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).

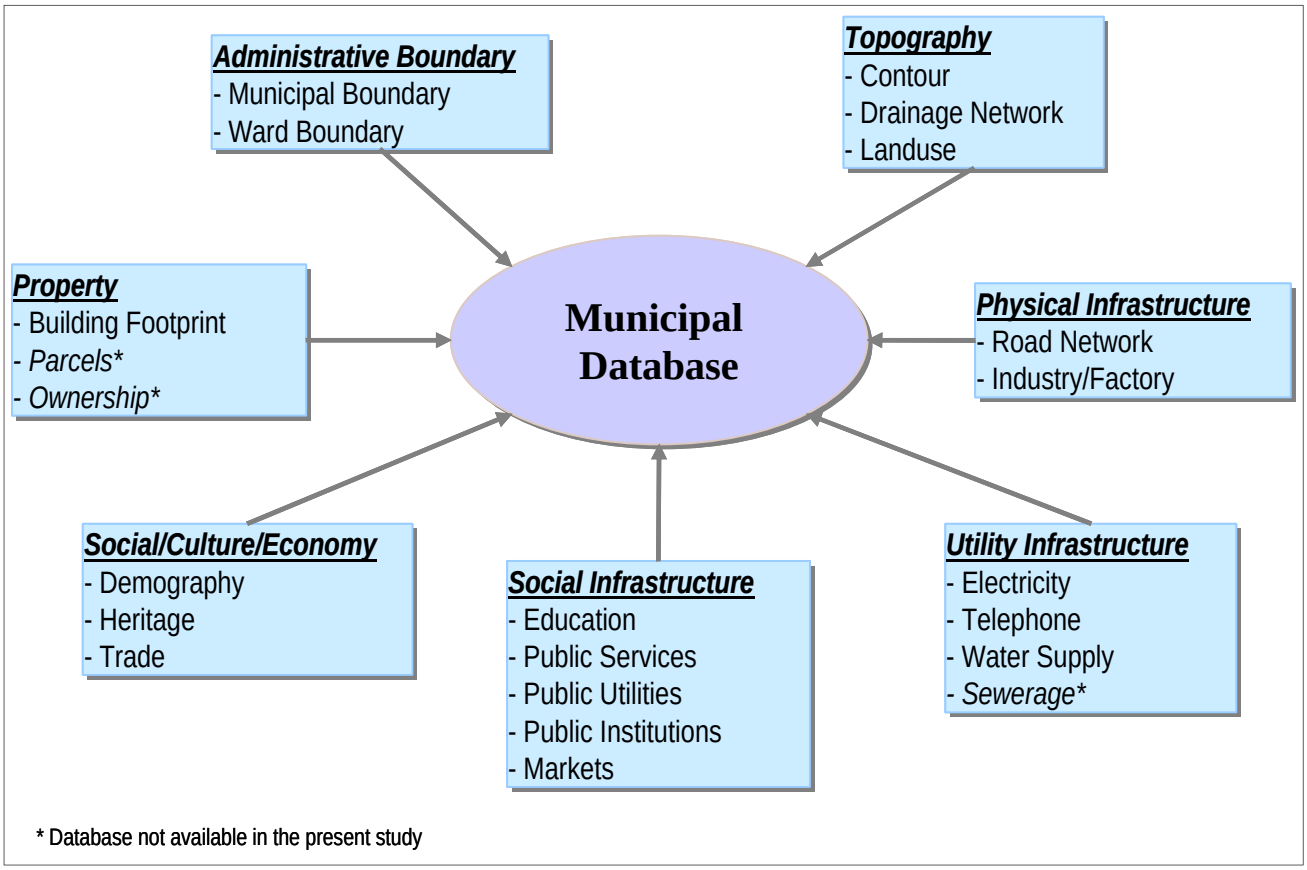

Figure 4: Data requirements for municipal planning

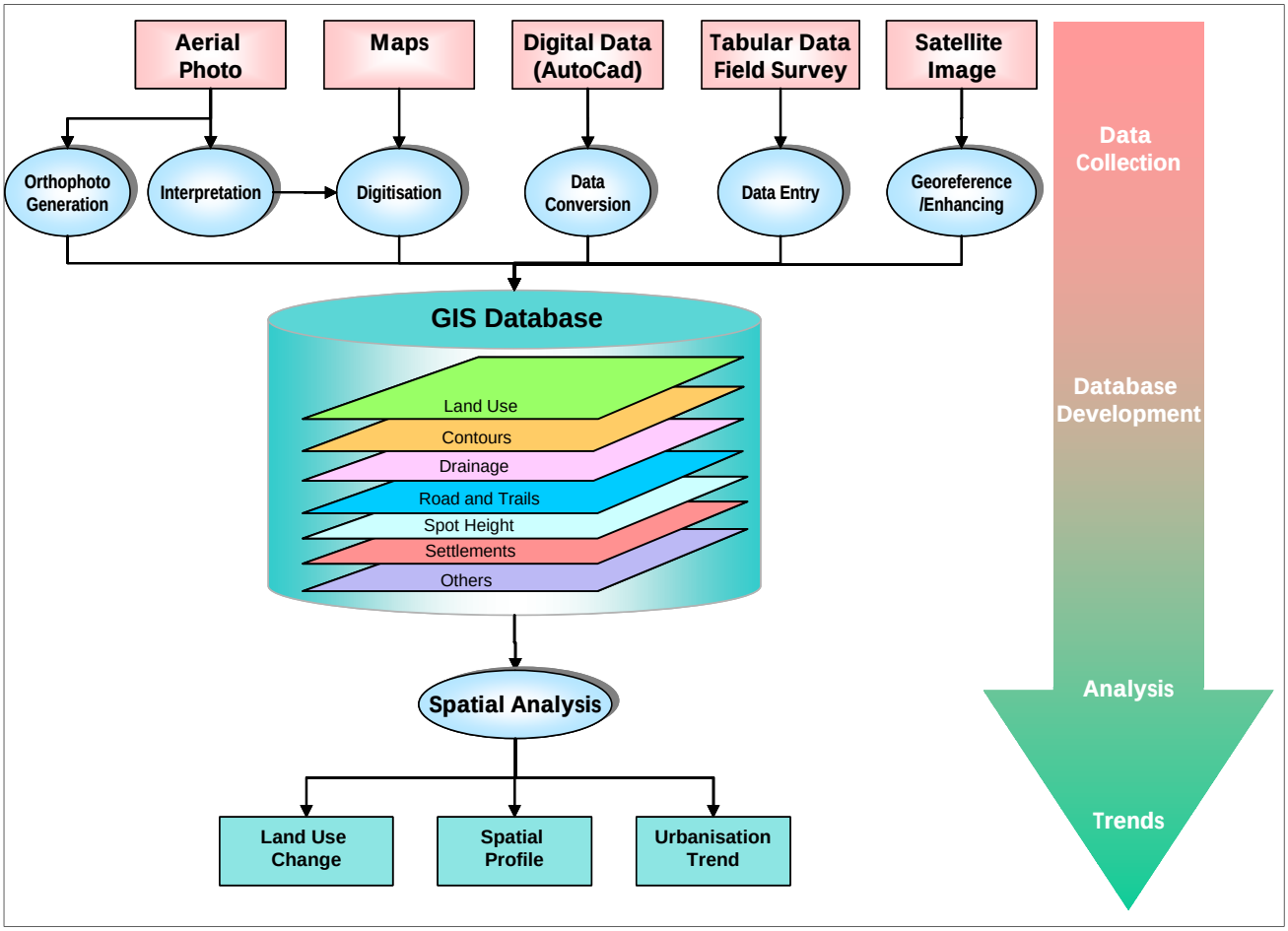

Figure 5: Methodology for GIS database development and spatial analysis

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

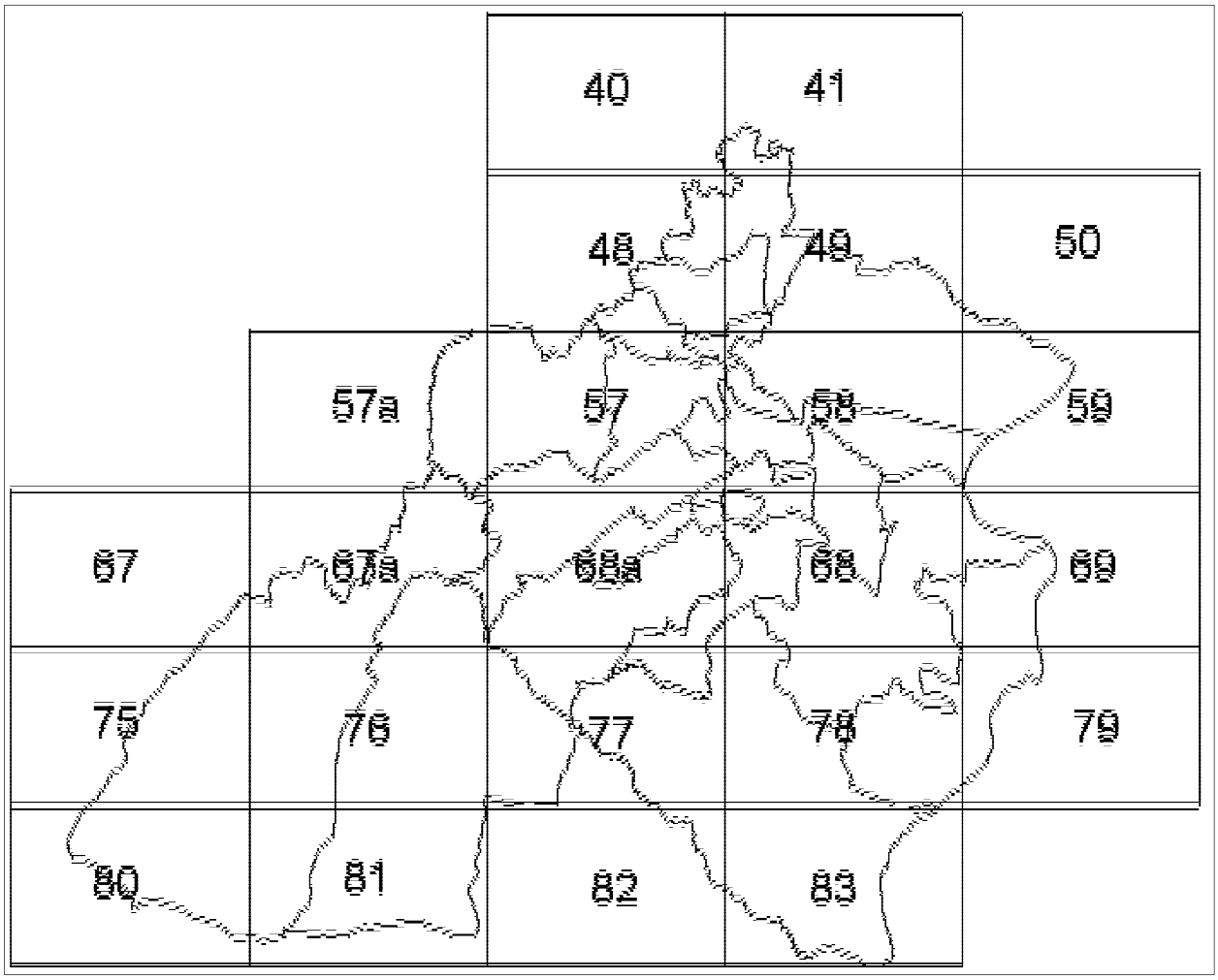

Figure 6: Modified sheet index map for Kirtipur Municipality (KUDP 1998)

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.

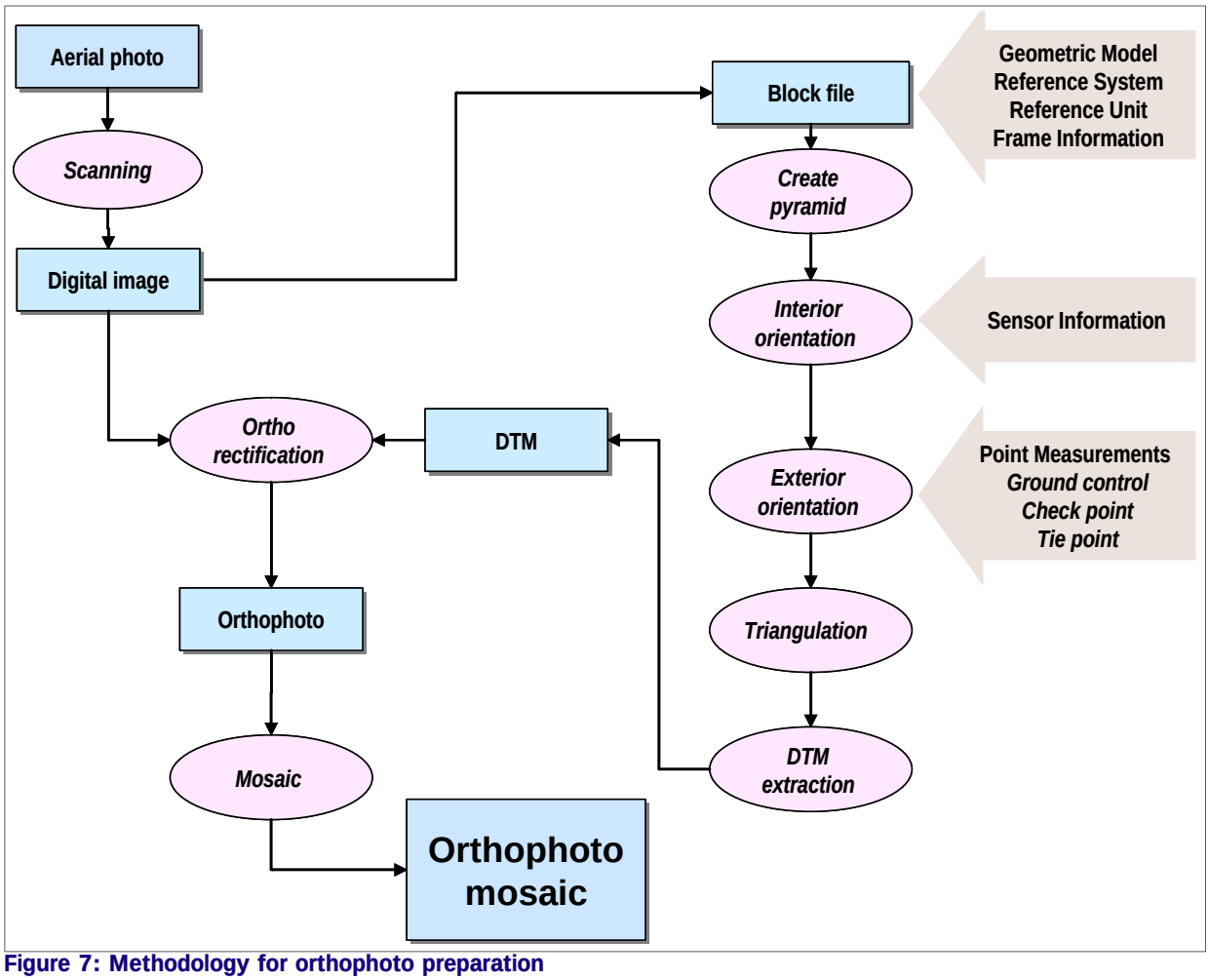

Figure 7: Methodology for orthophoto preparation

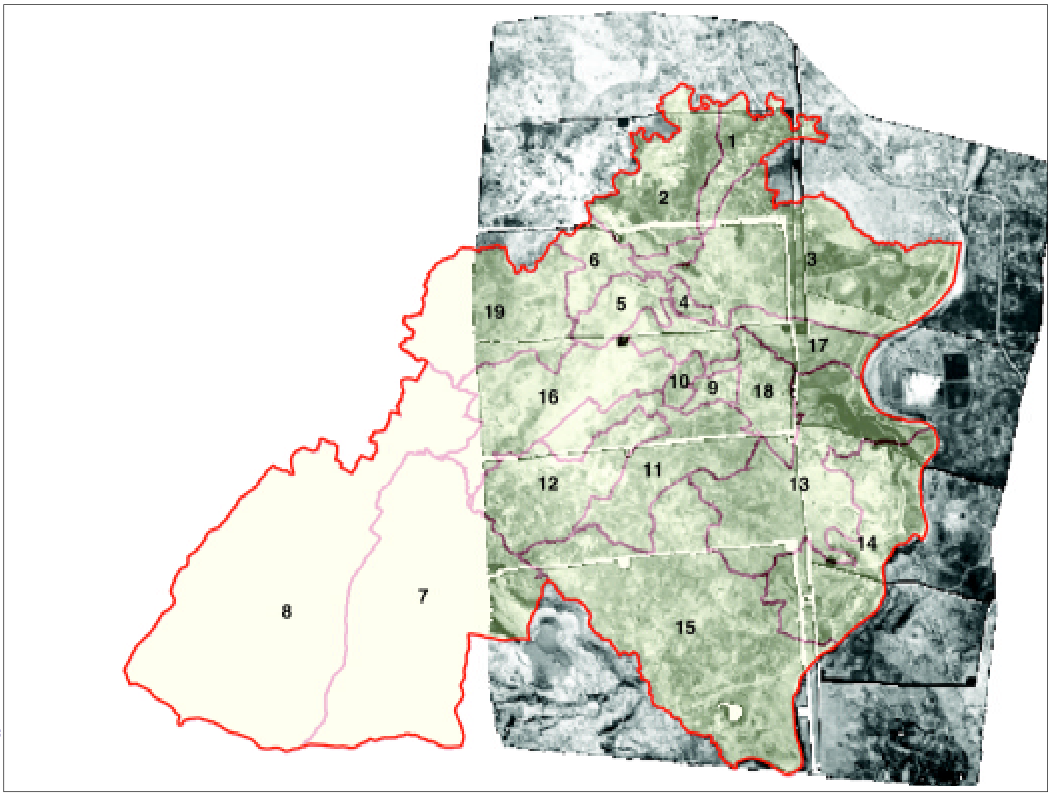

Figure 8: Block of aerial photographs

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.