DISASTER MANAGEMENT USING GIS TOOL FOR PANVEL MUNICIPAL CORPORATION

Submitted in partial fulfilment of the requirements

for the degree of

Bachelor of Engineering

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Academic year 2017-- 2018

ABSTRACT

Disaster preparedness and pre and post disaster management has always been a major concern for the urban area authorities worldwide. It involves collection, storage and efficient retrieval of a huge database integrated with maps for graphical visualisation. Doing this manually is time consuming & cumbersome as the size of the urban areas today has increased manifold. Disasters of varying types and combinations are being presented in front of us either by Mother Nature or by our ownself. Geographic Information System (GIS) is a very effective tool for integrating & managing various types of information required for efficient disaster management. This piece of work is an attempt to understand how GIS can be applied for making disaster management easier It also aims at developing a system which can help decisionmakers to make a proper and timely decision in case of an emergency.

Keywords— Disaster, database, GIS, decisionmakers, emergency.

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CHAPTER 1

INRODUCTION

1.1 General

A disaster is a grave occurrence having ruinous results (Webster's dictionary). The World Health Organization defines a disaster as 'any occurrence that causes damage, economic destruction, loss of human life and deterioration in health and health services on a scale sufficient to warrant an extra ordinary response from outside the affected community'. It is a phenomenon that causes huge damage to life, property and destroys the economic, social and cultural life of people.

1.2 Types of Disasters

Natural Disasters

These disasters are the outcomes of natural activity occurring in the nature & are beyond the control of human capacity. Various natural disasters are as follows:

- Volcanic eruption
- Earthquake
- Cyclone ,Hurricane, tsunami
- Avalanche
- Flood
- Drought

- Forest fire or Bushfire

Man Made Disaster:

- Fires
- Spills Utility
- Construction Failure
- Epidemics
- Crashes
- Explosions
- Internal Disturbances

The findings of Global Assessment report produced by UN office for Disaster Risk reduction states that:

TABLE 1.1: Findings of Global Assessment report produced by UN office

Description	Cost
Cost of average annual economic loss due to disasters occurring in India	9.8 billion dollars
Cost of India's Infrastructure Investment for next 5 years	1 trillion dollars
Annual global Investment of 6 billion dollars in disaster risk management can generate benefits of around 360 million dollars in post disaster mitigation and management	
From 2005 to 2015 380 natural disasters occurred in which 76416 annual average deaths	

(Source:www.indiaenvironmentportal.org/content/407005/global-assesment-report-on-disaster-reduction-2015)

On the basis of above statistics, the importance and scope of disaster management is clearly underlined. Hence, we thought of taking up this topic.

1.1 Aim of Project

To prepare a Disaster Management plan for the area under Panvel Municipal Corporation using GIS tool -Gram++.

1.2 Objective

- To study and assess the risks associated with natural and man-made disasters.
- To create a database of various facilities in Panvel city which can be sought to in case of a disaster.
- To develop a disaster management interface in Gram++ using the database created.
- To help decision makers in pre and post disaster relief and rehabilitation.

1.3 Expected Outcome

- Creation of a database of various facilities/services and which can be of use during any disaster.
- Learning of Software-GRAM++.
- Creation of a report.
- Creation of a GRAM++ based user friendly interface for pre and post disaster management which can be of great use to people of Panvel.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

During the literature review for this piece of work, we referred quite a few books on GIS, technical and research papers in various journals. This chapter focuses on the same. It briefly touches the literature on GIS technology, its components, its working, GIS data and data conversion, data analysis, data representation and GIS applications in construction industry. Literature on the past works carried out in relation to Disaster management using GIS tool is also covered under this chapter. We have tried to put down whatever we could infer at the end of the reading.

2.2 Geographic Information System (GIS):

Geographic Information System (GIS) is a computer based tool which can be used for capturing, storing, analyzing, querying and displaying the geographic information. Although the two terms, data and information, are often used indiscriminately, they both have a specific meaning. Data can be described as different observations, which are collected and stored. Information is that data, which is useful in answering queries or solving a problem. Digitizing (process of creating replica of an existing map in GIS environment) a large number of maps provides a large amount of data after hours of painstaking works, but the data can only render useful information if it is used in analysis.

GIS can be used extensively to solve various engineering problems related to spatial data (Bansal and Pal, 2006). These include problems of construction industry involving complex visualization, integration of information, route planning, E-commerce, cost estimation, etc.

- **Points**: for showing point features like post office, fire stations, buildings, lamp post etc.
- **Lines**: for showing linear features like road, railways, telephone lines, sewer lines etc.

- **Polygons**: for showing area features like plot, lake, open grounds etc.

Non Spatial or Attribute data refers to the properties of spatial entities. They are often referred to as non-spatial data since they do not in themselves represent location information. This type of data describes characteristics of the spatial features. These characteristics can be quantitative and/or qualitative in nature. Attribute data is often referred to as tabular data. The GIS attributes are represented using colours, textures and linear or graphic symbols. The actual value of the attribute that is measured or sampled and stored in the database is called Attribute Value.

Traditionally, there are two GIS **spatial data models** used to store data in a GIS for both kinds of abstractions mapping references:

- Raster Data Model
- Vector Data Model

2.2.1 Raster Data Model:

Raster data represents geographic data by discrediting it equally spaced and quantizing each raster cell. A raster cell is often also referred to as a pixel (picture element). A pixel can hold data values within the specified possible range or color depth of a raster image or raster geodata set. This data value can represent a color or gray value, depth or height, measurements or any other thematic value, such as an index to a Landover class. Raster cells are usually organized in a matrix (rows and columns). By specifying the coordinates of the raster origin and the spatial resolution of a raster cell, the spatial position of each cell within the raster grid can be easily calculated.

Logically, raster data are organized into layers, which are also variously called bands, themes or overlays (Refer Figure 2.1). Depending upon the application objective, a raster geographic database often contains multiple layers of data. Each of the layers depict a specific characteristics of Earth‟s surface, such as land use, elevation, soil type, hydrology or vegetation cover. In each raster cell, there is one and only one thematic attribute or value. For application in GIS, these layers must be spatially registered with one another and geo-referenced to a particular map coordinate system.

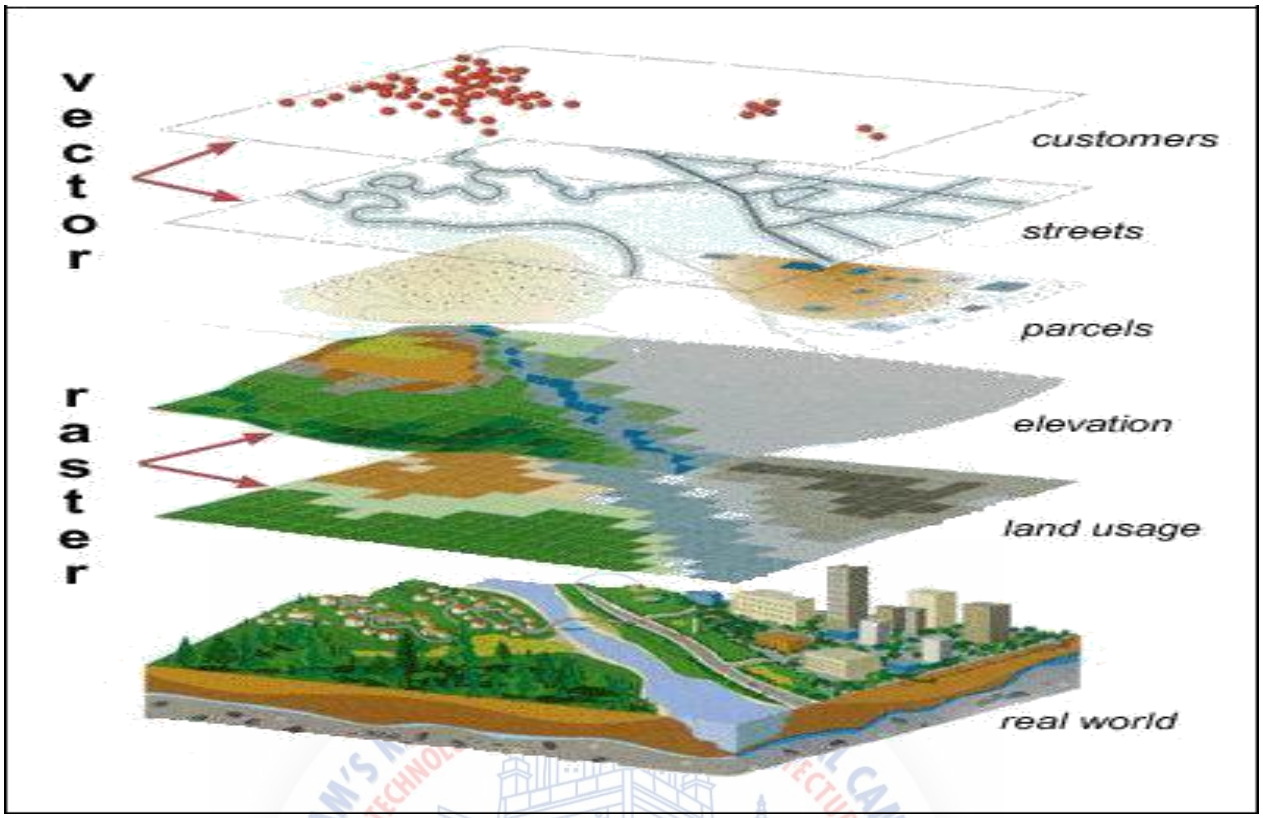


Figure 2.1: Vector and Raster models of GIS

(Source: http://gislearningforyou.blogspot.in/2012/06/introduction-to-gis.html)

2.2.2 Vector Data Model:

Vector data in a digital geographic database depict individual spatial features as discrete entities using three basic graphical elements: points, lines, and polygons. In the database, these entities are identified as feature classes, each pertaining to a particular theme, such as drainage, vegetation, topography, transportation, land parcels, and administrative boundaries. Vector data, therefore are used for GIS applications that focus primarily on the characteristics of individual classes of spatial features in a particular geographic area of interest.

In a digital vector database, feature classes are logically organized as layers (Refer Figure 2.1). Since each layer is allowed to have only one type of graphical element, feature classes are also organized according to graphical element type by default. Functional primitive unit of vector data is a point. Arcs are created by connecting these points with straight lines, thus defining the different areas as seen on the earth's surface.

Environmental Systems Research Institute (ESRI), Inc. and Intergraph Corp. are the pioneers in the GIS industry in terms of software market and software revenues. The main software product from ESRI, Inc is **ArcGIS**. Another software named **Gram++** developed by **IIT Mumbai** is used for data integration, query display, data editing and some additional analysis and data editing facilities. (Kolagotla,2008).

According to **ESRI**, a GIS is defined as an 'organized collection of computer hardware, application software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographic referenced information'.

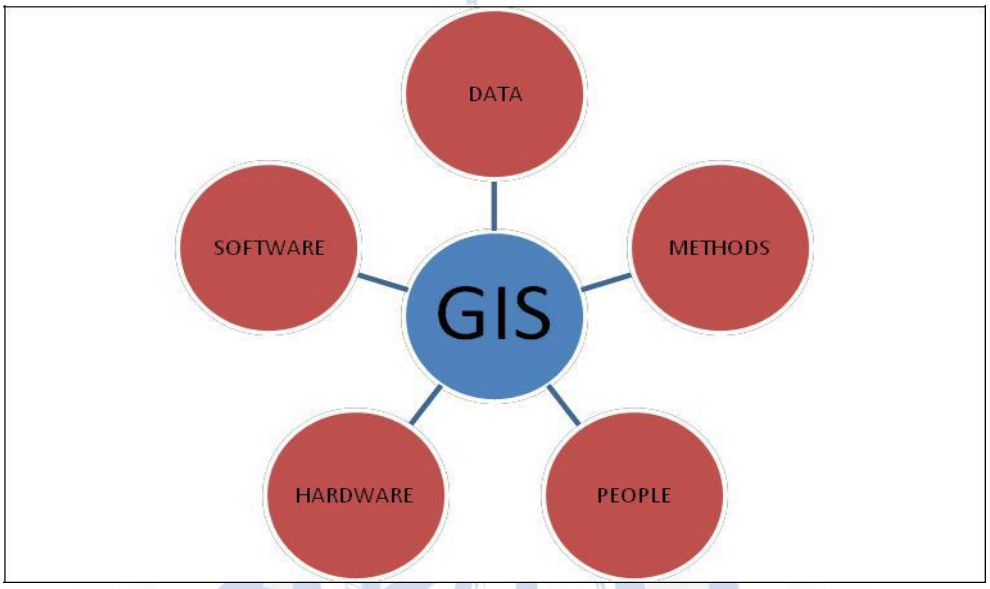


Figure 2.2: Components of GIS

2.3 Applications of GIS

- **Emergency Response:** GIS helps locate where help is needed and helps in finding the shortest route for the responders to get there.
- **Utility:** Power, Telecom, Oil and Gas companies use GIS to map and manage their networks.
- **Urban Planning:** Planners use GIS to monitor city growth and identify areas of future development.
- **Insurance services:** Insurance companies can process claims much faster and accurately, if they have access to mapping data and geographical information. Buyers benefits from reduced premiums and faster settlements.

- **Wildlife management:** GPS tracking of animals to study their habitat and migration patterns. GIS helps to identify ways for wildlife conservation and optimal use of resources.
- **Healthcare:** Using GIS one can identify a possible epidemic outbreak and take preventive measures. Officials use GIS for planning healthcare facilities that are accessible to more citizens.
- **Marketing:** Helps business sell and direct their products to the right market using GIS datasets and analysis tools.
- **Disaster relief:** Remote Sensing, GIS and field GPS units can help locate victims and speed rescue efforts.
- **Tourism:** First thing you do when travelling to a new place is to buy a map, right? By using GIS and web-mapping services, tourism authorities, travel agents, hoteliers and others can provide accurate and relevant information to travelers.
- **Finding local information:** People can search for local information, places to eat, shop and visit. A GIS database enables searches like 'restaurant within 2 km from here'.
- **Getting directions:** This has become very common these days to the extent that we use it almost everyday.
- **E-Governance:** Land Information Systems uses GIS to create and manage digital land records. Governments all over the world use it to manage the land parcel database. Citizens benefit by getting accurate, timely and easy access to property information.
- **Military / Defense:** Remote sensing techniques have been used for decades for surveillance and reconnaissance.
- **Agriculture:** Surveying soil conditions, analyzing crop patterns and using GPS-enabled field instruments to better manage agriculture produce.

- **Real Estate:** Developers benefit from getting quantitative information on market needs and existing infrastructure. Agents use mapping services to help clients find the right property by applying location constraints (near to school, within 15 minutes' drive to workplace etc.).
- **Transport / Delivery services:** Using live GPS tracking and GIS tools, companies can manage their fleet efficiently.

- **Archaeology:** Using spatial analysis techniques and visual interpretation of aerial imagery, archaeologists can discover potential sites, and manage the excavations.
- **Power:** Electricity companies use GIS extensively in planning and managing their assets, laying networks and monitoring usage.
- **Hydrological Modeling:** GIS adds spatial dimension to hydrological modeling and helps predict water levels in rivers/lakes, rain water runoff, ground water availability and better manage water levels.

According to ESRI, **GIS applications in Civil Engineering** are as follows:

- Locating underground utilities.
- Civil infrastructure management.
- Construction Scheduling and progress monitoring.
- Maintaining land records.
- Designing alignment for freeways and transit.
- Watershed analysis.
- Route generation and urban planning.
- Communication and tracking of Construction vehicles.
- Construction waste collection and locating disposal grounds.
- Locating public facility areas.
- Locating points of frequent accidents on roads.

2.4 Status of GIS in India:

The first GIS users in India in the early 90s were mostly national mapping agencies, educational and research institutes. Several government pilot projects like NRDMS, IMS, NNRMS and Defense projects started using GIS concepts. While the early focus was on government managed projects, it was the Universities that played a major role in creating interest among students about, the use of GIS and spatial technology (Kolagotla,2008).

During the year 2000, India started to face a volatile GIS growth fueled by increasing work opportunities, availability of competent workers, development of powerful GIS software and a rapid increase in the awareness of GIS among all the stakeholders. It is heartening to note that by and large, around 35 GIS related conferences were organized in India during the year 2000.

GIS now aids in providing better operational efficiencies, decision making at the level of planning and modeling and helps organizations to communicate better. The growth and development of a nation largely depends upon the ability of the decision maker and to use the information available to them for optimum benefit. Hence it is high time that various societies and organizations dealing with Geomatics industry in India must come to a common platform and provide thrust to inculcate awareness of the GIS potential among cross section of people either in Government or academics or industry.

2.5 Application of GIS in Disaster Management

Disaster Management needs pre and post-disaster planning. This needs an extensive study of various aspects of an area ranging from the demography to the topography, climate, location,etc. GIS being inherently geographic possesses considerable potential for pre and post disaster management. It is required to understand the process of adaptation of GIS to disaster management through the:

- identification of types of disasters which can be managed by adapting GIS;
- review of current applications of GIS concepts for effective disaster management;
- discussion of issues affecting the design and implementation of GIS to the disaster management process.

To do this we referred to quite a few research papers. The findings of the same are mentioned in the paragraph to follow.

To start with our work, it was necessary to examine and evaluate the so far accomplished work in relevant fields of various natural and manmade disasters. This helped us to identify the thrust areas and pave necessary way for future research (Krishnamurthy, 2016)[1].In case of an emergency, with the help of GIS-based maps the requirement of food, camps, water, and required relief shelter can be provided for the selected study area. The basis for damage allocation assessment and consequent provision of compensation and fund allocation for required infrastructural improvement can be developed using the present GIS-based disaster management strategy (Rifaat Abdalla *et al* 2014)

The knowledge of soil properties and its behavior under different set of conditions if known well in advance can be of great use for pre-disaster management and planning. Mhaske and Chaudhary[2] (2011) have discussed the typical application of GIS based software GRAM++ to obtain the thematic maps of soil index properties such as specific gravity, moisture content, liquid limit with depth of water table for Mumbai city. The usefulness of the integration of GIS–GPS technology and the thematic maps prepared for various soil index properties has been clearly demonstrated through their work. The GIS based digital database for city like Mumbai will also help to reduce the planning time and can provide economic design alternatives at a particular site. However, it is true that the generated GIS maps cannot be the total replacement for soil exploration but definitely will help the exploration agencies to make proper planning with minimum loss with a gross validation of soil properties for Mumbai city.

Before carrying the soil Index maps, the same authors have studied the liquefaction susceptibility of various soil samples across the city of Mumbai and prepared a GIS-based soil liquefaction susceptibility map of Mumbai city for earthquake events.Several borehole test data, both undisturbed and disturbed soil test reports of Mumbai city were collected to carry out the analysis for liquefaction of soil at various earthquake moment magnitudes ranging from M_w = 5.0 to 7.5.

The soil profile between 2 m to 4 m below ground level is mostly very loose to medium dense cohesionless soil and ground water depth is fluctuating from 1.5 m to 2.0 m below ground for typical sites of Mumbai city. From results it is found and recommended that the areas like Borivali, Malad, Dahisar, and Bhandup may be prone to different types of liquefaction for earthquake moment magnitudes ranging from M_w = 5.0 to 7.5. These areas are developed on reclaimed land along sea or creek shore, which can be easily identified through Google Earth images. These maps with results and recommendations will benefit the designers and practicing engineers for further use in detailed analysis before any civil construction to check the vulnerability of the proposed work with respect to the liquefaction of soil at a particular area of Mumbai city (Mhaske and Chaudhary, 2010)[3].

On the basis of the three papers mentioned above, we inferred that an integrated approach to Natural Disaster Assessment can be done by the study of 3 main components (i.e.Literature review, Historical event review, Post-disaster field research and modeling).Doocy and Gorokhovich (2008)[4] further strengthened our inference. They have described the three components as:

Literature review: It includes a systematic review of scientific journal articles, newspaper literature, and key publications in the field and aims to identify a comprehensive list of population and environmental risk factors for natural disasters.

Historical event review : It focuses on characterizing spatial and temporal patterns of select types of natural disasters, including floods, tsunamis and tidal waves, tropical storms,etc.and determining relationships between characteristics of each event type and impact on the human population in terms of mortality, injury, and displacement.

Post-disaster field research and modelling —Post-disaster assessments helps to integrate geographic information systems (GIS) with population-based surveys and aims to characterize the status of the affected population as well as identify risk factors for displacement, injury, and mortality in the population.

The authors have assessed risk associated with natural disasters and provided information on affected populations to the decision makers.

For carrying out effective pre and post disaster management, we need to have a strong baseline data. For doing this, the four key characteristics of comprehensiveness, accuracy, timeliness and accessibility is necessary. A strong database can help in designing an effective disaster management system that can promote the future safety and well-being of the public in urban areas irrespective of the scope and nature of the disaster. The authors had developed a similitude model using GIS which predicted a flood in Huwaie river in 2003.This when associated with remote sensing could give better results to the authors.(Laefer *et al,* 2006*).*[5]

Visualisation of the losses that can occur or the extent of area that can get affected because of a particular disaster can be of great use to the emergency managers.GIS gives him this ability. Another advantage of the visual image is that nontechnical observers will be able to understand the information provided without extensive training. The major drawback to a GIS based disaster management system such as this is effective implementation. Each site has to be identified, added to the appropriate database, and located on the map. This consumes lot of time and manpower (Gunes and Kovel, 2005)[6].

The topography of the area which gets affected due to any disaster has a major role to play in the pre and post disaster planning and management. With the help of GIS-based maps, the requirement of food, camps, water, and required relief shelter can be provided easily in the hilly areas. Knowledge of various routes/ways and methods of providing relief proves to be of great use especially in areas with difficult terrain. The basis for damage allocation assessment and consequent provision of compensation and fund allocation for required infrastructural improvement can be developed using the GIS-based disaster management strategy devised by the authors (Oberoi and Thakur, 2005)[7].

Each and every component of the human society if gets involved in the pre and post disaster management can surely create wonders. The involvement of bilateral and multilateral agencies in the recovery and reconstruction program following major natural disasters has helped developing countries undertake long-term disaster mitigation and preparedness. After the Latur earthquake in 1993, the state of Maharashtra, India undertook an important initiative for the preparation and implementation of a disaster management plan for the state (Vatsa and Joseph, 2003)[8].

2.6 Gaps and Findings

After referring to the research papers described above, we found that the pre & post disaster management plans and preparedness to face any kind of disaster is seen in the foreign countries. Except for few exceptions here and there, we in India are not at all considering it as a priority. The haphazard urbanisation in India is occurring at an enormous pace without any proper planning and capacity building. These blooming (?) urban and semi-urban areas do not have any readiness to face a disaster of any kind.

Panvel, located in Raigad District of Maharashtra, India, having close proximity to Mumbai, was a Municipal Council till recent past. It was converted into a Municipal Corporation in October 2016. Our academic institution lies in the Panvel Municipal region. Thus we felt to initialize the process of creating a small model of a disaster management plan for the city of Panvel.Further,the literature reviewed help us in finalising the idea of application of GIS for disaster management as our project topic. This attempt is a part of academics and we have tried to gather as much information as we could relating to rescue and mitigation measures during any kind of disasters. The development of the concept, its utility and methodology to be adopted is discussed in the next chapter.

CHAPTER 3

STUDY AREA & RESOURCES USED

3.1 General

This chapter discusses two important aspects of this academic project; first the details of the study area and second the brief methodology for the accomplishment of project alongwith the details of the software used for the same. At the end of this chapter, the reader would have a fair idea of how the project was planned to be carried out. The actual methodology is described in detail in the chapter to follow.

3.2 Study Area

Panvel is the most populated city (1, 80,464) and also the most densely populated (around 14000/sq km) town in India (National average density 365/sq km) in Raigad district of Maharashtra, India. (*Source*: Census 2011). Panvel is situated on the bank of Gadhi River which meets to an arm of the Arabian Sea. The city is the headquarters of the Panvel sub-division of Raigad district, which is the largest in the district as per number of villages (564) including Panvel taluka which has 177 villages under it.Panvel has a literacy rate of 93.28 %.

Panvel is an important junction as many major Highways pass through the city. Mumbai-Pune Express Way, Sion-Panvel Expressway, NH-4B & NH-17 start from here while NH-4 passes through Panvel.it is also a major railway junction where the suburban services of harbor railway terminate and the operations of Konkan railway start. The upcoming Navi Mumbai International Airport (NMIA) lies in the vicinity of Panvel and Navi-Mumbai Municipal region. The development authority of Panvel as on today is the Panvel Municipal Corporation (PMC) .However, certain facilities are still provided by the City and Industrial Development Corporation (CIDCO).Panvel, about 300 years old, was developed around trade routes (both land and sea), during the Mughal rule and thereafter by the Marathas, British and the Portuguese. Once upon a time Panvel was famous for its rice market. Panvel Municipal Council (PMC) was established in the year 1852, and is the oldest municipal council of Maharashtra. The city prospered and grew due to the influence of large scale trade by land and sea.

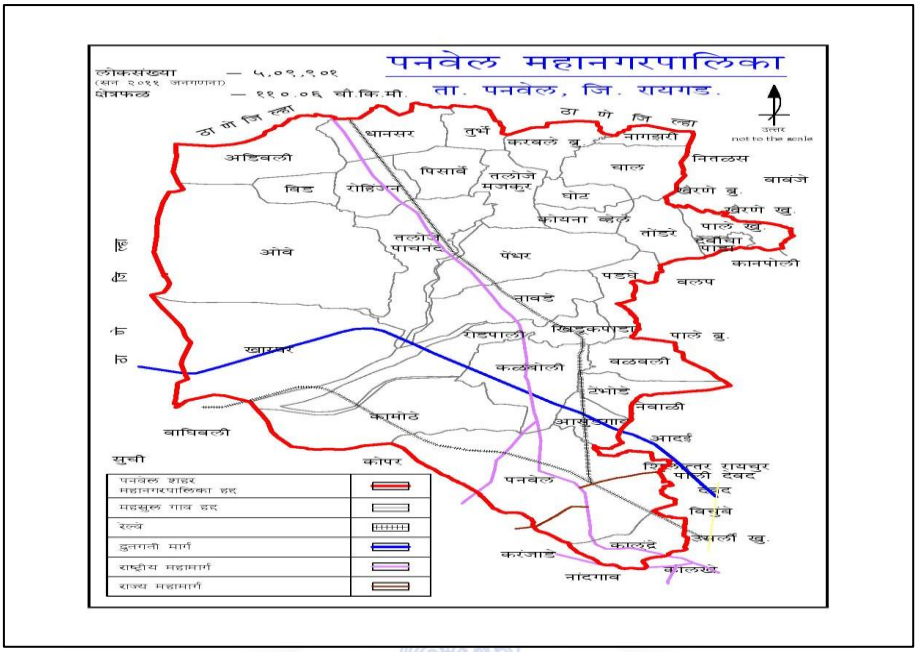


Figure 3.1 Map of Panvel Municipal Corporation

(**Source**: http://www.panvelcorporation.com/EIPPROD/singleIndex.jsp?orgid=112)

Panvel is surrounded by some Maharashtra Industrial Development Corporation (MIDC) managed major regions like Patalganga, Taloja, Nagothane, Roha and Khopoli. Some of the Indian industry majors like Larsen & Toubro Limited, Reliance, Hindustan Organics Chemicals Ltd., ONGC, and IPCL are based around Panvel providing mass employment. The development of New Panvel was initiated in 1970 to meet the housing requirements of employees working in the nearby industrial MIDC areas. The JNPT port is also located near Panvel. New SEZ declared by government is coming up near Panvel. This has direct and indirect effects on infrastructure and services of Panvel during last few years.

Following are the Coordinates of Four Corners on the boundary of Panvel Municipal Corporation. These co-ordinates will be required for the GIS based disaster management plan developed by us as a part of this academic project.

Table 3.1 Coordinates of four corners of Panvel Municipal Corporation

(used as a preliminary step for the development of a disaster management plan for Panvel)

Sr No	Name of the Point	Latitude	Longitude
1	Adivali	19°06'3.1"N	73°02'43.7"E
2	Kharghar	19°01'21.3"N	73°03'28"E
3	Nagzhari	19°47'1.6"N	72°51'33.2"E
4	Kalundre	18°58'58.4"N	73°07'46.1"E

The false coordinates are calculated by taking the mean of all the Latitude and Longitude coordinates. These are also required to be entered as a preliminary step in the software to be used. The false coordinates of the project site are confined between 73°01'22.75" East Longitude and 19°13'21" North Latitude.

The climate of Panvel is semi-arid and sub humid type having tropical monsoon atmosphere. Average rain fall is 2400mm; of which major rain falls in the month of July i.e. 800 mm. The humidity is 57% to 81% in the month of July. Panvel is located at 6.7m above sea level.

3.3 Software used

The software used for this Project is GRAM++ (Geo Referenced Area Management) Version 11.2, developed by CSRE, IIT MUMBAI.MS-Access 2003, attached with GRAM++, forms a platform for handling database. It is a GIS based tool and serves as a platform for creation of various maps and integrated databases. The recommended system configuration is Pentium II or better processor recommended for good performance, any Windows operating system and a data base management system software to handle attribute data.

The different modules that this software has are Input Output, Map edit, Vector Analysis, Network Analysis,Tin,Raster Analysis, Terrain modeling, Image processing, Statistics and Vector Layout. Out of these, Input Output, Map Edit and Vector Analysis modules were used for this project work.The next few paragraphs briefly describe about these three modules.

Figure 3.2 below shows the welcome page of GRAM++.Though it shows only five modules on the front window, but the modules which are talked of above form a subpart of these major modules.

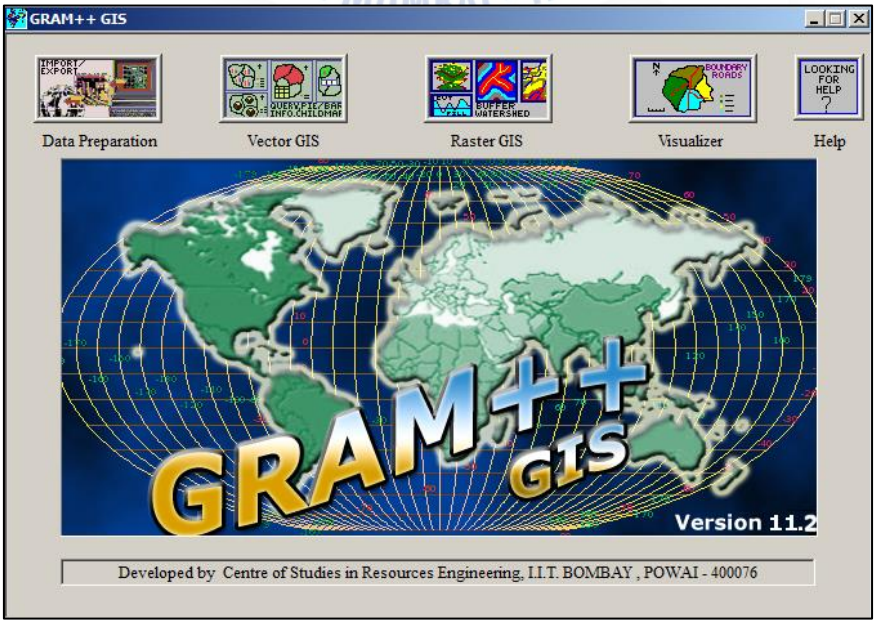


Figure 3.2 Welcome page of GRAM ++

3.3.1 Input Output Module

Input Output in a GIS environment has a very broad perspective. The data can come from reports compiled by various governmental agencies, digitized data from maps prepared by surveying departments, satellite images, and so on.

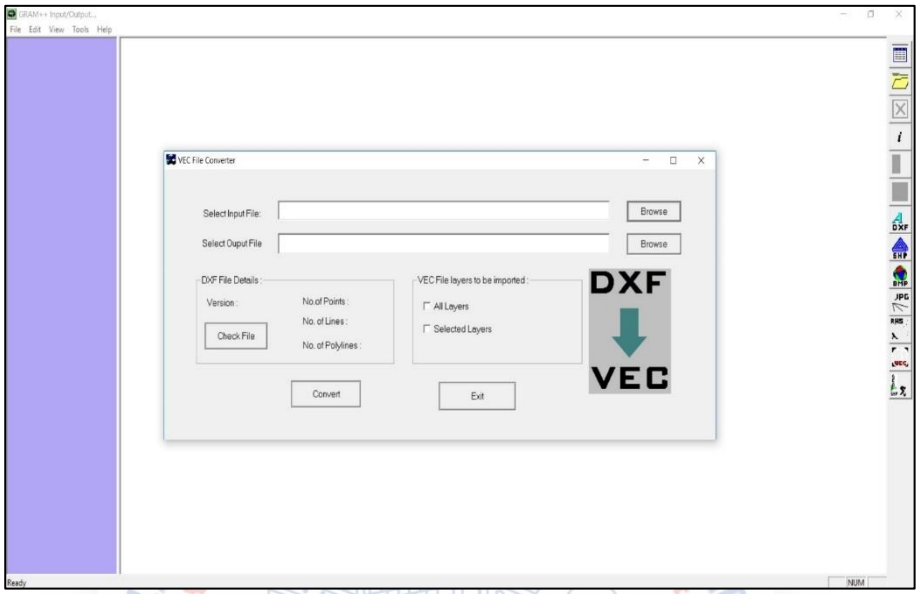


Figure 3.3 User Interface of Input-Output module, GRAM +

As seen clearly in Fig 3.3, the Input/ Output module gives the facility to import data from other formats into GRAM++ format. The GRAM++ vector and raster data can also be exported into various formats through this module.

For our project work, this module was used to convert the '.dxf '(AutoCAD file) & '.bmp' (Bitmap image) files into a '.vec 'file (file format compatible with GRAM++ GIS).

3.3.2 Map Edit Module

This module provides facility for digitization / vectorisation of map on the screen by opening an image / map at the background. A map can be digitized (creation of replica) in three different forms of layers i.e. point, segment and polygon. This module also provides the facility of editing a digitized map by adding segments or points and deleting a segments or points, joining segments, moving a vertex or a point on the segment and labeling the polygons, segments, and points. This module also provides the facility to create database linked to the point, segment or the polygon layers of the map. The database linked to these map elements is in MS access '.mdb' format.

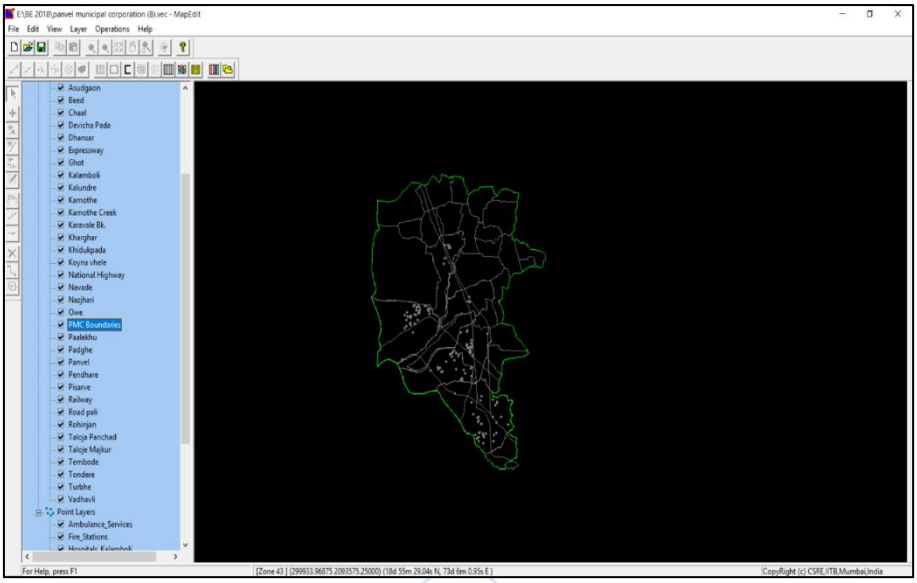


Figure 3.4 User Interface of Map-Edit module, GRAM ++

Figure 3.4 above shows the replica of Panvel municipal corporation map created by us in GIS Environment. It was created using all three forms of layers. Related databases were also created to make the map more useful.

3.3.3 Vector Analysis Module

A spatial feature has several attributes which need to be stored in the database. For instance, a road feature has a name, width, surface material etc. which should be accessible when the road is displayed on the screen. For this, a link must exist between the spatial and the non-spatial parts of GIS. The Vector Analysis module gives the facility to display the point, segment and polygon layer of a vector map and provides various utilities to query the map, display the output on map, generate thematic and statistical maps.

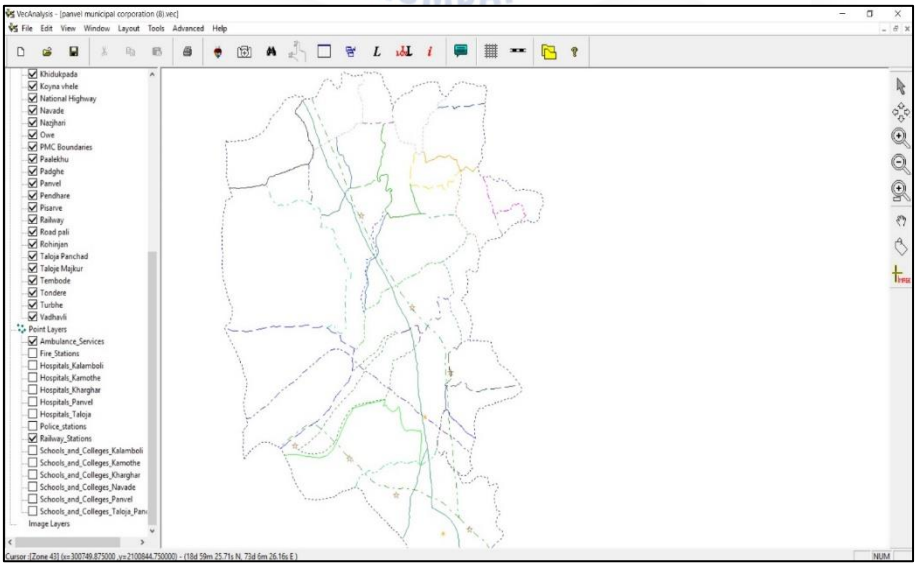


Figure 3.5 User Interface of Vector Analysis module, GRAM ++

Figure 3.5 above shows the replica of Panvel Municipal Corporation (created in Map edit module) in Vector analysis module of GIS Environment. This replica alongwith its attached database can be fired queries by the users to receive answers in this module.

3.4 Summary

With the knowledge of the study area and the software used for accomplishing this project work, we shall now proceed to know how exactly the entire work was carried out. The next chapter discusses the entire work process followed by the results obtained and the discussions related to the same.

CHAPTER 4

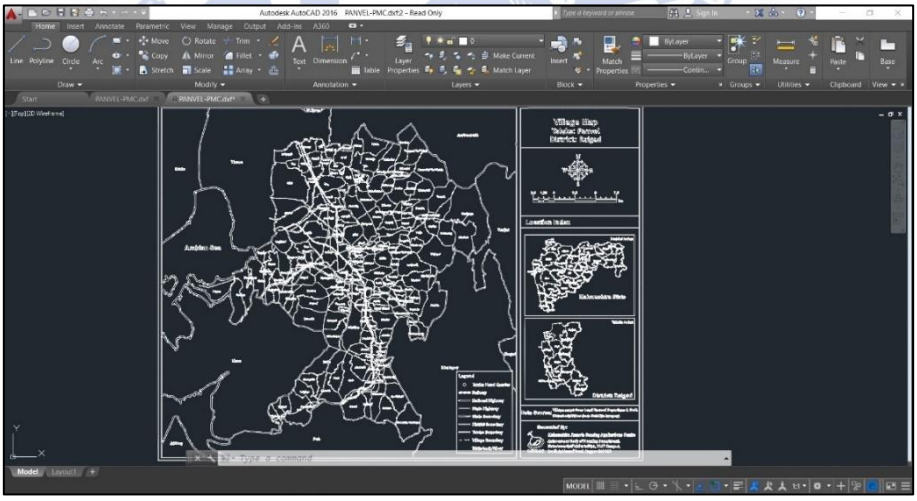
METHODOLOGY

4.1 General

With the background of study area and software used mentioned in Chapter 3, this Chapter explains the methodology adopted for creation of Attribute Database in Gram++.It gives the step by step procedure adopted right from importing the foreign file into GIS environment to the final step of running queries and getting solutions which can be of great use to the decisionmakers. The entire process of development and functioning of this GIS tool for disaster management of Panvel city is explained in detail in the pages to follow.

4.2 Methodology adopted

1. Initially, the CAD file of the work (Fig 4.1) is procured. Care has to be taken that everything related to the application should be saved in the same single folder.



(Source: E:\BE_2018 \PANVEL PMC.dxf**)**

Fig 4.1: Original CAD file procured from Maharashtra Remote sensing Application Centre.

Fig 4.1 depicts the boundaries of the newly formed Panvel Municipal Corporation and shows its location in the state of Maharashtra, India. It also gives information about the major highways ,railway lines as well as political boundaries of state,district.taluka and villages with respect to Panvel municipality limits.

2. A printout of CAD file is taken, scanned and saved as a bitmap image (PANVELPMC.bmp) (Shown in Fig 4.2 below).

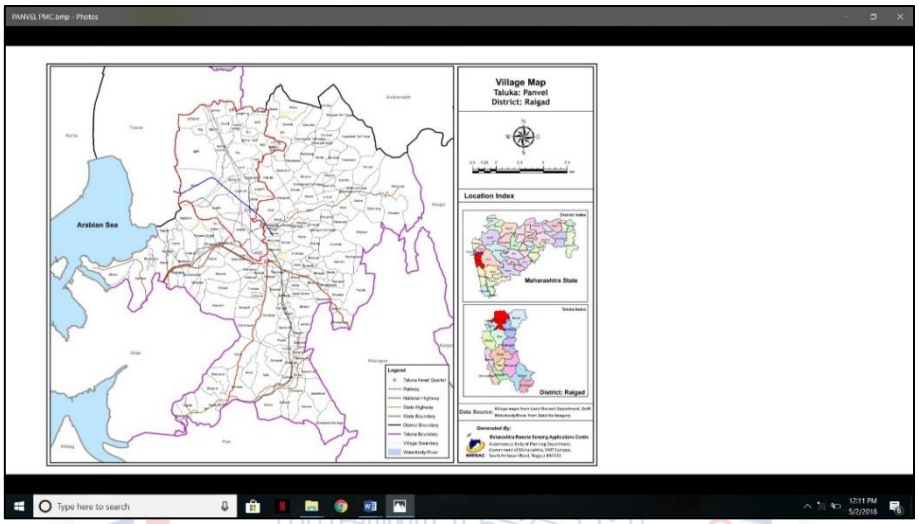


Fig 4.2: Conversion of Original CAD file procured from Maharashtra Remote sensing Application Centre to .bmp format.

3. With the help of Google earth, the point marks are fixed, co-ordinates for the same are known and accordingly are marked on the bitmap image(Fig 4.3).The algorithm for doing it is as under

a) Start
b) Open **Gram++**.
c) Select map edit from menu.
d) Create new file by entering file name, map details, projection and map scale details. Also enter its origin in terms of lat-long or ground co-ordinates and false coordinates. False coordinates are calculated by taking the mean of all Latitudes and all Longitudes separately. An empty **.**vec file will be created. (panvel municipal corporation. Vec)
e) Open the scanned drawing through open image function.
f) Add tick marks to calculate the errors to avoid shifting of image while working.
g) Save the file.
h) Stop.

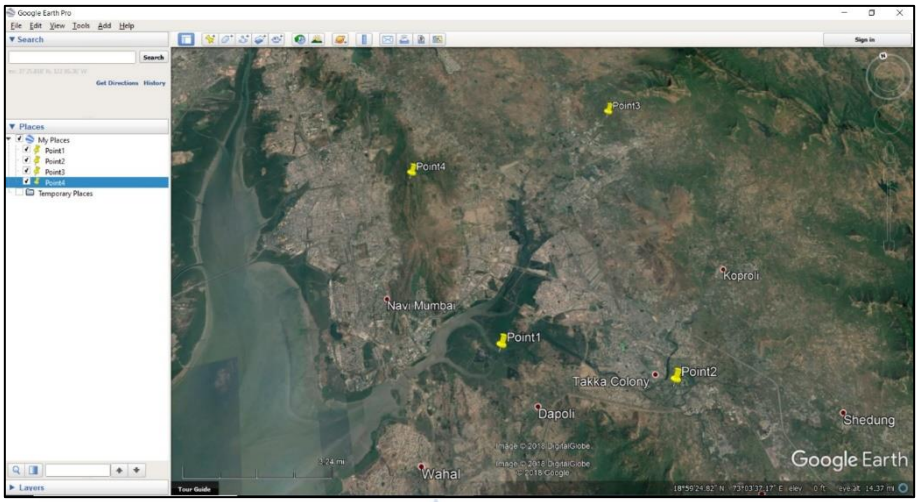


Fig 4.3: Fixing the tic marks and getting the co-ordinates from Google Earth

Fig 4.3 above shows the marking of tic marks in the bitmap image. This is done so as to avoid the shifting of the image (quite similar to clips that we fix on a drawing board so that our sheet does not move).These are the same points whose coordinates are mentioned in Table 3.1.

4. The bitmap (.bmp) file is then converted to a vector (.vec) file in the Input-Output module of Gram ++ (Fig 4.4). The algorithm for doing this is as under :

a. Start

b. Open the AutoCAD file (panvelpmc.dwg) and save the drawing file as .dxf file.

c. Open **Gram++**

d. Select input/output module menu

e. Press the dxf icon and browse the required dxf file to the file name

f. Check dxf file for details. If this step is omitted, the software won't give us further results.

g. Then import the dxf file to vector format in all layers.

h. Specify the vector file and the location where you want to save the vector file (panvel Municipal Corporation. Vec)

i. Click OK.

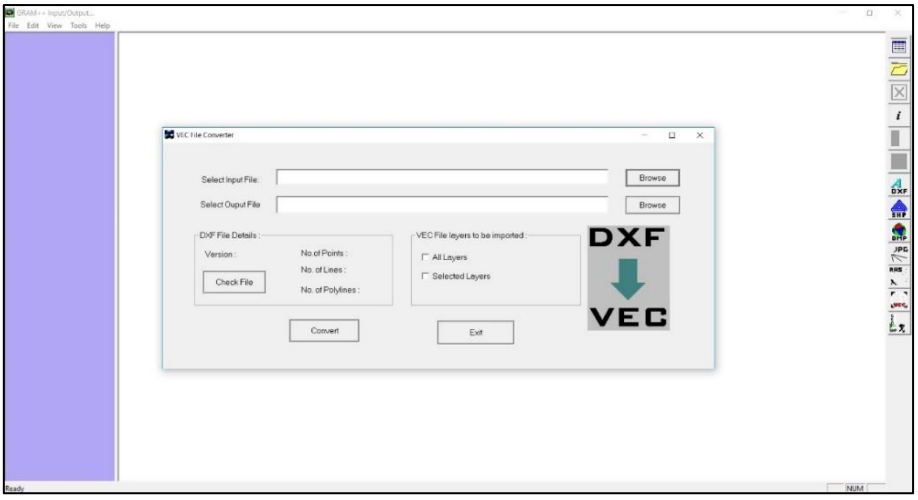


Fig 4.4: Conversion of Bitmap file converted to .vec file in Input-Output module.

The conversion of '.dxf 'file into '.vec' file and '.bmp' file into '.vec' file both play a crucial role in the successful implementation of the project. Once these two conversions are done, we are ready for the most important step of digitization.

5. The entire map is digitized and layers as per the requirement are formed in Map-Edit module of Gram ++.(Panvel municipal corporation.vec)

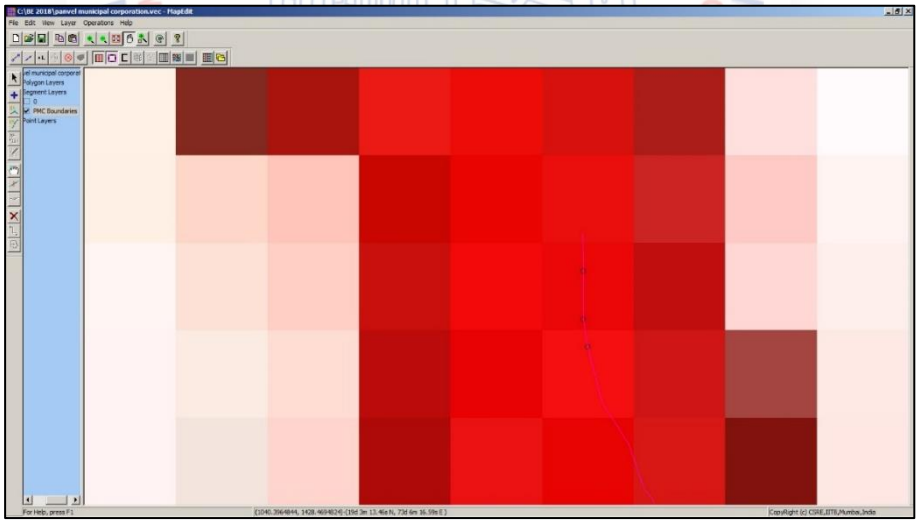


Fig 4.5: Zoomed view of the Digitization in progress of the .vec file in Map-edit module

The algorithm for digitization is as follows:

a) Register the scanned drawing.(panvelpmc.dwg ---- panvel municipal corporation.vec)
b) Select the layer option to add a new layer.(Refer Fig 4.6 below)

c) Select the proper layer in the new layer option and type the layer name and select Ok.The layer which were created are villages within the PMC limits.

d) Take the cursor to the required part of the drawing to start digitization and click the right mouse button for the starting node and then click the left mouse button for intermediate nodes and to end the segment, again right click the mouse button. Keep on saving the file.

e) Save the digitized work.

f) The entire PMC is divided into 29 different polygons (villages actually).

g) Stop.

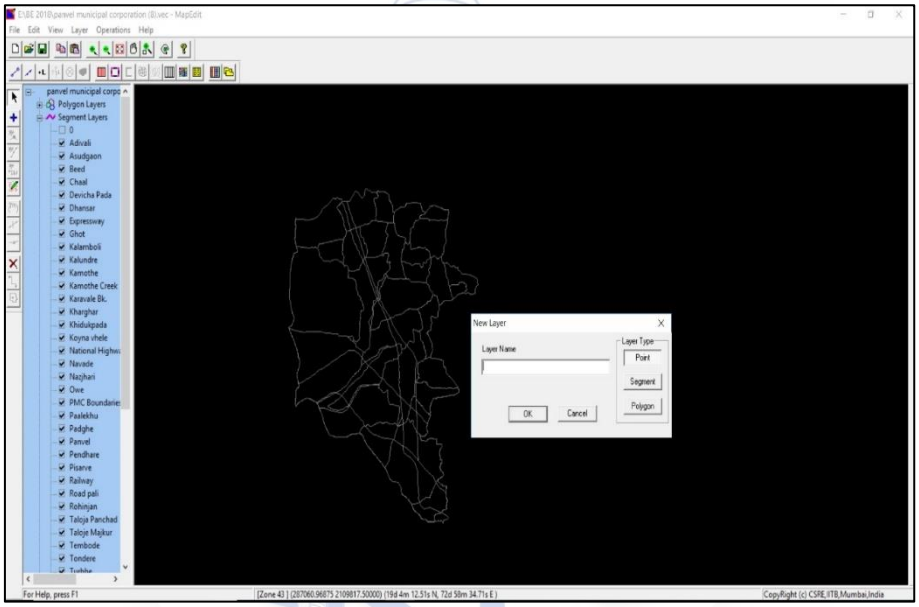


Fig 4.6 : Creation of a new layer in Map-edit module of Gram++

6. The cleaning operation to remove off any discrepancies is then started by going to clean icon on the interface. (Refer Fig 4.7 and 4.8). The algorithm for Cleaning operation is as under :

a) Select the Operation menu for cleaning; Select the layer to be cleaned first.(for e.g. KhargharPolygon)

b) Go to operation menu and select the option to clean the layer. Errors if any will be highlighted in red colour. Remove those errors and once again try to clean the layer until all errors are removed.

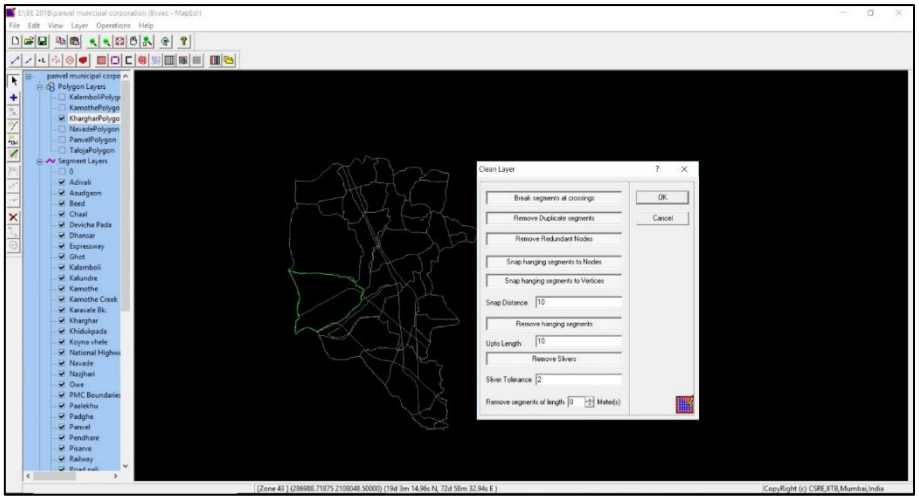


Fig 4.7: Clean operation in progress in Map-edit module

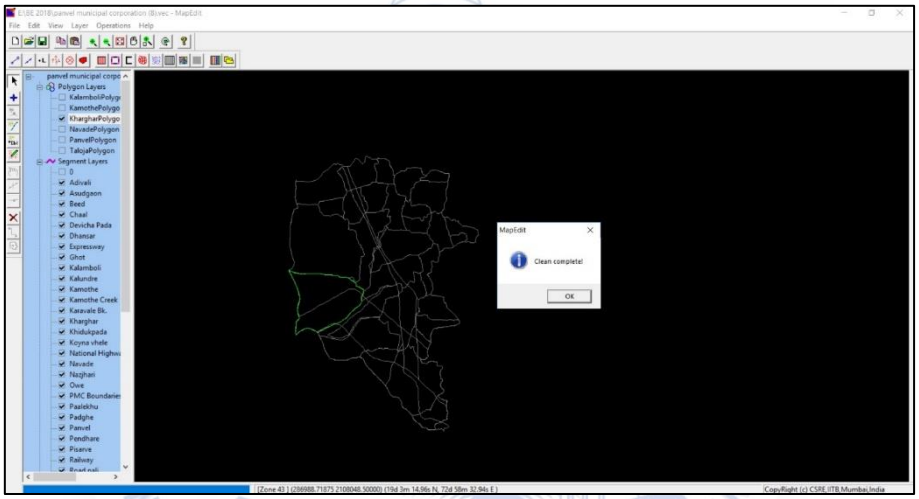


Fig 4.8: Clean operation completed in Map-edit module

7. Labels are then attached to the polygons (say KhargharPolygon, Kamothe Polygon and so on) formed so as to assign them a unique identification. This is done by clicking on Add label icon and then clicking on each of the polygon and assigning it a unique label or identification (Refer fig 4.9).

8. Location of database (Hospitals, Railways Station, Fire Station) is then marked as follows:

a) Create New Point Layer and give a desired name to it (Hospitals, Railways Station, Fire Station)

b) Then Right Click & Add Point and continue labelling till all the points are labelled.

c) Save the labeling work.

d) Then the "Create Table" option will be highlighted. Click "Create Table". A message will be displayed stating "Table Formation Complete". Click Ok.

e) Stop

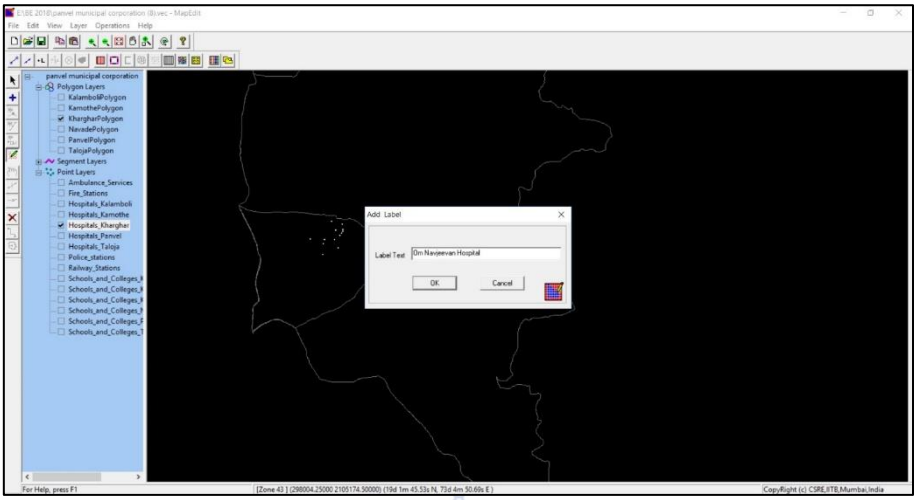


Fig 4.9: Addition of Labels in progress in Map edit module.

Labelling of each and every point layer inside a polygon is very important of attaching database to the point layers. If this operation is not done properly, the further steps cannot be accomplished.

9. Creation of database is started by clicking on create table icon, giving a name to the '.mdb' file that is created. Care has to be taken so that the name of the layer for which the table is generated and the name of the table should exactly be the same, failing which the system will malfunction. (Fire_Stations.mdb) (Refer Fig 4.10).

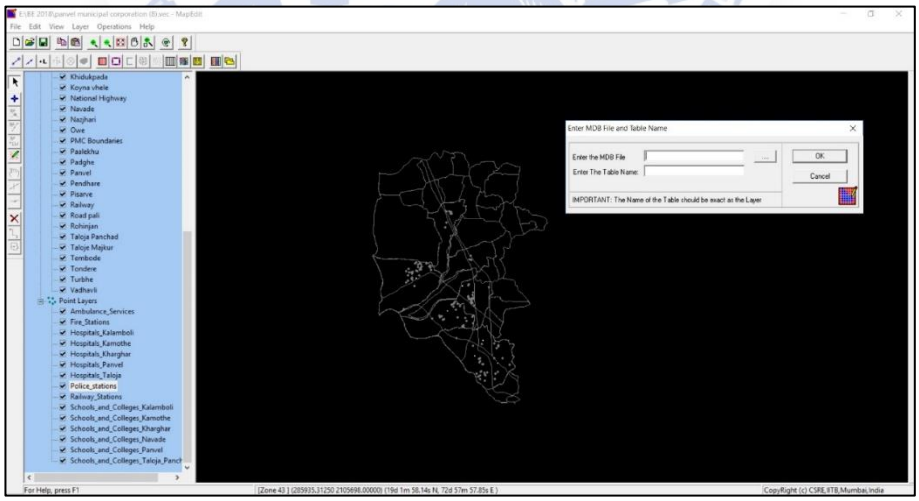


Fig 4.10: Creation of a database file (.mdb) in Map edit module.

Once the database file is created (Refer fig 4.10), the algorithm for Creating Database and Adding fields to the Database is as follows:

a) Start

b) Open Gram++ and then Vector Analysis.

c) Open the .vec file created in MapEdit module.

d) Then select the Point layer who's Database is to be created. (Fire_Stations) Then click "View" in the top tool bar and select "Label". All labels attached to the polygons will be displayed.

e) Then go to "Advanced" menu in the top toolbar and select "Database Operation" then "Add Field to Database".

f) Give the desired name to the field in "New Field Name" and select the "Data Type".

Click Ok. The new field is created.

g) To view the database table go to "Tools" menu in the top tool bar and select "View Database". The database table with new added fields will be displayed on the screen as shown in Fig 4.11 below. Add the attribute values to the fields against their respective labels.

SID	UID	X_COORD	Y_COORD
1	Sanjivani International School	298508.2	2106537
2	Greenfingers Global School	297813.8	2106496
3	Gokhale High School	297745.5	2106131
4	Siddharth Multipurpose Residential High School	298483.8	2106487
5	Vibgyor High School	298547.5	2106416
6	Ryan International School	298002	2106242
7	Apeejay School	297704.4	2106647
8	Red Cliffe School	297715.2	2105186
9	D.A.V International School	298604.2	2106283
10	Bal Bharti Public School	297288.4	2105789
11	Convent of Jesus & Mary School	297638.6	2106554
12	Ramsheth Thakur Public School	298293.5	2106634
13	KPC English School	297924.4	2106595
14	Harmony School & Junior College	297492	2105983
15	R.S.P.M MahaVidyalaya	298498.5	2106516
16	Saraswati Education Society	297303.9	2106172
17	AC PAtil College of Engineering	297308.8	2105478
18	N.I.F.T	297564.8	2105568
19	YMT Campus	297529.7	2105682
20	Bharti Vidyapeeth Campus	297240.8	2105334

Fig 4.11: Created database file (.mdb) with default and added data fields in Map edit module.

h) Perform the same for creating database table for all layers.

i) Save the work and Stop.

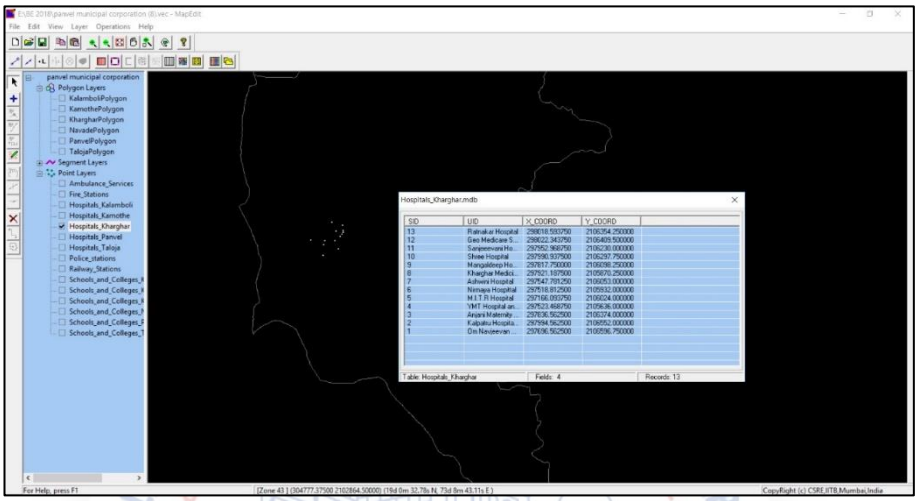


Fig 4.12: Creation of database completed (default data fields) as seen in MapEdit module

10. A default database is generated by the software (Refer Fig 4.11). To this, we can add the desired fields and the values for the same by clicking on Add field to database and update/modify database icon (Advanced menu) (Refer Fig 4.13).

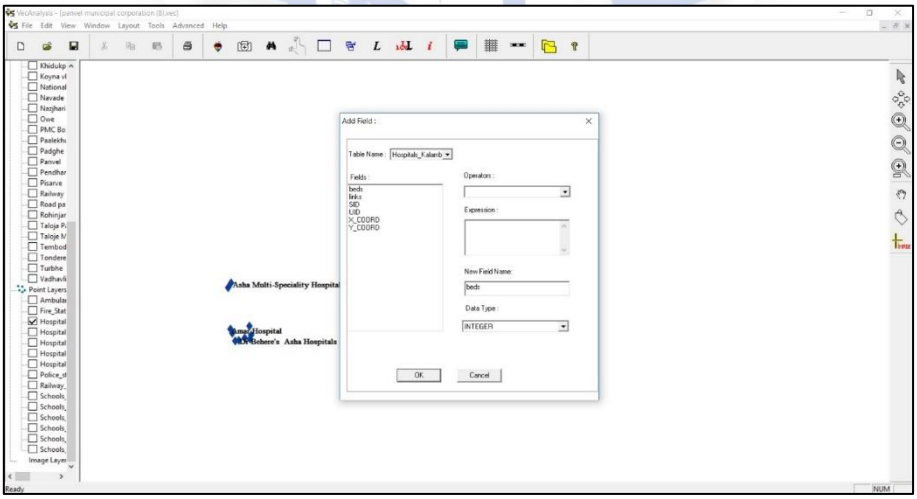


Fig 4.13: Additional Database created under various fields in Vector Analysis module

Number of such data fields can be added to improve the utility of the application. For eg .if a point layer of a Hospital is selected, we can add data fields like list of doctors available, their

details, no of beds available, facilities available, cost of different treatments/surgeries, location of nearby blood banks, medical stores, pathology lab,etc.

11. It might happen that we need to add certain non-spatial data which cannot be added in the database by following step no 10 mentioned above. For e.g. maps, photographs, cross sections or L-sections.etc.In such a circumstance, the child map feature is utilized. For this, a new field named links is created in the database and to it, in front of the respective SID and UID, the path where the image is stored alongwith the extension of the filename is pasted. (Fig 4.14 and 4.15)

Fig 4.14: Sample non-spatial attribute data (Photograph of Kharghar Railway Station)

The algorithm to View the Child Map attached to a particular section is as under:

a) Start.

b) Open **Gram++.**

c) Select the Vector Analysis module.

d) Open the .vec format file.(panvelpmc.vec)

e) Activate the layer for which the database was created.(say Kharghar railway station)

f) Go to “View” menu in the top tool bar and select “Child Map”.

g) Click inside the boundary of the polygon layer. A window appears containing the image linked to the particular point layer.(Refer fig 4.15).

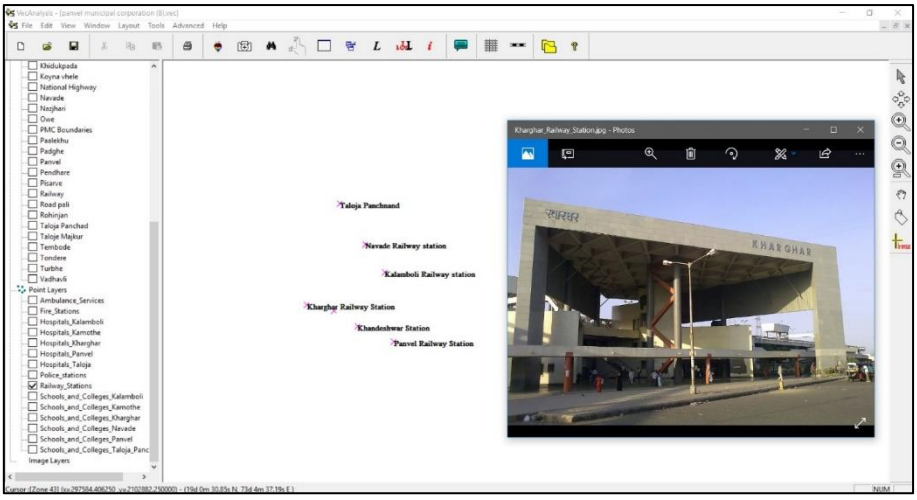


Fig 4.15: Integration of spatial and non-spatial attribute data using child map feature

Comparing fig 4.14 and 4.15, we can understand the utility of child map feature. Fig 4.15 clearly depicts that the moment we click on the point layer of Kharghar railway station on the main map, it displays the image attatched to it as a child map.

Steps 1 to 11 mentioned above describe the procedure of creation of the GIS map and addition of various databases to it.Step 12 below mentions a sample utility of how the GIS application developed can serve the users. The users need to run a query to get the desired information from the database.

12. Queries are run to get the desired information out of the database (Fig 4.16 to fig 4.18). The algorithm for Running Simple Query in Vector Analysis module is as under :

a) Open **Gram++.**
b) Select the Vector Analysis module and open the .vec format file.
c) Activate the layer for which database was created.
d) Go to “Tools” menu in the top tool bar and select “Query” for the selected layer
e) A menu pops up containing three options as shown in fig 4.16 below. Select “Simple query” option. Click Ok.

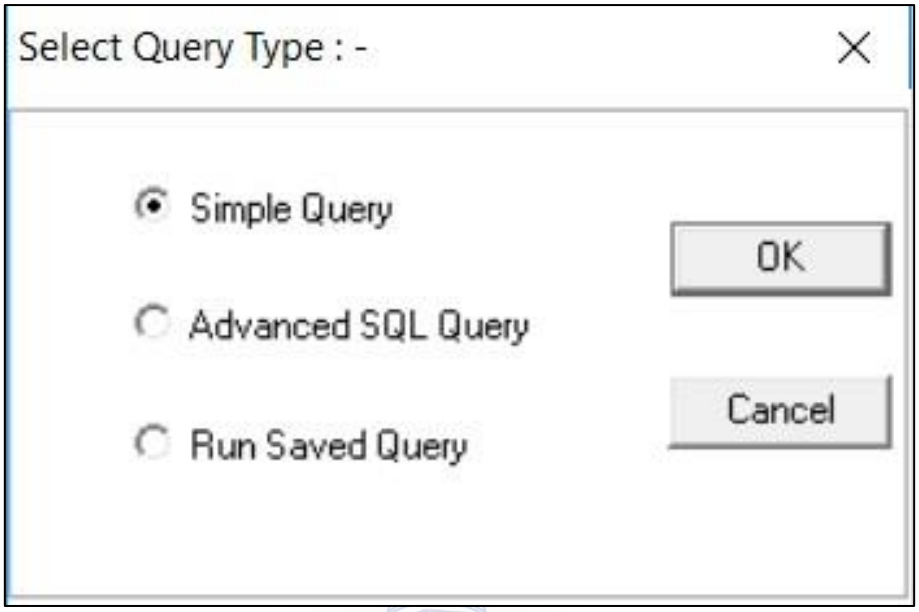


Fig 4.16: Menu pop-up showing types of queries that can be run in vector analysis module

f) Once a simple query is selected another menu as shown in fig 4.17 below will pop-up. Select (double click) a field for which the query is to be run.

g) The selected field will be shown in the "Enter Condition/Query" window. (beds) Enter the desired operators (<,>, <=,>=,=). Then double click on the "Field Values" to select a value. This value will also be shown in the "Enter Condition/Query" window. Click Ok.

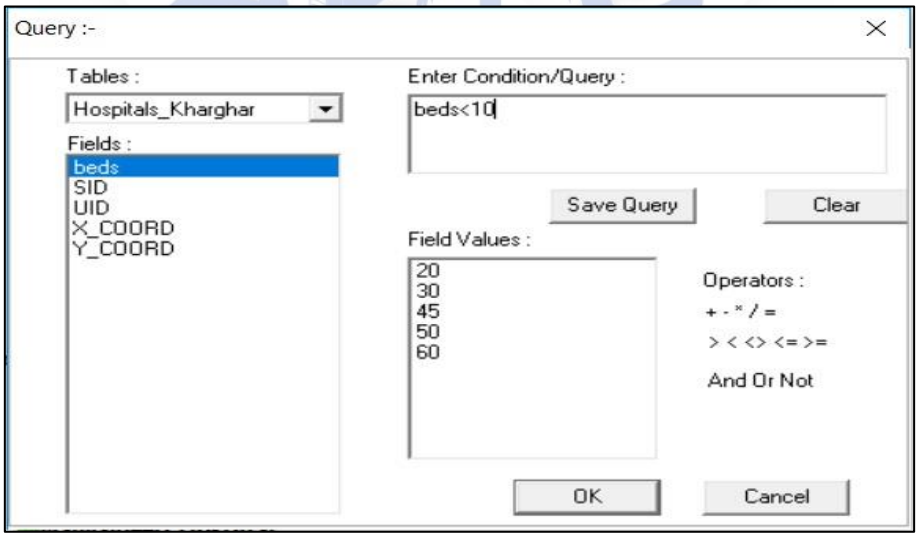


Fig 4.17: Pop-up showing field & condition to be entered to run a query in vector analysis module

h) The results of the query will be shown highlighted on the layer for which query is run.

i) Stop.

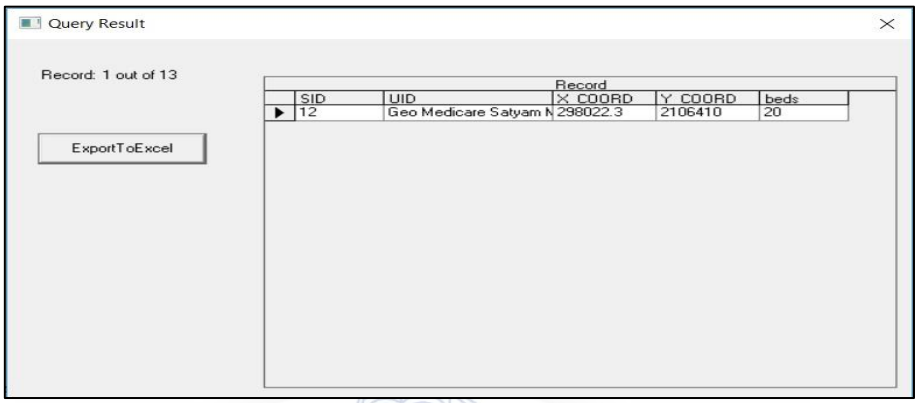


Fig 4.18: Pop-up showing query result displayed in vector analysis module

With reference to fig 4.17, a query was asked to the application for showing all the hospitals having less than 10 beds in it.The list of all the hospitals (in this case only 1 hospital) having less than 10 beds is displayed in fig 4.18.

4.3 Summary

This chapter described the entire methodology for creation of a GIS Map and allied databases for the newly formed Panvel municipal corporation. The utility of developing such an application for disaster management is discussed in the chapter to follow.

CHAPTER 5

RESULTS & DISCUSSIONS

5.1 General

After knowing the methodology adopted to accomplish this piece of work, the results obtained and their utility/application are discussed in this chapter. After the literature review, a huge amount of database about panvel city pertaining to all features/facilities that can be of use or those to whom help can be sought to in case of an emergency were identified. This included demographic details of Panvel, Contour map of Panvel, major roads, railway lines and railway stations, location and details of all hospitals, major schools, blood banks, police stations, fire brigade stations,NGO's,ambulance services etc. All this data was then added to the digitized map of Panvel city in GIS environment. The procedure of doing this is already mentioned in Chapter 4.

5.2 Results and Discussions

The availability of all the information of a city at the fingertips of the decisionmakers can greatly enhance the pre and post disaster management planning and management. This is possible with the help of creation of an GIS application as described in chapter 4.

The results of the same and its utility in different kinds of disaster is discussed in the table below:

Table 5.1: List of benefits derived from GIS Map and Integrated database

Sr No	Type of Disaster	Type of Data available with the decision maker	Benefit derived
1	Flood, Tsunami	Contour map of a city. Location of relief sheds	• The areas which can get submerged because of flood or tsunami due to various intensities of rainfall/earthquake can be easily known and the people can be evacuated well in advance if the disaster is predicted well in advance or at least before the situation is worsened. • The location of temporary relief sheds may be in the form of schools, government buildings, etc. can help in providing relief to the affected people. • Aerial surveys can be carried out effectively if GIS maps are available with the decisionmakers.
2	Earthquake	Study of soil and strata conditions, earthquake prone ness of different areas.	• This will help in reducing the loss of life and property in case of earthquakes. • Measures can be taken to convert the weak buildings into earthquake resistant structures. • Important structures like power-stations, dams, underground railways, etc. can be constructed in less earthquake prone areas.
3	Major fire	Location of fire brigade stations/hospitals & facilities available with them.	• Emergency routing of fire brigade vehicles to the disaster site and ambulances to the hospitals can be done effectively thus saving no of lives as well as reducing loss to property.

			• The capacity and facilities available at both fire stations as well as hospitals can help in immediate an optimum utilization of resources.
4	Major road or railway accident.	Road network and rail network in the vicinity	• Immediate relief measures can be provided to the affected people and the injured can be immediately rushed to the nearby hospitals.
5	Bomb explosion	Road, rail network, Hospitals, blood banks, NGO's	• Immediate relief measures can be provided to the affected people and the injured can be immediately rushed to the nearby hospitals.

5.3 Specific Examples

If a major road accident occurs at Khanda colony, we need to just use the application for locating the hospitals in the nearby vicinity by running a query and the application will show us the results in the form of a list of hospitals alongwith the facilities available therein within few seconds. The relief team can effectively plan the relief measures accordingly.

In the event of a major fire outbreak in Old panvel which is densely populated and has narrow roads, if the decision makers have the data related to alternative roads, location and capacity of nearby fire stations,hospitals,NGO's etc.help can be immediately rushed to the disaster site.

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

6.1 Conclusion

Based on the literature review, and the results presented in the foregoing chapters, following conclusions are derived:

- GIS is an effective tool for map visualisation and integration of database to form a foolproof management system.
- GIS has in the past and will also in the future prove to be an efficient tool for pre and post disaster management.
- Many complex civil engineering problems like construction planning, disaster management, maintenance of land records, records of soil characteristics, maintenance of demographic data and many others can be effectively solved using GIS.

6.2 Future Scope

This work can be extended to touch many other aspects related to Panvel city like transportation planning, road construction planning, and impact of upcoming International airport on the surroundings, maintenance of land records, rehabilitation of dilapidated structures and so on.