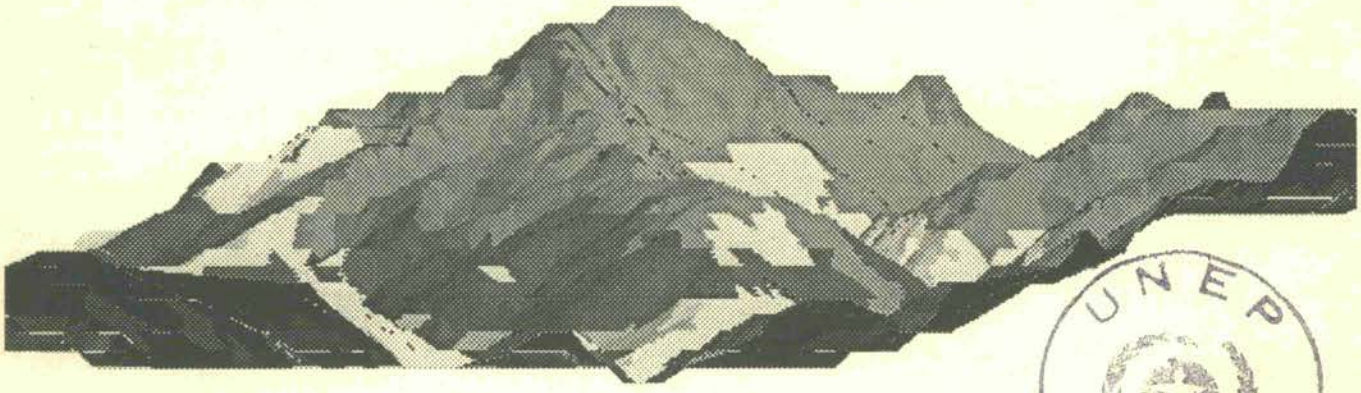
GRID

GLOBAL RESOURCE INFORMATION DATABASE

GRID
CASE STUDY SERIES
NO. 6

GENEVA
JANUARY 1992



BAGMATI ZONE, NEPAL: MAPS AND GRAPHICS

Otto Simonett

ICIMOD INTERNATIONAL CENTRE FOR INTEGRATED MOUNTAIN DEVELOPMENT

UNEP UNITED NATIONS ENVIRONMENT PROGRAMME

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PREFACE

The UNEP/GRID (United Nations Enviroment Programme/Global Resource Information Database) and ICIMOD (International Centre for Integrated Mountain Development) Nepal Geographic Information Systems (GIS) activities have been conducted with the following objectives:

1. Demonstrate the use of Geographic Information System technology for the planning process in Nepal and establish GIS capabilities at ICIMOD.
2. Create digital environmental databases with data at different scales and resolutions with emphasis on the district-level.
3. Conduct problem-orientated GIS analyses and examine applicability of the tool at various planning levels, ranging from panchayat to national.
4. Assist ICIMOD and UNITAR in setting up a curriculum for future GIS training for Himalaya region professionals.
5. Visualize case study results in the form of maps and graphics.

With MENRIS (Mountain Environment Resource Information System) ICIMOD has now evolved into a Geographic Information System center in the Himalaya-Hindukush region with trained staff and a variety of GIS soft- and hardware in place.

For environmental decision-making the technology has one principal goal to fulfill: To provide readily usable and highly communicable information to the planners and politicians, as well as the general public. And here, GIS certainly has some invaluable assets: First of all, through their geographical location, data from a variety of souces and formats can be integrated, thus making previously dispersed information better available. Secondly, through combination of various layers within an information system, analysis can be conducted and relevant statistical data can be derived. Thirdly, GIS is a communication tool *par excellence*: Output from the systems can be very attractive and highly communicable, it can also be tailored to the various user-needs, ranging from more sophisticated cartographic and statistical products to slides or films.

In this booklet we want to show only one of many possible output types from a GIS: Simple, black and white portfolio maps and graphics, giving an overview of the resource information as well as the general Geography of the Bagmati Zone. All the graphics shown have been produced on standard, personal computer-based software, this also to demonstrate the applicability of Geographic Information Systems under financial as well as technological constraints, prevailing in a developing country context.

ACKNOWLEDGEMENTS

I want to gratefully acknowledge all those who have contributed to the UNEP/ICIMOD Geographic Information System activities:

Above all, my thanks go to Dominique Del Pietro at GRID-Geneva who did most of the ARC/INFO data processing ranging from data entry to final plot production. Without his efforts we would still be far away from a complete Bagmati database.

A great help with data entry was Bhandit Pornkraisri at GRID Bangkok who assisted the digitization of some of the 'big' Bagmati datasets: Land Utilization and Land Capability. This data entry out of house was only possible through the efforts of Bangkok management, my thanks go to Wayne Mooneyhan and Gary Johnson.

At ICIMOD, I was always well received, for which I want to thank MENRIS coordinator Surendra Shrestha and ICIMOD director Frank Tacke. Through the enthusiastic support of ICIMOD staff I was able to collect the necessary information, maps and reports very efficiently, for this I want to thank Manesh Banskota, Saroj Basnyet, Balram Bhatta, Kumar Kotta, Govinda Joshi, Zafir Karim, Sein Mya, KK. Panday, Pramod Pradhan, Tej Partap, Susan Ranger, Rainer Schmidt, Suresh Sharma, Basanta Shrestha and Aviendra Shrestha.

Nassrine Azimi and Steven Gold at UNITAR Geneva were always open for discussions and kept me informed on their training activities; my thanks also go to UNITAR director Marcel Boisard.

For their advice and discussions during my stays in Kathmandu I am grateful to the following persons: Jerrold Berke and Paul Lundberg, UNDP; Jeremy Carew-Reid and Devendra Amatya, IUCN; P.B. Shah and Khagendra Jabegu, Topographical Survey Branch; Charles Chandler and Peter Rabley, PADCO Inc.; Krishna Malla, National Remote Sensing Center; Robert Groeli, Michael Griesbaum and Walter Schmid, Suspension Bridge Division; Gerold Müller, Bagmati Watershed Project; Bernhard Oettli, Integrated Hill Development Project and Trevor Beaumont, James Cutler and Steve Vincent, Scott Wilson Kirkpatrick (SWK).

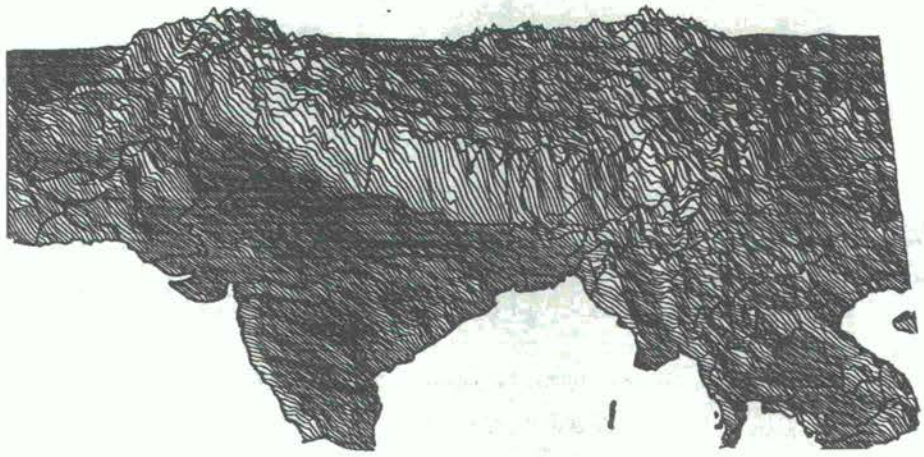
Technical and other advice through discussions and by correspondence was generously provided by Bruno Messerli, Bern University, Bern; Hans Schreier, University of British Columbia, Vancouver; Barry Haack, George Mason University, Washington D.C.; Sean Ahearn, University of Minnesota, Minneapolis; Glenn Morgan and Wayne Luscombe, The World Bank, Washington D.C..

The 'Sherpa Culture' artwork has been painted by Nima Sherpa.

Finally, I want to thank GRID management and staff in Geneva and Nairobi, notably Ole Hebin and Harvey Croze, for their coordinating activities and allowing me to conduct my work in a flexible and unbureaucratic manner.

Geneva, September 1991

Otto Simonett, GRID-Geneva



OVERVIEW

"The primary objectives of the Centre shall be to help promote the development of an economically and environmentally sound mountain ecosystem and to improve the living standards of mountain populations of the Hindu Kush-Himalayan Area which, for the purpose of these Statutes, includes Afghanistan, Bangladesh, Bhutan, China, India, Myanmar (Burma), Nepal, and Pakistan."

(ICIMOD's Statutes, Article 1, 1983)

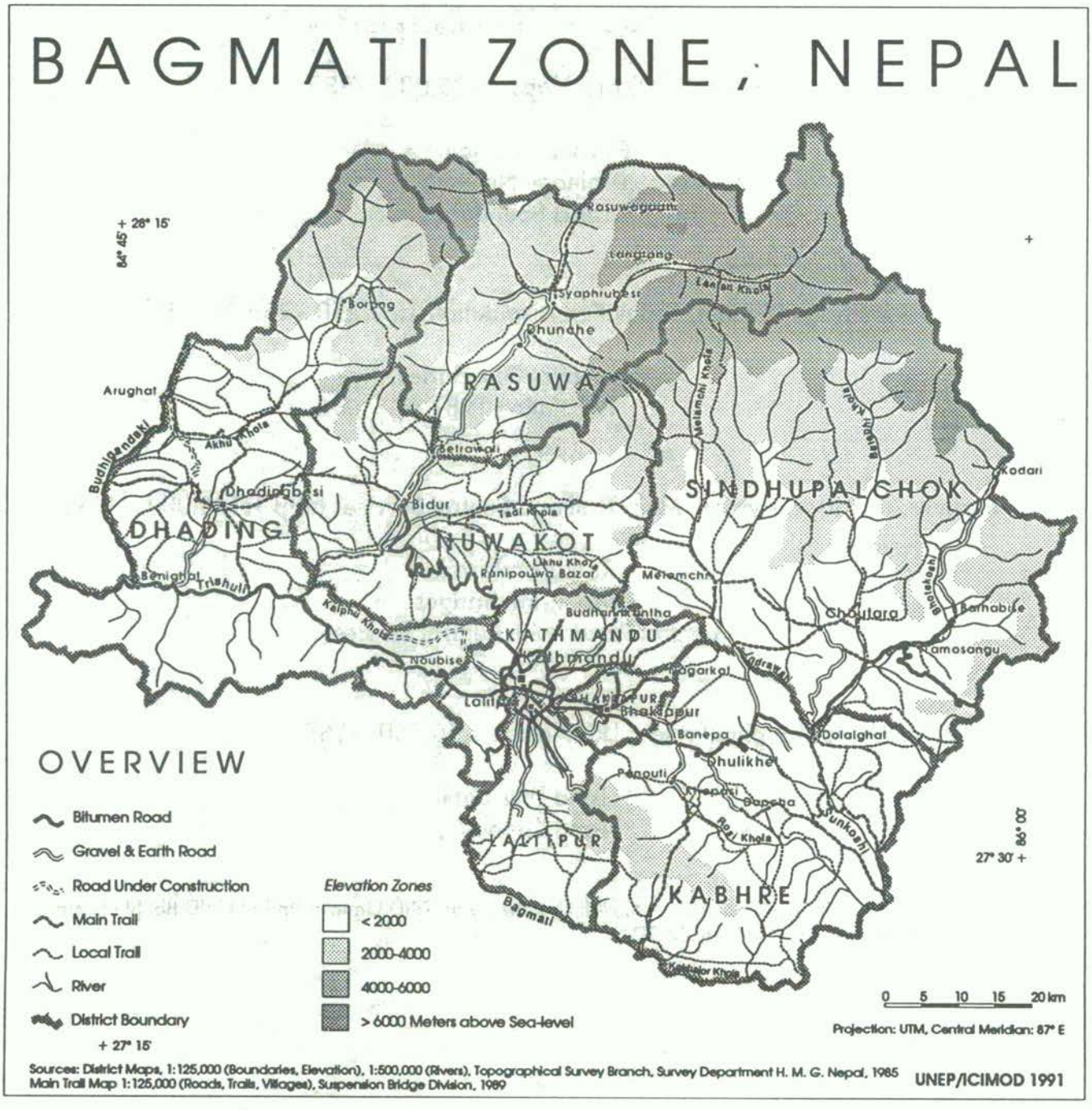
Nepal

Bagmati Zone: Area and Population 1981

District	Area * (in km²)	Population 1981 (in 1,000)	Population Density (per km²)
Rasuwa	1,519	30	20
Nuwakot	1,188	203	171
Dhading	1,913	243	127
Sindhupalchok	2,492	232	93
Kabhre	1,400	307	219
Kathmandu	403	422	1,047
Lalitpur	393	184	468
Bhaktapur	118	160	1356
Bagmati Zone	**9,426**	**1,781**	**189**
NEPAL	**147,181**	**15,023**	**102**

* The area indicated is based on our own calculations within the GIS and may slightly differ from the official figures

Bagmati Zone



Bagmati Zone Database

The GIS database for the Bagmati zone has been compiled from the following sources:

1 Topographical Survey Branch, District Maps 1:125,000, 1985:

Elevation Contours
Drainage Network
District Boundaries

2 Suspension Bridge Division, Population Distribution 1:63,250 - 250,000, 1988:

Panchayat Boundaries
Population 1981

3 Suspension Bridge Division, Main Trail and Central Services Map 1:125,000, 1989:

Roads and Trails
Suspension Bridges
Central Places with Central Services

4 Land Resources Mapping Project, LRMP Maps 1:50,000, 1985:

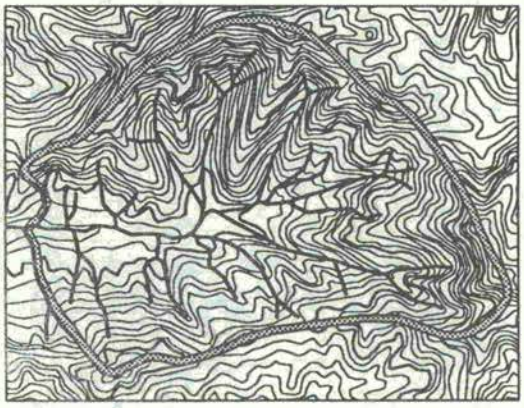
Land Utilization
Land Capability

These maps have been digitized using ARC/INFO software at GRID Geneva and at GRID Bangkok, the database has been transferred to ICIMOD.

TOPOGRAPHY

With Topography being the most important factor for the characterization of mountain ecosystems it becomes a key element in any Geographic Information System for mountain areas. Digital terrain modeling is relevant for analysis (slope, aspect) as well as for the visualization of environmental information, for example in three-dimensional displays.

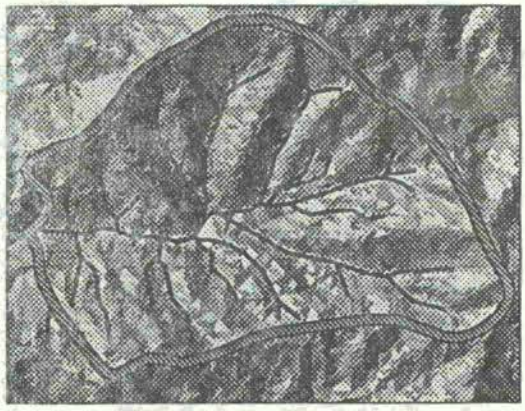
Generation of a Digital Terrain Model (DTM) of Bhardeo Panchayat, Latlitpur District



CONTOURS

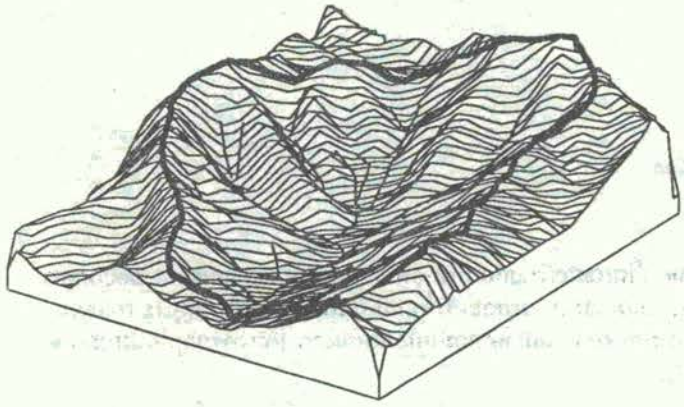
The original elevation contours (here displayed in conjunction with the Panchayat boundary and the drainage network) have been digitized from the 1:50,000 topographic map.

These data then have been converted to a Triangular Irregular Network (TIN), a data structure allowing the extraction of slope and aspect maps as well as the interpolation of elevation contours with different intervals.



SHADED TERRAIN

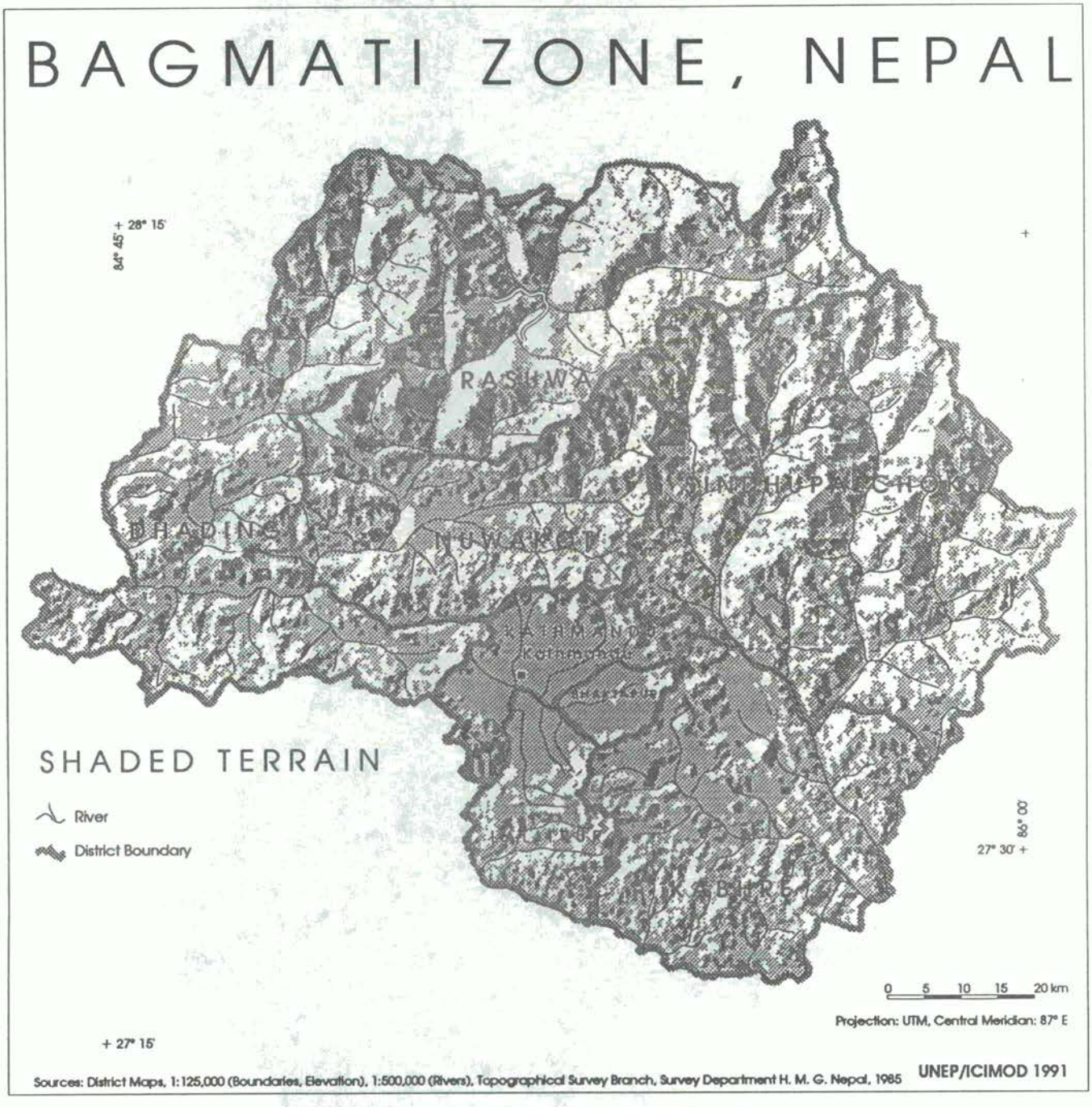
Using the slope and aspect parameters of the triangles and assuming an azimuth of the sun this shaded terrain display has been generated from the Triangular Irregular Network (TIN). For display purposes, the drainage network and the panchayat boundary have been superimposed.



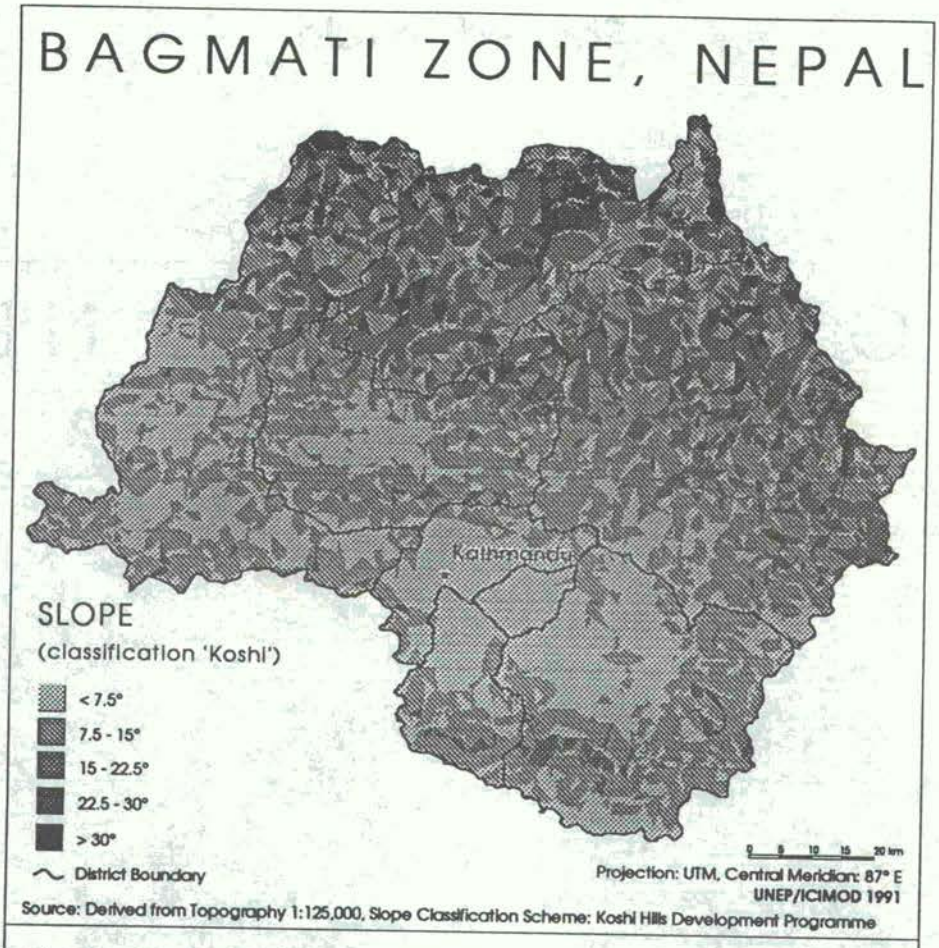
THREE DIMENSIONAL VIEW

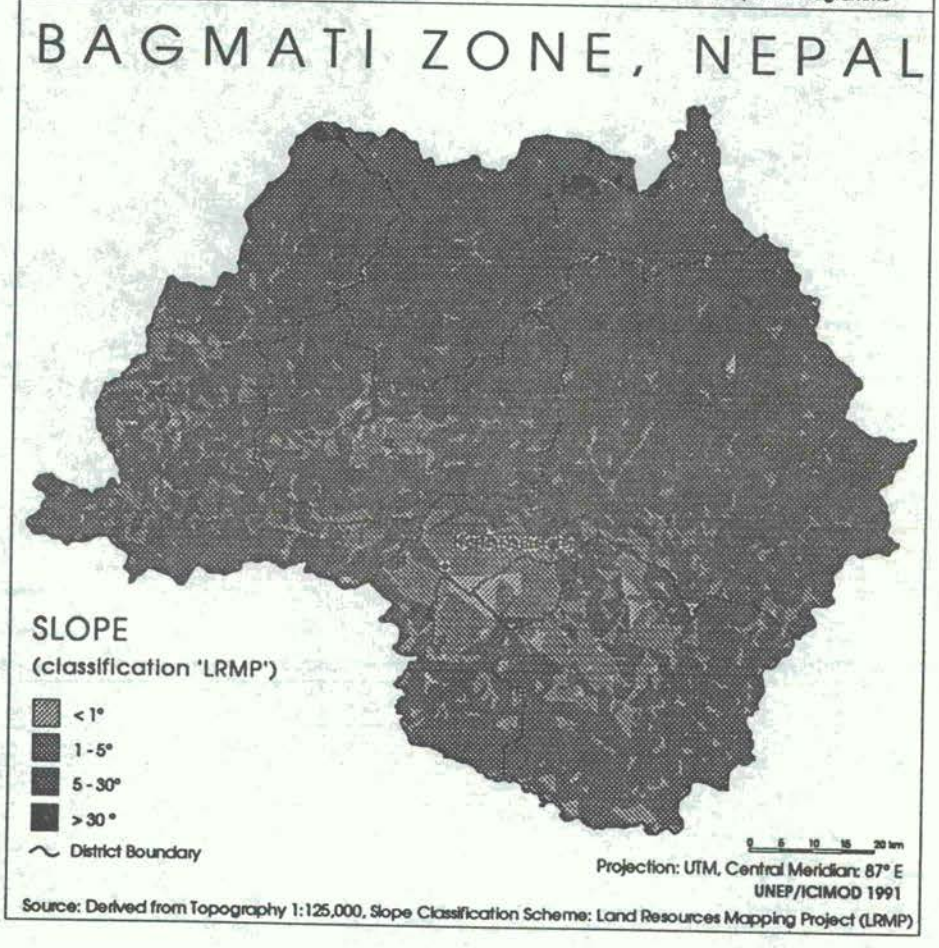
Three dimensional views, such as this wireframe model can be derived from digital terrain models, in our case from the Triangular Irregular Network (TIN). Such displays can be quite efficient for the visualization of spatial data.

Shaded Terrain

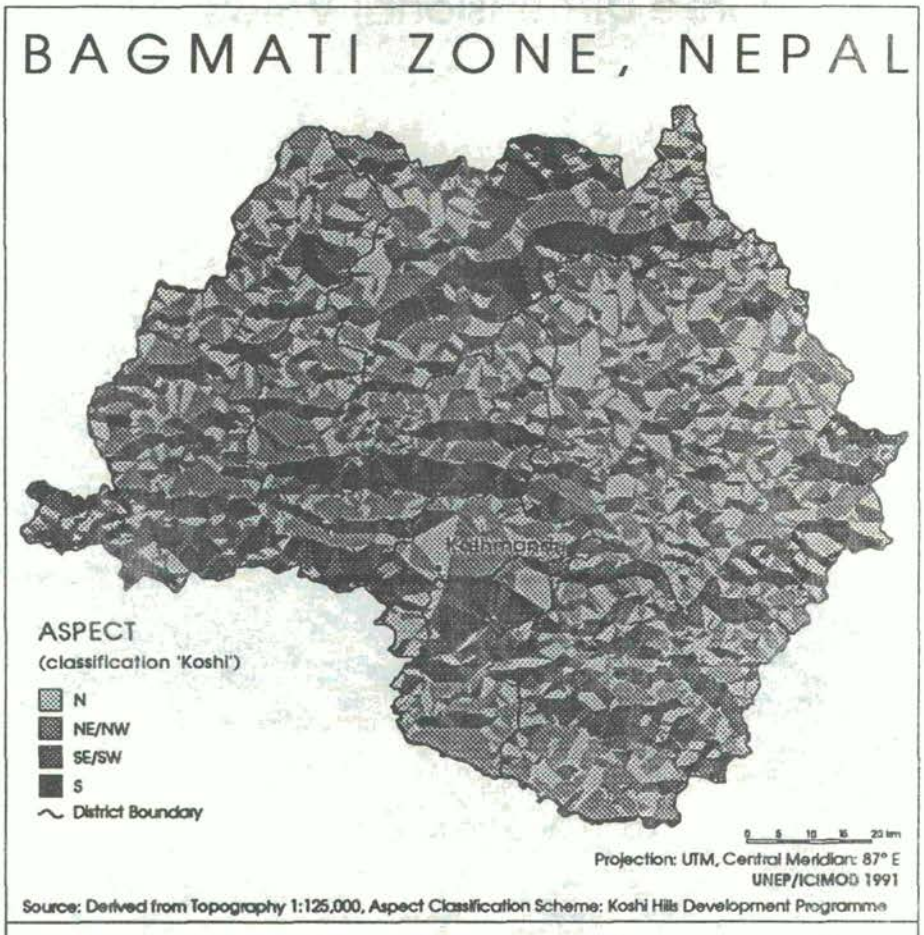


Slope: Different Classification Schemes

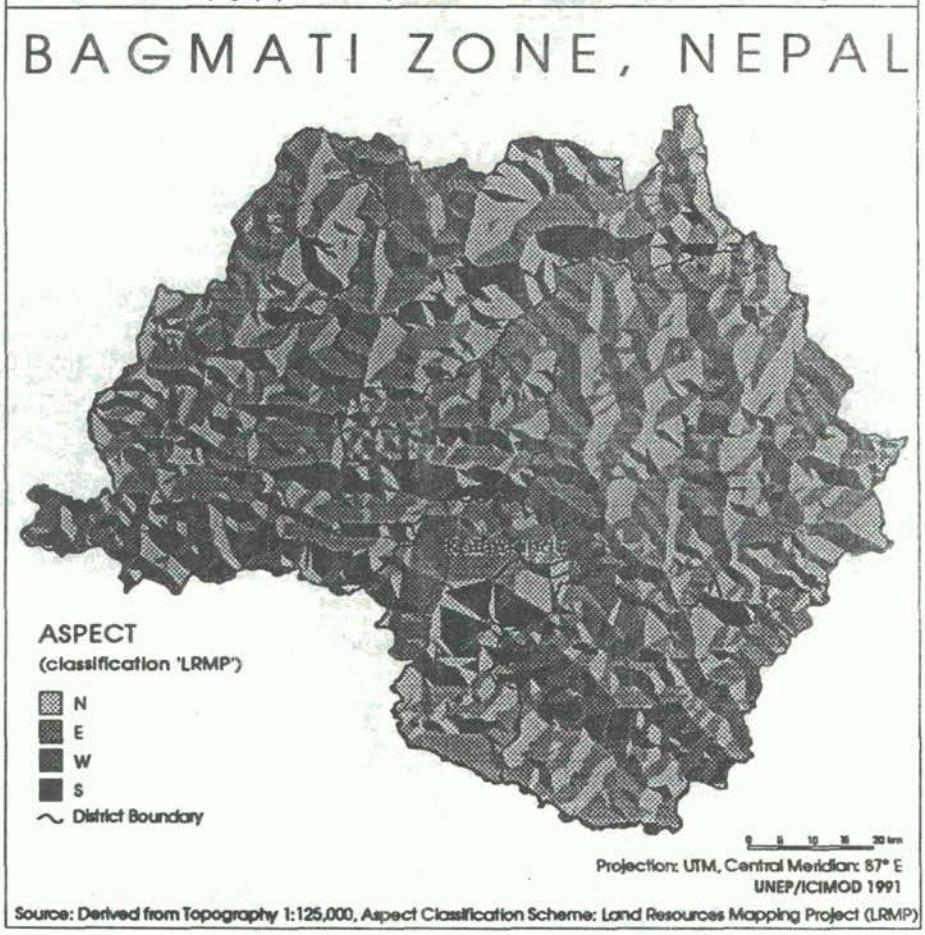




Aspect: Different Classification Schemes

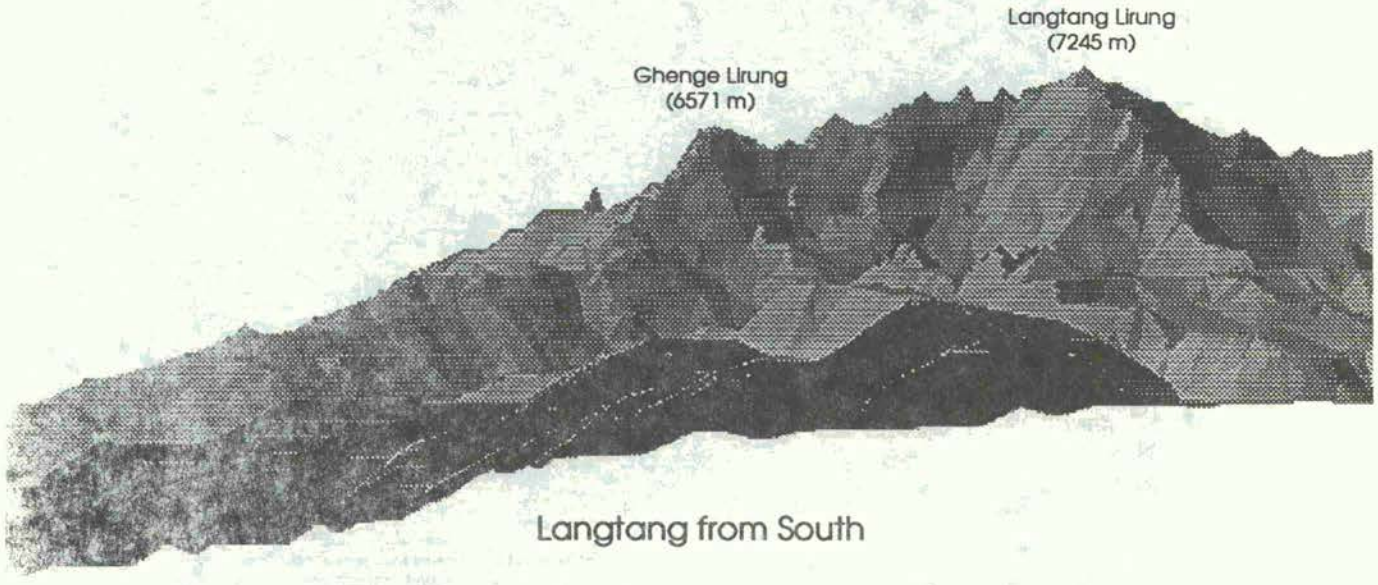


Source: Derived from Topography 1:125,000, Aspect Classification Scheme: Koshi Hills Development Programme

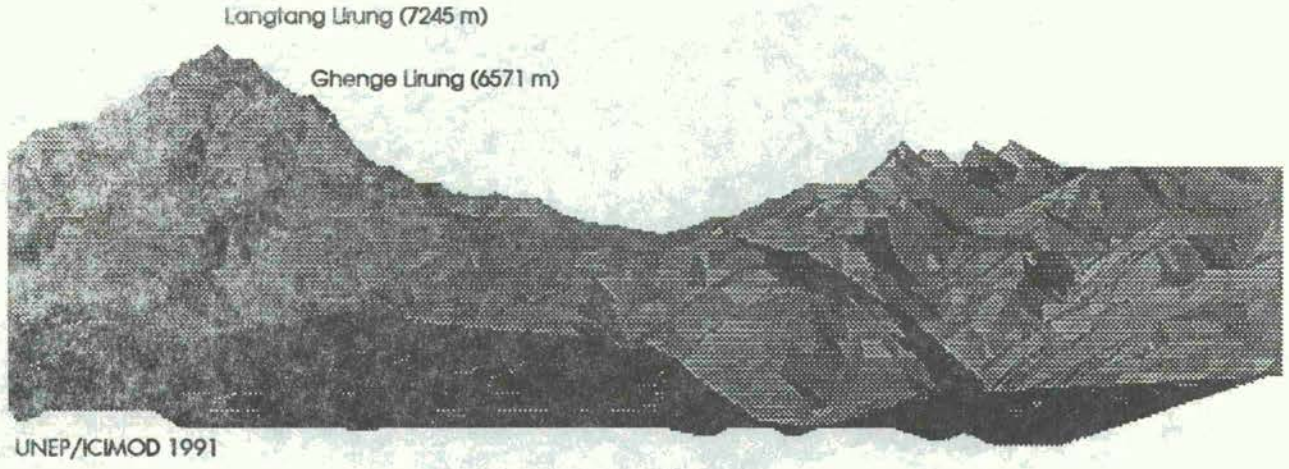


Source: Derived from Topography 1:125,000, Aspect Classification Scheme: Land Resources Mapping Project (LRMP)

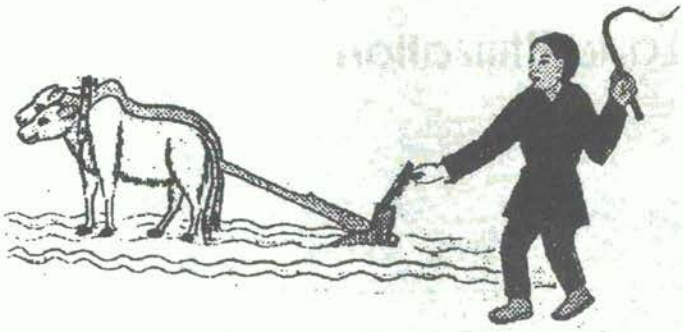
Three Dimensional Views



Langtang from South



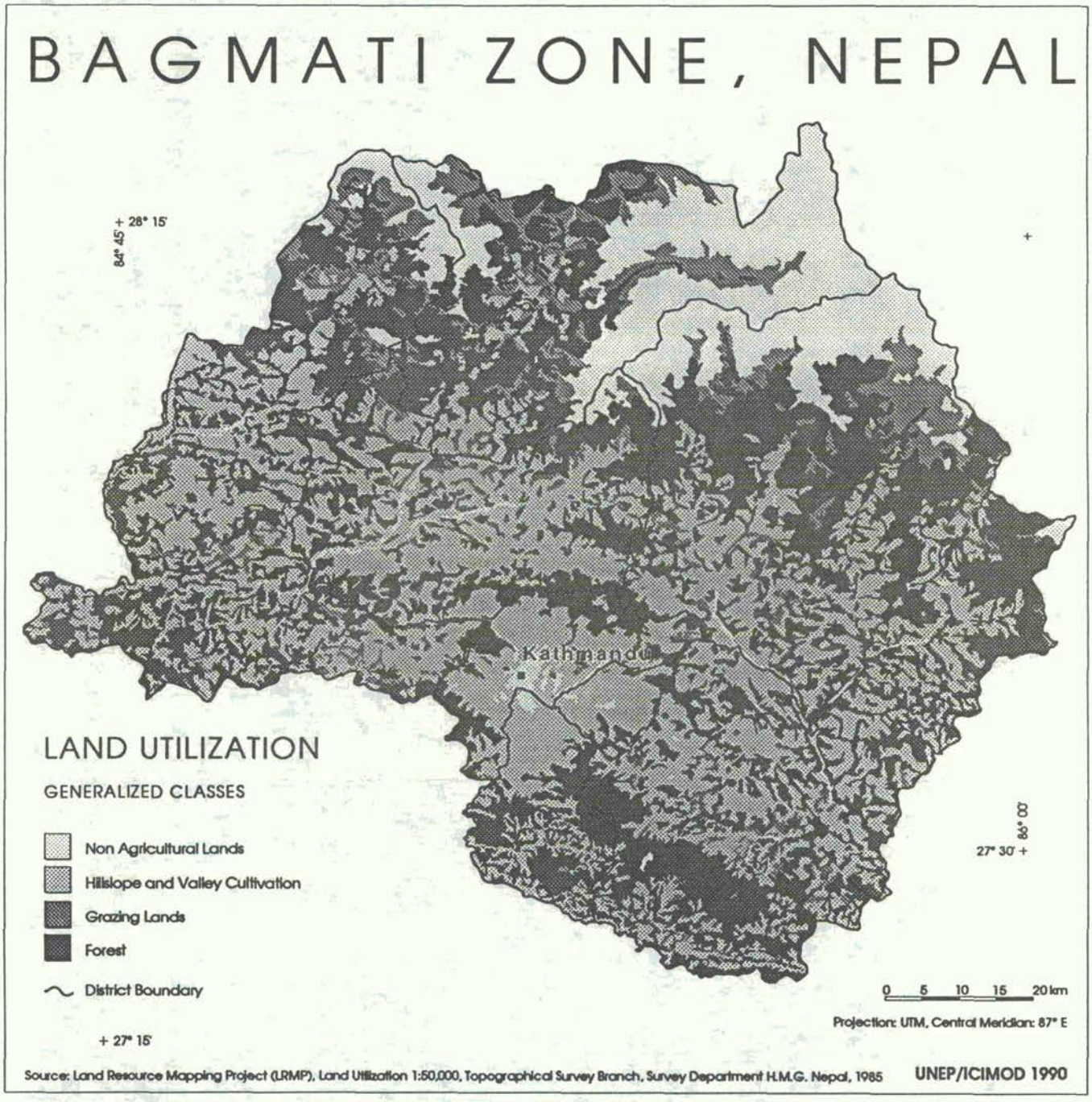
Langtang from West



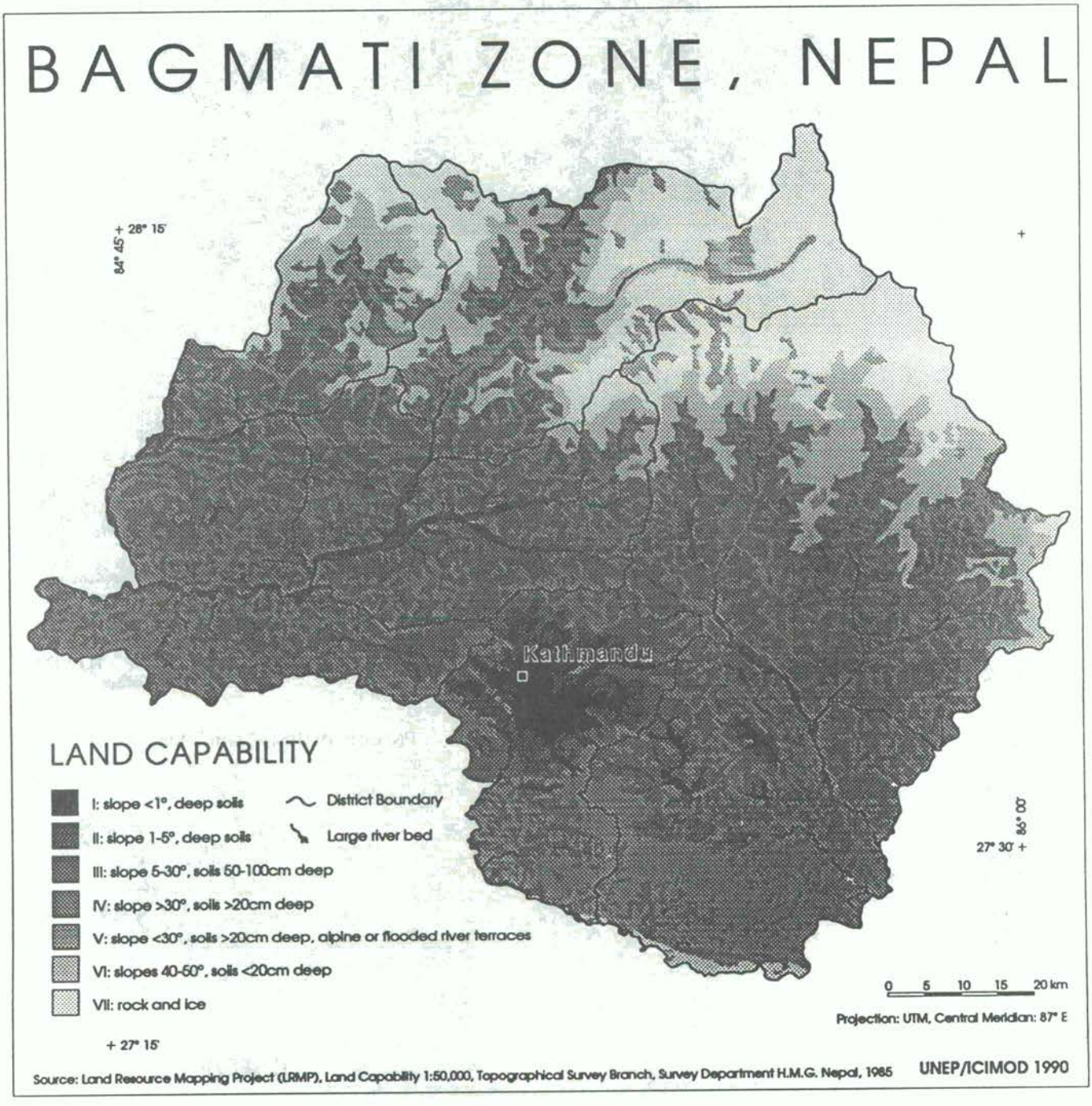
LAND RESOURCES

Land Resources data are based on the Land Resource Mapping Project (LRMP) Land Utilization and Land Capability maps. These maps offer a wealth of data on the land and manyfold opportunities for analysis and visualization of environmental information at the district level, as shown on the following pages.

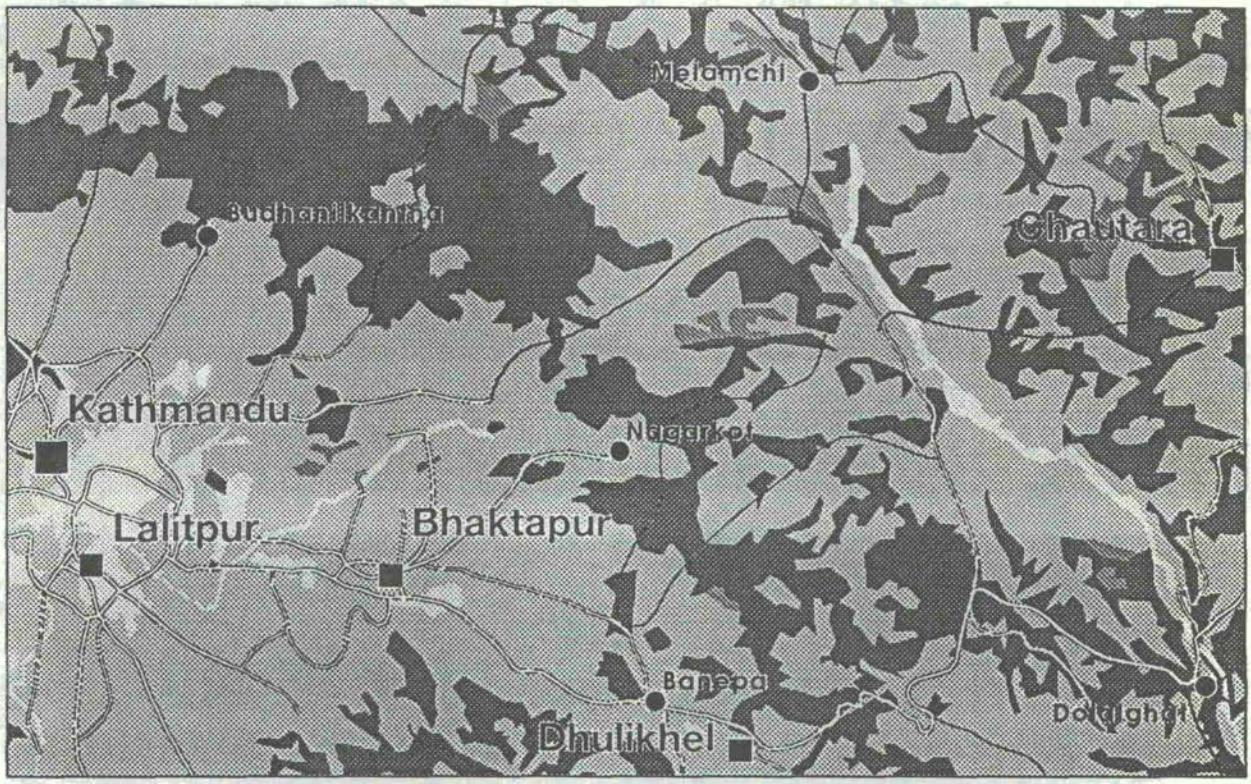
Land Utilization



Land Capability



Land Utilization: Zoom Selection



LAND UTILIZATION

- Non Agricultural Lands
- Hillslope and Valley Cultivation
- Grazing Lands
- Forest

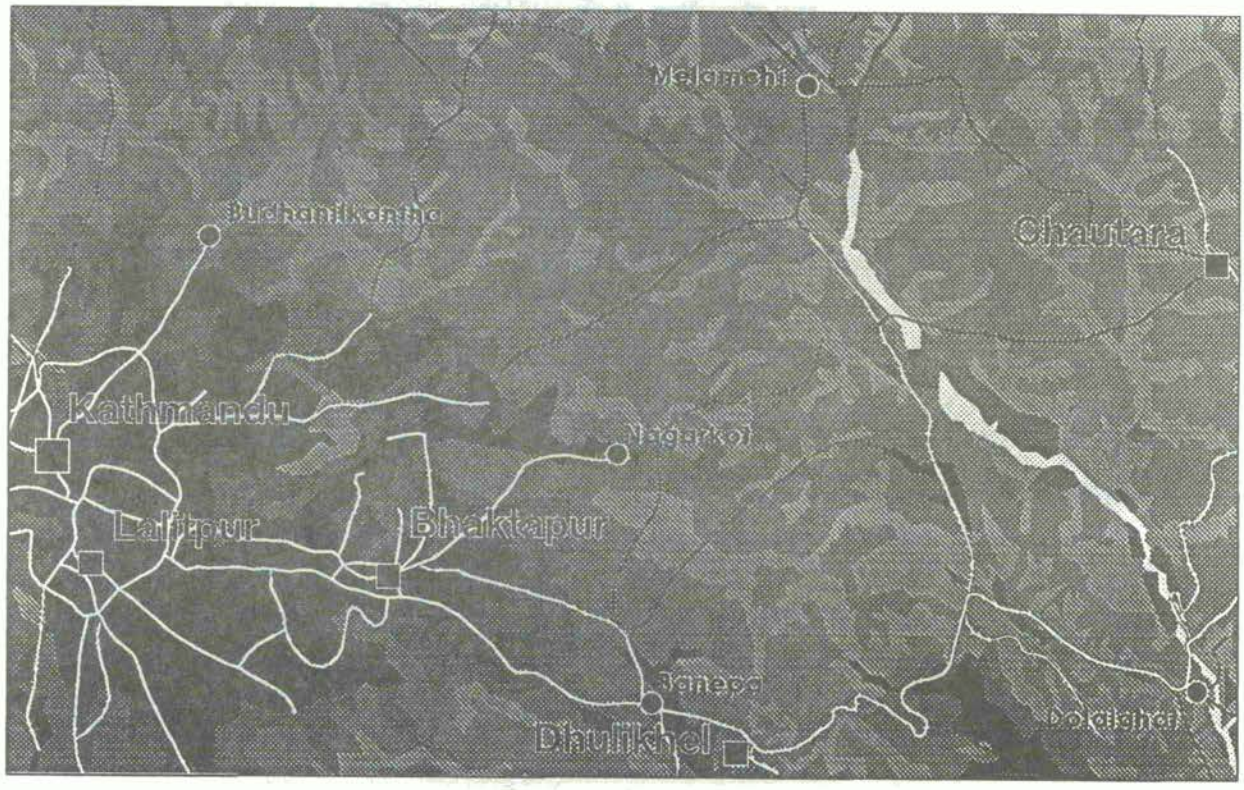
0 5 10 km

Projection: UTM, Central Meridian: 87° E

UNEP/ICIMOD 1991

Source: Land Resource Mapping Project (LRMP), Land Utilization 1:50,000, Topographical Survey Branch, Survey Department H.M.G. Nepal, 1985

Land Capability: Zoom Selection



LAND CAPABILITY

0 5 10 km

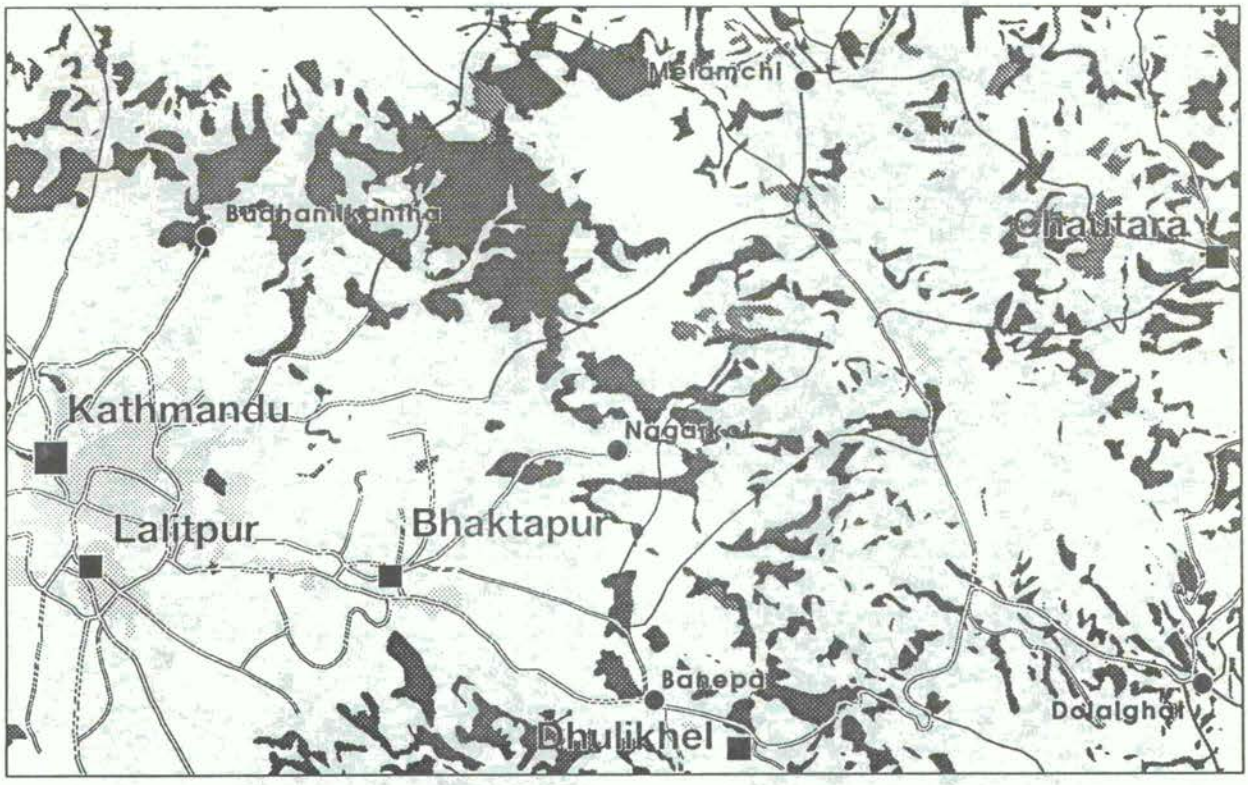
Projection: UTM, Central Meridian: 87° E

- I: slope <1°, deep soils
- II: slope 1-5°, deep soils
- III: slope 5-30°, soils 50-100cm deep
- IV: slope >30°, soils >20cm deep
- V: slope <30°, soils >20cm deep, alpine or flooded river terraces
- VI: slopes 40-50°, soils <20cm deep
- VII: rock and ice

UNEP/ICIMOD 1991

Source: Land Resource Mapping Project (LRMP), Land Capability 1:50,000, Topographical Survey Branch, Survey Department H.M.G. Nepal, 1985

Under-Utilized Land: Zoom Selection



UNDER-UTILIZED LAND

High Quality Land not under Cultivation (Forest, Grazing Lands and Non Agricultural Lands on Land Capability class I-III)

- Non Agricultural Lands
- Grazing Lands
- Forest

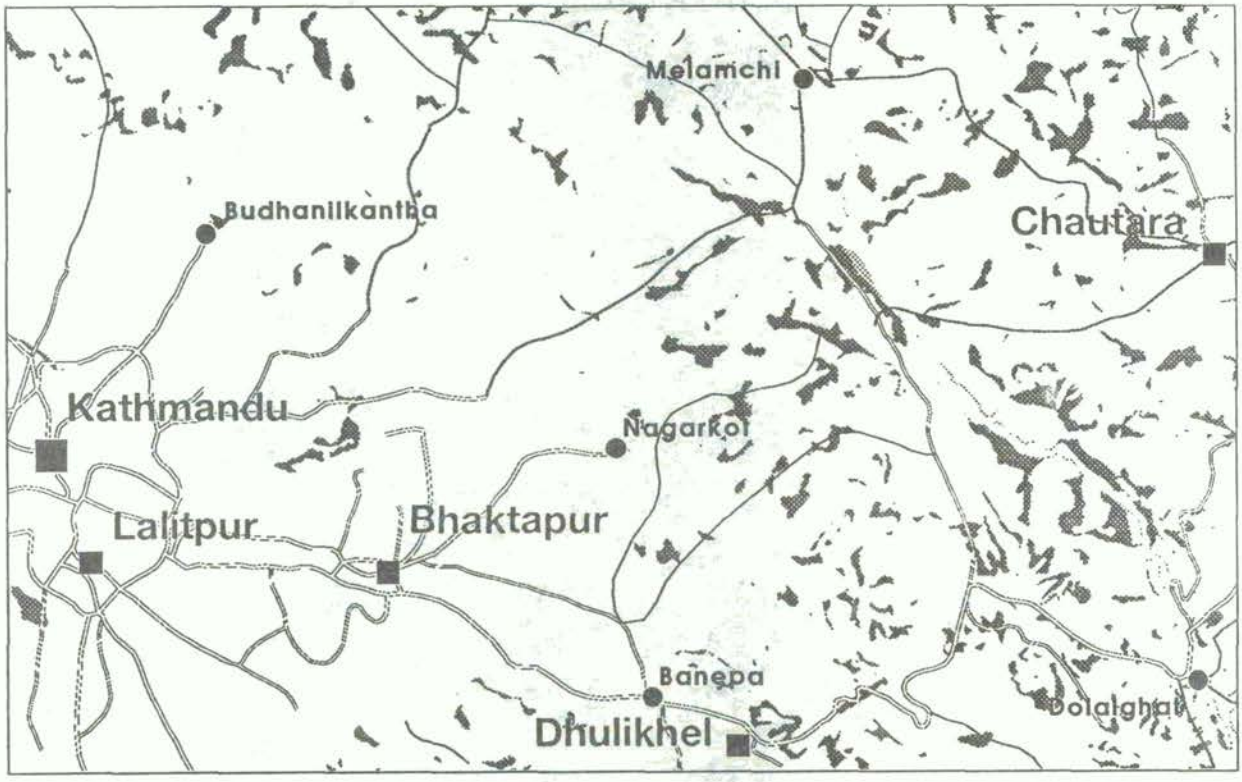
0 5 10 km

Projection: UTM, Central Meridian: 87° E

UNEP/ICIMOD 1991

Source: Land Resource Mapping Project (LRMP), Land Utilization and Land Capability 1:50,000, Topographical Survey Branch, Survey Department H.M.G. Nepal, 1985

Land Under Pressure: Zoom Selection



LAND UNDER PRESSURE

0 5 10 km

Cultivation on poor quality land (Land Capability Class IV - VII)

Projection: UTM, Central Meridian: 87° E

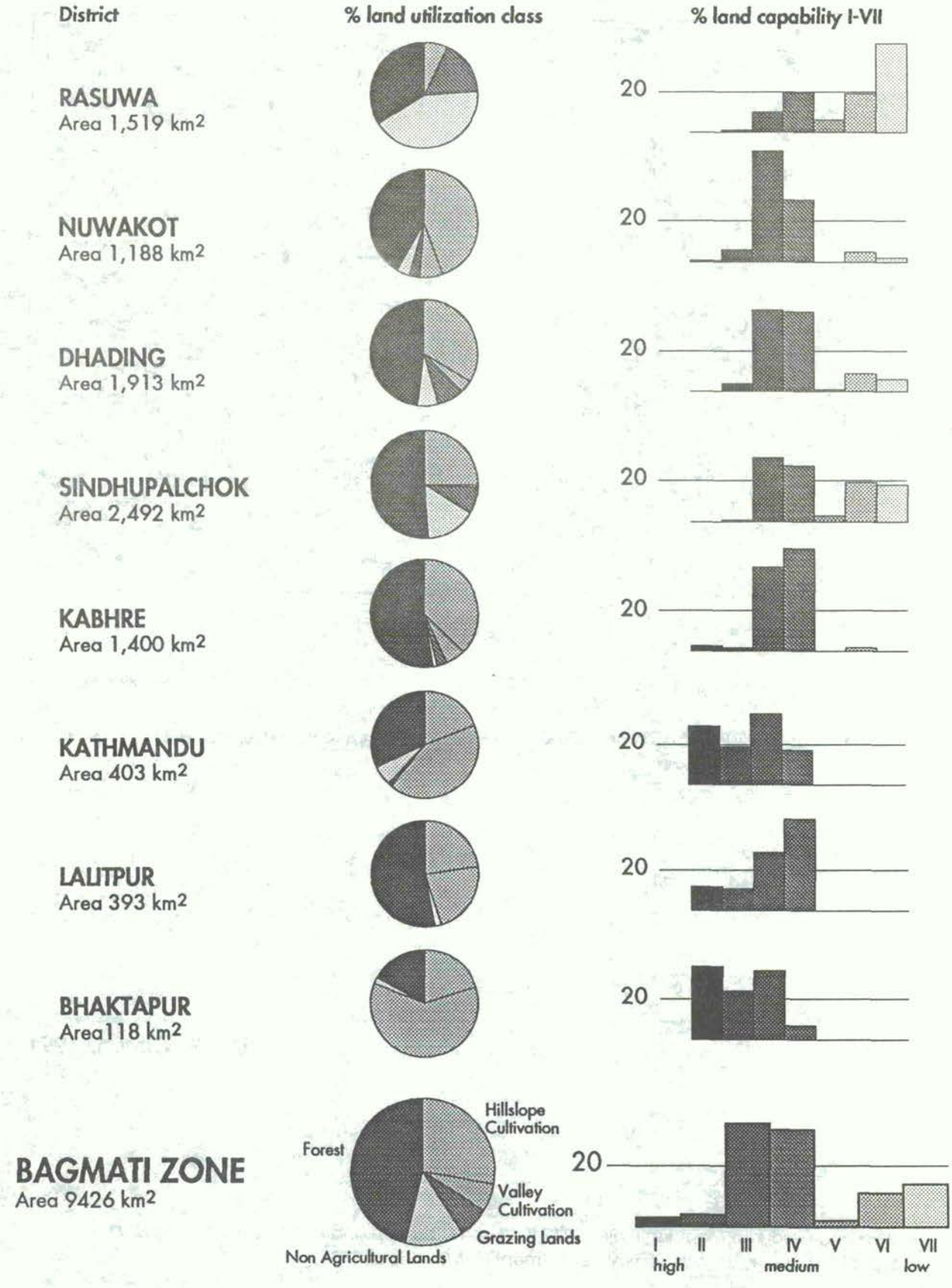
Valley Cultivation

Hillslope Cultivation

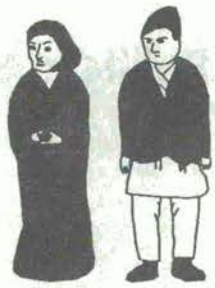
UNEP/ICIMOD 1991

Source: Land Resource Mapping Project (LRMP), Land Utilization and Land Capability 1:50,000, Topographical Survey Branch, Survey Department H.M.G. Nepal, 1985

Land Utilization and Land Cabability: Summary Statistics



Source: Land Resource Mapping Project (LRMP), Land Utilization and Land Capability 1:50,000, Topographical Survey Branch, Survey Department H.M.G. Nepal, 1985

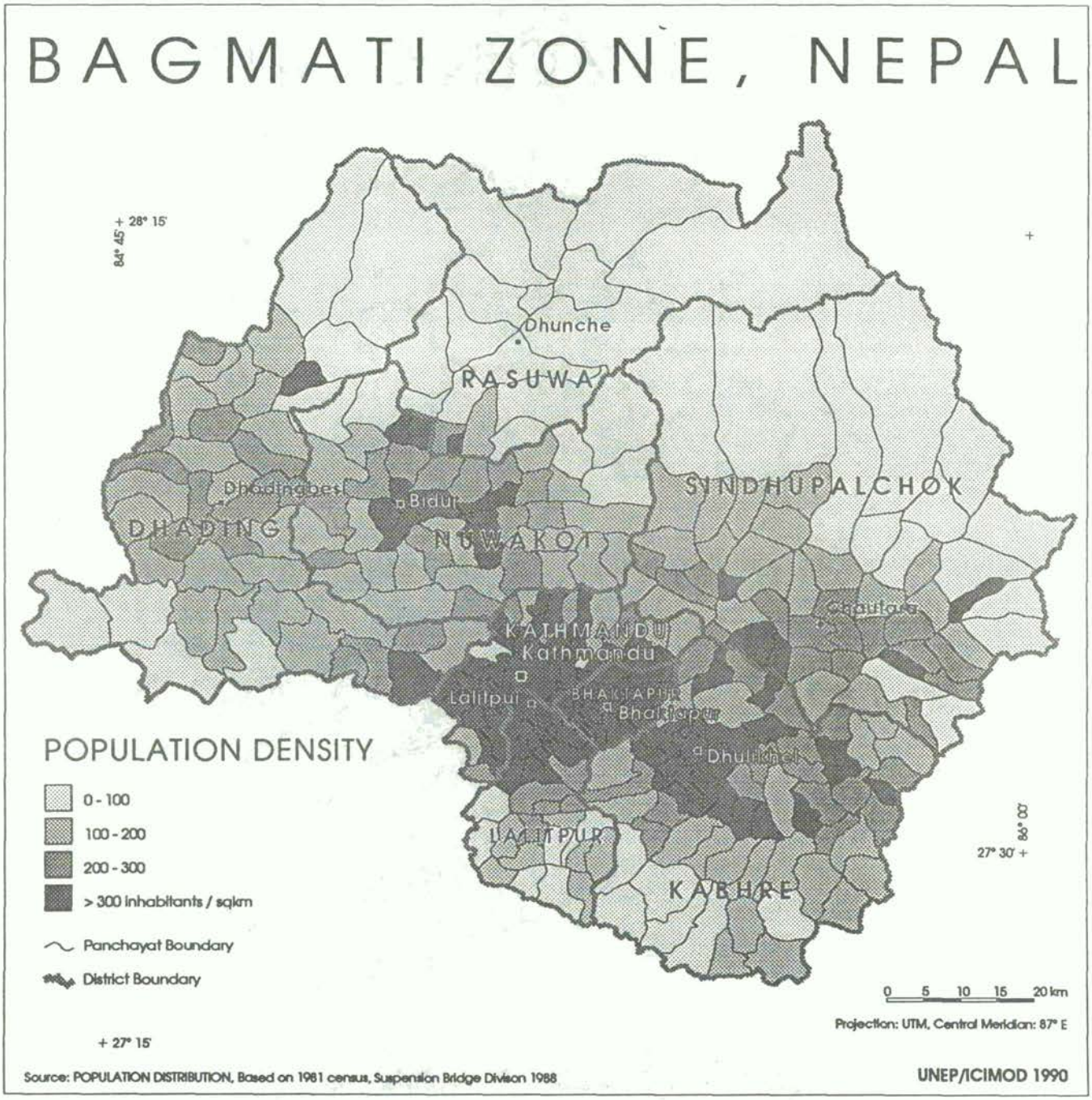


POPULATION

The primary source of information on the human population for Nepal are the national censuses, the most recent having taken place in 1991. Additional relevant information comes from socio-economic ground surveys. Within Geographic Information Systems these mostly tabular data can be linked to environmental information at their spatial location and relations can be analyzed and displayed.

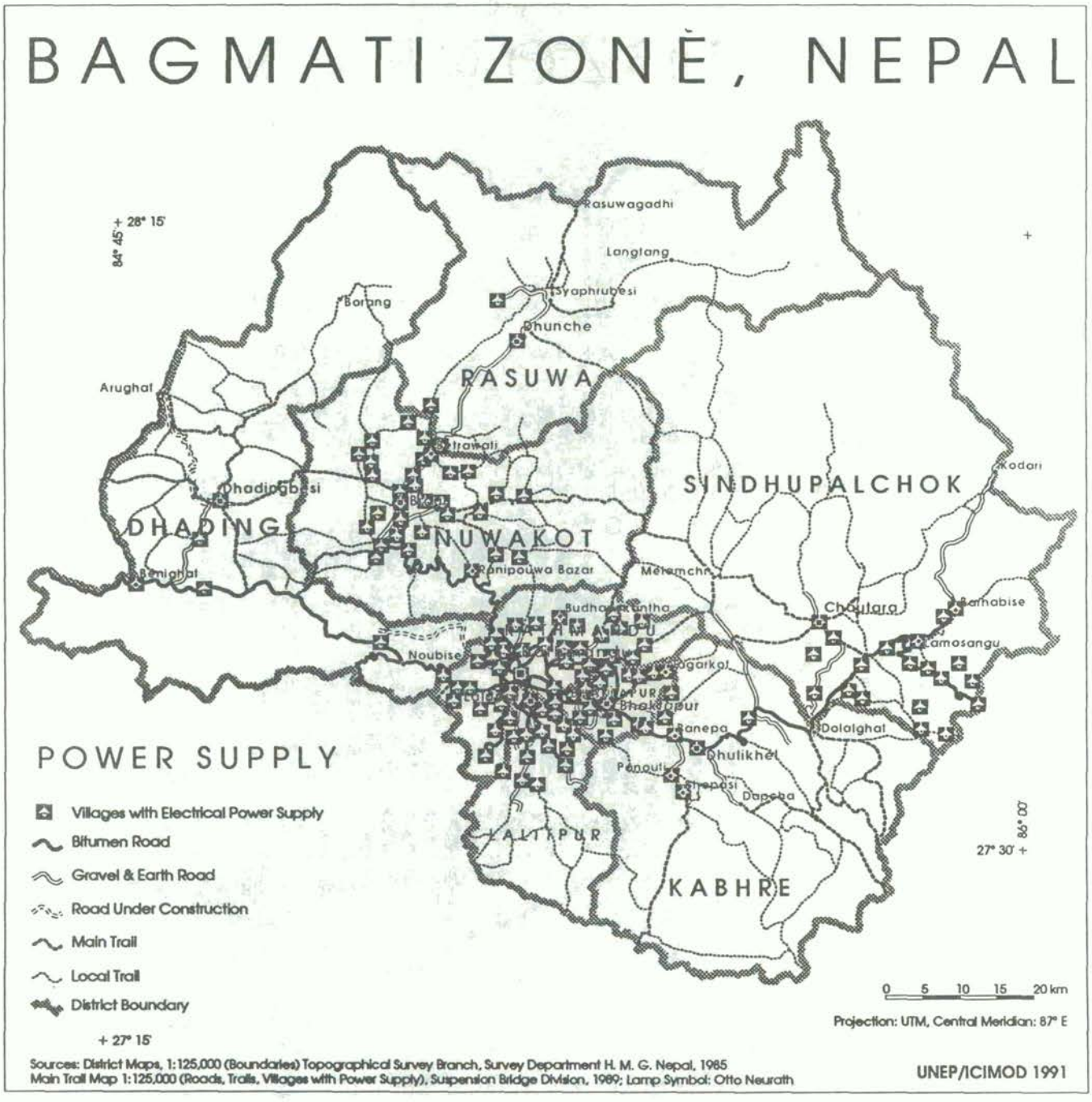
Political Subdivisions

Population Density

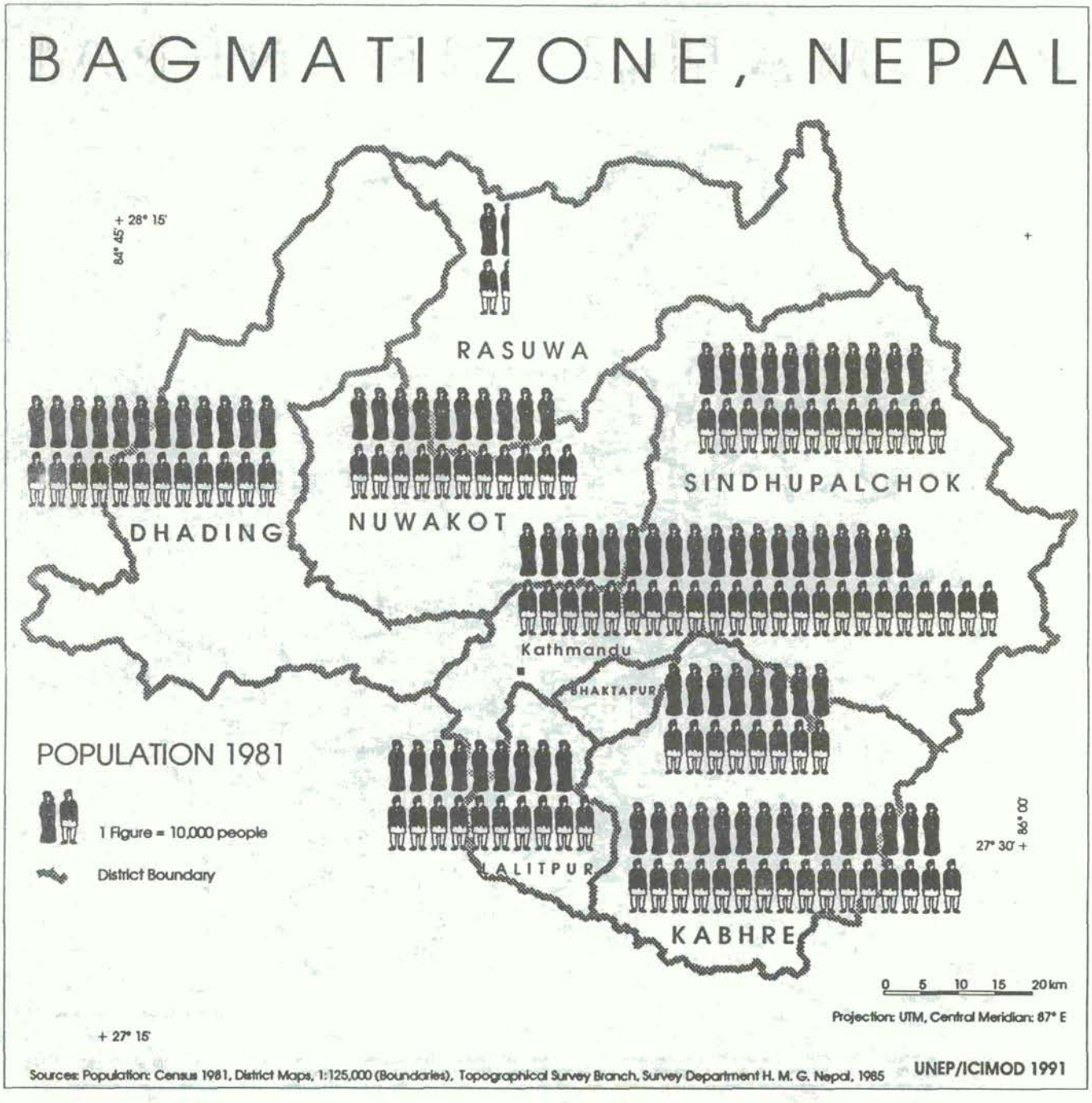


Higher Education

Power Supply



Population


BAGMATI ZONE, NEPAL
+ 28° 15'
84° 45'
RASUWA
DHADING
NUWAKOT
SINDHUPALCHOK
Kathmandu
BHAKTAPUR
LALITPUR
KABHRE
POPULATION 1981
1 Figure = 10,000 people
District Boundary
86° 00'
27° 30' +
0 5 10 15 20 km
Projection: UTM, Central Meridian: 87° E
+ 27° 15'
Sources: Population: Census 1981, District Maps, 1:125,000 (Boundaries), Topographical Survey Branch, Survey Department H. M. G. Nepal, 1985
UNEP/ICIMOD 1991

TRANSPORT

In mountain areas accessibility is a vital economic factor determining amongst other results, the marketability of agricultural products. In rural Nepal most goods are still transported on foot or on pack animals making transport a matter of days or even weeks for certain remote areas. With Geographic Information Systems, factors such as accessibility can be modelled and subsequently be used in analysis, for instance concerning the placement of central services.

Roads and Main Trails

Accessibility