Two Day Training Programme on

Operation of GIS Packages

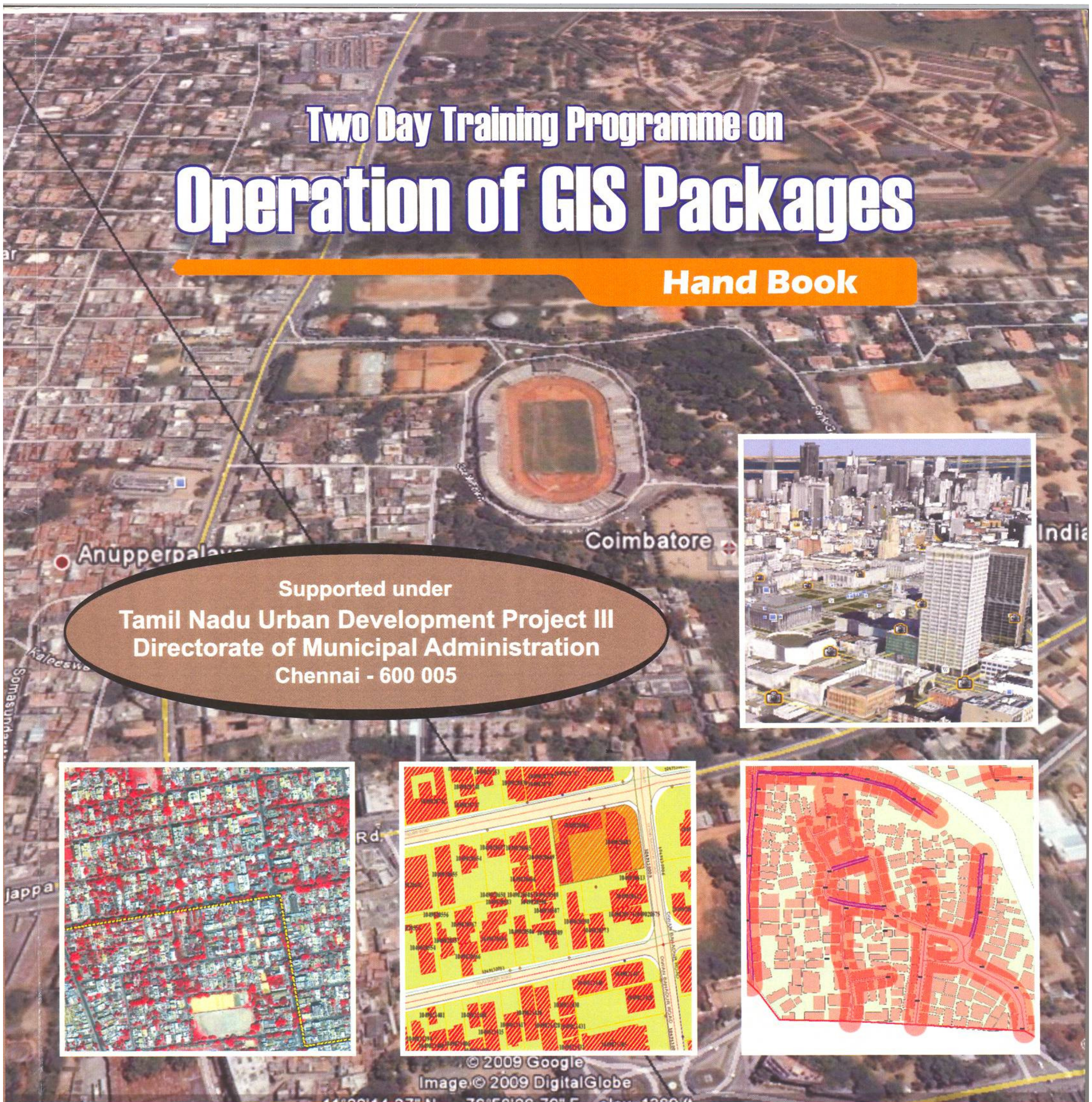
Hand Book

Supported under

Tamil Nadu Urban Development Project III

Directorate of Municipal Administration

Chennai - 600 005



Organized by

Tamil Nadu Institute of Urban Studies

Coimbatore - 641 011

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Phone : 0422 : 2441086

Fax : 0422 - 2457404

email : **information@tnius.org**

website : **www.tnius.org, www.news.tnius.org**.

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1. Implementing a Web Based GIS in Selected ULBs Under TNUDP-III

1.1. Background & Introduction

Governments are under pressure to deliver a range of services such as land records, health, education and municipal services in a manner that is timely, efficient, economical, equitable and transparent. Information Technology (IT) comes as an excellent tool to the governments which are keen to respond to these demands and to hasten the pace of development,

The application of IT in the developmental process of the government, e-governance in short, can have a profound impact on the efficiency, responsiveness and accountability of the governments and on the quality of life and productivity of citizens, especially the poor and ultimately on the economic output and growth of the country as a whole.

Various reforms of the government emphasise on adopting IT practices in enterprise management at the different administrative hierarchies. The government is very keen in funding such initiatives and these e-governance initiatives of the policy makers in the country have resulted in various departments/ stakeholders in administration adopting IT for enhancing the service providing capabilities. This approach has proved to be economically fruitful, enabling the service provider to meet the everlasting demands of the customers efficiently.

In recognition of the critical importance of rapid urban development, the Government of India has undertaken several initiatives to encourage sustainable urban development in the country, including the recently declared national incentive-linked fund, the Jawaharlal Nehru National Urban Renewal Mission (JNNURM).

The reforms agenda defined under the JNNURM initiative, emphasizes on the need for introducing e-governance, using IT applications like, Geographic Information System (GIS) and Management Information System (MIS) for various services provided by Urban Local Bodies (ULBs). Further, it has been envisaged to bring property tax reforms by adopting GIS, so that property tax realization efficiency increases and the ULBs can make arrangements on its own for effective implementation of developmental programs.

1.2. Government of Tamil Nadu Initiatives

Tamil Nadu is one among the leading states in the country, which has adopted IT implementation in governance and citizen services. The state has achieved significant improvements in various sectors through e-governance initiatives. The Government of Tamil Nadu rightly acknowledges that e-governance is an inevitable way of governance that brings with it the promise of convenience and transparency with focus on the citizens.

The Government of Tamil Nadu has initiated several e-governance projects under various urban renewal programmes. These include adopting IT applications like, GIS and MIS to enhance the delivery system for the various services provided by ULBs. The Government has implemented the e-governance initiatives in a phased manner at the ULBs. In the earlier phases, the functional activities have been computerized and a valuable MIS database has been created at all ULBs, except Grade-III ULBs. Subsequently in some selected ULBs in the State, initiatives such as on-line tax payment, issue of certificates etc., with real time database updating are implemented.

Continuing with such e-governance initiatives, the Government of Tamil Nadu has proposed to introduce GIS on a pilot basis in five ULBs. The State of Tamil Nadu has received a loan from the International Bank for Reconstruction and Development (IBRD) through the Government of India towards the cost of implementing this pilot project under Tamil Nadu Urban Development Project III (TNUDP-III).

The Commissionerate of Municipal Administration (CMA), under TNUDP-III through the procurement procedures stipulated by the World Bank, has appointed M/s. TATA Consultancy Services (TCS) for the “Consultancy to Design, Develop and Implement a web based GIS for selected Urban Local Bodies in Tamil Nadu” viz., Coimbatore, Madurai and Tiruchirapalli Corporations, and Rajapalayam and Gobichettipalayam Municipalities. TCS is implementing this project in the above mentioned 5 ULBs of the State, under the able guidance of CMA and ULBs.

1.3. Objective of the Assignment

The objective of this assignment is to develop a GIS knowledge base on municipal infrastructure with due linkages to the Management Information System (MIS) to assist the decision making process for various municipal functions, including improvement of property tax assessment, collection of taxes and infrastructure planning for expansion and management.

1.4. Scope of Services

The scope of the services of the assignement is as follows

- Study of Existing Systems
- GIS database development
  - ☐ Preparation of base map using Satellite Imageries
  - ☐ Creation of property mapping and utility network
  - ☐ Field verification and updation of Maps
- Performance Indicator Mapping
- Web based GIS application development and integration of GIS application with existing systems like MIS
- Training the officials of the ULBs
- Post Implementation Maintenance & Support

1.5. Project Area and Extent

Location of the towns where the GIS is being implemented is given in Figure 1.0 and the area, population and number of properties are tabluated in Table -1

Table -1 Project Area and Extent

Sl. No.	Name of ULB & District	Area (sq. kms)	Population (in lakhs)	No. of properties (in lakhs)
1.	**Coimbatore Corporation,** Coimbatore	105.06	14.61	2.03
2.	**Madurai Corporation,** Madurai	51.5	12.03	1.50
3.	**Tiruchirappalli Corporation,** Tiruchirappalli	146.9	7.46	1.65
4.	**Rajapalayam Municipality,** Viruthunagar	11.36	1.21	0.43
5.	**Gobichettipalayam Municipality,** Erode	7.51	0.55	0.17

1.6. Methodology / Workflow for the implementation of GIS in ULBs

The detailed Methodology/Workflow is shown in Figure 1.1. The work has two main components

1.6.a. GIS Base Map & Database Creation

As part of the GIS database development, the following data creation activities are carried out.

- Base map creation using high-resolution satellite imagery

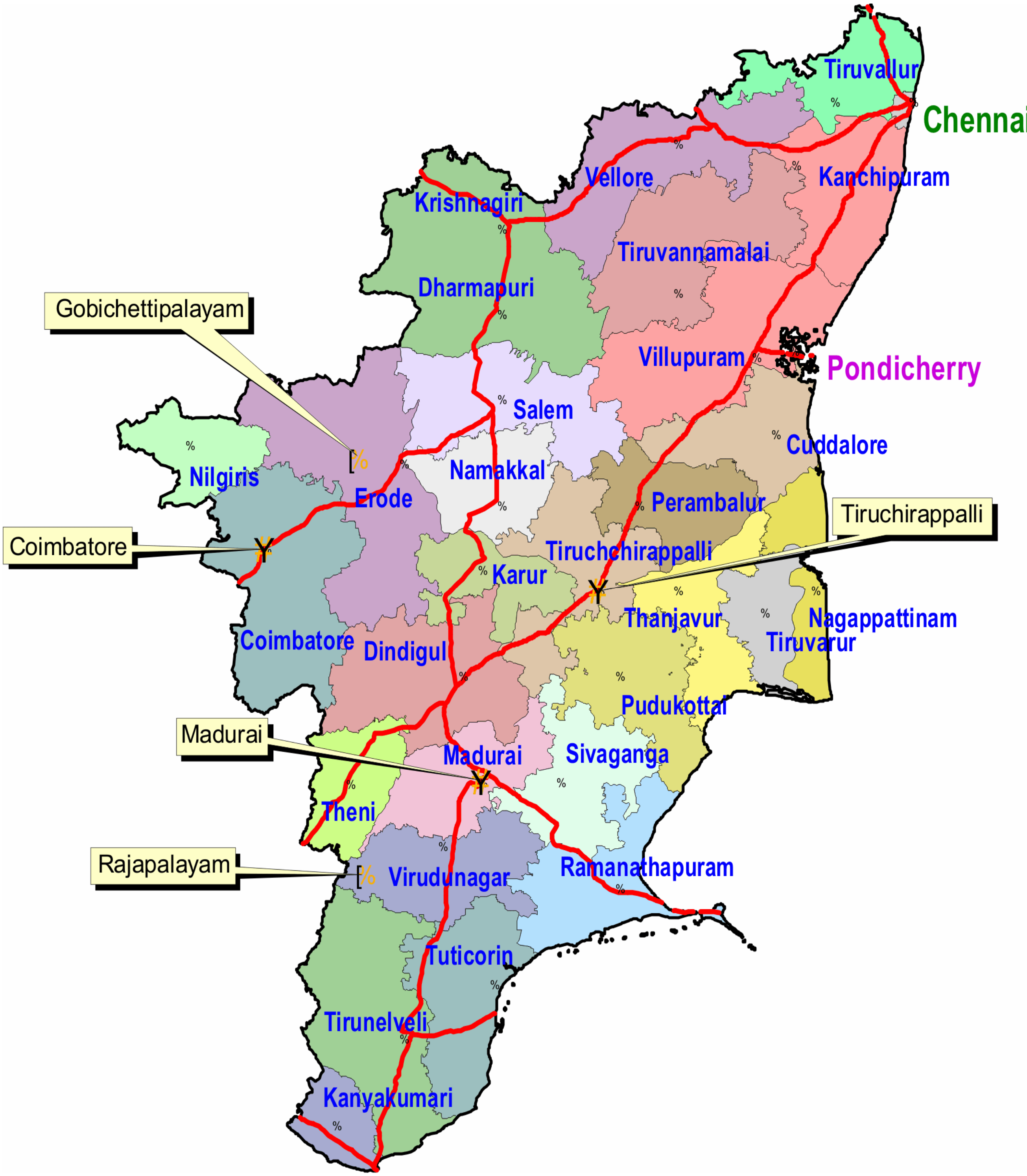


Figure 1.0. Location map of ULBs where GIS is implemented

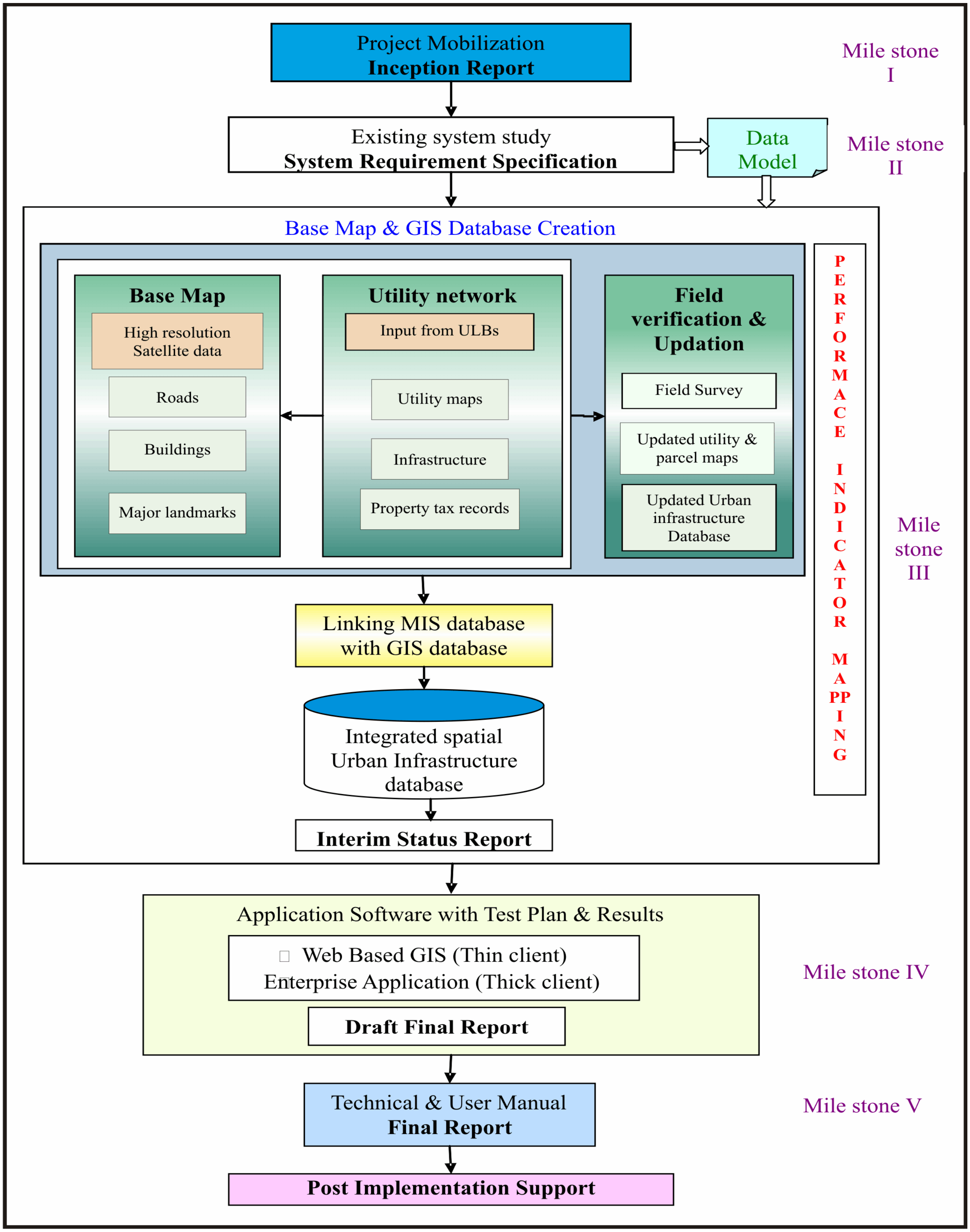


Figure 1.1. Methodology for GIS Implementation at ULBs

CMA has procured high resolution satellite imagery (QuickBird-0.62m resolution) from National Remote Sensing Centre (NRSC), Hyderabad.TCS has used this satellite data for preparation of up-to-date large-scale base maps for Coimbatore Municipal Corporation. The satellite image of ward 49 of Coimbatore Municipal Corporation is shown in Figure 1.2. Identification of building from the satellite image is given in Figure 1.3 (a & b)

- ❑ Creation of utility network
  - Digital conversion of existing hard copy maps available with ULBs

The following features are created using ULB data and feature extraction from high-resolution satellite imagery (QuickBird)

- Administration Boundary
- General Infrastructure
- Education Network
- Office Network
- Road
- Railways
- Transportation Network Elements
- Solid Waste Management Network
- Water Bodies
- Water Supply
- Sewerage
- Street Lights
- Landmarks
- ULBs Assets
- Storm Water Drainage
- Other Land use

The above features are shown in Figure 1.4 as an Integrated Map

- ❑ Field verification and data updation
  - ▪ Door-to-door survey (Survey format is given in Table 2)
  - ▪ Ground truthing / field verification of base map and attribute collection
  - ▪ Field verification of utility maps and attribute collection
  - ▪ Updation of base map, utility & property information

Figure 1.5a. shows the linked attribute information on the land parcel and Figure 1.5b shows the linked attribute information on building.

Table 2 Property Survey Form

ANNEXTURE – 2

Property Survey Form

Name of Data Collector:……………………………………………………… Date:……………………………… Name of ULB Staff:…………………………………………..

Name of ULB:……………………………………………………………. Name of Ward & No:…………………………………..

Sl No	Road Segment ID	Road/ Street ID	Survey No		Property/ Door No.		Property Assessment	Ownership/ Assesses	No. of Floors (B.G.N)	Total No Flats	Plot/Site area (Sq.ft)	Builtup area (Sq.ft)	Occupancy Status	Water Connection - status assessment	Sewerage Connection Status	Property Usage	Building Name	Assessment Status	Year of Construction	Roof Type	Remarks
			New	Old	New	Old															

Road Segment ID: Unique Id Generated in Lab

Road name: Name of the Road/Street, If name not available enter No Name

Survey No: As provided by ULBs

Property Door No: Collect the Number Marked on the Property

Property Assess : as per ULB records made available

Ownership: Private/Govt (Go, GoTN, & Q uasi Govt) / ULB/ assesses name as provided by ULBs/Others

No of floors: Basement (B)-Ground Floor (G)- No of Other Floors (Eg;5 (G+4)

Total No. of Flats: This is only applicable to Apartments/ Community Quarters

Plot/sital Area: Area of property in Sq.ft Remarks:

Built-up Area : Built-up Are of the prope rty in Sq.ft

Occupancy Status : Occupied/Under Construction/Abandoned/Un der Dispute/Vacant

Water Connection status : Yes/No/as sessment number as prov ided by ULBs

Sewerage connection Status: Yes/No/ass essment number as provided by ULBs

Property Usage: Residential/Commercial (Banks, Hostels, Star Hotel, Boarding and Lodging/Mansions, cinema theatre, Community Hall, Kalyana Mandapam, Hospitals,Market/Godown,telecomTowers)Vacant/Industrial(SSI/Others/P ublic/Educational/Heritage

Building Name : For Prominent -Commercial, Industrial, Govt Building Only (landmarks)

Assessment Status: Assessed/Not Assessed

Year of Construction : Completion year of the Ground Floor (0 -5, 6-15,16-20,>20 years)

Roof Type: RCC/Madras Terraced/Thatched/Tiled/Asbestos/Others

Remarks: Exempted Buildings (Religious Places, Educational Institutes, Charitable trust Chavadis)/Door locked/Owner not co-operating/Map updating information etc.

Figure 1.2.QuickBird Satellite Imagery

Figure 1.3 a. Building feature extraction from imagery

Figure 1.3 b. Closed view of extracted building feature from imagery

Figure 1.4 Integrated Map

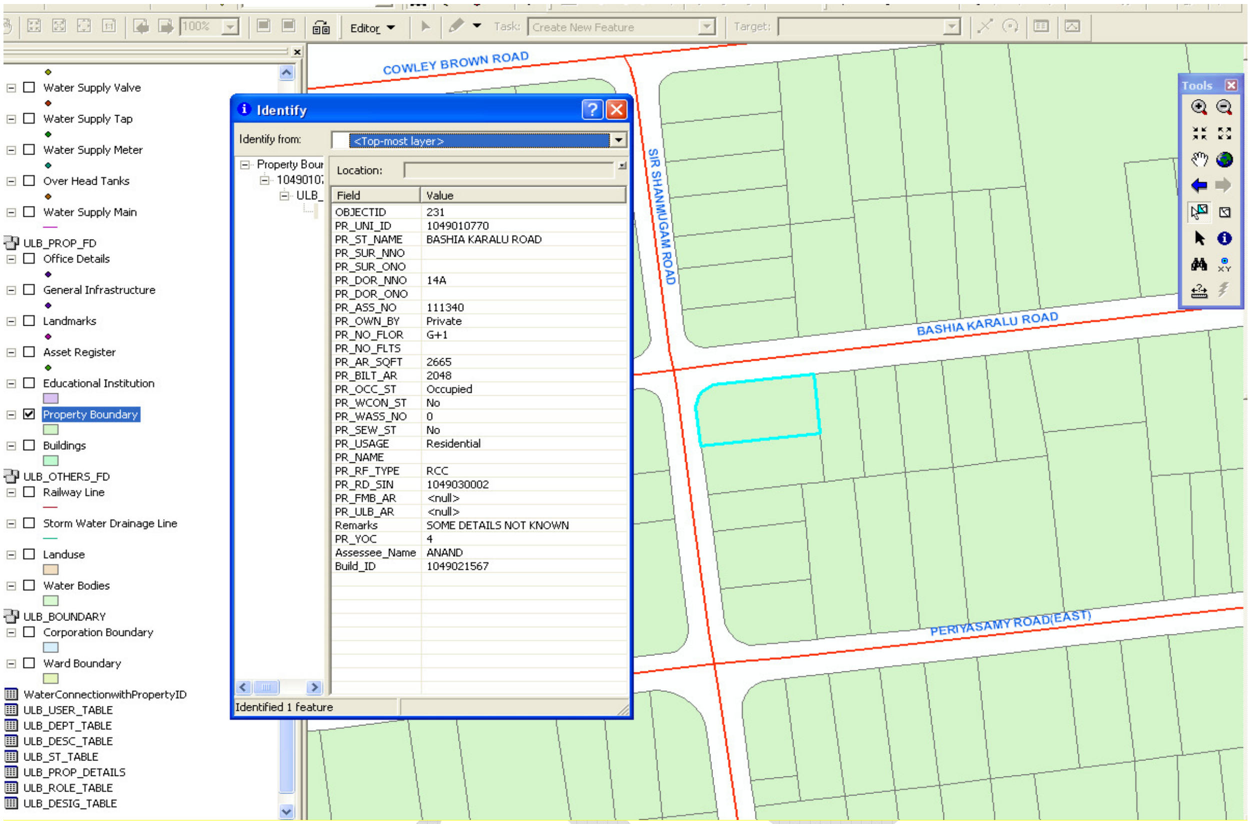


Figure 1.5. a. Land parcel information

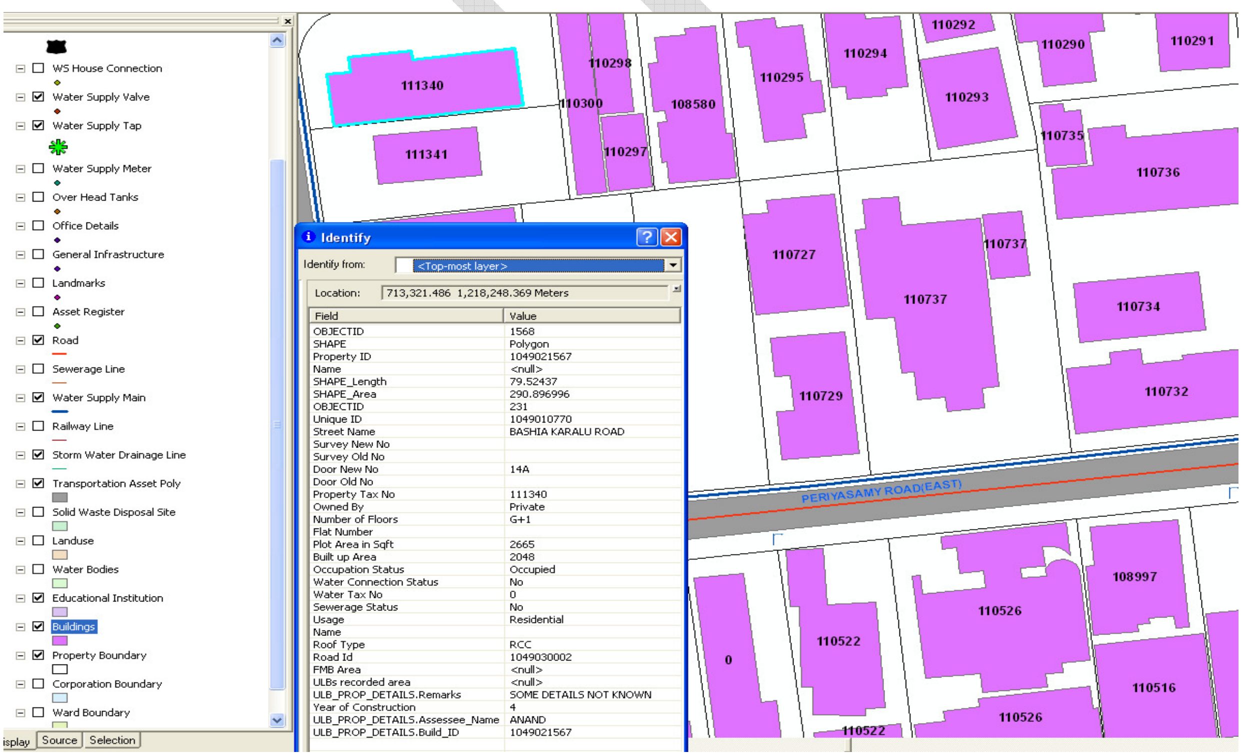


Figure 1.5. b. Building information

1.6.b. GIS Application Development

The architecture for web/ desktop GIS application developed by TCS is shown in Fig 1.6

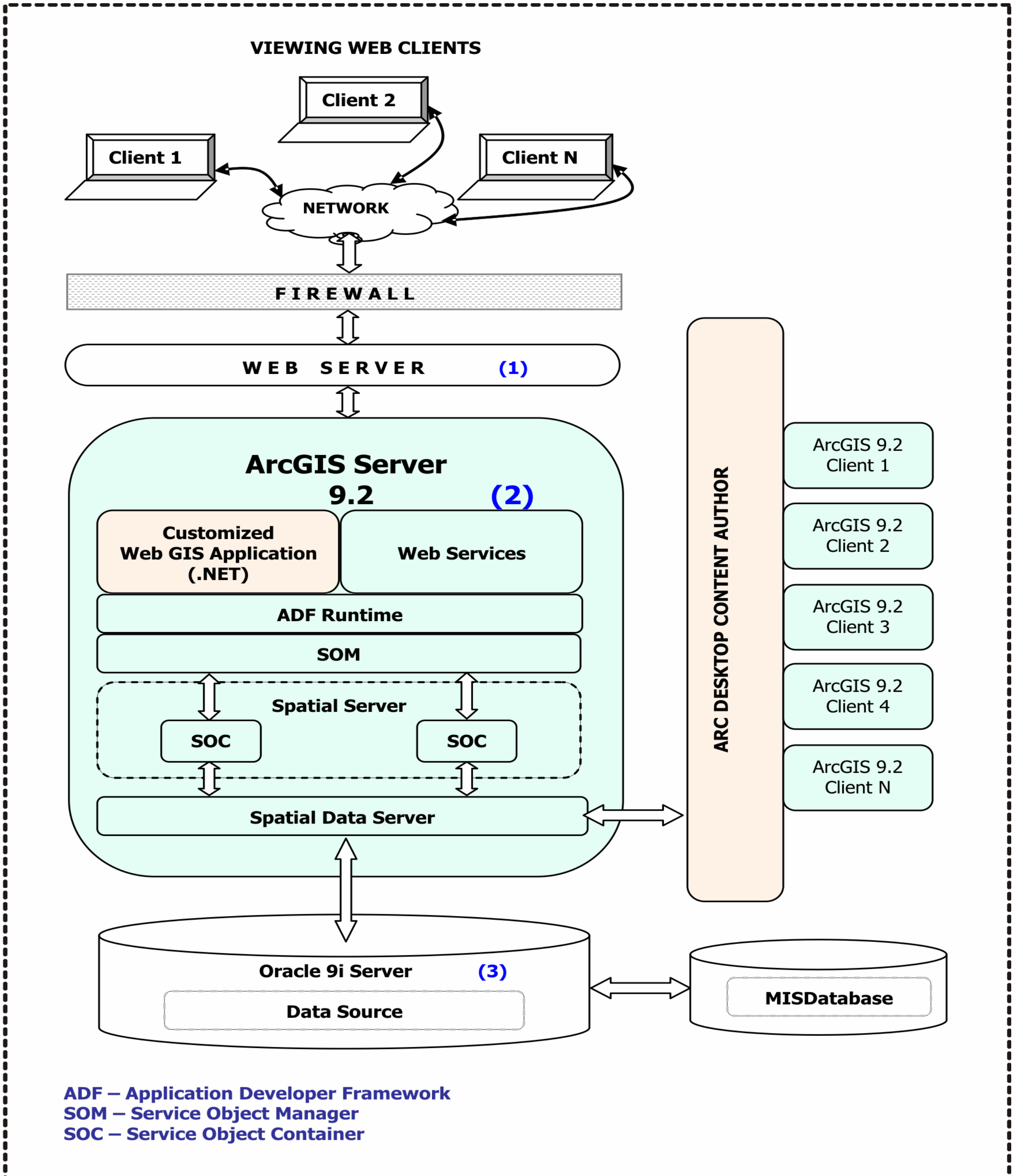


Fig 1.6 Architecture for Web/Desktop GIS Application

Design modular

The list of designed web and desktop applications are as follows

- Menu-driven, dynamic, flexible and user friendly interface where required functions are quickly and efficiently operated and maintained
- Robust & scaleble architecture
- Modular approach for application design & development
- Built on ArcGIS technology – ArcGIS server & ArcGIS desktop
- Multiple security layers – User authentication & access privileges
- Support on Windows 2003/linux or higher operating system
- Open GIS Consortium (OGC) compliant
- Layer wise display of map features with option to switch a layer on (visible) or off (not visible).
- Map navigation tools like zoom in, zoom out, pan, move previous etc.
- Facility to generate user defined reports and support WYSIWYG plotting and printing of graphical areas
- Support Unified Geo-spatial data with infrastructure details and integrated with existing database
- Ability to map urban performance indicators

Use of Web Application for ULBs

The following are the key GIS functionalities of the application developed by TCS.

- Layer Display
  - All the layers can be displayed in the map
  - Can select the required layer to be made visible / invisible
- Attributes View
  - Can select the layer and view the attributes of the layer.
  - Selection of row will display the feature spatially.
- Fixed Pan and Zoom
  - The tool is created to pan and zoom the map with the fixed ratio.
- Interactive Pan and Zoom
  - The map can be zoomed and panned
- Scale
  - On-the-fly scale change
- Identifying the Feature
  - Identify the details of feature on spatial click
- Measure
  - Location of the point
  - Line distance
  - Perimeter
  - Area of the polygon

Selection by Attributes

- The user can query the features with respect to the interested attributes value.(The query output is given in Figure 1.7, 1.8 and 1.9)

Fig 1.7 Application GUI

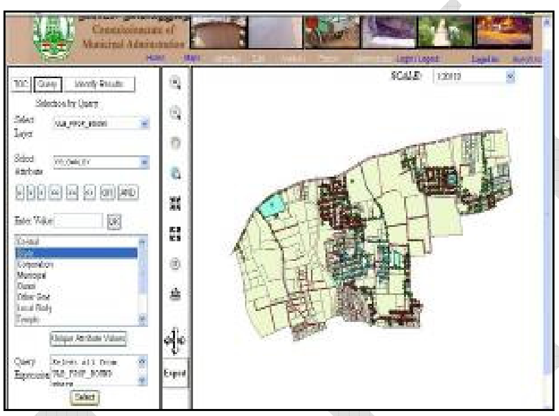


Fig 1.8 Attribute Query

Fig 1.9. Feature Selection

Selection by spatial data

- Select the features on spatial click

Pre defined query

The following queries may be frequently raised by the ULB officials and with respect to the business knowledge, the following predefined queries are listed

- Properties which are not having water connections
- Select ULB properties
- Select properties which pay tax greater than user specified amount
- Educational Institutions which are within certain distance from the selected properties
- Properties located in the buffer of certain distance from Water Bodies / Road / Railway Line

- Properties which are not assessed
- Roads with the user specified road type and road category
- Roads which are not having Bus-stops
- Hospitals located on National Highways
- Assets of ULBs located in specific wards

1.7. Performance Indicator Mapping

Objectives

The objectives of the Performance Indicator Mapping are:

- To study and analyze the existing business process/ practices regarding the property tax and other core functional services provided by the ULBs
- To develop performance indicators for Property Tax & Core services provided by ULBs.

In order to address the various issues in the urban governance, specifically in core infrastructure and municipal finance, the ULBs are required to be empowered with information in an analytical format, bringing more transparency and accountability by providing decision-makers and implementation agencies with a set of comparable data, which would enable more informed planning and decision-making.

This process of performance assessment will be useful for different stakeholders in urban development. Such an exercise would be beneficial to ULBs and to state-level monitoring and regulatory agencies. In addition, financial institutions, investors, and credit rating agencies would benefit from reliable comparative information on the performance of ULBs. Over a period of time, such a system would help to develop sector norms or benchmarks and the current initiative under the TNUDP-III program is an effort towards facilitating tools for urban development agencies and services. The tools developed under the program will help to improve performance and accountability of local governments by providing an useful benchmarks for services and financial performance.

Urban Indicators and Performance Measurement (UIPM) aims to address issues in urban governance, specifically in core infrastructure and municipal finance, for achieving better understanding and control over it. It would be done through:

- Empowering the urban local bodies with information in an analytical format, bringing more transparency and accountability
- Providing decision-makers and implementation agencies with a set of comparable data enabling more informed planning and decision-making.
- Createing a unique and helpful database for cities to enhance their developmental planning work
- Developing UIPM as a management and analytical tool for monitoring and evaluating the programmes at every stage
- Developing UIPM as a tool to measure the impact of the programmes
- Identifying the critical areas and assess the severity of the problems
- Aiding ULBs to prioritize actions and plan resource allocation

Under the various urban reforms initiatives, the ULBs have collected data on its infrastructure and core functionalities. The data regarding the various urban performance indicators are collected for the ULBs. The data on the urban indicators are linked to the respective spatial features to enable enhanced visualization perspective with improved analytical interpretations. TCS has adopted the following methodology to develop a comprehensive performance indices measurement programme under the current assignment.

- Studying and analysing the existing business process/ practices regarding the property tax and other core functional services of ULBs
- Developing the performance indicators for Property Tax & Core services of ULBs
- Compiling all the available data on Urban Indicators under different categories
- Linking the data spatially in GIS as per the provision provided in the predefined data model
- Inputs from urban planners and ULBs are taken to develop customized tools, for effective mapping of the urban indicators spatially
- Analysing and conducting a comparitive study based on the Performance Indicators
- Recommending the outcomes of the analysis and study to the CMA/ULBs with corrective actions to be initiated to improve the efficiency of core services provided by the ULBs

1.8. Conclusion

GIS based system with accurate spatial information created from high resolution satellite imagery and adequate field survey can be well utilized for urban infrastructure planning and development which will aid to increase in revenues and improve services within the existing institutions. Initial time is required for setting up the system, but benefits start even in the early stages and will be exponential once the system is stabilized.

The GIS based representation of the urban indicators result in an enhanced visualization perspective with improved analytical interpretations. The process would also assist the policy makers at various stages in municipal administration for improved decision making.

2. Geographic Information System (GIS) and Its Packages

2.1. Introduction

A Geographic Information System (GIS) is a computer based system for capturing, storing, querying, analyzing and displaying geo-spatial data of the earth surface. It is also called geographically referenced data (Geospatial data) that describes both the locations and characteristics of spatial features such as Landuse and landcover (includes land parcels, built-up area), transportation and infrastructure network (Road, Water supply, Sewerage), environmental details, topography and vegetation etc., on the earth surface. The above spatial features are stored in different layers and overlaying all the above can produce the realistic information which is depicted in Figure 2.0.

In today's world about 75 % to 90% of the information we use everyday to take decisions are geographic based.

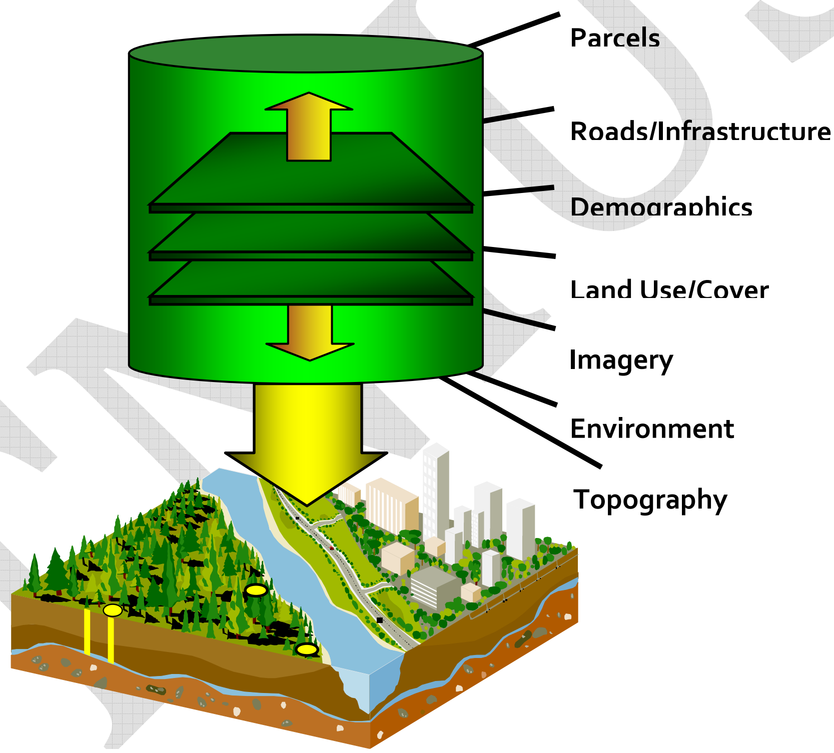


FIGURE : 2.0 LAYERS OF INFORMATION : GIS

2.2 Components

The key components are listed below and shown in Figure 2.1

a. Data

b. Hardware

c. Software

d. People

e. Methodology / Procedure

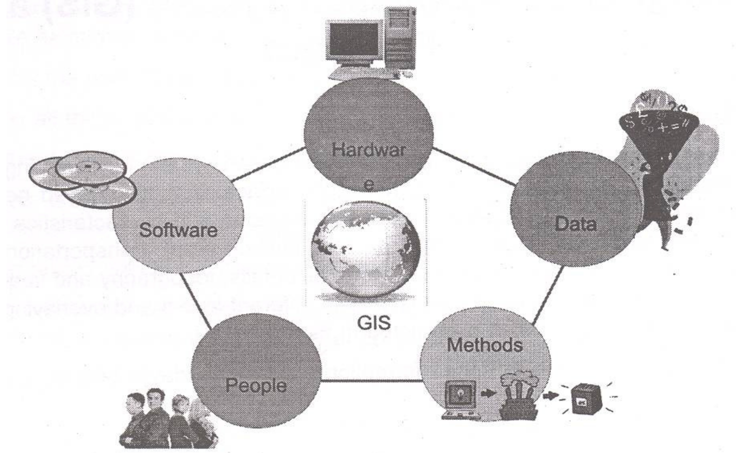


Figure 2.1. Components of GIS

a. Data

Geographic data are categorised into two types. Such as spatial data and non-spatial data or attribute data.

1. Spatial Data

Spatial information pertain to location and shape of geographic features. These are represented by location features like point, line and area.

Point feature : A point may be used to represent a discrete location defining a map object eg. Borewell point, E.B.Pole and Telephone pole etc.

Line feature : A line is a set of co-ordinates that, when connected may represent the linear shape of a map object too narrow to be displayed as an area (like a river, road etc.)

Area feature : An area is a closed figure whose boundary encloses a homogeneous area (such as a country, desert, water body etc.)

2. Non-Spatial or Attribute Data

Descriptive attributes associated with the spatial features form another important dimension of geographic information. Attribute information contains the descriptions, classifications and measurements of the geographic features. Each geographic feature may have many attributes depending on the significance of it. The attribute data has descriptive, quantitative and qualitative information.

Descriptive information will have elements which cannot be compared with each other in quality and quantity (examples are property ID number, owner's name, vegetation type, zoning type, material type etc.).

The quantitative information provides attributes that can be distinguished by measurement and numbers (examples are length, area, value of the property, average age, bearing capacity, diameter of pipe line, voltage etc.).

The qualitative information form the attribute data of the features such as water, soil quality and slope.

b. Hardware

GIS can be run on a variety of computer systems ranging from portable personal computers

(PCs) to multi-user super computers and are programmed in a variety of software languages. For effective GIS operation, a number of elements are essential. They are

a) The presence of a processor with a sufficient power to run the software.

b) Sufficient memory to store large volume of data.

c) Good quality, high resolution colour graphic screen.

d) Data input and output devices. Examples: scanner, plotter, printer, keyboard.etc.

c. Software

GIS software provides the functions and tools needed to store, analyze, and display geographic information. Key software components are:

- A Data Base Management System (DBMS)
- Tools for the input and manipulation of geographic information
- Tools that support geographic query, analysis and visualization
- A Graphical User Interface (GUI) for easy access to tools

d. People

GIS technology is of limited value without the people who manage the system and develop plans for applying it. GIS users range from technical specialists who design and maintain the system to help everyday work.

e. Methodology / Procedure

A successful GIS operates according to a well-designed plan and business rules, which are the models and operating practices unique to each organization.

2.3. Data Structure

Experts note that the human eye is highly efficient at recognizing shapes and forms, but the computer needs to be instructed exactly how spatial patterns should be handled and displayed. The computers require precise and clear instructions on how to turn data about the spatial entities into graphical representations.

This process is the second stage in designing and implementing a data model. At present, there are two main ways in which computers can handle and display spatial entities. These are the raster and vector approaches. The data structures that have little to do with graphic representation of cartographic objects are simple, ordered sequential files and indexed file systems. These three systems combine to form attribute database management system.

a. Raster Data Structure

In the raster world, the basic building block is the individual grid cell and the shape and the character of an entity is created by grouping of cells. The size of grid cell is very important as it influences how an entity appears. The Figure 2.2 shows how a range of different features from happy valley sky area, can be modelled using the raster approach.

A vector spatial data model uses two dimensional co-ordinates(x,y) to store the shape of a spatial entity. In the vector world the point is the basic building block from which all spatial entities are constructed. The simplest spatial entity, the point is represented by a single (x, y) co-ordinate pair. Line and area entities are constructed by connecting series of points into chains and polygons. Figure 2.2 shows how the vector model has been used to represent various features for Happy Valley Sky Area.

In the raster world, a range of different methods is used to encode a special entity for storage and representation in the computer. Figure 2.3 shows the most straightforward method of coding raster data.

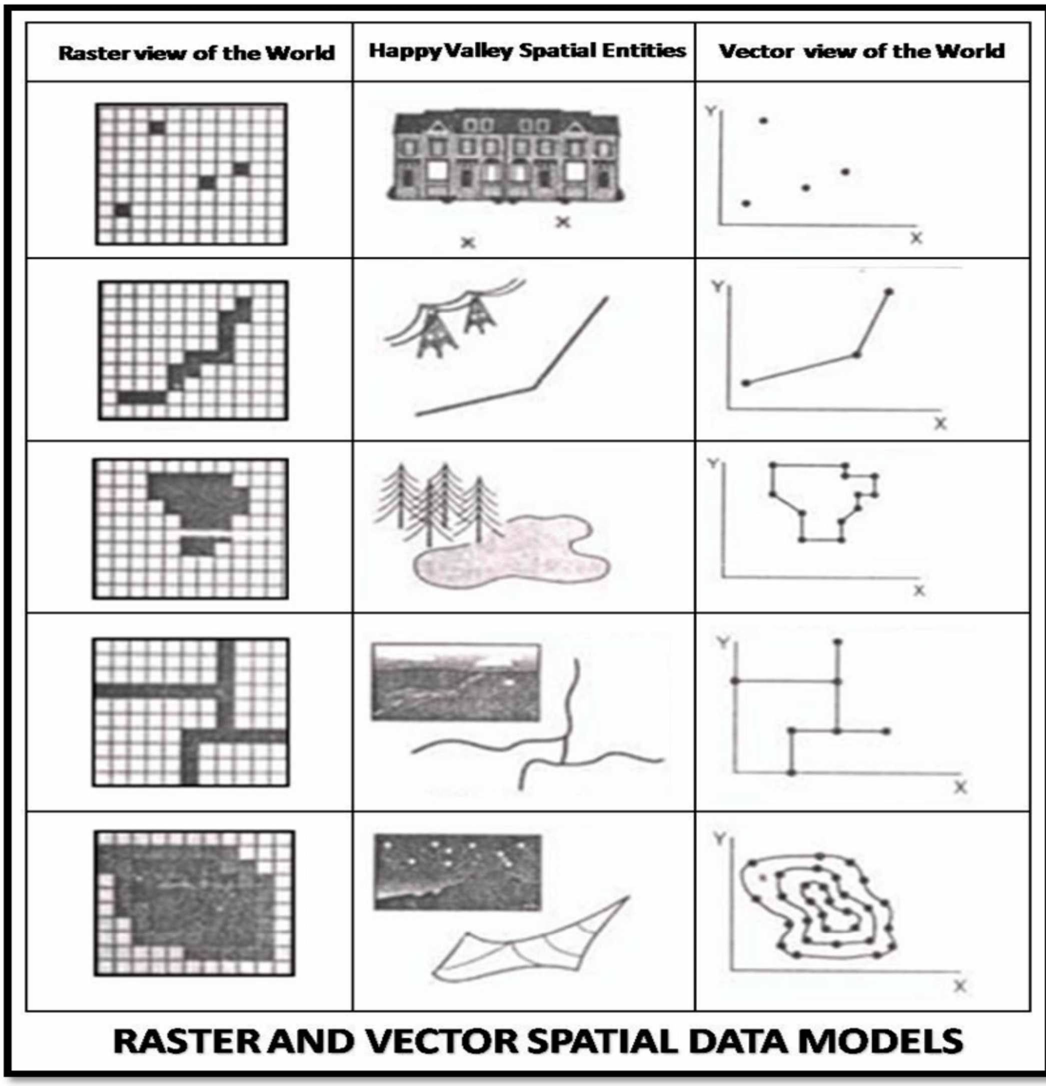


Figure 2.2. Raster and Vector data models

The cells in each line of the image (Figure 2.3a) are mirrored by an equivalent rows of numbers in the file structure (Figure 2.3c).The first line of the file tells the computer that the image consists of 10 rows and 10 columns and that the maximum cell value is 1. In this example, a value of 0 has been used to record cells where the entity is present (Figure 2.3b).

b. Vector Data Structure

Figure 2.4 shows how the different entity types – points, lines, areas- can be defined by co-ordinate geometry. However, as with the raster spatial data model, there are many potential vector data structures that can be used to store the geometric representation of entities in the computer. The simplest vector data structures that can be used to reproduce a geographical image in the computer is a file containing (x, y) co-ordinate pairs that represents the location of individual point features (or the points used to construct lines or areas). Figure 2.4 shows such a vector data structure for the Happy Valley Car Park. Note how a closed ring of co-ordinate pairs define the boundary of the polygon.

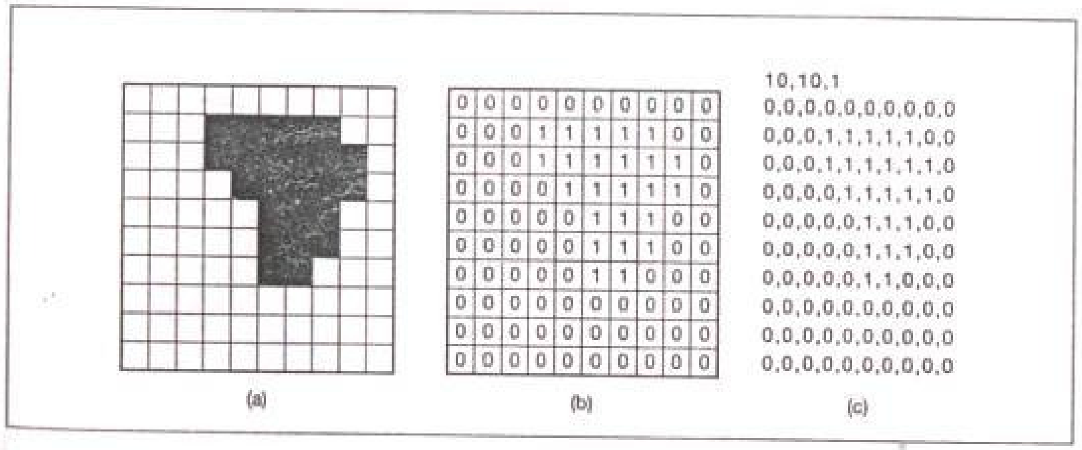


Fig 2.3 A Simple Raster Data Structure – a) Entity Model; b) Cell Values; c) File Structure

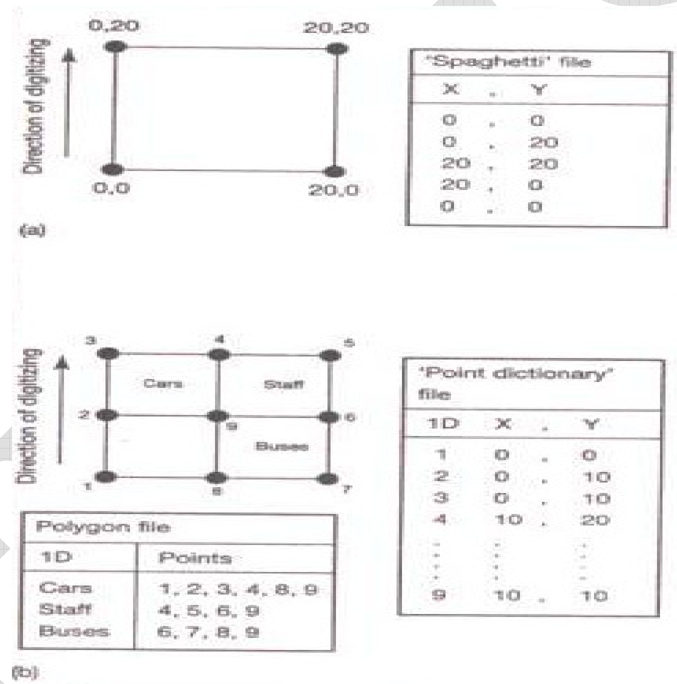


Figure 2.4 Vector data structure

2.4. Data Input Format

Data input describes the methods for getting data into the computer that is a process known as data encoding. Without data a GIS will not produce output. Maps, which are available as paper sheets or digital files may be uploaded by digitizing, scanning or direct file transfer. Aerial Photographs may be scanned into a GIS. Satellite images may be downloaded from digital media. Spatial data can be directly input in to GIS from field equipments such as Global Positioning System (GPS) or from sources of readily prepared data, i.e. from retailers or internet.

The range of methods available to get data into GIS includes keyboard entry, digitizing scanning and electronic data transfer.

All data in an analog form should be converted into digital form before they are input into GIS. Four methods are widely used for data input

1) Keyboard entry 2) Manual digitizing

3) Automatic digitizing 4) Scanning.

Maps

The traditional method of storing, analyzing and presenting spatial data is the map. A map is the representation of the features of the earth drawn to scale. The surface of the map is a reduction of the real scenario. The map is a tool of communication and it has been in use since the days of primitive man. The map is of fundamental importance in GIS as a source of spatial data, a structure for storing data and a device for analysis and display. Therefore, understanding maps and how they are produced are essential starting points for exploring the characteristics of spatial data.

Types of Maps

Even though, there are many different types of maps, all the maps are broadly classified on the basis of two criteria namely scale and contents or purpose**.** On the basis of scale, the map may be classified as small scale map or large scale map. On the basis of content, maps are classified as physical maps and cultural maps. In addition, based on the thematic contents of GIS coverage, map can be termed as thematic maps (like Vegetation Map, Transportation Map, Landuse/Landcover Map, etc.). It is common to make a distinction between thematic and topographic map. Thematic maps show data relating to a particular theme or topic, such as soil, geology, geomorphology, land use, population or transport. Topographic maps contain a diverse data on different themes like land use, relief and cultural features.

Scale

Virtually, all sources of spatial data, including maps are smaller than the real world they represent. Scale gives an indication of how much a map is smaller than reality. Scale can be defined as a ratio of distance on the map to the corresponding distance on the ground. Scale can be expressed as in one of three ways as:

I. A ratio scale (Ex:1:5000)

II. A verbal scale (Ex:1 cm represents 50 m)

III. A graphical scale

A graphical scale is usually drawn on the map to illustrate the distances represented visually.

Map Projection

Map Projection is a basic principle of map making. Map projections transfer the spherical earth onto a two dimensional surface. In doing so, they approximate the true shape of the earth, but the objects on the earth's surface are distorted in someway either in size, shape or in relative location. The process of transformation of three dimensional space into a two dimensional map inevitably distorts at least one of the properties, namely; shape, area, distance or direction and often more than one.

Grouping of Map Projections

They are classified in three groups according to the underlying geometrical conversions involved (Figure 2.5)

I. Cylindrical

II. Conical

III. Azimuthal or plain surface

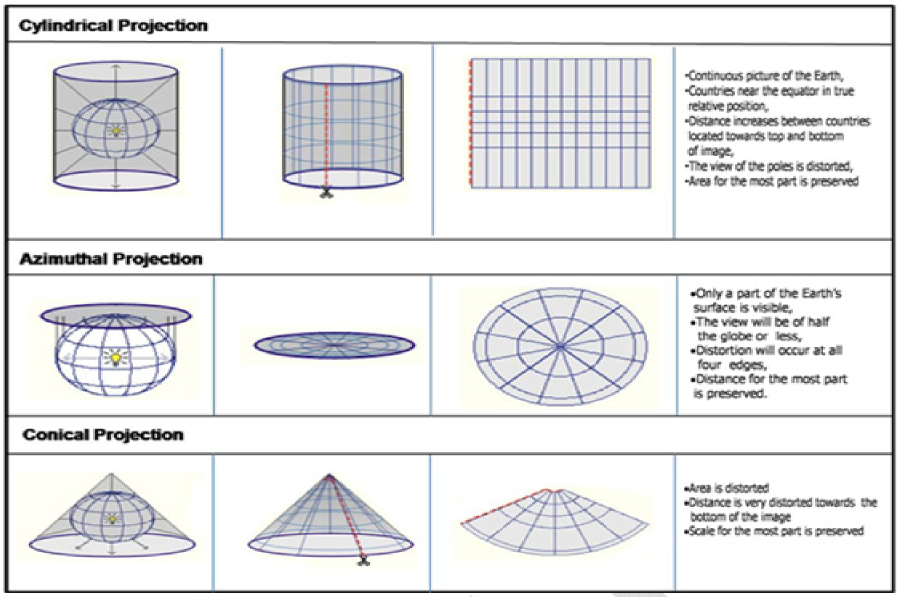


Figure 2.5 Types of Map Projections

Data Editing

It is important for data to be absolutely correct. But errors may be present in vector data or raster data. There may be errors in co-ordinate data as well as inaccuracies in attribute data. Good practice in GIS involves continuous management of data quality. To achieve this, special provision is available for identification and correction of errors. It is better to intercept errors before they contaminate the GIS databases and infect the higher levels of information that are produced. ThIs process is known as data editing or cleaning. Data editing can be compared to the filter between the fuel tank and the engine that keeps the fuel clean and the engine running smoothly. Editing can be classified into three topics,

- Detection and correction of errors
- Reprojection, transformation and generalization
- Edge matching and rubber sheeting

Detection and correction of errors

Errors introduced during encoding or during data transfer and conversion can be detected and corrected without much difficulty. Errors in source data may be difficult to identify. Most GIS packages provide a number of editing tools for the identification and removal of errors in vector data. Errors will also be present in raster data like missing entities and noise which may be corrected by filtering

Reprojection, Transformation and Generalization

a) Data derived from maps drawn on different projections need to be converted into a common projection system.

b) Data derived from different sources may be referenced using different co-ordinate systems. It is necessary to transform the co-ordinates of each of input data set into a common grid system.

c) Data may be derived from maps of different scales. If source maps of widely differing scales are to be used together, data derived should be generalized to a comparable smaller scale maps.

2.5 GIS Packages

Nowadays, dozens of software systems offer GIS decision making capabilities. The range and number available sometimes make it difficult to discern the differences among systems and the strengths and limitations of each. The important point to remember is that, there are as different types of GIS software systems as there is decision – making processes. Particular GIS software systems are often specialized to fit certain types of decision making. That is, they are customized to meet needs of specific applications like demographic forecasting, transportation planning, environmental resource analysis, urban planning, and so on. These systems may respond well to individual problems, but there are also limitations. A GIS software designed for airport planning and maintenance, for instance, may not be well suited to demographic modeling.

The most popular GIS software packages are

ArcGIS

ArcGIS is the product from Environmental System Research Institute (ESRI), Inc. It has a scalable system that features Arcview, ArcEditor and ArcInfo, three versions of the system operate on the Windows platforms and share the same applications and extensions, but they differ in their capabilities. ArcView has data integration, query, display and some analysis capabilities. ArcEditor has additional functionalities for data editing. ArcInfo has more data conversion analysis capabilities than ArcView and ArcEditor.

AutoCAD Map 3D

AutoCAD® Map 3D mapping software is built on the latest release of AutoCAD® software and it is enhanced with a suite of geospatial tools and features. These core capabilities make it easy to share data across an organization. AutoCAD Map 3D functionality enables engineers, planners, mapping technicians, surveyors and GIS personnel to access, edit, visualize and analyze a variety of CAD and spatial data. Core features include: easy-to-use ribbon interface, direct data access, map creation and stylization, analysis capabilities, CAD editing on geospatial data, COGO and survey functionality, publishing tools, extensibility via open source.

Bentley Map

Bentley Map is a fully-featured desktop GIS which can be used to map, plan, design, build and operate infrastructure. Bentley Map enhances underlying MicroStation® capabilities to power precise geospatial data creation, maintenance and analysis. Bentley Map works with and complements the Bentley® Geospatial Server and Bentley's mobile, web publishing, and industry applications.

GeoMedia

Intergraph Corporation has two main products viz., GeoMedia and MGE. GeoMedia is a desktop GIS package for data integration and visualization and is compatible with standard Windows development tools. MGE, which operates on the Windows Operating Systems or UNIX consists of a series of products for data production and analysis. Data can be migrated from GeoMedia to MGE and vice versa.

MapInfo

MapInfo Professional is a powerful Microsoft® Windows®-based mapping and geographic analysis application from the experts in location intelligence. Designed to easily visualize the relationships between data and geography. MapInfo Professional helps business analysts, planners, GIS professionals – even non-GIS users – gain new insights into their markets, share information-rich maps and graphs and improve strategic decision-making.

GRASS

GRASS (Geographic Resources Analysis Support System) is an opensource GIS software package. Originally developed by the U.S. Army Construction Engineering Research Laboratories. GRASS is currently maintained and developed by a worldwide network of users.

Other popular GIS packages are

- Manifold
- SmallWorld

2.6. GIS APPLICATIONS

Major Application areas of GIS are

a. Municipal Applications

- Property tax mapping
- Solid waste management-collection point and routing
- Water supply and sewerage network planning and management
- Administrative boundary mapping
- Land use inventory & mapping
- Site analysis and site selection
- Slum area mapping
- Asset management mapping - Hospital, School and Park
- Water body conservation & management

b. Other Applications

- Transport planning
- Environmental planning
- Town & country planning
- Socio economic development
- Disaster management

3. Desktop GIS, Server Based GIS, Web Based GIS and Enterprise GIS

3.1. Introduction

Municipal GIS

It is needless to say that everyday a new area of application finds its entry into the world of GIS. A GIS is not simply a computer space for creating maps. In fact, a map is the most common way of reporting information from a GIS database. A GIS system developed for a municipal workflow is known as Municipal GIS. In other words, it is a GIS based support tool for planning, management and maintenance of workflows/ activities of a municipal corporation or municipality. It includes both spatial and aspatial information required for facility/asset management, tax assessment and collection, solid waste disposal and management of grant of plan approvals/ permissions with customized tools and many more. The following are some of the typical application scenarios of GIS in urban local bodies.

- Assessment of land use patterns
- Assessment of property tax
- Assessment of land use / floor space index violation
- Assessment of ownership change / sales transaction and
- Analyze a property for grant of building plan approval / permission

The capabilities of a GIS no doubt can provide municipal agencies with significant quantitative and qualitative benefits. In fact, the technology can be the basis for revolutionizing the municipal agencies to carry out their day to day activities. Some of those benefits and changes can be achieved fairly early in the GIS development process; others may take much longer to realize. Not all GIS capabilities are suitable for all towns/cities. A GIS cannot be developed in a matter of months and its full benefits can take years to achieve. Time is required to build a database and procure a system; training people to use the system and, perhaps most importantly, changing their work processes can be as challenging as the system development itself.

3.2. Desktop GIS, Server Based GIS, Web Based GIS and Enterprise GIS

From the common definition of GIS, the underlying basic fact is that GIS is a computer based system that provides its users a set of pre-defined capabilities irrespective to what it is applied for advancements in information and communication technologies as well as hardware have revolutionized the IT industry and deployment of customized applications. GIS has lately picked up such advancements offering flexibility to the GIS system integrators/ developers, who develop and deploy GIS and users who consume GIS data.

3.2.1. Desktop GIS

Desktop GIS is a GIS system available on a desktop PC or a computer. A desktop GIS is a mapping software that is installed and runs on a PC and allows users to display, query, update and analyze data about geographic locations and the information linked to those locations. The GIS software is executed on a desktop and accessed or controlled from or by a user on the same desktop and not remotely. Organizations that already use or adopting to use spatial data in their day to day activities such as municipal agencies using parcel/ property maps for tax assessment or land use/ building code violations, for some of the simpler primary tasks prefer desktop GIS. Desktop GIS is simpler to set up when the requirements are simpler such as GIS data creation, editing, desktop based analysis and desktop GIS map publishing. Desktop GIS software can be both proprietary as well as open source. The characteristics of a desktop GIS can be summarized as below:

This software allows users to view, analyze, manage and create geographic data as well as publish quality professional maps on the desktop

- Functionalities are limited to the desktop computer on which the GIS is set up.
- Not everyone can access the desktop GIS applications from anywhere they like
- Traditional desktop GIS can only serve dedicated desktop users with limited public access.

Some Commercially Off The Shelf (COTS) proprietary desktop

GIS software include: AutoCAD Map from Autodesk, Bentley Map from Bentley Systems, ArcGIS Desktop from ESRI, MapInfo Professional from MapInfo etc. Among the free and open source software some of the popular desktop GIS software includes GRASS (Geographic Resources Analysis Support System), QGIS (Quantum GIS), uDIG (user friendly Desktop GIS), ILWIS (Integrated Land and Water Information System), JUMP (Java Unified Mapping Platform) etc.

3.2.2. Server Based GIS

Server GIS provide basically the same functionality as desktop GIS but allows to access this functionality (so-called geoprocessing) via networks. Server based GIS is typically used for centrally hosted GIS computing. The server-based GIS technology offers multiple advantages to both clients with diverse quantity of data as well as those with complex workflows. GIS software can be centralized in application servers to deliver GIS capabilities to large numbers of users over networks and used to develop additional industry specific client/server applications. Enterprise GIS users connect to central GIS servers using traditional desktop GIS, customized GIS applications built according to client specifications as well as web browsers, mobile computing devices and digital appliances.

Comprehensive GIS capabilities are provided to support a broad range of server GIS requirements. For example, server GIS is used for:

- Managing large GIS databases
- Internet delivery of geographic information
- Hosting central GIS web portals for information discovery and use
- Centrally hosting GIS functions that are accessed by many users in an organization
- Back-office processing of enterprise GIS databases
- Distributed GIS computing (such as distributed GIS data management and analysis)
- Internet delivery of comprehensive GIS functionality WebGIS

3.2.3. Web GIS or Internet GIS

Developing GIS functionality in the Internet or World Wide Web and private intranets is termed as Web GIS. Web GIS is a Geographic Information System distributed across a networked computer environment to integrate, disseminate, and communicate geographic information visually on the World Wide Web over the Internet". Web GIS is also popularly called as Internet GIS. Web GIS holds potential to make Distributed Geographic Information (DGI) available to a very large worldwide GIS audience.

Web GIS allows to add GIS functionality to a wide range of network-based applications. Many of Web GIS applications run on intranets within businesses and government agencies as a means of distributing and using geospatial data. One of the important areas of innovation involves "pay-for-use" mapping and GIS services.

The rise of the Internet has created an infrastructure ideally suited to the widespread distribution and dissemination of geographical information. The Internet technology as a digital communication medium enhances the capability of GIS data and software application by making them more accessible and reachable to wider range of users, planners and decision makers. Web GIS is a means for GIS users to exchange GIS data, conduct GIS analysis and present GIS output in the form of maps over the web. Its applications provide almost all functionalities of traditional GIS software but over the web. The client on web can work with GIS data interactively on the web browser without owning GIS software on his/her local machine.

In performing the GIS analysis tasks, Web GIS is similar to the Client-Server architecture of the Web. The geo-processing breaks down into a server-side and client-side task which allows the users of the GIS to access, manipulate and retrieve the GIS data through their browser without purchasing proprietary GIS software.

A Web GIS typically is based on one of the three types of architecture such as

a. Client-server Architecture

A client-server based Internet or Web GIS is 3-tiered architecture as below:

Presentation tier	–	This is nothing but the web based user interface for the GIS users
Application logic tier	–	This is the component that hosts the GIS model & processes GIS data
Storage tier	–	This is the database(s) that store(s) GIS data

A client typically is a web browser and the server-side consists of a web server that provides a Web GIS software program. The client requests for a map or some geo-processing over the web to the remote server. The server translates the request into an internal code and invokes the GIS functions by passing on the request to the WebGIS software. The software returns the result that is reformatted for interpretation by the client browser application itself or with additional functionality from a plug-in or Java applet. The server then returns the result to the client for display, or sends data and analysis tools to the client for use on the client-side. An Internet GIS server usually combines a standard web server, a GIS application server and the GIS database server.

b. Thin & Thick Clients

The clients are again classified as thin or thick clients. Thin clients (e.g. a web browser used to display Google maps) provide only display and query functionality while thick clients (e.g. Google Earth or a Desktop GIS) provide often additional tools for data editing, analysis and display.

c. Distributed Web GIS Architecture

In a distributed Web GIS architecture so called geoprocessing functions and the GIS data processing components are distributed. The client and server do not refer to a specific machine. In short, the distributed web GIS is a "Geodata anywhere, Geoprocessing anywhere" model.

3.2.4. Enterprise GIS

Enterprise GIS is the catchword of the GIS industry today. In the recent years, many large organizations using GIS or in the deployment stage have moved from stand-alone desktop GIS systems to more integrated approaches that share resources and applications called Enterprise GIS. The basic idea of the Enterprise GIS is to address the needs of user departments collectively instead of individually. The development of one comprehensive system minimizes potential conflicts, resulting in significant cost savings and performance improvements to the organization. An Enterprise GIS is a mix of tightly and loosely coupled systems. Individual departments can have tightly coupled systems, software and hardware but across departments, field units and public interfaces the coupling has to be loose to allow freedom to the users to choose their own systems. It is an integration of spatial, non-spatial data and technology across the organization, coupling centralized management with the freedom of decentralized use.

An Enterprise GIS is a geographic information system that is integrated through an entire organization so that a large number of users can manage, share, and use spatial data and related information to address a variety of needs, including data creation, modification, visualization, analysis, and dissemination.

When organisations started using GIS in the 1960s and 1970s, the focus was on individual projects where individual users created and maintained data sets on their own desktop computers. Due to extensive interaction and work-flow between departments, many organisations have in recent years switched from stand-alone GIS systems to more integrated approaches that share resources and applications.

The objectives of any Enterprise GIS can be summarized as below:

- ❑__Organization wide approach to GIS implementation, operation and management
- ❑ Broad access to geographic data and processing
- ❑ Integrate spatial data and technology across the organization, coupling centralized management with decentralized use
- ❑ Common infrastructure to build and deploy GIS
- ❑ Integrated database and system architecture that provides users with different types and levels of Data can be integrated and used in decision making processes across the whole organisation.

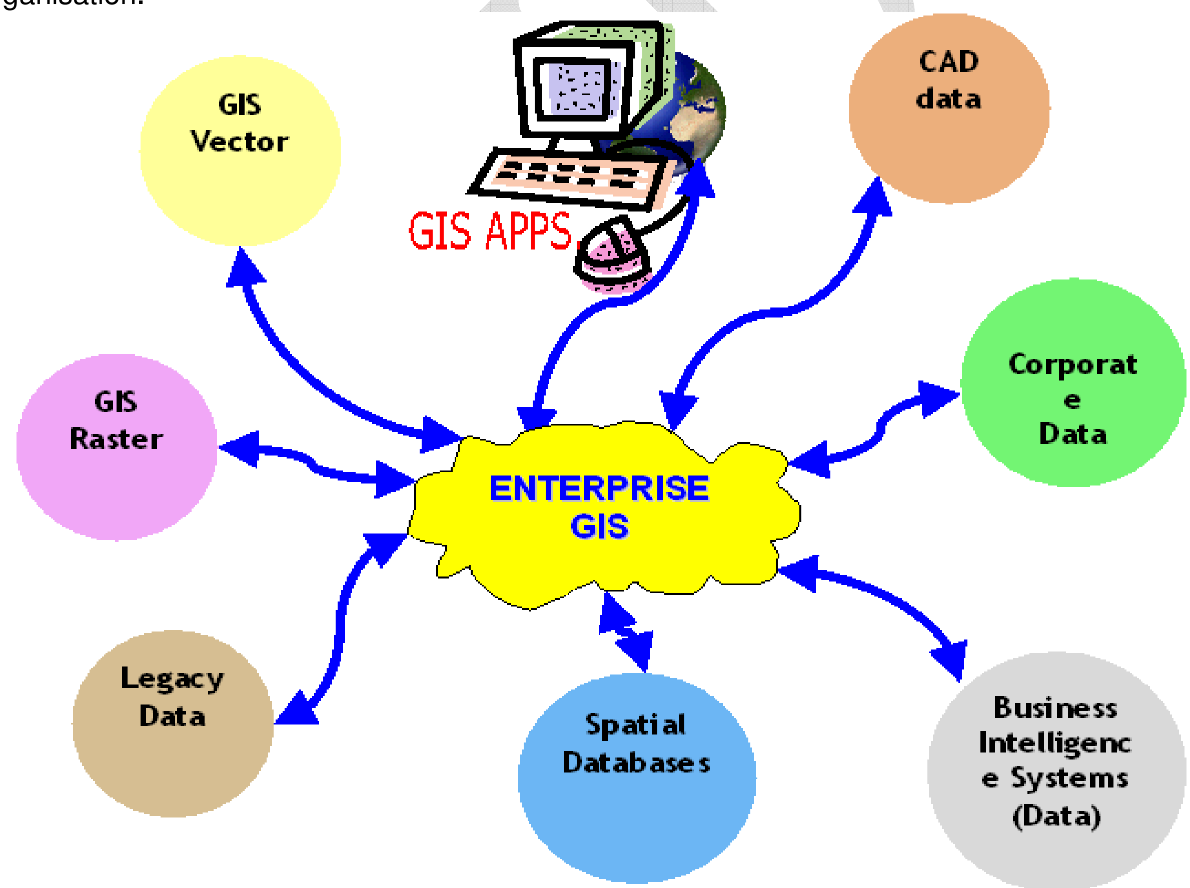


Fig.3.1. Enterprise GIS

- Gain economies of scale through organization wide GIS use
- Share GIS resources, functionality & data across the organisation
- Address business needs collectively instead of individually
- Thick or thin, mobile or stationary clients
- Service oriented approaches (Web Services)

Some of the potential benefits that an enterprise GIS can provide include significantly reduced redundancy of data across the system, improved accuracy and integrity of geographic information, and more efficient use and sharing of data. Since, data is one of the most significant investments in any GIS programme, any approach that reduces acquisition costs while maintaining data quality is important. The implementation of an enterprise GIS may also reduce the overall GIS maintenance and support costs providing a more effective use of departmental GIS resources.

4. Attribute Information & Analytical Tools for GIS Packages

4.1 Introduction

A typical Geographical Information System integrates the following five key components:

- Spatial and Aspatial Data: Data required for the GIS (spatial and non-spatial or aspatial)
- Hardware: Set of supporting hardware required for the GIS
- Software: Set of supporting software required to run the GIS
- Personnel/ People: People/ Personnel working on the GIS or users of GIS
- Procedures: Workflows/Methods for the GIS

It is said that the most important component of a GIS is the data. It is general thumb rule and practice that 80-90% of the time in building a GIS would be spent towards data collection and creation to make it as comprehensive and holistic as possible to meet the objectives of the GIS system being developed. Geographic data (spatial data) and related tabular data (non-spatial or aspatial data) can be collected in-house or outsourced to a service provider. Most of GIS employ a Data Base Management System (DBMS) to create and maintain a database to help organize and manage data.

1. Spatial data – contains the co-ordinates and identifying information describing the map itself
2. Attribute data - contains information that can be linked to the spatial data

Spatial data contains the co-ordinates for identifying information for various map features. The generally accepted practice in GIS is that any feature on the earth can be represented spatially in GIS using a point, line or a polygon or a combination. Spatial data can be subdivided into vector and raster. Vector data is represented as points, lines and polygons. Raster data is cell-based data such as aerial imagery and digital elevation models.

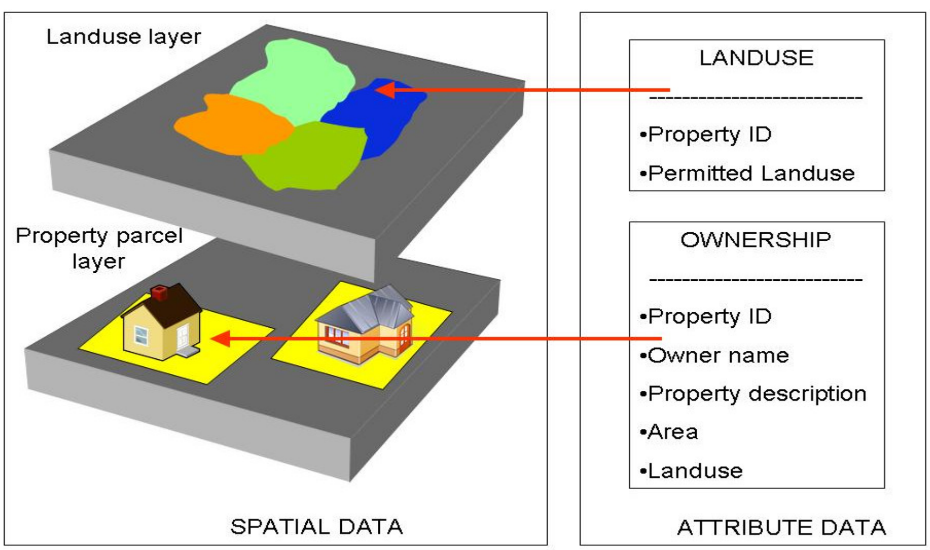


Figure 4.1. Spatial Data & Attribute Data

A layer can be either static or thematic. Static layers use the same symbology attributes such as color, fill color, pattern, line width, line style, symbols etc for all the features in a layer. Thematic layers on the other hand use different symbology to classify the features in the layer. For example, in a thematic area layer on property parcels in a city by the municipal ward, number of attribute could be used by different colors to show the ward property. Thematic line layer representing highways can be used in different line widths to show the types of roads such as National Highways, State Highways etc.

Attribute Data contains information that can be linked to the spatial data. Attribute information in GIS terminology means non-spatial information about a spatial feature. For example, attribute information about a spatial feature such as roads could be the name of the road, width of the road etc. The non-spatial or attribute information about a geographic feature in a GIS is usually stored in a table and linked to the feature by a unique identifier or unique ID.

Attribute data is usually collected and compiled against a specific data model on which a GIS is built. The data model design itself is based on the prime objective or reason for which a GIS is built. For example the data model for a municipal property tax GIS system will be designed in such a way that all attribute data relating to municipal property tax collection, processing and reporting can be input into the GIS.

Why attribute data is equally important as spatial data?

There can be no debate on the fact that attribute data is equally important as spatial data. The accuracy of the attribute equally determines the reliability of the output of a GIS analysis as that of the accuracy of the spatial data represented in a GIS. Attribute accuracy refers to the precision of the attribute database linked to the map's features. For example, if a map shows road classifications, are they correct? If it shows street addresses, how accurate are they? Attribute accuracy is the most important to users with complex data requirements.

Meta Data

While discussing about attribute data, it becomes relevant to discuss regarding meta data as well. Meta data (meta data, or sometimes meta information) is "data about other data", of any sort in any media. Meta data is a protocol for GIS in which the user makes note of certain information about the data behind the GIS such as the source of the data; its creation date and format; date upto which the data is valid (in situations where the data is transient in nature; its projection, scale, resolution, and accuracy; and its reliability with regards to some standard. Though there are several local standards in practice among the GIS community, the most popular practice of meta data standards are those formulated by OGC (Open Geospatial Consortium Inc.), a non-profit, international, voluntary consensus standards organization that is leading the development of standards for geospatial and location based services.

Attribute Data Model

When implementing a GIS, the most common sources of attribute data are usually from within the organisation implementing the GIS combined with data sets purchased (such as base map of the area) or acquired through field surveys.

A separate data model is used to store and maintain attribute data for GIS. These data models may exist internally within the GIS, or may be external to the GIS in a Database Management System (DBMS). A variety of data models exist for the storage and management of attribute data.

Tabular Model

The simple tabular model stores attribute data as sequential data files with fixed formats (or comma delimited for ASCII data), for the location of attribute values in a predefined record structure. This type of data model is outdated in the GIS industry. It lacks any method of checking data integrity, as well as being inefficient with respect to data storage.

Hierarchical Model

The hierarchical database organizes data in a tree structure. Data is structured downward in a hierarchy of tables. Any level in the hierarchy can have unlimited children, but any child can have only one parent. Hierarchical DBMS have not gained any noticeable acceptance for use within GIS. They are oriented for data sets that are very stable, where primary relationships among the data change infrequently or never at all. Also, the limitation on the number of parents that an element may have is not always conducive to actual geographic phenomenon.

Network Model

The network database organizes data in a network or plex structure. Any column in a plex structure can be linked to any other. Like a tree structure, a plex structure can be described in terms of parents and children. This model allows children to have more than one parent.

Relational Model

The relational database organizes data in tables. Each table, is identified by a unique table name, and is organized by rows and columns. Each column within a table also has a unique name. Columns store the values for a specific attribute. Rows represent one record in the table. In a GIS, each row is usually linked to a separate spatial feature. Accordingly, each row would be comprised of several columns, each column containing a specific value for a geographic feature.

Data is often stored in several tables. Tables can be joined or referenced to each other by common columns (relational fields).Usually the common column is an identification number for a selected geographic feature, e.g. property id or survey number. This identification number acts as the primary key for the table. The ability to join tables through use of a common column is the essence of the relational model. Such relational joins are usually ad hoc in nature and form the basis of for querying in a relational GIS product. Unlike the other previously discussed database types, relationships are implicit in the character of the data as opposed to explicit characteristics of the database set up. The relational database model is the most widely accepted for managing the attributes of geographic data.

The relational DBMS is attractive because of its:

- Simplicity in organization and data modeling.
- Flexibility - data can be manipulated in an ad hoc manner by joining tables.
- Efficiency of storage-proper design of data tables can reduce redundancy.
- Queries do not need to take into account the internal organization of data.

Object Oriented Model

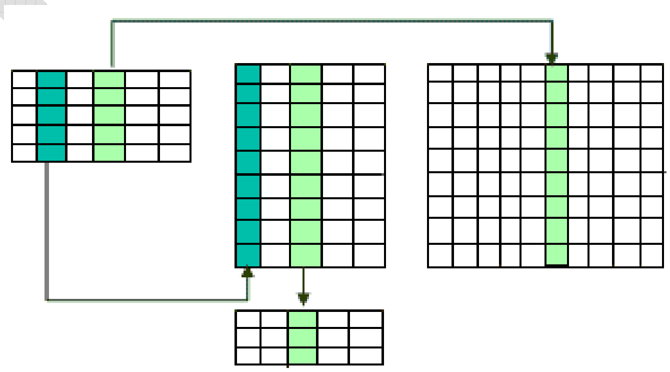


Figure 4.2 RELATIONAL DATA MODEL

The object-oriented database model manages data through objects. An object is a collection of data elements and operations that together are considered a single entity. The object-oriented database is a relatively new model. This approach has the attraction that querying is very natural, as features can be bundled together with attributes at the database administrator's discretion. To date, only a few GIS packages are promoting the use of this attribute data model. However, initial impressions indicate that this approach may hold many operational benefits with respect to geographic data processing. Fulfillment of this promise with a commercial GIS product remains to be seen.

Analytical Tools for GIS Packages

An analytical tool is something used to analyze or "take a closer look at" something. It is normally a way to review the effectiveness of something. For example, Google offers a web analytics tool that is used by web masters of websites to track visitors on a given website. It allows web masters to see where visitors are coming from, how long they stay, what links they are reviewing, etc.

Analytical skill is the ability to visualize, articulate, and solve complex problems and concepts, and make decisions that make sense based on available information (Source: Wikipedia).

GIS is a great tool that can be effectively used to answer questions and make reliable and accurate decisions. To use GIS properly, it is important to know what is required or desired as output and follow a systematic procedure to get the results. The effective and optimal use of a systematically built GIS depends on the end users, their knowledge of GIS analysis and tools within the software package on which the GIS itself is built.

4.2. ANALYSIS USING GIS

The heart of any GIS is its analytical capabilities. What distinguishes a GIS from other information systems are its spatial analysis functions. The inbuilt analysis functions in any GIS software package use the spatial and non-spatial attributes in the GIS database to answer the user queries. Geographic analysis facilitates the study of real-world processes by developing and applying models. Such models illuminate the underlying trends in geographic data and thus make new information available. Results of a GIS analysis can be both graphical (maps) or attributes (reports) or both.

The objective of any GIS analysis should be to transform available data into useful information to satisfy the requirements or objectives of decision-makers at all levels in terms of details. An important use of the analysis is the possibility of predicting events in another location or at another point in time by using models.

The analysis capabilities of a GIS can be summarized as why, where, when, what and how or what (Figure 4.3). This essentially means that given any situation where GIS is being used to analyze a given problem, one can get answers on queries of type why, where, when, what and how? The analysis can be on either spatial and non-spatial data or a combination of these.

Let us look at some of the most common types of GIS analysis with a sample data set relating to Municipal GIS.

FIGURE 4.3 WHAT A GIS CAN DO?

4.2.1. Database Query

This is the most common type of analysis that can be performed using a GIS. A database query is usually written or composed using Structured Query Language (SQL) or a more user friendly Visual Structured Query Language (VSQL) Query Builder. The purpose of a database query is to look for matching spatial and non-spatial data from a GIS system based on a defined criteria, built using relational, logical, arithmetic or spatial operators on a single layer (table) or multiple layers (tables). Here is a simple query illustrated graphically (Figure 4.4.) where the user searches the property records for a specific parcel id with the help of VSQL query builder tool in a GIS software, which is then graphically located on the map as well

4.2.2. Overlay Analysis

This is another common spatial analysis performed using GIS. In an overlay analysis, the overlay could be of two basic types

- ❑ Raster overlay and
- ❑ Vector overlay

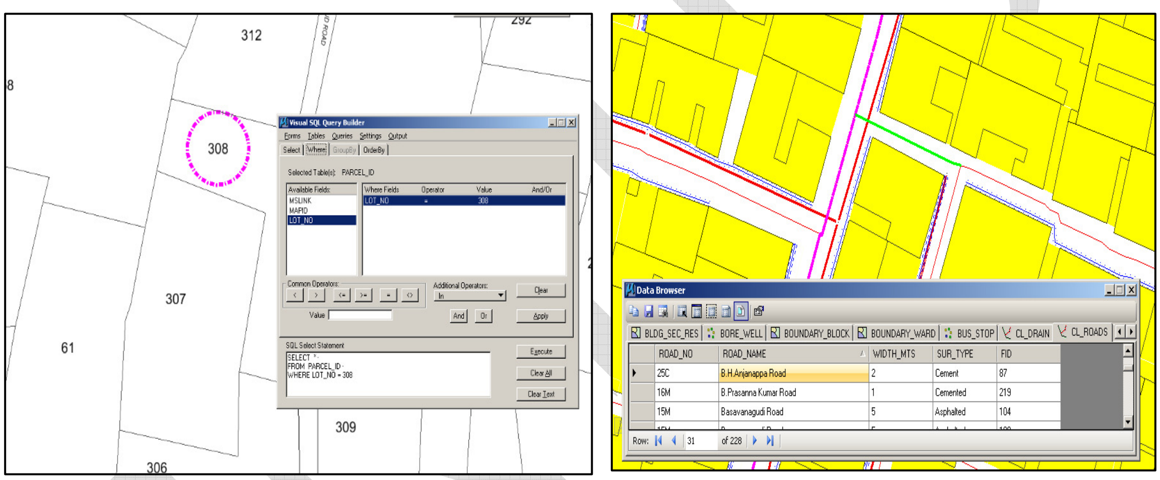


Figure 4.4. VSQL Query Builder – Search and Locate

In a raster overlay the overlaid layers are intelligent raster information such as raster Digital Elevation Models (DEMs). In raster overlay, the pixel or grid cell values in each map are combined using arithmetic and Boolean operators to produce a new value in the composite map. The maps can be treated as arithmetical variables and perform complex algebraic functions. The method is often described as map algebra. The raster GIS provides the ability to perform map layers mathematically. This is particularly important for the modelling in which various maps are combined using various mathematical functions. Conditional operators are the basic mathematical functions that are supported in GIS.

The vector overlay can be further classified into

- ❑ Point on Area Overlay
- ❑ Point on Line Overlay
- ❑ Line on Area Overlay
- ❑ Area on Area Overlay

The concept behind this spatial analysis is to overlay spatially one or more layers of information and arrive at results/ conclusions.

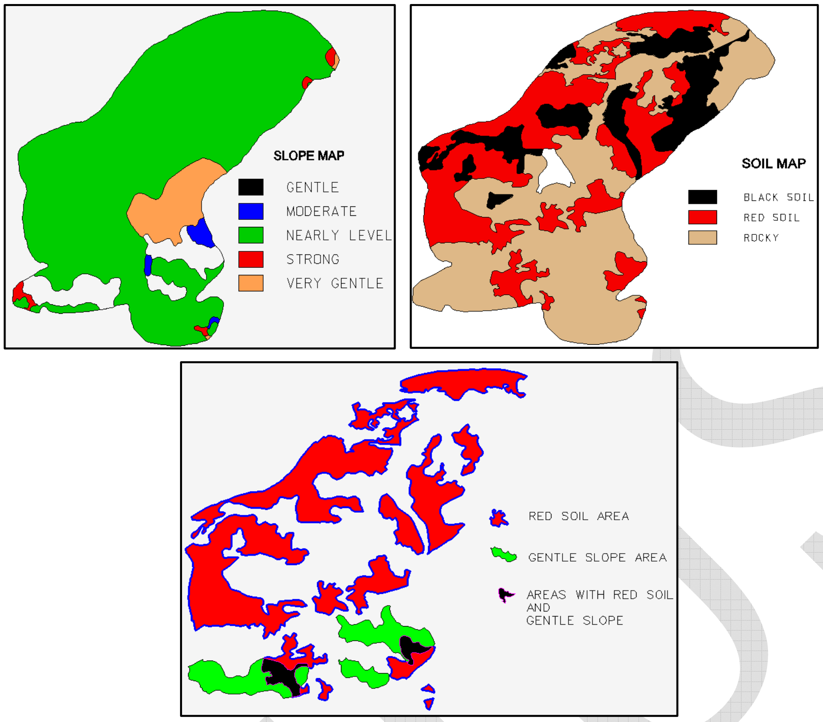


Figure 4.5 Overlay Analysis: Site Suitability Analysis

4.2.3. Network Analysis

Shortest route by distance between two points

Geometric networks offer a way to model common networks and infrastructures found in the real world. Roads, water distribution, electrical lines, gas pipelines, telephone services etc. are all examples of networks with resource flows that can be modeled and analyzed using a geometric network. A geometric network is a set of connected edges and junctions, along with connectivity rules that are used to represent and model the behavior of a common network infrastructure in the real world. Network Analysis is used for identifying the most efficient routes or paths for allocation of services(Figure 4.6).

Some typical network analysis tools in GIS are

- ❑ Shortest route
- ❑ Trace forward (for water/sewer or other utility networks)
- ❑ Trace backward (for water/sewer or other utility networks)
- ❑ Radial search

Basic forms of network analysis simply extract information from a network. More complex analysis process information in the network model to derive new information.

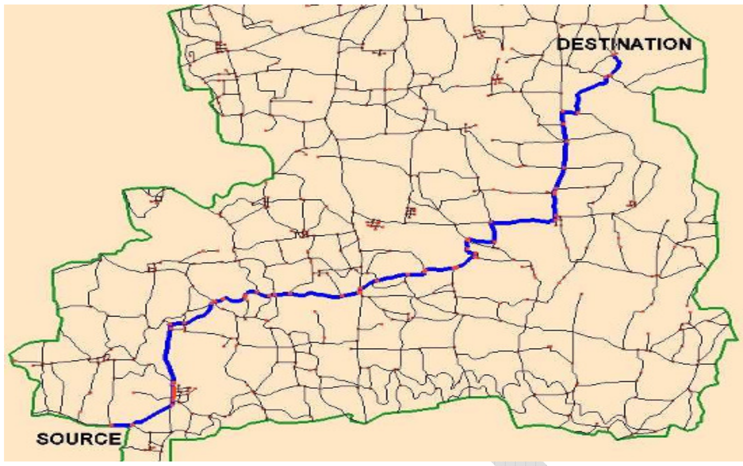


Figure 4.6 Network Analysis – Shortest route by distance between two points

4.2.4. Proximity Analysis

Proximity analysis is a way of analyzing spatial disposition of features by measuring the distance between them and other features in the area. The distance between point A and point B may be measured as a straight line or by following a networked path, such as street network. Example: Site suitability analysis – Check for residential land use within a distance of 2 km from a proposed solid waste dumping yard as shown in Figure 4.7.

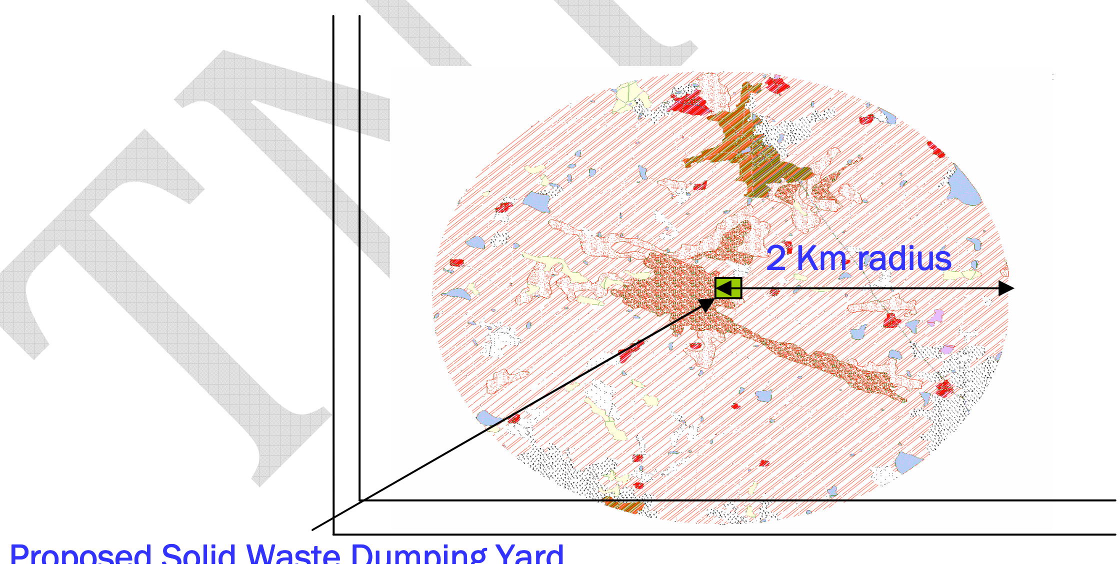


Figure 4.7.Proximity Analysis

4.2.5 Buffer Analysis

GIS can create buffer zones around selected features. The features or layers of interest could be based on the results of a database query. For example, a radius of 250 m around a street network of a locality on both sides can be used to find out how many land owners would be affected because of proposed road widening along with extent of land to be acquired by each property id. Buffering operation many a time could result in large polygons when the dissolve option to dissolve the common boundary between two adjacent polygons is done. Depending on the context, buffer generation tools in most commercially available GIS software make it possible to generate one single buffer for all the features of interest, which are usually lines or points or single buffer for all features. Figures 4.8 and 4.9 are showing the buffer analysis.

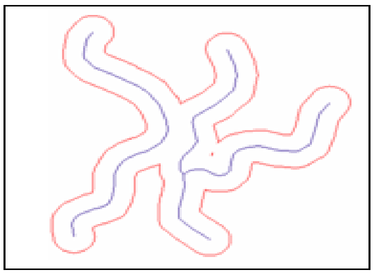


Figure 4.8. Single buffer for all features

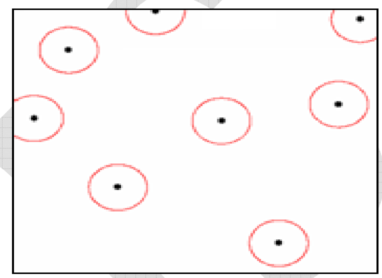


Figure.4.9.Individual buffer for every feature

4.2.6. 3D Analysis

For the proper planning and construction of Storm water drain of the municipal ward, digital terrain model (DTM, Figure 4.10) was created using the elevation information in 3D analysis of Bently Geopack. The 3D Geographic map is overlaid on a DTM, which represented in a figure 4.11. From the above information low lying areas and flood plains can be identified.

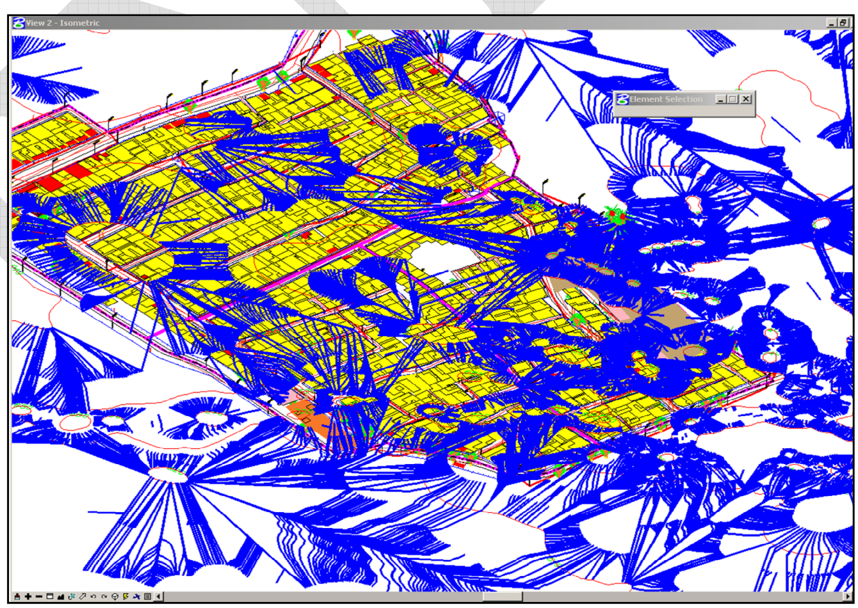


Figure 4.10. 3D analysis using Bentley Geopak

4.2.7 Visualization Analysis Using Google Earth

Google Earth is a virtual globe, map and geographic information programme that was originally called Earth Viewer, and was created by Keyhole, Inc, a company acquired by Google in 2004. It maps the earth by the superimposition of images obtained from satellite imagery, aerial photography and GIS 3D globe. It is available under three different licenses: Google Earth, a free version with limited functionality; and Google Earth Pro, which is intended for commercial use (Source: http://en.wikipedia.org/wiki/Google_Earth). Google Earth lets you fly anywhere on earth to view satellite imagery, maps, terrain, 3D buildings, from galaxies in outer space to the canyons of the ocean. You can explore rich geographical content, save your toured places, and share with others. Most commercially available GIS software such as Bentley Map, AutoCAD Map3D etc. have either free in-built tools or add on third part tools to export/ import data in CAD/GIS formats to Google Earth format called Keyhole Markup Language (KML). Figure 4.12 shows the satellite image 3D view of municipal ward in Google Earth software, available from World Wide Web (WWW). The topographic map is superimposed on the Google Earth which is shown in figure 4.13. The above information is one of the handy information for the decision makers, planners and execution agencies to understand easily the topographical nature of the municipal ward. The public also can understand and get the information of their locality. Figure 4.14 and 4.15 shows other 3D view of features like street lights, trees, roads and other terrain features.

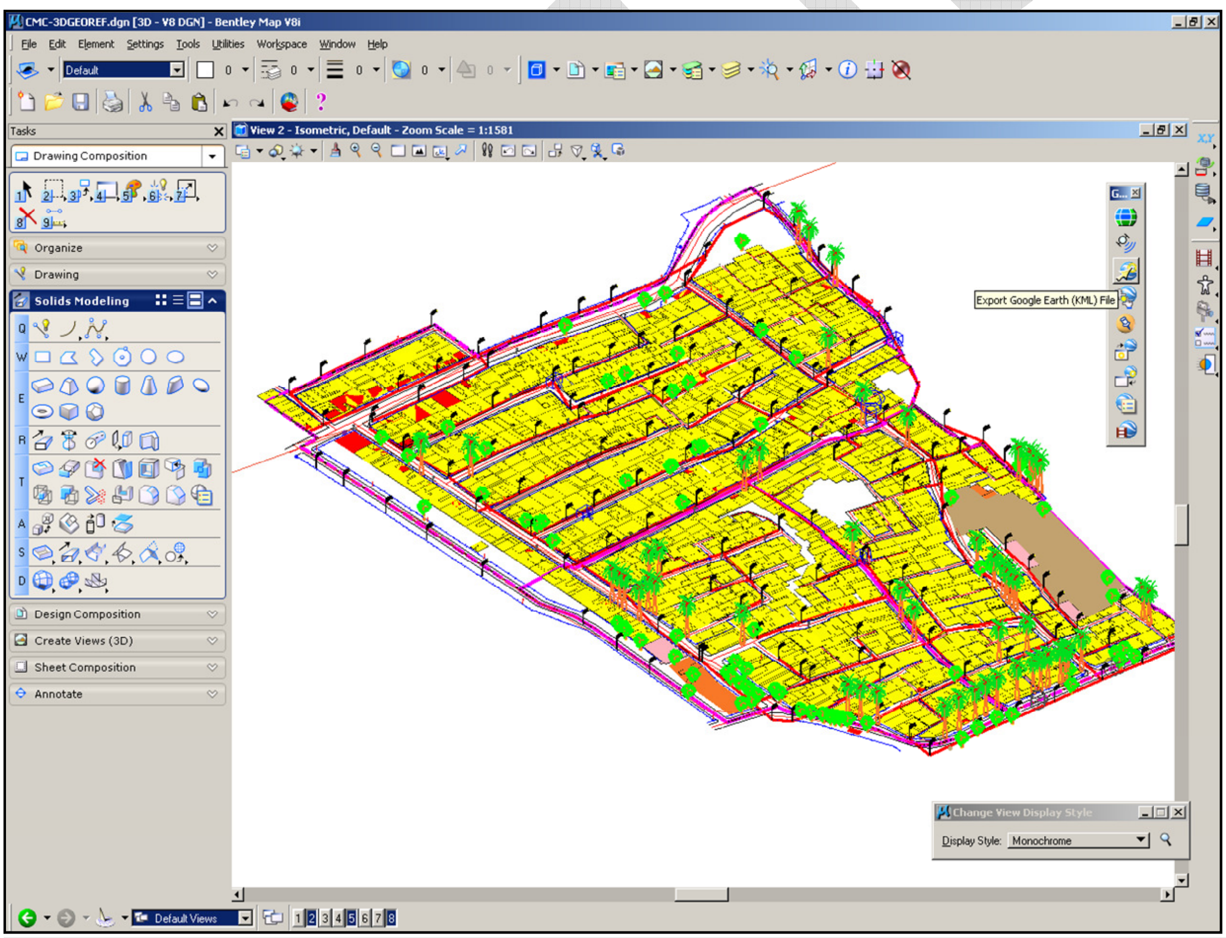


Figure 4.11. 3D Topographic Map of a Municipal Ward in Bentley Map V8i Software

Figure 4.12. 3D View of the municipal ward in Google Earth software

Figure 4.13. Superimposed 3D topographic map of municipal ward in Google Earth satellite imagery

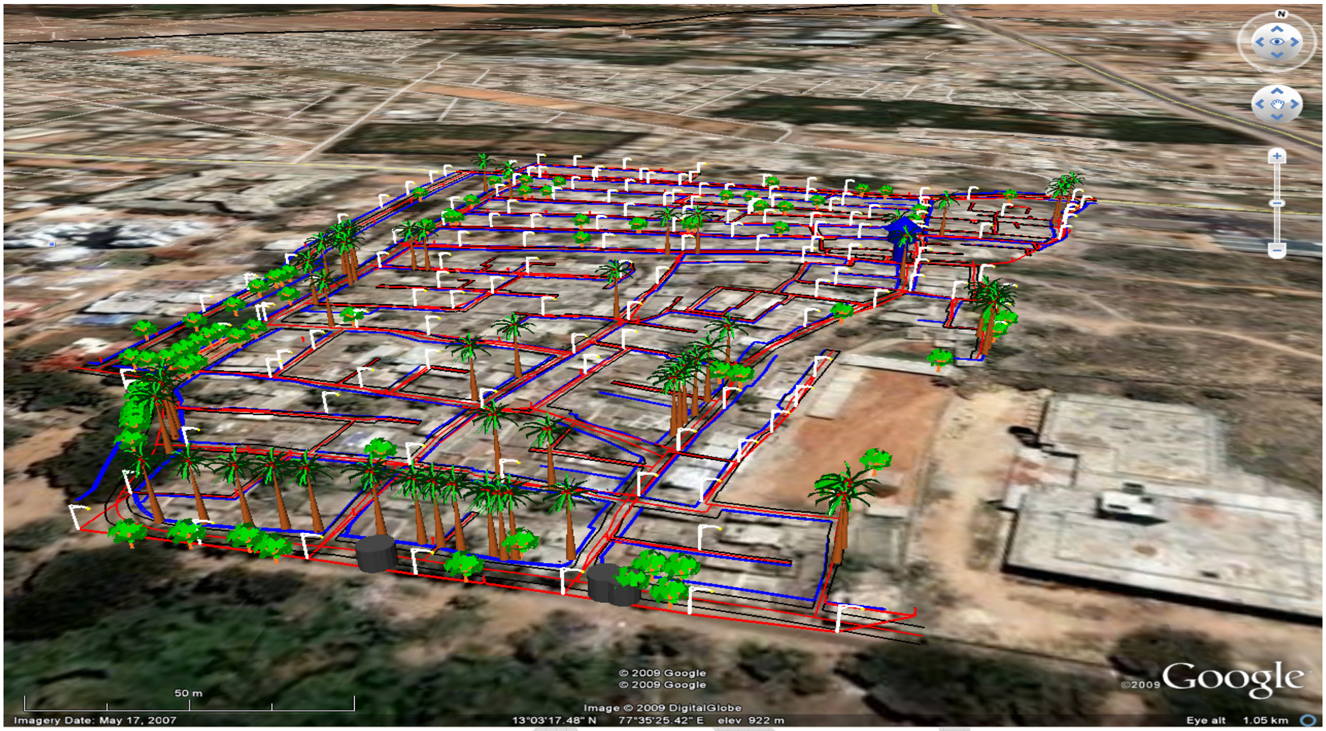


Figure 4.14. 3D View of the municipal ward in Google Earth Software

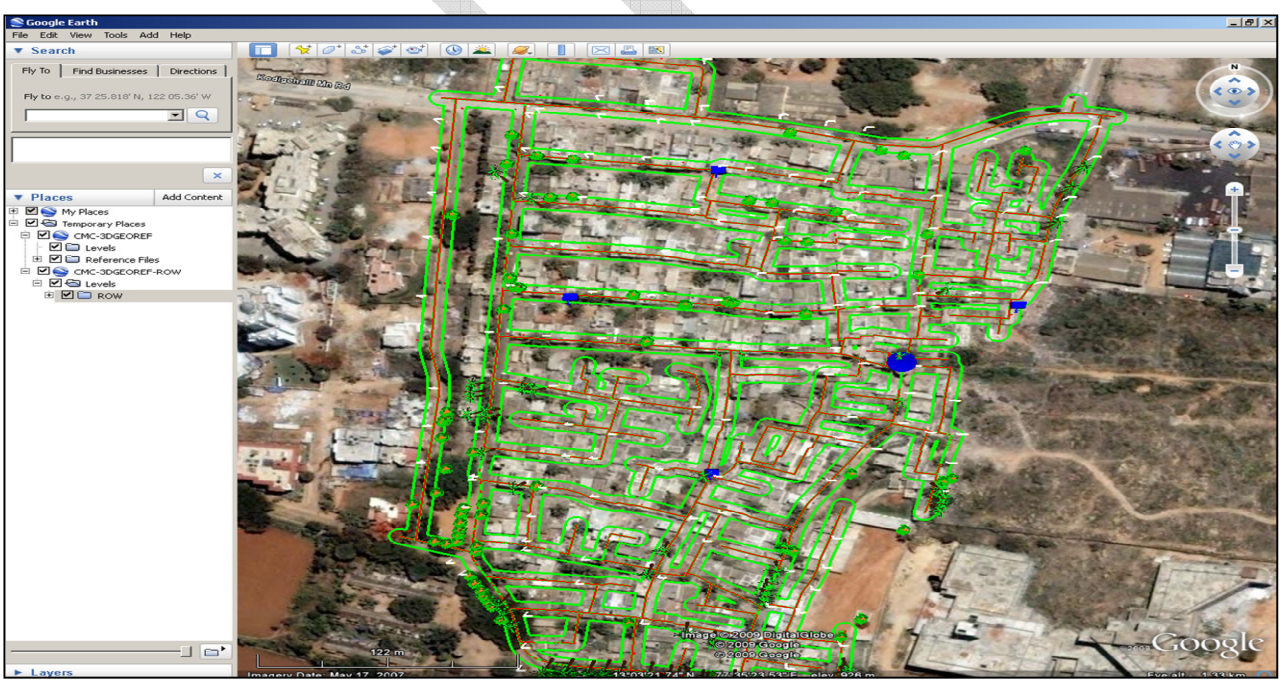


Figure 4.15. 3D View of the municipal ward in Google Earth software - road and its boundary

5. USE OF GIS FOR URBAN LOCAL BODIES

Generally the day-to-day activities of the urban local bodies are administered by the various divisions. They are as follows:

5.1. Administration

5.2. Engineering

5.3. Town Planning

5.4. Health

5.5. Revenue

5.6. Accounts

5.1. Administration

Commissioner is the administrative head of the urban local body. The GIS will facilitate to perform the following duties and responsibilities of the Commissioner

1. To furnish the necessary information from time to time required by the Municipal Council, Standing Committees and Ward Committees.
2. To monitor the progress of developmental works of schemes, projects etc.,
3. To identify the unauthorized/un-assessed/under assessed properties and water and sewage connections (Water/Sewer) for improving the revenue of the ULB.
4. To protect the properties of ULB
5. To remove the encroachments

Uses of GIS to Municipal Commissioners

For efficient administration and decision making Municipal Commissioners are in need of accurate and readily available basic information about the ULB. The required information can be retrieved from GIS database as detailed below.

a. From Figure 5.1 of satellite imagery, Commissioners can visualize the whole area of the ward/ULB.

b. Administrative Jurisdiction / ward boundaries and its related information such as ward number, area, perimeter, etc can be retrieved from the GIS database as shown in Figure 5.2

c. The length, width, and type/name of roads running in the ULBs and its related information can be retrieved.

d. Road furniture viz. bus stop shelter, medians, storm water drain, water supply line, sewerage network, telecom, EB, etc., and its offset/distance from the road boundary can be retrieved.

e. Retrieval of details regarding contract works viz., date of previous work carriedout, cost, extent, present work details and completion time – for the road, water supply and sewage network is also possible.

f. Location, extent and utility information about the assets of ULBs such as schools, hotels, commercial complexes, markets, bus stands, parks, playgrounds, vacant lands, etc can also be retrieved.

g. Extent of water supply networks, tapped water supply & untapped water supply connection details can be retrieved.

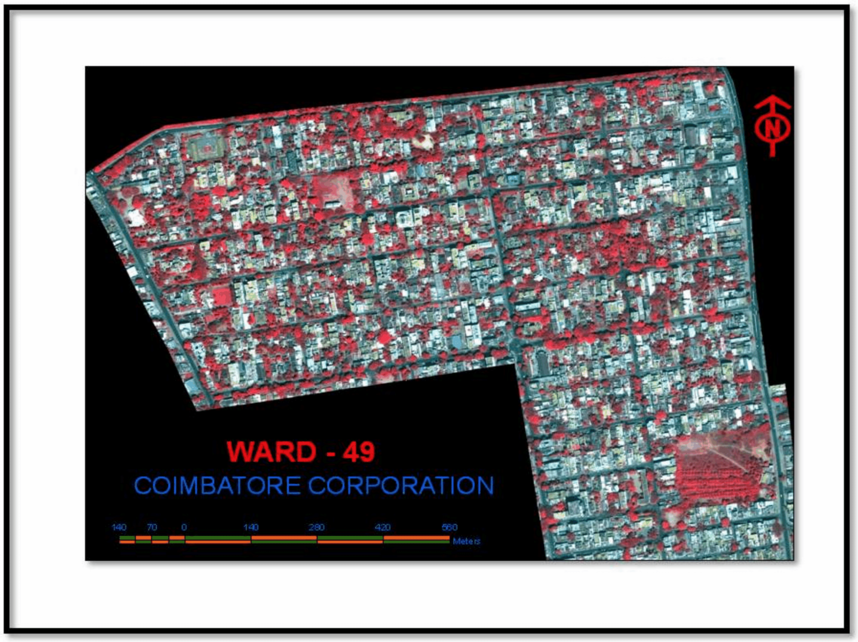


Figure 5.1. Satellite Imagery for Ward No.49 of Coimbatore Corporation

h. Extent of sewerage connection and its types (open drainage, underground drainage, etc.,) location of manholes and flow direction can also be retrieved.

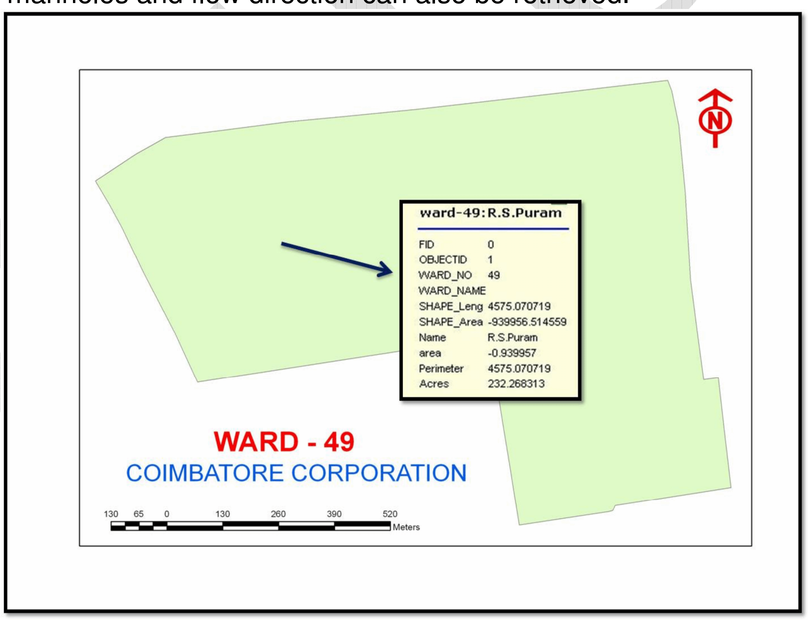


Figure 5.2. Ward Boundary and its Information

5.2. Use of GIS to Municipal Engineers

Engineering section is headed by a Municipal Engineer under the control of Municipal Commissioner. Development works including planning, operation and maintenance of roads, buildings, water supply, underground drainage, and storm water drains, street lights are carried out by this division.

5.2.1 Water Supply

Engineers can retrieve the information relating to water supply such as water supply zones, service reservoirs, pumping mains, distribution network (Diameter, material and year of pipeline laid), location of public tabs, location of valves, areas without water supply network , areas without adequate pressure, quality of water pumped, per capita supply, etc., with the help of GIS database . Figure 5.3 shows the water supply main networks and pipe diameter of ward no .49 of Coimbatore city Municipal Corporation.

The following are the sample outputs retrieved from the GIS database of Coimbatore city Municipal Corporation.

1. Size and length of water supply network,
2. Spatial location of water supply taps over the base map.
3. Pipe lines of greater than 250 diameters (Figure 5.4)
4. Materials used as shown in Figure 5.5.

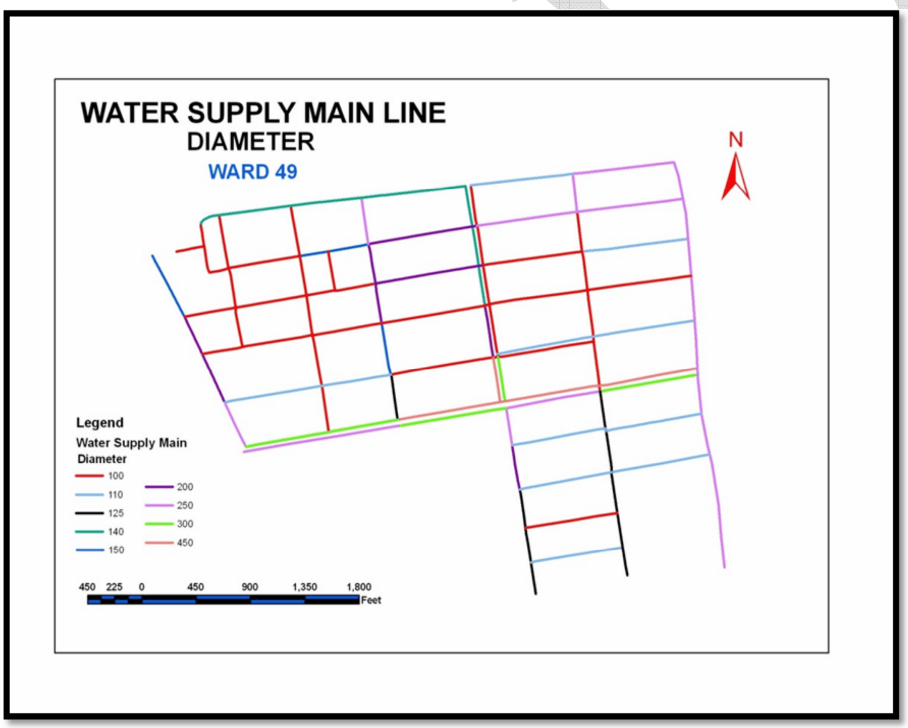


Figure 5.3. Water Supply Network and Pipe diameter

5.2.2 Under Ground Drainage (UGD)

The availability of data in the GIS database will facilitate the engineer to attend the day-to-day maintenance and operation of UGD network which includes nature of UGD network, year of construction, diameter and material of pipe, location of manholes and location of pumping stations, areas not served by pumping station, etc.,

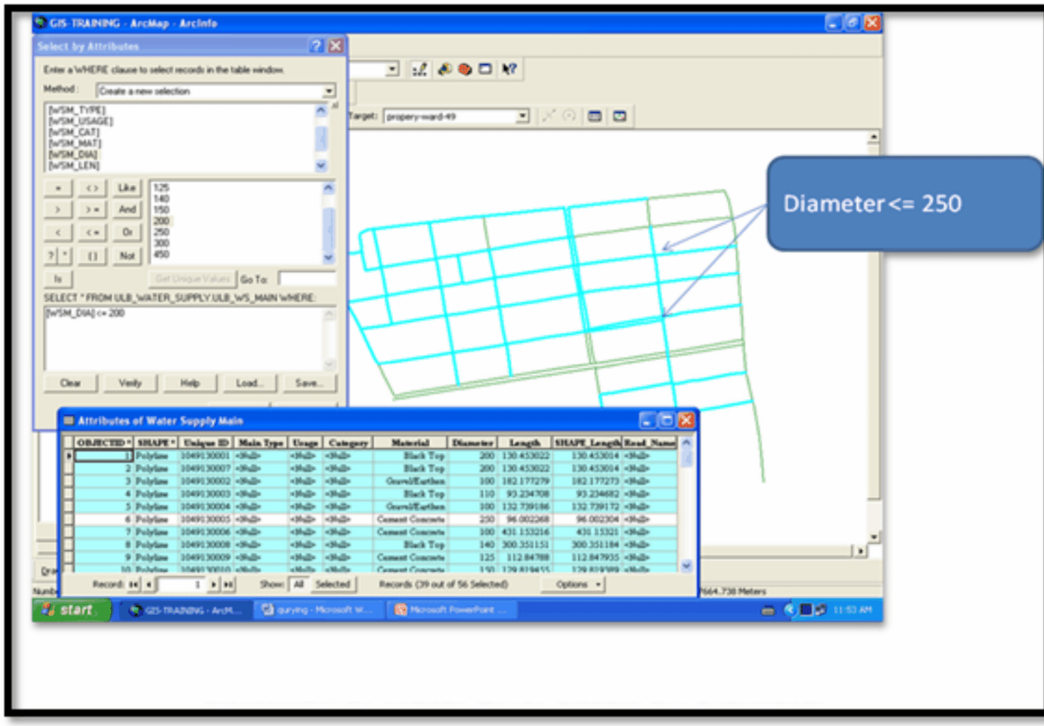


Figure 5.4 Selection of water pipe line based on diameter

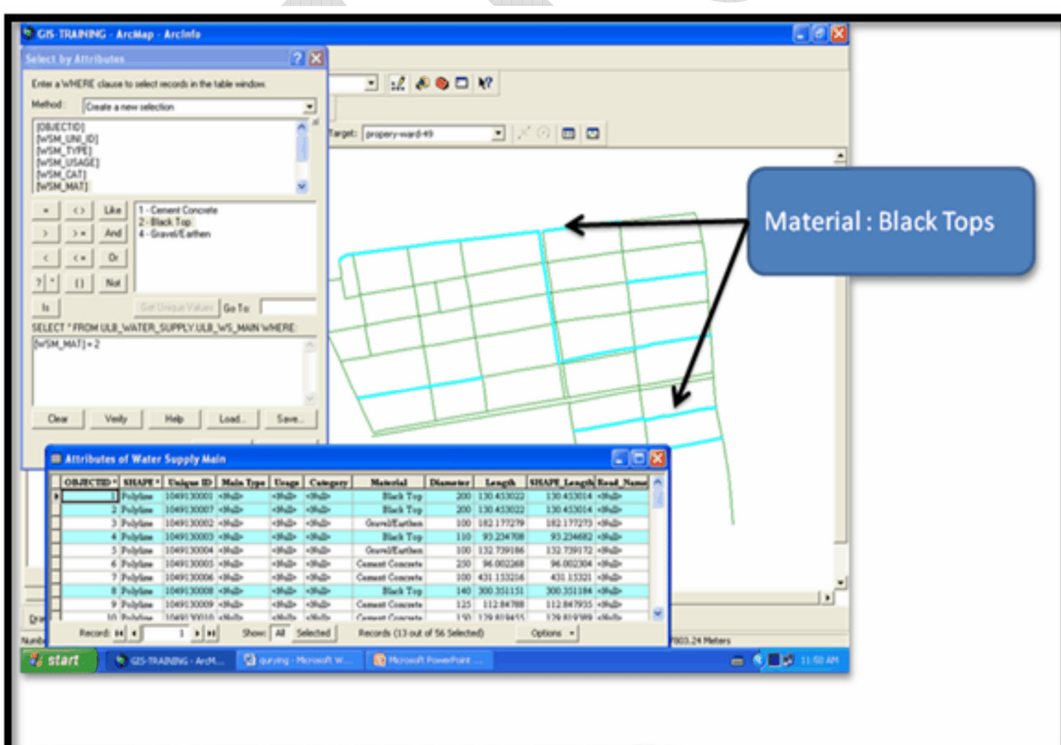


Figure 5.5 Selection of water pipe line based on material type

5.2.3 Roads

The following available GIS map can be seen readily on the Desktop Computer. The map is useful to the Municipal Engineer for planning and execution of the road projects.

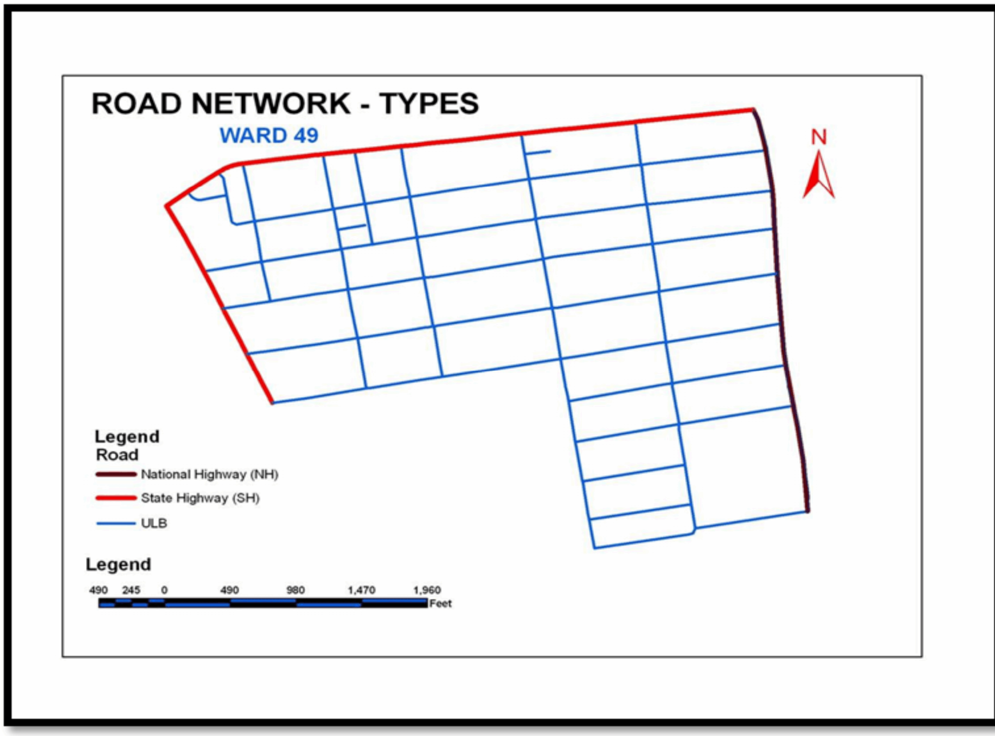


Figure 5.6 Road Network Types

a) The location of the road network in and around the city/ town can be comprehensively seen at the desktop itself.

b) Location of roads according to the surface classification such as (Cement Concrete (CC) / Bituminous (BT) / Water Bound Macadam (WBM) / Gravel road) can be readily seen with details in the GIS map.

c) Ward wise road length, Width of the road network (Municipal roads & non municipal roads), roads with/without storm water drains, location of culverts, bridges, fly overs, etc, can also be seen in the map.

d) List of roads in the municipal limits for immediate surface improvement with CC/BT.

e) Roads under Town Planning Schemes /Detailed Development Plan.

f) Details on road improvement works undertaken during the last five years –ward wise / year wise data can be retrieved.

A report for a sample road segment and its information such as road name, width, length, type, median availability, pedestrian, storm water drain availability etc can be retrieved from GIS database in a map format, which is shown in Figure 5.7. The above information can be useful for making estimation on road improvement works.

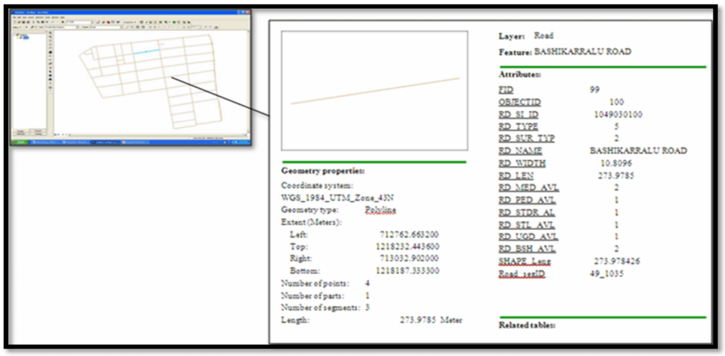


Figure 5.7 Report on a Road Segment

5.2.4 Buildings

The database related to immovable assets such as schools and hospital buildings, office complex, shopping complex etc can be created and accessed in a GIS. For example in schools - the extent, school type (Primary, Secondary/Higher Secondary), infrastructure facilities available and number of students (Past and Present) etc can be had from the GIS database. These database will facilitate planning and development of social infrastructure to a greater extent. The type of building and constructed area of building in a land parcel can be queried as depicted in the Figure 5.8 and 5.9 respectively.

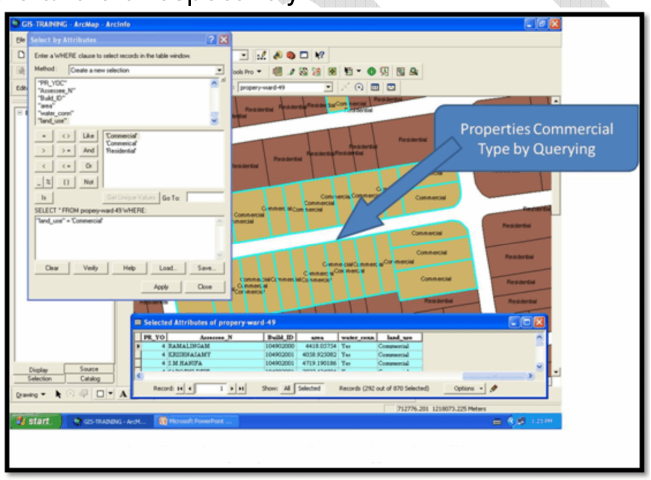


Figure 5.8 Selection of property based on Landuse type

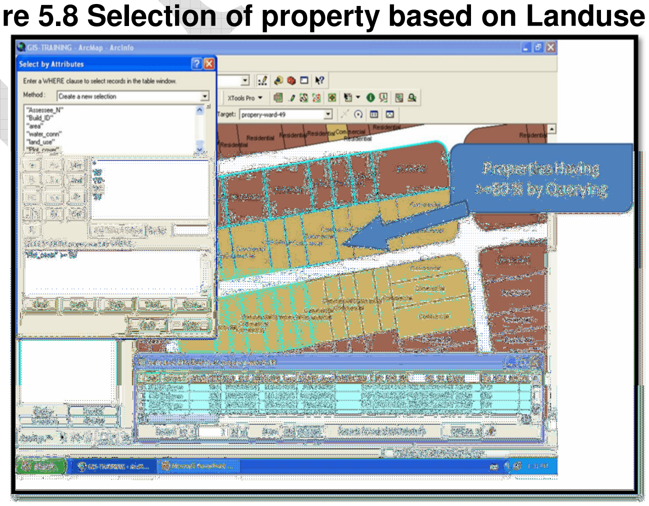


Fig 5.9 Selection of property based on Building Coverage

5.2.5 Storm Water Drain (SWD)

The information such as existing network of storm water drain in the municipal limits, location of disposal point, size of drains, type of drains (open /closed), year of construction, location of wards without storm water drains , low lying area, prone to flooding during monsoon , location of canal and water bodies etc, can be gathered through GIS. This will facilitate the planning for storm water drains and safe disposal of flood water during monsoon and non-monsoon seasons.

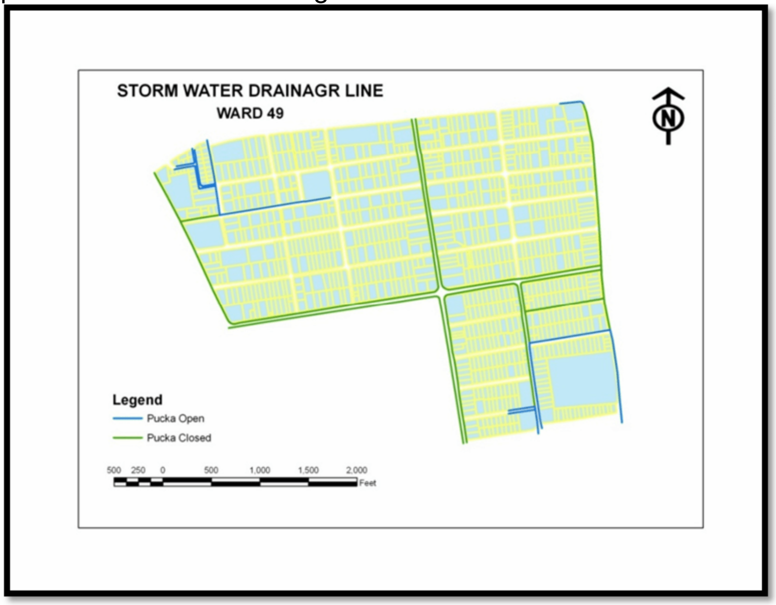


Figure 5.10 Storm Water Drainage Line

5.2.6 Street Lighting

GIS maps will display the present network of street lights in the municipal area indicating the location of lamp posts (Figure 5.11) with ID number, classification of lights (tube lights, sodium vapor lamps) and high mast lamps etc., The Commissioner /Municipal Engineer will locate the area with inadequate street lighting, space between lamp posts, future extension of street lighting, and day-to-day maintenance work with the help of GIS map. From the above data Operation of Maintenance cost can be generated.

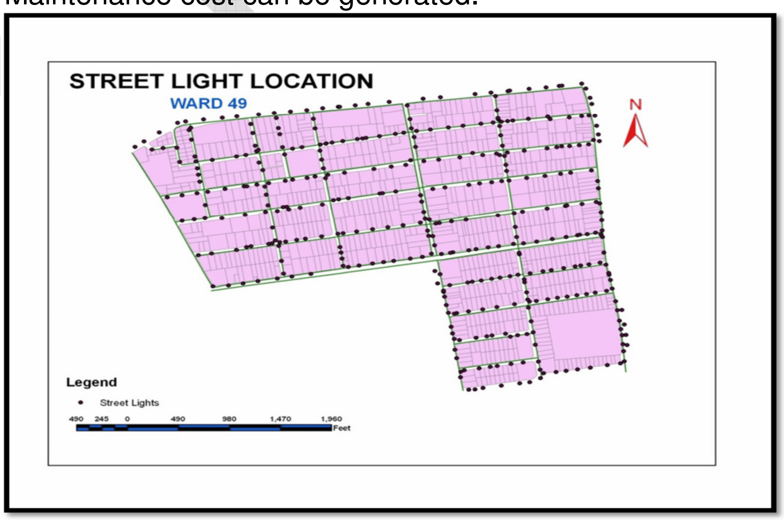


Fig 5.11. Street light location

5.3. Town Planning

For the purpose of issuing building and layout approval, planning and development of the town, Municipal Commissioner / TPO should know the information like location of land use zones (residential, commercial, industrial, educational, public &semi-public use, traffic & transportation, parks & play grounds and water bodies, burial & burning grounds with survey numbers, area, accessibility, location of scheme and non scheme areas, notified/un-notified slums, property assessment numbers, door number of the building etc. In this regard, GIS will provide all the information in a spatial map for the better understanding and quick process of planning permission. This will facilitate the Municipal Commissioner/TPO toissue of building and layout approval and planning and development of the city/ town including formulation of IHSDP /BSUP schemes.

The following are some of the outputs from Ward number 49 of Coimbatore City Municipal Corporation.

GIS map will also depict the revenue survey boundary of all properties in the ULB. It also facilitates to display the unauthorized buildings, and layouts.

Street alignment, building lines can also be accessed and used for future development. For issuing of planning permission, the following information can be retrieved from GIS map at each station.

- ❑ Area and width of the plot
- ❑ Approach/Abutting road width
- ❑ Location zone – Primary residential/Commercial/ Institutional/Industrial (as per the master plan)
- ❑ Detailed development plan and its location of scheme roads
- ❑ Existing building setbacks – Front, Side, Rear
- ❑ Street alignment.
- ❑ Location of burial ground
- ❑ Roadway line/ Street line alignment

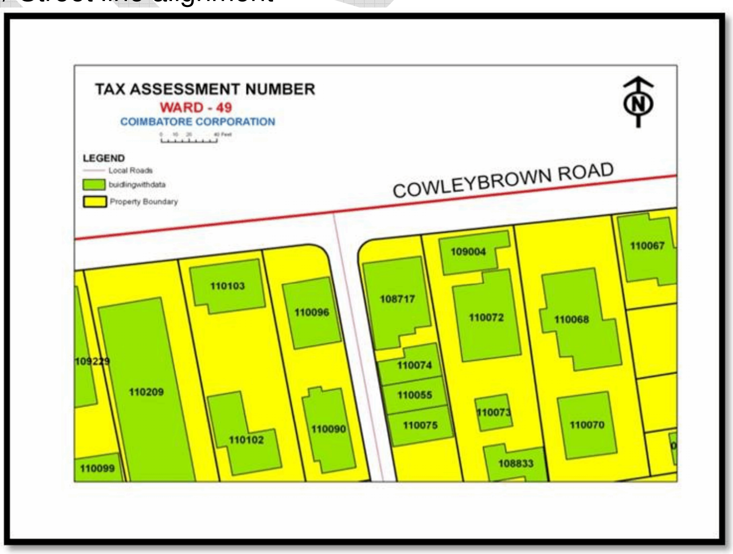


Figure 5.12 Property boundary/building boundary of the Ward No 49 with its assessment numbers.

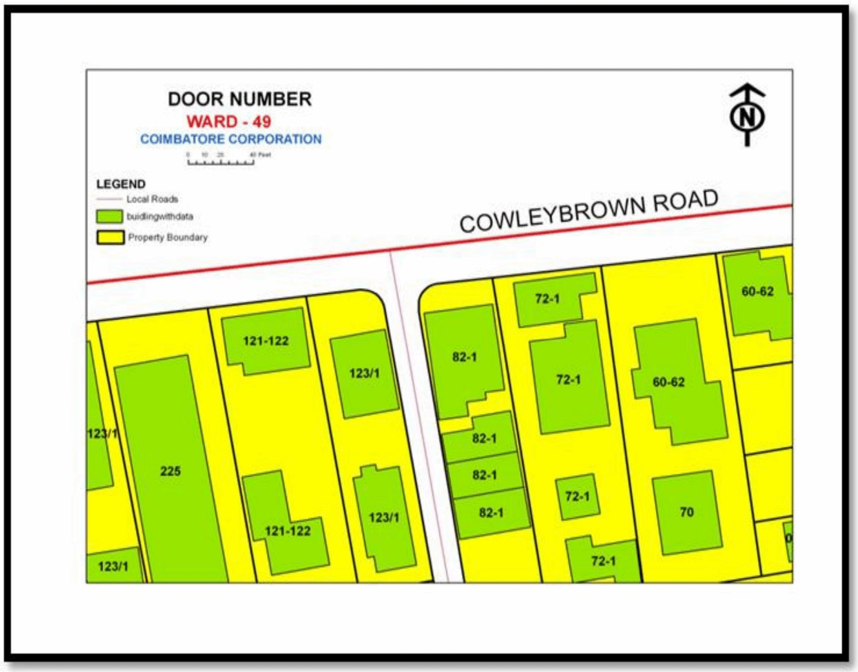


Figure 5.13 Property boundary/building boundary of the Ward No 49 with its door numbers

5.4. Health

GIS map can also facilitate to display the location of sanitary zones, street cleaning, community toilets, hospitals, maternity homes, Anganwadis, location of garbage collection centres /sub depots, compost yards, vehicle routing-burial & burning grounds, gassifier, slaughter house, etc. for planning and monitoring the maintenance activities of the health division.

5.5. Revenue

Revenue generation is the backbone for the Urban Local Bodies. GIS facilitates display of spatially, parcel wise revenue collection of the property tax and profession tax.

The unauthorized layout/buildings are identified through remote sensing data. So it is valid/authenticated as well as legal information. Hence, this property survey / mapping improves the revenue collection of urban local bodies.

5.5.1 Property Tax - Coimbatore Corporation

a) Non-assessment

The implementation of web based GIS in the Urban Local Bodies of Tamil Nadu has been initiated at Coimbatore Corporation on trial basis at ward No. 49 . The Table 5.1 shows the comparision between the existing property database of Coimbatore Corporation and TCS-GIS survey information as on 20/07/09. The validation of the above data are also in progress.

Table 5.1 Comparision between the existing property database of Coimbatore Corporation and TCS surveyed data

ROAD NAME	ULB Property Database	TCS – GIS & survey
AROKIYASAMY ROAD	89	108
BASHIKARRALU ROAD	253	328
COWLEY BROWEN ROAD	225	259
KANNUSAMY ROAD	71	110
LOGMANIA STREET	197	226
METTUPALAYAM ROAD	134	133
PERIYSAMY ROAD	356	424
PONNURANGAM ROAD	365	414
PUNNIYAKODI STREET	12	84
RAMACHANDRA ROAD	149	98
SIR SHANMUGAM ROAD	101	214
THADAGAM ROAD	NIL	11
THIRU VENKATASAMY	440	563
VENKATACHALAM RORAD	41	82
VENKATASAMY ROAD	400	425
VINCENT COLONY ROAD	53	58
DEVAN BAHADUR SINGH	20	425
GURU GOVIND SINGH	NA	59
SAMBANDAM ROAD	5	254
TOTAL RECORDS	2911	4275
TOTAL NUMBER OF NEW RECORDS COLLECTED	----	1364
% OF ADDITION / INCREASE IN ULB RECORDS POST SURVEY	------------	47%

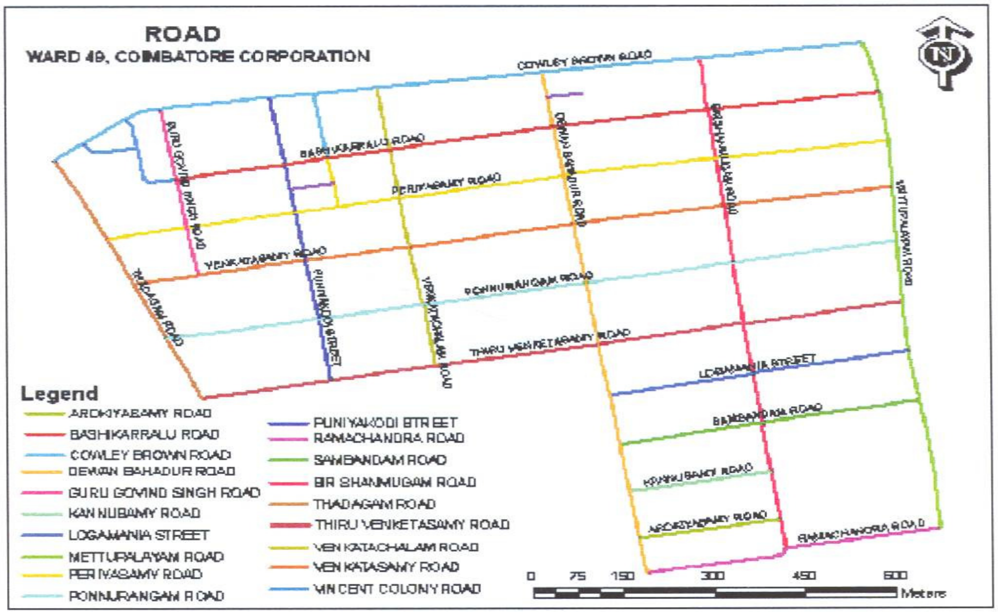


Figure 5.14. Road information of Ward 49

It could be observed that out of 19 roads in ward 49 17 roads are found as un-assessed properties and two roads as less assessed properties. Overall 47% of un-assessed properties have been found additionally.

b) Under-assessment

The Periyasamy Street of ward 49 (Figure 5.15) was taken to study the under-assessment. It is found from the Table 5.2 that, there are 68 (19%) un-assessed records. The difference in built-up area of 74,960 Sq.ft is also found through TCS - GIS survey.

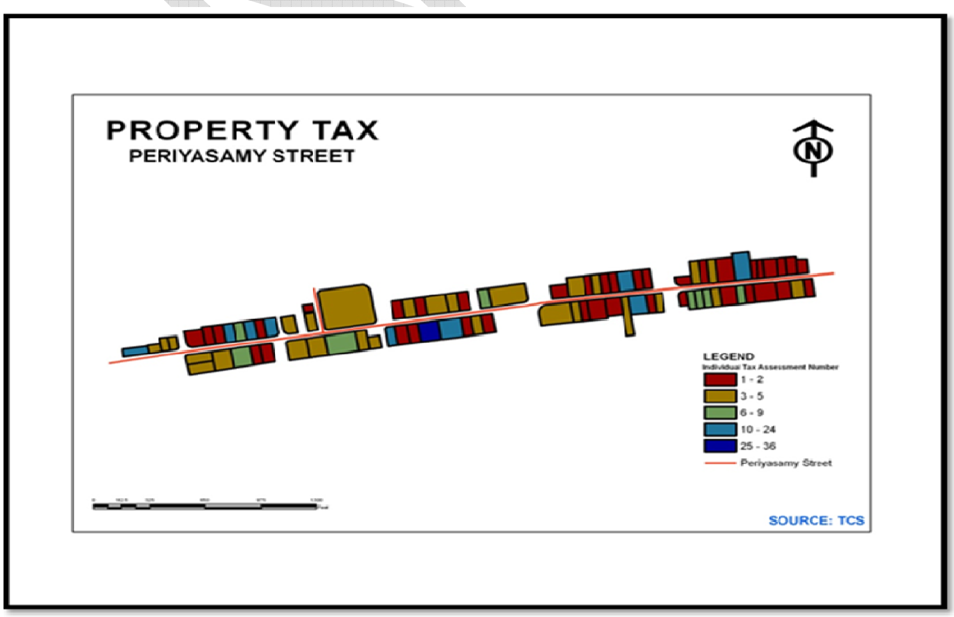


Figure 5.15. Road map of Periyasamy Street

Table 5.2. Under-assessment details of Periyasamy Street

For Periyasamy Street	ULB Property Database	TCS - GIS & Survey
Records collected from Field	356	424
Total Number of new records collected		68
% Additions to ULB Records		19%
Number of new/ un-assessed records collected from survey		41
Number of records which require ULB reconcilliation		27
Total built-up area in Periyasamy Street	851,950	926,910
Increase in built-up (to be covered under assessment) - sq.ft.	74,960	
% Increase in built-up (to be covered under assessment)		9%

*** Details are given in Annexure - IV**

5.6. Accounts

The financial data relating to a ward/work can be retrieved from GIS. These data may be used for arriving actual expenditure incurred for a particular work and for preparing outcome and performance budgets.

6. Issues and Implications of Operation of GIS In Functional Activities of ULBs

6.1. Introduction

The initiatives of Tamil Nadu Urban Development Project (TNUDP) have made a significant break through in transformation of traditional Urban Local Bodies (ULBs) into modern management institutions in the state in the recent years. Under the TNUDP, computerisation of ULBs has been implemented in a phased manner. During the first phase under TNUDP-II, the functional activities have been computerised in all the ULBs of the state. Sixteen computerised modules have been introduced in the ULBs using the in-house developed software with client server technology. The computerized modules of the ULBs are given in Annexure-1.

The information has been updated and valuable database has been created, which is currently used as a Management Information System (MIS) in the ULBs. During the second phase, e-governance activities such as on-line payment of taxes and issue of certificates were introduced and data base has been updated on real time basis.

The ULBs are expected to provide more efficient service and responsive delivery of infrastructure services, particularly in improving the operation and maintenance of utility assets. An important gap in achieving this objective is the absence of maps and records of the existing system. Information and records of the system are often out of date, and only contain partial information. Information lie variously with individuals/ sections of the ULBs and in written records. The information on tax and non tax items are often not readily available. Further, there is no proper linkage between maps and database. In order to overcome this impasse, and to move into the next generation of technology, it is proposed under TNUDP-III to introduce Geographical Information System (GIS) in selected Corporations and Municipalities on a pilot basis. Basically a GIS provides a geographically related MIS system for making variety of decisions in ULBs. This system can be viewed geographically rather than just traditional data base records, which provides visual capabilities for decision making /planning in the ULBs.

6. 2. Geographic Information System (GIS)

A GIS is usually a computer-based system which provides facilities for data capture, storage, manipulation, analysis and presentation. The emphasis is on preserving and utilising the inherent characteristics of spatial data. Spatial data comprise both a physical location in space plus a set of characteristics about the specific location. A graphical representation is be most appropriate for visualising spatial relationships, while some kinds of databases are more appropriate for storing and analysing attribute information. A GIS, therefore, needs ability to relate the attribute information to the spatial locality. The advent of fast, cheaper and most powerful computer hardware has led to the wide spread integration of GIS Technology into decision making process in the ULBs.

At present, there is no best GIS, considering a wide variety of GIS software available in the commercial market. A GIS should be evaluated in terms of potential user's needs and requirements in consideration of work procedures, organisational requirements, and deliverables as per terms of reference. Developing a GIS is a long term investment. The turn around investment for results may be long term than initial expectation. The realisation, results and benefits will not be achieved over night. Incorporating State- of –the –art technology is inevitably challenging. Gaining support for GIS application from users in the ULBs coming under different domains namely tax collection, urban planning, infrastructure planning, etc depend customisation of the software application. However, once the users/ULBs are able to see the direct advantages filtering in the ULBs by virtue of their work getting easier and efficient, the users/ ULBs will start using the spatial technology interestingly in the coming years. The various stakeholders of GIS application can visualize what an enterprise GIS capable of delivering to them with reference to the municipal functions. If there are still some tasks to be done under GIS implementation, it will be done step by step to ensure that the object and scope of the GIS application in ULBs is fulfilled.

The municipal administration aims to use GIS for better planning and management through four principle uses – revenue mapping, infrastructure mapping, resource / assets and poverty mapping.

- Revenue mapping - showing details of all municipal taxes and charges, like property tax, trade licenses, water charges, etc. levied on various assesses.
- Municipal Infrastructure mapping - showing the details of municipal infrastructure like roads network, water supply network, sewerage and drainage network, solid waste management system, street light network, etc.
- Resource / Assets mapping – showing specifically the assets of ULBs
- Poverty mapping – showing socio-economic attributes of the poor households.

Definitions of a GIS can vary considerably. The definition provided here combines both the components and functions of a GIS. The components needed to perform GIS tasks include people, data, hardware, Software, and procedure as described below:

6. 2.1. People

This is the most important component in a GIS. People must develop the procedures and define the tasks of the GIS. People can often overcome shortcomings in other components of the GIS, but the best software and computers in the world cannot compensate for the incompetence of people.

6.2.2. Data

The availability and accuracy of data can affect the results of any query or analysis.

6.2.3. Hardware

Hardware capabilities affect processing speed, case of use, and the type of output available.

6.2.4. Software

This includes not only actual GIS software but also various database, drawing, statistical, imaging, or other software.

6.2.5. Procedures

Analysis requires well-defined, consistent methods to produce accurate reproducible results. Any GIS should be capable of the following fundamental operations in order to be useful for finding solutions to real-world problems.

6.2.6. Capturing Data

A GIS must provide methods for inputting geographic (Coordinate) and tabular (attribute) data. The more input methods available, the more versatile the GIS.

6.2.7. Storing Data

There are two basic data models for geographic data storage: vector and raster. A GIS should be able to store geographic data in both models.

6.2.8. Querying Data

A GIS must provide utilities for finding specific features based on location or attribute value.

6.2.9. Analysing Data

A GIS must be able to answer the questions regarding interaction of spatial relationships between multiple datasets.

6.2.10. Displaying Data

A GIS must have tools for visualizing geographic features using a variety of symbology.

6.2.11. Output

A GIS must be able to display results in a variety of formats, such as maps, reports, and graphs.

Because the geographic database is the expensive and long –lived component of the GIS, data entry is an important consideration.

The GIS integrates a variety of data types from a variety of sources, so it provides multiple data entry options, and offers efficient data entry methods for automating paper maps and other non-digital data sources. To take advantage of the vast collection of geographic referenced data that already exists in digital format; the GIS application provides the most comprehensive data conversion capability of any GIS on the market.

6.3.Implementation of GIS In Selected ULBs Under TNUDP III

It is universally established fact that GIS tools play a major role in tax improvement and infrastructure development. GIS is used to digitally represent and analyse the geographic features present on the Earth's surface and the events (non –spatial attributes linked to the geography) that taking place on it. Thus maps can be drawn from database and data can be referenced from the maps. When a database is updated, the associated map can be dynamically updated simultaneously. GIS databases include a wide variety of information layers related geographic, socio-economic, and environmental with respect to lat-long coordinates.

Recognising the importance of the GIS, the TNUDP-III has proposed to introduce GIS application in functional areas of ULBs of Tamil Nadu. As a pilot study, it is proposed to introduce in Coimbatore, Madurai and Tiruchirapalli Corporations and Rajapalayam & Gobichettipalayam municipalities.

Based on the recommendation of the State Level Project Sanctioning Committee (SLPSC) in its meeting held on 20-11-2007, the Government accorded a revised administrative sanction in G.O. (D) Ms.No. 5, MA &WS Dept dated 03.01.2008 for a total outlay of Rs. 3,91,56,221/- for the GIS Project in supercession of the G.O.76, MA& WS Dept., dt.04.09.2006.

The breakup of details of the total cost is as follows:

Table 6.1 – Estimated Cost of GIS Application in Functional Areas of ULBs

S. No	Description	Amount in (Rs.)
1	Survey, Digitization, Attribution Of Data & Software Consultancy	1,78,73,750
2	Procurement Of Software Tools	70,60,000
3	Procurement Of Peripherals	27,44,000
4	Procurement Of Satellite Imagery	5,57,326
5	Additional Items Including Salary For Gis Experts, Gis Technicians, Training For Ulbs Staff & Maintenance Of The Systems For 3 Years After Completion Of The Study	87,44,500
6	Service Tax	21,76,645
	Total	**3,91,56,221**

6.3.1. Scope of the GIS must be predefined:

The ULBs must predefine the scope of the GIS project that they are going to implement , the deliverables, the layers that are to be created ,and these requirements must well be incorporated in the Terms of Reference (ToR) / Agreement between the ULBs and the Consultant who carry out the project. For example, if a separate layer showing the survey boundary, block boundary and survey ward boundary are to be generated and to be super imposed on the base map, it must be clearly indicated in the ToR/ agreement; otherwise, the Consultant may not agree for any additional work and may charge additional cost which may burden the ULBs. In addition to preparing property mapping and utility mapping, the scope of the GIS project in selected ULBs are as follows.

a. Preparation of up-to-date large scale base map of ULBs of Tamil Nadu using satellite imagery (1m resolution or better)
b. Existing database to be integrated as unified Geo-spatial data with infrastructure details which consists both spatial and corresponding attribute data.
c. Interpretation of high resolution satellite (0.6 meter or better resolution/satellite image for capturing of building, roads, major land mark and other visible features.
d. Information of utilities such as electricity, water, telephone and unauthorised properties as provided by the ULBs are also needed to be incorporated in the base map.
e. Conduct physical survey to create updated (2006) database of the properties.
f. The surveyed data and the proposed GIS based municipal solution need to be integrated with MIS.

The TNUDP-III proposed to introduce web based GIS for better operational planning and management of ULBs in the state.

6.3.2. Absence of Expertise in ULBs

ULBs in the state at present do not have resources, besides adequate expertise and experience for implementing GIS in their functionalities. Therefore, the ULBs have to depend upon the external assisted programs like TNUDP and consultants for implementing the GIS.

6.3.3. Pre-planning for GIS Implementation

Implementing GIS in ULBs under World Bank assisted programme under standard bidding procedure like Quality cum Cost Based System (QCBS) involves a series of steps such as getting approval from the World Bank for Expression Of Interest(EOI), TOR, Evaluation of Technical Proposals of the vendors and approval of the consultant , who secures the highest score etc . After the clearance of the world bank for appointing a successful consultant to take up the GIS assignment in ULBs, the project needs the approval of the State Level Project Sanctioning Committee (SLPSC), based on which Government Order (GO) has to be obtained for implementation of the project in the ULBs. All these sequential steps need preplanning and considerable time.

6.3.4. Procurement of Imagery

Fresh satellite data of high resolution (Imagery) is an essential item for the ULBs to take up property mapping and utility mapping. The high resolution (0.6 m or better) satellite imagery of the concerend ULBs, have to be procured from National Remote Sensing Centre (NRSC), Hyderabad , who is the sole agency of the Government of India to supply the imagery to the Government departments in India. To get the correct imagery with accuracy for the ULBs, co-ordinates of the ULBs (longitude and latitude) needs to be supplied to the NRSC. Otherwise, imagery showing the correct area of the ULBs will not be received. The NRSC should be given the co-ordinates of lower left and upper right corners of the ULBs limit and the corresponding area for delivery of the imagery. The extent of the town area available in the municipal records/maps should not be given to the NRSC as it may mislead the organisation. The satellite imagery has to be obtained in grids and the total area of imagery to be procured will probably be 3-5 times the municipal area, depending upon the shape of the town. However using the grid option of Google Earth will facilitate the identification of the co-ordinates and area for procurement of the imagery for ULBs from the NRSC.

Though 30 days is the normal time for delivery of the image from the date of payment of the cost of the imagery to the NRSC, the supply of imagery takes more than 6 months. The Digital Globe, USA, who supplies the Quick bird imagery (0.6 m resolution), takes time to deliver imagery of the ULBs, as it depends upon cloud free conditions. Further, the imagery supplied by the Digital Globe/ NRSC must be properly geo referenced and processed, so that the geographical features and the properties within the municipal boundary are captured clearly in the map.

6.3.5. Ground Truth Verification

This is another important component of the municipal GIS as the success of the GIS application in ULBs depends on the ground truth verification. The survey for ground truth verification of the physical/ geographical features and properties within the town limit must be carried out scientifically. Professional surveyors must be engaged in the ground truth verification to assess the properties with reference to built up area, number of floors, type of usage, etc accurately. The survey team members must be apprised of the scope of the property survey and properly trained with a structured format to carry out the survey without any hassle. A copy of a model survey format for ground truth verification is given in Annexure - II for reference. Property survey without due attention may lead to repetition of the survey, which is a time consuming exercise, besides the public and the ULB officials may not cooperate with the survey team.

6.3.6. Hardware

The type of machines, number of terminal, networking requirements, digitising and printing requirements all have to be considered for successful implementation of GIS in an ULBs. Final choice of a full-fledged hardware, peripherals depend on the budget available in ULBs, the number of potentials users and type of GIS to be installed. The ULBs facing financial constraints will not be able to procure the required hardware and peripherals. However, Plotter& Scanner – A0 Size (cost- Rs.3,50,000/-), are essential requirements for ULBs, where the GIS is implemented.

6.3.7. Software

Though a variety of software is available in the market, user friendly can be the desirable one, and the software depends on the needs of the organisation /ULBs, number and type of users. The TNUDP III has procured the following software for implementation in selected ULBs at a cost of about Rs.70 lakhs.

Table 6.2.GIS softwares procured under TNUDP III

ArcGIS 9.1 Software for Windows 2003/XP including	Price (Rs)
a. ArcInfo	13,75,000
b. ArcEditor	7,75,000
c. ArcGIS Extensions	2,35,000
i. Network Analyst for ArcGIS	2,35,000
ii. ArcGIS Publisher	2,35,000
iii. ArcGIS Spatial Analyst	2,35,000
iv. ArcGIS 3D Analyst	2,35,000
v. ArcGIS Geo statistical Analysis	2,35,000
vi. ArcGIS Survey Analyst	2,35,000
d. ArcGIS Server	25,00,000
e. ArcSDE	10,00,000
Total	70,60,000

The high initial cost of the software, updating and annual device contract (at the rate of Rs.10 lakhs per annum) will be a burden to the ULBs.

6.3.8. Data

Collection of revenue map, and resolving disputes of boundary in the field; assessment of built-up area and assessment of property tax is not scientific. No visual look of the property and corresponding data for analysis exist; If a well managed computer based record system is made available, there will not be any hitch in proceeding towards to the GIS application. The accuracy, source, ownership, copyright, confidentiality, security, standards and formats of data are important issues to consider. GIS technology allows the integration of data from a variety of sources, scales and formats for visualisation and analysis purposes. However, the output from any GIS can only be as reliable and relevant as the information entered into it. Sufficient care is thus needed during data acquisition and input in order to maintain accurate and reliable data sets. This is an important consideration since data acquisition and conversion usually represents the major component in the cost of implementing a GIS. Also as organisations become more open and begin to share their information, it is vital to ensure the security and confidentiality within the database to safeguard the interests of the data owners.

6.3.9. LIMITATIONS

Geographic Information System can be used to any extent for the creation, addition, modification, analyzing, customizing and presenting the geographic data for better planning, management and administration of ULBs. But the remote sensing data used for the creation of GIS data base and updation of data have limitations. They are given below.

a. Remote Sensing Data

The geocoded Quickbird high resolution remote sensing data is used for the identification of features on the earth surface such as road, building and trees etc. But underground features, like water supply and sewerage network cannot be identified using the above data.

i. Building

Independent building can be identified and its boundary can be demarked easily from the Quickbird satellite imagery. But for continuous building (ex. commercial area), unless the tonal variation (color) is presented in the top surface/terrace floor of the building, separation of building is not possible. It requires field verification and measurement.

The total number of floors (vertical height information) cannot be found from the mono Quickbird satellite data. But it may be found by LIDAR and aerial photograph or stereo satellite imagery. But adopting the above method is involves high cost and expertise. Adopting the cost effective method is under research.

For the trees obscured building, the shape and its boundary are difficult to demark. Elimination of tree from the required method is also under research.

ii. Roads

Identification of roads can be done by the satellite imagery. If trees are continuously presented in the street it is difficult to demark the boundary.

iii. Under Ground features

Using Ground Penetrating Radar, the underground features such as water supply and sewerage can be identified. But the cost of implementation of the above technology is costlier.

b. Updating of Satellite Data

Capturing the satellite data from imagery is one time task and the cost of procuring the imagery, particularly the Quickbird imagery used for the property survey , is comparatively very high (Rs.1500/sq.km) . Besides, processing of the imagery is a specialized job. As the developmental activities in towns and cities take place at a phenomenal rate, updating the base map from the imagery requires GIS Experts and technical persons. Further, there is a need to appoint GIS experts / technical persons to carryout the above specialised task in the ULBs.

6.3.10. Best Practices in GIS

There is a few successful reassessment of properties in India namely Mirzapur, Gorakhapur which are well documented. It is established that the heart of municipal data base is property records. Mirzapur is the first municipality in India, where GIS application was established with property records, systematically carried out Assessment survey, updating the property records through property enumerators, and, the detailed maps were linked with the property tax records. The property survey identified 44% more properties and brought into municipal tax records. In Mirzapur existing infrastructure records on water distribution and drainage networks were also added to the GIS. The existing infrastructure information available in the GIS platform, the usefulness of the network became apparent in ULBs.

6.3.11. Training & Manpower

GIS is a computer based system that is designed to operate specifically on geographical information. Presently, the technology has developed rapidly that it is considered as an essential tool for effective use of spatial data. GIS will be implemented in the selected ULBs by the end of 2010 by the Consultant. The implementation of a GIS can have profound implications and ramifications within an organisation. In particular, corporate scale, GIS will require various departments to co-operate and share information, and will necessitate training the staff and employment of new ones, and will involve technology probably unfamiliar to most employees. Successful GIS implementation within an organisation appears to be dependent on a high level of staff awareness, involvement, training and support. The management of the ULBs should be supportive in this and provide sufficient time and resources. As with the incorporation of any IT development, there will probably be resistance to change and a reluctance to assist from some of the staff. Experience seems to suggest that careful management is required at all stages of GIS implementation in order for the various organisational changes to occur smoothly. Professionals must be employed in the ULBs for successful operation and maintenance of the system under good leadership at the ULB level.

6.3.12. Conclusion

Government of India and the Government of Tamil Nadu have come in a big way to introduce the GIS application in the functionalities of ULBs under the National Urban Information System (NUIS) and the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) . One of the reforms the JNNURM recommends at the ULB level is the introduction of GIS application in Property Tax Assessment. The pilot study on the GIS application undertaken by the Directorate of Municipal Administration under TNUDP III in the five selected ULBs namely Coimbatore, Madurai and Tiruchirapalli Corporations and Rajapalayam and Gobichettipalayam Municipalities will pave way to scale up the GIS application in other corporations and municipalities of the state in the coming years.

7. GIS SOFTWARES - AN OVERVIEW

7.1 ArcGIS

From private business to public agencies, people are using ArcGIS to improve their workflows and solve their most challenging issues.

ArcGIS helps with

- Asset/data management including systems integration, claims/case management, service/territory area management, and constituent/customer management
- Planning and analysis such as forecasting and risk analysis
- Business operations such as call center/dispatching; monitoring and tracking; field data collection; inspections, maintenance and operations; and routing
- Situational awareness including decision support and customer/public access

Arcgis works across the enterprise

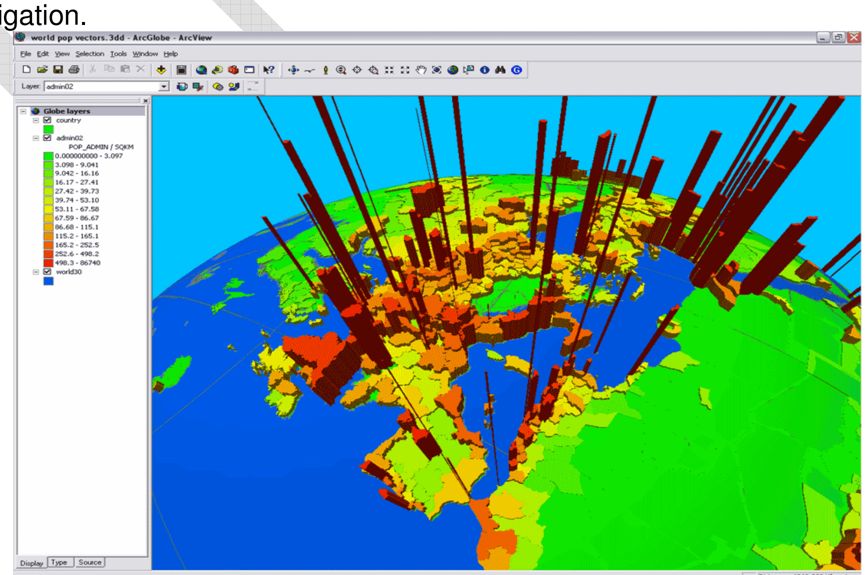
ArcGIS organizes and manages geographic information to support fast and efficient visualization and analytic applications, regardless of the amount of data held within your organization.

ArcGIS is an integrated collection of GIS software products that provides a standard-based platform for spatial analysis, data management, and mapping. ArcGIS is scalable and can be integrated with other enterprise systems such as work order management, business intelligence, and executive dash boards.

ArcGIS Supports Your Work on Desktop, Server, Web, and Mobile

Whether we work at our desktop, in the field, or need to share information via the Web, an ArcGIS product provides the tools you need.

a. ArcGIS 3D Analyst is an extension to ArcGIS desktop that allows we to effectively visualize and analyze surface data. Using ArcGIS 3D Analyst, we can view a surface from multiple viewpoints, query a surface, determine what is visible from a chosen location on a surface, create a realistic perspective image that drapes raster and vector data over a surface, and record or perform three-dimensional navigation.



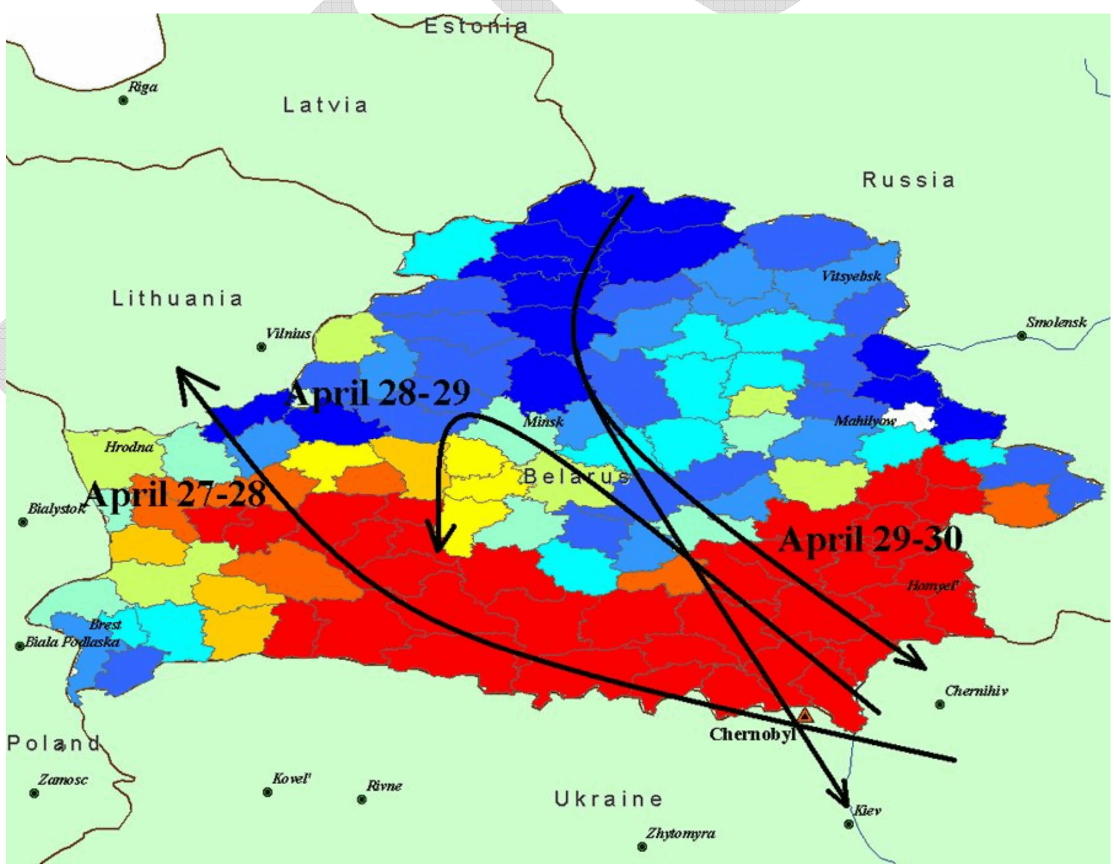
With ArcGIS 3D Analyst, we can

- Create three-dimensional views directly using GIS data.
- Analyze three-dimensional data using cut/fill, line-of-sight, and terrain modeling.
- View our data from a global to local perspective.
- Navigate through multiresolution terrain data seamlessly.
- Do spatial analysis in two or three dimensions.
- Visualize modeling or analysis results in three-dimensions.
- Use three-dimensional models and symbols for realism.
- Export our visualizations into videos.

These are just a few of the ways ArcGIS 3D Analyst can help an organization. Read customer success stories to see how people are using ArcGIS 3D Analyst for 3D visualization and analysis

b. ArcGIS Geostatistical Analyst is an extension to ArcGIS desktop that provides a powerful suite of tools for spatial data exploration and surface generation. It effectively bridges the gap between geostatistics and GIS analysis by enabling you to model spatial phenomena, assess risk and accurately predict values within a study area.

ArcGIS Geostatistical Analyst creates surfaces from data measurements taken over areas where collecting information for every location would be impossible or cost prohibitive. It fully examine sample data, evaluate uncertainties, generates unique insights and creates customized interpolation surfaces for more informed decision making.



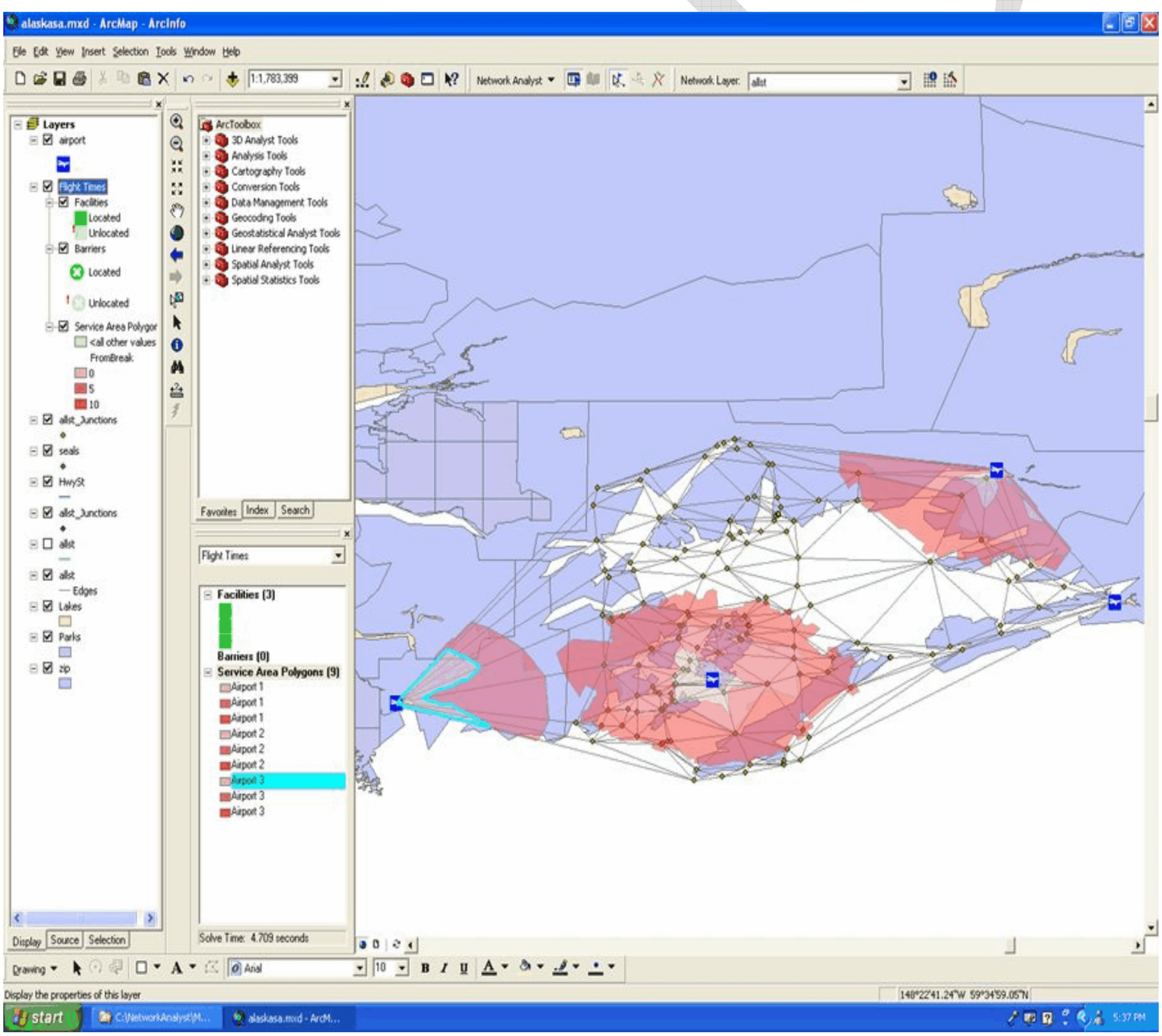
With ArcGIS Geostatistical Analyst we

- ❖ **Visualize, model, and predict** spatial relationships.
- ❖ **Link data, graphs, and maps** dynamically.
- ❖ **Perform deterministic and geostatistical interpolation.**
- ❖ **Evaluate models and predictions probabilistically** to assess risks.

ArcGIS Geostatistical Analyst helps we cost-effectively probe real-world issues in:

- ❖ Environmental analysis
- ❖ Socio-economic analysis

c. ArcGIS Network Analyst provides network-based spatial analysis including routing, travel directions, closest facility, service area origin-destination cost matrix, and vehicle routing problem analysis. ArcGIS Network Analyst helps you to dynamically model realistic network conditions, including turn restrictions, speed limits, height restrictions, and traffic conditions, at different times of the day.

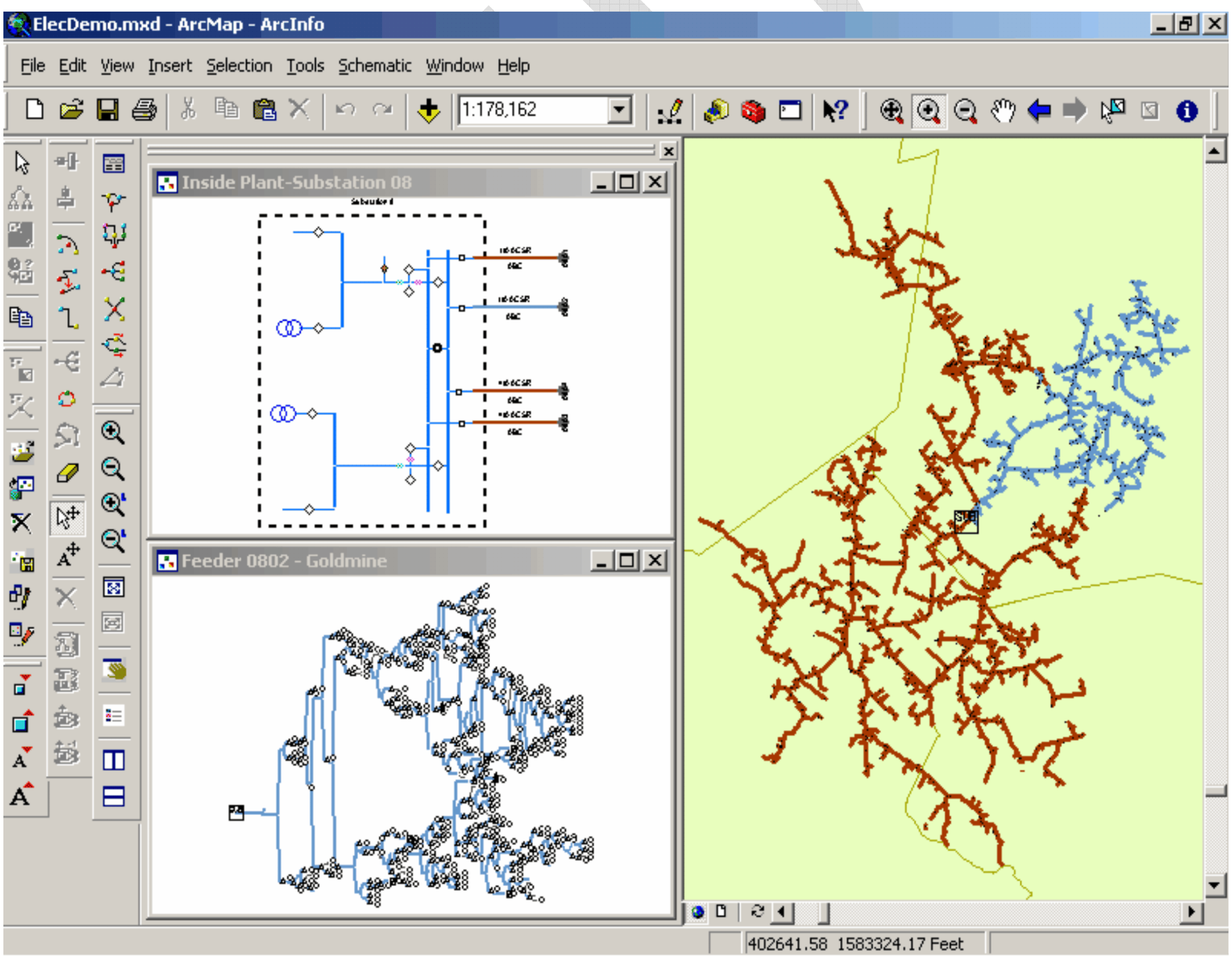


With ArcGIS Network Analyst, we can conduct

- Drive-time analysis
- Point-to-point routing
- Fleet routing
- Route directions
- Service area definition
- Shortest path
- Optimum route
- Closest facility
- Origin-destination analysis

d. ArcGIS Schematics is an extension to ArcGIS desktop that allows for the rapid checking of network connectivity. It lets us quickly understand network architecture and shortens the decision cycle by presenting synthetic and focused views of the network.

ArcGIS Schematics gives organizations a demonstrable return on investment in diagram generation (automatic generation vs. computer-aided design).



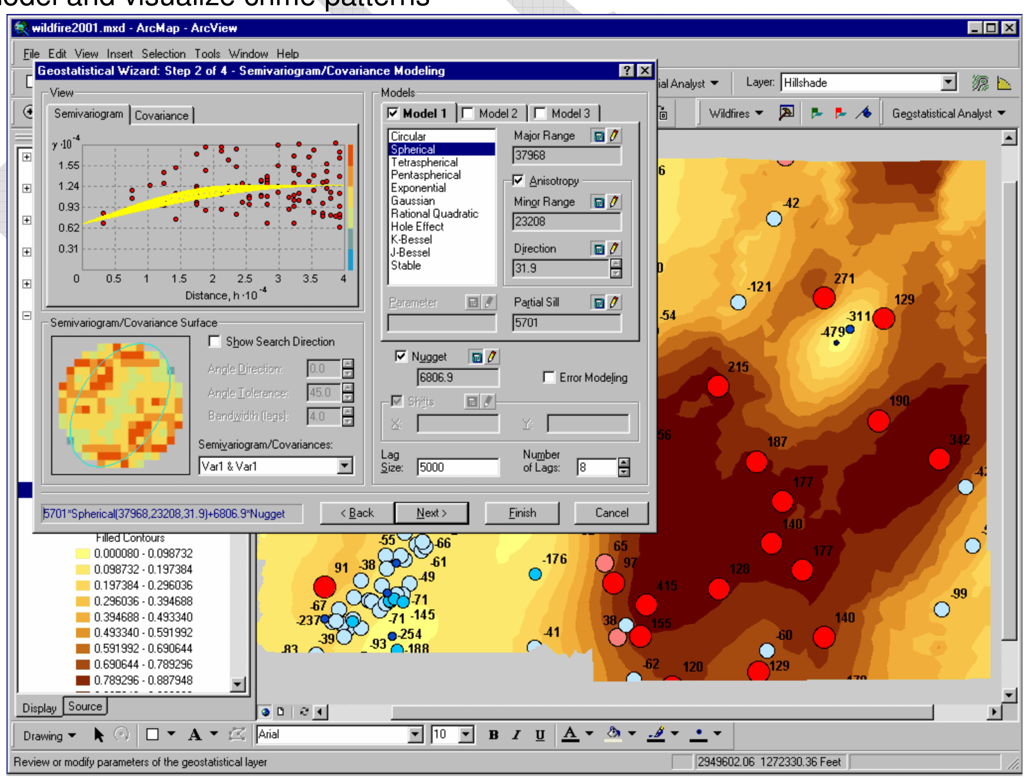
With ArcGIS Schematics, we can

- ❖ Automatically generate schematics from complex networks.
- ❖ Check network connectivity.
- ❖ Perform quality control of network data.
- ❖ Optimize network design and analysis.
- ❖ Evaluate network forecast and planning (modeling, simulation, comparative analysis).
- ❖ Dynamically interact with GIS through a schematic view.
- ❖ Perform commercial and market analysis.
- ❖ Model social networks, generate flowcharts, and manage interdependencies

e. ArcGIS Spatial Analyst provides powerful tools for comprehensive, raster-based spatial modelling and analysis. Using ArcGIS Spatial Analyst, we can derive new information from our existing data, analyze spatial relationships, build spatial models, and perform complex raster operations.

With ArcGIS Spatial Analyst tools, we can

- ❖ Find suitable locations
- ❖ Calculate the accumulated cost of travelling from one point to another
- ❖ Perform land use analysis
- ❖ Predict fire risk
- ❖ Analyze transportation corridors
- ❖ Determine pollution levels
- ❖ Perform crop yield analysis
- ❖ Determine erosion potential
- ❖ Perform demographic analysis
- ❖ Conduct risk assessments
- ❖ Model and visualize crime patterns



Who Uses ArcGIS Spatial Analyst?

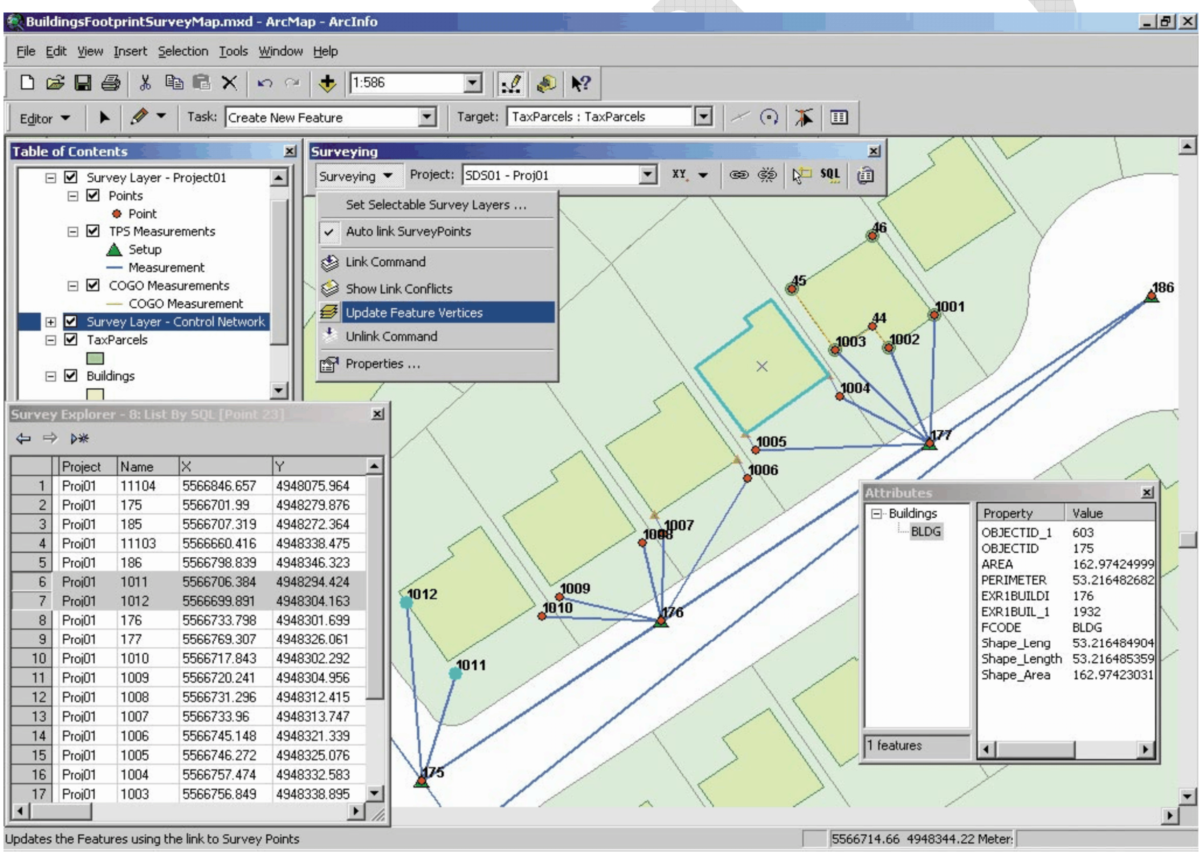
Any organization or individual who needs spatial analysis for solving real-world problems will benefit from ArcGIS Spatial Analyst.

Example applications of ArcGIS Spatial Analyst include

- ❖ Contractors who use ArcGIS Spatial Analyst to identify areas suitable for new development.
- ❖ Hydrologists who use hydrologic modelling to analyze temporal changes in sedimentary processes in a given terrain.

f. ArcGIS Survey Analyst is an ArcGIS Desktop extension that provides surveyors and GIS professionals with tools to create and maintain survey and cadastral data in ArcGIS. With this application, surveyors can centrally locate, process, and manage their data, enabling them to work more efficiently. GIS professionals use ArcGIS Survey Analyst to manage and continually enhance the accuracy of their data using existing survey methodologies.

ArcGIS Survey Analyst 9.2 introduced a new dataset called Cadastral Fabric and a new workflow called Cadastral Editor.

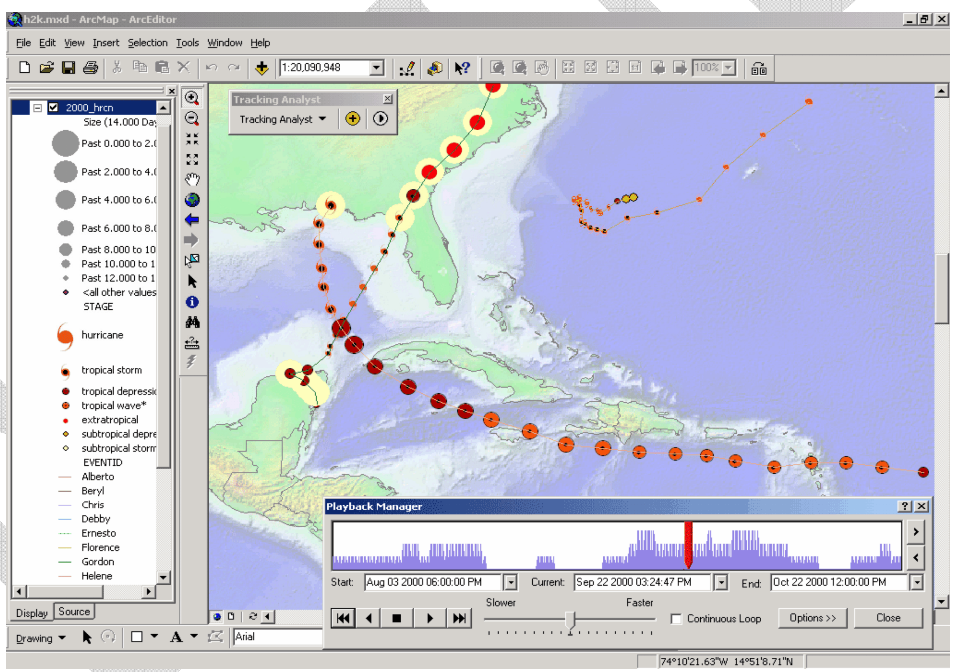


With ArcGIS Survey Analyst we can

- ❖ Reduce the time needed to maintain parcels while increasing the accuracy of cadastral data and related GIS features.
- ❖ Maintain parcel data (including record information from deeds and survey plans) in a cadastral fabric dataset. The fabric delivers a seamless coverage of our parcel boundaries and associated survey control free of gaps and overlaps.
- ❖ Create accurate parcel and subdivision data via direct data entry of the record information using specialized co-ordinate geometry tools. Track the history of all fabric changes.

- ❖ Use the survey (least squares) adjustment feature to accurately and incrementally update your fabric with each new survey plan. In parallel, we can also adjust related GIS layers such as building footprints, roads, and easements.
- ❖ Create, edit, and manage GIS features based on survey measurement data and survey procedures.
- ❖ Integrate survey measurements into a GIS database using field observations and survey data collector files.
- ❖ Manage and process survey data with a set of comprehensive tools.
- ❖ Store survey measurements, points, and computations in a GIS database for future analysis and reuse.
- ❖ Perform coordinate geometry computations.
- ❖ Perform survey computations such as traverse and least-squares adjustments using the original raw observations.
- ❖ Create custom importers and tools using a standard development environment

g. ArcGIS Tracking Analyst provides tools for play back and analysis of time series data. Tracking Analyst helps visualize complex time series and spatial patterns and interactions while integrating with all other GIS data within the ArcGIS system.



With ArcGIS Tracking Analyst we can

- ❖ Play back historical data.
- ❖ Use rule-based drawing.
- ❖ See temporal patterns in data.
- ❖ Integrate temporal data within our GIS.
- ❖ Leverage existing GIS data to create time series visualizations.
- ❖ Build charts for analyzing change in historical or real-time data.

ArcGIS Tracking Analyst extends the ArcGIS Desktop with time series and real-time visualization of change.

7.2 AutoCAD Map 3D

AutoCAD® Map 3D software is an engineering platform for creating and managing spatial data. Bridging the gap between CAD and GIS, AutoCAD Map 3D makes it possible for engineering and GIS professionals to work with the same data and enables design processes to integrate geospatial functions in a single environment for more efficient work flows.

Built on AutoCAD Software

Because Map 3D software is built on AutoCAD® technology, organizations can take full advantage of the extensive CAD-trained workforce to manage geospatial data. And by using familiar CAD tools, team members can make the most of their AutoCAD expertise.

More Informed Design

AutoCAD Map 3D enables organizations to create better designs. Map 3D software's integrated geospatial tools provide mapping and analysis functions for easy visualization and evaluation of design and asset management projects.

With powerful, affordable, and open geospatial solutions at every stage of data creation, maintenance, and distribution— AutoCAD Map 3D, Autodesk MapGuide Enterprise, and Autodesk Topobase software—organizations can seamlessly share spatial and non-spatial information with minimal effort. Seamlessly work with spatial data.

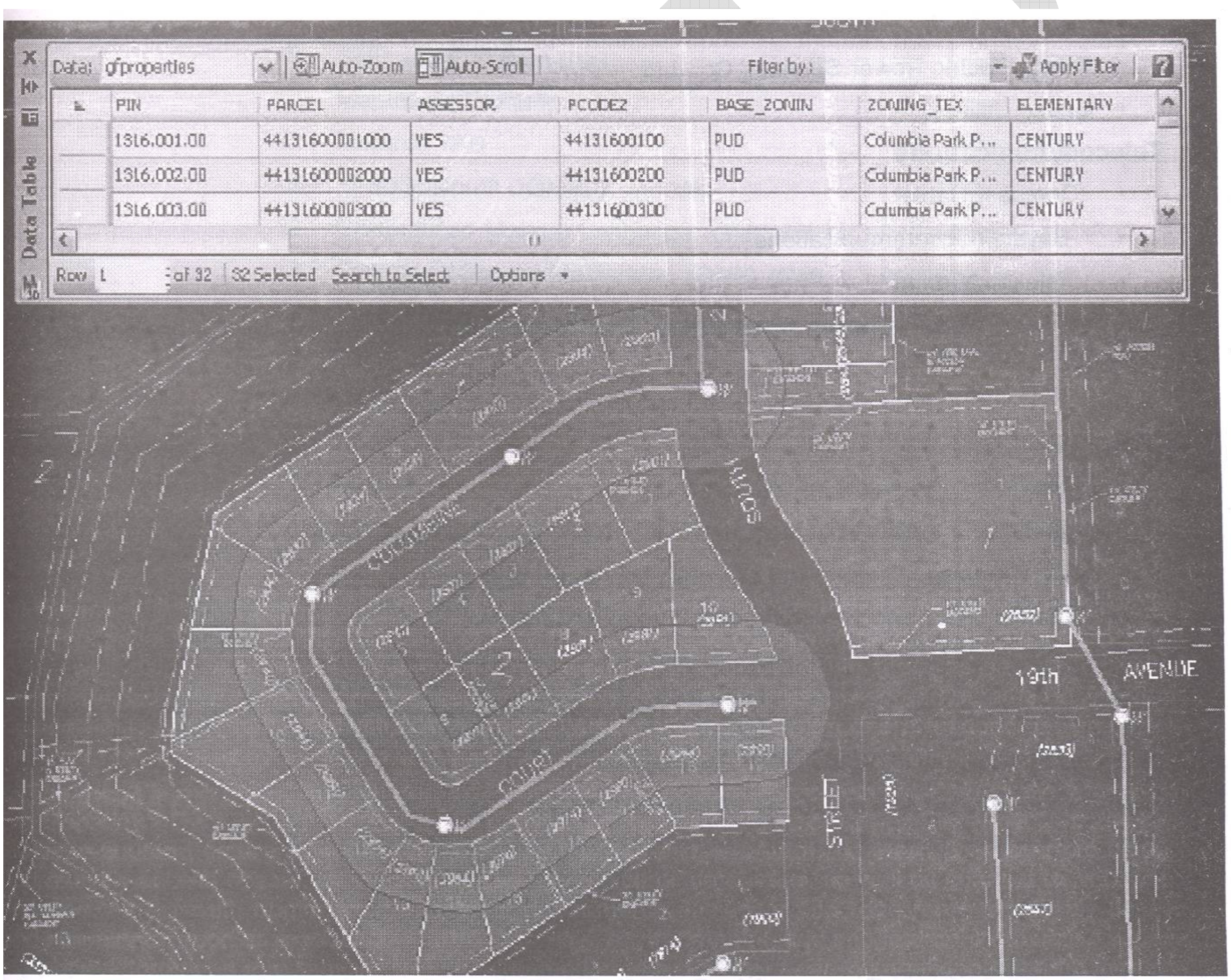
Powerful Mapping and Visualization Tools

Use Map 3D to visualize and evaluate vector, raster, and tabular data in a variety of ormats. Use draping functionality to combine topography data with aerial photographs for stunning and revealing 3D renderings, and easily analyze or highlight information such as service areas, zoning districts, land usage, and pipe and cable installation dates and diameters with easy-to-use cartographic tools.

The result is more professional designs, plans, maps, proposals, and reports. Sharing Accurate Map and Geospatial Data Maximize the value of drawings, maps, and geospatial data. Easily publish drawings to the web using A todesk MapGuide® Enterprise software, or distribute them as secure, individual georeferenced DWF™ files, or multisheet DWF map books that can be viewed and marked up with free* Autodesk® Design Review software. And Map 3D makes it easy to export georeferenced design data to other formats for use by back-end GIS and mapping systems.

Streamlined Data Access

Open-source Feature Data Objects (FDO) technology enables AutoCAD Map 3D software to directly and natively access spatial data stored in files and relational databases, as well as connect to webbased services. As a result, engineering and other departments, including GIS, can more effectively access and share data, such as road, cadastral, topographic, environmental, and image data. With native access to spatial information in a familiar CAD environment, team members can be confident that the information they depend on is up-to-date, supporting more-informed decision making.



Analytical buffer in Autocad Map3d (tool can be used to easily identify property owners who will be impacted by scheduled work on the water line.)

More Accurate Designs and Data

Reduce time wasted on imprecise drawings and data. Map 3D makes it easy to integrate field collected data in varying formats to accurately update drawings, maps, and databases to reflect the as-found locations in the field. Combined with powerful tools to automate the cleanup of drafting and digitizing inaccuracies, Map 3D helps to maintain data integrity throughout the design, build, operate, and lifecycle maintenance .

Using AutoCAD Map 3D, we exploited our AutoCAD skills to tap quickly into ESRI maps, utility data, property data, and more without having to use ESRI software. AutoCAD Map 3D gave us the GIS tools we needed, but allowed us to use our AutoCAD expertise, reducing training time and expenses.

Used around the world

Utilities—Electric, Gas, Water and Wastewater

- Vermont Electric Power Company
- Tokyo Electric Power Services Co., Ltd
- United Utilities

Telecommunications

- Comcast Cable
- Bayan Telecommunications
- Telekom Srbija

Natural Resources—Mining, Petroleum, Environmental Engineering and Management, Water Resources

- Petrobras Transporte S.A. – Transpetro
- KARICO
- Rushmoor Borough Council, England

Government—Public Works, Land Planning and Management

- San Francisco Department of Public Works Bureau of Engineering
- Rehabilitation and Reconstruction Board, Indonesia

DETAILED FEATURES

AutoCAD® Map 3D mapping software enables engineers, planners, mapping technicians, surveyors, and GIS professionals to directly access, edit, visualize, and analyze a variety of CAD and spatial data within a familiar AutoCAD® software environment.

BUILT ON THE NEW AUTOCAD 2010 PLATFORM

AutoCAD Map 3D 2010 software is built on the latest release of AutoCAD software, and is enhanced with a suite of geospatial tools. It contains all the features and functionality of AutoCAD 2010, which is automatically installed with AutoCAD Map 3D 2010—so you know you're working with proven, reliable, industry-leading software.

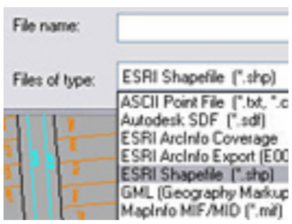
Geographic Coordinate Systems

It work with more than 4,000 real-world coordinate systems. Perform coordinate transformations and use tools such as Transform, Rubbersheeting, and Track Coordinates to accurately georeference a AutoCAD design data.

Direct Data Access

Using open-source Feature Data Object (FDO) technology, AutoCAD Map 3D provides direct access to spatial data from a variety of data sources, including ESRI SHP files and Oracle®, Microsoft® SQL Server™, MySQL®, and ESRI® ArcSDE® managed databases. access aerial and satellite imagery, including Mr.SID, ECW, and geo-referenced TIFF files, and connect to web mapping services (WMS) and web feature services (WFS) to take advantage of publicly available data. Direct access means no data translations, which helps to ensure integrity.

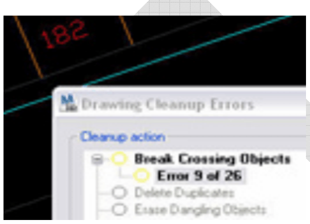
Data Exchange



AutoCAD Map 3D interoperates with all major design and GIS software, so can read, write, and convert data between standard formats, including:

- DWG™
- Arc/Info® coverages
- SHP and E00 from ESRI
- MapInfo MIF/MID™
- MapInfo TAB
- MicroStation® DGN (V7 and V8)
- Generalized Markup Language (GML 3.1.1)
- Ordnance Survey MasterMap (DNF) (GML2, read-only)
- Vector Product Format (VPF, read-only)
- ASCII
- LandXML
- SDF
- Spatial Data Transfer Standard (SDTS, read-only)

After working with the data, we can maintain it in a DWG file, and convert into an external file or move it into a spatial database

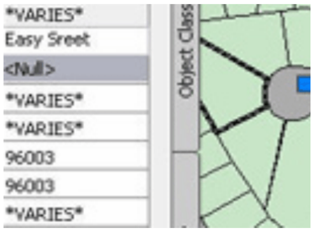


Automatic Data Cleanup

One can automate the correction of common drafting and digitizing errors using Drawing Cleanup tools. It will delete duplicates, correct undershoots and dangling objects, and more. Clean and accurate data makes integration into a GIS or mapping system easier.

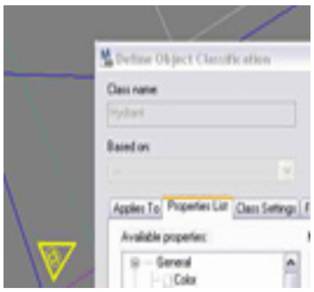
DWG Query

Using DWG query functionality, multiple users can access, view, search through, and edit the same sets of DWG files or base maps simultaneously. DWG query provides quick viewing of drawing information, including the number and type of objects, symbol tables, object data tables, and object classes. Alter-properties functions can be used to change CAD object properties, such as layer, color, linetype, lineweight, and more. This efficient and reliable way to work collaboratively with DWG-based information reduces the need for version control and can minimize time wasted waiting for data.



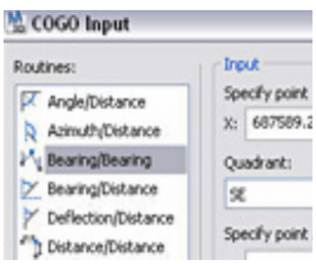
CAD Editing on Geospatial Data

Data accessed through FDO can be directly edited with standard AutoCAD commands such as Pedit, Trim, Break, Join, Offset, Extend, Rotate, Move, and Cut/Copy/Paste. One can easily edit polygon objects with split and merge functions, and use the Expression Builder to populate feature attributes using data calculations and intrinsic object properties.



Classification

Organize objects in a drawing by the real-world features that they represent, such as roads, parcels, cables, or water pipes. When we create an object using object classification, it automatically takes properties and values from its object class, maintaining consistency and establishing standards in a drawing. By applying a classification to an existing or new object, we can be assured that it meets one's standards for both data and display. Visit the AutoCAD Map 3D Extensions page to learn about free* industry-specific tool-kits that can help streamline the classification process.



Co-ordinate Geometry (COGO)

Use Coordinate Geometry is used to accurately locate and create features captured via traditional survey methods. Streamline the process of drawing plats and existing conditions by allowing for the input of geometry in terms of Bearing/Distance, Azimuth/Distance, Angle/Distance, Deflection/Distance, Orthogonal/Offset, Bearing/Bearing, Distance/Distance, and Inverse Report.

Survey Functionality

AutoCAD Map 3D survey functionality focuses on asset data collection and mapping. This feature allows you to organize, manage, and effectively use data collected in the field within the AutoCAD Map 3D environment. The functionality includes:

- ASCII point and LandXML data import
- Survey datastore and schema
- Point groups
- Creation of FDO features from survey features

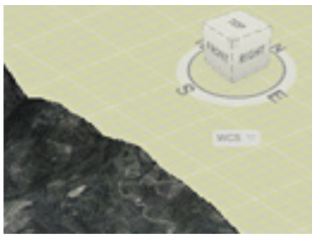
Map Creation and Stylization

Cartography tools enable you to create maps without additional GIS-specific software. Easily create stylized maps that highlight specific features or information, such as service areas, zoning districts, land usage, pipe and cable installation dates and diameters, and more. Create legends and call out details with attribute-driven labels that provide text along a curve and segment stitching functionality. Use transparency to blend data and reuse styles in any project, saving time and streamlining map production. Move beyond CAD maps to advanced cartography and presentations.

Analysis Tools

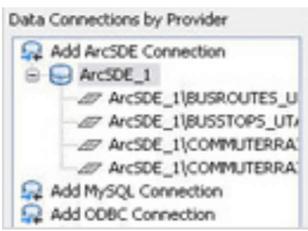
Analysis tools enable you to answer questions and make decisions about data. They link information in vector and tabular formats together, perform data queries, create thematic maps, build topologies, create reports, and perform buffer, tracing and overlay analysis, and more. With integrated geospatial tools, AutoCAD Map 3D provides easy visualization and evaluation of design and geospatial information.

Surfaces and 3D Visualization



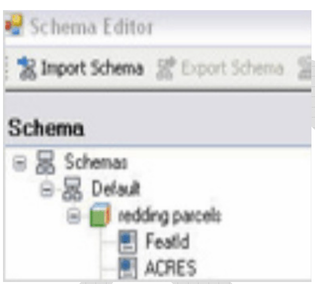
They visualize and analyze large-scale topographic information, including digital elevation models (DEM) and ESRI GRID files, for elevation, slope, and aspect. Create contours and perform sunlight studies with hillshading. Draping functionality combines topography data with aerial photographs and vector data for stunning, revealing 3D renderings that can be published to 3D DWF™ files viewable in free* Autodesk® Design Review software.

Database Integration



AutoCAD Map 3D mapping software provides open, standards-based database support. It easily joins CAD objects to commonly used databases such as Microsoft® Access and stores CAD and GIS data in popular relational database management systems, including Oracle®, Microsoft® SQL Server™, and MySQL® without expensive middleware, or connect to ESRI ArcSDE managed databases.

Data Management Tools



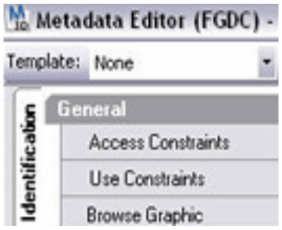
Data Management Tools effectively manage spatial data in almost any format. Intuitive tools enable you to quickly and easily create users, define schemas (databases and files), or load data models via XML Metadata Interchange (XMI) from industry-standard modeling programs. They move and convert data that resides in one data store to another (for example, SDF/SHP to Oracle). AutoCAD Map 3D acts as a hub for managing large amounts of spatial data, allowing you to unlock legacy spatial information and streamline your workflow

Spatial Data File (SDF)

The spatial data file (SDF) enables user to organize and manage his / her data as real-world features. This easy-to-manage file-based data repository is a smart choice when an enterprise database doesn't make sense. SDF supports rich geometry, multiple tables, and spatial indexing, and it provides a solid foundation for a smooth transition to a database such as Oracle or Microsoft SQL Server in the future, if the need arises.

Workflows

Using the Windows® Workflow Foundation (WF), AutoCAD Map 3D makes it easy to automate repetitive tasks with a new and powerful workflow framework and user interface. With this framework, one can build, save, and share simple and complex workflows with a visual editor. Workflows can include logic and initiate calls to other workflows—all with a single mouse click, improving efficiency and consistency in results.



Create and Edit Metadata

Create and Edit Metadata maintain investment in spatial data with tools to create and edit metadata. These tools helpuser call out the who, what, when, where, why, and how of his / her spatial information and publish it in standard formats, including ISO 19115 and 19139 and FGDC. With automatic metadata creation, it's easy for an user to share your data with colleagues, contractors, and regulatory agencies.

Map Books

Map Book quickly and easily produce accurate, up-to-date tiled map books of user service area, and provide field crews with necessary information for the project.

Publishing Tools

Publishing Tools distribute geospatial data, maps, and designs in ways that meet your organization's needs. They create drawings, designs, and maps and publish them to the Internet quickly using Autodesk MapGuide® Enterprise software (or) distribute them as individual geo-referenced DWF files, multisheet DWF Map Books, or paper plots.They help customers and teams throughout an organization to have the latest information.

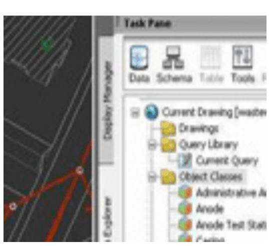
Extensibility via Open Source

With the power of FDO data access technology on the desktop, AutoCAD Map 3D makes it easy to take advantage of the open-source world by extending data access with third-party and open-source FDO providers for data stores not currently supported by Autodesk.

To make it easier for developers to extend capabilities of FDO, Autodesk has released FDO as an open-source project under the Open Source Geospatial Foundation (OSGeo). This initiative enables developers all over the world to tap into powerful geospatial data access technology.

Robust APIs

AutoCAD Map 3D comes with robust .NET application programming interfaces (APIs) that organizations can use to create custom tools and automate common procedures. Additionally, AutoCAD Map 3D and Autodesk MapGuide® Enterprise software share a unified geospatial API, as well as unified FDO technology that can be used to build custom applications that share business logic and common code. user can learn more about using the AutoCAD Map 3D and Autodesk MapGuide APIs to extend their capabilities to fit his / her needs at the AutoCAD Map 3D and Autodesk MapGuide Enterprise Developer Centers.



Industry Toolkits

One can use the AutoCAD Map 3D Industry Toolkits to enhance productivity and support data standardization for planners, drafters, engineers, and designers, who are working on water, wastewater, and electric system networks. There are available to Autodesk® Subscription customers only.

7.3. MapInfo

MapInfo Features

MapInfo Professional provides layering, thematic mapping and templates, interpolatery, SQL selection with geographical extansions intranet support and more as defailed below. Features for mapping and analysis include:

Layering

One of the most powerful aspects of MapInfo Professional is its ability to combine data from widely different sources, even with different formats and projections, in the same map window. Once combined in the map window, relationships that only exist geographically are revealed. User can also overly vector and raster data together. In the map window, he can control the order of layers, their display characteristics, and labeling. A new feature added gives the ability to control the translucency of raster images. Now, instead of simple backdrops, raster images can be made semi-transparent and mixed with vector and other raster images.

Thematic Mapping and Templates

Uncover patterns and trends based on data values with Thematic Mapping. You can shade, use bar & pie charts, graduated symbols, dot density , and grids. The new prism mapping feature lets the user take a flat map and turn it into something special. He can select regions on your map, extrude them to any height and maps pop off the page. User can choose from hundreds of colors, symbols and line types to enhance comparisons and store popular combinations in Thematic Templates. He can save frequently used templates for future reference and modification.

Interpolating

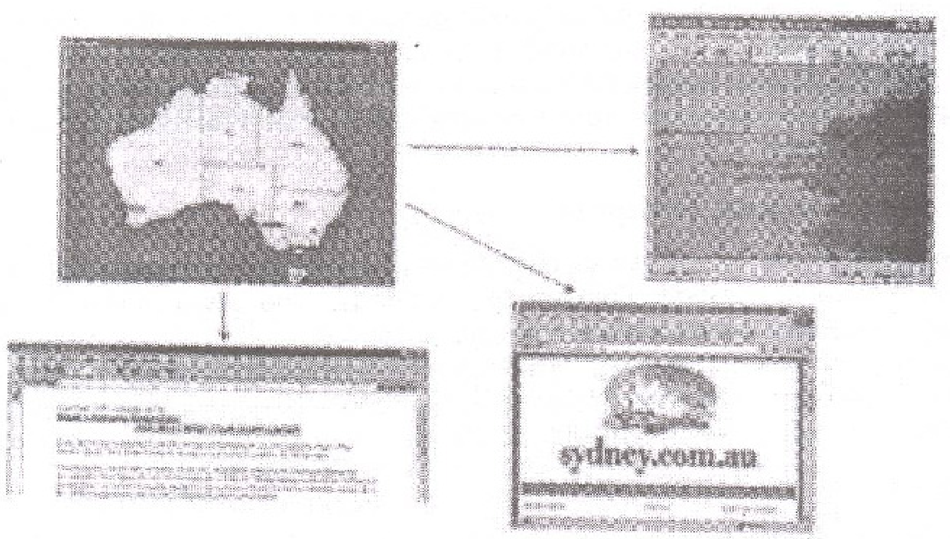
MapInfo Professional provides continuous thematic mapping, independent of any existing geographic layer, via interpolation. For example, showing air temperature as measured at various locations as a continuously varying color spread instead of trying to color political boundaries, postal delivery zones, or something else as inappropriate.MapInfo Professional gives more choices in Interpolations. User can choose between Inverse Distance Weighting (IDW) - based and Triangulated Irregular Network (TIN) - based interpolation.User can also add relief shading to the results of interpolation to make variations in the surface stand out.Any interpolated grid can be used to display a map in the 3D window.

SQL Selection with Geographic Extensions

Build and save SQL queries that access and integrate data from multiple tables. Frequently performed queries can be written once, re-used and even distributed to others. In addition to the standard key words: SELECT, FROM, WHERE, GROUP BY, ORDER BY, and INTO MapInfo Professional offers special geographic key words: CONTAINS, WITHIN, PARTLY WITHIN, ENTIRELY WITHIN, and INTERSECTS You can also aggregate data with:§ Sum(), Min(), Max(), Count(*), Avg(), and WtAvg() functions Build and save SQL queries that access and integrate data from multiple tables. Frequently performed queries can be written once, re-used and even distributed to others.A new feature gives you the ability to invert the current selection. Instead of crafting a complex query to select all but a few records or objects, just select the few you want to exclude, and invert the selection to unselect them and simultaneously select all the others.

Internet Support

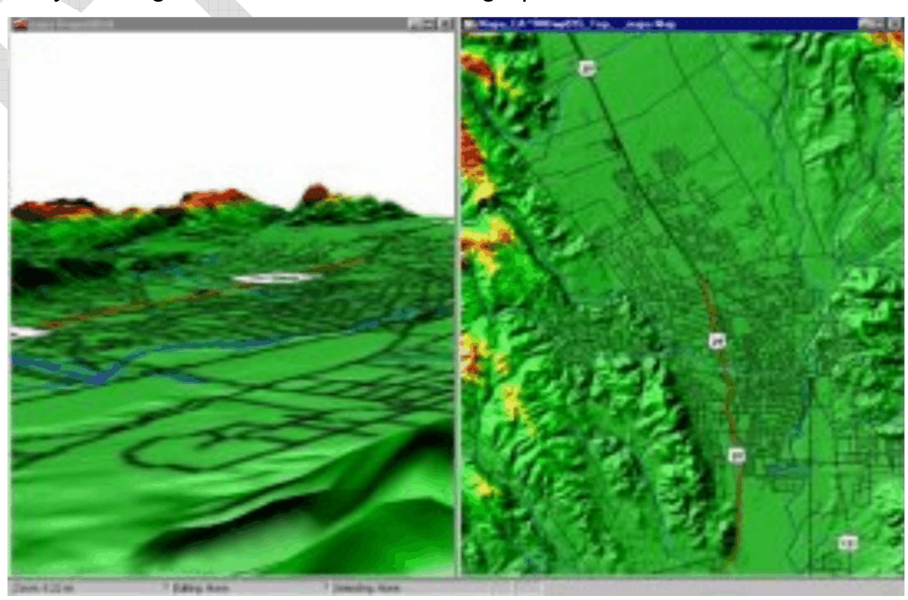
It can publish maps on the world wide web with HTML image maps. Now link maps to the world with MapInfo Professional's new Internet connectivity. Any object in a map can now contain a URL automatically launching User browser when he clicks on that object with our new HotLink tool. For example, linking company web site to the point location on the map identifying the corporate headquarters. User can use the HotLink tool to link to other types of document files that the Windows Operating System can launch (.doc, .xls, .ppt, .tab, .wor, .mdb, etc.). Using *MapInfo Professional* to generate HTML Image maps and publish maps on his / her web site. The new Create Image Map feature enables to select the layers, columns, output format, image size and even copyright line for images. User can check the dialog box and he has made landing pages for each object in his / her.



Publish maps on the worldwide web with HTML image maps

Charts & Graphs

Get noticed with *MapInfo Professional's* interactive graphs and charts including 3D, bubble, column, histogram, surface, area, bar, line and pie scatter charts. Select graph templates from thumbnail sketches. Graphing style control includes position, tilt, rotation and pie explosion. Choose database records by clicking on sections of a chart or graph.



3D Viewing

3D viewing allows for freehand tilt and rotations of maps as well as for traditional panning and zooming.

Continuous Thematic Shading

Continuous color visualization for point data sets results in easy-to-understand maps. Save frequently used templates for future reference and modification.

Raster Image Support

Use raster images such as scanned paper maps, satellite images, photographs and logos to provide detailed content layers for your maps.

Attach Data to Map Objects

View information associated with a particular point on a map such as name, address and account history.

Linked Views

Users can view and/or edit data in three linked views - including rows and columns, graphs and maps - simultaneously.

Create Buffers Around Objects

Perform detailed geographic searches with buffering and area selection tools.

Geographic Searches

Integrate geographic criteria into database queries (contains, intersects, within, etc.).

Seagate Crystal Reports

Use the built-in report writer from Seagate Crystal Reports to provide additional support for your visual analysis.

Drag and Drop Tool

Improve presentations by "dragging and dropping" a map into other applications such as Microsoft® Word, Excel and PowerPoint and Corel Draw or export maps directly into PhotoShop.

Built-in Conflict Management

Manage discrepancies in data when multiple users write to the server.

Server-side Storage and Data Management

For use with Oracle8*i*®, IBM DB2 Extender and Informix® Universal Server.

Universal Translator

Translate bi-directional between MapInfo Professional and other mapping environments including AutoCAD, ESRI and Intergraph/Bentley. Formats include DWG, DXF, DGN, Shape and E00. Government formats newly supported in v6.0 include VPF and SDTS.

Other Features MapInfo Map Basic

As always, MapInfo MapBasic is updated to control all of the MapInfo Professional's new features such as new statements for 3D viewing and object processing capabilities as well as updated statements for printing and geocoding.

MapInfo Meta Data Browser

MapInfo MetaData Browser is an intelligent internet search client designed for spatial data consumers enabling you to collect information about geospatial data available from various clearinghouses, as well as to compare and analyze the delivered meta data. MetaData Browser is included on MapInfo Professional v6.0.

Rotate Map Window Utility

Rotate the map window a specific number of degrees with the Rotate Map Window Utility.

MapX GeoSet Utility

Gain read/write access to MapX GeoSets.

Easy Loader

Upload MapInfo TAB files into Oracle 8i Spatial and SpatialWare DataBase (Informix-Universal Server [IUS] with SpatialWare DataBlade/DB2 Universal Server with SpatialWare Extender)

7.4. GeoMEDIA

GeoMedia

The GeoMedia® product suite is a set of well-integrated applications that provide with the full breadth of geospatial processing capabilities needed by industries, such as governments and transportation agencies for map production, infrastructure management, and land management. Utility and telecommunications companies, as well as defense and intelligence organizations, also rely on this product suited for data analysis, data sharing and map production.

Who can benefit ?

GeoMedia's unique ability to access geospatial data in almost any form and bring an integrated geospatial view together, along with a broad set of powerful analytic and editing tools, enables customers in several industries to efficiently manage and understand their investments in geospatial assets:

- Local, state, and national governments for emergency response and planning
- Government and state transportation departments for network planning and management, asset management, and map production
- National and state government agencies for the exchange of geospatial data, metadata, and services between other departments, countries, and agencies
- Defense agencies for military planning and map production
- Utility and telecommunications companies for planning, environmental standards analysis, and land management
- Local governments for parcel management, utility asset management, public distribution of data and information
- Almost any agency or industry that can benefit from a geospatial view of its business and assets

Customer benefits

- **Universal data access** – GeoMedia's data server architecture provides you with access to all common geospatial forms, most computer-aided design formats, and even simple forms such as text documents. The data server architecture makes it possible to integrate both visually and for interrogation a broad range of mostly disparate forms, thus bringing to one view all the data needed to make sound business decisions.
- **Standards-based approach to enterprise and public data exchange** – The GeoMedia suite provides a strong set of interfaces for data and metadata exchange that fully align with global standards such as those specified by OGC.
- **Easy integration with Geospatial browsers** – GeoMedia WebMap provides simple methods for integrating local data and services with the most popular geospatial browsers, such as Microsoft's Virtual Earth and Google Maps.
- **Rich geospatial analysis** – The GeoMedia suite provides all the analytic and presentation tools required to enable businesses and agencies to combine their business questions with geospatial data to provide key insights for planning and efficient asset management.
- **High level of productivity** – GeoMedia products are engineered for production systems. All commands are scrutinized with regards to user input and workflows. Minimizing mouse movements, button clicks, along with a well-organized graphical user interface, improves productivity, saving hours of labor in production environments.

- **State-of-the-art map composition** – The GeoMedia suite provides an easy-to-use, yet sophisticated map layout environment that supports workflows – from quick simple generation of workprints to complex detailed national mapping products.
- **Expansive customization environment using standard development tools** – The GeoMedia suite is designed to be extensible, using standard software development environments for the unique requirements of a particular customer workflow. The same development environment provided to customers is used to construct the products themselves, thus guaranteeing a rich and stable development platform.

GeoMedia Product Suite

GeoMedia® Database Curator - As part of Intergraph's Geospatial Intelligence Production Solution (GIPS), Database Curator is the innovative solution to the storage and maintenance of feature data and is specifically designed for geospatial intelligence community members whose tasks involve the integration, validation, and maintenance of feature data from various sources. Designed to accept data collected from tools such as Feature Topographer, Database Curator provides a database-centric solution for geospatial intelligence data warehousing.

GeoMedia® Feature Cartographer - As part of Intergraph's Geospatial Intelligence Production Solution (GIPS), Feature cartographer provides a rich set of commands that extend the capabilities of GeoMedia Professional and GeoMedia Map Publisher to construct cartographically accurate map products.

GeoMedia® Feature Curator - GeoMedia Feature Curator – As part of Intergraph's Geospatial Intelligence Production Solution (GIPS), Feature Curator provides data management capabilities for feature data from various input sources. Included is the ability to identify and isolate changed features from an enterprise database, as well as support for long-term transaction management during offline revision scenarios.

GeoMedia® Feature Topographer - GeoMedia® Feature Topographer - As part of Intergraph's Geospatial Intelligence Production Solution (GIPS), Feature Topographer provides comprehensive data capture capabilities from image and map sources. This product is built on the GeoMedia Professional platform and extends the feature collection capabilities to automate collection and validation of feature data for key digital products for the Defense and Intelligence community such as MGCP.

GeoMedia® - GeoMedia® enables you to bring data from disparate databases into a single GIS environment for viewing, analysis, and presentation. No translation of data is required. You avoid problems with redundant and out-of-date data because everyone is getting their information from the source. GeoMedia's data server technology supports open standards, providing direct access to all major geospatial/CAD data formats and to industry-standard relational databases. GeoMedia is uniquely suited to perform what-if analysis because it enables you to string together multiple operations in an analysis pipeline. Changing any of the data along the pipeline automatically updates the results.

GeoMedia® Digital Cartographer - As part of Intergraph's Geospatial Intelligence Production Solution (GIPS), This product contains a set of add-on commands for the GeoMedia environment that generates digital output in either Vector Product Format (VPF) or Multinational Geospatial CoProduction program (MGCP) extracts.

GeoMedia® Fusion - GeoMedia® Fusion helps you create and maintain collections of geospatial feature data and provides a flexible work environment – enabling you to match the uniqueness of your data and working style.

GeoMedia® GI Toolkit - As part of Intergraph's Geospatial Intelligence Production Solution (GIPS), this add-on product for GeoMedia® provides a rich set of tools for streamlining large-scale map production data collection, analysis, validation, and reporting.

GeoMedia® Grid - GeoMedia® Grid provides seamless integration of vector and grid data formats for viewing and analysis. It is ideally suited for carrying out complex spatial analysis such as site location (locating the best site), corridor planning (finding best path between multiple locations), and hot spot detection (spatial clustering of sparse points).

GeoMedia® Image - GeoMedia® Image provides a full set of image display, enhancement, and manipulation tools entirely integrated with other GeoMedia products. You can interact with vector and image data in a single, seamless, geo-fused environment. A specialized image enhancement toolbar supports simple and intuitive workflows. You can apply image processing algorithms simultaneously to multiple images on-the-fly without affecting the original images, or save them to disk as new images. Advanced image registration tools provide you with a detailed level of registration algorithms for improved registration accuracy.

GeoMedia® Map Publisher - GeoMedia® Map Publisher is a new product that has been added to the GeoMedia product family. National, regional, and military mapping agencies will use GeoMedia Map Publisher whenever they require enhanced cartographic capabilities and high levels of automation to produce their map series products.

GeoMedia® Parcel Manager - GeoMedia® Parcel Manager provides the ability to generate accurate cadastral maps in the timely manner required for the support of tax assessment. GeoMedia Parcel Manager lets you perform parcel geometry operations and interact with the database while viewing the parcel map or neighborhood. The software provides tools to simplify the subdivision process, as well as other tools, to enhance the rapid capture and correction and integration of data. GeoMedia Parcel Manager is designed to work in a database environment and provides tools that let you interactively search or make queries on maps to produce information from the database.

GeoMedia® Professional - GeoMedia® Professional supplies all the functionality of GeoMedia and adds smart tools to capture and edit spatial data. It builds on GeoMedia's flexibility, scalability, and open standards, and delivers productivity gains for collecting and modifying data and speeding implementation of GIS databases. It also enables you to make live connections to multiple GIS data warehouses simultaneously.

GeoMedia® Public Works Manager - GeoMedia® PublicWorks Manager is designed to help manage many of the aspects of a complex water and wastewater project – from initial data entry to network analysis and reporting. GeoMedia PublicWorks Manager delivers productivity-enhancing tools that allow you to create, validate, maintain, and analyze your network data, all within the GeoMedia environment.

GeoMedia® Terrain - GeoMedia® Terrain adds terrain analysis and visualization to the GeoMedia environment. Capitalizing on GeoMedia's capabilities to display multiple geographic data types simultaneously without translation, GeoMedia Terrain delivers the ability to ingest terrain, feature, and image data to support a variety of terrain analysis applications. GeoMedia Terrain also includes components to generate three-dimensional terrain models and dynamically fly through terrain models.

GeoMedia® Transaction Manager - GeoMedia® Transaction Manager is designed for organizations that have multiple users who simultaneously build and maintain geospatial data models within a department or across an enterprise. It introduces the functionality for long transaction management, versioning, and temporal data management for the GeoMedia Professional and Oracle9i environment. With Transaction Manager, organizations can manage the life cycle of data changes while safeguarding the integrity and validity of valuable enterprise geospatial information.

GeoMedia® Transportation Analyst - GeoMedia® Transportation Analyst provides the key geospatial technology to help professionals in municipalities, airports, seaports, departments of transportation (DOTs), rail companies, waterway agencies, and pipeline operations efficiently analyze the transportation infrastructure. These analysis capabilities allow you to track information about your networks and perform specialized analyses to help make better decisions about public safety, maintenance priorities and expenditure of funds.

GeoMedia® Transportation Manager - GeoMedia® Transportation Manager provides the key geospatial technology to help professionals in municipalities, airports, seaports, departments of transportation (DOTs), rail companies, waterway agencies, and pipeline operations efficiently analyze and maintain the transportation infrastructure. Functionality is included for building a linear network model that will support both linear referencing system (LRS) and vehicle routing applications.

GeoMedia® WebMap - GeoMedia® WebMap and GeoMedia WebMap Professional provide Intergraph's GeoMedia geospatial technology in a fully scalable server solution. This solution may be deployed as Web services or interactive Web sites (thin-client solutions), including enterprise data access, sophisticated geospatial analysis, and map generation, thus reducing the overall cost of such solutions. By providing direct, real-time access to enterprise geospatial data with all of the spatial analysis functionality of GeoMedia, this product lets you build a Web site that gives thin clients with only a Web browser access to a powerful, dynamic, and open geospatial application previously available only in a powerful desktop application. GeoMedia WebMap Professional provides all of the capabilities of GeoMedia WebMap, plus powerful linear analysis capabilities (including routing and dynamic segmentation Web services) and the ability to build a Web application that writes data to Oracle Spatial or Microsoft® SQL Server application.

GeoMedia® WebMap Professional - GeoMedia® WebMap and GeoMedia WebMap Professional provide Intergraph's GeoMedia geospatial technology in a fully scalable server solution. This solution may be deployed as Web services or interactive Web sites (thin-client solutions), including enterprise data access, sophisticated geospatial analysis, and map generation, thus reducing the overall cost of such solutions. By providing direct, real-time access to enterprise geospatial data with all of the spatial analysis functionality of GeoMedia, this product lets you build a Web site that gives thin clients with only a Web browser access to a powerful, dynamic, and open geospatial application previously available only in a powerful desktop application. GeoMedia WebMap Professional provides all of the capabilities of GeoMedia WebMap, plus powerful linear analysis capabilities (including routing and dynamic segmentation Web services) and the ability to build a Web application that writes data to Oracle Spatial or Microsoft® SQL Server application.

Label-EZ - Label-EZ from Maptext performs automated labeling of map features in a GeoMedia® Professional workspace. Labels are automatically generated based on one or more data attributes associated with a feature and label placement is performed according to cartographic conventions for appearance, clarity, and legibility.

Map2PDF - MAP2PDF for GeoMedia® from TerraGo Technologies leverages the popular Adobe Acrobat PDF document standard to provide a portable mapping format known as GeoPDF. MAP2PDF allows you to create and publish layered, georeferenced maps from GeoMedia layout window environment. You have the option to publish key feature attribute information into the GeoPDF file as well.

OnDemand - GeoMedia® OnDemand is a low-cost, off-the-shelf, easy-to-use vector-based software product that runs on Microsoft® Windows® Mobile (Pocket PC) and Trimble GeoExplorer devices. It gives mobile field crews access to view and update data from their corporate geographic information system (GIS). Highly compact file formats and advanced spatial indexing are used to provide maximum performance on the devices.

TerraExplorer Pro - TerraExplorer Pro and TerraExplorer from Skyline enhance new and existing spatial data systems. Combined, they allow you to create their own customized 3D visualization environment by editing and annotating the database.

Feature Analyst - Feature Analyst from Visual Learning Systems (VLS), a division of Overwatch Geospatial, is well-integrated into GeoMedia® and provides remote sensing experts, geospatial analysts, intelligence analysts, and cartographers with a complete toolset for extracting features of interest from imagery and scanned maps. Along with the powerful analysis tools already supplied by GeoMedia, the Feature Analyst extension adds to the feature collection capabilities by performing unsupervised classification, change detection, advanced clean-up techniques, and more. Feature Analyst ultimately brings you accelerated feature extraction (AFE), overcoming the time-consuming nature of manual feature identification by using state-of-the-art learning procedures that automatically recognize users features of interest.

Image Topographer - Intergraph's Image Topographer integrates GeoMedia with ImageStation to support all your photogrammetric needs. By integrating photogrammetric workflows on the GeoMedia platform, Image Topographer offers the all the geospatial data integration functionality of GeoMedia. This integration provides you with a rich geospatial framework in which you can process and cross-reference imagery with many other georeferenced raster and vector data forms. These capabilities enhance and unleash Intergraph's underlying photogrammetric data management, access, and exploitation power.

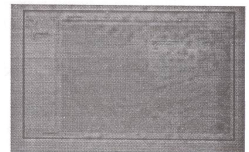
GeoMedia® Viewer - GeoMedia Viewer is an easy to use, FREE GIS software application for desktop viewing and distribution of geospatial data. It allows an organization to maximize the value of its geospatial data by extending availability to novice users who wouldn't otherwise have access because of the barriers of purchasing and learning how to use a full GIS software application.

7.5 Bentley Map

Bentley Map is a fully-featured desktop GIS which can be used to map, plan, design, build and operate infrastructure. Bentley Map enhances underlying MicroStation® capabilities to power precise geospatial data creation, maintenance, and analysis. Bentley Map works with and complements the Bentley® Geospatial Server and Bentley's mobile, Web publishing, and industry applications.

Convergence of GIS and CAD

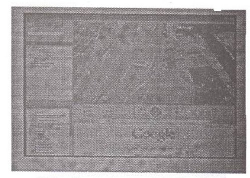
Bentley has historically been a leader in the computer aided design (CAD) software industry with MicroStation. Bentley Map extends the power of MicroStation to include traditional GIS capabilities. Users can construct highly accurate, seamless geographic representations of all features being modeled and perform further advanced spatial analysis.



Buffer of proposed buildings showing *transparency.*

Comprehensive Mapping Capabilities for Infrastructure Assets

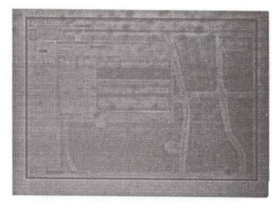
Bentley Map has unparalleled capabilities for those needing to create and maintain geospatial information as part of the management of infrastructure assets across their lifecycle. Bentley Map allows you to enforce business and topological rules defined by the Geospatial Administrator. The Geospatial Administrator also defines geographic objects, their behaviour, and the GUI. Bentley Map brings the accuracy of CAD and the ease-of-use of GIS together in one environment, and it is fully compatible with all of Bentley's AEC industry applications.



3D city map published to Google Earth.

Easy Access to Enterprise Data

Bentley Map facilitates geospatial data integration within the enterprise and extends the value of all types of spatial information. Bentley Map can be implemented with any 2-tier database connection supported by MicroStation, a 2-tier connection to Oracle Spatial or a 3-tier connection to Oracle Spatial or ESRI ArcGIS.



Thematic map of parcels buildings and *water pipes.*

XML Feature Modeling (XFM)

Bentley Map takes full advantage of XML feature modeling. Through the Geospatial Administrator, XFM lets subject matter experts create highly interactive graphic applications without programming and provides for customization by developers in VBA, MDL, and other languages. XFM applications help users maintain standards by encapsulating them with the feature definition and placement tools, including property-based annotation and symbology.

Topology

Topology can be created 'on-the-fly' or 'on-demand' in Bentley Map. Topological relationships are stored in the DGN file according to the same model used by Oracle Spatial.

Oracle Spatial Editing

Bentley Map can edit data directly in any standard Oracle Spatial environment employing a feature-locking mechanism for multi-user environments. Organizations can also take advantage of Oracle versioning to manage conflicts in an 'extract, edit and post to Oracle Spatial' workflow enabled by the Bentley Geospatial Server.

Spatial Analysis and Presentation

Bentley Map includes a full suite of spatial analysis and presentation capabilities. These include tools for creating buffers around objects, performing topology overlays, creating thematic maps and more. The results of these analytical processes can be plotted, printed, or published to PDF.

High Productivity Output

Bentley Map supports high fidelity output through MicroStation and maps and prints can be published to intelligent PDFs (with 3D images, bookmarks and web links). Map finishing can be taken to the next level using Bentley® CADscript®, which supports WYSIWYG map finishing and the production of print-ready four color separations.

Bentley Map At-a-glance

Mapping And Infrastructure GIS

- Efficient data compilation and editing
- Design, build and publish accurate maps
- Enforce business and topological rules
- Brings CAD accuracy, ease-of-use and efficiency to GIS
- Fully compatible with Bentley's AEC applications

All the power of Microstation

- Smart, quick drawing and editing of GIS features in a Microstation environement
- Raster management
- AccuSnap, AccuDraw ®
- Display priority, transparency
- Full 3D modeling

Map Manager

- An easy-to-learn interface into your spatial data
- Intuitive, easy-to-use, persisted map definitions
- Drag and drop layers to control display order

XML Feature Modeling

- XML metadata-driven GIS
- Extensible
- Enforces user standards
- Easy to implement without programming

Geospatial Administrator

- Manages the XFM framework through one interface
- Runs outside MicroStation
- Defines and maintains XFM project files
- Defines coordinate system and projection information
- User interface definition – dynamically loaded at run-time

Choice of Data Stores

- A two-tier connection to Oracle Spatial
- A 3-tier connection to Oracle Spatial
- A 3-tier connection to E STRI ArcGIS
- Self-contained 'XFM' DGN files
- Any RDBMS/DGN supported by MicroStation

Oracle Spatial Editing

- Fully Oracle Spatial compliant
- Three-tier connection available via the Bentley ® Geospatial Server
- Native Oracle Spatial feature and topology models
- Topology model is based on the Oracle 10g topology model
- Topology modes

Topology Maintenance

- Place features like any other XFM features
- Topology graph is maintained while editing
- Use shared editing commands to move common primitives

Spatial Analysis and Presentation

- Spatial analysis
- Thematic display
- Buffer creation

Map Generation and Print Preparation

- Grid and graticule generation
- Marginalia
- Interactively place multi-vi borders
- Publish to intelligent PDF Map projection and coordinate conversion
- 5500+ projections including user defined
- Store coordinate systems information with mapping and engineering data
- On-the-fly transformation

Data Cleanup and Integrity Tools

- Solve integrity problems with imported or legacy data
- Easily adopt XFM schema for imported or legacy data through Dynamic Feature Scoring (DFS)

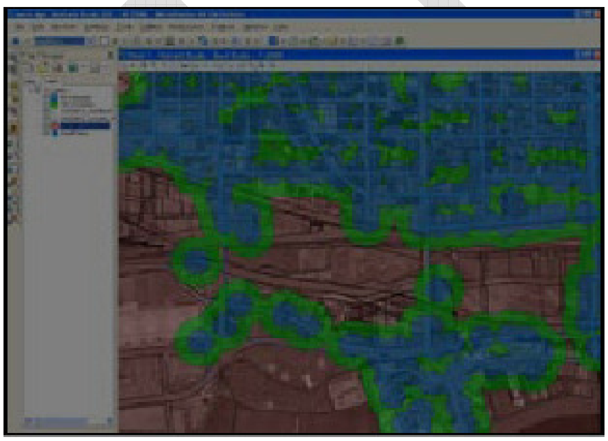
Interoperability

- Direct reference geospatial formats

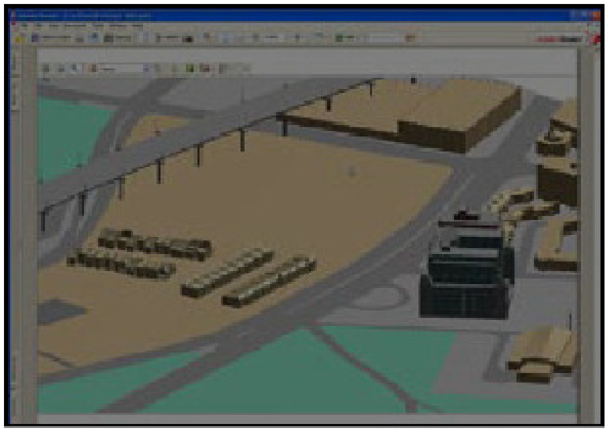
♦ MapInfo (TAB, MID/MIF), Shapefiles, Oracle

GIS Development Platform

- Subject Matter Experts can customize Bentley Map
- Property based symbology and annotation
- Criteria
- Methods
- Operations
- Dialogs
- Tool frames and tool boxes
- Prompts
- Developers can customize
- Geospatial Administrator and the
- Standard Placement Library via:
  - C expressions
  - XSLT
  - VBScript
  - VBA
  - MDL
- **NET API**



Fire hydrant study.



3D CITY MAP PUBLISHED TO PDF

7.6. IMAGINE Essentials (ERDAS)

Product Description

IMAGINE Essentials® offers the basic tools for image mapping, visualization, enhancement and geocorrection, including enterprise-enabled access to relational databases such as ArcSDE and Oracle Spatial. At the heart of IMAGINE Essentials is the IMAGINE Geospatial Light Table™ (GLT), which provides the basis for all interactive display and processing. The viewer displays, combines, geographically links, analyzes and presents multiple data sets in a single window. IMAGINE Essentials also provides a well-rounded set of tools for geocorrection and reprojection, image analysis, visualization, vector editing, batch processing and map output.

Key Features

Data Types and Integration -

There are two types of data format access:

1. Direct access to many raster data formats for the use of files in their native format without conversion
2. Import and export routines for data exchange to a broader spectrum of data.

Raster Data Direct Read

- ADRG Image (.img)
- ADRG Legend (.lgg)
- ADRG Overview (.ovr)
- Alaska SAR Facility (.L)
- ALOS PALSAR, AVNIR-2 and PRISM
- ArcSDE Raster
- ASRP (.img)
- AVIRIS
- Bitmap (.bmp)
- CADRG
- CIB
- DTED
- ENVI (.hdr)
- ENVISAT
- EOS HDF
- ERDAS ER Mapper (.ers and .ecw)
- ERDAS IMAGINE (.img)
- ERDAS (.lan)
- ERDAS (.gis)
- EROS A1 (Imagesat)
- ESRI GRID and GRID Stack
- ESRI BIL, BIP and BSQ
- FIT
- FORMOSAT DIMAP (.dim)
- Generic RAW (binary) access
- Geodatabase raster
- GeoTIFF (.tif)
- GIF
- HDF4 Raster & Scientific
- HYDICE (.cub)
- Hyperion
- Intergraph (.cit and .cot)
- JFIF (.jpeg)
- JPEG 2000 (including GeoJP2)
- MrSID Generation 2 and 3
- Oracle GeoRaster
- NITF 1.1 and 2.x
- PCI (.pix)
- Portable Network Graphics (.png)
- RadarSAT1 and 2

Vector Data Direct Read

- RPF
- Silicon Graphics FIT
- SOCET SET Support (.sup)
- Space Imaging BIL, BIP and BSQ
- SPOT DIMAP
- Surfer Grid (.grd)
- Targa (.tga)
- TerraSAR-X
- THEOS DIMAP (.dim)
- TIFF (.tif)
- USRP (.img)
- VITEC (.vit)

- ArcIMS
- ESRI ArcSDE Vectors
- ESRI Geodatabase vector features
- ESRI 2D and 3D Shapefiles
- ESRI ArcInfo coverages (8.x, 7.x, 6.x, 3.5)
- DGN, DXF and DWG
- Geography Network
- ERDAS IMAGINE Annotation layers (.ovr)
- ERDAS IMAGINE Area of Interest layers (.aoi)
- Oracle Spatial Feature
- TerraModel Project files (.pro)
- VPF

ERDAS IMAGINE also supports the import and export of numerous satellite, GIS and image file formats. See the chart later in document.

Easy to Learn and Use

- Intuitive graphical user interface throughout
- Common tools used throughout the suite
- Context-sensitive, hypertext-linked on-line help
- Bubble help
- All documentation is available within the software in Adobe
- PDF format

Data Visualization - The IMAGINE Viewer efficiently displays, combines, analyzes and presents disparate geographic data.

- Drag-and-drop data loading to the viewer (Microsoft Windows only)
- International 2-byte fonts supported (Microsoft Windows only)
- Multiple image display types
- Overlay multiple data types
- Treat multiple image layers as
  - Discrete, independent files
  - Virtual mosaic
  - Virtual layer stack
- Arrange layers index
- Multi-view linking by
  - Geographical
  - Spectral
  - Real-time roam and rotate locking

- User-definable projection system for data display
- Dynamic roam
- Fractional zoom, rectangle zoom, pyramid level zoom and continuous zoom and continuous rotate
- Zoom to a specific scale
- Zoom to layer extent
- Font to symbol utility
- User-selectable resampling techniques
  - Nearest Neighbor
  - Bilinear Interpolation
  - Cubic Convolution
  - Bicubic Spline
- Rotation of data to user-defined angles
- Interactive north arrow and scale bar
- On-the-fly reprojection
- Print using Map Composer templates
- Area of Interest (AOI) definition
- Use AOI layers for masking
- Image histogram modification
  - Automatic statistics calculation option
  - Simple brightness/contrast tools
  - Piecewise linear adjustments
  - Standard, statistically-based automatic lookup tables (LUTs)
  - Full graphical histogram contrast adjustment tool
  - Save and reload multiple LUTs
- Window extent statistics
  - Avoids poor utilization of available screen contrast
  - Quickly calculate statistics for current viewer
- Pseudo color table editing for thematic layers
  - Define new attribute fields
  - Apply color patches
  - Statistical report generation
  - Attribute-based criteria selection and display
  - Point-and-click attribute selection
- Recode class values
- Filtering for thematic images (Neighborhood Analysis)
- Filtering for continuous images

- ❖ Standard smoothing, edge enhancement and edge detection filters
- ❖ Custom filter editor and librarian

❑ Interpolation methods for editing image regions

❑ General raster editing tools

❑ Visual change detection between any data types

- ❖ Swipe
- ❖ Blend
- ❖ Flicker

❑ Inquire cursor and inquire box

❑ Measurement tool

- ❖ Point locations
- ❖ Lengths, bearings and angles
- ❖ Polygonal areas and perimeters
- ❖ Cylinder lying on ground
- ❖ Ellipse
- ❖ Control of units and coordinate systems for reporting

❑ MGRS coordinate display and drive to

❑ Profile tools

- ❖ Spectral profile for hyperspectral analysis
- ❖ Spectral reference libraries
- ❖ Spatial profile for cross-section, surface distance and line-of-sight analysis
- ❖ Surface profile for rapid isometric surface views

❑ Image Drape Tool for creating perspective views on platforms supporting OpenGL

- ❖ Rendering of DEM or any surface information as a 2.5D view
- ❖ Control vertical exaggeration
- ❖ Specify observer position and viewing geometry
- ❖ Customizable backgrounds
- ❖ Atmospheric effects
- ❖ Draping of multiple data layers
- ❖ Retention of geographic coordinates

❑ Annotation layers

- ❖ Manually digitize objects
- ❖ Objects include text, polylines, rectangles, ellipses, polygons, symbols, arcs and points
- ❖ Style editor
- ❖ Freehand (streaming) polyline editor
- ❖ Lock annotation rotation angle

- Vector layers
  - Built-in ArcInfo, Geodatabase, Shapefile and ArcSDE vector data models
  - Display and present as points, polygons, polylines, tics or in combination
  - Select features by point-and-click, regional selection or attribute-based criteria
  - Style editor, including attribute-based symbolization
  - Display and print all or selected features only
- TerraModel layers
  - Define color palettes
- GPS live-link
  - Display location in viewer based on NMEA-0183 communication
  - Drive View based on GPS coordinates in real time

In addition, the **IMAGINE GLT™** provides the following on the Microsoft Windows platform only.

- Multiple viewers embedded into a single dialog for easy screen management
- Dedicated “overview” linked window, ideal for dual monitor configurations
- DirectX hardware acceleration
- Multi-CPU support
- Thumbwheels for brightness, contrast, zoom and rotation control
- Percentage Look-Up Table (ideal for 16-bit data such as IKONOS and QuickBird)
- Dynamic Range Adjustment (DRA) with user definable clipping parameters
- Snail Trails
- Flicker-free raster and vector auto-roaming with regular or user-defined search paths
- Contextual Magnifier (lens magnifier)
- Auto-rotate images
  - Grid North
  - True North
  - Sensor Look Angle (Up is Up)
  - Common rotation angles (45°, 90°, etc.)
- Lock rotation angles of GLT with Overview windows
- Image chipping
- Snapshot view content to standard image format
- Copy view content to Windows clipboard
- Feature Counting Tool with user-customizable categories and icons
- Ruler integration (Ruler 14 and 16.x)
- Intelligent (sensor-specific) band combination selectors
- Session saving and loading
- Jump Roam to a user-selected location from overview

- Research and Navigation tools for multi-image change detection
- Automatic application of MTFC kernels
- Spectral Mixer tool for predefined weighted band Combinations

Vector Data Handling - IMAGINE Essentials enables shapefile and coverage data to be rapidly viewed, created and/or edited and provides extensive tools for this purpose through the viewer.

- ArcSDE and Enterprise Geodatabase vector clients
- ESRI Shapefile, Arc Coverage and Simple Personal Geodatabase (Microsoft Windows only) read/write/create
- Create points, arcs, polygons and tics
- Digitize and split existing polygons with shared boundaries
- Reshape an existing shape
- Create and enter attribute data
- Cut, copy, paste and delete
- Unlimited undo levels
- User-defined symbolization
- Node and arc snapping
- Split and unsplit arcs
- Specify weed and grain tolerance
- Splining, densifying and generalization
- Node and polygon error detection
- Arc reshaping
- Drag and drop individual arc vertices or arc segments
- Continuous, "hands-free" roam while editing
- Automatic feature extraction
- Heads-up digitizing in viewer, digitizing tablet input or keyboard data entry
- Rename, copy, delete and external coverages
- Reproject to another projection
- Add hyperlinks to Microsoft Windows applications or Web pages from vector features

Raster Data Handling

- Writeable raster DLLs for IMG, TIFF (including GeoTIFF and TIFF World) and ESRI GRID Stack formats
- Enhanced TIFF image creation for control over parameters such as compression, tiling and creation of TIFF world files in the resulting image file
- Support for files over 2 GB in size
- DLL extendible
- Default format filtering including "All Rasters" option
- Pyramid layer generation for rapid and visually accurate image zooming

Image Management - The IMAGINE Image Catalog provides a database that serves as an image library, softcopy search and information management system.

- Attribute-based querying of records (images)
- View image footprints on reference maps
- Customize reference maps
- Display selected images

Batch Wizard Processing

- Record and repeat common functions
- Automation to provide multi-file input/output support
- Wildcard selection of files
- Drag-and-drop data loading
- Image Command tool for changing projection and map information

Geometric Correction - IMAGINE Essentials provides an intuitive set of tools to georeference raw image data.

- Automatic geometric correction from valid ephemeris information
- Manual georeferencing can be applied to any raster data
  - Affine
  - Polynomial (first to tenth order)
  - Rubber sheeting
  - Reprojection
- Edit Ground Control Points (GCPs)
  - Intuitive graphical user interface
  - GCP selection from map, image, vector or keyboard
  - Automatic coordinate conversion
  - Automatic error reporting
  - Independent verification of accuracy with check points
  - Chip extraction (magnifier) viewers
  - Automatic drive-to-point
  - Automatic point prediction
  - Automatically position a predicted GCP
- Drop point simple geocoding
- Image resampling to coordinate system
  - Nearest Neighbor, Bilinear, Cubic Convolution or Bicubic Spline resampling
  - User-defined pixel sizes and geographic subsets
  - DLL extendible
- Over 1000 projected coordinate systems included
- Over 65 spheroids and 500 datums included

- ❑ User may add more spheroids and datums
- ❑ Vertical datums, including vertical datum transformations
- ❑ Support for both standard and user-defined projection libraries, allowing thousands of projection systems to be defined
- ❑ ArcInfo Vector Transformations: affine or projective
- ❑ Viewer Geographic Link by reproject
- ❑ Viewer reproject images on-the-fly
- ❑ Mapmaker reproject images on-the-fly
- ❑ Reproject command interface
- ❑ Read/create World Files

Simple Classification - Easy-to-use unsupervised classification routine (ISODATA) with only file names and the number of classes needed for input.

User control of:

- ❑ Number of iterations
- ❑ Number of classes
- ❑ Skip factors
- ❑ Initial class means on diagonal or principal axis
- ❑ Scaling of class ranges
- ❑ Color scheme initialization options
- ❑ Convergence threshold

Map Composer - CREATE OR ACCESS INDIVIDUAL CUSTOM MAPS OF USER-DEFINED SIZE.

Add any of the following:

- ❑ Multiple data frames containing one or more data layers each
- ❑ Automatically generated grid ticks, lines and graticules
- ❑ Titles
- ❑ Lines, bounding boxes and symbols
- ❑ Annotation
- ❑ Logos
- ❑ North arrows
- ❑ Scale bars
- ❑ Automatically generated legends
- ❑ User-definable styles
  - ❖ Build customized map templates
  - ❖ Automatically generate USGS maps at standard scales
  - ❖ Automatically generate international map series at any scale
  - ❖ Industry-standard printer languages and devices

General Tools and Utilities

- ❑ File Chooser mechanism
  - ❖ File system and network navigation
  - ❖ Connection mechanism for database access
  - ❖ Recent list of files accessed
  - ❖ “Go To” list of directories accessed

    - Select multiple files at once
    - Preview thumbnail
    - Rename/delete/set permissions on files
    - "All Rasters" and "All Vectors" filters
- Enterprise database spatial selection tool, including:
    - User-customizable backdrop maps
    - MBR footprint display
    - Thumbnail image display
    - Image selection by attribute query, spatial and/or point and click criteria
- Quickly customize ERDAS IMAGINE to the production environment through the Preference Editor
- Access to peripherals and networks
- Text editor
- Layer information tools
- View binary data
- Data compression
- Coordinate calculator
- Subset tool
- Movie player and sequence editor
- Spreadsheet functionality via the CellArray™
- Convert fonts to symbol libraries

Extensibility

- ERDAS Macro Language (EML)
- Font manager

About ERDAS

ERDAS – The Earth to Business Company – helps organizations harness the information of the changing earth for greater advantage.

ERDAS creates geospatial business systems that transform our earth's data into business information, enabling individuals, businesses and public agencies to quickly access, manage, process and share that information from anywhere.

Using secure geospatial information, ERDAS solutions improve employee, customer and partner visibility to information, enabling them to respond faster and collaborate better. It also means better decision-making, increased productivity and new revenue streams.

ANNEXURE - I

Computerized Modules of ULBs

The computerized modules of the ULBs are as follows:-

1. Birth and Death Records Maintenance System
2. Property Tax
3. Water Charges
4. Professional Tax
5. Non Tax items
6. Financial Accounting System (FAS)
7. Personnel Information System & Pay Roll
8. Building Plan Approval System
9. Hospital Records Maintenance
10. Family enumeration
11. Movable & Immovable Properties
12. Grievances Records
13. Stores & Inventory
14. Solid Waste Management
15. Dangerous & Offensive Trade License
16. Vehicle Records Maintenance
17. Electoral Rolls
18. Census Records

ANNEXURE - II

GIS Applications

This Chapter presents GIS applications in three functional areas

1. Property Tax Mapping using GIS
2. Solid Waste Management using GIS
3. Watersupply and Sewerage Management Using GIS.

1. PROPERTY TAX MAPPING USING GIS

A case study of e-Governance and Property Tax gis for ward 16 - City Municipal Council (cmc) – Byatrayanapura, Bangaluru, Karnataka

The e-Gov Foundation (http:// www.egovernments.org) developed the Property Tax with GIS system to integrate the e-Govern Property Tax Application with the e-Govern GIS application. The idea was to create a GIS base map for city planning and administration with a specialized thematic layer for property taxation. In order to understand the nitty-gritty details of such a system for replication in 56 cities, the eGov Foundation prototyped this project in one municipality, Byatrayanapura, just north of Bangaluru. Since implementing the project involved highly specialized technologies and skill sets the e-Gov Foundation put together a set of partners, who would provide their services for free for the Byatrayanapura prototype project. PIXEL SOFTEK (www.pixelgroup.in), a Bangalore based GIS solutions provider took up the task of property tax mapping and GIS for ward 16 of Byatrayanapura. On November 26, 2003, the system was launched in Byatrayanapura. Upon completion, the project was demonstrated to the then Hon'ble Chief Minister of Karnataka, S.M.Krishna, and other ministers.

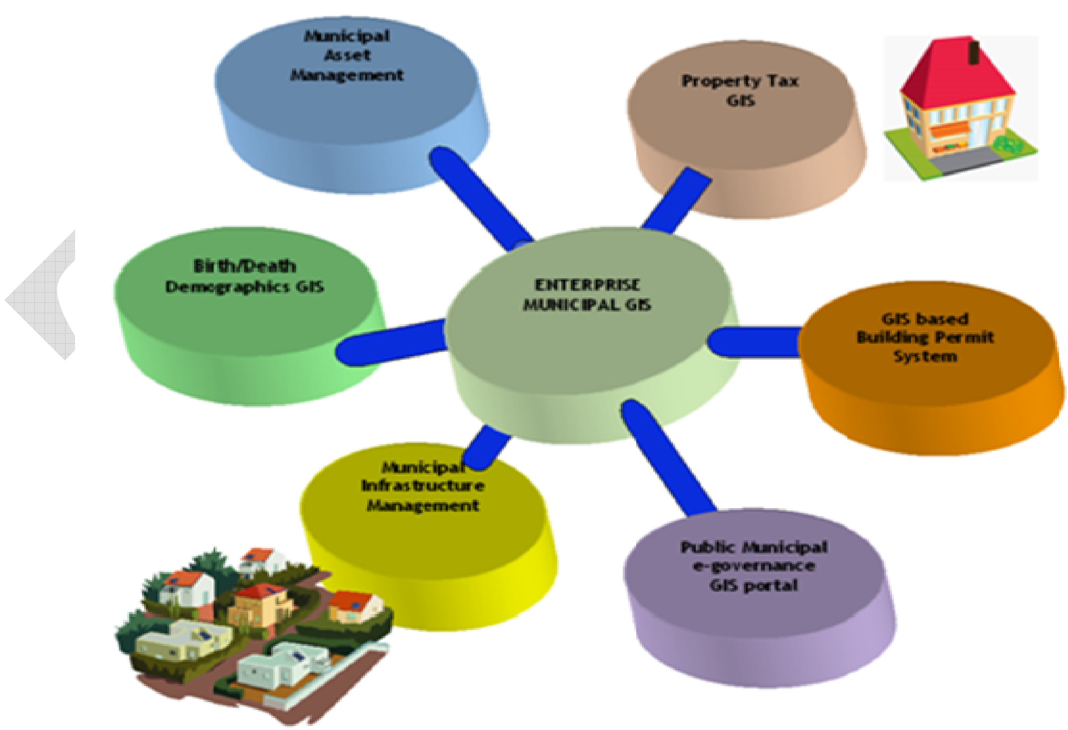


Figure A. Enterprise GIS and its application areas

METHODOLOGY FOR THE PROJECT

The figure B shows all the surveyed land parcels information, importantly land boundary, building boundary and its use, area (ground floor, First floor, stair case, common area , etc.,). The above information will be used in the process of calculation of property tax. The network details such as water supply line, sewerage, storm water drainage, manholes, road center line, road edge, electrical line etc., are input and shown in the figure C.

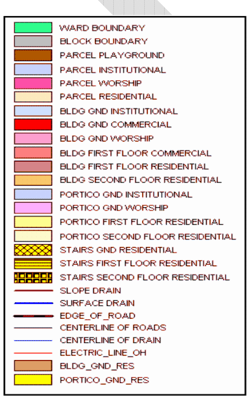
And it represents road side furnishes such as bus stops, road signals, light poles, power poles, OFC, bore well, water tank etc.,

Field data collection, surveying of newly developed features like roads and parcels etc. for base map updating and migration of data captured from field survey using total stations into CAD format and finally to GIS format (ESRI Geodatabase model)

Property survey using total stations was carried out assigning the property ID numbers along with the linear measurement of the property using tape for all the open area, constructed area/ built up area, staircase, ground floor, 1st floor, 2nd floor etc. Other topographical features were surveyed using total station. These data were entered in a predesigned form called Form B in consultation with CMC. Property sketch was prepared with north directional arrow and the dimensions entered. Thus for each property through field survey data in Form 'B' format to enable quicker data entry and validation was made available.

The survey data collected using total station instruments was processed using InRoads Survey software from Bentley Systems and imported into Bentley MicroStation V8 dgn format. InRoads Survey software enables users to transfer data from electronic field books (EFBs) to the MicroStation or AutoCAD environment, reducing time from field to finished drawings with interactive data editing capabilities. It produces plot-ready graphics immediately upon reading the survey data. The layer specifications available for the project were entered into Comma Separated Values (CSV) file format before importing the survey data from total station formats like gsi of Leica and sdr of Sokkia.

Data Scrubbing and Topology Checks: The output of the earlier process is a MicroStation V8 dgn file (CAD format) with the survey data and other topology details captured into different levels/ layers. In order to ensure that the data sent for migration to GIS is topologically correct, an extensive data scrubbing is necessary. For this purpose a comprehensive set of data scrubbing and topology tools were built. The topology checks applied were more to do with the feature representation and the geometry of the element in GIS. Additionally tools to check for unique ids for the parcels, streets etc. were also applied to the survey data in dgn format. The output dgn file obtained after the data scrubbing and topology checks was subjected to GIS data migration.



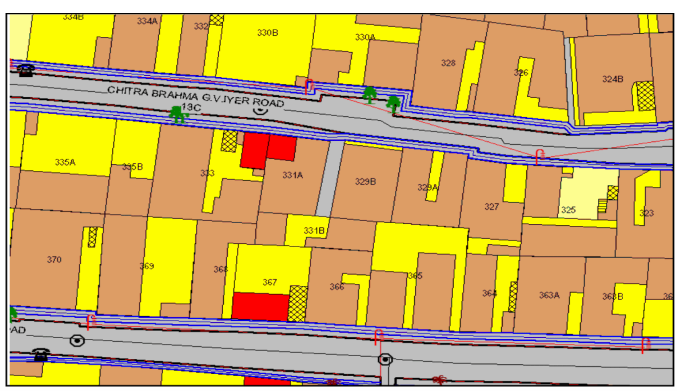


Figure B. Surveyed Land Parcels Information

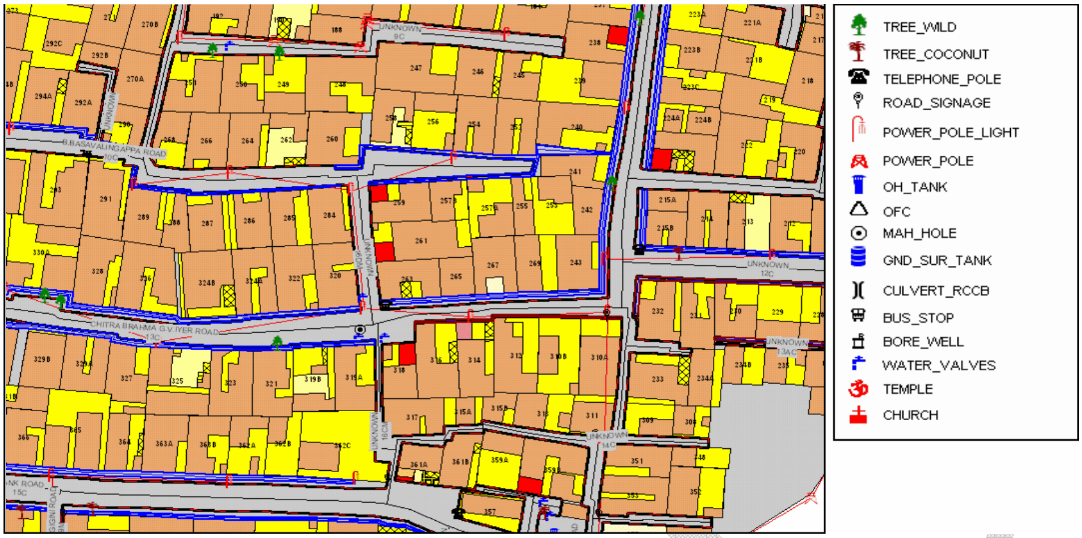


Figure C. Surveyed Land Parcel with Network Details

Data migration to GIS: Data interoperability has long been a burning issue in the GIS community, especially a CAD to GIS format translation. For the purpose of migrating data from MicroStation V8 dgn format to ESRI Shape files; Features Manipulation Engine (FME) a Spatial Extra Transform and Load (ETL) technology from Safe Software, Inc Canada was used. FME allows building of custom mapping files with a rich data model underneath to ensure that the data migrated from CAD to GIS (ESRI Shape files) and by enabling users to manipulate the data into the desired representation. Custom mapping files were built to match the specification provided for the layers listed below to migrate data from dgn to shape format. All the attribution for different layers like parcels, buildings, roads, power poles etc. have been carried out using FME by using Overlay techniques like Area on Area Overlay, Point on Area Overlay, Line on Area Overlay etc.

Data Validation: Post data migration validation was done after migrating the CAD data to ESRI to ensure that the required attributes and specified topology are available in the output geodatabase/ shape file layers. This has been done using certain special features and functionalities available inside FME Workbench of the Feature Manipulation Engine.

GIS Data Layers in ESRI: The following layers of information were captured through field survey for the property tax GIS:

S. No	LAYER	GEOMETRY
1.	Bore well	Point
2.	Bus stop	Point
3.	Culvert RCC	Point
4.	Ground surface tank	Point
5.	Man hole	Point
6.	Optical fiber cable	Point
7.	OH tank	Point

8.	Power pole	Point
9.	Power pole with light	Point
10.	Road signage	Point
11.	Solid waste points	Point
12.	Telephone pole	Point
13.	Tree coconut	Point
14.	Tree wild	Point
15.	Water valves	Point
16.	Centerline of drain	Line
17.	Centerline of roads	Line
18.	Edge of road	Line
19.	Electric line OH	Line
20.	Slope drain	Line
21.	Surface drain	Line
22.	Block Boundary	Polygon
23.	Ward Boundary	Polygon
24.	Building first floor commercial	Polygon
25.	Building first floor residential	Polygon
26.	Building ground floor commercial	Polygon
27.	Building ground floor institutional	Polygon
28.	Building ground floor residential	Polygon
29.	Building ground floor worship	Polygon
30.	Building second floor residential	Polygon
31.	Parcel institutional	Polygon
32.	Parcel playground	Polygon
33.	Parcel residential	Polygon
34.	Parcel worship	Polygon
35.	Portico first floor residential	Polygon
36.	Portico ground floor institutional	Polygon
37.	Portico ground floor residential	Polygon
38.	Portico ground floor worship	Polygon
39.	Portico second floor residential	Polygon
40.	Stairs first floor residential	Polygon
41.	Stairs ground floor residential	Polygon
42.	Stairs second floor residential	Polygon

2. Solid Waste Management Using GIS

2.1. Introduction

Municipal solid waste generated in India is disposed mostly in open dumps, which form a menace to the ambient environment. They become a source of objectionable smoke and odours and serve as breeding grounds for flies and mosquitoes. A landfill siting analysis typically requires evaluation of various rules, factors, constraints and numerous spatial data. Satellite data provide a range of this information quickly and cost-effectively. The area chosen for study is Chennai, which is located on the east coast of southern India. The main objective of this study is to fix appropriate weightages for various factors for siting sanitary landfills using Multi Criteria Evaluation (MCE) and GIS techniques. In this study an attempt has been made to develop a Multiobjective Decision Support System (MODSS) to help urban planners, environmental managers and administrators in identifying new landfill sites and in evaluating the existing landfill sites.

2.2. Urban waste situation

Urban waste situation in metropolitan cities in India 2001 - 02

City	Generation (Tonnes per day)	Cleared (Tonnes per day)	Annuamunicipal Budget (Rs. In crores)
Delhi 3880	2420	1016.28	
Kolkata	3500	3150	250
Mumbai	5800	5000	2436
Bangalore	2130	1800	237
Chennai	2675	2140	145
Lucknow	1500	1000	48
Patna	1000	300	15
Ahmedabad	1500	1200	270
Surat 1	250	1000	170

2.3. Solid Waste Management problems in Chennai City

Chennai, the state capital city is extent over 174 sq.kms holding a population of 5.4 million. The city generates about 500 gm per capita per day. The total refuse generated in the city is 3000 tons per day. The corporation collects about 2520 tons ie, 84% of the total waste generated and dumps in Perungudi and Kodungaiyur situated on the southern side of the city.

Issues in the solid waste management

- The total population is about 60 lakhs
- Only two places are being used for dumping (Perungudi & Kannapalyam).
- The total garbage generated around 3000 tons and 500 gms per capita per day.

- The overall requirement of void space for landfill development will be 30 Million cubic meters.
- No material recovery facilities and Incinerators.
- Vermicomposting plants run by NGO's in southern parts of city.
- Haulage distance is more and lorries used for collection takes more time to reach the landfill sites
- Only ten transfer stations are used

2.4. Management of solid waste

The objective of solid waste management is to minimize wastes and efficiently manage the waste produced. The integrated waste management, includes source reduction, reuse, recycling, volume reduction, composting, recovery, land fill and incineration.

2.5. Objectives of the work

- Collect data on generation, collection, treatment and disposal of municipal solid wastes.
- Examine the existing solid waste management practices with respect to capacity, location and environmental protection and public health issues.
- Digitize base map for sanitary landfill sites of Chennai city.
- Develop Expert System based GIS approach for siting of sanitary landfills by incorporating guidelines given by ministry of environment and forests.
- Identify new transfer stations in the divisions of Chennai city
- Select optimal routes for solid waste collection based on the constraint distance and time.
- Compare the fuel cost between proposed optimum route and existing run route for selected divisions of Chennai city.
- Determine the optimal route for transfer stations/landfill sites for Chennai city.
- Identify new transfer stations in the divisions of Chennai city.
- Disseminate the capabilities of the emerging technology GIS by organizing training programmes and workshops.
- Take up consultancy works utilizing the expertise and facilities acquired through this project.

2.6. Study Area

- Chennai Metropolitan Development Area about 1200 Sq.Km.
- Chennai city is located on the south east coast of India and area of the city is 174 Sq.km.
- City is divided in to ten zones and 155 divisions by Corporation of Chennai.
- The CMDA area has been divided into 15 blocks for the study.
- The latitude and longitude of this area 13^{0}08'50" and 80º12'10".
- The land is flat and the highest point only 60 m above mean sea level.

2.7. Data Used

- IRS - 1C,LISS III,FCC 1:50,000 Scale prints, Survey Of India (SOI) toposheets.

- Maps from Chennai Metropolitan Development Area.
- Block maps from Institute of Remote Sensing, Anna University, Chennai.
- Zonal and division maps of Chennai city from Corporation of Chennai.
- Reports prepared by agencies like ERM, Exnora.
- Questionnaire for Data Collection.

2.8. Methodology

- Use Geographic Information Systems packages like Arc/Info,Geomedia Professional, Arc view and AutoCAD Map for digitizing the map and analyzing different data collected.
- Prepare different thematic layers like Geomorphology, Geology, Land use and Drainage Density for all the blocks identified. (Figure 2.5)
- Develop a suitable scale to rank the attributes in the above thematic layers.
- Perform the overlay analysis for the various thematic maps prepared.

Geotechnical (soil type, bed rock permeability)

Environmental (quantity of solid waste, co-disposal with municipal waste, use of liners, incineration with off gas cleaning, leachate treatment, distance of drain, distance from collection points, type of waste, effect on air quality, effect on noise environment

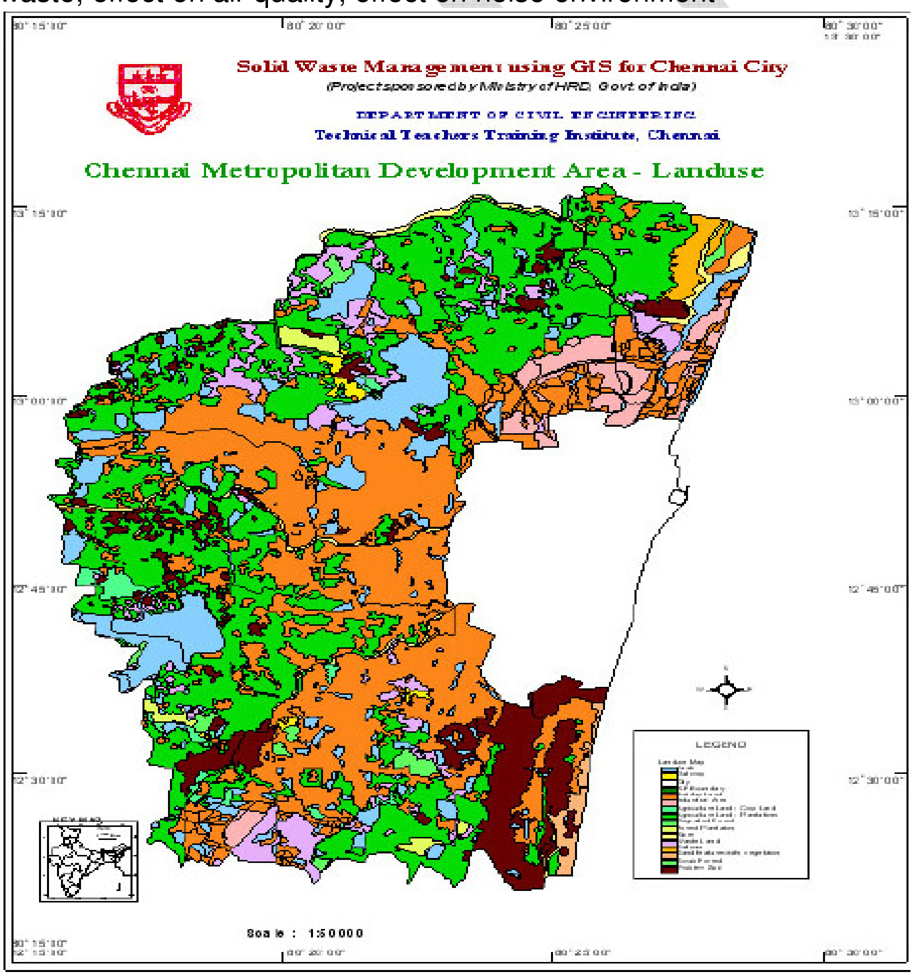


Figure D. Landuse Map of Chennai

- Procure and install the necessary facilities to the GIS lab for organizing emerging area programme.
- Plan and organize training programmes/workshops on relevant GIS real life applications of the region.
- Employ the facilities acquired to take up consultancy works for government organizations like PWD and Ground Water Boards and Local Bodies.

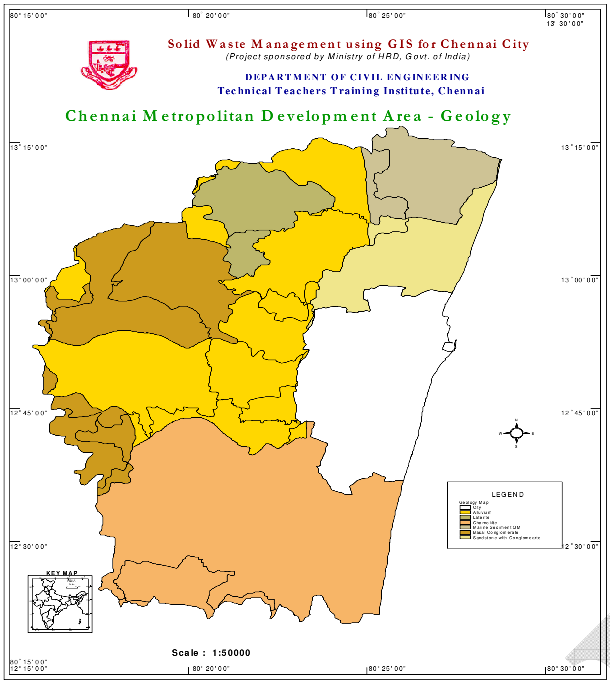
Figure E. Location and Data Collection of solid waste

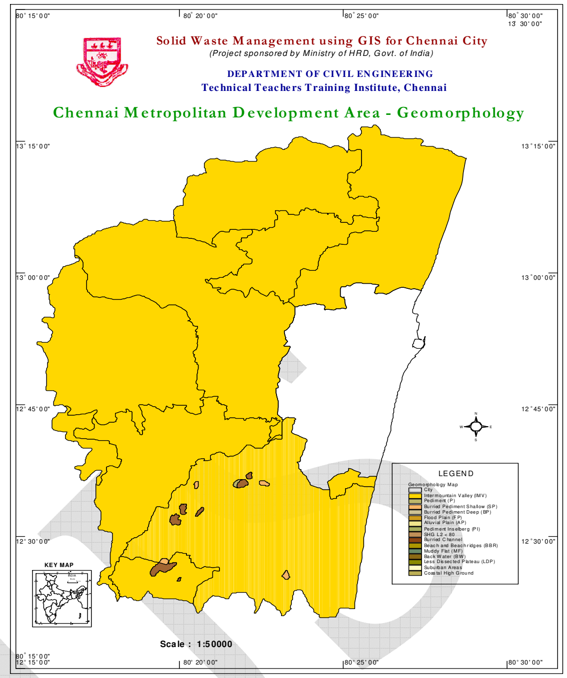
2.9. Zonal and divisional information for Chennai city

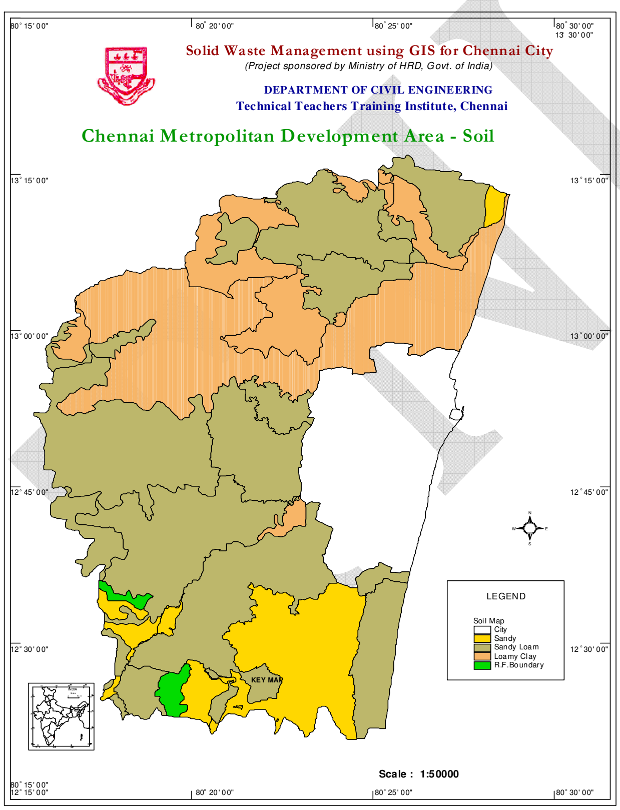
- Zone No., Division No., Ward No., Date, Population.
- Lorries, Trucks, Trillers, Haulage distance, Haulage Time, Details of collection .
- Sanitary workers, Supervisors, Drivers, Engineers.
- Quantity of garbage collected.
- Location of Intermediate transfer station.
- Location of material recovery facility.
- Name of the garbage dumping yards.
- Other informations.

2.10. Considerations in Siting of Solid Waste Facility

For sitting optimum location for solid waste facility the following factors taken into consideration are geology, geomorphology, soil and slope. These factors are mapped in a vector format and the weight age value will be given according to their importance. Then these layers will be used to perform overlay analysis to obtain the optimum location of solid waste facility.







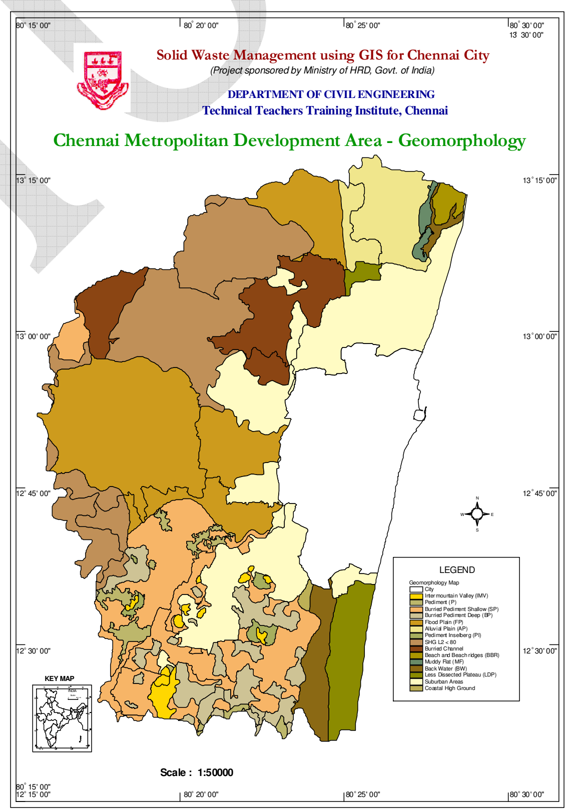


Figure F. Thematic Map of Geology, Soil and Geomorphology

Geology

Geology of the area is an important factor to find out the rock structure, rock types, period of formation and its properties (Figure 2.5.). Based on their attributes the weightage will be assigned.

Geomorphology

Geomorphology deals with the morphometric characteristics of the land. This will help to understand the past, present and future developmental changes of the terrain, and to evaluate for exact location of the solid waste disposal. Figure 2.5.shows the different geomorphological zones of Chennai city.

Physical features (topography, land suitability, seismic soils, surface soils, water streams, subsurface geology & aquifers, wind direction)

Ecological features (flora and fauna, conservation, habitat)

Land use features (development potential, landuse classification (residential / industrial), agricultural value, transportation corridor, extractive industry/mining)

Logistics (proximity to users, transport access, availability of utilities and services (hospitals, fire etc)

Human values (landscape, recreation, historical and archaeological, population density and health status, employment opportunities)

2.11. Suitability of a particular site

The suitability of the site for solidwaste disposal depends on the following factors and the result is shown in Figure 2.7

Characteristics of the waste (quality and quantity of waste, natural features of site, engineered safeguards, operational safeguards and operational procedures)

Socio Economic (population, use of site by nearby residents, distance to nearest, building, presentation of major transportation routes, landuse /zoning, site security, safety measures, site area

Hydrology (distance to nearest surface water, distance to nearest drinking water well, depth to ground water, fluctuation to water table)

Geotechnical (soil type, bed rock permeability)

Environmental (quantity of solid waste, co-disposal with municipal waste, use of liners, incineration with off gas cleaning, leachate treatment, distance of drain, distance from collection points, type of waste, effect on air quality, effect on noise environment

2.12.Geographical Information System

- Computer based tool to capture, manipulate, process and display spatial or geo-referenced data
- They contain both geometry and attribute data
- Accurate and effective in data retrieval, manipulations and analysis.
- GIS can be used in Constraint Mapping which eliminates environmentally unsuitable sites and narrows down the number of sites for further consideration.

- Results of GIS analysis can be communicated with maps, reports or both.

2.13.Use of GIS

GIS serves as a tool for making decision on investment in infrastructure facilities. It is applied for assimilating the voluminous information for analysis.

GIS also used to create population density map and housing / property density maps. In turn, it can be useful to create the influencing area map, the location and number of solid waste collection points.

In practice 80% of the data used for the solidwaste management has a spatial component. Therefore the use of GIS on this application such as site suitability, transportation of solid waste ie routing Existing and proposed route (optimized) shown in Figures I, J and K), is very well needed to make cost effective mechanism.

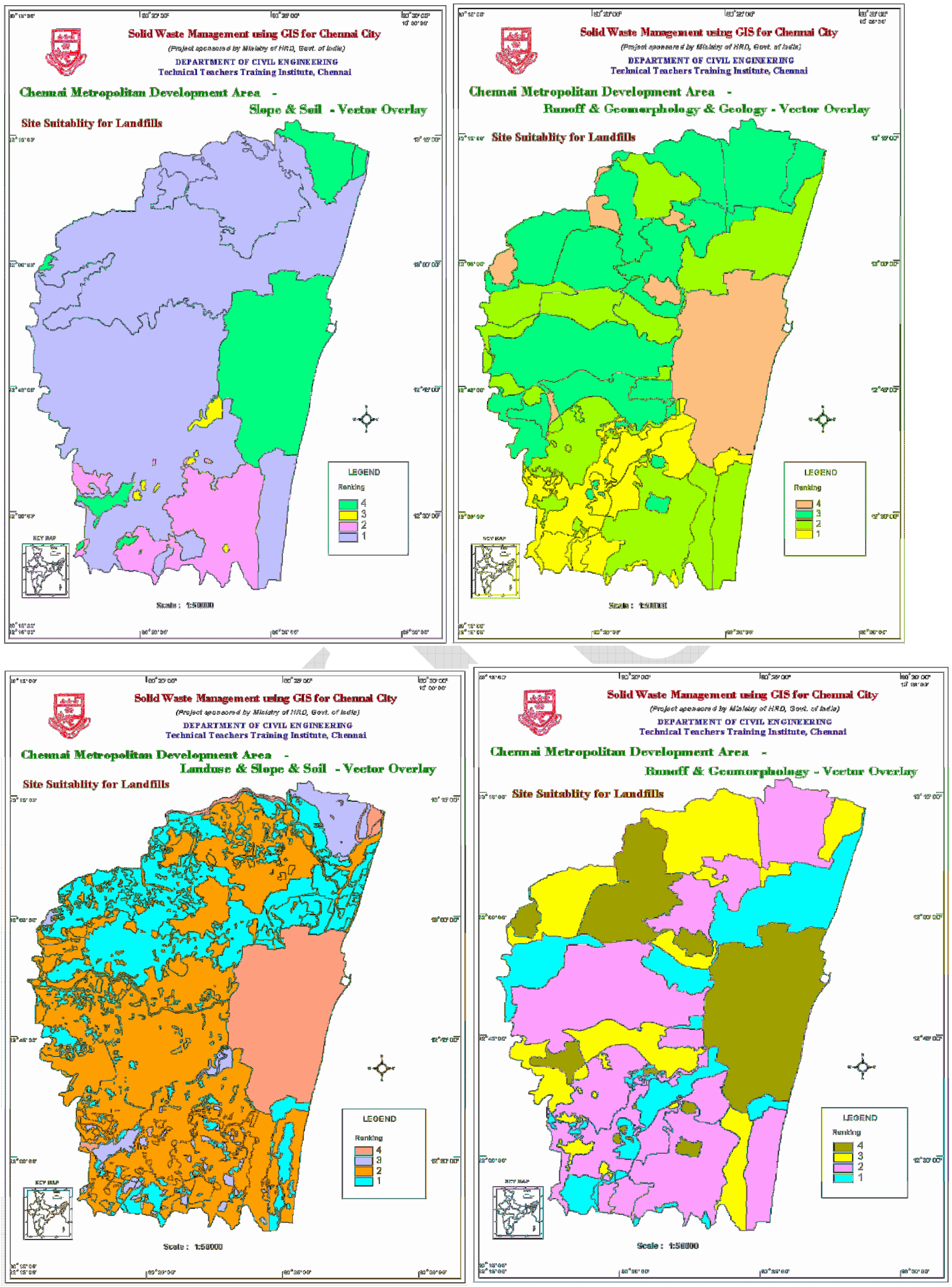


Figure G. Vector overlay analysis of different thematic layers for site suitability analysis

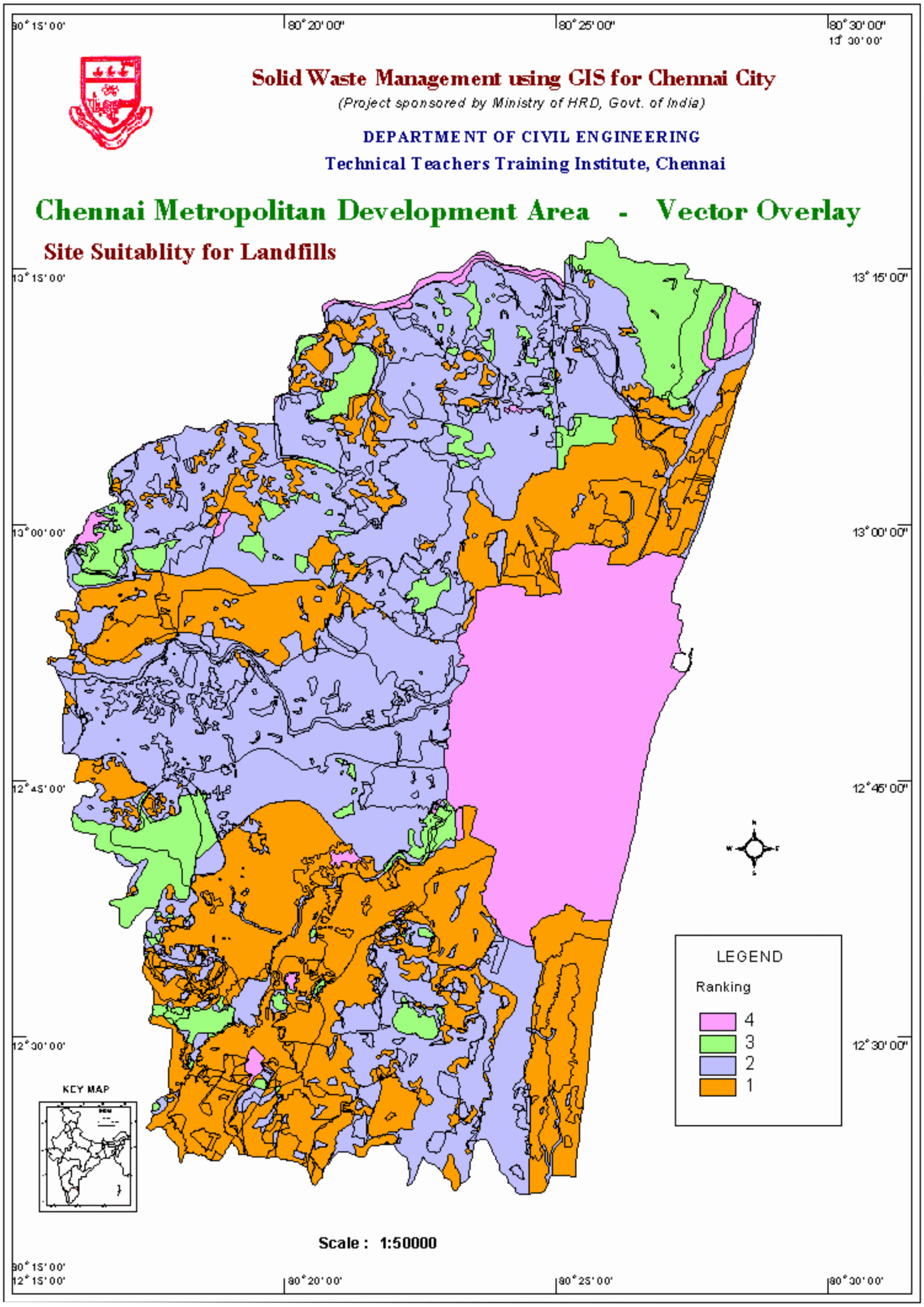


Figure H. Site Suitability Ranking Map of Soildwaste Landfill.

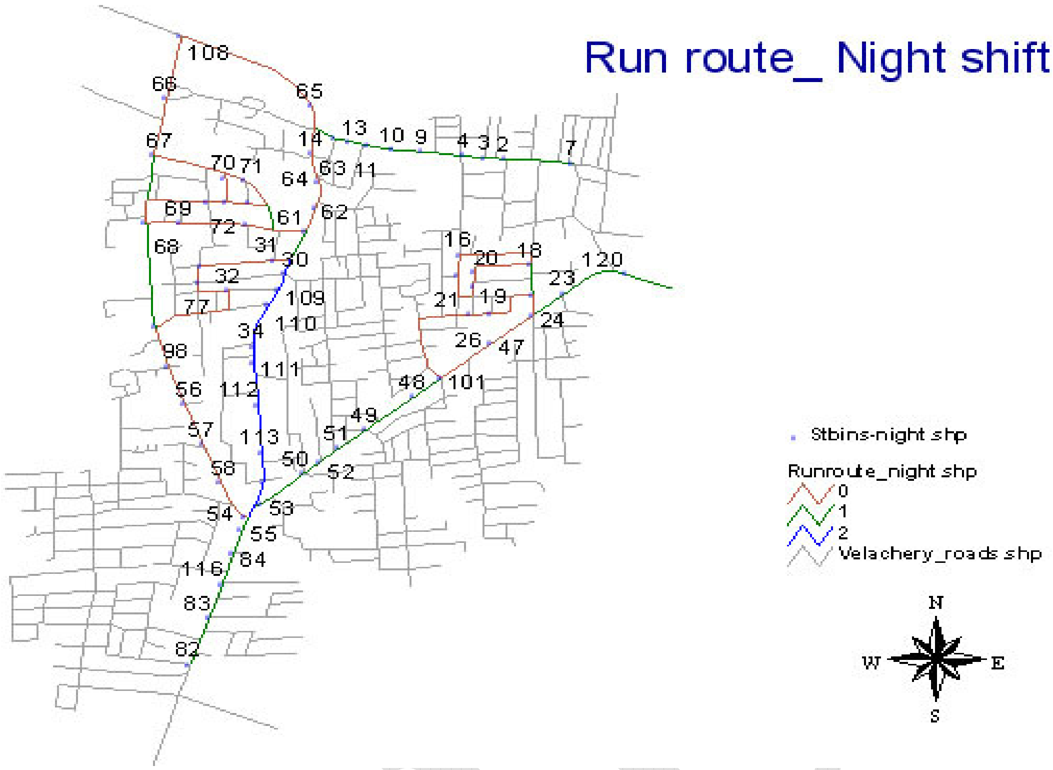


Figure I. Run route (Night shift) for solid waste transport

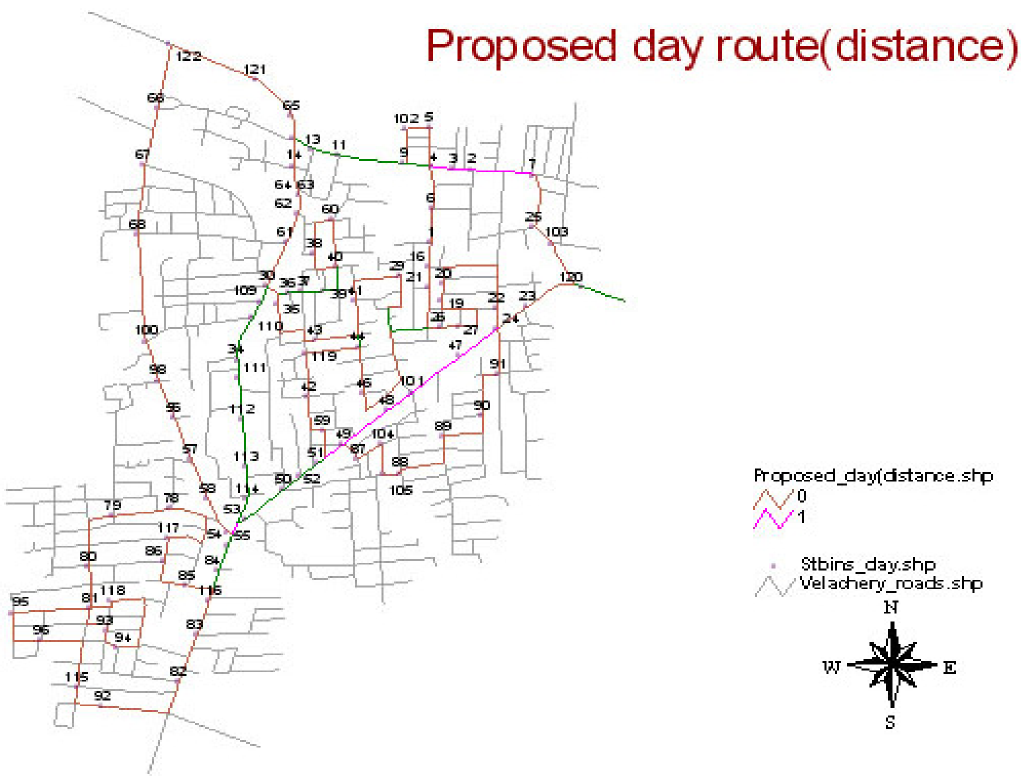


Figure J. Run Route (Day shift) for solid waste transport.

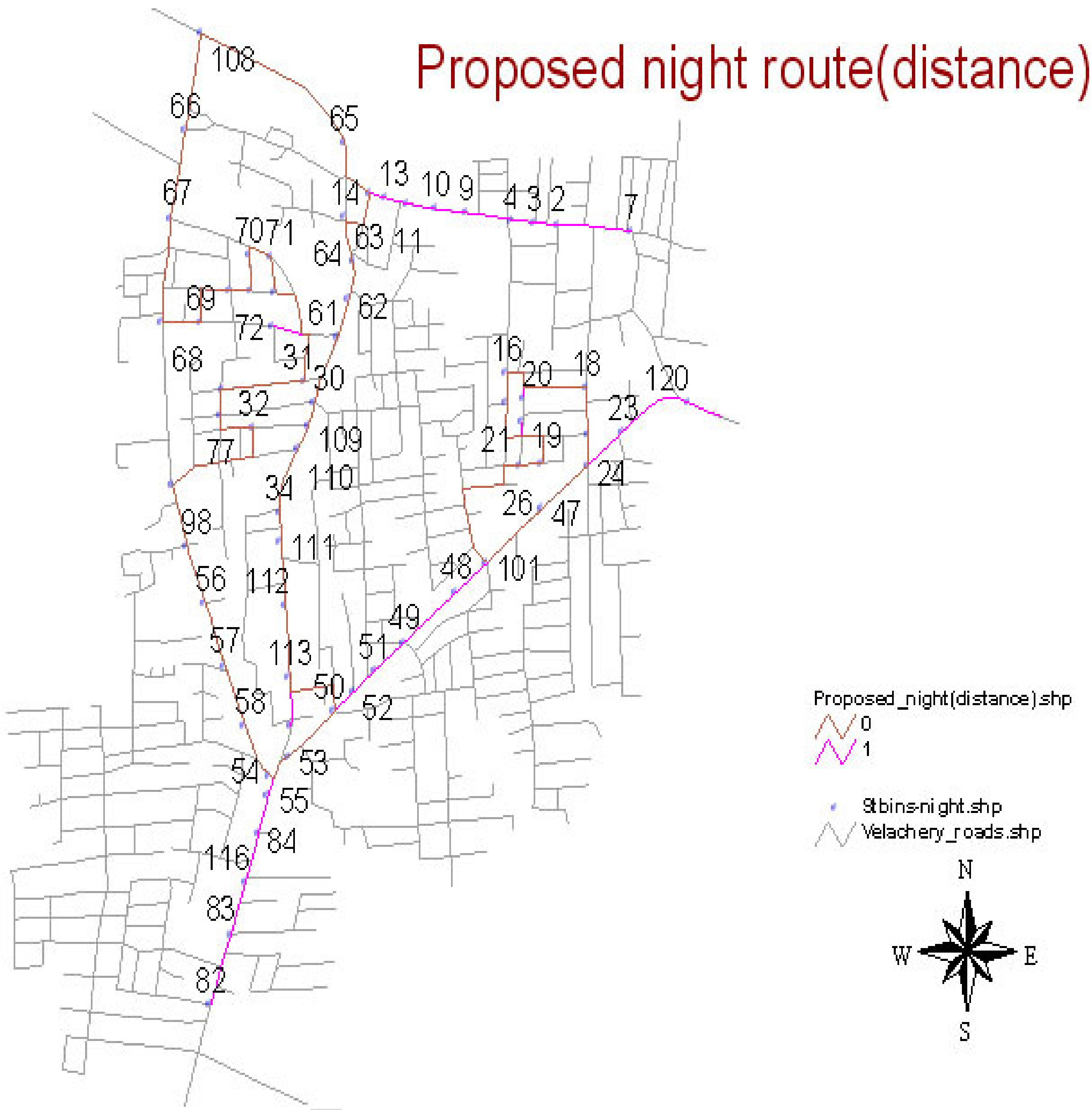


Figure K. Proposed night route (Distance) for solid waste transport.

3 Watersupply and Sewerage Management Using GIS

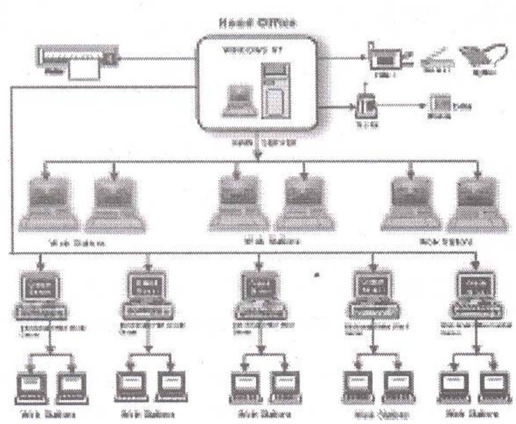
Computerized Mapping, GIS Development and Utilities Computerization for Bangalore Water Supply & Sewerage Board (BWSSB)

3.1 Background and Objectives

The Bangaluru water supply and sewerage systems have grown enormously during the last 4 decades. In order to handle such a large system with large volumes of geographically related information, it was imperative to develop and give decision makers a powerful management and decision making tool. The aim of the BWSSB GIS project consisted of setting up a Geographical Information System for Water Supply and Sewerage Systems using geographical and numerical data.

The key business objectives driving the need for a corporate GIS were as follows:

- To provide interactive access to up-to-date network and geographical information for Operations and Maintenance purposes
- To provide a planning tool to enable the acquisition of new and replaced main
- To provide accurate and comprehensive network information for monitoring, reporting, decision making and data consolidation
- To allow the integration of geographical information from different sources and scales, both internal and external
- To provide a widely available asset management system
- To set up a pilot repository spatial data set for the BWSSB.



Functional architecture of hardware and software

3.2. Scope of work

- The scope of the work was defined after a comprehensive user needs assessment, conducted by the Consultant during the first stage of the project implementation
- Provide high-end equipment and computers to BWSSB head office and its operational divisions
- Supply and installation of computers, networking products and peripherals for BWSSB head office and divisional offices

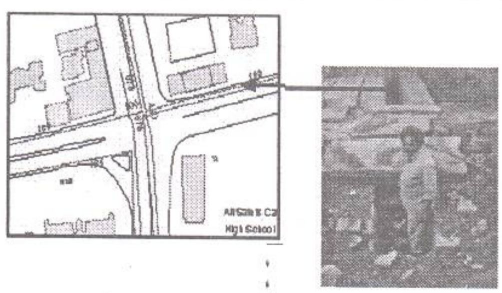
- Windows NT Server, Windows NT Workstations, Oracle 8i Server and Clients, Oracle Developer 2000 Spatial Database Engine (ArcSDE) Microsoft Exchange Server Visual Basic Pro 6.0, Visual C++ 6.0 Firewall CA Le Guardit Map Objects Lite
- Provide services for database and GIS design and development, field surveys for spatial and alphanumerical data collection & integration
- Capacity Building: Transfer of technology, user training

Key aspects of the project

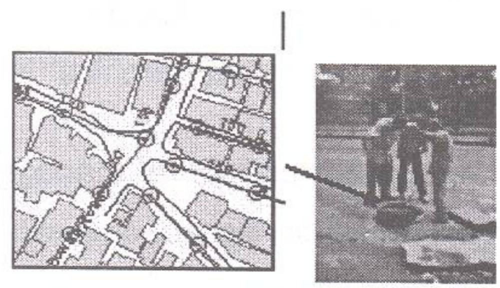
The key aspects of the project lie in the following elements:

Data collection challenge

- 98% of data had to be collected on the field directly by the consultant in close collaboration with BWSSB for the 290 Sq.km representing the BWSSB jurisdiction. In less than one year, the Consultant had to collect all the information, both graphical & alphanumerical concerning the BWSSB assets, the consumers, the BWSSB employees, etc. representing a tremendous challenges in a surface area twice the size as Paris.
- Strong, efficient and relevant methods were thus implemented to fulfil the client's expectation in a very tight time frame and to ensure the delivery of an international data quality standard.



Water Pipeline Data collections in close collaboration with BWSSB *field Staff*



Furthermore, the GIS dissemination in 60 different and remote locations has established confidence. Today the system has around 400 daily users.

Organizational issues

- Among the 2886 employees, only 8% are engineers and their average age is between 45 and 50 with a strong segregation of functions. The departments communicate little and the BWSSB core dataset that should have constituted the repository didn't exist.
- Moreover, the general attitude of people towards IT was reserved and one of suspicion. The fear of modifying ancient methods of working was quite prevalent.
- The project has managed to develop a positive attitude towards IT within the organization, by promoting decentralized approach, accountability and extremely user friendly tools
- Furthermore, the GIS dissemination in 60 different and remote locations has established confidence. Today the system has around 400 daily users.

Large magnitude of users

- Key decision Makers: Chairman and the 5 Chief engineers

▪ 5 Departments (Maintenance, Project, Corporate planning, Cauvery etc.)

▪ 6 divisions, 55 Service Stations.

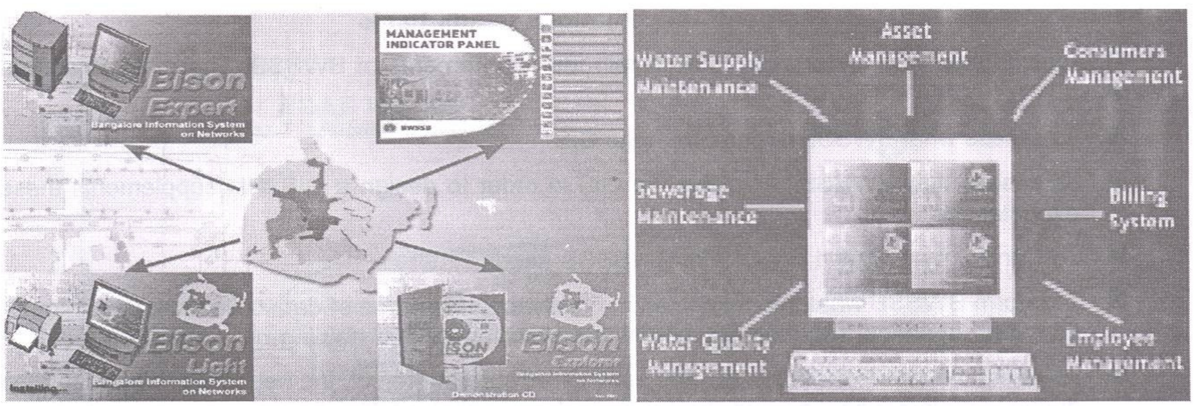
Development of a total GIS Solution

BISON Light is looked at as a combination of three tools in a user-friendly environment that doesn't require strong computer knowledge, but at the same time offers a wide range of capabilities.

BISON Vision allows the user to display and to query all the different water supply and sewerage layers in a smooth and easy way. It will offer consultation of interactive maps dealing with SS concerns, and provide hard and soft copies of maps in all kinds of scale.

BISON Editor constitutes the core tool for the updation process. It deals with point data at the service Station level: consumers, complaints & repairs, water quality.

Management Indicator Panel (MIP): This product was defined in order to provide a document that will give the key persons at the decision making level information at a glance of the entire assets of the BWSSB through a series of maps and important indicators. Its main targets are the Chief Engineers and the Chairman.



Customised Tools providing a comprehensive GIS solution for the BWSSB

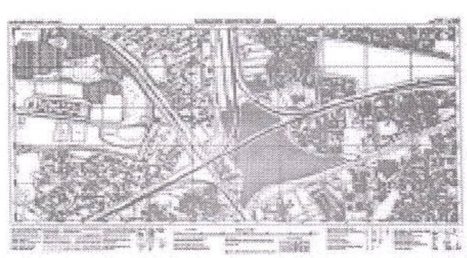
3.3 Services Rendered and Methodology

Area covered

- A 290 Sqkm pilot area, covering the whole BWSSB jurisdictions area to implement the GIS system.

• Base Maps

- The digital vector data and maps based on aerial photography for the pilot area were provided by National Remote Sensing Agency 1 :2 000 scale NRSA maps delivered by NRSA



1 :2 000 scale maps delivered by NRSA

Phase 2 - Equipment procurement and installation

- Hardware, software supplied and installed in three shipments

Phase 5 - Detailed water supply and sewerage systems analysis

- Compilation and synthesis of available information
- Identification of information gaps
- Acquisition of the basic knowledge to conduct the UNA
- Study of BWSSB organization
- Detailed description of procedures followed by BWSSB
- Preliminary stage for GIS and database design requirements of BWSSB

Phase 6 - User needs assessment - expectations needs basis

This crucial step was undertaken to ascertain the requirements of BWSSB. The main objectives were:

- To assess what BWSSB experts from the GIS
- To assess how BWSSB will utilise the GIS in order to design a GIS that supplements these expectations
- To Carry out a detailed analysis of BWSSB's needs
- To inform BWSSB what thier expectations really mean in terms of data collection, data integration, data updation, required equipment, staff availability and training on a long term basis.
- To select the needs that can be fulfilled within the current project, the needs that can be fulfilled during a project extention and the needs that can only be fulfilled later.
- To arrive at a mutual consensus on the implementation of the selected user needs and to tailor a customised GIS

Phase 7 - GIS Design and Phase 10 (Coding): implementation of the MERISE method

- Conceptual organisation and process model for elaboration of processes necessary to fulfill the selected needs
- Logical data model for definition of logical links between tables designed in the conceptual Data Model
- Functional architecture designs which sites have to be equipped according to the above organization and design
- Physical data model, a collection of scripts building the entire structure of the oracle database, that was designed according to the above requirements
- Design of user interfaces such as application menus, toolbars, popup and windows, as it will be seen by the users
- Operational process model for details of procedures coded in phase 10 ("Development and testing of front-end application")
- The employee database along with the billing system integration in the GIS improves the Bill Collection and the transparency among the organization.

ANNEXURE – III

Other Applications

1. Priority for pavement maintenance:

For each link can upload the number and size of potholes and cracks. The pavement serviceability index based on condition of links can be generated for maintenance and operation.

Below	95	–	Excellent
	95-119	–	Good
	120-144	–	Fair
	145 – 240	–	Poor
Above	240	–	Very Poor

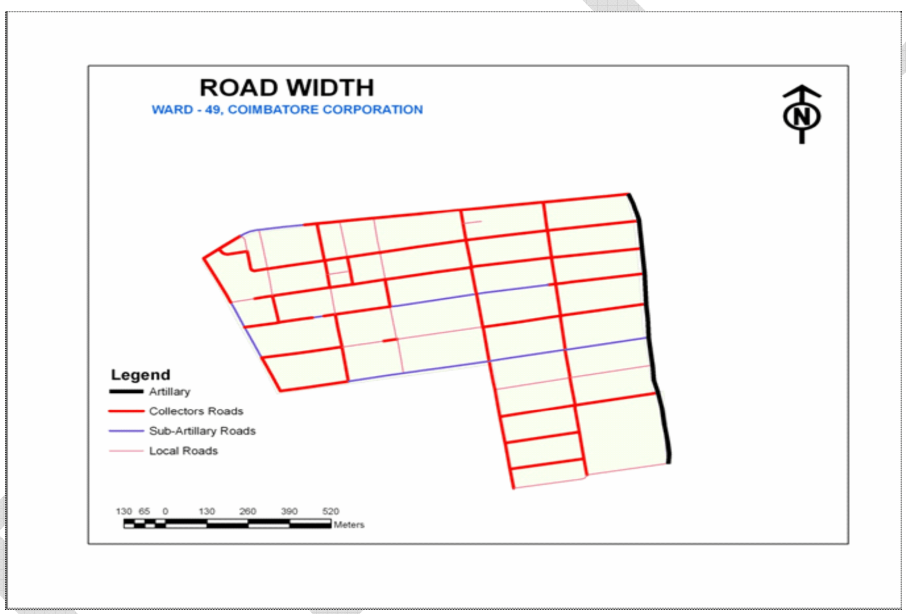


Figure L. Classification of Roads based on Road Width

The buffer can be generated on each category of road and the accessibility to the roads can be found out. The new roads may be identified for the un-served areas.

2. Planning for new roads/ assessing the existing networks

The objective is to find out whether people living in different part of the city have equal accessibility. And this is identified by drawing buffers along with roads.

Hierarchy:

1. Arterial	-	1000m on either side	
2. Sub-arterial	-	500m	,,
3. Link Streets	-	250m	,,
4. Local Street	-	None	

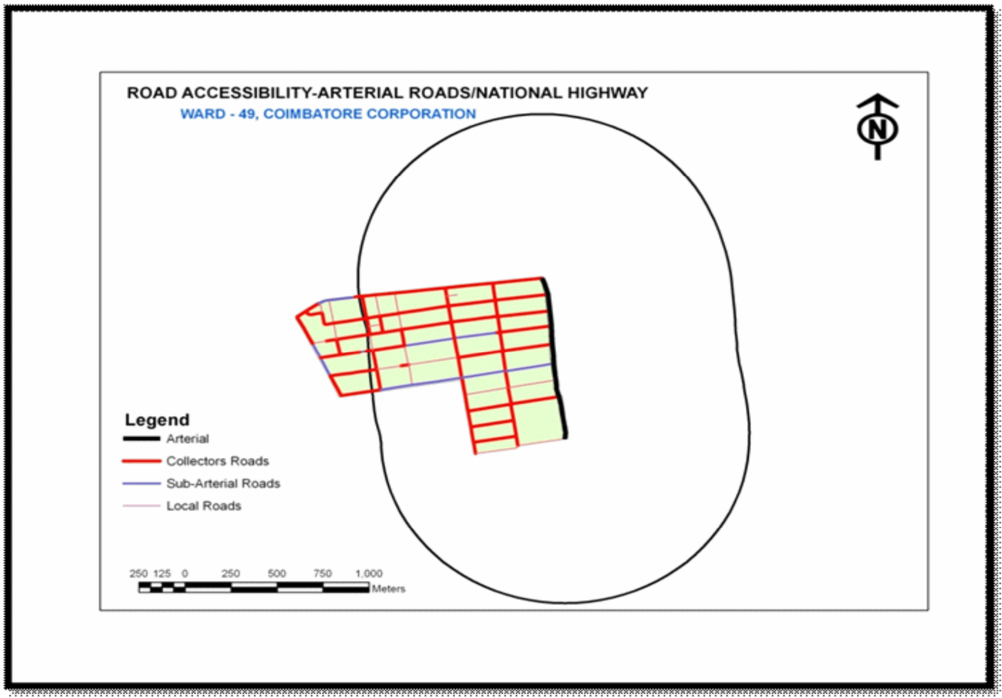


Figure M. Road Buffer for Arterial Roads

3. Land Suitability Analysis

The land suitability for different purpose is identified by GIS using scientific approach for various purposes. Such as, selection of bus stand, solid waste dumping yards etc.

Based on the integration of the following database the land suitability can be done.

1 Existing Land use,

2 Soil Characteristics,

3 Accessibility of difference hierarchy of roads,

4 Water bodies

5 Depth to the ground water table

6 Quality of water in term of Total Dissolved Solids

7 Availability for the on-site facilities.

4. Property Tax

The property (Land and Building) is assessed based on the location of the property /land zone, Use of the building, (Residential/ commercial/Industrial), extent of the building area, (Ground floor area and other floor areas). The building boundary is identified, through remote sensing data Quick bird and door to door field survey, and the built-up area is input into GIS Environment for the retrieval of information. And the existing tax collection value can be identified and compared with the actual area. So that demand is generated. Assessed area can be identified spatially and report /map can be generated.

5. Solid Waste Management

Solid wastes, generated in cities, are disposed mostly in open dumps, which affect the environmental quality of the disposed area. Suitable sites can be indentified using GIS for dumping solid wastes. Physical features (Slope, land suitability, seismic soils, surface s0ils, drainage, ground water quality, aquifer media, wind direction... etc.), Ecological features (Flora, fauna, conservation, and habitat), and land-use pattern (Development potential, land-use classification (Residential/Commercial), agricultural potential, and extractive Industry/Mining) have to be considered for locating solid waste disposal sites.

The suitability of the site depends upon the following factors:-

a. Characteristics of the waste,
b. Land-Use,
c. Soil,
d. Geomorphology,
e. Geology, and
f. Hydrology,

Sl.No	Greenspace Types	Area (Ac)
1	Residential Trees	21.64
2	Avenue Trees	20.45
3	Park	7.451
4	Institutional Greenary	1.02
	Total	50.561

Table 1.0

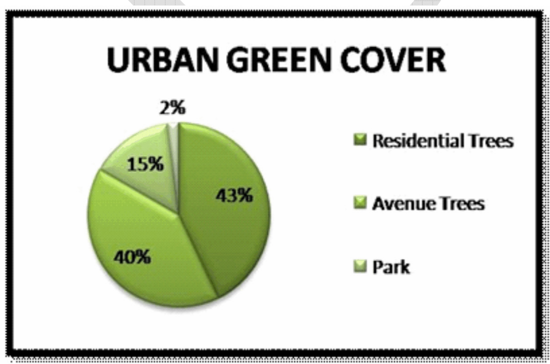


Figure N. Distribution of Green Covers

In each factor, suitable parcel of land can be identified. The weightage value will be assigned for each factor based on the characteristics, after complete study. Then overlay analysis can be performed in GIS environment using all the above factors.

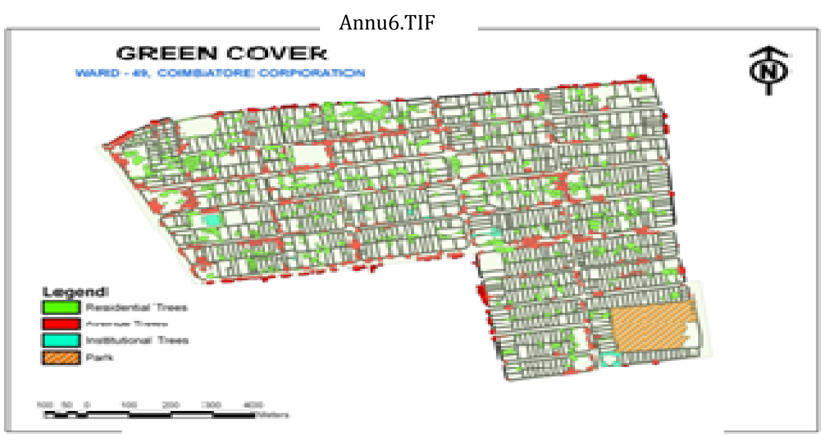


Figure O. Green Cover Map of Ward 49

ANNEXURE - IV - COMPARISION OF ULBs AND TCS – DATA

Sl. No	TCS			ULB			Difference	Difference (%)
	Assessment no.	Builtup area	Us age	Assessmen t no.	Builtup area	Us age		
1	108502	4403	1	108502	3538	1	865	**24**
2	108599	217	1	108599	2785	1	-2568	**-92**
3	108605	3177	1	108605	450	1	2727	**606**
4	108631	2513	1	108631	2899	1	-386	**-13**
5	108788	1413	1	108788	1295	1	118	**9**
6	108836	3362	1	108836	2614	1	748	**29**
7	108837	3362	1	108837	2550	1	812	**32**
8	108838	3362	1	108838	2468	1	894	**36**
9	108839	3362	1	108839	1955	1	1407	**72**
10	108840	3362	1	108840	2614	1	748	**29**
11	108841	3362	1	108841	2550	1	812	**32**
12	108842	3362	1	108842	2468	1	894	**36**
13	108843	3362	1	108843	2614	1	748	**29**
14	108844	3362	1	108844	2550	1	812	**32**
15	108845	3362	1	108845	2468	1	894	**36**
16	108846	3362	1	108846	1955	1	1407	**72**
17	108847	3362	1	108847	2615	1	747	**29**
18	108848	3362	1	108848	2468	1	894	**36**
19	108849	3362	1	108849	1955	1	1407	**72**
20	108851	2513	1	108851	3024	1	-511	**-17**
21	108852	2513	1	108852	1547	1	966	**62**
22	108856	583	1	108856	2224	1	-1641	**-74**
23	108857	583	1	108857	2207	1	-1624	**-74**
24	108858	583	1	108858	2224	1	-1641	**-74**
25	108859	583	1	108859	2207	1	-1624	**-74**
26	108860	583	1	108860	2224	1	-1641	**-74**
27	108861	583	1	108861	2207	1	-1624	**-74**
28	108862	583	1	108862	2224	1	-1641	**-74**
29	108869	2369	1	108869	2559	1	-190	**-7**
30	108870	2369	1	108870	2369	1	0	**Nil**
31	108871	2369	1	108871	2260	1	109	**5**
32	108872	2369	1	108872	2260	1	109	**5**

Sl. No	TCS			ULB			Difference	Difference (%)
	Assessment no.	Builtup area	Usage	Assessment no.	Builtup area	Usage		
33	108873	2369	1	108873	2559	1	-190	**-7**
34	108874	2369	1	108874	2559	1	-190	**-7**
35	108875	2369	1	108875	2260	1	109	**5**
36	108876	2369	1	108876	2260	1	109	**5**
37	108877	2369	1	108877	2559	1	-190	**-7**
38	108878	2369	1	108878	2559	1	-190	**-7**
39	108879	2369	1	108879	2260	1	109	**5**
40	108880	2369	1	108880	2260	1	109	**5**
41	108881	2369	1	108881	2589	1	-220	**-8**
42	108882	2369	1	108882	2589	1	-220	**-8**
43	108883	2369	1	108883	2260	1	109	**5**
44	108884	2369	1	108884	2260	1	109	**5**
45	108885	608	1	108885	1721	1	-1113	**-65**
46	108886	608	1	108886	1678	1	-1070	**-64**
47	108887	608	1	108887	3106	1	-2498	**-80**
48	108888	608	1	108888	1721	1	-1113	**-65**
49	108889	608	1	108889	1678	1	-1070	**-64**
50	108890	608	1	108890	3106	1	-2498	**-80**
51	108891	608	1	108891	1721	1	-1113	**-65**
52	108892	608	1	108892	1678	1	-1070	**-64**
53	108893	608	1	108893	1553	1	-945	**-61**
54	108894	608	1	108894	1553	1	-945	**-61**
55	108896	608	1	108896	1678	1	-1070	**-64**
56	108897	608	37	108897	3106	1	-2498	**-80**
57	108901	2283	1	108901	9285		-7002	**-75**
58	108947	1818	1	108947	320	1	1498	**468**
59	108975	1262	1	108975	1249	1	13	**1**
60	108976	1262	1	108976	1278	1	-16	**-1**
61	108977	1262	1	108977	1615	1	-353	**-22**
62	108979	1262	1	108979	1249	1	13	**1**
63	108980	1262	1	108980	1278	1	-16	**-1**
64	108981	1262	1	108981	1615	1	-353	**-22**
65	108982	1262	1	108982	1641	1	-379	**-23**

Sl. No	TCS			ULB			Difference	Difference (%)
	Assessment no.	**Builtup area**	**Us age**	**Assessm ent no.**	**Builtup area**	**Us age**		
66	108983	1262	1	108983	1278	1	-16	**-1**
67	108984	1262	1	108984	1278	1	-16	**-1**
68	108985	1262	1	108985	1615	1	-353	**-22**
69	108986	1262	1	108986	1641	1	-379	**-23**
70	108987	1262	1	108987	1249	1	13	**1**
71	108988	1262	1	108988	1278	1	-16	**-1**
72	108989	4186	1	108989	1615	1	2571	**159**
73	108990	3180	1	108990	2368	1	812	**34**
74	108991	3180	1	108991	3721	1	-541	**-15**
75	108992	3180	1	108992	3721	1	-541	**-15**
76	108993	8788	1	108993	3721	1	5067	**136**
77	108997	1200	1	108997	2794	2	-1594	**-57**
78	109007	1810	1	109007	5100	2	-3290	**-65**
79	109081	1459	1	109081	1583	1	-124	**-8**
80	109082	1459	1	109082	1739	1	-280	**-16**
81	109083	1459	1	109083	1739	1	-280	**-16**
82	109084	1459	1	109084	1739	1	-280	**-16**
83	109086	517	1	109086	2297	1	-1780	**-77**
84	109087	517	1	109087	2297	1	-1780	**-77**
85	110506	5380	2	110506	9142	2	-3762	**-41**
86	110507	2962	2	110507	1376	2	1586	**115**
87	110508	558	2	110508	5420	2	-4862	**-90**
88	110509	2933	2	110509	1344	2	1589	**118**
89	110510	7810	2	110510	1200	2	6610	**551**

ANNEXURE - V

GLOSSARY

Accuracy

Degree of conformity with a standard, or the degree of correctness attained in a measurement. Accuracy relates to the quality of a result, and is distinguished from precision which relates to the quality of the operation by which the result is obtained. The accuracy of a point location would be the difference between the point's coordinates in the GIS and the coordinates accepted as existing in the real world.

Aerial photo (aerial photograph) Photograph taken from an aerial platform (usually an aero plane), either vertically or obliquely.

Altitude Elevation above or below a reference datum; the z-value in a spatial address.

Analog image An image where the continuous variation in the property being sensed is represented by a continuous variation in image tone. In a photograph, this is achieved directly by the grains of photosensitive chemicals in the film; in an electronic scanner, the response in, say, millivolts, is transformed to a display on a cathode ray tube where it may be photographed.

Arc Vector data representing the location of linear features or the borders of polygon features.

Area A level of spatial measurement referring to a two-dimensional defined space. A polygon on the earth as projected onto a horizontal plane is an example of an area.

Atmospheric windows Wavelength intervals of electromagnetic spectrum at which the atmosphere transmits most electromagnetic radiation.

Attribute A descriptive characteristic or quality of a feature. An attribute has a defined set of attribute values. An attribute value is a measurement assigned to an attribute for a feature instance.

Attribute accuracy Component of data quality describing the likelihood of an attribute of a spatial feature being erroneous.

Attribute data Data that relate to a specific, precisely defined location. The data are often statistical, text, images, or multimedia. These are linked in the GIS to spatial data that define the location.

Attribute querying A query that extracts features from a layer based on the value of its attributes data; for example, 'select polygons with an unemployment rate greater than 15%' would be an attribute query.

Attribute tagging Process of assigning an attribute to a particular feature.

Attribute value A specific quality or quantity assigned to an attribute (e.g., asphalt to define road quality), for a specific entity instance.

Band A wavelength interval in the electromagnetic spectrum. For example, in Landsat sensors, the bands designate specific wavelength intervals at which images are acquired.

Blackbody An ideal substance that absorbs the entire radiant energy incident on it and emits radiant energy at the maximum possible rate per unit area at each wavelength for any given temperature. No actual substances, such as lampblack, approach its properties.

Buffering A buffer is a polygon that encloses all areas within a set distance of the spatial features. Points, lines, and polygons can all have buffers placed around them. For example, if a user is interested in all areas within 1 km of a temple, a buffer would be placed around all the points representing temples. This would create a new layer areas within 1 km of a temple.

Cadastral survey A survey of the boundaries of land parcels.

Cadastre A public register usually recording the quantity, value, and ownership of land parcels in a country or jurisdiction.

Cartography The art and science of producing maps, charts, and other representations to spatial relationships.

CARTOSAT Indian satellite for cartographic application.

Cell An area on the ground from which electromagnetic radiation is emitted or reflected; represented by a pixel.

Choropleth maps Maps of quantitative data that show patterns by using different colours or different shading for polygons classed in some way. For example, a map of polygon based unemployment rates (expressed as percentages) might subdivide rates into 0-5, 5-10, 10-15, and 15-20 and shade the polygons accordingly.

Classification(GIS) The assignment of similar phenomena to a common class. An individual phenomenon is an instance of its class. Mahatma Gandhi Road is an instance of class road.

Classification (image processing) Process of assigning individual pixels of an image to categories, generally on the basis of spectral reflectance characteristics.

Contour An imaginary line drawn on a map joining all the points on the earth that are at the same height above the sea level.

Contour point Any station in a horizontal and/ or vertical control system that is identified on a photograph or digital image and used for correlating the data shown on that photograph/image.

Coordinate system A particular kind of reference frame or system, such as plane rectangular coordinates or spherical coordinates, that use linear or angular quantities to designate the position of points used to represent locations or fixed references. In planimetric mapping (two-dimensional coordinate system) locations are represented by x, y, coordinate pairs while in topographic mapping (three-dimensional coordinate system) locations are represented by x, y, and z values.

Coordinate geographic A system of spherical coordinates for describing the positions of points on the earth. The declinations and polar bearings in this system are the latitudes and longitudes, respectively.

Data set Collection of similar and related data records that are recorded for use by a computer.

Data structure Organization of data, particularly the reference linkages among data elements.

Database A collection of information related by a common fact or purpose.

Database creation Process of bringing data into the electronic environment of a database for later use.

Database development Process of determining what elements will be included in a database and their internal relationships.

Datum A mathematical surface (reference) on which a mapping and coordinate system is based.

DEM Digital Elevation Model. A geographic grid of an area where the contents of each grid cell represents the height of the terrain in that cell. Consists of x, y and z coordinates.

Depression angle(y) In radar, the angle between the imaginary horizontal plane passing through the antenna and the line connecting the antenna and the target.

Detector The component of a remote sensing system that converts the electromagnetic radiation into a signal that is recorded.

Digital data Data displayed, recorded, or stored in binary notation.

Digital image An image where the property being measured has been converted from a continuous range of analog values to a range expressed by a finite number of integers, usually recorded as binary codes from 0 to 255, or as 1 byte.

Digitizer A device for scanning an image and converting it into numerical picture elements.

Drape Involves laying features over a digital terrain model to provide information on features that lie on the terrain. The terrain model provides the shape of the terrain. Draped features may then include a satellite image of the terrain to show land use, and vector data to show features such as roads.

Elevation The vertical distance from a datum, usually mean sea level, to a point or object on the earth's surface; the z-value in a spatial address.

ERDAS Earth Resources Data Analysis System. An image-processing and GIS software package now called ERDAS Imagine and produced by ERDAS Inc.

Error In the context of GIS this means the difference between the real world and its digital representation.

False-colour composite (FCC) A colour image where parts of the non-visible electromagnetic spectrum are expressed as one or more of the red, green, and blue components, so that the colours produced by the earth's surface do not correspond to normal visual experience. The most commonly seen false-colour images display the near infrared as red, red as green, and green as blue.

GAGAN GPS-Aided Geo Augmented Navigation. A planned implementation of a satellite based augmentation system (SBAS) by the Indian government.

Geocoding The activity of defining the position of geographical objects relative to a standard reference grid or coordinate system.

Geographical coordinates A position given in terms of latitude and longitude.

Geographical grid Grid derived from geographical coordinated(commonly referred to as longitude and latitude).

Georeferenced Digital spatial data (and non-digital map features) for which the geographic coordinates or location can be determined.

Georeferencing The dimensions used for specifying geographic data, longitude, latitude, and altitude; also called spatial dimensions, the terms spatial and geospatial are equivalent.

GIS Geographic Information System. A data handling and analysis system based on sets of data distributed spatially attached with attributes.

GIS data Data stored in a GIS are represented in two ways: attribute data says what the feature is, and spatial data says where it is using points, lines, polygons, or pixels.

GPS Global Positioning System. A network of 24 ratio transmitting satellites (NAVSTAR) developed by the US Department of Defence to provide accurate geographical position fixing.

Ground control Ground control obtained by ground surveys as distinguished from control obtained by photogrammetric methods; may be for horizontal or vertical control, or both. Ground (in situ) observations to aid in the interpretation of remote sensing data.

Histogram A means expressing the frequency of occurrence of values in a data set within a series of equal ranges or bins, the height of each bin representing the frequency at which values in the data set fall within the chosen range. A cumulative histogram expresses the frequency of all values falling within a bin and lower in the range. A smooth curve derived mathematically from a histogram is termed the probability density function (PDF).

Image processing Encompasses all the various operations that can be applied to image format data. These include, but are not limited to, image compression, image restoration, image enhancement, image rectification, preprocessing, quantization, spatial filtering, and other image pattern- recognition techniques.

INSAT Indian National Space Satellite. A series of meteorological, telecommunication, and television broadcasting satellites.

Interpretation key Characteristic or combination of characteristics that enable an interpreter to identify an object on an image.

Key attributes A set of attributes such that the combination of the attribute values forms a unique identifier for each entity instance.

Laser Light Artificially stimulated electromagnetic radiation. A beam of coherent radiation with a single wavelength.

Layer An integrated, area-wise distributed set of spatial data usually representing entity instances within one theme or having one common attribute or attribute value in an association of spatial objects. In the context of raster data, a layer is specifically a two dimensional array of scalar values associated with all of or part of a grid or image.

Layover In radar images, the geometric displacement of the top of objects towards the near range relative to their base.

Lidar (also expressed as LiDAR or LIDAR) Light detection and ranging. Uses lasers to stimulate fluorescence in various compounds and to measure distances to reflecting surfaces.

LISS Linear Imaging Self-scanning Sensor. A type of sensor carried on Indian remote sensing satellites.

Luminance Quantitative measure of the intensity of light from a source.

Map A representation of the earth's surface. A cadastral map is one showing the land subdivided into units of ownership; a topographic map is one showing the physical and superficial features as they appear on the ground; a thematic map displays a particular theme, such as vegetation or population density.

Metadata Data that describe a dataset to allow others to find and evaluate it.

METSAT (Indian) Meteorological Satellite.

Microwave The region of the electromagnetic spectrum in the wavelength range from 1 mm to beyond 1 m.

Mixed pixel (Mixel) A pixel who's DN represents the average energy reflected or emitted by several types of surface present within the area that it represents on the ground; sometimes called a mixel.

Mosaic Composite image or photograph made by piecing together individual images or photographs covering adjacent areas.

Mosaicking Assembling of photographs or other images whose edges are cut and matched to form a continuous photographic representation of a portion of the earth's surface.

Network analysis Analytical techniques concerned with the relationships between locations on a network, such as the calculation of optimal routes through road networks, capacities of network systems, or best location for facilities along networks.

Node The start or end point of a line segment. As such a node is often the point at which lines intersect.

Object A digital representation of all or part of an entity instance.

ODBC Open Database Connectivity and is a database standard. Any database that is ODBC compliant can connect to any other database that is ODBC compliant.

Overlap Extent to which adjacent images or photographs cover the same terrain, expressed as a percentage.

Overlay A formal geometric intersection between two or more layers of spatially refernced data. A layer produced by an overlay will contain both the spatial data and the attribute data from the input layers.

Passive remote sensing Remote sensing of energy naturally reflected or radiated from the terrain.

Panchromatic film Black-and-white film that is sensitive to all visible wavelengths.

Panchromatic image A single band image of a sensor detector system covering the entire visible part of the electromagnetic spectrum.

Pattern Regular repetition of tonal variations on an image or photograph.

Photogrammetry The science and art of obtaining measurements from photographs.

Picture element In a digitized image, this is the area on the ground represented by each digital value. Because the analog signal form the detector of a scanner may be sampled at any desired interval, the picture element may be smaller than the ground resolution cell of the detector. Commonly abbreviated as pixel.

Point A level of spatial definition referring to an object that has no dimension. Map examples include wells, weather stations, and navigational lights.

Polygons Spatial features that are areas or zones enclosed by precisely defined boundaries. The boundaries of a polygon are formed from one or more lines.

Projection system A method by which features on the curved earth are translated to be represented on a flat map sheet. This involves converting from longitude and latitude to x and y coordinates.

Raster data model A way of representing the earth's surface by subdividing it into small pixels, usually square cells. Each pixel has values attached to it providing attribute data about the pixel.

Raster Image (Raster data) A digital image is a 2D array of pixels (picture elements), where each pixel either directly or indirectly defines the colour of that.

Raster-to-Vector (R2V) conversion The process by which vector features (points, lines, and polygons) is automatically extracted from raster data. This usually requires a large amount of user input and is often error-prone.

RBV Return beam vidicon. A little-used imaging system on Landsat that consists of three cameras operating in the green, red, and photographic infrared spectral regions. Instead of using film, the images are formed on the photosensitive surface of a vacuum tube. The image is scanned with an electron beam and transmitted to the earth's receiving station.

Real time Refers to images or data made available for inspection simultaneously with their acquisition.

Remote sensing The acquisition of information about an object without physical contact. Usually associated with the acquisition of information about the earth's surface by electronic and/or optical instruments from satellites, airborne platforms, or ground observation.

Resampling The calculation of new DN for pixels created during geometric correction of a digital scene, based on the values in the local area around the uncorrected pixels.

Resolution, sensor Resolving power of a sensor, a measure of the ability of a sensor to distinguish between signals that are spatially near or spectrally similar.

Scanning Process of using an electronic input device to convert analog information from such as maps, photographs, or overlays, into a digital format usable by a computer.

Signal Information recorded by a remote sensing system.

Signature A characteristic, or combination of characteristics, by which a material or an object may be identified on an image or photograph.

Site suitability analyses Analytical techniques used to present a coherentpictre of how well a particular location is suited for a specific purpose. Generally involves analysis of a multitude of various types on interrelated information.

Skylight Component of light that is strongly scattered by the atmosphere and consists predominantly of shorter wavelengths.

Silver polygons Small polygons formed as a result of overlaying two or more layers of vector data. These are formed due to small differences in the way that identical lines have been digitized.

Stereoscope Binocular optical device for viewing overlapping images or diagrams. The left eye sees only the left image, and the right eye sees only the right image.

Subscene A portion of an image that is used for detailed analyses.

Theme A generalization of entity classes (e.g., culture, hydrography, transportation).

TIFF Tagged Information File Format. Raster image format created by Aldus and Microsoft Corporations and designed to be a universal format. It is used extensively in desktop publishing packages. TIFF can be compressed using a wide range of compression routines. The most common of these is LZW.

TIN Triangulated Irregular Network. A data structure which describes a three – dimensional surface as a series of irregularly shaped triangles. Usually used in connection with digital terrain modeling.

Tolerance The amount by which the measurement of a value can very without causing problems.

Topography Description or representation on a map of the physical and cultural surface features.

Topological relationship How data elements relae to each other within the database. In particular, how a change to can elements affects other elements.

Topology a branch of geometrical mathematics which is concerned with order, contiguity, and relative position, rather than actual linear dimensions. The description of how spatial features are connected to each other.

Vector data model divides space into discrete features, usually points, lines, or polygon.

Vector format the expression of points, lines, and areas on a map by digitized Cartesian coordinates, directions, and values.

Vector-to-raster conversion the process by which a vector data is converted to rasters. This is usually automated.

Layer An integrated, area-wise distributed set of spatial data usually representing entity instances within one theme or having one common attribute or attribute value in an association of spatial objects. In the context of raster data, a layer is specifically a two dimensional array of scalar values associated with all of or part of a grid or image.

Web-based mapping maps created for use of the internet so they often have some interactive functionality.

WGS84 World Geodetic System 1984. a geocentric geodetic datum used for the determination of geographical coordinates developed by the US Department of Defense. For al practical purposes, GDA94 approximates to WGS84.

WWW World Wide Web.

ANNEXURE - VI

Frequently Asked Question

What is the difference between GIS and a map?

"GIS is the application that compares the tabular data and illustrates the spatial relationships. It allows for selective analysis and informed decisions. The end results of the various analyses are usually illustrated as 'maps.' However, the layman mistakes GIS as simply map-making."

"A map is generally static and might be thought of as a cartographic output. Once created, the map does not provide any additional information. Conversely, GIS is an integrated system that enables a user to ask numerous questions of a database and visualize the answers."

What advantages do I, as a citizen gain from GIS?

"If you are performing the analysis in a GIS, you have an intimate knowledge of the data being used, its accuracy, and the type of spatial relationships desired and illustrated. If you only see the end product but know that it was derived from tabular information, you begin to appreciate geospatial patterns and relationships, the first steps in GIS."

How can GIS be used to make decisions?

"GIS is a planning tool. It combines known tabular data with spatial relationships to analyze the relationships and determine the most efficient use of limited resources. It can also be combined with modeling applications to determine 'what if' scenarios, or to compare results of applied resources or natural events over time."

How can GIS help my city

"GIS can assist a city or a country with a number of daily processes: planning, waste water/utilities, voting precincts, road/bridge maintenance, E-911, etc."

How accurate is the system?

"GIS accuracy varies depending on the data. It is critical that users refer to metadata to determine the accuracy of the data and make sure it is suitable for their application.

What are some non-map generation uses of GIS?

"GIS can be used to create charts and graphs of databases to verify the quality of the database. These processes can also be performed in standard spreadsheet packages. Ordinarily, GIS is used to map the database so one can visualize the location of events. Generally speaking, answers acquired from map analysis performed in a GIS could be concluded through standard database queries. However, the answers may not be as easy to interpret."

How can GIS be beneficial for all forms of government?

"GIS can be beneficial in many ways, but in the simplest of terms, it connects people to information through geography. Government can use GIS to store, manage, and access information about its facilities, people, and environment. It gives government officials a way to visualize data that helps them make decisions about project planning and economic development. It also allows them to disseminate a large quantity of information to the public in terms of where things and events are located."

What is the average replacement cycle of data and equipment?

"The average replacement cycle is 3 to 5 years for computers. Data such as satellite or aerial photography should be replaced as frequently as can be afforded. Data such as cadastral or road centerline data should be maintained weekly at minimum."

What is the startup cost and what is the maintenance cost of GIS?

"The cost to start up a GIS will vary dependent on the depth at which you begin. To begin a basic/low cost GIS would not be too expensive. First you would need a high-end computer workstation, which might cost around $2,000-$3,000. Next, you would need one of the various GIS software packages, costing $1,500-$3,000. Finally, the salary for a GIS Technician would be around $23,000-28,000/year. As for maintenance costs, the only cost would be the salary for the GIS Technician to maintain the data." Check out this GIS Cost Estimate.

How can GIS help our city maintain its water system?

"GIS can benefit a water utility by providing seamless integration of facility mapping. GIS can help the utility authenticate what type, how many, and where their assets are located, as well as when they are installed, what type of material they are made of, what their size is, and many other attributes. This allows the utility managers to model changes to the system or changes within the system. They can also print maps and reports to help them plan their improvement projects. Maps may also be used to help field technicians locate work order information. GIS also helps utilities comply with strict government regulations such as Government Accounting Standards Board Statement 34 (GASB34), National Pollutant Discharge Elimination System (NPDES), as well as many others."

What is projection?

"A projection is a mathematical model used to define 3-dimensional earth space onto a flat plane."

ANNEXURE – VII

GIS Web Links

http://www.amherstma.gov/index.aspx?NID=400

http://www.nrsa.gov.in/

http://www.bisag.gujarat.gov.in/objective.html

http://www.ksrsac.gov.in/html/main-page.html

http://www.cedindia.org/

http://www.sigpune.com/

http://www.spa.ernet.in/

http://www.annauniv.edu/

http://gis.co.mifflin.pa.us/website/bratton/viewer.htm

http://www.gisdevelopment.net/

http://www.sac.gov.in/

http://www.nasa.gov/

http://www.beavertonoregon.gov/departments/gis/landuse_maps.aspx

http://www.esriindia.com/ESRIINDIA.htm

http://usa.autodesk.com/

http://www.autodesk.in/

http://www.geoinformatics.com/

http://www.spatialsciences.org.au/

http://210.212.20.94/JSAC/

http://www.peoplegis.com/municipalgis.html

GIS Tutorials and On-line Help:

http://www.geo.ed.ac.uk/

http://www.ciesin.org/gisfaq/faq-index.html

http://egsc.usgs.gov/isb/pubs/gis_poster/

http://www.gisdevelopment.net/tutorials/

http://gislounge.com/tutorials-in-gis/

http://libinfo.uark.edu/GIS/tutorial.asp

http://www.fema.gov/plan/prevent/fhm/ot_main.shtm

http://www.lib.uwaterloo.ca/locations/umd/digital/tutorials.html

GIS Software Makers:

- http://usa.autodesk.com/
- http://www.avenza.com/
- http://www.bluemarblegeo.com/
- http://www.clarklabs.org/
- http://www.erdas.com/
- http://www.esri.com/
- http://www.freegis.org/
- http://www.intergraph.com/
- http://www.pbinsight.com/
- http://edc2.usgs.gov/geodata/public.php
- http://www.lmic.state.mn.us/EPPL7/EPPL7/
- http://www.maptext.com/

On-line GIS Magazines:

- http://www.directionsmag.com/
- http://www.gpsworld.com/gis
- http://www.profsurv.com/eomonline.aspx
- http://spatialnews.geocomm.com/
- http://www.gisdevelopment.net/

ANNEXURE – VIII
GIS NEWS

1) GIS centre at Corporation

Special Correspondent

It will help in tapping revenue and planning infrastructure

COIMBATORE: Coimbatore Corporation has obtained from the National Remote Sensing Centre in Hyderabad satellite images of all types of buildings, roads, water and sewer lines in the city as part of establishing a Geographical Information System (GIS) centre that will help in tapping revenue and also in planning infrastructure.

The city corporations of Coimbatore, Madurai and Tiruchi and the Gobichettipalayam and Rajapalayam municipalities have been chosen for a pilot project to establish such centres in a tie-up with Tata Consultancy Services (TCS).

Ahead of the other local bodies, Coimbatore Corporation will begin a door-to-door physical verification of the city's assets in the first week of February.

This was announced at a meeting Coimbatore Corporation Commissioner Anshul Mishra held on Saturday to review the works being carried out by the civic body.

A database of the assets will be prepared and given to even select user groups that will be involved in city planning.

The pattern of existing water or sewer lines and how to proceed with laying new ones is one of the areas where the GIS mapping will be helpful.

According to the Commissioner, this will help in tapping tax revenue from the buildings across the city.

The system will enable accurate assessment of tax and also improve services to the public.

An identity number will be provided to all buildings and this will replace the current property tax and water charges assessment numbers.

Using the new number, the Corporation can know the type of building, how many floors it has, who the owner is and the amount of property/water tax being paid.

After the physical verification across the 105 sq.km. city, the GIS centre with an up-to-date database will be ready around October.

The database will be updated as and when new assets (buildings or other infrastructure) are created and latest satellite images received.

Once the centre opens, TCS will maintain it for three months and train the Corporation staff in running it.

Based on the pilot project's success, the system will be expanded across the State.

URL: http://www.thehindu.com/2009/01/18/stories/2009011859220300.htm **Date:18/01/2009**

2) GIS mapping of parks soon

Special Correspondent *Six more nurseries to be added to existing 16GHMC develops over 353 parks; 321 are colony parks* HYDERABAD: The Greater Hyderabad Municipal Corporation has taken up GIS mapping of all parks and open places under its jurisdiction. The urban forestry wing has been directed to coordinate with HMDA, Ministry of Forests, interested public sector and other private institutions to further green the city. Commissioner S.P. Singh, who held a meeting with officials here on Friday, called for speeding up civic works of 85 colony parks which are under various stages of development. Six more nurseries are to be set up in addition to the existing 16 to meet the annual requirement of avenue plantation and flowering plants. The Municipal Corporation's requirement is about 10 lakh plants per year. The Commissioner was informed that as many as 2,209 open places have been identified in the twin cities and compound walls were constructed at many of these sites to prevent encroachment in the last couple of years. Nearly 1,700 acres of land thus stands 'protected' and it was being proposed to develop playfields and parks in these open places. Additional Commissioner (Parks) M. Rajeswara Rao said, the GHMC has so far developed over 353 parks, out of which 321 are colony parks, 13 are city level and seven theme parks. About 173 colony parks are being maintained by Residential Colony Welfare Associations with cooperation of the Urban Forestry Department. Senior officials from different wings participated.© Copyright 2000 - 2009 The Hindu

URL: http://www.thehindu.com/2009/08/08/stories/2009080859660200.htm **Date:08/08/2009**

3) Municipal council to use GIS to increase revenue

By Our Staff Correspondent

HASSAN, MARCH 24. Hassan City Municipal Council has taken up a pilot project to apply the Geographical Information System (GIS) in a ward to improve infrastructure and assess its benefits. It will manage assets using this technology and increase revenue by rationalising property tax. This in turn will help augment the targeted expenditure on various schemes.

Customised

The ORG GIS Division of Sarabhai Electronics Ltd. was given the job of customising Ward Number 9 in Hassan on a turnkey basis at a cost of Rs. 95,000. The project was completed in February 2002 and the application of the information system indicated that more than 2,36,000 sqft. of land was not included in the municipal records. It also found that 50 per cent of the land in the city is being encroached upon. Of the 9 lakh sqft of built up area identified, 80 per cent is liable for taxation.

According to the president of the council, G.T. Kumar, defaulters can be identified and revenue can be generated by regularising these encroachments. On an average, each ward will ensure additional revenue of Rs. 7 lakhs in the form of property tax after installation of the system.

G. Paramesh, former Commissioner of the council, who took initiative for introducing the information system, says that the pilot project has been found effective in enforcing tax compliance. The system is now one of the components of the Nirmal Nagara Yojane.

Sustainable

Urban local bodies have a greater role to play in the post-liberal economy. They take care of maintaining records for tax collection, property assessment and reassessment, property tax zone maps, solid waste management system and public grievance redressal for utilities. Managing these services is not easy owing to inaccurate data collection by the officials.

While there is no scientific system to assess the information procured by revenue officials, transparency and accountability are still important in urban management. The practice is sustainable as it represents a paradigm shift in Government procedures.

URL: http://www.thehindu.com/2005/03/25/stories/2005032511050300.htm **Date:25/03/2005**

4) Coimbatore Corpn. working on GIS project

Special Correspondent *Discussion held with representatives of Tata Consultancy Services* — Photo: M. Periasamy ***TECH TALK:*** **A representative of Tata Consultancy Services explains the functioning of the geographic information system at a meeting at the Coimbatore Corporation on Monday.** COIMBATORE: The Coimbatore Corporation is working on a project to have a geographic information system (GIS) through which it can have satellite mapping of all infrastructure, buildings on its territory and keep track of its services to the people.GIS is a system that helps capture images or collect data and also store and analyse them. It helps in urban planning, asset management and scientific investigation. The system can display all geographically referenced information on every asset of the Corporation.Requirements The Corporation discussed here on Monday with representatives of Tata Consultancy Services (TCS), the software and other requirements for establishing the GIS in the civic body. Corporation officials said this was part of the Rs. 2.87-crore proposal of the Tamil Nadu Urban Development Project. The amount was being paid to TCS to provide the software for the GIS in Coimbatore, Madurai and Tiruchi Corporations and Gobichettipalayam and Rajapalayam Municipalities.Study The company will have to complete the study in one-and-a-half years and also take up maintenance of the system for three years after it is installed. The Corporation will also train all its staff members on the system.The Commissioner of Municipal Administration has given TCS the task of conducting a study on the requirements of these local bodies.According to the Corporation, the GIS can provide satellite images of the city. The developed area of the city, buildings, roads, parks, street lights, drainage playgrounds, solid waste management system and the position of water lines will be captured in images and stored. Information on city These will also be put up on the Corporation's website to enable the office of the Commissioner of Municipal Administration, other Government offices, the offices of the Corporation and the public to obtain information on the city. People can get to know of the location of their property, details of taxation and the services offered to them by the Corporation.Specific information on hospitals, educational institutions, Government offices, bus stands and other traffic and transportation related information can be obtained from the data stored by this system.Monitoring The system will also enable close monitoring of the condition of the Corporation's services to the people. It can help in locating the exact spot where people face problems such as disruption in water supply, non-functioning of street lights and blocks in drainage.A press release from the Corporation said after the meeting that all these aspects would help in improving the services of the civic body.

URL:http://www.thehindu.com/2008/02/12/stories/2008021253900300.htm Date:12/02/2008

5) GIS system helps Chennai Corpn earn Rs 70 cr more

Correct assessment of commercial property tax.

Mr Rajesh Lakhoni

M Ramesh

S Bridget Leena

Chennai, March 8 Backed by technology, the Corporation of Chennai has earned Rs 70 crore more this financial year only through correct assessment of commercial property tax.

A GIS-based application has helped the Corporation of Chennai ensure that commercial establishments in its jurisdiction state the extent of their property correctly for the purpose of paying property tax.

"It helped us control under-assessment," says Mr Rajesh Lakhoni, Corporation's Commissioner. In 2007-08, it collected Rs 230 crore from property tax levies; in the current year, it expects to secure at least Rs 300 crore.

He said that the corporation has got an agency to map 40 sq km of Chennai city. It expects to get the other 140 sq km done by June, after which it would have a high-resolution digital map of the city, "upon which we plan to run several exiting applications."

These maps are made by film-shoots from low flying aircraft. Hence they are much better in resolution than, say, Google Earth.

Once the project is over, many initiatives are possible, Mr Lakhoni said. For example, prepaid car services can calculate the exact distance between two locations and charge the customer accordingly.

The corporation has also seen windfall revenues from another stream: advertisements from the new bus shelters. The corporation has been pulling down existing shelters and building new, flashy ones, with considerable space for advertisements. In the current year, the corporation is sure of getting Rs 30 crore from advertisers.

Unfortunately, the corporation could not similarly replicate this model on its proposed foot-over-bridge plan. Earlier, the plan was to put up a series of foot-over-bridges across main roads with escalators, so that pedestrians could cross over easily.

URL:http://www.thehindubusinessline.com/2009/03/09/stories/2009030950891300.htm

Date:09/03/2009

6) GIS for mapping stormwater drains

Kannal Achuthan

Chennai: Stormwater drains in two zones of the Chennai Corporation have been digitally mapped using the geographic information system (GIS).

Just a few clicks on the digitised map will help officials find data on stormwater drains, which need to be managed well to reduce floods and improve public health in the area. The GIS mapping of stormwater drains in 18 wards in the Basin Bridge and Pulianthope zones was taken up as a project by Loyola College, the University of Madras and the Corporation.

Using sketch maps, the project team physically verified the route of the stormwater drains, their outlets into a waterway and the missing links in the network. This was done using the global positioning system. Project's chief investigator S. Vincent, reader from the Department of Zoology in Loyola College and Tamil Nadu State Council for Science and Technology member secretary, said, "Mosquitoes spend their larval and pupal states in water. They can breed in stormwater drains. The digital database can be used to indicate vulnerable zones for various mosquito-borne diseases." Data from the Health Department on the number of cases of vector-borne diseases have been incorporated into the digital map to find disease incidence trends.

URL: http://www.thehindu.com/2008/03/11/stories/2008031156270100.htm **Date:11/03/2008**

7) Pilot project to assess houses, major roads in Velachery

By Karthik Subramanian

CHENNAI July 22. The Chennai Corporation has approached the Institute of Remote Sensing, Anna University, to carry out a pilot project in Velachery (division 153) to assess the number of houses, roof top area and length-width of major roads through geographic information system (GIS).

The civic agency has held preliminary discussions with the institute and the project is expected to start soon. It would be completed within three months.

The project would entail collection of satellite imagery from Hyderabad-based National Remote Sensing Agency. "The satellite images of 1 m metre resolution from IKONOS satellite would offer in-depth analysis for the project," said director of Institute of Remote Sensing, K.Venugopal.

The IKONOS data would be digitally processed to analyse the number of houses and estimate the roof top area. This data would then be integrated with the already available data of the Corporation. Several insights such as unassessed property and encroachments could be identified from this.

Velachery has been chosen for the pilot project with a purpose. "Since it falls into the extended city area, the possibility of determining unassessed properties is greater," points out City Engineer, A.R.Ramakrishnan.

Over the last couple of months, three private firms have given demonstration of the GIS technology to higher officials of the Corporation. The idea was mooted by the Standing Committee for Town Planning, headed by TMC leader, P.Vetrivel. Officials too have shown an enthusiasm to implement GIS, which could become pivotal in making the civic administration's functions transparent. "We can use the technology to assess the functioning of all the local units. For example, we can know which are the wards where there are larger number of unassessed property. Then we can hold those officials accountable," said the Commissioner, M.Kalaivanan.

As per the Corporation records, there are just over 4.6 lakh assessed property in the city. For long, several councillors have argued that this is a grossly under rated figure. "Every year, more than 7,000 building plans come up for sanctioning at the Corporation. Add to this, the plans approved by the CMDA. These only point at an under valuation of property," an official said.

Mr.Kalaivanan too admitted the importance of assessing property. During a review meeting of Revenue Department held on Tuesday, the Commissioner warned all the officials of strict action if they were found "deliberately avoiding assessment". "If the GIS is extended for the entire city incorporating the assessed property, it would yield enormous revenue," he added.

Apart from property tax, the technology can also be used to keep a close watch of the mushrooming of hoardings and even the cable TV network.

Currently, the civic agency is yet to process the application of 3,609 hoardings in city. The advertisement tax received by the Corporation was to the tune of Rs 62 lakh in 2000-2001. Similarly, the revenue generated through Cable TV tax was just Rs 25 lakh last year.

URL:http://www.thehindu.com/2002/07/23/stories/2002072307420300.htm **Date:23/07/2002**

8) Chennai has 1:1000 scale digital map

Chennai : The Geo Spatial Data wing of the Survey Of India (SOI) has completed digital mapping of the city to the minute details. The digital map, in a scale of 1: 1000, would form the foundation of GIS-enabled services to help government agencies plan and execute civic and development work better.

Based on aerial images provided by the National Remote Sensing Centre (NRSC), Hyderabad, which excluded defence-controlled areas, SOI has digitised the city map covering 172 sq km. This does not, however, include the suburbs. "Digital maps covering 47.25 sq km has been handed over to the Chennai Corporation through the National Informatics Centre (NIC), Chennai, for additional attributes," informed an SoI senior official.

The utility mapping project, a brainchild of the Union Planning Commission, was conceived to create large-scale digital maps of service networks using GIS.

About 50 technical staff drawn from different states like Rajasthan and Andhra Pradesh have been working out of the SoI's Chennai office for the last one year to prepare field attributes such as street names, landmark buildings, parks, playgrounds and road junctions based on the digitised map of the city. "It will be completed by this month and the end product will be submitted to NIC by June," an official said.

"GIS will bring down wastages in all our services drastically, while maintenance of roads will improve extensively," corporation commissioner Rajesh Lakhoni said. As the first step, the local body has identified a contractor to physically survey the field attributes for five sq km in Broadway for which digitised maps are available. Another tender has been floated for another 20 sq km in Pulianthoppe and Ayanavaram for physical verification of properties.

http://timesofindia.indiatimes.com/Chennai/Now-Your-City-has-a-digital-map/articleshow/4262386.cms

16 March 2009

9) TNEB to pinpoint power failures with GIS

, 0443 HRS IST, Vivek Narayanan, TNN

CHENNAI: Tamil Nadu Electricity Board (TNEB) has started work on implementing a Geographic Information System (GIS) that will detect power failure quickly. More than 100 sq km in the city will be covered and the work is expected to be completed in two years.

Once the system is in place, TNEB staff will not only be able to tell customers why there has been an outage but also pinpoint the faulty junction box. This is part of the computer-aided utility mapping project carried out by the planning commission.

In Tamil Nadu, a total of 1,140 sq km are to be covered, but initially the work will start for 180 sq km. GIS is a database system, which analyses and displays digitised maps and tables through a software tool. Maps developed for Chennai using GIS applications will be on a 1:1000 scale and would pinpoint the location of utility lines or structures.

“We are doing this project in co-ordination with Chennai Corporation. If someone calls the TNEB call centre regarding a power cut, the caller’s location will be identified on the map. Staff will know why there has been a fault and will be guided to the exact spot,” said a TNEB official.

A TNEB engineer, on condition of anonymity, said that upon receiving a complaint, line men visit the complainant’s area and check whether the fault is in the transformer, junction box or the line. Only after this do they start work. “If the location of the fault is identified through the GIS, we can rectify the problem and restore power sooner,” he said.

He said that as GIS would also map underground cables, chances of them getting cut while digging will also reduce. “As of now, TNEB has state-of-the-art, computerised Supervisory Control And Data Acquisition (SCADA) facilities to monitor and control 95 substations of 110/33-11 KV in Chennai area to achieve system reliability for the city distribution network. With GIS in place, the efficiency of the board will improve,” said the engineer.

http://timesofindia.indiatimes.com/Chennai/TNEB_to_pinpoint_power_failures_with_GIS/articleshow/4083868.cms

6 Feb 2009

10) Detailed City Map for Ranchi, Jharkhand

India - Soon Ranchi Municipal Corporation will have all the information it can possibly need about the capital thanks to a detailed map of the city including all buildings, houses, roads, bylanes and even drains, that has been prepared by the Jharkhand Space Application Centre (JSAC).

The RMC believes the comprehensive database of images and maps of all 55 wards, prepared by using satellite mapping technology, will help it provide better services to the citizens. It would also help it make property tax collections more efficient.

When civic officials access the system a month from now, not only will they know a building’s exact geographical location — latitude and longitude included — they will also have information on its mode of use — whether residential or commercial — number of floors.

“This will make our task of ensuring civic amenities easier and more efficient,” said R.S. Jaipuriyar, the new RMC chief executive officer. He said that he planned to operationalise the system from September.

The JSAC took over two years to complete the satellite mapping of the city. The maps, in digital form, would be handed over to the RMC in a day or two, though hard copies were already with the RMC.

“There are a couple of issues in the software design which need to be sorted out before we can operationalise the system,” Jaipuriyar said.

As per plan, each building would be attached with a holding number allotted by the RMC. Once this is complete, a click on the image of the building would display every detail, including the number of storeys, its manner of use — whether residential or commercial — owner’s name and tax dues, if any. Once ready, Ranchi will be the second city after Pune to have a comprehensive satellite map that facilitates delivery of civic amenities. “Presently, only one ward of Pune has been mapped with space technology,” claimed Ravish Kumar, a junior scientist at JSAC whose team worked with the RMC on this project.

Kumar said the JSAC first took high-resolution satellite images of the city called, “quick bird”. As many as 15 men made extensive field surveys to record each building, street, river and road for three months. “We then attached the information collected from the field survey to the buildings, roads and streets, thereby readying the map for use,” he added.

www.gisdevelopment.net

http://www.pryroda.gov.ua/en/index.php?newsid=5001169

11) GIS must be integrated with national e-governance’

Phalguna Jandhyala

Hyderabad, Feb. 11 The Union Government has been urged to look at integrating geographic information system (GIS) with the national e-governance programme.

“E-governance to me means embedding geospatial information, maps of different types showing resource usage, where the education and health facilities are located and so on. All these are GIS applications,” Ms Preetha Pulusani, Director, Rolta India, told *Business Line* on the sidelines of the Map World Forum here on Wednesday.

She added that the Government should look at making GIS applications more pervasive.Ms Pulusani said that budgetary allocation for GIS must be increased like it has been done for the information technology sector.

“GIS has always been taken as a very special and niche area. GIS has hardly been looked at by the Government from a strategic and long-term perspective, rather it was looked at as project based rather than enterprise wise,” she said.

Welcoming the move to set up an independent regulator for the sector, Ms Pulusani said such a body must be inclusive and have representatives from the private sector and the academia and not just with Government focus.

“As the Map Policy frees up digital map information, we will be able to deploy more applications in this area. The industry should look at the developed countries where such applications have been deployed to replicate here,” she said.

Earlier, speaking at a session on Geospatial Technology – Development and Trends, Mr Mark Steele, Chief Operating Officer, Tele Atlas Asia Pacific, said, “Navigational devices are no longer a novelty. Soon navigation devices will be ubiquitous just like the mobile phones.”

He also said that the future of digital maps will have higher levels of accuracy but for this collection is the key.

“The new applications and digital maps of the future will have more personal information and this will be the next wave that we will ride,” Mr Steele added.

12) Chennai’s Metrowater to use GIS for fault-rectification

CHENNAI, India: Officials of the Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB) or Metrowater will soon use GIS to identify the location and details of pipelines and other utilities. This, they say, will speed up the process of fault-rectification.

The Planning Commission recently introduced the concept of electronically mapping Chennai to help identify the utilities of various government bodies. The CMWSSB is included in the project which will be coordinated by the Chennai Corporation. The latter will have the main server.

Though the Planning Commission has just announced the project, the CMWSSB had carried out its pilot project three years ago. “It included 10 depots in and around Anna Nagar. We first obtained the satellite maps and then digitized them in GIS format. Details about all our utilities, including pipelines and its depth, the number of connections, the route of the pipes, etc. were fed in and could be accessed by merely placing the cursor on the desired location.” said a senior Metrowater official.

Source : http://timesofindia.indiatimes.com

http://www.gisdevelopment.net/news/viewn.asp?id=GIS:N_smtzxjbano **16 FEBRUARY 2009**

13) GPS technology to monitor Corporation vehicles

Published by Chennai 365 on May 24, 2007in News and Technology

Officials of the Chennai Corporation will soon be able to keep an eye on the movement of garbage trucks in the city without having to move from their seats in the Ripon Building, the civic body’s headquarters.

The Corporation plans to use the global positioning system (GPS) technology to monitor if garbage trucks, fogging machines, ladder-mounted streetlight repair vehicles and parks’ watering tankers are taking the prescribed route and stopping for work at the designated points.

“At present, we only have a system to record the march-out time of our trucks. The monitoring will help us know where exactly the trucks went,” says Chennai Corporation Commissioner Rajesh Lakhoni. The new technology can also deduce which routes are more fuel-efficient.

Manual detection

One of the benefits the tracking offers is better fuel management. Fuel pilferage from the Chennai Corporation’s vehicles has put a strain on the civic agency’s resources and manual detection of fuel theft has proved difficult.

The GPS device is concealed in the vehicle to be tracked. The monitoring desk records its movement through satellite technology. The GPS information can be fed into a Global Information System, which is used to interpret the data. This process can be done only if Chennai’s geographic information is converted into a digital form that the computer can recognise. Digital mapping of the city is now on.

Pilot project

The Chennai Corporation will begin with a pilot project to track a few vehicles. The service will be expanded once the system is in place, says an official. Bids have been invited from GIS/GPS solution providers.

The Tamil Nadu Electricity Board and the Chennai Police recently started GPS monitoring pilot projects for fault-repair vehicles and patrol jeep

14) GPS, GIS to be tried out in Chennai-Madurai buses

Special Correspondent

They will help to increase productivity, cut costs

- The systems are used worldwide for optimum utilisation of fleets
- *Centre has sanctioned Rs. 3 crore for introducing technology*

Chennai : The Global Positioning System and the Geographical Information System (GIS) will be introduced, on a trial basis, in the Chennai - Madurai bus services and in the Metropolitan Transport Corporation service between Avadi and Tambaram to collect real-time traffic data.

Depending on their success, they will be introduced in other services, Transport Secretary Debendranath Sarangi said, inaugurating a workshop on “Vehicle tracking using GPS and GIS” here on Tuesday.

Mr. Sarangi said, the systems were being used worldwide for optimum utilisation of fleets, operational efficiency and monitoring and punctual service through improved and accurate information on position. The technology would help to increase productivity, cut operational costs, improve customer service and enhance security for both crew and vehicles.

The Centre had sanctioned Rs. 3 crore to the State for introducing the technology in State Transport Corporation buses. Based on the report of the committee set up by the State, the Government would take a decision.

R. Sivanandan, of the Indian Institute of Technology-Madras, said the vehicle detection technologies, coupled with information and communication technologies, would help to collect real-time traffic data. The technologies were good in that they required minimal manpower.

Talking to journalists later, Mr. Sarangi said the Government was planning to introduce an inter-modal system linking the Metro Transport Corporation, the Mass Rapid Transit System and the proposed Metro Rail System. Single ticket could be used for all these services.

http://www.hindu.com/2007/03/07/stories/2007030705500500.htm

Tamil Nadu Institute of Urban Studies

203, Alagesan Road, Saibaba Colony, Coimbatore - 641 011.
Phone : 91 422 2441086, Fax : 91 422 2457404
email : information@tnius.org, website : www.tnius.org, www.news.tnius.org