TOPOMAP PROCESSING:
UNIVERSITY OF HYDERABAD AS A CASE STUDY

A Dissertation submitted to the University of Hyderabad in partial fulfillment of the degree of

MASTER OF TECHNOLOGY

in

ARTIFICIAL INTELLIGENCE

by

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CERTIFICATE

This is to certify that the dissertation entitled "**TOPOMAP PROCESSING – UNIVERSITY OF HYDERABAD AS A CASE STUDY**" submitted by **A ABHINAV REDDY** bearing Reg. No **09MCMI01** in partial fulfillment of the requirements for the award of **Master of Technology** in **ARTIFICIAL INTELLIGENCE** is a bonafide work carried out by him under my supervision and guidance.

The dissertation has not been submitted previously in part or in full to this or any other University or Institution for the award of any degree or diploma.

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DECLARATION

I **A ABHINAV REDDY** hereby declare that this dissertation entitled "**TOPOMAP PROCESSING – UNIVERSITY OF HYDERABAD AS A CASE STUDY**" submitted by me under the guidance and supervision of **Prof. ARUN AGARWAL** is a bonafide work. I also declare that it has not been submitted previously in part or in full to this University or other University or Institution for the award of any degree or diploma.

Date: **A ABHINAV REDDY**

09MCMI01

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A ABHINAV REDDY

ABSTRACT

The project deals with digitization of a topomap of University of Hyderabad's spatial information. Earlier work has divided this information into various thematic layers like building, grounds, water streams, lakes, rocks, roads, power lines etc. The project also deals about processing the contour layer consisting of Bezier curve that fits the contour lines extracted from the topomap.

By using the layers created we are developing a GIS system that would be capable of processing some of spatial queries like:

1. Generate 3-D view of the University of Hyderabad terrain.
2. Establish Correspondence between Google map (buildings) and the terrain model
3. Original Stream paths/lakes and its obstruction by the current buildings/ constructions
4. Possible areas for future construction maintaining natural streams and lakes
5. Original area/boundary length as per the land map of UOH and changes that have occurred.
6. Route map planner for existing Optical Fiber and Electrical cable and also for future laying.
7. Probable sites for placing submersible pumps based on ground water table data, etc.

To accomplish this we used GIS tools like ArcMap, Arc Scene, ArcGIS Server, etc.

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CHAPTER 1

INTRODUCTION

People have always been fascinated with investigating their home- the Earth. To understand our planet, ancient scholars in Rome, Greece, and China founded the study of geography over 2,500 years ago. Today, geography is more relevant as issues of climate change, urban sprawl, biodiversity loss, water quality and quantity, tourism, crime, and natural hazards grow in importance on a global scale but also increasingly affect our everyday lives.

A geographical information system (GIS) is a system for capturing, storing, analyzing and managing data and associated attributes, which are spatially referenced to the earth. In the strictest sense, it is a computer system capable of integrating; storing, editing, analyzing, sharing and displaying geographically referenced information. In a more generic sense, GIS is a tool that allows users to create interactive queries, analyze the spatial information, edit data, maps, and present the results of all these operations.

In this project we are studying the geography of University of Hyderabad and processing the data using the GIS based system. This GIS based system is used as an information system through which we get the information relating to the University and different functionalities of the departments and other agencies. This system will process the user queries and displays the results in the map.

1.1 Topographic map

A map is a representation of the Earth, or part of it. The distinctive characteristic of a topographic map is that the shape of the Earth's surface is shown by contour lines. Contours are imaginary lines that join points of equal elevation on the surface of the land above or below a reference surface, such as mean sea level. Contours make it possible to measure the height of mountains, depths of the ocean bottom, and steepness of slopes.

A topographic map shows more than contours. The map includes symbols that represent such features as streets, buildings, streams, and vegetation. These symbols are constantly refined to better relate to the features they represent, improve the appearance or readability of the map, or reduce production cost.

Consequently, within the same series, maps may have slightly different symbols for the same feature. Examples of symbols that have changed include built-up areas, roads, intermittent drainage, and some lettering styles. On one type of large-scale topographic map, called provisional, some symbols and lettering are hand drawn.

A topographic map is a type of map characterized by large-scale detail and quantitative representation of relief, usually using contour lines in modern mapping, but historically using a variety of methods. A topographic map shows both natural and man-made features. A contour line is a combination of two line segments that connect but do not intersect; these represent elevation on a topographic map. A sample topographic map is shown in figure 1.1.

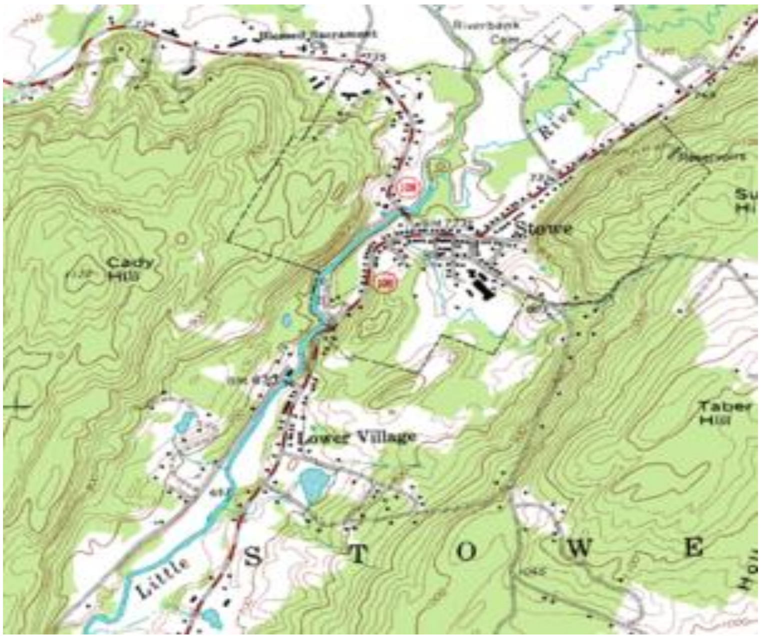


Fig1.1: A topographic map with contour lines

A topographic map is a detailed and accurate graphic representation of cultural and natural features on the ground. These maps are widely used in large-scale architecture, earth sciences, mining, hiking and other geographic disciplines.

Topographic maps are also commonly called contour maps or topo maps.

1.2 Need of Topomap Processing

A topomap (topographic map) represents many features such as buildings, lakes, roads and forests using different colors, signs and symbols. As a topomap contains different features, in order to digitize the map we need to extract the data of each layer. We need to create the layer for each kind of data. Thus created layers are used in digitization of the map.

A GIS enabled system for topomap will have different kinds of layers; those layers are created using the topomap processing.

To develop a GIS enabled system that can able to answer the user questions, we need the data from maps and database files that contains the geographic data required to answer the question. To develop such kind of a system which can able to solve GIS related queries we need the topomap processing.

Each country has different standards topographic maps. In India Survey of India (SoI) is authorized to provide base maps for expeditious and integrated development. In USA, United States Geological Survey (USGS) is a science organization that provides impartial information on the health of our ecosystems and environment.

1.3 Earlier Work

Gupta et al [1] in their work used the topomap of University of Hyderabad and created different layers such as boundary, area, buildings, gardens, grounds, roads, lakes, water streams and rocks. And using the contour layer they created a 3D model, they published it using the ArcIMS server.

Yuan Lifeng from Ninjang University developed a GIS based system using the ArcIMS architecture [2]. Contour layer extraction from the topomap is a complex task, different methods have been proposed by different researchers. The algorithms used for contour line extraction and reconstruction are Rubber band technique [5], c-mean algorithm and clustering [6].

Many organizations have developed GIS enabled systems for the easy access of geographical information. Environmental Information Centre (EIC) has been set-up to work as a repository of Environmental Information. GIS (Geographical Information System) is thus, the most apt and powerful tool to help one combine all this information and give a holistic understanding of the site and area of study at large. In addition GIS gives you the flexibility to combine layers of information depending specifically to your purpose—analyzing environmental damage, finding the best location for a new store, viewing similar crimes in a city to detect a pattern among others.

1.4 Description of present work

Developing a GIS enabled information system that can able to process the user queries regarding the University geographical information. The system has to be developed from the topomap and by creating layers such as roads, buildings, grounds, lakes, water streams, parking places, overhead tanks, electric lines, network lines etc.

These layers are joined or related with other layers so that a common task can be attained. A contour layer is extracted from the topomap using the algorithms proposed by Sandhya [4]. This contour layer contains the elevation information of the University of Hyderabad. Using these layers we can answer the user queries such as spatial queries, parameter queries and action queries.

The different spatial queries include creation 3-Dimensional terrain model, finding area, length of different fields of university, finding the optimal location for future construction, route planner for network lines etc.

Using the GIS system we can process many such kinds of queries and for that we require the related database files containing the relevant information.

Finally we need to publish the system as a portal service so that the system can be widely used by many kinds of users. We publish the maps using the ArcGIS Server and GEON portal services.

1.5 Organization of dissertation

For the easy understanding of the work, we divided it into 6 chapters.

In the Chapter 1 we start with introduction of the topomaps and need and requirement for processing the topomaps. Then we discuss about the earlier work, and description of present work.

In Chapter 2 we deal with different standards present for topomaps and differences between open source and proprietary software, and we end up with a brief introduction to the ArcGIS tool.

In Chapter 3 we start with digitization of the university map by creating different layers and extracting contour layers. We Use ArcGIS tool for creating the layers.

In chapter 4 spatial queries are discussed along with their algorithms and how they are to be answered.

In chapter 5 we publish the maps using ArcGIS server and Geon Portal software. We write a client program and publish by creating a portlet.

In chapter6 we will give conclusion and discuss about the future enhancements that are possible and discuss some results.

CHAPTER 2

DEVELOPMENT TOOLS FOR GIS – A STUDY

To develop a GIS enabled system we need to understand the development tools required for GIS. Many vendors provide different kinds of GIS software and tools, many tools are open domain and some are proprietary software. A lot of study is required to select the optimum tool for our requirement. Here we discuss about GIS and the tools and standards to be fallowed and introduction to ArcGIS tool.

2.1 Introduction

A Geographical Information System is a system for capturing, storing, analyzing and managing data and associated attributes which are spatially referenced to the earth. In the strictest sense, it is a computer system capable of integrating, storing, editing, analyzing, sharing, and displaying geographically – referenced information. In a more generic sense, GIS is a tool that allows users to create interactive queries (User created searches), analyze the spatial information, edit data, maps, and present the results of all these operations.

GIS is more than the integration of computer hardware and software. It is the acquisition, management, analysis, and display of data that have geographic locations as an important characteristic. Data that has a spatial character is usually displayed in the form of maps. For Example, the level of nitrates found in a water sample by itself does not have geographic character. However, the location of the site where the water sample was obtained is important when viewed geographically relative to other features around the sampling site, such as proximity to potable water sources.

A GIS is also designed to recognize that there is more than one feature or activity that occupies the same geographic space. For example, a soil type may occupy some of the same area as that of a plant community. Both occupy similar space and, subsequently can be delineated and mapped as two distinct spatial distributions. The ability to analyze coincidental and proximal (nearness) relations of features that occupy the same or nearly the same geographic space is what makes a GIS unique from conventional business relational database systems.

Not only the location but also the manner in which location relates to a specific position on the surface of earth is also important. There are several earth based coordinate systems used to define geographic location, such as latitude/longitude, Universal Transverse Mercator (UTM), and state plane. Arbitrary X,Y coordinates are often used in computer aided Drafting (CAD) systems to draw graphic features such as floor plans and electrical circuits.

A GIS usually has the capabilities of computer mapping but it is also designed to undertake some degree of exploratory analysis of spatial data. A GIS requires the user to clearly indentify the steps of the spatial data analysis. The result can be a means either to evaluate the effectiveness if a spatial data analysis model or to investigate the spatial relationship among variables found at user defined locations.

The basic terms used in any GIS system are:

a) Latitude/ Longitude:

Spherical reference system used to measure locations on Earth's surface, latitude is measured from the equator, with positive values going north and negative values south; longitude is measured from the prime meridian (Greenwich, England) with positive values going east and negative values west.

b) Datum:

A datum is a set of reference points on the earth's surface against which position measurements are made, and an associated model of the shape of the earth to define a geographic coordinate system. Horizontal datums are used for describing a point on the earth's surface, in latitude and longitude or another coordinate system. Vertical datums measure elevations or depths. In engineering and drafting, a datum is a reference point, surface, or axis on an object against which measurements are made.

A reference datum is a known and constant surface that is used to describe the location of unknown points on the earth. Since reference datums can have different radii and different center points, a specific point on the earth can have substantially different coordinates depending on the datum used to make the measurement. There are hundreds of locally developed references around the world, usually referenced to some convenient local reference point. Contemporary datums, based on increasingly accurate measurements of the shape of the earth, are intended to cover large areas. The most common reference datum in use is WGS84.

WGS84 (1984)

Equatorial radius	6,378,137 meters
Polar radius	6,356,752.3142 meters
Inverse flattening	298.257223563

c) Geographic coordinate system:

A Geographic coordinate system (GCS) uses a three-dimensional spherical surface to define the locations on the earth. A GCS is often incorrectly called a datum, but a datum is only one part of a GCS. A GCS includes an angular unit of measure, a prime meridian, and a datum (based on spheroid).

One of the most common coordinating systems in use is the Geographic Coordinate System, which used degree of latitude and longitude to describe a location on the earth's surface. Lines of latitude run parallel to the equator and divide the earth into 180 equal portions from north to south. The reference latitude is the equator and each hemisphere is divided into 90 equal portions, each representing one degree of latitude.

d) Projected coordinate system:

This reference system is used to locate x, y and z positions of point, line and area features in two or three dimensions. A projected coordinate system is defined by a geographic coordinate system, a map projection, any parameters needed by the map projection, and a linear unit of measure,

A measurement of locations on the earth's surface expressed in a two-dimensional system that locates features based on their distance from an origin(0,0) along two axes, a horizontal x-axis representing east-west and a vertical y-axis representing north-south. Projected coordinates are transformed from latitude and longitude to x, y coordinates using a map projection.

Using this we project maps of the earth's spherical surface as shown in Fig 2.1 (a) onto a two-dimensional Cartesian coordinate plane as shown in Fig 2.1 (b)

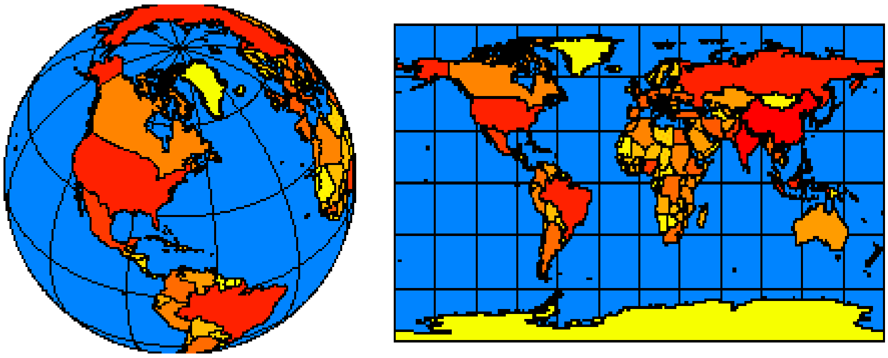


Fig 2.1 a) locations are expressed as latitude and longitude on the globe b) and as x, y coordinates on a map

2.2 GIS data

GIS as a tool helps locate available information spatially. All the information available on a particular area can be collated using this tool. Thus, information which would otherwise be fragmented can be viewed from a comprehensive shared database, enabling one department to benefit from the work of another. The GIS data collected once can be customized for varied purposes and used many times.

Environmental Information Centre (EIC) collects environmental data in India from various sources including government agencies such as Central Pollution Control Board (CPCB), National Remote Sensing Agency (NRSA), Department of Ocean Development (DOD) and other literature available with various government departments, universities and environmental professionals.

2.2.1 Standards

Like many areas of information technology, GIS is growing rapidly. Standards are crucial to share GIS spatial data accurately, and for GIS systems to be able to work together. Effective sharing of data and services, both within and across organizations, depend on accepter standards. Industry standard organizations such as the

International Organization for standardization (ISO) develop, discuss, and publish requirements and specifications for implementation by software vendors and system integrators.

The Open Geospatial Consortium, Inc. (OGC) is working on the development of geospatial interoperability standards that will facilitate access to and use of geographic information by a broad range of users.

Many survey organizations present in the world generated different kinds of maps. These maps can be used for GIS processing. A map should follow some standards. The United states Geological survey is the standard science organization that provides impartial information on health of our ecosystems and environment, the natural hazards that threaten us, the natural resources we rely on, the impacts of climate and land –use change, and the core science systems that help us provide timely, relevant, and useable information.

In India Survey of India is the standard organization for conducting survey and mapping. Survey of India bears a special responsibility to ensure that all resources contribute with their full measure to the progress, prosperity and security of our country now and for generations to come.

2.2.2 Open source s/w Vs Proprietary s/w

Recent years have seen an increasing interest in the open source movement as a new paradigm for software development. Open Source Software (OSS) have been hailed as a substitute for proprietary software and greeted with great fanfare in a variety of forums. Unlike the traditional proprietary paradigm of software development, users have free access to the source code in open source environment which can be modified to correct software bugs, port the software to new hardware platforms or simply use it for free. In a proprietary market, the closed source codes are providing needs of the users, industries, organizations such that programmers can use various methods built in the software, however, the working of these methods remain hidden.

The OSS in the field of GIS is growing rapidly. In general, this software follows the open GIS standards provided by Open Geospatial Consortium (OGC) and World Wide Web Consortium (W3C). The OGC is an independent organization for the development of standards for geospatial applications and services. The growing trend of the adoption of open source technologies for GIS is largely due to the fact that many successful OSS projects have proven to perform at acceptable and sometimes exceptional levels as compared to proprietary products

Public Domain Software is not subject to copyright and can be used for any purpose, and free software, licensed by the owner under more permissive terms.

The development of open source GIS software has - in terms of software history - a long tradition with the appearance of a first system in 1978. Numerous systems are nowadays available which cover all sectors of geospatial data handling. Some of the softwares are GRASSGIS, SAGAGIS, Quantum GIS, ILWIS, postGIS, Map point etc.

Proprietary *software* is computer software licensed under exclusive legal right of the copyright holder. The licensee is given the right to use the software under certain conditions, but restricted from other uses, such as modification, further distribution, or reverse engineering.

The notable commercial or proprietary GIS software are Autodesk, ERDAS EMAGINE, ESRI ArcGis, MapInfo, AGIS, Intergraph, ENVI etc.

2.2.3 Raster Data:

In a raster model, the world is represented as a surface that is divided into a regular grid of cells. The x, y coordinates of at least one corner of the raster are known, so they can be located in geographic space.

Raster models are useful for storing and analyzing data that is continuous across an area. Each cell contains a value that can represent membership in a class or category, a measurement, or an interpreted value.

Raster data include images and grids. Images, such as aerial photograph, a satellite image, or a scanned map, are often used for generating GIS data.

2.2.4 Vector Data:

Most work archaeologists do in GIS is based in vector data. This system of recording features is based on the interaction between arcs and nodes, represented by points, lines, and polygons. A point is a single node, a line is two nodes with an arc between them, and a polygon is a closed group of three or more arcs. With these three elements, it is possible to record most all necessary information.

ArcGIS uses three different implementations of the vector model to represent feature data: coverage, shape files, and geodatabase.

2.2.5 TIN data

In a triangulated irregular network model, the world is represented as a network or linked triangles drawn between irregularly spaced points with x, y and z values. TINs are an efficient way to store and analyze surfaces. Heterogeneous surfaces that vary sharply in some areas and less in others can be modeled more accurately, in a given volume of data, with a triangulated surface than with a raster. That is because many points can be placed where the surface is highly variable, and fewer points can be placed where the surface is less variable.

2.2.6 Tabular Data

We can think of a GIS as a database that understands geometry. As with other databases, ArcGIS lets us link tables of data together. Almost any table of data can be joined to an existing feature class or raster if they share an attribute.

Geolocating is another means of putting tabular data in a map. Perhaps the simplest example of geolocating is plotting points based on tables of geographic coordinates. For example, we can plot the locations of soil samples based on latitude-longitude values obtained from a global positioning system (GPS) receiver. We can also plot points by geolocating tables of addresses on an existing street network. This is often called address geocoding.

2.3 Exploring ArcGIS

ArcGIS is a suite consisting of a group of Geographic Information System (GIS) software products produced by ESRI (Environmental Systems Research Institute), sources estimate that about seventy percent of the current GIS users make use of ESRI products [13], and operate in desktop, server, and mobile platforms. ArcGIS also includes developer products and web services.

ArcGIS Desktop software products provide capability to author, analyze, map, manage, share, and publish geographic information. Basically ArcGIS Desktop has three licensing levels as ArcView, ArcEditor and ArcInfo. ArcView, lowest level of ArcGIS Desktop, give the opportunity to view and edit GIS data held in flat files, or view data stored in a database management system. ArcEditor allow more extensive data editing and manipulation, including server geodatabase editing and as highest level ArcInfo includes increased capability in the areas of spatial analysis, geo-processing, data management. GIS users can use applications like ArcMap, ArcCatalog and ArcToolbox exist within three levels of licensing.

To work with ArcGIS Desktop needs windows 2000, xp, vista, 7 operating systems with 1.6 GHz recommended or higher CPU speed, Intel Core Duo, Pentium 4 or Xeon Processors, 1 GB RAM, 1024 x 768 or higher screen resolution, 3.2 GB Disk space and 24-bit capable graphics accelerator. [14]

2.3.1 Exploring ArcMap

ArcMap is the central application in ArcGIS desktop for all map-based tasks, including cartography, map analysis, and editing. ArcMap is a comprehensive map authoring application for ArcGIS desktop. ArcMap offers two types of map views: a geographic data view and a page layout view. In geographic data view, you work with geographic layers to symbolize, analyze and compile GIS datasets. A table of contents interface helps us to organize and control the drawing properties of the GIS data layers in our data frame. In layout view, we work with map pages that contain geographic data views and other map elements, such as scale bars, legends, north arrows, and reference maps. ArcMap is used to compose maps onto pages for printing and publishing.

As shown in fig 2.2 the left of the arcMap display window is the table of contents, showing us which geographic layers are available to display. To the right is the map display area.

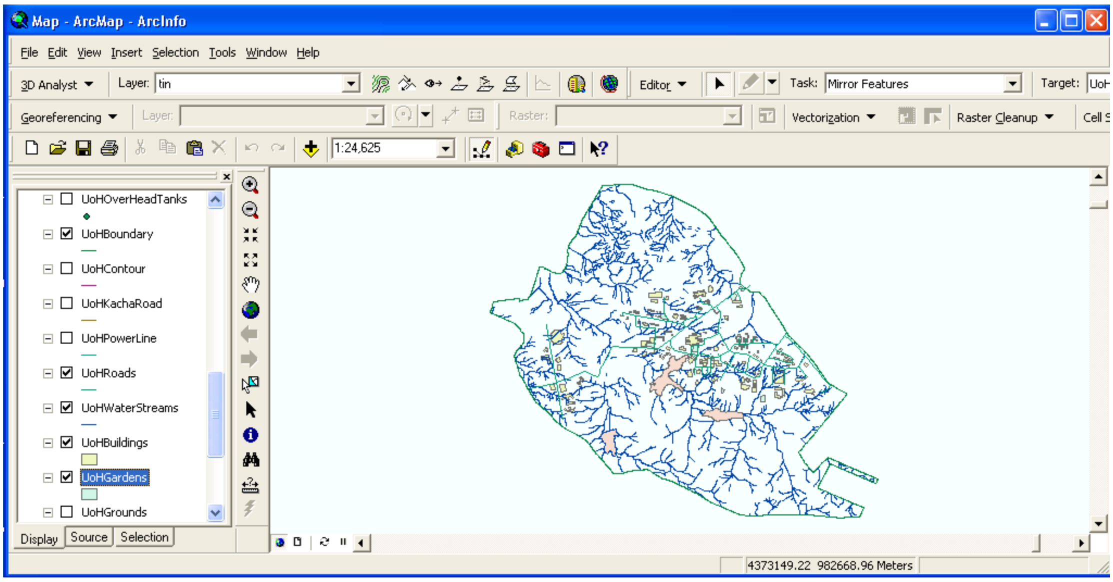


Fig 2.2: Exploring ArcMap

2.3.2 Exploring ArcCatalog

ArcCatalog helps us organize and manage all our GIS information (maps, globes, datasets, models, metadata, services and so on). It includes tools to:

1. Browse and find geographic information
2. Record, view and manage metadata
3. Define, export and import geodatabase schemas and designs
4. Search for and discover GIS data on local networks and the web.
5. Administer an ArcGIS server

We can use ArcCatalog to organize, find, and manage GIS data as well as to document our data holdings using standards based on metadata. A GIS database administrator can use ArcCatalog to administer a GIS server framework. ArcCatalog lets us explore and manage our data. After connecting to our data, use the catalog to explore our contents. When we find the data we want to use, we can add it to a map. Often, when we get data for a project, we can't use it right away; we may need to change its projection or format, modify its attributes, or link geographic features to attributes stored in another table. When the data is finally ready, we should document its contents and the changes we have made. Those data management tasks can all be accomplished using tools that are available in the catalog. The typical ArcCatalog window is shown in Fig 2.3.

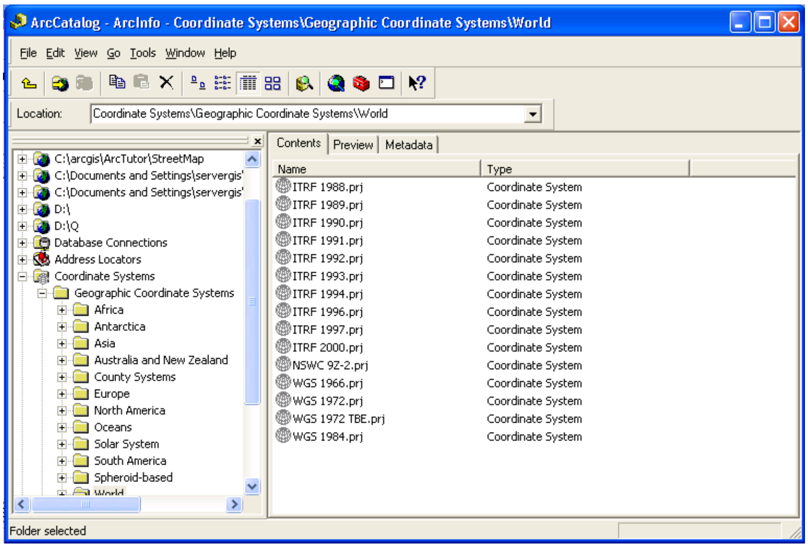


Fig 2.3: Exploring ArcCatalog

2.4 Extensions

Extension products let you add more capabilities to ArcGIS Desktop. These specialized tools allow us to perform extended tasks such as raster geoprocessing, three-dimensional analysis, and map publishing.

2.4.1 ArcScan

ArcScan for ArcGIS software has the tools we need to convert our scanned raster images into vector based GIS layers. This process can be performed interactively or in an automated fashion.

With ESRI for ArcGIS, we can

1. Perform automatic or interactive raster-to-vector data conversion with high precision
2. Create shapefile or geodatabase line and polygon features directly from raster images
3. Use raster-snapping capabilities to make interactive vectorization more accurate and efficient.
4. Prepare images for vectorization with simple raster editing.

a) Automatic Vectorization:

One of the key features of arcscan is its ability to automatically convert raster data into vector features. This process, known as automatic vectorization, can significantly reduce the time it takes to vectorize scanned images.

b) Interactive Vectorization:

Along with automatic vectorization, we can also generate features manually. This process is known as interactive vectorization and is similar to existing techniques used to create features with the editor tools. Interactive vectorization consists of two components.

1. Raster tracing
2. Raster snapping

2.4.2 3D Analyst

The ArcGIS 3Danalyst extension provides tools for three-dimensional visualization, analysis and surface generation. With this we can

1. View a surface from multiple viewpoints
2. Query a surface
3. Create realistic perspective imaging
4. Examine the visual impact of building new structures
5. Analyze atmospheric, surface, and subsurface pollution dispersion
6. Visualize the income distribution in their community

3D analyst also provides tools for three-dimensional modeling and analysis, such as view shed and line-of-sight analysis; spot height interpolation; profiling; steepest path determination; and contouring.

2.5 Discussion

In this chapter we discussed about the Geographical Information system, what it is and how it is useful, and the different standards for topographic maps and GIS software. Then we discussed about different kinds of software available for topomap processing. Then we give little introduction to the tool ArcGIS, that we are using. And we discussed how to start working with the ArcGIS tool and how to access them. And different extensions available in the tool are also discussed. ArcGIS is proprietary software and it is widely used by many organizations and universities. Its wide spread usage and easy to use GUI tools and the wide range of options make it a choice for GIS operations.

CHAPTER 3

DESIGN OF LAYERS

A Topomap includes symbols that represent features such as roads, buildings, vegetation, lakes, streams etc. we need to extract those features from the topomap for better utilization. Thus the layers are created for each feature separately, and each layer contains a data base file that will have the data related to that feature.

Previously Gupta et al [1] created some layers from the topomap of University of Hyderabad. Now we are using the layers created by them and updating those layers and creating some new layers.

Work Done Earlier:

3.1 Field Work:

To develop a GIS enabled system, first we need to process the topomap. For that we need a topographic map of University of Hyderabad. Centre for Earth and Space Sciences of University of Hyderabad did a survey in University and prepared a topomap of the university. We are using the map thus designed. The Topomap of university can be seen in Fig 3.1.

a) Preparing Soft copy of topomap:

To start the digitization we need to make a soft copy of the university map we have. We scan that map using a good resolution A0 scanner. Once the scanned image is ready we can load that into ArcGIS.

b) Measuring Control Points:

For proper Georeferencing we need to Georeference the map with control points. We Georeference the map with original longitude and latitude values using some control points. The details of those control points can be calculated using a GPS device and we can compare the values with the values taken from the Google Earth. Those control points include main gate, small gate, Gopanpally gate, shopping complex etc.

We store the longitude, latitude values and the Elevation values of these points in an Excel file as shown in Fig 3.2.

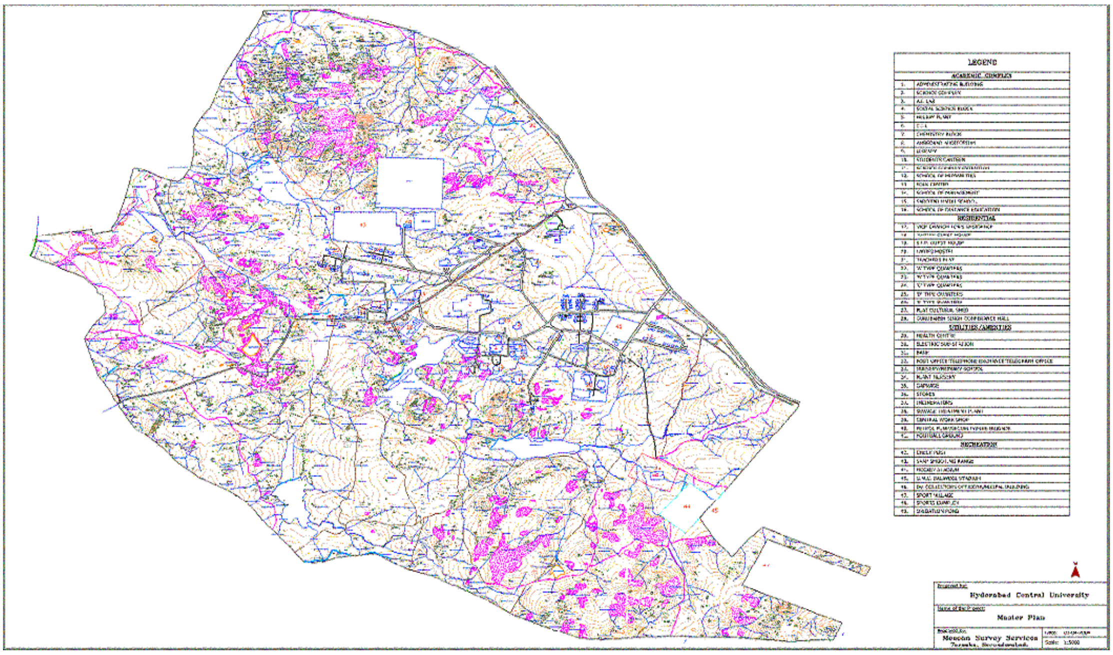


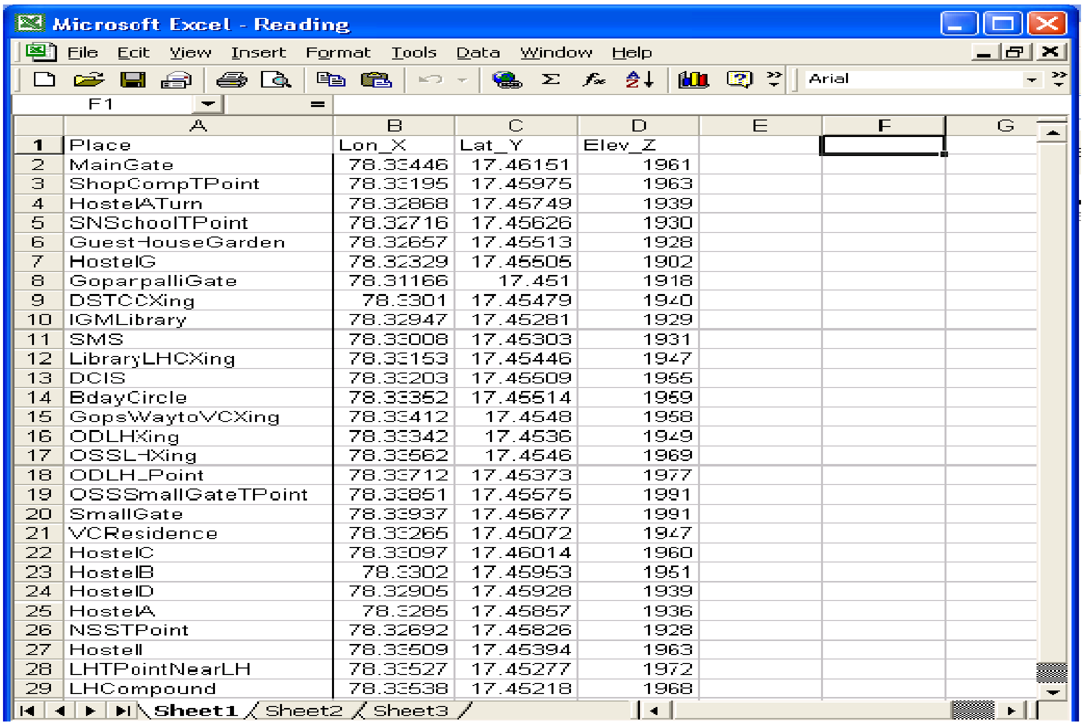
Fig 3.1: Scanned Image of University of Hyderabad

3.2 Preprocessing

The preprocessing is used for format conversion and making the data usable for the processing. A typical GIS data may have different formats; we need to convert them into an ArcGIS understandable format. Georeferencing of topomap with control points and selecting a proper Geographic coordinate system and datum

a) Make an excel sheet:

The collected (latitude/longitude) is stored into excel sheet. This Excel sheet includes four columns. First column is place, second column is latitude values in decimal degrees, third column is longitude values in decimal degrees and fourth column has elevation values as shown in fig 3.2.



	Place	Lon_X	Lat_Y	Elev_Z
2	MainGate	78.33446	17.46151	1961
3	ShopCompTPoint	78.33195	17.45975	1963
4	HostelATurn	78.32868	17.45749	1939
5	SNSchoolTPoint	78.32716	17.45626	1930
6	GuestHouseGarden	78.32657	17.45513	1928
7	HostelG	78.32329	17.45505	1902
8	GoparpalliGate	78.31166	17.451	1918
9	DSTCCXing	78.3301	17.45479	1940
10	IGMLibrary	78.32947	17.45281	1929
11	SMS	78.33008	17.45303	1931
12	LibraryLHCXing	78.33153	17.45446	1947
13	DCIS	78.33203	17.45509	1955
14	BdayCircle	78.33352	17.45514	1959
15	GopsWaytoVCXing	78.33412	17.4548	1958
16	ODLHXing	78.33342	17.4536	1949
17	OSSLHXing	78.33562	17.4546	1969
18	ODLH_Point	78.33712	17.45373	1977
19	OSSSmallGateTPoint	78.33851	17.45575	1991
20	SmallGate	78.33937	17.45677	1991
21	VCResidence	78.33265	17.45072	1947
22	HostelC	78.33097	17.46014	1960
23	HostelB	78.3302	17.45953	1951
24	HostelD	78.32905	17.45928	1939
25	HostelA	78.3285	17.45857	1936
26	NSSTPoint	78.32692	17.45826	1928
27	HostelI	78.33509	17.45394	1963
28	LHTPointNearLH	78.33527	17.45277	1972
29	LHCompound	78.33538	17.45218	1968

Fig 3.2: Excel sheet of Control points

b) Format conversion:

The format conversion was necessary from excel sheet to text file because excel sheet was not supported by ArcGIS 9.1.

Procedure for converting from excel sheet to text file was:

i) Open the file containing latitude/ longitude (or other X Y coordinates) in Excel

ii) Remove all spaces in the column heading

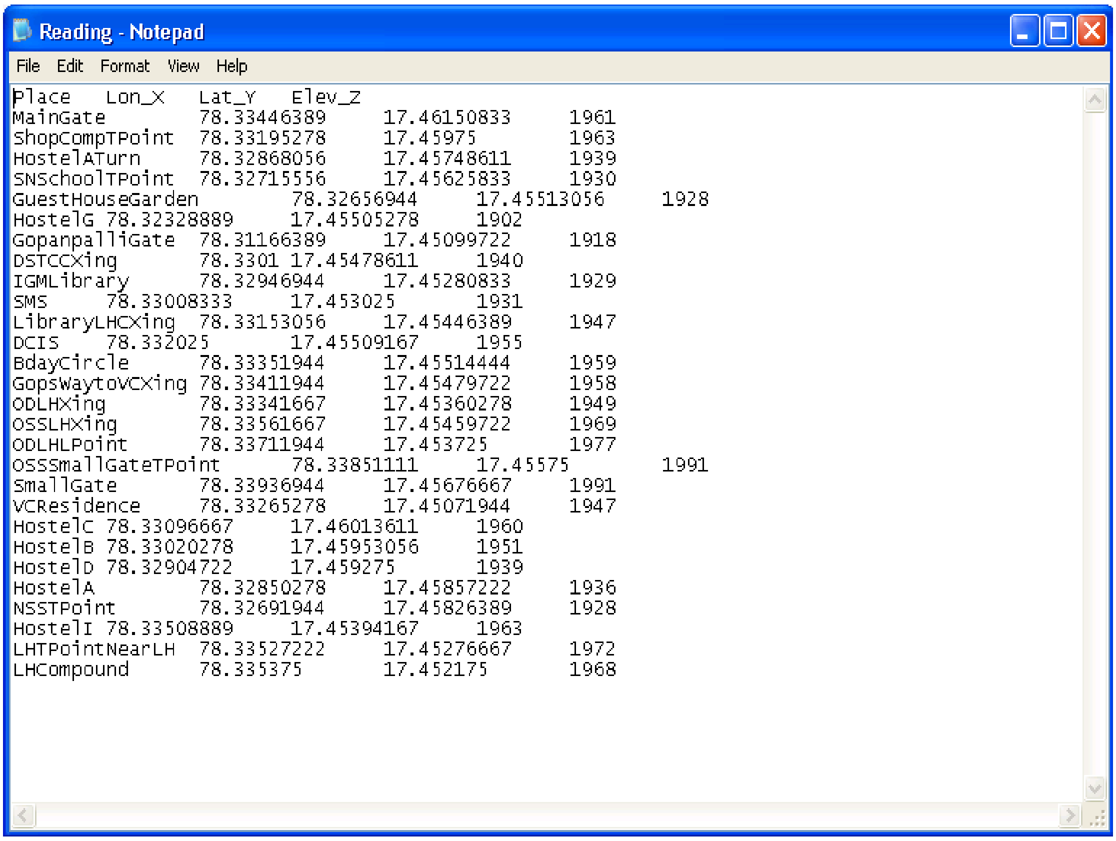
iii) Save the file as a tab delimited text file:

From the Drop-down menu at the top select File -> Save As, then provide a file name and choose "Text (tab delimited)" from the "Save As type:" drop-down box at the bottom. You will get a dialog box that says. "filename.txt may contain features that are not compatible with text (tab delimited). Do you want to keep the workbook in this format?"

Click Yes.

iv) Close the file in Excel. When attempting to close the file we will get another dialog box, with the following message: "Do you want to save the changes you made to filename.txt?" click No.

The output text file is shown in Fig 3.3.



Reading - Notepad

File Edit Format View Help

Place	Lon_X	Lat_Y	Elev_Z
MainGate	78.33446389	17.46150833	1961
ShopCompTPoint	78.33195278	17.45975	1963
HostelATurn	78.32868056	17.45748611	1939
SNSchoolTPoint	78.32715556	17.45625833	1930
GuestHouseGarden	78.32656944	17.45513056	1928
HostelG	78.32328889	17.45505278	1902
GopanpalliGate	78.31166389	17.45099722	1918
DSTCCXing	78.3301	17.45478611	1940
IGMLibrary	78.32946944	17.45280833	1929
SMS	78.33008333	17.453025	1931
LibraryLHCXing	78.33153056	17.45446389	1947
DCIS	78.332025	17.45509167	1955
BdayCircle	78.33351944	17.45514444	1959
GopsWaytoVCXing	78.33411944	17.45479722	1958
ODLHXing	78.33341667	17.45360278	1949
OSSLHXing	78.33561667	17.45459722	1969
ODLHLPoint	78.33711944	17.453725	1977
OSSSmallGateTPoint	78.33851111	17.45575	1991
SmallGate	78.33936944	17.45676667	1991
VCResidence	78.33265278	17.45071944	1947
HostelC	78.33096667	17.46013611	1960
HostelB	78.33020278	17.45953056	1951
HostelD	78.32904722	17.459275	1939
HostelA	78.32850278	17.45857222	1936
NSSTPoint	78.32691944	17.45826389	1928
HostelI	78.33508889	17.45394167	1963
LHTPointNearLH	78.33527222	17.45276667	1972
LHCompound	78.335375	17.452175	1968

Fig 3.3: Text File containing the values of Control Points

c) Plotting the points:

i) Open arcMap

ii) Add the filename.xls file to arcMap just as you would spatial data, (File -> Add data or use Add data button)

iii) Filename.xls will appear in the table of contents (TOC). Right click on filename.xls in the TOC and choose "Display XY data"'

In the dialog box, the X field should be longitude and the Y field should be latitude. If you know the spatial reference of the input coordinates, click the "Edit" button and select it. Otherwise, the shape file will have an unknown coordinate system.

The resultant points in arcMap are shown in Fig 3.4.

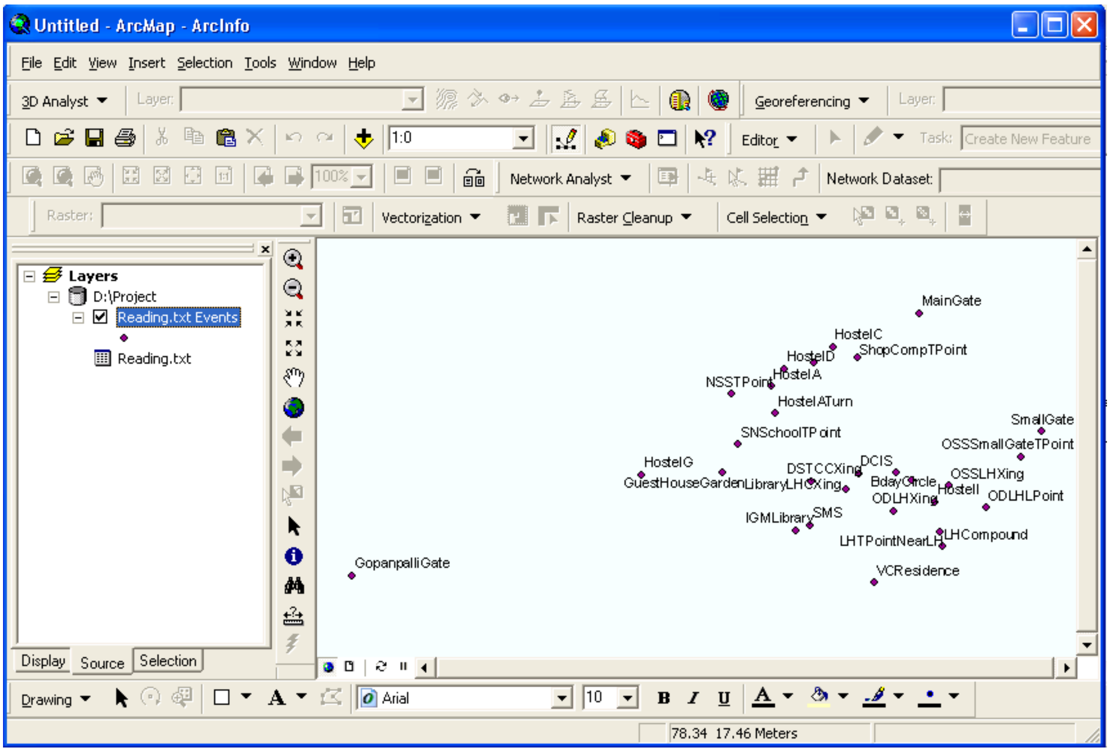


Fig 3.4: Control Points Plotted on ArcMap

d) Georeferencing:

Align geographic data to a known coordinate system so it can be viewed, queried, and analyzed with other geographic data. Georeferencing may involve shifting, rotating, scaling, skewing and in some cases wrapping or rubber sheeting of an image.

Assigning coordinates from a known reference system, such as latitude/longitude. UTM or state plane, to the page coordinates of a raster or planar map. Georeferencing raster data allows it to be viewed, queried and analyzed with other geographic data.

e) **Add and explore the image that we are Georeferencing**:

i) Add the scanned map to the ArcMap project

ii) ArcGIS get a warning about the “Unknown spatial reference: the following data sources we added are missing spatial reference information. This data can be drawn in arcMap, but cannot be projected.” Click ok.

iii) The map appears as a layer in your table of contents but does not draw on top of your control point shape file.

iv) Run the mouse over the control point shapefile and notice the coordinates in the lower right hand corner of your project.

v) Right click on the map and select ‘zoom to layer’ then again examine the coordinates in the lower right hand corner of your project – the file is ‘out of this world’ and needs geographic coordinates assigned to make it appear in its appropriate geographic location

vi) Right click the control point shape file and select ‘zoom to layer’.

Fig 3.5 shows the resultant arcMap before Georeferencing.

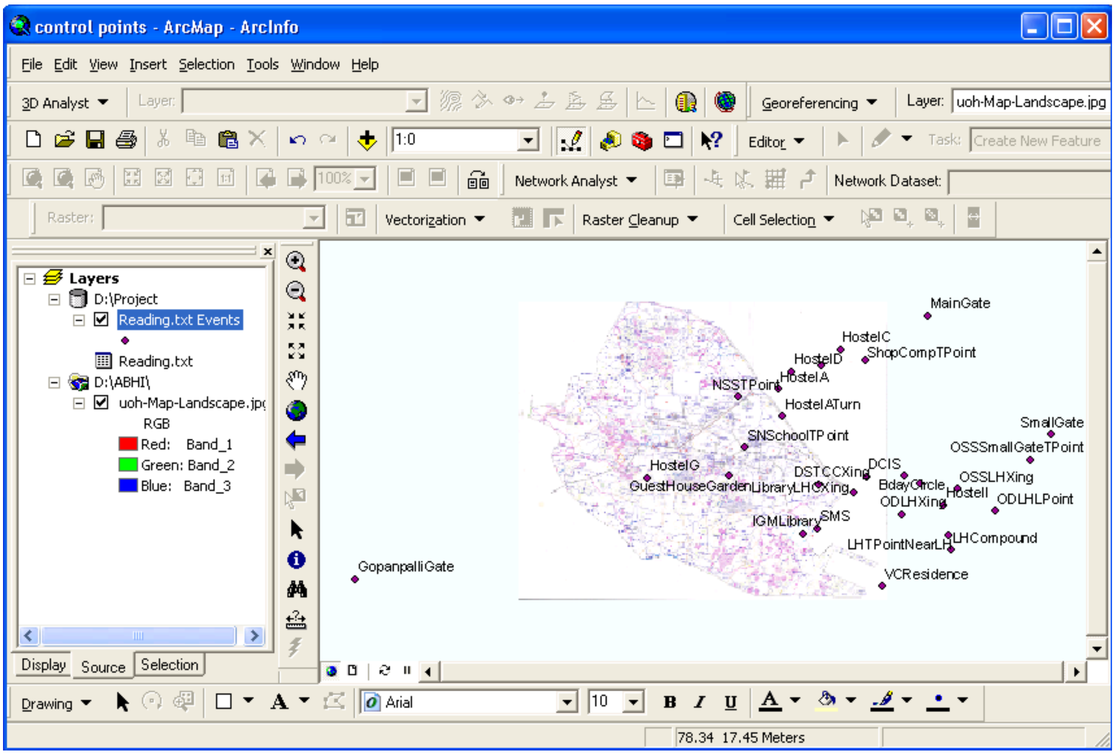


Fig 3.5: Map before Georeferencing

f) Georeference the map using the control point shape file:

i) Turn on the Georeferencing toolbar (right click in the toolbar area and select ‘Georeferencing’)

ii) Make sure the layer on the Georeferencing toolbar is set to Map.jpg

iii) Click Georeferencing -> fit to display

iv) The map will appear centered in your data frame

v) To georefererence one could enter the coordinates of the map or one could assign coordinates to the scanned map by clicking on the scanned map then clicking in the same place on the gis file

vi) Click 'add control points' on the Georeferencing toolbar.

vii) Find places you can ensure are the same on the scanned map then clicking on the GIS file. The locations chosen should be well-distributed places around the map. It can be helpful to zoom in to ensure the areas clicked are the same.

viii) Once our map is well lined up with the control points we will save it as a .TIF image so the coordinate information will be permanently in the header of the TIF file. (This is what known as 'geotiff')

ix) Click Georeferencing -> rectify

x) Save RectifyMap.tif

xi) Add Rectify Map.tif to our project and make sure it looks ok

By this the Georeference of topomap as shown in Fig 3.6 is done

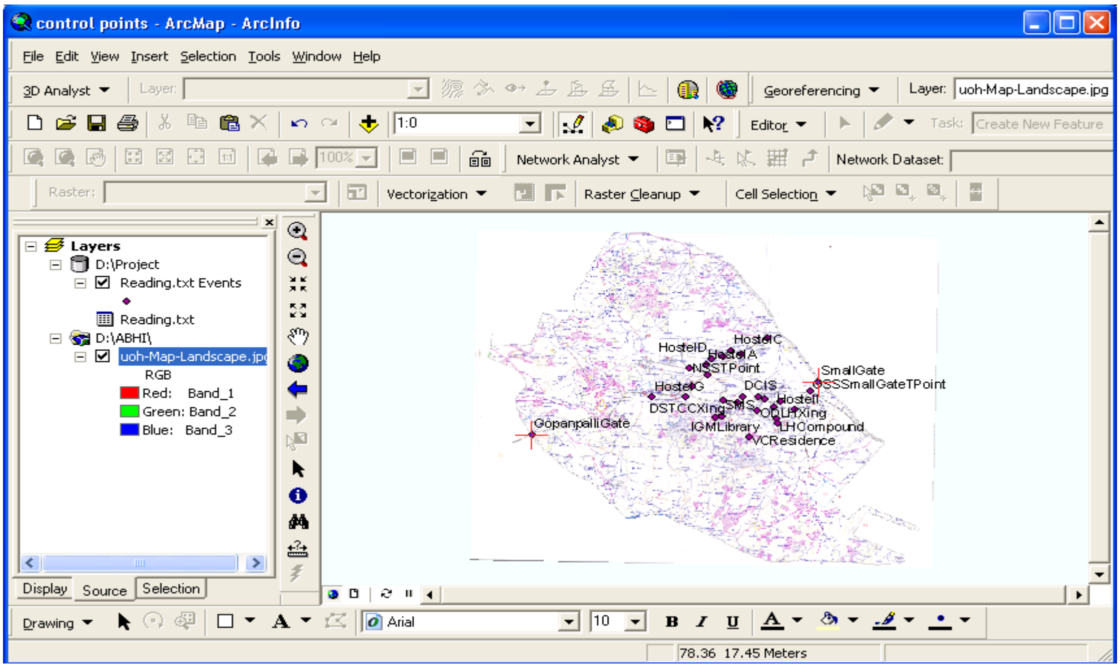


Fig 3.6: Georeferenced Map of University of Hyderabad

g) Conclusion and Next Step

From the preprocessing we generated a properly Georeferenced topomap of University of Hyderabad. The coordinates of the University topomap are now referenced with original longitude and latitude values of University geography. The next step is to creation of different layers from the features of the topomap and extraction of the contour layer using the algorithms proposed by Sandhya [4].

3.3 Creation of Layers

A layer is a single thickness of a material covering a surface or forming an overlying part or segment. For each feature we create a layer. For creating a layer we need to create a shapefile for each layer. A shapefile is a popular geospatial vector data format for geographic information systems software. It is developed and regulated by ESRI as a open specification for data interoperability among ESRI and other software products.

Shapefiles spatially describe geometries: points, polylines, and polygons. These for example, could represent water wells, rivers and lakes, respectively. Each item may also have attributes that describe the items, such as the name or temperature [9].

The topomap rectified after the Georeferencing is used as a base topomap for creation of layers, that topomap is shown in Fig 3.7.

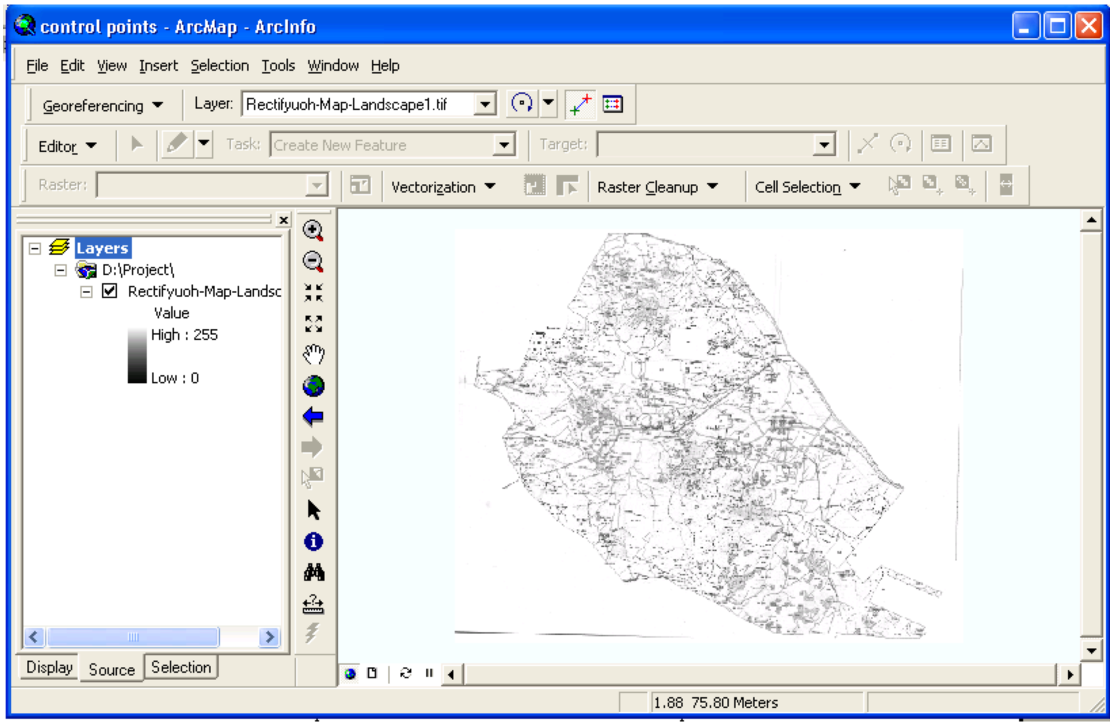


Fig 3.7: Rectified Grey level Map of University

3.3.1 Creation of new shapefile

i) Open ArcCatalog

ii) Navigate to the folder in which we want to create the shapefile

iii) Right click in the content tab and choose new shapefile

iv) Fill the name and type

Every new shapefile that we create needs a coordinate system; we can define a coordinate system in one of the three ways.

- Select a predefined coordinate system
- Import a coordinate system from other source, or
- Create a new coordinate system by filling the fields like datum, prime meridian etc.

The creation of shapefile is shown diagrammatically in Fig 3.8

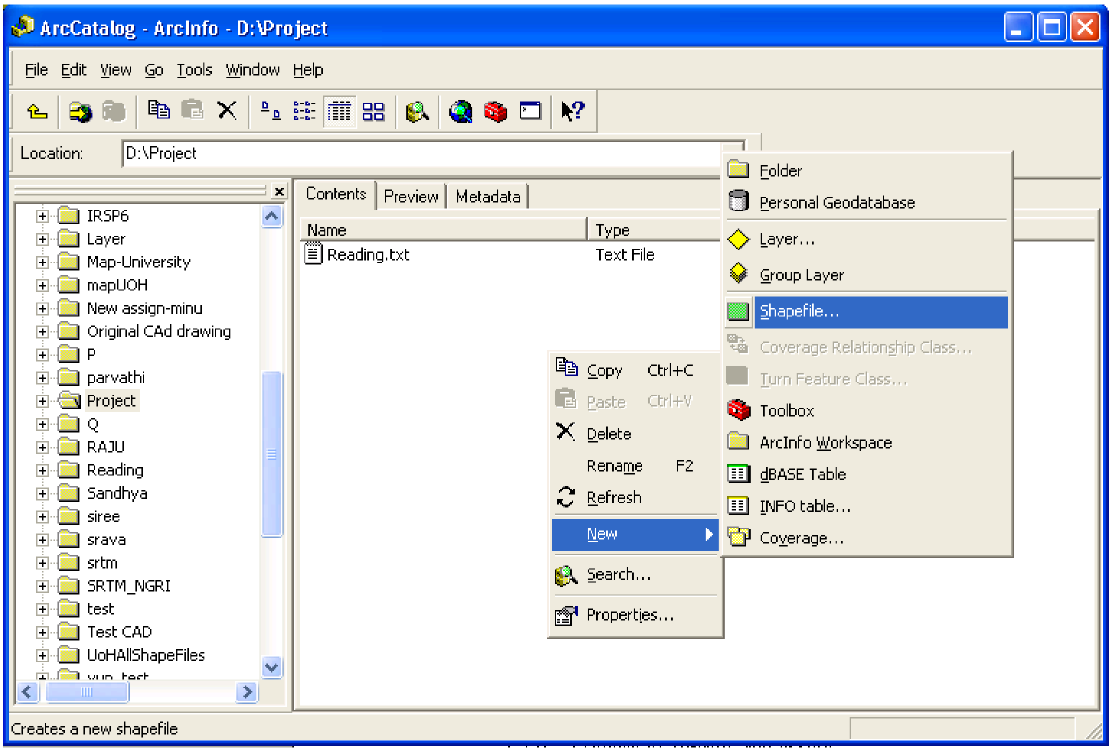


Fig: 3.8: Creation of a Shapefile

3.3.2 Process of Editing the layers

i) Add base map which is in the raster form to the ArcMap

ii) Change the symbology of the map and made into bi-level image as shown in Fig 3.9, because using ArcScan we can vectorize only if the raster image is in bi-level format.

iii) Click the editor toolbar button to display the editor toolbar

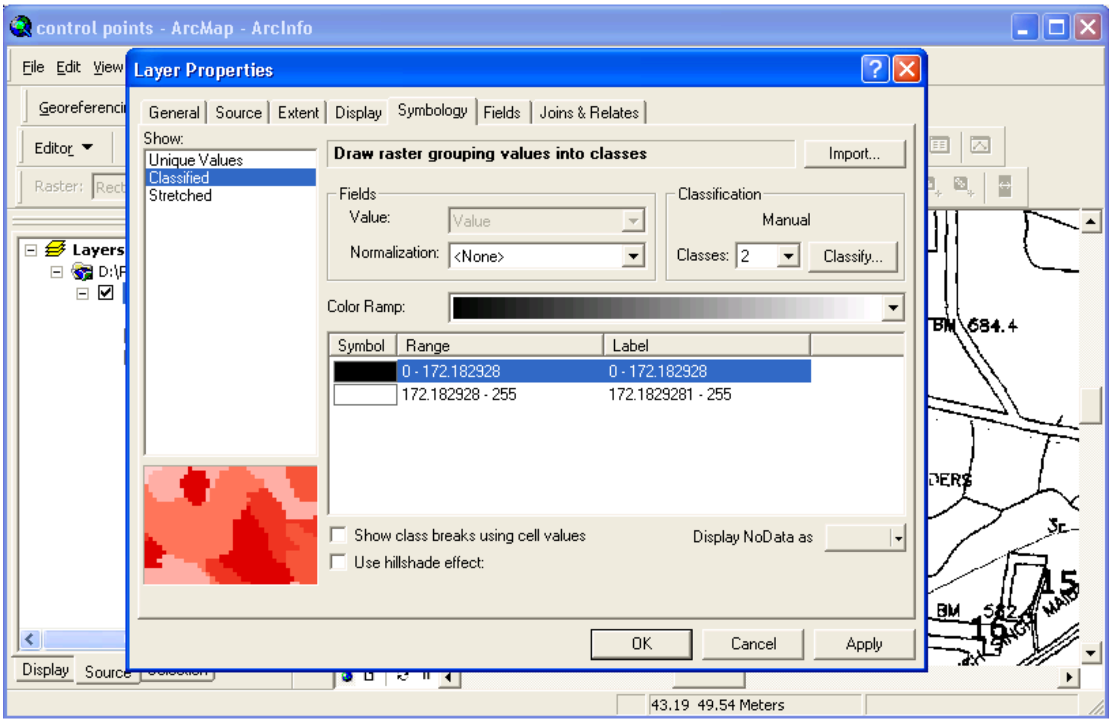


Fig 3.9: Changing the Symbology of the map

3.3.3 Setting snapping:

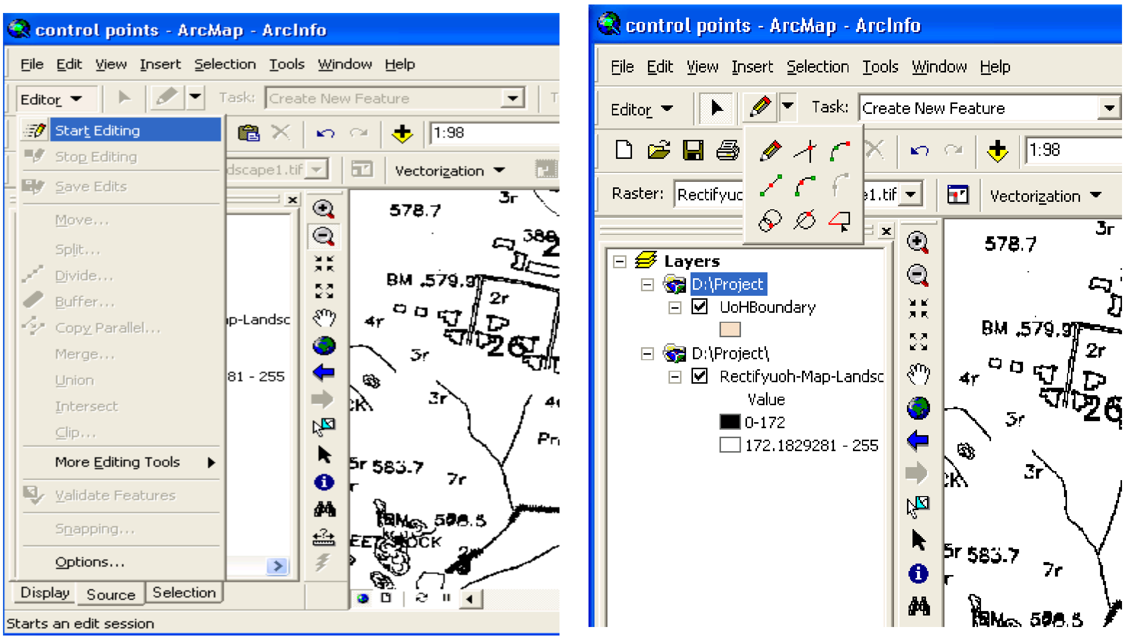


Fig 3.10: a) Editor Tool Box b) Selecting the Snapping Tool

The features from the topomap are to be edited using the editor toolbar as shown in Fig 3.10 (a). In the editor toolbar we have different options for creating new features to modifying or deleting the old features. For these we use the snapping tool. By using a snapping tool we can add a feature to the layer or we can delete a feature from the layer. The edited feature values are updated in a attribute table. The snapping tool with different options is shown in Fig 3.10 (b).

i) Click editor and click snapping
ii) Check the boxes for edge and end for new shapefile
This specifies that the new line you draw in the new shapefile dataset will snap to existing lines (edges) and endpoints of existing lines
iii) Close the snapping environment dialog box, and add the shapefile that we have created using ArcCatalog.
iv) The target layer in the editor toolbar should be the name of the file in which you are editing
v) Click the editor menu and click start editing
vi) Trace the raster image to create the new feature. The feature can be polyline, point or polygon depending on the type of the shapefile.
vii) Press F2 or double click to finish the sketch.

3.3.4 Layers Created

The geographic coordinate system used is World Geographic System 1984 (WGS84) and all layers will use the same coordinate system. And the projected coordinate system used is World Mercator. The WGS system extent is present in Decimal degrees, where as the extent in Projected coordinate system is in Meters. The main layers created for the University of Hyderabad topomap are Boundary, Area, Buildings, Lakes, Gardens, Grounds and parking places etc. These layers are created using the editor tool present in the arcMap and creating the corresponding shapefile in the ArcCatalog.

Each layer is created are shown below with the figures. And the type of the layer is also given.

a) Creation of UOHBoundary Layer

It defines the boundary of University of Hyderabad. Type of this shapefile is polyline

The boundary of the University will be created by editing the topomap, start at any point on the boundary and follow the path by selecting the points and complete the boundary of University. Thus the boundary layer is created as shown in Fig 3.11.

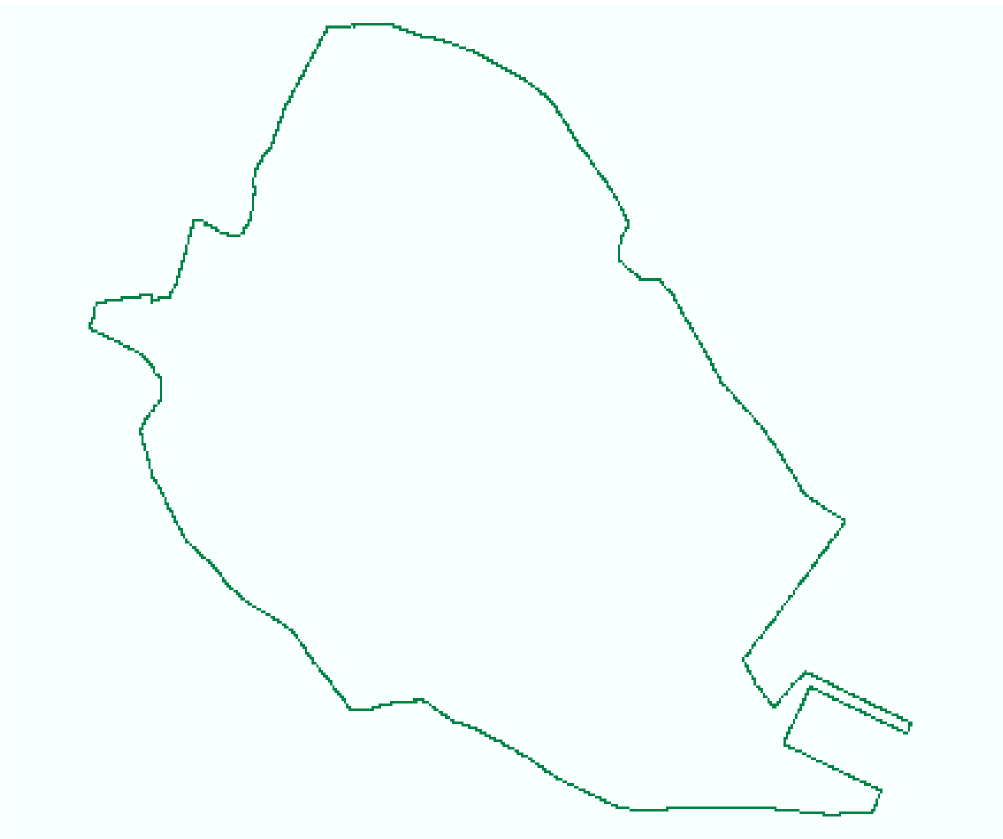


Fig 3.11: UoHBoundary Layer

b) Creation of UOHArea layer

UoHArea layer is similar to boundary layer but here the shapefile type is polygon, polygon will fill the space. This covers the total area of the University of Hyderabad as shown in Fig 3.12.

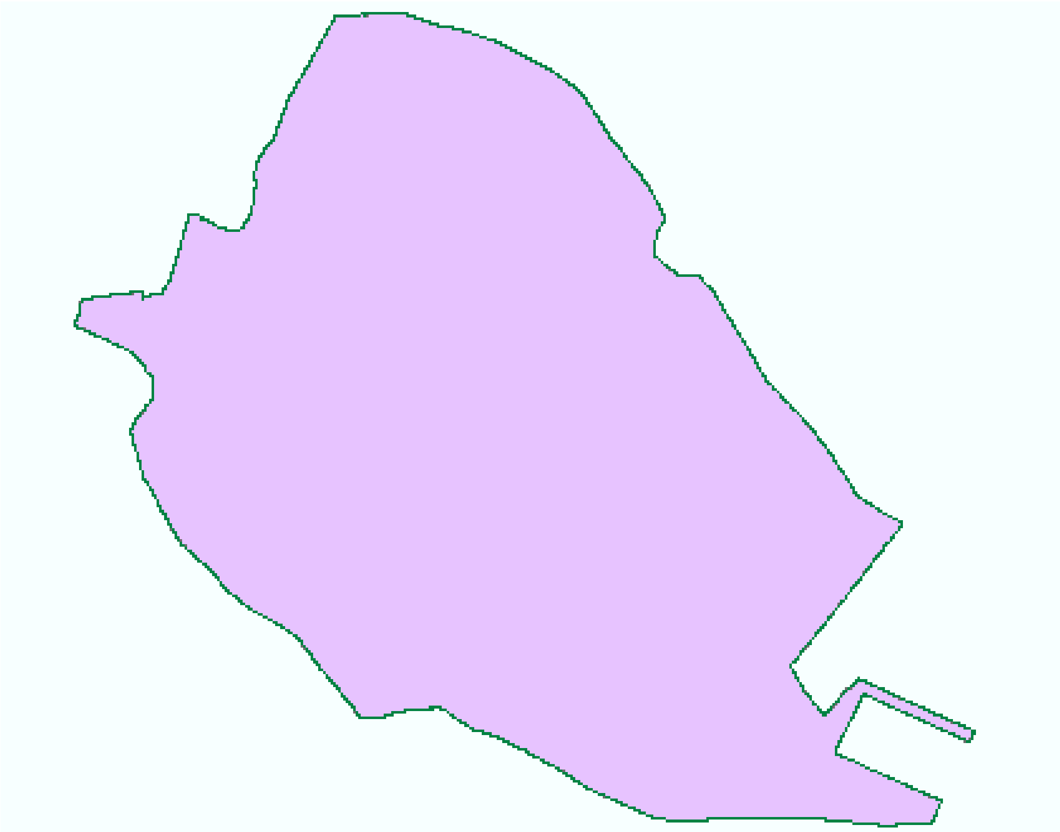


Fig 3.12: UoHArea Layer

c) Creation of UoHRoads layer

The UoHRoads Layer defines all the main roads of University of Hyderabad. The type of this shapefile is polyline. Here we need to select the Z domain and M domain values. The Fig 3.13 shows the all the major roads present in the University.

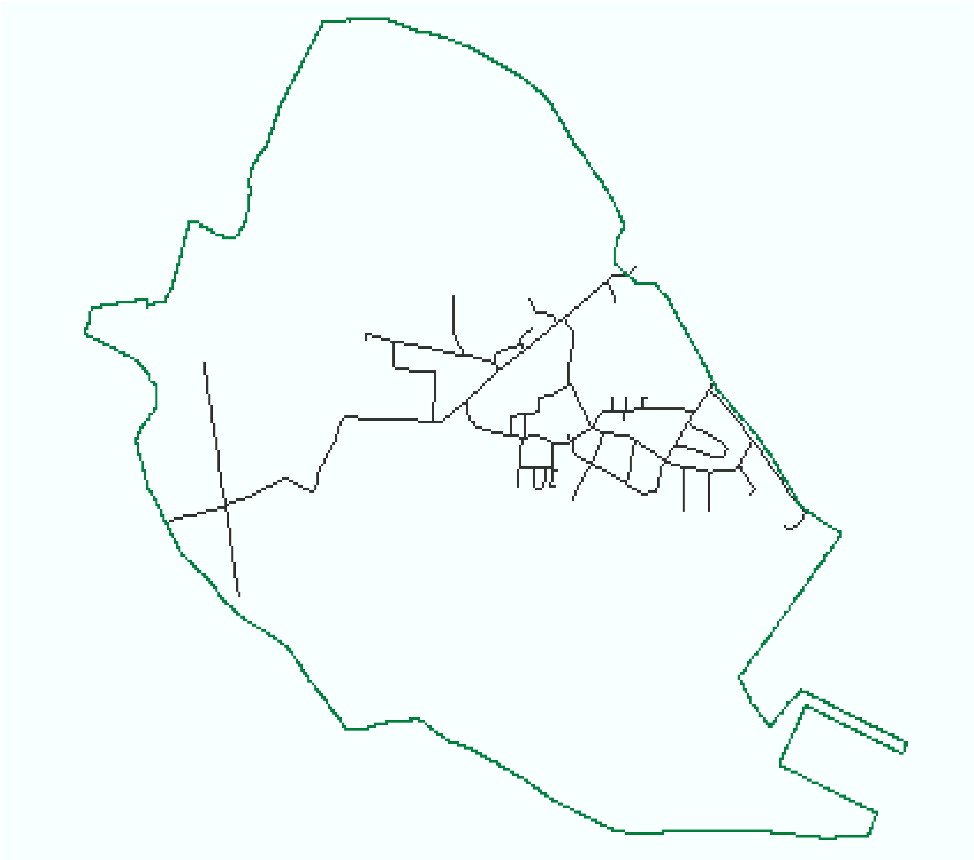


Fig 3.13: UoHRoads Layer

d) Creation of UOHBuildingArea layer

UoHBuildingArea layer defines all the buildings area of University of Hyderabad. The type of this shapefile is polygon. Using the editor tool we edit all the buildings present in the Topomap. The resultant layer is as shown in the figure 3.14.

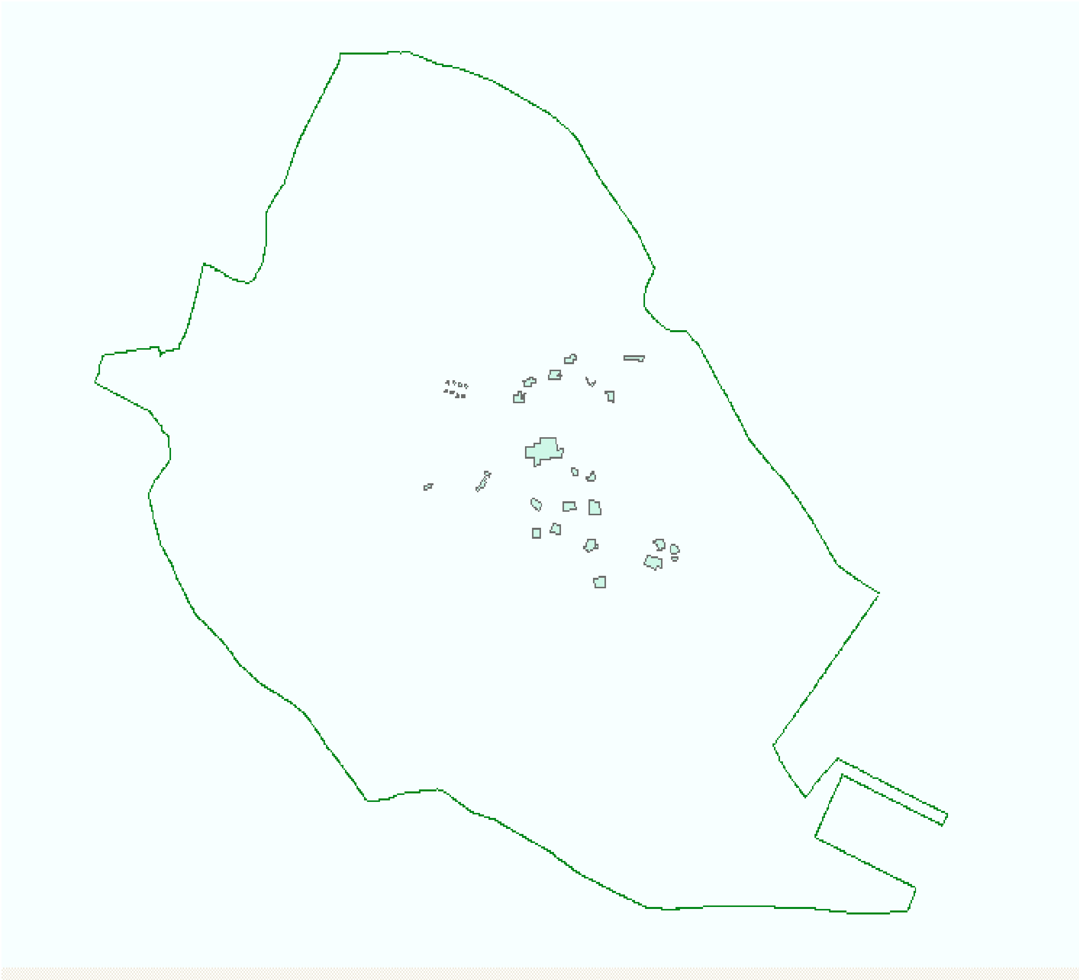


Fig 3.14: UoHBuildingsArea Layer

e) Creation of UOHGardens layer

UoHGardens Layer displays all the gardens of University of Hyderabad. The type of this shapefile is polygon. All the gardens present in the university base topomap have been edited and added to the layer. The attribute table should be updated with the labels. The resultant layer is as shown in Fig 3.15.

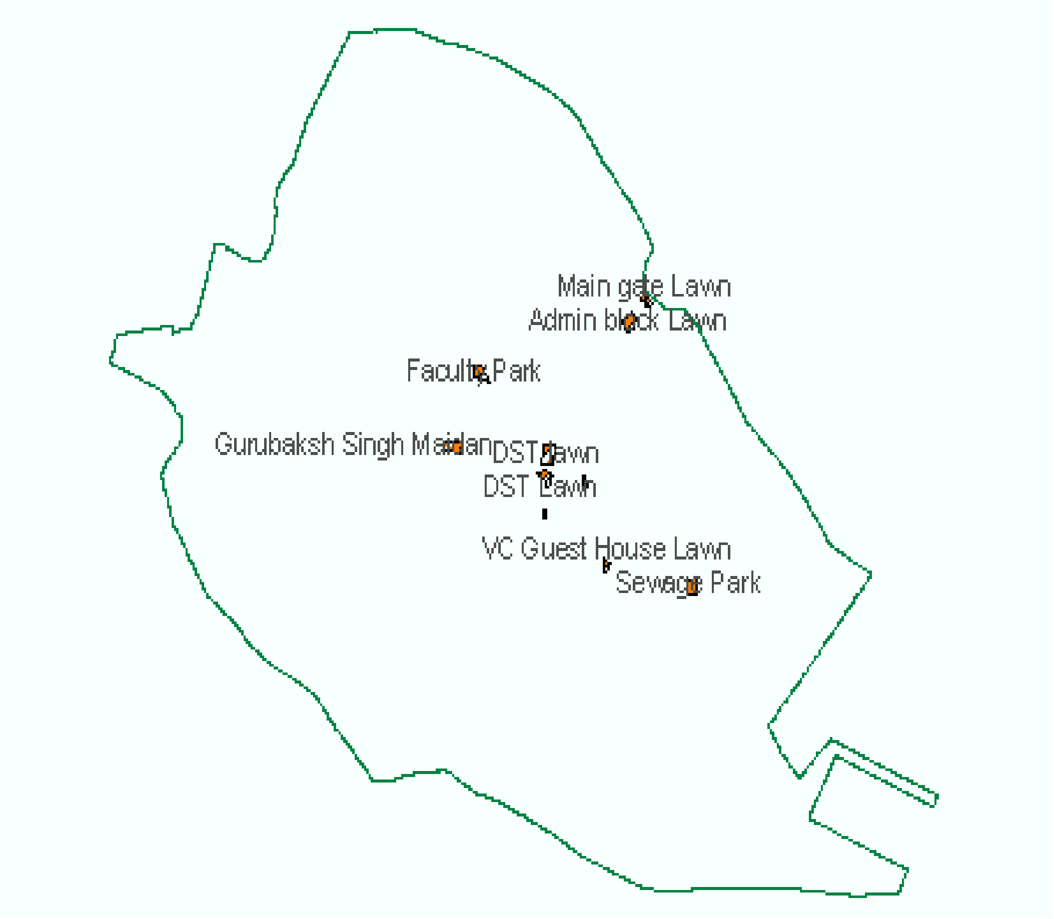
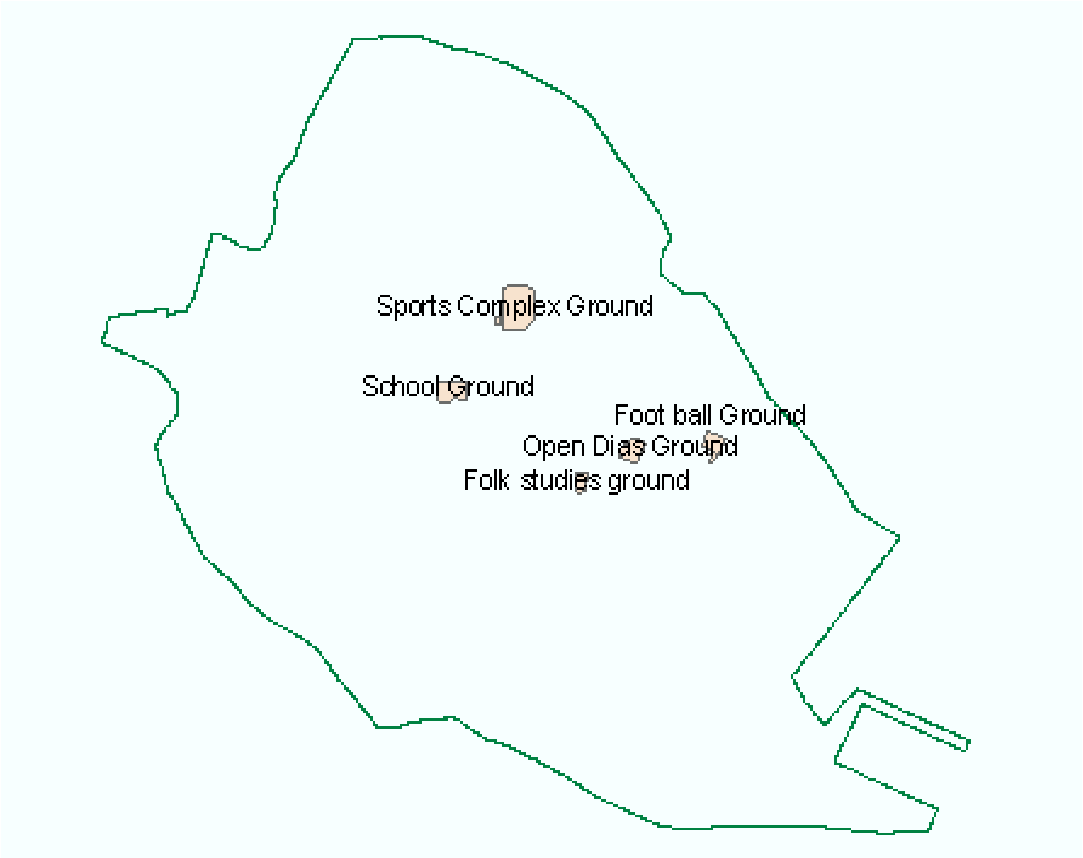


Fig 3.15: UoHGardens Layer

f) Creation of UoHGrounds layer

UoHGrounds Layer displays all the grounds of University of Hyderabad. The type of this shapefile is polygon. Same as gardens layer the grounds are edited using the editor tool and they are properly labeled. The gardens will be displayed in the layer as shown in Fig 3.16.



Fid 3.16: UoHGrounds Layer

g) Creation of UoHSheetRock layer

UoHSheetRock Layer displays all the sheet rocks present in University of Hyderabad. The type of this shapefile is polygon. All the sheet rocks are to be edited and stored in the attribute table. The sheet rocks present in the University are displayed in the layer as shown in fig 3.17.

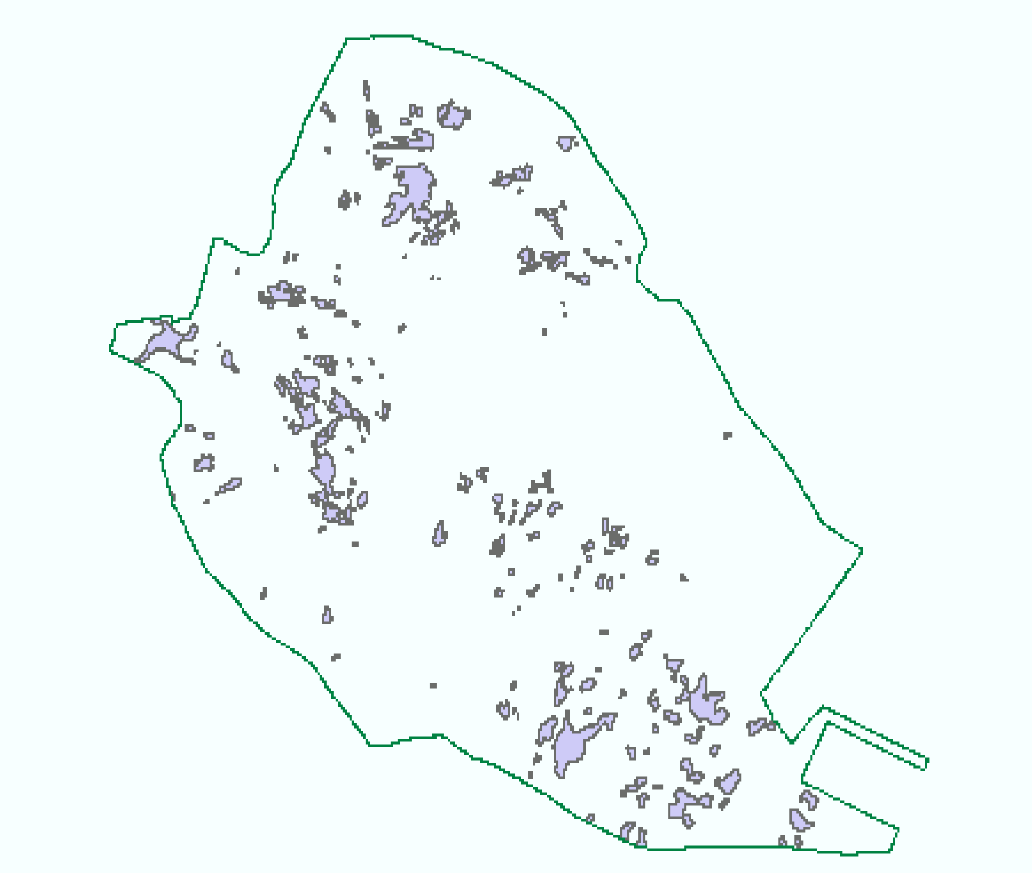


Fig 3.17: UoHSheetRock Layer

h) Creation of UoHLakesArea layer

UoHLakesArea layer displays all the lakes present in the University of Hyderabad. The type of this shapefile is polygon. The lakes boundary has to be edited and the edited fields are stored in an attribute table. The resultant layer is as shown in fig 3.18.

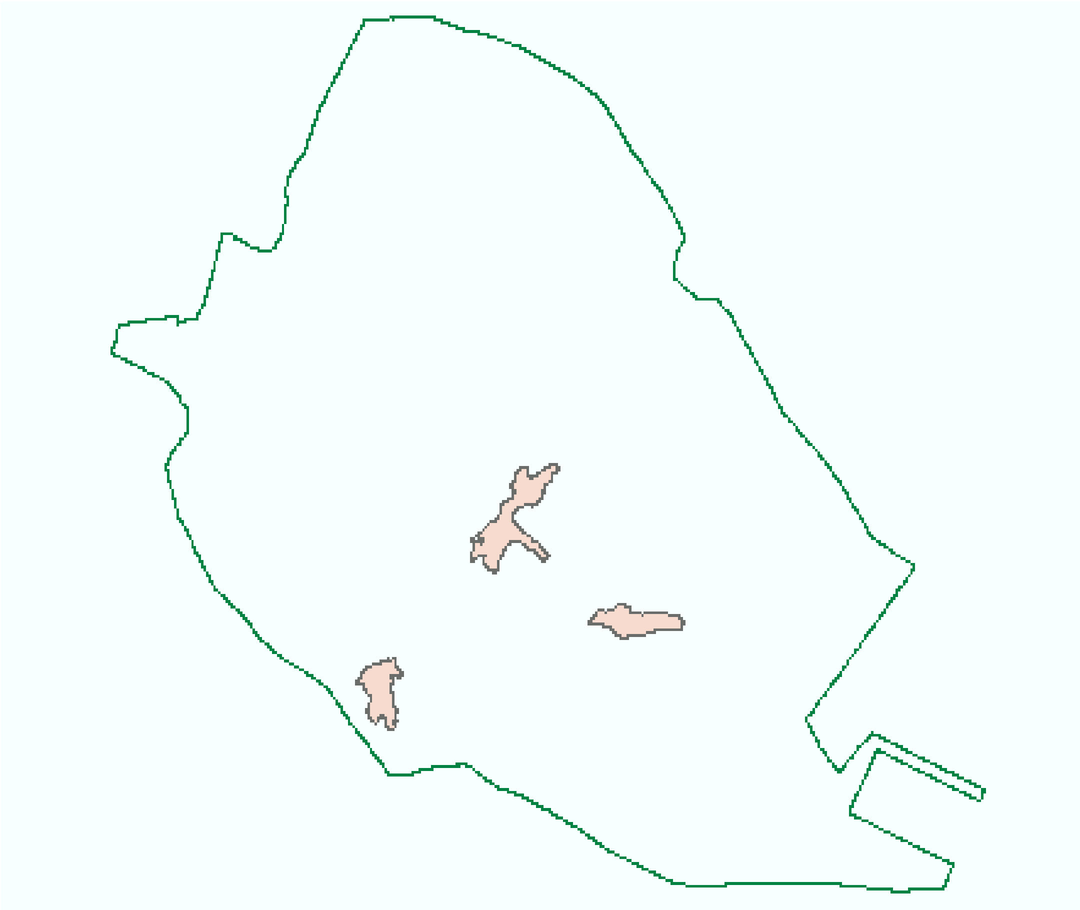


Fig 3.18: UoHLakesArea Layer

i) Creation of UoHWaterStreams Layer

UoHWaterStreams Layer displays all the natural water streams present in the University of Hyderabad. The type of this shapefile is polyline. The water streams are to be edited and they automatically updated to the attribute table. These water streams data is useful in identifying the possible locations for future construction. The water streams layer is displayed as shown in fig 3.19.

Fig 3.19: UoHWaterStreams Layer

j) Creation of UoHPowerLine layer

UoHPowerLine Layer defines all the main power lines that cross University of Hyderabad. The type of this shapefile is polyline. The resultant power lines are displayed as shown in fig 3.20.

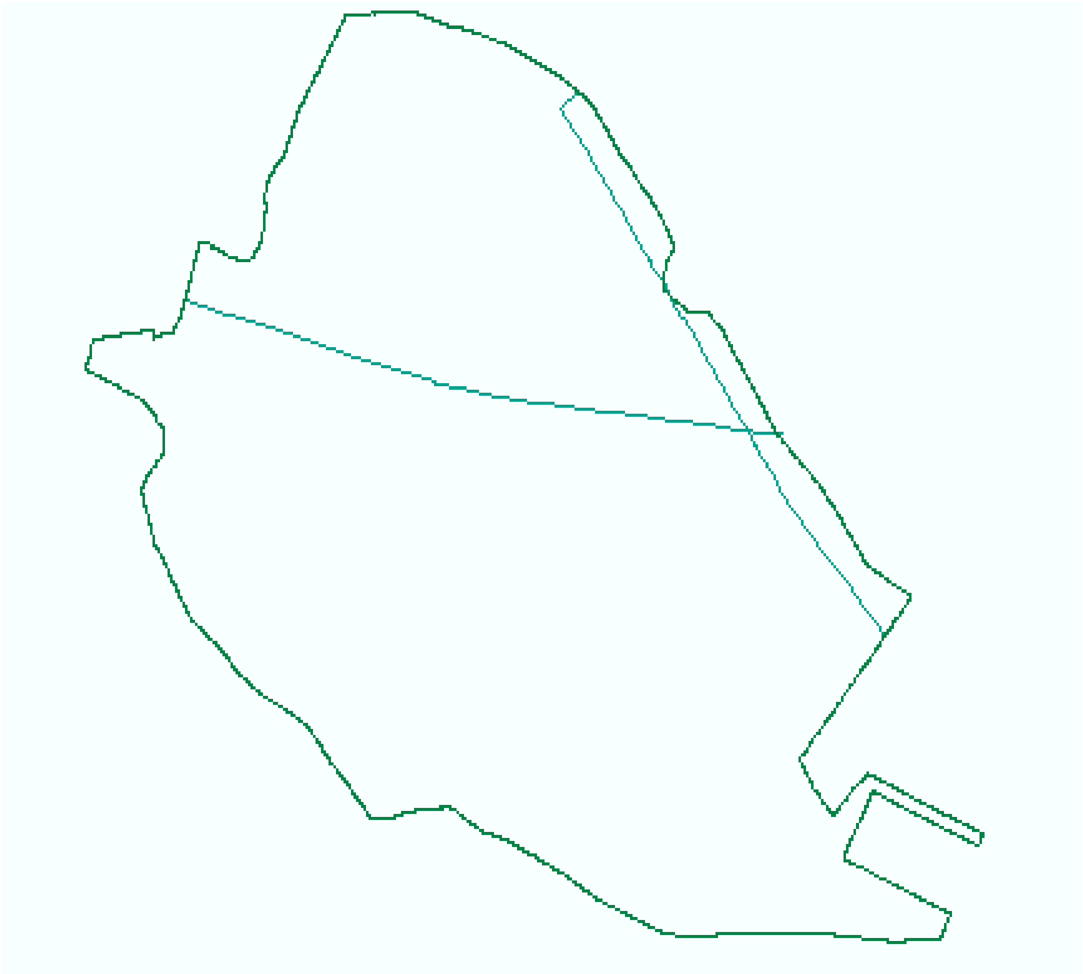


Fig 3.20: UoHPowerLine Layer

k) Creation of UoHKachaRoad Layer

UoHKachaRoad Layer displays all the muddy roads and seasonal roads present in University of Hyderabad. The type of this shapefile is polyline. These roads are edited from the base topomap. The resultant kacha roads are displayed in the layer as shown in fig 3.21.

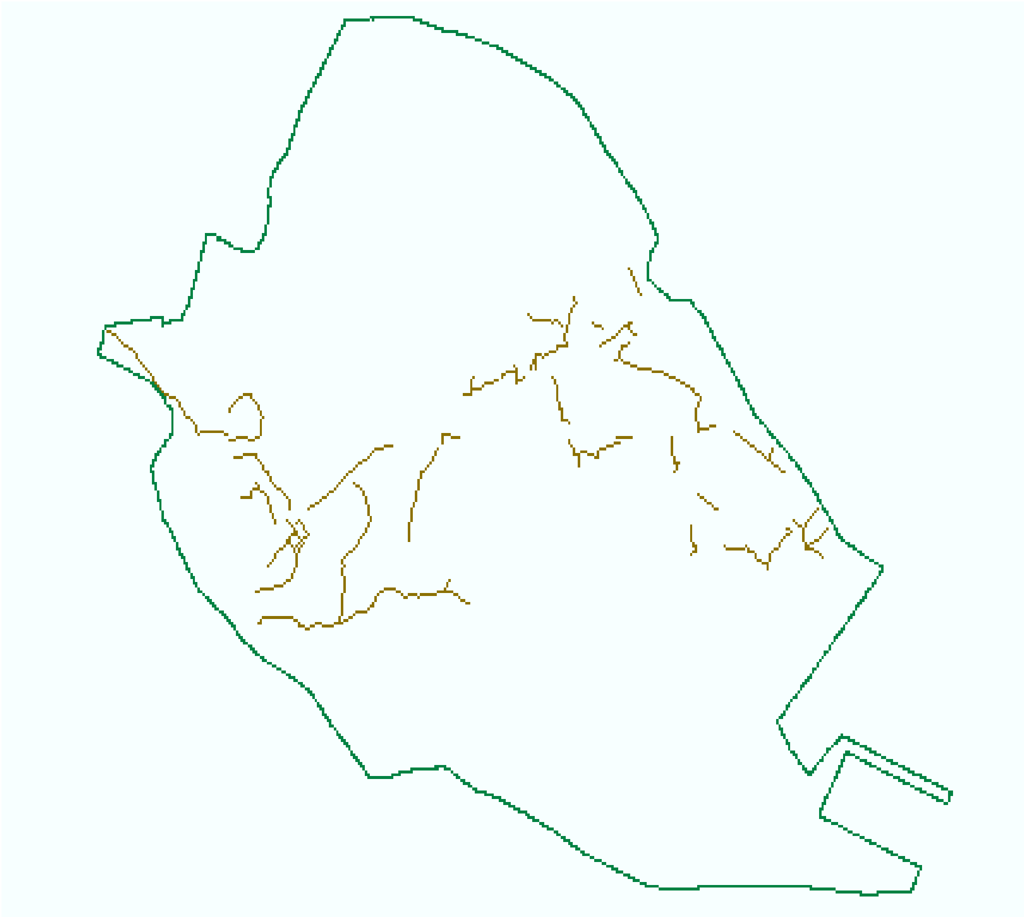


Fig 3.21: UoHKachaRoad Layer

Present Work:

l) Creation of UoHParkingPlaces layer

UoHParkingPlaces Layer displays all the parking stands present in the University of Hyderabad. The type of this shapefile is Polygon. The parking stands are edited and stored in attribute table. The parking places present in the University are displayed in this layer as shown in fig 3.22.

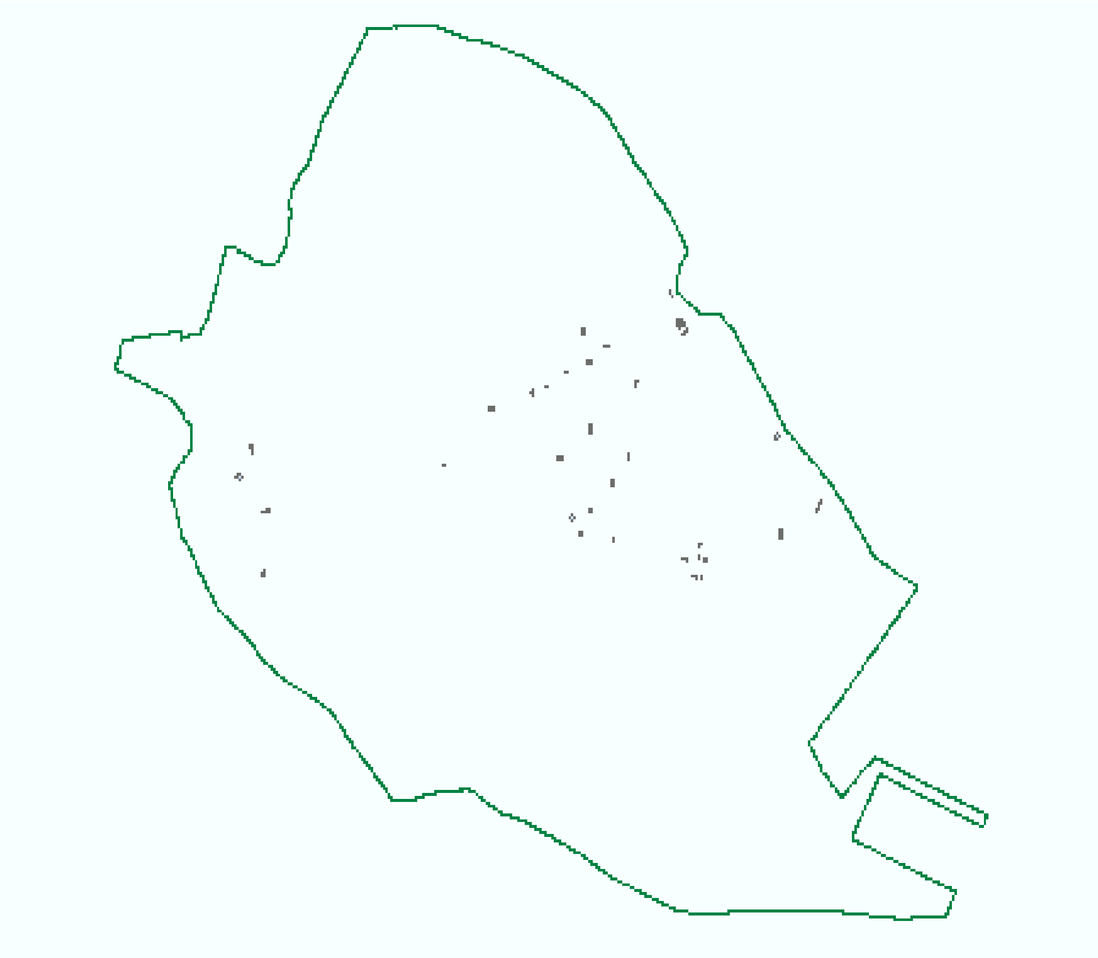


Fig 3.22: UoHParkingPlaces Layer

m) Creation of Modified UoHBuildings Layer

This layer contains all the buildings present in the previous UoHBuildings layer and the newly constructed buildings have been updated by corresponding with the Google maps. The major updates are present in the south campus. The buildings present in the university are displayed in the layer as shown in fig 3.23.

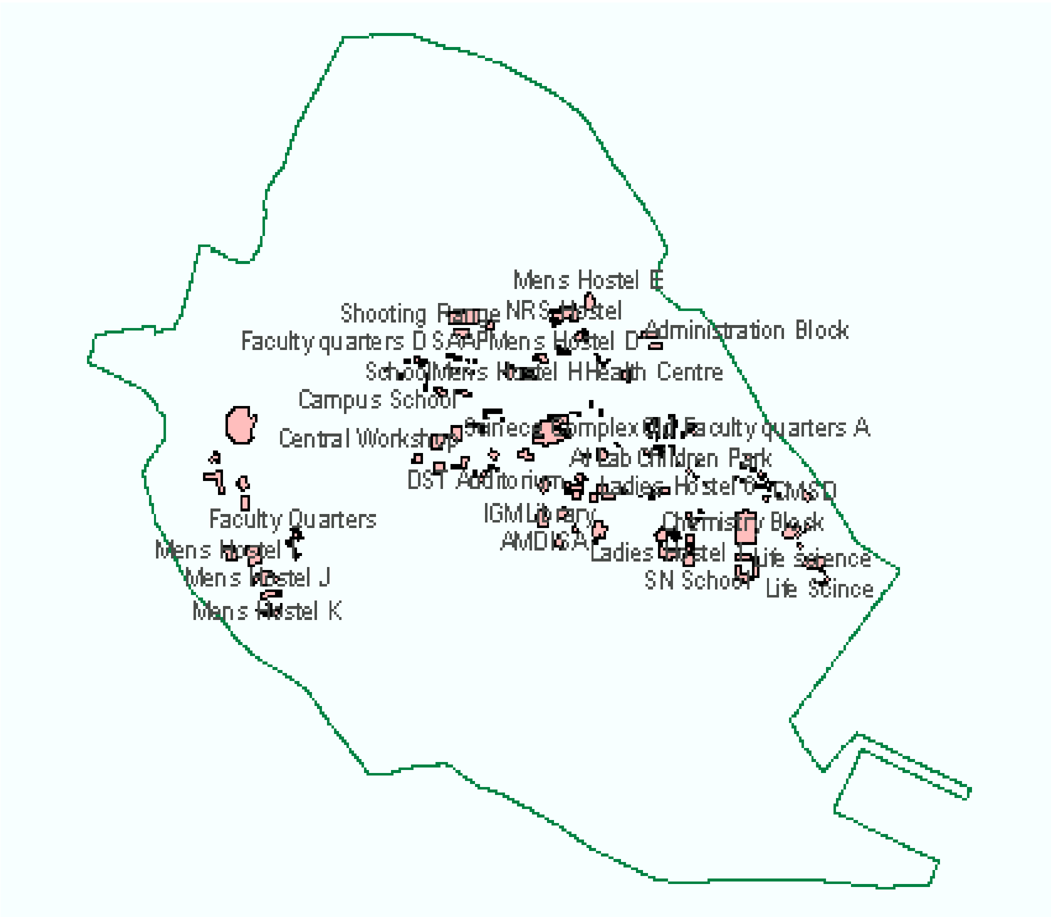


Fig 3.23: UoHBuildings Layer

n) Creation of UoHOverHeadTanks layer

UoHOverHeadTank Layer displays all the overhead tanks present in the University of Hyderabad. The type of this shapefile is Point. This layer shows the major water supply tanks present. Resultant layer is shown in fig 3.24.

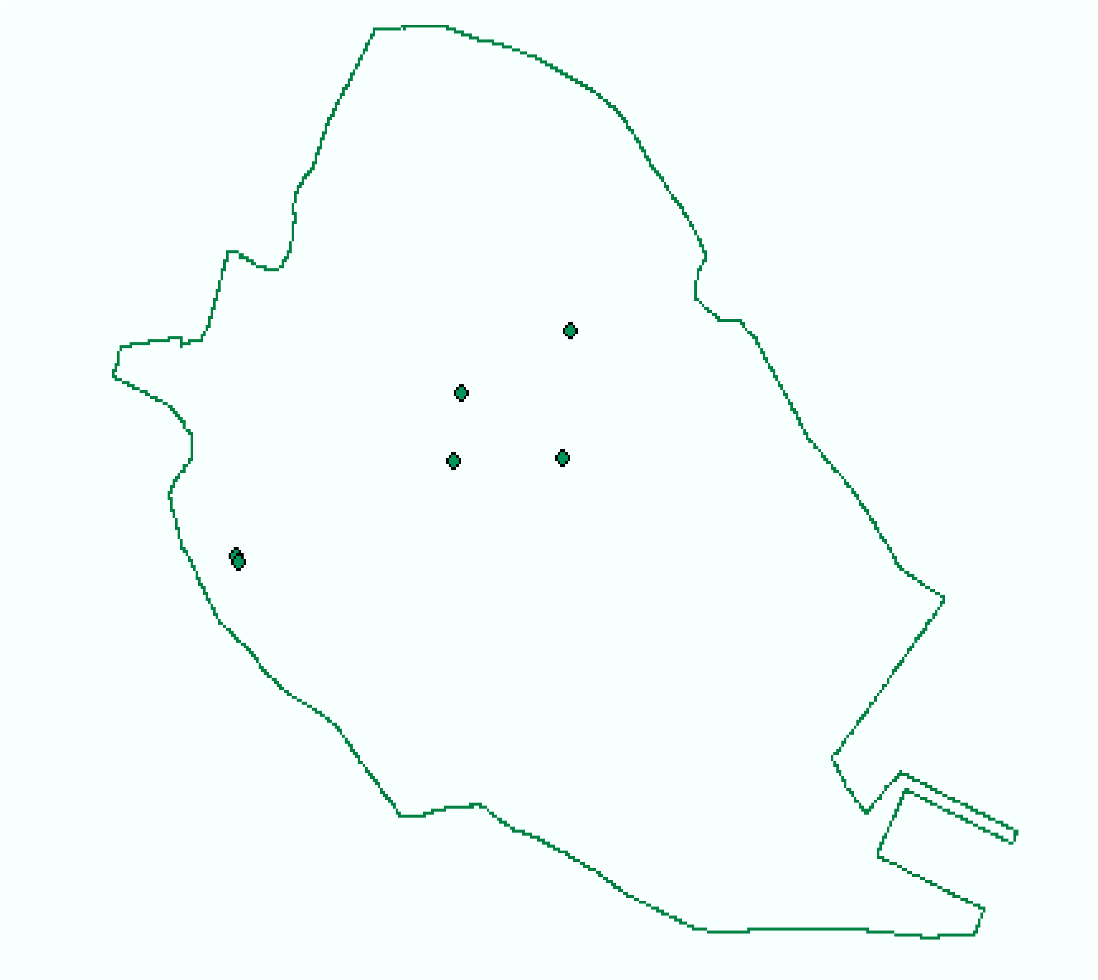


Fig 3.24: UoHOverHeadTanks Layer

3.4 Extraction of contour layers

Contour line is the main linear feature on topographic maps. Extraction of contour lines is tedious and time-consuming process, and is still interesting problem. Topographic map essentially consists of linear features and area features. Different features printed with different color. Brown/ yellow is used to depict contour line. Contour line is a smooth, continuous curve. On 300 dpi resolution maps, contour line's width is approximate from 2 to 4 pixels. Contour lines of topographic maps are taken as approximate parallel continuous curves. They may overlap each other on precipitous cliff. Usually, contour lines are looked as independent to each other and no overlap.

There exist many contour tracing algorithms – square tracing, Moore neighbor, Radial sweep, Theo Pavlidi's tracing algorithms etc. but each algorithm has its own pros and cons. They mainly fail in defining the stopping criterion for terminating an algorithm.

We use the following procedure for extracting the contour lines.

a) Extracting the yellow/ brown color data from the topomap using the color segmentation. For this we used Adobe photoshop. Using this tool we extracted all the lines present in the yellow color.
b) Using the algorithm proposed by Sandhya [4] we traced the contour lines. Here we use the neighboring techniques.

From the above steps we get the contour lines. The type of this shape file is polyline, and the coordinated system is WGS_1984. The resultant contour layer is shown in Fig 3. 25.

ArcGIS tool has a capability to reconstruct the contour lines. It can automatically join the links and white spaces present in the contour line. So we do not require a tool to reconstruct the contour lines. But the resultant lines may not be optimum.

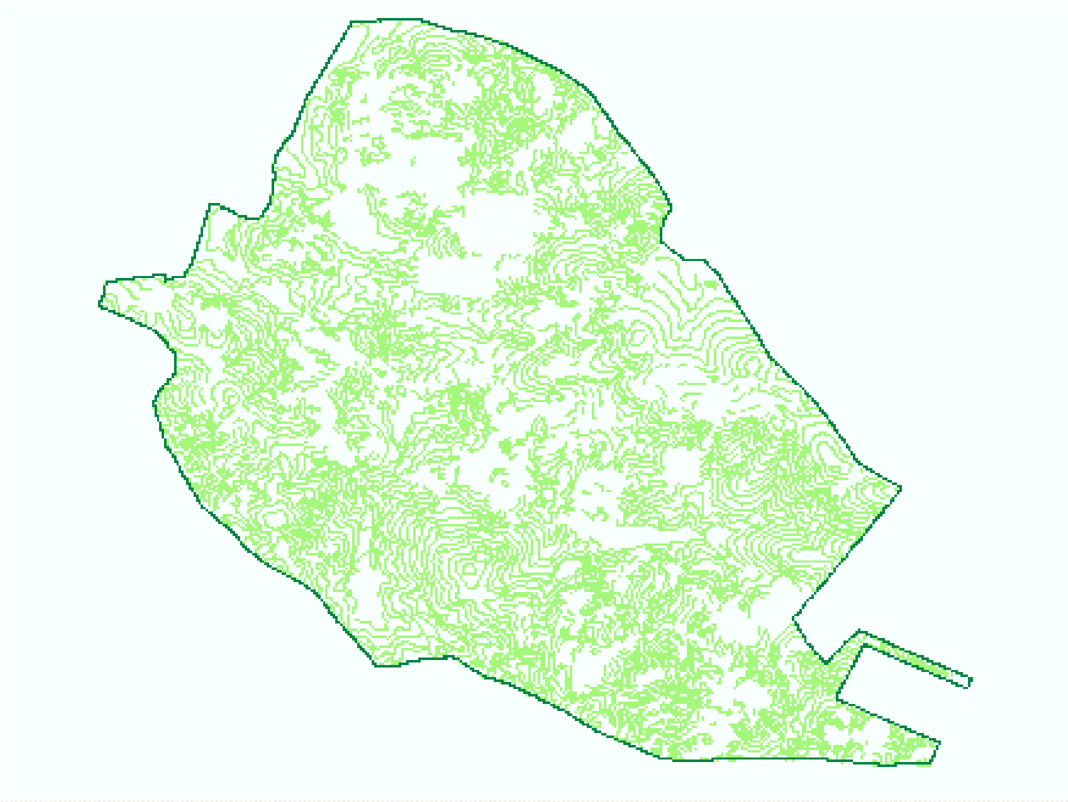


Fig 3.25: UoHContour Layer

3.5 Working with DB Files

Each shape file has a corresponding database file associated with it. When the layer is edited all the corresponding changes are made in the database file. A database is file used in solving the user given queries. A database table consist all the relevant information about the layer. Each database file has a unique attribute primary key and type and other details. These DB Files are used for writing the SQL queries.

a) Properties

i) Each shapefile has a dbf file associated with it. It contains all the attributes of a shapefile

ii) Each feature has a unique FID that is automatically created as the new feature is created

iii) By default when the dbf file is created it contains three fields: FID, ID and TYPE

iv) ID field contains value 0 for each feature you have created

v) We can add or remove the field in the dbf file, enter the values of the attributes, calculated the values of attributes with the help of the values of other attributes by using the given functions.

b) Procedure for adding and removing fields in db files:

i) Make sure the attribute table is open and you are not in edit mode

ii) Click on ‘options’

iii) Click ‘Add field’ to add a new blank field (column)

iv) Assign a name and type to the field

v) Click ok

c) Procedure for entering values in the attributes into db files in ArcMap:

i) Right click on the feature. Dialog box will appear

ii) Click next to the attributes, type value and press Enter

iii) Close the attributes window

iv) Click the editor menu and click stop editing. Click yes when prompted to save your edits.

v) Close the editor toolbar

3.6 Discussion

In this chapter we discussed how to create shapefiles and layers, and how to edit the topomap to create different kinds of layers. These layers will have same coordinate system and they can be joined or related with each other to process them. We created around 13 different layers and each layer consists of a specific feature. These layers are useful in generating a GIS system and solving the spatial queries. We can also join the multiple layers into a single layer depending on the requirement. When the layers are joined, their corresponding database files also added.

Using ArcCatalog we can access the database files of all layers.

CHAPTER 4

PROCESSING THE SPATIAL QUERIES

This Geographical information system enabled topomap of University of Hyderabad able to process the spatial queries. Those queries can be processed by a series of operations. A spatial query is a special type of database query supported by geodatabase. The queries differ from SQL queries in several important ways. Two of the most important are that they allow for the use of geometry data types such as points, lines and polygons and that these queries consider the spatial relationship between these geometries.

Example spatial queries are, A telecommunications company studies the terrain to find the locations for new cell phone towers seen in Fig 4.1. As shown in fig 4.2 an electric utility models its circuits to minimize power loss and to plan the placement of new devices.

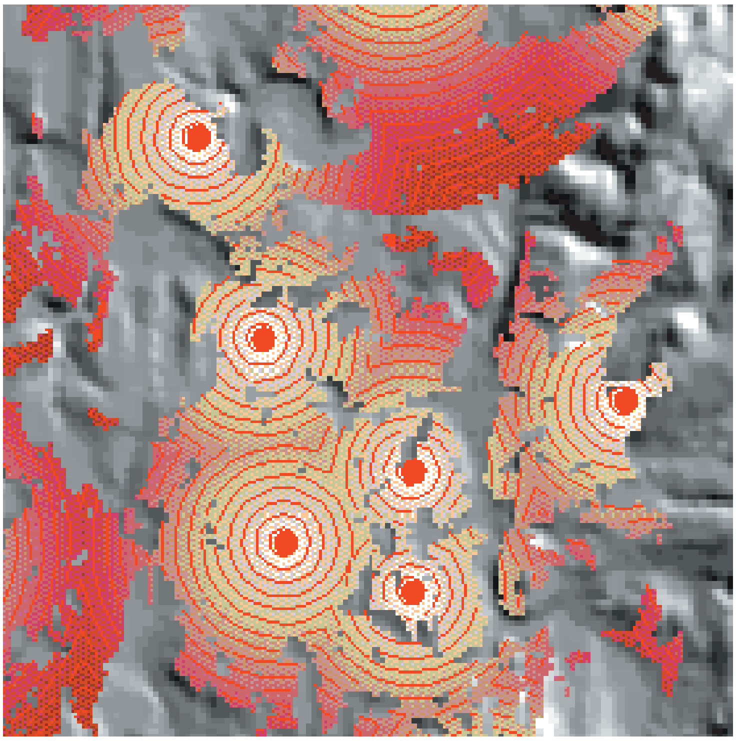


Fig 4.1: possible locations for cell phone towers

Fig 4.2: Electric Utility Model

The spatial queries that we are processing in this section are

i) Creation of 3D terrain model
ii) Finding the Area of Different regions in the map
iii) Finding the optimum location for future constructions
iv) Finding the Streams obstructed by the constructions

4.1 Creation of 3D Terrain Model

A Terrain is the vertical and horizontal dimension of land surface. A terrain model is used to visualize the area in different directions. It depicts the elevation and slope. Here we are creating the 3D terrain for the topomap of University using the elevation details given by the contour layer. By converting the features into TIN (Triangulated Irregular Network) we get the terrain model. TIN is a digital data structure used in a GIS for the representation of a surface. TIN is a vector based representation of the physical land surface or sea bottom, made up of irregularly distributed nodes and lines with three dimensional coordinates (x, y, and z) that are arranged in a network of non overlapping triangles. For viewing and generating the 3D maps we use ArcScene tool.

Procedure for creating TIN:

1. Open the ArcScene
2. Add all the Layers created using the Add Button
3. Select 3DAnalyst and select Create/modify TIN then select Crete TIN from features.
4. This will display a window; in that window select Contour Layer.
5. Select the height source as Elevation
6. Select the Triangulated as Hardline
7. Select UoHBoundary Layer and select height source as Null and Triangulated as Soft clip
8. Select UoHWaterStreams Layer and select height source as Null and Triangulated as Hard Break lines.
9. Click Ok

The TIN thus generated can be viewed in different ways. TIN edges with the same symbol on the symbology tab will give us a TIN view of the terrain as shown in fig 4.3.

Face elevation with graduated color ramp will show the total map in graduated colors, we divided the colors into 32 classes based on the elevation. Thus the 3-D terrain map is generated as seen in fig 4.4.

ArcScene is a map display program customized for displaying 3D data. Using this we can create a 3D fly-through.

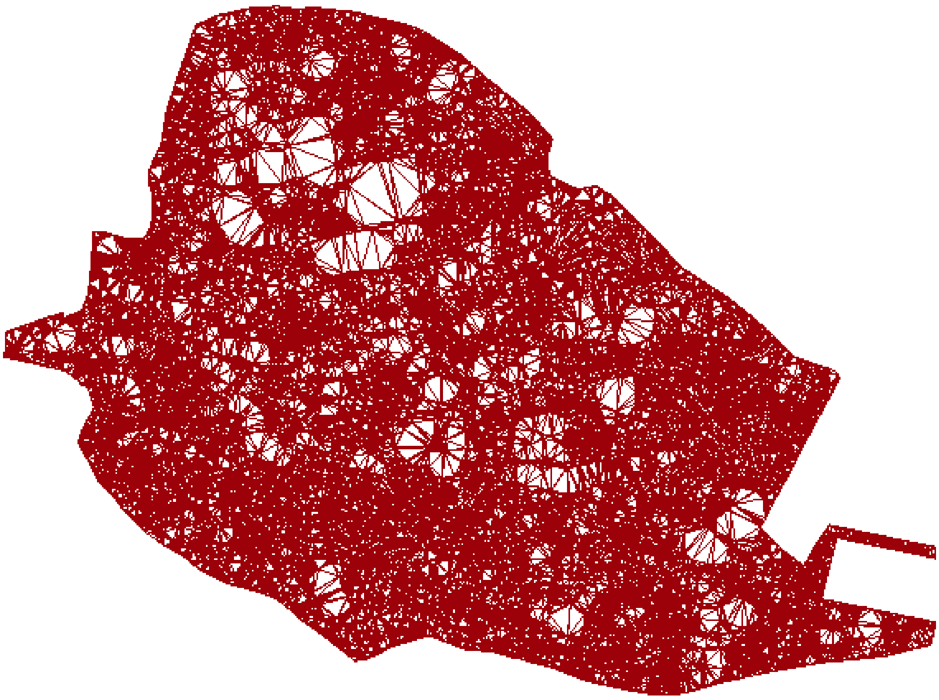


Fig 4.3: TIN model for University of Hyderabad

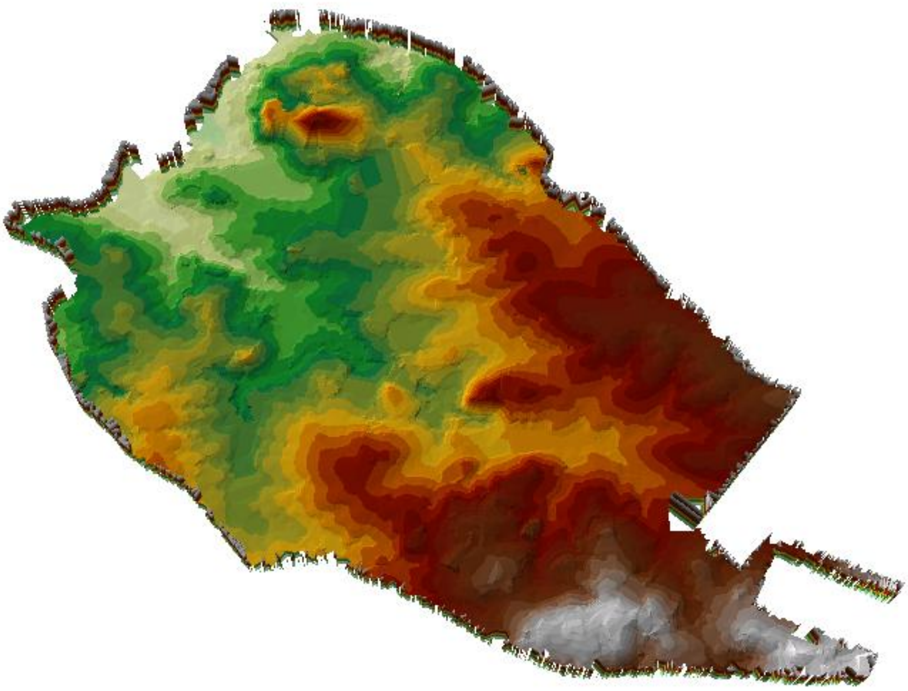


Fig 4.4: 3-Dimensional terrain model in ArcScene Fly-through

4.2 Correspondence between Google map and terrain model

In this we are trying to correspond between the Google map and our terrain model, so that we can compare the two maps with the degree of extent and coordinates and we can compare the location of building by superimposing on map on the other. Also we added some new construction from the Google earth. We updated our terrain model by comparing it with the Google maps. From Google earth we downloaded the images of University. This is not a single map but a collection of maps. So we did georeferencing on all the maps with our map. So the maps extent is same as our topomap. Then we edited the new constructions on to their corresponding layers.

In the fig 4.5 we have shown map of south campus taken from google earth is georeferenced with topomap of University. Using the resultant map we are updating the new constructions.

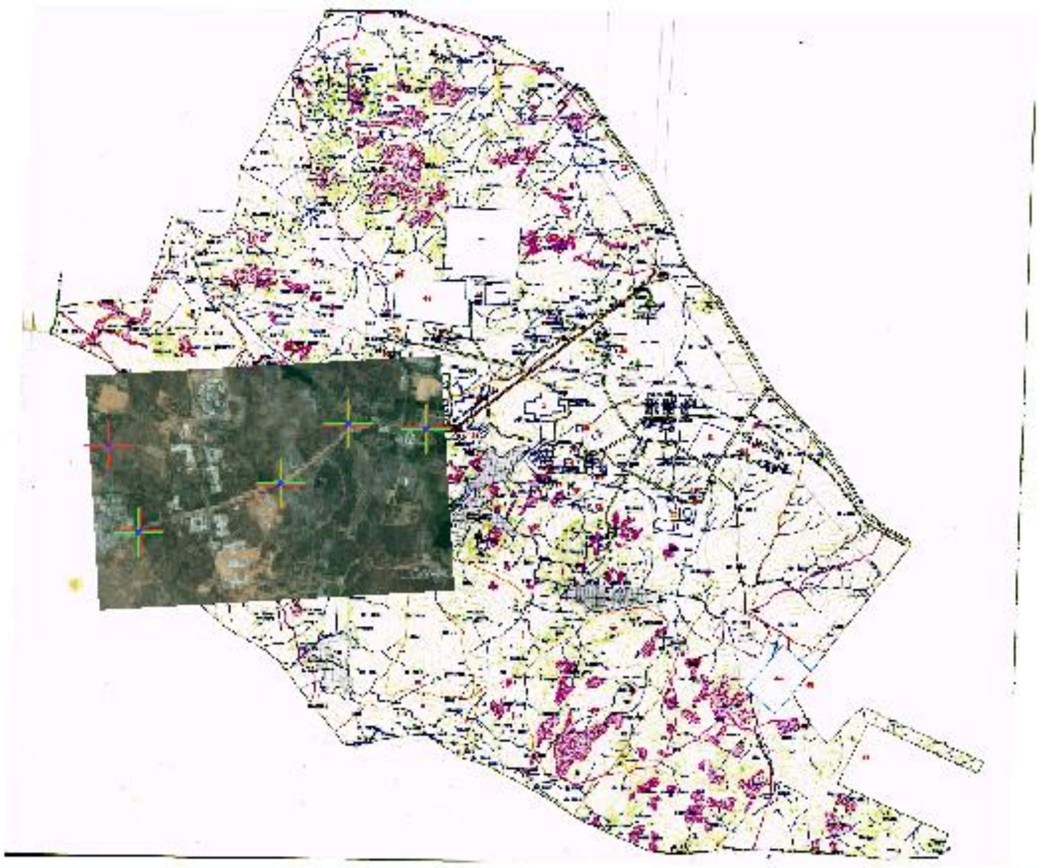


Fig: 4.5 Correspondence between Google map and our map

a) Procedure for comparing

1. Download the map of university from Google Earth Pro
2. Georeference the downloaded map with our map.
3. Make all layers ON and compare them with the Google map.

b) Adding new buildings

Since our map is prepared in 2007, to place new construction in our map, we used the Google maps.

1. Georeference the both maps
2. Add UoHBuildings layer to the ArcMap
3. Select start editing in editor Tool.
4. After editing the map save edits, that will update the buildings layers

In this manner we have updated the newly constructed roads, buildings and gardens. These modifications are shown in the layer diagrams 3.13, 3.23, 3.15 respectively in the previous chapter.

4.3 Area/lengths of different parts of University

In processing the topomaps, an attribute table is created for each layer; these tables contain the Id, type and Label information. Additionally we can add some fields to these tables. For polygons we find the area and store them in the table. To find the area we need to make some changes to the coordinate system. Because World Geographic Coordinate system (WGS_84) uses longitude and latitude values. But to find the area we need a standard unit that we can understand (ex: Acres, square meters etc.), So we need to change the geographical coordinate system to projected coordinate system (PCS). In the PCS the earth represented in x, y coordinates. The PCS we are using is Worl_Mercator which store the coordinate values in meter. So the area will be in Square meters.

a) Procedure for changing to projected coordinate system

i) Go to view -> Data Frame Properties
ii) Select coordinate system and click modify
iii) Select the Projection name as Mercator and click Ok
iv) Select DataFrame, check the Fixed Extent and click Advanced

v) Select Custom extent and uncheck the degrees click Ok

vi) Click Ok

The fig 4.6 shows the window where we change the coordinate system.

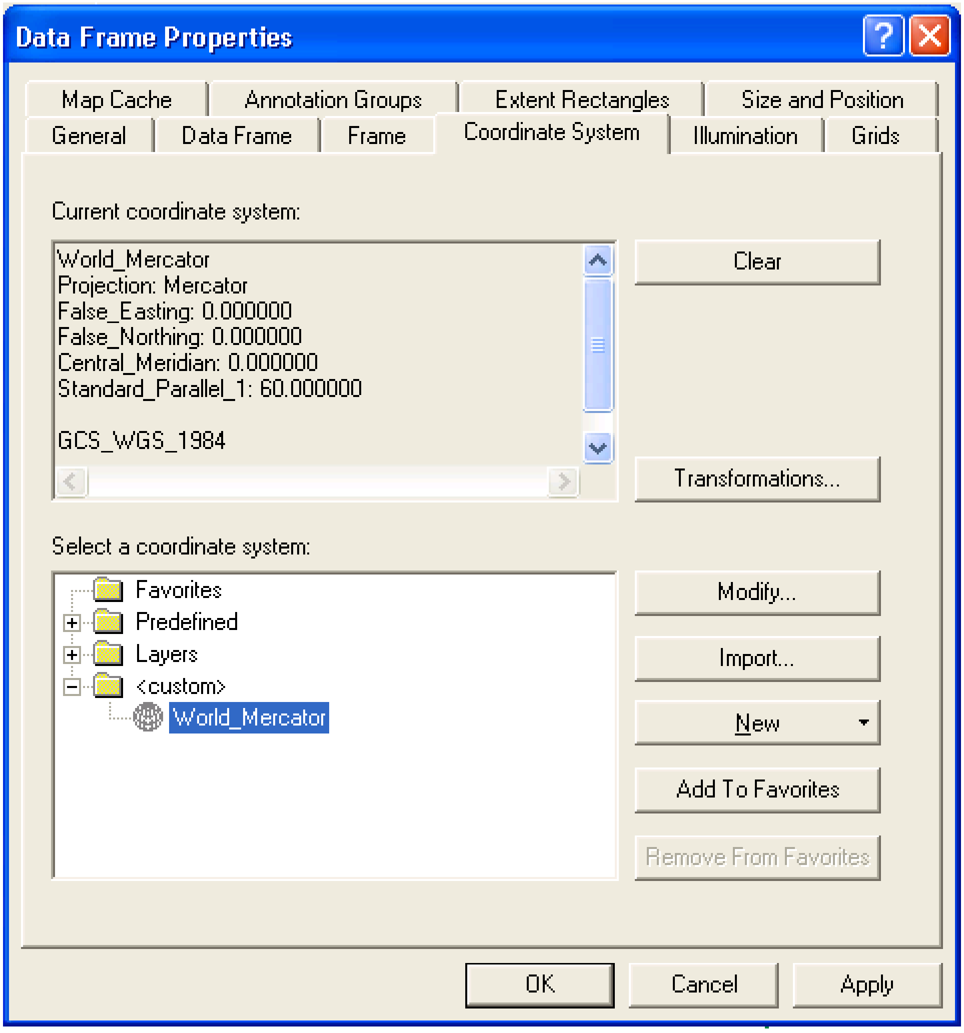


Fig 4.6: Changing to Projected Coordinate System

vii) Right click on the layer select Data -> Export Data as shown in fig 4.7

viii) Select the dataframe and change the output location

ix) Click Ok

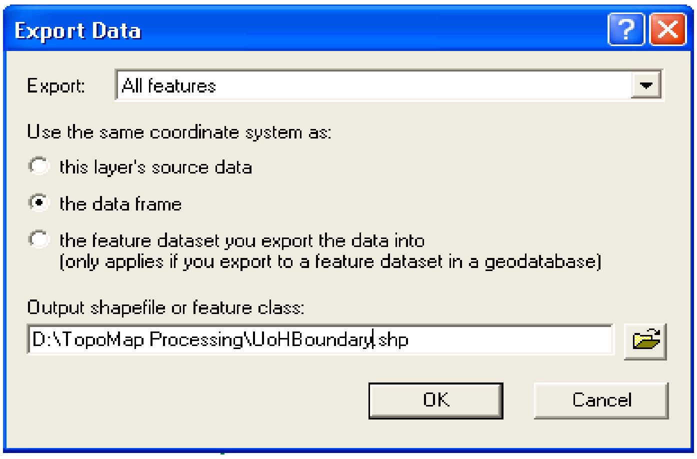


Fig 4.7: Exporting the Data Frame

x) This will generate a new layer with projected coordinate system.

xi) Repeat the steps 7 to 9 for all layers.

b) Procedure for finding the area of UoHbuildings Layer

i) In the ArcMap or ArcCatalog Right click on the UoHbuilding layer and select Open attribute table

ii) Select options and click add field

iii) A window will open, enter name as Area and Type as Double click OK

iv) This will create the area column in the table

v) Select the column and right click and click calculate values

vi) Check mark the Advanced box

vii) Type the following VBA statements in the first box

Dim dblArea as double

Dim pArea as lArea

Set pArea = [shape]

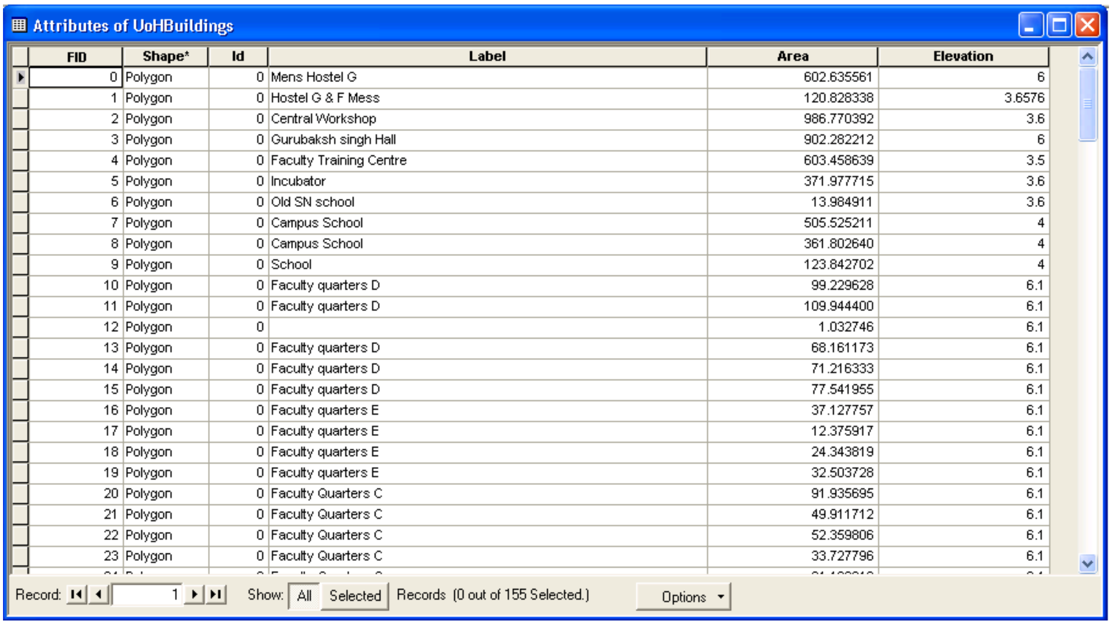
dblArea = pArea.area

viii) Type the variable dblArea in the second box

ix) Click Ok

This will create the Area of the polygons. We can find the area for all layers and the area of buildings can be shown in the fig 4.8.

The algorithm used in ArcGIS to calculate area is called ‘Area Calculation by Gauss’.



Attributes of UoHBuildings

FID	Shape*	Id	Label	Area	Elevation
0	Polygon	0	Mens Hostel G	602.635561	6
1	Polygon	0	Hostel G & F Mess	120.828338	3.6576
2	Polygon	0	Central Workshop	986.770392	3.6
3	Polygon	0	Gurubaksh singh Hall	902.282212	6
4	Polygon	0	Faculty Training Centre	603.458639	3.5
5	Polygon	0	Incubator	371.977715	3.6
6	Polygon	0	Old SN school	13.984911	3.6
7	Polygon	0	Campus School	505.525211	4
8	Polygon	0	Campus School	361.802640	4
9	Polygon	0	School	123.842702	4
10	Polygon	0	Faculty quarters D	99.229628	6.1
11	Polygon	0	Faculty quarters D	109.944400	6.1
12	Polygon	0		1.032746	6.1
13	Polygon	0	Faculty quarters D	68.161173	6.1
14	Polygon	0	Faculty quarters D	71.216333	6.1
15	Polygon	0	Faculty quarters D	77.541955	6.1
16	Polygon	0	Faculty quarters E	37.127757	6.1
17	Polygon	0	Faculty quarters E	12.375917	6.1
18	Polygon	0	Faculty quarters E	24.343819	6.1
19	Polygon	0	Faculty quarters E	32.503728	6.1
20	Polygon	0	Faculty Quarters C	91.935695	6.1
21	Polygon	0	Faculty Quarters C	49.911712	6.1
22	Polygon	0	Faculty Quarters C	52.359806	6.1
23	Polygon	0	Faculty Quarters C	33.727796	6.1

Record: 1 Show: All Selected Records (0 out of 155 Selected.) Options

Fig 4.8: Calculated Area of the Buildings

ESRI uses a normalized form of it to preserve numeric precision. To calculate the total area of a polygon we need to divide the polygons into rings. Here we use the trapezoid's area formula i.e.,

PartialSums[0] = (points[1].x - points[cPoints - 1].x) * (points[0].y - y0origin)

If the ring contains nonlinear segments, such as Circular Arc, Elliptical Arc, and Bezier curve, a correction of the area is applied for each trapezoid.

The final area of ring is: SUM (PartialSums)/2

The final area of the polygon is SUM (Area of each ring)

4.4 Find the Buildings that are obstructing the Water Streams

As the number of people registering for University increasing, to cope up with the growing population we need to construct the new infrastructure like class rooms, labs etc. so this construction of buildings in the past years have caused the obstruction to water streams as well as stopped the natural water sources to the lakes. Identifying of those buildings can be done using the ArcMAP tool. Here we are identifying the Buildings that are obstructing the water streams present.

a) **Procedure for finding the buildings obstructing the water Streams**

   i) Open ArcMap and add UoHbuildings and UoHWaterStreams layer to the map.

   ii) The layers are visible in the right hand side.

   iii) In the selection Tool, select the features from UoHBuildings layer that intersect the features in the UoHWaterStreams layer.

   iv) This will give us the buildings that are obstructing the water streams as shown in Fig 4.9.

The buildings in the Cyan color represent the resultant buildings that are obstructing the water streams.

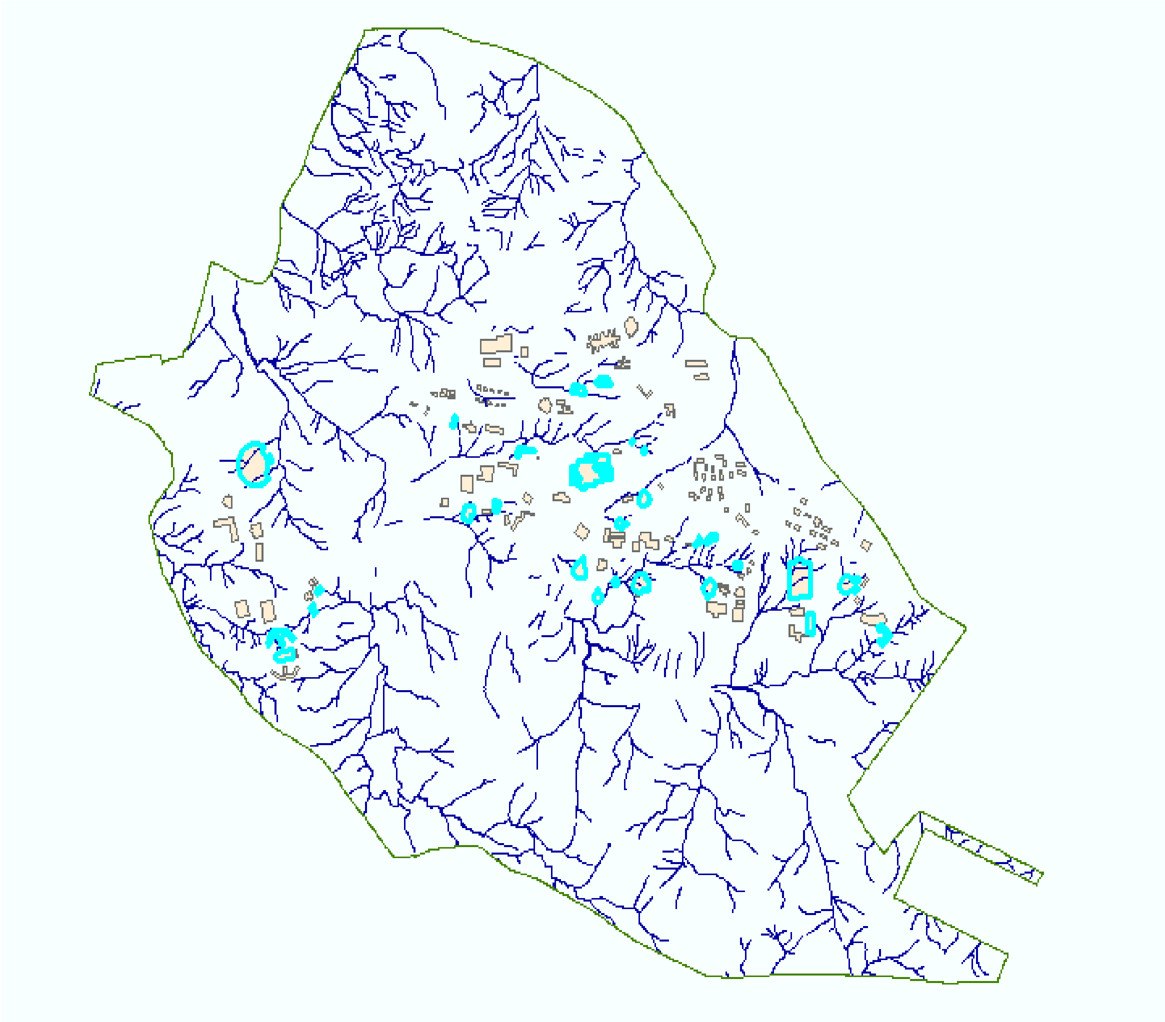


Fig 4.9: Buildings obstructing the Water Streams

4.5 Discussion

In this chapter we processed some of the queries using the different layers and joining them. The database files have different fields such as FId, Id, Type, Labels and Area and Elevation details for each layer. These details are used for processing the queries. To process a query we first need to identify the required information to process that query, then finding the necessary attributes in the database file and identifying the layer which are required for processing. To use two or more layers we use join and relate options. Once the layers are related, we write an algorithm which uses input data to solve user queries.

CHAPTER 5

PUBLISHING MAPS

Map publishing means we are publishing the map in a portal so that it can be available for other users. We are developing the GIS system for University of Hyderabad, so the people in the university i.e., various departments, researchers and administrators has to access this system. So rather than keeping the maps in a single system, we are publishing it in a portal, so that it can be viewed by others. Different departments need to update the maps, for example engineering section has to update the map as the new construction happens, so we are sharing the data through the portal. Once the map is updated it is available for other sections and departments. For developing maps each section should have a GIS expert, he will update the maps and publish them. So the coordination between the sections is present. Thus is decreases the chance of mistakes like digging a newly constructed road for laying the network cables etc. so by publishing system the information through maps in available to all. Similarly the users can process the queries using the published maps.

For publishing the maps we are using ArcGIS Server 9.3, this software is developed by ESRI (Environmental Sciences Research Institute). Using this ArcGIS Server we run the map as a service. It will generate a WSDL (Web Service Description Language) file, it is an XML like file. Then we write a client program and create portlet service to generate a WAR. In the next step we are using a GEON (GEO sciences Network) portal to develop a web application. By this the map will be published successfully on the GEON portal.

5.1 Arc GIS Server

ArcGIS server is the core server geographic information system (GIS) software made by ESRI. ArcGIS Server is used for creating and managing GIS Web services, applications, and data. ArcGIS Server is typically deployed on-premises within the organizations service – oriented architecture (SOA) or off-premises in a cloud computing environment.

ArcGIS server software gives us the ability to create, manage, and distribute GIS software over the web to support desktop, mobile and web mapping applications

ArcGIS server provides us with a scalable GIS server platform that can be deployed on a single machine to support small workgroups, or it can distributed across multiple servers for supporting enterprise applications. We can also deploy ArcGIS server on cloud infrastructure.

To see the maps and other geographic information integrated into websites arcGIS server is helpful. Access to GIS server is embedded inside the web application and typically hidden from the user of the application.

The ArcGIS desktop suite of applications (Arc Catalog, ArcMap, etc.) provides access to the GIS resources on the GIS server. ArcGIS desktop users can be divided into two groups: those that simply use the GIS resources hosted on the GIS server and those that are actively involved with creating and managing the GIS resources.

Once we install the ArcGIS server we can access the server from its IP address. Here we installed the ArcGIS Server with IP address 172.16.112.77, once we enter the IP address in the URL as http://172.16.112.77:8099/arcgismamager it will display login page of the ArcGIS Server Manager as shown in Fig 5.1.

The ArcGIS server will run the map as a service and it will generate a URL displaying the WSDL file. The web services description language (WSDL) file is an XML based language that provides a model for describing web services. The WSDL describes services as collections of network endpoints, or ports. The WSDL specification provides an XML format for documents for this purpose. The abstract definitions of ports and messages are separated from their concrete use or instance, allowing the reuse of these definitions. A port is defined by associating a network address with a reusable binding, and a collection of ports defines a service.

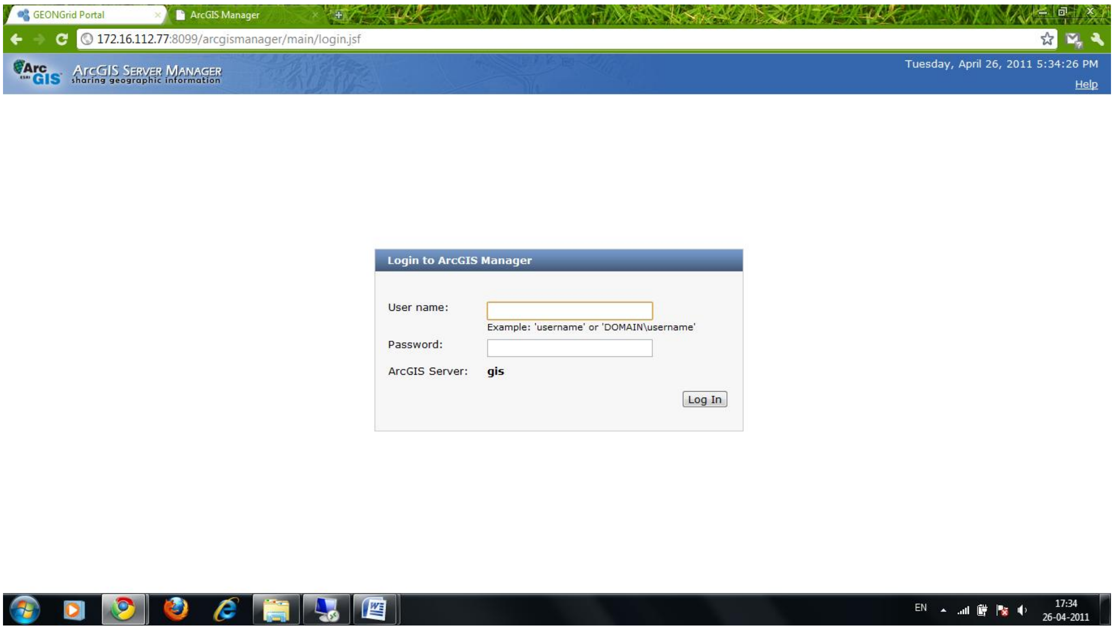


Fig 5.1: ArcGIS Server Manager Login page

After login in the home page of ArcGIS Server Manager we have an option publish a map, globe or other GIS resource as a service as shown in Fig 5.2. Select that option then it will ask for the type of service we are publishing. Select the service as ‘map service’ as shown in Fig 5.3.

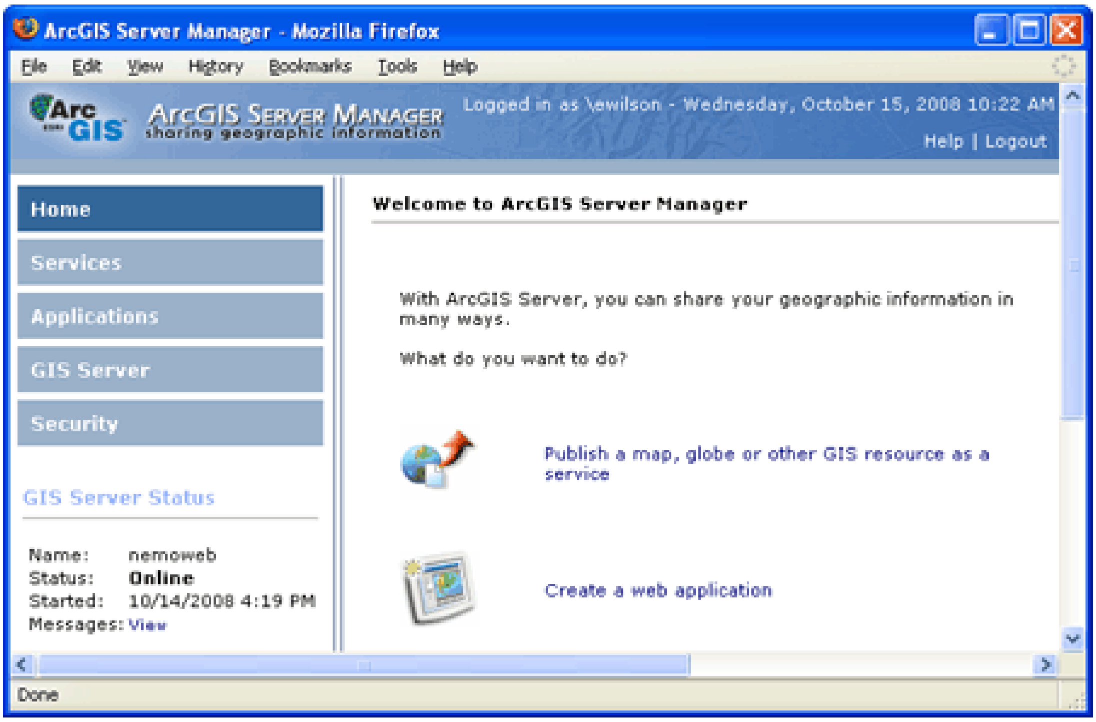


Fig 5.2: Home page of ArcGIS Server Manager

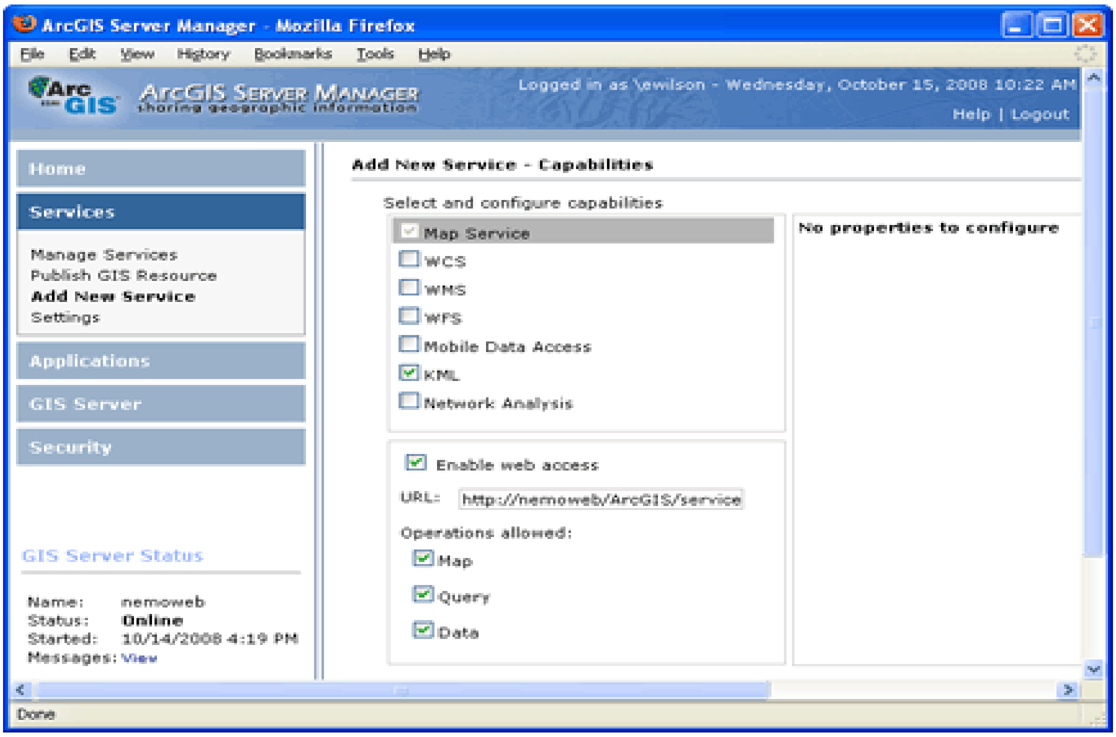


Fig 5.3: Service selection in ArcGIS Server Manager

To use the data present in the ArcGIS Desktop in the ArcGIS Server we need to administer the server from the Desktop. In the ArcCatalog we have an option to add the ArcGIS Server as shown in Fig 5.4. click add Arc GIS Server this will open a window as shown in Fig 5.5.

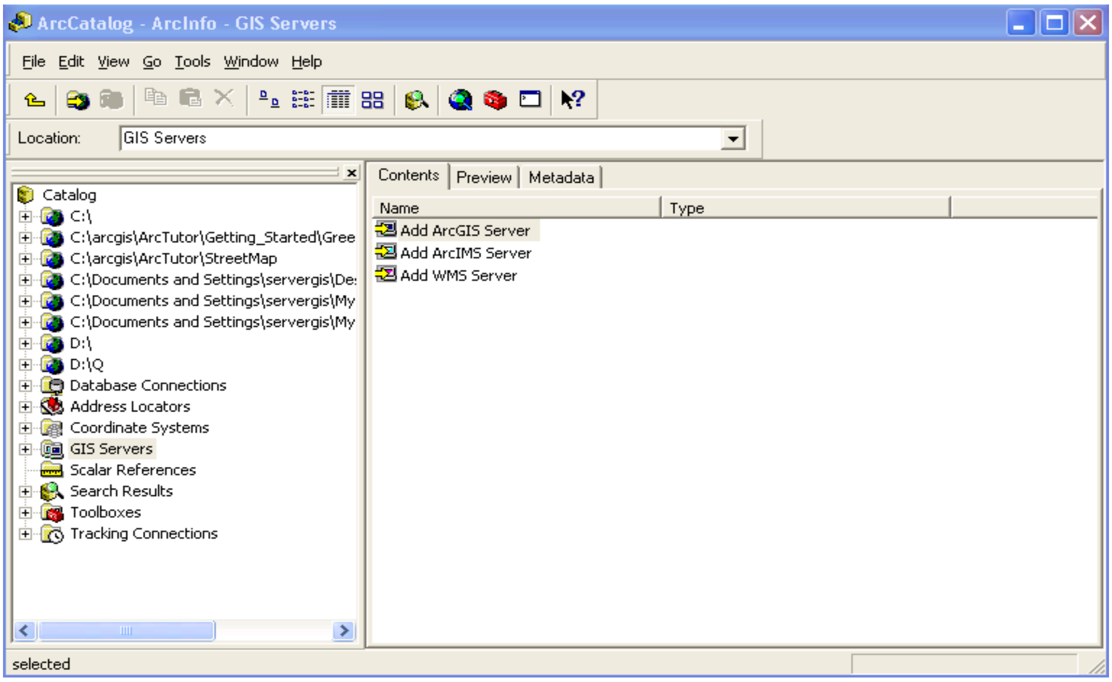


Fig 5.4: Adding an ArcGIS Server to the ArcGIS Desktop

Here enter the server name and other details. Now the ArcGIS Desktop and ArcGIS Server are connected. We can view the services running on the server from the desktop.

After the Map service is started as shown in Fig 5.3 it will generate a WSDL file in a URL. By accessing that URL we can get the WSDL file. By using this address in the GEON portal we publish the maps. Those maps are available for the entire GEON community.

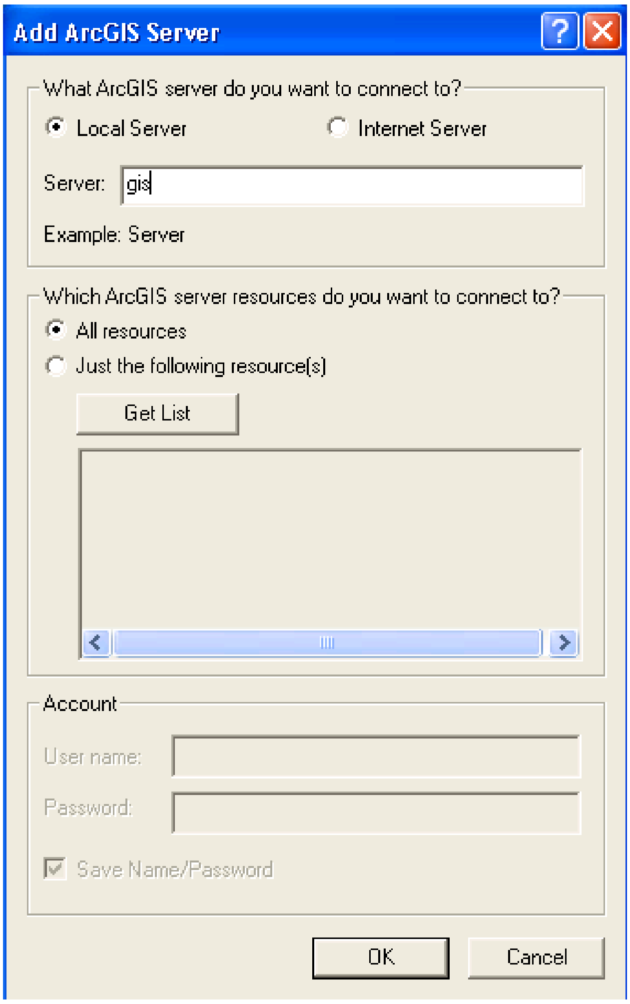


Fig 5.5: Add ArcGIS Server

5.2 Geon Portal

GEON – India is collaboration with the University of Hyderabad with their centre for Modeling, simulation and design and centre for earth and space sciences. The goal of

GEON –India is to establish a data hub at the University of Hyderabad for sharing earth science data in India, via the GEON network.

Geon is a common environment to develop and deploy grid/web service based applications, portal applications, database applications, and HPC applications [3].

GEON portal is installed in Rocks cluster software. Installtion of Rocks cluster i386 and all supporting roll are installed [15]. This builds the GEON portal, once the portal is build, we can access the GEON information from entire GEON network. Now we can create a Portlet for the University map. Using the WAR (Web application ARcheive)

Portlets are pluggable user interface software components that are managed and displayed in a web portal. Portlets produce fragments of markup code that are aggregated into a portal. Typically, following the desktop metaphor, a portal page is displayed as a collection of non-overlapping portlet windows, where each portlet window displays a portlet. Hence portlet resembles a web-based application that is hosted in a portal.

We upload the WAR file of the University of Hyderabad in the location Upload Portlet WAR as shown in fig 5.6. Then we deploy the portlet Web app, this will publish the map of University

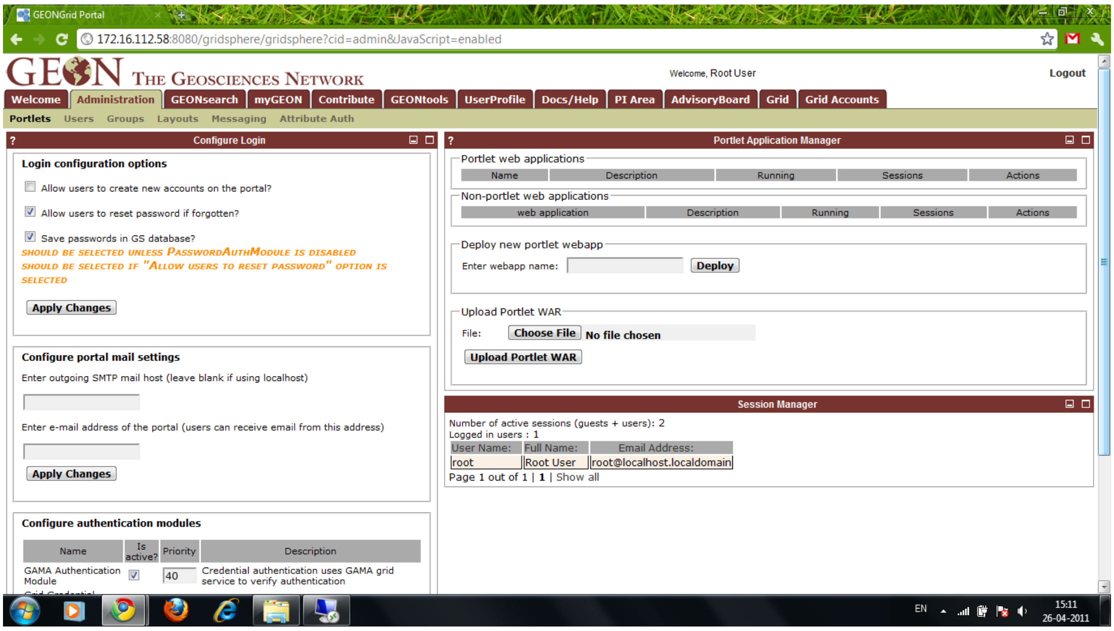


Fig 5.6: GEON Portal

A portlet is a pluggable user interface software components that are managed and displayed in a web portal. Portlets produce fragments of markup code that are aggregated into a portal.

After the successful publishing of the portlet we get the resultant published map in the URL as shown in Fig: 5.7. Using this we can view the map interactively, we can select desired layers, can ask queries to the system.

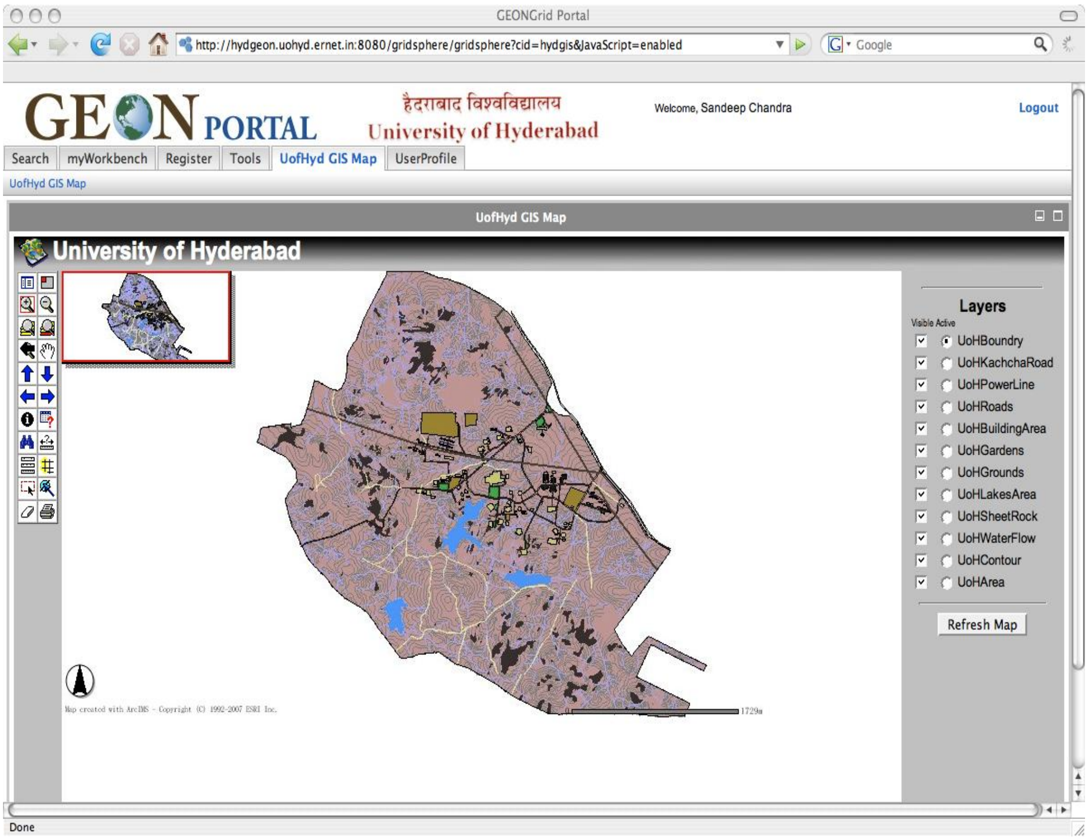


Fig 5.7: University of Hyderabad Map in GEON Portal

5.3 Discussion

In this chapter we successfully published the topomap of University of Hyderabad with all other layers created. The .mxd file (ArcGIS map file) is successfully run as service in ArcGIS Server. The GEON portal is efficient for writing portlets. Portlets produce fragments of markup code that are aggregated into the portal. Thus created portlet file is uploaded into the Geon portal, thus making our map service publish. Using this published map we can integrate between different sections and organizations.

CHAPTER 6

CONCLUSION AND FUTURE WORK

We have successfully developed a Geographic Information System for University of Hyderabad. In this we have designed a layered architecture for the University. Each layer contains some information. By superimposing one layer on the top of other gives us the new set of information. So we can get the required information by using a different combination of layers. We efficiently extracted the contour lines from the base map. By using this layer we created a 3-Dimensional fly-through model of University of Hyderabad terrain. By using this system we can able to solve some of the spatial queries such as finding the area of a region, distance between two points, possible locations for future constructions, and the constructions obstructing the natural water streams. Then we published the system using the ArcGIS Server and GEON portal. With publishing the map can be available for different kinds of users and the system can be updated.

Thus we are successful in generating a Geographic Information System for University of Hyderabad.

We can enhance this project according to the future requirements. Each layer stores its data in the Data base file in the background. Using this data we can write different algorithms to process different kinds of spatial queries. We can also add new layers such as network layer, power lines layer, and underground water layer etc. For adding those layers we need the exact location of the lines and the proper data about them. This is tough task, once the data is collected we can update them in the system and then we can able to find if there any failures just by sitting before the GIS system.

This GIS system can solve many problems, for example, in Hyderabad metro rail project due to lack of coordination the pillars are coming over the power lines. And due to lack of coordination and information many tasks are done repeatedly. So this GIS system can be used as a information system as well as used for processing the spatial queries.

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