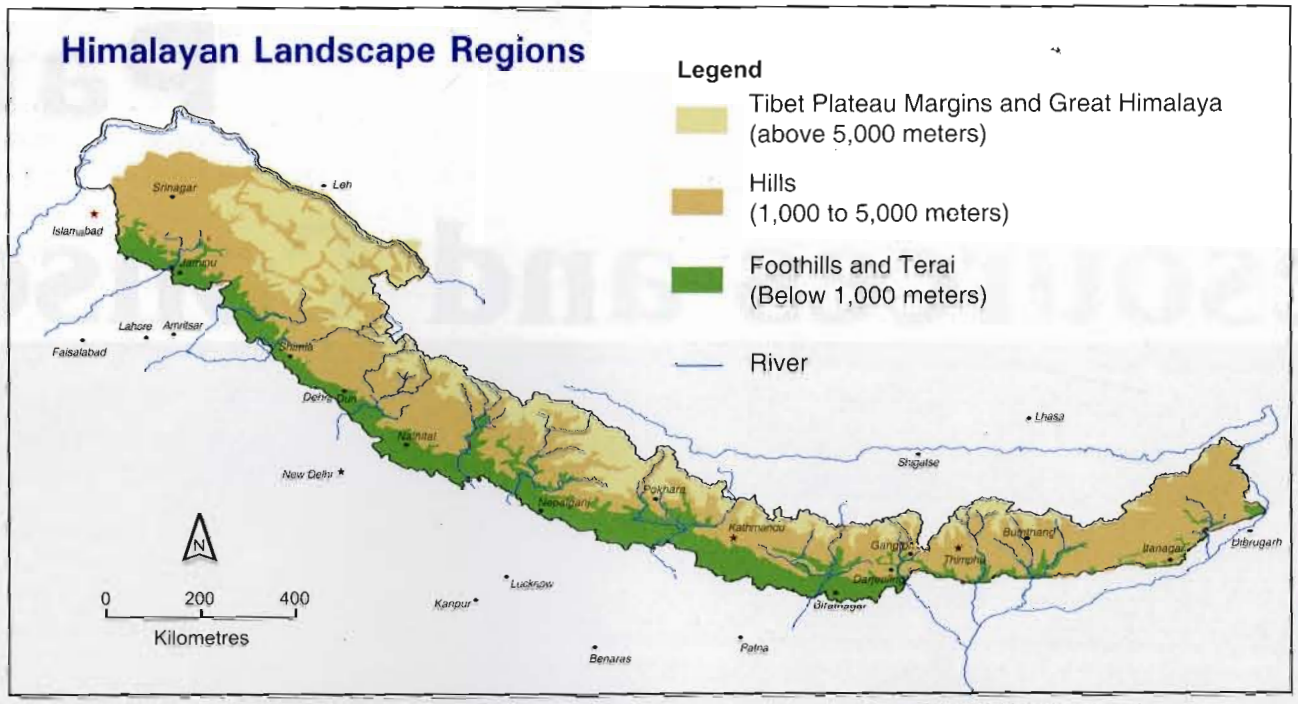
Part Four

Resources and Conservation

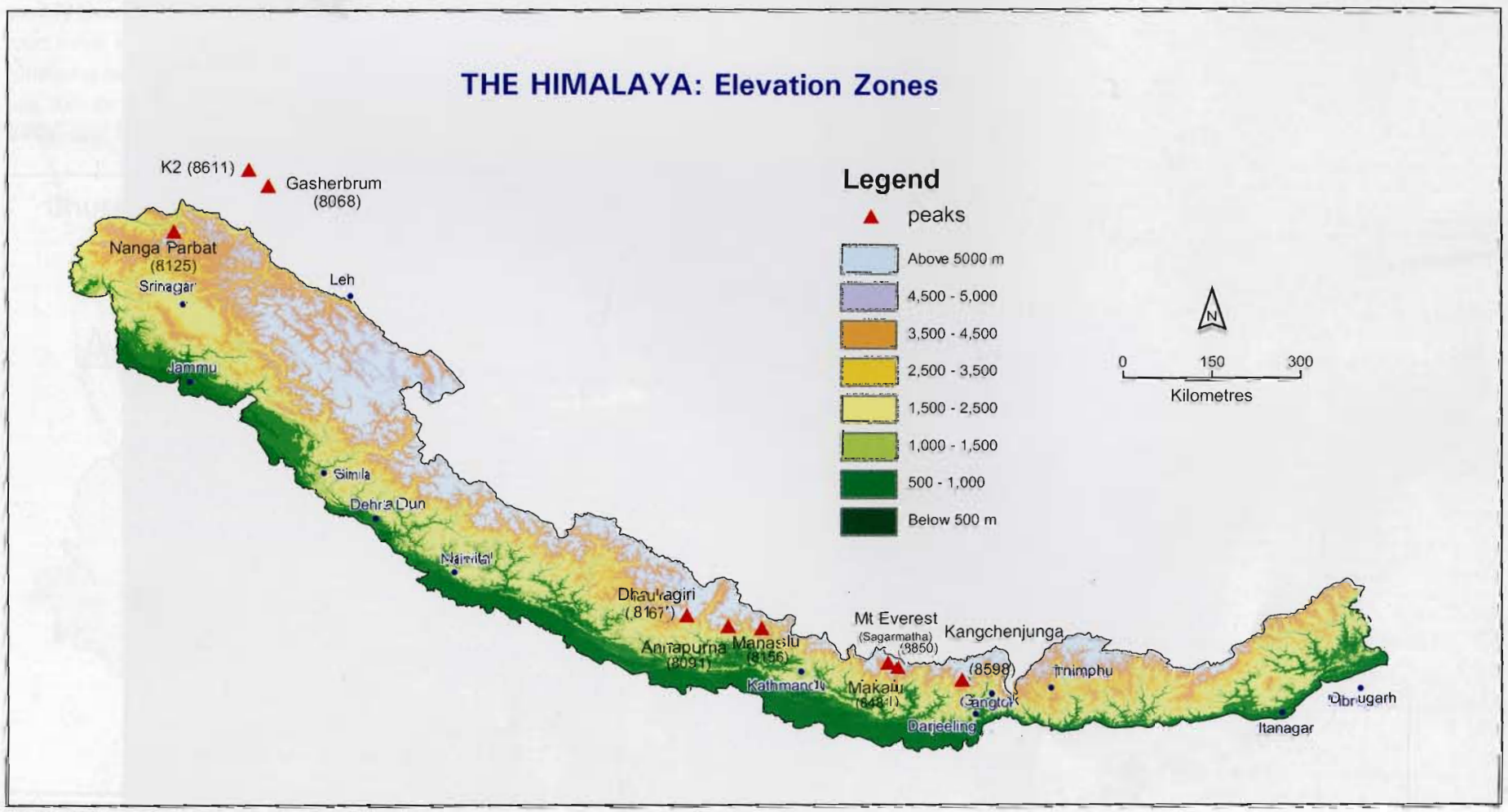
Baspa Valley, Western Himalaya

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.



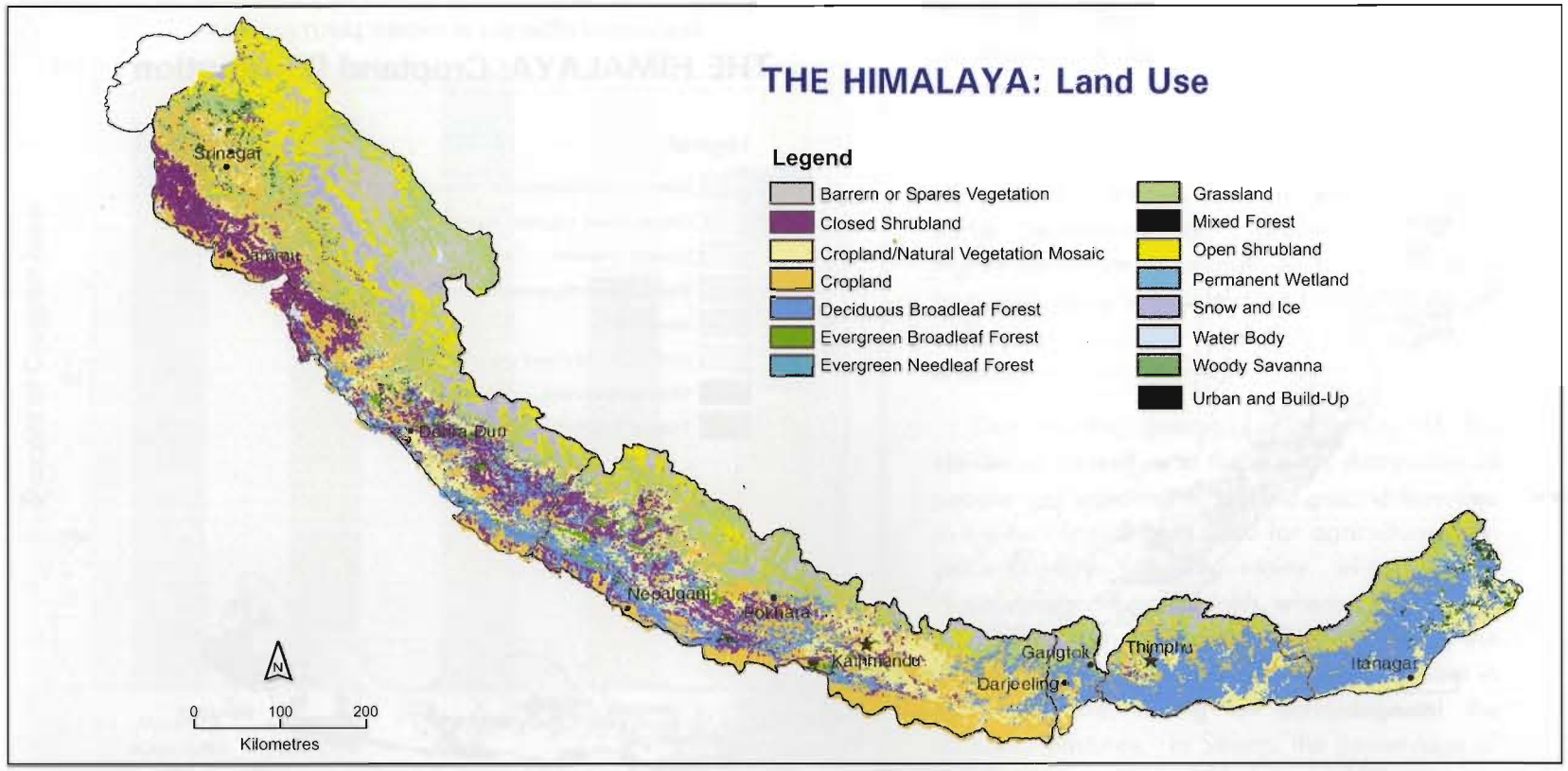
Source: Compiled by the authors. Adapted from Zurick D. and Karan P.P., 1999. Himalaya: Life on the Edge of the World. Baltimore and London: Johns Hopkins University Press

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.*

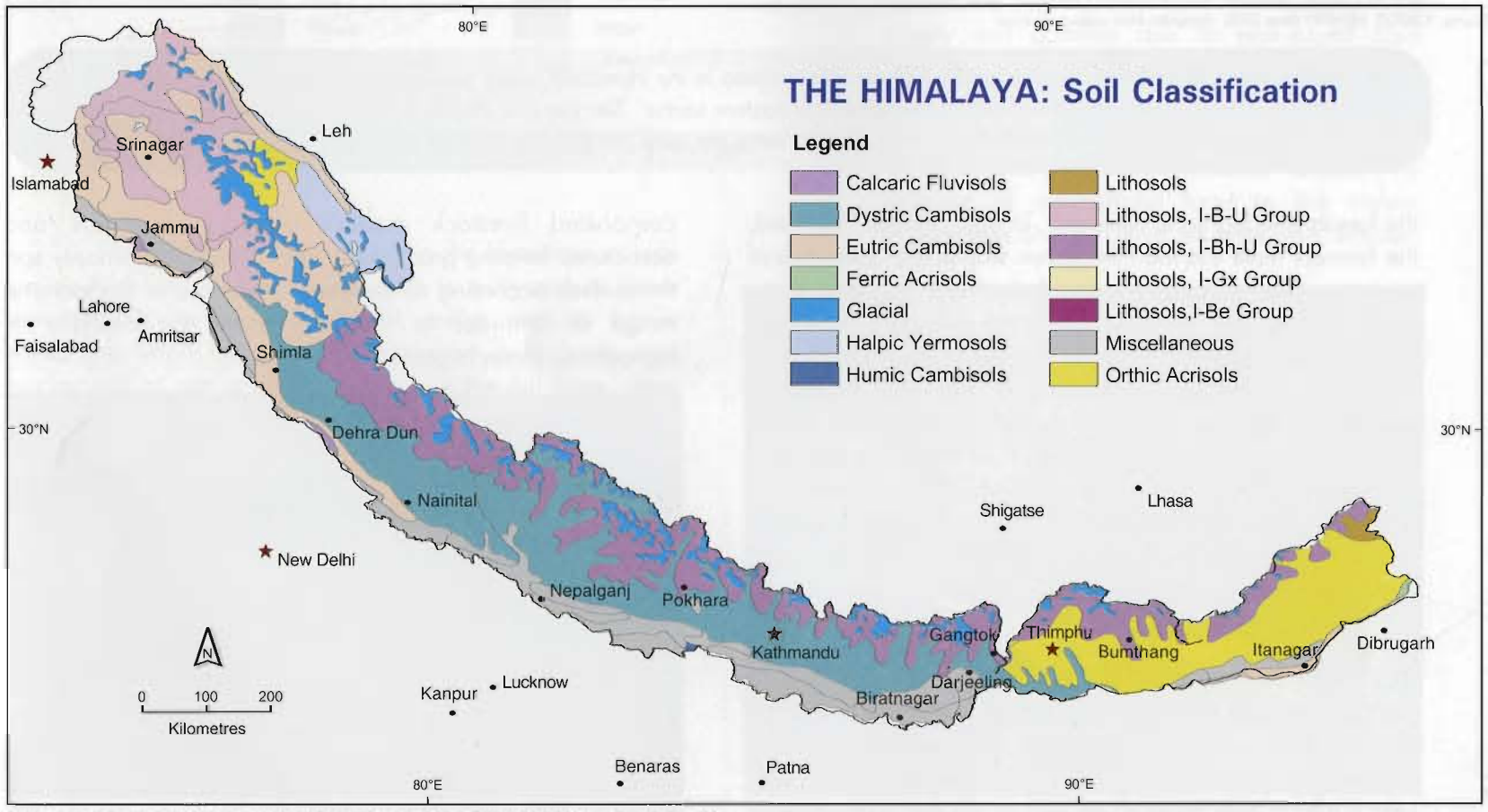


Source: ICIMOD, MENRIS data - derived from GTOPO data

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

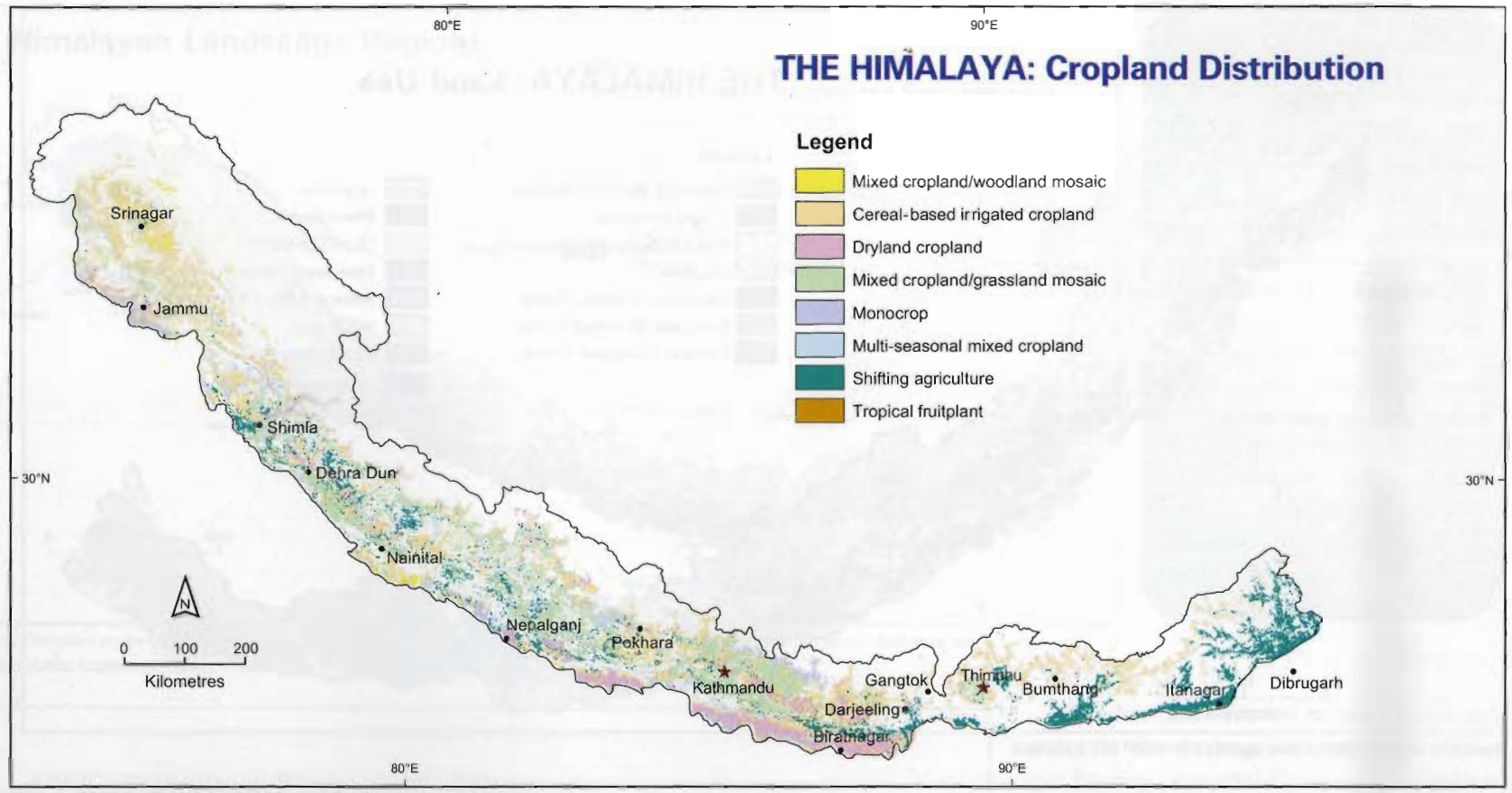
Source: Adapted from UNEP, 2001. Nepal: State of the Environment 2001. Bangkok: UNEP-RRC.AP

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

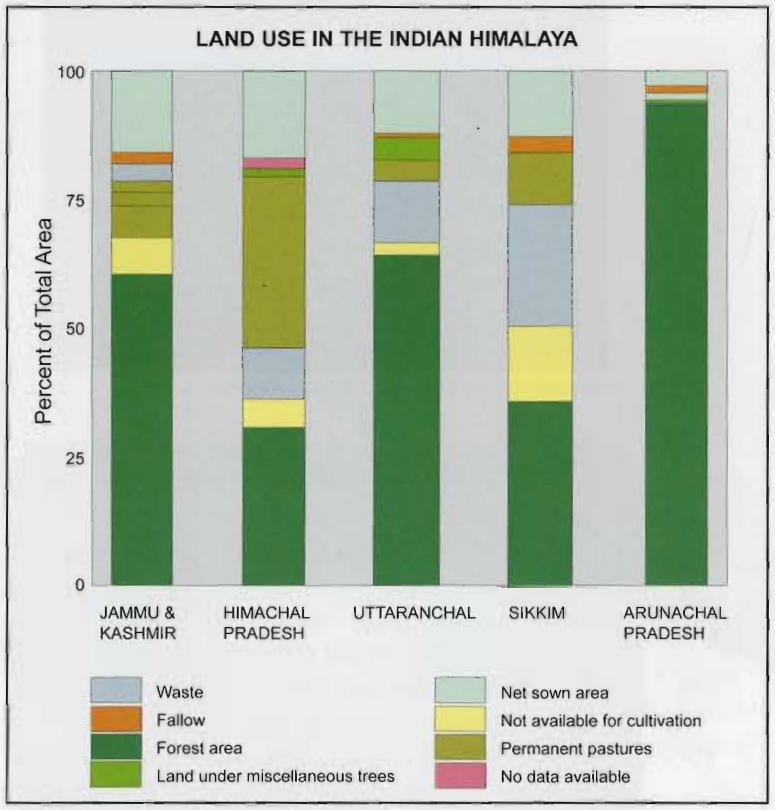
AGRICULTURAL LAND

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.



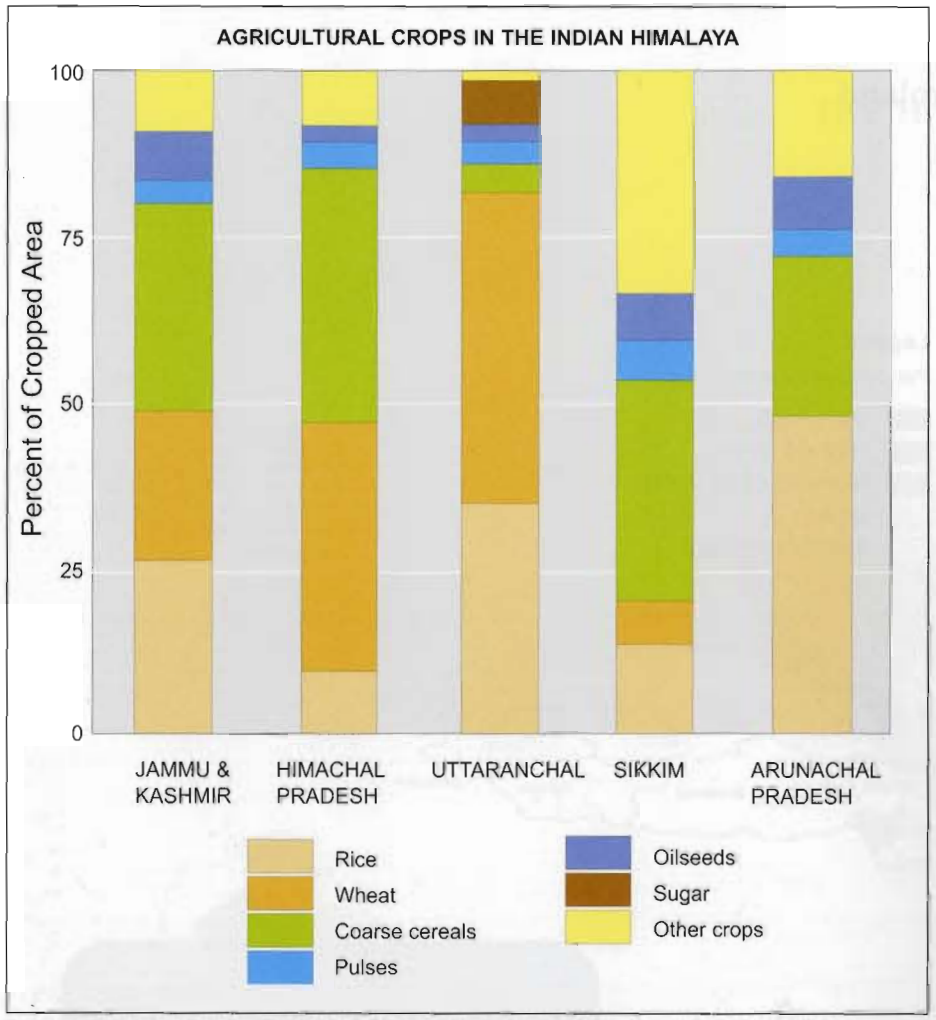
Source: ICIMOD, MENRIS Data 2000, compiled from various sources



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

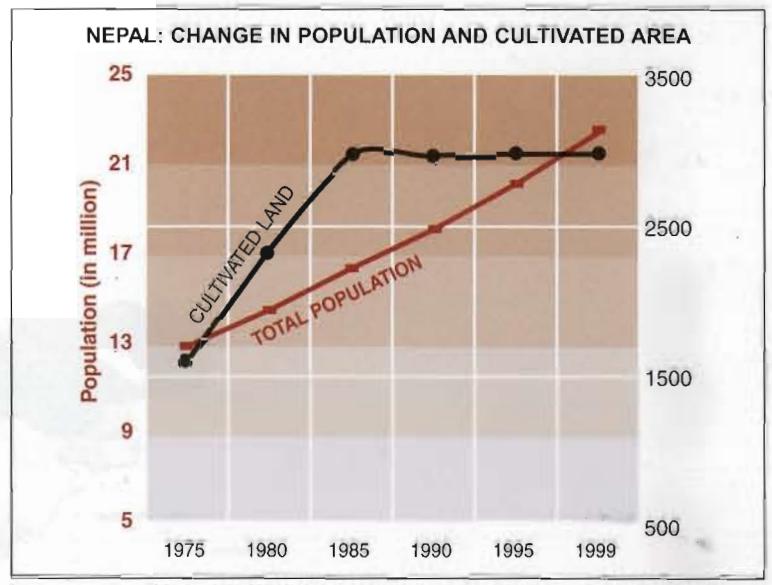


Source: Adapted from INDIAN HIMALAYA: A Demographic Database (2002). Almora: G. B. Pant Institute

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.



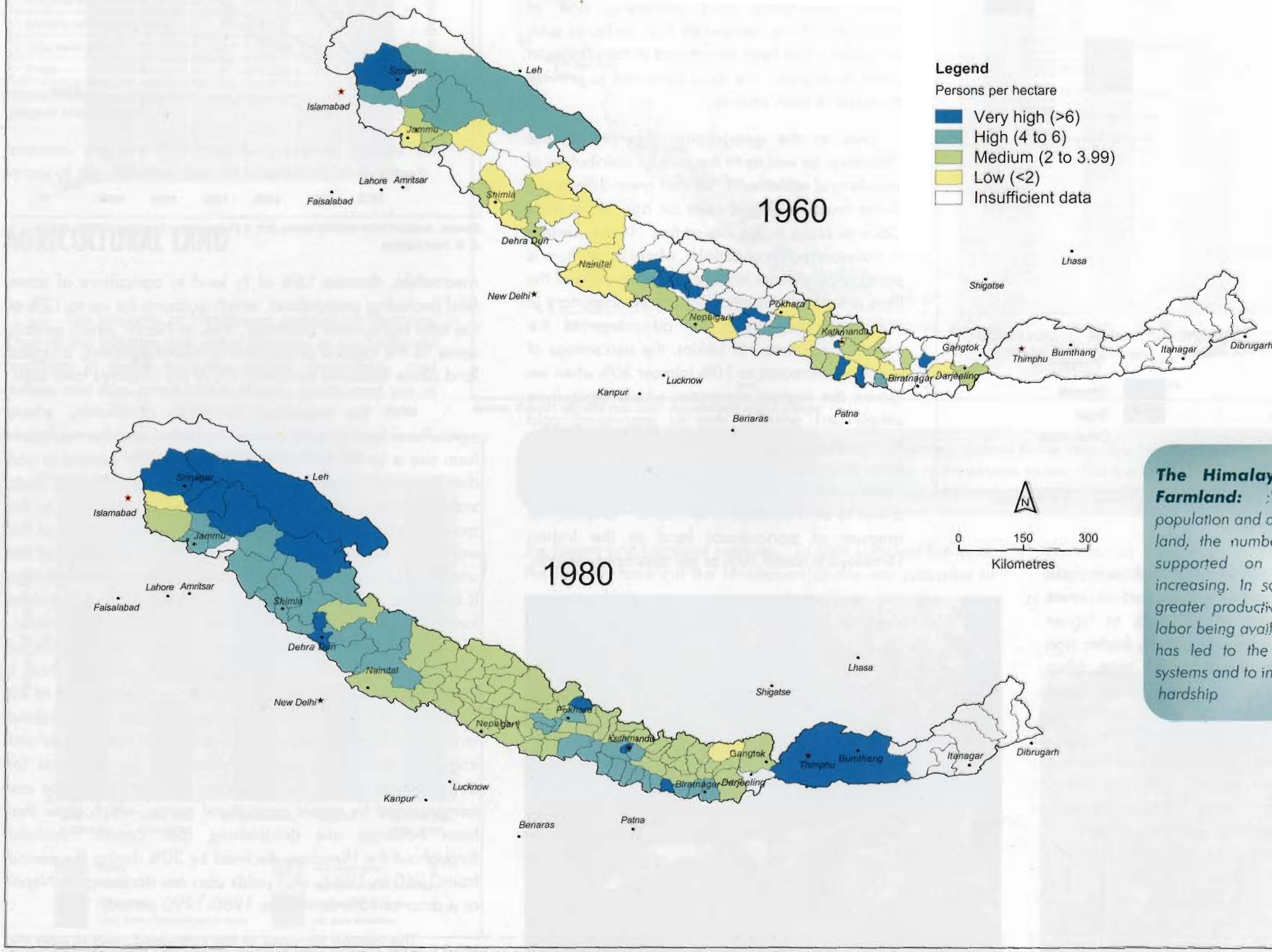
Source: Adapted from INDIAN HIMALAYA: A Demographic Database (2002). Almora: G. B. Pant Institute

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

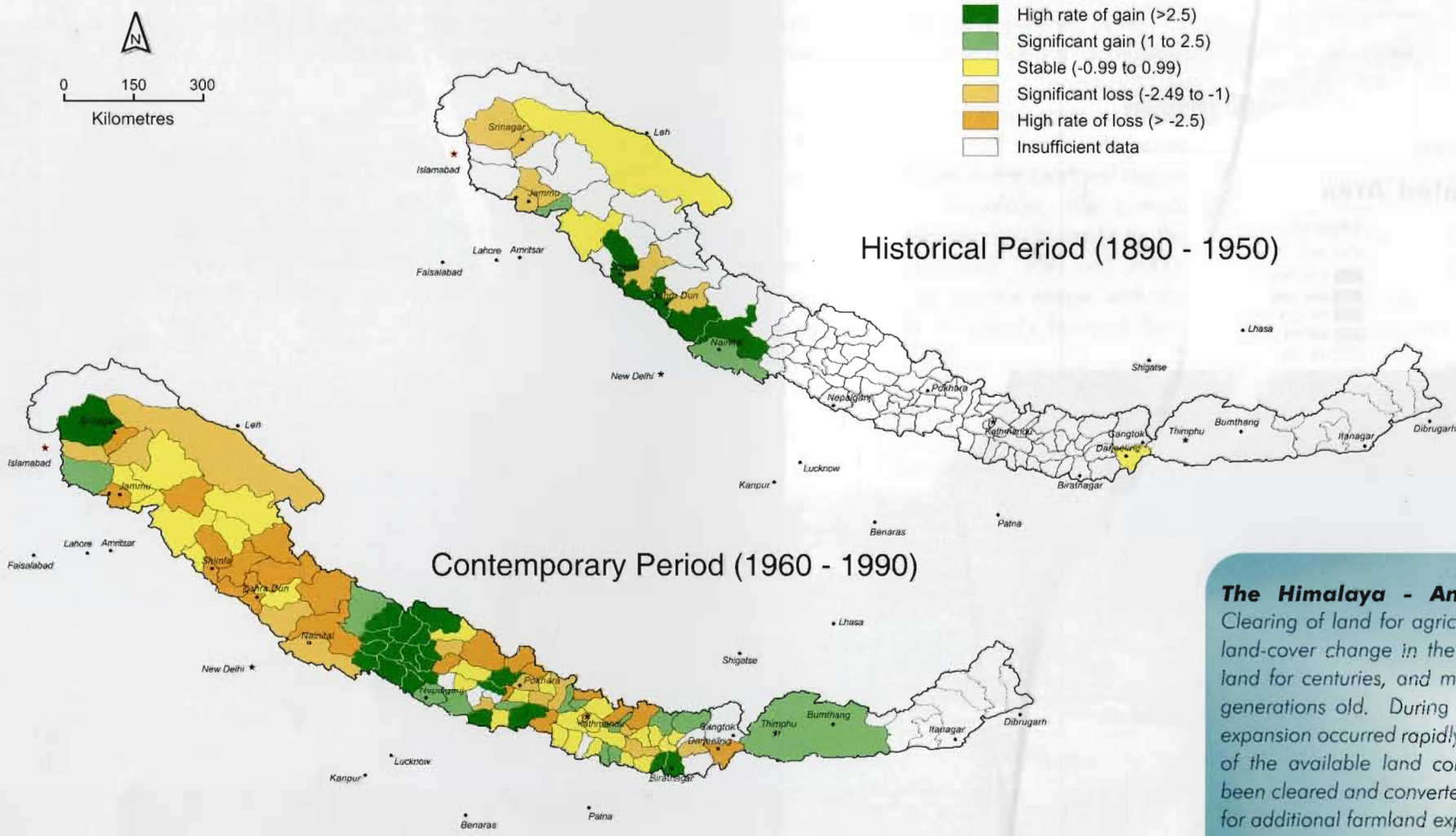
THE HIMALAYA: Population and Farmland



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*

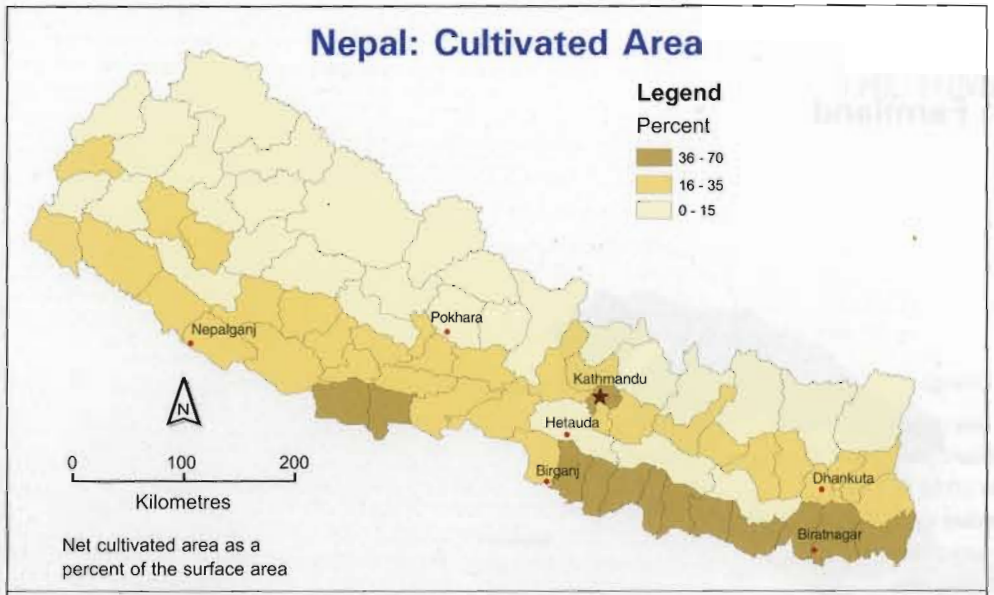
Source: Adapted from Zurick D. and Karan P.P., 1999. Himalaya: Life on the Edge of the World. Baltimore and London: Johns Hopkins University Press. Based on data from various government sources.

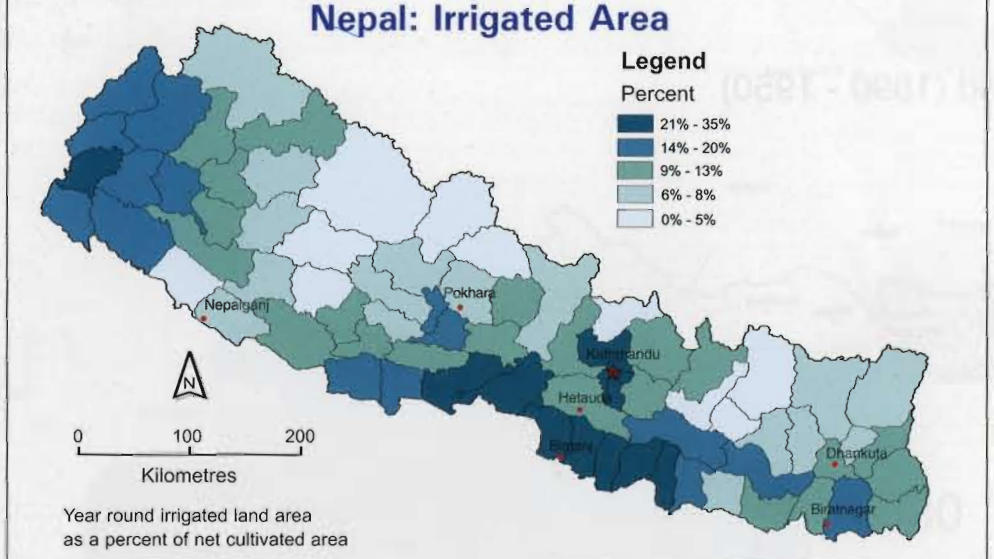
THE HIMALAYA: Annual Change in Farmland

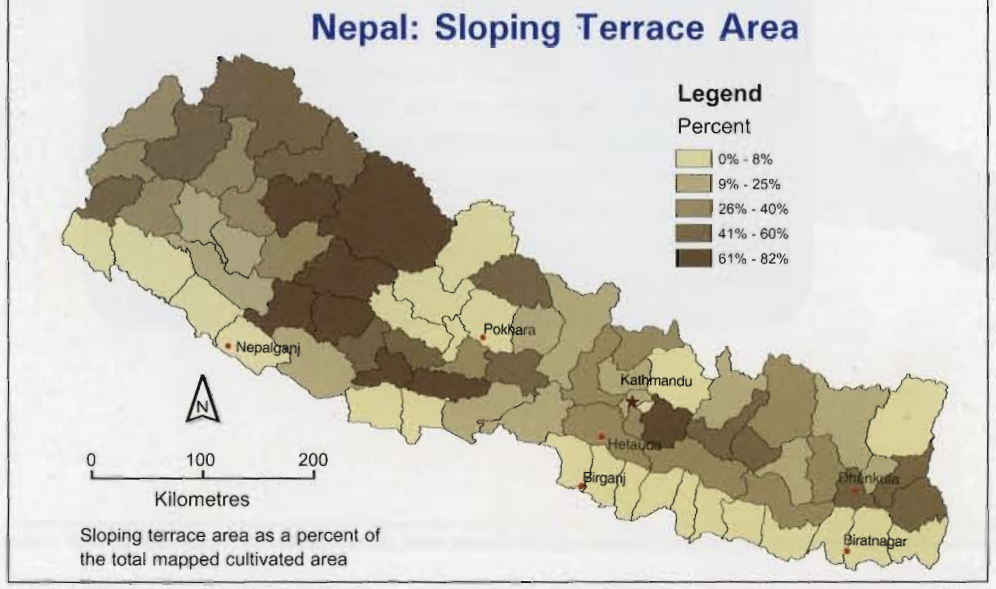


The Himalaya - Annual Change in Farmland: *Clearing of land for agriculture is one of the major factors in land-cover change in the mountains. Farmers have cleared land for centuries, and much of the agricultural landscape is generations old. During the contemporary period, farmland expansion occurred 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).

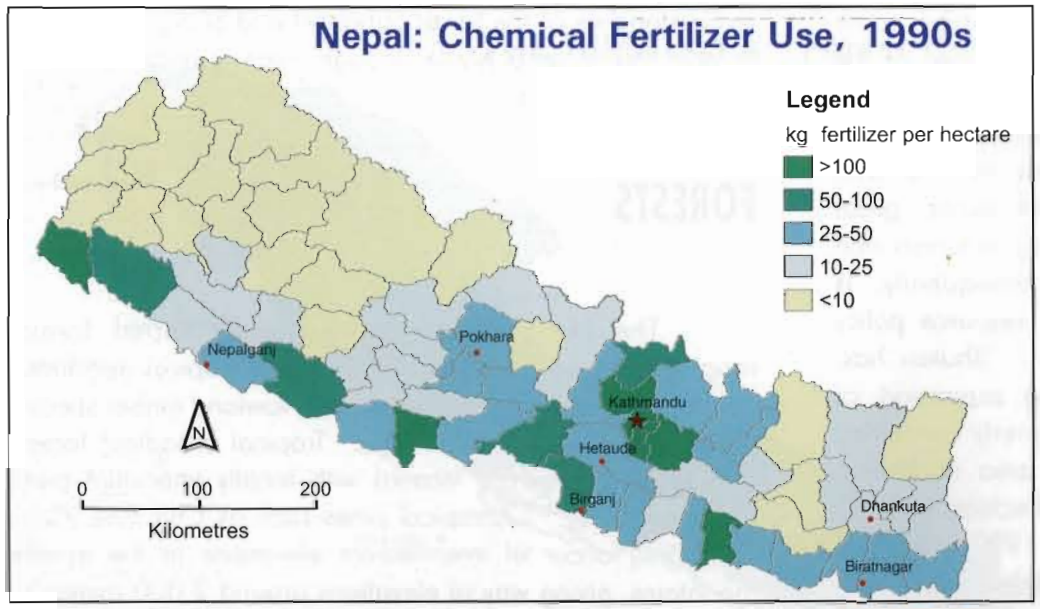






Source: ICIMOD, 1996. GIS Database of Key Indicators of Sustainable Mountain Development in Nepal. Kathmandu: ICIMOD

Woman threshing barley

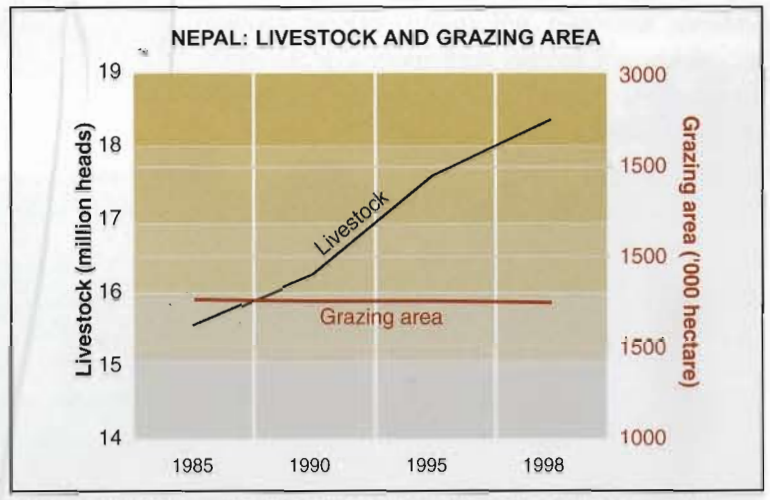


Source: Adapted from UNEP, 2001. Nepal: State of the Environment 2001. Bangkok: UNEP-RRC.AP

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.*

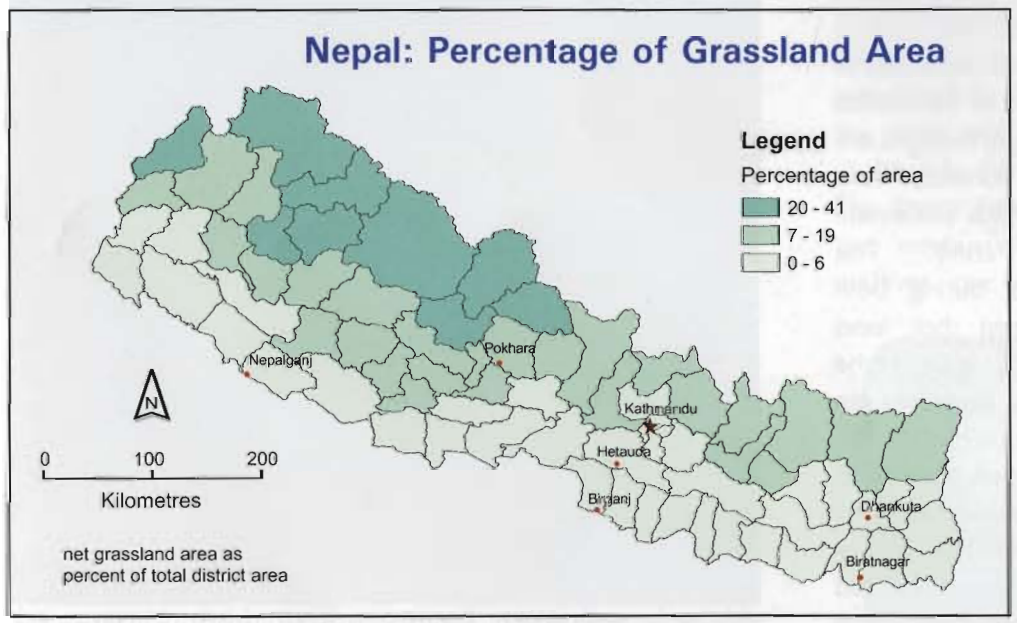
archival records kept by the British and later by the Indian governments, as well as those of Nepal, show a steady increase in the cropped area in most localities since 1890, with the most rapid gains observed in the hills and foothill zones. In some places, for example in the Garhwal region in the western 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.

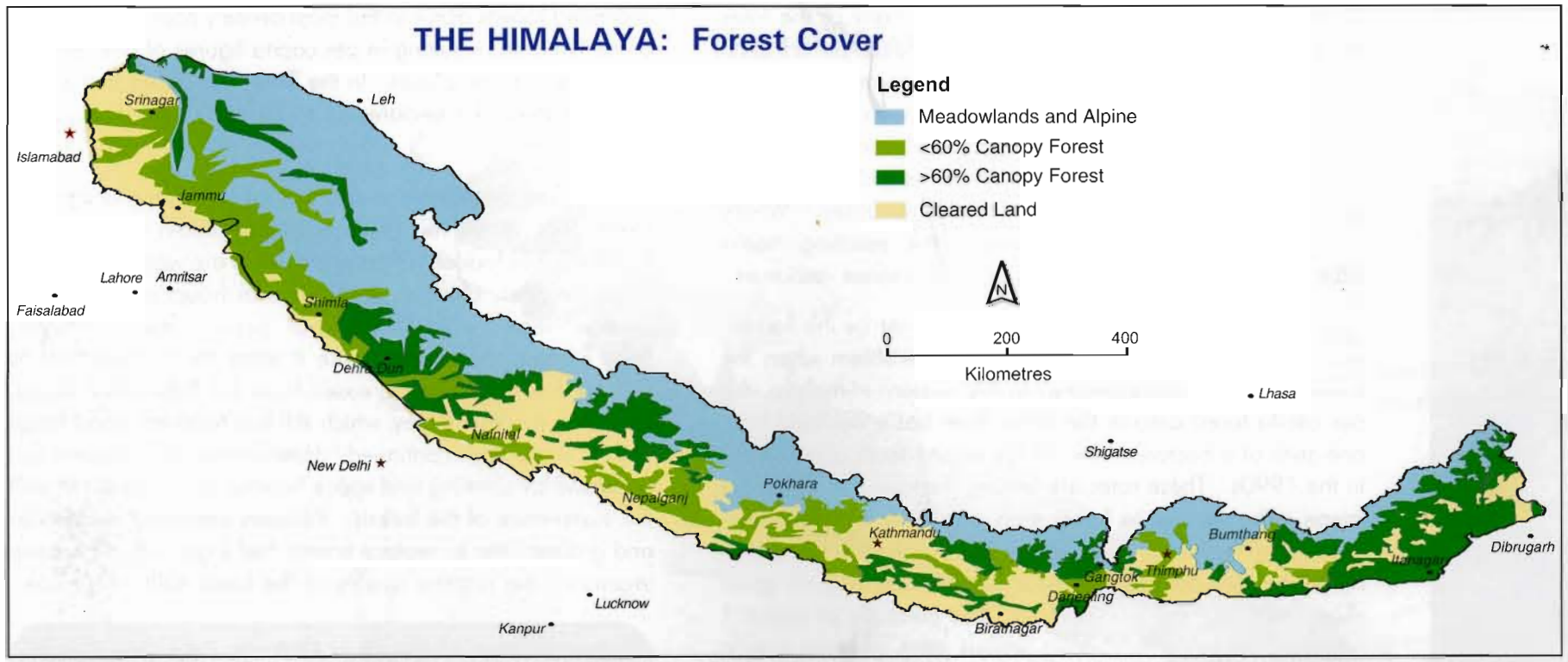
Bhutan, meanwhile, exhibits some of the lowest population densities of the Himalayan countries and, consequently, has some of the most favorable natural conditions for agricultural development. The country, however, places great importance on maintaining its forests and the farming frontier, consequently, 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.

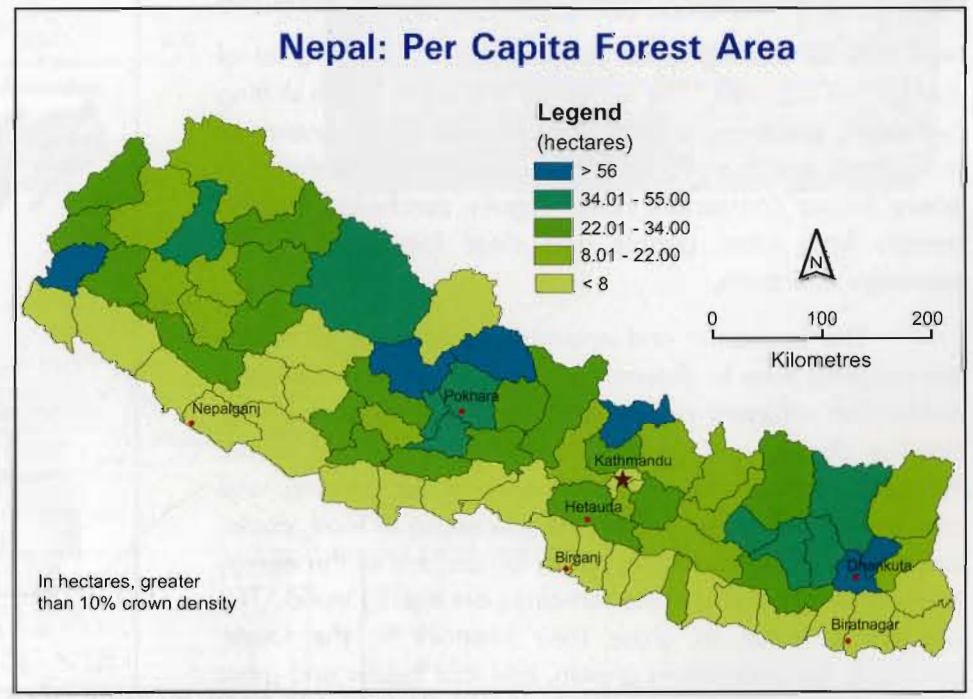
pines (*Pinus spp*), spruce (*Picea spp*), fir (*Abies spp*), and juniper (*Juniperus*) occur in the upper temperate and subalpine zones, which converge with the alpine level in a stunted mix of dwarf conifers (*Coniferae spp*), willows (*Salix spp*), and birches (*Betula spp*).

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

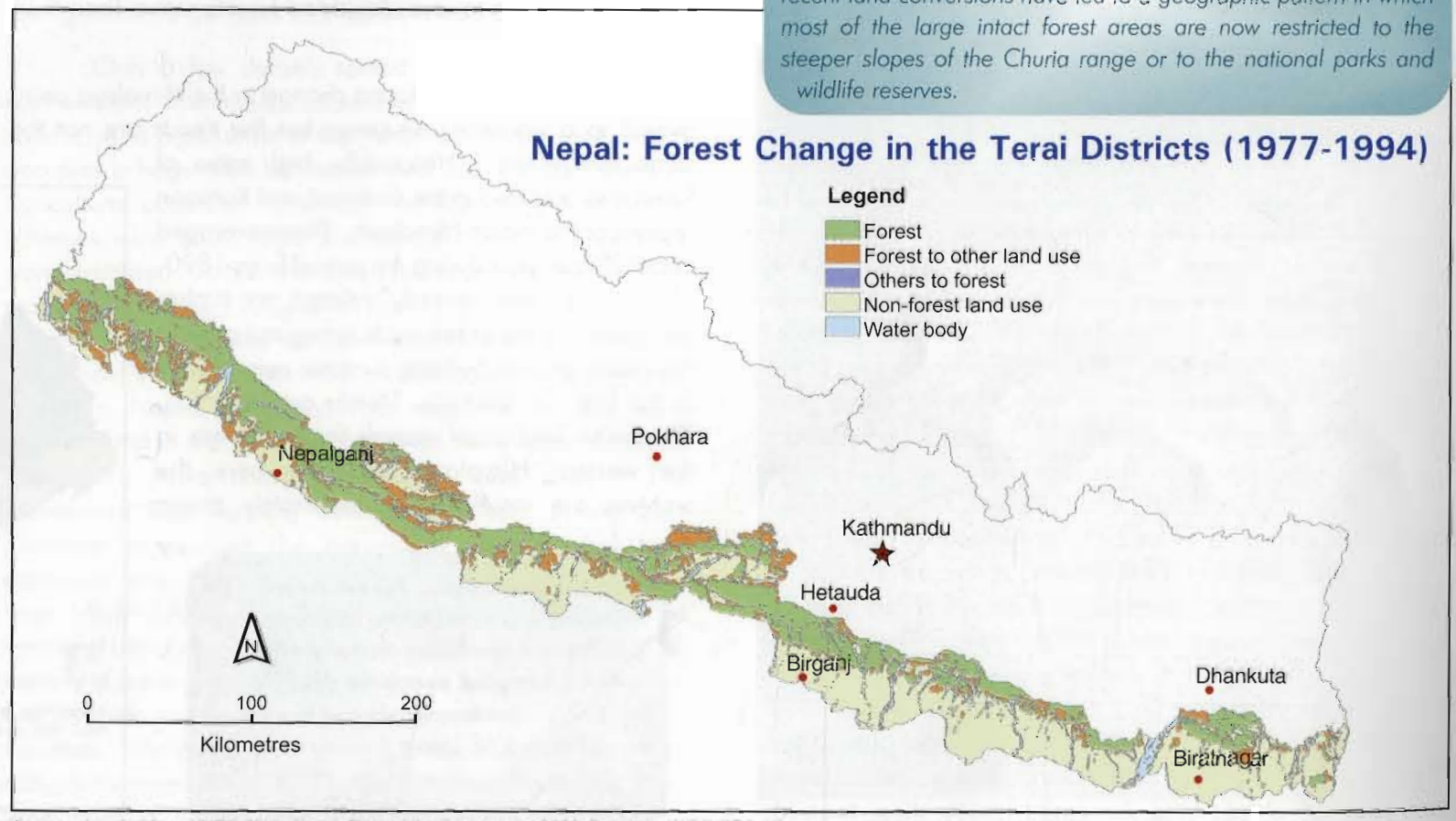
high rates of existing forest cover suggest that not a lot of decline has occurred. The exception is in areas where shifting cultivators, practicing a form of agriculture locally known as jhum, slash and burn forests in an unsustainable fashion, or where timber contractors have illegally purchased logging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

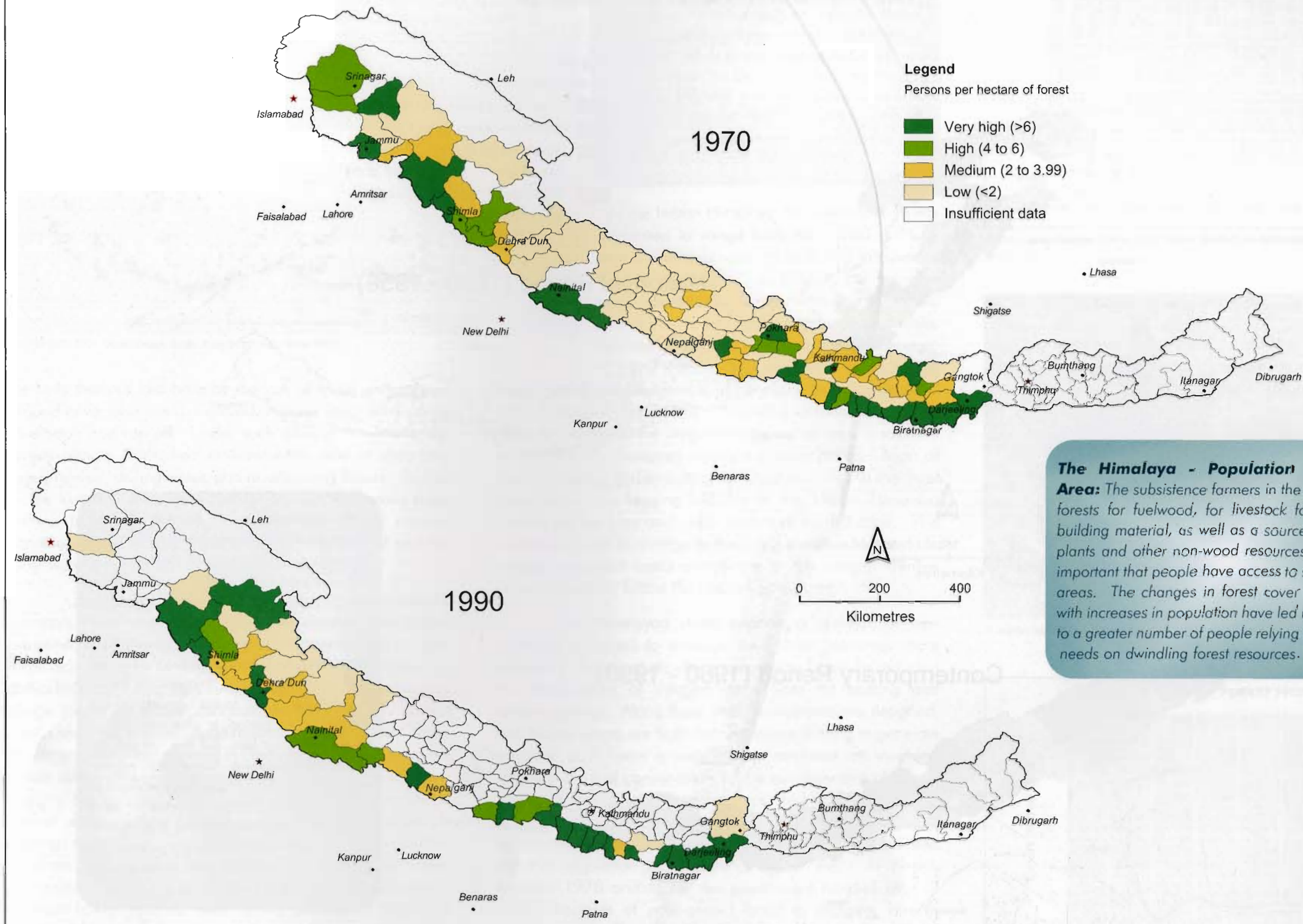
The decreasing availability of forests for village use means that people must work harder to obtain the necessary fuelwood and fodder. Greater distances are walked to gather wood for fires, often requiring several hours each day. In eastern Nepal, which hosts large populations of refugees from Bhutan, 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

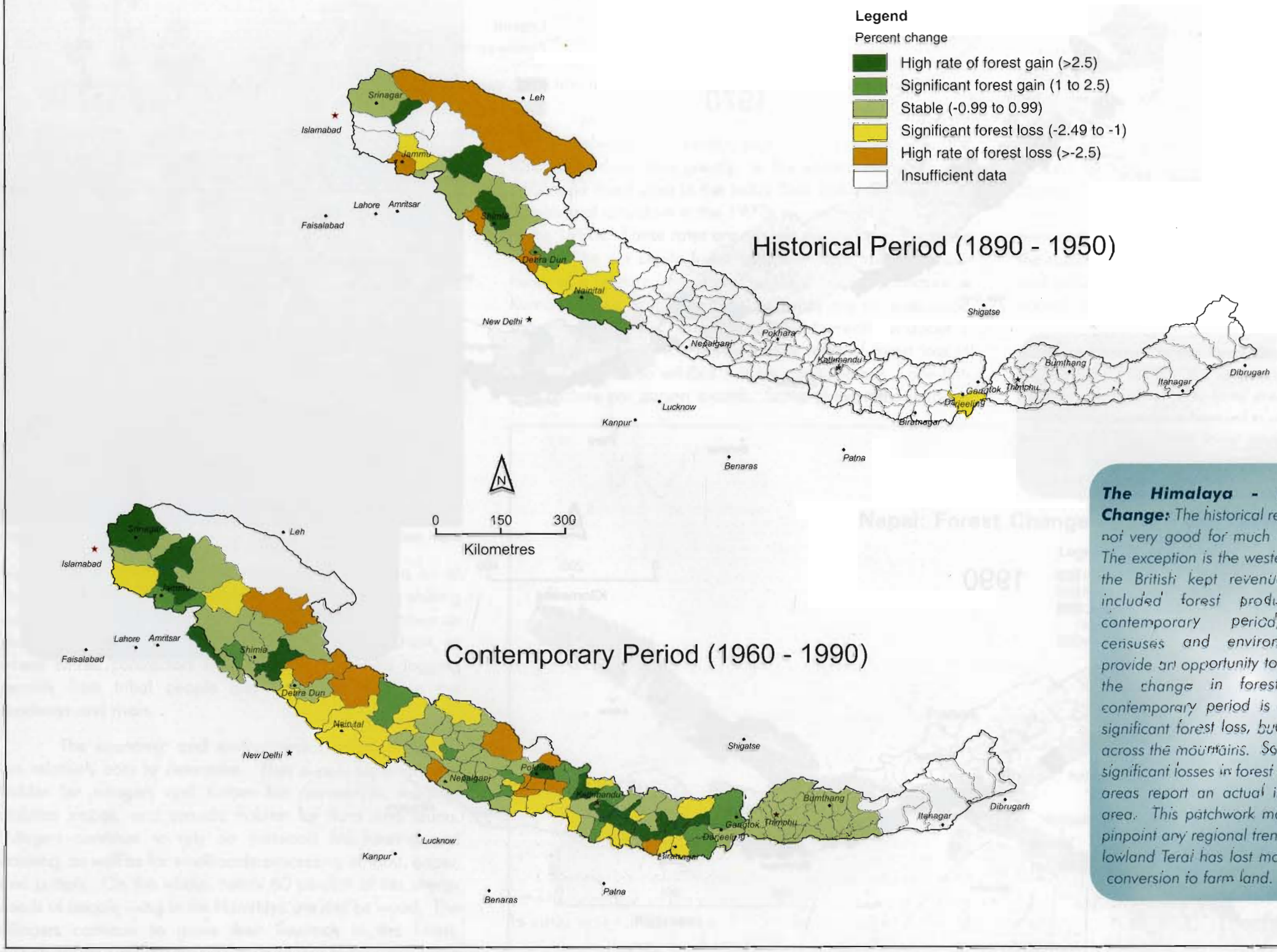
THE HIMALAYA: Population and Forest Area



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.*

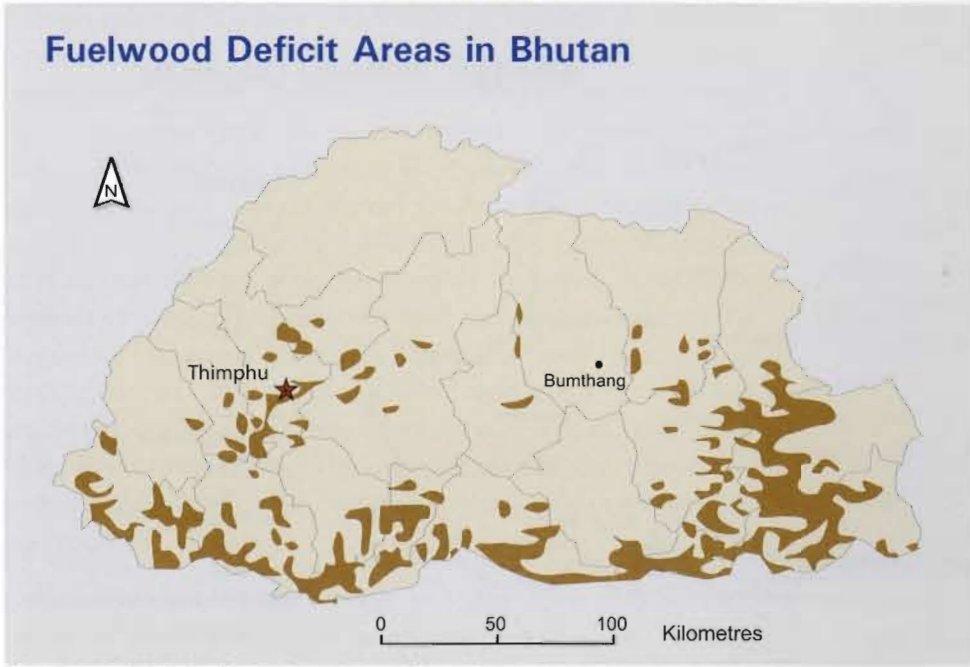
Source: Adapted from Zurick D. and Karan P.P., 1999. Himalaya: Life on the Edge of the World. Baltimore and London: Johns Hopkins University Press. Compiled from various government censuses and land use reports for Bhutan, India, and Nepal.

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

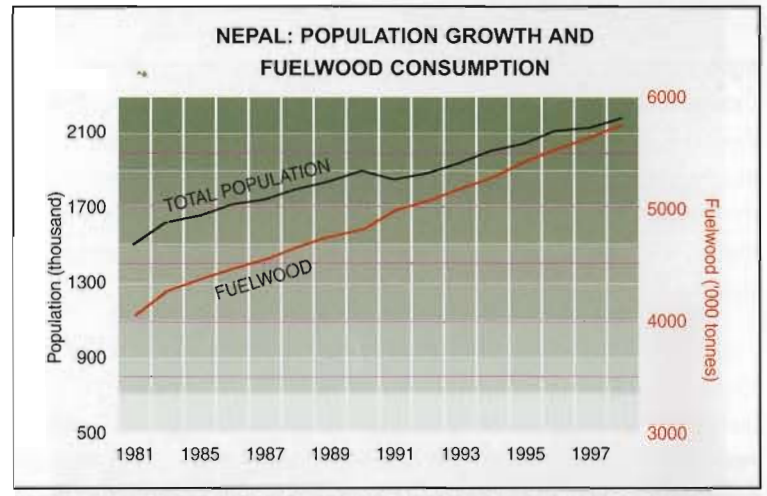
Fuelwood Deficit Areas in Bhutan: *The use of wood for cooking and heating fuel has led to its depletion in heavily-populated areas of Bhutan. This is a particular problem where forests are most degraded. Efforts to introduce more fuel-efficient stoves, such as the ceramic chulla stove designs, have 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.

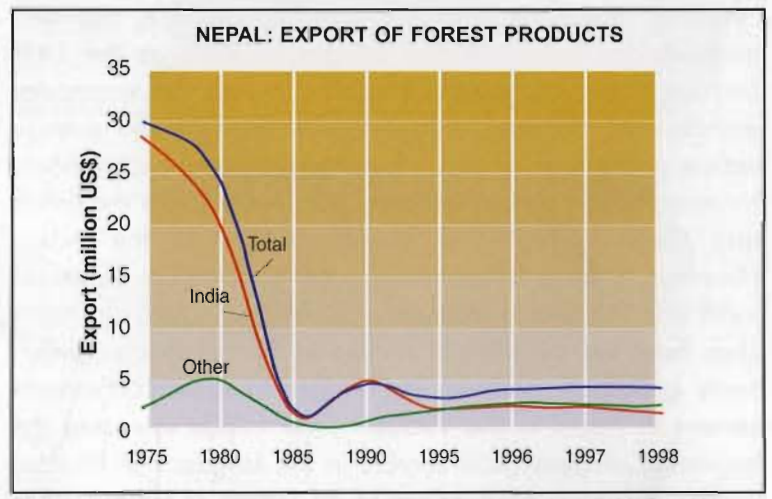
In the Indian Himalaya, the value of logs was calculated to range from Rs. 1,980 for Chir pine (*Pinus roxburghii*) to Rs.8,100 for Deodar (*Cedrus deodara*). In Bhutan, the value of wood exports to India increased threefold during the late 1980s. Nepal, meanwhile, reported a decline in timber exports 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



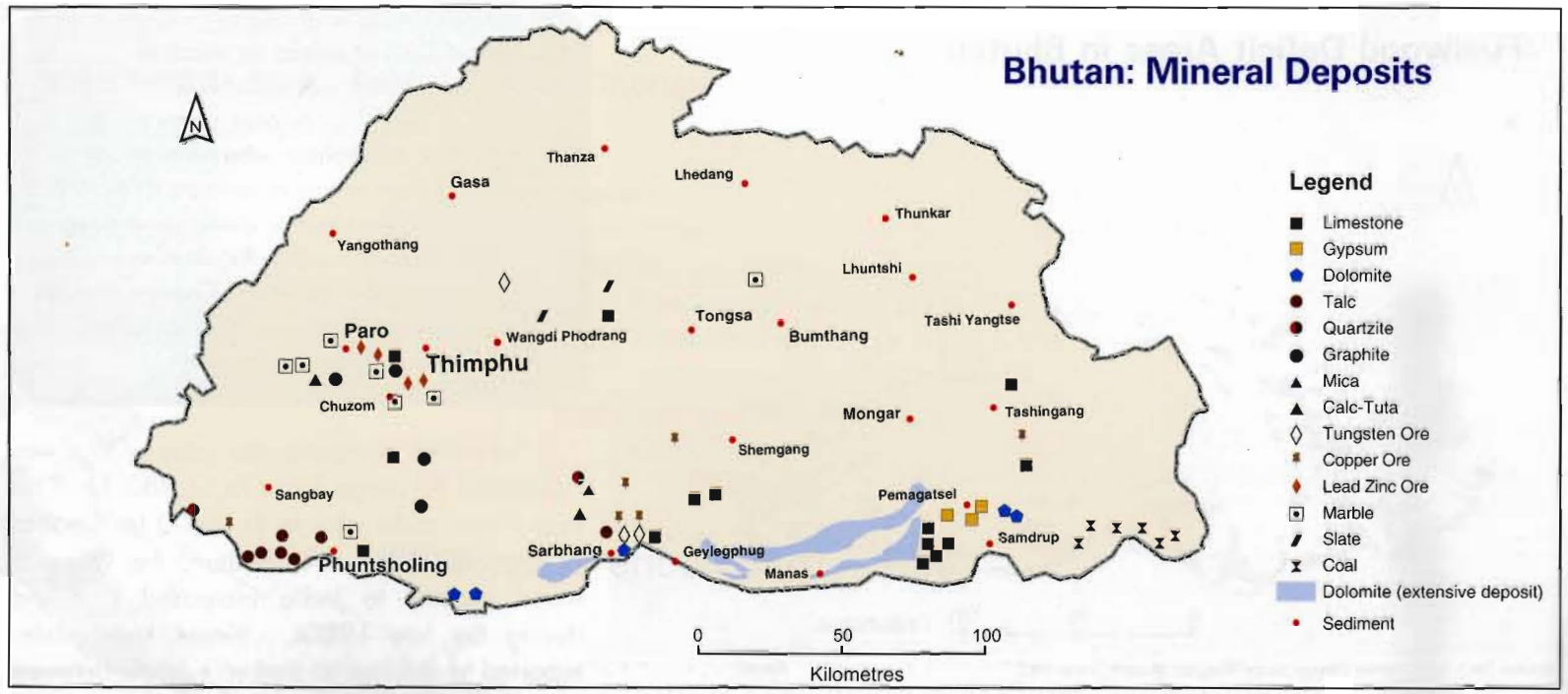
Source: Adapted from UNEP, 2001. Nepal: State of the Environment 2001. Bangkok: UNEP-RRC.AP

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.

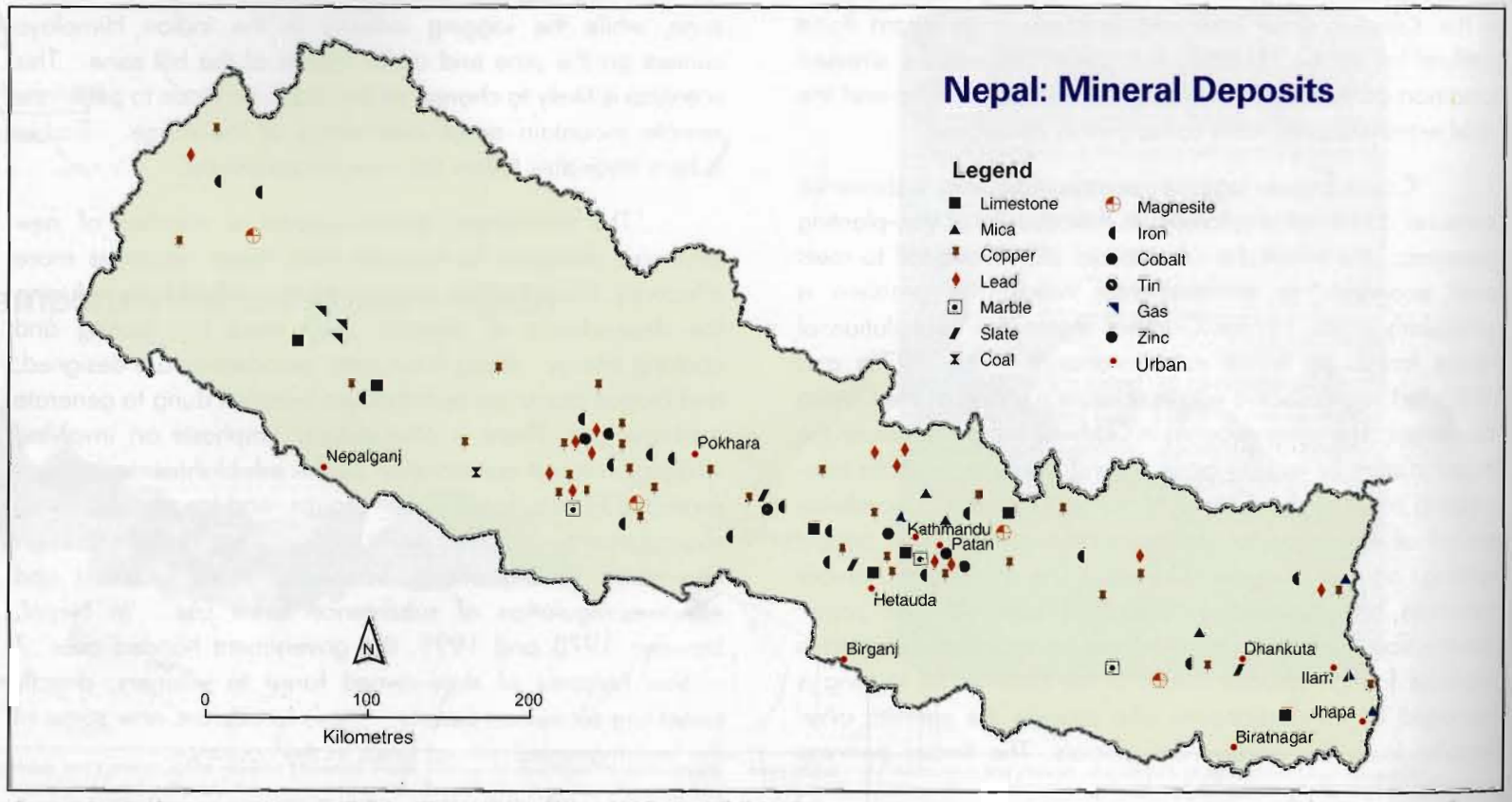
MINERALS

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

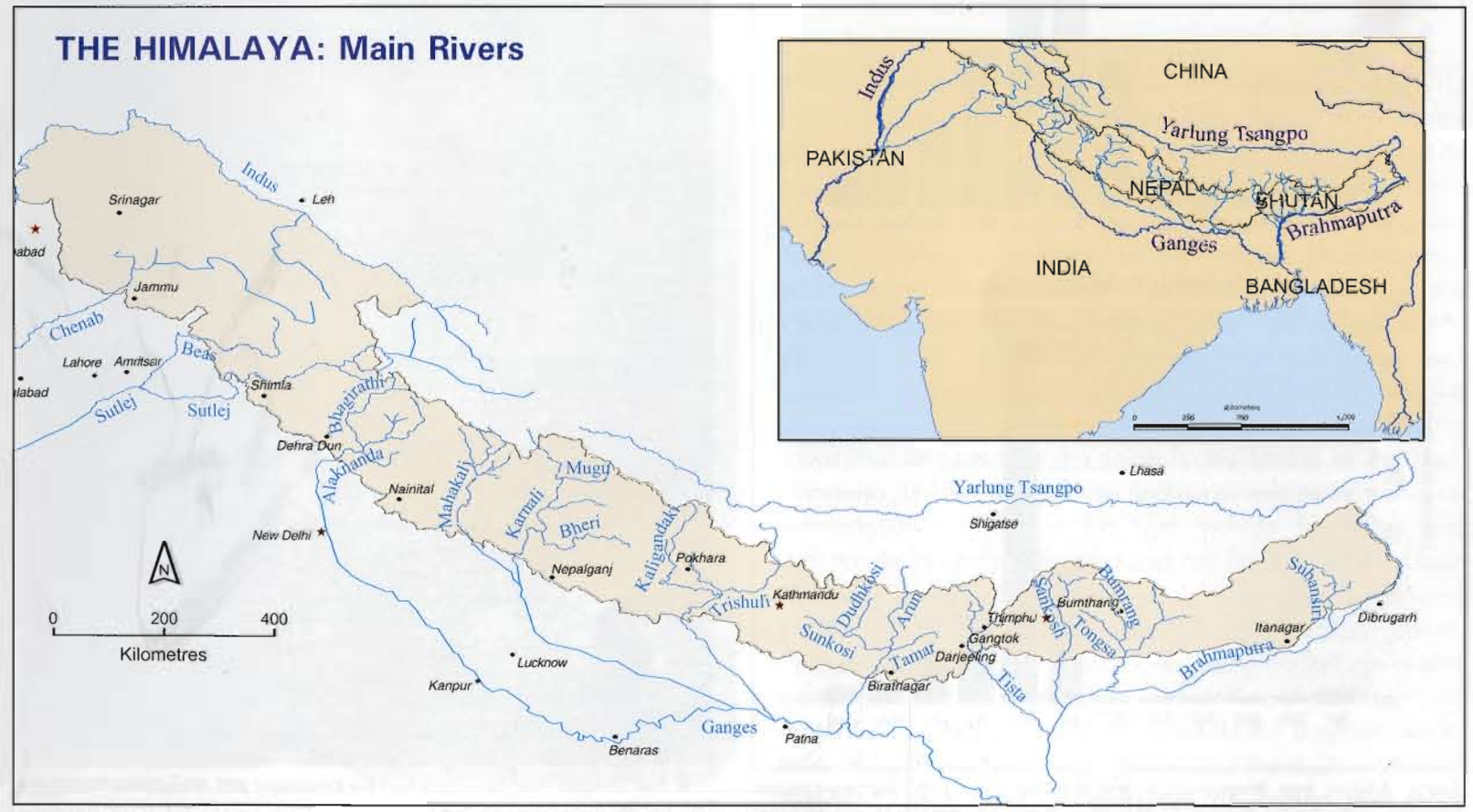
Government of Bhutan's Department of Geology and Mines. The main goal behind these various efforts has been to assess the mineral potential that lies beneath the Himalayan surface. With the exceptions of Bhutan, where less than 30% of the country has been geologically mapped in any detail, and the remote 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.

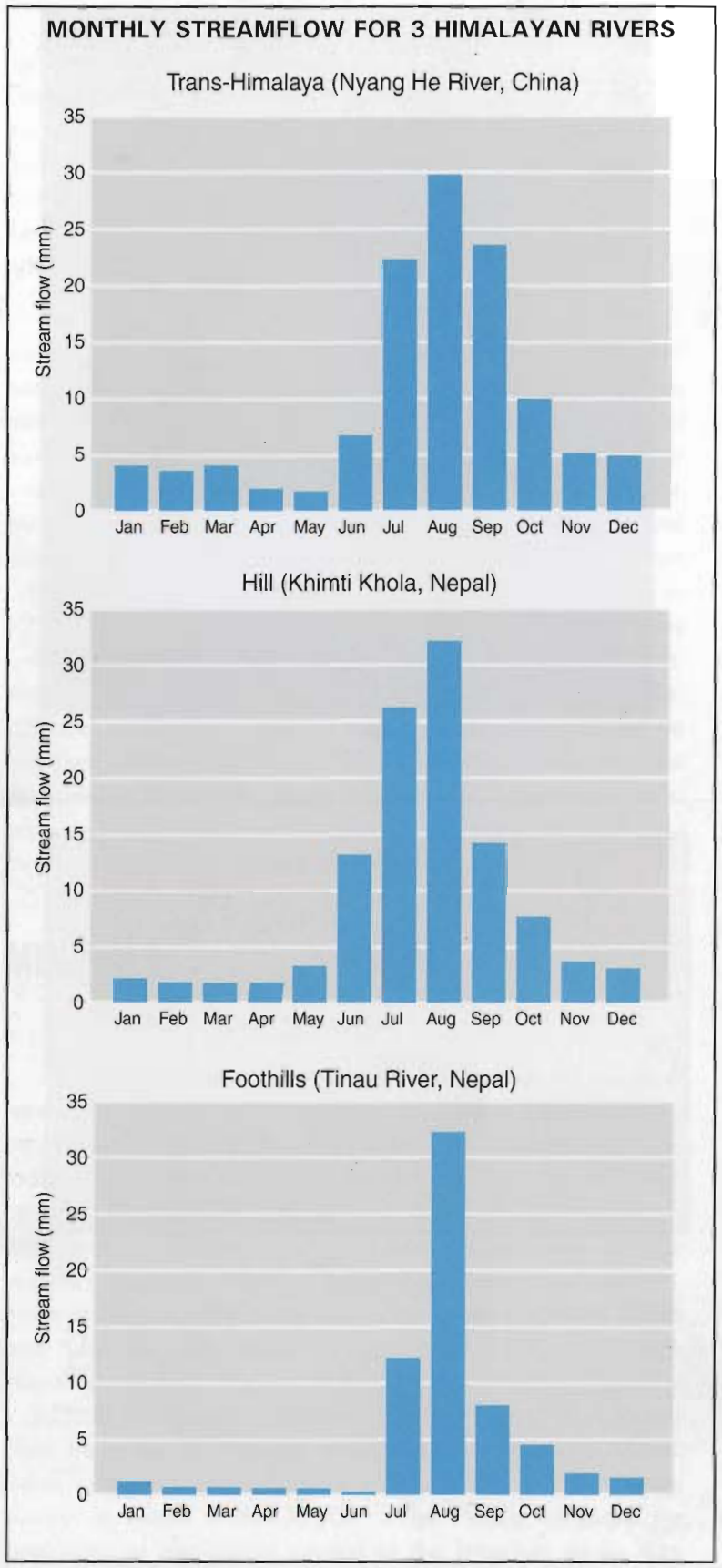
WATER RESOURCES

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



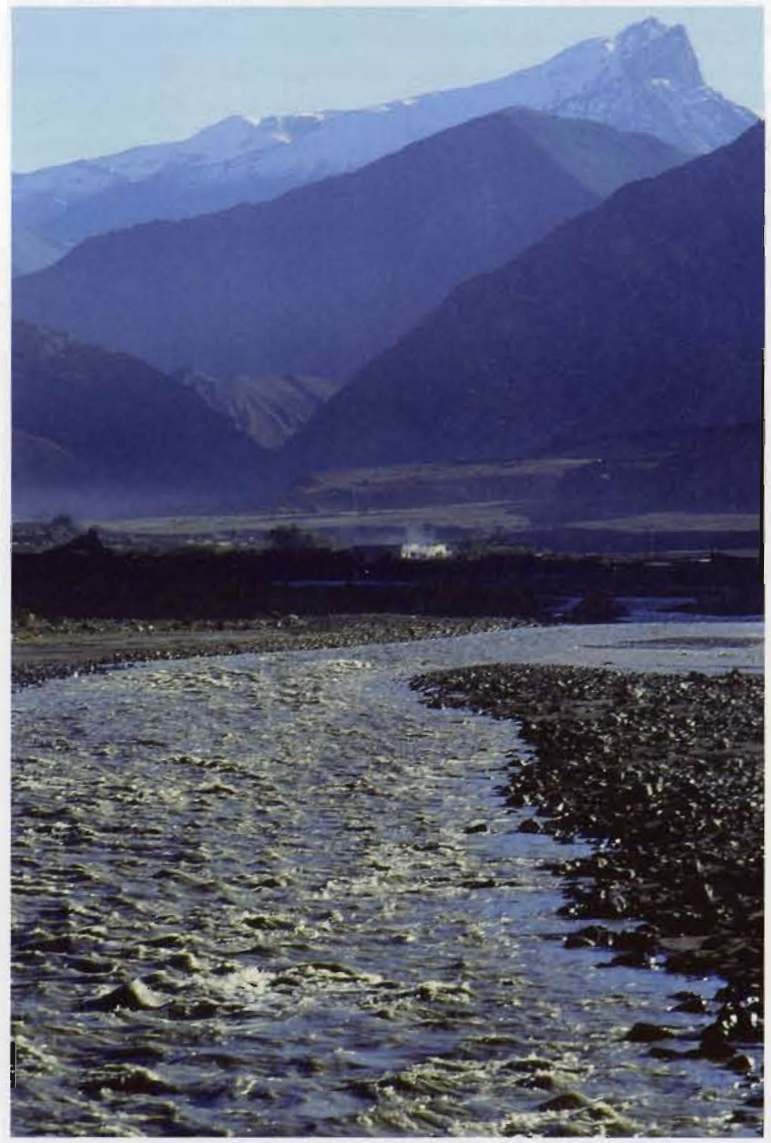
Source: Adapted from Zurick D. and Karan P.P., 1999. Himalaya: Life on the Edge of the World. Baltimore and London: Johns Hopkins University Press



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

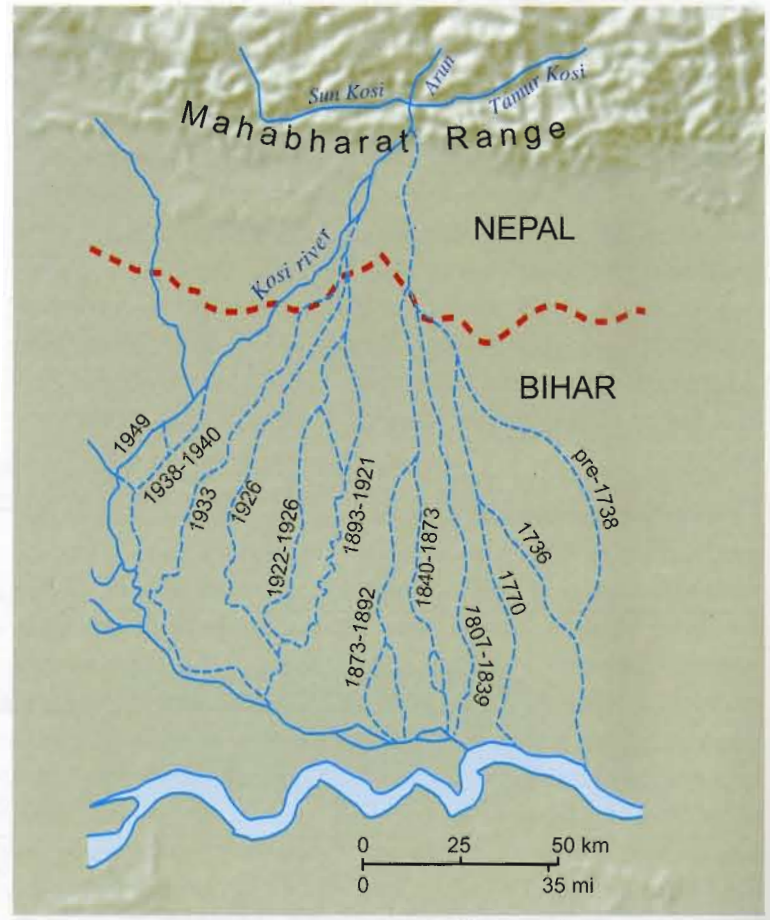
northern India (10% from the Indian Himalaya and 32% from Nepal and Tibet). The Brahmaputra River, where it discharges from the Himalaya, has a mean annual flow of 200,000 million cubic meters. An additional 180,000 cubic meters are added to the Brahmaputra by its tributaries originating in Sikkim, Bhutan, 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

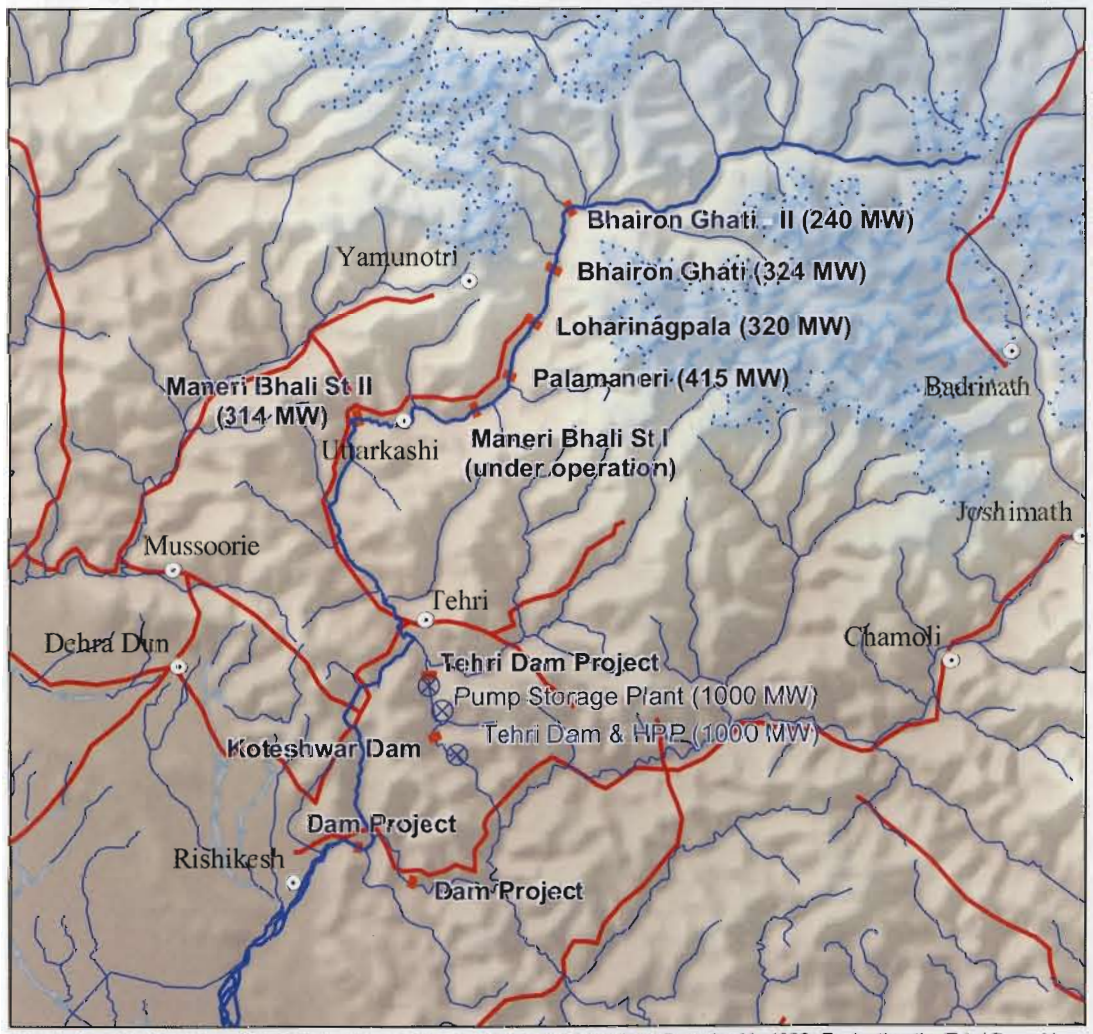
The Changing Course of the Koshi River, Nepal: *The Himalayan rivers are not immutable - they may be dammed or rush in floods, nor are they stationary as this map of the Koshi River demonstrates. When the rivers rush out of the mountains, carrying heavy loads of sediment, and reach the plains, they slow 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.

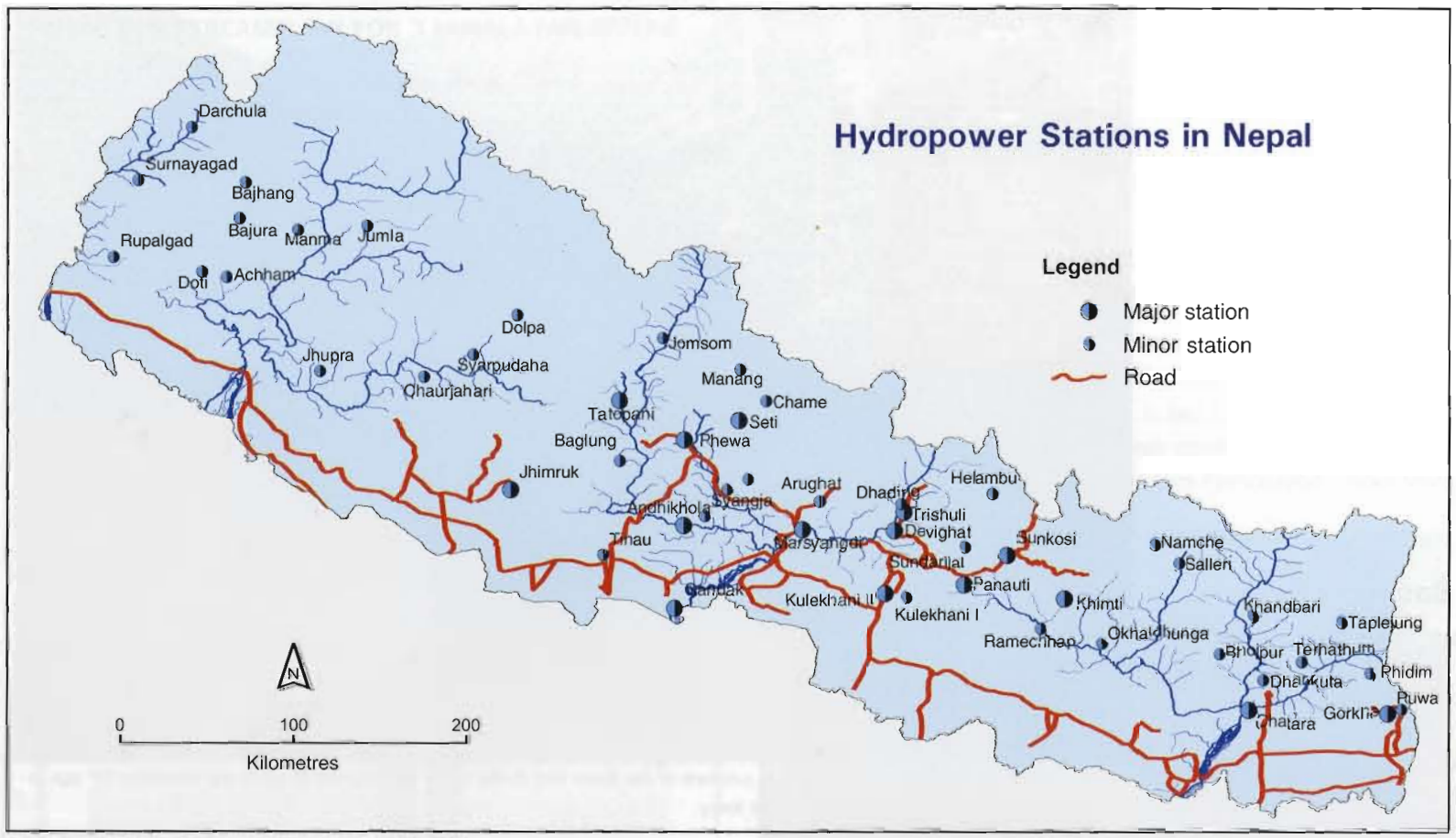
Hydro-Electric Projects on the Bhagirathi River Basin



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

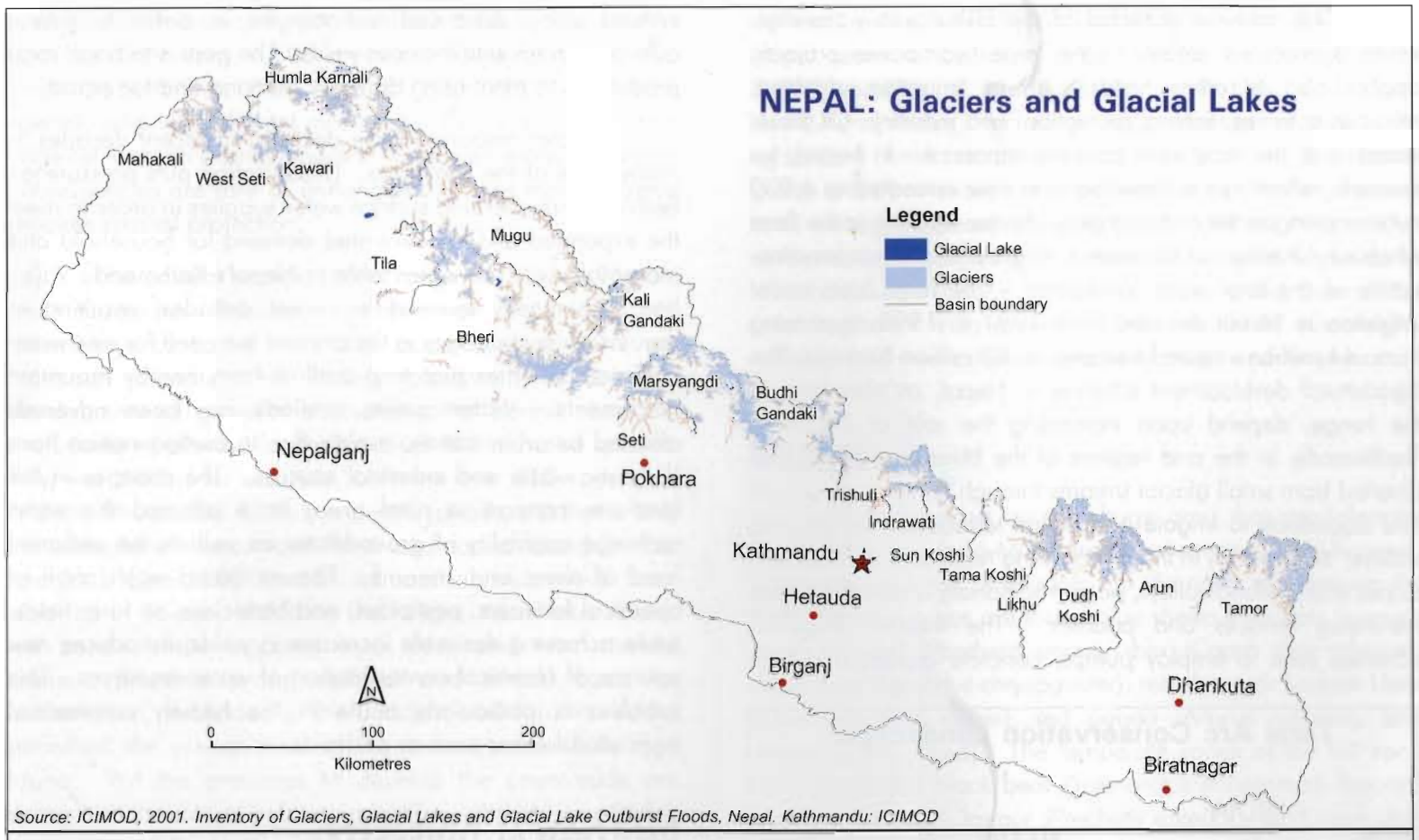
	Drinking water			Electricity		
States	**1981**	**1991**	**% change**	**1981**	**1991**	**% change**
Himachal Pradesh	44.50	77.34	73.80	54.86	87.01	58.60
Sikkim	30.33	73.19	141.31	23.11	60.66	162.48
Arunachal Pradesh	43.89	70.20	59.95	15.15	40.85	169.64
Jammu & Kashmir	40.28	N.A.	-	60.87	N.A.	-

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.

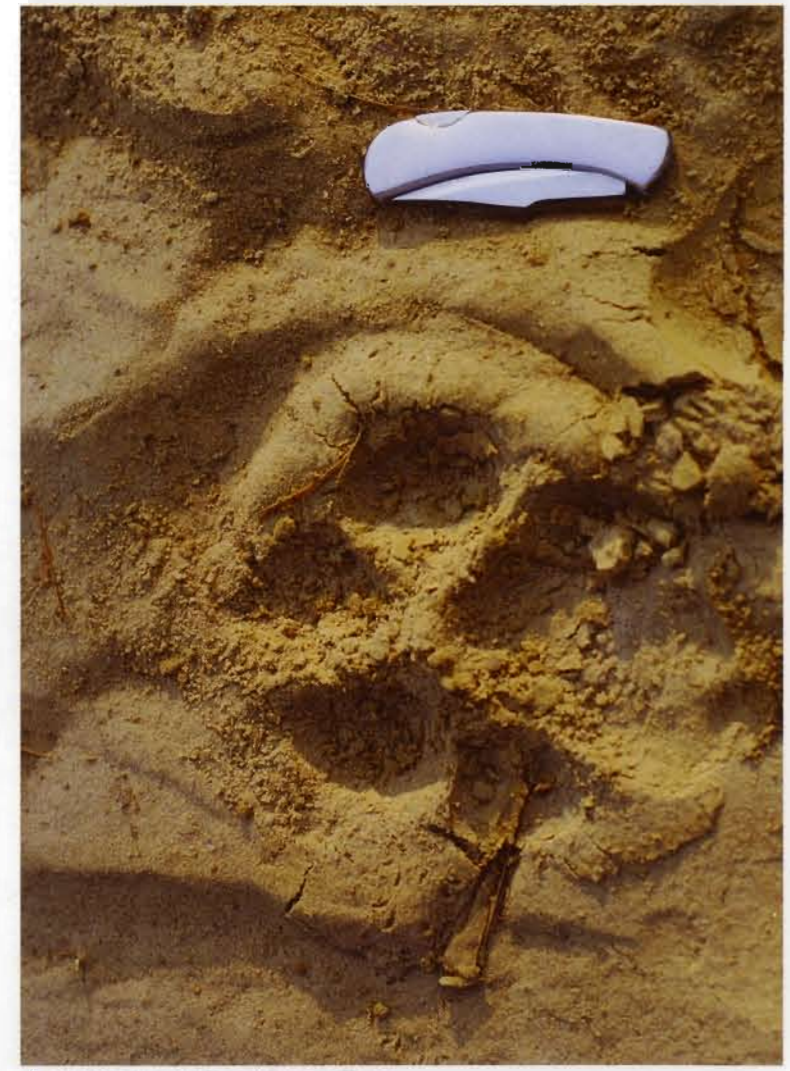
In support of biodiversity conservation, the Himalayan countries have given legal protection status to many species of plants and animals. Nepal, for example, protects 13 plants, 26 mammals, 9 birds, and 3 reptile species. The legal protection status of plants and animals, though, is only effective when 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.

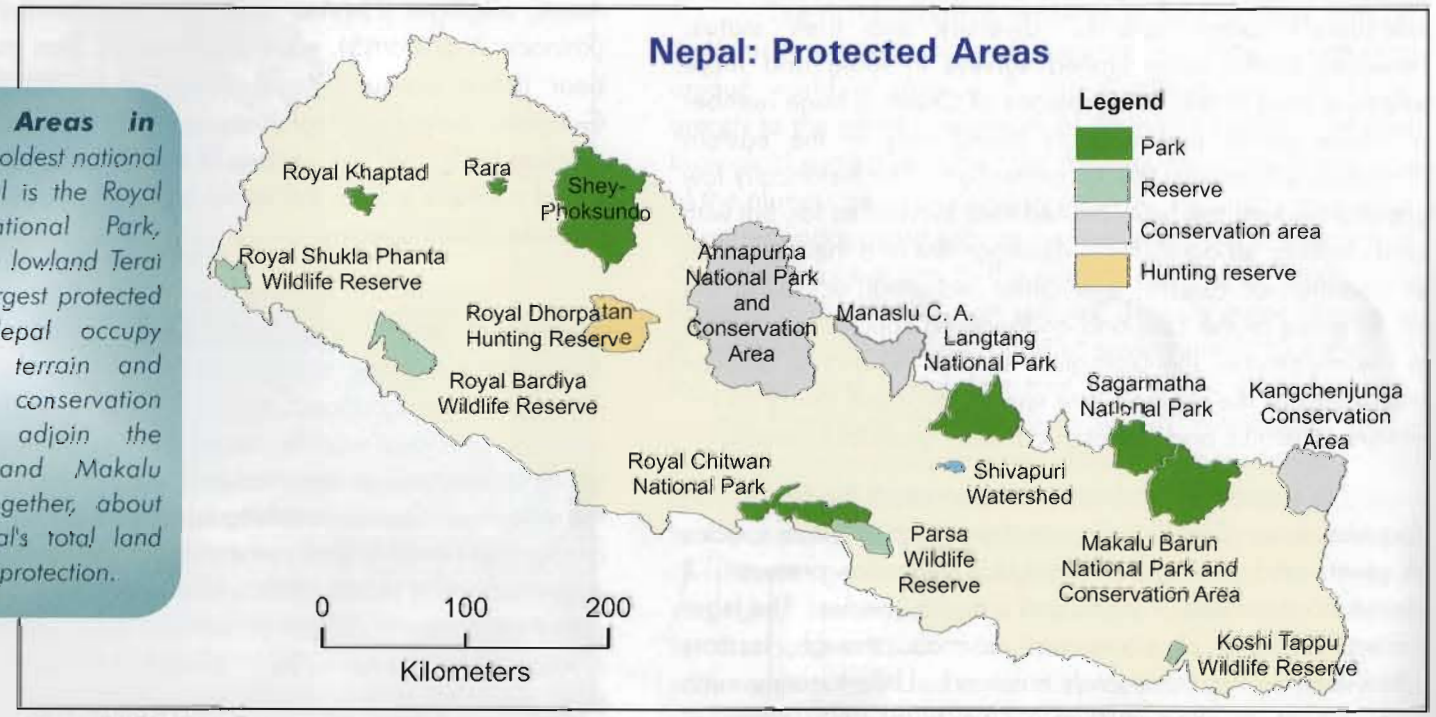
PARKS AND CONSERVATION AREAS

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.

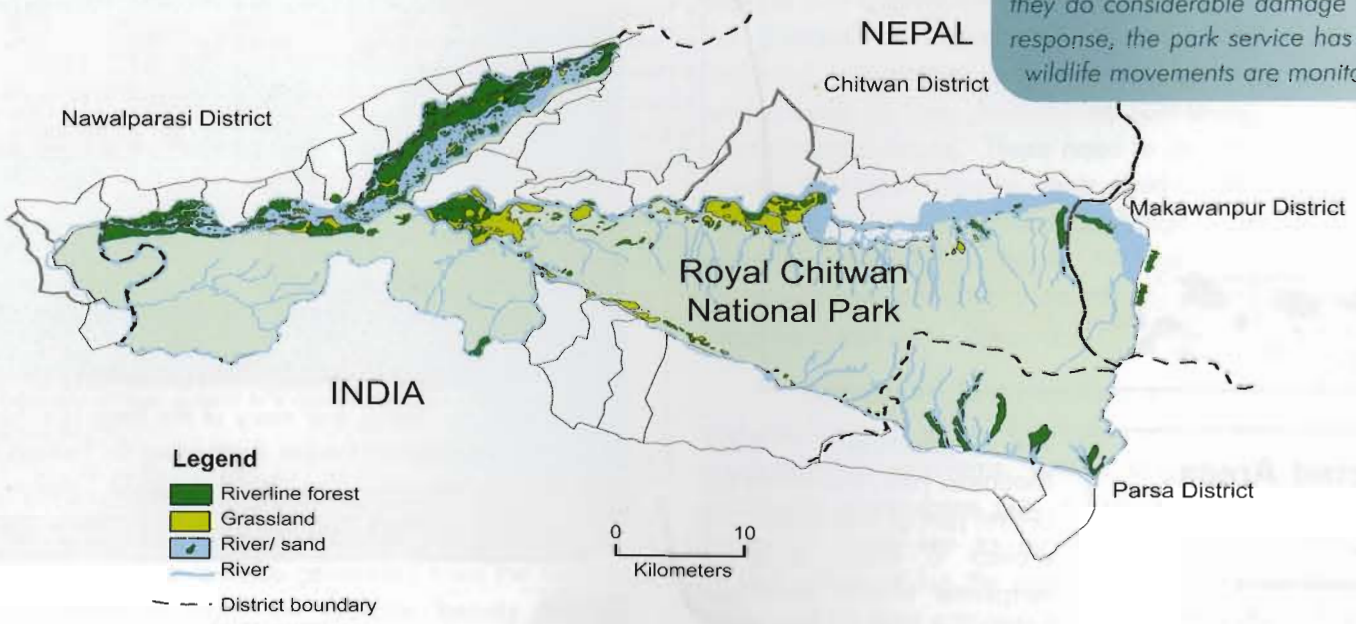
Protected Areas in Nepal: *The oldest national park in Nepal is the Royal Chitwan National Park, located in the lowland Terai zone. The largest protected areas in Nepal occupy mountainous terrain and include the conservation areas that adjoin the Annapurna and Makalu summits. Altogether, about 18% of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

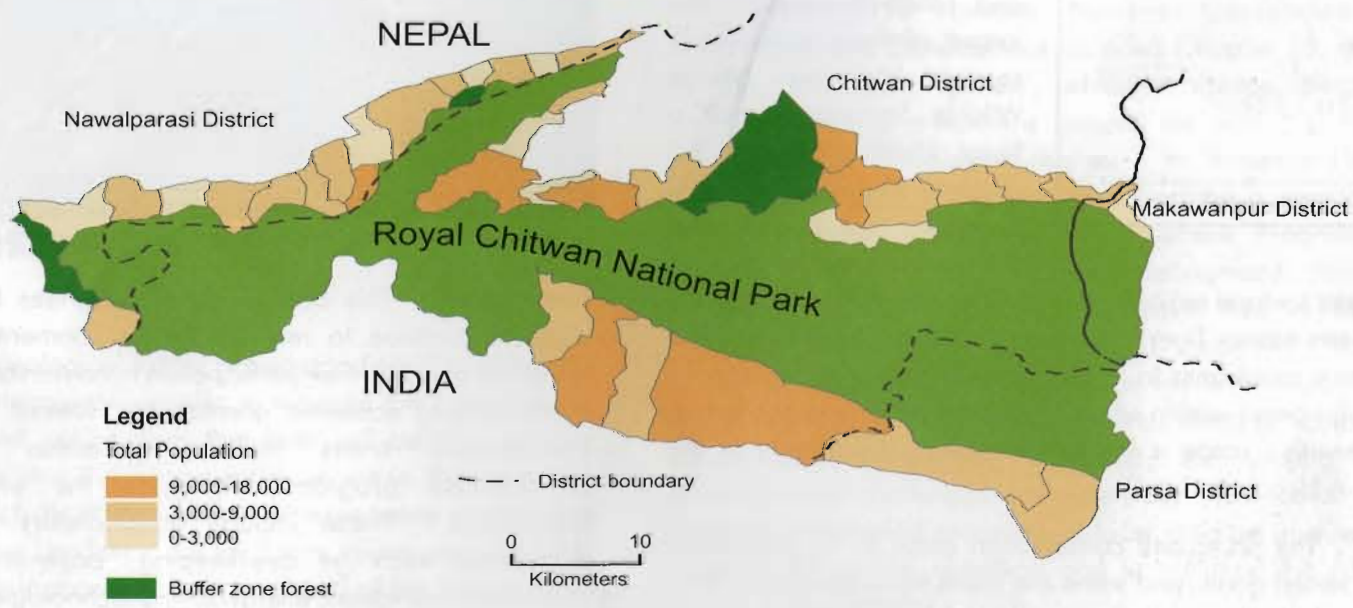
Royal Chitwan National Park



The entrance to Royal Chitwan National Park

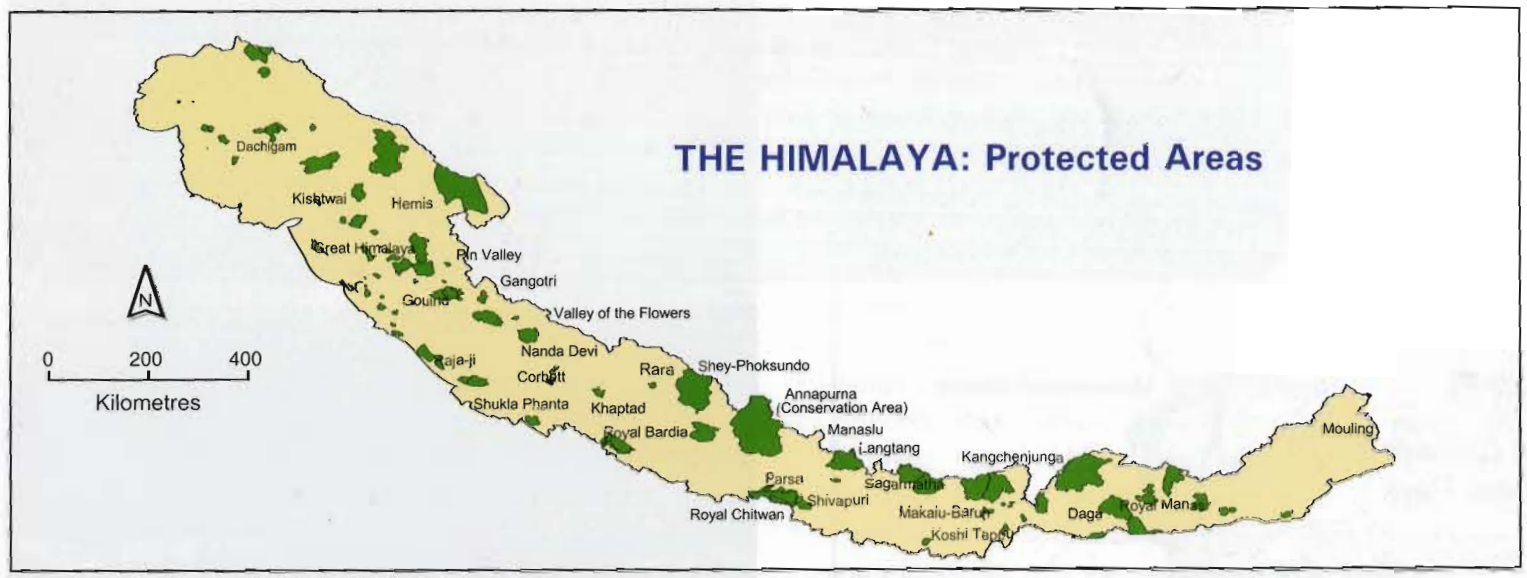
A villager collects thatch from inside the Royal Chitwan National Park

Royal Chitwan National Park and Surrounding Villages Population Density

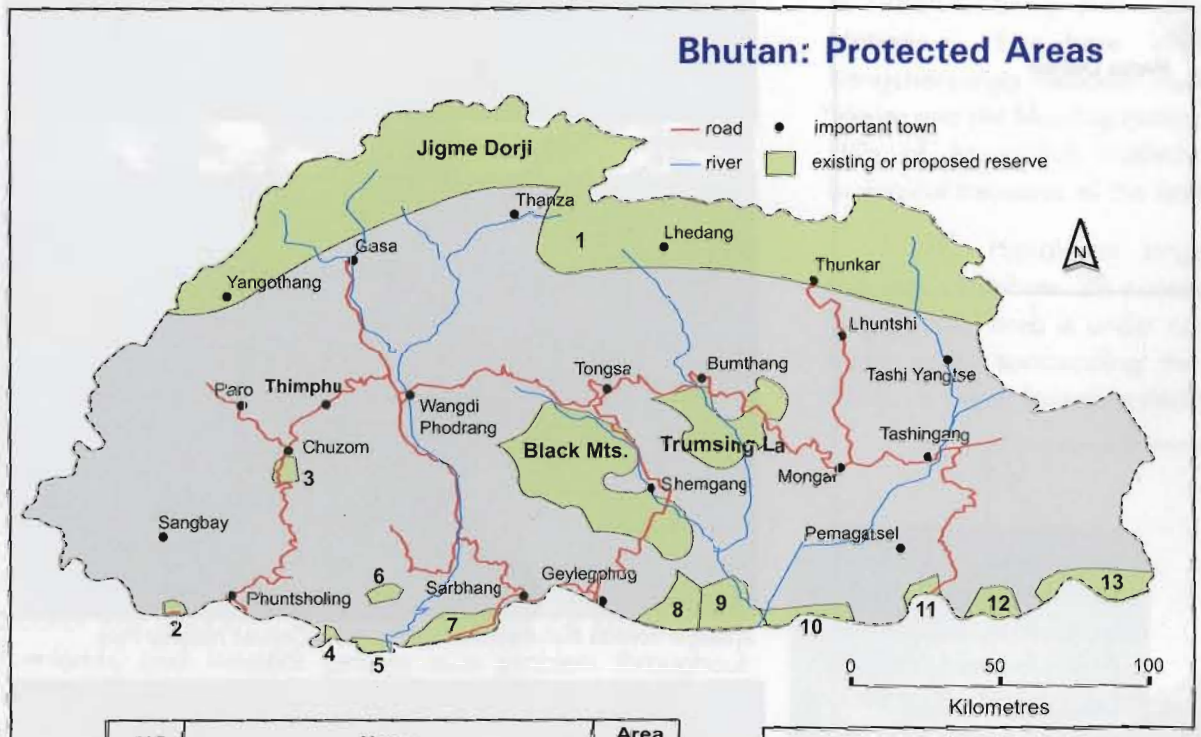


Source: Adapted from DNPWC, 2000. Royal Chitwan National Park: Resource Profile. Kathmandu: HMG Nepal, DNPWC

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.

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