



GIS for Municipal Planning

A Case Study from Kirtipur Municipality

Basanta Shrestha
Birendra Bajracharya
Sushil Pradhan
Lokap Rajbhandari

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.

GIS for Municipal Planning

A Case Study from Kirtipur Municipality

Basanta Shrestha
Birendra Bajracharya
Sushil Pradhan
Lokap Rajbhandari

International Centre for Integrated Mountain Development (ICIMOD)
Mountain Environment and Natural Resources Information Systems (MENRIS)
October 2003

Copyright © 2003

International Centre for Integrated Mountain Development
All rights reserved

Published by

International Centre for Integrated Mountain Development
GPO Box 3226
Kathmandu, Nepal

ISBN 92 9115 765 1

Editorial Team

Jenny Riley (Consultant Editor)
A. Beatrice Murray (Editor)
Dharma R. Maharjan (Technical Support & Layout)

Printed and bound in Nepal by

Hill Side Press (P) Ltd.
Kathmandu

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

Foreword

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

Table of Contents

Foreword	
Acknowledgements	
Executive Summary	
Acronyms and Abbreviations	
Chapter 1 Introduction	1
Background	1
Overview of Kirtipur	2
Development trends	2
Rationale and objectives of the study	3
Chapter 2 The Municipal Planning Process in Nepal	5
Integrated action planning (IAP)	5
GIS in municipal planning	5
Information requirements for municipal planning	7
Chapter 3 Design and Development of the Database	9
Data collection and needs assessment	9
Conversion of existing digital data	9
Aerial photographs	12
Digital orthophoto	12
Satellite data	14
Data on social infrastructure	14
Data on utilities	14
Socioeconomic data	14
Chapter 4 Spatial Profile of Kirtipur Municipality	15
Demography	15
Physical infrastructure	16
Social infrastructure	19
Land use and land cover	22
Ward profiles	23
Chapter 5 Change in Land-use and Land Cover	25
Land-use and land cover from 1992 to 1998	25
Urban growth analysis	26
Urban growth versus accessibility	27
Chapter 6 Conclusions	29
References	31
Maps	33
Annex 1 Generation of the Orthophoto	75
Annex 2 Important Heritage Sites in Kirtipur Municipality	77
Annex 3 Metadata	79

List of maps

- 1: Orthorectified Aerial Photo for Part of Kirtipur Municipality
- 2: IKONOS Satellite Image for Part of Kirtipur Municipality
- 3: Location Map, Kirtipur Municipality, Nepal
- 4: Administrative Boundaries
- 5: Population Distribution, 2001
- 6: Settlements, 1998
- 7: Road Network
- 8: Industry
- 9: Electricity Supply and Telephone Line Network
- 10: Water Supply
- 11: Educational Institutions
- 12: Health and Veterinary Services
- 13: Public Institutions
- 14: Shops and Market Areas - all types
- 15: Food and Vegetable Markets
- 16: Heritage Sites
- 17: Land Use and Land Cover Map 1992
- 18: Land Use and Land Cover Map 1998
- 19: Land Use and Land Cover Change, 1992-1998
- 20: Urban Growth, 1992-1998
- 21: Land Use Types Contributing to Urban Growth, 1992-1998
- 22: Land Use Types Contributing to Urban Growth within 100m of Major Roads (Surfaced and Gravel), 1992-1998
- 23: Possible Areas of Future Urban Expansion
- 24: Ward Profile - Ward No. 1
- 25: Ward Profile - Ward No. 2
- 26: Ward Profile - Ward No. 3
- 27: Ward Profile - Ward No. 4
- 28: Ward Profile - Ward No. 5
- 29: Ward Profile - Ward No. 6
- 30: Ward Profile - Ward No. 7
- 31: Ward Profile - Ward No. 8
- 32: Ward Profile - Ward No. 9
- 33: Ward Profile - Ward No. 10
- 34: Ward Profile - Ward No. 11
- 35: Ward Profile - Ward No. 12
- 36: Ward Profile - Ward No. 13
- 37: Ward Profile - Ward No. 14
- 38: Ward Profile - Ward No. 15
- 39: Ward Profile - Ward No. 16
- 40: Ward Profile - Ward No. 17
- 41: Ward Profile - Ward No. 18
- 42: Ward Profile - Ward No. 19