

Statistical Anatomizing and Visualization of Data for Planning and Decision Making using POSTGRES and GIS Tools

Asha Kiran M ^{1*}, M. Sreedevi ²

Department of Computer Science and Engineering
Koneru Lakshmaiah Education Foundation, Guntur, Andhra Pradesh, India.
Email: ¹ asha3577@gmail.com, ² msreedevi_27@kluniversity.in

Abstract - Planning and Decision making is an incessant process for anything to experience a growth in any field. Likewise, anatomizing (analysing) and visualization also helps us understand the things in a much better way. In this paper we consider spatial data to identify the problems that exist in an area or a location and to determine solutions by observation in terms of location, water, roads, buildings, railway, population, etc. In India, there are many metropolitan as well as cosmopolitan cities which have been developing daily by materializing processes like globalization, liberalisation etc. It provides huge opportunities for several investors, technologists to use the area which they want to develop and manage their business in by investing on that area. For this, the work has been done by developing a database using various technologies, such as postgres and GIS powerful tools and database systems to manage spatial data. Furthermore, we use a GIS tool called Geoserver to visualize the data in the form of maps for better understanding of the spatial data. Finally, we develop an application to integrate the whole work done by postgres and geoserver for visualization of maps and analysing the data statistically.

Keywords - GIS (Geographic Information System), Urbanization, POSTGRESQL, Geospatial data, Geo server.

I. INTRODUCTION

Planning is predominantly an exercise that involves a development, management and generation of resources based on the availability in a location or an area [1]. This is based merely on how they are planned, developed and managed in terms of economically and efficiently. The development and expansion both are driven by numerous factors including land availability of an area for planning and developing the industries, road network, water, population (analysing the population and comparing from other areas or cities) etc., But an intense scrutiny should be done while using the available land as the natural resources which are available may be lost due to the construction of heavy buildings. This leads to complex problems in future. For this, the spatial distribution should be observed along with land patterns for making better decisions at the end [9] [10]. These patterns can be used for planning and development [11]. For this a GIS tool plays a prominent role in storing the spatial data.

A. Spatial and Non-Spatial Data

Spatial Data is also known as Geographic information that defines a location on the earth's surface. This geospatial data is generally stored as coordinates and it is used for mapping [2]. Spatial data consists of different formats such as points, lines, polygons and pixels which are called as vector data. An example of spatial data is a "shape" file. This file format has been originated from ESRI (Environmental Systems Research Institute). Each spatial file is associated with SHX, PRJ and DBF files. Whereas

non-spatial data is a type of data which has attribute data that elucidates the spatial objects. Generally, the attributes are arranged in tables. Each table contains rows and as well as columns, each row depicts an entity and each column depicts an attribute.

B. Maps and Spatial Data

To identify and represent the location of a geographic data, a technique used called a Map. A map is a graphical representation of features which are relative to each other. A map consists of different geographic features such as points, lines and polygons. Each geographic feature is specified by the location and its attributes. The Spatial data is referred as geographic information. The features of spatial data are referenced in a coordinate system which defines a location on the surface of the earth. There are different types of coordinate systems such as:

C. Geographic Coordinates

Geographic coordinates are usually referred as degrees, minutes and seconds. An example of geographic coordinates are latitude and longitude such as 75°28'60" and 121°32'45".

D. Map Projection

An example of a map projection is a Universal Transverse Mercator projection (UTM). It is a grid-based method to specify the location of an earth's surface. It is an application of two-dimensional coordinate system.

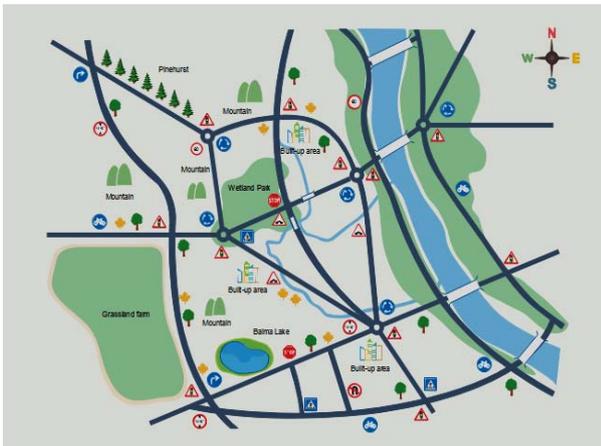


Figure 1: An example of a map with roads, water, buildings etc.

II. GIS (GEOGRAPHIC INFORMATION SYSTEMS)

GIS is an acronym for Geographical Information System. It is one of the most powerful computer-based tools that is used to manipulate and visualize the geographic information in the form of a map. It allows the users to manage the attribute data. In addition to that, it allows to capture the data, manage the data and incorporates in the analysis [3]. GIS is not merely a tool to show maps, but it is also an analysis tool that helps us analysing the data [4].

A. Components of GIS

As GIS is an integrated tool that helps the users in managing the data. Each GIS tool has its components which combine and make the whole system work efficiently. These components are principal for a successful GIS. Each GIS has been divided into five components [5].



Figure 2: Components of a GIS.

- **Hardware:** Hardware is a computer-based system where GIS works. Each GIS tool runs on various types of hard

wares, from centralized servers to desktop systems either used in standalone or networked configuration.

- **Software:** Each GIS system imparts several functions and tools required for storing, analysing and displaying the geographical information.
- **Data:** The most vital component of GIS is the “data”. The geographic data and its related tabular data is either collected together, and compiled to the custom specifications and as well as requirements or can be purchased from data provider commercially .on the whole, GIS can combine the spatial data with other subsisting data resources, stored in corporate DBMS often. The main functionality afforded by GIS is to integrate spatial data and tabular data stored in DBMS.
- **Analysis:** A well-defined implementation planning, business rules and consistent methods are required for analysis to exhibit accurate and reproducible results [5].
- **People:** GIS cannot manage in segregation from the organizational context and people must exist for planning, implementing and operating the system to make the decisions based on output.

B. Applications of GIS

GIS is a highly dynamic environment which has been growing at a very rapid pace tread of technological change and increasing number of applications. Precisely, it is a system able to capture, store, integrate, edit, analyse and display the geographical content or data [6]. Moreover, GIS has a special feature that allows the users to use the queries for analysing the spatial data, editing the data and maps and present these results based on the user requirement. GIS technology is used on variety of applications which are summarized in the below table I.

TABLE I. SUMMARIZES THE APPLICATIONS OF GIS

Mapping in GIS	Mapping is a main function in GIS that provides the visual representation of data.
Telecommunication and network services	GIS enables wireless telecom firms to combine geographic data into complex design, planning and maintenance.
Urban planning	GIS is used to analyse the urban growth to find the suitable areas for further development.
Accident analysis	GIS is used to reduce accident on roads and road network can be optimized.
Transportation planning	GIS is used to plan and manage the logistical problems. It is used to plan new road or railway network based on topographical data.
Land use planning	GIS is used to determine land use patterns, agricultural lands, buildings etc.,.

III. POSTGRESQL

PostgreSQL is often called as PostgreSQL which is one of the most powerful database systems. Unlike other database systems, PostgreSQL is an object-oriented database system. The main features of PostgreSQL are:

Reliability, validation, Data Integrity and consistency. It can run on all operating systems. PostgreSQL supports text data, Image data, audio and as well as video. simply, PostgreSQL is an alternative to the other commercial databases [7]. PostgreSQL has unlimited database size when compared to other databases like MySQL [8].

A. Spatial Data in POSTGRESQL

In addition to the above advantages, PostgreSQL has another advantage i.e., it supports the spatial data in the following manner:

- Importing the spatial data: Spatial data i.e., shape files can be imported directly into the PostgreSQL instead of text files (csv, excel) where other databases don't support. Each shape file is stored as a Table.
- Querying the spatial data: After the data is loaded, different queries (GROUP BY, AGGREGATE FUNCTIONS) can be applied on the shape file data to edit the data, to analyse the data and to extract the data.
- Retrieving the spatial data: Extracted data can be retrieved using SELECT statement.

IV. EXISTING SYSTEM

In the existing system, a geospatial database has been developed for assessing the maps for a particular area to understand the land patterns, solid waste management, road network based on visualization of maps. This work has been done based on an application called ArcGIS and remote sensing satellites accessing the maps, a GUI has been developed using a software called "Visual Basic" to incorporate several components of geospatial database and to implement under GIS environment. An ArcGIS 8.3 has been used to develop geospatial database and to visualize the maps. For menu-driven interface Visual Basic has been used.

A. Disadvantages of Existing System

- In the existing system, although a map has been developed to visualize the land patterns, road networks etc., It was very vague to visualize and understand the land patterns.
- It has not shown any analysis on each layer for better understanding.
- The software ArcGIS which was being implemented is not an open source software (commercial), so that no user can utilize the software for free.
- The visual Basic software which has been used for menu driven interface is a platform dependent.

V. THE PROPOSED SYSTEM

To overcome the drawbacks of the existing system, an advanced and coherent work has been done which aims at implementing a geospatial database for planning and development of a city called Hyderabad which is in a state of Telangana by using a GIS tool called Geo server. The process that has been implemented is shown in fig 3.

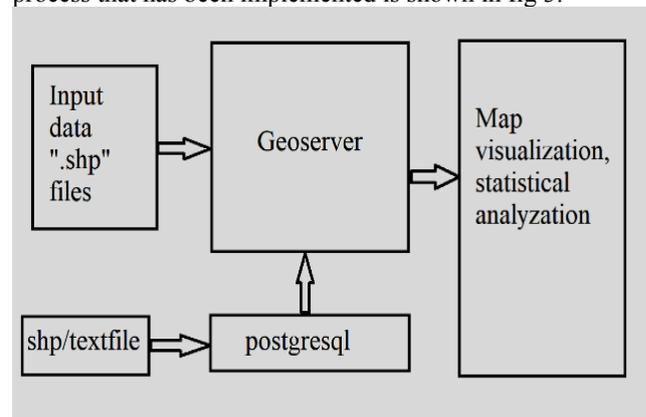


Figure 3: Work flow of the present work.

- In the first step, the input data must be taken in the form of SHP file or text files (csv/excel files).
- Input dataset has to be loaded into either PostgreSQL (for extracting data) or into the Geo server directly.
- Extract the tables using PostgreSQL queries based on the requirement.
- connect the PostgreSQL and Geo server to visualize the data in the form of maps.
- Finally, Showing the result set (maps) and statistical analysis in an application.

From the above work flow, an application has been developed by taking the shape file of a city called Hyderabad which is in the state of Telangana. The city is covered with the total area of 650 square kilometres. This shape file has been taken for analysis of various layers for further planning and development of the city.

The following figures shows the map data of the Hyderabad city which includes a few layers such as Buildings, Road network, Railway network, Water network, land usages, population of the city.

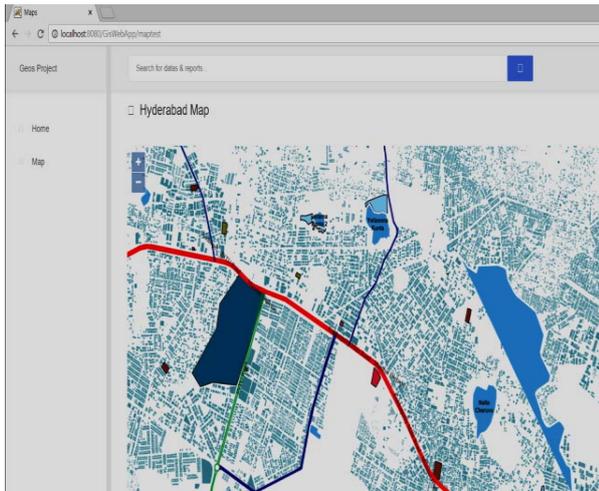


Figure 4: The above figure shows the buildings in the Hyderabad city.

Figure 5 shows how the major road network; railway networks are distributed across the city. The Red colour indicates the highways, Green and blue colour lines indicate the Primary and Secondary roads in the map.

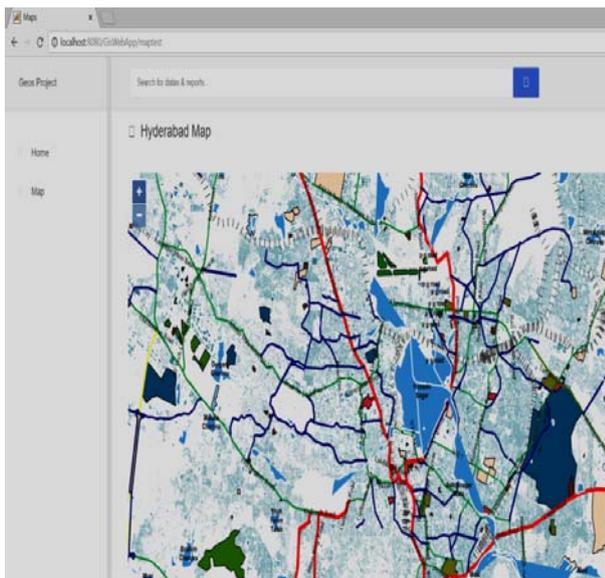


Figure 5: shows the road and railway network of the city.

Figure 6 shows how the water network/supply has been distributed across the city with major rivers such as Musi river. The water layer has been indicated with Aqua blue colour.

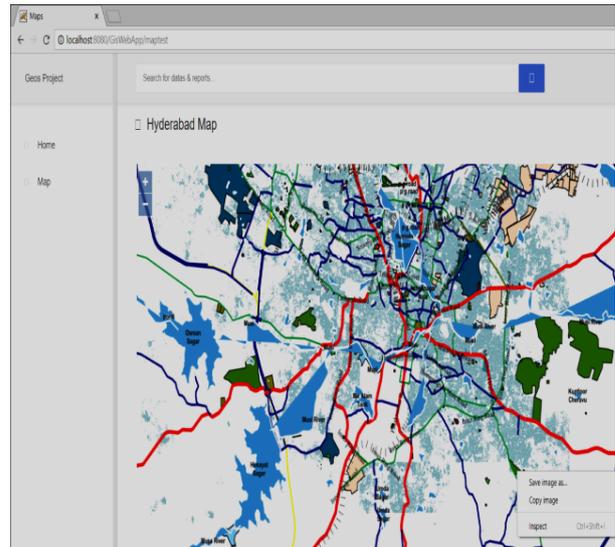


Figure 6: Shows the water network in the city of Hyderabad.

Figure 7 shows the overall map distribution with all the layers included such as land usages (schools, industries, farmlands, universities, colleges) along with buildings, roads, railway, water.

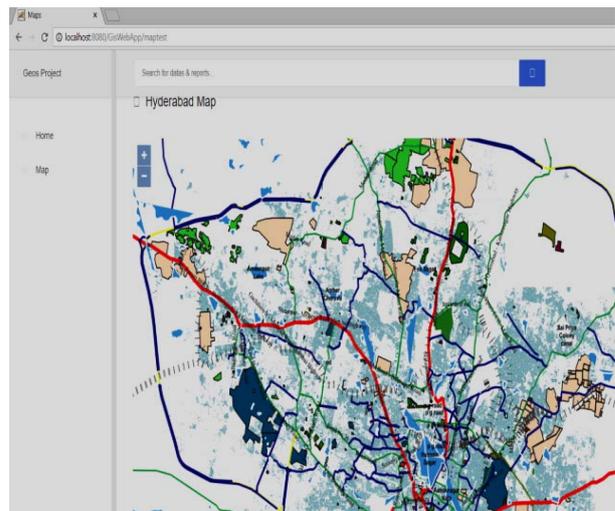


Figure 7: shows all the layers including Roads, Railways, buildings, water land usage

A. Statistical Anatomization

In addition to the above results, Statistical analysis has also been shown for better understanding of the data along with the maps visualization. For that purpose, the population data and the land usage data of the Hyderabad city has been taken for analysing clearly and efficiently. In the population data, the data has been analysed in the form of total number of populations, total number of male populations, total number of female populations, total number of literates, total number of male literates and total

number of female literates. Furthermore, out of the total population.it has been divided that, the population with different religions. The following figure depicts the bar graph with the population data.

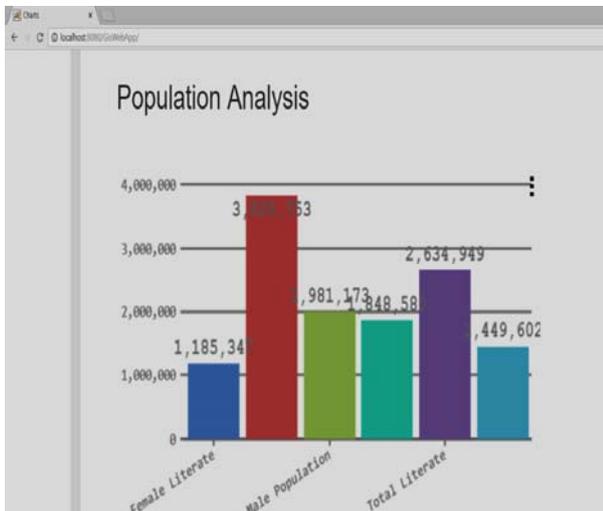


Figure 8: Depicts the bar graph of population Analysis with total population, males, females, literates, male literates and female literates.

district	persons	males	females	personsliterate	malesliterate	femalesliterate	personsliterate	malesliterate	femalesliterate
character varying	integer	integer	integer	integer	integer	integer	double precision	double precision	double precision
Hyderabad	78,104,915	39,117,104	38,997,810	24,490,02	11,853,47	12,636,55	78.6	83.74	73.5

Figure 9: Shows the table of population data from PostgreSQL.

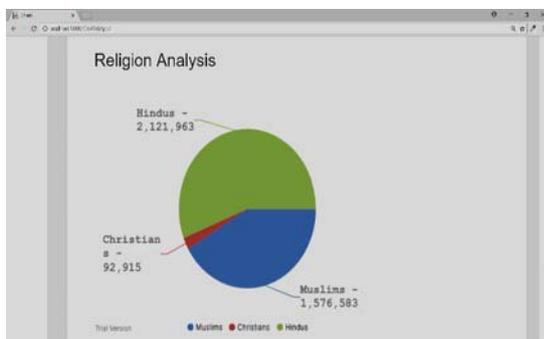


Figure 10: shows the pie chart with Religion analysis based on the population.

religion	relpop
character varying	integer
1 Hindu	212196
2 Muslims	157658
3 Christians	92915

Figure 11: Shows the table of religion analysis in PostgreSQL.

Figure 12 and 13 depicts land usage in terms of the amount of land occupied for different purposes such as forest, farmland, schools, hospitals, industries, railway, scrub, universities. Each data has been taken in (key, value) pairs. The key value consists of the name and value indicates the amount of area occupied in square kilometres.

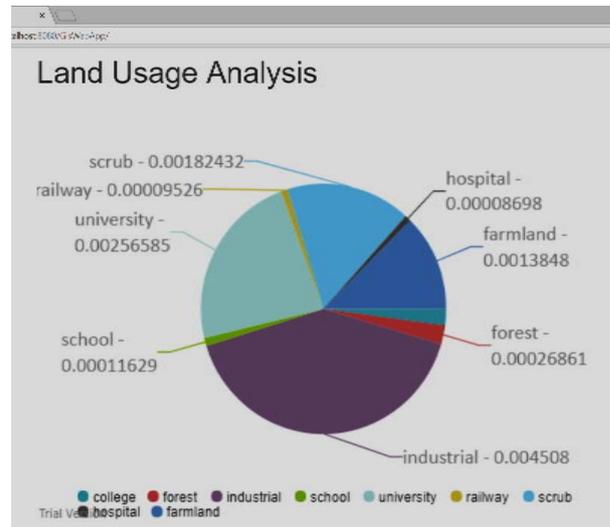


Figure 12: Depicts the pie chart of land usage with the amount of area.

type	no_of_build	amount	area
character varying(17)	bigint	numeric	numeric
1 university	22	0.002565852	
2 railway	8	0.000095258	
3 farmland	86	0.001384797	
4 scrub	29	0.001824323	
5 hospital	53	0.000086983	
6 college	41	0.000234677	
7 school	87	0.000116291	
8 forest	14	0.000268608	
9 industrial	94	0.004508003	

Figure 13: shows the table of land usages in PostgreSQL.

Figure 14 and 15 depicts the pie chart with water area such as how much area of water is distributed across the city. water, reservoir data has been taken as key and amount of area has been taken as value.

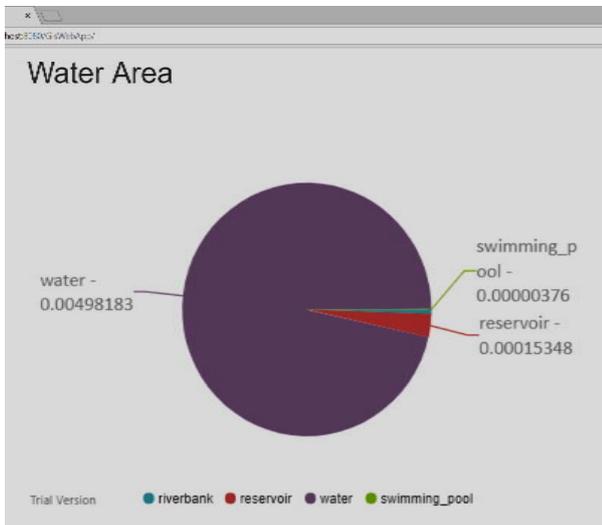


Figure 14: shows the pie chart of the water area.

type	area
1 water	0.00498
2 reservoir	0.00015
3 swimming_pool	0.00000
4 riverbank	0.00002

Figure 15: shows the table of the water data from PostgreSQL.

VI. CONCLUSION

A coherent and efficient work has been done by developing an application by using different database tools and GIS tools. For that purpose, POSTGRESQL and GEOSERVER has been used which are a database and a GIS tool respectively. The Input dataset has been taken in the form of shape files of Hyderabad city for further

planning and analysing the land usage patterns by generating several layers such as distribution of water, road network, railways, buildings, forests etc., Eventually, all these layers has been integrated together to visualise them on the map and analyse in bar graphs and pie charts. Based on the maps and charts, one can see and understand the land patterns very quickly and effectively. This work can be helpful for making decisions in future endeavours.

REFERENCES

- [1] Anuj Bariar, R.D. Gupta, S.C. Prasad, "Geospatial Database Development for Urban planning using using satellite data under GIS environment".
- [2] Ahmed Eldawy and Mohamed F Makbel, "spatial Hadoop: A Map Reduce framework for spatial data" in 2015 IEEE 31st International conference on data Engineering.IEEE,2015, pp.1352-1363.
- [3] Brian E Mannecke school of Business, East Carolina University, Greenville, NC 27858, Martin D Crossland, College of Business Administration, Southwest Missouri State University, Springfield, MO 65804 "Geographic Information Systems: Applications and Research Opportunities for Information Systems Research".
- [4] Miroslav Rusko, Roman Chovenec, Dana Roskova "An overview of Geographic Information System and Its Role and Applicability in Environmental Monitoring and Process Modelling".
- [5] Geoffery J Meaden FAO consultant Canterbury United Kingdom of Great Britain and Northern Ireland, Jose Aguilar-Manjarrez Aquaculture officer Aquaculture Branch FAO Fisheries and Aquaculture Department Rome, Italy "Advances in Geographic Information Systems and remote sensing for fisheries and aquaculture".
- [6] Santosh Reddy Yekola Lecturer, Bapatla Engineering college, DR. Kiran Yarrakula Assisitant professor, Bapatla Engineering department, DR.K. Lakshmi Prasad professor, BVSR college, T. Madhu Lecturer, Bapatla Engineering college "Land use planning using Geographic Information Systems".
- [7] Mikhail Zimble MSC advisor, South Ural State University "Development of a parallel DBMS on the basis of PostgreSQL".
- [8] Ratnasari, R.T., Gunawan, S., Fauzi, R.M.Q., Septiarini, D.F. " Patient intimacy and innovation development to improve health service performance",(2018), Journal of International Pharmaceutical Research, 45, pp. 1-4.
- [9] G. Vijay Kumar¹, M. Sreedevi², K. Bhargav³, Mohan Krishna⁴ "Incremental Mining of Popular patterns from Transactional Databases.
- [10] G. Vijay Kumar, Dr. V. Valli Kumari "MaRFI: Maximal Regular Frequent Itemset Mining using a pair of Transaction-ids", International Journal of Computer Science & Engineering Technology, Volume 4 No.7,2013.
- [11] G. Vijay Kumar, Dr. V. Valli Kumari "Incremental Mining for Regular Frequent Patterns in Vertical Format" International Journal of Engineering and Technology, vol 5 No 2,2013.