snowfalls. The significance of the winter storms tapers off toward the east and is limited to only the highest summits in eastern Nepal, Bhutan, and Arunachal Pradesh.

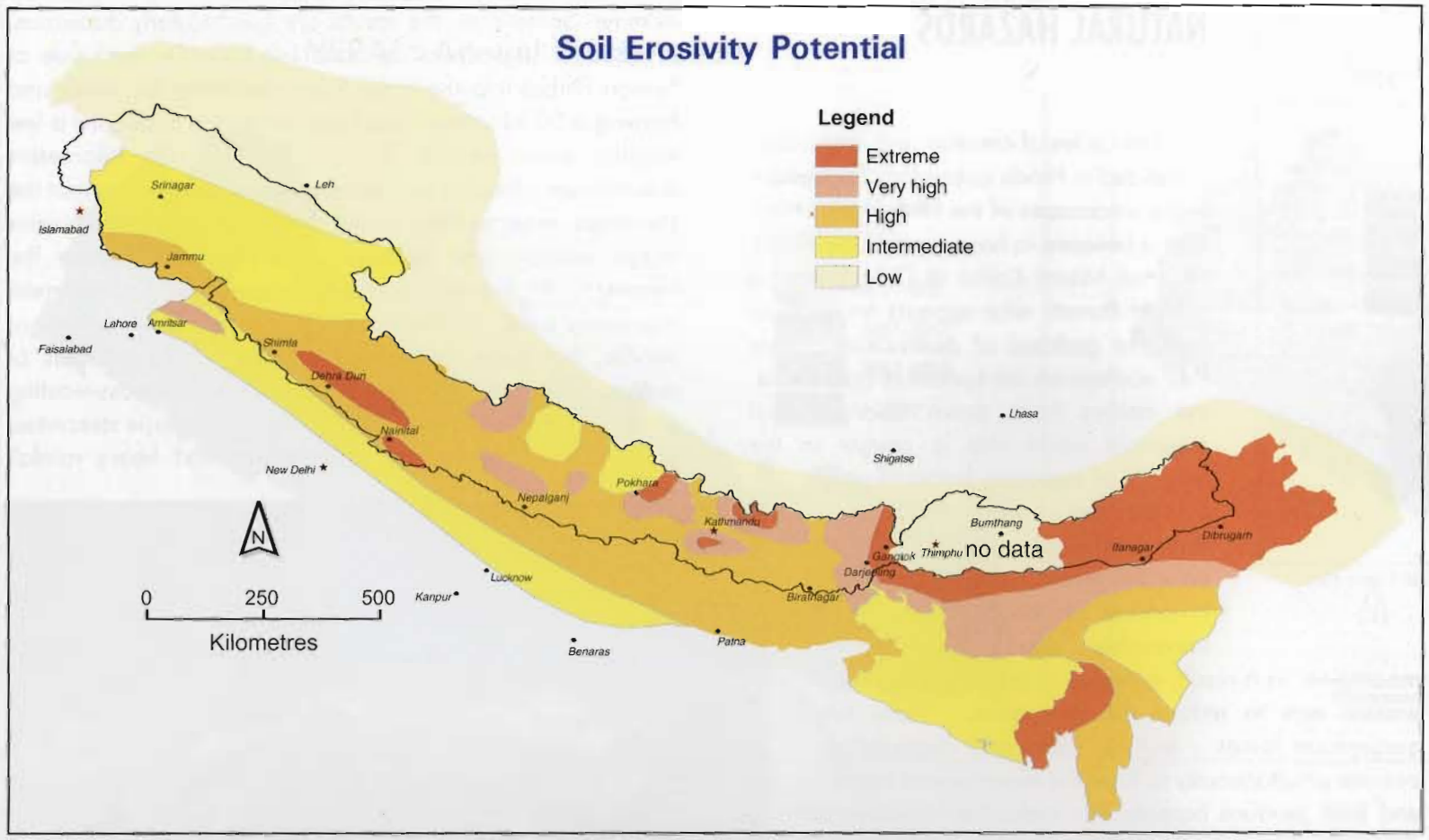
NATURAL HAZARDS

The cycles of creation and destruction imbedded in Hindu cosmology find refrain in the landscapes of the Himalaya. Shiva, who is believed to have created the world, sits atop Mount Kailas (6,714m) with his consort Parvati, who appears on earth as Kali, the goddess of destruction. From their vantage on the summit of holy Kailas, the deities look down upon a vast mountain world that is caught in the balance of opposing forces of uplift and erosion. India continues to drift northward, pushing against Asia, the thrust sheets that form the basement of the Himalaya grind inexorably upward, and the mountains, as a result, continue to grow. All the while erosion acts to reduce the mountains. These two gargantuan forces - tectonic uplift and degradation- operate simultaneously to form the mountainous terrain, and both produce hazards that make the Himalaya a dangerous place to live. In some cases, the natural hazards are cataclysmic events - raging floods, glacial lake outbursts, earthquakes, landslides; at other times they are slow and insidious, such as the annual loss of soil by erosion, which renders agricultural fields less productive and threatens the stability of farm structures. By many accounts, the activities of man have contributed further instability to the Himalayan environment by clearing forests, building roads, and settling in disaster-prone areas. But the degradation caused by humankind, however significant for the society of man, pales against the enormous power of natural events in the Himalaya.

Geologists refer to mountains as 'high energy' environments because they contain an enormous potential for such kinetic events as mass wasting, earthquakes, and floods. Mass wasting refers to earth debris that is dislodged in a single, momentous action, such as a landslide. It is a natural phenomenon in the Himalaya, the dominant process in the formation of mountain slopes, and is common in the most geologically active zones and where precipitation is extreme. Sometimes, the results are spectacularly disastrous. In 1841 a huge chunk of earth fell from the west side of Nanga Parbat into the Indus River, damming the water and forming a 50-kilometer long lake. When the dam burst a few months later, people died in floods 150 kilometers downstream. Smaller landslides are common throughout the Himalaya, most notable during the monsoon when the rains trigger erosion and landslips, and the scars appear the freshest. In certain localities, where the land is most intensively used, landslides are produced by the actions of people, but these generally are secondary to the acts of nature. Many factors are involved in the mass-wasting process, including rock type and weathering, slope steepness, presence of fractures and sheer stress, and heavy rainfall

Pradeep Mool

Tsho Rolpa glacial lake dammed by 150m high moraine, October 2000



Source: Adapted from Lauterburg, A., 1993. The Himalayan Highland-Lowland Interactive System: Do Land Use Changes in the Mountains Effect the Plains? In Messerli, B., Hofer, T., and Wymann S., (eds.), 1993. Himalayan Environment: Pressure-Problems-Processes. Berne: University of Berne, Institute of Geography

Soil Erosivity Potential: *The kinetic energy of rainfall acting upon soils of different types results in a soil erosivity potential. This generally increases in the Himalaya from west to east, following precipitation gradients, and is greatest along the southern flanks of the mountains. Local conditions of climate and soil, along with land cover management, will produce actual rates of soil erosion.*

which can activate landslides. Where people disturb the slopes in major ways, for example by building roads and dams, often the occurrence of landslides is accelerated.

A special kind of mass wasting occurs at high elevations in the Himalaya when natural dams formed by glacial debris break loose and allow the impounded waters of the highland lakes to flood downstream. During the past half century a rapid melting of the glaciers has created a large number of glacial lakes, which are dammed by the terminal moraines of retreating glaciers. The dams are composed of loose till and unconsolidated rock and thus are easily breached when the force of the impounded water becomes too great or when a seismic disturbance disrupts the structure. The sudden release of water is called a 'glacial lake outburst flood' (GLOF). The most famous of such events in the Himalaya occurred over 600 years ago in Nepal, when a 10 square-kilometer glacial lake located behind Mt. Machhapuchhre burst and surged into the Pokhara Valley, raising the floor of the valley with over five cubic kilometers of glacial debris. More recently in 1985, a moraine-dammed lake at the terminal of the Langmoche Glacier burst above Namche Bazaar in the Mt. Everest region. A huge chunk of ice dropped from a nearby summit into the lake, causing a tidal surge that broke through the moraine dam, releasing the lake water into the Bhote Koshi River. The flash flood raged downstream 40 kilometers, destroying farm land, 30 houses, 14 bridges, and a hydro-electric power plant. This event sparked concern throughout the Himalaya about the hazardous potential of glacial lake outbursts, and recent studies have identified numerous dangerous lakes throughout the region, including 27 in Nepal alone.

Severe soil erosion and gullies threaten farm land in western Nepal.

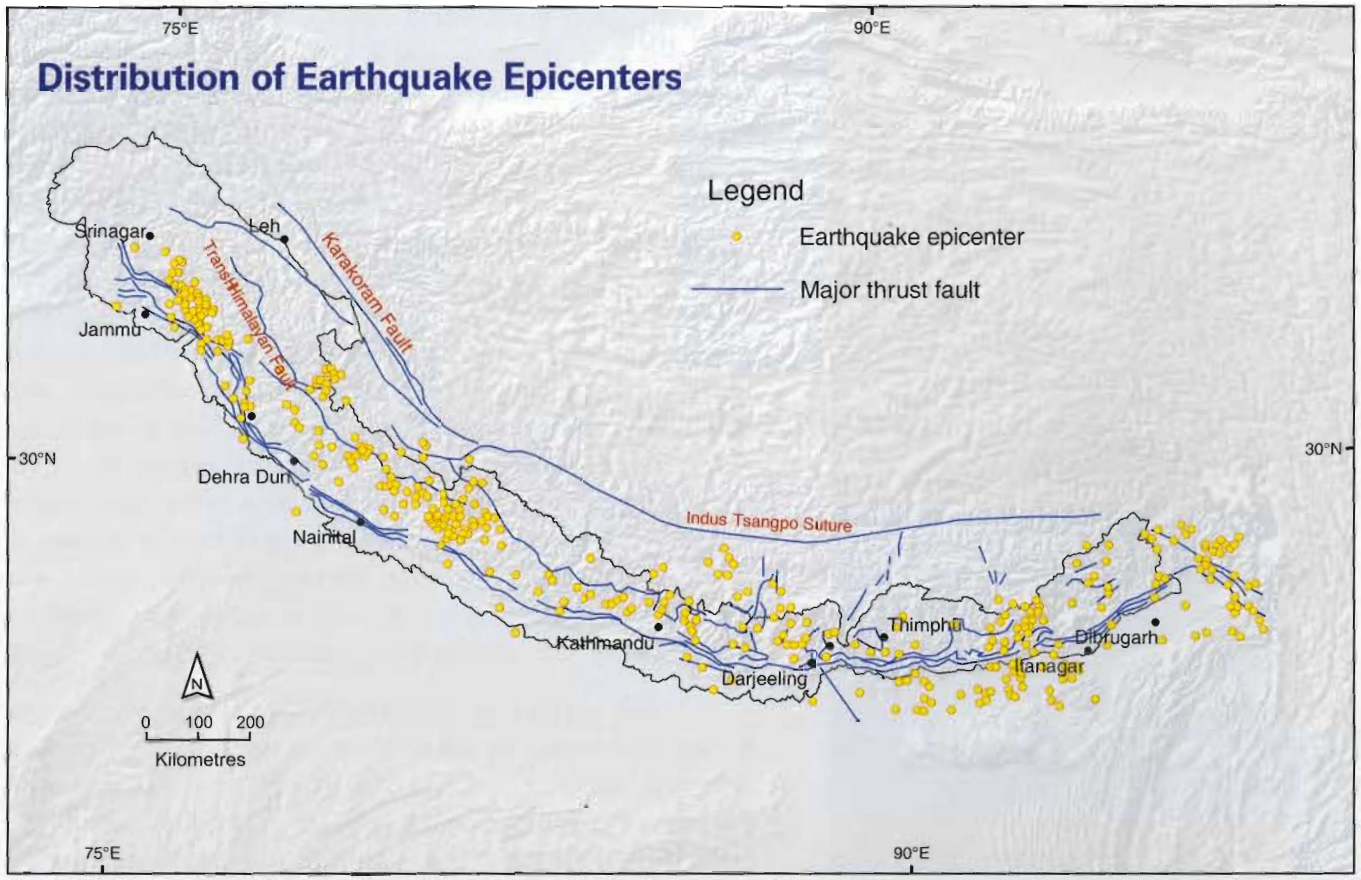
Himalayan roads constantly face the danger of landslides. Here, a 100-meter section of road in Lahaul district slipped away, causing vehicular traffic to detour over 500 kilometers.

A landslide triggered by heavy monsoon rains carried away farmland, homes, and a section of a mountain trail in Sikha, central Himalaya.

The seismic hazard of the Himalaya produces the ever-present danger of earthquakes. They are a fact of life in the region and an almost daily occurrence. Eight major earthquakes measuring over 7.5 on the Richter scale have occurred in the Himalaya in the past century. And it does not take an earthquake that large to be disastrous. In 1991, an earthquake measuring 6.1 on the Richter scale struck the Garhwal region, killing over 1,000 persons, destroying 30,000 homes and ruining bridges and roads in a 60 km. radius. In Nepal alone more than a thousand earthquakes ranging from 2 to 5 on the Richter scale are recorded every year. It is estimated that a truly big earthquake strikes the kingdom every 75 years, with the last one occurring in the Kathmandu Valley in 1934. The 1934 earthquake killed more than 10,000 people. It has been troublingly quiet during the last decades of the 20th century, which means that a great deal of tectonic pressure is building, and current earthquake forecasts predict that a major event of catastrophic consequence will likely strike the Himalaya within the next 50 years. If it were to center again on Kathmandu, the consequences would be disastrous for the city. With an unstable sedimentary floor and poorly-constructed buildings, Kathmandu ranks among the world's most vulnerable places for an earthquake disaster. Earthquake risk studies predict that such a tremour would result in over 60% of the city's buildings destroyed and more than 135,000 human casualties.

Seismic disturbances in the Himalaya may trigger sudden floods from burst lakes, whose effects, although disastrous, are generallly contained by the river valleys below the lakes. More widespread flooding occurs as a result of the heavy monsoon rains and the high sediment loads carried by the rivers during periods of peak discharge. The river sediments, originating mainly from natural mass wasting upstream, clog the lowland rivers and flood plains, silt up reservoirs and irrigation canals, and cause changes in river channels. Accelerated human population growth, forest clearing, and livestock grazing also contribute to higher erosion rates, which result in the loss of topsoil on cultivated lands and a decline in land productivity, as well as increases in downstream sediment loads in rivers. Overall, the erosion damage caused by people is most pronounced in the localities where it occurs, and its contribution to regional flooding is minor compared to the natural rates of erosion. Nonetheless, widespread concern exists among lowland societies who allege that the destructive activities of people living in the highlands produce the extreme floods that plague life in the Himalayan foothills and adjoining plains. The catastrophic floods in the Ganges Plain actually result from a mixture of factors: The region's high and intense monsoon rainfall and the fact that more people are living in flood-prone areas, as well as heavy sediment loads of mountain rivers.

The spectacular character of the physical environment of the Himalaya, its remarkable topography and climatic extremes, are facts of nature. Geological uplift has produced the highest mountains in the world and some of the planet's most rugged terrain. The monsoon climate, in association with the mountainous terrain, forms some of the wettest places on earth. Together, they produce a landscape of massive scale and of extreme physical events. The hazardous nature of the Himalayan environment, its propensity towards cataclysmic events such as earthquakes, landslides, and floods, make the mountains a dangerous place to live. Himalayan societies have long understood these dangers and have developed ingenious ways of coping with instability in their alpine worlds. As a result, the cultures we find in the range are every bit as diverse as the mountain environment itself. The trick to living in the Himalaya has always been to make good use of the natural resources it provides. Villagers use the alpine landscape intensively in their daily tasks of subsistence living. And nowadays the mountains are looked upon by the Himalayan nations and societies as a frontier for new, large-scale economic development. The challenge at hand is to insure that the natural resources of the Himalaya meet both needs in a sustainable future.



Source: Adapted from Gaur, V. K. (ed.), 1993. Earthquake Hazard and Large Dams in the Himalaya. New Delhi: INTACH

Distribution of Earthquake Epicenters: *The steady uplift of the Himalaya results in seismic hazards, including earthquakes. Minor earthquakes occur on a daily basis in the range, and major ones (>8.0 Richter scale) occur about every 75 years. The map shows the locations of the epicenters (marked by yellow circles) of the important earthquakes in the Himalaya during the past century.*

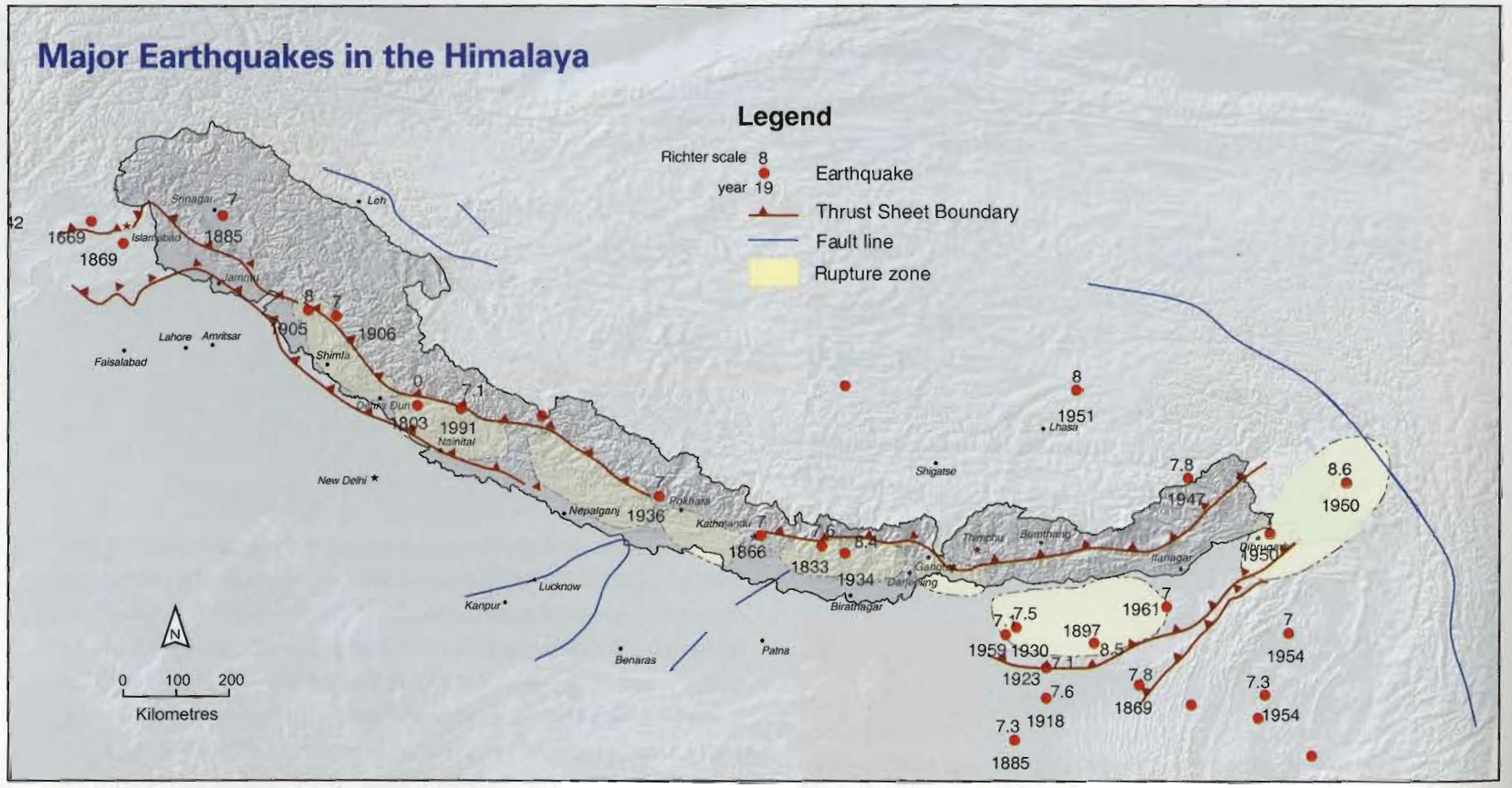
Pradeep Mool

Damage to the Dharan Dhankuta road by 21 August 1988 earthquake, Nepal

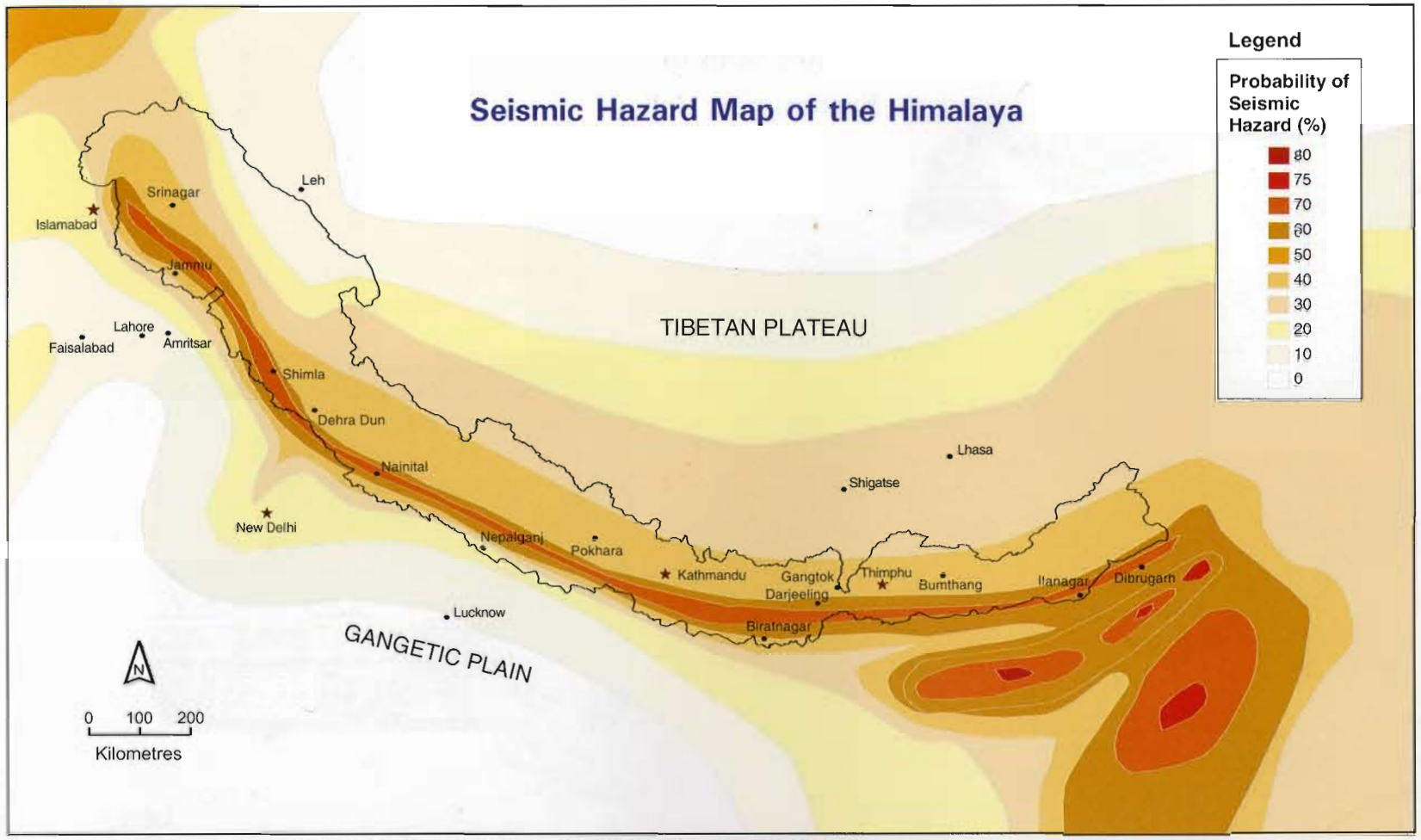
Pradeep Mool

21 August 1988 earthquake, Bhaktapur, Nepal

Major Earthquakes in the Himalaya: *The red dots on this map signify the epicenters of major earthquakes. Each dot is accompanied by the date of occurrence and its strength (Richter scale measures). Note the correspondence of earthquakes with the locations of major fault lines and thrust sheet boundaries. These axes are the most earthquake prone regions in the Himalaya.*



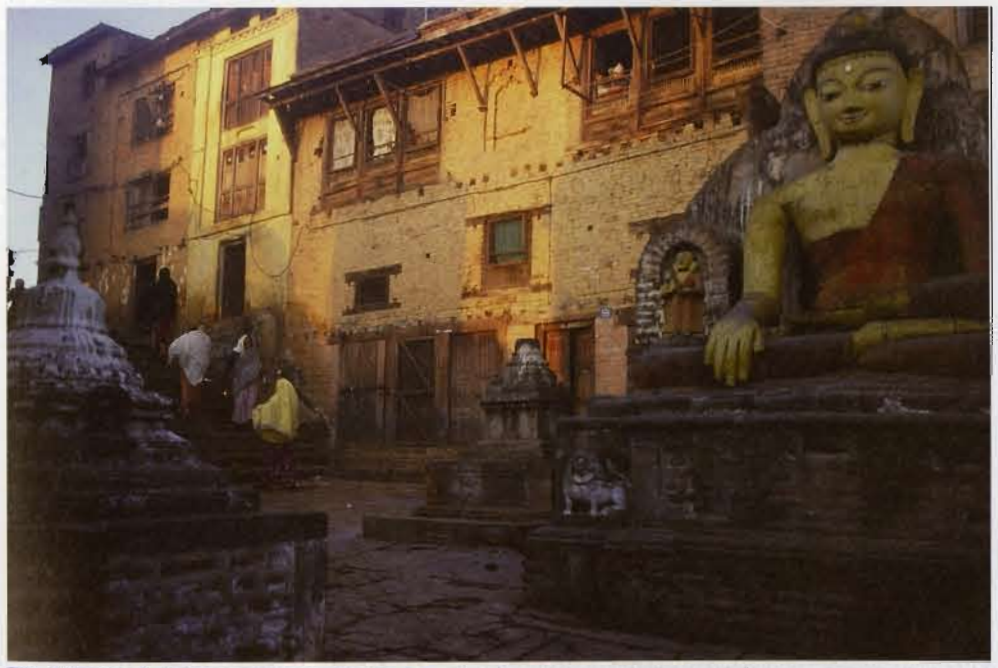
Source: Adapted from Gaur, V. K. (ed.), 1993. Earthquake Hazard and Large Dams in the Himalaya. New Delhi: INTACH



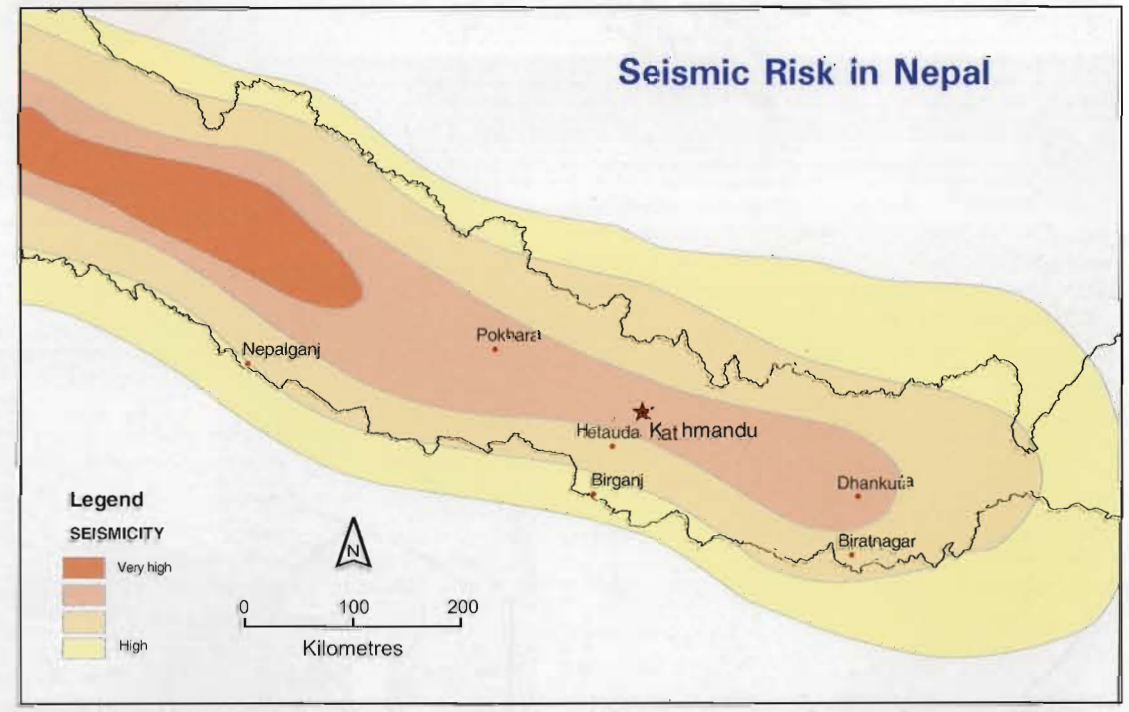
Source: *Adapted from Gaur, V. K. (ed.), 1993. Earthquake Hazard and Large Dams in the Himalaya. New Delhi: INTACH*

Seismic Hazard Map of the Himalaya: *The areas of highest hazard probability occur along the axes of the major tectonic structures, mainly in the southern reaches of the Lower Himalaya and in the Siwalik foothill zone.*

Seismic Risk in Nepal: *With almost daily occurrences of small seismic tremors, and a large earthquake about every 75 years, the tectonic risk in Nepal is high. It is concentrated in the central and western zones, in a belt that includes the most populated regions of the country. Geologists predict that the next major earthquake (greater than 8.0 on the Richter Scale) will occur by the year A.D. 2050.*

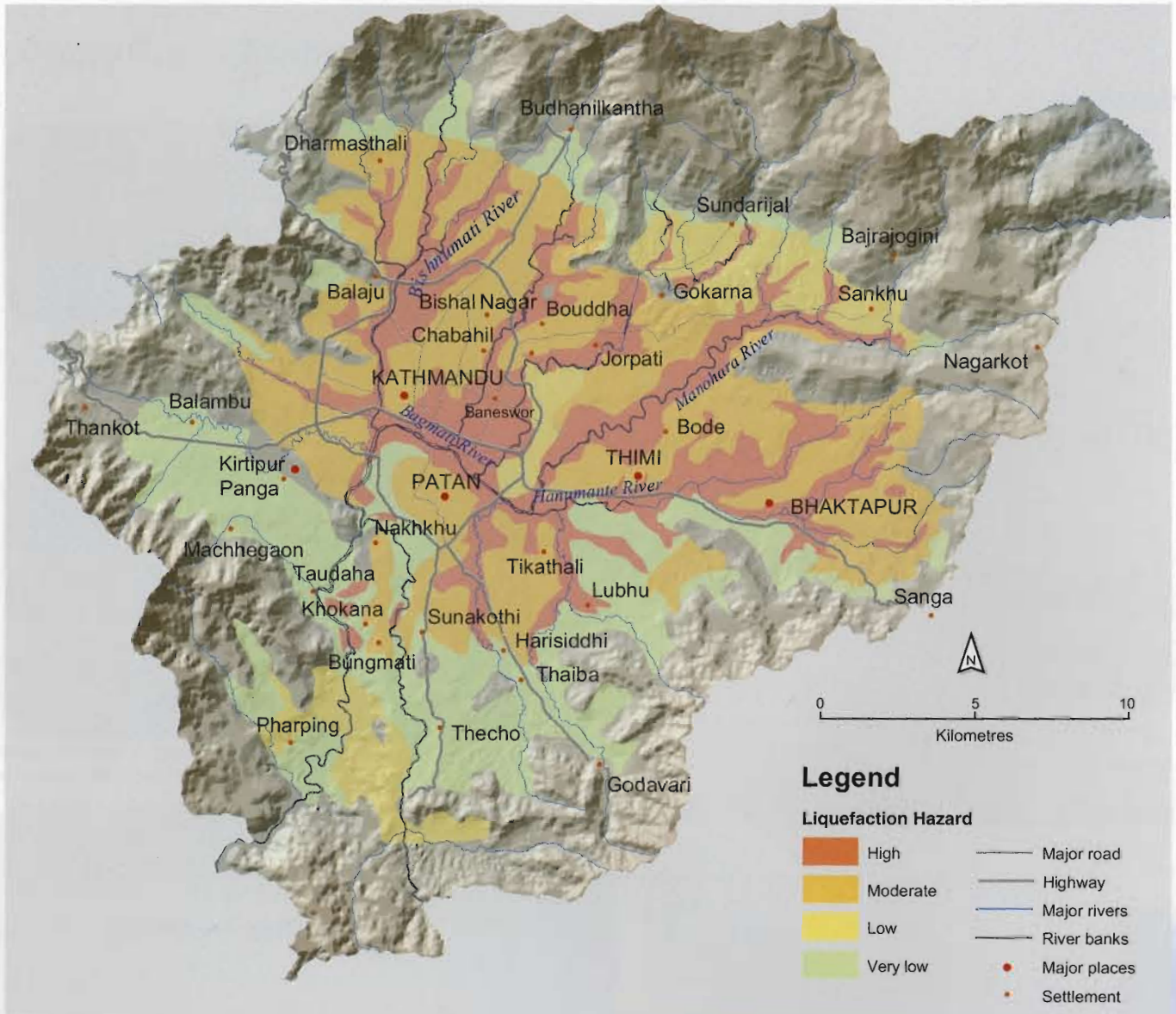


The historical buildings of Kathmandu have survived earthquakes in the past, but are at risk in the event of future seismic events.



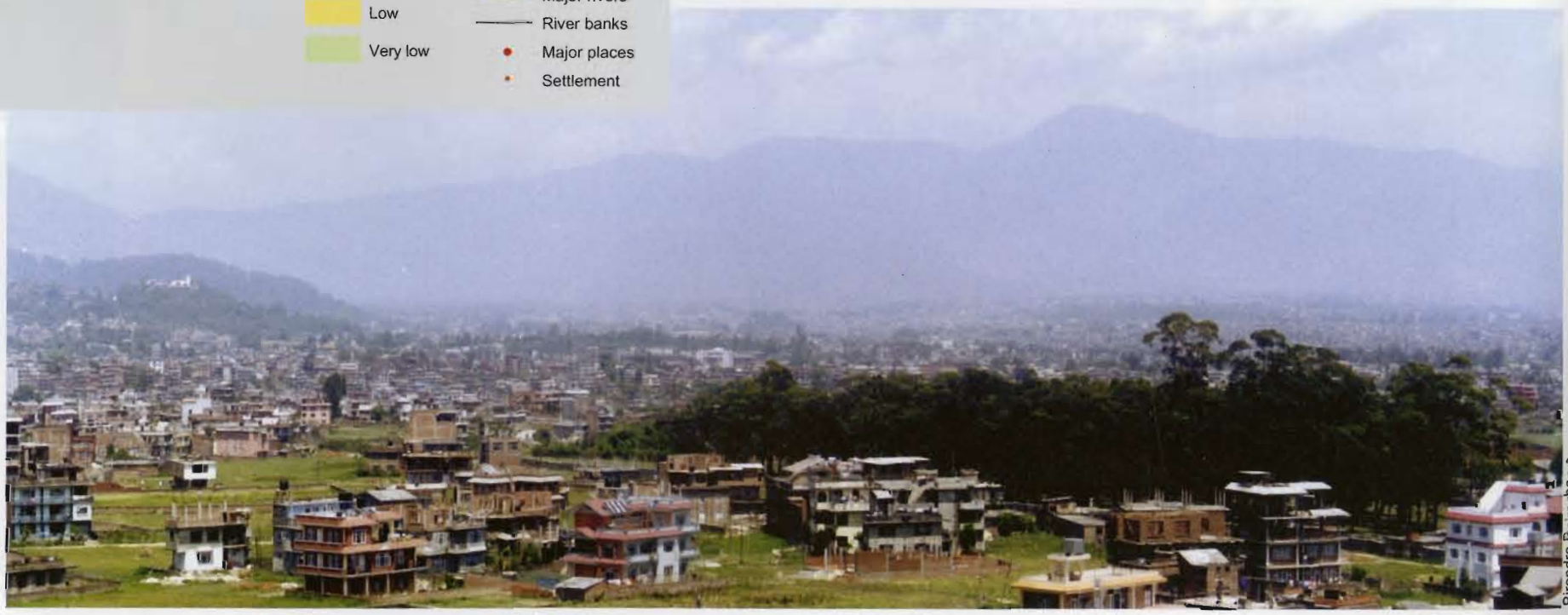
Source: *Adapted from United Nations Disaster Management Team, 2001. Nepal: UN Disaster Response Preparedness Plan, Part I. Kathmandu: The United Nations System*

Hazard Map of Kathmandu Valley



Liquefaction Hazard Map of Kathmandu Valley: *The Nepalese capital of Kathmandu sits in a valley where ancient lake sediments make up the valley floor. These materials move a great deal with seismic disturbance, with the ground literally liquefying under severe shaking. The damage to human life and structures are likely to be great in the case of a severe earthquake since the vast majority of buildings in Kathmandu are not engineered to withstand this kind of stress.*

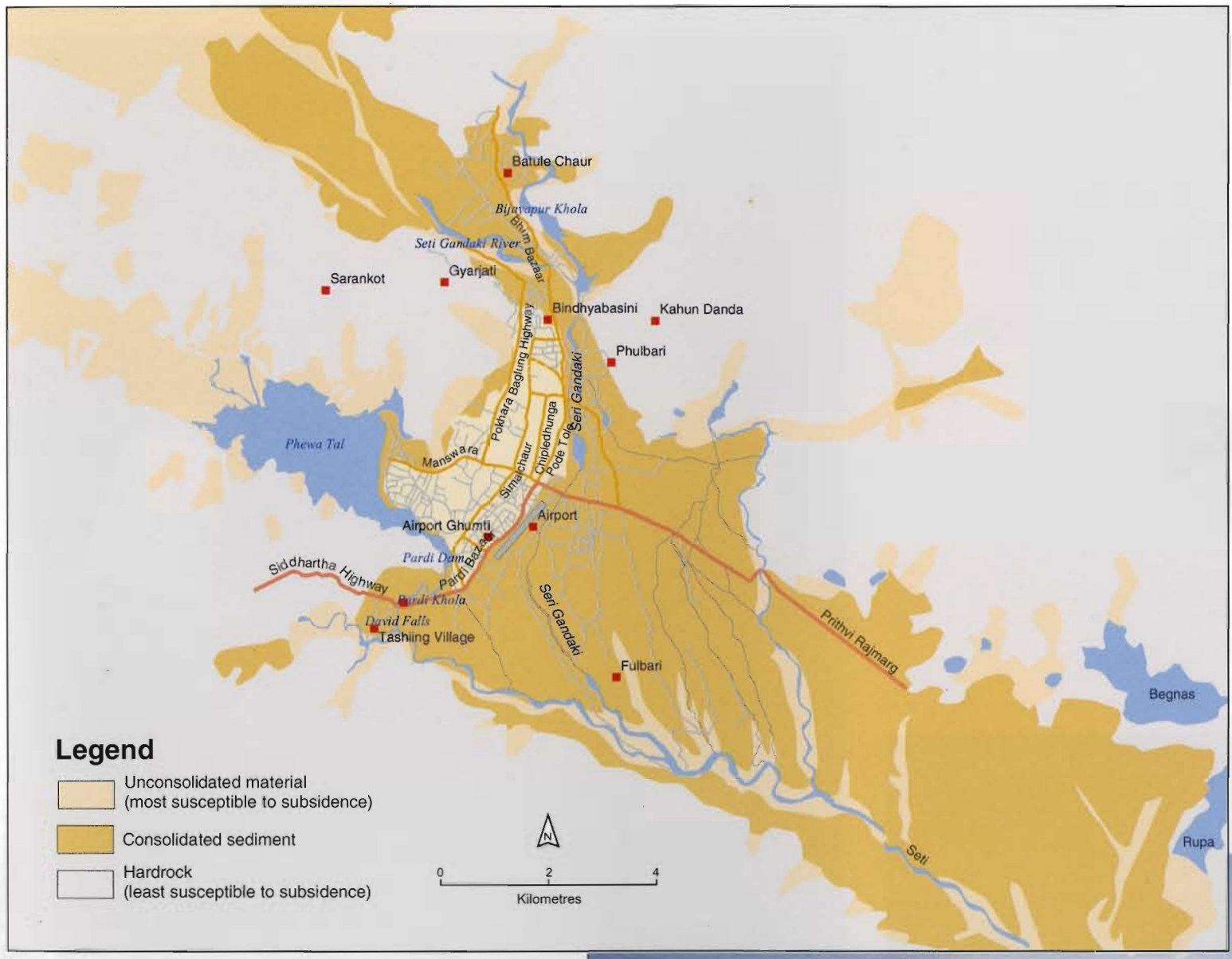
Source: Adapted from Engineering and Environmental Geology Map of the Kathmandu Valley, prepared by Department of Mines and Geology, Kathmandu (with data from HMG Dept. of Hydrology and Meteorology; HMG Ministry of Housing and Physical Planning; HMG Department of Forestry).



Birendra Bajracharya

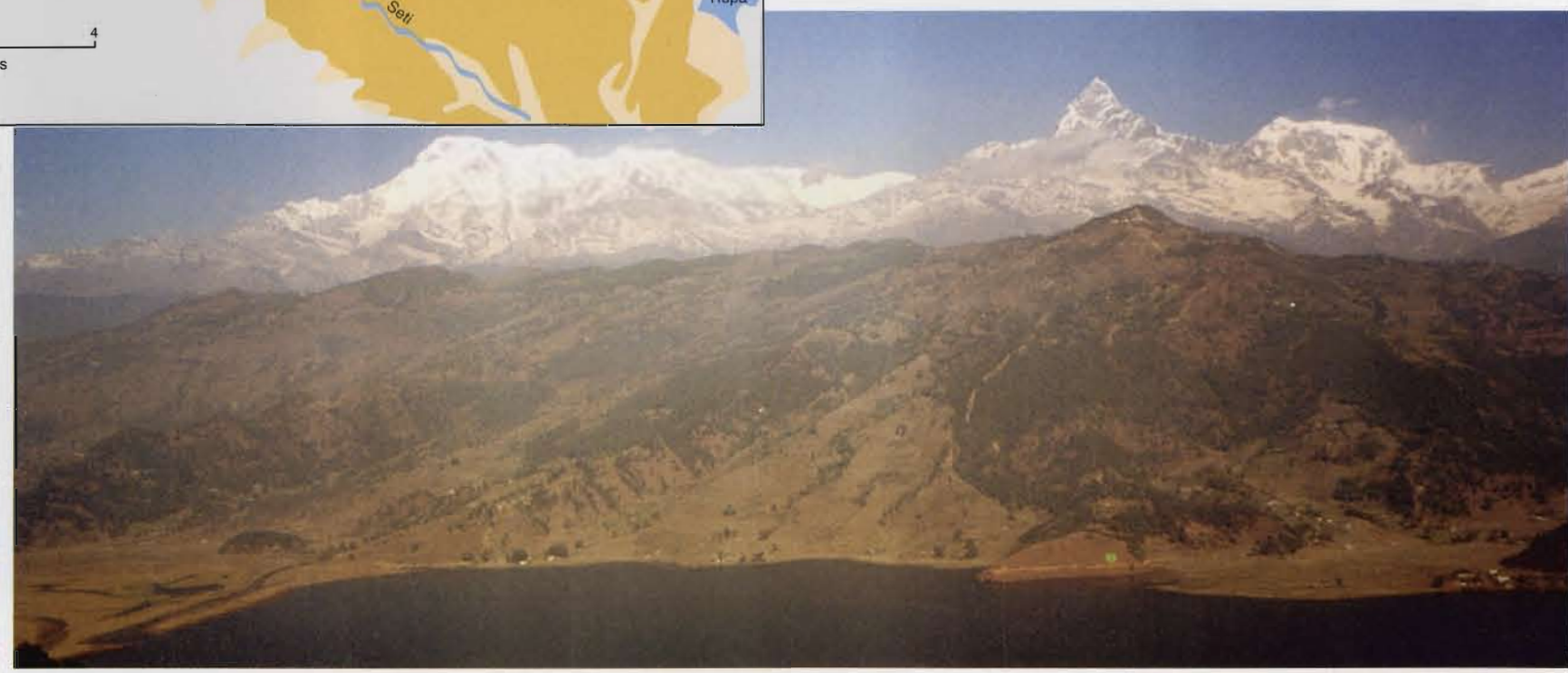
Rapid and unplanned growth in the Kathmandu Valley has increased vulnerability to natural disasters

Hazard Map of Pokhara Valley



Source: Adapted from Engineering and Environmental Geology Map of the Pokhara Valley, prepared by Department of Mines and Geology, Kathmandu (with data from HMG Dept. of Hydrology and Meteorology; HMG Ministry of Housing and Physical Planning; HMG Department of Forestry).

Hazard Map of Pokhara: *Nepal's fourth largest city, Pokhara (187,491 population estimate; 2001 Census), sits alongside the Phewa Tal lake and expands into the adjoining areas of the Pokhara Valley. Much of the Valley is comprised of unconsolidated materials and consolidated sediments, both of which have a large hazard potential for subsidence, rock falls, gully erosion, and flooding. This results in the regular occurence of road blockages, bridge washouts, and water-logged farm fields. The engineering requirements to overcome the hazards are costly and not always effective.*



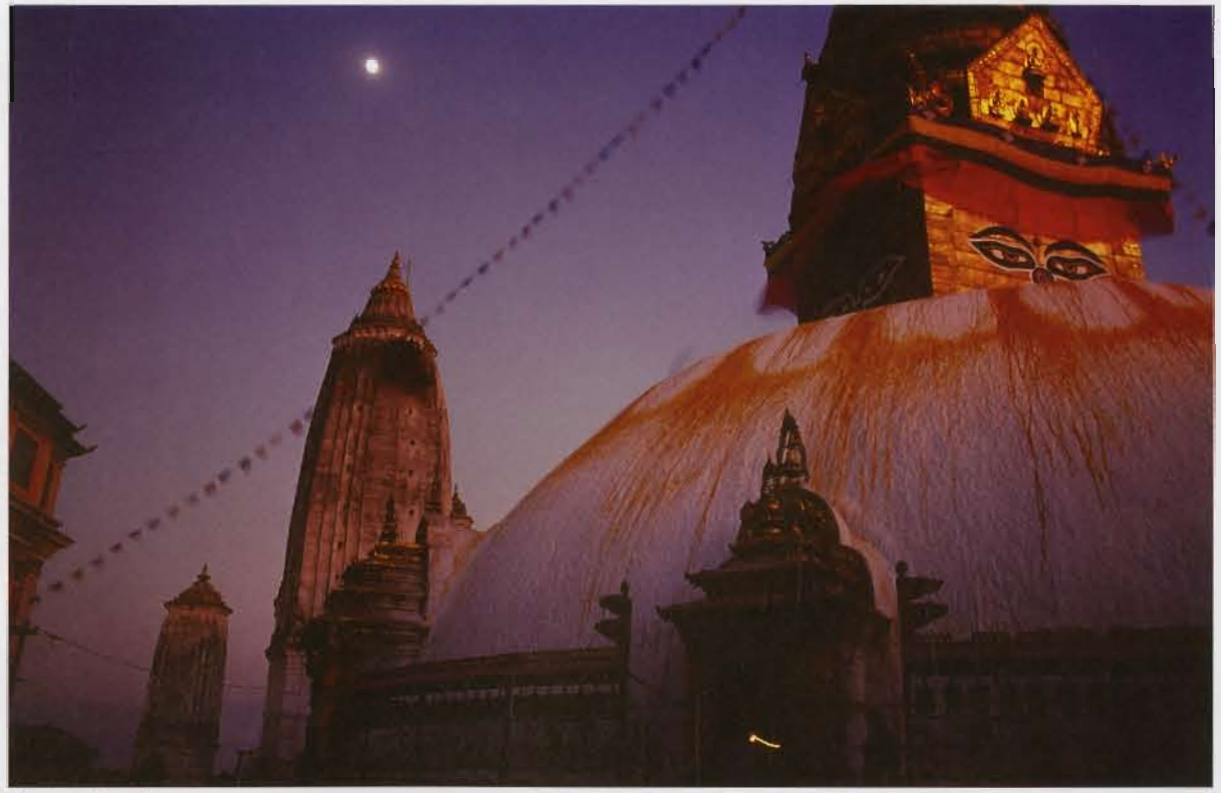
Phewa Lake with Annapurna range in the background, Pokhara Valley

Birendra Bajracharya

Bhotia woman

Part Three

Society



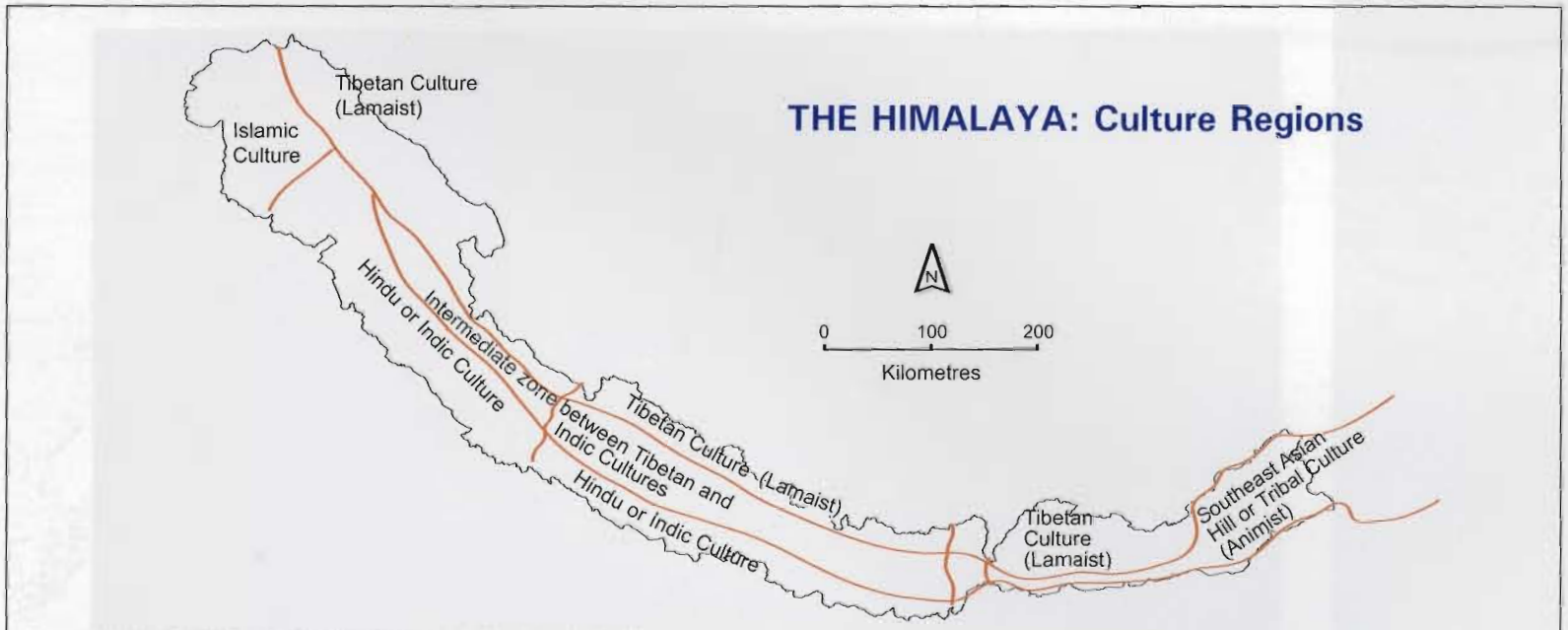
Swayambhu Stupa

The Himalaya hold the religious and cultural traditions of Hindu, Buddhist, and Islamic civilizations, as well as of numerous tribes and ethnic groups. A meeting of spirit and material subsistence exists within these diverse societies, defining a traditional order for mountain life. It has led to the devout character of the Himalayan people, to the design of local communities, and to the establishment of historical theocracies in the mountains. It permits the distinctive cultural patterns and an astonishing array of lifestyles; and it shapes a landscape in which the textures of human society are interwoven in a traditional world of sacred places and powerful natural forces. But the demands of modern times and global trends have become dominant in many localities, instilling new forms of social organization and forging new appraisals of life that may create conflict as well as provide opportunity among the mountain communities. In this ever-changing world, Himalayan societies struggle between tradition and modernity.

The ancient religious books of India date the settlement of the Himalaya to the early Vedic times, before the age of Christ, although little is known about the actual origins of the initial inhabitants. The early chroniclers infused the mountains with a mythological outlook. The deity Shiva is believed to reside atop Mount Kailas, which is sacred to both Hindus and Buddhists, and many of the Himalayan peaks are the abodes of other deities. The Himalayan rivers, especially the Ganges, are revered as powerful spiritual places, and devout practitioners commonly make pilgrimages to their headwaters. The great rivers delimit a sacred geography that shows the Himalaya to be a truly celestial realm, within which native people find a spiritual order and guidance for life.

The religious bond that mountain cultures traditionally have with the mountains is manifested in the magnificent structures of the Hindus, Buddhists, and Muslims, in the ceremonial markers that everywhere adorn the landscape, and in the religious propitiations of people throughout the mountains. The Hindus understand the Himalaya to be the northern boundary of sacred India, or Bharatavarsha, just as the modern geologists consider it to be the tectonic delimitation of the subcontinent. The Buddhists, too, view the mountains as sanctified land, containing treasure places of legendary power - containing a kind of knowledge that is fit only for those with the proper spiritual training. In the Indus Mountains in the west, the Muslims lay claim to long-held cultural territory that holds their religious history, mosques, and ancestral places. The animistic traditions of tribal people all across the range find spiritual resonance among the summits and valleys, caves, forests, and rocky outcrops, which harbor deities of both good and bad intention. These diverse religious beliefs imbed the mountains within the cultural histories of the resident people, thus creating a native geography that ultimately affirms the territorial rights and obligations of Himalayan societies.

A painting at the entrance of a Buddhist monastery, Sermathang village



Source: Adapted from Ives, J.D. and Messerli, B., 1989. The Himalayan Dilemma. New York: Routledge

Culture Regions in the Himalaya: *Three major civilizations converge in the Himalaya. Tibetan culture, based upon Lamaistic Buddhism, is dominant in the high elevation zone and in the northern tier of the range. Indic culture, practicing Hinduism, diffused northward from India and predominates in the southern tier of the range and among the lower elevations. Islam is found in the westernmost sector of the Himalaya. The high degree of cultural diversity produced by the convergence of these major civilizations is further augmented by the numerous tribal traditions found throughout the mountains.*

Himalayan Trade Routes: *The historical Silk Road in China was connected with the Grand Trunk Road in South Asia via a series of routes south through the western Himalaya, mainly along the Indus Valley. Subsidiary Himalayan trade routes connected Tibet and India for the purpose of the salt and grain trade, as well as for the exchange of other products. Many of these caravan routes followed the river valleys through the mountains, and several of them remain important trading routes today*

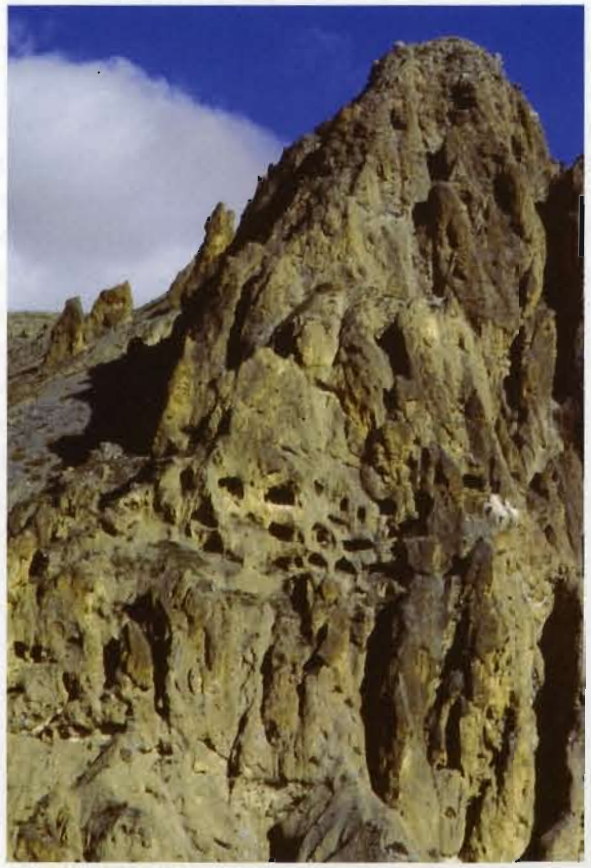
Source: Adapted from Zurick, D. and Karan P.P., 1999. Himalaya: Life on the Edge of the World. Baltimore: Johns Hopkins University Press

EARLY CIVILIZATION

The western Himalaya witnessed the migration of Aryan people as early as 2000 B.C., most likely from the steppes of central Asia. The Aryans settled the Indus Mountains in Kashmir before moving onto the plains of northern India. Little is known about the people they conquered, but the linguistic evidence suggests that the earliest tribes most likely originated in the far-off Dravidian societies of southern India. They lived autonomously in the mountains by hunting and gathering, possibly supplemented by slash and burn agriculture, before being conquered by the Aryans. An Indo-Aryan civilization emerged in the period 2000-1200 B.C., as chronicled in the Aryan text, the Rig Veda. The later societies of the western and central Himalaya are documented in the Sanskrit literature of the Puranas and Mahabharata. These accounts describe a process of acculturation between the people of the mountains and the plains, most notably during the time of the Khasa people, when Hindu traits were assimilated into highland tribal life. The consolidation of Hindu influence in the Himalaya occurred in the 15th and 16th centuries, when coalitions of Rajput principalities were established across the range. A dominant Pahari culture emerged in the central Himalaya.

The high altitude zone, meanwhile, was settled mainly from the north by Tibetan peoples. The 7th century witnessed the geographic expansion of Tibetan society into the western Himalaya, where it became dominant in Ladakh and Zanskar. The Tibetan Empire reached its zenith during this period, extending as far east as Turkestan, and formed the influential Ladakhi dynasty as a vassal state. The Tibetan forces also invaded the central Himalaya, and by A.D. 640

The fortress of Phalabang, western Nepal



Hard-to-reach meditation caves in the predominantly Buddhist trans-Himalaya zone – For the Tibetans, the Himalaya are filled with places of sacred power and spiritual insight

took control of much of Nepal as far south as the Kathmandu Valley. A series of Tibetan feudal states was established in the trans-Himalayan valleys, notably in such places as Mustang, which continued as autonomous societies until fairly recent times. The Tibetan and Hindu influences intermingled most conspicuously in Nepal, where society today is marked by its unique syncretism of Tantric Buddhist and Hindu practices. The scattered tribes living in the eastern Himalaya, meanwhile, have retained much of their cultural autonomy and tribal traditions, residing largely outside the sphere of the major cultural invasions.

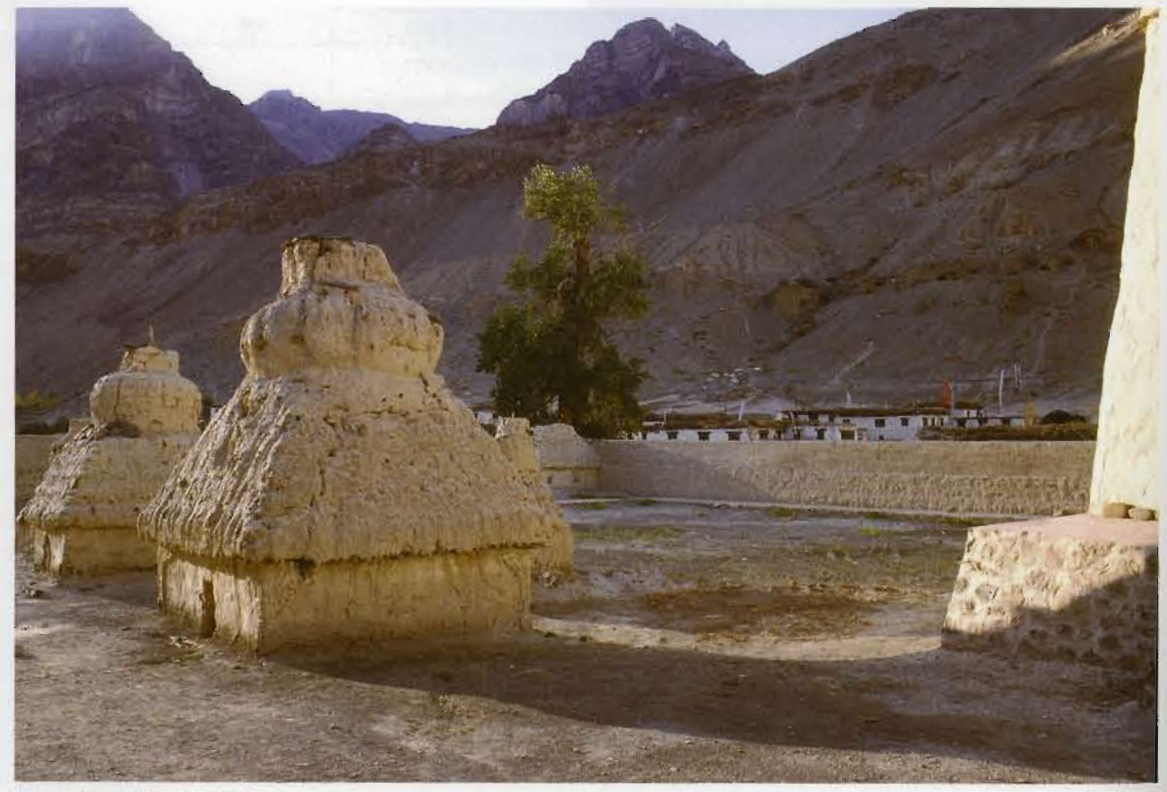
The medieval period in the Himalaya was marked by the consolidation of political power among the Hindu princes in the lower regions and of the Tibetan kingdoms in the northern mountains. Both subjugated the native populations, forcing villagers to produce crops, build infrastructure, maintain armies, and establish monuments and temples for the good of the petty kingdoms. Land taxes were introduced, and a rural aristocracy prospered amid widespread poverty. A monastic order was imposed in the areas under Tibetan control, which gave great power to the high-ranking religious clergy. In the Hindu areas, meanwhile, the local rajas governed as absolute sovereigns. In Nepal, the Hindu princes eventually succumbed to the expanding power of the king of Gorkha. The modern state of Nepal traces its origins to this Gorkha empire, which by 1815 had extended its territorial control across the Himalaya from Sikkim to Kangra.

The convergence of Hindu, Buddhist, and, in the west, Islamic, civilizations provides the cultural arena within which most Himalayan societies developed. The influence of these great traditions on mountain life are immeasurable, imbedded in religious beliefs, family and community organization, artistic and folk traditions, and economy and politics. Between the middle of the 19th century and 1947, when India gained its independence, Himalayan society was also greatly influenced by colonial powers. In what has in Asia come to be called the Great Game, much of the mountain territory was coveted and disputed by the British, Russian, and Chinese empires. Each sought the mountains for their own imperial gain. The influence of the British on mountain life was great, for they directly controlled large areas of the western and eastern Himalaya, and had much influence on the internal affairs of Nepal and Bhutan. The British sent surveyors into the mountains to chart and map the territory and to identify their economic potential in terms of forests, agriculture, and minerals. Numerous skirmishes occurred early on between the British forces and the armies of the Himalayan kings, notably in Bhutan, Nepal, and Sikkim, heightening tensions among the competing rulers.

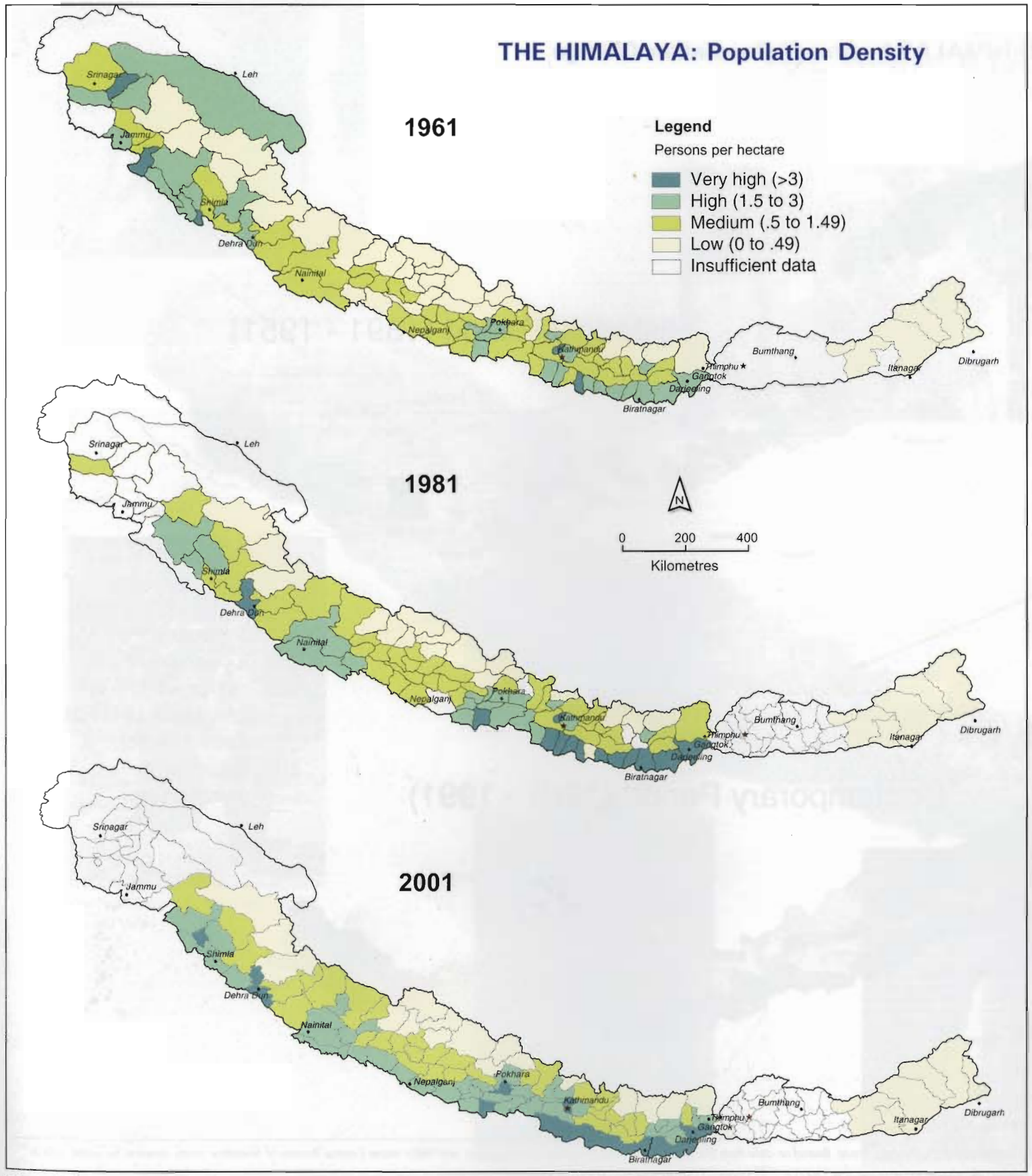
During their occupation of the mountains, the British opened up much of the range to colonial trade, drawing upon the traditional trade routes - especially the lucrative Silk Route - while also establishing new ones. Timber resources in the mountain forests were exploited, trees cut to provide materials for building railroads, and new regulations were imposed on villagers' use of forest reserves. The British introduced new forms of agriculture, notably the apple orchards in Himachal Pradesh and tea plantations in Darjeeling. Where the British did not control directly, they did so through their influence on the local rulers. Gradually, as the colonial resolve of the British firmed, society and economy in the mountains became oriented toward the southern plains and even abroad. This new outlook continued after the withdrawal of the British from South Asia in 1947, and the establishment of the modern nation states in the Himalaya. Today, the independent countries of Bhutan and Nepal, as well as the adjoining Indian Himalayan territories, struggle with the enormous challenge of bridging their pasts, including the colonial component, with their quests for a more prosperous future.

POPULATION

Among the dilemmas that modern Himalayan societies face are the impacts of the burgeoning population. The human numbers were kept in check during the early times by high mortality rates and by cultural practices, such as



The famous Chorten at Tabo, Spiti Valley, is over one thousand years old.



Source: Zurick, D. and Karan P.P., 1999. Himalaya: Life on the Edge of the World. Baltimore: Johns Hopkins University Press. Based on data from Census of India, HMG Nepal Central Bureau of Statistics, Government of Bhutan Census Report. Updated with information from various government censuses for 2000.

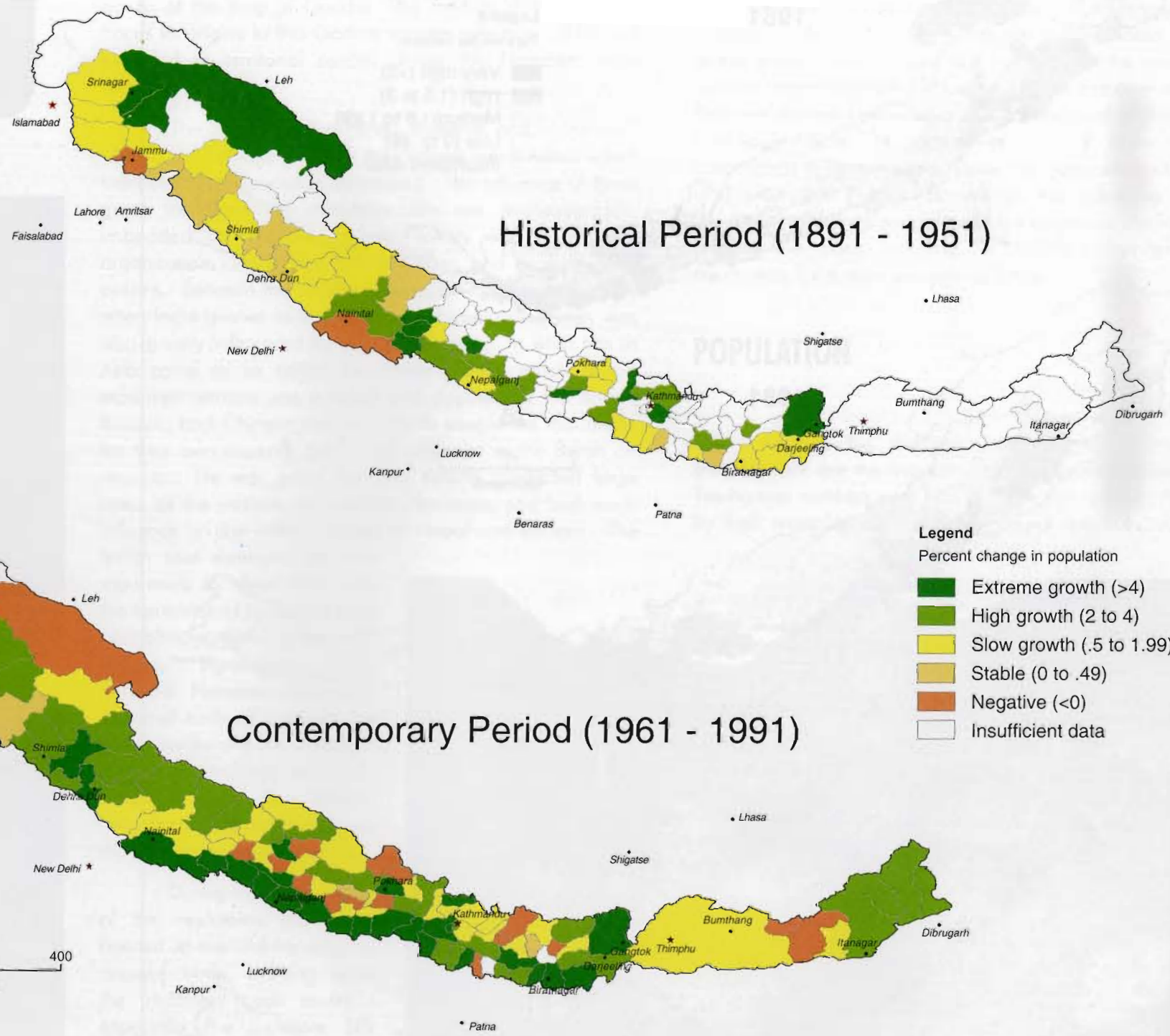
The Himalaya - Population Density: *The number of persons per square kilometer has increased along with overall population growth. This translates into increasing pressure on available farm land and forests, as well as on water resources. In the mountainous districts, where much of the land is taken up in slopes and is therefore not conducive to agriculture, the population densities become even more acute.*

A flat-roofed adobe is common among houses in Tibetan-dominated villages of the arid, trans-Himalaya zone.

Mud and thatch homes of a Tharu village in the lowlands

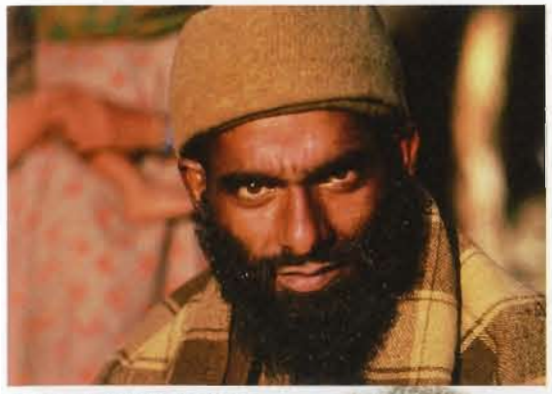
THE HIMALAYA: Annual Population Change

The Himalaya - Annual Population Change: *The historical period was a time of slow growth in the mountain population, with significant rates of growth reported in only a few scattered districts. The contemporary period corresponds to the phase of high population growth. Much of this is centered in the hills and Terai region of Nepal, where population growth rates in some districts exceed 4% per year. The high rates of growth in the lowlands are partially a result of migration.*



Source: Adapted from Zurick, D. and Karan P.P., 1999. Himalaya: Life on the Edge of the World. Baltimore: Johns Hopkins University Press. Based on data from the Census of India, India District Gazeteers, and HMG Nepal Central Bureau of Statistics (note: timeline for some data is less than total period).

THE HIMALAYA: Ethnic Groups



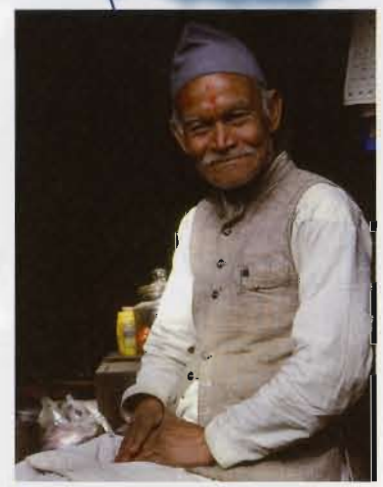
Bakarwal herder, Kashmir

Tibetan tribal women, Spiti

Gurung woman, Annapurna region

Garhwali women threshing wheat, Sangla Valley

Tharu farmer, western Terai



Newar shopkeeper, central Nepal

Drukpa girl, central Bhutan

Balti
Bakarwal
Ladakhi
Zanskari
Gaddi
Gujjar
Pahari
Bhotia
Buksa
Magar
Gurung
Tharu
Tharu
Tamang
Newar
Sherpa
Rai
Limbu
Lepcha
Santal
Drukpa
Sherdukpen
Monpa
Mismi
Nocte

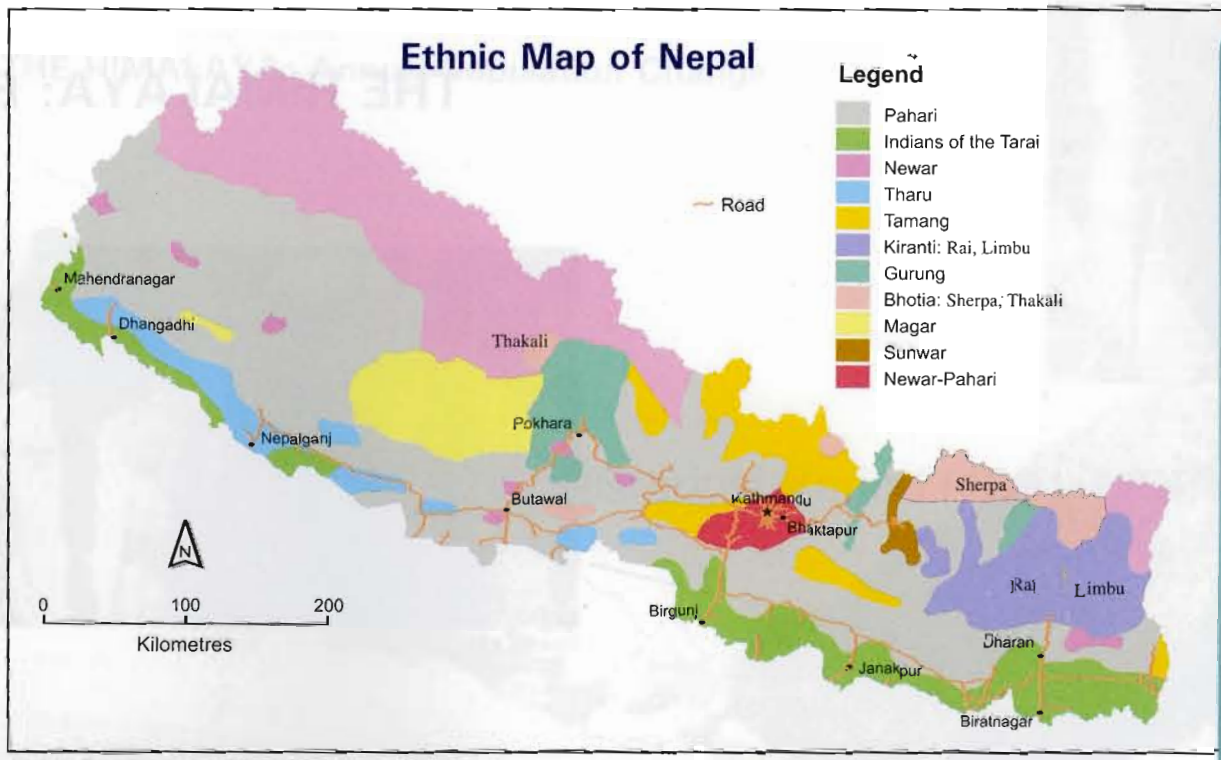
Source: Compiled by the authors from various sources.

polyandry that acted to limit family size. Beginning in the latter part of the 19th century, though, large gains were recorded in the numbers of people living in the mountain localities. Overall, an estimated 17 million persons resided in the Himalaya in 1891, based upon the first census in the mountains. By 1951, the population of the mountains reached 25 million, and by the beginning of the 21st century it surpassed 50 million. The steady increase in population between 1891 and 1951 occurred unevenly, with colonial hill stations, road corridors, and fertile agricultural zones recording the highest rates of growth. Much of the concern about the negative impact of population growth, though, centers on the events since 1951 when the largest increases in human numbers have been reported.

In the last half of the 20th century, more than 25 million people were added to the Himalayan landscape. Nepal witnessed some of the highest growth rates, with several of its districts reporting population increases at rates greater than four percent per year. The Indus Mountains, the lower elevations of Garhwal, and Sikkim exhibit very high rates of population increase. Across the range, and especially in Nepal, the highest rates of growth occur in the outer foothill zone where farmland is still available and in the cities, which are expanding at alarming rates due to in-migration from the countryside. The population of the combined territories in the Indian Himalaya is over 20 million. Nepal contains 23 million persons. Bhutan has two million inhabitants. The Indus region of northern Pakistan contributes an additional 4.3 million persons to the total. Important as they may be, the Himalayan population is more than simply demographic statistics. It is an extremely diverse collection of people of varied backgrounds. Maintaining this cultural diversity is one of the chief tasks at hand for the Himalayan states.

CULTURE AND ETHNICITY

With few exceptions, the ethnic diversity in the Himalaya is tied to specific geographic regions. The major religions of South Asia coalesce and maintain a unique expression in the western areas of Kashmir and Ladakh. The Indus mountains and the northern portion of Kashmir are Muslim areas, Ladakh retains its Tibetan Buddhist heritage, and the southern part of Kashmir and the adjoining areas of Himachal Pradesh are predominantly Hindu. The largest ethnic group in the Garhwal and Kumaon regions is the

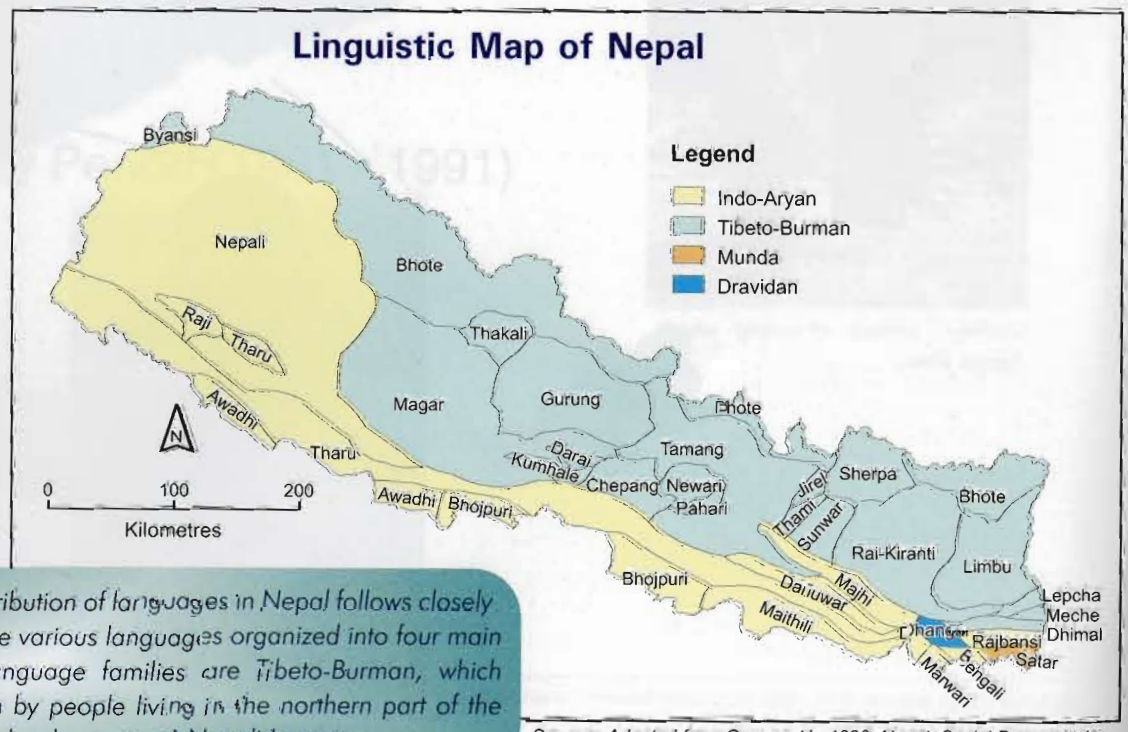


Source: Compiled by the authors from various sources

Ethnic Map of Nepal: *Nepal is one of the most culturally diverse places in the Himalaya, a result of the many tribal traditions in the kingdom, as well as of the convergence of Tibetan and Indic realms. The ethnic map of Nepal reflects the fact that the various tribes have long settled in specific territories. Many groups are associated with particular mountains. The Sherpas live in the shadow of Mt. Everest Mt. Everest, which they call Choma Lungma. The Gurungs live near Annapurna, and the Magars are found mainly along the southern flanks of Dhaulagiri. The main groups are located on the map, but there are numerous other small ethnic populations with their own languages, customs, and religious practices.*

'Pahari', a term often ascribed to hill dwellers in general. In fact, the Pahari culture itself contains a great deal of internal heterogeneity, with members of different castes ascribing to distinctive occupations and food taboos according to ritual status.

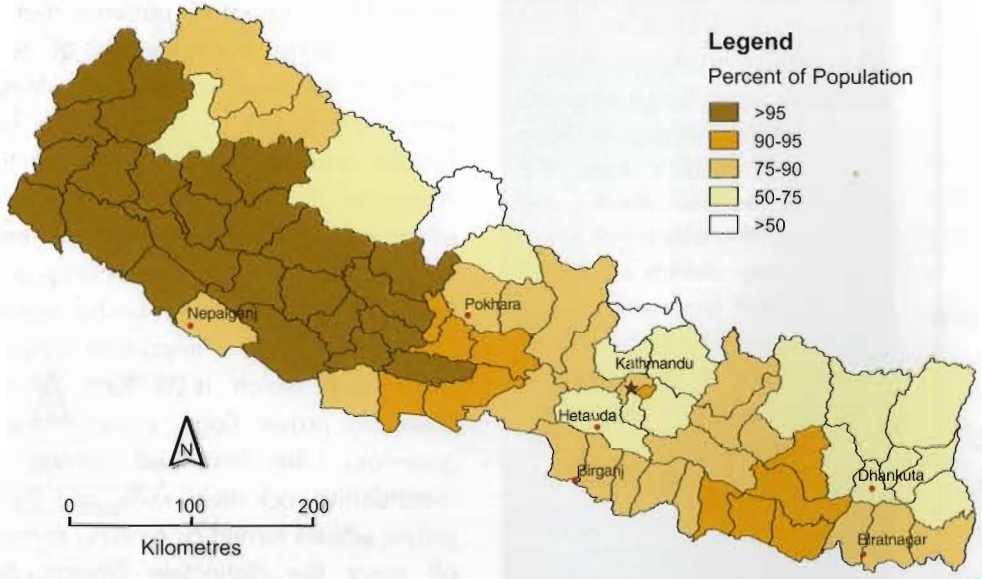
Nepal comprises perhaps the most remarkable mosaic of religion and ethnicity in the entire Himalaya. While Hinduism is dominant throughout Nepal's lowlands and middle hills, Buddhism prevails in the high elevations. Many places actually exhibit a Buddhist-Hindu syncretism, in which the religious practices, deities, and temples are shared by devotees of both traditions. Significant numbers of Muslims, meanwhile, reside in the Nepalese Terai. These are mainly immigrants whose origins lie in India. Altogether, Nepal contains 93 different ethnic and caste



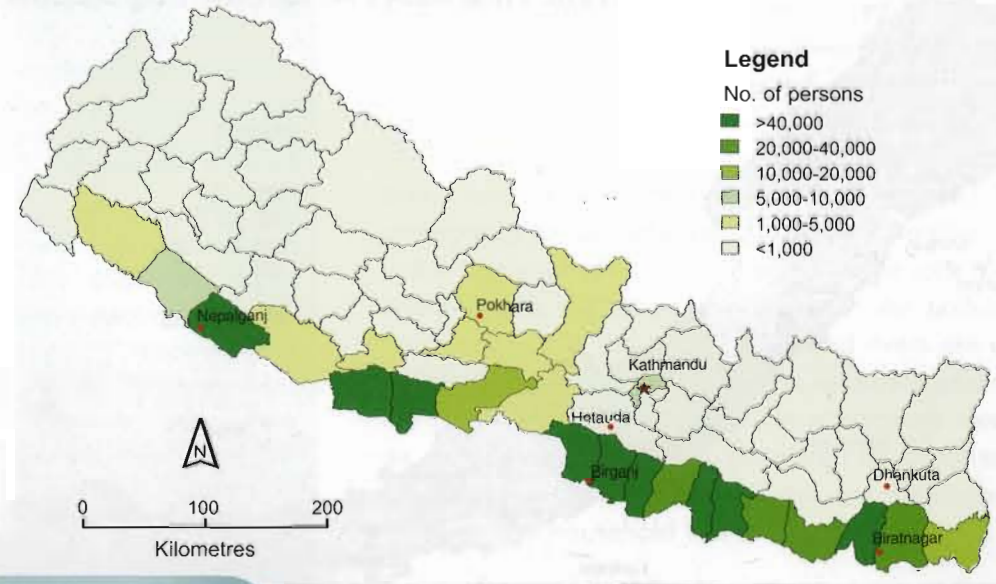
Linguistic Map of Nepal: *The distribution of languages in Nepal follows closely the distribution of ethnic groups, with the various languages organized into four main language families. The dominant language families are Tibeto-Burman, which contains the Tibetan languages spoken by people living in the northern part of the kingdom, and Indo-Aryan, which includes the national Nepali language.*

Source: Adapted from Gurung, H., 1998. Nepal: Social Demography and Expressions. Kathmandu: New Era Publications

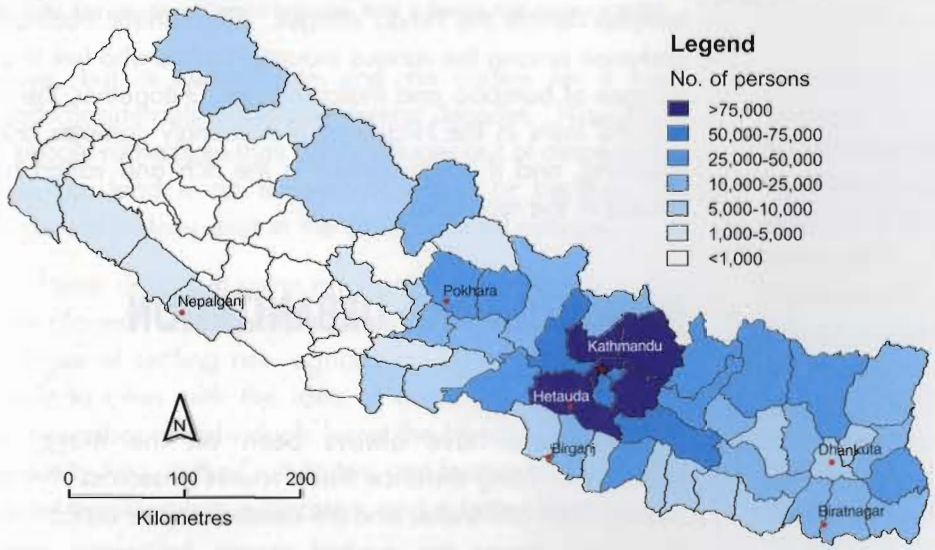
NEPAL: Hindu Population by District, 1991



NEPAL: Muslim Population by District, 1991



NEPAL: Buddhist Population by District, 1991



Source: Compiled from HMG-Nepal government statistics, and adapted from Gurung, H., 1998. Nepal: Social Demography and Expressions. Kathmandu: New Era Publications

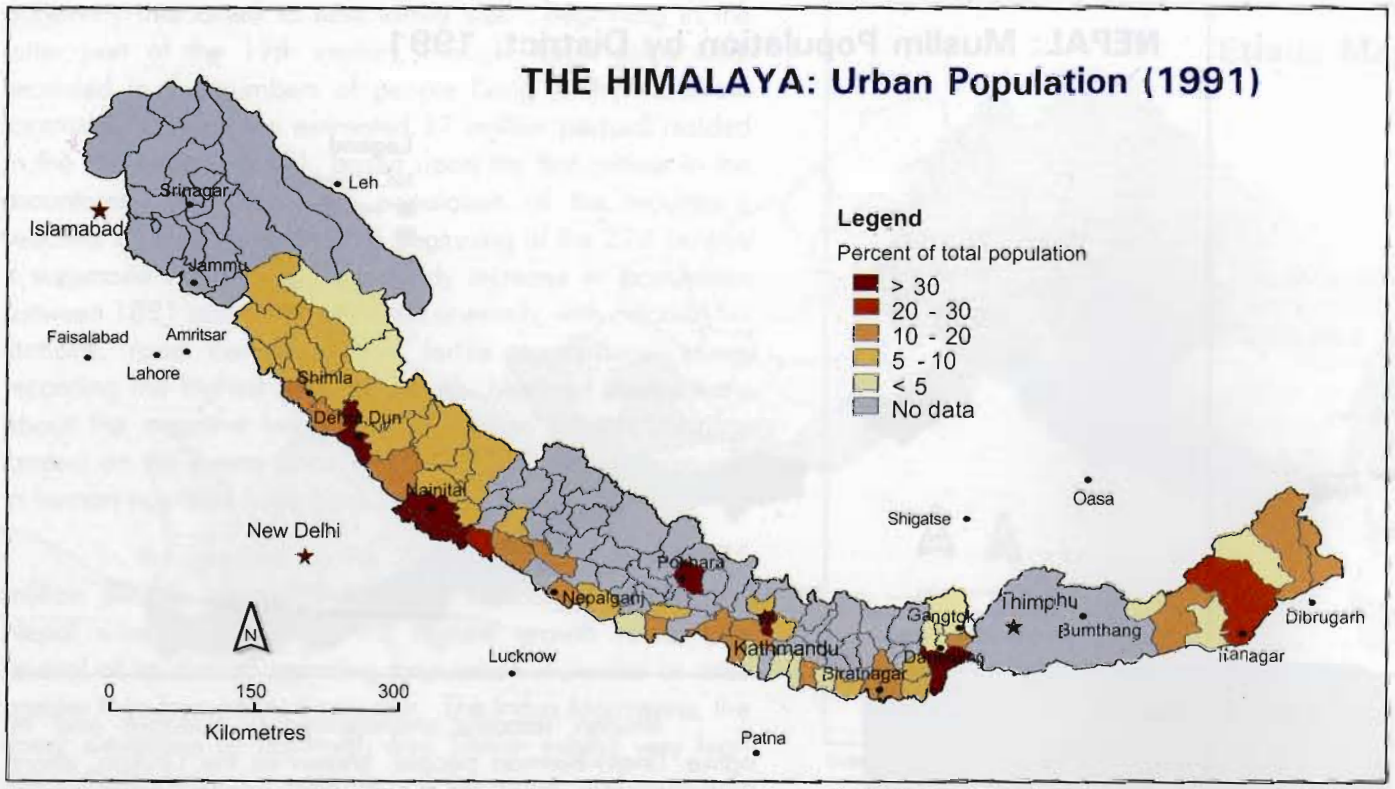
Religions in Nepal: *The three maps show the distribution of the major religious groups in Nepal. The Hindu and Buddhist populations are longstanding. 'Discrete waves of small Muslim settlements have taken place since the 1400s in Nepal, the most recent of these being immigration to the Terai districts of Islamic people from India that began in the 1970s.'*

groups and over 100 languages and dialects. The dominant ethnic group in Nepal in the hills is the hill caste population, which includes Bahun, Chhetri, and Thakuri, as well as the artisan castes. Other significant ethnic groups in Nepal include the Sherpas in the Mount Everest region, the Gurungs on the southern slopes of Annapurna, the Magars south of Mount Dhaulagiri, the numerous Bhotiya (Tibeto-Burmese) clans residing mainly in the trans-Himalayan valleys, the Rai and Limbu tribes of the eastern hills, and the Tharus who inhabit the Terai lowlands.

Bhutan remains overwhelmingly Buddhist and its native Tibeto-Burman people, known as the Drukpa, share fundamental cultural traits. The Bhutanese language, the distinctive native dress, and the traditional arts and crafts are fostered by the central government which promotes the idea of a distinctive Bhutanese nationality. Nepalese immigrants who settled in the Bhutanese lowlands in the early 20th century are known as the Lotshampas and constitute the country's largest

© Birendra Bajracharya

Wangdue Dzong, Wangdue, Bhutan



Source: Adapted from INDIAN HIMALAYA: A Demographic Database, 2002. Almora: G. B. Pant Institute; and ICIMOD, 2003. Mapping Nepal Census Indicators 2001 & Trends. Kathmandu: ICIMOD

Urban Population of the Himalaya: *Although the majority of people living in the Himalaya are still rural, the number of towns is growing and so too is the percentage of urban dwellers. This is especially notable where roads are common. It is also a trait of the larger valley districts located in the southern mountains. In the eastern sector of the range, where population size is relatively small, the percentage of urban population is greatly influenced by the towns that have sprung up at the base of the Himalaya overlooking the Brahmaputra Valley.*

ethnic minority. Darjeeling and Sikkim also contain an overwhelming population of Nepalese migrants some of who have intermixed with the native lepcha population.

The earliest ethnic minority population in Sikkim is that of the Lepchas who originate in Assam but have lived for centuries at the base of Mount Kangchenjunga. The eastern Himalaya contain a large number of tribes practicing animistic traditions. Some of them, such as the Monpa, Sherdukpen, and Khampti, have adopted Buddhism. The overall tribal character of Arunachal Pradesh reflects the great concentration of ethnic groups who maintain their own language and traditions such as shamanism, shifting cultivation, clan dress, and other forms of material culture.

The latitudinal diversity of Himalayan culture is enhanced by the vertical distribution of lifestyles. Rice farmers of the Himalayan valleys live in tight clusters of homes made from traditional stucco and thatch. Agro-pastoral people live higher up in the mountains, among stone and slate-roofed villages, and combine their grain farming with semi-nomadic livestock grazing. A common feature of these groups is their seasonal migration to the high elevation pastures, where they keep flocks of sheep and goats during the summer months. The trans-Himalayan valleys, meanwhile, are settled mainly by Tibetan peoples. They live in flat-roofed, adobe structures, and grow high-altitude grain in irrigated fields, raise potatoes, and keep herds of yak and goats. Only one group of Himalayan people - the Bakarwal - remain fully nomadic. They move continually through the landscape of the Indus Mountains in Kashmir, ranging between highlands and lowlands as the season changes. Some Himalayan valley groups, such as the Thakali and Newar, are best known for their trading and mercantile skills, while other highlanders are renowned as mountaineers (the Sherpa) or as mercenary warriors (the Gurkha soldiers recruited from the Gurung and Magar tribes).

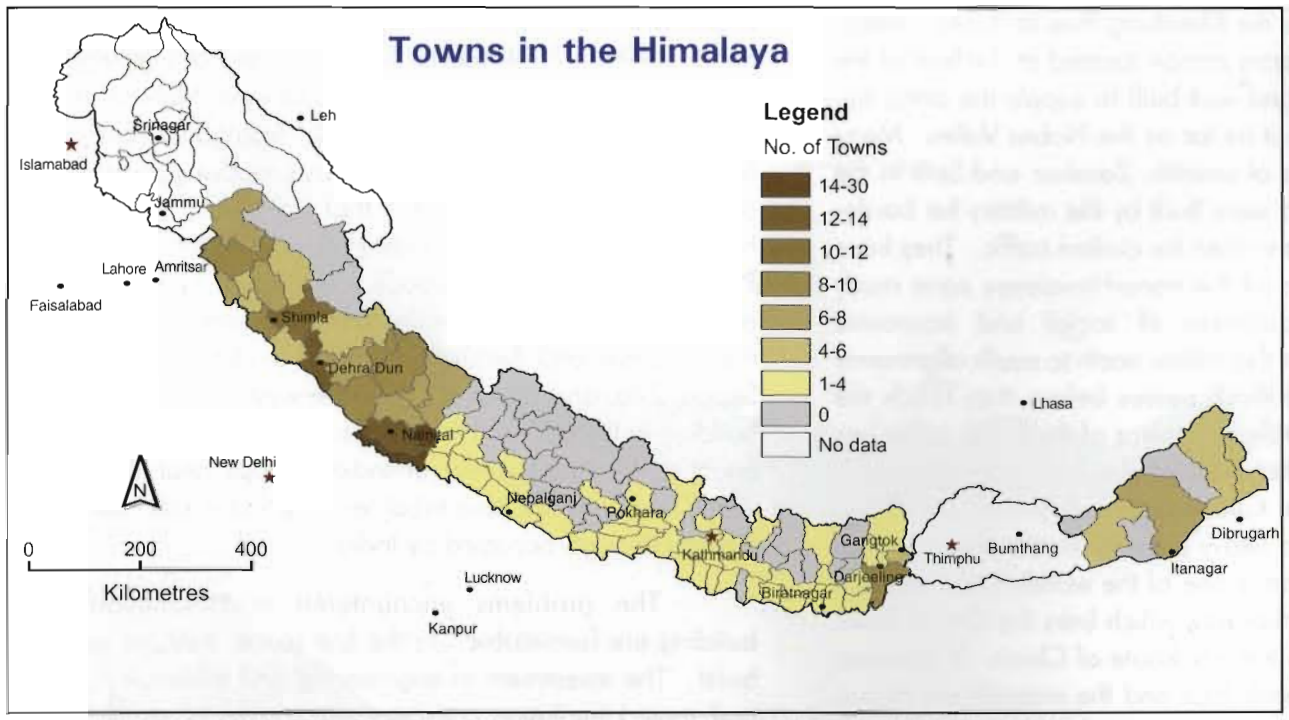
The human diversity in the Himalaya is manifest in the architecture and temples, in the clothing, jewelry and body tattoos worn by villagers, in the ceremonial practices, spiritual observances, and rites of passage, in language and dialect, and in the plethora of items that people place in the landscape. The shapes and materials of homes reflect the practical needs of villagers as well as their supernatural beliefs. In the cold and arid trans-Himalayan valleys, the houses are built of stone with flat roofs to dry grain in summer and to store firewood in winter. A huge array of house styles is found in the middle hills, ranging from the simple thatch and stucco dwellings of the Paharis and the oval shaped hill houses to the elaborate, multi-storied wooden structures of the Newars.

The handwoven textiles, which are prominent in the mountain villages, display particular colors and patterns that denote specific ethnic backgrounds of residents. Some of the most exquisite tapestries in the world are found among people living in Ladakh and Spiti, and among the tribes of Arunachal Pradesh. Women of the distinct ethnic groups wear their wealth differently as jewelry. The huge golden ear rings and nose rings worn by Rai and Limbu women are characteristic of the important cultural value of jewelry, which is a form of savings. Fluttering prayer flags, stone chortens and gateways, the inscribed tablets of the meandering rock mani walls, and the copper prayer wheels turned by running stream water all mark the distinctive Tibetan Buddhist realm. Meanwhile, sacred cremation places, sculptured stone deities, and pagoda-roofed temples denote the Hindu villages. Shamanistic traditions are common among the various mountain tribes who live in simple villages of bamboo and thatch homes. Altogether, the mix of cultural traits in the Himalaya is stunningly complex and far-reaching, and it is manifested in the rich and varied human society in the mountains.

MIGRATION AND URBANIZATION

People have always been on the move in the Himalaya. Long-distance trade routes crisscross the range, linking Tibet and India, and the caravans have exchanged salt for grain across the rugged terrain for many centuries. Smaller mercantile routes also connect villages within more tightly-bounded mountain settings, influencing the long-standing ties between highland and valley settlements. The seasonal migration of herders, which is a hallmark of high mountain culture, is an important adaptation to the environment, requiring people to move considerable distances on a regular basis. The herders trade animal products for grains and vegetables produced by sedentary farmers. Marriage also traditionally requires a new spouse to leave home and to move to a new residence.

These age-old reasons for moving from place to place add up to the fact that migration is nothing new in the



Source: Compiled and adapted from Sharma, P. (ed.), 2001. Market Towns in the Hindu Kush-Himalayas. Kathmandu: ICIMOD; and ICIMOD, 2003. Mapping Nepal Census Indicators 2001 & Trends. Kathmandu: ICIMOD

Towns in the Himalaya: *Many of the larger towns located in the Indian Himalaya were established by the British as hill stations during the colonial period. But the number and size of new towns are increasing along with population growth and modernization trends. The towns attract migrants who seek employment and an improved standard of living. All the major towns lie along important roadways.*

Himalaya, but its current rate and the causes for it have changed considerably in the past several decades. Nowadays, many people move from their home villages out of desperation, because the land is no longer productive or because few economic alternatives exist in the crowded rural settings.

Food deficits in some rural areas force people to flee to other places. Some people move to other rural localities in the hope of settling new agricultural land. Others make their way to cities with the idea of improving their lives. A growing number of individuals leave the Himalaya for places elsewhere in Asia, in the Gulf States, and further abroad in the search for employment, education, and a better lifestyle.

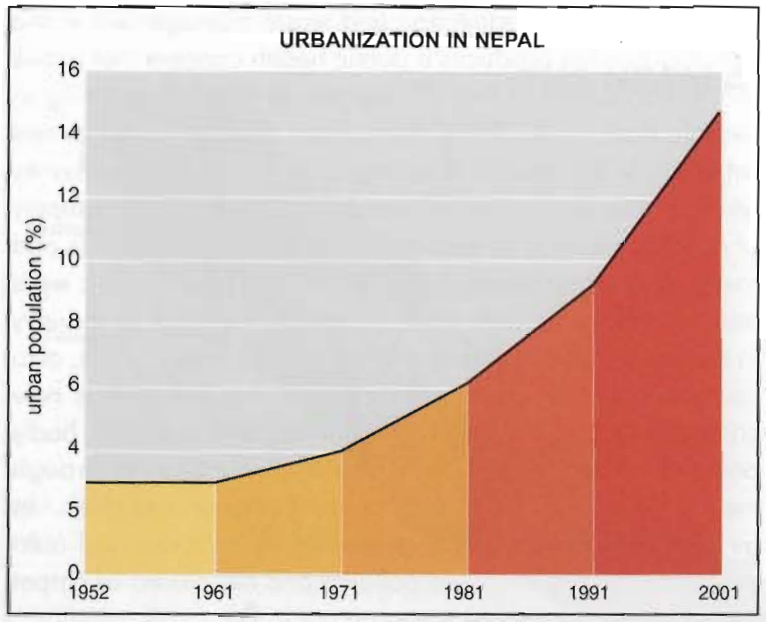
The Paharis of Garhwal and Kumaon in the western Himalaya have been moving onto the southern plains in significant numbers since the middle of the 19th century. Many of them were drawn to the employment opportunities offered by the British. The highland-lowland migration stream is more recent in Nepal where migrants first began to flow out of the hills onto the Terai in steady numbers beginning in the 1960s, when the government initiated a land resettlement scheme in the lowlands. In 1971, the highlands of Nepal contained 62.4% of the country's population, but by 1991 that had declined to 53.3%, mainly as a result of out-migration to the lowlands and cities. The Terai, Inter-regional migration map which received 75% of the migration flow originating in Nepal in 1991, also gained in population because of immigration from India. The border between Nepal and India is open for both nationalities, and many undocumented Indians find advantages in living in the towns located in Nepal's Terai zone. These migrations are turning the Terai into one of the most densely settled areas in the Himalaya, and transforming its society to a hybrid of Nepalese and Indian influences.

The great majority of migrants settle in the relatively new towns and cities. These places are growing at a very rapid rate, in most cases without sufficient infrastructure or planning. As recently as 1981, less than one in ten Himalayan persons lived in a town or city. By the turn of the 21st century, the percentage of urban population had doubled to twenty. In 1954, Nepal listed only ten localities with over 5,000 persons; the 1991 census showed 33 such urban places and in 2001 the number of designated towns and cities stood at 58. Nepal's urban population, meanwhile, increased from 9.2% in 1991 to 12% in 2001. Bhutan has a smaller percentage of urban population, less than 5%, but that too is increasing, while the urban population in neighboring Sikkim grew from 2% in 1951 to 16% in 1981. In the far eastern regions of Arunachal Pradesh, the population remains primarily rural, while the western Indian Himalaya contain some of the range's largest cities (Srinagar, Dehra Dun, Shimla, Mussoorie, Nainital).

The lack of sanitation and waste management in the Himalayan cities produces a public health concern that grows with urbanization. Over 70 percent of the people living in Nepal's Kathmandu Valley dump their garbage in the streets (where only 40 percent is collected) or along the river banks where it piles up to create local disease hazards. The supply of drinking water is inadequate in most of the large cities and towns, and urban residents still rely on antiquated public wells and springs for potable water. The concentration of industry in the towns, which attracts migrants to the jobs it offers, also contaminates the urban environment. Air pollution is now commonplace in the large towns, and rivers are often badly polluted. Kathmandu, which was relatively pristine through the 1970s, is one of the world's most contaminated cities. Its air is thick now with smog generated by factories and auto emissions, and its rivers are polluted and discolored by carpet factories and household waste.

Some of the Himalayan towns have ancient origins as pilgrimage centers or the capitals of feudal kingdoms. A few, such as Shimla and Darjeeling, developed under the British as hill stations. Most of the new towns, though, stem from regional economic development occurring in the mountains. Large development projects such as the hydropower schemes require large administrative and labor forces, which settle in the area to create new towns. Many people migrate to these towns to seek work in the new industries being created there. They work in factories, build roads, or undertake all sorts of menial labor. Most of the towns are spurting up along the new roads. In Nepal, for example, such places as Dhankuta and Dharan in the east, Dhunche north of the Kathmandu Valley, and Dailekh in the far western region all owe their

Migrant workers from India find seasonal employment in the Himalayan foothills.



Source: Adapted from UNEP, 2001. Nepal: State of the Environment 2001. Bangkok: UNEP-RRC.AP

A new road, hydroelectric plants and incipient industry have created a mini-urban corridor along a section of the Sutlej River in Himachal Pradesh.

recent development to transportation inroads into the mountains. In the western Himalaya, which enjoys a relatively advanced road system, the new towns are giving the mountains a determinedly urban and industrial look.

TRANSPORTATION

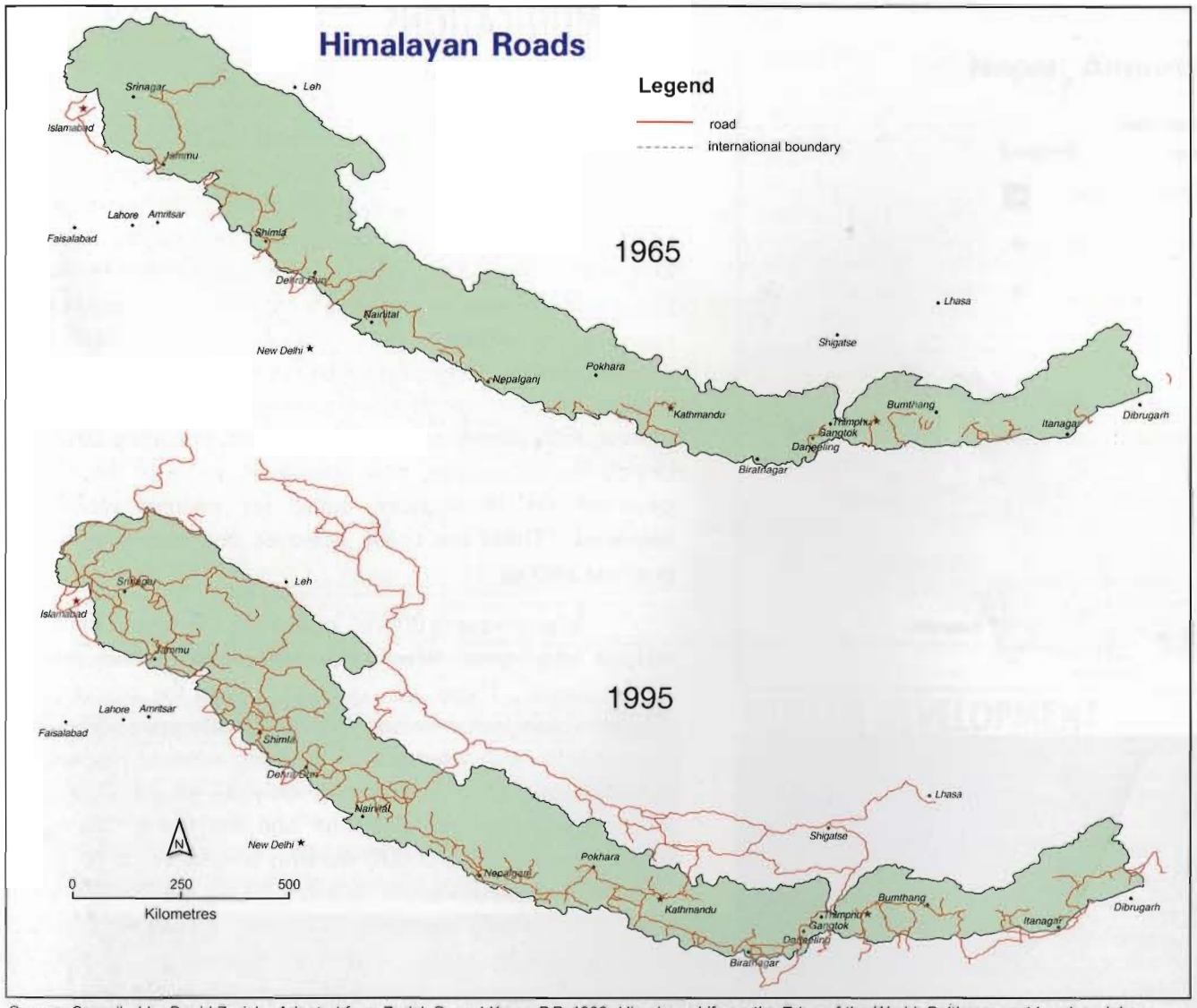
The Himalayan roads are engineering marvels, traversing mountain passes, crossing rivers, cutting through the hard rock cliffs of canyons and steep ridges. The highest road in the world starts in Leh in Ladakh, rises 2,000 meters in 15 kilometers, crosses the Khardung Pass at 5,340 meters, and ends in the Indian army station located at the foot of the Siachen Glacier. The road was built to supply the army, but the public can travel on it as far as the Nubra Valley. Many of the newest high roads of Ladakh, Zanskar, and Spiti in the Indian western Himalaya were built by the military for border defense, but most now are open for civilian traffic. They have made the remote valleys of the trans-Himalayan zone much more accessible for purposes of social and economic development. The roads that follow north to south alignments often must cross over difficult passes before they reach the plateau zone. For example, the towns of the Indus valley are reached by road only after climbing the Zoji La from Kashmir or the Rohtang Pass from Kulu Valley. Both passes are closed much of the year due to heavy snow or avalanches. Across the Indus River in Pakistan is one of the world's great modern roads - the Karakoram Highway, which links the Grand Trunk Road of South Asia with the Silk Route of China. It traverses the 4,880 meter Khunjerab Pass and the magnificent Hunza Valley, covering some of the most rugged terrain in the world. Altogether, about 15,000 kilometers of roads have been built in the Indian Himalaya since the early 1960s.

The first roads were built in Nepal beginning in 1953 and were limited to the Terai and the Kathmandu Valley. A road link between Kathmandu and the outside was completed in 1956. By 1964, Nepal had only 289 kilometers of roads. Limited financial resources and the rugged mountain terrain held a check on road construction throughout most of the kingdom until the late 1960s to early 1970s, when a flurry of road-building efforts began. The Chinese and the Indians built many of the early roads in Nepal, both countries seeking to gain strategic inroads into the mountains. By 2000, the country had over 2,500 kilometers of paved roads, most of which are located in the hills and lowland Terai. The roads serve Nepal's modernization interests which require making distant rural areas more accessible for social and economic development. Still, about a third of the country's population has no access to roads. Most recently, road building has begun into the heart of the High Himalaya, connecting Tibet with Nepal and India, and opening remote valleys in the trans-Himalaya to the rest of the country. One of the most ambitious road projects will traverse the Kali Gandaki Gorge - the world's deepest valley and some of the harshest terrain in the Himalaya, connecting the remote district of Mustang with the lowlands in the south and Tibet in the north.

The eastern Himalaya remain the least accessible part of the range. The maps of the area are notably empty. Bhutan began road construction in 1959 with the assistance of India, and in 1990 had less than 1,500 kilometers of highway. The longest stretch of road is the East-west highway which connects the capital Thimphu with Tashigang (546 km.). Much of the remainder of the country's roadway contributes a network of feeder roads that connects the district headquarters with the East-West Highway. Much of Arunachal Pradesh remains without roads. The major highways in the easternmost Himalaya are limited to the important valleys of the Subansiri and Brahmaputra, and lead to such towns as Seppa, Ziro, and Pasighat. As in the west, much of the road-building in the eastern Himalaya supported military purposes, enabling the deployment of Indian troops near the border with China in a fractious tribal territory that is still claimed by China although occupied by India.

The problems encountered in Himalayan road building are formidable. In the first place, they are costly to build. The investment in engineering and materials is great, and most Himalayan countries rely on donor assistance to build their roads. Most roads at some point cross major rivers, requiring the construction of costly bridges. Many of the current bridges were built as temporary affairs and have passed their design life. The heavy rainfall in the summer causes numerous landslides along the road alignments. The debris clearing, repairing undercuts of road embankments, replacing asphalt surfaces, and numerous other seasonal maintenance tasks are simply beyond the resources of the Himalayan countries. In Nepal, between 1980 and 1993, environmental damage to roads resulted in 2.5 billion rupees of repair work. As a result of the high maintenance costs, the roads in many mountain localities are in bad shape.

An iron bridge spans a river in the northwestern Himalaya.



Source: Compiled by David Zurick. Adapted from Zurick D. and Karan P.P. 1999. Himalaya: Life on the Edge of the World. Baltimore and London: Johns Hopkins University Press

A number of alternative modes of transportation exist that augment the roads. Historically , the movement of people and goods across the Himalaya depended upon the role of trails and porters, and these still constitute the main way of getting around in most parts of the mountains. The plateau regions and the wide valleys of the western Himalaya are crossed by pony caravans, which are a primary means of trade and travel in many places in Ladakh, Zanskar, and Spiti, as well as in the valleys and plateau lands north of the Himalayan crest in Nepal. The steep trails in the mountains, however, often cannot be traversed by pack animals, and human porters, therefore, have traditionally carried the weight of goods on their backs. On some of the busier trails in Nepal, upwards of a thousand porters may pass in a single day. Suspension bridges are an important feature of the foot trails and mule tracks, allowing the safe crossing of rivers and gorges. In recent years, the importance of ropeways has increased. The first ropeway in Nepal was built in 1927 to ferry goods into the Kathmandu Valley. Since then, numerous large and small ropeways have been constructed in the Himalaya, greatly reducing the burden of portering heavy goods up steep inclines in heavy traffic areas.

The steep terrain of the Himalaya has not allowed much in the way of rail transport. One narrow gauge railway in Nepal links border towns with India, and is used mainly for cargo traffic. Small, narrow gauge railroads built by the British still go to Darjeeling and to Shimla in the Indian Himalaya. The so-called 'toy trains' that move on these lines are used exclusively for passenger traffic, mainly people on holiday. A railroad goes as far as Pasighat in the eastern Himalaya, and is used for military transport as well as for civilian purposes. Air transport plays a key role in many mountain localities, both for passenger movement and to ferry food and other necessities across impossible terrain. In Nepal, the small, grassy short take-off and landing (STOL) airstrips provide vital lifelines to many villages. Air transport began in 1950 with the construction of the airstrip in Kathmandu, and in 1958 the Royal Nepal Airline Corporation was established. Since then, the number of airstrips in Nepal has increased to over 40, and the fleet of private airlines has mushroomed, mainly to serve the tourism industry. Bhutan, meanwhile, has only one airport in Paro, but numerous helipads exist across the country, used mainly for emergency or governmental purposes.

Himalayan Roads: *The period 1965-1995 ushered in a road-building frenzy in the Himalaya. In the western and eastern sectors, much of the road construction was targeted for military purposes and many of the roads remained off limits to civilians until the late 1990s. Elsewhere, the roads were part of national or regional economic development initiatives. With roads comes increasing accessibility for purposes of market development and the delivery of social services, but roads also bring problems, notably environmental instability. The road cuts in steep regions contribute to landslide problems and soil erosion. They also make it easier for illegal timber cutters to expand operations in the remote forests.*

Much of the Himalayan region lacks roads and the trails are too steep even for pack animals. Porters carry the heavy loads in these places.

Bridges have improved considerably in the past few decades, making travel easier in parts of the Himalaya.

Source: ICIMOD, MENRIS data, compiled from various sources.

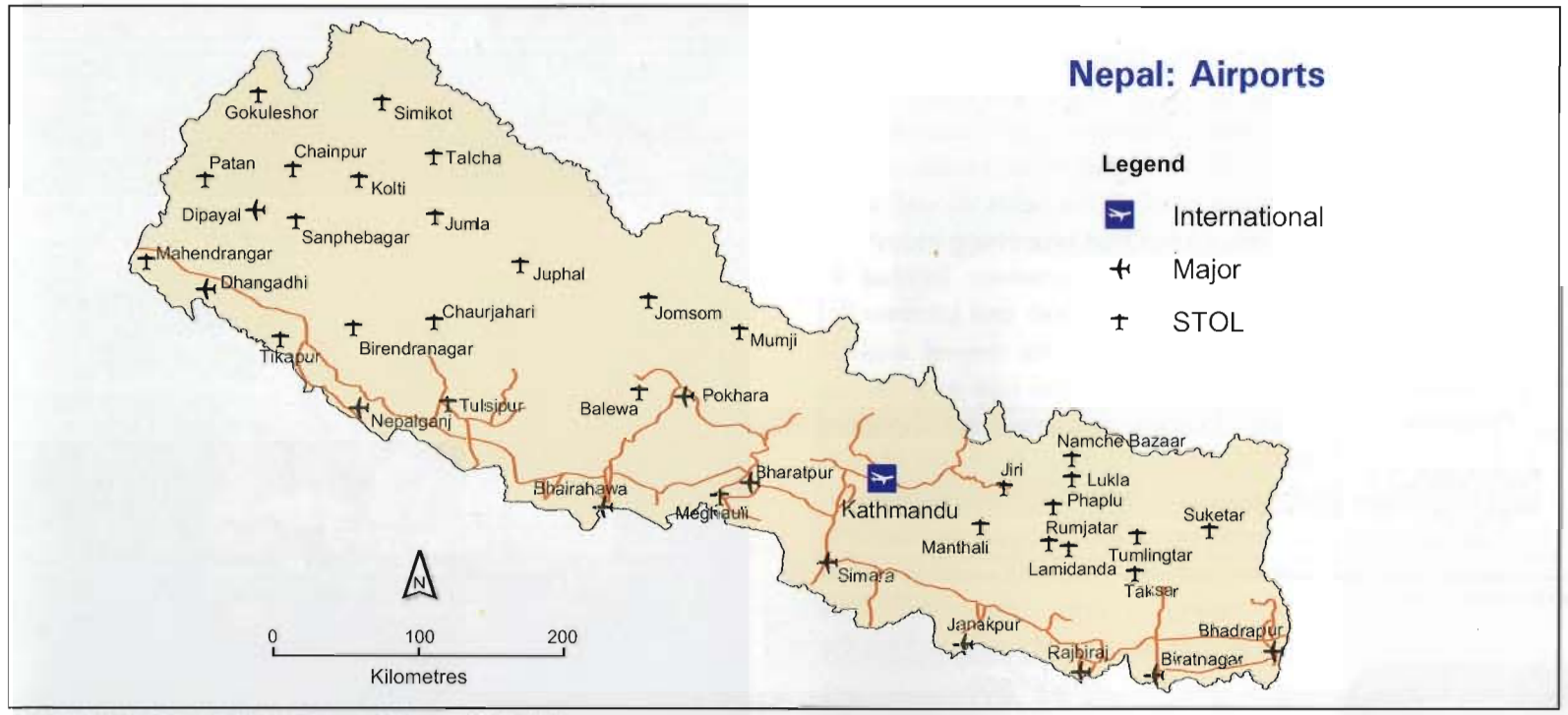
Birendra Bajracharya

One of the longest supension bridges in Bhutan over the Phochu river, Punakha.

COMMUNICATIONS

The remote and scattered population of the Himalaya, combined with the lack of motor transport, makes the need for communication especially vital among the mountain communities for purposes of human development and government participation. Large areas of the Himalaya are still not covered by postal services. Buses are used along roadways to dispatch mail, and air deliveries reach the remote airstrips. Otherwise, villagers rely on the unscheduled services of volunteer or government-paid runners to obtain printed mail. A few private mail services, including DHL and United Postal Services, now operate in some of the capital cities of the Himalayan region for express worldwide deliveries. These are costly, however, and mainly serve the business sector.

Telecommunications operating in the Himalaya include telephones, telegraph, wireless radio, and satellite transmissions. These are common now in the cities, along with television transmissions, but the rural areas, particularly those with no electricity, remain without adequate communications. For example, only 55 of 75 districts in Nepal are served by telephone and the entire country of Bhutan has less than 3,000 working telephone connections. The communication sector is more highly developed in the western Himalaya, especially in Himachal Pradesh, which is better served by electricity and by government as well as private telecommunications exchanges. Satellite telephones and television dishes are still rare in the mountains but can be found where electricity is available. Small hydropower stations provide electricity, and parabolic dishes bring a global system of television programs to the remote villages. Most of the Himalayan towns and the villages along the roads are served by print media in national and vernacular languages, as well as in English in the large cities. The Indian districts are served by the national Hindi newspapers as well as by local tabloids. Nepal has numerous small weekly newspapers, many of them aligned with political parties, as well as the national private daily papers such as the Kantipur and Kathmandu Times, and the government papers Gorkhapatra and Rising Nepal. Bhutan is served by the weekly national newspaper Kuensel, which is published in Thimphu.



Source: Adapted from HMG-Nepal Topographic Survey Branch map

Nepal - Airports: *Some of the most remote places in Nepal are served by air, with planes landing on dirt airstrips in very rugged terrain. During emergencies, such airstrips may be the only lifeline to the rest of the country. Many of the mountain airstrips are seasonal and close down in the winter or in the event of high winds or threatening storms.*

Satellite dishes powered by small hydro-electric installations bring the world to the remote mountain villages.

HUMAN DEVELOPMENT

The United Nations Human Development Report provides an index of variables (life expectancy, education, income) which, taken together, comprise a measure of the development of human society. In the U.N. calculations for 162 countries, the Himalayan region fares badly. Nepal came in at 129, followed by Bhutan at 130. India and Pakistan measured a bit better, at 115 and 127 respectively, but their Himalayan territories contain some of those countries' poorest districts. The United Nations calculations, which emphasize material wealth, is contested by Bhutan, which proposed its own 'Gross National Happiness Index' in its Human Development Report 2000 submitted to the United Nations. In the Bhutanese view, the goal of development is a happy society, which must consider the spiritual and emotional, as well as material, factors. Nonetheless, the common United

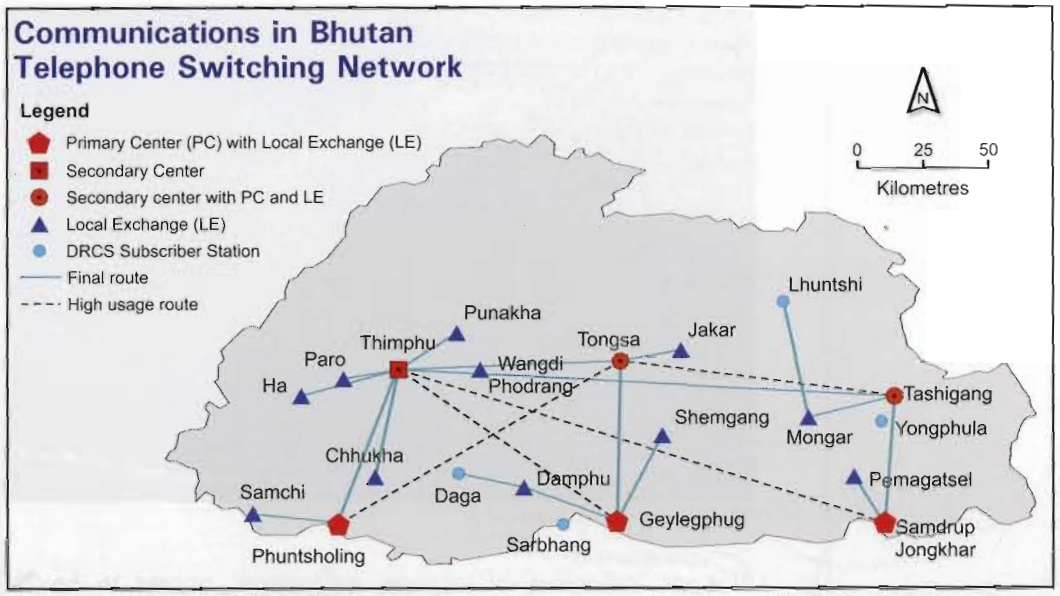
Helipad in the Himalaya

Nations indicators of income, education, access to health service, and life expectancy represent worthwhile, if not exclusive, goals for national development, even in Bhutan.

Poverty and Employment

Although the bulk of the Himalayan population remains agricultural, the traditional farming systems cannot absorb the growing workforce. The result is increasing poverty. The development challenges in the region, therefore, include the creation of alternative economic opportunities in the non-farm sector. Currently, the region experiences levels of income poverty among the lowest in Asia. Nepal's GNP per capita in 1998 was $200, ranking it alongside the poorest countries in Africa. Over half its population lives on less than a dollar a day. India's overall GNP per capita is US$370, but its Himalayan region includes some of its poorest places (Sikkim, for example, reports a state per capita GDP of around $215, while Arunachal Pradesh reports per capita incomes less than US$200). The per capita GNP reported by Bhutan is a higher, US$594, and the emphasis Bhutan places on conserving its natural capital (e.g. forests, water, soils) leads the country to conclude that, when natural capital is included, the per capita wealth in Bhutan increases to US$16,500.

Although the official overall unemployment line in the Himalaya is quite low - less than 5%, its total workforce is underutilized by about 50%, due in part to the seasonal nature of farm work. It is this latter figure that is most important in modern times as more people seek a living in the towns and industries. In Nepal, the active work population includes 22% laboring in services and less than 14% in



Source: Royal Government of Bhutan, 1992. Seventh Five Year Plan (1992-1997), Vol.1. Main Plan Document. Thimphu: RGOB, National Planning Commission

Communications in Bhutan: *Traditional telephone networks in Bhutan, as well as elsewhere in the Himalaya, do not reach very far into the remote areas. These systems are gradually being augmented by wireless and satellite-based communication systems.*

manufacturing. The workforce participation of women in Nepal has almost doubled since 1971, while that of men has decreased. Nonetheless, poverty is alarmingly high throughout the country. In 1996, the percentage of population living below the national poverty line ranged from 23% in the urban areas to 56% in the mountains. Agriculture, meanwhile, has largely stagnated and many mountain districts are now food deficit. Nepal's overall sluggish economy has led to slow income growth (1.4% per annum during the past 25 years) for everyone. The underemployment problem is compounded by the labor migration from India, which fills menial jobs as well as entrepreneurial roles. In Bhutan, meanwhile, the GDP grew at a rate of 7.3% per annum during the 1980s, and at 5.9% between 1990 and 1998. The mining, manufacturing, and energy sectors of the national economy contribute a significant proportion to this growth in wealth, from 4% of the national GDP in 1980 to 25% in 1998. These increases have led to new jobs in the industrial sector in Bhutan.

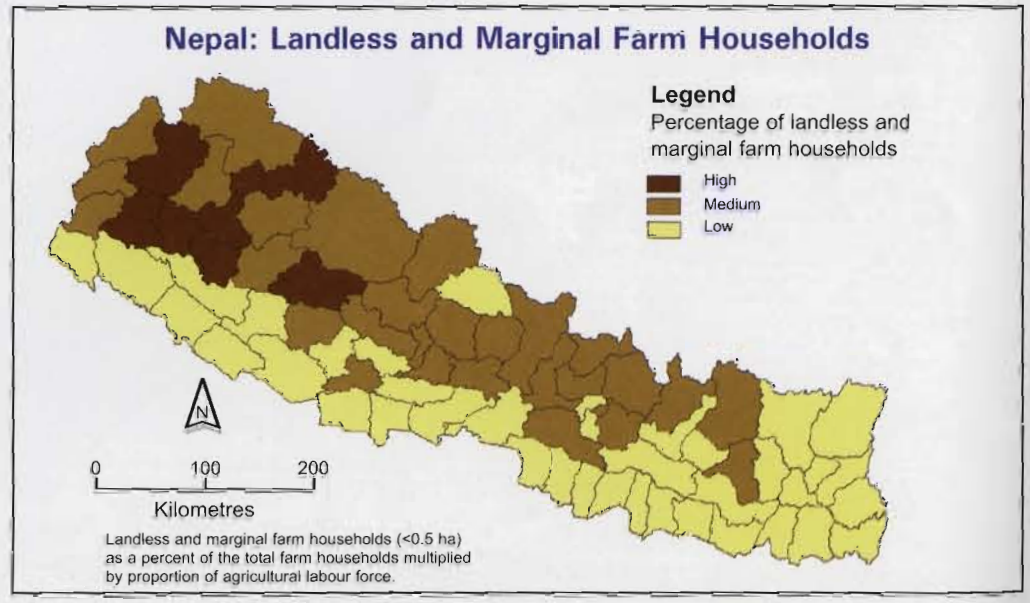
The economic prospects in the western Himalaya vary considerably from one place to another. The decades of instability in Kashmir have led to economic stagnation in all sectors of the economy and to very serious levels of income poverty throughout the state, as well as to other forms of human misery. Himachal Pradesh and Uttaranchal, however, fare better. The rural sector in Himachal Pradesh has invested heavily in commercial agriculture, notably orchards, which provides work in the fields as well as in the associated fruit processing industries. The hydroelectric schemes located in both Himachal Pradesh and Uttaranchal provide employment for menial workers as well as for technical and engineering staff. Tourism, too, plays an important role in the rural service economy of both states. Throughout the Himalaya, cottage industries, such as handicrafts, paper-making, textiles, and food processing, are promoted as sustainable sources of livelihood for the rural mountain populations.

With the growth of urban places, the prospects for employment in the industrial, service, and trade sectors have increased in some areas. A small proportion of town dwellers is engaged in household industries (in the Indian Himalaya this ranges from 0.3% in Arunachal Pradesh to 4% in Sikkim), despite its heavy promotion by government policies. The largest concentration of urban workers in the Himalaya is in trade and commerce and in the service sector. These categories account for two-thirds of the urban workers in the

Human poverty is at its greatest in some of the remote villages in western Nepal.

Indian Himalaya. Similar rates prevail in Nepal. Impediments to urban employment throughout the range include the lack of training and low educational levels, as well as the low

Nepal - Percentage of Landless and Marginal Farm Households: *The problem of landless farmers occurs where population densities are high and agricultural area is limited. This is particularly acute in places where the rural elite controls a significant proportion of the available farmland. In Nepal, the western districts report high rates of landlessness. These also are some of the poorest districts in the country. Landlessness has also become a concern in some of the lowland Terai districts, which have experienced high rates of migration in recent decades.*



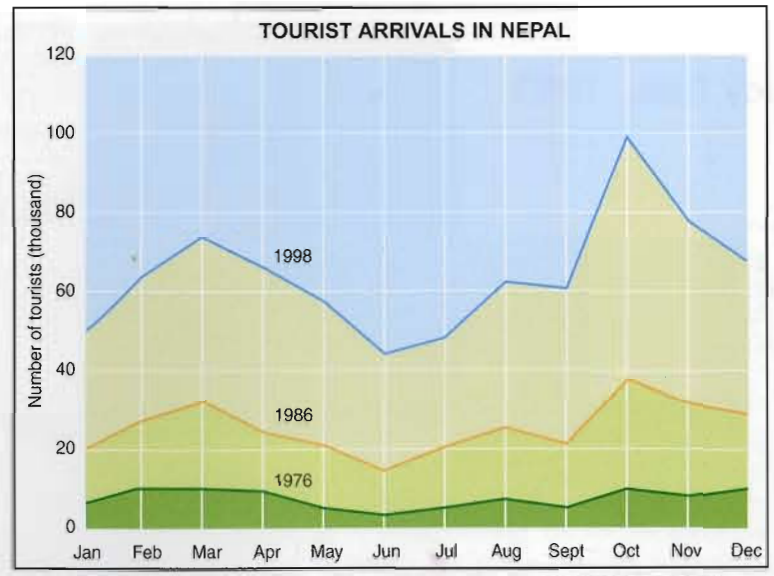
Source: ICIMOD, 1997. Indicators of Development - Districts of Nepal. Kathmandu: ICIMOD

wages paid to employees. With continued high rates of rural to urban migration, and where most immigrants move to the cities in search of jobs, it is clear that employment generation becomes even more important. In Sikkim, where people increasingly seek livelihoods in the cities, the poverty rate increased from 36% in 1988 to 41% in 1994, highlighting the need for job creation in the towns.

Education

Historically, the education levels in the Himalaya have been low, and they continue to be among the lowest in the world, but recent decades have seen significant improvements in classroom enrollments and adult literacy. This change recognizes the fundamental role education plays in human development. In Nepal, the adult literacy rate increased from 8% in 1961 to 45% in 1997. In a recent survey, parents in Nepal unanimously ranked education as the top priority in their children's future. Bhutan has witnessed similar strides in education, with its adult literacy rate increasing from 10% in 1970 to 48% in 1994. Still, less than half the Bhutanese population can read or write, and education remains a top priority for both countries. Gender inequity also needs to be

Tourism services provide employment in many parts of the Himalaya.



Source: Adapted from UNEP, 2001. Nepal: State of the Environment 2001. Bangkok; UNEP-RRC.AP

addressed alongside the efforts to improve overall literacy. In Bhutan in 1990, the boy-girl ratio in primary school was 61-39. This has improved somewhat, but women are still seriously under-represented in schools at all levels. In Nepal, the gender imbalance is reflected in the fact that the literacy rate for men is 62%, while for women it is only 28%. This discrepancy is even greater in the remote mountain villages. Some of the highest education levels are reported in the Indian Himalaya where schools and teachers are more numerous. For example, Sikkim's adult literacy rate is almost 70% and about 83% of all children from 6-17 years' old attend school. The literacy rates are lowest in the Indian regions among the tribal groups and where urbanization levels are also low. The districts of Arunachal Pradesh, for example, report literacy rates as low as 9% in the West Siang district.

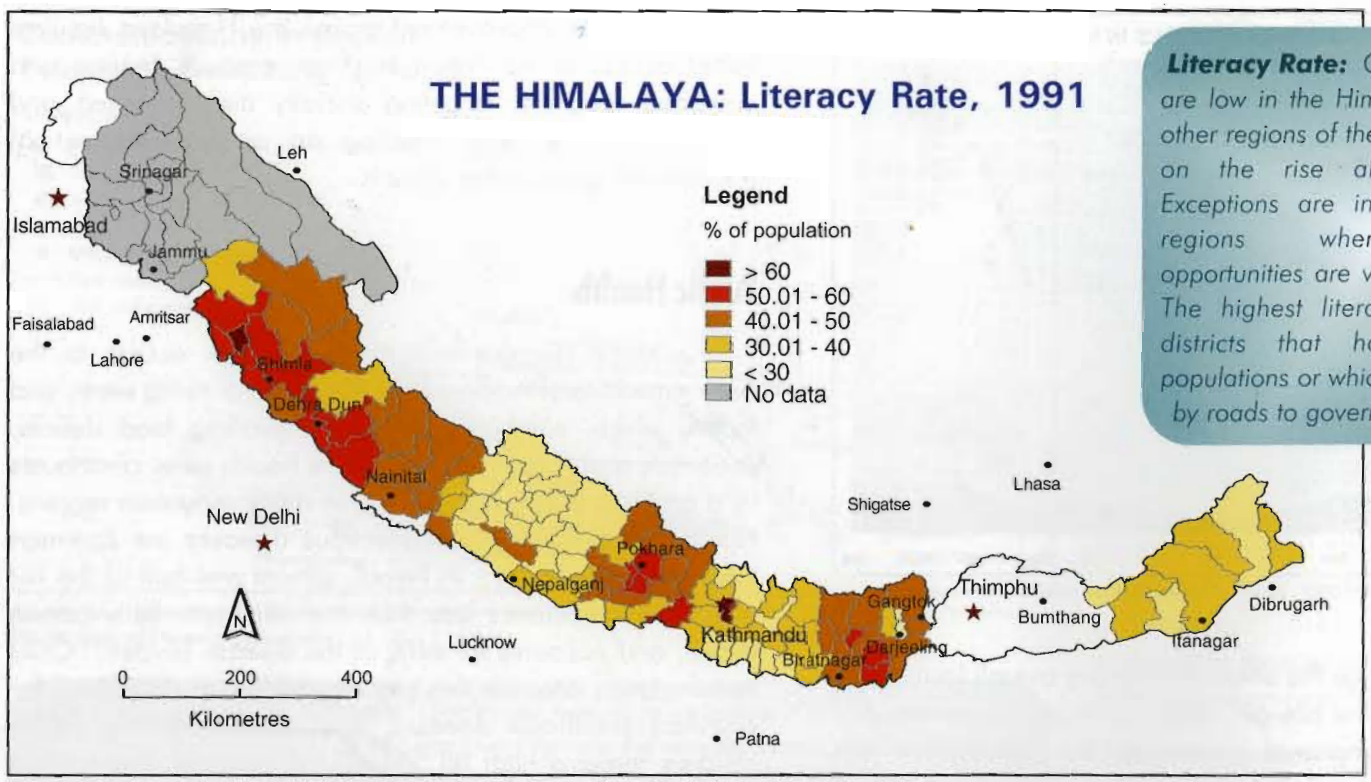
The expanding demand for schools means that the institutional infrastructure of education will need to be developed. Currently in the Himalaya, there are too few teachers and schools. Bhutan has always faced a shortage of teachers, which it meets in part by employing expatriates, mainly Indians, in its schools. The teacher training institutes in Bhutan, however, are expanding their capacity to meet the new demand, and the number of graduating teachers increased there from 487 in 1998 to 713 in 1999. The public schools in Nepal likewise are poorly equipped and the teachers often are not properly trained. As a result, the quality of public education is sadly lacking. This has led to an increasing number of private schools, including costly boarding schools, and many parents choose to sacrifice elsewhere in order to send their children to better schools. In sum, education improvement across the Himalaya requires better access to education facilities, properly trained and equipped teachers, targeting socially disadvantaged and minority groups, and creating an accountable set of educational goals in the schools.

Public Health

Many Himalayan communities lack access to the basic amenities of modern life - electricity, drinking water, and toilets, which, combined with the prevailing food deficits, sanitation problems, and inadequate health care, contributes to a growing public health crisis in many mountain regions. Nutritional deficiency and infectious diseases are common throughout the range. In Nepal, almost one-half of the hill population consumes less than the minimum daily caloric intake, and accounts for 68% of the disease burden. Child immunization rates are low, placing children at special risk for common childhood diseases, and anemia among young children remains high (in Sikkim, for example, the anemia rate for children below 3 years is 77%). The most common diseases and disorders in the Himalaya include diarrhoea, iodine deficiency (leading to goiter and cretinism), tuberculosis, leprosy, and various vector-borne diseases such as malaria and encephalitis. The prevalence of HIV/AIDS is not well documented, but is believed to be growing, especially in mobile urban societies.

Fortunately, many of the common diseases and disorders are manageable through effective disease intervention, prevention, and curative health services. The Himalayan people traditionally rely on local healthcare givers, including faith healers and ayurvedic practitioners. Modern allopathic systems associated with national health services became important across the range during the 1950s. Today, the public health sector in the mountains remains inadequate due to the shortage of trained health personnel and drug supply. The shortages are compounded by the fact that much of the Himalayan population is widely dispersed among remote villages in very rugged terrain that is not accessible by motor vehicle. Nonetheless, important successes have been achieved in the area of public health.

Infant mortality rates in the mountain districts are high compared to other developing regions in the world, but they are coming down mainly due to improvements in pre-natal maternal care, sanitation, and child immunization. Nepal's infant mortality rate dropped from 172 in 1971 to 98 in



Source: Adapted from INDIAN HIMALAYA: A Demographic Database, 2002. Almora: G. B. Pant Institute

Literacy Rate: *Overall literacy rates are low in the Himalaya compared to other regions of the world, but they are on the rise almost everywhere. Exceptions are in the most remote regions where educational opportunities are virtually non-existent. The highest literacy rates occur in districts that have large urban populations or which are or connected by roads to government centers.*

School facility in the Terai

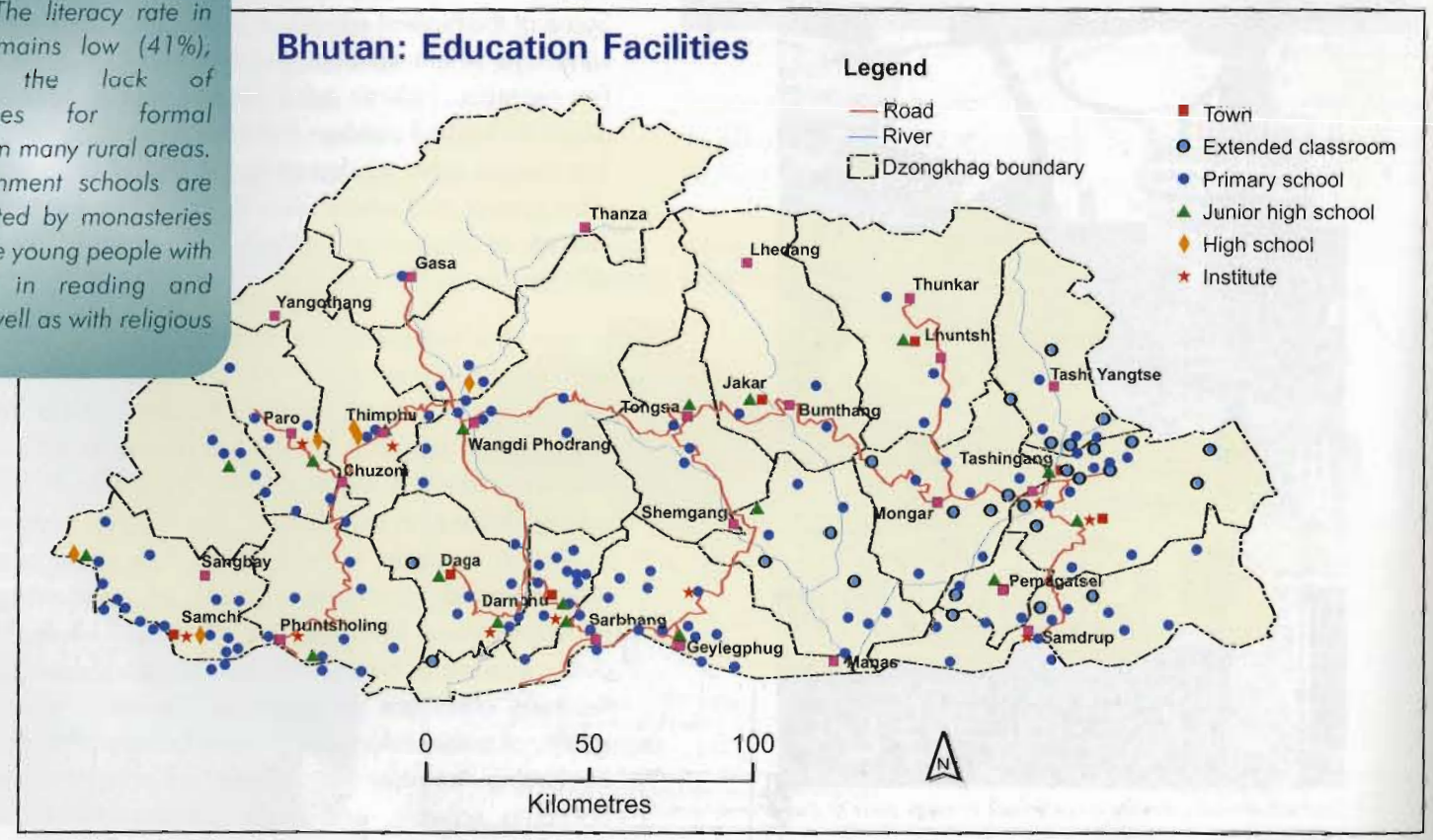
Historically, the region has been controlled by an assortment of tribal coalitions, feudal principalities, monastic orders, or colonial regimes. The establishment of modern nation-states has resulted in new institutional arrangements for organizing mountain societies. New democratic initiatives are widespread, but in many places civil society is threatened with violence. Kashmir, for example, has been embroiled in civil unrest and military action since the independence of India

1994. Bhutan's rate dropped by half in a single decade, from 142 in 1984 to 71 in 1994. Sikkim's infant mortality rate dropped from 60 in 1990 to 51 in 1997. Diarrheoal diseases, which commonly afflict young children, are prevented by improving access to safe drinking water and enhancing cleanliness and hygiene conditions in the home. The number of well-staffed and maintained health service posts is far below the number required by the mountain population. This remains a high priority among the Himalayan regions, but the lack of financial resources impairs the delivery of health services. Most people continue to live many hours or even days away from a health clinic of any sort. Few specialized medical staff work outside the major metropolitan areas. To overcome these problems, the Himalayan countries have placed emphasis on training village health workers and community health volunteers who provide basic medical health and share information toward disease prevention.

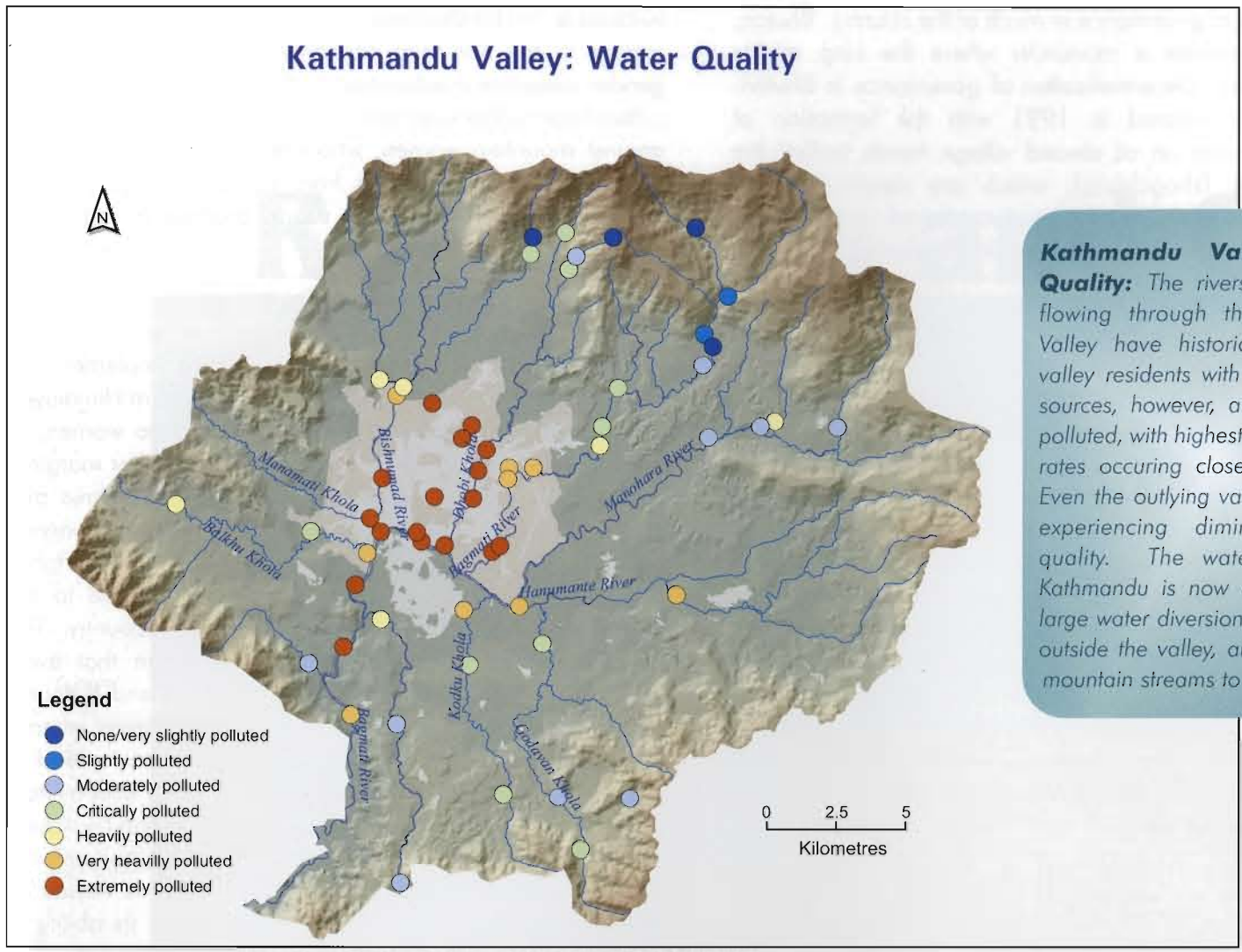
GOVERNANCE AND HUMAN RIGHTS

The satisfaction of basic human needs and the preservation of the mountain environment depend upon the participation of Himalayan people in their own governance.

Education Facilities in Bhutan: *The literacy rate in Bhutan remains low (41%), reflecting the lack of opportunities for formal education in many rural areas. The government schools are supplemented by monasteries that provide young people with instruction in reading and writing as well as with religious training.*



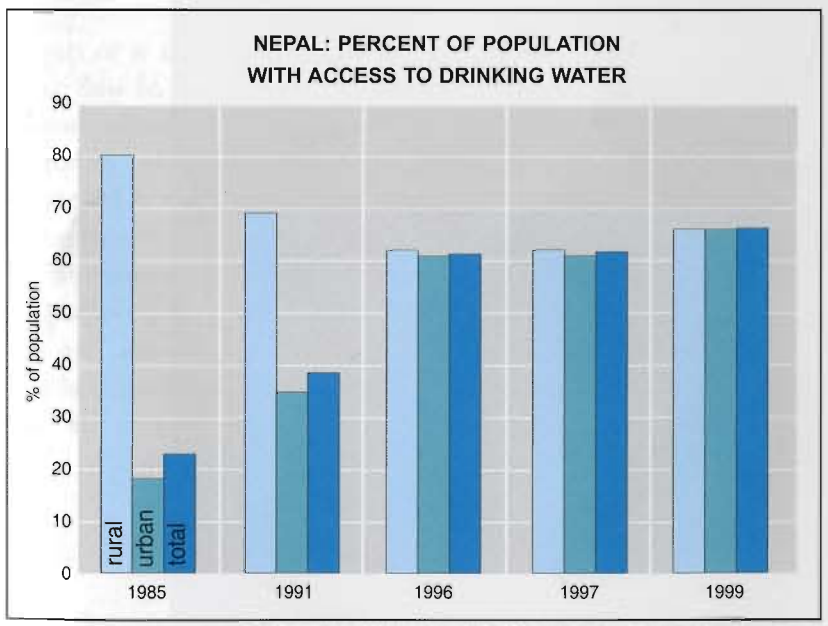
Source: Royal Government of Bhutan, 1992. Seventh Five Year Plan (1992-1997), Vol.1. Main Plan Document. Thimphu: RGOB, National Planning Commission



Kathmandu Valley Water Quality: *The rivers and streams flowing through the Kathmandu Valley have historically provided valley residents with water. These sources, however, are increasingly polluted, with highest contamination rates occuring closest to the city. Even the outlying valley, though, is experiencing diminished water quality. The water supply for Kathmandu is now augmented by large water diversions from sources outside the valley, among the high mountain streams to the north.*

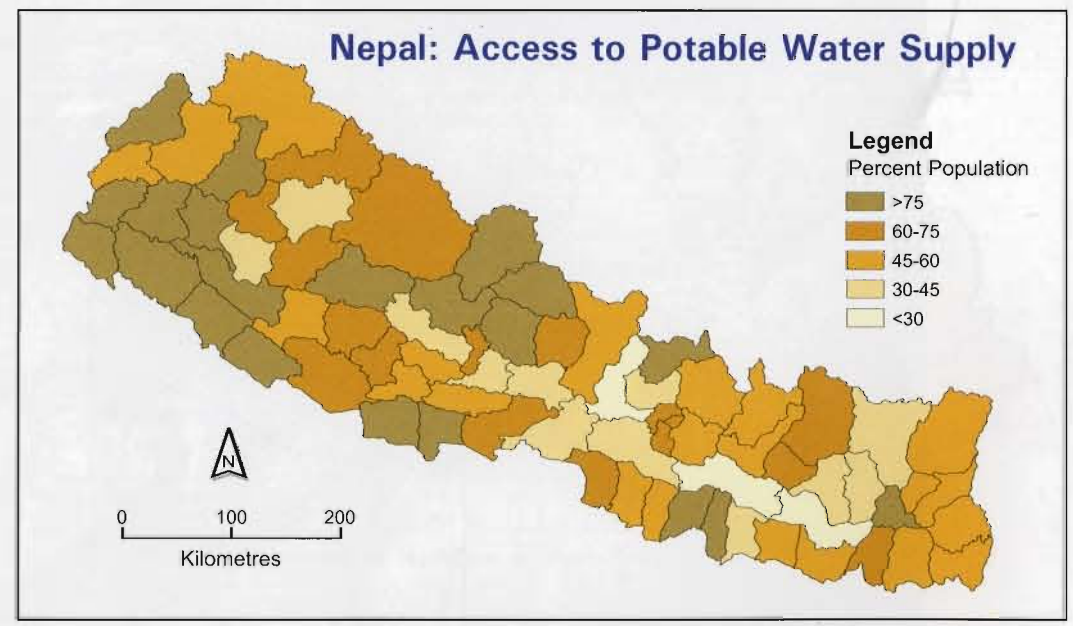
Source: *Adapted from UNEP, 2001. Nepal: State of the Environment 2001. Bangkok: UNEP-RRC.AP*

Women spend hours waiting at the village spring to fill the household water vessels.



Source: *Adapted from UNEP, 2001. Nepal: State of the Environment 2001. Bangkok: UNEP-RRC.AP*

Access to Potable Water in Nepal: *Drinking water supply systems in the villages rely upon local springs and streams. The water is diverted to households by plastic pipes, which may carry water above ground for several kilometers from its source. Reliable and safe drinking water is a high priority in many rural areas, where declining water tables or pollution may threaten the potable water supply. This is a particular problem in the most densely settled rural localities.*



Source: *Adapted from UNEP, 2001. Nepal: State of the Environment 2001. Bangkok: UNEP-RRC.AP*

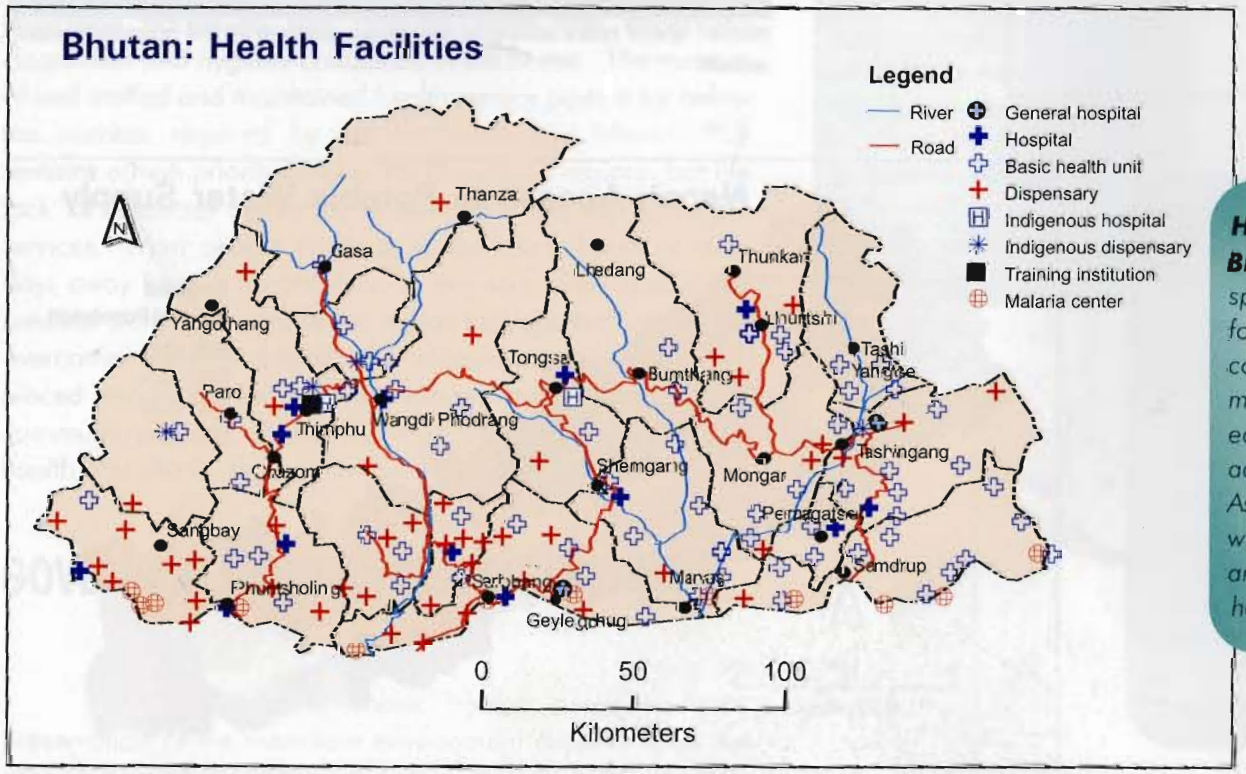
and Pakistan. Separatist activity in Darjeeling, directed toward autonomy, created civil unrest throughout much of the 1980s. Bhutan evicted tens of thousands of minority Nepalese (the Lotshampas) who now live in refugee camps in eastern Nepal. Tribal agitations in the eastern Himalaya serve to keep that part of the range mainly off-limits to all but Indian military personnel and government. Most recently, in Nepal, a Maoist insurrection threatens the peace and security of the country. Under such conditions it is difficult to achieve an effective local system of governance.

Amid these large controversies are local questions about public administration, social discrimination, and indigenous and general human rights. The Indian Himalaya operates basically within the country's system of parliamentary democracy. Practically, though, the mountain regions in India have little influence on national political affairs. This under-representation was one of the driving forces that led in 2000 to the establishment of the new Indian state of Uttaranchal, located in the Garhwal-Kumaon region (formerly part of the state of Uttar Pradesh). Good governance is absent in Nepal mainly because of the unstable political climate. Nepal has held three elections since democratic reforms in 1990, which formed a new parliamentary democracy, and no government has run its full term. The Maoist insurrection that began in 1996 and flared into nationwide violence in 1999 continues to suppress local governance in much of the country. Bhutan, meanwhile, remains a monarchy where the king retains absolute power. Decentralization of governance in Bhutan, however, was initiated in 1991 with the formation of committees made up of elected village heads (called the Geog Yargye Tshogchung), which are responsible for mobilizing local development, and continued in 1998 with the devolution of executive authority in the elected Council of Ministers.

Himalayan women traditionally hold greater independence and higher status than do women in the South Asian plains. This is most true among the Tibetan-Buddhist cultures and such ethnic groups as the Thakali and Sherpa where women are major decision-makers in the household. Women, of course, also do a great deal of the work in the mountains. The 1992 National Agricultural Survey in Nepal found that women are responsible for up to 71% of farm labor and 57% of all subsistence work. Yet a 1997 study showed that only 23% of women were allowed to dispose of their earning in capital transactions. The work of women goes largely unrecorded in the economic data and does not necessarily lead to their empowerment in the family. A major form of wealth in the mountains is land. However, land inheritance practices among Himalayan cultures often are prejudiced against women, and hence they are the most vulnerable to landlessness and poverty. The absence of women in the non-farm economy is due in large part to gender inequities in education and training, as well as to the cultural norms that keep women at home. The discrimination against mountain women, who often are unaware of their basic human rights, ranges from domestic inequity to the violent trafficking of girls to supply brothels in India and elsewhere.

The cultural norms of the Himalayan societies are generally conservative, and the attitudes and values held by many mountain leaders make it difficult to implement the principles of human rights upon which the modern Himalayan states are purportedly founded. This applies to women, to low caste groups, to ethnic minorities, and to other marginal members of society. Nonetheless, human rights' laws and legal procedures exist throughout the Himalaya, with varying degrees of implementation and efficacy. The human rights' record in Nepal is currently difficult to assess due to the unstable political climate and civil unrest in the country. The governments in the Indian Himalaya maintain that every citizen has the right to social justice, equality, and a decent standard of living. This is difficult to insure, however, when a large proportion of the mountain population is unaware of its rights or, as in the case of Kashmir, civil unrest and military action overwhelm the human rights' cause. Bhutan cautiously places the national sense of peace, happiness, and security above the needs of the individual. This policy is viewed by some as repressive, but a positive outcome is its ability to minimize the corrupting influences of modernity and globalization.

One of the main tasks in the Himalaya is to devise ways of maintaining traditional life and culture, as well as of preserving the natural environment, while implementing programs needed to reduce poverty and to enhance opportunities for human and social development. A balanced development is needed to achieve this goal, one that expands economic opportunities while safeguarding environmental resources and fostering responsible systems of governance. The mountains, for all their imposing appearances, are not immutable. The Himalayan region, in fact, is a fragile place, where society and nature are deeply challenged by the new demands of a modern, mobile, and global society.



Health Facilities in Bhutan: *Government-sponsored health units are found scattered across the countryside of Bhutan, but many of these are poorly-equipped and without adequately trained personnel. As a result, many people go without modern health care and rely on traditional village healers.*

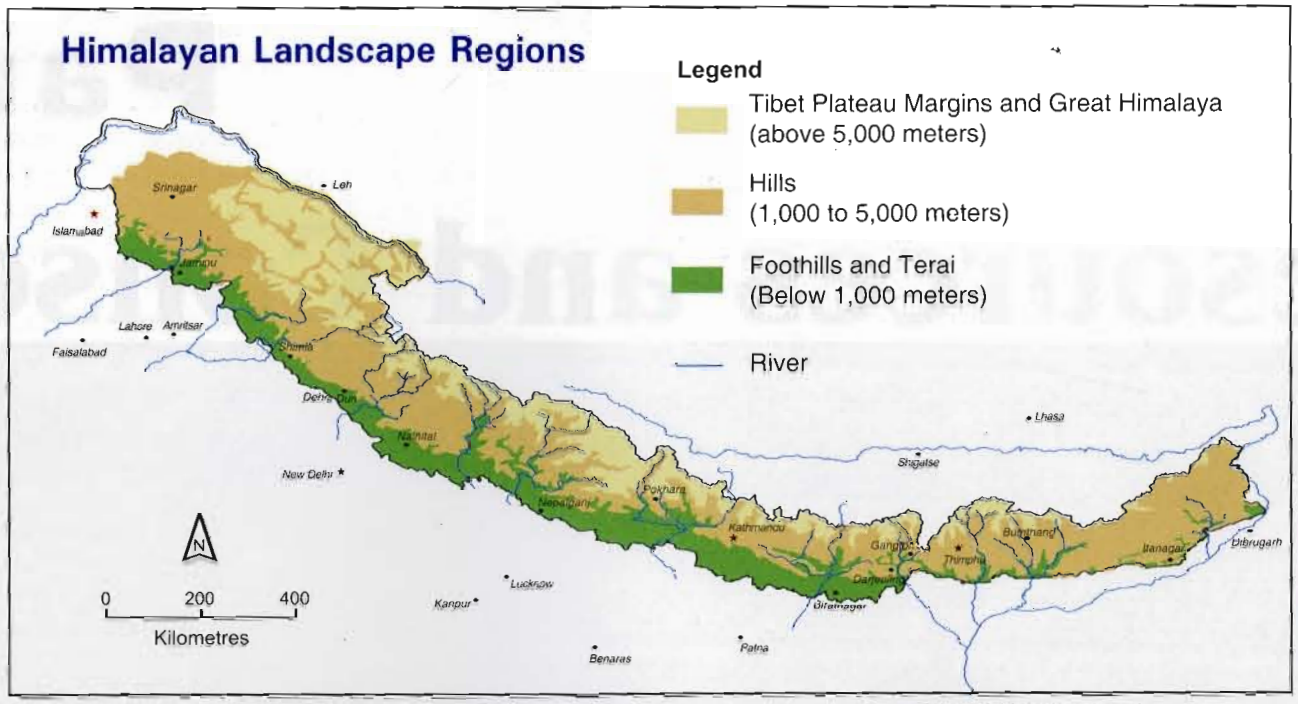
Source: Royal Government of Bhutan, 1992. Seventh Five Year Plan (1992-1997), Vol.1. Main Plan Document. Thimphu: RGOB, National Planning Commission

Part Four

Resources and Conservation

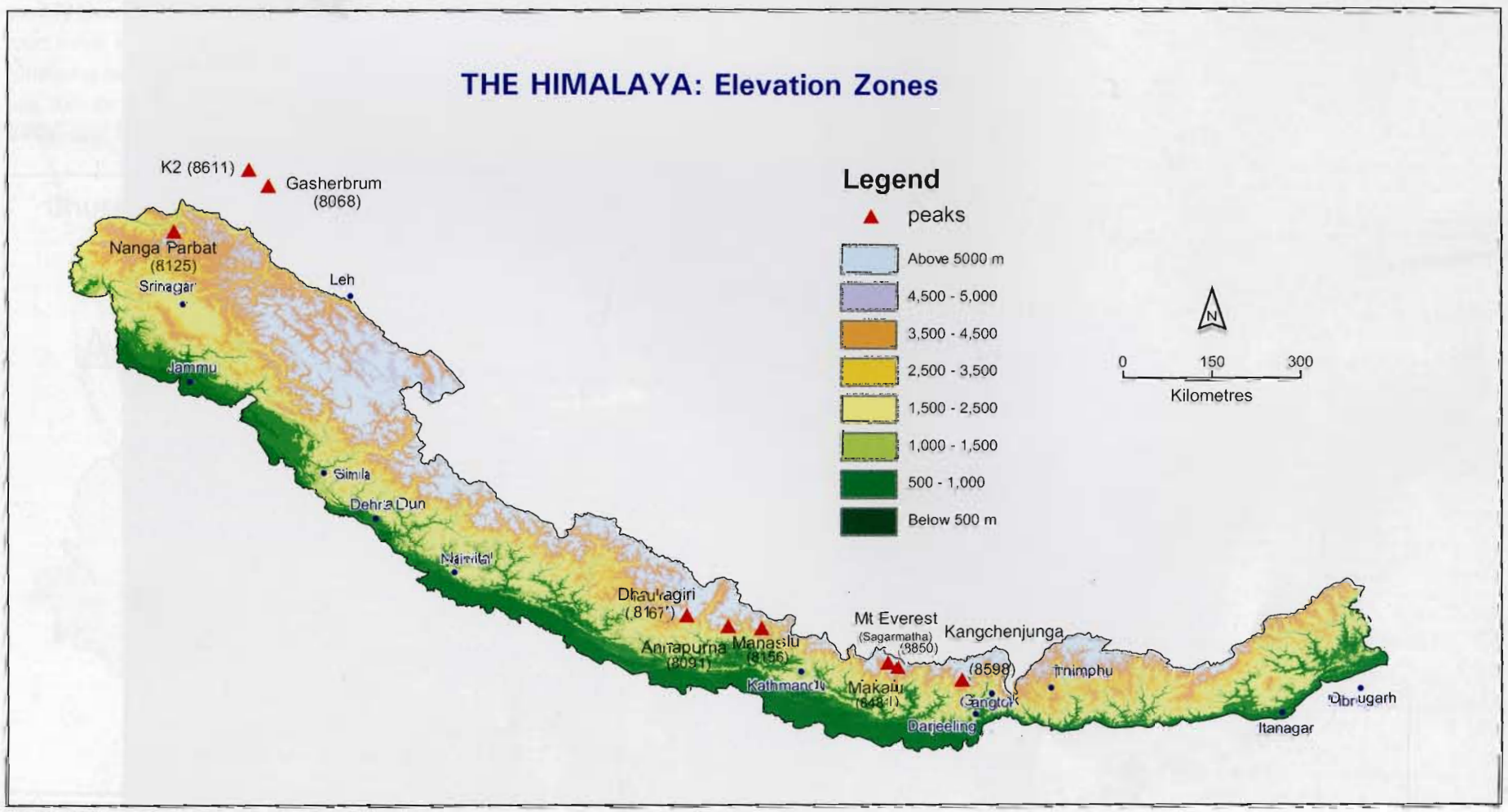
Baspa Valley, Western Himalaya

The Himalayan environment provides natural resources for local people as well as for the economic development of mountain states. The villagers traditionally rely upon the land for agriculture and livestock grazing, the forests for fuelwood, medicinal herbs, and timber, the rivers and streams for drinking water and crop irrigation, and the native wildlife for game hunting. These age-old practices continue amid the ever greater requirements of the growing human population. In places where the heightened demand for resources has led to their depletion, the sustainability of village economies and environments may be threatened. Too often the result is human poverty and land degradation. This dilemma has led, in recent years, to many innovative approaches toward resource management and social development in mountain villages. Such strategies seek to combine the sustainable elements of traditional mountain life with the new opportunities for conservation-based development.



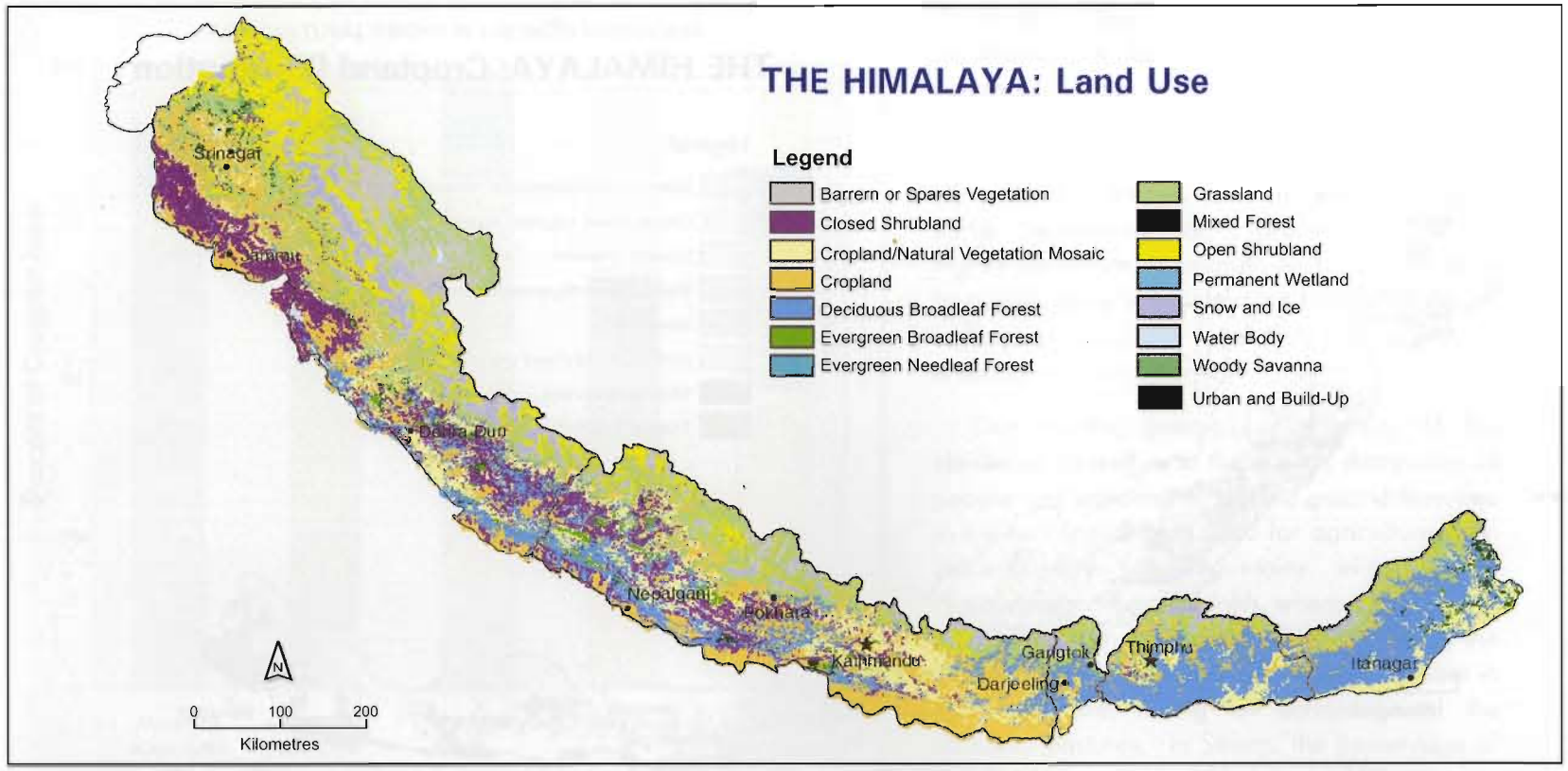
Source: Compiled by the authors. Adapted from Zurick D. and Karan P.P., 1999. Himalaya: Life on the Edge of the World. Baltimore and London: Johns Hopkins University Press

Himalayan Landscape Regions: *Land is the singlemost important resource in the Himalaya, where the vast majority of people are farmers who live in villages. The landscape regions of the Himalaya follow a generalized geographical pattern based upon elevation. Most Himalayan farmers live in the hill zone where elevations range from 1,000 to 5,000 meters. The 2,000 meter zone is the most densely settled area. The outer foothills and plains, with elevations below 1,000 meters, receive a large number of migrants who clear the fertile lowlands and establish new farms.*

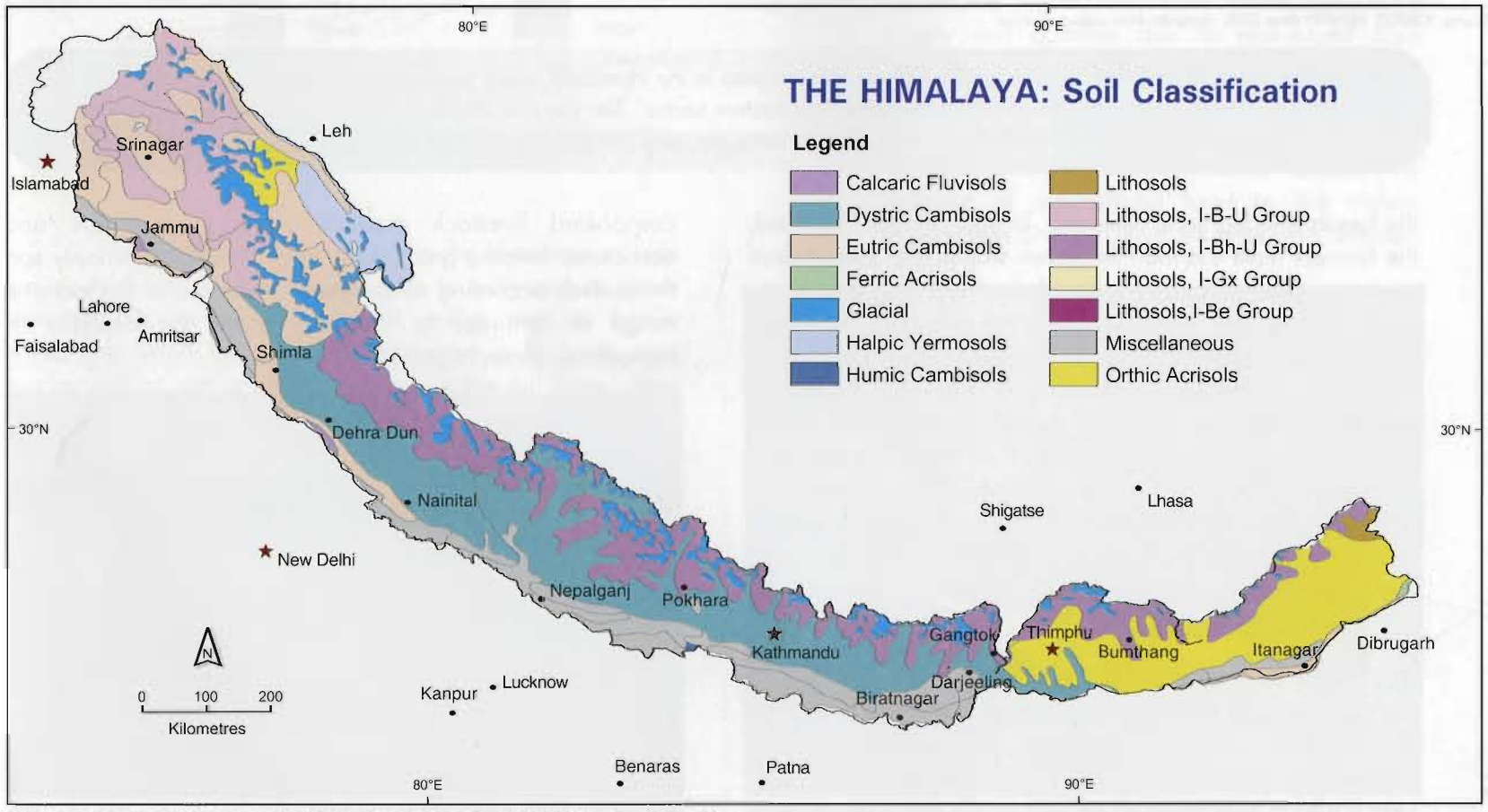


Source: ICIMOD, MENRIS data - derived from GTOPO data

Of particular interest to the Himalayan states is the hydropower capacity of the fast-flowing mountain rivers, the timber value of forests, and the role of commercial agricultural development, especially horticulture. National policies strive to develop such resources for the purpose of marshalling the forces of economic growth. Unfortunately, such efforts often may be managed incoherently or to the primary benefit of urban localities or societies in the plains. Hence they may be ineffectual and even contrary to the needs of most mountain people. Moreover, the dual demands of the expanding subsistence and commercial sectors exert a taxing pressure upon Himalayan environments and societies. This trend is alarming for many reasons, mainly because it conflicts with human rights and cultural survival, but also because it endangers one of the planet's great biological treasures. Numerous unique and threatened plants and animals are endemic to the Himalaya. If they disappear there, they are gone from the world. In the view of many people, biodiversity is the range's most precious



Source: ICIMOD, MENRIS data derived from IGBP DIS 1 km data



Source: ICIMOD, MENRIS data - derived from FAO-UNESCO Digital Soil Map of the World 1996

The Himalaya - Land Use: *The distribution of land-cover types in the Himalaya reflects a combination of environmental and human factors. Soil, climate, and topography influence the natural distribution of plant communities. The management of land by human societies has altered the composition of the natural land cover. Forests have been cleared, and, in some cases, planted; grazing lands have expanded onto other land categories where the size of livestock herds has increased and other changes have occurred. The result is a land-cover system that appears complex and diverse across the range.*

Agricultural land is scarce in the Himalaya

The Himalaya - Soil Classification: *The productivity of the land for agriculture is closely tied to soil type. Soil formation is a product of the weathering of parent material, or bedrock, and the addition of organic matter. Heavy rainfall on steep slopes, meanwhile, erodes the soil at a much faster rate than that at which it is created. Himalayan farmers, in turn, alter the composition and fertility of soils by adding compost and manure. The soil classifications in the map follow groupings determined by the UN, FAO.*

Land Use Types in Nepal (1999)

Landuse	Area (thousand ha)	%
Cultivated land	2,968	20
Non-cultivated land	998	7
Grass land	1,745	12
Forest land	4,269	29
Shrub land/degraded forest	1,559	11
Other land uses	3,179	21
Total	14,718	100

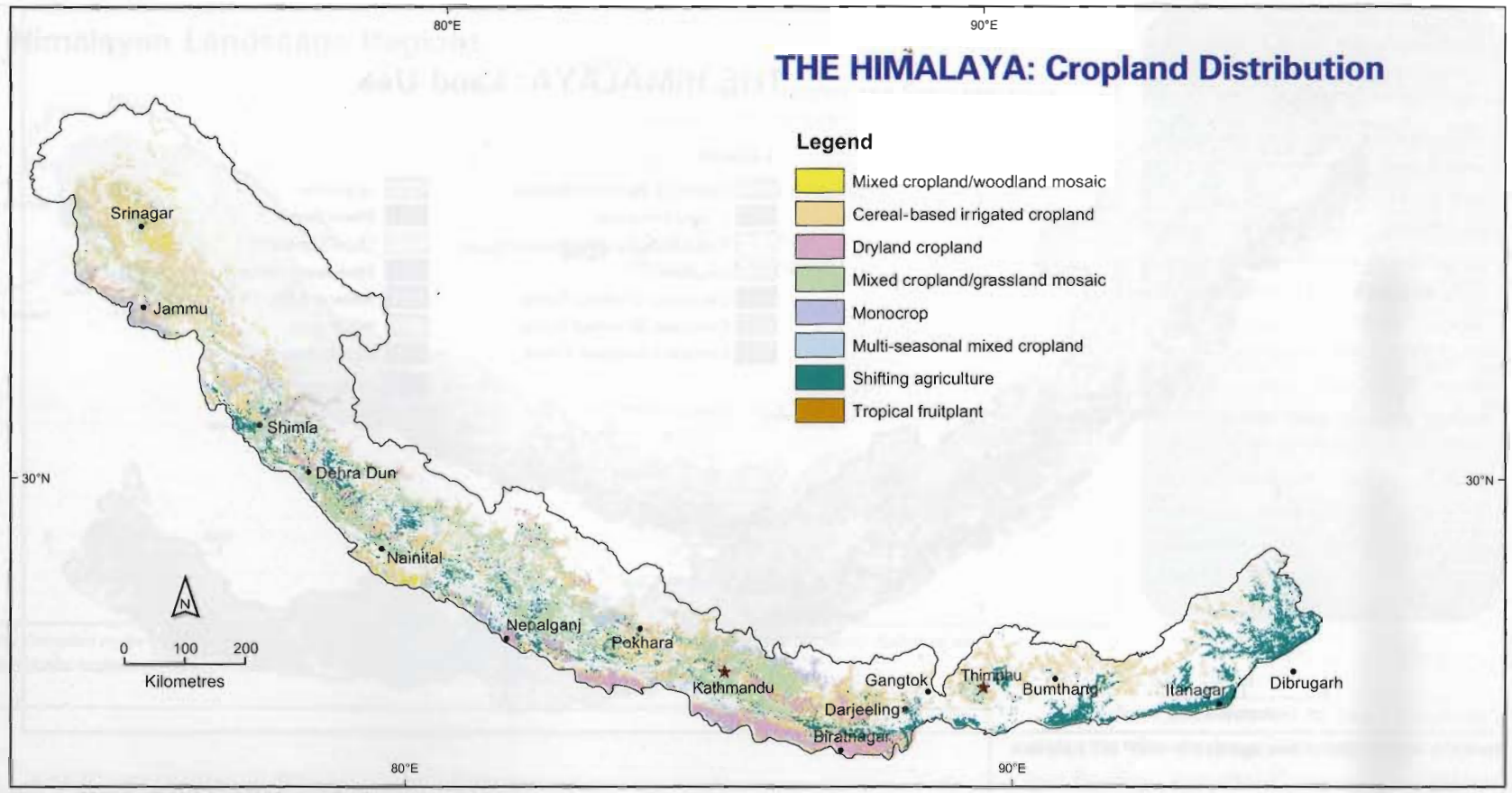
Source: Adapted from UNEP, 2001. Nepal: State of the Environment 2001. Bangkok: UNEP-RRC.AP

resource, and one that must be preserved against the forces of development that act to diminish or destroy it.

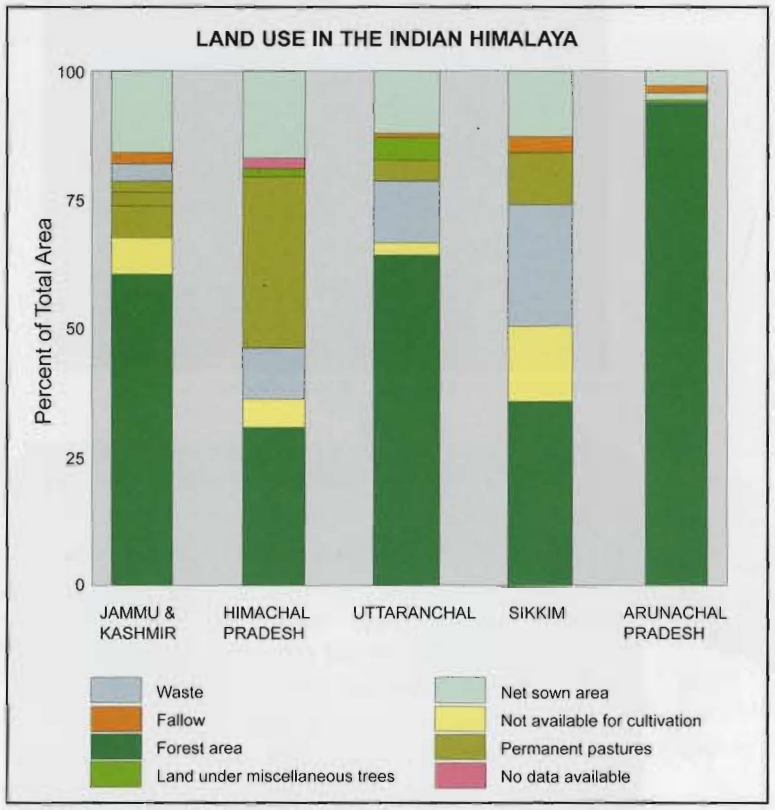
AGRICULTURAL LAND

The majority of Himalayan people are farmers. They till the hillsides and valley bottoms in centuries-old practices in order to grow grains, vegetables, and pulses, and they graze cattle, sheep, goats, and yak in the forests and highland pastures. To gain sufficient flat land, the farmers have cut the Himalayan slopes into cascades of terraces which support crops and distribute irrigation water across the tiny level surfaces. Due to the steepness of the land and to the erosive force of the monsoon rain, the loss of topsoil is an ever-present problem on Himalayan farms. In building the terraces, however, the mountain farmers reduce soil erosion by interrupting the length of the slope, and they often plant the strips of intervening land between the terraces with fodder trees and shrubbery in order to forestall the down slope movement of precious soil. It is only with such careful husbandry that the fragile mountain farms are maintained over generations of intensive use.

The productivity of the land farming depends on several environmental factors, including the local climate, the soil type, the orientation of the field to the sun (hence directly influencing energy receipts), and the altitude of the fields (which affects temperature), as well as on the application of composted livestock manure or other fertilizers and associated farming practices. Crop patterns commonly sort themselves according to elevation. Because of the extreme range of altitudes in the mountains, the diversity of agricultural zones is great.



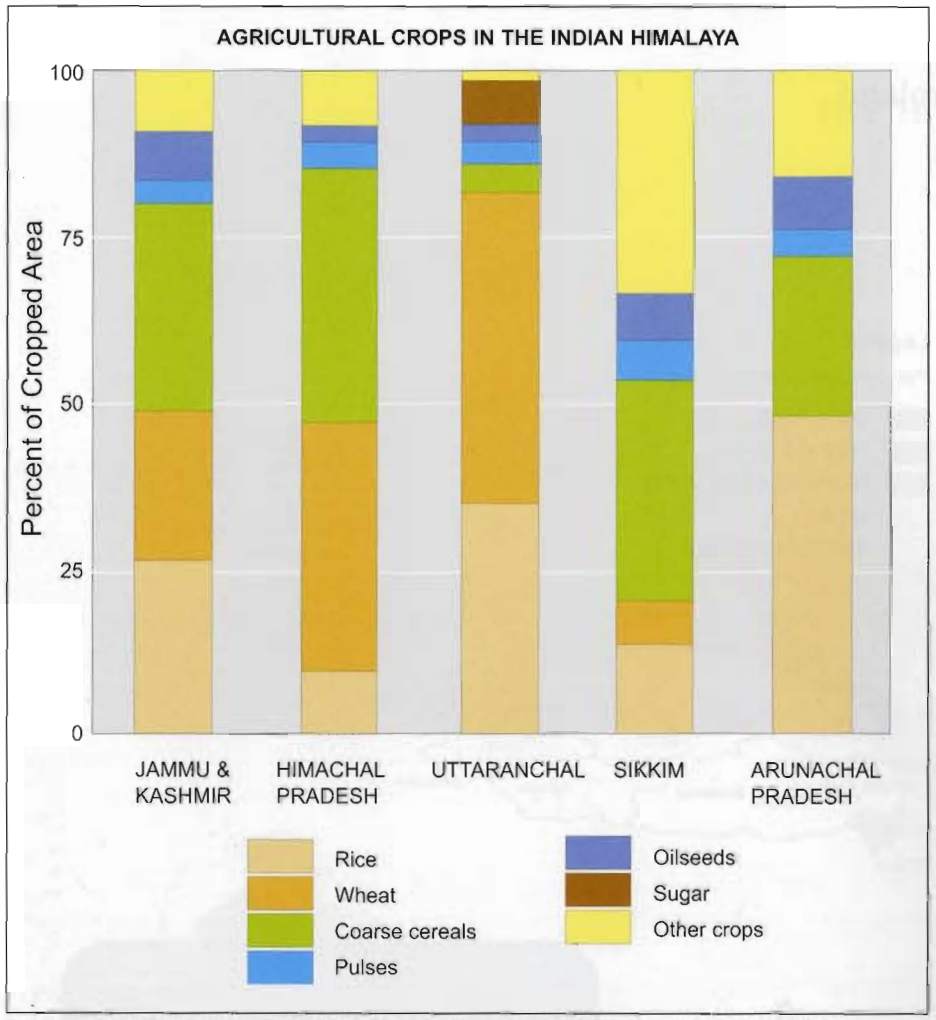
Source: ICIMOD, MENRIS Data 2000, compiled from various sources



Source: Adapted from INDIAN HIMALAYA: A Demographic Database (2002). Almora: G. B. Pant Institute

The Himalaya - Cropland Distribution: *The farming systems in the Himalaya reflect environmental conditions as well as cultural systems of adaptation. Shifting cultivation is common in the eastern sector. The low and middle hills of the central and western regions predominantly support mixed grain cultivation. The high mountains are used primarily for livestock grazing.*

Irrigated rice fields in the Marsyangdi Valley

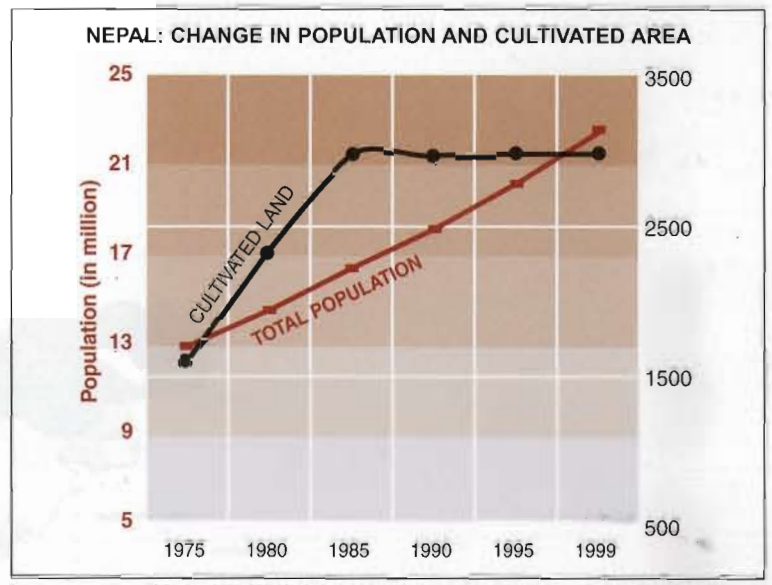


Source: Adapted from INDIAN HIMALAYA: A Demographic Database (2002). Almora: G. B. Pant Institute

The traditional crops grown in the Himalaya include grains such as rice, which normally is cultivated at lower elevations under irrigation; wheat, millet; and, at higher elevations, where the growing seasons are short, barley and buckwheat. Corn is grown throughout the hill zone, often inter-planted with other grains or with vegetables. Most households maintain home gardens and a few fruit trees. Potatos were introduced to the Himalaya in 1774 and are important throughout the alpine zones. Village livestock commonly include cattle, water buffalo, chickens which normally are kept around the farmsteads. Sheep and goats grazed on the more distant highland pastures, often in a semi-nomadic fashion, and provide villagers with meat as well as wool. One of the most unique kinds of livestock in the Himalaya is the yak, a type of cattle indigenous to the high elevations of the range. The yak herds are most commonly found among the Tibetan populations living in the trans-Himalayan zone and are used as beasts of burden, providing the herders with meat, dairy products, and wool. In addition to their farm work, villagers also commonly forage in the forests surrounding their homes for edible tubers, greens, and medicinal herbs. In recent decades, new crops and agricultural practices, such as mushrooms and herbs, beekeeping, dairy processing, and, at higher elevations, temperate fruit orchards such as apples, have been introduced in the villages in order to augment the local diets and to provide a source of cash income.

Due to the geographic diversity of the Himalaya, as well as to the skewed distribution of people and settlements, we find great differences in the amount of land used for agriculture from place to place in the mountains. In the western Himalayan region of Ladakh, where agriculture is possible only under irrigation, less than 2% of the land is farmed. Livestock grazing is important in this arid zone, taking full advantage of the seasonal pastures. In Sikkim, the percentage of farmland increases to 10% (almost 30% when we ignore the highest elevations where agriculture simply isn't possible due to year-round cold temperatures). Some of the lowest amounts of land under cultivation are found in the eastern Himalaya. Arunachal Pradesh reports less than 5% of its area devoted to farmland. Overall, the amount of agricultural land in the Indian Himalaya is about 10% of the total area. Bhutan,

Irrigation canals provide water to crops grown in the arid trans-Himalayan valleys.



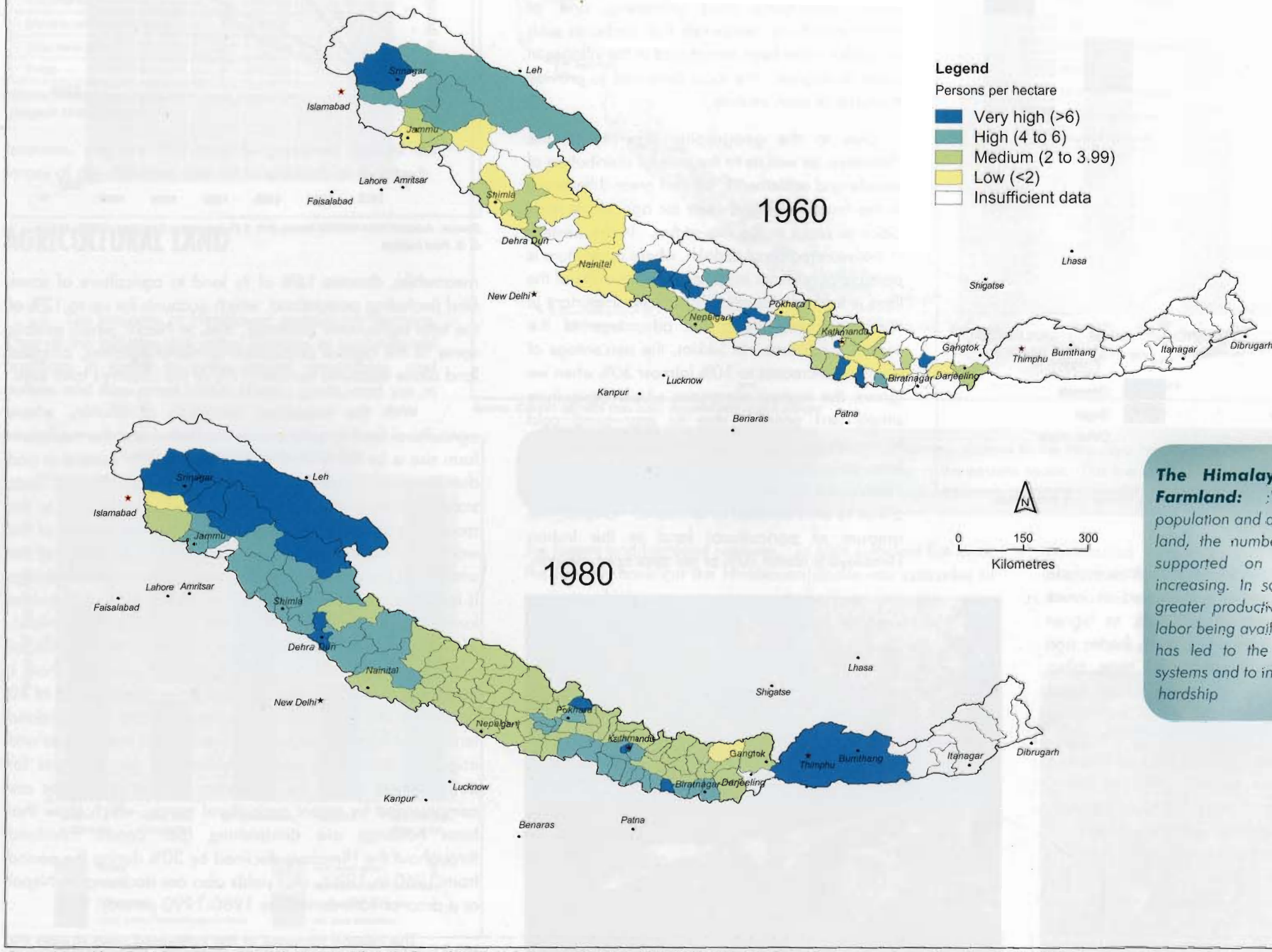
Source: Adapted from INDIAN HIMALAYA: A Demographic Database (2002). Almora: G. B. Pant Institute

meanwhile, devotes 16% of its land to agriculture of some kind (including pastureland, which accounts for up to 12% of the total agricultural holdings), and, in Nepal, which exhibits some of the highest population-farmland densities, cropped land alone accounts for over 17% of the country's total area.

With the important exception of Bhutan, where agricultural land is quite evenly distributed and the maximum farm size is by law limited to 10 hectares, the ownership and distribution of Himalayan farmland reflects wealth and caste status. Overall, per capita agricultural landholdings in the mountains are low compared to other farming regions of the world. In Nepal, where farm plots tend to be some of the smallest in the entire range, the average size of landholdings is less than a quarter hectare. The poorest 40% of Nepalese farmers own less than 10% of the country's total farmland, while the richest 6% control over a third of the agricultural area. In Bhutan, almost 50% of farmers own less than 1 hectare of land, much less than the government ceiling of 10 hectares. The small size of holdings, the fact that farmland tends to be fragmented, and the low rates of fertilizer use and irrigation combine to portray challenging circumstances for poor farmers across the Himalaya. These challenges are compounded by recent agricultural trends, which show that farm holdings are diminishing (per capita farmland throughout the Himalaya declined by 30% during the period from 1960 to 1990), and yields also are declining (in Nepal at a drop of 15% during the 1980-1990 period).

The overall increase in the cultivated area during the past 100 years is due mainly to population growth, which

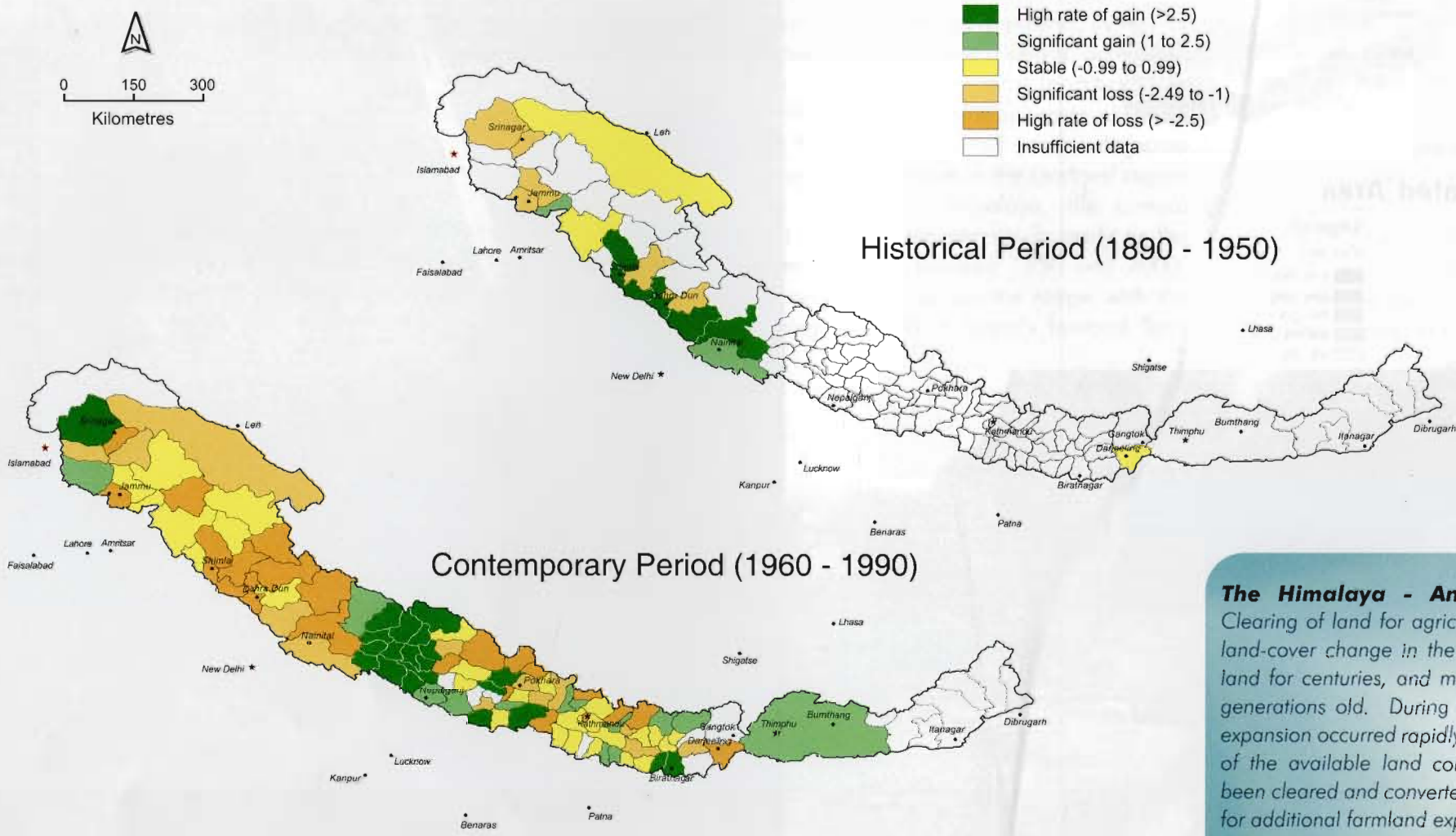
THE HIMALAYA: Population and Farmland



The Himalaya - Population and Farmland: *:With an increasing human population and a finite amount of agricultural land, the number of people who must be supported on the mountain farms is increasing. In some cases, this has led to greater productivity on the farms with more labor being available. Elsewhere, however, it has led to the collapse of environmental systems and to increasing human poverty and hardship*

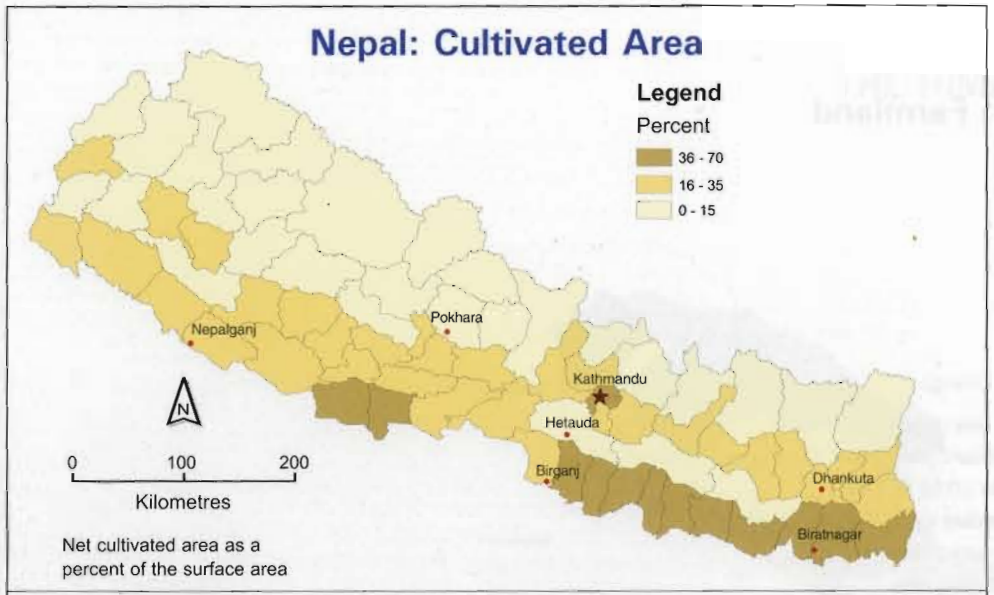
Source: Adapted from Zurick D. and Karan P.P., 1999. Himalaya: Life on the Edge of the World. Baltimore and London: Johns Hopkins University Press. Based on data from various government sources.

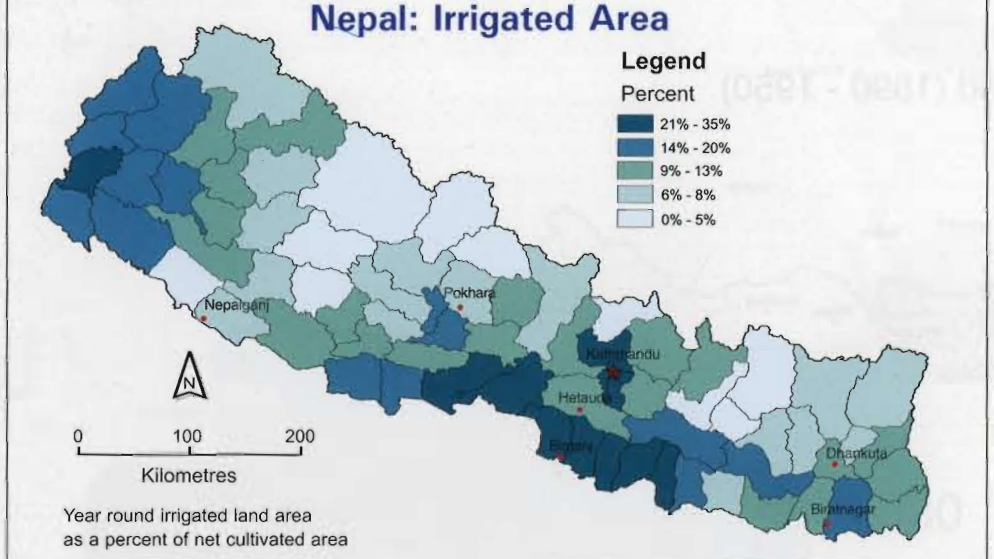
THE HIMALAYA: Annual Change in Farmland

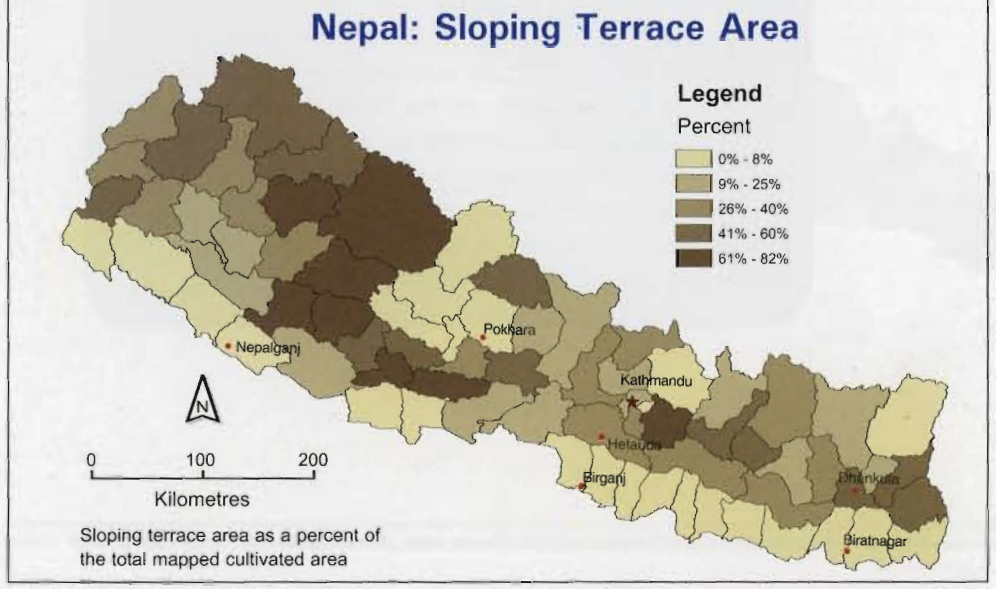


The Himalaya - Annual Change in Farmland: *Clearing of land for agriculture is one of the major factors in land-cover change in the mountains. Farmers have cleared land for centuries, and much of the agricultural landscape is generations old. During the contemporary period, farmland expansion occurred rapidly until the 1980s, by which time most of the available land conducive to agriculture had already been cleared and converted to farms. There remains little land for additional farmland expansion, and farm yields are likely to increase only by increasing the intensity with which existing farmland is utilized.*

Source: Adapted from Zurick D. and Karan P.P., 1999. Himalaya: Life on the Edge of the World. Baltimore and London: Johns Hopkins University Press. Based on data from the Government of India, Ministry of Environment and Forests, India District Gazeteers, HMG Nepal Central Bureau of Statistics, Land Resources and Mapping Project-Nepal, Government of Bhutan Planning Commission (note: data timeline for some districts is less than total period).

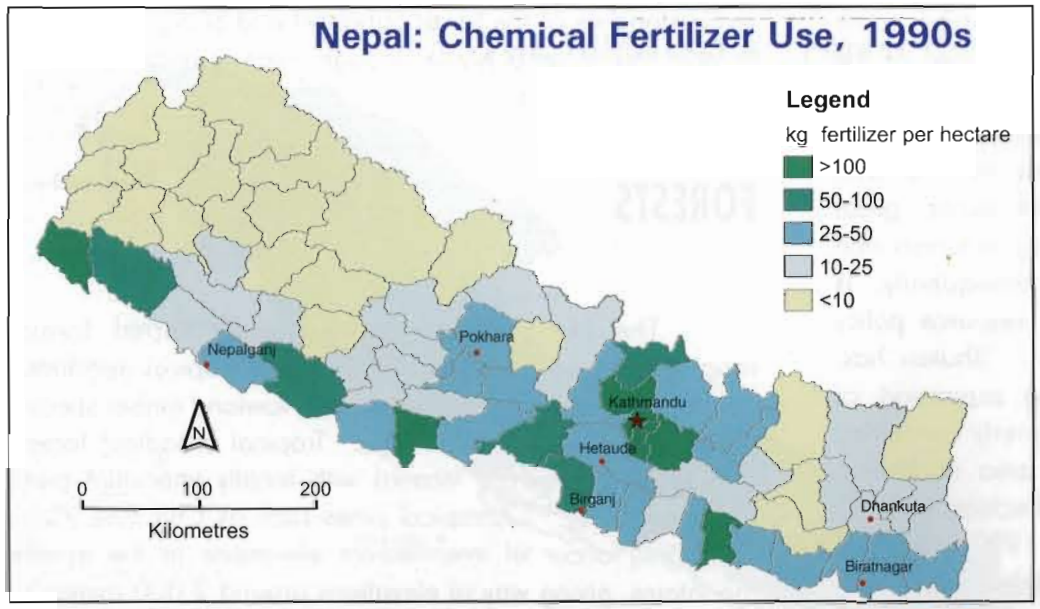






Source: ICIMOD, 1996. GIS Database of Key Indicators of Sustainable Mountain Development in Nepal. Kathmandu: ICIMOD

Woman threshing barley

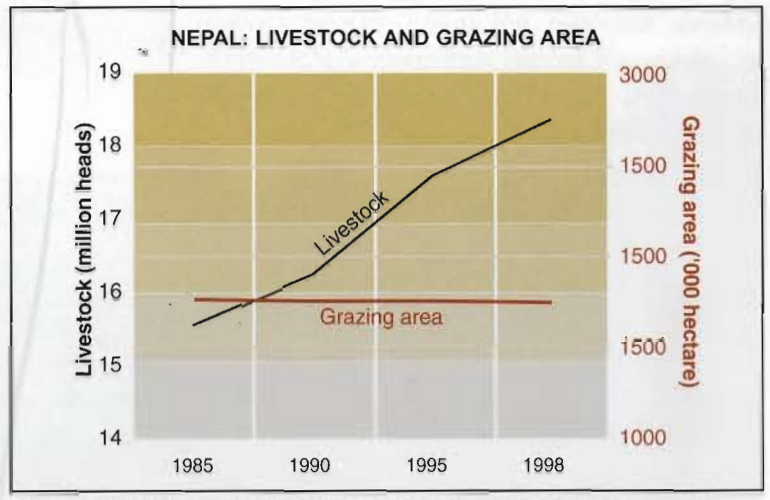


Source: Adapted from UNEP, 2001. Nepal: State of the Environment 2001. Bangkok: UNEP-RRC.AP

causes people to clear and farm more land, and to migration, whereby people leave overcrowded areas and settle the new land frontiers. Some recent increase is due to government schemes and advances in agricultural technologies. The

Chemical Fertilizer Use: *The use of chemical fertilizer in many places is increasing, especially among larger farmers, and results in higher grain yields. The chemical fertilizers lessen the requirements for organic nutrients, which are often scarce, but it adds to the problem of chemical pollution of soil and water.*

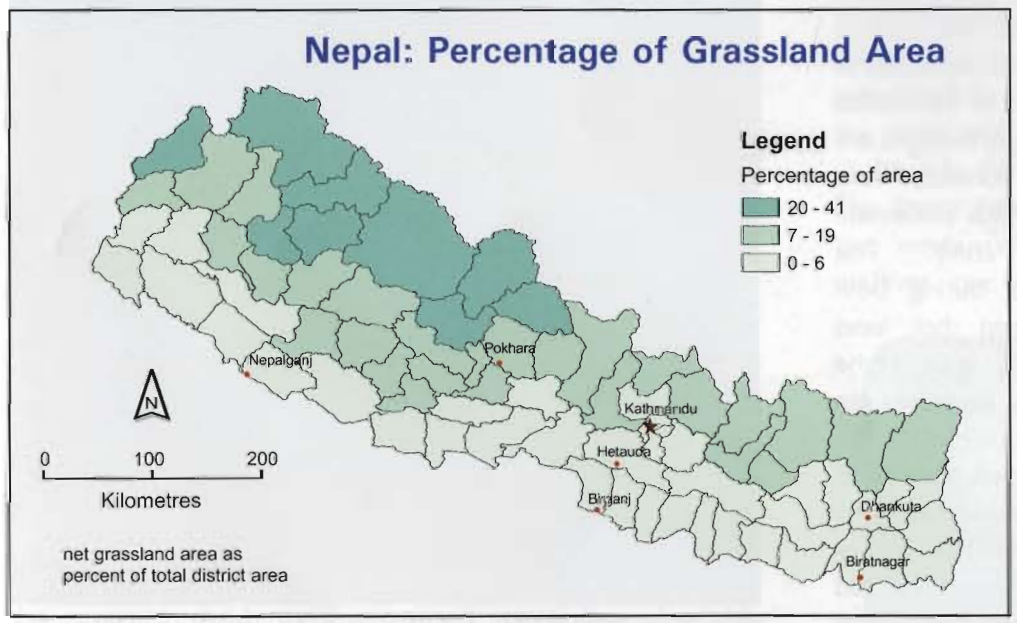
archival records kept by the British and later by the Indian governments, as well as those of Nepal, show a steady increase in the cropped area in most localities since 1890, with the most rapid gains observed in the hills and foothill zones. In some places, for example in the Garhwal region in the western Himalaya, the annual increase of farmland exceeded ten percent as early as the beginning of the 20th century. Between 1950 and 2000, farmland expansion occurred all across the range, with the greatest increase being recorded in Nepal's lowland Terai



Source: Adapted from UNEP, 2001. Nepal: State of the Environment 2001. Bangkok: UNEP-RRC.AP

zone. The increase in Terai farmland is due specifically to the rapid migration of people onto the lowlands, beginning in the 1960s when Nepal initiated a malaria eradication program and introduced a planned resettlement scheme. This policy shifted population density from the crowded hill areas onto the unsettled plains, resulting in significant new pressure on the Terai lands. In a few localities, in the western Himalaya,

Nepal - Percentage of Grassland Area: *The main grazing lands occur naturally in the high mountains, or in the lowlands where land is cleared of forest. The high mountain pastures, where villages are located, extend in some cases to altitudes greater than 5,000 meters, making some of these places the highest inhabited lands on earth. Yak and sheep are commonly grazed in the high grasslands. Cattle and water buffalo are common in the lower pastures.*



Source: ICIMOD, MENRIS data, 1995, compiled from various sources

Summer grazing lands in Langtang Valley, Nepal

Apple orchard, Himachal Pradesh

however, particularly around the town of Shimla and along the lower reaches of the Sutlej River valley, the amount of land devoted to foodgrains actually decreased during the 1960s through the 1990s. This was due in part to the extensive development of temperate apple orchards which displaced traditional farms in parts of Himachal Pradesh. Other farmland decreases are recorded in scattered pockets where land degradation is serious enough that cultivated land has been taken out of production. In such cases, the high rate of soil erosion simply rendered the farms infertile.

Some of the sharpest gains in agricultural land during the past three decades occurred in Nepal where a cluster of 14 districts in the western region, covering more than 25,000 square kilometers, reported an extremely high percentage of farmland increase. This area historically is poverty-stricken, with a relatively low population density, and the increase reflects the new roads, bridges, and irrigation canals that were built in part to support agricultural development. Overall, though, the most significant real gains in farmland during the past 50 years have occurred in lowland Nepal where the annual rate of farmland increase in the Terai districts commonly exceeds 10 percent. East of Nepal, in Darjeeling, the land records show a recent loss in the amount of farmland devoted to foodgrains. This is due mainly to the high rate of urbanization in the area and to the expansion of commercial agriculture, mainly tea plantation, at the expense of subsistence fields.

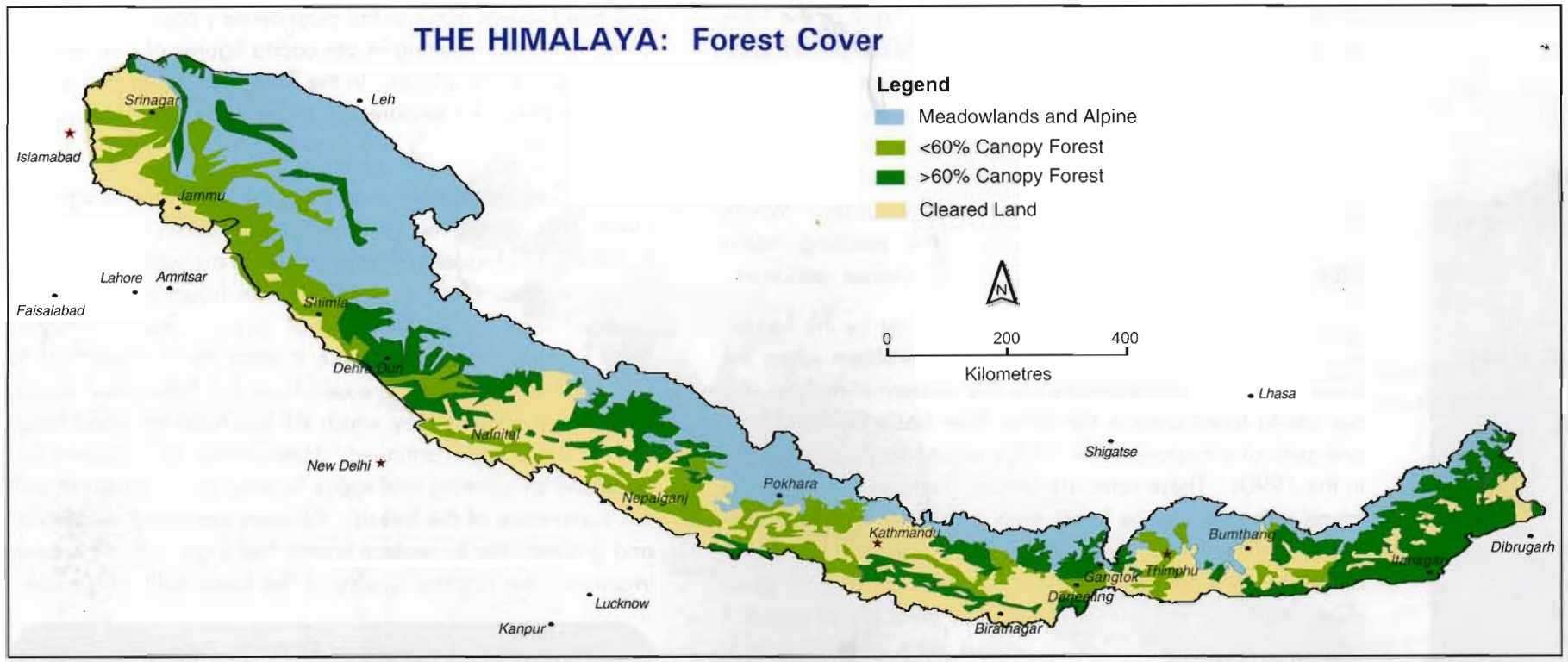
Bhutan, meanwhile, exhibits some of the lowest population densities of the Himalayan countries and, consequently, has some of the most favorable natural conditions for agricultural development. The country, however, places great importance on maintaining its forests and the farming frontier, consequently, is limited by the kingdom's resource policy favoring forest protection. Bhutan has, however, experienced an expansion of farmland in some formerly unsettled places. The cultivated area in Bhutan increased from 300,000 hectares in 1958 to 554,000 hectares in 1990, a rate of increase that basically matched population growth. Geographically, the expanding farmland in Bhutan is at the behest of government sponsored land settlement schemes and occurs in places where the planning interest promotes sustainable agricultural growth. The increase, however, also reflects the spontaneous land clearing by Nepalese who migrated into the Bhutanese hills during the early decades of the 20th century.

Only a few densely settled farm areas exist in the northwestern Himalaya. Generally, the climate is not conducive to agriculture in the trans-Himalayan zone, which occupies a huge area of Ladakh and Zanskar, but intensive agriculture occurs in scattered localities where irrigation schemes were built. Low and medium farmland densities were scattered across the lower elevation of the western mountains until the 1970s when rapid population increases in Kumaon and Garhwal led to the expansion of farmlands throughout the area. The most crowded districts, though, are found in Nepal. Initially, the Nepalese farmers were concentrated in the hill zone, but since the 1980s settlement expansions have characterized the Terai zone. The widespread high farming densities in Nepal during both historical times and the presentday suggest that land resources have been scarce in that country for quite some time. Both Sikkim and Bhutan enjoyed low pressures on farmland during early times, but the last decades of the 20th century show accelerating demands for farmland, with up to five persons now living on each hectare of farmland in many localities. The agricultural records in Arunachal Pradesh are difficult to assess, but government estimates show localized land stress in places such as the Ziro Valley and along the fertile stretches of the lower Subansiri and Siang rivers. The eastern region as a whole, though, reports relatively stable agricultural holdings.

FORESTS

The Himalaya contain extremely varied forests ranging from wet tropical to alpine. The tropical deciduous Sal tree (*Shorea robusta*) is a valuable lowland timber species that is widespread in the range. Tropical broadleaf forests also include (*Quercus incana*) with locally important pipal (*Ficus religiosa*). Subtropical pines such as Chir Pine (*Pinus roxburghii*) occur at intermediate elevations in the middle mountains, giving way at elevations around 2,000 meters to mixed temperate hardwoods dominated by oak (*Quercus incana*) and Rhododendron (*Rhododendron arboreum*) forests. Temperate forests in the western part of the range include the economically important species (such as Pinus *wallichiana*) and *Cupressus torulosa*. Moist subtropical and temperate forests in the central and eastern sectors of the range contain numerous species of bamboo. A variety of

Hill zone temperate forest



Source: Adapted from Zurick D. and Karan P.P., 1999. Himalaya: Life on the Edge of the World. Baltimore and London: Johns Hopkins University Press. Compiled from various sources, including Kawosa, M.A., 1998. Remote Sensing of the Himalaya. Dehra Dun: Natraj Publishers; and ICIMOD, MENRIS data.

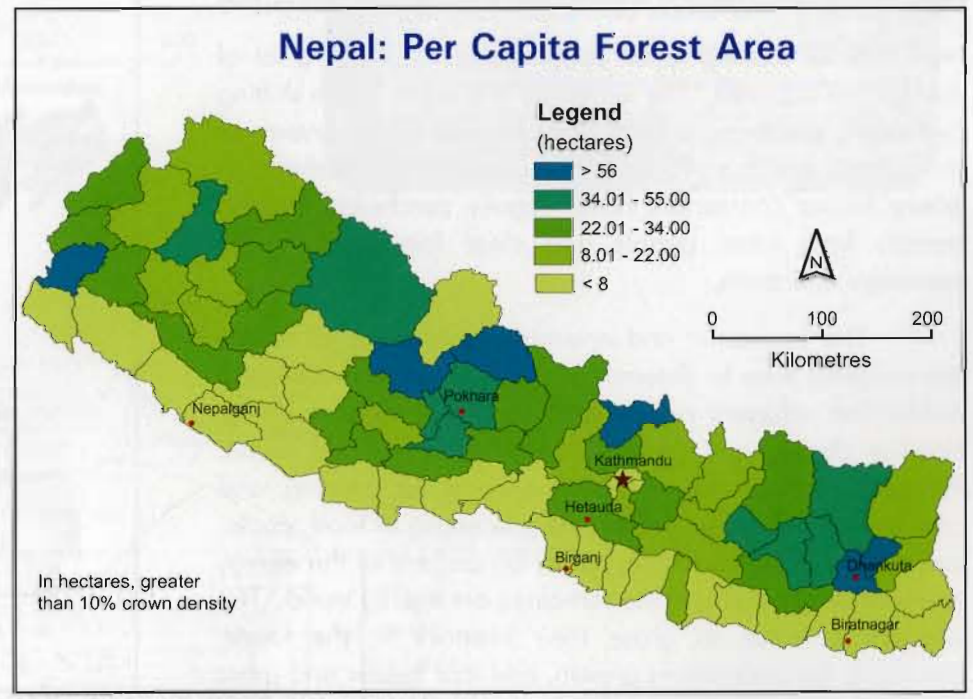
pines (*Pinus spp*), spruce (*Picea spp*), fir (*Abies spp*), and juniper (*Juniperus*) occur in the upper temperate and subalpine zones, which converge with the alpine level in a stunted mix of dwarf conifers (*Coniferae spp*), willows (*Salix spp*), and birches (*Betula spp*).

The condition of the Himalayan forests varies widely across the range, not only as a result of natural geographic factors, such as climate and elevation, but also because of the varied use of the forests by villagers and by commercial loggers. Overall, the Indian Himalayan area reports 52% of the total area covered by forest, much of which occurs in the sparsely populated eastern region of Arunachal Pradesh (over 90% of which is covered by forests). In Nepal, forests account for 29% of the total land area (an additional 10% of the country is covered in shrub), and in Bhutan the forested area currently is estimated to be 57% of the country's total area (revised downward from 68% reported in the late 1980s). In almost all these areas, however, the forest is decreasing at an estimated overall rate of about 1% per year across the entire Himalaya. The reported decline is most severe in Nepal, where forests decreased by 24% between 1978 and 1994 (currently, the annual deforestation rates in Nepal are 2.3% in the hills and 1.3% in the Terai). For the same period in Nepal, the area of shrub land increased more than twofold, indicating a trend toward degraded forests rather than their wholesale loss.

The estimates of forest change in the Himalaya point overall to a worsening situation, but the trends are not the same everywhere. Historically, high rates of forest loss occurred in the Garhwal and Kumaon regions of the Indian Himalaya. These averaged about 2% per year during the period from 1890-1950 and were directly related to timber extractions by the British for building railroads in the plains and for building summer resort towns in the hills (for example, Shimla and Nainital). The British kept good records for the forests in the western Himalaya, but elsewhere the archives are insufficient to accurately assess forests change during the historical period. However, it is clear that, across the range, as farmland increased so, too, did forests proportionally decrease in the early periods.

The land records are more complete for the modern era. Between 1960 and 1990, approximately one-third of all Himalayan districts reported a forest loss. While this trend is alarming, it is not as bad as might be expected from the environmental reports of the 1970s, which suggested that the entire range would be denuded by the early 21st century and might become a desert. Much of the contemporary forest loss has occurred in the outer foothill zone where timber merchants and migrant farmers put considerable pressure on the forest areas. In Nepal, where the forest condition is allegedly bad everywhere, some parts of the kingdom are better off than others. The western region of the country, where population densities remain the lowest, maintains a good forest cover, although serious losses are being reported along the Indian border. Rates of forest loss in Bhutan are not readily known, but the overall condition of the forest there remains good. In the far eastern Himalaya, an absence of data does not permit an assessment of forest change, but the

Nepal - Per Capita Forest Area: *The increasing population of the hills relies upon diminishing forest areas, many of which are seriously degraded so that the density of the forest crown (a measure of intact forest) may be less than 10%. Under these conditions, it is difficult for villagers to obtain their subsistence needs from local forests.*



Source: ICIMOD, MENRIS data, 1995, compiled from various sources

Degraded trees heavily lopped for livestock forage in the Dang Valley, Terai, Nepal

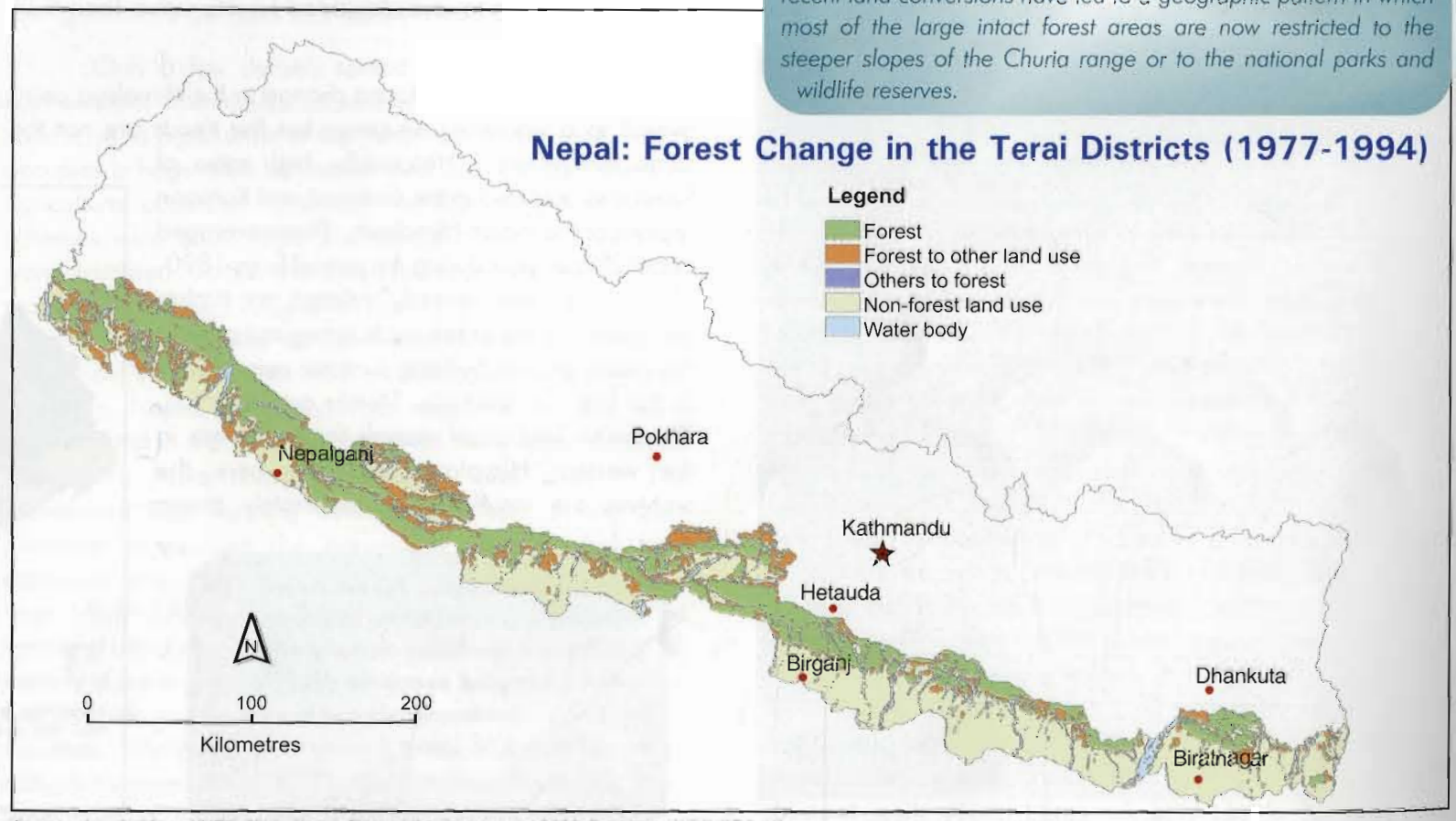
high rates of existing forest cover suggest that not a lot of decline has occurred. The exception is in areas where shifting cultivators, practicing a form of agriculture locally known as jhum, slash and burn forests in an unsustainable fashion, or where timber contractors have illegally purchased logging permits from tribal people and clear forests along the roadways and rivers.

The economic and environmental values of forests are relatively easy to determine. They supply fuelwood and fodder for villagers and timber for commercial logging, stabilize slopes, and provide habitat for flora and fauna. Villagers continue to rely on fuelwood for heating and cooking, as well as for small-scale processing of food, paper, and pottery. On the whole, nearly 80 percent of the energy needs of people living in the Himalaya are met by wood. The villagers continue to graze their livestock in the forest, disturbing the understorey growth, and leaf fodder and grass collected from forests are the main sources of household animal feed. In densely populated areas, many of the trees are so heavily lopped for leaf fodder they no longer maintain their canopy or provide seed for future generations of trees. The villagers also forage in the forests for food and medicinal plants. These are traditionally sustainable practices, but the high value of some of the non-timber resources compels people to harvest them for commercial purposes. Where local regulations are not enforced, the resulting heavy extraction may take a serious toll on all the forest resources.

The traditional subsistence needs met by the forests, mainly fuelwood and fodder, become a problem when the forest area diminishes greatly. In the western Himalaya, the per capita forest area in the Indus River basin declined from one-sixth of a hectare in the 1970s to one-tenth of a hectare in the 1990s. These rates are among the lowest in the entire range. The per capita forest area is a more favorable two-thirds of a hectare in Garhwal and one-half of a hectare in Kumaon. The forests in the Kulu Valley are in quite good shape, with the per capita forest area currently at about 1 hectare. Nepal, which shows serious rates of forest loss in many districts, also exhibits low per capita forests - one-fifth of a hectare per person overall. Some of the most seriously degraded forests occur in the most densely populated districts of the hill area, resulting in per capita figures of one-tenth of a hectare in some places. In the Terai, per capita forest area declined from .13 hectares in 1970 to .07 hectares in the early 1990s.

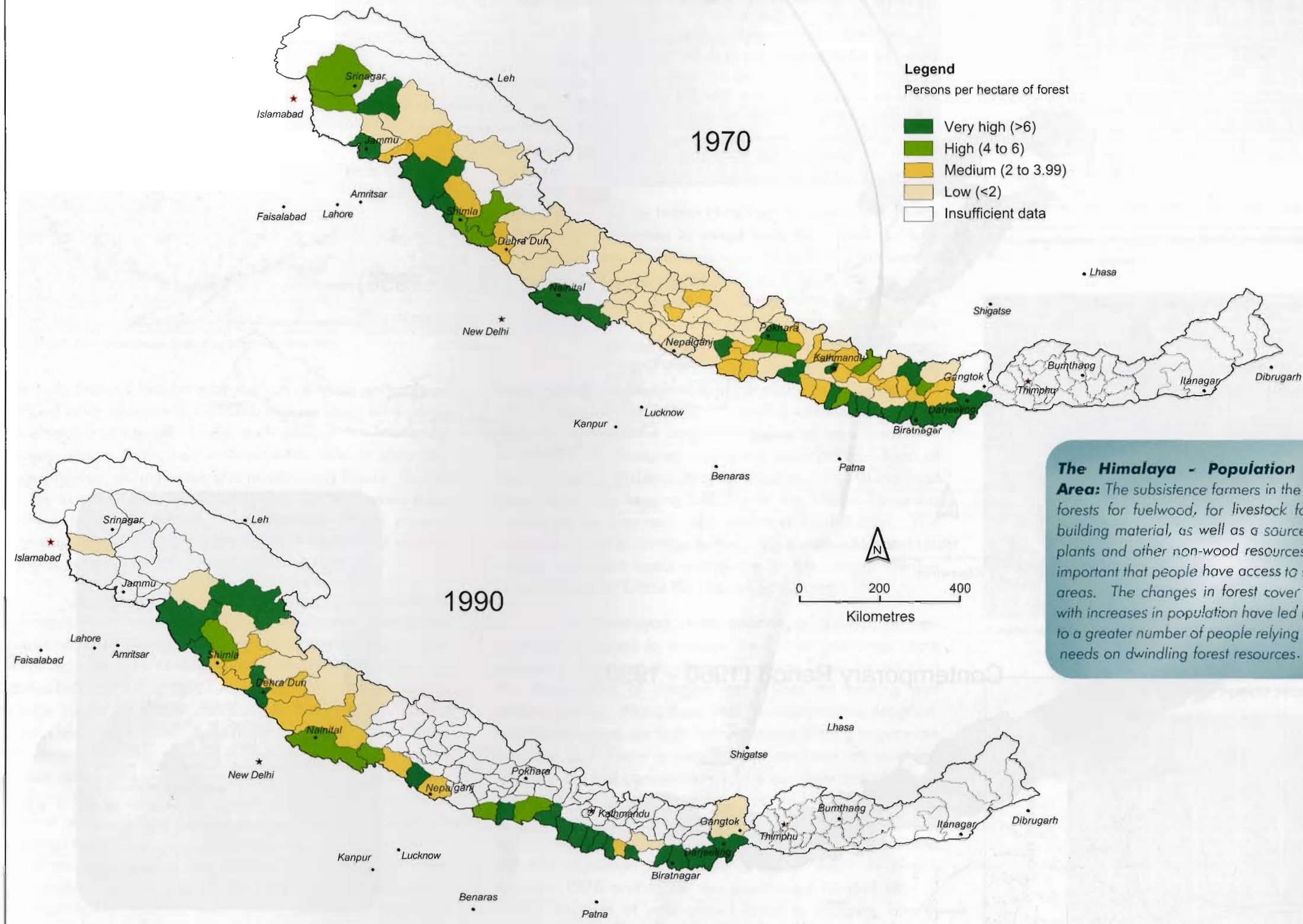
The decreasing availability of forests for village use means that people must work harder to obtain the necessary fuelwood and fodder. Greater distances are walked to gather wood for fires, often requiring several hours each day. In eastern Nepal, which hosts large populations of refugees from Bhutan, the average time it takes for a household to procure fuelwood has increased from 1.5 hours to 8 hours. Studies in the Kulu Valley, which still has relatively good forest cover, show the continued dependence of villagers on fuelwood for cooking and space heating is incompatible with the sustenance of the forests. Villagers are using more twigs and ground litter to replace scarce fuel logs, with a negative impact on the organic quality of the forest soils. Moreover,

Forest Change in the Terai Districts: *The highest rates of forest clearing occur in the Terai, where land has been settled by migrants and converted to farms and other non-forest uses. The recent land conversions have led to a geographic pattern in which most of the large intact forest areas are now restricted to the steeper slopes of the Churia range or to the national parks and wildlife reserves.*



Source: Adapted from UNEP, 2001. Nepal: State of the Environment 2001. Bangkok: UNEP-RRC.AP

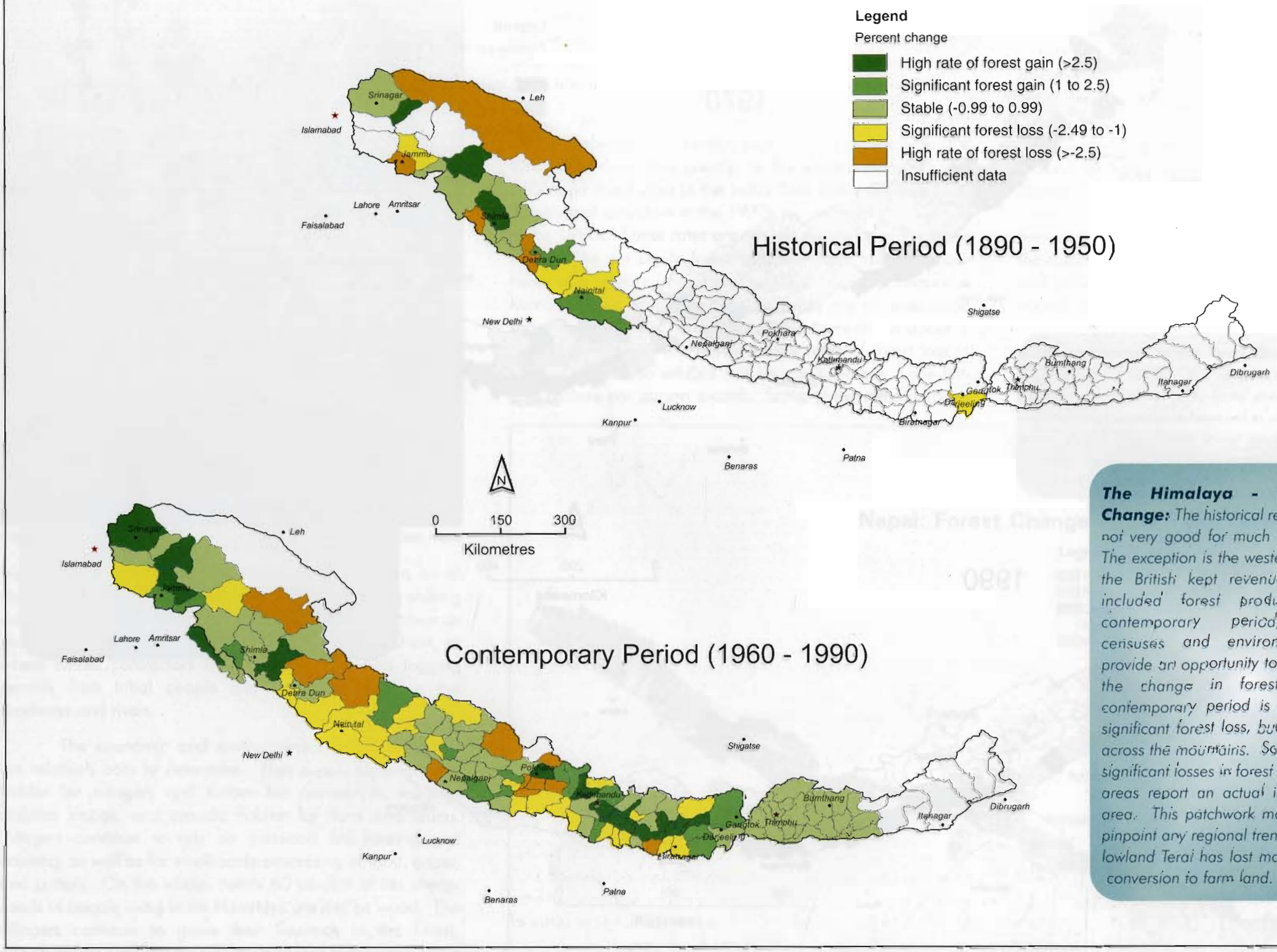
THE HIMALAYA: Population and Forest Area



The Himalaya - Population and Forest Area: *The subsistence farmers in the Himalaya use forests for fuelwood, for livestock fodder, and for building material, as well as a source for medicinal plants and other non-wood resources. Hence, it is important that people have access to sufficient forest areas. The changes in forest cover in conjunction with increases in population have led in many places to a greater number of people relying for subsistence needs on dwindling forest resources.*

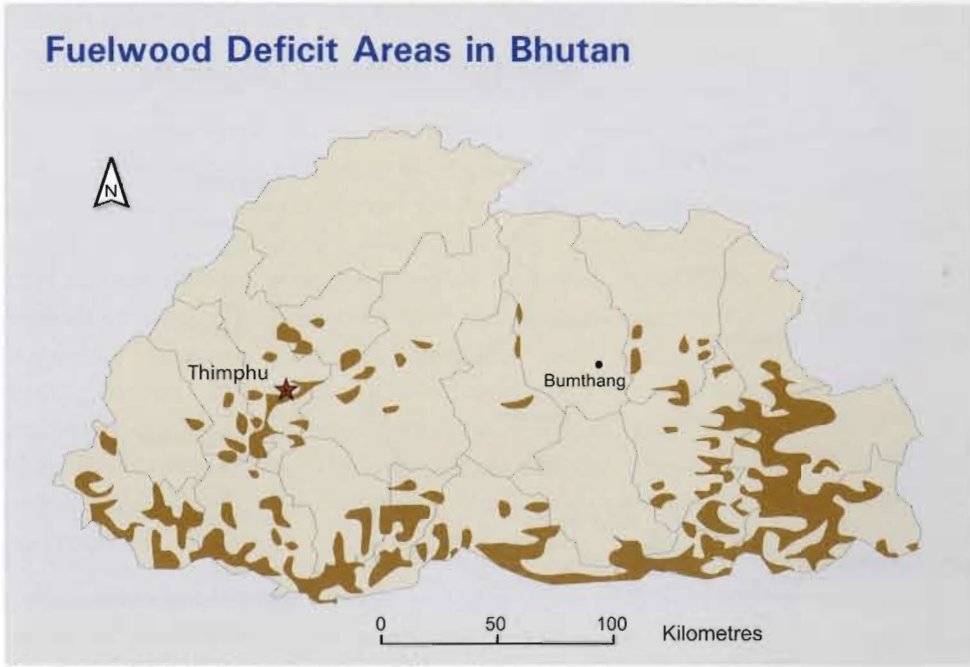
Source: Adapted from Zurick D. and Karan P.P., 1999. Himalaya: Life on the Edge of the World. Baltimore and London: Johns Hopkins University Press. Compiled from various government censuses and land use reports for Bhutan, India, and Nepal.

THE HIMALAYA: Forest Cover Change



The Himalaya - Forest Cover Change: *The historical record for forests is not very good for much of the Himalaya. The exception is the western section where the British kept revenue accounts that included forest products. In the contemporary period, government censuses and environmental surveys provide an opportunity to assess by district the change in forest cover. The contemporary period is characterized by significant forest loss, but it is not uniform across the mountains. Some areas register significant losses in forest cover, while other areas report an actual increase in forest area. This patchwork makes it difficult to pinpoint any regional trend. In general, the lowland Terai has lost more forest through conversion to farm land.*

Source: Adapted from Zurick D. and Karan P.P., 1999. Himalaya: Life on the Edge of the World. Baltimore and London: Johns Hopkins University Press. Based on data from the Government of India Ministry of Environment and Forests and Ministry of Agriculture, Land Resources Mapping Project-Nepal, Government of Bhutan Planning Commission



Source: FAO, 1991. Wood Energy Sector Analysis, Bhutan. Rome: FAO

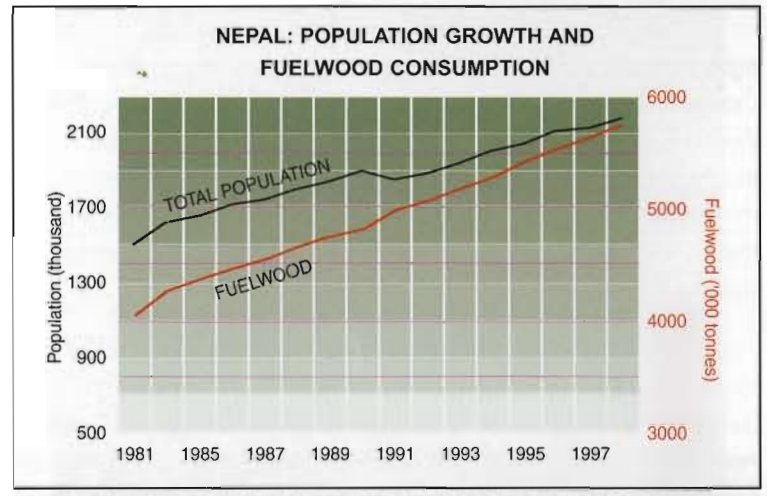
Fuelwood Deficit Areas in Bhutan: *The use of wood for cooking and heating fuel has led to its depletion in heavily-populated areas of Bhutan. This is a particular problem where forests are most degraded. Efforts to introduce more fuel-efficient stoves, such as the ceramic chulla stove designs, have been effective in some localities in reducing the local fuelwood demand. Overall, though, fuelwood remains the single, most important type of energy consumed in the Himalaya.*

the soils that are laid bare by the loss of forest canopy and ground cover also are overgrazed, making them more prone to erosion and run-off. Under such adverse conditions, the forests play a diminished environmental role in absorbing heavy rainfall, storing water, and ameliorating floods. Studies in the Kumaon show how mature forests may retard flood outflow by up to 25 days, but under the current stressed condition of the Almora forests, the outflow is rapid and the local water supplies have consequently decreased.

Commercial logging compounds the subsistence pressures on Himalayan forests. In the absence of tree-planting measures, and where the commercial plantations fail to meet local economic or environmental needs, the problem is particularly acute. In the Garhwal region, the exploitation of village forests by timber concessionaires in the 1970s and 1980s led to a collective village resistance known as the Chipko Movement. The village women in Garhwal sought to restrain the timber cutters by locking arms around the trees, and the tree-hugging motif of the Chipko Movement became a worldwide symbol of environmental resistance among indigenous people fighting against outsider interests. The Himalayan timber resources are exploited for industrial uses such as paper, construction, packaging, and furniture, and for export abroad to generate foreign revenue. Much of the commercial logging is managed by concessionaires who procure the permits, often illegally, from the government officials. The timber business provides a lucrative income for both.

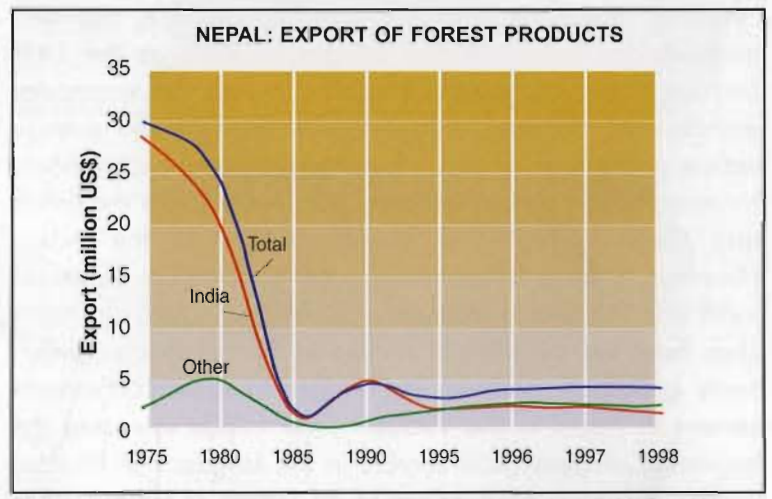
In the Indian Himalaya, the value of logs was calculated to range from Rs. 1,980 for Chir pine (*Pinus roxburghii*) to Rs.8,100 for Deodar (*Cedrus deodara*). In Bhutan, the value of wood exports to India increased threefold during the late 1980s. Nepal, meanwhile, reported a decline in timber exports between 1975 and 1985, when steps were taken to halt illegal cutting, and the formal timber export to India remained static throughout the 1990s. According to some local forest officials, however, the illegal smuggling of logs across the border actually increased during the same period. Most of the commercial timber-cutting in Nepal is limited to the Terai zone, while the logging industry in the Indian Himalaya centers on the pine and cedar forests of the hill zone. This scenario is likely to change as the roads continue to penetrate remote mountain areas everywhere in the range. Timber cutters invariably follow the new infrastructures.

The Himalayan states support a number of new strategies designed to manage their forest resources more effectively. These include efforts to conserve forests by reducing the dependence of villagers upon trees for heating and cooking energy. Along these lines, woodstoves are designed, and biogas plants are built that use livestock dung to generate methane gas. There is also greater emphasis on involving villagers in forest conservation by the establishment of village protected forests, forestry user groups, and leaseholder forest management. Such participation, organized through community forestry efforts, establishes more localized and effective regulation of subsistence forest use. In Nepal, between 1978 and 1999, the government handed over .7 million hectares of state-owned forest to villagers, directly benefiting six million people. These forests are now some of the best-managed natural lands in the country.



Source: Adapted from UNEP, 2001. Nepal: State of the Environment 2001. Bangkok: UNEP-RRC.AP

A winter supply of firewood



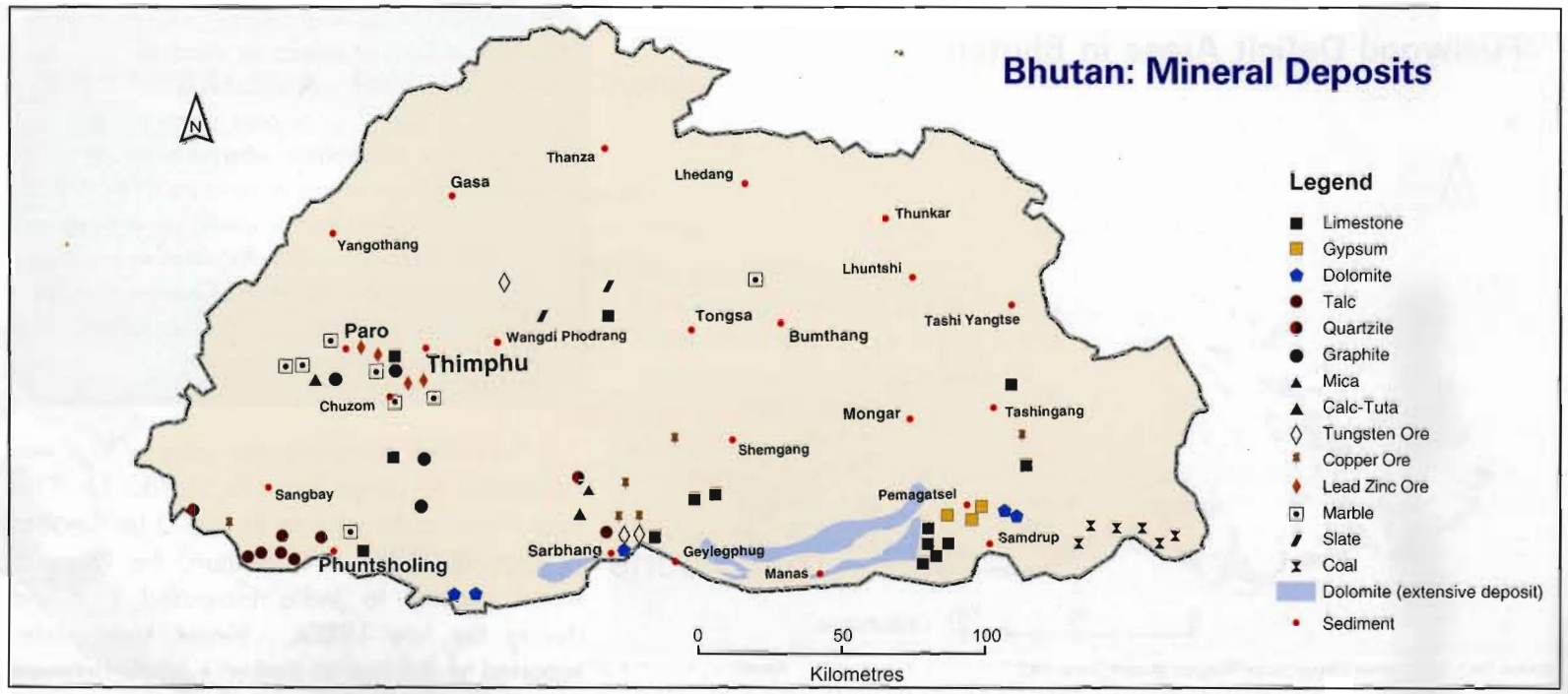
Source: Adapted from UNEP, 2001. Nepal: State of the Environment 2001. Bangkok: UNEP-RRC.AP

Commercial timber operations nowadays are more tightly regulated and tied directly to reforestation efforts. The Government of Bhutan transferred all commercial logging to the national Department of Forest, with timber then being auctioned to private wood processors. In Nepal and India, commercial logging requires new plantation forests as well as the development of new sustainable yield timber holdings on private lands.

A shared feature of all the Himalayan states' efforts toward forest conservation is the establishment of national parks and conservation areas. These designated areas restrict the use of forests for both subsistence and commercial purposes, with the intention of preserving forests for their environmental value. Bhutan currently has almost 1 million hectares of land (20% of the total area) under parks and reserves. The area of protected land in Nepal increased from 0.976 million hectares in 1984 to 2.476 million hectares in 1998. It is further proposed that all forested land in the Churia foothill zone in Nepal be incorporated into nation-wide protected status. The Indian Himalaya, meanwhile, contains numerous protected areas, totaling over 2 million hectares. Altogether, almost 20% of the Himalaya is set aside in various types of designated parks, preserves, and conservation areas which serve multiple purposes including forest conservation, habitat preservation, and tourism.

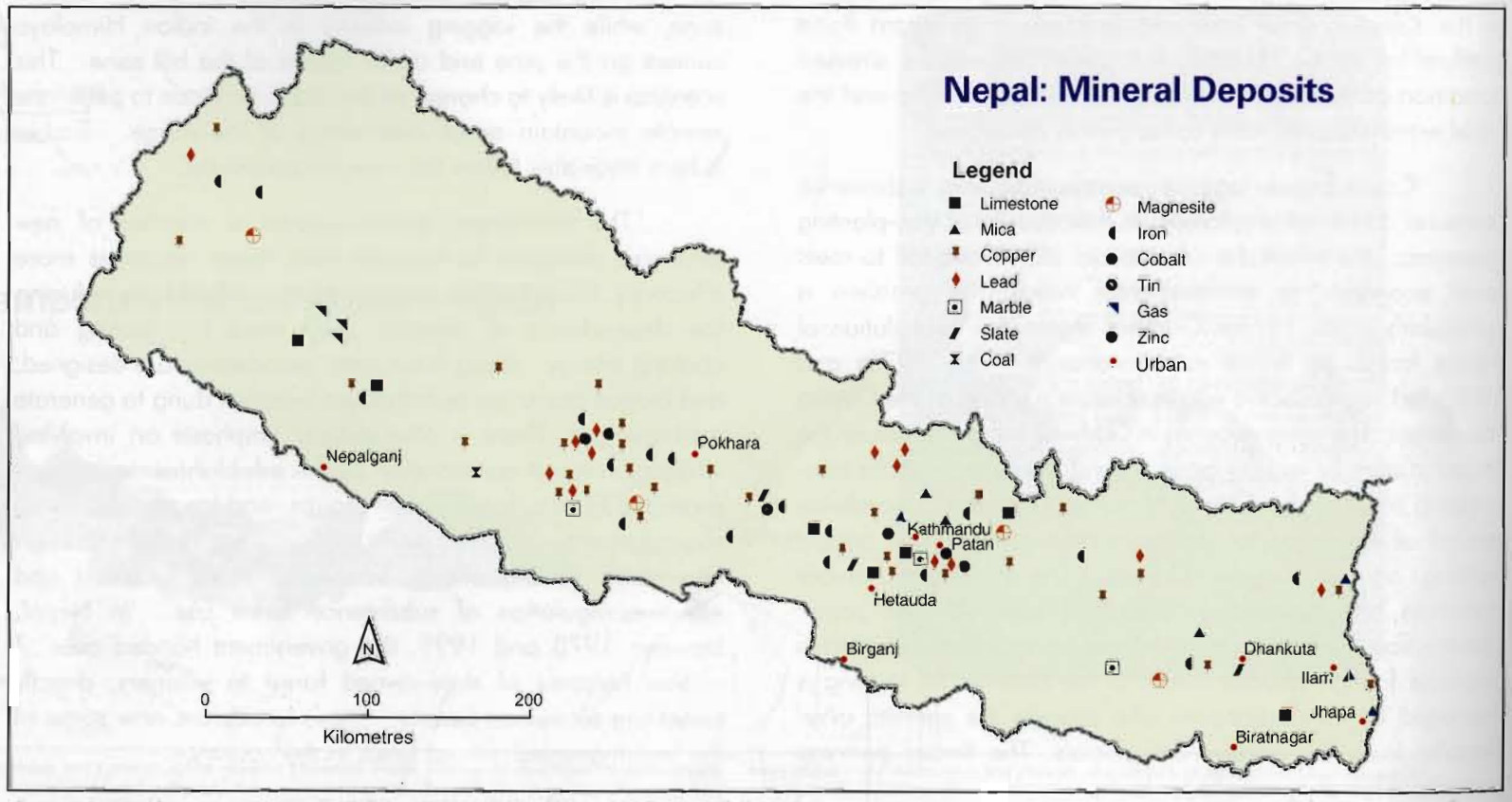
MINERALS

The bedrock of the Himalaya provides mineral resources that have been exploited on a small scale for many centuries. Lead-zinc and iron ores, for example, provided materials for weaponry and bridges as early as the 14th century. Slate is a traditional roofing material in vernacular architecture. Copper, early on, was wrought into storage vessels and prayer wheels. Systematic mineral explorations, however, began only in the early 20th century with the British and German geological reconnaissance in the Indian Himalaya. Since independence, the government Survey of India and the Wadia Institute of Geology, located in Dehra Dun, have led the mineral surveys in the Indian mountains. Swiss geologist, notably Toni Hagen, began countrywide surveys in Nepal in the 1950s. The 1960s witnessed the beginning of geological surveys in the kingdom of Bhutan, conducted under the auspices of the Survey of India, with its experienced Himalayan geologists, and the Royal



Source: Adapted from Royal Government of Bhutan, 1992. Seventh Five Year Plan (1992-97). Vol. 1. Main Plain Document. Thimphu: RGOB, National Planning Commission

Bhutan and Nepal - Mineral Deposits and Nepal: Mineral Deposits: *Although the mineral resources of the Himalaya are considered to be significant, a lack of engineering technology and problems of accessibility hamper efforts to develop them.*



Source: Adapted from map prepared by HMG-Nepal Department of Mines and Geology, Kathmandu

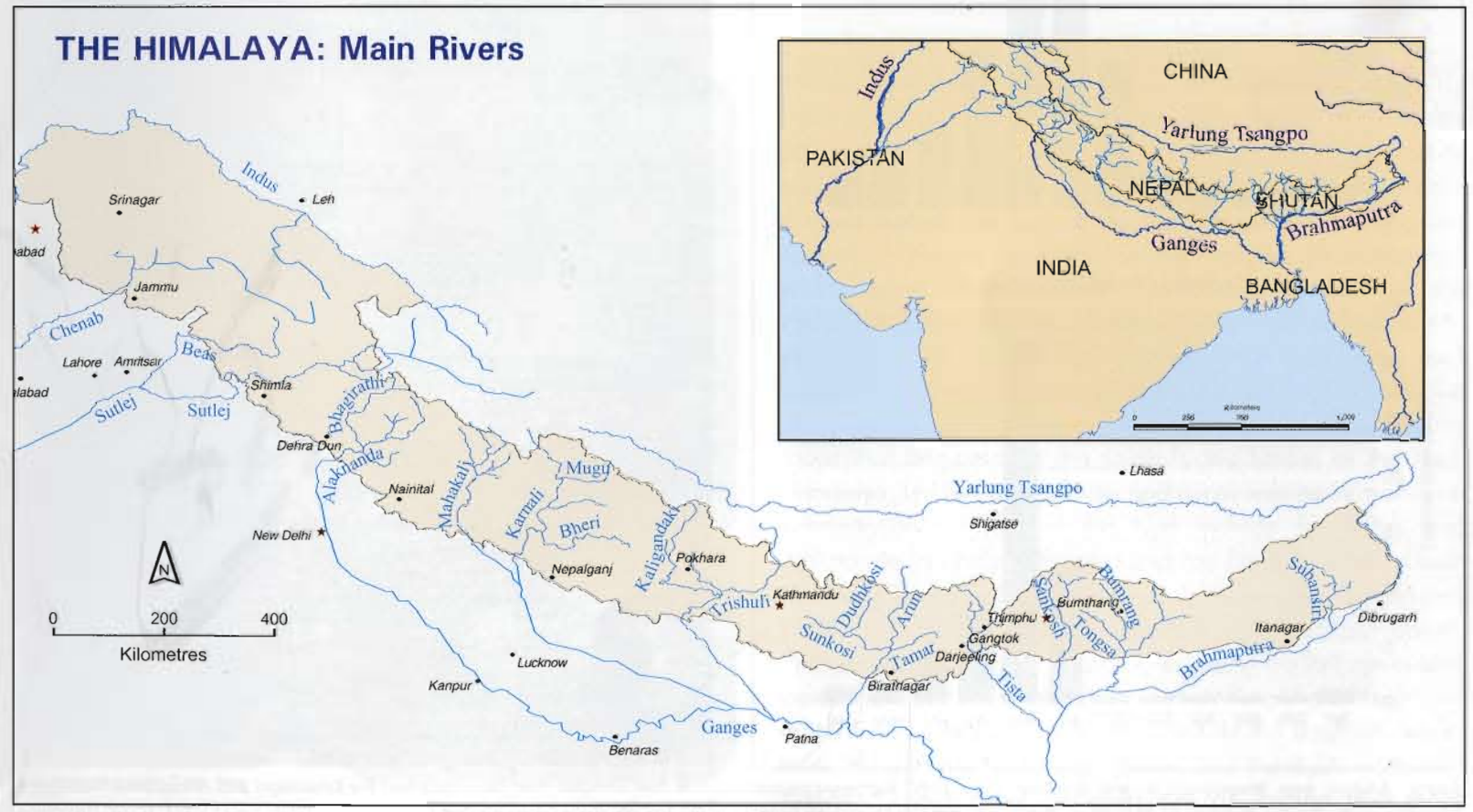
Government of Bhutan's Department of Geology and Mines. The main goal behind these various efforts has been to assess the mineral potential that lies beneath the Himalayan surface. With the exceptions of Bhutan, where less than 30% of the country has been geologically mapped in any detail, and the remote and difficult terrain of Arunachal Pradesh, the range has been surveyed quite extensively. The geological studies indicate important reserves of industrial minerals as well as of base metal deposits and gem-quality rocks. The important industrial resources, used for steel and energy production as well as for building and road construction materials, include dolomite, limestone, gypsum, coal, iron slag, marble, and slate. The base metals include copper ore, and the gemstone quality minerals include gold, garnets, and tourmalines.

The geological surveys in India have concentrated much of their exploration efforts in Ladakh and Zanskar, where iron ore and precious metals are known to exist, and in the lower Siwalik range near Mussoorie and Dehra Dun, where limestone mining is intensive. The commercial minerals in Nepal include scattered iron ore and copper ore deposits, limestone, and the possibility of rich deposits of precious gemstones. One of the highest mines in the world is located in Nepal at over 5,000 meters above sea level, along the southern flanks of Ganesh Himal, north of the Kathmandu Valley. The mine is purportedly for zinc production, but unsubstantiated reports indicate rich deposits of sapphire, ruby, and other precious stones. The Sikkim Mining Corporation is currently developing mines for the production of copper ore (at the Rangpo Copper Mine), as well as of coal and graphite. Bhutan currently mines dolomite, coal, gypsum, and quartzite for export to India and Bangladesh and limestone for domestic use. Mineral exports contributed only about 1% of Bhutan's gross domestic product in the 1990s, but the expansion of this sector is clearly part of that country's development strategy. Across the Himalaya, mineral development is geared toward meeting the anticipated needs of domestic industrial growth as well as generating foreign revenue through mineral exports to the southern plains.

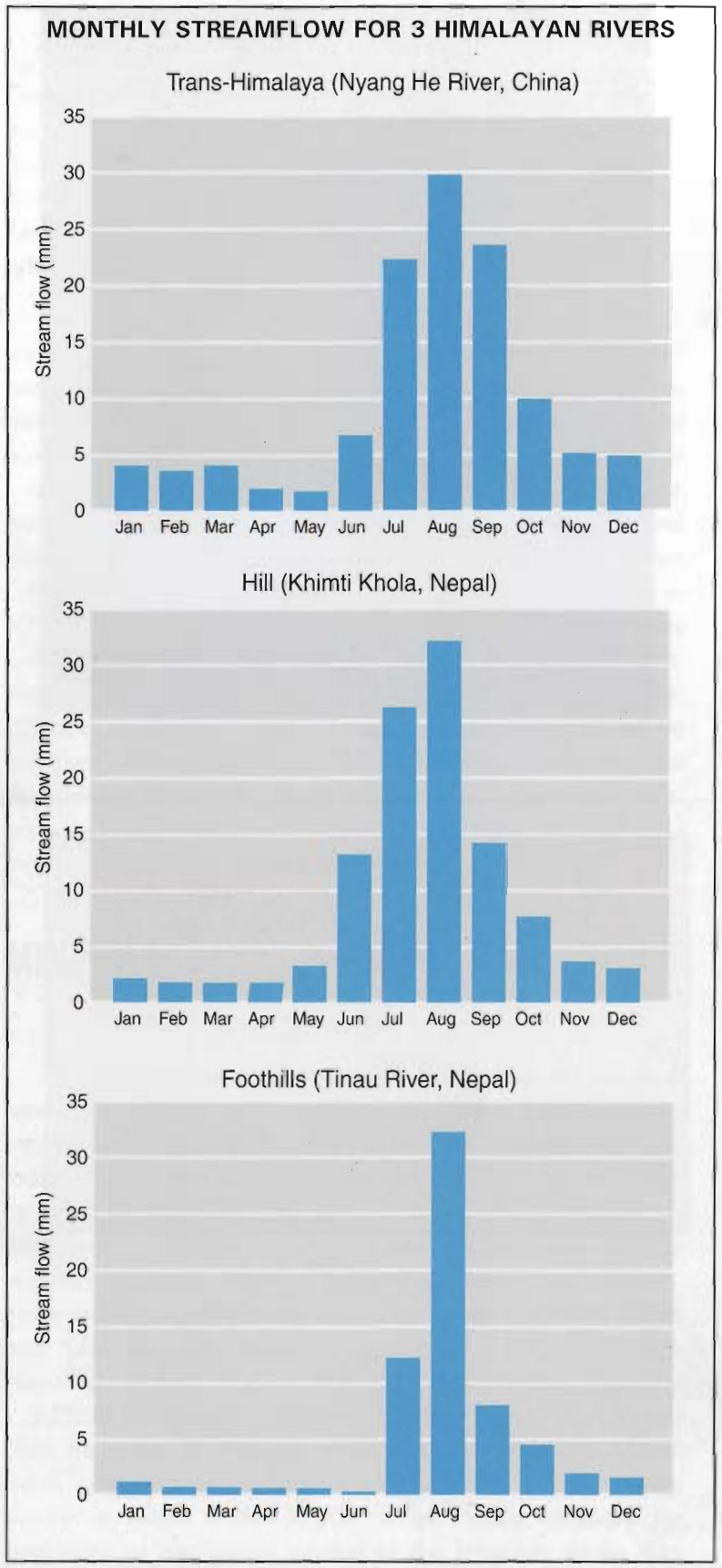
WATER RESOURCES

Water is a key resource in the Himalaya, used for drinking and hygiene, irrigation for agriculture, and energy. Its availability at any given place is determined by the local climate, topography, and vegetation, as well as by human management practices. The most important natural sources of water include precipitation, stream flow, and glacial storage. In the outer foothills, groundwater storage in aquifers is also important. The monsoon largely determines the distribution of rainfall, with the greatest receipts occurring across the range in the summer months. Winter storm fronts provide important rainfall, mainly in the western regions. The runoff from rain and melting snow and glaciers shape the mountain's complex stream systems whose water flow, in turn, is influenced by the terrain and vegetation. The average annual rate of flow in the upper Indus River in the western Himalaya is 115,000 million cubic meters. Rivers originating in the mountains contribute overall about 200,000 million cubic meters to the total flow of the Ganges River as it crosses

Tharu fisherfolk on the Rapti River



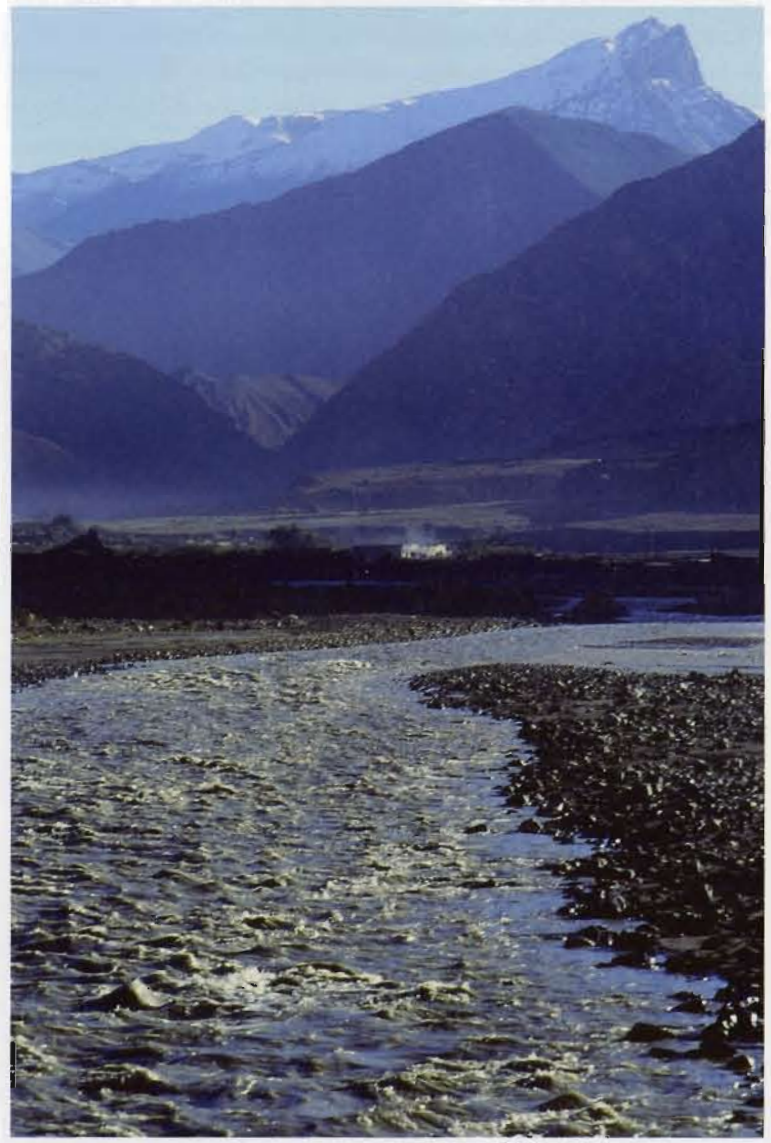
Source: Adapted from Zurick D. and Karan P.P., 1999. Himalaya: Life on the Edge of the World. Baltimore and London: Johns Hopkins University Press



Source: Adapted from Bruijnzeel, L.A. and Bremmer C.N., 1989. Highland-Lowland Interactions in the Ganges-Brahmaputra River Basin. Kathmandu: ICIMOD, Occasional Paper No. 11

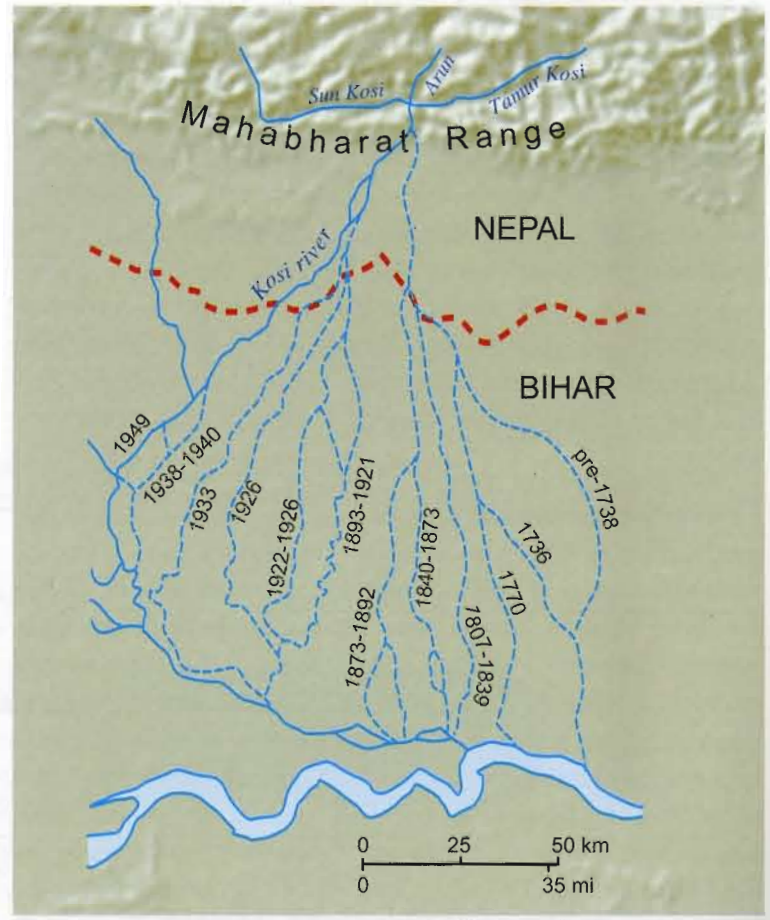
northern India (10% from the Indian Himalaya and 32% from Nepal and Tibet). The Brahmaputra River, where it discharges from the Himalaya, has a mean annual flow of 200,000 million cubic meters. An additional 180,000 cubic meters are added to the Brahmaputra by its tributaries originating in Sikkim, Bhutan, and Arunachal Pradesh, before it empties into the Bay of Bengal. That all adds up to a lot of water.

Melt water from snowfields and glaciers contributes substantially to the discharge of the Himalayan rivers, especially in the arid trans-Himalayan zones and elsewhere during the warmer, dry months of the year. Knowledge about the water storage role of glaciers is key to understanding the annual cycles of river flow. Glaciers cover an estimated 15% of the entire Hindu Kush-Karakoram-Himalayan mountain



The Kali Gandaki river flows between the Dhaulagiri and Annapurna mountains, carving the deepest gorge in the world

Changing Course of the Koshi River, Nepal



Source: Adapted from Carson, B., 1985. Erosion and Sedimentation Processes in the Nepalese Himalaya. Kathmandu: ICIMOD, Occasional Paper No. 1

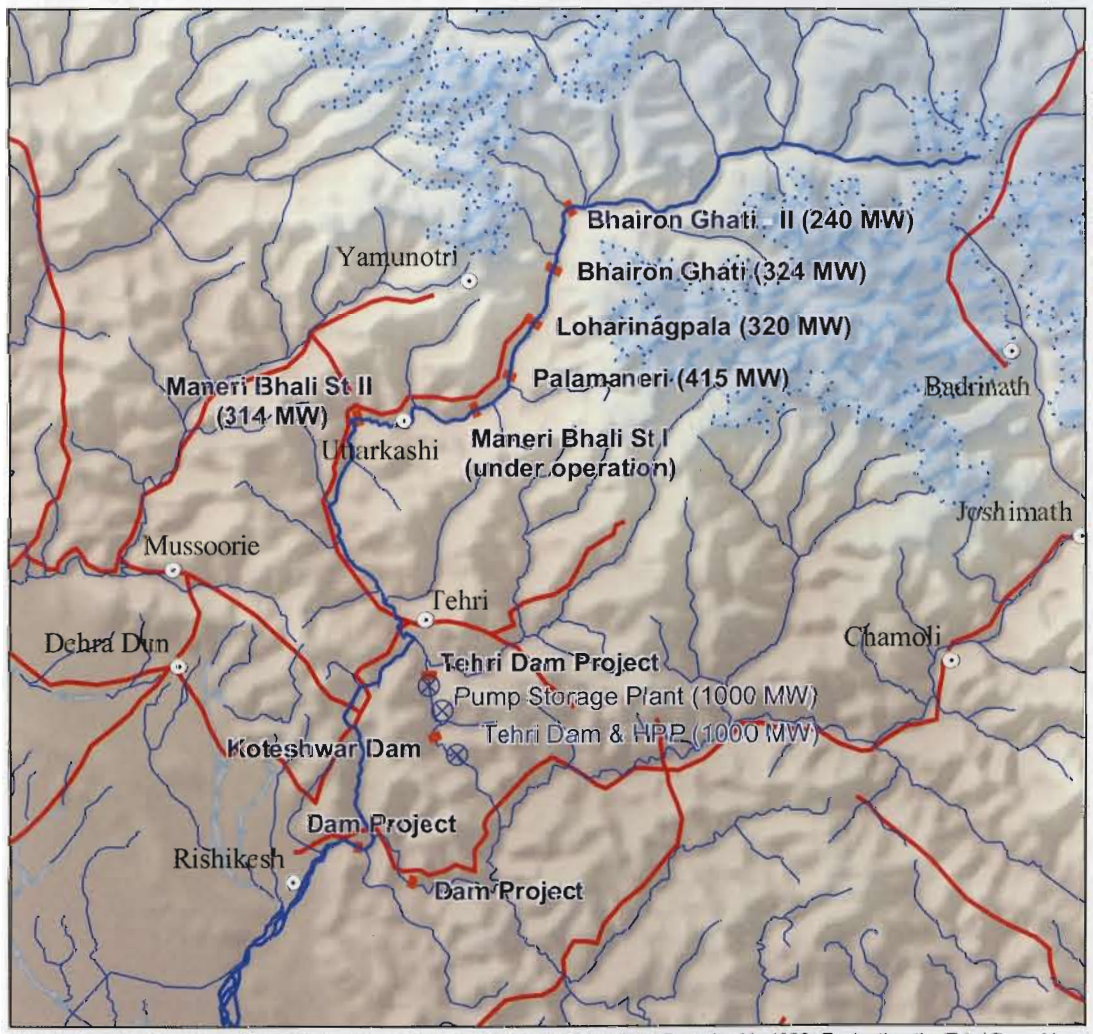
The Changing Course of the Koshi River, Nepal: *The Himalayan rivers are not immutable - they may be dammed or rush in floods, nor are they stationary as this map of the Koshi River demonstrates. When the rivers rush out of the mountains, carrying heavy loads of sediment, and reach the plains, they slow and meander, often changing their course. This results in flood-prone areas as in well as problems for irrigated agriculture.*

belt. An additional 30-40 percent of the range is covered seasonally by snow. The percentage of glacier and snow cover diminishes from west to east, though, with the Indus mountains containing some of the longest glaciers on earth. These commonly exceed 10 kilometers in length, and several exceed 50 kilometers. By way of contrast, the glaciers in eastern Nepal, which count as the country's largest, rarely exceed 10 kilometers. The diminished glacial area from west to east reflects the more southerly latitudes of the eastern part of the range, as well as topographic and climatic differences.

A fish trap set in a mountain stream

A hydropower development located at the juncture of the Beas and Sutlej rivers is designed to generate electricity for use in Indian cities located hundreds of kilometers away.

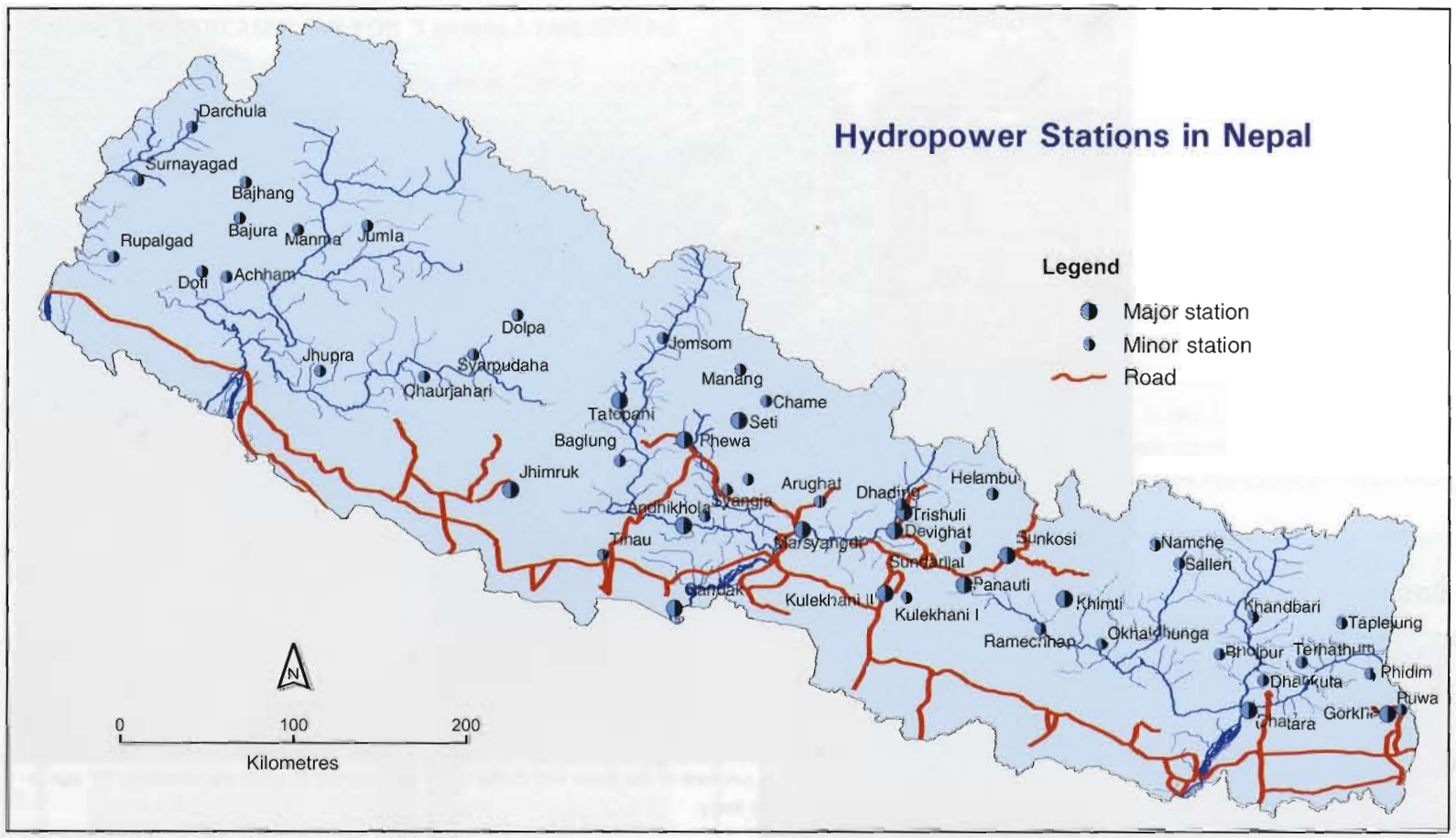
Hydro-Electric Projects on the Bhagirathi River Basin



Source: Compiled by the authors from various Indian media sources and from Paranjye,V., 1988. Evaluating the Tehri Dam. New Delhi: ITACH

Hydro-Electric Projects on the Bhagirathi River Basin: *The Himalayan rivers increasingly are being developed for their hydropower potential. This may involve small-scale projects designed to meet local village needs or, as in the case of the Bhagirathi River Basin, huge projects that cover entire watersheds and require enormous dams, tunnels, and engineered water diversions. The proposals for the Tehri Dam Project in Uttaranchal have met considerable opposition due to safety concerns about the placement of the dam in a seismically active region and to the human rights issues brought about by the forced relocation of many thousands of people.*

Three major types of river occur in the Himalaya, reflecting their geographic origins. Some originate on the Tibetan plateau and the northern slope of the High Himalaya, and as such predate the geological thrust of the mountains. These rivers include the Indus in India; the Arun, Kali Gandaki, and Karnali in Nepal; and the Yarlung-Tsangpo (Brahmaputra) whose bend coincides with the eastern syntaxis of the Himalaya near Namcha Barwa. They start as tributaries principally fed by melting glaciers and snowfields, and gradually gather volume as they flow southward with the additions of joining streams. A second type of river includes those that originate on the south-facing slopes of the High Himalaya, fed by melting snow and ice as well as by monsoon precipitation. Rivers of this type include the Sutlej and Alaknanda in northwest India; and the Bheri and Seti; Dudh Kosi, and Tamur in Nepal; the Tista in Sikkim; the Tongsa and Bumrang in Bhutan; and the Subansiri in Arunachal Pradesh. The origins of the third kind of river are in the hill zones and outer foothills zones, especially in the Mahabharat Lekh and in the Churia Range. Such rivers include the Bagmati, which flows through the Kathmandu Valley, and the Rapti in western Nepal. These rivers generally are of smaller and more



Source: HMG-Nepal, Department of Topographic Survey data

fluctuating volume than the rivers that begin in the high mountains, and they have shallow gradients, but they tend to flood heavily during the monsoon season when water overflows their banks.

Himalayan people have used the rivers and streams for centuries in order to operate millhouse grinding wheels, and to turn waterwheels and prayer flags, thus utilizing the kinetic energy that is contained in the flow of water. It was the British, however, who first considered the grand idea of damming the Himalayan waterways to generate massive amounts of electricity. They surveyed the Sutlej River in 1908 with that goal in mind. Nothing was accomplished, however, before India gained its independence in 1947. The country's first prime minister, Jawaharlal Nehru, understood the potential of harnessing water energy in the mountains, but it was not until 1963 when the first major hydroelectric project was built in the Himalaya. The 226-meter high Bhakra Dam was constructed on the Sutlej River, near the town of Bilaspur, in keeping with the suggestions of the early British surveyors. The Bhakra Dam was designed to generate 1,200 megawatts of electricity for export to the southern industrial plains. Ten years later, in 1974, the Indian Government built a second dam on the Beas River, producing 360 megawatts of energy. In the 1990s, a massive hydroelectric construction project linked the Beas and Sutlej rivers in a system of diversion tunnels to produce 660 megawatts of electricity at the Dehar power plant.

Indian Himalaya: Percent of Household Access to Water and Electricity

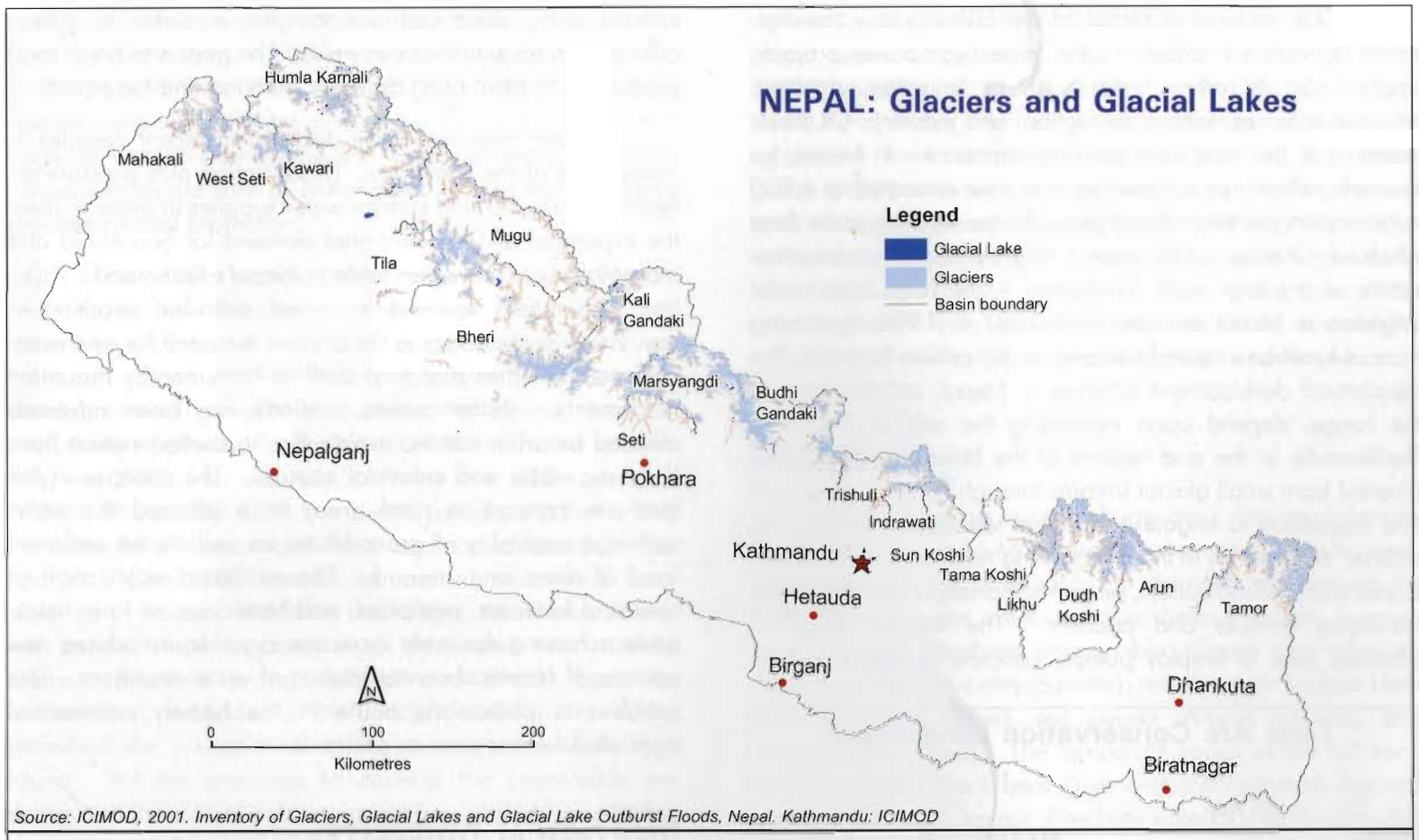
	Drinking water			Electricity		
States	**1981**	**1991**	**% change**	**1981**	**1991**	**% change**
Himachal Pradesh	44.50	77.34	73.80	54.86	87.01	58.60
Sikkim	30.33	73.19	141.31	23.11	60.66	162.48
Arunachal Pradesh	43.89	70.20	59.95	15.15	40.85	169.64
Jammu & Kashmir	40.28	N.A.	-	60.87	N.A.	-

Source: INDIAN HIMALAYA: A Demographic Database (2002). G.B. Pant Institute, Almora

The newest and most controversial dam project in the Indian Himalaya is the Tehri Dam, located on the Bhagirathi River in Garhwal. This 260-meter high dam was first approved by the Indian Planning Commission in 1972, but has met considerable local and international opposition. It is located in an active seismic area, and when the dam is completed the reservoir will submerge 5,200 hectares of prime farmland and forest and displace over 100,000 villagers. The opposition has highlighted the many concerns of people about building such big dams in the Himalaya. The devastating potential impact of earthquakes on the dams and the loss of land rights among indigenous people are now at the forefront of the debates about hydroelectric power generation in the mountains. These controversies have caused the Tehri Dam scheme to move forward in fits and stalls, and the project remains uncompleted.

Nepal, which contains over 6,000 major rivers and streams, is considered to have one of the world's largest hydropower potentials. With 94% of its energy needs still met by traditional sources such as fuelwood and animal dung, a high priority is placed on developing that country's hydroelectric capacity for its domestic use. Moreover, hydropower is seen to be the major resource Nepal has to export in the future. Its primary market is India, and the huge foreign revenue that may be derived from hydroelectricity in one of the world's poorest countries is a powerful argument for its development. Nepal theoretically has an energy potential sufficient to meet the needs of over 700 million South Asians (83,000 megawatts), of the 83,000 MW 42,000 is feasible potential but the current installed capacity is only 552 megawatts, sufficient to meet only a small part of the country's domestic requirements. The proposed large dam and run-of-the-river projects concentrate on the Mahakali and Karnali rivers in the west, on the Kali Gandaki River in the central part of the country, and on the Kosi River in the east. The largest of the projects, the 270-meter high dam at Chisapani on the Karnali River, would generate

A mini hydropower scheme, Sangla Valley



Source: ICIMOD, 2001. Inventory of Glaciers, Glacial Lakes and Glacial Lake Outburst Floods, Nepal. Kathmandu: ICIMOD

Source: ICIMOD, 2001. Inventory of Glaciers, Glacial Lakes and Glacial Lake Outburst Floods, Bhutan. Kathmandu: ICIMOD

Glacial Lake, Langtang

Glaciers and Glacial Lakes of Nepal and Bhutan: *The glaciers that form among the high peaks of the Himalaya constitute an important source of water for the rivers and streams that make up the mountain watersheds. They eventually converge into the main river systems of South Asia. There is evidence that the Himalayan glaciers are retreating, perhaps caused by global warming. Ridges of glacial till, called moraines, often dam the melt water from the glaciers to form lakes at their base. Seismic action or other disturbances may cause the dams to burst, unleashing the lake water in devastating floods. These glacial lake outburst floods (GLOF) are a natural hazard in the high mountains.*

enough electricity to meet all of Nepal's domestic requirements and still allow some to be exported to India. The additional dams on the Koshi River and Mahakali River would generate another 5,400 megawatts, almost all for export to India. If all the proposed hydropower projects were actually to be built in Nepal, though, over 20 percent of the country's total irrigable land in the hills would be inundated.

Bhutan is in a similar energy circumstance as Nepal. Fuelwood alone constitutes 77% of total energy consumption in the country, and the energy sector places high priority on developing its hydroelectric potential. The theoretical hydropwer potential is 30,000MW of which 16,436 is feasible potential, sufficient to meet the country's total energy needs and provide export sales, but only 444 megawatts are exploited. The Chhukha Hydro Scheme, which began generating power in 1986, has the capacity to generate 336 megawatts. Bhutan, however, seeks to exploit its hydropower through a combination of large dams and mini and hydro plants. The latter, which have up to 1,000 kilowatt in capacity (although most are in the 100 kilowatt range), are considered to be more viable than the large projects because they have lower environmental and social, as well as fiscal, costs. The sustainability of the small hydro schemes, which are much easier to implement and maintain, make them an attractive alternative throughout the Himalaya. In Pakistan, the Agha Khan Foundation has assisted in the installation of 160 small hydro plants in the Indus mountains. India set a goal of 600 megawatts of total installed capacity of mini and micro hydropower plants by the beginning of the 21st century in its Himalayan regions. Nepal installed about 1,000 small hydro plants during the 1990s (mainly in the 3-30 kilowatt range), mostly from private ventures. Bhutan's micro hydro capacity at the turn of the century included 7 small hydro plants with capacities ranging from 300 to 1,000 kilowatts, and 12 micro schemes with capacities from 10 to 80 kilowatts. The prospects of small-scale hydro development for the purposes of local consumption are bright, notwithstanding current technical and infrastructural constraints, and clearly the Himalayan countries are investing heavily in them. Nevertheless the development of hydropower as an export commodity, which remains very high on the economic priority lists of the Himalayan countries, demands the construction of the costly and environmentally and socially disruptive high dam and run-of-the-river projects. These loom imminent in the future of water resource development across much of the range.

The resource potential of the Himalayan waterways, which is captured notably in the large hydropower projects, applies also to other needs such as irrigation, drinking, religious activities, fishing, recreation, and industry. Of these, irrigation is the most economically important. In Nepal, for example, which has a snow-fed river flow estimated at 4,930 cubic meters per second and groundwater reserves in the Terai of about 12 billion cubic meters, irrigation accounts for nine-tenths of the total water consumed. The farm area under irrigation in Nepal doubled from 1984 to 1998, increasing from .44 million irrigated hectares to .88 million hectares. The agricultural development schemes in Nepal, as elsewhere in the range, depend upon expanding the role of irrigation. Traditionally, in the arid regions of the Himalaya, water was diverted from small glacial streams through hand-made canals and aquaducts to irrigate agricultural terraces in the dry river valleys. Meanwhile, in the rice growing regions of the southern slopes and lowland valleys, water traditionally is diverted across hand-dug terraces and paddies. The modern irrigation schemes seek to employ pumps, concrete canals, and lock systems using advanced technologies in order to extend cultivated areas and increase yields. The goal is to boost food production to meet rising domestic demand and for export.

Terai Arc Conservation Landscape

Source: World Wildlife Fund - Nepal Program.

Terai Arc Conservation Landscape: *The World Wildlife Fund's Nepal Program, in coordination with government agencies in Nepal and in India, has developed a model park that straddles the Nepal-India border. The intention is to create a contiguous area of preserved habitat for such large endangered animal species as the royal Bengal tiger, the one-horned rhino, and the Asian elephant. The trans-boundary park is a relatively new concept in the Himalaya, and it reflects the fact that the land requirements for environmental conservation do not necessarily conform to political boundaries. Such parks require close international cooperation among the participating countries.*

Water resources have declined in recent decades in many parts of the Himalaya. Urbanization puts pressure on both groundwater and surface water supplies in order to meet the expanded and concentrated demand for household and industrial use. The water table in Nepal's Kathmandu Valley has substantially lowered in recent decades, resulting in regular water shortages in the city and the need for new water diversion schemes that trap outflow from nearby mountain catchments. Water quality, similarly, has been adversely affected by urbanization, mainly due to contamination from domestic waste and industrial sources. The changes in the land-use patterns in rural areas have affected the water recharge capability of groundwater as well as the sediment load of rivers and streams. The increased application of chemical fertilizers, pesticides, and herbicides on farm fields, while achieving desirable increases in yields, introduces new sources of chemical contamination of water resources. This problem is particularly acute in the heavily commercial agricultural areas such as orchards.

BIOLOGICAL DIVERSITY

The rich biological treasures of the Himalaya may be their most precious natural resource, for they constitute a unique world of plant and animal species and contribute greatly to the genetic resources of the entire planet. Detailed biological surveys indicate that the mountains constitute one of the planet's great biodiversity centers. The high percentage of native endangered species located in the eastern section of the range make it one of the planet's top twenty 'biodiversity hotspots'. The overall high species' diversity in the Himalaya is related to the dazzling range of environments found within the range, and to the fact that four major biogeographic regions constitute the mountain world: Paleoarctic, Indo-Chinese, Indo-Malayan, and Indian subcontinent. The convergence of these natural regions in the Himalaya brings to the mountains a superb concentration of flora and fauna of diverse geographic origin. Additionally, the diverse ecological conditions in the mountains create niche habitats for the occurrence of many endemic species whose world-wide range is restricted to the Himalaya or to small parts of it. Nepal, for example, contains 136 distinct ecosystems ranging

from tropical monsoon forests to alpine tundra. The country hosts 35 forest types, 6,500 species of flowering plants, 656 kinds of butterflies, 844 types of birds, 160 amphibian species, and 181 different mammals. This is an exceedingly large list for such a small country. Moreover, many of Nepal's native species are rare or endangered, hence their presence requires special protection.

The eastern section of the range, in Sikkim, Bhutan, and Arunachal Pradesh, contains an especially rich assemblage of native flora and fauna species. The wet monsoon climate and varied topography insure the development of complex ecosystems that permit abundant evolutionary pathways for the development of native species. Tiny, wet Sikkim, for example, contains over 650 species of orchids. Bhutan lists 47 truly endemic species, but that is only an estimate of the unique flora and fauna found in that country. Over 160 species of rare animals have been reported in Bhutan, including the langur, takin, blue sheep, red panda, snow leopard, musk deer, and black-necked crane. Bhutan's strong cultural and ethical basis for conservation, imbedded in the Buddhist tradition, has so far permitted the preservation of the country's rare flora and fauna. But the pressures to develop the countryside are strong and the role of habitat protection is therefore critical to the success of Bhutan's wildlife conservation program.

The eastern regions of Arunachal Pradesh have not yet received the kind of extensive biological surveys needed to adequately assess species' diversity and their status. However, based upon limited surveys in India and more extensive ones in adjoining regions of China, a huge number of native plants and animals found only in the eastern Himalaya will require special protection. The historically low population densities have insured their survival so far, but with land clearing for agricultural development and the expansion of commercial forestry and other industrial activities, the future status of the rare and endangered species is tenuous. In the meantime, the biological surveys needed to provide inventories of the region's rare species proceed slowly as the region's scientific and research capacity gradually develops.

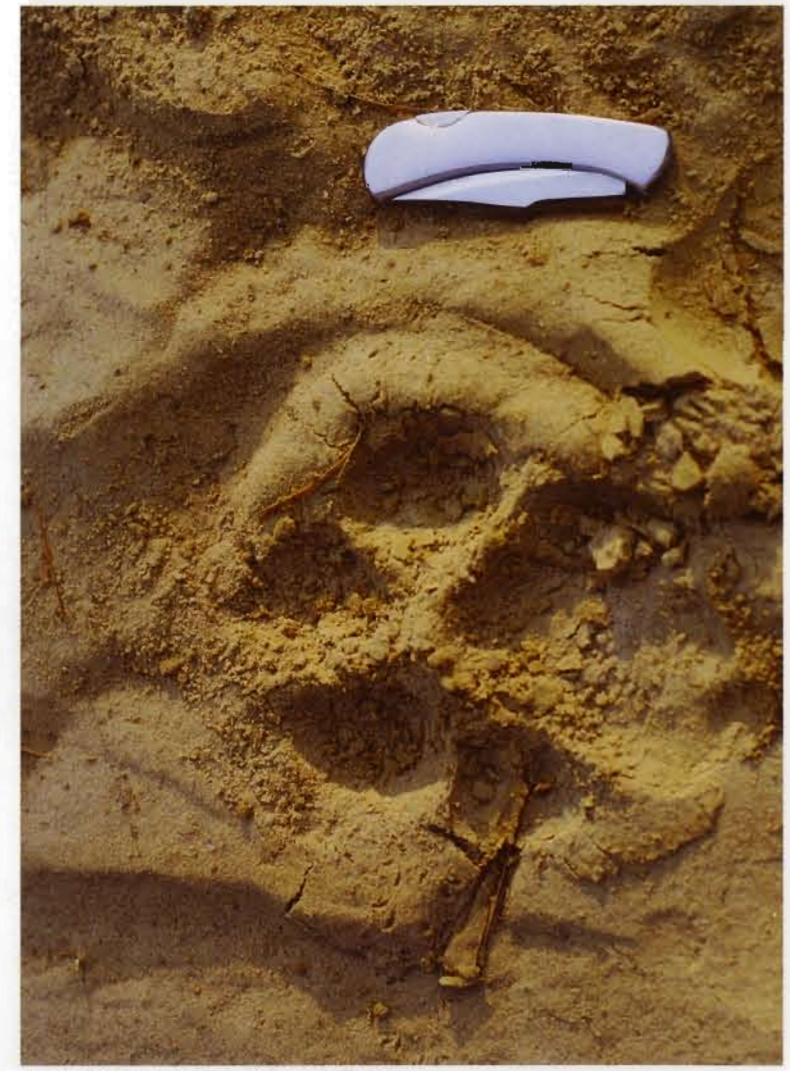
In support of biodiversity conservation, the Himalayan countries have given legal protection status to many species of plants and animals. Nepal, for example, protects 13 plants, 26 mammals, 9 birds, and 3 reptile species. The legal protection status of plants and animals, though, is only effective when it is adequately enforced. Unfortunately, such enforcement is often lacking. The biodiversity value of domestic plants and animals is often practically ignored, but Nepal recently has taken steps to store the germplasm of 8,400 varieties of grains, fruits, vegetables, and agro-horticultural crops, including 680 varieties of rice. As agriculture turns to commercial monoculture, the native grains and other crops are threatened with extinction, making such storage increasingly significant. Although a mix of conservation strategies is considered to be necessary in order to successfully manage Himalayan biodiversity, one of the most important is to protect habitat, mainly by establishing national and international systems of parks and reserves.

WILDLIFE

The Himalaya cover a huge area that straddles the Paleo-arctic and Indo-Malayan faunal zones, and is home to a great many kinds of animals. In the north and among the high elevation areas are found blue sheep (*Pseudois nayaur*), snow leopard (*Panthera uncia*), ibex (*Capra ibex sibirica*), musk deer (*Moschus chrysogaster*), red sheep or Ladakh Urial (*Ovis orientalis vignei*), red panda (*Ailurus fulgens*), and wolves (*Canis lupus*). The temperate zones of the hill zone host Himalayan black bear (*Sclenarctos thibetanus*), leopard (*Panthera pardus*), langur (*Presbytis entellus*), wild boar (*Sus scrofa*), and barking deer (*Muntiacus muntjak*). The southern parts of the range, especially the subtropical foothills, provide habitat for a rich assemblage of wildlife that includes the Asiatic elephant (*Elephas maximus*), one-horned rhinoceros (*Rhinocerus unicornis*), gaur (*Bos frontalis, Bos gaurus*), sloth bear (*Ursus ursinus*), Royal Bengal tiger (*Panthera tigris*), Gangetic dolphin (*Plantanista gangetica*), and numerous reptiles, birds, and fish. Many of the Himalayan animals are found nowhere else in the world and are globally threatened or endangered species.

Foraging and hunting have always been an important component in the subsistence lives of mountain people. Animals traditionally provide meat, hides, and medicines. Many of the new national environmental regulations seek to manage precious wildlife resources by restricting hunting, which often brings government policies into direct conflict with the villagers. Game poaching is especially common in and around the national parks where many rare species with high economic value reside. This is due in part to the fact that the parks exist mainly on paper without sufficient resources to enforce the wildlife rules. Bhutan has banned hunting throughout the country, which affirms its Buddhist orientation, but illegal hunting continues among villagers who seek game for protein and for the illegal sale of pelts and medicines. Hunting is outlawed in most of the national parks in India and Nepal, although both maintain game preserves for regulated hunting purposes. In Nepal, the national parks along the southern border are subject to poaching by both local villagers and hunters coming from across the border in India. Farmers often kill animals that leave the park boundaries out of self defense or because they are protecting their crops from the marauding wildlife. This problem is particularly acute in cultivated areas around the Chitwan and Royal Bardia national parks, where rhinos and elephants do a great deal of damage to the cultivated fields and villages.

The major threat to wildlife resources in the Himalaya, however, comes not from hunting but from habitat destruction. Shifting agriculture and burning encroach upon forests in the eastern Himalaya, which is rich in wildlife,



A pug mark of the Royal Bengal Tiger

Indian Great One-horned Rhinoceros

A macaque monkey in a protected forest

threatening native habitat in some areas of Arunachal Pradesh. Habitat loss associated with forest clearing, the expansion of farmlands, and livestock grazing is a problem throughout Nepal. Its early recognition prompted the establishment of the national parks which serve to maintain habitat for wildlife. Overgrazing and the enlargement of pastures in the highland regions of northern Bhutan, which occur steadily with an 8% per year increase in the domestic livestock population, have transformed the natural habitat of the native blue sheep population. In this case, the blue sheep make use of the expanded grazing land, and the blue sheep population has consequently increased. In some areas of Bhutan, the problem now is rising competition between the wild ungulates and the domestic livestock. This instance is unique, though, and the dominant theme across much of the Himalaya is the loss of wildlife due to increased poaching and habitat destruction.

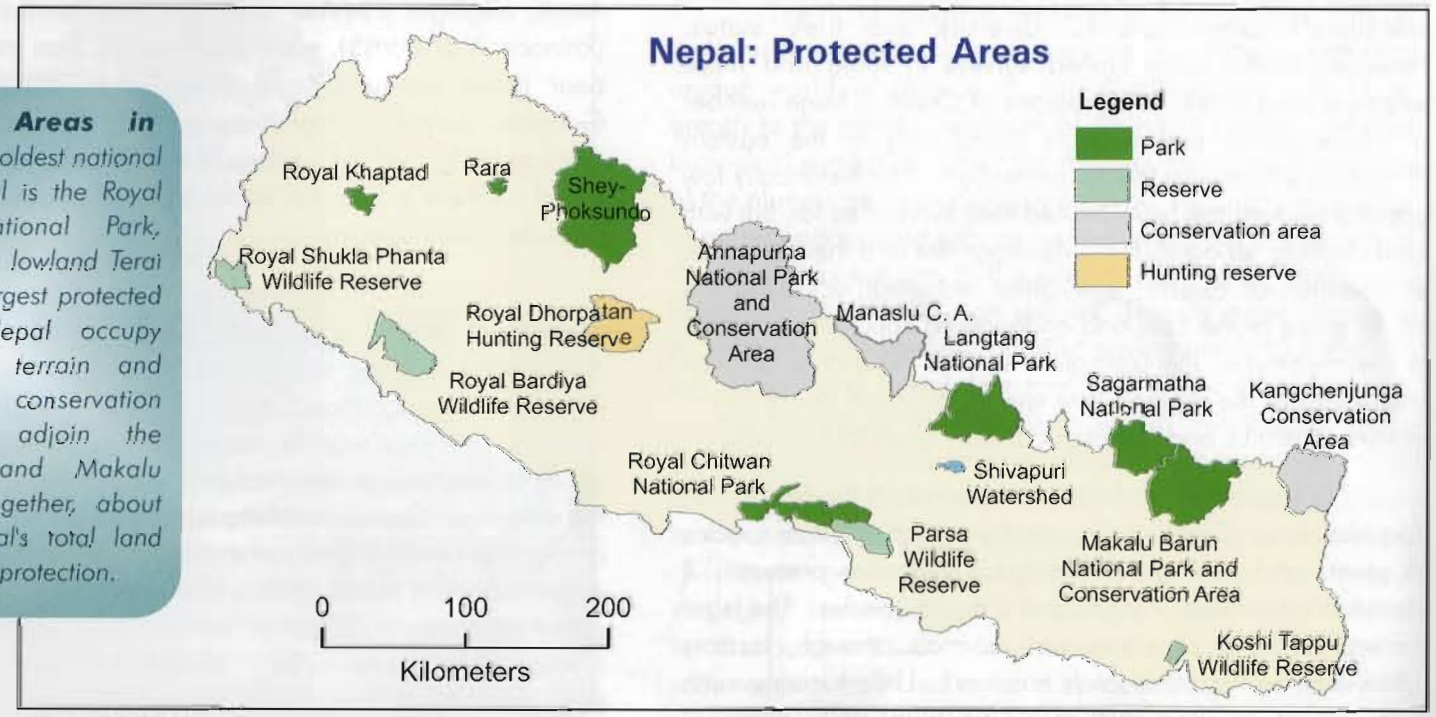
PARKS AND CONSERVATION AREAS

There currently are about 130 formal protected areas in the Himalaya, covering 13,600 square kilometers. They appear as national parks, wildlife preserves, conservation areas, and hunting reserves. The western Indian Himalaya contains 23,600 square kilometers of land protected by parks, sanctuaries, and ecological zones, including the oldest conservation landscape in the Himalaya - the Shimla Sanctuary, which was established in 1958. The western Indian parklands include the 4,000-square kilometer Hemis National Park, which protects high desert ecosystems in Ladakh; the 1,413-square kilometer Great Himalaya National Park-Pin Valley National Park in Kulu and Spiti Valleys, home to Himalayan brown bears, musk deer, and snow leopards; and the magnificent Nanda Devi Park, which in 1988 was designated a World Heritage Site by the United Nations. Elsewhere in the Indian Himalaya, the Kangchenjunga National Park was established in 1977 in Sikkim and the Mouling National Park was set up in the Mismi Hills of Arunachal Pradesh to safeguard some of the biological treasures of the eastern region.

The Himalayan kingdoms of Nepal and Bhutan together contribute 29 conservation areas. About 18% of Nepal's total area is under conservation status (including the buffer zones surrounding the national parks) and 20% of Bhutan is under formal protection. The oldest national park in Nepal is the 932 square-kilometer Royal Chitwan National Park, established in 1973 to protect subtropical habitat in the lowland Terai for populations of endangered tiger, rhino, crocodile, and other wildlife. The largest protected area in Nepal is the Annapurna Conservation Area (7,629 square kilometers) which straddles the high mountains in the central part of the country, covering territory ranging from the arid trans-Himalayan valleys to the summit of Annapurna and south to the middle mountains. Local villagers helped design the Annapurna Conservation Area so that it would be compatible with their cultural and economic needs as well as meet its environmental goals. The successful Annapurna project has come to signify a model of sustainable conservation development, and its approach has been adopted worldwide, including elsewhere in Nepal in the cases of the Makalu Barun, Kanchenjunga, and Manaslu conservation areas. The most famous national park in Nepal, and quite possibly in the world, is Sagamartha National Park, which protects 1,148 square kilometers along the southern flanks of Mt. Everest. It is one of the flagship Himalayan parks. With the recent addition of the Makalu Barun Conservation Area to the east, as well as of the Chomolungma Park in China, situated along the north face of Everest, the world's highest mountain is protected now on all sides.

Bhutan's conservation lands total 9,782 square kilometers, with about 80% of the total area taken up by the huge Jigme Dorje Wildlife Sanctuary in the northern part of the kingdom.

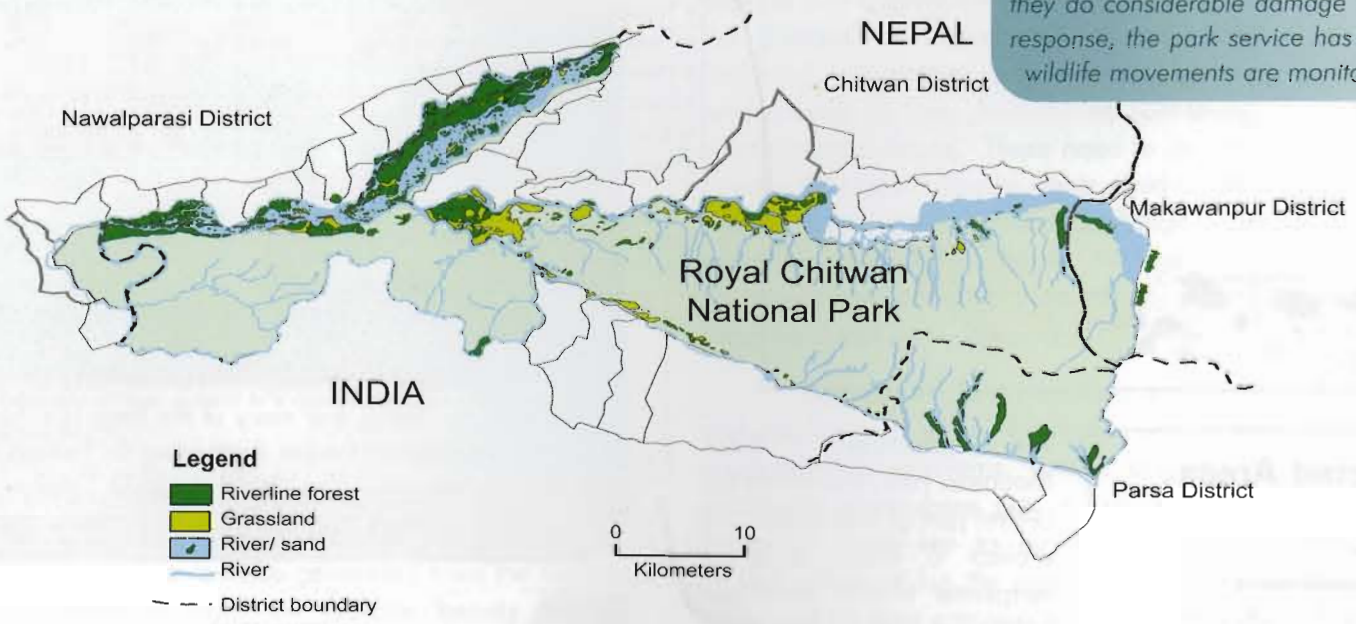
Protected Areas in Nepal: *The oldest national park in Nepal is the Royal Chitwan National Park, located in the lowland Terai zone. The largest protected areas in Nepal occupy mountainous terrain and include the conservation areas that adjoin the Annapurna and Makalu summits. Altogether, about 18% of Nepal's total land area is under protection.*



Source: ICIMOD data on Protected Areas in Nepal, compiled from various reports by HMG Nepal Department of National Parks and Wildlife Conservation.

Royal Chitwan National Park: *The oldest park in Nepal, Royal Chitwan National Park, was established in 1973 primarily as a sanctuary for many endangered animals, especially the Asian one-horned rhino ceros, Royal Bengal tiger, Asiatic elephant, Gangetic dolphin, and Gharial crocodile. Farmers live in the surrounding area. The preferred habitat of rhinos occupies the fringes of the park, and rhinos often enter the farmers' fields where they do considerable damage to the crops. This has led to serious conflicts between villagers and wildlife. In response, the park service has established buffer zones around the park where human activity is restricted and wildlife movements are monitored.*

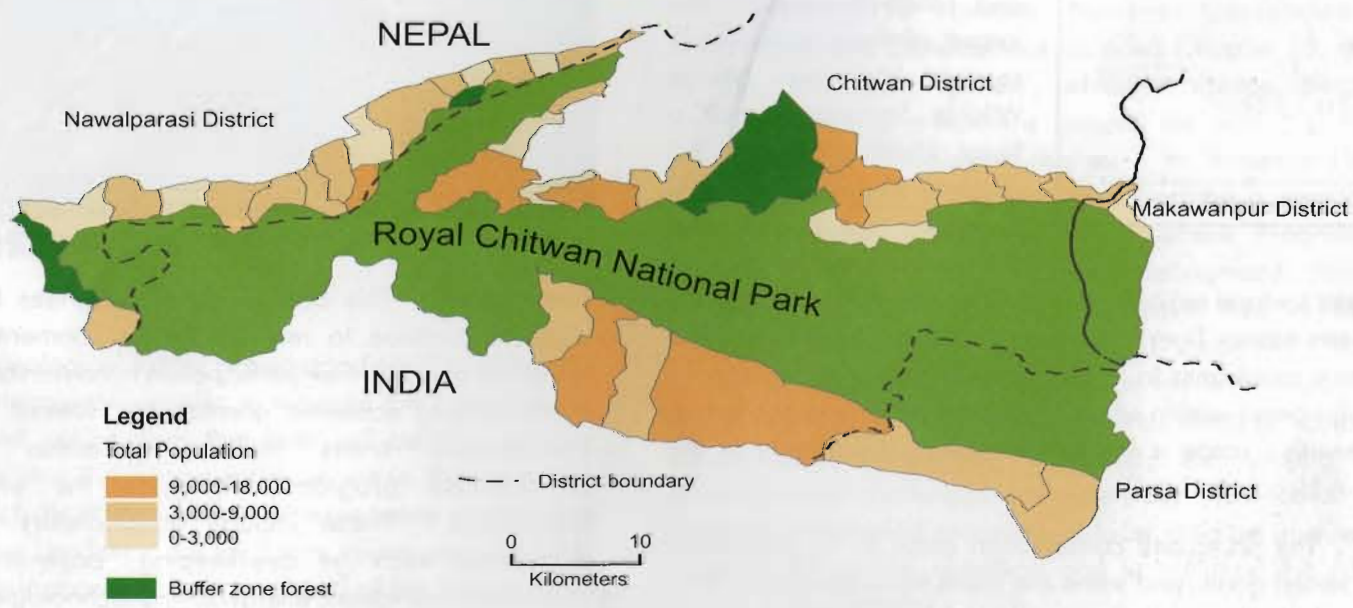
Royal Chitwan National Park



The entrance to Royal Chitwan National Park

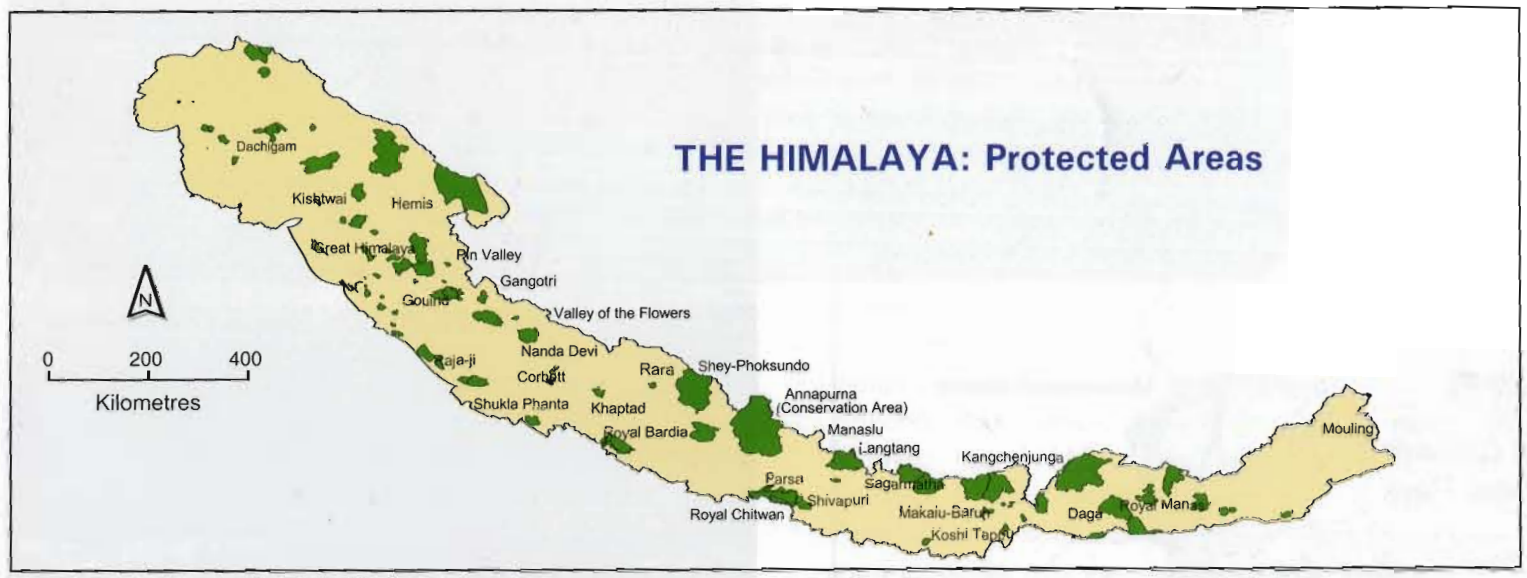
A villager collects thatch from inside the Royal Chitwan National Park

Royal Chitwan National Park and Surrounding Villages Population Density

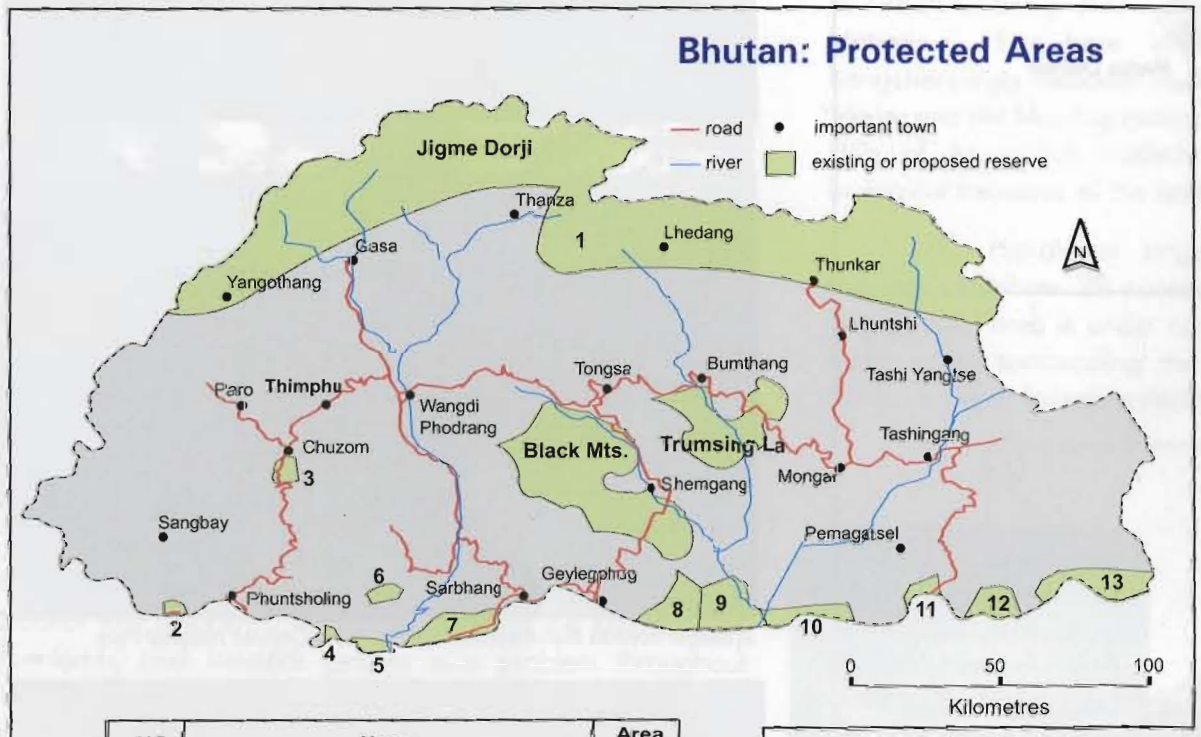


Source: Adapted from DNPWC, 2000. Royal Chitwan National Park: Resource Profile. Kathmandu: HMG Nepal, DNPWC

Farmers living in the buffer zone of the Royal Chitwan National Park sit in makeshift towers at night to guard their fields from marauding rhinos and other wildlife.



Source: IUCN, UNEP data, 2005 World Database on Protected Areas



NO	Name	Area (km²)
1	Jigme Dorje Wildlife Sanctuary	7813
2	Zhoshing Reserved Forest	5
3	Doga National Park	21
4	Sinchula Reserved Forest	80
5	Mochu Reserved Forest	277
6	Pochu Reserved Forest	140
7	Phipsoo Reserved Forest	175
8	Namgyal Wangchuk Wildlife Sanctuary	195
9	Manas Wildlife Sanctuary	463
10	Shumar Wildlife Reserve	160
11	Dungsum Reserved Forest	180
12	Neoli Wildlife Sanctuary	40
13	Khaling Reserved Forest	233

Source: Adapted from Zurick, D. and Karan P.P., 1999. Himalaya: Life on the Edge of the World. Baltimore and London: Johns Hopkins University Press

THE HIMALAYA: Protected Area and Biodiversity

	Bhutan	Nepal	Indian Himalaya	Total Himalaya
Total Area (sq. km.)	46,500	140,800	425,000	612,300
Total Protected Area (sq. km.)	9,400	22,654	28,454	60,508
# Threatened Mammal Species	12	17	29	58
# Threatened Bird Species	3	2	5	10
# Threatened Reptile Species	1	4	12	17
# Plant Species	5,000	6,500	15,000	26,500
% Endemic Flora	10-15	33	35*	
# Rare or Threatened Plant Species	5	15	1103	1123

* Figure is for the eastern Himalaya.

Source: Compiled from Shengji, Pei (ed.), 1995. Banking on Biodiversity. ICIMOD, Kathmandu

The Himalaya - Protected Areas: *The Himalayan countries have set aside significant areas of land for protection under approximately 130 designated areas. Most of these occur in the high mountains, and many of the large Himalayan parks have become popular tourism destinations for trekkers and other outdoor enthusiasts. The lowland parks, meanwhile, are established mainly as refuges for rare and endangered wildlife.*

A trekker consults a map along a trail in Langtang National Park.

The proposed Black Mountain Park, located in the central part of the country, will protect a large area of temperate Middle Mountain landscape, which elsewhere in the Himalaya receives little attention for parkland development. Much of the remainder of Bhutan's conservation lands occupies subtropical lowlands in a series of wildlife sanctuaries and forest reserves. The largest of these is the 463-square kilometer Manas Wildlife Sanctuary, once a Royal Hunting Reserve but declared in 1966 a Wildlife Sanctuary. It is the least disturbed protected area in Bhutan's lowland region and is contiguous with the 230-square kilometer Manas Tiger Reserve across the border in India. The southern sanctuaries in Bhutan support important populations of endangered wildlife whose legal protection under the formal conservation areas is key to maintaining biodiversity in the eastern Himalaya.

The parks and conservation areas in the mountains have varied goals, and some are much more developed than others, but all seek in some ways to combine the goals of environmental protection with the need for economic development. This dual purpose recognizes the fact that villagers continue to rely on the environment for natural resources and that their participation in conservation depends upon realizing economic alternatives. Toward this end, the conservation areas include numerous sustainable development programs alongside the environmental regulations. These include agro-forestry and micro-enterprises such as bee-keeping, paper-making; and mushroom cultivation, energy-saving technologies, medicinal plant management, and tourism. Such activities are managed to be compatible with sustainable local resource

A government-sponsored tree nursery in a central Himalayan village provides seedlings to farmers.

extraction. The promotion of nature-based and cultural tourism also is an essential component of most of the conservation areas. The revenue generated from the visitors seeking to experience both the natural beauty of the mountains and the lifestyles of their resident cultures contributes significantly to both national and village economies. It is believed that such tourism can be best managed in a parkland design where local people are responsible for managing the tourism activities and developing its infrastructure. The premise of the conservation development models is the notion that where local people financially benefit from parks they engage more deeply in them, developing sustainable livelihoods and managing resources wisely and with an outlook toward the future. As a result, the conservation areas become more than simply paper parks.

FUTURE TRENDS

The geological forces notwithstanding, it is within the capacity of Himalayan peoples to manage the future course of society and nature such that both will benefit. History clearly shows that the opportunities lie within the mountain cultures, which hold the wisdom of experience and all the rights of native residency, but the future efforts also need the support of the national governments and of the international community. In the minds of many people, the real challenge is for decision-makers to understand that the biological diversity of the Himalaya can only be sustained by maintaining their cultural diversity. This challenge is made all the more difficult by the impacts of globalization, which provide new opportunities for economic growth but threaten the diversity and autonomy of indigenous communities. Reducing population growth and alleviating poverty are fundamental to any formula for achieving a sustainable environmental future. These need to be managed, however, in ways that insure human rights amid a clean and equitable industry. It is an enormous challenge. Despite the many examples of positive change, the current trends of major social and environmental indicators across the range are in a negative direction.

The appeal of the Himalaya worldwide for their scenic and inspirational value, the magnitude of their societal and environmental problems, and a growing recognition that mountains everywhere play a critical role in the planetary biosphere have led to new international resolve toward finding solutions for the problems in the Himalaya and for safeguarding their precious natural environment. The United Nations Man and Biosphere programs were among the earliest international efforts to tackle the Himalayan problems. They supported the establishment in 1983 of the International Centre for Integrated Mountain Development (ICIMOD), based in Kathmandu, which is devoted to the sustainable development of the entire Hindu Kush-Karakoram-Himalayan region.

The 1992 United Nations Conference on Environment and Development included Chapter 13, known as the 'Mountain Agenda', which promotes the study and protection of mountains around the world, including the important Himalayan region. In the mid-1990s, land-cover change in the Himalaya became a component of the International Geosphere-Biosphere Program on Global Change. This inclusion recognized that the environmental health of the Himalaya is tied to that of the entire planet. Such a fundamental recognition led the United Nations to declare 2002 to be the International Year of the Mountains. Such designations, although global in scope, understand that, at heart, the societal and environmental challenges are essentially local ones. They combine with myriad programs of local initiative in quests to improve the human condition and to maintain the natural wealth of the Himalaya.

REFERENCES

Amatya, K.M. and B.M. Jnawali, 1994. *Geological Map of Nepal.* Kathmandu: KAAAS Consultancy and His Majesty's Government, Survey Department.

Bhati, J.P., 1990. *Development Strategies in Himachal Pradesh.* Kathmandu: International Centre for Integrated Mountain Development (ICIMOD)

Bista, D. B., 2000. *People of Nepal.* Kathmandu: Ratna Pustak Bhandar (7th edition)

Bruijnzeel, L.A. and Bremmer C.N., 1989. *Highland Lowland Interactions in the Ganges-Brahmaputra River Basin.* Kathmandu: ICIMOD, Occasional Paper No. 11

Carson, B., 1985. *Erosion and Sedimentation Processes in the Nepalese Himalaya.* Kathmandu: ICIMOD, Occasional Paper No. 1

Crook, J. and Osmaston, H. (eds.), 1994. *Himalayan Buddhist Villages.* New Delhi: Motilal Banarsidass Publishers

Directorate of Economics and Statistics, n.d. *Important Statistics of Himachal Pradesh.* Shimla: Directorate of Economics and Statistics

Department of National Parks and Wildlife Conservation (DNPWC) 2000. *Royal Chitwan National Park: Resource Profile.* Kathmandu: HMG-Nepal, DNPWC

Dubey, M. and Sinclair T. (eds.), 1992. *Insight Guides - Western Himalaya.* Singapore: Apa Publications

FAO, 1991. Wood Energy Sector Analysis, Bhutan. Rome: FAO

Gansser, A., 1964. *Geology of the Himalayas.* London: Wiley Interscience

Gaur, V. K. (ed.), 1993. *Earthquake Hazard and Large Dams in the Himalaya.* New Delhi: Indian National Trust for Art and Cultural Heritage (INTACH)

G.B. Pant Institute, 2002. INDIAN HIMALAYA: A Demographic Database, 2002. Almora: G. B. Pant Institute

Getis, A. et al., 2000. Introduction to Geography. Boston: McGraw Hill

Government of India, 1992. *Geological Map of the Western Himalaya.* New Delhi: Government of India

Gurung, H., 1998. *Nepal: Social Demography and Expressions.* Kathmandu: New Era Publications

Hagen, T., 1980. *Nepal. Kingdom in the Himalayas.* Berne: Kummerly and Frey Publishers

ICIMOD, 1993. *International Symposium on Mountain Environment and Development.* Kathmandu: ICIMOD

ICIMOD, 1996. *Climatic and Hydrological Atlas of Nepal.* Kathmandu: ICIMOD

ICIMOD, 1996. *GIS Database of Key Indicators of Sustainable Mountain Development in Nepal.* Kathmandu: ICIMOD

ICIMOD, 1997. *Districts of Nepal - Indicators of Development.* Kathmandu: ICIMOD

ICIMOD, 2001. *Inventory of Glaciers, Glacial Lakes and Glacial Lake Outburst Floods, Bhutan.* Kathmandu: ICIMOD

ICIMOD, 2001. *Inventory of Glaciers, Glacial Lakes and Glacial Lake Outburst Floods, Nepal.* Kathmandu: ICIMOD

ICIMOD, 2003. Mapping Nepal Census Indicators 2001 & Trends. Kathmandu: ICIMOD

Ives, J. and Messerli, B., 1989. *The Himalayan Dilemma.* New York: Routledge

Jayal, S. V. ; Tongru N.D.; Kumat K. B., 1993. *Ignoring Reason, Inviting Disaster: Threat to Ganga-Himalaya.* Dehra Dun: Friends of Chipko and Natraj Publishers

Karan, P.P., 1967. *Bhutan: A Physical and Cultural Geography.* Lexington, Kentucky: University of Kentucky Press

Karan, P.P. and Ishii, H., 1996. *Nepal: A Himalayan Kingdom in Transition.* Tokyo: United Nations University Press

Kawosa, M.A., 1998. *Remote Sensing of the Himalaya.* Dehra Dun: Natraj Publishers

Lauterburg, 1993. *'The Himalayan Highland-Lowland Interactive System, Do Land Use Changes in the Mountains Affect the Plains?'* In Messerli, B. et al. (eds.), *Himalayan Environment: Pressure-Problems-Processes 12 Years of Research.* Berne: Geographica Bernensia

Lewis, T. and Riccardi, T., Jr., 1995. *The Himalaya: A Syllabus of the Region's History, Anthropology, and Religion.* Ann Arbor: Association for Asian Studies

MacFarlane, A. et al. (eds.), 1999. *Himalaya and Tibet.* Boulder, CO: The Geological Society of America

Malinconico, L. and Lillie, R. (eds.), 1989. *Tectonics of the Western Himalaya.* Boulder, CO: The Geological Society of America, Special Paper 232

Messerli, B., Hofer, T. and Wymann S. (eds.), 1993. *Himalayan Environment: Pressure-Problems-Processes.* Berne: University of Berne, Institute of Geography

Mool, P., 2001. *Inventory of Glaciers, Glacial Lakes, and Glacial Lake Outburst Floods: Bhutan.* Kathmandu: ICIMOD

Mool, P., 2001. *Inventory of Glaciers, Glacial Lakes, and Glacial Lake Outburst Floods: Nepal.* Kathmandu: ICIMOD

Nepal South Asia Center, (NESAC) 1998. *Nepal: Human Development Report 1998.* Kathmandu: NESAC

Paranjpye, V., 1988. *Evaluating the Tehri Dam.* New Delhi: INTACH

Pangtey, Y.P.S. and S.C. Joshi (eds.), 1987. *Western Himalaya, Vol. 1: Environment.* Nainital: Gyandaya Prakashan

Pommaret, F., 1991. *Introduction to Bhutan.* Geneva: Editions Olizane SA

Price, L.,"1981. *Mountains and Man.* Berkeley: University of California Press

Pei Shengji, 1995. *Banking on Biodiversity: Report on the Regional Consultation on Biodiversity Assessment in the Hindu Kush-Himalayas.* Kathmandu: ICIMOD

Royal Government of Bhutan, 1992. *Seventh Five-Year Plan (1992-1997), Vol. 1. Main Plan Document.* Thimphu: RGOB, Planning Commission

Royal Government of Bhutan, 2000. *Bhutan National Human Development Report 2000: Gross National Happiness and Human Development - Searching for Common Ground.* Thimphu: RGOB, Planning Commission Secretariat

Sharma, P. (ed.), 2001. *Market Towns in the Hindu Kush-Himalayas.* Kathmandu: ICIMOD

Shroder, J. F. (ed.), 1993. *Himalaya to the Sea: Geology, geomorphology and the Quaternary.* London and New York: Routledge Publishers

Sill, M. and Kirkby J., 1991. *The Atlas of Nepal in the Modern World.* London: Earthscan Publications

Sud, O.C., 1992. *The Simla Story.* Simla: Maria Brothers

Thakur, V.C. and Rawat, B.S. 1992. *Geological Map of Western Himalaya.* Dehra Dun: Wadia Institute of Himalayan Geology

Topographic Survey Branch, n. d. *School Atlas of Nepal.* Kathmandu: HMG-Nepal, Survey Department, Topographic Survey Branch

UN, 1999. *Nepal: Common Country Assessment.* Kathmandu: The United Nations System

United Nations Disaster Management Team, 2001. *Nepal: UN Disaster Preparedness Response Plan, Part I.* Kathmandu: The United Nations System

UNEP, 2001. *Nepal: State of the Environment 2001.* Bangkok: UNEP-RRC.AP (prepared by ICIMOD)

Wallen, R.N., 1992. *Introduction to Physical Geography.* Dubuque, Iowa: A: Wm. C. Brown

Wheller, T.; Finlay, H.; Everest, R., 1997. *Nepal.* Hawthorne, Australia: Lonely Planet Publications

World Wildlife Fund, 2000. *WWF in Nepal: Three Decades of Partnership in Conservation.* Kathmandu: WWF-Nepal

Zurick, D., 1988. *Resource Needs and Land Stress in Rapti Zone, Nepal.* The Professional Geographer, 40(4):428-444

Zurick, D., 1990. "The Himalayas". In Magill, F.N. (ed.) *Survey of Earth Science.* pp. 1073-1078. Pasadena, CA: Salem Press

Zurick, D. and Karan P.P., 1999. *Himalaya: Life on the Edge of the World.* Baltimore and London: Johns Hopkins University Press

About the Authors

David Zurick: Dr. David Zurick is Professor of Geography at Eastern Kentucky University. He has conducted research during the past 25 years in various regions of the Himalaya, and is the author of ERRANT JOURNEYS and HIMALAYA: Life on the Edge of the World (with P.P. Karan).

Julsun Pacheco: Mr. Julsun Pacheco is a cartographer and GIS specialist. He has produced maps for numerous atlases, including the Atlas of Southeast Asia, and the Atlas of Hawaii.

Basanta Shrestha: Mr. Basanta Shrestha is Division Head of Mountain Environment and Natural Resources Information Systems (MENRIS) at the International Centre for Integrated Mountain Development (ICIMOD) in Nepal. He has played a pioneering role in promoting GIS technology and applications in the Himalayan region and published numerous publications on GIS applications for mountain regions.

Birendra Bajracharya: Mr. Birendra Bajracharya is a GIS Specialist at Mountain Environment and Natural Resources Information Systems (MENRIS) at the International Centre for Integrated Mountain Development (ICIMOD). He has developed several GIS applications and decision support system tools for the mountain environment and published numerous publications and papers.

International Centre for Integrated Mountain Development (ICIMOD)
Khumaltar, Lalitpur, GPO Box 3226, Kathmandu, Nepal
Tel: + 977 1 5525313, Fax: + 977 1 5524509 / 5536747
Email: distri@icimod.org
www.icimod.org

ISBN 92 9115 224 2