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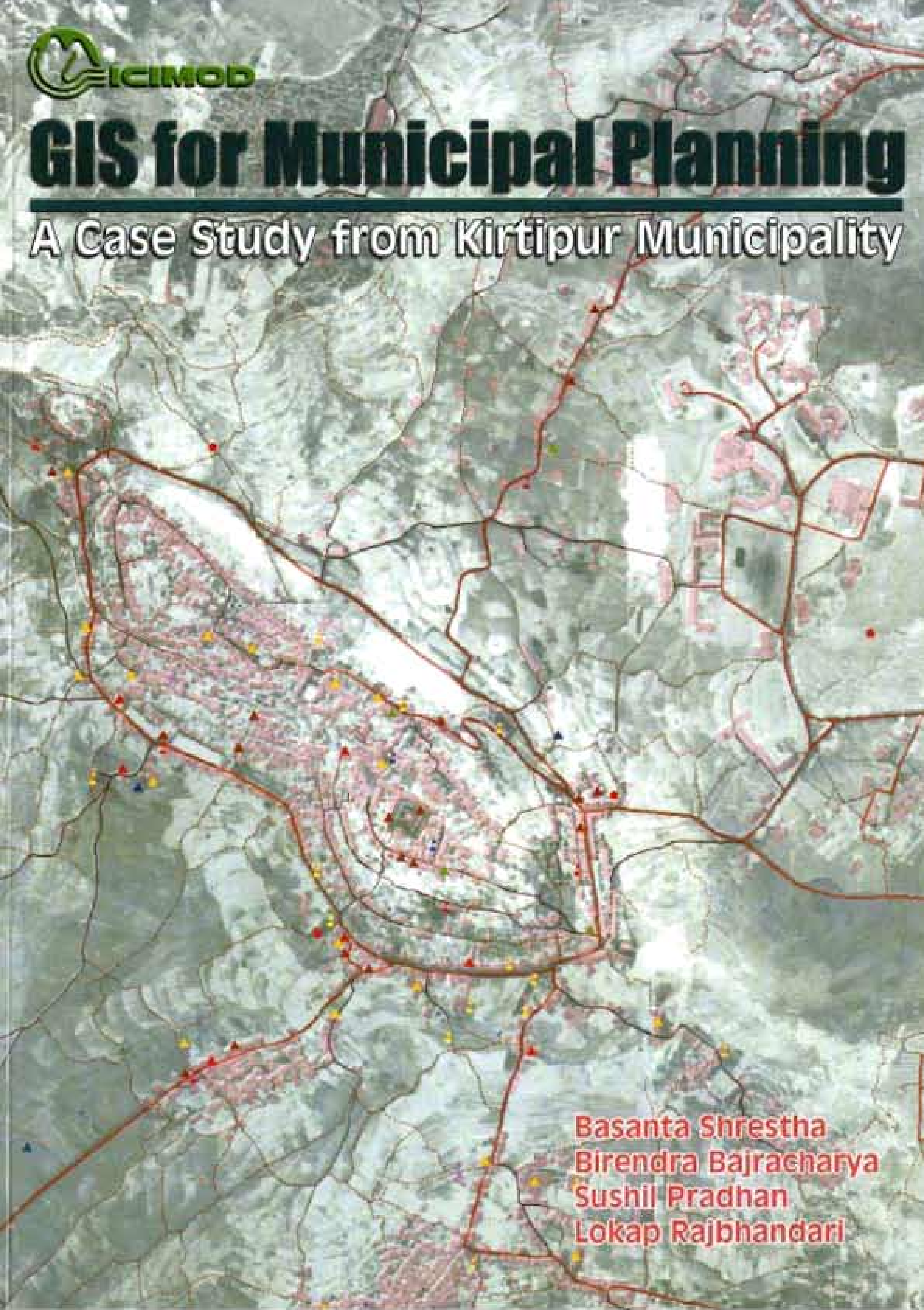
GIS for Municipal Planning

A Case Study from Kirtipur Municipality



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about the organisation

ICIMOD

The **International Centre for Integrated Mountain Development** (ICIMOD) is an independent 'Mountain Learning and Knowledge Centre' serving the eight countries of the Hindu Kush-Himalayas – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – and the global mountain community. Founded in 1983, ICIMOD is based in Kathmandu, Nepal, and brings together a partnership of regional member countries, partner institutions, and donors with a commitment for development action to secure the future of the Hindu Kush-Himalayas. The primary objective of the Centre is to promote the development of an economically and environmentally sound mountain ecosystem and to improve the living standards of mountain populations.

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Foreword

ICIMOD has been promoting the use of geographic information systems (GIS) technology in the Hindu Kush-Himalayan (HKH) region for many years through its Mountain Environment and Natural Resources Information System (MENRIS) programme. Capacity building and networking activities, combined with applications development, have helped support and promote the wider adoption of GIS for different applications across the region. As a part of this, MENRIS implemented a project on 'Strengthening of Training Capabilities for GIS Applications in Integrated Development in the HKH Region' from 1996 to 2000, supported by the Government of the Netherlands. This project focused on capacity building of national institutions through training programmes in using GIS as a tool in four critical areas of mountain development: planning for mountain agriculture and land use management; assessment, planning, and management of natural resources; locational planning for basic infrastructure and services; and slope instability and hazard mapping.

Participants in a series of national and regional training courses on the theme 'Locational planning for basic infrastructure and services' held in Kathmandu used Kirtipur Municipality as a model urban centre and as a part of the training carried out extensive field visits to verify and collect data. The case study on Kirtipur Municipality presented in this publication built upon a post-training exercise by trainees from the course. The study was designed to provide a model demonstrating how GIS can provide a useful tool to support municipal planning processes and decision-making. The datasets developed previously were verified during extensive field visits undertaken in close cooperation with the municipality and supplemented with information obtained from a high-resolution satellite (IKONOS) image and an orthophoto generated from earlier aerial photographs for the study.

The GIS approach offers major advantages over static mapping. The user can select and overlay different types of data from the datasets greatly facilitating understanding of the existing situation, the planning needs, and the potential impact of planning decisions. Moreover, it is much less resource intensive to update datasets than to prepare new maps so that it helps future planning, and by using a base dataset updated at intervals it is possible to analyse and review trends. The analyses presented in the study indicate clearly how GIS can be used in different urban applications. One of the most important aspects of the study was being able to develop a comprehensive large-scale database, which is both time and resource consuming. The database that was developed can be used as a foundation for a wide range of applications and will help reduce duplication of effort.

GIS tools can be very useful for municipalities in mountain areas like Kirtipur that are undergoing rapid change without having a proper planning framework. In most parts of Nepal, however, the municipalities do not yet have the resources to start using GIS technology, and in many cases are not aware of how powerful a tool it can be to support and facilitate planning and decision-making at the municipal level. To use GIS technology effectively in a country, the process of database creation and its periodic maintenance must be institutionalised at the local level and adequate technical capability ensured to perform necessary data (spatial) analyses for planning and decision-making.

For the last decade or so, ICIMOD's MENRIS programme has been working towards enhancing the capacity of partner organisations to use GIS tools, and applying these tools and techniques in various mountain specific applications. There is a continuing demand for these tools by many of our partner institutions and an expressed need for training in their use. This book is a further contribution to these activities, intended both to raise awareness of the potential of GIS in planning applications, and to provide an example that can be used as a base by those interested in applying GIS to their own local situation, particularly municipal level planning. The datasets, associated metadata, maps, and reports used in the study are being prepared as a companion publication on a CD-ROM. The datasets will be integrated with simple GIS functionality so that they can be viewed from a spatial perspective and allow users to investigate the multitude of possibilities for using these tools.

We hope that this study will do much to demonstrate the potential of GIS as a decision support system tool for integrated municipal planning, both in Nepal and in the HKH region in general. The book should prove useful to all those interested in applying GIS in urban planning, as well as to those interested in the process of urbanisation and urban planning per se in Nepal.

Dr. Binayak Bhadra
Director of Programmes
ICIMOD

Executive Summary

A case study was prepared for Kirtipur Municipality, in Kathmandu District, Nepal, to demonstrate with a practical example the potential for using geographic information systems (GIS) as a tool to support municipal planning and decision-making processes, with particular reference to integrated action planning (IAP), a participatory planning approach being implemented in a number of municipalities in Nepal. Kirtipur was selected both because of its proximity to Kathmandu and because it typified the situation in areas with rapid urbanisation, which nevertheless still retain the rural characteristics of an ancient settlement in the mid-hills of the HKH region. The study started as a post-training exercise by participants in a course on 'Locational planning for basic infrastructure and services' held in Kathmandu, which had used Kirtipur Municipality as a model urban centre. The datasets used in and developed during the course were used as a basis for the case study and verified during extensive field visits undertaken in close cooperation with the municipality. They were supplemented with information obtained from a high-resolution satellite (IKONOS) image and an orthophoto generated from earlier aerial photographs. These served both to provide basic information and as a way of identifying changes over time.

The background, details of the study, and results are presented. The general information requirements for municipal planning are discussed and a brief overview given of the planning process in Nepal. The design and development of the database, including the data collection approach and data sources, are described in detail. Metadata is provided for standardisation and future use of data. Spatial profiles of the municipality and its wards (the lowest administrative boundary) are presented in the form of thematic maps; with each discussed briefly. Together, these maps provide a clear picture of the existing facilities and their spatial distribution within the municipality. Such maps can be used to help identify priority areas for development or management intervention. Land use and land cover change (derived from aerial photographs taken some years apart) was studied in detail and a first analysis made of the pattern and trend of urbanisation. The land use changes are also presented in map form. The land use criteria used for this first evaluation generated a very good scenario of the trends in growth, which can be used as a basis for developing future development plans. The analysis could be extended in future to include socioeconomic factors.

The advantages of using GIS technologies in municipal planning are discussed, together with the present limitations, which tend to reflect organisational challenges more than technical difficulties. The study underlines the need to develop the capacities of municipalities and institutionalise the process within the local authorities. It is important to provide the motivation for local authorities to generate and maintain spatial information, and use it.

The database generated by the study and the methodology employed will provide the basis for a larger scale database for Kirtipur Municipality. It will be valuable both to Kirtipur Municipality itself and to the many other agencies involved in planning and development activities in the municipality.

Note:
An interactive multi-media CD-Rom is being published separately and will provide access to all the datasets, the associated metadata, maps, and reports used in the study, and will integrate them with simple GIS functionality so that they can be viewed from a spatial perspective.

Acknowledgements

We would like to acknowledge the contributions of the MENRIS trainees Ms. Sarita Maskey and Mr. Rajendra Man Singh from the Department of Housing and Urban Development (DHUD) and Mr. Tribhuvan Man Singh Pradhan from Kathmandu Metropolitan City who started the study in close cooperation with ICIMOD, and thank them for their untiring efforts in developing and compiling the database during the initial phase. We also express our sincere appreciation to Kirtipur Municipality for organising a workshop in Kirtipur during the course of the study; and we thank Mr. Anuj Pradhan and Mr. Raju Maharjan from the Municipality in particular for their assistance in the fieldwork and data collection. Special thanks are due to Prof. Barry Haack from George Mason University, Washington DC, USA, for his review of the draft and useful comments.

We would like to thank all the individuals and institutions that provided the data and information needed for the study, and all the staff of MENRIS who have contributed in various ways to its completion. Lastly, we would like to thank our editorial and layout team, Dr. A. Beatrice Murray, Ms. Jenny Riley, and Mr. Dharma R. Maharjan.

Acronyms and Abbreviations

CBS	Central Bureau of Statistics
DEM	digital elevation model
DHUD	Department of Housing and Urban Development
DWSS	Department of Water Supply and Sewage
GIS	geographic information system
HKH	Hindu Kush-Himalayas
HMG/N	His Majesty's Government of Nepal
IAP	integrated action plan
ICIMOD	International Centre for Integrated Mountain Development
KMC	Kathmandu Metropolitan Corporation
KUDP	Kathmandu Valley Urban Development Programme
MENRIS	Mountain Environment and Natural Resources Information Systems
MPAMKV	Master Plan for Agricultural Marketing in the Kathmandu Valley
MSIP	Multi-Sector Investment Programme
NEA	Nepal Electricity Authority
NGO	non-government organisation
NSET	National Society for Earthquake Technology
NTC	Nepal Telecommunications Corporation
NWSC	Nepal Water Supply Corporation
PEDP	Physical and Environment Development Plan
PHECT	Public Health Concern Trust
TU	Tribhuvan University
UDLE	Urban Development Through Local Effort
VDC	village development committee

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Chapter 1 Introduction

Background

Nepal has undergone rapid urbanisation in the last two decades with the urban population growing at an average rate of 6.5% per annum – the highest growth rate in South Asia (UNEP 2001). About 15% of the country's population now lives in towns. As a result of this rapid urban growth, the Government of Nepal created an additional 22 municipalities in 1997 in accordance with the Municipality Act 1983. Although many smaller municipalities continue to be settlements with rural characteristics, urbanisation in Nepal is often characterised by unplanned and haphazard growth. This situation has resulted in a lack of basic infrastructure such as quality roads, sanitation, and drinking water. In addition, this unplanned growth can cause environmental problems such as air and water pollution, public space and riverbank encroachment, and unmanaged solid waste disposal. Unless timely development interventions are made, many municipalities are destined to grow into large, crowded cities with poor quality of life for the inhabitants who will be faced with inadequate infrastructure and amenities.

In accordance with the decentralisation policy of Nepal, the Local Self-Governance Act 1999 gives municipalities complete responsibility for local-level planning and decision-making. Planning and management of resources and infrastructure at the local level need to be based on accurate and up-to-date information and to use modern techniques that enable complex analysis and assessment. Geographic information systems (GIS) are increasingly being seen as versatile tools in urban applications and decision support systems. The study presented here demonstrates how GIS can help in integrating and analysing various types of information that are important for municipal-level planning. Kirtipur Municipality, which is close to Nepal's two largest municipalities of Kathmandu and Lalitpur and has all the characteristics of rapid and haphazard growth, was chosen as an example for the study (Maps 1-3).

Municipal applications need databases at a large scale for micro-level planning. In this study an attempt was made to compile and develop basic data layers at a scale of up to 1:2000 using aerial photographs, digital data, and high-resolution satellite images. Data on social infrastructure were collected from primary and secondary sources and verified in the field to obtain a picture of the development scenario. The study also looked at changes in the municipality over the last 10 years based on a time-series database. Close consultations were held with Kirtipur Municipality at various stages of this study to obtain their inputs and ensure that their views were reflected. Some municipality staff members were also trained in GIS techniques and helped carry out the field verification. Besides presenting the development scenario of the municipality, it is hoped that the databases generated will make an important contribution to initiating the development of a spatial data infrastructure for the municipality.

Overview of Kirtipur

Kirtipur is an old settlement situated on a double hillock in the southwest of the Kathmandu Valley (Figure 1); it is one of five municipalities in the Valley. It is located at 27º 38' 37" to 27º 41' 36" N and 85º 14' 64" to 85º 18' 00" E, and at present has 19 wards and covers 1787 ha. It is bordered by the Bagmati river to the east, Machhengaun Village Development Committee (VDC) to the west, Kathmandu Metropolitan City (KMC) to the north, and Chalnakhel VDC to the south.

Figure 1: Kirtipur – a hillock covered with houses

Kirtipur was established in the twelfth century as an outpost of Patan. It later became an independent kingdom for a short period. The town was built initially within a wall surrounded strategically by dense vegetation and then open ground as outer rings. Until 1950, the settlement was confined within the outer wall built during the Malla period (1168–1768 A.D.) (Manandhar and Shrestha 1990). Kirtipur was identified as a 'town' or urban locality in the 1952/54 and 1961 censuses of Nepal. It was declassified as a town in the 1971 census when the criteria for designating urban localities were changed. Kirtipur Municipality was formed in 1997 by combining eight VDCs, namely Palifal, Layaku, Bahirigaun, Chithubihar, Champa Devi, Bishnudevi, Balkumari, and Chobhar. The total population of these VDCs in the 1991 census was 31,338. The 2001 census gives a total population of 40,835 in 9487 households, equivalent to an overall average population density in the municipality of 2.3 persons per hectare.

The ancient layout of open and built-up areas on the hilltop has survived with little change in recent years, most expansion has been concentrated at the southern base of the hill (Figure 1). The establishment in Kirtipur of the Tribhuvan University campus, and the proximity of the municipality to the Ring Road, has made the area attractive as residential land for the people of Kathmandu. This has brought about significant changes in land-use patterns and the occupational structure of the municipality in recent years.

Development trends

Being a new municipality with a comparatively low population density, the problems of unplanned growth are not yet severe; however, they are beginning to appear. A study conducted by the Kirtipur Environmental Mapping Project (conducted by the National Society for Earthquake Technology (NSET) with the support of the USAID Urban Environment Programme in 2000) identified solid-waste management, river water pollution, and air pollution as growing problems (NSET 2000) (Figure 2). The report noted dumping of solid waste in and around settlement areas, historical ponds, and heritage sites; direct discharge of sewage and untreated industrial waste into surface water drainage systems; air pollution resulting from industries and unpaved roads, among others; poor maintenance of temples, shrines and historical structures; and inadequate financial resources and technical manpower to deal with the environmental problems.

Services such as solid-waste management, drinking-water supply, and roads need the immediate attention of planners. Despite having panoramic views of Kathmandu valley and the mountains beyond, this historic and culturally significant town has not been able to promote itself as a quality tourist destination. Instead, with its poor infrastructure and preponderance of low-income families in the core area, it is seen by tourists as an example of picturesque poverty. It is imperative that the development activities of the municipality are managed and coordinated before the situation becomes worse.

Figure 2: Waste dumped in a pond

Rationale and objectives of the study

GIS technologies are capable of handling large volumes of data from multiple sources, integrating them to produce information in a spatial context in the form of maps, and modelling the impact of management decisions. Thus GIS can be an extremely useful tool for municipal planning and decision-making that involves analysis of needs assessment and resource allocation. In most parts of Nepal, however, municipalities do not yet have the resources to start using GIS technology, and in many cases are not aware of how powerful a tool it can be to support and facilitate planning and decision-making at the municipal level.

ICIMOD has a long experience of introducing GIS approaches in the HKH region in general, and Nepal in particular, including applications development in many different fields and hands on training. Over the years, ICIMOD has concentrated on, and developed training materials for, application of GIS to improve planning of basic infrastructure and location of facilities in mountain towns (see, for example, Shrestha et al. 2001). A series of training events have been held for relevant organisations in the HKH region, including one in urban planning for participants from Nepal. Kirtipur municipality was used as a case study and model, and field visits were made to the municipality to demonstrate how GIS can be used to support municipal planning processes. Kirtipur was chosen both because of its convenient location close to Kathmandu, which facilitated information exchange and ground-truthing of data, and because it typified the problems faced by growing urban districts across Nepal. In recent years, the Urban Development Through Local Efforts (UDLE) programme, supported by the German Government through the Department of Housing and Urban Development of His Majesty's Government of Nepal (HMGN), has implemented integrated action planning (IAP – see Chapter 2) for physical and environmental planning in a number of municipalities. In the Kirtipur study, we attempted to integrate GIS within the IAP framework as a model case study for potential users.

For new municipalities like Kirtipur, there is an urgent need for rational planning before urban expansion becomes unmanageable, and it is an ideal location to test approaches using GIS.

The specific objectives of the study were:

- to build a comprehensive geographically referenced database of Kirtipur Municipality that will be a building block in the municipal GIS database development process, and
- to demonstrate how GIS can be used in the municipal planning process through application of integrated action planning (IAP) to improve the level of services to the community

With these objectives, the study attempted the following.

- To collect and collate primary and secondary information from various available sources
- To illustrate the design and development of a municipal GIS database, and demonstrate its usefulness for planning activities such as IAP
- To prepare a spatial profile of Kirtipur Municipality, and analyse its urban development trends

IAP has not yet been done in Kirtipur Municipality. It is expected that the results of the study will provide substantial support in terms of information input if and when such an exercise is carried out in the future.

Chapter 2 The Municipal Planning Process in Nepal

Integrated action planning (IAP)

Integrated action planning (IAP) was introduced to Nepal in the late 1980s as an alternative to the conventional approach to planning. IAP seeks to obtain a significant level of people's participation as an integral part of the planning process. The study begins with the identification and prioritisation of problems from various sources. These are refined and verified through meetings with contact groups at the ward level, and intensive discussions with an IAP steering committee, the town council, line agencies, non-government organisations (NGOs), and other relevant institutions. The data and information required to formulate appropriate programmes are collected and analysed during the course of the IAP (DHUD/UDLE 1998; Mattingly and Winarso 1999). The major outcome of IAP is a report containing three interrelated policy statements:

- a physical and environment development plan (PEDP) stating policies for the expansion of built-up areas, and for land-use zoning of present and future built-up areas;
- a list of mutually supportive projects for basic infrastructure and services to be carried out during the planning period, combining the projects at ward level and at the municipality level; and
- a multi-sector investment programme (MSIP) that relates projects to the expected funds, reflecting the priorities given by the people and their representatives.

Considerable spatial and socioeconomic data and information is needed to produce these outputs. Without appropriate and adequate data and information, one cannot plan effectively or coherently for basic services such as roads, water supply, electricity, telephones, managed market areas, land-use zoning, and environmental monitoring. During the IAP exercise, data and information are collected from primary and secondary sources. Spatial data are manipulated using conventional cartographic tools, and various thematic maps are prepared. These maps are manually overlaid and analysed to provide a basis for the development of plans and programmes.

GIS in municipal planning

The participatory approach used in IAP is useful for identifying needs and problems at the grass roots level. It is natural for residents to expect clean and good quality roads, and a high level of access to services such as schools, healthcare, banks, and other facilities. However, planners need to consider the feasibility of providing such facilities within the available resources. Decisions have to be made concerning the priorities and location of facilities that meet local needs. Similarly, land-use planning and construction of physical infrastructure should be evaluated for their environmental impact.

A large amount of spatial information is collected during the preparatory analysis and assessment phase of the IAP process. A base map of the municipality is prepared with data related to topography and natural features. Thematic maps of land use, development trends, roads, water lines, and sewerage, electricity, and telephone networks are overlaid on the base map to identify places where a combination of factors indicates constraints or opportunities for expansion of the urban area. One limitation to this complex planning process is a lack of tools for handling this information; it requires a substantial effort to collect data and prepare thematic maps manually. When it was introduced, it was hoped that IAP would become a regular activity of local urban governments, and would help them to prepare annual development budgets, to coordinate expenditure, and to implement physical development plans. In practice, the task has proven beyond the means of most local governments due to lack of technical capacity. Not only is the initial process resource intensive, it is difficult to use the large amount of analogue information generated effectively when repeating the process.

GIS can provide a solution for many of these problems. It facilitates the archiving and management of various types of data and information in an efficient and effective way. It can be used to prepare automatic overlays of selected spatial information, and it provides tools for modelling spatial interactions and a framework for comparative analysis of new urban infrastructures and their impact on surrounding areas. In addition it ensures that the data is archived for future uses, and also as a basis for analysing trends. Thus GIS can provide an important tool to support decision-making. The local situation can be analysed more intensely by integrating additional themes, such as demographic and socioeconomic data, along with spatial data.

There is increasing demand from municipal authorities and other relevant organisations for systematic data and information on the existing infrastructure and environmental status that can be used to guide a rational planning process. The proliferation of GIS has created new opportunities for the management of data and information, and for spatial modelling at various scales. With the development of databases with a common spatial reference, use of GIS encourages interaction and cooperation among line agencies. Figure 3 shows the present IAP process and how GIS can be incorporated to support the municipal planning process.

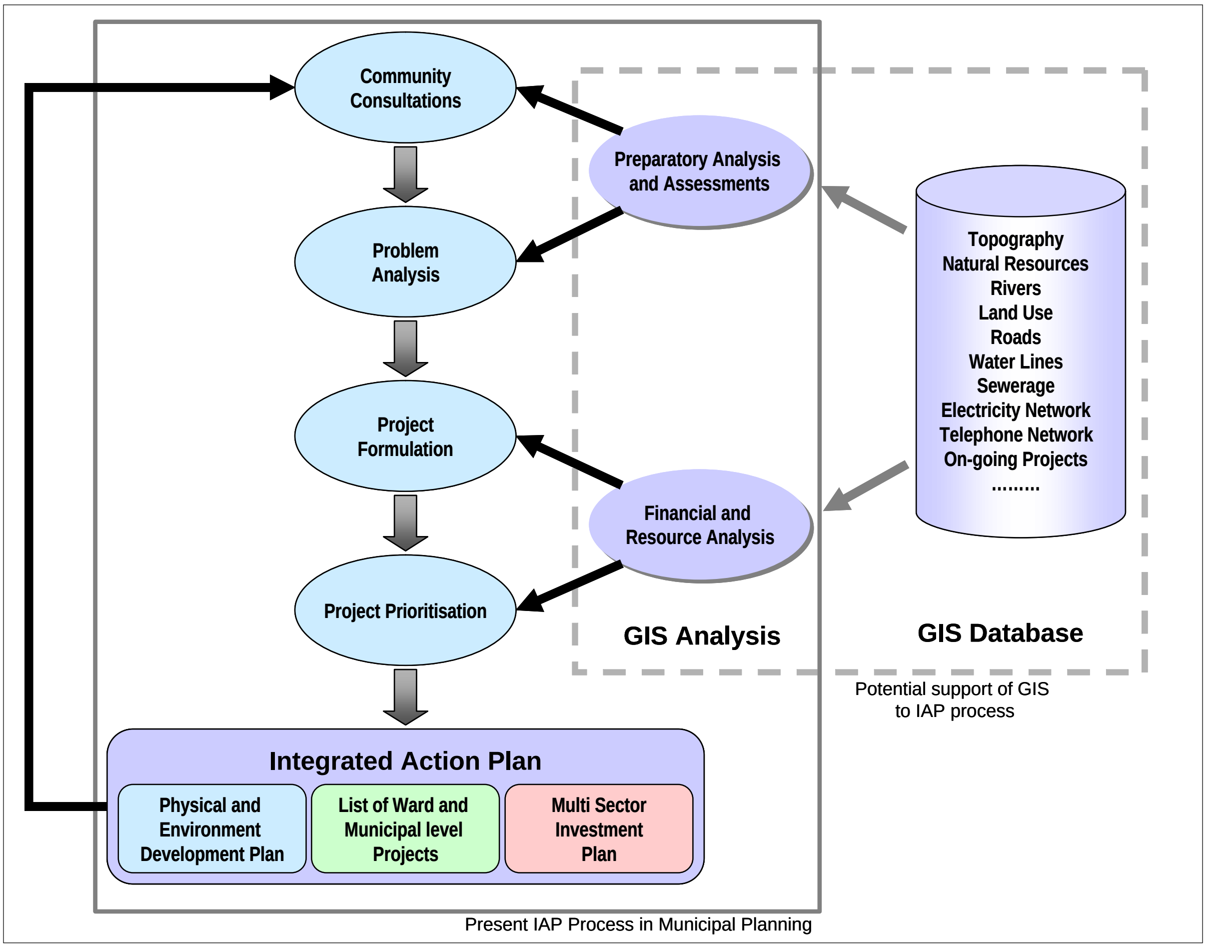

Figure 3: GIS support in the IAP process

Information requirements for municipal planning

A major component of the municipal planning process is the identification of priorities for the development and improvement of physical and environmental conditions in the municipality. The data and information requirements are determined by the desired application. Most municipal applications require spatial data at a scale of 1:5000 or higher, together with associated socioeconomic information. Table 1 shows an indicative list of the biophysical and socioeconomic datasets required for major municipal applications.

Table 1: Indicative list of information requirements for municipal level planning

Major area of planning	Biophysical data	Socioeconomic data	Potential areas of application
Location of infrastructural components and other facilities	**Topography** Digital elevation map (DEM), slope, drainage **Service centre locations** Education, public services, public utilities, public institutions, markets **Transportation network** Roads, trails, bridges **Land use/land cover** Dominant land uses, built-up area	**Administrative units** Municipal boundary, ward boundaries **Demography** Population density, demographic patterns **Social characteristics** Literacy, mortality, health, employment **Economy** Dominant economic activities, trade	▪ Location of new service facilities like schools, hospitals, and markets ▪ Accessibility analysis, improvement of roads ▪ Planning and implementation of drainage and sanitary facilities
Urban land use zonation	**Topography** DEM, slope, drainage **Land use/land cover** Dominant land uses and land cover, land-use change, built-up area **Transportation network** Roads, trails, bridges **Social infrastructure** **Location of services**	**Administrative units** Municipal boundary, ward boundaries, parcels **Demography** Population density, migration	▪ Land-use zonation, e.g. open areas and recreation facilities, ▪ Suitability for urban expansion ▪ Urban land-use change analysis
Environmental management	**Topography** DEM, slope **Geology** Major faults or sensitive geological features **Drainage** Major, minor rivers, streams **Land use/land cover** Urban land use, forest, agriculture **Waste management** Industries/factories, sewerage **Social infrastructure** Cultural/heritage sites **Location of services**	**Administrative Units** Municipal boundary, ward boundaries **Demography** Settlement patterns, population density **Pollution** Air pollution, river water pollution, solid waste	▪ Hot spot monitoring ▪ Pollution control ▪ Solid waste management ▪ Hazard mapping ▪ Sewage treatment
Utility mapping and planning	**Topography** DEM, slope, aspect **Utility infrastructure** Electricity, telephone, water supply, sewerage **Transportation network** Roads, trails, bridges **Water resources** Rivers/springs/seasonal flows, ponds **Property** Building footprints, parcels	**Administrative units** Municipal boundary, ward boundaries **Demography** Settlement pattern, population density **Utility infrastructure** Electricity supply, telephone distribution, water supply	▪ Planning and management of utility line services, e.g., telephone, electricity, water supply ▪ Network analysis ▪ Emergency response planning

Chapter 3 Design and Development of the Database

Data collection and needs assessment

There are inherent limitations in compiling GIS datasets for a municipality like Kirtipur because the concept of digital mapping is relatively new and there is no established map culture. The difficulties are compounded by the limited data and information handling capability in the various organisations associated with the municipality, and a lack of coordination and harmonisation between different offices and activities. Different activities and projects use paper maps at varying scales, often without adequate information about the lineage of the map data. With little coordination and a conservative approach to information-sharing among line agencies, existing maps and digital data often lack proper standards and are difficult to access.

In the study an attempt was made to compile sufficient data and information from available sources and a field study in a satisfactory spatial framework to fulfil the basic information requirements for municipal planning (Figure 4). The methodology used to build the Kirtipur Municipal GIS Database, and to perform spatial analyses, is summarised in Figure 5. As far as possible, data were collected from secondary sources, bearing in mind the considerable resources required for the preparation of databases. Where there were no secondary sources available, limited primary data were collected in a field survey. The GIS layers that were developed are summarised in Table 2. The metadata for each of these layers is given in Annex 1. The data sources and process used to create each data layer are described below.

Conversion of existing digital data

The base map for the present study was prepared using the data acquired from the Kathmandu Urban Development Project (KUDP). These data were originally developed by Nepal Telecommunication Corporation (NTC) in AutoCAD format from aerial photographs taken in 1992 at a scale of 1:10,000. Data layers like roads, drainage, contours, and building footprints, were converted from AutoCAD DXF format into Arc/Info coverages. A digital elevation model (DEM) was created by interpolating the contour data at 2m intervals. Figure 6 shows the sheet index for the KUDP data used for preparing the database.

The detailed information in the maps was then updated to reflect the recent changes as described in more detail below. Briefly, the ward boundaries and municipality boundary were updated using information from the municipality office as these had changed from those in the KUDP database. Field visits were carried out to verify major features, and layers were updated using the high-resolution IKONOS image from 2001 and the orthophoto prepared during the study (see below).

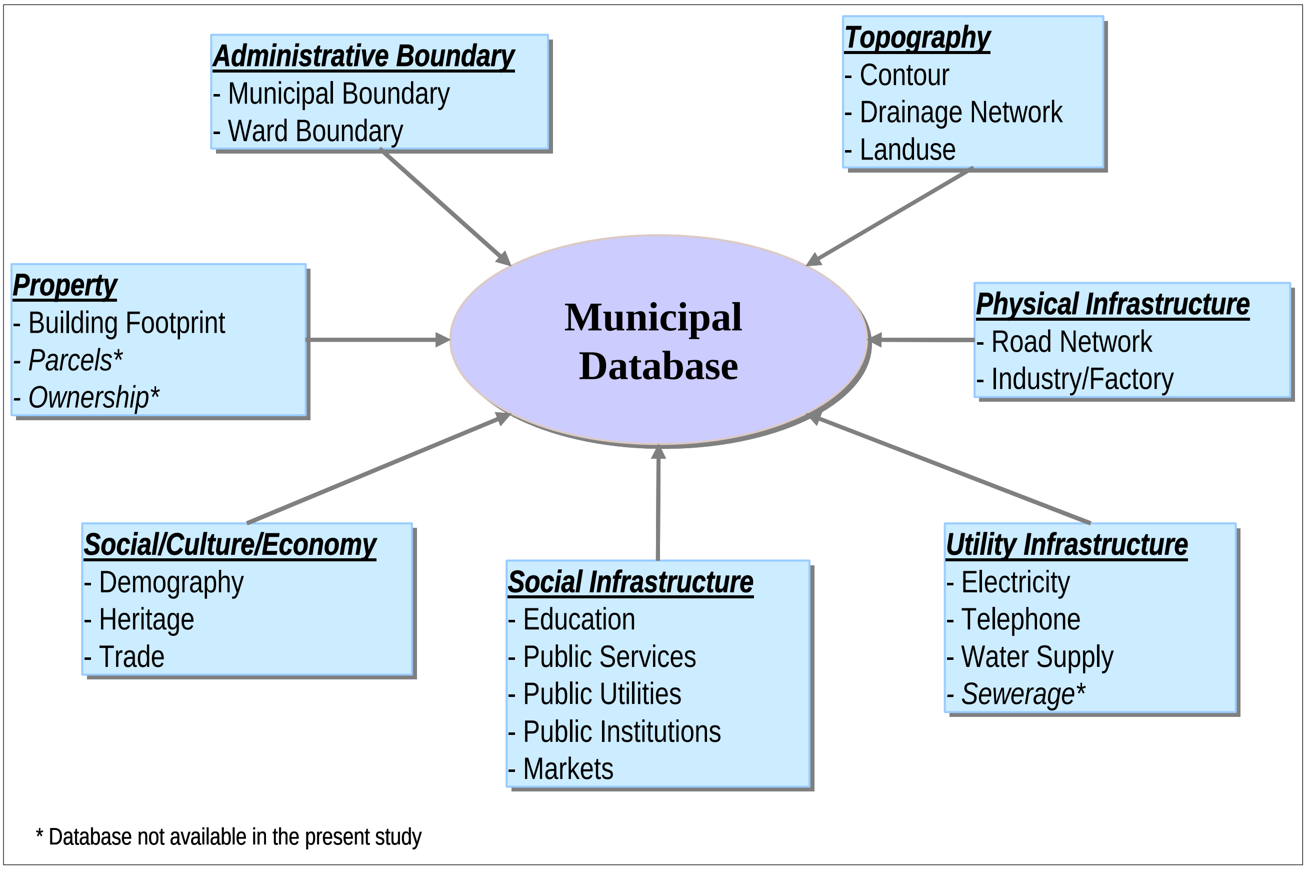

Figure 4: Data requirements for municipal planning

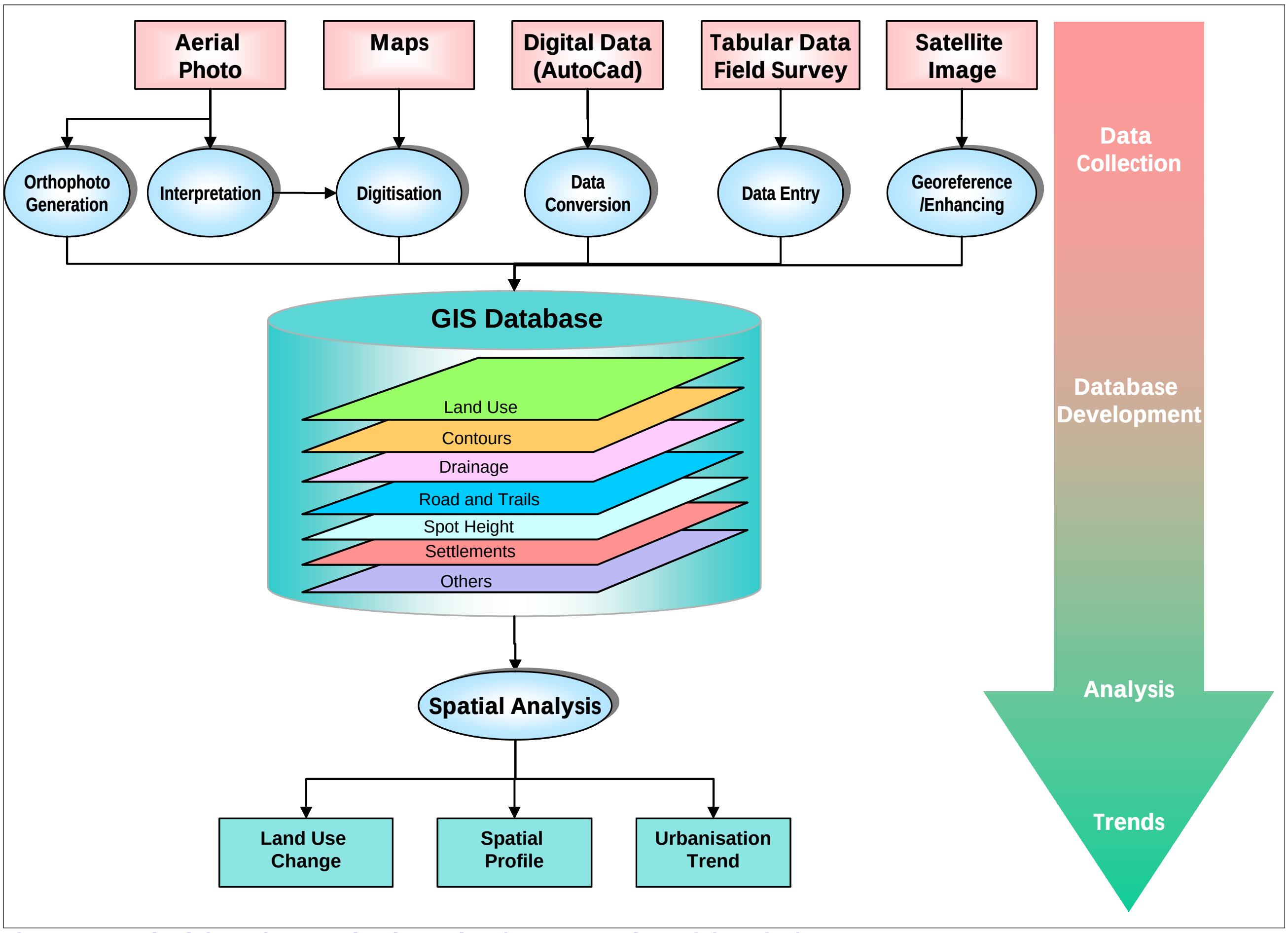

Figure 5: Methodology for GIS database development and spatial analysis

Table 2: Baseline GIS database layers			
Data Layer	**Description**	**Maps Scale/Resolution**	**Source**
Topographic feature			
Elevation	Contours at 2m and 10m intervals	1:2000	KUDP 1998
Drainage network	Major and minor rivers	1:2000	KUDP 1998
Water bodies	Man-made/natural ponds	1:2000	KUDP 1998/ Field Survey
Land use			
Land use 1992*	Land-use map 1992	1:10,000	Aerial photographs NTC 1992
Land use 1998*	Land-use map 1998	1:15,000	Aerial photographs DoS 1998
Transport infrastructure			
Road network	Metalled and gravel roads and tracks, bridges	1:2000	KUDP 1998/IKONOS 2001/ Field Survey
Utilities			
Electricity lines	Electricity network	Various sketch maps prepared by the utility departments	NEA
Electricity substations	Electric substation locations		NEA
Water supply	Water supply network, wells, taps, water tanks, and so on		NWSC
Telephone network	Telephone network		NTC
Social infrastructure			
Vegetable (and food) markets	Vegetable market locations	MPAMKV map	FAO 2000/ Field survey
General markets	Shops and market areas	MPAMKV map	FAO 2000/ Field survey
Educational services	University campus, high schools, primary schools, and others	—	Field survey
Health services	Health centres, hospitals, health posts, clinics, veterinary clinics	—	Field survey
Public institutions	Government offices, banks, finance companies, postal services, and others	—	Field survey
Industrial infrastructure			
Industry / factory	Factories and industrial locations	—	Field survey
Property			
Building footprint	Building footprints	1:2000	KUDP 1998
Administrative boundary			
Municipal boundary	Municipality boundary	1:2000	Kirtipur Municipality
Ward boundaries	Ward boundaries	1:2000	Kirtipur Municipality

Notes: * Maps prepared from aerial photographs

DoS : Department of Survey
FAO : Food and Agriculture Organization
KUDP : Kathmandu Urban Development Project
MPAMKV : Master Plan for Agricultural Marketing in the Kathmandu Valley
NEA : Nepal Electricity Authority
NTC : Nepal Telecommunications Corporation
NWSC : Nepal Water Supply Corporation

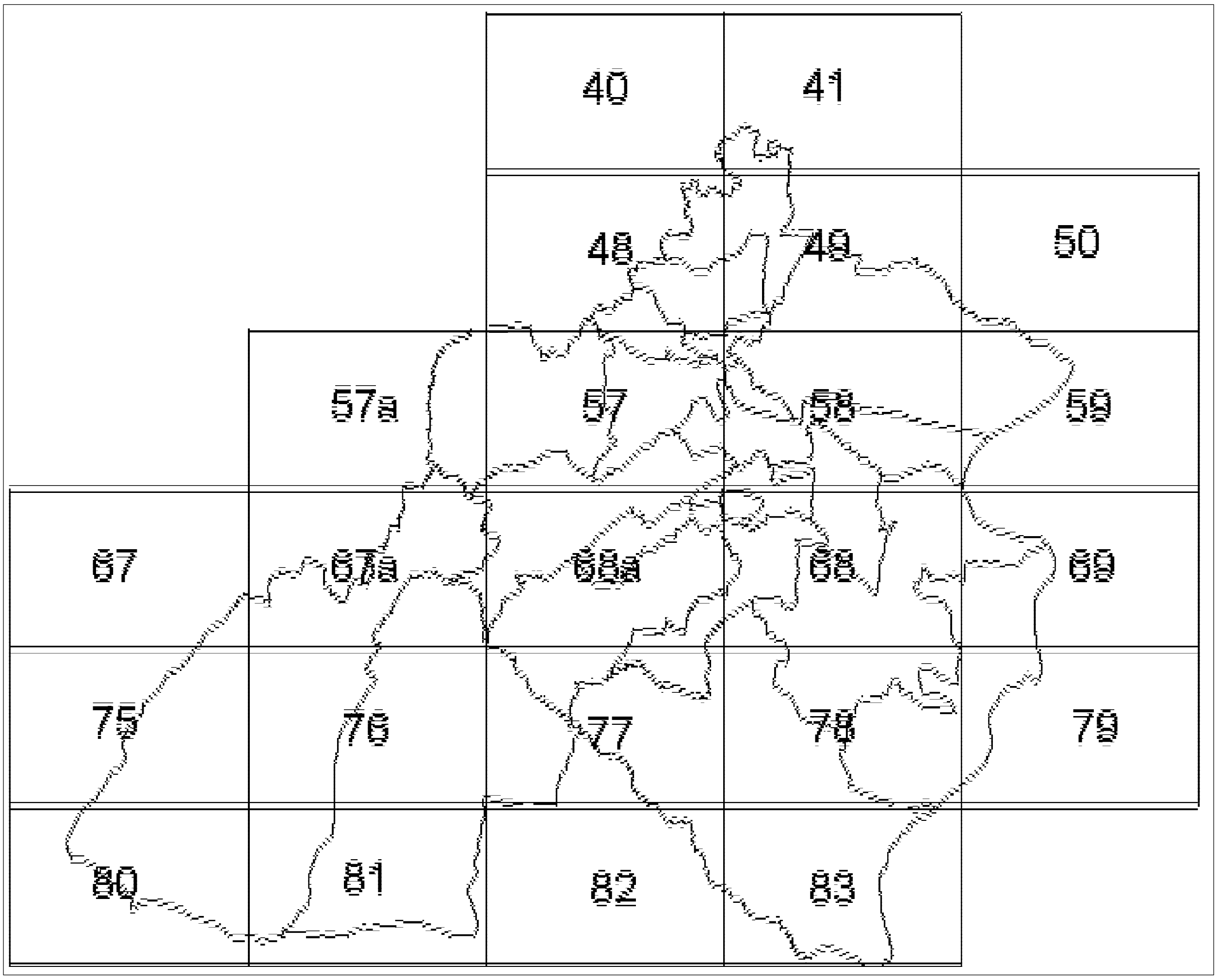

Figure 6: Modified sheet index map for Kirtipur Municipality (KUDP 1998)

Aerial photographs

Aerial photographs taken in 1992 at a scale of 1:10,000, and 1998 at a scale of 1:15,000, were acquired from the Department of Survey. The 1992 photographs were the same as those used by NTC to derive the AutoCAD data from which the base map of the present study was developed. Land use data were derived from interpretation of the two sets of photos and the results used to derive the land-use changes in the municipality. The interpretation was carried out using the standard land use classification system of DHUD/UDLE (1998). Field verification was conducted by taking sample polygons for various land-use types. The interpreted information was transformed on to the base map, taking references from the aerial photographs. Finally, the map was digitised using PC Arc/Info software.

Digital orthophoto

Orthophotos are photographs that have been corrected for the scale, tilt, and relief distortions present in aerial photographs. The digital orthophoto is considered to be the basic indispensable data layer for urban GIS applications, especially where there is no accurate map available. Digital orthophotos are planimetrically accurate and two-dimensional features can be digitised directly from them. They are convenient for use as background reference frameworks for GIS applications, and enhance communication of spatial data, as it is often easier to explain with photographic images than with conventional line and symbol map displays (Lillesand and Keifer 1994).

For this study, an orthophoto was created for Kirtipur from the aerial photographs of 1992 at a scale of 1:10,000. ERDAS Imagine OrthobasePro software was used for the digital photogrammetric processes. Coordinates from the KUDP digital database were used for geo-referencing. The steps used in preparing an orthophoto are shown in Figure 7. The details of the reference system and aerial photographs are given in Annex 2. Figure 8 shows the block of aerial photographs used in the preparation of the orthophoto. No 1992 aerial photos were available for the western part of the municipality, thus the orthophoto does not cover part or all of the wards 7, 8, 12, 16, and 19 . The orthophoto is shown in Map 1.

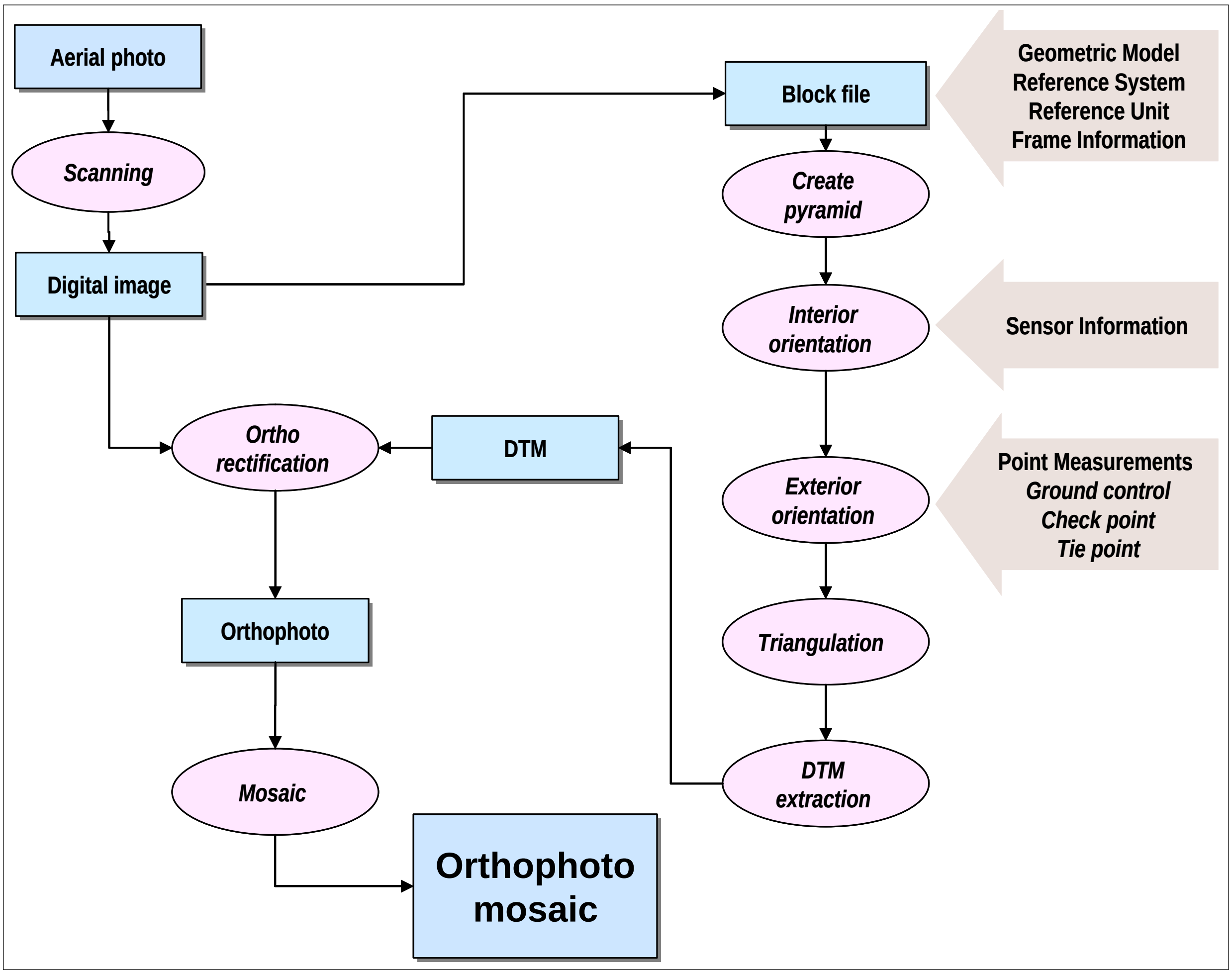

Figure 7: Methodology for orthophoto preparation

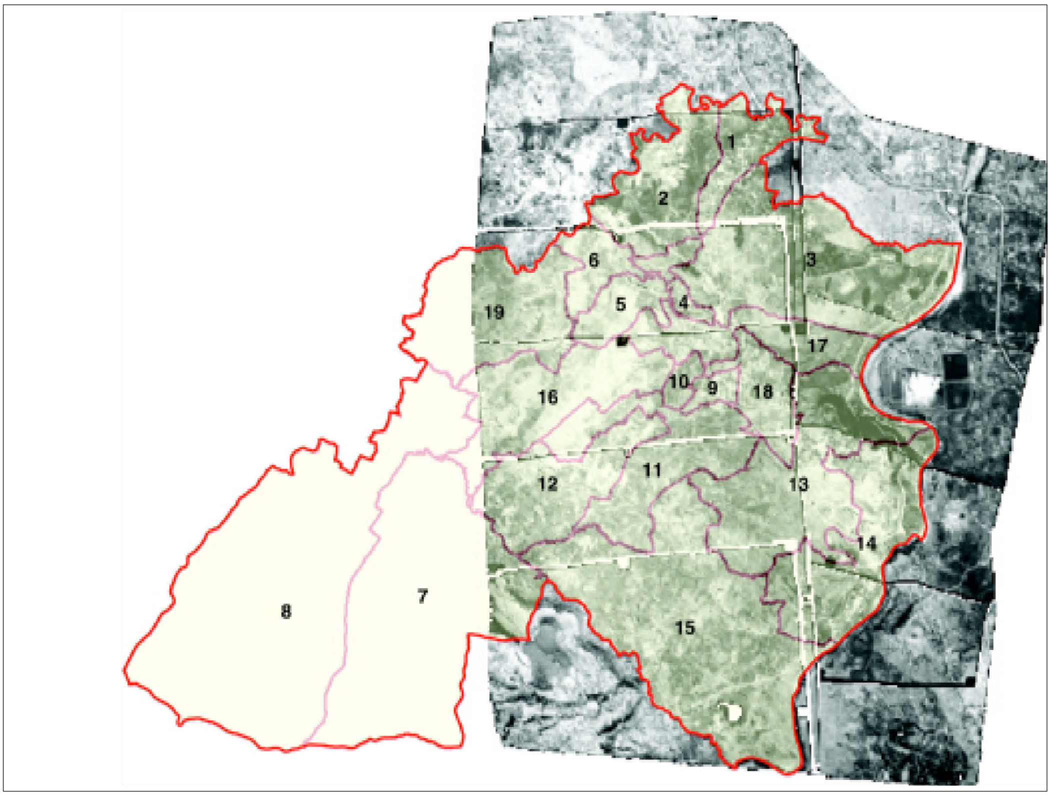

Figure 8: Block of aerial photographs

Satellite data

An IKONOS satellite image from 10 November 2001 (panchromatic, 1m resolution) was acquired for the study area; it covers the major part of Kirtipur municipality (Map 2). (The IKONOS satellite is the world's first commercial, high-resolution imaging satellite. It was launched on September 24, 1999, and can collect 1m resolution panchromatic images and 4m resolution multispectral images simultaneously.) The IKONOS image was used as a reference during field verification and to update the road data in the KUDP database. The image was compared with the orthophoto derived from 1992 aerial photographs to study the changes that had occurred during the intervening decade, particularly in residential areas.

Data on social infrastructure

A field survey was used to collect data on more than 1000 institutional service functions of six different types: educational institutions, public utilities, public institutions, health facilities, markets, and factories/industries. Information on the locations of these services was mapped using GIS and attribute information entered accordingly. Information collected from the FAO-supported Vegetable Market Analysis Project (FAO 2000) was also integrated into the database. The initial field survey and data collection was done in 1999-2000. Field visits were again carried out jointly with Kirtipur Municipality in 2003 to update and verify these data.

Data on utilities

As far as possible, information on utility lines, i.e., telephone, electricity, and water supply networks, was obtained from the local offices of the respective utilities in Kirtipur during the field survey in 2000. Although the available information was not comprehensive and generally in the form of sketch maps, the study attempted to integrate it into the database. Data on public utilities such as ponds, spouts, wells, water tanks and taps were collected in 2000 and updated during the 2003 field survey.

Socioeconomic data

Ward-wise population data from the 2001 census was obtained from the Central Bureau of Statistics (CBS). Since Kirtipur Municipality was created after the 1991 census, the data for 1991 was estimated from the population figures for the VDCs that were included when the municipality was formed. It was not possible to integrate much of the demographic data available from the 1991 census as the ward boundaries today do not match the VDC boundaries used in that census.

Chapter 4 Spatial Profile of Kirtipur Municipality

The spatial profile of Kirtipur Municipality was extracted in the form of thematic maps from the GIS database described above. The maps are presented at the end of this chapter. The maps provide a general overview of the spatial distribution of population and physical infrastructure within the municipality. Maps 1 and 2 show the 1992 orthophoto and the 2001 satellite image, and give an overall picture of the change in settlement structure within the municipality. Map 3 shows the location of Kirtipur Municipality in the national context and Map 4 the administrative boundaries within the municipality. These are followed by maps of population distribution, settlements, road network, industry, electricity and telephone networks, public utilities, educational institutions, public services, public institutions, general markets, vegetable markets, heritage sites, land-use and land cover 1992 and 1998, land-use change, and urban growth. Each of the themes is discussed briefly below with reference to the respective map.

Demography

The 2001 census gave a total population of 40,835 individuals with 21,686 males and 19,149 females in 9487 households, i.e., an average household size of 4.3 persons; and a male-to-female ratio of 1.13. Map 5 and Figure 9 show the population density by ward, Figure 10 the population distribution by age and sex, and Figure 11 the male-to-female ratio in different age

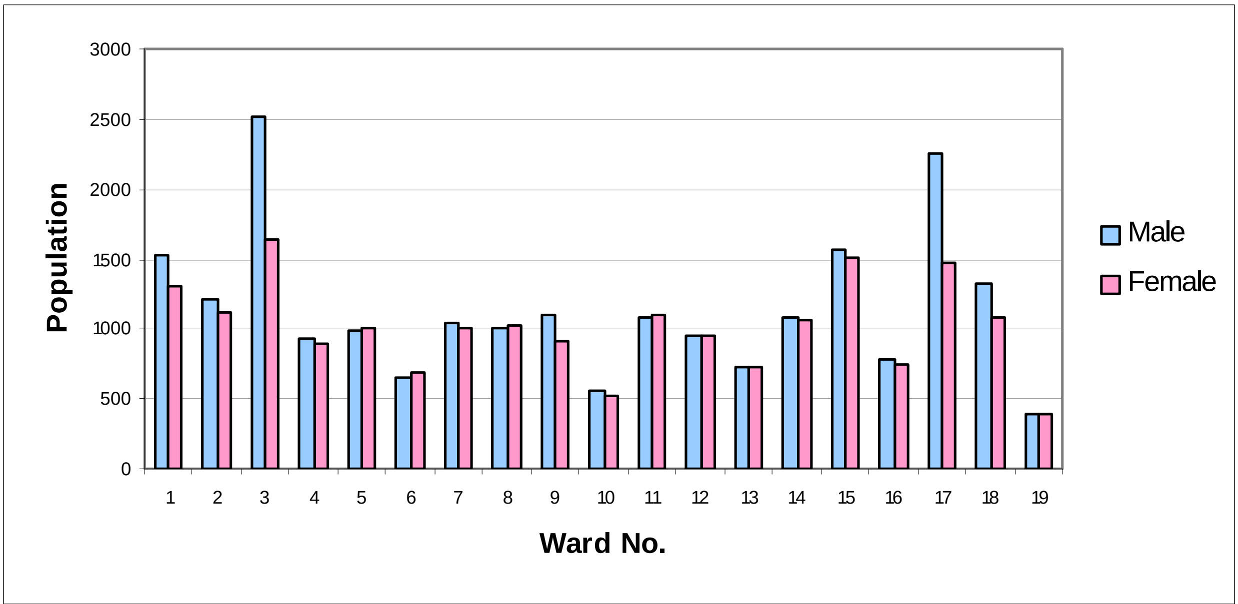

Figure 9: Male and female population by ward

groups. In the 1991 census, the population of the VDCs that now form Kirtipur Municipality was 31,338 with 16,080 males and 15,258 females in 5666 households; i.e., an average household size of 5.53 persons and a male-to-female ratio of 1.05. Thus in the intervening 10 years the population increased by about 30% while the average family size decreased and the male-to-female ratio slightly increased.

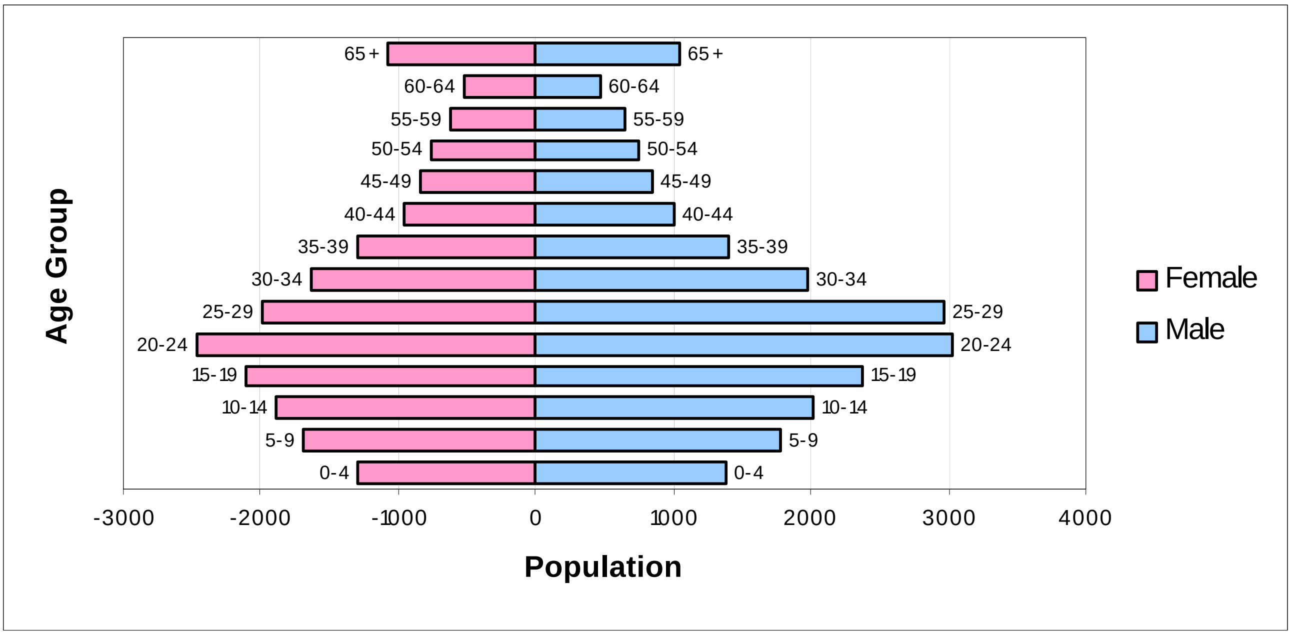

Figure 10: Male and female population by age, 2001 census

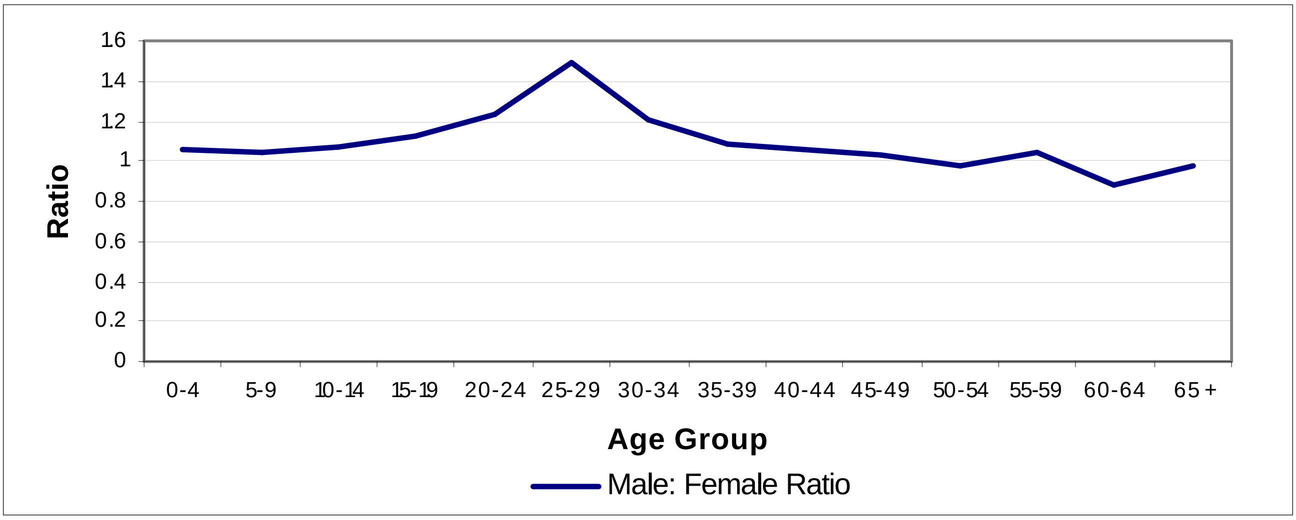

Figure 11: Male-to-female ratio by age group, 2001 census

Physical infrastructure

Road network

The road network in the municipality is shown in Map 7. The roads are based on the KUDP database (1998), and were updated using the IKONOS image of 2001 and verified in the field. The roads are classified as surfaced, gravel, and trails. The width and quality of roads are not uniform throughout their lengths. The average width of surfaced road is 5.3m and of gravel roads 3.7m. The total length of surfaced roads is 23.7 km, of gravel roads 52.6 km, and of trails 149.0 km. The field verification in 2003 showed that some 5 km of gravel road had been surfaced since the data were first compiled in 1998, and trails had increased by about 2 km.

Figure 12: Pedestrian street in the core area

The major road in the municipality runs along its eastern border parallel to the Bagmati river. This road connects the municipality to Kathmandu Metropolitan City in the northeast and Dakshinkali in the southeast.The remaining surfaced roads are limited to the area around the base of the old settlement, the Tribhuvan University compound, Panga, and roads to the settlements of Bhatkepati and Tyanglaphant. More than 60 % of the municipal area is only served by gravel roads or trails.

The traditional streets and courtyards of the old core area are built mainly for pedestrians (Figure 12). They are constructed with stone and brick or mixed paving, and are deteriorating rapidly. The lack of a proper surface drainage system causes fast deterioration of the road infrastructure. The core area is densely populated, but many parts of the area are not accessible to vehicles. This raises serious concerns as ambulances and fire brigades cannot reach the area in times of emergency.

Factories/industries

The sites of factories and industries identified during the field survey and incorporated in the GIS database are shown in Map 8. Kirtipur is known for its traditional handloom industry and many households possess a handloom to supplement their income (Shrestha 1995). People in Kirtipur also engage in economic activities such as carpet-weaving, paper-making, and craft work (Figure 13). Although the collective contribution of these industries at the household level may be significant to the local economy, it was not possible to incorporate them into this study. Table 3 shows the number of households according to the 2001 census engaged in different non-agricultural economic activities in the municipality.

Figure 13: Women weaving a carpet

Table 3: Number of households engaged in non-agricultural economic activities

Type of activity	No. of households
Manufacturing	123
Trade/business	651
Transport	36
Services	289
Other	167
Total economically active households	1266
Total households in municipality	9487

Figure 14: A textile mill

Kirtipur has some national industries such as the Himal Cement Factory (not in operation since December 2001) and Krishi Chun Industry (a limestone factory), and a few big factories like the Sitaram Gokul Mill and Pashmina Factory in Nagaun (Figure 14). Carpet factories are a major industry. However, the number of carpet factories declined from 33 in 1998 to 24 in 2003, and those remaining have downsized as business has weakened. Wards 3 and 17 have the greatest number of industries. There is one brick factory in Ward 19. A brick factory visible in 1992 aerial photographs that occupied a large area in Ward 2 has now disappeared.

Electricity

Information on the electricity network was obtained from the local Nepal Electricity Authority (NEA) office in the form of a sketch map and integrated into the GIS database. The electricity transmission and distribution network including locations of transformers is shown in Map 9. There are 58 transformers with varying capacities from a minimum of 15 KVA to a maximum of 1000 KVA. The Siuchatar ropeway substation is the main source of electricity. It covers the Kirtipur, Salyansthan, Khasibazar, Nagaun, Bhatkepati, Machhengaun, and Dudh Pokhari areas. The substation at Teku covers the Tribhuvan University area, Chobhar, Bhajangal, Nayabazar, Chilancho, Panga, and Charghare. Kirtipur Municipality also receives electricity from the Lalitpur substation. Industries and educational institutions consume around 70% of the available capacity. According to the local NEA office, electricity could be made available to 100% of the population, but only 75% of households are on the list of consumers.

Telephone network

Information on the telephone network was obtained from the Nepal Telecommunications office in Kirtipur. The Telephone Exchange Office is located in Nayabazar. The main telephone line and location of cabinets are shown in Map 9. There are 14 telephone cabinets with 420 distribution boxes (DB); each DB has a capacity of 10 telephone line connections. At present, there are 2224 subscribers connected. According to the Telephone Exchange Office, the present infrastructure could provide an additional 300 telephone lines.

Figure 15: Daily chores at a public water tap

Figure 16: A reservoir under construction

Water supply

Information on water supply lines was collected from the Nepal Water Supply Corporation and details of other public water sources collected during the field survey; their location is shown in Map 10.

The municipality's two main sources of drinking water are the springs at Dudh Pokhari and Sim Jhowahiti located in Ward 7. They each have a centralised piped water supply system with a capacity of 2200 m^3 per day for Dudh Pokhari and 1000 m^3 per day for Sim Jhowahiti. An additional source at Lwangkot, which lies outside the municipal boundary in Machhengaun VDC, has a capacity of 1200 m^3 per day and serves the old core area of the municipality. A large number of households in the municipality still depend upon traditional water sources such as wells, stone spouts, springs, and ponds. A field survey done in 1999 showed that only about 25% of households had a house connection. A number of public taps have been constructed by the Nepal Water Supply Corporation (NWSC) but there are still many areas that lack a drinking-water supply (Figure 15). Available sources are not fully utilised because the small reservoir capacity limits storage (Figure 16). Water quality is poor because of surface water infiltration into supply pipelines; there are no treatment facilities for drinking water.

Figure 17: New building on the TU campus

Figure 18: A high school (combined secondary/primary)

Social infrastructure

Educational institutions

Information on educational institutions was collected during the field survey. Their locations are shown in Map 11.

The location of Tribhuvan University (TU) in the municipality makes Kirtipur a centre for higher education (Figure 17). Students from all over the country come here to study. There are three colleges, 26 combined secondary/primary schools (usually referred to simply as 'secondary schools'), 12 primary only schools, and 2 childcare centres within the municipality area (Figure 18). Ward 17 has the highest number of educational institutions with one college, seven secondary/primary schools, and one primary only school. Wards 4, 6, and 13 have no schools at all and large parts of Wards 7, 8, 16, and 19 are far from any educational facilities The standard and the physical infrastructure of schools vary greatly with some schools such as the Laboratory High School and Modern Indian School catering to students from Kathmandu and Lalitpur municipalities. Besides the schools and colleges, there are five public reading rooms in the municipality which are included in the category of educational institutions. (Generally referred to as 'libraries', these reading rooms are often located in local clubs and provide access to newspapers and similar, and occasionally books). Figure 19 shows the population of school age children (5-19 years) and the total number of schools in each ward.

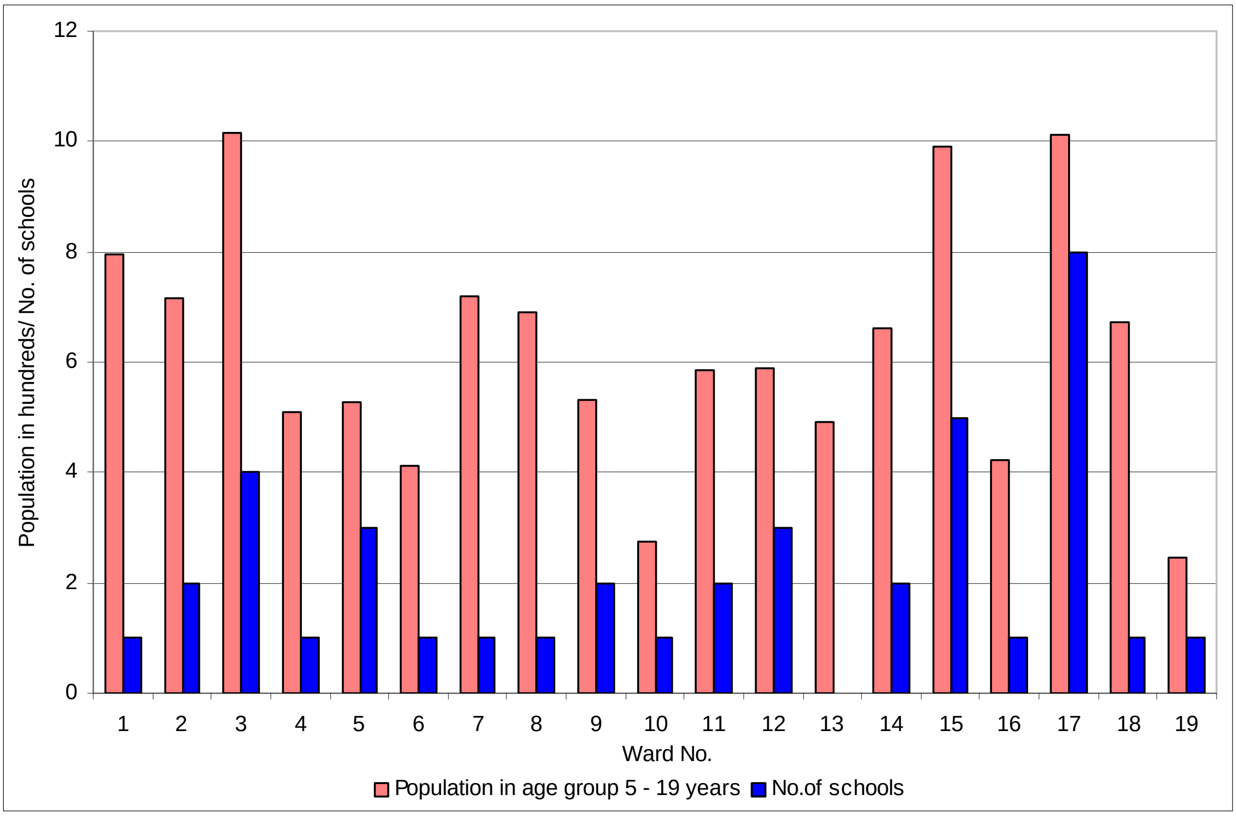

Figure 19: Population of school age children and number of schools by ward

Figure 20: Health services at PHECT-NEPAL

Figure 21: Kirtipur Municipality's office building

Figure 22: A meat shop in the main town

Figure 23: Shop area in Nayabazar

Health facilities

Information on health (and veterinary) facilities was collected during the field survey (Map 12).

The population is poorly served by health facilities. There is no hospital in the municipality; in an emergency, local people must go to Kathmandu or Lalitpur. There are two health centres, four health posts, five sub health posts and three health clinics. In addition there is one yoga centre, one veterinary and agricultural service centre, and one centre for the disabled. A community-based reproductive health service centre and a community dental centre (included in the above) established in 2000 by the Public Health Concern Trust (PHECT-NEPAL) cater to the needs of people from surrounding villages as well as local people (Figure 20).

Public institutions

Banks, post offices, ward offices, and government and semi-government organisations were categorised as public institutions (Figure 21). Information on these was collected during the field survey and is presented in Map 13. Apart from ward offices and a few post offices, virtually all public institutions are located at the base of the hill surrounding the core area in Wards 5 and 17.

Shops and markets

The locations of shops and markets (taken to mean any retail outlets including shops, stalls, tea and food stands, and similar, see Table 4) were identified during the field survey and incorporated together with data from the FAO survey on vegetable (food) markets (FAO 2000) into the GIS database. The locations of these retail outlets are shown in Maps 14 (general) and 15 (food only). About 45% of Kirtipur Municipality is agricultural land and agricultural products occupy a major portion of market trade. Markets and shopping areas are concentrated in the core district and its peripheries (Figures 22 and 23).

Table 4: Market types

General	Food
General store	Mixed
Electrical/electronics	Fixed
Restaurants	Fruits and vegetables
Repairs/workshops	Meat
Media/communications	
Rental	
Entertainment	
Hardware	
Beauty parlour	
Ready-made garments	
Medical	
Cloth and tailoring	
Books and stationery	
Other	

Figure 24: Bagh Bhairab temple

Figure 25: Chilancho Vihar complex

Figure 26: Taudaha lake

Figure 27: Theravada temple at Nayabazar

Heritage Sites

The locations of heritage sites in the municipality was verified during the field survey; they are shown in Map 16.

Kirtipur is one of the oldest settlements in the Kathmandu valley and thus has many cultural heritage sites (Figures 24 - 29). The majority of these structures are concentrated in the old core area, Panga, and Chobhar area, with some scattered around Salyansthan, Kauniachaur, and Godamchaur.

The most significant cultural sites are the Bagh Bhairab complex (Figure 24), Chilancho Vihar complex (Figure 25), Uma Maheswor temple (Figure 28), and Adinath temple (Figure 29). Details of these are given in Annex 2.

Besides these, there are a number of Buddhist monasteries, bahals (courtyards), sattals (pilgrim's houses), and more than fifty patis (raised platform for pilgrims) and small chaityas (small stupas) scattered around the old core area. The heritage sites of the municipality have great cultural and historic value and provide one of the potentials for tourism development, but many are in serious need of conservation.

Taudaha lake is another site of cultural significance (Figure 26). Legend has it that the lake was created by Manjushri to provide a home for the *nags* (snakes) that lived in the lake that covered Kathmandu before it was drained through the Chobhar gorge. People living near to the lake use it as a source of water.

In addition to the old heritage sites, a number of new monasteries have been built in the municipality. The Nagara Mandapa Kirti Vihar in Nayabazar, completed in 1989, includes a Thai-style Theravada temple (Figure 27).

Figure 28: Uma Maheswor temple

Figure 29: Adinath temple

Land use and land cover

Land-use maps were prepared for 1992 (Map 17) and 1998 (Map 18) from aerial photographs taken at scales of 1:10,000 and 1:15,000, respectively. The urban areas were divided into three classes: high density residential areas with more than 90% houses within the built-up area; medium density residential areas with 50 to 90% houses; and low density residential areas with less than 50% houses. Agricultural land was also classified into three types: steep cultivated land with more than 15 degrees slope; medium slope cultivated land with 7-15 degrees slope; and flat cultivated land with less than 7 degrees slope.

The proportional distribution of land use and land cover in 1998 is shown in Figure 30 and Table 5 (next chapter). Agricultural land, mainly flat cultivated land and steep slope cultivated

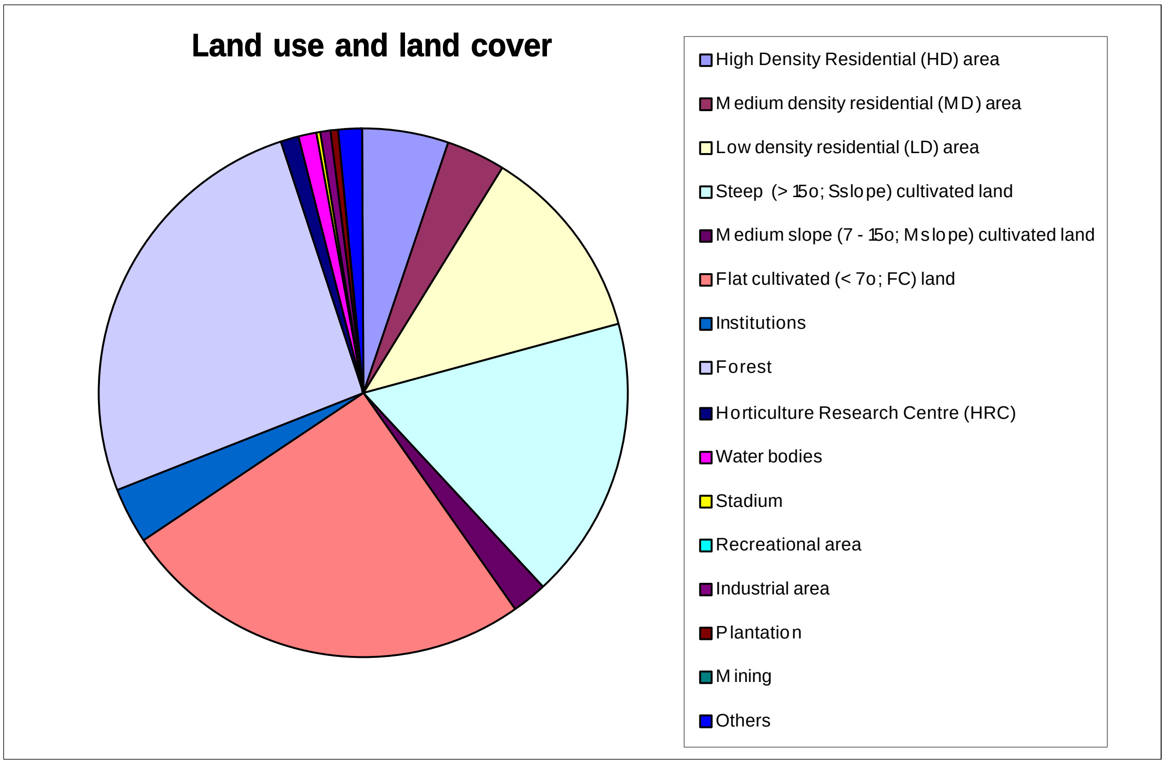

Figure 30: Distribution of land use and land cover, 1998


Figure 31: Agriculture is the predominant land-use type

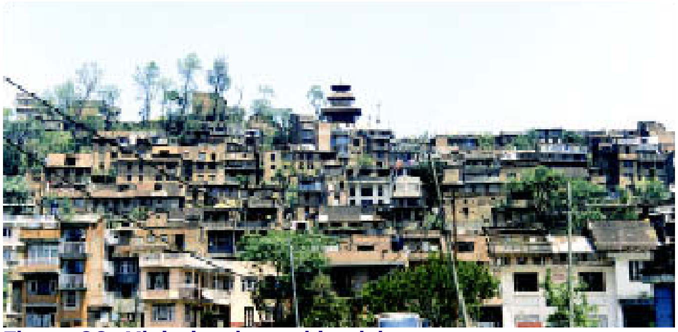
Figure 32: High density residential area

land (Figure 31) is the dominant land-use type, with forest second and urban areas third (Figure 32).

Actual and potential changes in land use and land cover are shown in Maps 19 to 23 and discussed in the next chapter.

Ward profiles

The spatial profile of each of the 19 wards is presented in Maps 24 to 42 to show in more detail the location of infrastructure, facilities and services. The educational institutions, factories and industries, public utilities, and heritage sites are shown on the maps and major characteristics such as area, number of households, and male and female population are given in a box for easy reference. The wards are of varied size and shape and the maps are presented at different scales to fit the page. The orthophoto is used as a background to the maps to show physical features that are not incorporated in the database and provide a sense of the surrounding features. Hill-shaded DEM and settlements are used for the maps of Wards 7, 8, 12, 16 and 19 as these are not covered by the orthophoto.

Chapter 5 Change in Land-use and Land Cover

Land-use and land cover from 1992 to 1998

The land-use and land cover changes from 1992 to 1998 were analysed using the data derived from the aerial photographs. The changes are summarised in Table 5 and shown in Map 19. Overall the area of agricultural land was reduced from 55% to 44% of the municipal total (a loss of 20% of the 1992 area), while the urban area increased from 10% to 21% of the municipal total (an increase of more than 100%). Forest land increased slightly from 23% to 26% of the municipal total, while the areas of recreation, industry, and mining showed slight decreases.

Table 5: Differences in distribution of land-use and land cover types

TYPE	1992		1998		Change	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Urban areas:						
High density (HD) residential area	80	4.5	94	5.3	14	0.8
Medium density (MD) residential area	29	1.6	65	3.6	36	2.0
Low density (LD) residential area	63	3.5	215	12.0	151	8.5
Agricultural land:						
Steep (> 15°, Sslope)	323	18.1	305	17.1	-18	-1.0
Medium slope (> 15°, Mslope)	76	4.2	42	2.4	-34	-1.9
Flat cultivated (< 7°, FC) land	580	32.5	451	25.2	-129	-7.2
Institution	52	2.9	57	3.2	5	0.3
Forest	418	23.4	467	26.1	49	2.7
Horticulture Research Centre (HRC)	21	1.1	21	1.1	0	0.0
Water	18	1.0	20	1.1	2	0.1
Stadium	5	0.3	5	0.3	0	0.0
Recreation	19	1.1		0.0	-19	-1.1
Industry	21	1.2	9	0.5	-12	-0.7
Plantation	20	1.1	13	0.7	-7	-0.4
Mining	31	1.7		0.0	-31	-1.7
Others	31	1.7	24	1.3	-7	-0.4
Total	1787	100.0	1787	100.0		

There was a significant increase in low and medium density residential areas, which indicates the rapid urban growth in the municipality. The changes in high density areas were more in terms of building structures than in spatial expansion. Where there is no land available for further expansion, new buildings are constructed with more floors. The construction of such buildings is affecting the architectural harmony of the core area (Figure 33). The urban growth pattern is discussed in more detail in the following sections.

Figure 33: Building structures are changing in the high density core area

Table 6 shows the detailed land-use and land cover change analysis in the form of a matrix showing the change from one type of use to another. Flat cultivated (FC) land has been converted to low density (LD), medium density (MD), and some high density (HD) residential areas. Steep slope cultivated land and medium slope cultivated land have been converted to low density (LD) residential areas. Some steep, medium, and flat slope agricultural land have been converted to forest as have some recreational areas and other types of land use/cover.

Table 6: Land use and land cover change matrix, 1992 - 1998

		1998															
	TYPE	HD	MD	LD	Sslope	Mslope	FC	Inst	Forest	HRC	Water	Stadium	Industry	Planta-tion	Others	Area (ha)	Per-cent
1992	HD	80	0	0	0	0	0	0	0	0	0	0	0	0	0	**80**	**4.5**
	MD	5	24	0	0	0	0	0	0	0	0	0	0	0	0	**29**	**1.6**
	LD	0	0	63	0	0	0	0	0	0	0	0	0	0	0	**63**	**3.5**
	Sslope	1	0	**32**	270	0	0	3	14	0	0	0	0	0	4	**323**	**18.1**
	Mslope	0	0	**26**	2	40	0	0	9	0	0	0	0	0	0	**76**	**4.2**
	FC	**6**	**40**	**85**	9	0	432	0	10	0	2	0	2	0	3	**580**	**32.5**
	Institution	0	0	0	0	0	0	52	0	0	0	0	0	0	0	**52**	**2.9**
	Forest	0	0	8	2	2	2	0	403	0	0	0	0	0	1	**418**	**23.4**
	HRC	0	0	0	0	0	0	0	0	21	0	0	0	0	0	**21**	**1.1**
	Water	0	0	0	0	0	0	0	0	0	17	0	0	0	1	**18**	**1.0**
	Stadium	0	0	0	0	0	0	0	0	0	0	5	0	0	0	**5**	**0.3**
	Recreation	0	0	0	0	0	0	1	18	0	0	0	0	0	0	**19**	**1.1**
	Industry	0	0	0	2	0	12	0	0	0	0	0	7	0	0	**21**	**1.2**
	Plantation	0	1	0	0	0	0	0	1	0	1	0	0	13	4	**20**	**1.1**
	Mining	0	0	0	31	0	0	0	0	0	0	0	0	0	0	**31**	**1.7**
	Others	2	0	1	0	0	6	1	11	0	0	0	0	0	11	**31**	**1.7**
	Area (ha)	**94**	**65**	**215**	**305**	**42**	**451**	**57**	**466**	**21**	**20**	**5**	**9**	**13**	**24**	**1787**	
																1787	
	Percent	**5.2**	**3.7**	**12.0**	**17.1**	**2.4**	**25.3**	**3.2**	**26.1**	**1.1**	**1.1**	**0.3**	**0.5**	**0.7**	**1.3**	**100.0**	**100.0**

Figure 34: Flat cultivated land being converted to residential use

Urban growth analysis

Map 20 shows a more detailed analysis of the urban growth pattern with the new areas of low , medium, and high density housing added between 1992 and 1998. There was significant urbanisation within the municipality, with low density residential areas accounting for approximately three-quarters of the total urban growth (Table 7 and Figure 34).

The major land use classes contributing to urban growth are shown in Table 8 and Map 21. In all three classes of residential area, growth has resulted mainly from conversion of flat cultivated land (Figure 35).

Table 7: Urban growth types

Urban growth type	Total growth	All major roads (%)	Surfaced roads (%)
Percentage of all growth	100	79	49
High density	7	7	17
Medium density	20	15	23
Low density	74	77	60

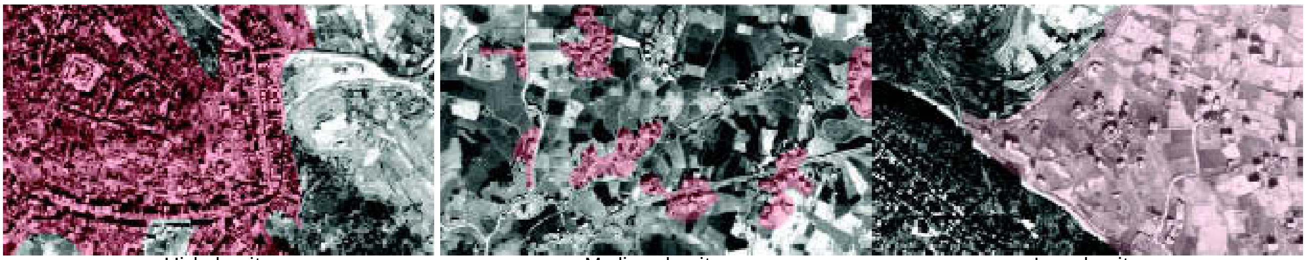

Figure 35: Urban growth patterns overlaid on IKONOS (1m PAN) image, 2001

Figure 36: Flat cultivated land within 100m of major roads is being converted to residential use

Table 8: Urban growth area by contributing class

Urban density type	Contributing class	Growth (ha)	% of total
High		**13.4**	**6.5**
	Steep slope cult. land	0.6	4.5
	Medium slope cult. land	4.6	34.3
	Flat cult. land	6.2	46.3
	Forest	0.1	0.7
	Other	1.9	14.2
Medium		**40.3**	**19.7**
	Steep slope cult. land	0.1	0.2
	Flat cult. land	40.2	99.8
Low		**151.3**	**73.8**
	Steep slope cult. land	31.6	20.9
	Medium slope cult. land	26.1	17.2
	Flat cult. land	85.2	56.2
	Forest	7.8	5.2
	Other	0.7	0.5

Urban growth versus accessibility

Roads are a major factor contributing to urban growth. Growth patterns depend on the distance from various types of road. To understand the nature of Kirtipur's growth pattern, the nature and pattern of urban growth within 100m of major roads was analysed in more detail (Map 22). About 79% of all growth took place within 100m of major roads (i.e. motorable surfaced and gravel roads), and 49% within 100m of surfaced roads (Table 7 and Figure 36). The proportion of high and medium density growth compared with low density growth was markedly higher near surfaced roads.

The major land use classes contributing to urban growth within 100m of surfaced roads are shown in Table 9. Flat cultivated land has been the main land type diverted to urban growth near to roads and almost the only type near to surfaced roads. Medium slope and steep cultivated land has been converted to a small extent close to gravel roads. The differences probably reflect the positioning of the roads.

Table 9: Contributing classes by urban growth types within 100m of all major roads, and surfaced roads alone

Contributing classes	High density		Medium density		Low density	
	All major roads	Surfaced roads	All major roads	Surfaced roads	All major roads	Surfaced roads
Flat cultivated land	48	54	100	100	60	90
Medium slope cultivated land	34	-	-	-	16	6
Steep slope cultivated land	5	6	-	-	19	2
Medium dense residential area	-	26	-	-	-	-
Others	13	14	-	-	5	2
Total	100	100	100	100	100	100

The trend indicates that in the future agricultural land, especially flat land, within 100m of surfaced or gravel roads has a high chance of being developed for settlement (Map 23). Figure 37 shows a typical example of such areas.

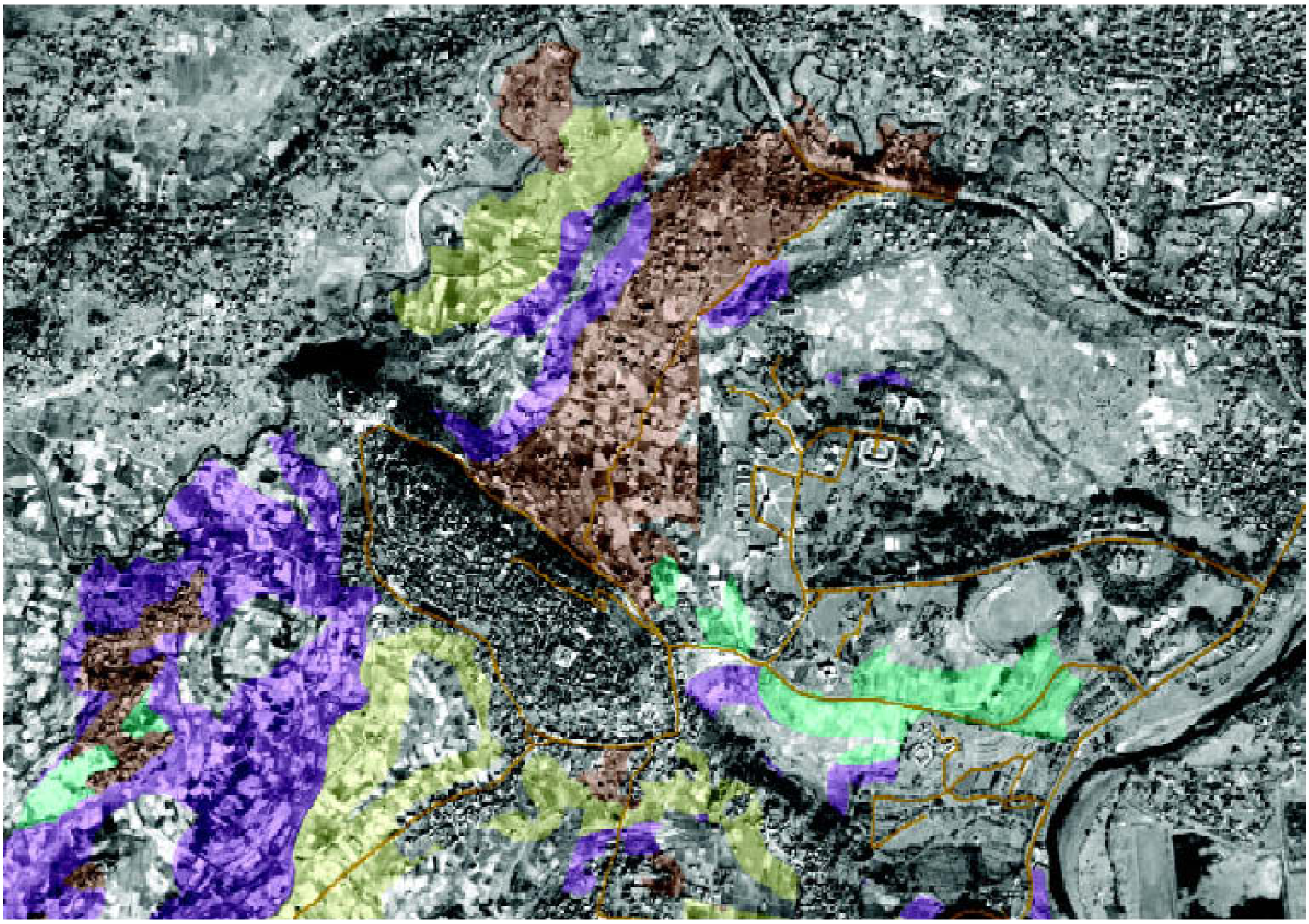

Figure 37: Areas with a high potential of being diverted to residential use

Chapter 6 Conclusions

GIS technology provides effective instruments for data capture, processing, and communication within urban planning and management processes. Furthermore, recent breakthroughs in high-resolution satellite imagery and digital photogrammetric techniques, combined with a rapidly developing GIS technology with flexible and versatile spatial analysis capabilities and ease of use, provide new possibilities for using these tools in urban applications. In comparison with simple maps, a GIS offers the enormous advantage of the user being able to select and overlay different types of information (layers) at the click of a button, providing tools that can greatly increase grasp and understanding of the existing situation, the planning needs, and the potential impact of alternative planning decisions. These tools can be very useful for municipalities like Kirtipur that are undergoing rapid changes without having a proper planning framework.

Integrated Action Planning – a participatory planning approach being implemented by municipalities in Nepal – uses a number of manual mapping processes to gain a spatial perspective. In contrast to manual (static) mapping, GIS offers a dynamic mapping capability with sophisticated computer-based spatial analysis and modelling. Both mapping and database development are time consuming and resource intensive. One of the significant advantages of using a GIS is that the database can be used and reused and can be easily updated and modified at suitable intervals. The present study aimed to show how GIS can help in the IAP process, and is an attempt to genuinely integrate GIS into such a process as a model example.

The study demonstrates how a spatial database can be developed for a small municipality in Nepal for use in municipal planning. It illustrates how GIS as a tool can be integrated within an IAP framework and summarises the information requirements for different applications in the municipal planning process. The study also presents a case for the design and development of a generic municipal level GIS database for municipalities in Nepal. The database generated by the study and the methodology employed will provide the basis for a larger scale database for Kirtipur Municipality. The database will be valuable both to Kirtipur Municipality and to the many other agencies involved in planning and development activities in the municipality. An interactive multi-media CD-Rom is being published separately and will provide access to all the datasets, the associated metadata, maps, and reports used in the study, and will integrate them with simple GIS functionality so that they can be viewed from a spatial perspective. This will provide interested municipalities and agencies with a practical example with which they can assess the usefulness and feasibility of GIS for their own planning processes.

The spatial profile of the municipality and the ward profiles provide quick and clear pictures of existing facilities. Using the visual maps and images, it is easy to grasp patterns and trends and identify distributions of services, areas with gaps, and many more. Such maps can be used to help identify priority areas for development or management intervention.

The level of reliability depends on the accuracy of the field verification. Although limited field verification was done for the infrastructure and facilities, it is possible that local people may recognise errors. A system for feedback from those with local knowledge, and a regular system of field verification and updating, would contribute greatly to enhancing the accuracy of the database.

The analysis of urban expansion provides basic information in terms of the urban growth pattern and trends. By using land use maps prepared from aerial photographs taken some years apart, it is possible to analyse land use changes and urban expansion in terms of urban growth pattern and trends, and also develop potential scenarios, as shown in the study. This type of exercise is important both for monitoring and for improving understanding of the dynamics of urban growth, and can help planners and decision-makers develop more rational and effective plans to improve the living conditions of the urban population.

The database will certainly help to some extent to fill existing information gaps and provides the basis for developing a consistent larger scale database for the municipality. The Ward Offices, among others, have clearly found it useful to have large-scale accurate maps of their respective areas. However, there remain clear limitations in using the database to its full potential to support the municipal planning processes, stemming more from organisational problems than technical difficulties. The lack of trained personnel and resources, the basic lack of a 'map culture', the poorly developed planning processes, and the lack of any real implementation and/or enforcement strategy for those planning decisions that are made, all work to limit the amount of benefit that can be gained from the database at the present time.

The situation is similar across Nepal, and clearly points to the need for a concerted effort towards capacity building in planning at the municipal level across the country. We hope that this study will do much to demonstrate the potential of GIS as a decision support system tool for integrated municipal planning, and underline the need to develop the capacities of municipalities and institutionalise the process within the local authorities. It is important to provide the motivation for local authorities to generate and maintain spatial information, and use it effectively in the planning process.

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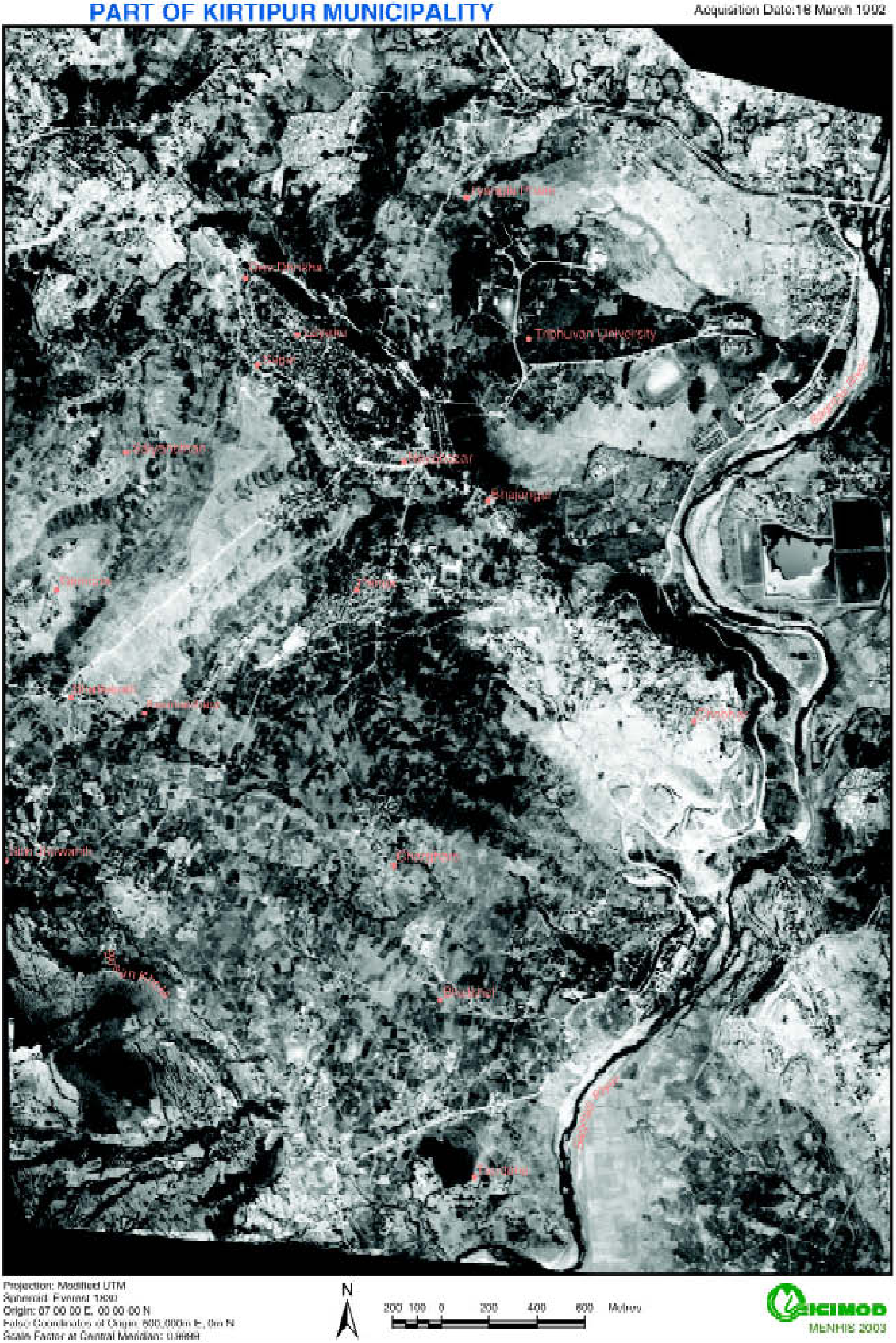
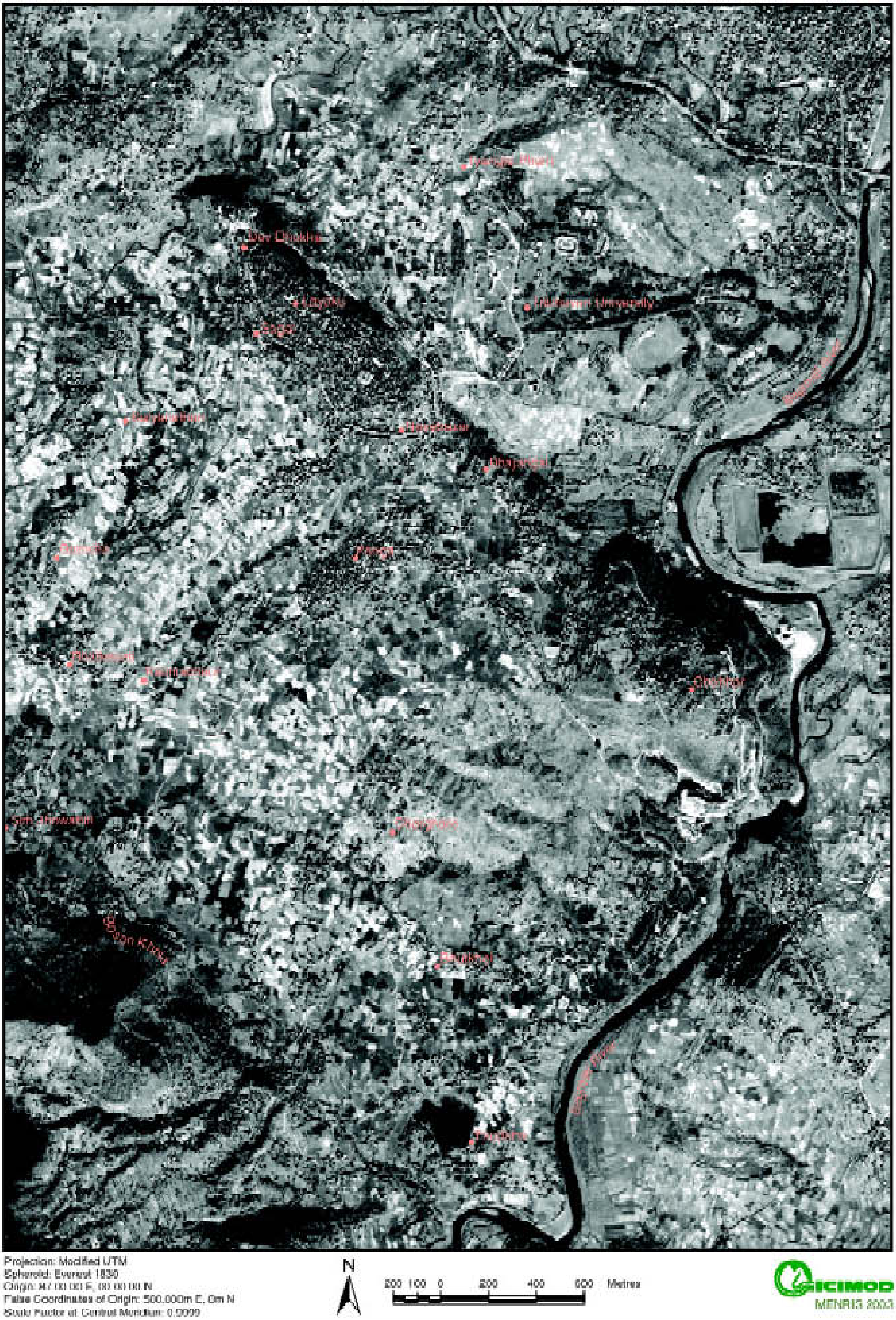
MAP 1: ORTHORECTIFIED AERIAL PHOTO FOR PART OF KIRTIPUR MUNICIPALITY



MAP 2: IKONOS SATELLITE IMAGE FOR PART OF KIRTIPUR MUNICIPALITY

Acquisition Date:10 November 2001



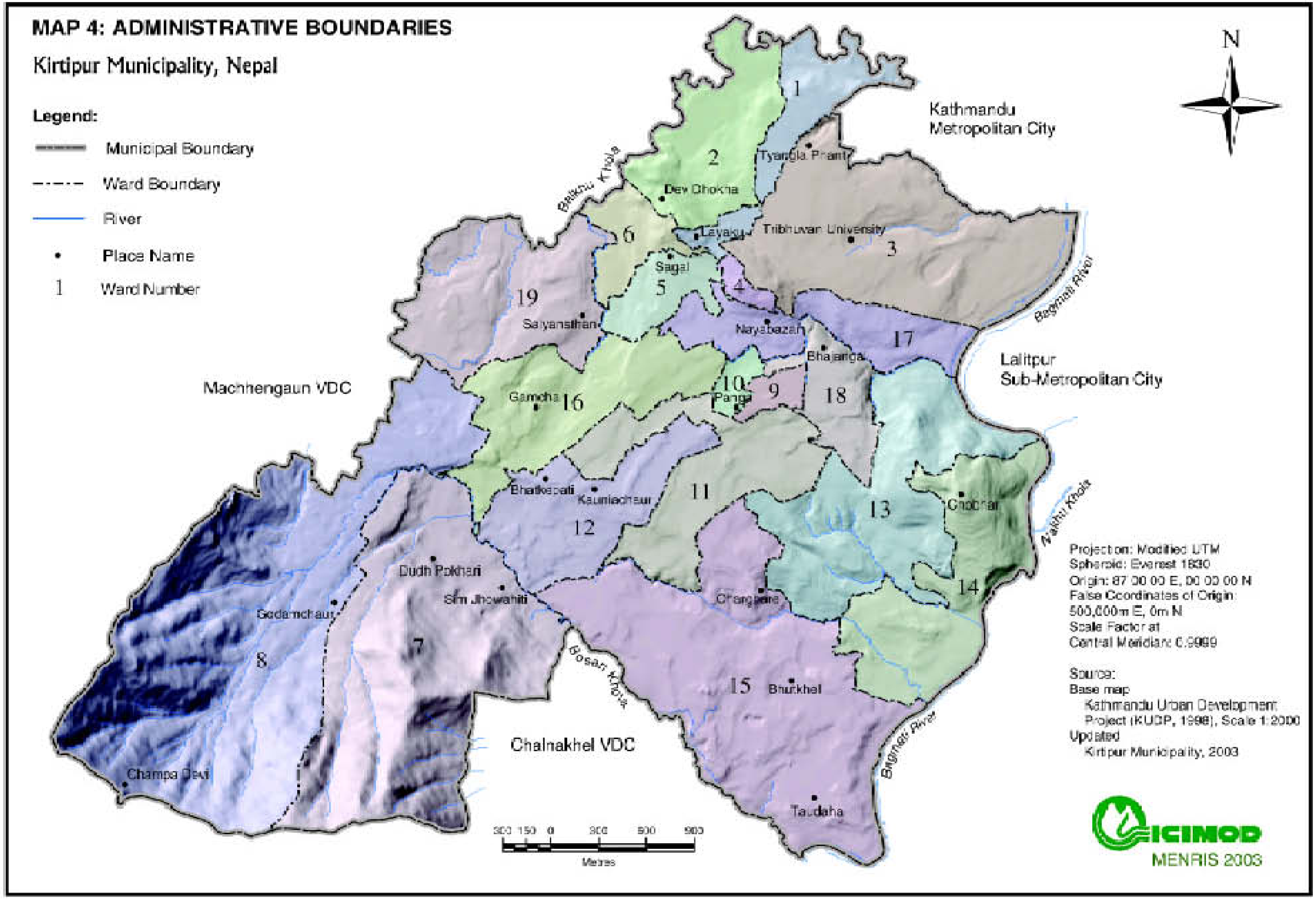
MAP 3: LOCATION MAP

Kirtipur Municipality, Nepal

Source:
Base map of Nepal
Topographical Zonal Map, Scale 1:250,000
Department of Survey, 1988

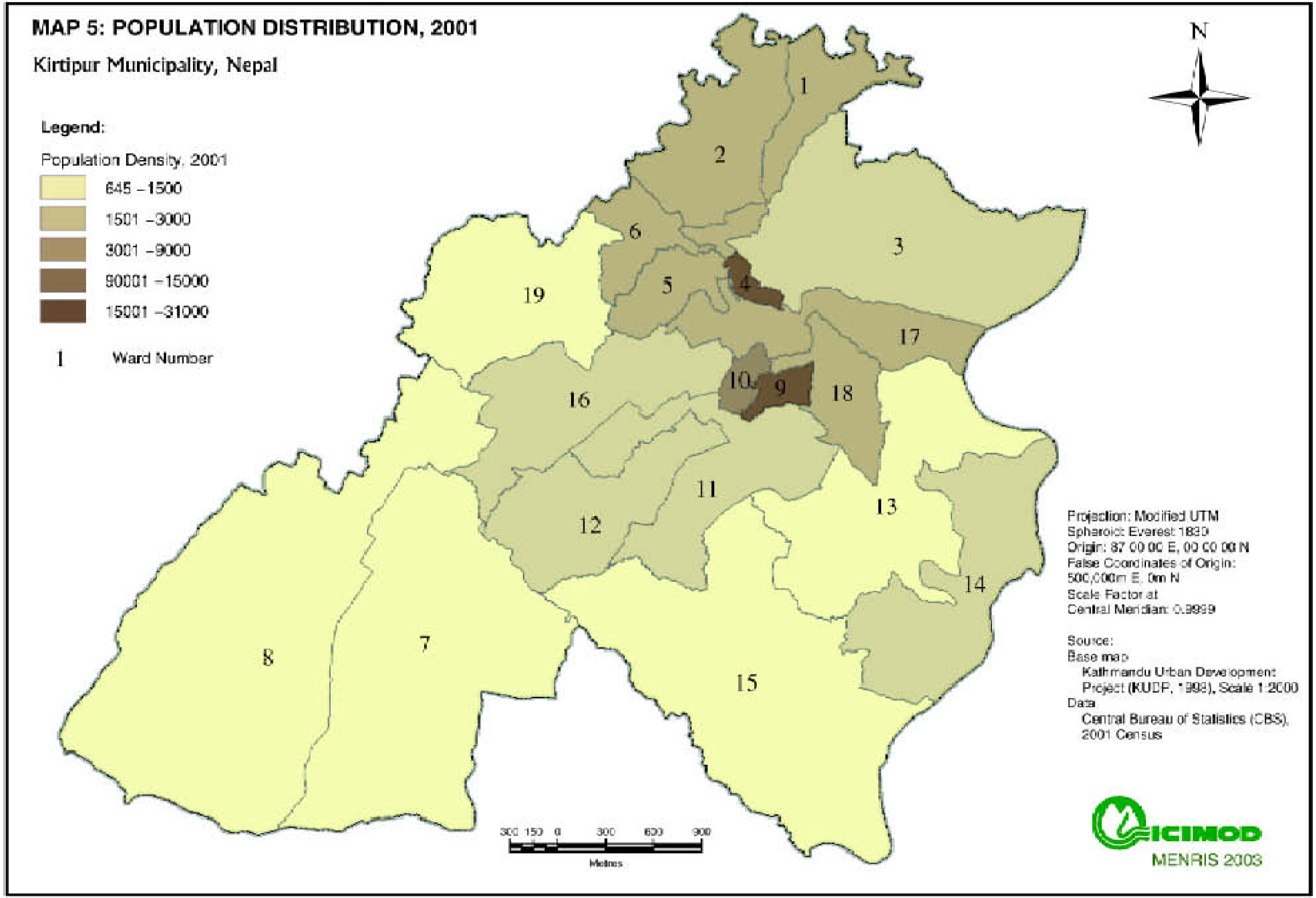
32 16 0 32 64 96 Kilometres

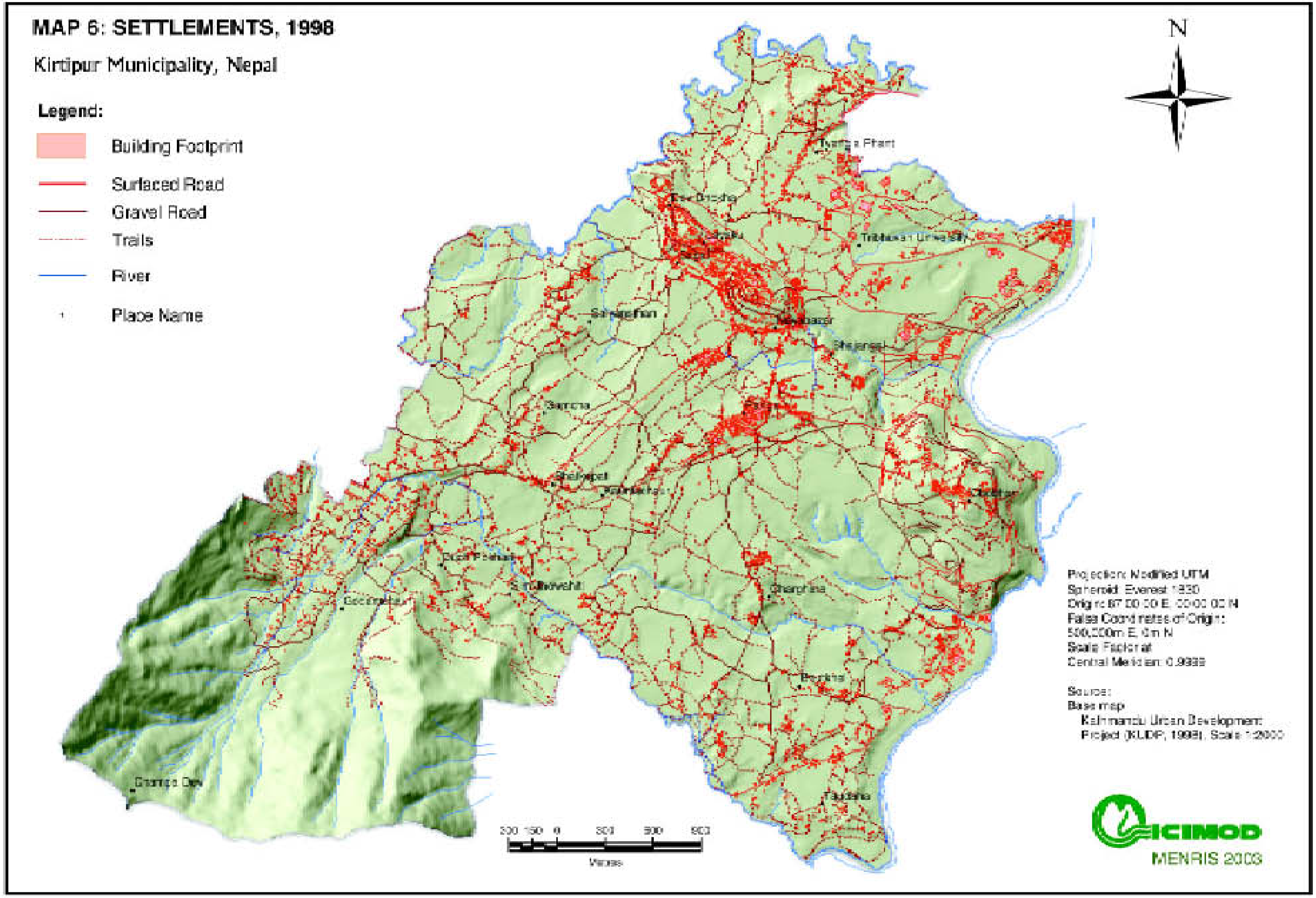
ICIMOD
MENRIS 2003

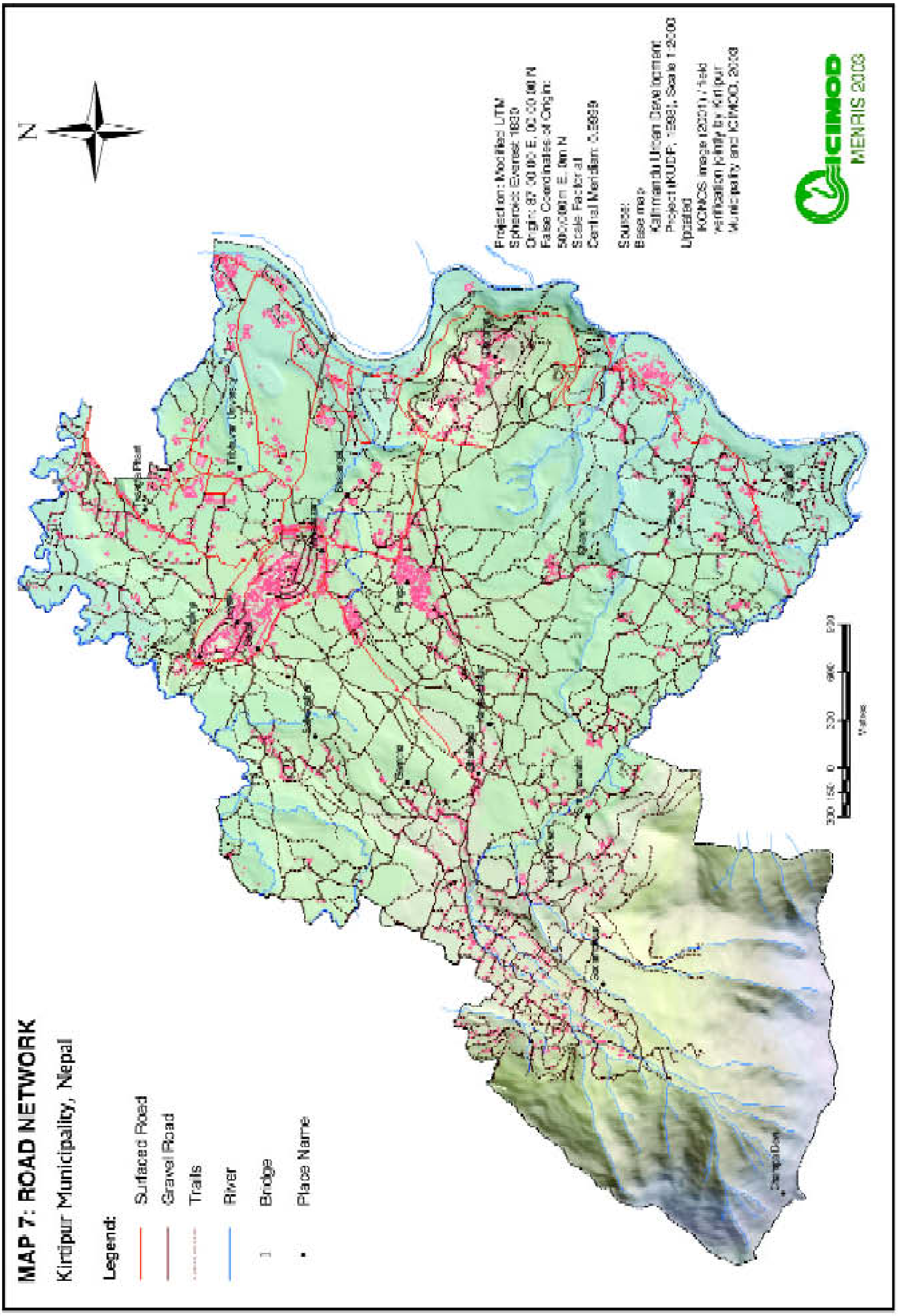

MAP 4: ADMINISTRATIVE BOUNDARIES
Kirtipur Municipality, Nepal
Legend:
Municipal Boundary
Ward Boundary
River
Place Name
1 Ward Number
N
Kathmandu Metropolitan City
Lalitpur Sub-Metropolitan City
Machhengaun VDC
Chalnakhel VDC
Balkhu Khola
Bagmati River
Nakhu Khola
Bosan Khola
Tyangla Phant
Dev Dhokha
Layaku
Tribhuvan University
Sagal
Nayabazar
Bhajanga
Panga
Saiyansthan
Gamcha
Bhatkepati
Kaunlachaur
Dudh Pokhari
Sim Jhowahiti
Godamchaur
Champa Devi
Chobhar
Changbere
Bhutkhel
Taudaha
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
Projection: Modified UTM
Spheroid: Everest 1830
Origin: 87 00 00 E, 00 00 00 N
False Coordinates of Origin:
500,000m E, 0m N
Scale Factor at
Central Meridian: 0.9999
Source:
Base map
Kathmandu Urban Development
Project (KUDP, 1998), Scale 1:2000
Updated
Kirtipur Municipality, 2003
ICIMOD
MENRIS 2003
300 150 0 300 600 900
Metres

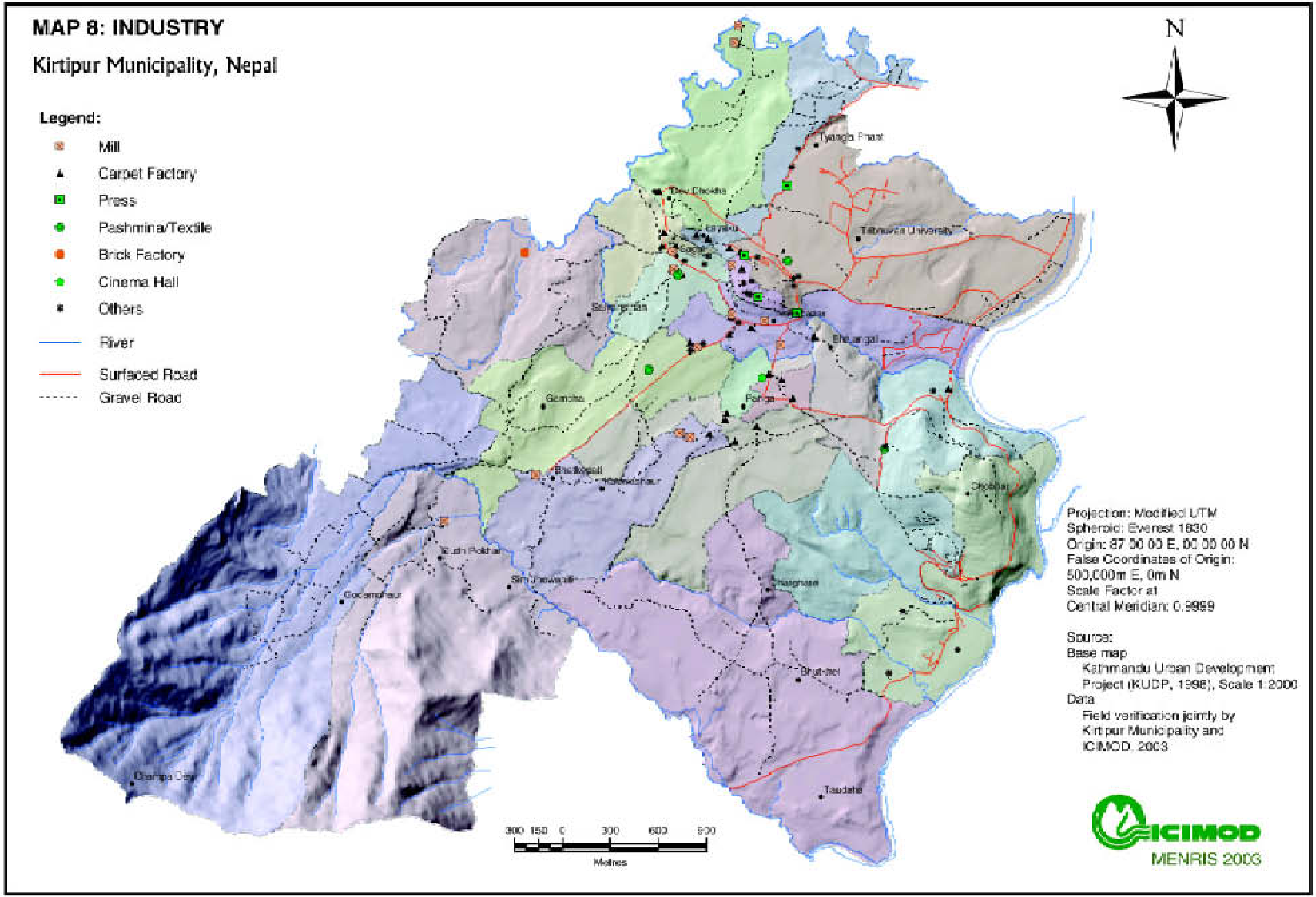
MAP 5: POPULATION DISTRIBUTION, 2001

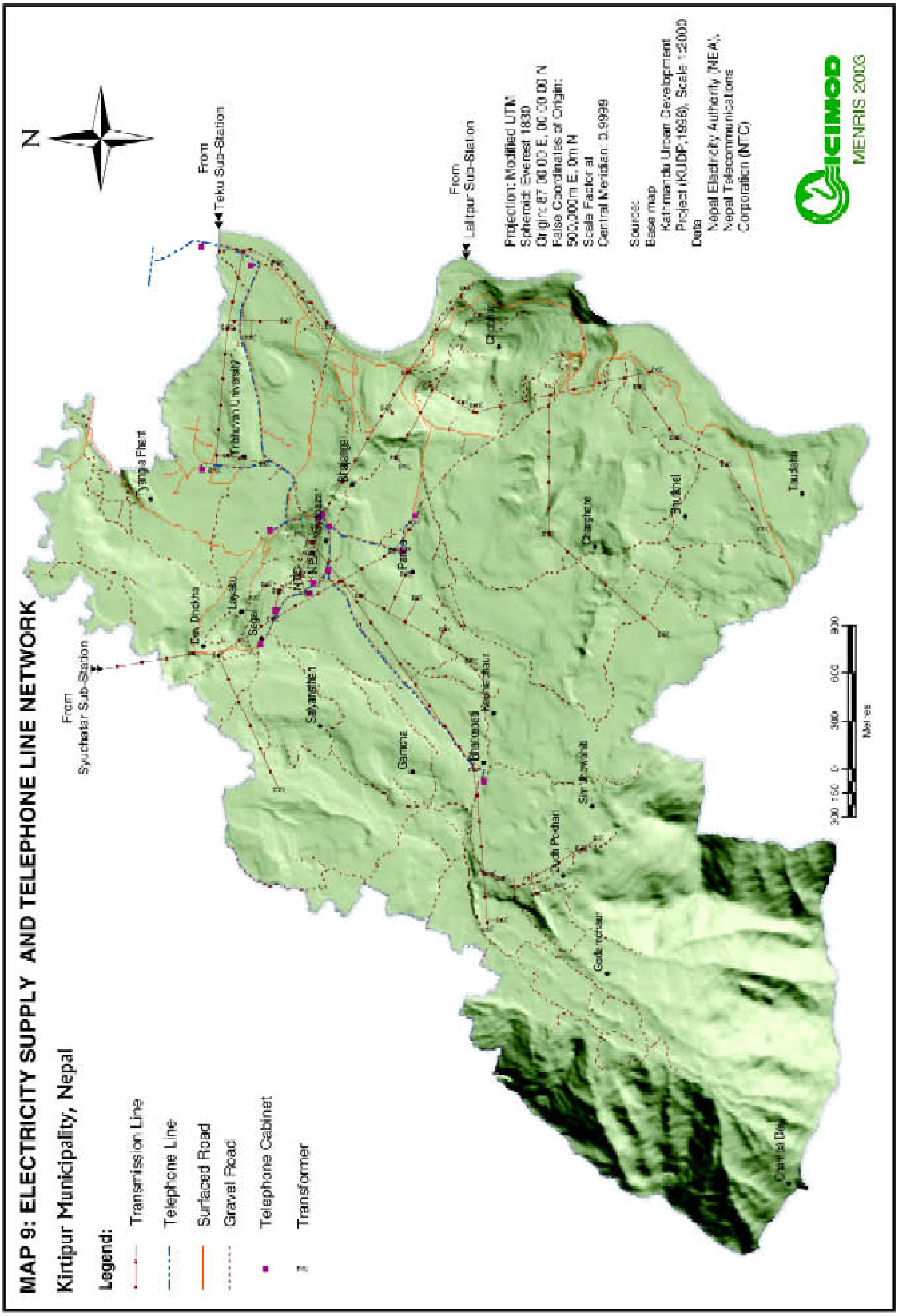
Kirtipur Municipality, Nepal



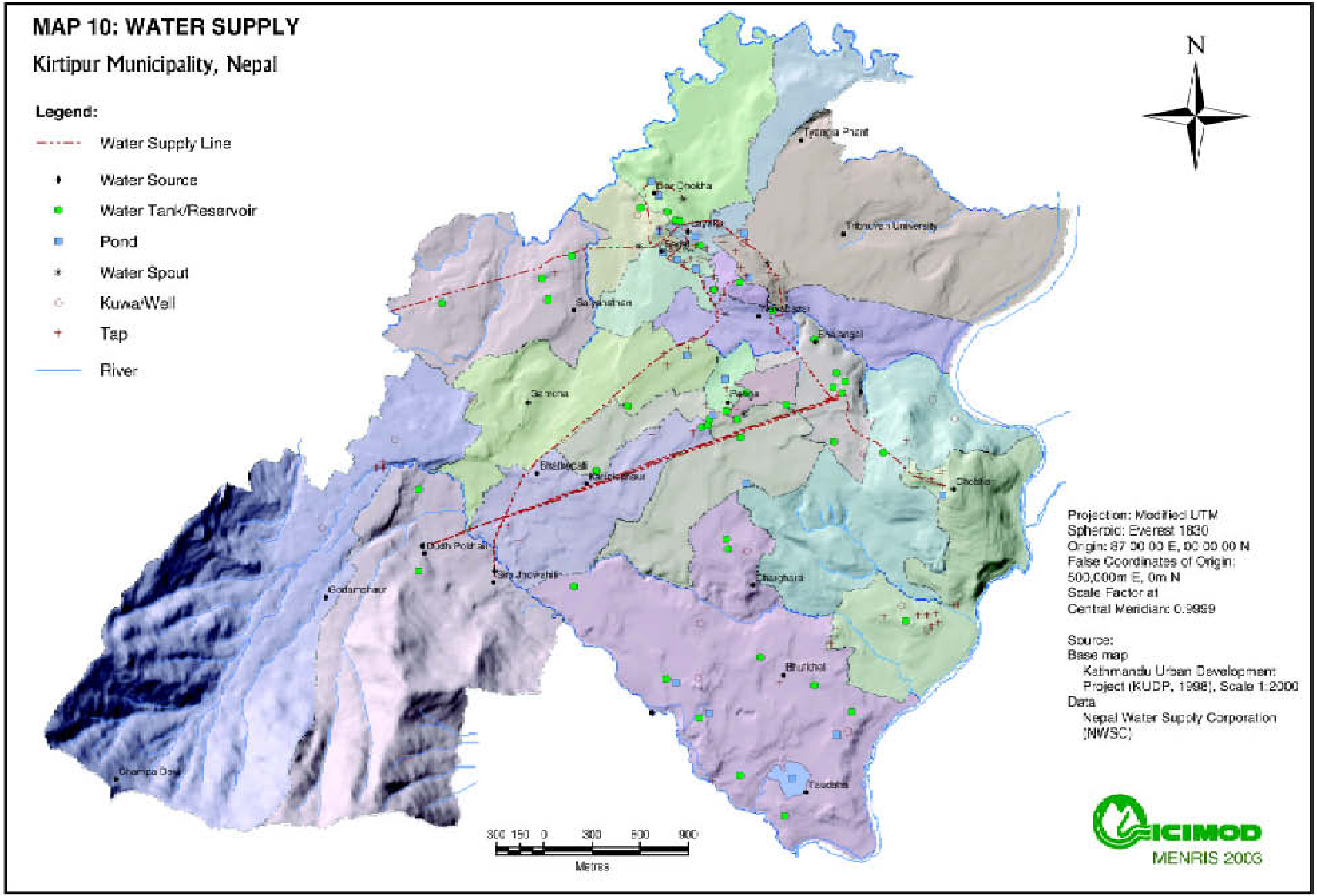

MAP 6: SETTLEMENTS, 1998
Kirtipur Municipality, Nepal
Legend:
Building Footprint
Surfaced Road
Gravel Road
Trails
River
Place Name
N
Tribhuvan University
Projection: Modified UTM
Spheroid: Everest 1830
Origin: 87 00 00 E, 00 00 00 N
False Coordinates of Origin:
500,000m E, 0m N
Scale Factor at
Central Meridian: 0.9999
Source:
Base map:
Kathmandu Urban Development
Project (KUDP; 1998), Scale 1:2000
300 150 0 300 600 900
Metres
ICIMOD
MENRIS 2003


MAP 7: ROAD NETWORK
Kirtipur Municipality, Nepal
Legend:
Surfaced Road
Gravel Road
Trails
River
Bridge
Place Name
N
Source:
Base map
Updated
MENRIS 2003

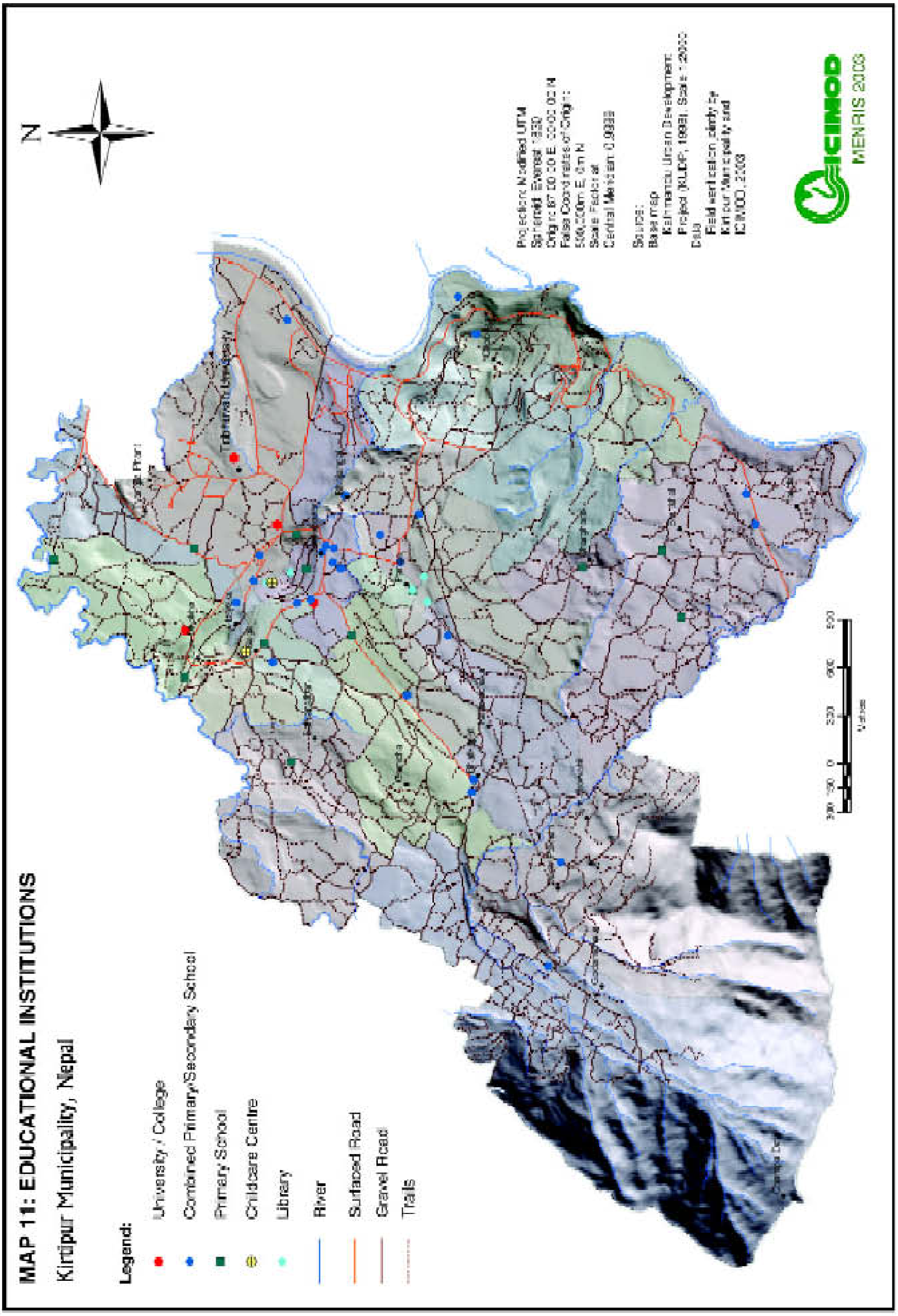

MAP 8: INDUSTRY
Kirtipur Municipality, Nepal
Legend:
Mill
Carpet Factory
Press
Pashmina/Textile
Brick Factory
Cinema Hall
Others
River
Surfaced Road
Gravel Road
N
Tyanglo Phant
Tribhuvan University
Taudaha
Projection: Modified UTM
Spheroid: Everest 1830
Origin: 87 00 00 E, 00 00 00 N
False Coordinates of Origin:
500,000m E, 0m N
Scale Factor at
Central Meridian: 0.9999
Source:
Base map
Kathmandu Urban Development
Project (KUDP, 1998), Scale 1:2000
Data
Field verification jointly by
Kirtipur Municipality and
ICIMOD, 2003
ICIMOD
MENRIS 2003
300 150 0 300 600 900
Metres



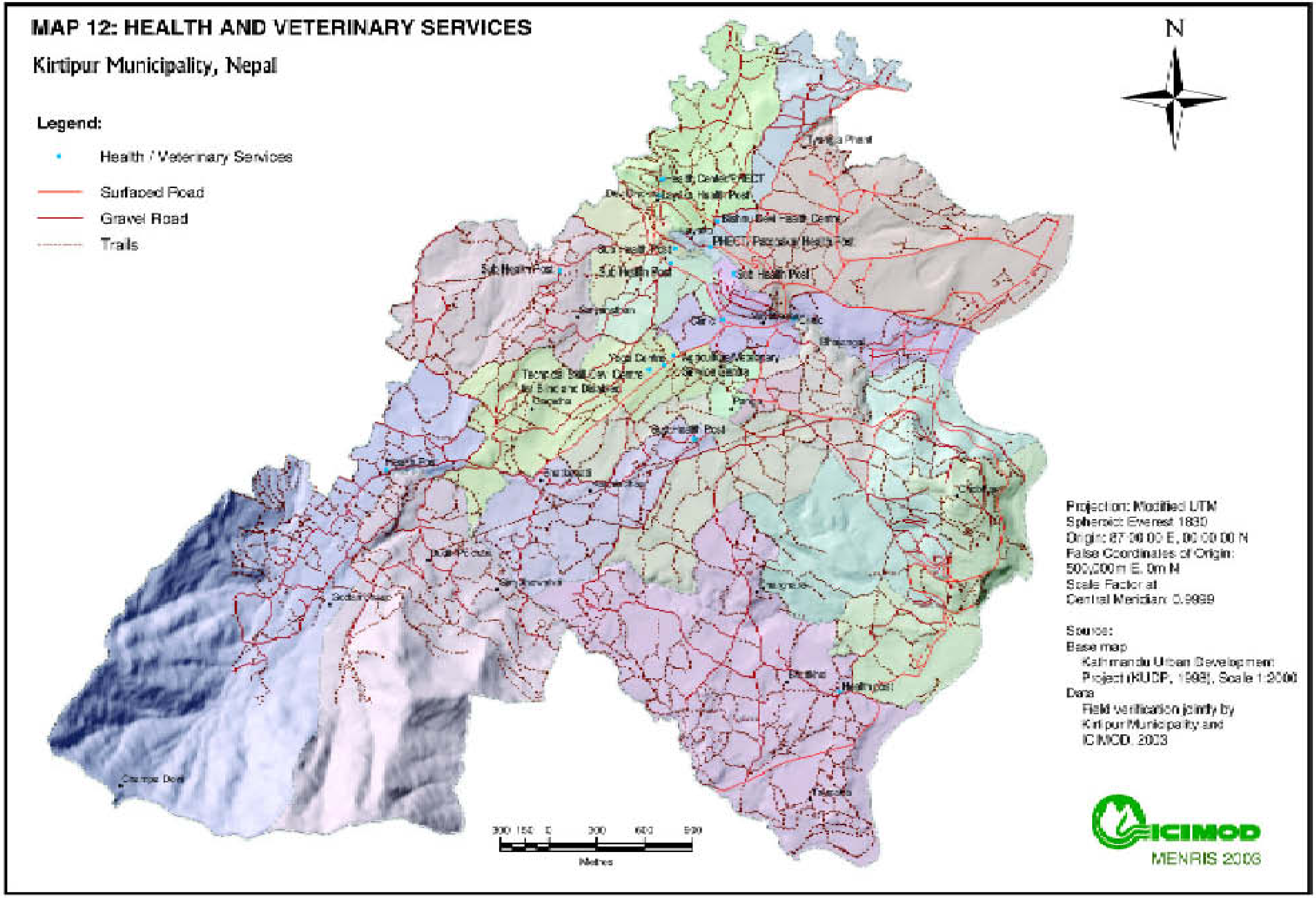
MAP 9: ELECTRICITY SUPPLY AND TELEPHONE LINE NETWORK
Kirtipur Municipality, Nepal
Legend:
Transmission Line
Telephone Line
Surfaced Road
Gravel Road
Telephone Cabinet
Transformer
N
From Teku Sub-Station
From Lalitpur Sub-Station
From Syuchatar Sub-Station
Tribhuvan University
Chobhar
Panga
Bhaisepati
Metres
Projection: Modified UTM
Spheroid: Everest 1830
Origin: 87 00 00 E, 00 00 00 N
False Coordinates of Origin:
500,000m E, 0m N
Scale Factor at
Central Meridian: 0.9999
Source:
Base map
Kathmandu Urban Development Project (KUDP, 1998), Scale 1:2000
Data
Nepal Electricity Authority (NEA),
Nepal Telecommunications Corporation (NTC)
ICIMOD
MENRIS 2003

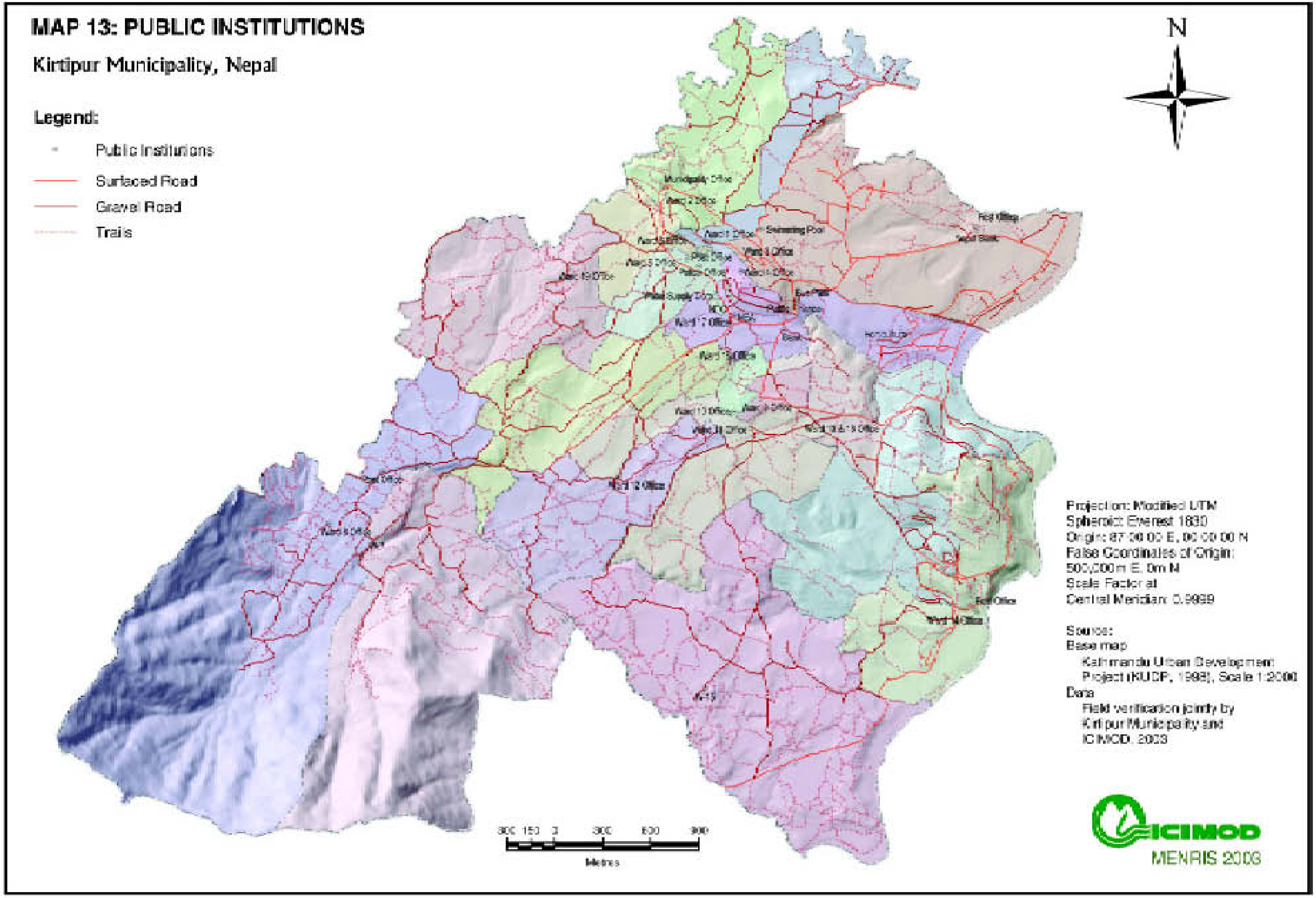


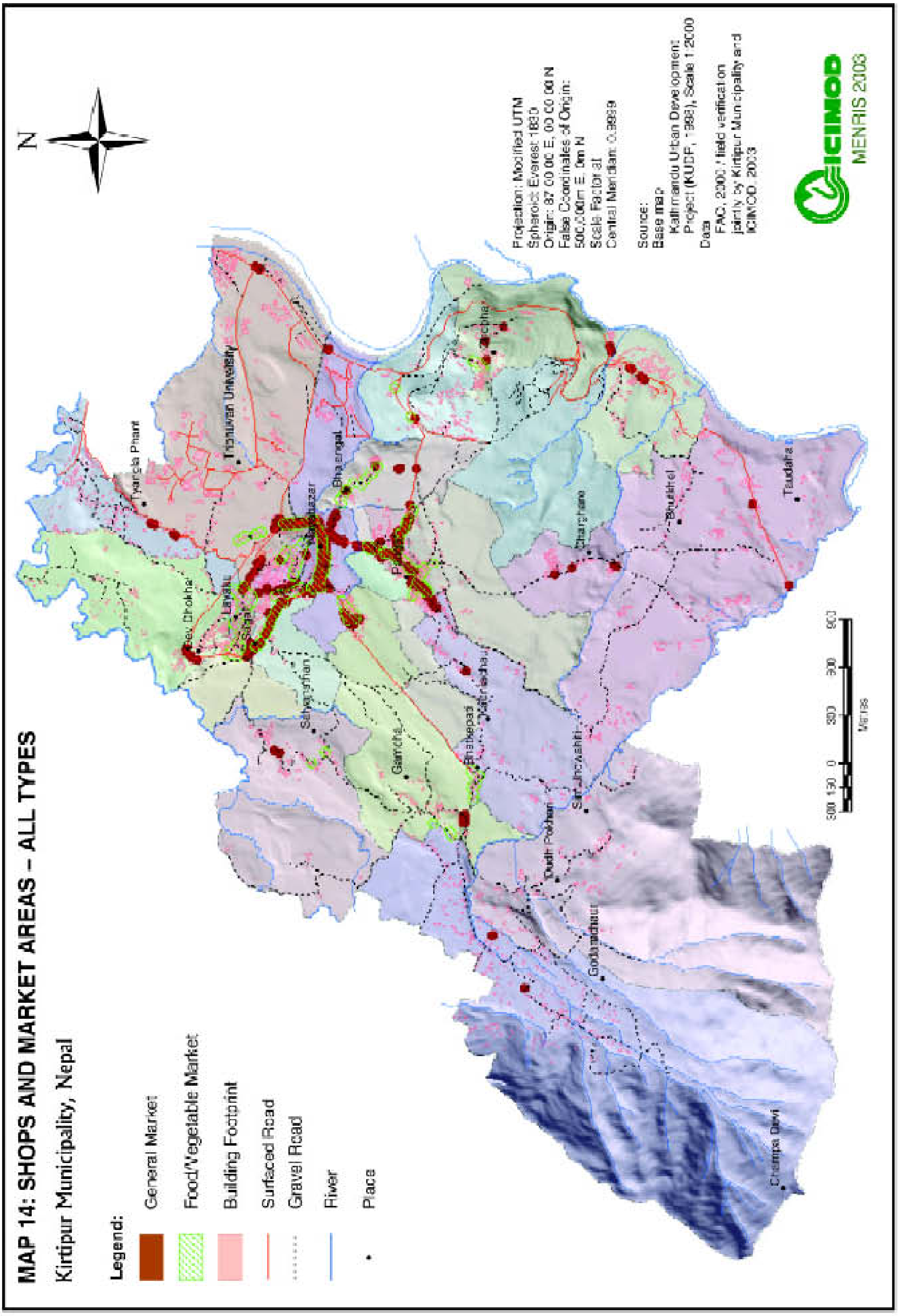
MAP 10: WATER SUPPLY
Kirtipur Municipality, Nepal
Legend:
Water Supply Line
Water Source
Water Tank/Reservoir
Pond
Water Spout
Kuwa/Well
Tap
River
N
Tribhuvan University
Bhuwal
Taudaha
Projection: Modified UTM
Spheroid: Everest 1830
Origin: 87 00 00 E, 00 00 00 N
False Coordinates of Origin:
500,000m E, 0m N
Scale Factor at
Central Meridian: 0.9999
Source:
Base map
Kathmandu Urban Development
Project (KUDP, 1998), Scale 1:2000
Data
Nepal Water Supply Corporation
(NWSC)
300 150 0 300 600 900
Metres
ICIMOD
MENRIS 2003



MAP 11: EDUCATIONAL INSTITUTIONS
Kirtipur Municipality, Nepal
Legend:
University / College
Combined Primary/Secondary School
Primary School
Childcare Centre
Library
River
Surfaced Road
Gravel Road
Trails
N
Metres
Source:
Base map
Data
MENRIS 2003

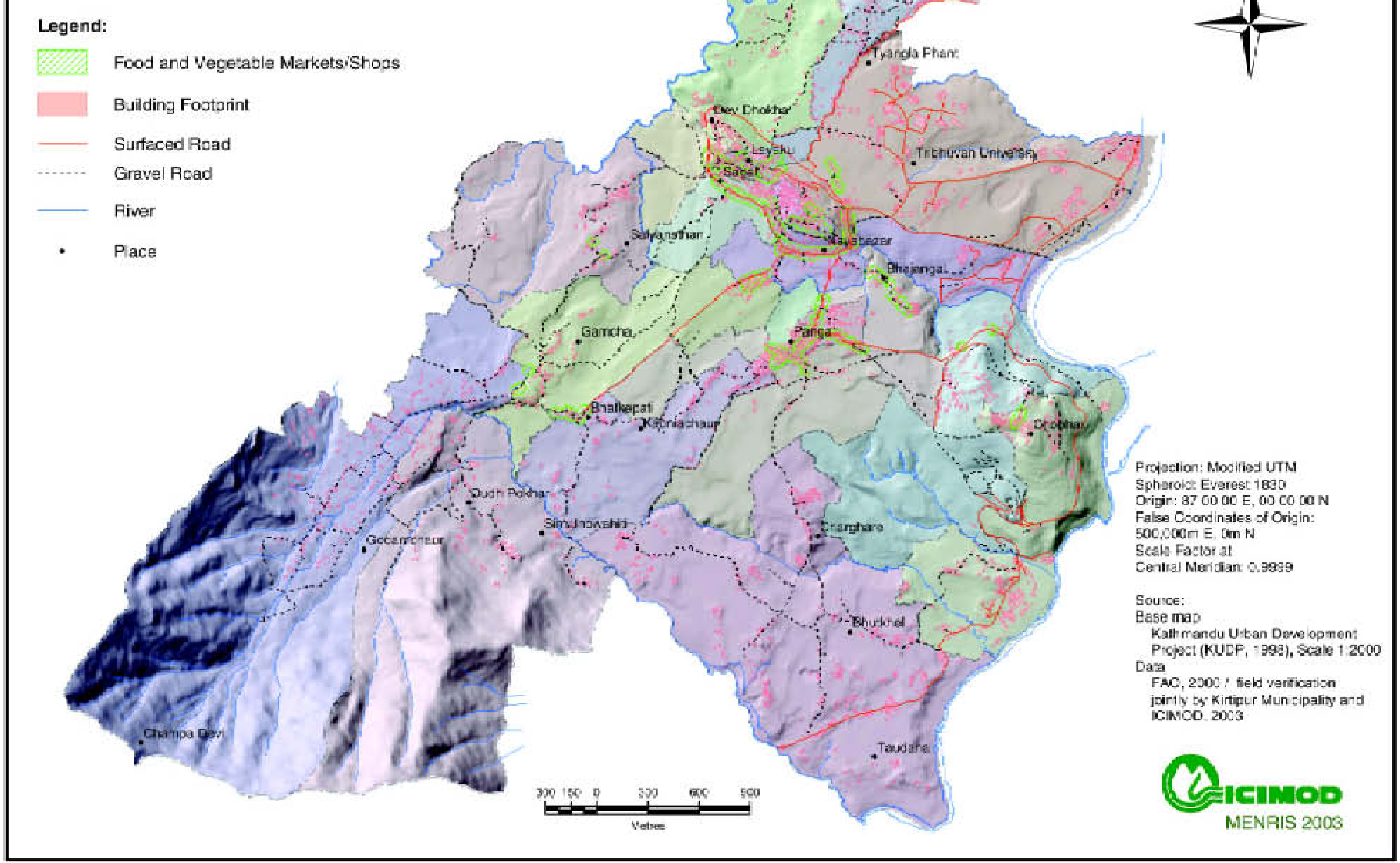

MAP 12: HEALTH AND VETERINARY SERVICES
Kirtipur Municipality, Nepal
Legend:
Health / Veterinary Services
Surfaced Road
Gravel Road
Trails
N
Projection: Modified UTM
Spheroid: Everest 1830
Origin: 87 00 00 E, 00 00 00 N
False Coordinates of Origin:
500,000 m E, 0m N
Scale Factor at
Central Meridian: 0.9999
Source:
Base map
Kathmandu Urban Development
Project (KUDP, 1998), Scale 1:2000
Data
Field verification jointly by
Kirtipur Municipality and
ICIMOD, 2003
ICIMOD
MENRIS 2003
Metres
Sub Health Post
Health Post

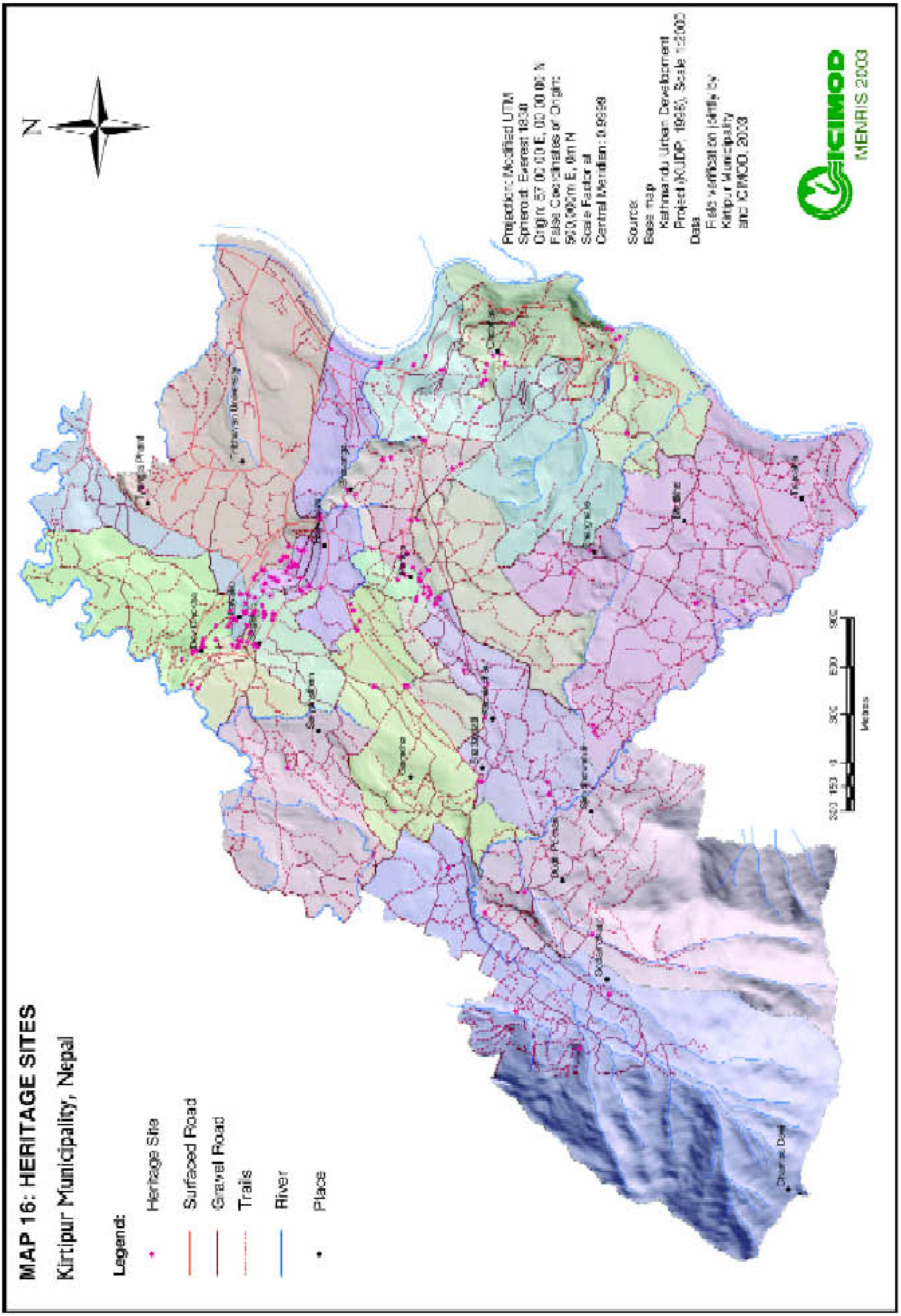

MAP 13: PUBLIC INSTITUTIONS
Kirtipur Municipality, Nepal
Legend:
Public Institutions
Surfaced Road
Gravel Road
Trails
N
Projection: Modified UTM
Spheroid: Everest 1830
Origin: 87 30 00 E, 00 00 00 N
False Coordinates of Origin:
500,000m E, 0m N
Scale Factor at
Central Meridian: 0.9999
Source:
Base map
Kathmandu Urban Development
Project (KUDP, 1998), Scale 1:2000
Data
Field verification jointly by
Kirtipur Municipality and
ICIMOD, 2003
ICIMOD
MENRIS 2003
Metres

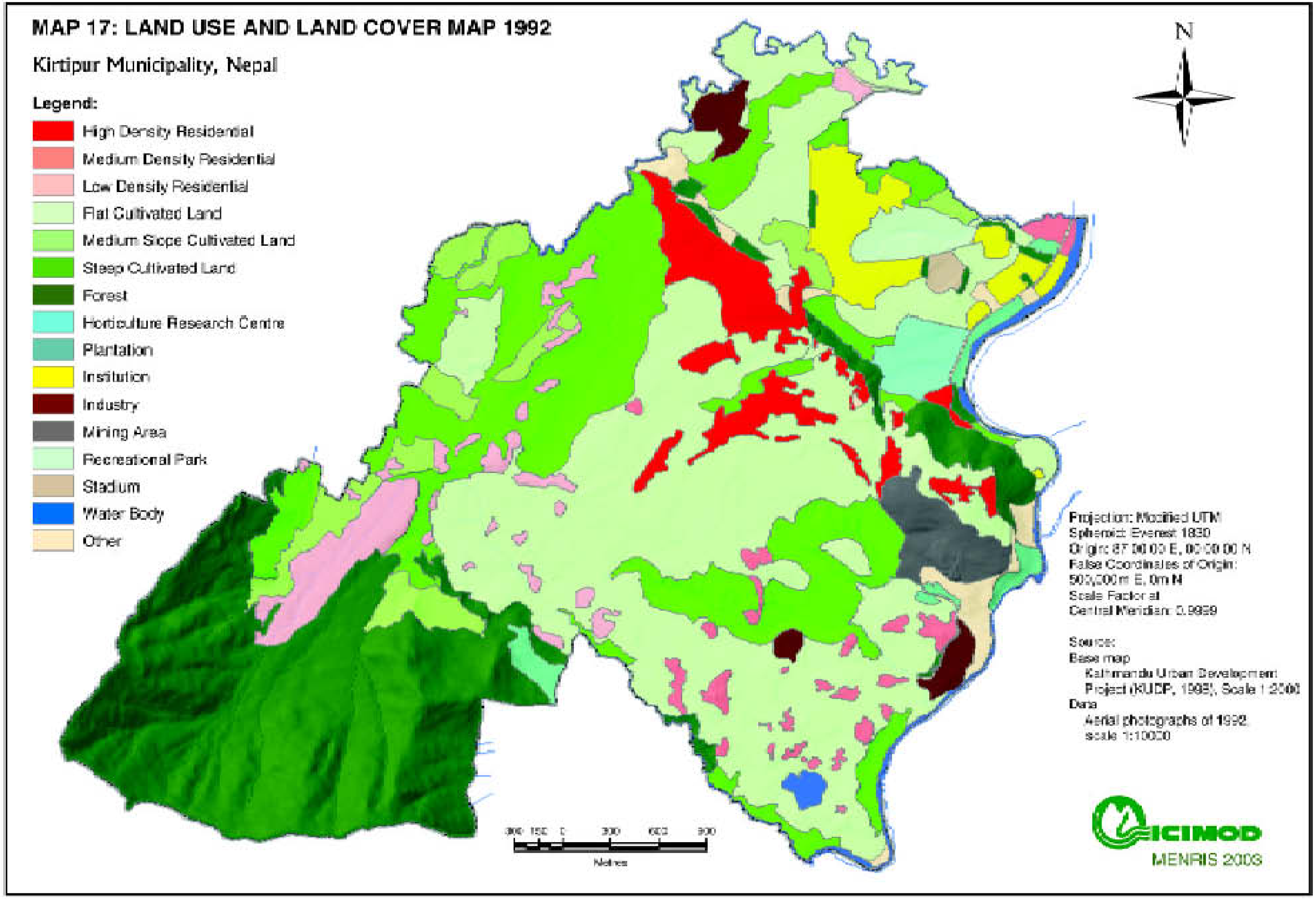

MAP 14: SHOPS AND MARKET AREAS – ALL TYPES
Kirtipur Municipality, Nepal
Legend:
General Market
Food/Vegetable Market
Building Footprint
Surfaced Road
Gravel Road
River
Place
N
Tyangla Phant
Tribhuvan University
Bhajangal
Naya Bazaar
Dev Dhokha
Layaku
Gamcha
Bhatkepati
Taudaha
Dudh Pokhari
Champa Devi
Meters
Projection: Modified UTM
Spheroid: Everest 1830
Origin: 87 00 00 E, 00 00 00 N
False Coordinates of Origin:
500,000m E, 0m N
Scale Factor at
Central Meridian: 0.9999
Source:
Base map
Kathmandu Urban Development
Project (KUDP, 1998), Scale 1:2000
Data
FAO, 2000 / field verification
jointly by Kirtipur Municipality and
ICIMOD, 2003
ICIMOD
MENRIS 2003

MAP 15: FOOD AND VEGETABLE MARKETS

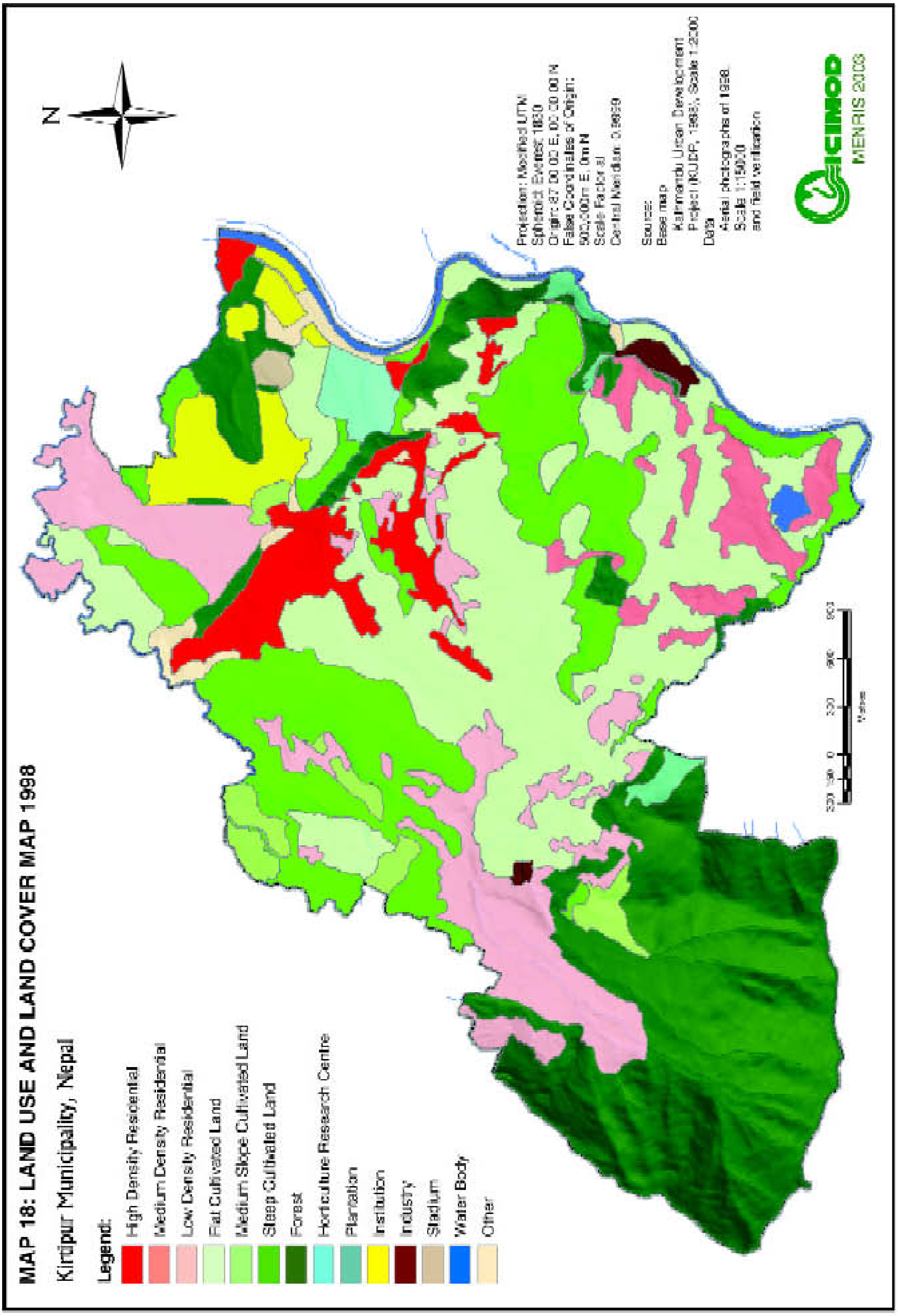
Kirtipur Municipality, Nepal

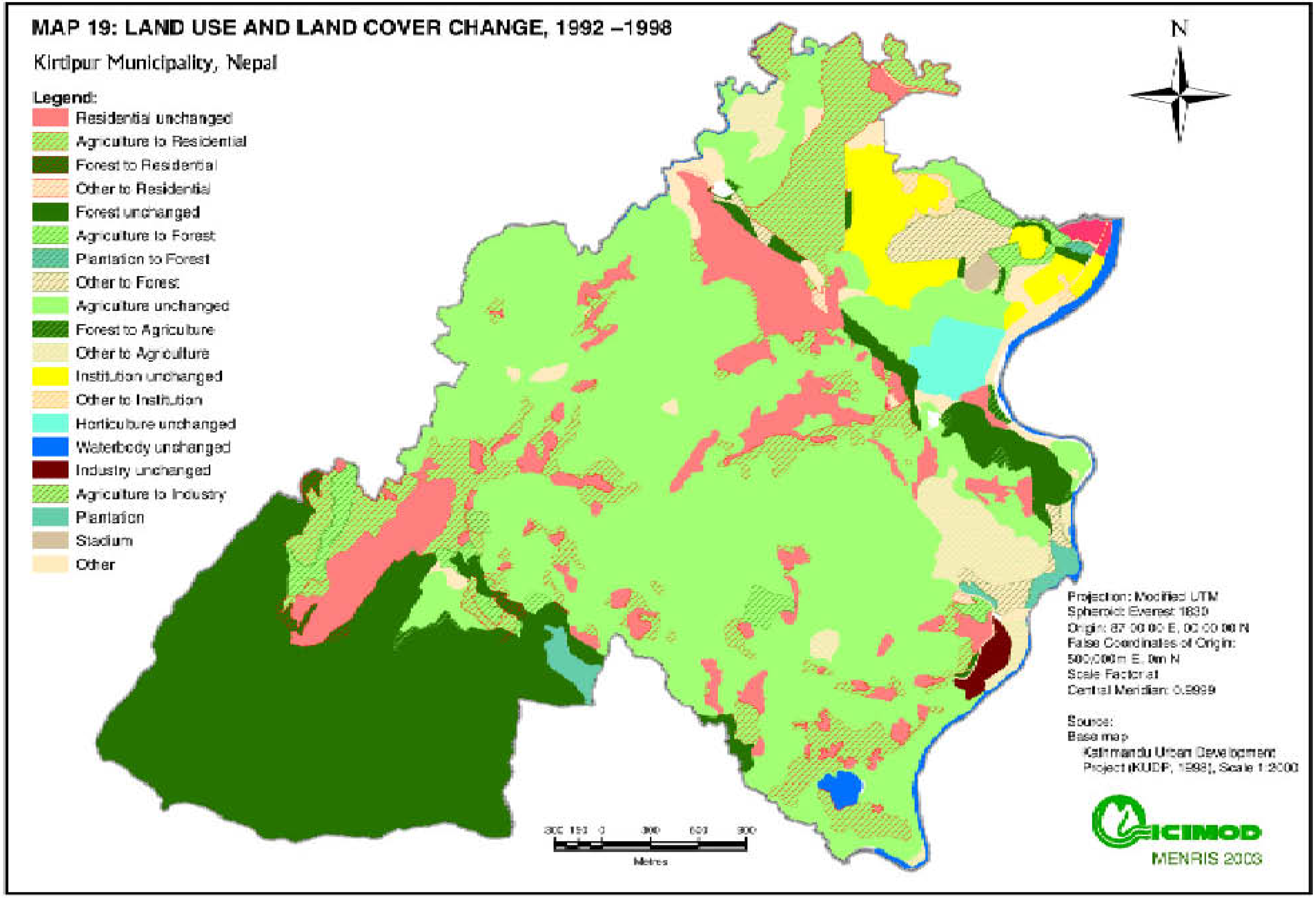


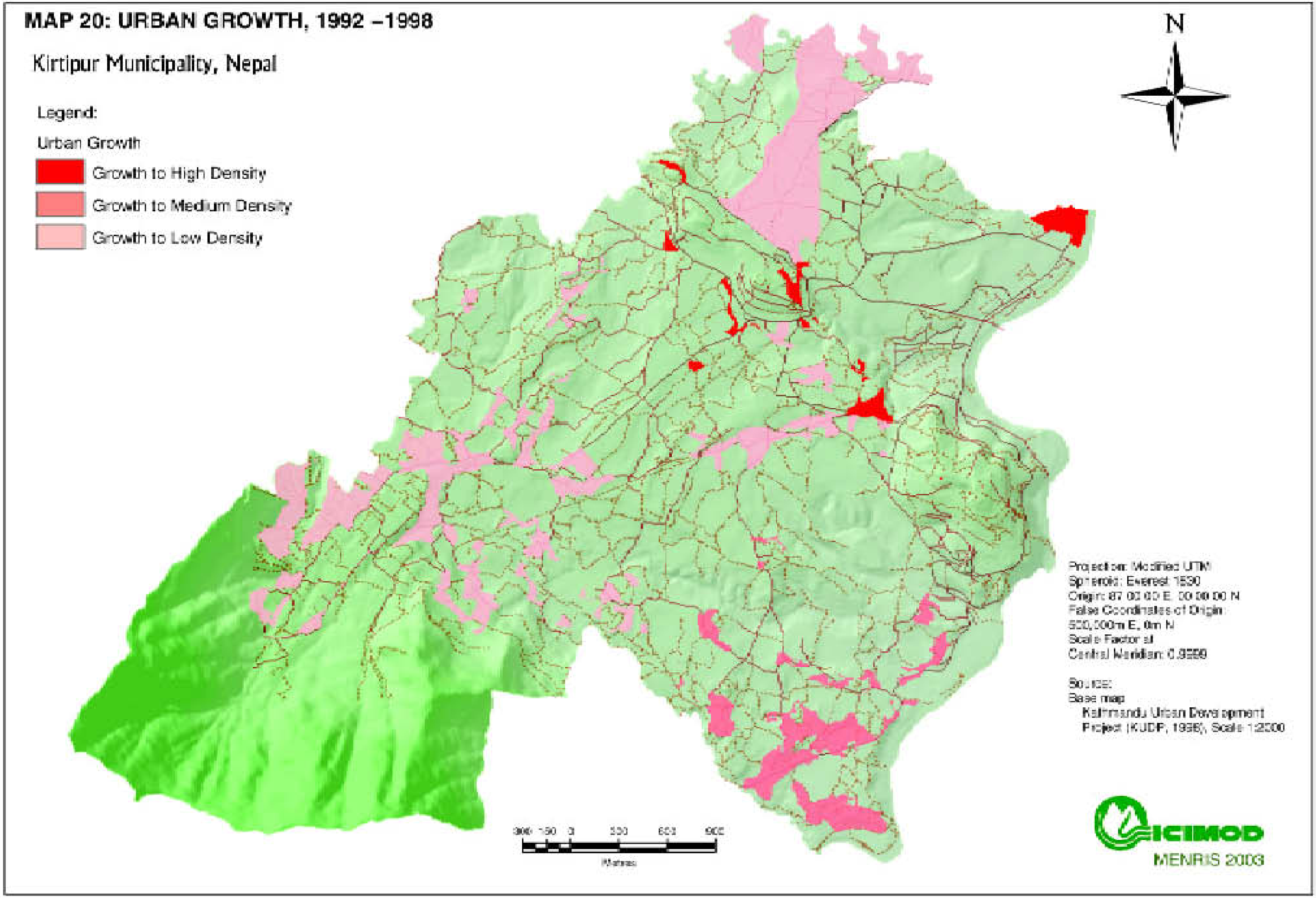

MAP 16: HERITAGE SITES
Kirtipur Municipality, Nepal
Legend:
Heritage Site
Surfaced Road
Gravel Road
Trails
River
Place
N
Meters
ICIMOD
MENRIS 2003

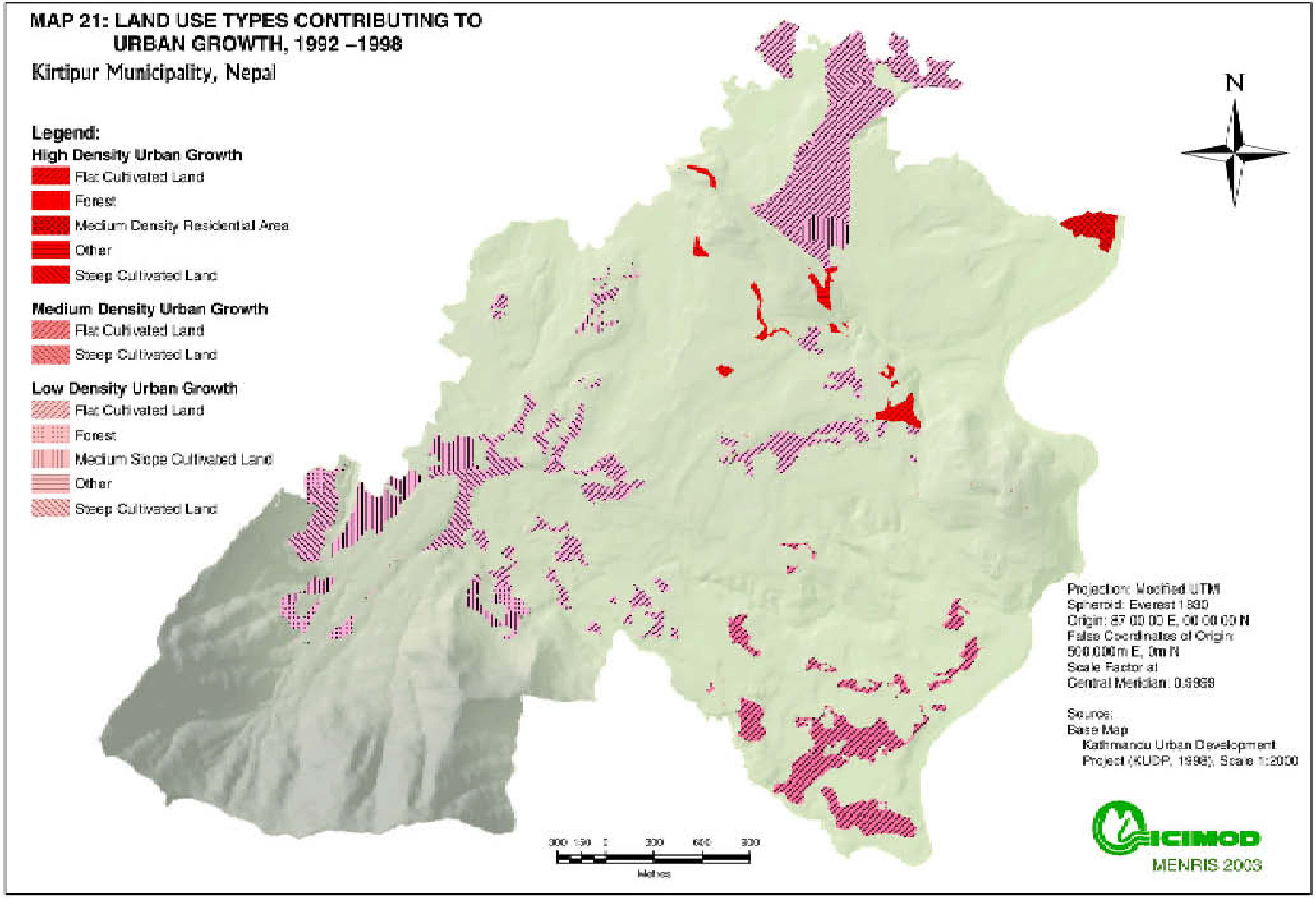


MAP 17: LAND USE AND LAND COVER MAP 1992
Kirtipur Municipality, Nepal
Legend:
High Density Residential
Medium Density Residential
Low Density Residential
Flat Cultivated Land
Medium Slope Cultivated Land
Steep Cultivated Land
Forest
Horticulture Research Centre
Plantation
Institution
Industry
Mining Area
Recreational Park
Stadium
Water Body
Other
N
Metres
Projection: Modified UTM
Spheroid: Everest 1830
False Coordinates of Origin:
Scale Factor at
Source:
Base map
Kathmandu Urban Development
Data
Aerial photographs of 1992
scale 1:10000
ICIMOD
MENRIS 2003


MAP 18: LAND USE AND LAND COVER MAP 1998
Kirtipur Municipality, Nepal
Legend:
High Density Residential
Medium Density Residential
Low Density Residential
Flat Cultivated Land
Medium Slope Cultivated Land
Steep Cultivated Land
Forest
Horticulture Research Centre
Plantation
Institution
Industry
Stadium
Water Body
Other
N
Metres
Projection: Modified UTM
Spheroid: Everest 1830
Origin: 87 00 00 E, 00 00 00 N
False Coordinates of Origin:
500,000m E, 0m N
Scale Factor: 1
Central Meridian: 0.9999
Source:
Base map
Kathmandu Urban Development
Project (KUDP, 1998), Scale 1:2500
Data
Aerial photographs of 1998
Scale 1:15000
and field verification
ICIMOD
MENRIS 2003

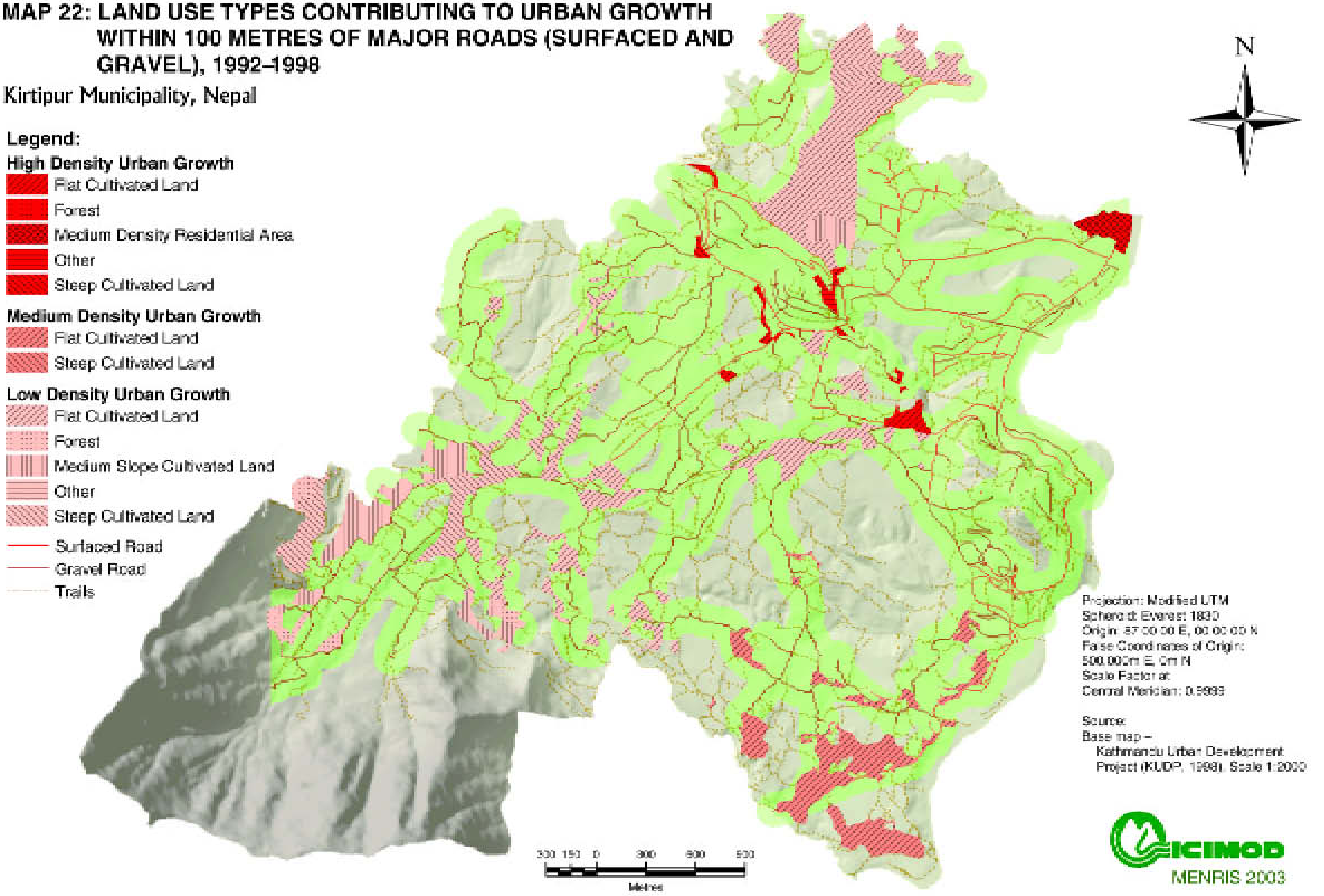

MAP 19: LAND USE AND LAND COVER CHANGE, 1992 –1998
Kirtipur Municipality, Nepal
Legend:
Residential unchanged
Agriculture to Residential
Forest to Residential
Other to Residential
Forest unchanged
Agriculture to Forest
Plantation to Forest
Other to Forest
Agriculture unchanged
Forest to Agriculture
Other to Agriculture
Institution unchanged
Other to Institution
Horticulture unchanged
Waterbody unchanged
Industry unchanged
Agriculture to Industry
Plantation
Stadium
Other
N
Metres
Projection: Modified UTM
Spheroid: Everest 1830
Origin: 87 00 00 E, 00 00 00 N
False Coordinates of Origin:
500,000m E, 0m N
Scale Factor: 1
Central Meridian: 0.9999
Source:
Base map
Kathmandu Urban Development
Project (KUDP, 1998), Scale 1:2000
ICIMOD
MENRIS 2003


MAP 20: URBAN GROWTH, 1992 –1998
Kirtipur Municipality, Nepal
Legend:
Urban Growth
Growth to High Density
Growth to Medium Density
Growth to Low Density
N
Projection: Modified UTM
Spheroid: Everest 1830
Origin: 87 00 00 E, 00 00 00 N
False Coordinates of Origin:
500,000m E, 0m N
Scale Factor at
Central Meridian: 0.9999
Source:
Base map
Kathmandu Urban Development
Project (KUDP, 1998), Scale 1:2000
0
300
600
900
Metres
ICIMOD
MENRIS 2003


MAP 21: LAND USE TYPES CONTRIBUTING TO URBAN GROWTH, 1992 –1998
Kirtipur Municipality, Nepal
Legend:
High Density Urban Growth
Flat Cultivated Land
Forest
Medium Density Residential Area
Other
Steep Cultivated Land
Medium Density Urban Growth
Flat Cultivated Land
Steep Cultivated Land
Low Density Urban Growth
Flat Cultivated Land
Forest
Medium Slope Cultivated Land
Other
Steep Cultivated Land
N
Projection: Modified UTM
Spheroid: Everest 1830
Origin: 87 00 00 E, 00 00 00 N
False Coordinates of Origin:
500,000m E, 0m N
Scale Factor at
Central Meridian: 0.9999
Source:
Base Map
Kathmandu Urban Development
Project (KUDP, 1998), Scale 1:2000
300 150 0 300 600 900
Metres
MENRIS 2003

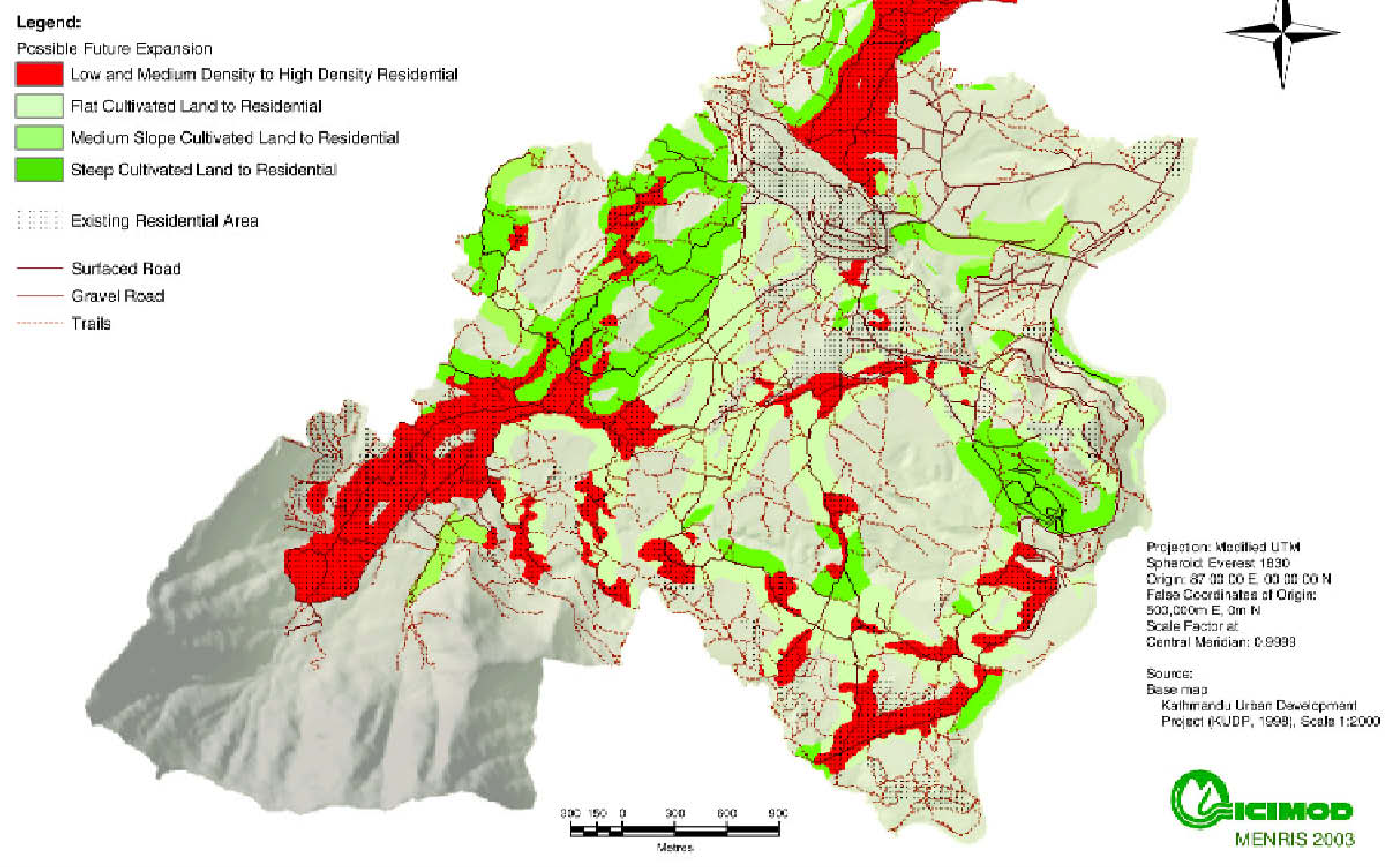
MAP 22: LAND USE TYPES CONTRIBUTING TO URBAN GROWTH WITHIN 100 METRES OF MAJOR ROADS (SURFACED AND GRAVEL), 1992–1998

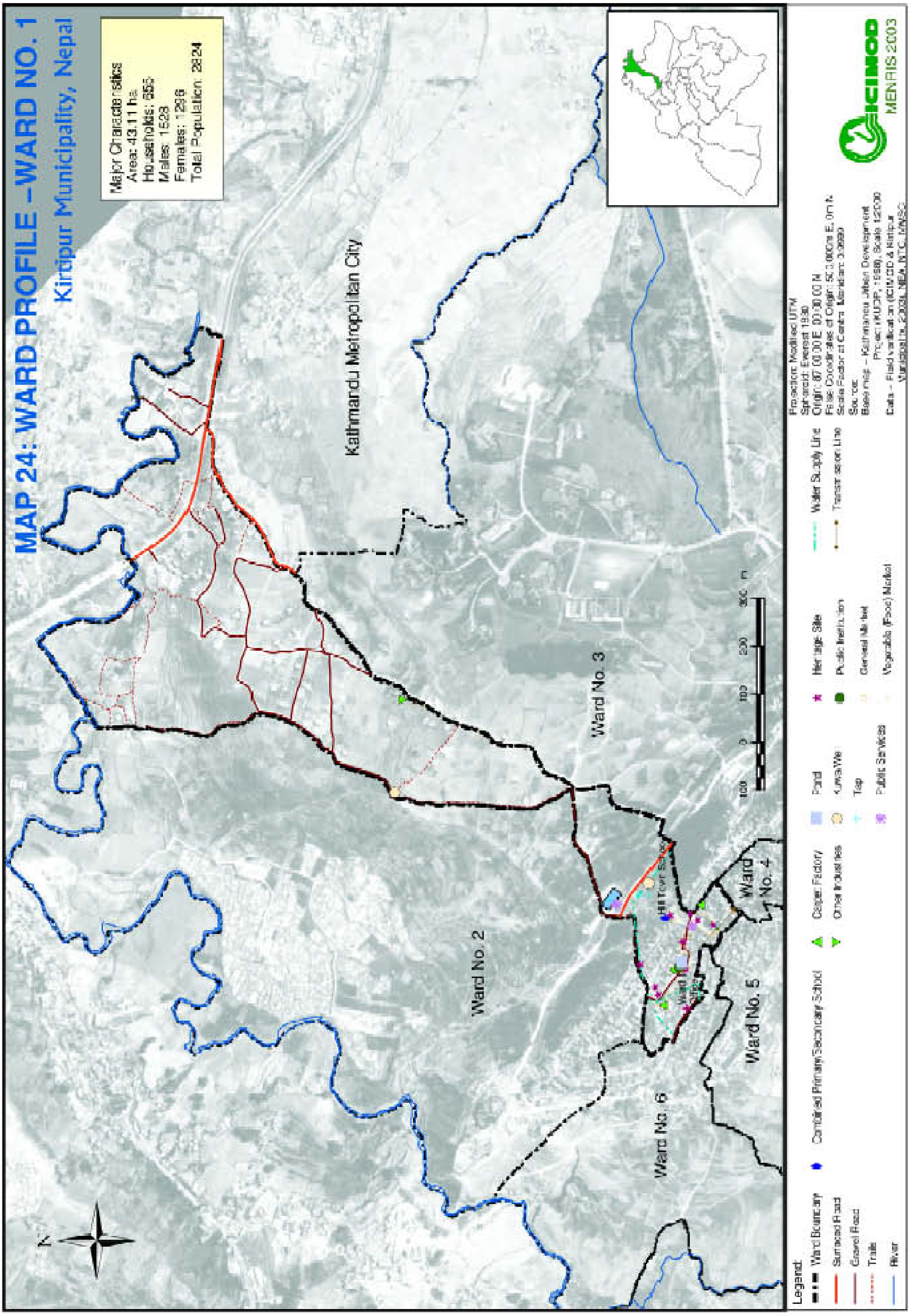
Kirtipur Municipality, Nepal



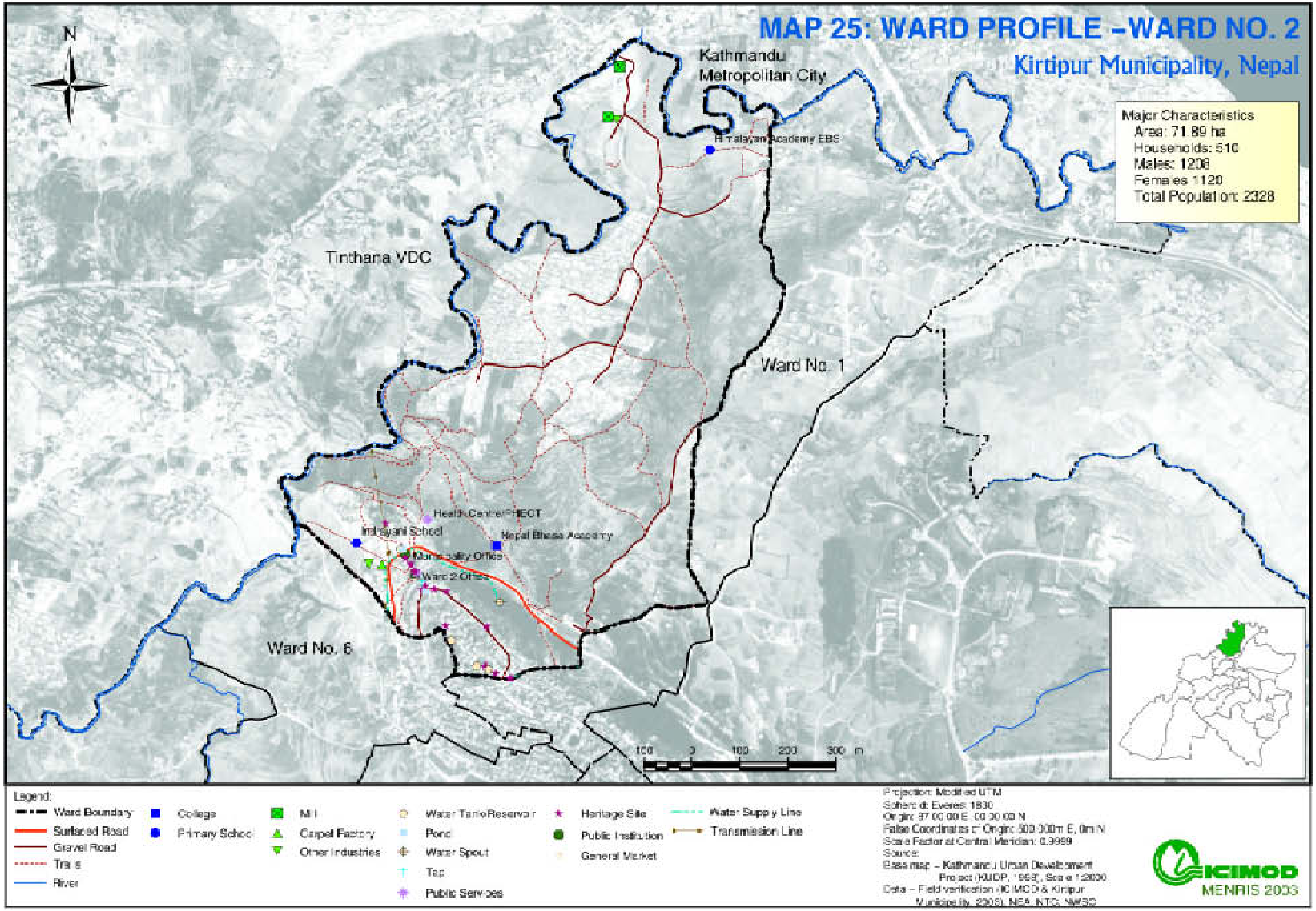
MAP 23: POSSIBLE AREAS OF FUTURE URBAN EXPANSION

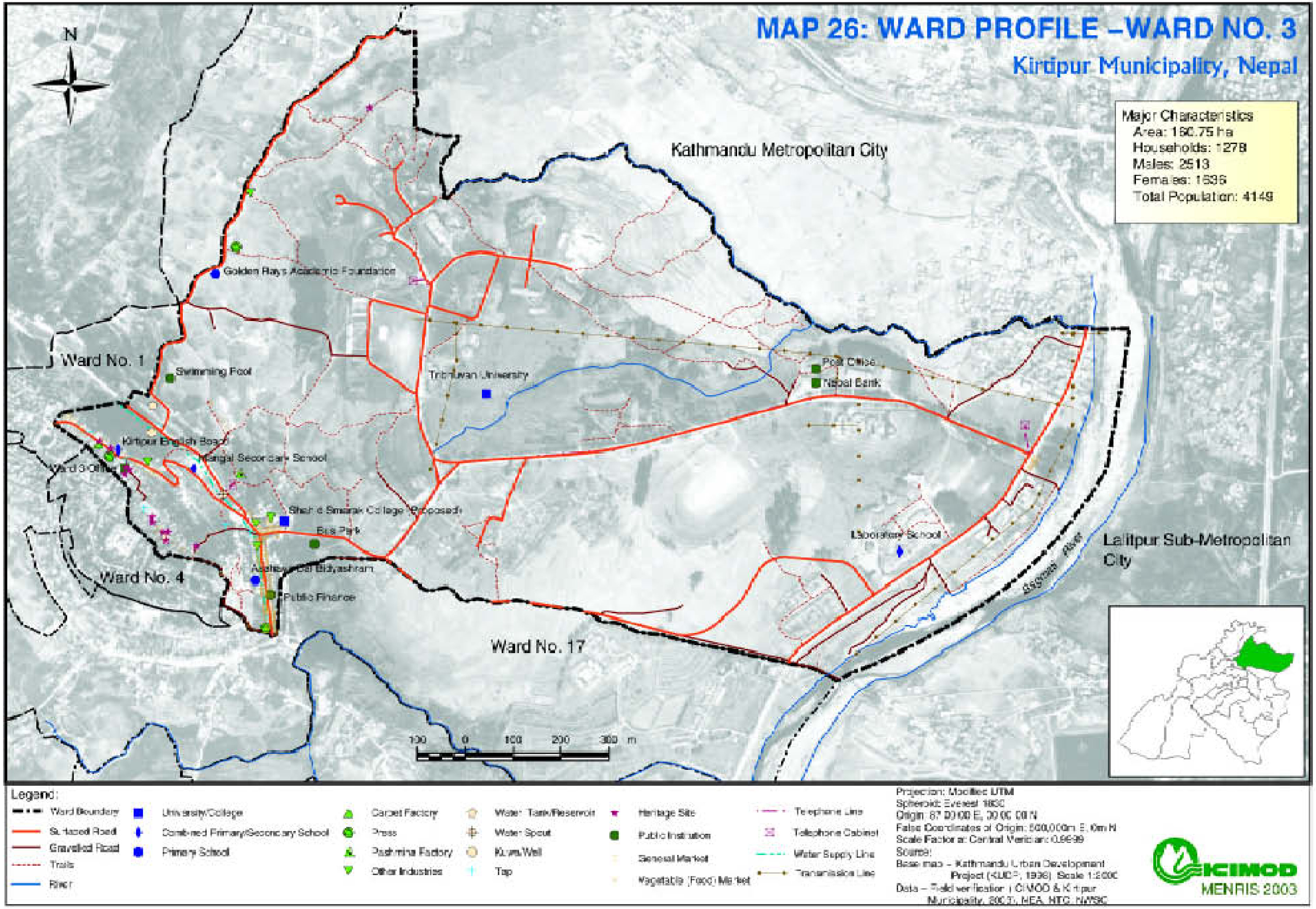
Kirtipur Municipality, Nepal

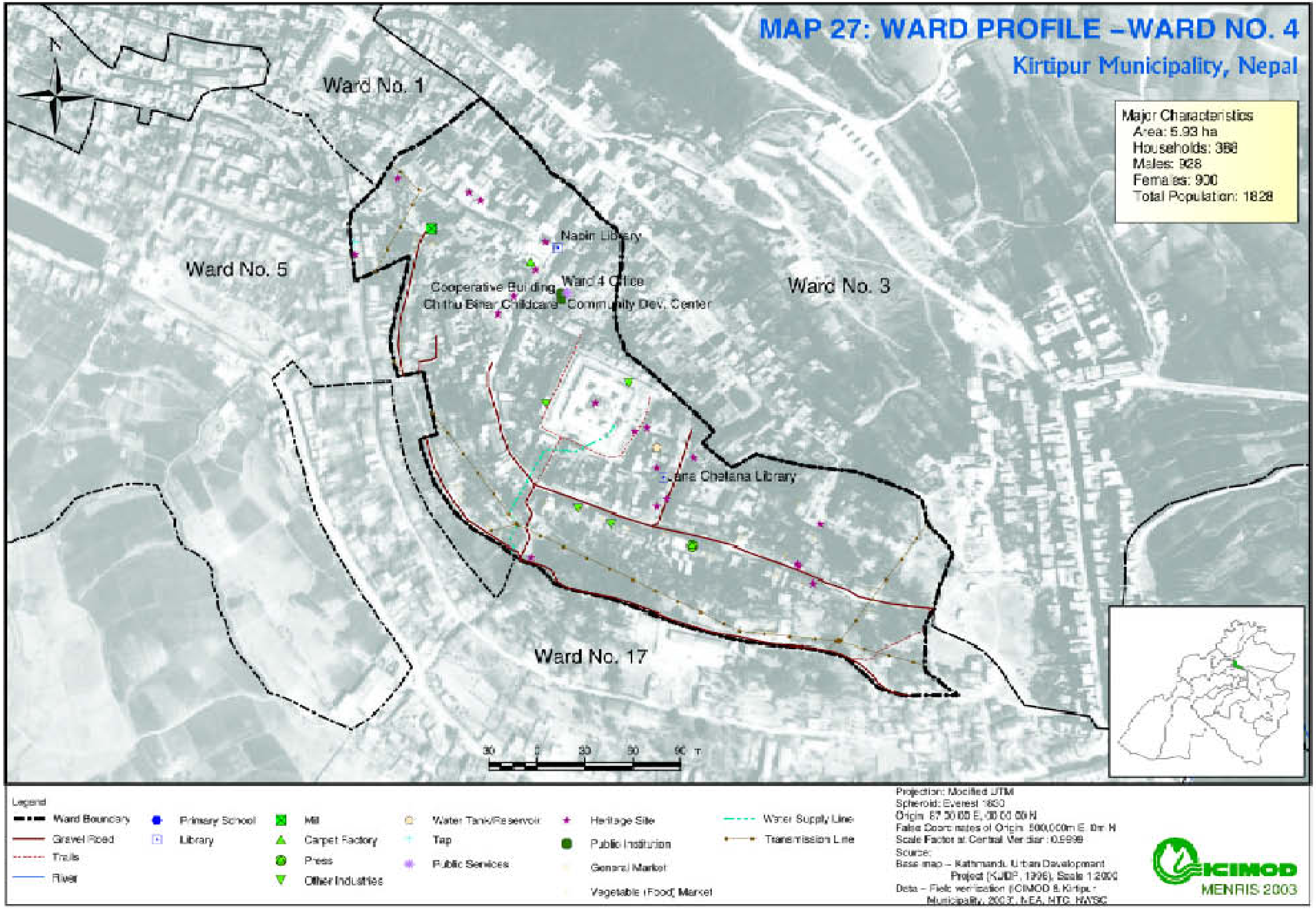


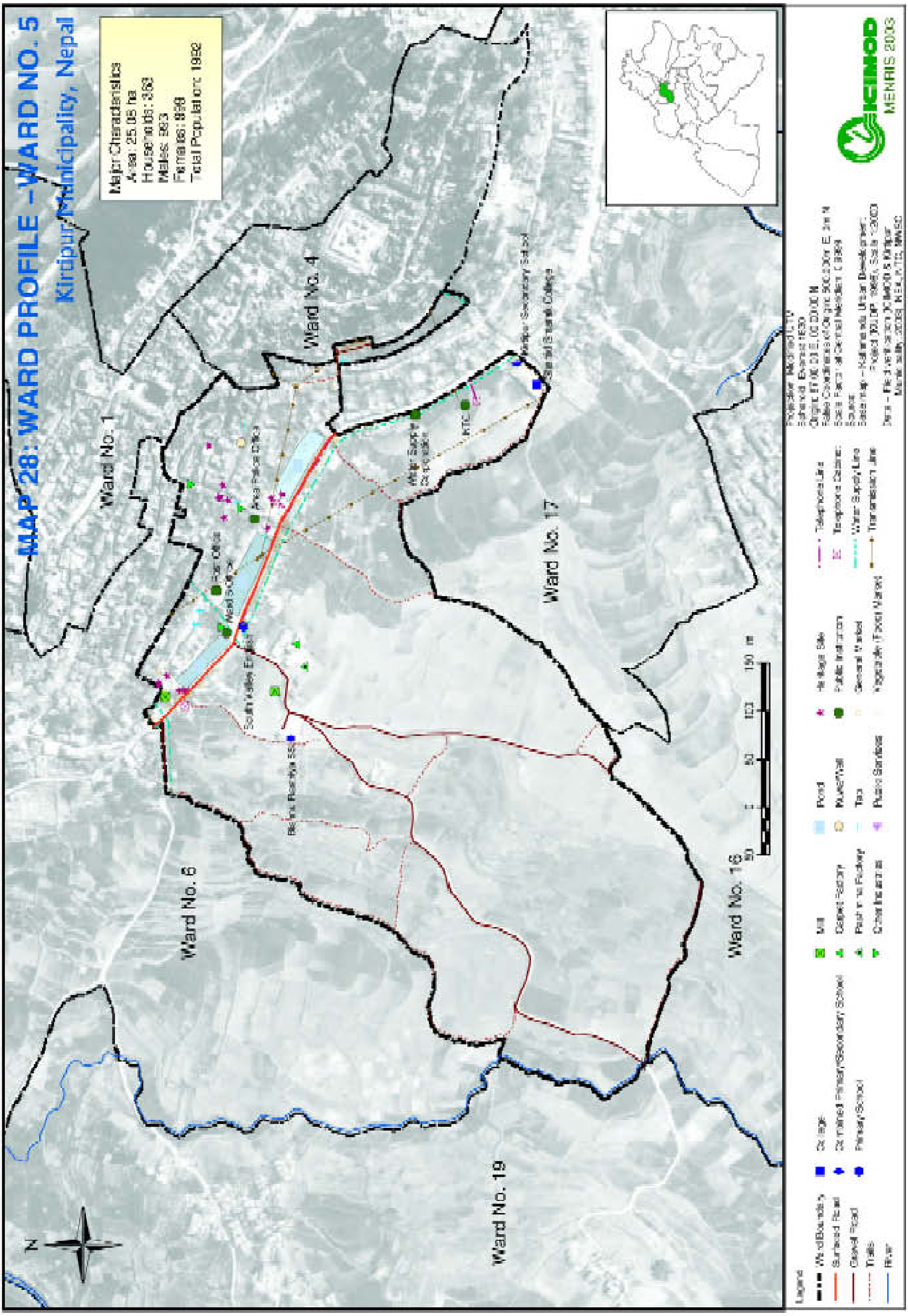


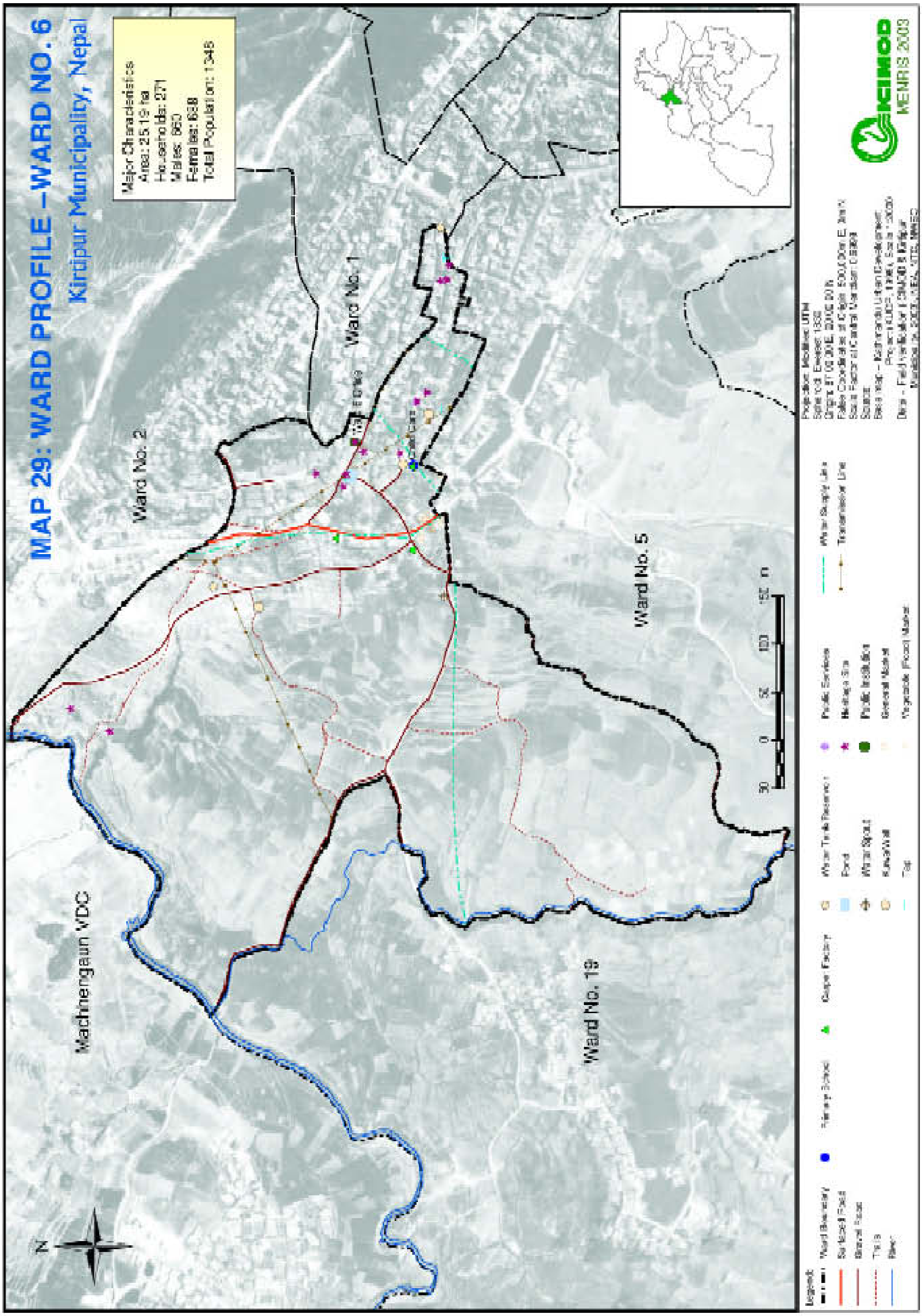
MAP 24: WARD PROFILE –WARD NO. 1
Kirtipur Municipality, Nepal
Major Characteristics
Area: 43.11 ha
Households: 655
Males: 1528
Females: 1296
Total Population: 2824
Kathmandu Metropolitan City
Ward No. 2
Ward No. 3
Ward No. 4
Ward No. 5
Ward No. 6
Hill Town School
N
100 0 100 200 300 m
Legend
Ward Boundary
Surfaced Road
Gravel Road
Trails
River
Combined Primary/Secondary School
Carpet Factory
Other Industries
Pond
Kuwa/Well
Tap
Public Services
Heritage Site
Public Institution
General Market
Vegetable (Food) Market
Water Supply Line
Transmission Line
Projection: Modified UTM
Spheroid: Everest 1930
Origin: 87 00 00 E 00 00 00 N
False Coordinates of Origin: 500,000m E, 0m N
Scale Factor at Central Meridian: 0.9999
Source:
Base map – Kathmandu Urban Development Project (KUDP, 1998), Scale 1:2000
Data – Field verification (ICIMOD & Kirtipur Municipality, 2003), NEA, NTC, MWSC
ICIMOD
MENRIS 2003

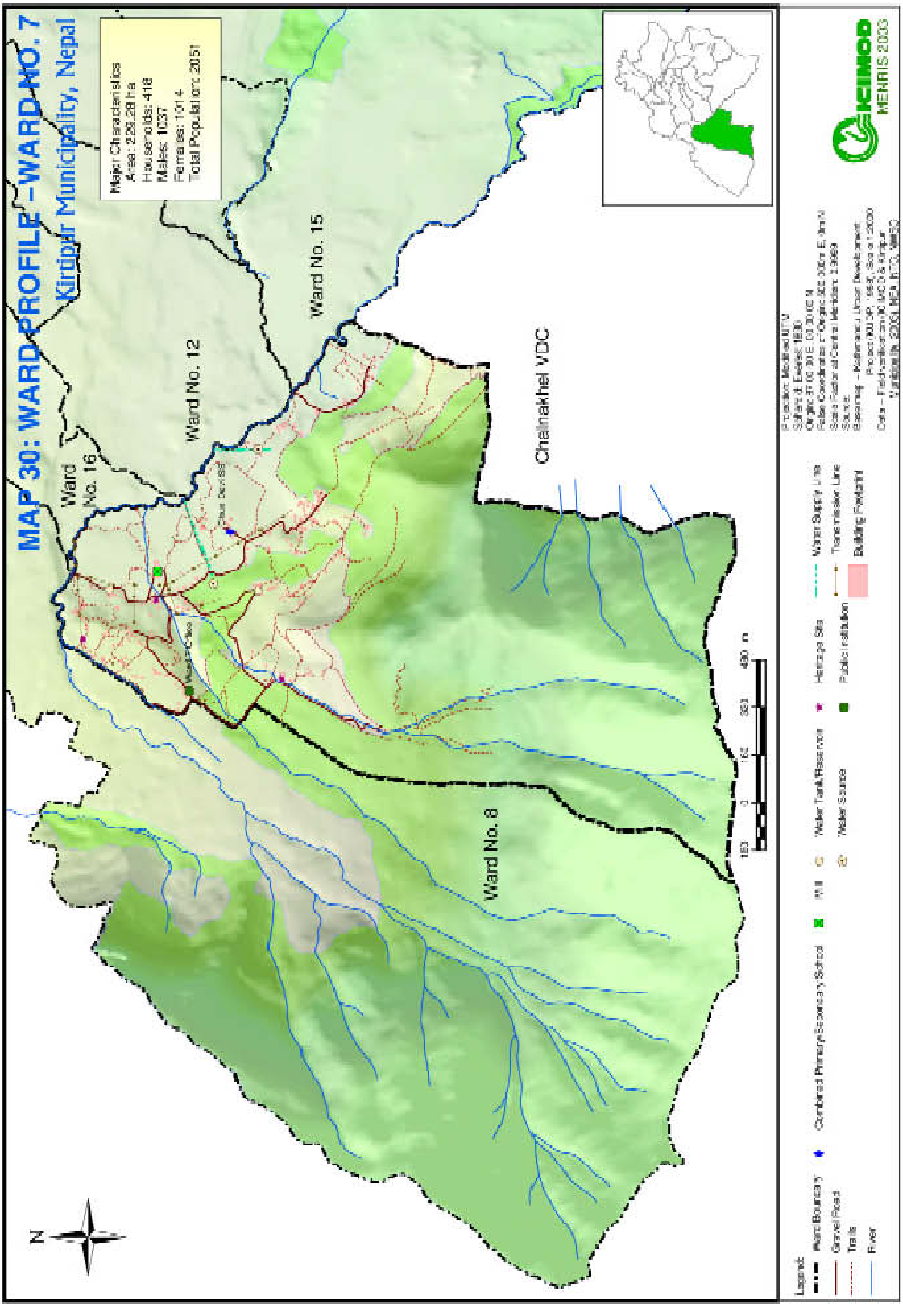

MAP 25: WARD PROFILE –WARD NO. 2
Kirtipur Municipality, Nepal
Major Characteristics
Area: 71.89 ha
Households: 510
Males: 1208
Females 1120
Total Population: 2328
N
Kathmandu Metropolitan City
Himalayan Academy EBS
Tinthana VDC
Ward No. 1
Ward No. 6
Health Centre/PHECT
Nepal Bhasa Academy
Ward 2 Office
100 0 100 200 300 m
Legend:
Ward Boundary
Surfaced Road
Gravel Road
Trails
River
College
Primary School
Mill
Carpet Factory
Other Industries
Water Tank/Reservoir
Pond
Water Spout
Tap
Public Services
Heritage Site
Public Institution
General Market
Water Supply Line
Transmission Line
Projection: Modified UTM
Spheroid: Everest 1830
False Coordinates of Origin: 500 000m E, 0m N
Scale Factor at Central Meridian: 0.9999
Source:
Base map – Kathmandu Urban Development Project (KUDP, 1998), Scale 1:2000
ICIMOD
MENRIS 2003

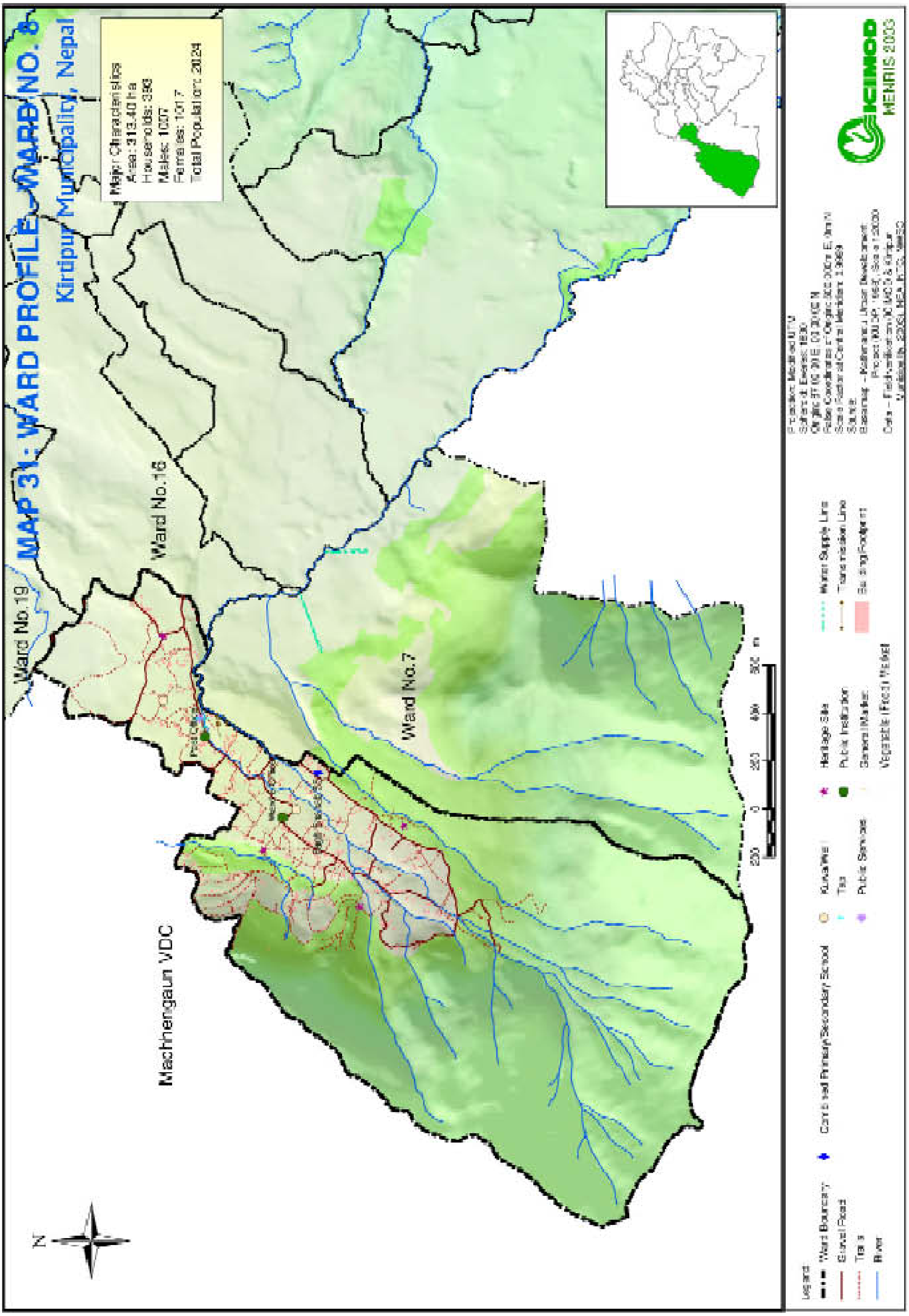

MAP 26: WARD PROFILE –WARD NO. 3
Kirtipur Municipality, Nepal
Major Characteristics
Area: 150.75 ha
Households: 1278
Males: 2513
Females: 1636
Total Population: 4149
N
Kathmandu Metropolitan City
Lalitpur Sub-Metropolitan City
Ward No. 1
Ward No. 4
Ward No. 17
Golden Rays Academic Foundation
Swimming Pool
Tribhuvan University
Post Office
Nepal Bank
Laboratory School
Kirtipur English Boarding
Bangal Secondary School
Shahid Smarak College (Proposed)
Bus Park
Public Finance
Bagmati River
100 0 100 200 300 m
Legend:
Ward Boundary
Surfaced Road
Gravelled Road
Trails
River
University/College
Combined Primary/Secondary School
Primary School
Carpet Factory
Press
Pashmina Factory
Other Industries
Water Tank/Reservoir
Water Spout
Kuwa/Well
Tap
Heritage Site
Public Institution
General Market
Vegetable (Food) Market
Telephone Line
Telephone Cabinet
Water Supply Line
Transmission Line
Projection: Modified UTM
Spheroid: Everest 1830
Scale Factor at Central Meridian: 0.9999
Source:
Base map – Kathmandu Urban Development Project (KUDP, 1998)
ICIMOD
MENRIS 2003

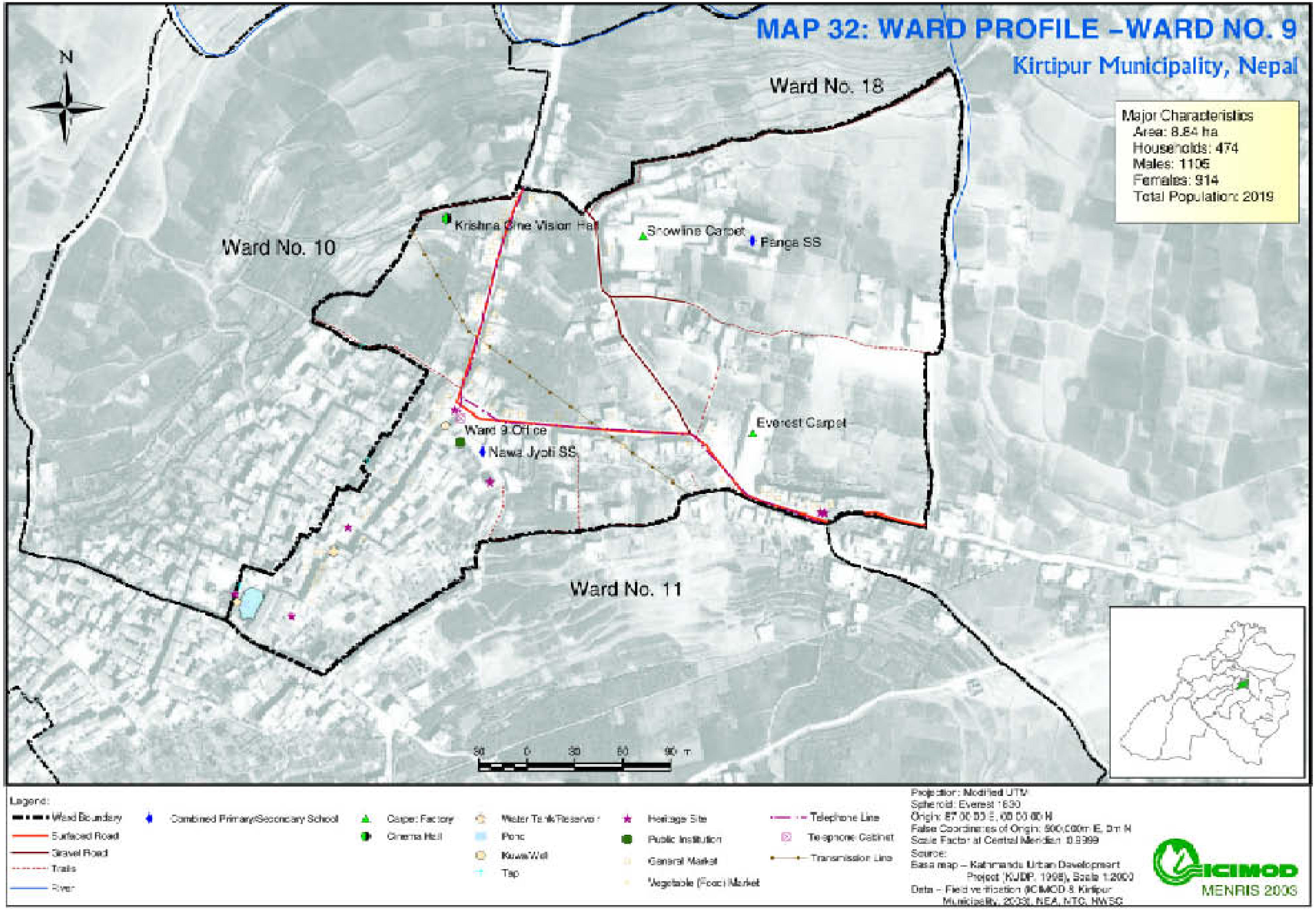

MAP 27: WARD PROFILE – WARD NO. 4
Kirtipur Municipality, Nepal
Major Characteristics
Area: 5.93 ha
Households: 368
Males: 928
Females: 900
Total Population: 1828
Ward No. 1
Ward No. 5
Ward No. 3
Ward No. 17
Napin Library
Ward 4 Office
Cooperative Building
Chithu Bihar Childcare
Community Dev. Center
Chetana Library
N
Legend
Ward Boundary
Gravel Road
Trails
River
Primary School
Library
Mill
Carpet Factory
Press
Other Industries
Water Tank/Reservoir
Tap
Public Services
Heritage Site
Public Institution
General Market
Vegetable (Food) Market
Water Supply Line
Transmission Line
Projection: Modified UTM
Spheroid: Everest 1830
Scale Factor at Central Meridian: 0.9999
Source:
Base map – Kathmandu Urban Development Project (KUDP, 1996), Scale 1:2000
ICIMOD
MENRIS 2003

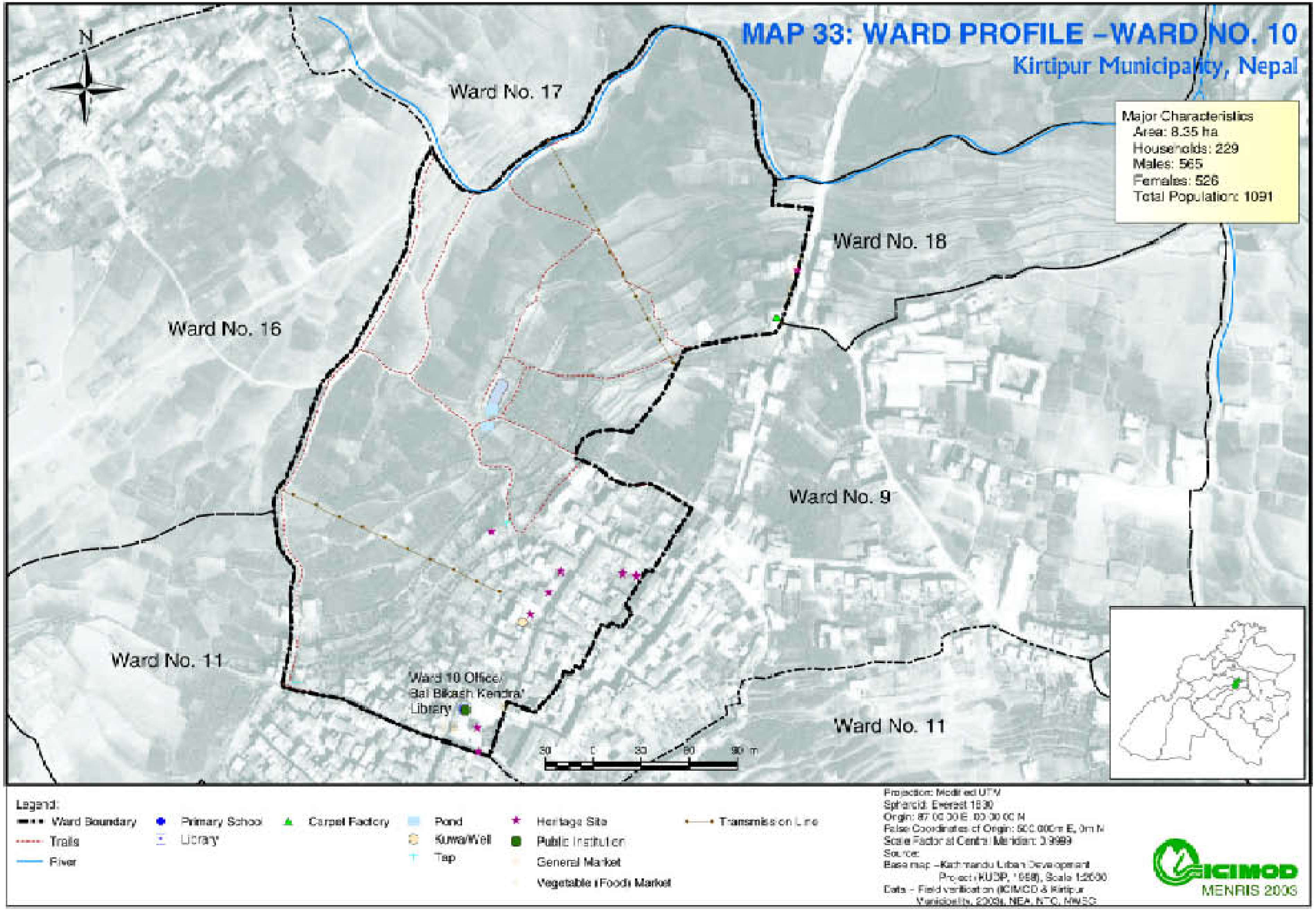

MAP 28: WARD PROFILE – WARD NO. 5
Kirtipur Municipality, Nepal
Major Characteristics
Area: 25.05 ha
Households: 363
Males: 993
Females: 939
Total Population: 1932
Ward No. 1
Ward No. 4
Ward No. 6
Ward No. 16
Ward No. 17
Ward No. 19
Post Office
Ward Office
Area Police Office
South Valley English
Water Supply Corporation
NTC
Legend
Ward Boundary
Surfaced Road
Gravel Road
Trails
River
Mill
Pond
Heritage Site
Public Institution
Telephone Line
Water Supply Line
Transmission Line
Primary School
Public Services
MENRIS 2003

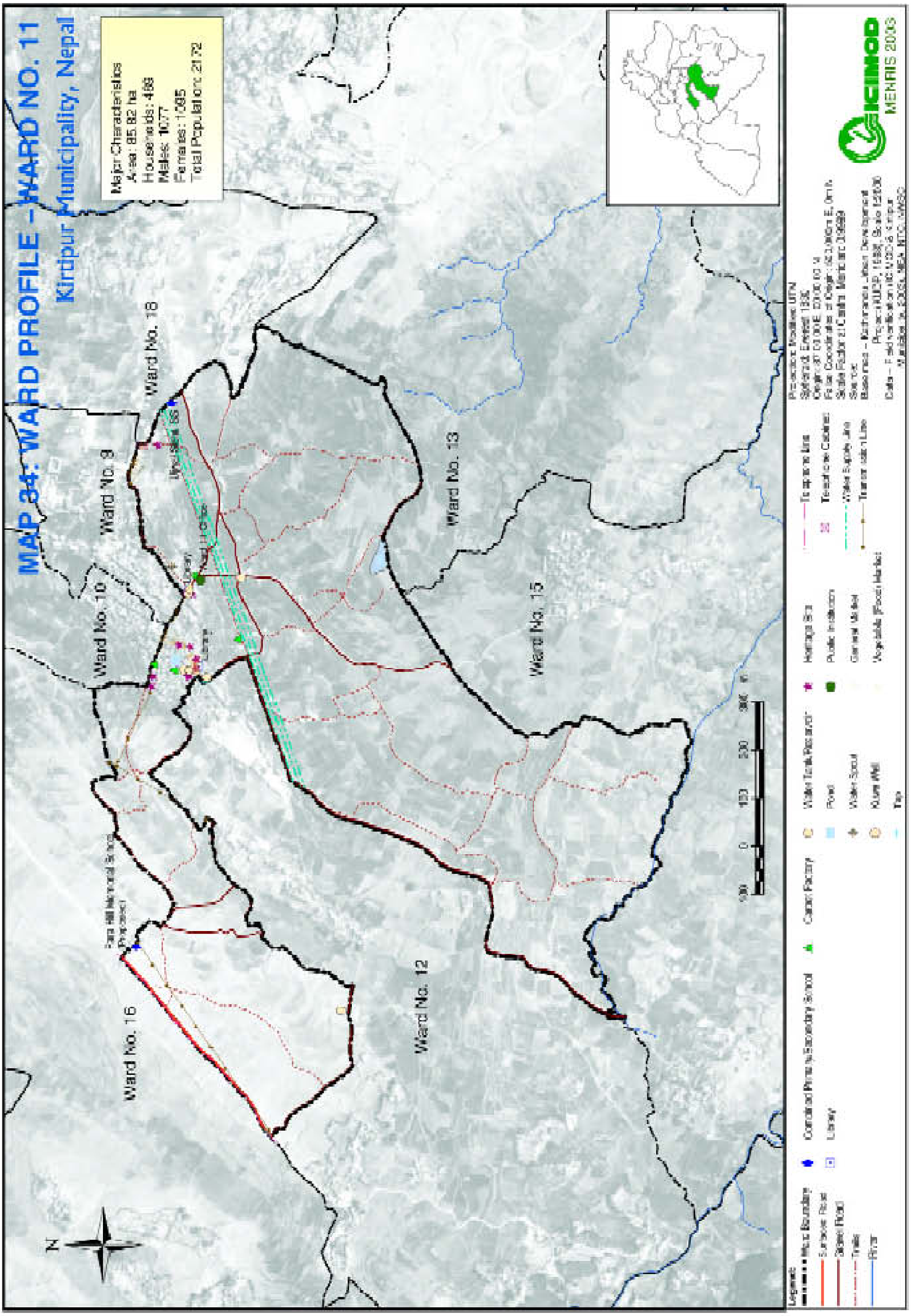

MAP 29: WARD PROFILE –WARD NO. 6
Kirtipur Municipality, Nepal
Major Characteristics
Area: 25.19 ha
Households: 271
Males: 660
Females: 688
Total Population: 1348
Ward No. 2
Ward No. 1
Ward No. 5
Ward No. 19
Machhengaun VDC
50 0 50 100 150 m
ICIMOD
MENRIS 2003

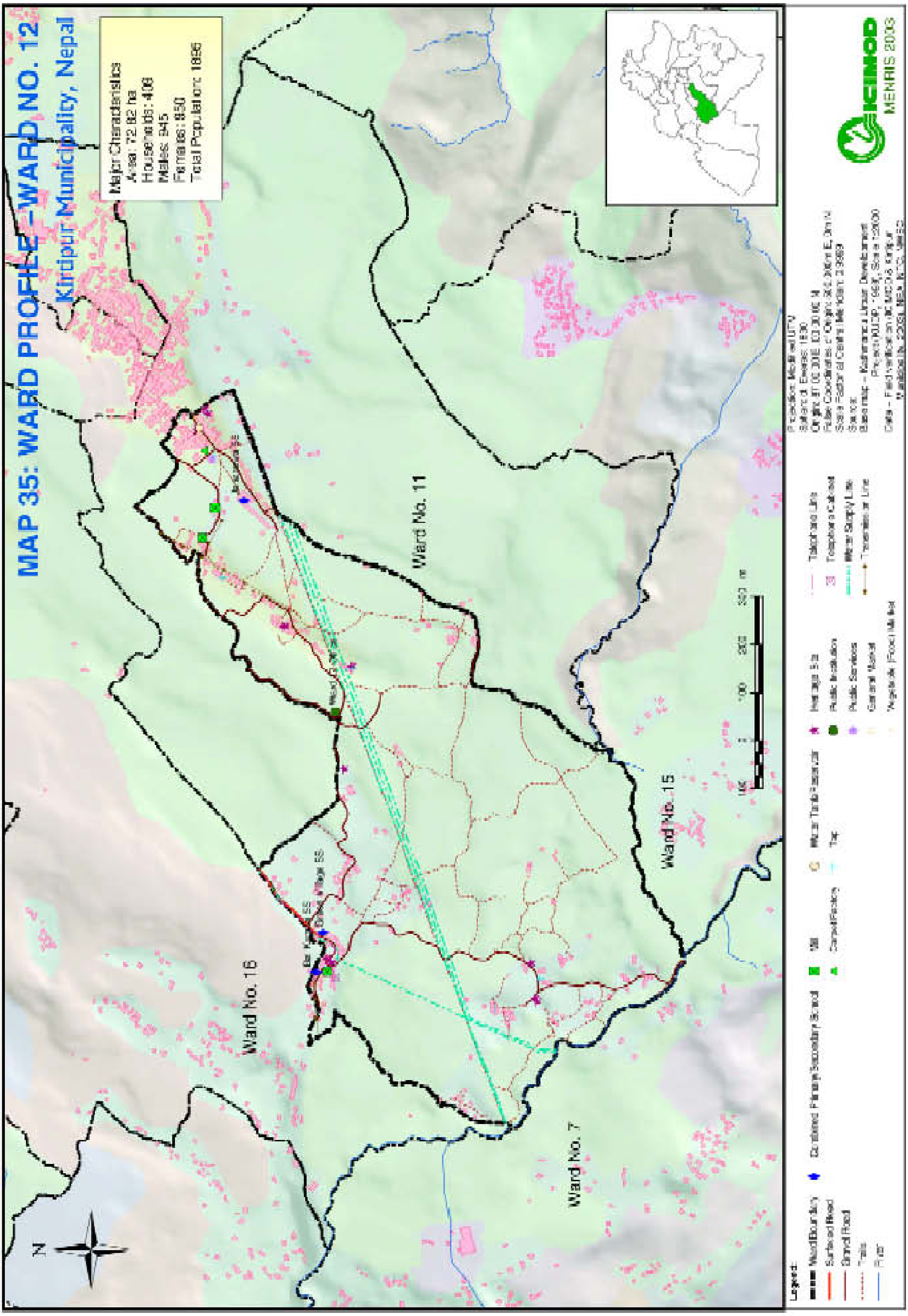

MAP 30: WARD PROFILE – WARD NO. 7
Kirtipur Municipality, Nepal
Major Characteristics
Area: 229.28 ha
Households: 418
Males: 1037
Females: 1014
Total Population: 2051
N
Ward No. 16
Ward No. 12
Ward No. 15
Ward No. 8
Chalnakhel VDC
160 0 160 320 480 m
Legend
Ward Boundary
Gravel Road
Trails
River
Combined Primary/Secondary School
Mill
Water Tank/Reservoir
Water Source
Heritage Site
Public Institution
Water Supply Line
Transmission Line
Building Footprint
Projection: Modified UTM
Spheroid: Everest 1830
ICIMOD
MENRIS 2003

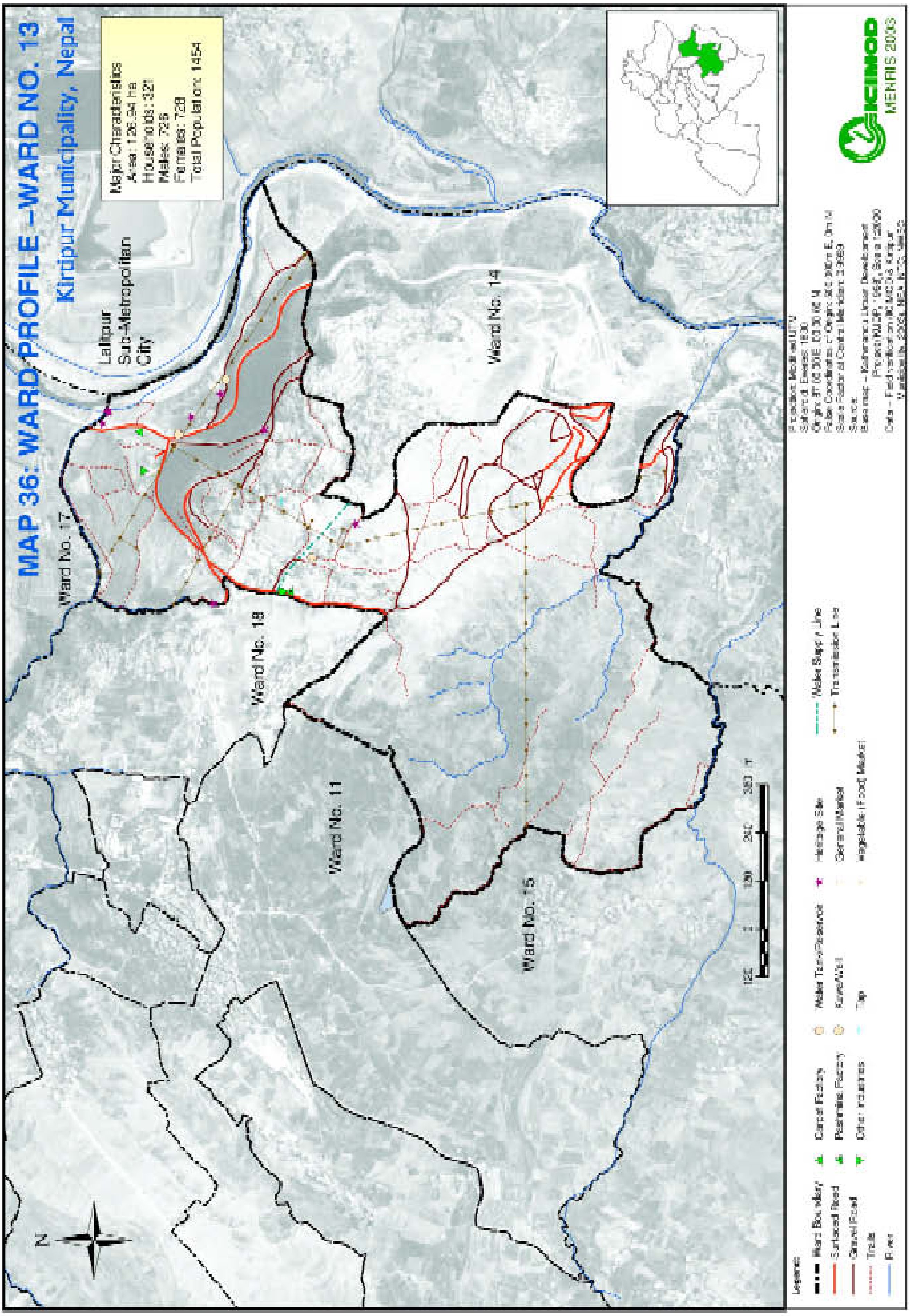

MAP 31: WARD PROFILE - WARD NO. 8
Kirtipur Municipality, Nepal
Ward No.19
Ward No.16
Ward No.7
Machhengaun VDC
ICIMOD
MENRIS 2003


MAP 32: WARD PROFILE –WARD NO. 9
Kirtipur Municipality, Nepal
Major Characteristics
Area: 8.84 ha
Households: 474
Males: 1105
Females: 914
Total Population: 2019
N
Ward No. 18
Ward No. 10
Ward No. 11
Krishna Cine Vision Hall
Snowline Carpet
Panga SS
Everest Carpet
Ward 9 Office
Nawa Jyoti SS
30 0 30 60 90 m
Legend:
Ward Boundary
Surfaced Road
Gravel Road
Trails
River
Combined Primary/Secondary School
Carpet Factory
Cinema Hall
Water Tank/Reservoir
Pond
Kuwa/Well
Tap
Heritage Site
Public Institution
General Market
Vegetable (Food) Market
Telephone Line
Telephone Cabinet
Transmission Line
Projection: Modified UTM
Spheroid: Everest 1830
Source:
Base map – Kathmandu Urban Development Project (KUDP, 1998), Scale 1:2000
Data – Field verification (ICIMOD & Kirtipur Municipality, 2003), NEA, NTC, NWSC
ICIMOD
MENRIS 2003

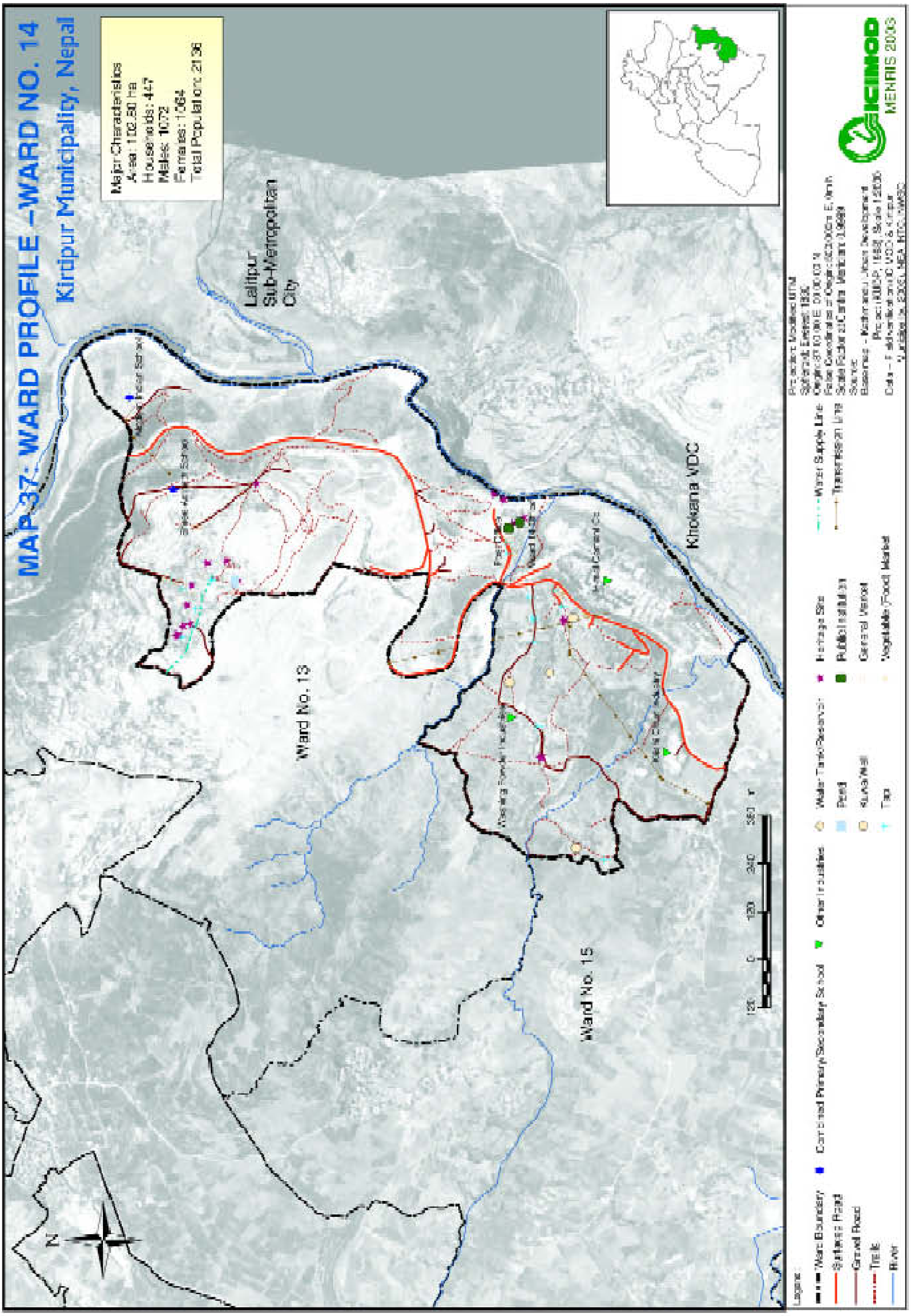

MAP 33: WARD PROFILE –WARD NO. 10
Kirtipur Municipality, Nepal
Major Characteristics
Area: 8.35 ha
Households: 229
Males: 565
Females: 526
Total Population: 1091
N
Ward No. 17
Ward No. 18
Ward No. 16
Ward No. 9
Ward No. 11
Ward No. 11
Ward 10 Office/
Bal Bikash Kendra/
Library
30 0 30 60 90 m
Legend:
Ward Boundary
Trails
River
Primary School
Library
Carpet Factory
Pond
Kuwa/Well
Tap
Heritage Site
Public Institution
General Market
Vegetable (Food) Market
Transmission Line
Projection: Modified UTM
Spharoid: Everest 1830
Origin: 87 00 00 E 00 00 00 N
False Coordinates of Origin: 500,000m E, 0m N
Scale Factor at Central Meridian: 0.9999
Source:
Base map – Kathmandu Urban Development Project (KUDP, 1998), Scale 1:2500
Data – Field verification (ICIMOD & Kirtipur Municipality, 2003), NEA, NTC, NWSC
ICIMOD
MENRIS 2003

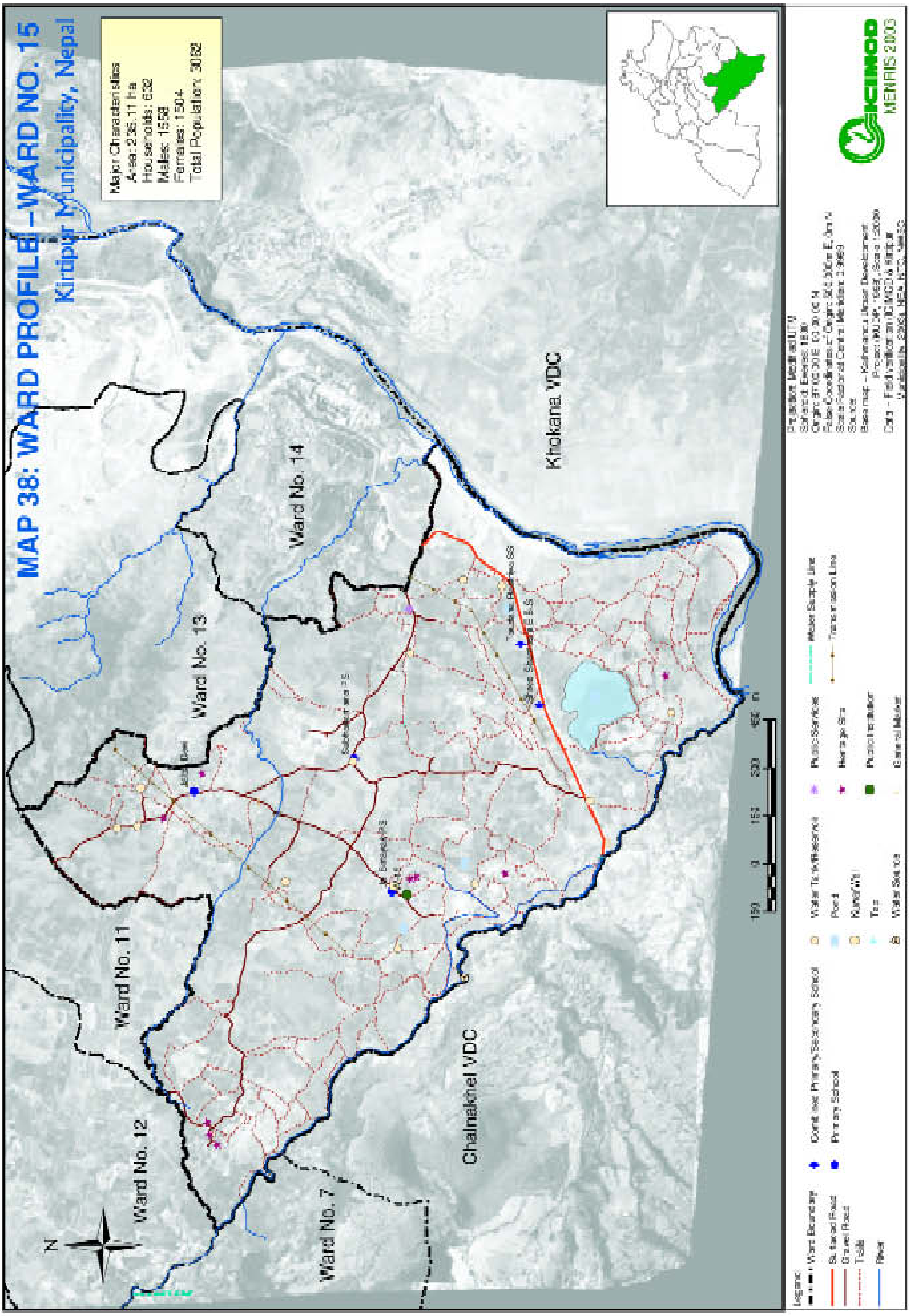

MAP 34: WARD PROFILE – WARD NO. 11
Kirtipur Municipality, Nepal
Major Characteristics
Area: 85.82 ha
Households: 488
Males: 1077
Females: 1085
Total Population: 2172
Ward No. 18
Ward No. 9
Ward No. 10
Ward No. 13
Ward No. 15
Ward No. 12
Ward No. 16
ICIMOD
MENRIS 2006

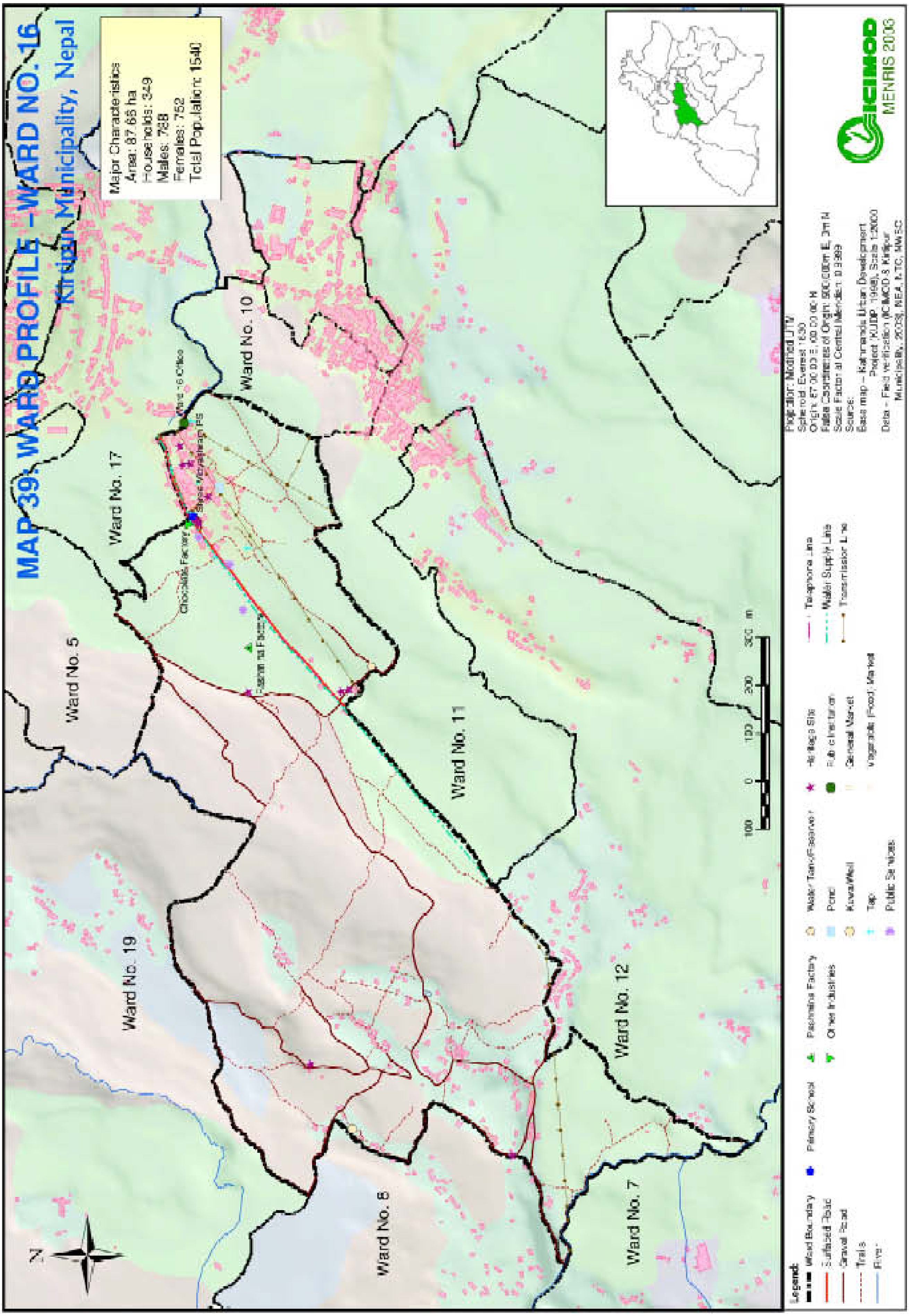

MAP 35: WARD PROFILE – WARD NO. 12
Kirtipur Municipality, Nepal
Major Characteristics
Area: 72.82 ha
Ward No. 11
Ward No. 15
Ward No. 16
Ward No. 7
N
Legend
ICIMOD
MENRIS 2003

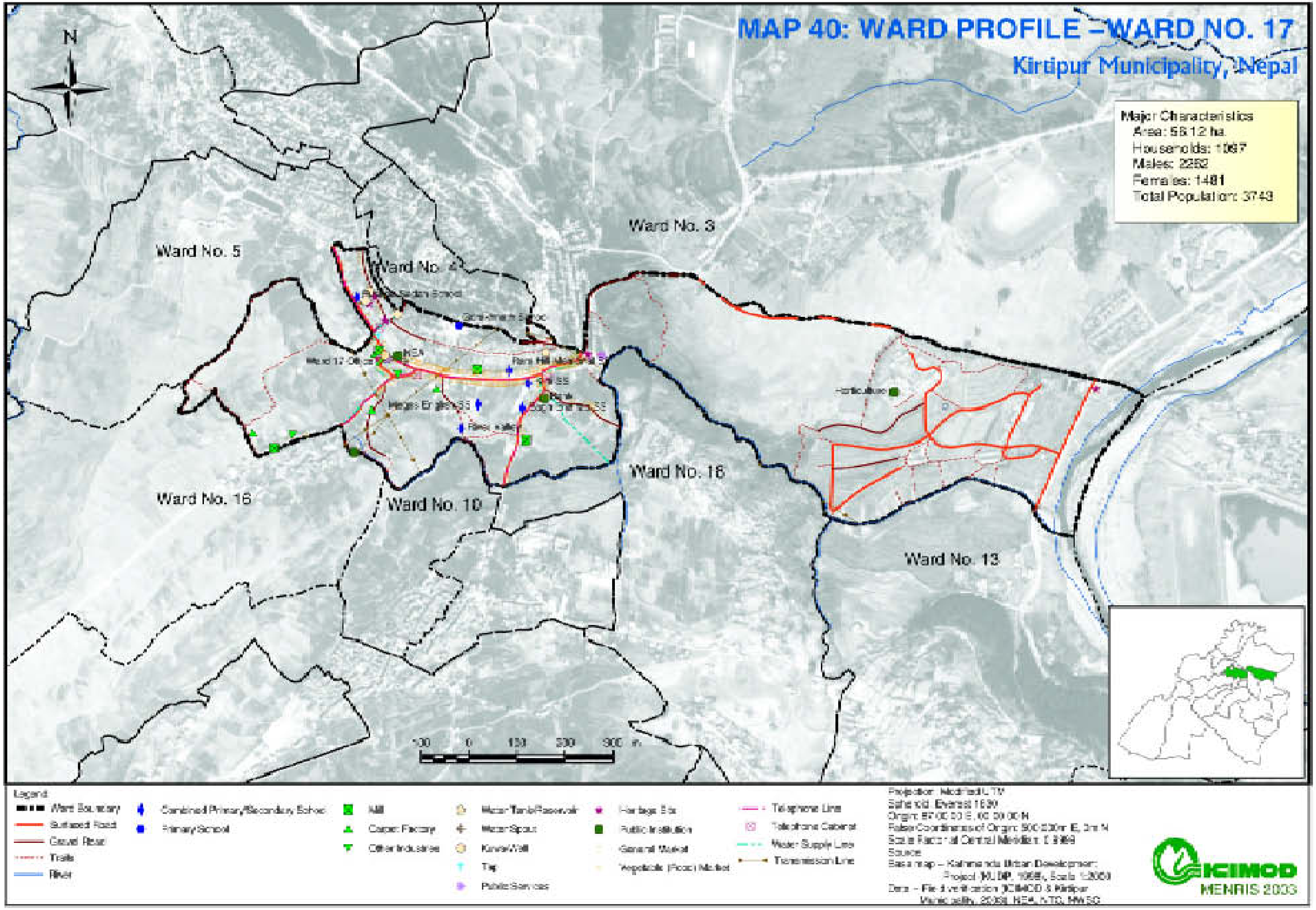


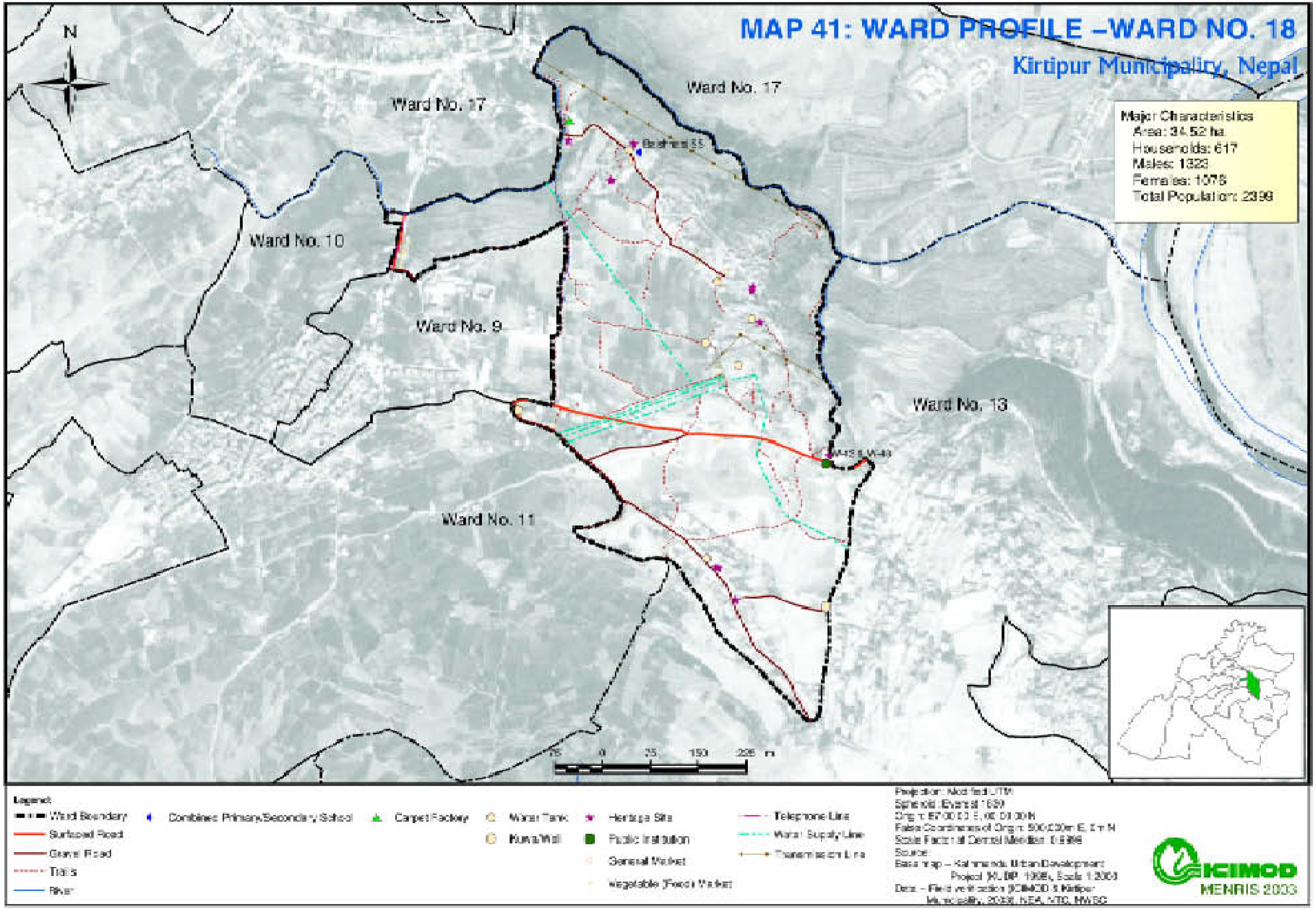
MAP 36: WARD PROFILE –WARD NO. 13
Kirtipur Municipality, Nepal
Major Characteristics
Area: 126.94 ha
Households: 321
Males: 726
Females: 728
Total Population: 1454
Lalitpur
Sub-Metropolitan
City
Ward No. 17
Ward No. 18
Ward No. 11
Ward No. 14
Ward No. 15
N
120 0 120 240 360 m
Legend
Ward Boundary
Surfaced Road
Gravel Road
Trails
River
Carpet Factory
Pashmina Factory
Other Industries
Water Tank/Reservoir
Kuwa/Well
Tap
Heritage Site
General Market
Vegetable (Food) Market
Water Supply Line
Transmission Line
ICIMOD
MENRIS 2003

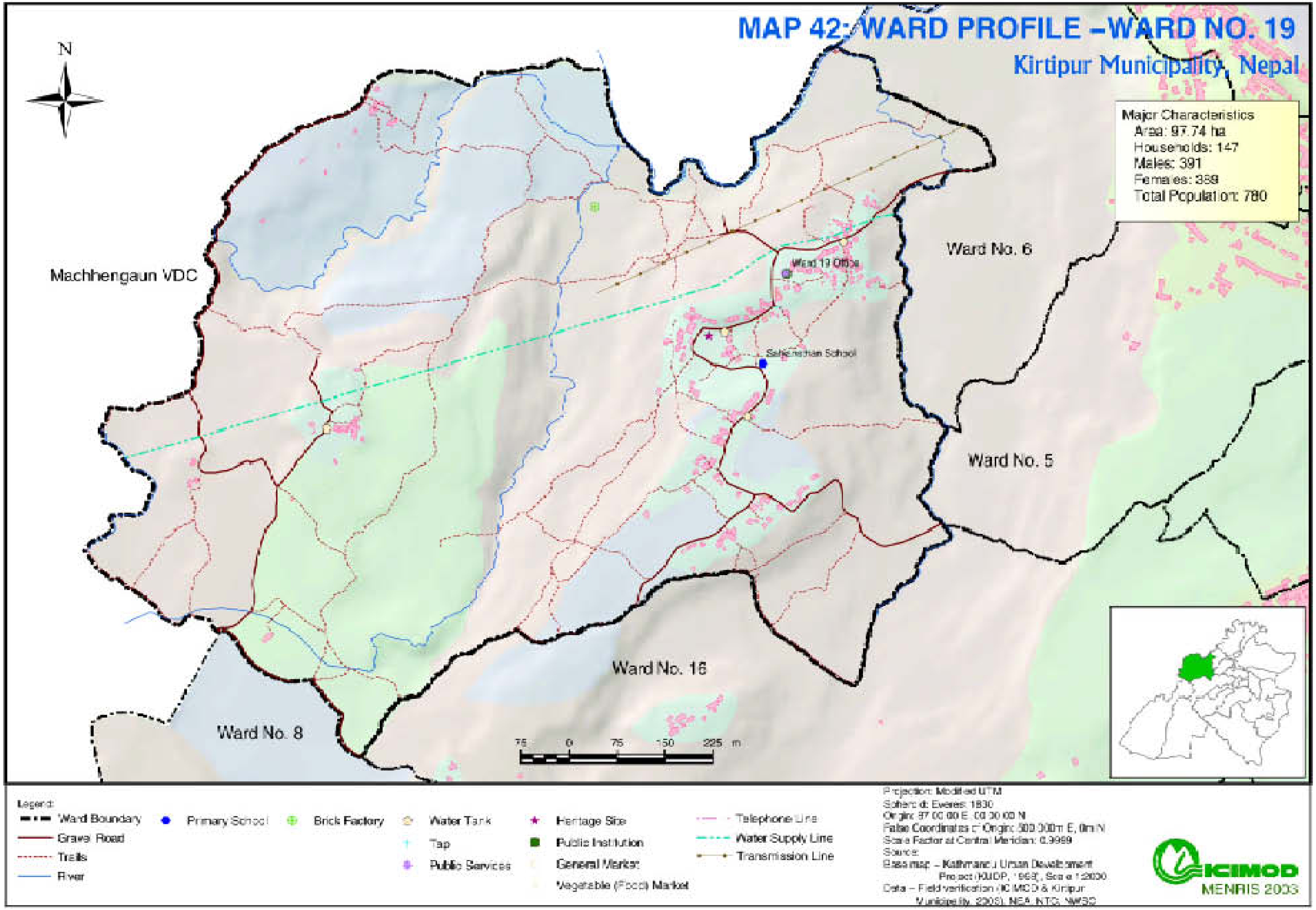

MAP 37: WARD PROFILE – WARD NO. 14
Kirtipur Municipality, Nepal
Major Characteristics
Area: 102.80 ha
Households: 447
Males: 1072
Females: 1064
Total Population: 2136
Lalitpur Sub-Metropolitan City
Khokana VDC
Ward No. 13
Ward No. 15
Legend
Ward Boundary
Surfaced Road
Gravel Road
Trails
River
Combined Primary/Secondary School
Other Institutions
Water Tank/Reservoir
Pond
Kuwa/Well
Tap
Heritage Site
Public Institution
General Market
Vegetable/Food Market
Water Supply Line
Transmission Line
ICIMOD
MENRIS 2006


MAP 38: WARD PROFILE – WARD NO. 15
Kirtipur Municipality, Nepal
Major Characteristics
Area: 236.11 ha
Households: 632
Males: 1558
Females: 1504
Total Population: 3062
Ward No. 14
Ward No. 13
Ward No. 11
Ward No. 12
Ward No. 7
Khokana VDC
Chalnakhel VDC
N
Legend
Ward Boundary
Gravel Road
Trails
River
Primary School
Pond
Tap
Water Source
Heritage Site
Water Supply Line
Transmission Line
ICIMOD
MENRIS 2003


MAP 39: WARD PROFILE – WARD NO. 16
Kirtipur Municipality, Nepal
Major Characteristics
Area: 87.68 ha
Households: 349
Males: 788
Females: 752
Total Population: 1540
Ward No. 17
Ward No. 10
Ward No. 5
Ward No. 11
Ward No. 19
Ward No. 12
Ward No. 8
Ward No. 7
Chocolate Factory
Pashmina Factory
Legend:
Ward Boundary
Surfaced Road
Gravel Road
Trails
River
Primary School
Pashmina Factory
Other Industries
Water Tank/Reservoir
Pond
Kuwa/Well
Tap
Public Services
Heritage Site
Public Institution
General Market
Vegetable (Food) Market
Telephone Line
Water Supply Line
Transmission Line
Projection: Modified UTM
Spheroid: Everest 1830
Base map – Kathmandu Urban Development Project (KUDP 1998), Scale 1:2000
ICIMOD
MENRIS 2006


MAP 40: WARD PROFILE – WARD NO. 17
Kirtipur Municipality, Nepal
Major Characteristics
Area: 56.12 ha.
Households: 1097
Males: 2262
Females: 1481
Total Population: 3743
N
Ward No. 3
Ward No. 5
Ward No. 4
Ward No. 16
Ward No. 10
Ward No. 16
Ward No. 13
Horticulture
Legend
Ward Boundary
Surfaced Road
Gravel Road
Trails
River
Combined Primary/Secondary School
Primary School
Mill
Carpet Factory
Other Industries
Water Tank/Reservoir
Water Spout
Kuwa/Well
Tap
Public Services
Heritage Site
Public Institution
General Market
Vegetable (Food) Market
Telephone Line
Telephone Cabinet
Water Supply Line
Transmission Line
ICIMOD
MENRIS 2003


MAP 41: WARD PROFILE –WARD NO. 18
Kirtipur Municipality, Nepal
N
Major Characteristics
Area: 34.52 ha
Households: 617
Males: 1323
Females: 1076
Total Population: 2399
Ward No. 17
Ward No. 17
Ward No. 10
Ward No. 9
Ward No. 11
Ward No. 13
Legend
Ward Boundary
Surfaced Road
Gravel Road
Trails
River
Combined Primary/Secondary School
Carpet Factory
Water Tank
Kuwa/Well
Heritage Site
Public Institution
General Market
Telephone Line
Water Supply Line
Transmission Line
ICIMOD
MENRIS 2003


MAP 42: WARD PROFILE – WARD NO. 19
Kirtipur Municipality, Nepal
Major Characteristics
Area: 97.74 ha
Households: 147
Males: 391
Females: 389
Total Population: 780
N
Machhengaun VDC
Ward No. 6
Ward No. 5
Ward No. 16
Ward No. 8
Ward 19 Office
75 0 75 150 225 m
Legend:
Ward Boundary
Gravel Road
Trails
River
Primary School
Brick Factory
Water Tank
Tap
Public Services
Heritage Site
Public Institution
General Market
Vegetable (Food) Market
Telephone Line
Water Supply Line
Transmission Line
Projection: Modified UTM
Spheroid: Everest 1830
Source:
ICIMOD
MENRIS 2003

Annex 1 Generation of the Orthophoto

Aerial photographs were used to generate an orthophoto covering part of Kirtipur Municipality. The details are given below.

Aerial photographs

Source:	Nepal Telecommunications Corporation
Scale:	1:10,000
Date:	16-03-1992
Scanning resolution:	12000 dpi

Specifications used to generate the orthophoto

1.	Geometric Model:		Frame Camera
2.	Reference System		
	a.	Projection:	ORG-87
		Projection Type:	Transverse Mercator
		Spheroid:	Everest 1956
		Datum:	Indian (India, Nepal)
		Scale factor at central meridian:	0.9999
		Longitude of central meridian:	87:00:00E
		Latitude of origin of projection:	00:00:00N
		False easting:	500000.00 metres
		False northing:	0.00000 metres
	b.	Reference Units	
		Horizontal units:	Metres
		Vertical units:	Metres
		Angle units:	Degrees
	c.	Frame specific information	
		Rotation system:	Omega, Phi, Kappa
		Photo direction:	z-axis for normal images
		Average flying height:	1540 metres
3.	Camera Settings		
	Camera:		Carl Zeiss
	Description:		RMK Top 15
	Focal Length:		154.058 mm
	Principal Point (x):		0.010 mm
	Principal Point (y):		0.000 mm

Fiducials: 8 nos.

	Film X (mm)	Film Y (mm)
i.	112.988	0.00
ii.	-112.987	0.00
iii.	0.013	113.007
iv.	0.013	-113.008
v.	112.998	113.000
vi.	-112.987	-113.003
vii.	-112.989	112.990
viii.	113.008	-113.003

Radial lens distortion:

	Radial distance (mm)	Distortion (microns)
i.	0	0.00
ii.	10	0.00
iii.	20	-1.00
iv.	30	-1.00
v.	40	-1.00
vi.	50	1.00
vii.	60	-1.00
viii.	70	2.00
ix.	80	1.00
x.	90	0.00
xi.	100	-1.00
xii.	110	-1.00
xiii.	120	-2.00
xiv.	130	-1.00
xv.	140	0.00
xvi.	150	0.00

Annex 2 Important Heritage Sites in Kirtipur Municipality

Bagh Bhairab

The Bagh Bhairab temple complex is situated at the centre of the old core area and is the most honoured shrine in Kirtipur. The temple, dedicated to Bhairab in tiger form, was built in the twelfth century. A collection of weapons, mounted on the open balconies of the upper levels of the temple, are said to have been captured during the siege of Kirtipur by the Gorkhalis. The temple complex consists of many small sculptures dedicated to various gods and goddesses built throughout its history.

Uma Maheswar Temple

The Uma Maheswar temple is a three-tiered structure situated at the highest point of the northern ridge of Kirtipur hill. It is dedicated to Shiva and Parvati. The temple has suffered damage during earthquakes and storms. It was last renovated in 1982. The temple has a picturesque view of the Kathmandu valley.

Chilancho Vihar (Jagatpal Vihar)

This complex consists of a Buddhist stupa surrounded by four similar shrines. It was established in 1515 by Mahapatra Jagatpal Verma and has been renovated many times.

Adinath Temple

The Adinath temple is situated on Chobhar hill. It was built in the fifteenth century by King Amsuvarman and is dedicated to Lokeswor. The temple is covered with domestic utensils offered by newlyweds.

Bahals

These are ancient courtyards often with a central religious stone carving. Hidden behind simple domestic facades, they can contain extensive wood carvings in the form of balconies and supports. Important ones in the municipality include the Chwe Bahal, Kwe Bahal, Padnochcha Bahal, Ikha Bahal, Kusi Bahal, Chithun Bahal, and Yoka Bahal.

Annex 3 Metadata

METADATA

Data Identification

Name:	**bridge**
Type:	vector digital data
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	Bridge
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.257893
East Coordinate:	85.294215
North Coordinate:	27.685935
South Coordinate:	27.642303
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit:	Metres
Projection Parameters:	Projection name: Transverse Mercator Spheroid: Everest 1830 Longitude of Central Meridian: 87 00 00 E Latitude of Projection Origin: 00 00 00 N False Easting: 500 000m E False Northing: 0m N Scale factor at central meridian: 0.9999

Data Storage

Data Format:	Shapefile

Citation

Data Developed by:	MENRIS
Data Source:	KUDP, 1998
Data Source Scale:	1:2,000

Attributes of: bridge

	Data type	Width	Precision	Scale	Description
FID	OID	4	0	0	Internal feature number
Shape	Geometry	0	0	0	Feature geometry
ID	Number	8			
BRIDGE_ID	Number	4			

METADATA

Data Identification

Name:	**build_all**
Type:	vector digital data
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	Building Footprint
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.246003
East Coordinate:	85.299194
North Coordinate:	27.685865
South Coordinate:	27.639809
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit: Metres

Projection Parameters:
Projection name: Transverse Mercator
Spheroid: Everest 1830
Longitude of Central Meridian: 87 00 00 E
Latitude of Projection Origin: 00 00 00 N
False Easting: 500 000m E
False Northing: 0m N
Scale factor at central meridian: 0.9999

Data Storage

Data Format: Shapefile

Citation

Data Developed by:	MENRIS
Data Source:	KUDP, 1998
Data Source Scale:	1:2,000

Attributes of: build_all

	Data type	Width	Number of decimals	Precision	Scale	Description
FID	OID	4		0	0	Internal feature number
Shape	Geometry	0		0	0	Feature geometry
AREA	Number	13	6			
PERIMETER	Number	13	6			
HOUSE_	Number	11				
HOUSE_ID	Number	11				
X_VAL	Number	10	5			
Y_VAL	Number	10	5			
WEIGHT	Number	16				
POPULATION	Number	16				

METADATA

Data Identification

Name:	con_all
Type:	vector digital data
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	Contour
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.234323
East Coordinate:	85.299597
North Coordinate:	27.685380
South Coordinate:	27.637890
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit:	Metres
Projection Parameters:	Projection name: Transverse Mercator Spheroid: Everest 1830 Longitude of Central Meridian: 87 00 00 E Latitude of Projection Origin: 00 00 00 N False Easting: 500 000m E False Northing: 0m N Scale factor at central meridian: 0.9999

Data Storage

Data Format:	Shapefile

Citation

Data Developed by:	MENRIS
Data Source:	KUDP, 1998
Data Source Scale:	1:2,000

Attributes of: con_all

	Data type	Width	Number of decimals	Precision	Scale	Description
FID	OID	4		0	0	Internal feature number
Shape	Geometry	0		0	0	Feature geometry
FNODE_	Number	11				
TNODE_	Number	11				
LPOLY_	Number	11				
RPOLY_	Number	11				
LENGTH	Float	13	3			
CON_ALL_	Number	11				
CON_ALL_ID	Number	11				

METADATA

Data Identification

Name:	**e129-f170e.img**
Type:	remote-sensing image
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	Orthophoto
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.261526
East Coordinate:	85.306855
North Coordinate:	27.691245
South Coordinate:	27.637167
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit:	Metres
Projection Parameters:	Projection name: Transverse Mercator Spheroid: Everest 1830 Longitude of Central Meridian: 87 00 00 E Latitude of Projection Origin: 00 00 00 N False Easting: 500 000m E False Northing: 0m N Scale factor at central meridian: 0.9999

Data Storage

Data Format:	Raster Dataset

Citation

Data Developed by:	MENRIS
Data Source:	Aerial Photo, NTC, 1992
Data Source Scale:	1:10,000

Attributes of: Layer_1

	Data type	Width	Precision	Scale
ObjectID	OID	4	0	0
Value	Integer	0	0	0
Count	Double	0	0	0
Contrast	Double	0	0	0
Breakpoints	Double	0	0	0

METADATA

Data Identification

Name:	**education03**
Type:	vector digital data
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	Educational Institution
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.253519
East Coordinate:	85.296543
North Coordinate:	27.684211
South Coordinate:	27.644097
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit: Metres

Projection Parameters:
Projection name: Transverse Mercator
Spheroid: Everest 1830
Longitude of Central Meridian: 87 00 00 E
Latitude of Projection Origin: 00 00 00 N
False Easting: 500 000m E
False Northing: 0m N
Scale factor at central meridian: 0.9999

Data Storage

Data Format: Shapefile

Citation

Data Developed by:	MENRIS
Data Source:	Field Survey, 1999/2003
Data Source Scale:	1:2,000

Attributes of: education03

	Data type	Width	Precision	Scale	Description
FID	OID	4	0	0	Internal feature number
Shape	Geometry	0	0	0	Feature geometry
WARD_ID	Number	2			
ID_NO	Number	4			
PLACE	String	14			
NAME_	String	22			
TYPE	String	15			
ID	Number	4			

METADATA

Data Identification

Name:	**factory03**
Type:	vector digital data
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	Industry
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.258728
East Coordinate:	85.291833
North Coordinate:	27.685712
South Coordinate:	27.648787
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit:	Metres
Projection Parameters:	Projection name: Transverse Mercator Spheroid: Everest 1830 Longitude of Central Meridian: 87 00 00 E Latitude of Projection Origin: 00 00 00 N False Easting: 500 000m E False Northing: 0m N Scale factor at central meridian: 0.9999

Data Storage

Data Format:	Shapefile

Citation

Data Developed by:	MENRIS
Data Source:	Field Survey, 1999/2003
Data Source Scale:	1:2,000

Attributes of: factory03

	Data type	Width	Precision	Scale	Description
FID	OID	4	0	0	Internal feature number
Shape	Geometry	0	0	0	Feature geometry
WARD_ID	Number	2			
ID_NO	Number	4			
PLACE	String	14			
NAME_	String	22			
TYPE	String	15			
ID	Number	4			

METADATA

Data Identification

Name:	**gmarket**
Type:	vector digital data
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	Market
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.251419
East Coordinate:	85.298350
North Coordinate:	27.678965
South Coordinate:	27.641873
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit:	Metres
Projection Parameters:	Projection name: Transverse Mercator Spheroid: Everest 1830 Longitude of Central Meridian: 87 00 00 E Latitude of Projection Origin: 00 00 00 N False Easting: 500 000m E False Northing: 0m N Scale factor at central meridian: 0.9999

Data Storage

Data Format:	Shapefile

Citation

Data Developed by:	MENRIS
Data Source:	FAO, 1999
Data Source Scale:	1:2,000

Attributes of: gmarket

	Data type	Width		Precision	Scale	Description
FID	OID	4		0	0	Internal feature number
Shape	Geometry	0		0	0	Feature geometry
ID	Number	8				
BUFFERDIS	Number	16	4			

METADATA

Data Identification

Name:	**heritage03**
Type:	vector digital data
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	Heritage Sites
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.247924
East Coordinate:	85.294404
North Coordinate:	27.679366
South Coordinate:	27.640479
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit: Metres

Projection Parameters:
Projection name: Transverse Mercator
Spheroid: Everest 1830
Longitude of Central Meridian: 87 00 00 E
Latitude of Projection Origin: 00 00 00 N
False Easting: 500 000m E
False Northing: 0m N
Scale factor at central meridian: 0.9999

Data Storage

Data Format: Shapefile

Citation

Data Developed by:	MENRIS
Data Source:	Field Survey, 1999/2003
Data Source Scale:	1:2,000

Attributes of: heritage03

	Data type	Width	Precision	Scale	Description
FID	OID	4	0	0	Internal feature number
Shape	Geometry	0	0	0	Feature geometry
WARD_ID	Number	2			
ID_NO	Number	4			
PLACE	String	14			
NAME_	String	22			
TYPE	String	15			
ID	Number	4			

METADATA

Data Identification

Name:	**ikono_aerial2.img**
Type:	remote-sensing image
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	IKONOS Satellite image
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.249122
East Coordinate:	85.305869
North Coordinate:	27.689978
South Coordinate:	27.633502
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit:	Metres
Projection Parameters:	Projection name: Transverse Mercator Spheroid: Everest 1830 Longitude of Central Meridian: 87 00 00 E Latitude of Projection Origin: 00 00 00 N False Easting: 500 000m E False Northing: 0m N Scale factor at central meridian: 0.9999

Data Storage

Data Format:	Raster Dataset

Citation

Data Developed by:	MENRIS
Data Source:	Space Imaging, 10 November 2001
Data Source Scale:	Pixel size 1m

METADATA

Data Identification

Name:	**kirtp_dem**
Type:	raster digital data
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	DEM
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.234282
East Coordinate:	85.300090
North Coordinate:	27.686337
South Coordinate:	27.637664
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit:	Metres
Projection Parameters:	Projection name: Transverse Mercator Spheroid: Everest 1830 Longitude of Central Meridian: 87 00 00 E Latitude of Projection Origin: 00 00 00 N False Easting: 500 000m E False Northing: 0m N Scale factor at central meridian: 0.9999

Data Storage

Data Format:	Raster Dataset

Citation

Data Developed by:	MENRIS
Data Source:	Generated from contour and spot height, KUDP, 1998
Data Source Scale:	1:2,000

METADATA

Data Identification

Name:	**lause92_all**
Type:	vector digital data
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	Land Use 1992
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.234315
East Coordinate:	85.300067
North Coordinate:	27.686314
South Coordinate:	27.637816
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit:	Metres
Projection Parameters:	Projection name: Transverse Mercator Spheroid:Everest 1830 Longitude of Central Meridian: 87 00 00 E Latitude of Projection Origin: 00 00 00 N False Easting: 500 000m E False Northing: 0m N Scale factor at central meridian: 0.9999

Data Storage

Data Format:	Shapefile

Citation

Data Developed by:	MENRIS
Data Source:	Aerial Photo, NTC, 1992
Data Source Scale:	1:10,000

Attributes of: lause92_all

	Data type	Width	Number of decimals	Precision	Scale	Description
FID	OID	4		0	0	Internal feature number
Shape	Geometry	0		0	0	Feature geometry
LAUSE92_ID	Number	19	11			
Cnt_LAUSE9	Number	9				
Max_AREA	Number	19	11			
Max_L_AREA	Number	13	11			
Max_PERIME	Number	19	11			

METADATA

Data Identification

Name:	**lause98_all**
Type:	vector digital data
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	Land Use 1998
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.234315
East Coordinate:	85.300067
North Coordinate:	27.686314
South Coordinate:	27.637816
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit:	Metres
Projection Parameters:	Projection name: Transverse Mercator Spheroid: Everest 1830 Longitude of Central Meridian: 87 00 00 E Latitude of Projection Origin: 00 00 00 N False Easting: 500 000m E False Northing: 0m N Scale factor at central meridian: 0.9999

Data Storage

Data Format:	Shapefile

Citation

Data Developed by:	MENRIS
Data Source:	Aerial Photo, Dept. of Survey, 1998/ Field Survey, 1999
Data Source Scale:	1:15,000

Attributes of: lause98_all

	Data type	Width	Number of decimals	Precision	Scale	Description
FID	OID	4		0	0	Internal feature number
Shape	Geometry	0		0	0	Feature geometry
LANDUSE_ID	Float	19	11			
Cnt_LANDUS	Number	9				
Ave_Max_AR	Number	19	4			
Ave_Max_L_	Number	19	4			
Ave_Max_PE	Number	19	4			

METADATA

Data Identification

Name:	**new_ward**
Type:	vector digital data
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	Administrative Boundary
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.234315
East Coordinate:	85.300069
North Coordinate:	27.686316
South Coordinate:	27.637687
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit:	Metres
Projection Parameters:	Projection name: Transverse Mercator Spheroid: Everest 1830 Longitude of Central Meridian: 87 00 00 E Latitude of Projection Origin: 00 00 00 N False Easting: 500 000m E False Northing: 0m N Scale factor at central meridian: 0.9999

Data Storage

Data Format:	Shapefile

Citation

Data Developed by:	MENRIS
Data Source:	Kirtipur Municipality, 2001
Data Source Scale:	1:2,000

Attributes of: new_ward

	Data type	Width	Number of decimals	Precision	Scale	Description
FID	OID	4		0	0	Internal feature number
Shape	Geometry	0		0	0	Feature geometry
AREA	Float	19	11			
PERIMETER	Float	19	11			
NEW_WARD1_	Number	9				
NEW_WARD11	Number	9				
warea_km	Number	5	3			

METADATA

Data Identification

Name:	**pond**
Type:	vector digital data
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	Pond
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.264476
East Coordinate:	85.291994
North Coordinate:	27.676712
South Coordinate:	27.641487
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit:	Metres
Projection Parameters:	Projection name: Transverse Mercator Spheroid: Everest 1830 Longitude of Central Meridian: 87 00 00 E Latitude of Projection Origin: 00 00 00 N False Easting: 500 000m E False Northing: 0m N Scale factor at central meridian: 0.9999

Data Storage

Data Format:	Shapefile

Citation

Data Developed by:	MENRIS
Data Source:	KUDP, 1998
Data Source Scale:	1:2,000

Attributes of: pond

	Data type	Width	Number of decimals	Precision	Scale	Description
FID	OID	4		0	0	Internal feature number
Shape	Geometry	0		0	0	Feature geometry
FID_	Number	9				
AREA	Number	13	6			
PERIMETER	Number	13	6			
POND_	Number	10				
POND_ID	Number	10				

METADATA

Data Identification

Name:	**public_institution03**
Type:	vector digital data
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	Public Institution
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.251758
East Coordinate:	85.293315
North Coordinate:	27.676576
South Coordinate:	27.647803
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit:	Metres
Projection Parameters:	Projection name: Transverse Mercator Spheroid: Everest 1830 Longitude of Central Meridian: 87 00 00 E Latitude of Projection Origin: 00 00 00 N False Easting: 500 000m E False Northing: 0m N Scale factor at central meridian: 0.9999

Data Storage

Data Format:	Shapefile

Citation

Data Developed by:	MENRIS
Data Source:	Field Survey, 1999/2003
Data Source Scale:	1:2,000

Attributes of: public_institution03

	Data type	Width	Precision	Scale	Description
FID	OID	4	0	0	Internal feature number
Shape	Geometry	0	0	0	Feature geometry
WARD_ID	Number	2			
ID_NO	Number	4			
PLACE	String	14			
NAME_	String	22			
TYPE	String	15			
ID	Number	4			

METADATA

Data Identification

Name:	**public services03**
Type:	vector digital data
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	Public Services (Health)
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.255921
East Coordinate:	85.285123
North Coordinate:	27.677124
South Coordinate:	27.647790
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit:	Metres
Projection Parameters:	Projection name: Transverse Mercator Spheroid: Everest 1830 Longitude of Central Meridian: 87 00 00 E Latitude of Projection Origin: 00 00 00 N False Easting: 500 000m E False Northing: 0m N Scale factor at central meridian: 0.9999

Data Storage

Data Format:	Shapefile

Citation

Data Developed by:	MENRIS
Data Source:	Field Survey, 1999/2003
Data Source Scale:	1:2,000

Attributes of: public services03

	Data type	Width	Precision	Scale	Description
FID	OID	4	0	0	Internal feature number
Shape	Geometry	0	0	0	Feature geometry
WARD_ID	Number	2			
ID_NO	Number	4			
PLACE	String	14			
NAME_	String	22			
TYPE	String	15			
ID	Number	4			

METADATA

Data Identification

Name:	**public utilities03**
Type:	vector digital data
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	Public Utilities (Water Supply)
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.252063
East Coordinate:	85.292934
North Coordinate:	27.678978
South Coordinate:	27.640380
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit:	Metres
Projection Parameters:	Projection name: Transverse Mercator Spheroid: Everest 1830 Longitude of Central Meridian: 87 00 00 E Latitude of Projection Origin: 00 00 00 N False Easting: 500 000m E False Northing: 0m N Scale factor at central meridian: 0.9999

Data Storage

Data Format:	Shapefile

Citation

Data Developed by:	MENRIS
Data Source:	NWSC/ Field Survey, 1999/2003
Data Source Scale:	1:2,000

Attributes of: public utilities03

	Data type	Width	Precision	Scale	Description
FID	OID	4	0	0	Internal feature number
Shape	Geometry	0	0	0	Feature geometry
WARD_ID	Number	2			
ID_NO	Number	4			
PLACE	String	14			
NAME_	String	22			
TYPE	String	15			
ID	Number	4			

METADATA

Data Identification

Name:	**river_all**
Type:	vector digital data
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	Drainage
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.235292
East Coordinate:	85.300545
North Coordinate:	27.686517
South Coordinate:	27.637576
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit:	Metres
Projection Parameters:	Projection name: Transverse Mercator Spheroid: Everest 1830 Longitude of Central Meridian: 87 00 00 E Latitude of Projection Origin: 00 00 00 N False Easting: 500 000m E False Northing: 0m N Scale factor at central meridian: 0.9999

Data Storage

Data Format:	Shapefile

Citation

Data Developed by:	MENRIS
Data Source:	KUDP, 1998
Data Source Scale:	1:2,000

Attributes of: river_all

	Data type	Width	Number of decimals	Precision	Scale	Description
FID	OID	4		0	0	Internal feature number
Shape	Geometry	0		0	0	Feature geometry
FNODE_	Number	10				
TNODE_	Number	10				
LPOLY_	Number	10				
RPOLY_	Number	10				
LENGTH	Number	13	6			
RIVER_	Number	10				
RIVER_ID	Number	10				
LENGTH_KM	Number	8	2			

METADATA

Data Identification

Name:	**road03**
Type:	vector digital data
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	Road Network
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.245990
East Coordinate:	85.299149
North Coordinate:	27.686121
South Coordinate:	27.638426
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit:	Metres
Projection Parameters:	Projection name: Transverse Mercator Spheroid: Everest 1830 Longitude of Central Meridian: 87 00 00 E Latitude of Projection Origin: 00 00 00 N False Easting: 500 000m E- False Northing: 0m N Scale factor at central meridian: 0.9999

Data Storage

Data Format:	Shapefile

Citation

Data Developed by:	MENRIS
Data Source:	KUDP 1998, Field Survey 1999/2003
Data Source Scale:	1:2,000

Attributes of: road03

	Data type	Width	Number of decimals	Precision	Scale	Description
FID	OID	4		0	0	Internal feature number
Shape	Geometry	0		0	0	Feature geometry
FNODE_	Number	9				
TNODE_	Number	9				
LPOLY_	Number	9				
RPOLY_	Number	9				
LENGTH	Float	13	11			
ROAD03_COV	Number	9				
ROAD03_C_1	Number	9				
FNODE1	Number	9				
TNODE1	Number	9				
LPOLY1	Number	9				
RPOLY1	Number	9				
RONET_	Number	9				
RONET_ID	Number	9				
LENGTH_KM	Float	19	11			

METADATA

Data Identification

Name:	**teleline**
Type:	vector digital data
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	Telephone Line
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.264518
East Coordinate:	85.299074
North Coordinate:	27.679220
South Coordinate:	27.659865
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit:	Metres
Projection Parameters:	Projection name: Transverse Mercator Spheroid: Everest 1830 Longitude of Central Meridian: 87 00 00 E Latitude of Projection Origin: 00 00 00 N False Easting: 500 000m E False Northing: 0m N Scale factor at central meridian: 0.9999

Data Storage

Data Format:	Shapefile

Citation

Data Developed by:	MENRIS
Data Source:	NTC, 2000
Data Source Scale:	1:2,000

Attributes of: teleline

	Data type	Width	Number of decimals	Precision	Scale	Description
FID	OID	4		0	0	Internal feature number
Shape	Geometry	0		0	0	Feature geometry
FID_	Number	9				
FNODE_	Number	10				
TNODE_	Number	10				
LPOLY_	Number	10				
RPOLY_	Number	10				
LENGTH	Number	13	6			
TELINE_	Number	10				
TELINE_ID	Number	10				

METADATA

Data Identification

Name:	**transline**
Type:	vector digital data
Purpose:	Establishment of a database for Kirtipur Municipality
Theme:	Transmission Line
Place:	Kirtipur Municipality

Spatial Domain

West Coordinate:	85.255075
East Coordinate:	85.299508
North Coordinate:	27.681600
South Coordinate:	27.643950
Level:	Municipal
Coverage Location:	Kirtipur Municipality

Projection Information

Geographical Unit:	Metres
Projection Parameters:	Projection name: Transverse Mercator Spheroid: Everest 1830 Longitude of Central Meridian: 87 00 00 E Latitude of Projection Origin: 00 00 00 N False Easting: 500 000m E False Northing: 0m N Scale factor at central meridian: 0.9999

Data Storage

Data Format:	Shapefile

Citation

Data Developed by:	MENRIS
Data Source:	NEA, 2000
Data Source Scale:	1:2,000

Attributes of: transline

	Data type	Width	Precision	Scale	Description
FID	OID	4	0	0	Internal feature number
Shape	Geometry	0	0	0	Feature geometry
TRANL_ID	Number	4			
CAP_KV	Number	4			
SOURCES	String	24			

METADATA

Data Identification

Name: waterline
Type: vector digital data
Purpose: Establishment of a database for Kirtipur Municipality
Theme: Water Supply Line
Place: Kirtipur Municipality

Spatial Domain

West Coordinate: 85.256399
East Coordinate: 85.291917
North Coordinate: 27.676668
South Coordinate: 27.653897
Level: Municipal
Coverage Location: Kirtipur Municipality

Projection Information

Geographical Unit: Metres
Projection Parameters: Projection name: Transverse Mercator
Spheroid: Everest 1830
Longitude of Central Meridian: 87 00 00 E
Latitude of Projection Origin: 00 00 00 N
False Easting: 500 000m E
False Northing: 0m N
Scale factor at central meridian: 0.9999

Data Storage

Data Format: Shapefile

Citation

Data Developed by: MENRIS
Data Source: DWSS, 2000
Data Source Scale: 1:2000, 1998

Attributes of: waterline

	Data type	Width	Number of decimals	Precision	Scale	Description
FID	OID	4		0	0	Internal feature number
Shape	Geometry	0		0	0	Feature geometry
FID_	Number	9				
FNODE_	Number	10				
TNODE_	Number	10				
LPOLY_	Number	10				
RPOLY_	Number	10				
LENGTH	Number	13	6			
WATERL_	Number	10				
WATERL_ID	Number	10				
WATERL_DIA	Number	3				

about the authors

Basanta Shrestha has an M.Eng. in Computer Science from the Asian Institute of Technology, Bangkok, Thailand, and a B.Eng. in Electrical and Electronic Engineering from Madras University, India, and has extensive experience in the field of information technology and applications. He joined ICIMOD in 1990 and is currently Head of MENRIS, focusing on geographical information systems' technology, remote sensing technology, and global positioning systems' technology. He has published five reports and numerous papers on various aspects of these technologies and their applications and has contributed to improving information technology infrastructure and access to information across the HKH region.

Birendra Bajracharya has an M.Sc. in Geo-Informatics from the International Institute for Aerospace and Earth Sciences (ITC), The Netherlands, an MBA from Tribhuvan University, Kathmandu, and a B.Sc. in Civil Engineering from the University of Rajasthan, India. At ICIMOD, he is involved in developing and conducting training on GIS and remote sensing, developing databases, and carrying out application case studies. His major contributions include the development of a CD-ROM on 'Computer Based Training on GIS/RS' and the publications 'Climatic and Hydrological Atlas of Nepal' and 'Districts of Nepal - Indicators of Development'. Prior to joining ICIMOD in 1995, he worked as an Engineer at the Department of Water Supply and Sewerage, mainly on management information systems, monitoring and supervision, and computer-aided design and facility mapping. He has also worked for various private organisations as a consulting engineer and CAD expert.

Sushil Pradhan has an M.Sc. in Geo-Information Systems (GIS) for Rural Applications from Wageningen Agricultural University and the International Institute for Aerospace Survey and Earth Sciences (ITC), The Netherlands, and a postgraduate diploma in Geo-Information Systems and Computer Information Systems from the International Statistics Programs Centre/US Bureau of Census, in cooperation with Washington University, Washington DC, USA. He joined ICIMOD in 1994 and is currently involved in the application of 3-S (GIS, RS, GPS) technologies in various programmes of ICIMOD. His publications include a report 'GIS Database of Key Indicators of Sustainable Mountain Development in Nepal' and a paper on 'Integration of GIS, Remote Sensing, and Area Frame Sampling for Crop Acreage Estimation'

Lokap Rajbhandari has a B.Sc. in Civil Engineering from Bangladesh University of Engineering and Technology (BUET), Bangladesh, and has received training in large scale digital mapping from Japan. Before joining ICIMOD, he worked as a consultant for different organisations in various capacities involving CAD, GIS, topographic map preparation, survey data interpretation, and design and supervision work. At ICIMOD, he is involved in the design and development of geodatabases, orthophoto generation, and photogrammetric applications.