

# LAND USE PLANNING USING GEOGRAPHICAL INFORMATION SYSTEMS (GIS)

SANTHOSH REDDY YEKOLA

Lecturer,  
Bapatla Engineering College,  
Bapatla- 522101,  
Andhra Pradesh,  
ysreddyce2001@gamil.com

DR. KIRAN YARRAKULA\*

Assistant Professor,  
Civil Engineering Department,  
Bapatla Engineering College,  
Bapatla- 522101,  
Andhra Pradesh,  
India -522101,  
kiranyadavphysik@gmail.com

DR. K. LAKSHMI PRASAD

Professor,  
Civil Engineering Department,  
BVSU Engineering College,  
Chimakurthy, Prakasam District,  
Andhra Pradesh, India,  
kolalapudi\_2000@yahoo.com

T.MADHU

Lecturer,  
Bapatla Engineering College,  
Bapatla- 522101,  
Andhra Pradesh,  
madhu.tummalapalli@gmail.com

**ABSTRACT:** Now a days the Use of Geographic Information System (GIS) has been increasing enormously. In this study land use planning has been carried out in GIS platform for Vijayawada urban city, Andhra Pradesh, India. The obligatory data for urban planning have been collected from Vijayawada-Guntur-Tenali-Mangalagiri Urban Development Authority (VGTUDA). During the execution of the work Geo - Referencing, Digitization and Attributing of different layers have been carried out. Finally overlapping of all features has been carried out in GIS platform. From the output 'Coverage map', one can easily understand the existing features of the city like aided high schools in the city, water distribution network, slum location, railway network etc. which are useful for the decision makers to implement management strategies in GIS platform and suggestions are also incorporated for the development of Vijayawada city.

**KEY WORDS:** GIS, VUDA, DBMS (DATA BASE MANAGEMENT SYSTEMS)

## 1. INTRODUCTION

Geographic Information System (GIS) is a system for capturing, storing, analyzing and managing data and associated attributes which are spatially referenced to the earth. GIS is a highly dynamic field, growing at very rapid pace of technological change and increasing number of applications (Davis, 2001). 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 technology can be used for scientific investigations, resource management, asset management, environmental impact assessment, urban planning, cartography, criminology, history, sales, marketing, and logistics. Table 1 lists a few of business sectors and how GIS technology can benefit them (Boyles, 2002; Harder, 1997; Tomei L, 2008). This serves to demonstrate the wide ranging applicability of GIS technology for business.

Table1: Applications of GIS Technology

Business Sector	GIS Contribution
Banking	Measuring market potential
Dental supply	Realigning sales territories of sales people
Food (Supermarkets)	Efficient delivery methods for food purchased via the web or by Phone order to homes.
Health (Gyms)	Evaluating suitability of sites for new gyms.
Healthcare	Evaluating healthcare resources, analysis of demand for specific treatments by location to better serve the public (Koch, 2005; Lang, 2000).
Insurance	Establish the value of real estate property to be insured.
Publishing (Newspapers)	Increase newspaper readership by targeting new subscribers; Mapping courier routes
Real Estate	Determining where to locate commercial real estate – new shopping centers, new stores, by analysis of demographics and competition (Longley, Clarke, 1996).
Retailing	Mapping customers, and providing custom advertising

GIS might allow emergency planners to easily calculate emergency response times in the event of a natural disaster, GIS might be used to find wetlands that need protection from pollution, or GIS can be used by a company to site a new business to take advantage of a previously undeserved market. In this study GIS was used for the application of urban planning to the Vijayawada city.

The area for which GIS is to be implemented, must have its features in the form of a picture. The picture may be a topographical map, AutoCAD Drawing or satellite imagery. The data required for carrying out the project was collected from Vijayawada Urban Development Authority (VUDA), in the form of 'AutoCAD drawings' and 'Ms Word documents'. Different kinds of data like, data pertaining to Road, Railway, Canal networks, Ward boundaries, Slum areas, Origin and Destination points etc., and their attribute information that is existing statistics, proposals were collected. The main steps involved for executing the project are (1) Geo Referencing (2) Digitizing, and (3) Attributing.

## 2. GEO REFERENCING

Rectification involves the initial processing of raw image data to correct for geometric distortions, to calibrate the data radiometrically, and to eliminate noise present in the data (lillesand, 2004). First the area under consideration should be geo-referenced, that is. its position must be fixed with respect to latitude and longitude correctly. For this purpose, the field survey has been performed at different locations of Vijayawada city with GPS (Global Positioning System). In this study for the rectification of the AutoCAD map, four different locations on the road network, for., Benz circle, intersection point of Eluru road with MG road, Ramavarappadu

circle and other point nearer to the Milk project are considered. Generally two types of data are to be required for geo - referencing that are Raster data and Vector data

2.1. Raster Data:

Raster data refers to data that are stored as multi-dimensional arrays. It contains a matrix of values representing the attribute property or properties (e.g. temperature, pressure, ozone concentration) at the locations where the matrix elements locate. The spatial property (that is. the location of each matrix element) of raster data is implicitly included in the spatial arrangement (that is. relative positions) of the matrix elements

The scanned image of any picture comes under Raster data, for., files of format .jpeg, .Mpeg, and .tiff. This type of geo referencing needs the image or picture to be scanned and later open it in the “Arc Map”. Having known the latitudes and longitudes of different points on the image, the raster image is geo referenced, using the “Geo Referencing” toolbar. In this study the AutoCAD drawings are collected from Vijayawada urban development authority and prepared these drawings into GIS format.

2.2. Vector Data:

Vector data refers to data that represents the spatial configuration of geospatial features as a set of directed line segments. It is usually used to represent such features as rivers, contours, profiles, transportation lines, and boundaries of natural and political regions.

In order to Geo Reference the AutoCAD drawing, it needs to be converted into a file format that is recognized by Arc GIS. Hence the AutoCAD drawing is to be converted into a “coverage file”. For this purpose, a folder is created first and the AutoCAD drawing is copied into it. The drawing is changed to “.DXF” file and is saved into the same folder. After saving the drawing, ‘Arc Work Station’ is started and the .DXF file is converted into a coverage (arc) file, using a series of commands and operations. Four Tics (points) are generated namely 1, 2, 3, 4 (Fig.1) which are to be placed on the chosen four points on the road network as stated earlier. Now, the coverage file is geo referenced using four ‘Tics’ developed. They are individually selected and using the ‘drag’ option, they are placed exactly on the four known points, by ‘continuous zooming and dragging’. Later, the latitude and longitude values are entered for the four points and the file is saved. The so saved coverage file is opened in the Arc Map. Thus an image is formed, as shown in fig.3, which shows the values of latitude and longitude of all the points on the map, wherever the cursor moves on. Thus, each layer for., Road, Railway network, slums is separately geo referenced and saved.

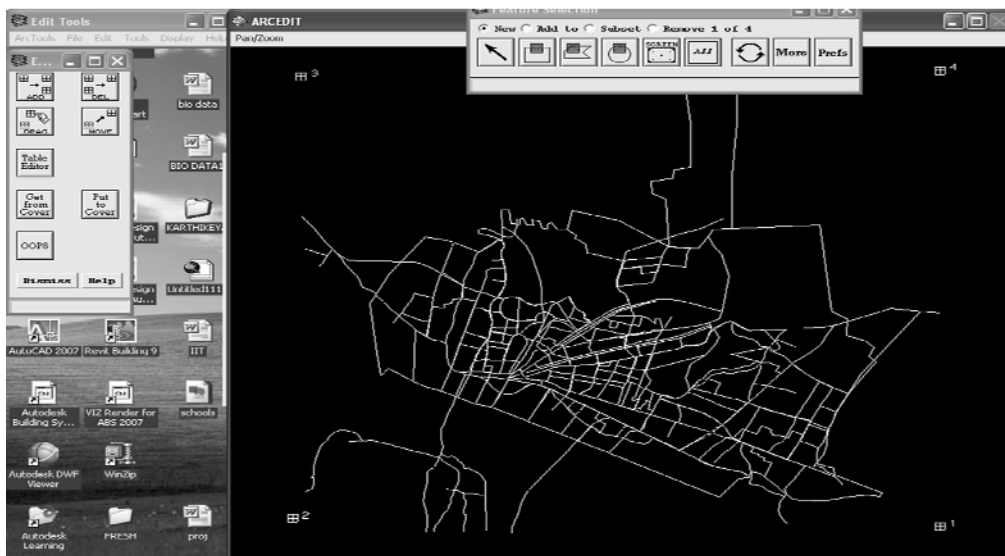


Fig.1: Geo Referencing of the Vector Data

3. DIGITIZATION

The final step of digital image formation is the digitization. This means sampling the gray values at a discrete set of points, which can be represented by a matrix (Bernd jahne, 2005). Each layer of the map is geo referenced with respect to the road network, that is. Whether it is slums or canals or whatever it may be, they are geo referenced along with road network, since the known points are taken on the road network. Hence to have a particular identity of each layer, it is to be digitized, excluding the road network.

A feature on a map can be identified either by a shape of a polygon, or a line, or a point. Three types of files are available to generate such shapes.

1. Shapefile , 2. Personal Geo Data Base (PGDB) (Grey), 3. Coverage file (Yellow).

3.1. Shape file:

The shape file format is used commonly in Geographic Information Systems (GIS). The format was developed by Environmental Systems Research Institute (ESRI), and is tied to their Arc View and Arc GIS products (Ben Fry, 2007)Shape files are simple because they store primitive geometrical data type of points, lines, and polygons. These primitives are of limited use without any attributes to specify what they represent. Therefore, a table of records will store properties/attributes for each primitive shape in the Shapefiles. Shapes (points/lines/polygons) together with data attributes can create infinitely many representations about geographical data, and depiction provides the ability for powerful and accurate computations.

3.2. Personal Geo Database (PGDB):

Geo database is the latest spatial data format commonly used, with all map data stored in relational database format. The personal geo data base is built into Arc GIS and uses the Microsoft Access database engine (Kurland, 2007).

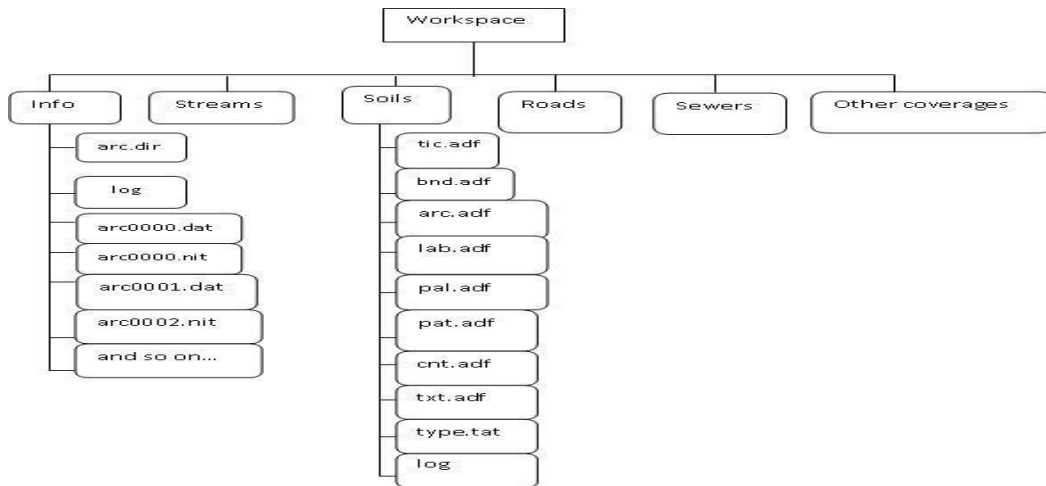
3.3. Coverage file:

Coverage is stored in the computer as a directory. The directory name is the coverage name. An organized collection of coverage is called a workspace. Coverage is composed of a set of files, each of which contains information about a particular feature class. The set of files stored in coverage varies depending on the feature classes present in coverage as shown in **Table 2**. For example, the illustration below shows a workspace that contains a number of coverage's. The directory structure and files contained in the coverage, soils, are shown in Table2. Note that this coverage contains polygon features and an annotation subclass, type.

Each coverage workspace has an INFO database stored under a subdirectory, info. Each .adf file in a coverage folder is related to a pair of the .dat and .nit files in the INFO folder. The arc.dir file in the INFO directory is used to keep track of which pair of .nit and .data files is related to which .adf file. Out of these three, 'Shape File' is most suitable to create and it occupies less space. The creation of such files is done in "Arc Catalog". 'Arc Catalog' is opened, a shape file is created and a name is given for the shape file, depending upon the layer to be digitized, for., 'Road' for road network and 'Slums' for digitizing slums, and is added to the Arc Map.

According to the shape file created, the respective coverage layer of the map is also added to the Arc Map. Keeping the 'Editor' toolbar in 'Start Editing' mode, all the layers are individually digitized by creating individual shape files. The digitizing of 'Ward Boundary' can be seen in **Fig.2**. A shape file called 'Ward Boundary' is created and its respective coverage file developed is added to the Arc Map and the digitization is carried out. The edits are finally saved and stopped.

Table 2: Coverage of work space



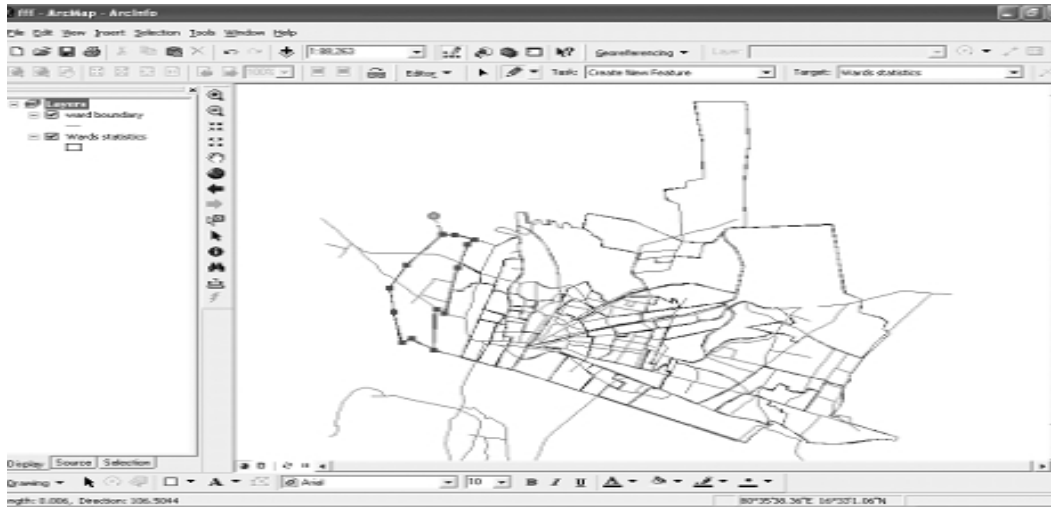


Fig.2: Digitization of coverage map

#### 4. ATTRIBUTING

Attributes are alphanumeric data that are associated with features and are typically stored in separate databases (some systems do integrate graphics and text). Attributes hold a variety of additional information for features (Glenn E. Montgomery, 1993). Attributes are descriptive data providing information associated with the geometrical data, and these are usually managed in external or internal GIS database management systems (DBMS) (Markus, 2008).

GIS relates database records and their associated attribute data to a physical location, thereby creating a "smart map". Visualization of discrete parts of these data on a GIS map is possible by layering the data into different "themes" like aided high schools in the city, water distribution network, slum location, etc.). GIS applications can then display the intersection of various "themes", as well as the spatial relationships between various features (Vanier, 2004).

Once all the layers are digitized, they are attributed that is. the statistical data regarding each layer is attached to it by entering the same in the 'attribute table'. The 'Attribute Table' of each of the shape files is opened. Depending on the data collected, other fields of the attribute table are created and shown in **Fig 3**. The collected data is then entered into all the columns of the table. Thus Attribute tables showing the existing data as well as the proposals data for each layer are prepared. The edits are saved and stopped. As the attribute table of a layer having both the existing as well as the proposals data will be too long, separate layers and tables are formed for both the data. In an empty Arc Map document, all the layers are opened or otherwise all the layers are 'Overlapped' to have an analysis of complete layers. By selecting or 'ticking on' the layers we wish, we can view the whole data regarding the respective layer. The layers can also be individually added to the Arc Map and analyzed, if overlapping of all the layers becomes cumbersome.

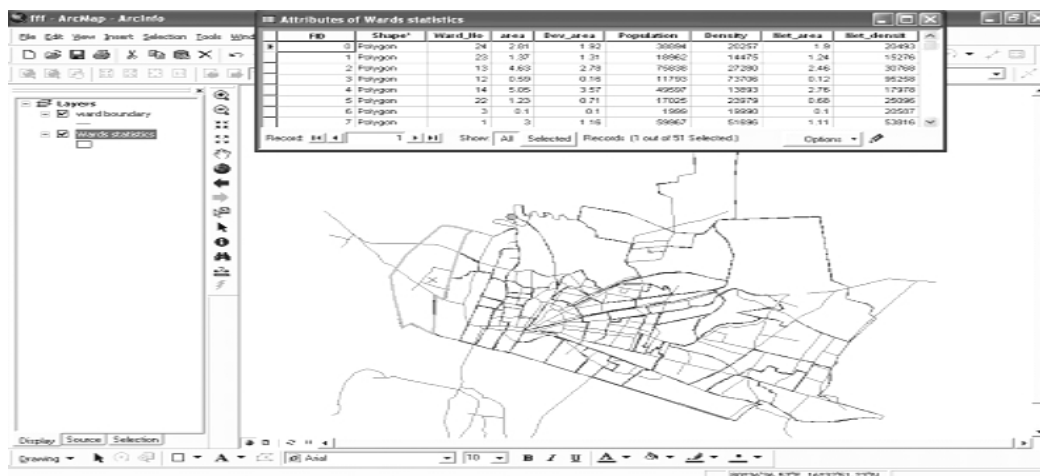


Fig.3: Attributing the Collected Data

5. APPLICATIONS

The GIS setup is now ready for implementation. It is used for the analysis of various layers as following: Fig.4 shows the location of various ‘Aided High Schools’ in the city. All the details of each school are known from the attribute table like, its name, location, total strength, staff particulars etc. The wards, which are far flung areas of the city (like wards 24, 23, 1, 46...) have got no high schools with them and hence needs the attention of policy maker for establishments of high schools. A command “total<=200” is given and all the schools having their total strength less than 200 gets highlighted in the map along with their attributes as shown in the figure 8. Hence the public can easily choose the ‘best school’ that suits them by knowing different details through such kind of operations. Moreover, the government can easily identify the schools with lack of proper standards, by such ‘commands’, and include them in its development schemes.

Fig.5 shows the statistics of water distribution network along different wards. One can simply know the intensity of water distribution for various wards. From this the ratio of ‘population’ to number of ‘public taps’ is calculated and found that ward 10 becomes the best served area and ward 2 becomes the least served area

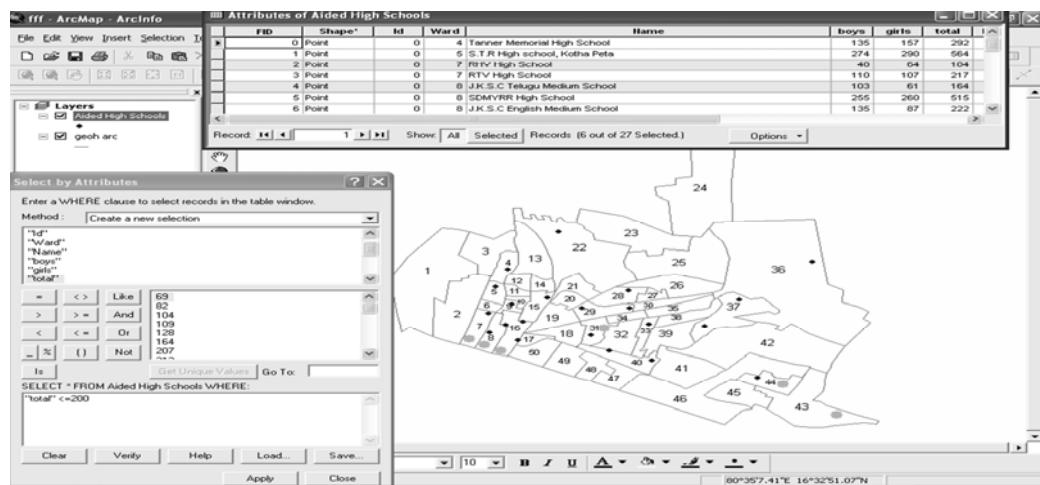


Fig. 4: Aided High Schools in the city

. Also in the areas where there are less house service connections, public taps and hand bores should be more. But the situation is found to be quite contrary in most of the wards like in wards 15, 28, 21 etc.

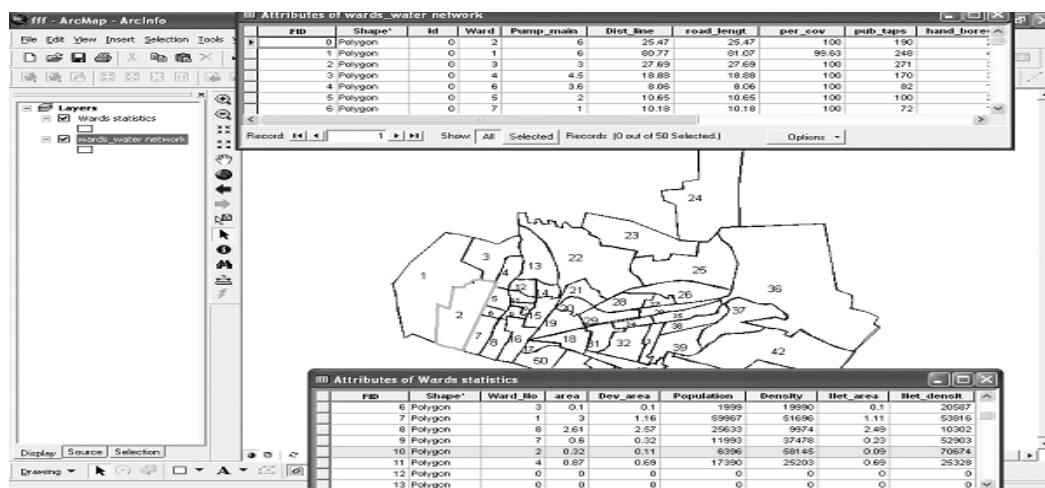


Fig.5: Water Distribution Network

In Fig.6, the composition of traffic at major locations of the city is given. One can know the percentage of ‘passenger vehicles’, ‘goods vehicles’ and ‘others’ along the important locations for 24 hours. Out of these, the

‘Ramavarappadu circle’ is found to have heavy traffic composition with daily moving vehicles of 29859 and the ‘Vijayawada-Milavaram’ road has got minimum traffic volume with daily moving vehicles of 5536.

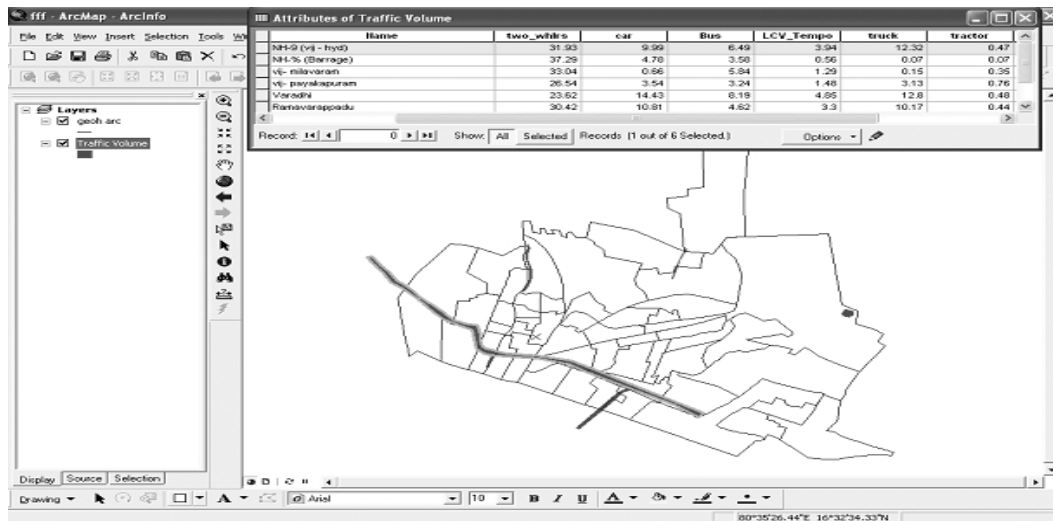


Fig. 6: Traffic Composition at Major Locations

From Fig.7, the pollution concentrations for the two main centers of the city for., ‘Benz Circle’ and ‘Patamata Road’ are shown, from the figure, it is observed that the ‘RSPM’ and ‘NO<sub>x</sub>’ concentrations at the Benz circle is more than the ‘city average’ concentrations which needs immediate attention where as for the Patamata road, they are within the reasonable limits. Hence the policy maker should plan accordingly to reduce the pollution in the area of Benz circle, by minimizing the traffic volume and planning for alternative routes of travel.

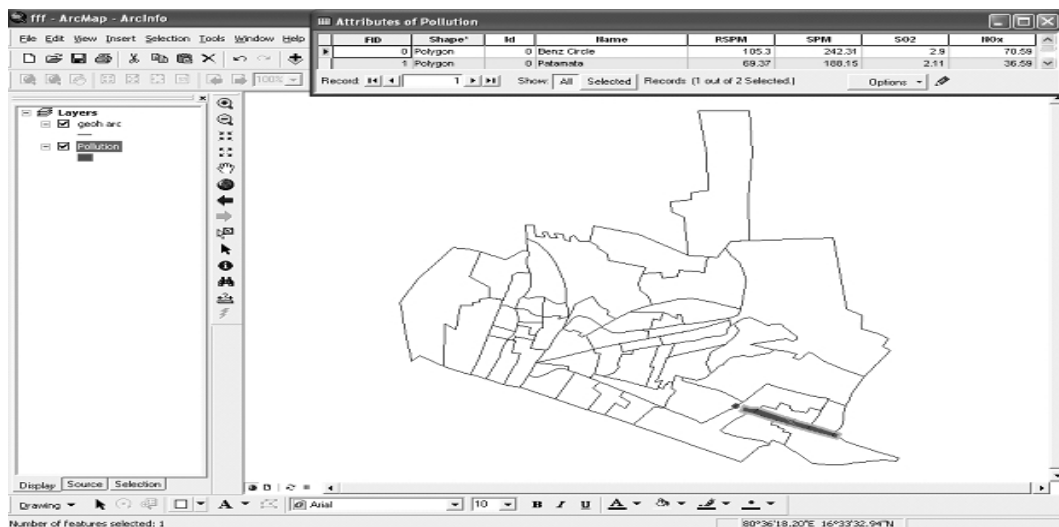


Fig. 7: Pollution Levels in Benz Circle and Patamata Road

Fig.8 shows the location of various ‘slums’ in the city. The details of all the slums for., its name, location, BPL (Below Poverty Line) families, BPL population in each ward etc. have been shown. By clicking a particular slum by the ‘identification icon’, one can get the complete details of it as entered in the attribute table. The number of slums having more BPL families is also be identified by the ‘commands’ as described earlier for the ‘Aided High Schools’ layer which is more useful for the government to implement its development schemes according to their requirements. The ratio of ‘total population’ to the ‘Number of families’ is calculated and it is found that ward 25 is likely to have more number of poor families.

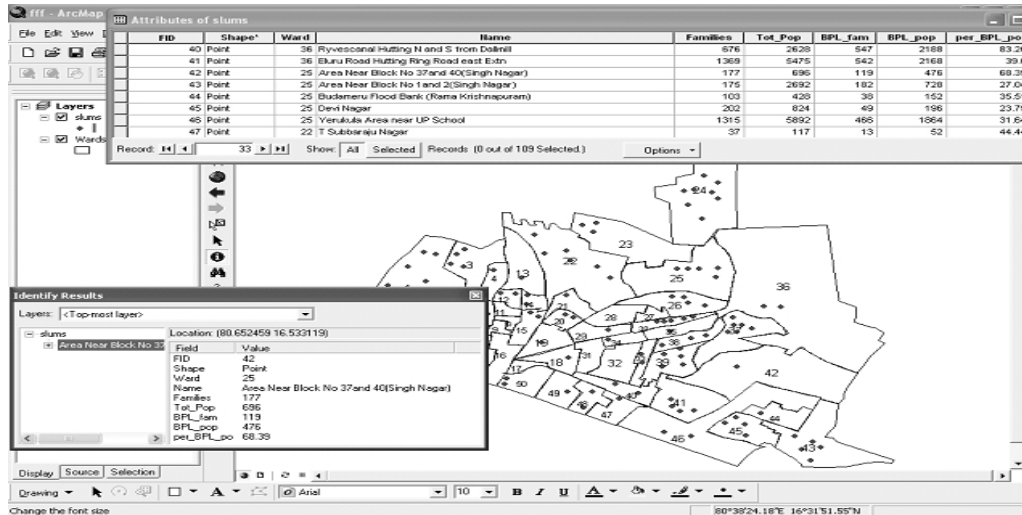


Fig. 8: Slum Locations

Fig.9 shows the distribution of 'Railway Network' across the city. The extent of commercial area in different wards is known and hence proposals for foot-over bridges and fly-overs are to be planned accordingly. Wards 25 and 26 have good commercial area and so, there is urgent need of fly-overs and foot-over bridges in these areas.

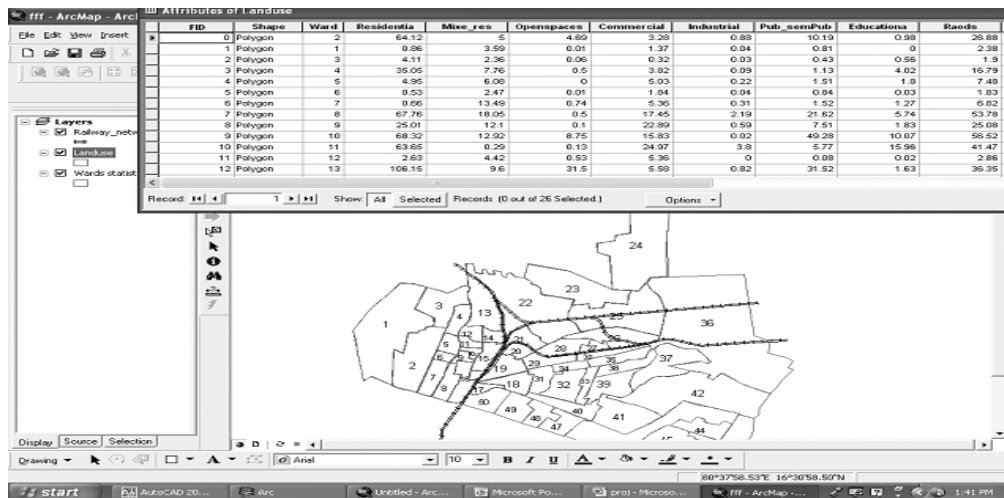


Fig.9: Railway Network

6. CONCLUSIONS

GIS, a database management system, is all pervasing effect of every individual's life. The development of land use planning for Vijayawada urban area is implemented in GIS platform by generating different layers like Aided high schools in the city, Water Distribution network, Slum location, Railway network etc. By the integration of all these information, the decision maker can come to take right decisions without wasting much time in correlating data from different sources.

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