ANALYSIS OF RURAL AND URBAN DEVELOPMENET

B.Tech CE Semester- VIII

Prepared at

ISO 9001:2008
ISO 27001:2013
CMMI LEVEL-5

Bhaskaracharya Institute for Space Applications & Geo-informatics

Science & Technology Department, Govt. of Gujarat.

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ISO 9001:2008
ISO 27001:2013
CMMI LEVEL-5

CERTIFICATE

This is to certify that the project report compiled by ***Mr. Akshay Methaniya, Mr. Chirag Patel, Mr. Hardikkumar Parmar and Mr. Vivekkumar parmar*** *students of 8th Semester* ***B.Tech-CE from Dharmsinh Desai University Nadiad,Gujarat*** *have completed their final semester project satisfactorily. To the best of our knowledge this is an original and bonafide work done by them. They have worked on web application for* ***"Analysis of rural and urban development using temporal OSM data"****, starting from December 9th, 2019 to March 28th, 2020.*

During their tenure at this Institute, they were found to be sincere and meticulous in their work. We appreciate their enthusiasm & dedication towards the work assigned to them.

We wish them every success.

Dr. Abdul Jhummarwala

Project Scientist,

BISAG, Gandhinagar

T. P. Singh

Director,

BISAG, Gandhinagar

CERTIFICATE

This is to certify that the project work titled

Analyzing The Growth Of Rural And Urban Areas Using Temporal Data From OpenStreetMap

is the bonafide work of

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HARDIKKUMAR PARMAR – 16CEUSG003

VIVEKKUMAR PARMAR – 16CEUSG030

carried out in the partial fulfillment of the degree of Bachelor of Technology in Computer Engineering at Dharmsinh Desai University in the academic session

December 2019 to April 2020.

Prof. Bhavika Gambhava	Dr. C. K. Bhensdadia
Assistant Professor	Head,
Dept. of Computer Engg.	Dept. of Computer Engg.

Faculty of Technology

Department of Computer Engineering

Dharmsinh Desai University

About BISAG

ABOUT THE INSTITUTE

Modern day planning for inclusive development and growth calls for transparent, efficient, effective, responsive and low cost decision making systems involving multi-disciplinary information such that it not only encourages people's participation, ensuring equitable development but also takes into account the sustainability of natural resources. The applications of space technology and Geo-informatics have contributed significantly towards the socio-economic development. Taking cognizance of the need of geo-spatial information for developmental planning and management of resources, the department of Science and Technology, Government of Gujarat established "Bhaskaracharya Institute for Space Applications and Geo-informatics" (BISAG). BISAG is an ISO 9001:2008, ISO 27001:2005 and CMMI: 5 certified institute. BISAG which was initially set up to carryout space technology applications, has evolved into a centre of excellence, where research and innovations are combined with the requirements of users and thus acts as a value added service provider, a technology developer and as a facilitator for providing direct benefits of space technologies to the grass root level functions/functionaries.

BISAG's Enduring Growth

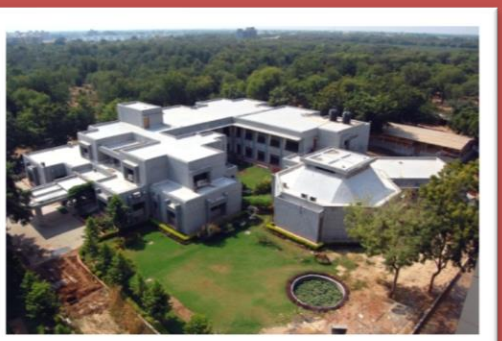
Since its foundation, the Institute has experienced extensive growth in the sphere of Space technology and Geo-informatics. The objective with which BISAG was established is manifested in the extent of services it renders to almost all departments of the State. Year after year the institute has been endeavoring to increase its outreach to disseminate the use of geo-informatics up to grassroots level. In this span of nine years, BISAG has assumed multi-dimensional roles and achieved several milestones to become an integral part of the development process of the Gujarat State.

BISAG's Journey

2003-04

Gujarat SATCOM Network

2007-08



Centre for Geo-informatics Applications

2010-11

Academy of Geo-informatics for Sustainable Development

2012-13

A full-fledged Campus

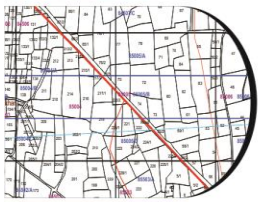
Activities

Satellite Communication..

for promotion and facilitation of the use of broadcast and teleconferencing networks for distant interactive training, education and extension.

Remote Sensing..

for Inventory, Mapping, Developmental planning and Monitoring of natural & man-made resources.

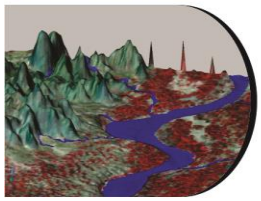


Geographic Information System..

for conceptualization, creation and organization of multi purpose common digital database for sectoral/integrated decision support systems.

Global Navigation Satellite System..

for Location based Services, Geo-referencing, Engineering Applications and Research.



Photogrammetry..

for Creation of Digital Elevation Model, Terrain Characteristic, Resource planning.

Cartography..

for thematic mapping, value added maps.

Software Development..

for wider usage of Geo-spatial applications, Decision Support Systems (desktop as well as web based), ERP solutions.

Education, Research and Training..

for providing Education, Research, Training & Technology Transfer to large number of students, end users & collaborators.

Applications of Geospatial Technology for Good Governance: Institutionalization

Through the geospatial technology, the actual situation on the ground can be accessed. The real life data collected through the technology forms the strong foundation for development of effective social welfare programs benefiting directly the grass root level people. The geospatial data collected by the space borne sensors along with powerful software support through Geographic Information System (GIS), the vital spatio-temporal maps, tables, and various statistics are being generated which feed into Decision Support System (DSS).

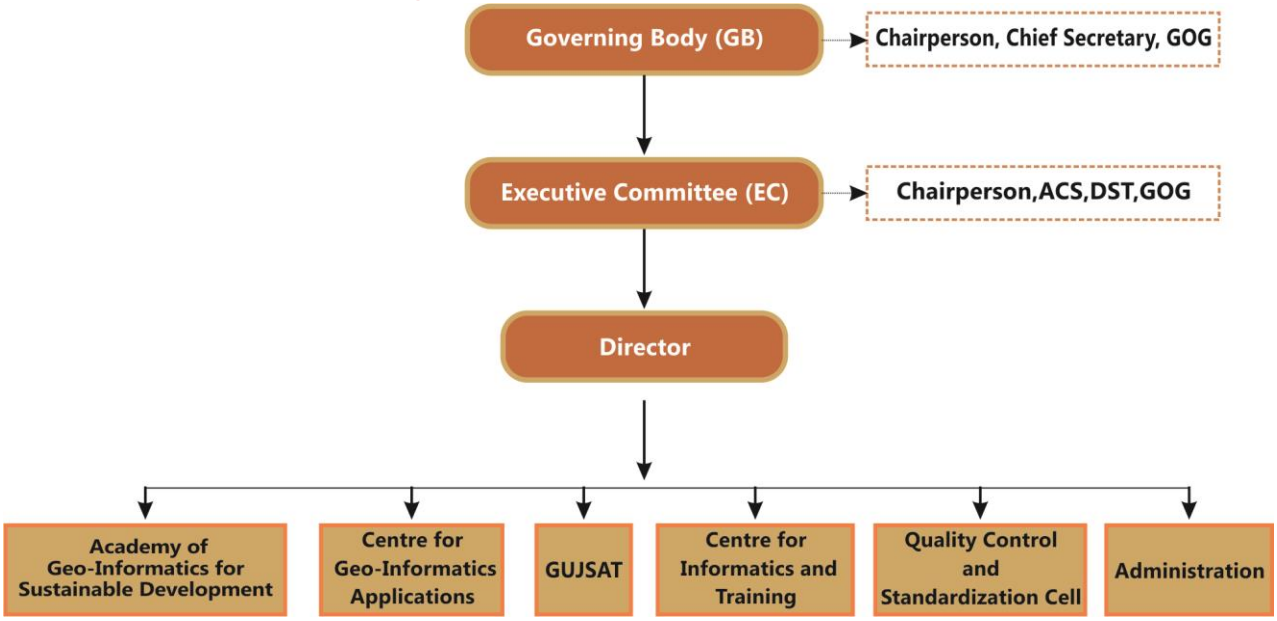
A multi-threaded approach is followed in the process of institutionalization of development of such applications. The 5 common threads which run through all the processes are: *Acceptability, Adaptability, Affordability, Availability and Assimilability*.
These are the "Watch Words" which any application developer has to meet. The "acceptability" addresses the issue that the application developed has met the wide acceptability among the users departments and the ultimate end beneficiary by way of providing all necessary data and statistics required. The "affordability" addresses the issue of the application product being cost effective. The "availability" aspect looks into aspect of easily accessible across any platform, anywhere and anytime. The applications should have inbuilt capability of easy adaptability to the changing spatio- and temporal resolutions of data, new aspects of requirements arising from time to time from users. The assimilability aspect ensures that the data from various sources / resolutions and technologies can be seamlessly integrated.

ACCEPTABILITY	▪ Problem definition by users • Proof of Concept development without financial liability on users ▪ Execution through collaboration under user's ownership
ADOPTABILITY	▪ Applications as per present systems & database ▪ Maximum Automation ▪ Minimum capacity building requirement at the user end
AFFORDABILITY :	▪ Multipurpose geo-spatial database, common, compatible, standardized (100s of layers) ▪ In house developed/open source software ▪ Full Utilization of available assets
AVAILABILITY:	▪ Departmental /Integrated DSS ▪ Desired Product delivery anytime, anywhere in the State
ASSIMILABILITY	▪ Integration of Various technologies like RS, GIS, GPS, Web MIS, Mobile etc.

Organizational Setup

The Institute is responsible for providing information and technical support to different Departments and Organizations. The Governing Body and the Empowered Executive Committee govern the functioning of BISAG. The Institute is registered under the Societies Registration Act 1860. Considering the scope and extent of activities of BISAG, its organizational structure has been charted out with defined functions.

Organizational Setup of BISAG



Governing Body

For smoother, easier and faster institutionalization of Remote Sensing and GIS technology, decision makers of the state were brought together to form the Governing Body. It is the supreme executive authority of the Institute. The Governing Body comprises of ex-officio members from various Government departments and Institutes.

- Chief Secretary, Government of Gujarat ..... Chairperson
- Secretary, Science and Technology ..... Member
- Secretary, Finance Department ..... Member
- Secretary, Education Department ..... Member
- Secretary, Revenue Department ..... Member
- Secretary, Panchayats, Rural Housing and Rural Development Department ... Member
- Director, Space Applications Center, ISRO, Ahmedabad ..... Member
- Dr. George Joseph, Former Director, SAC, ISRO, Ahmedabad ..... Member
- Vice Chancellor, Gujarat University, Ahmedabad ..... Member
- Chief Executive Officer, Gujarat Infrastructure Development Board ..... Member
- Jt. Secretary..... Invitee
- Director, BISAG ..... Member Secretary

Secretary means : Additional Chief Secretary / Principal Secretary / Secretary of Respective Department of Government of Gujarat

Centre for Geo-informatics Applications

Introduction

The objective of this technology group is to provide decision support to the sectoral stake holders through scientifically organized, comprehensive, multi-purpose, compatible and large scale (village level) geo-spatial databases and supporting analytical tools. These activities of this unit are executed by a well-trained team of multi-disciplinary scientists. The government has provided a modern infrastructure along with the state-of-the-art hardware and software. To study the land transformation and development over the years, a satellite digital data library of multiple sensors of last twenty years has been established and conventional data sets of departments have been co-registered with satellite data. The geo-spatial databases have been created using conventional maps, high resolution satellite 2D and 3D imagery and official datasets (attributes).The geo-spatial databases include terrain characteristics, natural and administrative systems, agriculture, water resources, city survey maps, village maps with survey numbers, water harvesting structures, water supply, irrigation, power, communications, ports, land utilization pattern, infrastructure, urbanization, environment data, forests, sanctuaries, mining areas, industries. They also include social infrastructure like the locations of schools, health centers, institutions, aganwadies, local government infrastructure etc. The geospatial database of nagar-palikas includes properties and amenities captured on city and town planning maps with 1000 GIS layers. Similar work for villages has been initiated as a pilot project.

The applications of space technology and geo-informatics have been operational in almost all the development sectors of the state. Remote sensing and GIS applications have provided impetus to planning and developmental activities at grass root level as well as monitoring and management in various disciplines.

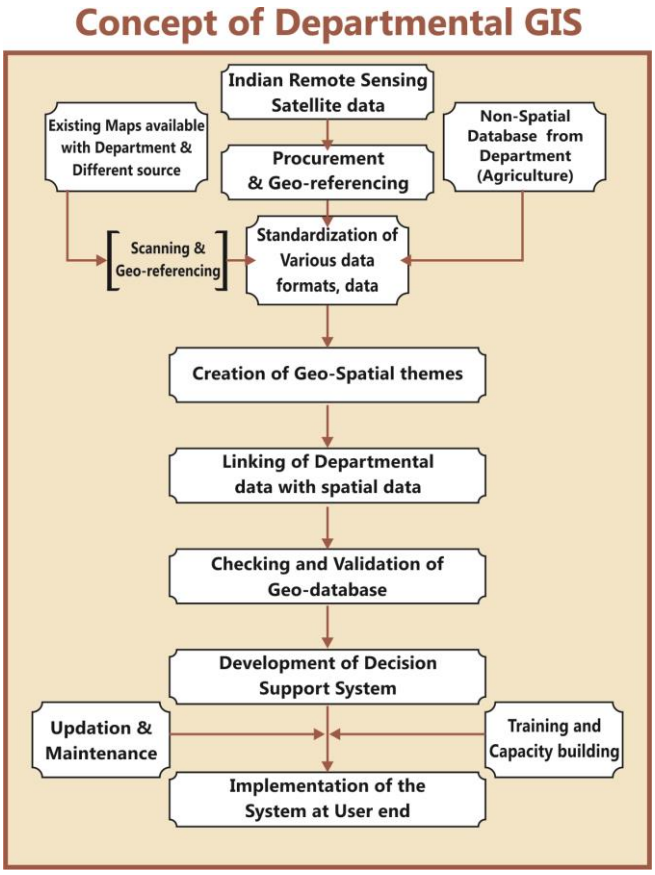
The GIS based Applications Development

The GIS software is a powerful tool to handle, manipulate and integrate both the spatial and non-spatial data. The GIS system operates on the powerful backend data base and Sequential Query Language (SQL) to inquiry the data bases. It has the capability to handle large volume of data and process to yield values of parameters which can be input to very important government activity as Decision Support System (DSS). Its mapping capabilities help the users and specialists in generating single and multi-theme wise maps.

The GIS based applications development has been institutionalized in BISAG. This process can be listed as (Refer Figure for Details)

- Making the users aware of the GIS capabilities through introductory training programme and by exposing to already developed projects as success stories.
- Helping the users in defining the GIS based projects.

- Digitizing the data available with the users and encouraging them to collect any additional data as may be required.
- Generating the appropriate data bases with the full involvement of the users following the data bases standards



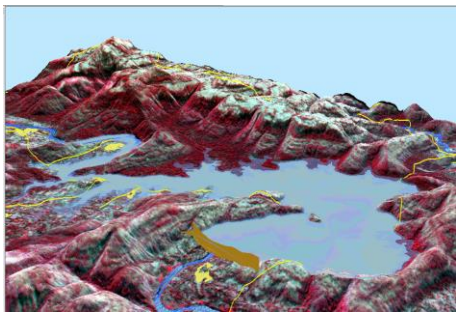
Remote Sensing and GIS Sectoral Applications:

Geo-informatics based Irrigation Management and Monitoring System

- The Geo-spatial information system for Irrigation water Management and Monitoring system for command areas in Sardar Sarovar Narmada Nigam Limited (SSNL) has been developed. Satellite image-based Irrigation monitoring system has been developed in GIS. From the multi-spectral Satellite images of every month, the irrigated areas were extracted.
- The irrigated area were overlaid on the geo-referenced cadastral maps and the statistics of area irrigated has been estimated.
- The user friendly Customized Decision Support System (DSS) has been developed.

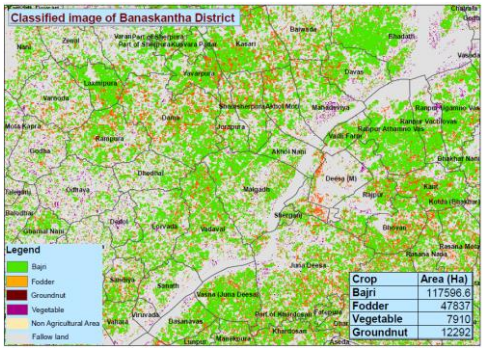
Preparation of DPR of Par-Tapi-Narmada Link using Geo-informatics for National Water development Agency (NWDA)

- The main objective of Par–Tapi-Narmada Link project is to divert surplus water available in west flowing rivers of south Gujarat and Maharashtra for utilization in the drought prone Saurashtra and Kachcha. On the request from NDWA, preparation of various maps for proposed DPR work was undertaken by the BISAG. Land use and submergence maps of proposed dams along with its statistics have been prepared by the BISAG. The detailed work consisted of generation of Digital Elevation Model (DEM), contour generation, Land use mapping, forest area generation of submergence extent at different levels etc.



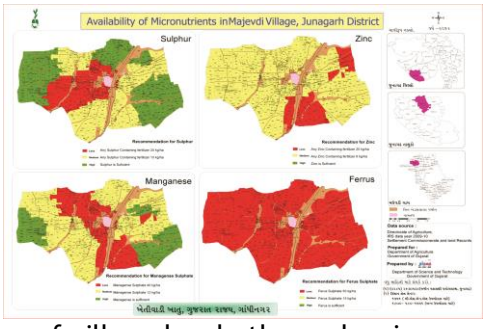
Agriculture

District and Village-level Crop Inventory



- Remote Sensing (RS) based Village-level Crop Acreage Estimation at was taken up in two villages of Anand and Mehsana districts of Gujarat state. The major objective of this study was to attempt village-level crop inventory during two crop seasons of Kharif (monsoon season) and Rabi (winter season) using single-date Indian Remote Sensing (IRS) LISS-III and LISS-IV digital data of maximum vegetative growth stage of major crops during each season.
- District-level crop acreage estimation during three cropping seasons namely Kharif, Rabi and Zaid (summer) seasons was also carried out in all the 26-districts of Gujarat State. Summer crop acreage estimation Gujarat State was carried out during 2012.

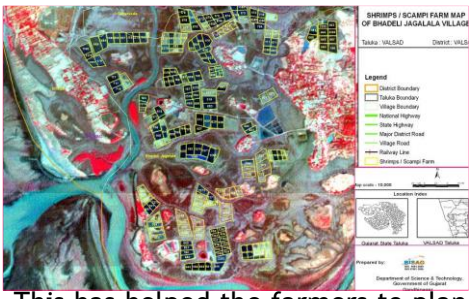
Spatial Variability Mapping of Soil Micro-Nutrients



- The spatial variability of soil micro-nutrients like Fe, Mn, Zn and Cu in various villages of different districts, Gujarat state was mapped using geo-informatics technology. The major objectives of this study were i) to quantify the variability of Mn, Fe, Cu and Zn concentration in soil; ii) to map the pattern of micro-nutrient variability in cadastral maps, iii) suggest proper application of micro-nutrients based on status of deficiency for proper crop management and iv) preparation of village-level atlases showing spatial variability of micro-nutrients.

Geo-spatial Information System for Coastal Districts of Gujarat

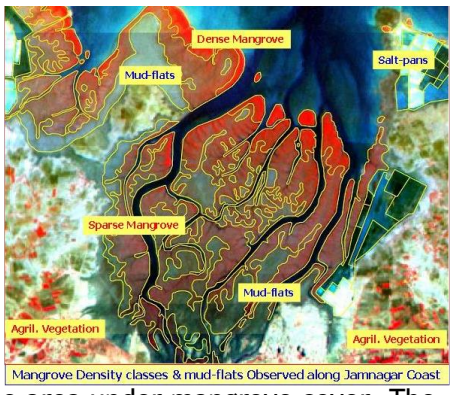
- The project on development of Village-level Geo-spatial Information System for Shrimp Farms in Coastal Districts of Gujarat, was taken with major objective of development of Village-level Geo-spatial Information System for Shrimp/Scampi areas using Remote Sensing



(RS) and GIS. This project was sponsored by the Marine Products Export Development Authority (MPEDA), Ministry of Commerce & Industry, Government of India for scientific management of Scampi farms in the coastal districts which can help fishermen to better their livelihood and increase the economic condition on sustainable basis. The customized query shell was developed using the open source software for sharing the information amongst the officers from MPEDA and potential users. This has helped the farmers to plan their processing and marketing operations so as to achieve better remunerations.

Environment and Forest

Mapping and Monitoring of Mangroves in the Coastal Districts of Gujarat State



Mangrove Density classes & mud-flats Observed along Jamnagar Coast

- Gujarat Ecology Commission, with technical inputs from the Bhaskaracharya Institute for Space Applications and Geo-Informatics (BISAG) made an attempt to publish Mangrove Atlas of the Gujarat state. Mangrove atlas for 13-coastal districts with 35-coastal talukas in Gujarat, have been prepared using Indian Remote sensing satellite images. The comparison of mangrove area estimates carried out by BISAG and Forest Survey of India (FSI) indicates a net increase in the area under mangrove cover. The present assessment by BISAG, has recorded 996.3 sq. km under mangrove cover, showing a steep rise to the tune of 88.03 sq. km. In addition to the existing Mangrove cover, the present assessment also gives the availability of potential area of 1153 sq. km, where mangrove regeneration program can be taken up.

Academy of Geo-informatics for Sustainable Development

Introduction

- Considering the requirement of high end research and development in the areas having relevance of geo-informatics technology for sustainable development, a separate infrastructure has been established. In collaboration with different institutes in the state as well as in the country, R&D activities are being carried out in the areas of climate change, environment, disaster management, natural resources management, infrastructure development, resources planning, coastal hazard and coastal zone management studies, etc. under the guidance of eminent scientists.

- Various innovative methodologies/models developed in this academy through the research process have helped in development of various applications. There are plans to enhance R&D activities manifold during coming years.
- This unit also provides training to more than 600 students every year in the field of Geo-informatics to the students from various backgrounds like water resources, urban planning, computer Engineering, IT, Agriculture in the areas of Remote sensing, GIS and their applications.

- This Academy has been established as a separate infrastructure for advanced research and development through following schools:
  - School of Geo-informatics
  - School of Climate & Environment
  - School of Integrated Coastal Zone Management
  - School of Sustainable Development Studies
  - School of Natural Resources and Bio-diversity
  - School of Information Management of Disasters

- School of Communication and Society

During XIIth Five year Plan advance applied research through above schools shall be the main thrust area. Already M. Tech and Ph.D. students of other Universities/ Institutes are doing research in this academy in applied sciences under various collaborative programmes.

M. Tech. Students' Research Programme

The academy started M. Tech. students' research programme in a systematic way. It admitted 11 students from various colleges and universities in Gujarat, Rajasthan and Madhya Pradesh for period of 10 months from August 2011 to May 2012. All the students were paid stipend of Rs. 6000 per month during the tenure. The research covered the following areas:

- Cloud computing techniques
- Mobile communication
- Design of embedded systems
- Aquifer modeling
- Agricultural and Soils Remote Sensing
- Digital Image processing Techniques (Data Fusion and Image Classification).

The research resulted in various dissertations and publications in national and international journals.

- Now nine students, one from IIT, Kharagpur, three from GTU, one from M. S University, Vadodara and four from GU, are undergoing their Ph. D programme. Out of nine, two thesis have been submitted. Two students are from abroad. One each from Vietnam and Yemen. Since then (after approval of research programme from the Governing Body), 200+ papers have been published by the Academy.

CANDIDATE'S DECLARATION

We declare that final semester report entitled "**Analysis of rural and urban development using temporal OSM data**" is our own work conducted under the supervision of the external guide **Dr. Abdul Jhummarwala** from BISAG (Bhaskaracharya Institute for Space Applications & Geo-informatics).We further declare that to the best of my knowledge the report for B.Tech final semester does not contain part of the work which has been submitted for the award of Bachelor Degree either in this or any other university without proper citation.

Candidate 1's Signature

Akshay Methaniya

Student ID: 16CEUOG082

Candidate 2's Signature

Chirag Patel

Student ID: 16CEUES112

Candidate 3's Signature

Hardikkumar Parmar

Student ID: 16CEUSG003

Candidate 4's Signature

Vivekkumar Parmar

Student ID: 16CEUSG030

Submitted To:

Dharmsinh Desai University, Nadiad

Nadiad.

ACKNOWLEDGMENT

We are grateful to **T.P.Singh**, **Director (BISAG)** for giving us this opportunity to work the guidance of renowned people of the field of MIS Based Portal also providing us with the required resources in the company.

We would like to express our endless thanks to our external guide **Dr. Abdul Jhummarwala**, And Admin Staff **Mr.Saurabh Bhabhor** and **Mr.Sidhdharth Patel** at Bhaskaracharya Institute of Space Application and Geo-informatics for their sincere and dedicated guidance throughout the project development.

Also our hearty gratitude to our Asst. Professor, **Bhavika Gambhava** for giving us encouragement and technical support on the project.

Akshay Methaniya — Student ID: 16CEUOG082

Chirag Patel — Student ID: 16CEUES112

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Chapter 1

Introduction

1. Introduction

1.1 Project Details

Project Title	**:**	Analyzing growth of rural and urban Areas using temporal from OpenStreetMap.
Students	**:**	Akshay Methaniya Chirag Patel Hardikkumar Parmar Vivekkumar Parmar
Student(s) Email ID	**:**	akshaymethaniya@gmail.com chiragpatel1499@gmail.com parmarhardik633@gmail.com vp393001@gmail.com
Language	**:**	Java (JSP and Servlet), HTML, JavaScript
Framework	**:**	GeoServer
Dataset	**:**	OpenStreetMap
Database	**:**	PostGIS
Library	**:**	Leaflet
Tools	**:**	NetBeans, PgAdmin4
Cloud Platform	**:**	Google Cloud Platform

1.2 Purpose

The role of rural and urban planning and management is becoming more and more crucial due to the dramatic increase in population and allied urban problems. Our government is using applications such as GDSS (Geospatial Decision Support Systems), GIS (Geospatial information system) to keep track of the growth of rural and

urban development. The government faces difficulties when it comes to tracking development done in a region over the past couple of years. The government spends a certain amount of money on development and they need to make sure that it is being utilized properly. The government also needs to find out remote areas and the best possible way to connect it with the rest of the world through transportation facility thus, we decided to simplify the process using technology through this project which will help government entities to plan development strategies more efficiently

Rural and Urban regions grow in area and population every day, calling for more resources, better living spaces and improved administration. Thus, we decided to analyze the growth of urban and rural areas. This project can be used by various government organizations to see the development done in a specific region in the past few years. This way government entity can keep track of development done and take necessary steps if required.

1.3 Scope

This system will be designed to analyze the growth of the rural and urban development. This research project is being developed for Geo-Informatics purpose which will be fruitful to the Government and various agencies in the area of rural and urban growth analysis. This project leads us to the information of the development of roads, construction, railing, bridges and other features over the different time stamps. More specifically this system is designed to know how the area is being constructed with different filters as written above in the span of given time. The agencies and corporations which will use this system can analyze the development and do the future planning of further construction and development where it is exactly required.

1.4 Objective

The objective of this project is to generate a graphical representation of development in rural and urban areas by analyzing the already available dataset. This analysis can be further used to take

critical actions by the government for the development of urban and rural areas.

1.5 Technology & Literature Review

1.5.1 Dataset

OSM:

Open Street Map (OSM) is a synergic project to create a free editable map. Data beneath the map is considered the mainstream output of the project. The dataset which is being taken in this project is gathered from OSM. To edit such maps, we will need software like iD (default web browser editor). Maps.me, OSM and Gnome software are also used. In addition to various sets of the satellite, image backgrounds are available to OSM editors, data from several street-level image platform are available as map data photo overlays.

Services using OSM: Craigslist, Flickr, Facebook, Tesla smart summon

When we are talking about historical datasets and temporal data, we also look into the amount of increase in the data which has happened over time.

[Figure: 1] OSM Logo

1.5.2 Language

Java:

Osmosis is a command-line Java application that can be used for processing Open Street Map. This tool can be used to perform a larger operation using a series of pluggable components that can be chained together. It has the components that can read from the database and file, write to the database, sort the data, etc.

Overpass API is a read-only API that serves up custom selected parts of the OSM map data. The client can send a query by search criteria like location, type of objects, tag properties, etc. and the API gets back the data set that corresponds to the query.

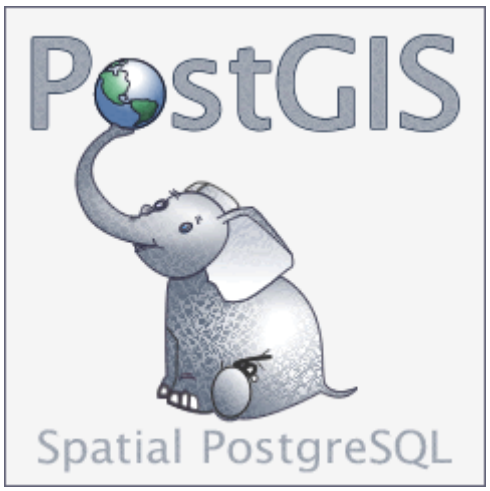
[Figure : 2] Java Logo

1.5.3 Database

PostGIS:

PostGIS is an extension to the PostgreSQL object-relational database system which allows GIS (Geographic Information Systems) objects to be stored in the database. PostGIS includes support for GiST-based R-Tree spatial indexes and functions for analysis and processing of GIS objects.

PostGIS is a spatial database extender for PostgreSQL object-relational database. It adds support for geographic objects allowing location queries to be run in SQL.



[Figure: 3] PostGIS Logo

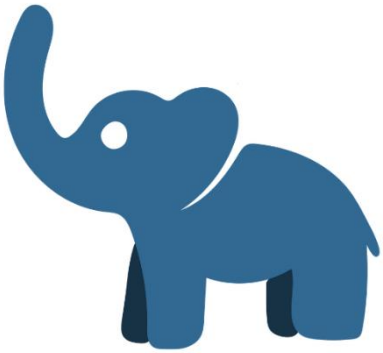
```
SELECT superhero.name
FROM city, superhero
WHERE ST_Contains(city.geom, superhero.geom)
AND city.name = 'Gotham';
```

In addition to basic location awareness, PostGIS offers many features rarely found in other competing spatial databases such as Oracle Locator/Spatial and SQL Server. Refer to PostGIS Feature List for more details. It adds support for geographic objects like points, line-strings, polygons and more. It also includes a large quantity of spatial functions, such as 'get the area of a polygon', 'calculate the length of a line' or 'get the distance between two different objects', etc. In addition, it has different operators to combine geometries, so we can get the union of two or more geometries, get the intersected polygon or even create a buffer of an object.

PostgreSQL:

PostgreSQL is a powerful, open-source object-relational database system that uses and extends the SQL language combined with many features that safely store and scale the most complicated data workloads. The origins of PostgreSQL date back to 1986 as part

the **POSTGRES** project at the University of California at Berkeley and has more than 30 years of active development on the core platform.



[Figure: 4] PostgreSQL Logo

PostgreSQL has earned a strong reputation for its proven architecture, reliability, data integrity, robust feature set, extensibility, and the dedication of the open-source community behind the software to consistently deliver performant and innovative solutions. PostgreSQL runs on **all major operating systems**, has been **ACID**-compliant since 2001, and has powerful add-ons such as the popular **PostGIS** geospatial database extender. It is no surprise that PostgreSQL has become the open-source relational database of choice for many people and organizations.

PostgreSQL comes with **many features** aimed to help developers build applications, administrators to protect data integrity and build fault-tolerant environments, and help you manage your data no matter how big or small the dataset. In addition to being **free and open-source**, PostgreSQL is highly extensible. For example, you can define your own data types, build out custom functions, even write code from **different programming languages** without recompiling your database!

PostgreSQL tries to conform with the **SQL standard** where such conformance does not contradict traditional features or could lead to poor architectural decisions. Many of the features required by the SQL standard are supported, though sometimes with slightly differing syntax or function. Further moves towards conformance can be expected over time. As of the version 12 release in October 2019, PostgreSQL conforms to at least 160 of the 179 mandatory features for SQL:2016 Core conformance. As of this writing, no relational database meets full conformance with this standard.

1.5.4 Tools

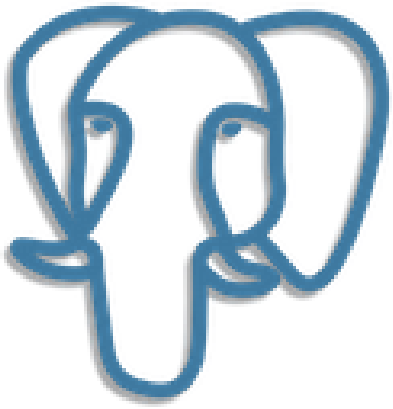
NetBeans:

NetBeans is not a newcomer to the Java arena. In fact, it is one of the oldest Java IDEs still available on the market. But the most exciting developments happened in the latest releases, specially 4.0 and 5.0, with the renewed commitment from Sun and participation of an ever-growing community of users and developers. In many respects, such as desktop development, NetBeans can be regarded as the most powerful and most easy-to-use Java IDE. The project will also stick to Object-Oriented best practices, showing that you can develop GUI applications quickly and interactively, without compromising long-term maintenance and a sound architecture.

[Figure: 5] NetBeans Logo

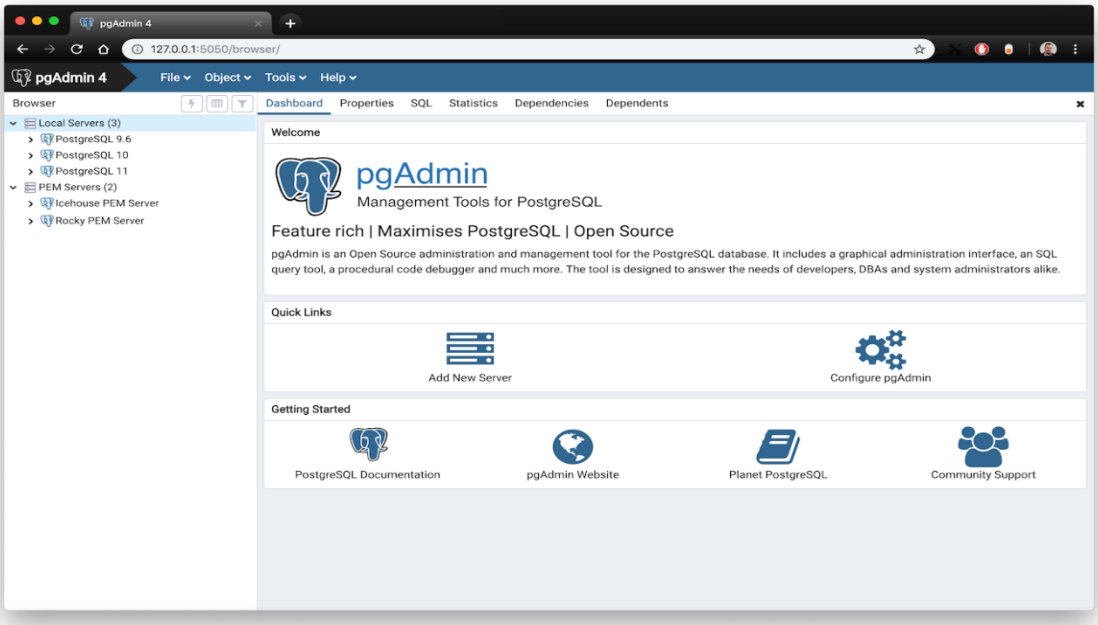
pgAdmin4:

PgAdmin is a free software project released under the PostgreSQL/Artistic license. The software is available in source and binary format from the PostgreSQL mirror network. Because compiling from source requires technical knowledge, we recommend installing binary packages whenever possible.



[Figure: 6] pgAdmin Logo

PgAdmin 4 is a complete rewrite of PgAdmin, built using Python and JavaScript/jQuery. A desktop runtime written in C++ with Qt allows it to run standalone for individual users, or the web application code may be deployed directly on a web server for use by one or more users through their web browser. The software has the look and feel of a desktop application whatever the runtime environment is, and vastly improves on PgAdmin III with updated user interface elements, multi-user/web deployment options, dashboards and a more modern design.



[Figure: 7] pgAdmin Dashboard

1.5.5 Frameworks

GeoServer :

GeoServer is a Java-based software server that allows users to view and edit geospatial data. Using open standards set forth by the Open Geospatial Consortium (OGC), GeoServer allows for great flexibility in map creation and data sharing. GeoServer allows you to display your spatial information to the world. Implementing the Web Map Service (WMS) standard, GeoServer can create maps in a variety of output formats. OpenLayers, a free mapping library, is integrated into GeoServer, making map generation quick and easy. GeoServer is built on GeoTools, an open-source Java GIS toolkit.

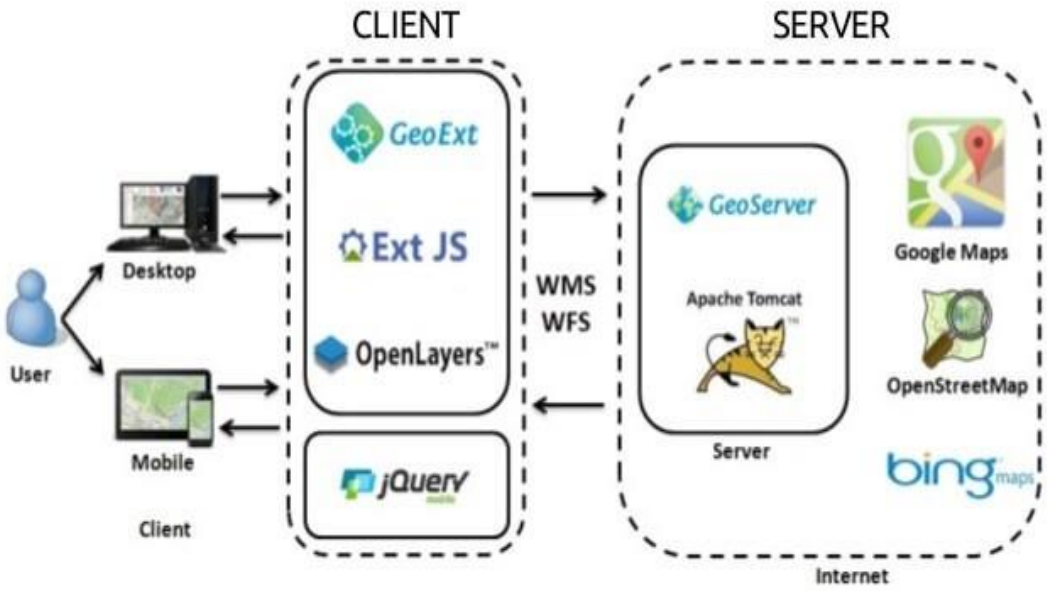
[Figure: 8] GeoServer Logo

There is much more to GeoServer than nicely styled maps. GeoServer conforms to the Web Feature Service (WFS) standard, and Web Coverage Service (WCS) standard which permits the sharing and editing of the data that is used to generate the maps. GeoServer also uses the Web Map Tile Service standard to split your published maps into tiles for ease of use by web mapping and mobile applications.

GeoServer is free software. This significantly lowers the financial barrier to entry when compared to proprietary GIS products. In addition, not only is GeoServer available free of charge, but it is also open source. Bug fixes and feature improvements in open source software occur in a transparent manner, often at an accelerated pace compared to closed software solutions. Leveraging GeoServer in your organization also prevents software lock-in, saving costly support contracts down the road.

A GIS Server is a software that listens for specific requests (by clients). These requests could be for different services (i.e. OGC compliant) like getMap request etc. A GIS server loads a dataset (e.g. a shape file or a Geo-Tiff) renders it, cut the image into tiles and sends it back to the requesting client. Every time a client pans or zooms, GIS server receives requests and sends image tiles as response

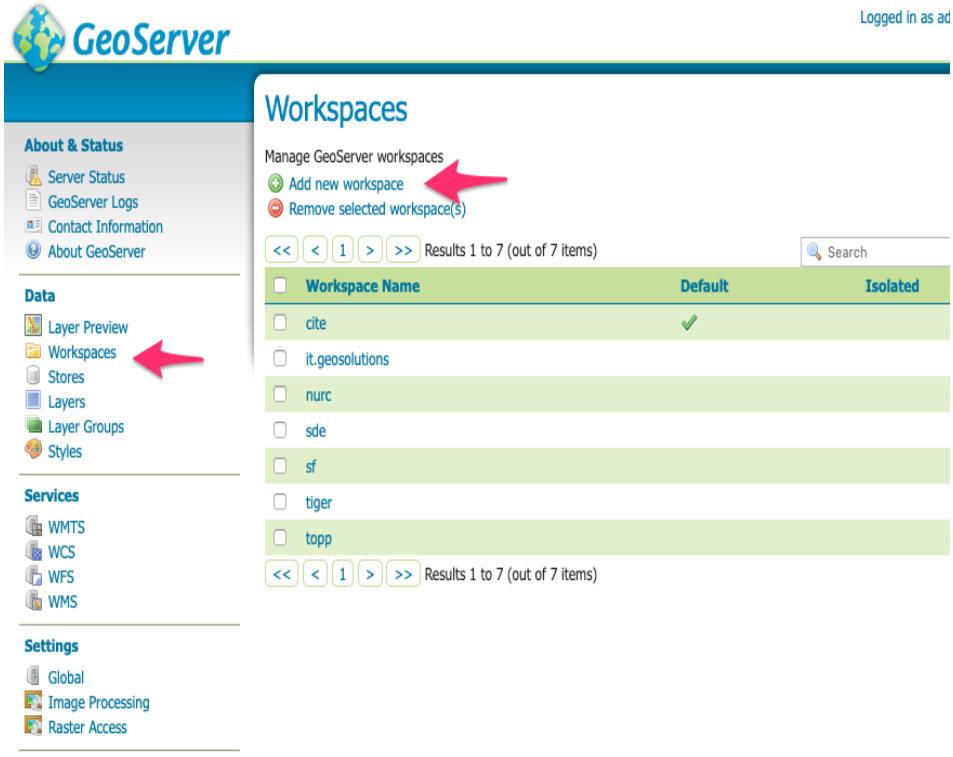
There are various Open Source options to choose for a GIS Server (i.e. https://www.gislounge.com/open-source-gis-applications).



[Figure: 9] GeoServer - Leaflet Communication

GeoServer (http://geoserver.org/), however, is one of the most commonly used frameworks. It has an edge over others because of its administration tool i.e. web-based administration interface and its simplicity deploying a dataset as a WMS, which makes it an ideal option for beginners in the WebGIS industry.

The advances in Information and Communication Technologies have changed the way in which spatial data are distributed. Today, Web GIS is utilized to disseminate maps over the Internet. **Spatial Information tends to be created, stored and managed by local providers. However, it is available to various clients anyplace and whenever.** This approach empowers a client application to get to spatial data across different networks and sources.



[Figure: 10] GeoServer Workspace

1.5.6 Cloud Platform

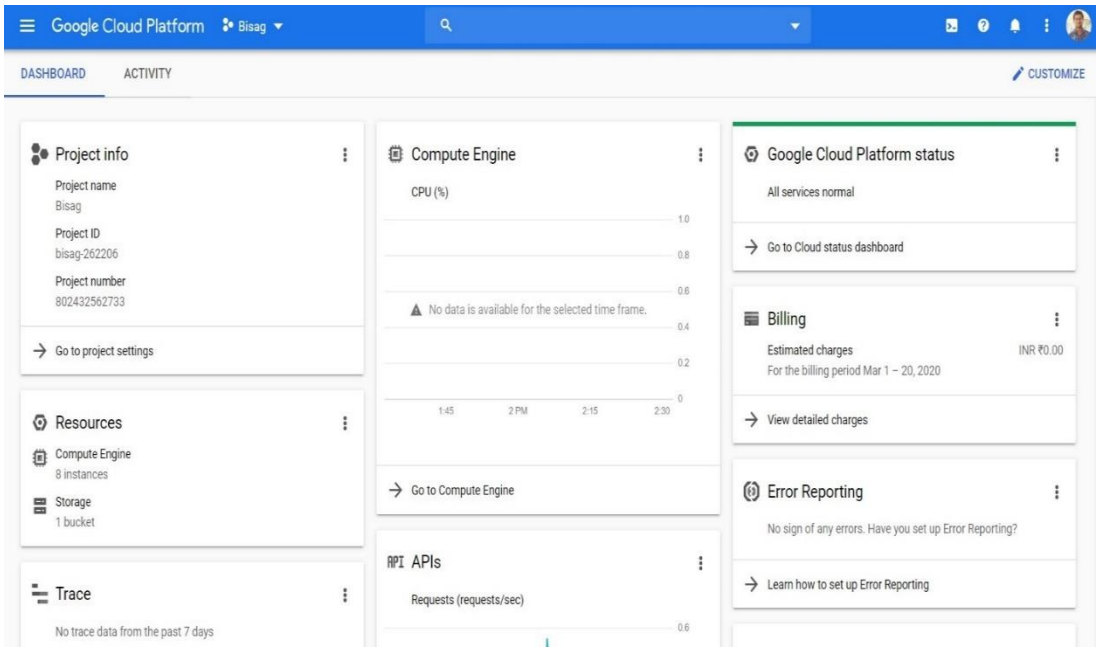
Google Cloud Platform:

Google Cloud Platform (GCP) is a collection of Google's computing resources, made available via services to the general public as a public cloud offering. Here GCP resources consist of physical hardware infrastructure — computers, hard disk drives, solid state drives, and networking — contained within Google's globally distributed data centers, where any of the components are custom designed using patterns similar to those available in the Open Compute Project.

[Figure: 11] GCP Logo

This hardware is made available to customers in the form of virtualized resources, such as virtual machines (VMs), as an alternative to customers building and maintaining their own physical infrastructure. As a public cloud offering, software and hardware products are provided as integrated services that provide access to the underlying resources. GCP offers over 50 services including Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) offerings in the categories of Compute, Storage & Databases, Networking, Big Data, Machine Learning, Identity & Security, and Management & Developer tools.

These services can be used independently or in combination for developers and IT professionals to construct their own, custom cloud-based infrastructure. GCP is hosted on the same underlying infrastructure that Google uses internally for end-user products including Google Search and YouTube.



[Figure: 12] GCP Dashboard

1.5.7 Libraries

Leaflet:

Leaflet is a JavaScript library that helps you make maps for the web. It's primary functions are to bring your baseman and feature data together and to handle interactivity. Leaflet.js is a library for adding interactivity to maps. They have a ton of features and plugins to support doing pretty much anything with a map that no one can think of.

[Figure: 13] Leaflet logo

```
<script>
    // Creating map options
    var mapOptions = {
       center: [17.385044, 78.486671],
       zoom: 10
    }

    // Creating a map object
    var map = new L.map('map', mapOptions);

    // Creating a Layer object
       var layer = new
       L.TileLayer('http://{s}.tile.openstreetmap.org/{z}/{x}
       /{y}.png');

    // Adding layer to the map
    map.addLayer(layer);
 </script>
```

[Figure: 14] Leaflet example

1.5.8 3rd Party Libraries

GeoJSON:

Ultimately, GeoJSON is an open-standard format, designed for representing simple geographical features — points (addresses and locations), line strings (streets, public transport lines, etc.), polygons (regions, states, etc.). The great thing about it is that it is based on the well-known JSON format.

CanvasJS :

CanvasJS charts are responsive and run across all devices including Tablets, Desktops & Phones. All Graphs are Cross-Browser compatible and have 10X better performance.

JFreeChart :

JFreeChart is an open-source framework for the programming language Java, which allows the creation of a wide variety of both interactive and non-interactive charts. It is possible to place various markers and annotations on the plot. JFreeChart also works with GNU Classpath, a free software implementation of the standard class library for the Java programming language. JFreeChart automatically draws the axis scales and legends. Charts in GUI automatically get the capability to zoom in with the mouse and change some settings through local menu. The existing charts can be easily updated through the listeners that the library has on its data collections. JFreeChart supports a number of various charts, including combined charts.

Chapter 2

Project Management

2. Project Management

2.1 Feasibility Study

2.1.1 Technical Feasibility

Product:

Our product will be used by government agencies as well as by private sectors. It gives the visual representation of rural & urban development done in the last five years. This is product is categorized as a Web Application. It has no physical appearance.

Manufacturing Process:

Once the application is fully developed, it can be used by the clients. Only the maintenance part will be carried out by developers. License- Agreement and patent will be reviewed.

Production Schedules:

The fixed cost of our application is dependent on cloud resources and number of requests. Our product will be operated all the time unless something malfunctioning comes up. The financing will be available for future extensions.

2.1.2 Time schedule Feasibility

We have planned the project in a way that it will be completed in estimated time having other time to prepare for report. In order to complete the project before deadline, we will not deteriorate the client's requirements. It will take 3.5 months to build the application and then it will be delivered to them.

2.1.3 Operational Feasibility

Analyzed the requirement of the client well. Prepared the basic plan to carry out for the development so that client's needs can be fulfilled within time period. We studied all the technologies which can be used in making of this application and verified whether it can be used to cover all the requirements.

2.1.4 Implementation Feasibility

We decided the strategy about the implementation. We discussed which software engineering model should be used. In this product we have used Incremental model for implementation strategy.

2.2 Project Planning

2.2.1 Project Development Approach and Justification

After gathering the requirement analysis for the given definition, we started to analyze the software engineering model that can be well suited for development of this application. We have used Incremental model for the product development. We have approached Object Oriented way to generalize modules. The project members divided modules and the development period boosted off.

2.2.2 Milestones & Deliverables

As it was a large project to complete, we had divided in into the modules. It is important to track progress of the project to get the insights. We had 5 milestones in general.

Milestones:

Project start date: 9/9/2019

Milestone 1st: Building basic module of plotting map

Milestone 2nd: Adding the functionalities

Milestone 3rd: Front -End

Project end date: 14/3/20

Deliverables:

After each milestone, we verified the outcome of application whether it is operating as per client's need.

2.2.3 Roles & Responsibilities

Back-end: Akshay Methaniya, Chirag Patel

Cloud Platform: Vivekkumar Parmar

Front – end: Hardikkumar Parmar

Chapter 3

System Requirement Study

3. System Requirement Study

3.1 Study of the current system

In order to take inspiration for our product development, we looked up for already available systems which can be thoroughly researched. After studying those open source systems, we did the analysis of the technology used in those, discussed whether those technology are feasible to us in production, do they suit with our hardware resource. We analyzed what this current system lacks and what we can improve on that.

3.2 Problems and the weakness of the current system

After analyzing the current system, we came to know about the drawbacks of it and we researched about those problems and weaknesses. One of the problems are listed below.

- System couldn't save the previously searched properties
- Multiple polygons were not possible
- The plotting was limited to Gujarat region only
- Lack of zooming feature

We researched about these problems and included all the solutions in our system.

3.3 User Characteristics

This covers the characteristics of users in three senses: the end user who will interact with the Analysis of development of rural and urban system which can be agencies, public/private sector users.

- Users should have a basic technical background to use this.
- Users who work or doing research in Geo-informatics area.
- Media groups
- Political Parties
- Government/ private sector offices
- Construction designers

3.4 Hardware and Software Requirements

Hardware Requirements:

- Bitnami-postgresql-10-11-0-1-r01-linux-debian-9-x86-64-mt-nami {10 GB}
- N2-standard-4 (4 vCPUs, 16 GB memory) machine type

Software Requirements:

- Geoserver
- pgAdmin4
- Netbeans

3.5 constraints

3.5.1 User Interface

- The user interfaces of our system prevent users from issuing commands in the wrong order by having quite clean, minimal and understandable to everyone.
- Users are usually given feedback within 10 seconds of issuing a click.
- After the failure, maximum acceptable time for restarting the system is 8 mins.
- We have specifically taken care for system's correctness, completeness, consistency and readability.

3.5.2 Communication Interface

This application uses GeoServer, pgAdmin4 for rendering the OSM Data and with leaflet JavaScript library to plots the map as the o/p depending on the selected property.

3.5.3 Hardware Interface

This application works on android, iOS, macOS, windows, UNIX. No other hardware is needed.

3.5.5 Safety and security consideration

- Our system is deployed on the GCP and using cluster of bitnami service assures that the system can withstand DDoS attack.
- End user is prohibited to get access of server and database.
- Our system doesn't save any details from user without asking. Plus, it does not process the given data by user to any 3rd party firms.
- So that makes our system sufficiently safe to operate.

3.6 Assumption

3.6.1 Assumption

- Platform: The application will be developed for web platforms only.
- Operating System: Latest browsers in Android, windows, iOS, macOS and UNIX will be able to run.

Chapter 4

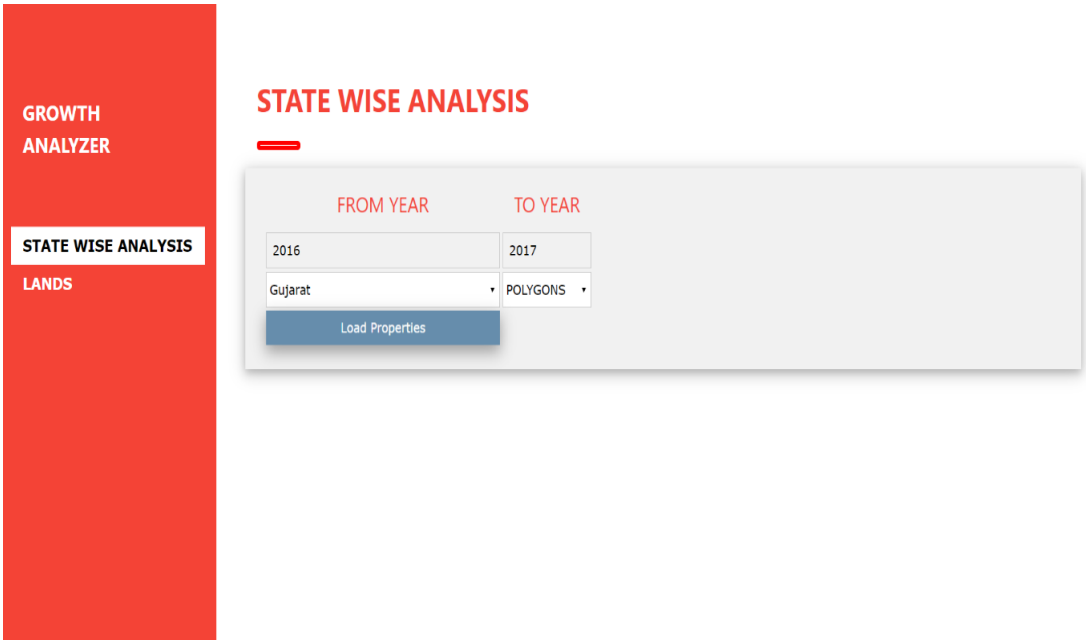
Requirement of proposed system

4. Requirement of the proposed system

4.1 Main module of the system

As we have divided our project into modules according to the software engineering model, we are following in the SDLC. We declare “State wise Analysis” module our main module. It covers the basic functionality of our project which is to give analytical data. The data is presented in the form of chart/png/jpg/pdf and on map.

Here is the still of main module of the system:



[Figure: 15] Homepage

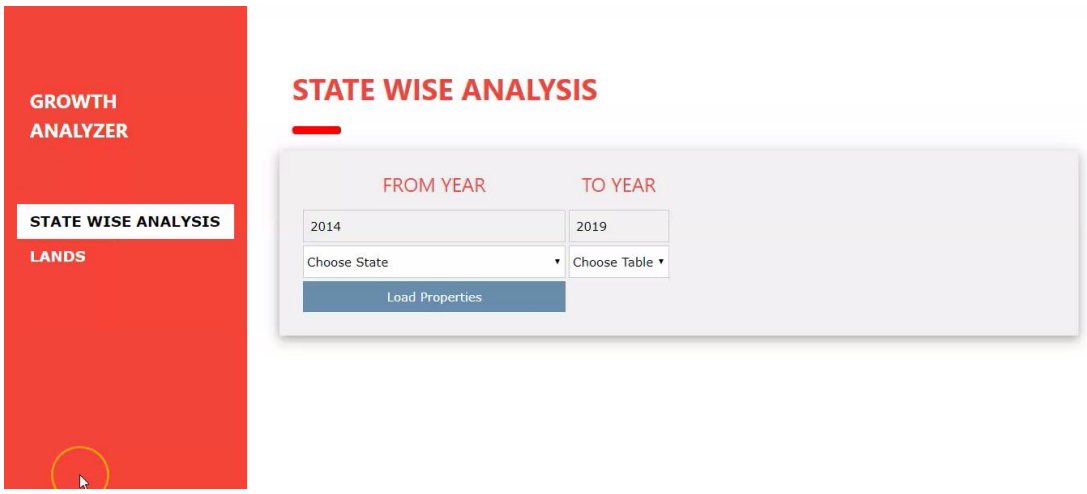
4.2 Module Descriptions

State wise analysis:

We have given the insights of this in previous sections. Now here is the module description that contains what it does and what the steps of performing same. Users can filter the search space by choosing state, table, properties and years. After loading a particular property, user will have to click on view result. Below are the steps for finding waterways of Gujarat state from the year 2014 to 2019.

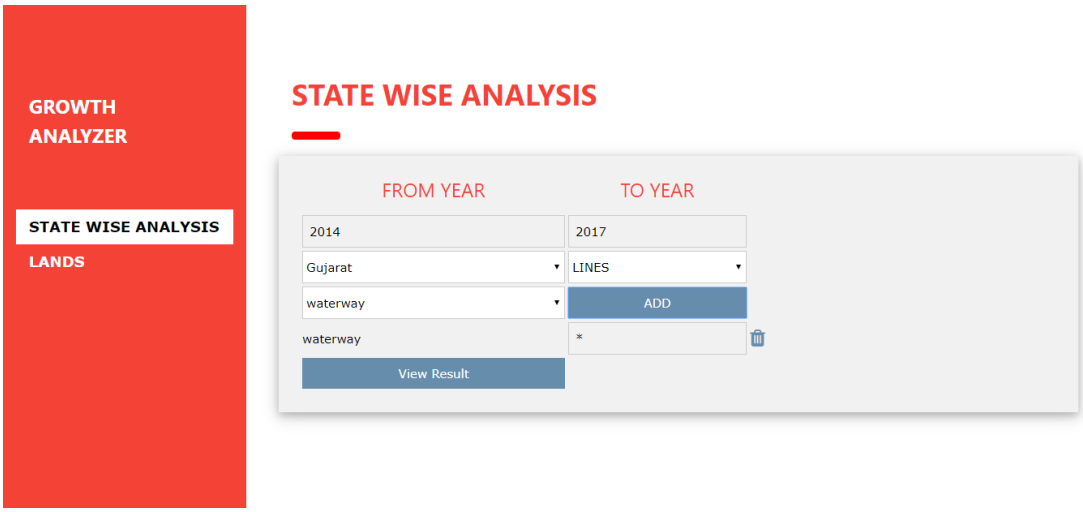
- User can view the analysis of certain entities state-wise using this module.
- User can also apply filter on some region by drawing polygons on map and can able to visualize the development done in that region.
- User can also specify coordinates of polygon to draw polygon on map and can apply filter in that region only and can able to visualize the development done in that region.
- User can also choose the land which are added by you from Land layer of system for filter process.
- User can apply CQL filters on the outcome.
- User can view Features of the drawn geometry on map by clicking on that.
- User can dynamically apply different colors for different years which can be helpful in better visualization and better separability of outcomes of different year.
- User can find any place on map using the find the place function.
- Map has more baseLayers for better visualization. User can switch to anyone.
- System automatically changes the camera view of the map based on the outcome produced.
- System suggests the description of the key property as well as its value.
- E.g. amenity property: It describes useful and important facilities for visitors and residents.

1. Select Year, State, Table



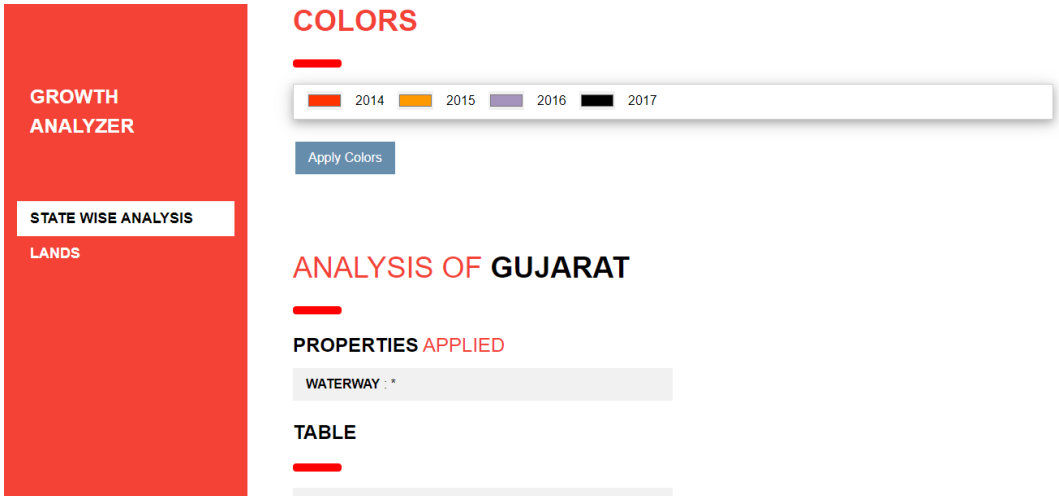
[Figure: 16]

2. Add Properties (Key - Value Pair) Based On Requirements

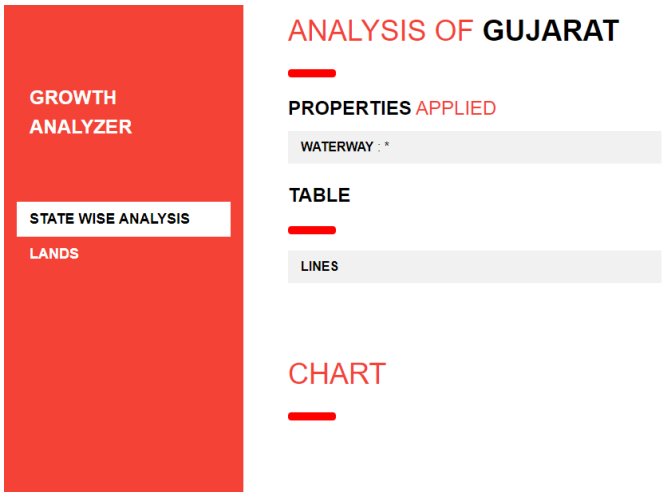


[Figure: 17]

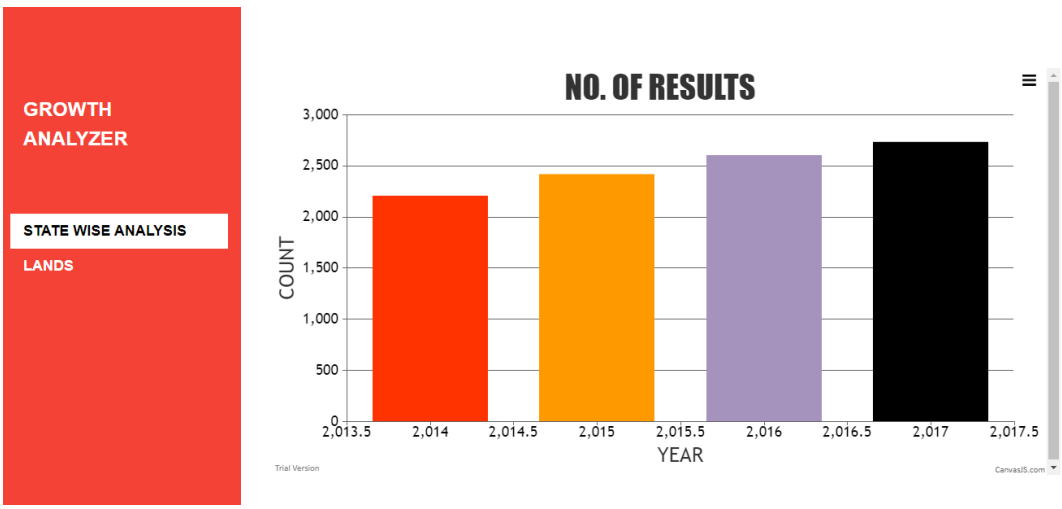
3. Click On View Result Button



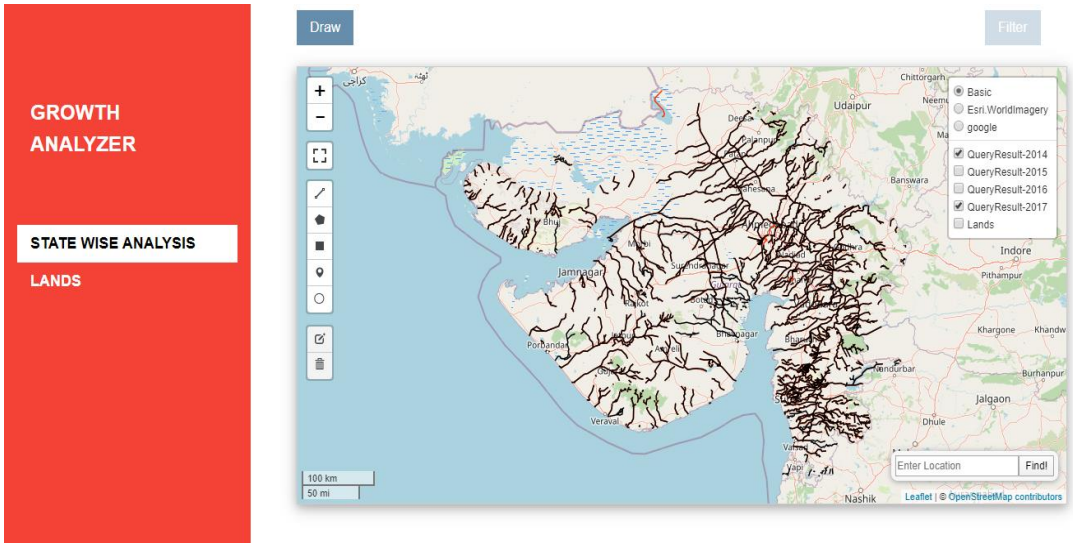
[Figure: 18] Output Page



[Figure: 19] Output Page



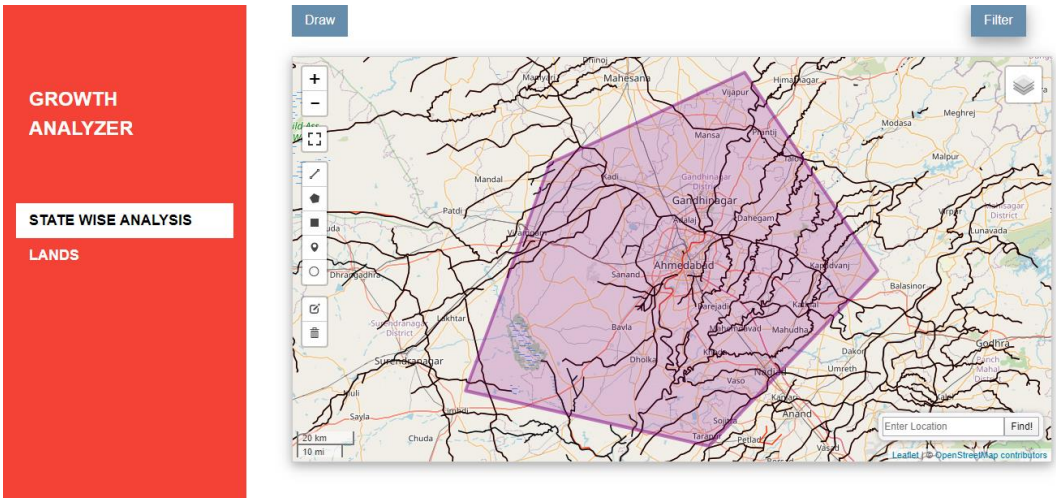
[Figure: 20] Output Page



[Figure: 21] Output Page

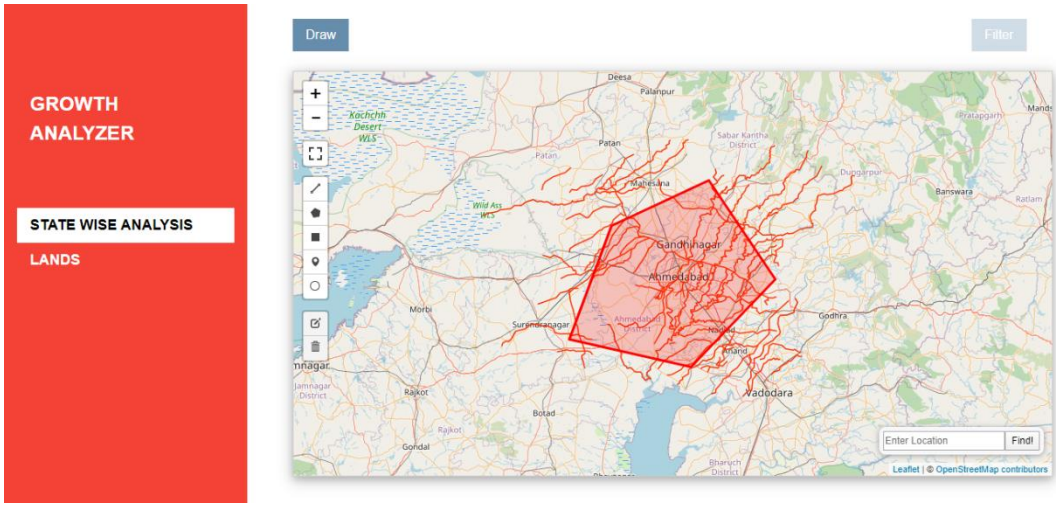
Now applying same filter on the polygon drawn using draw control.

1. Draw Polygon



[Figure: 22] Draw polygon

2. Click On Filter Button

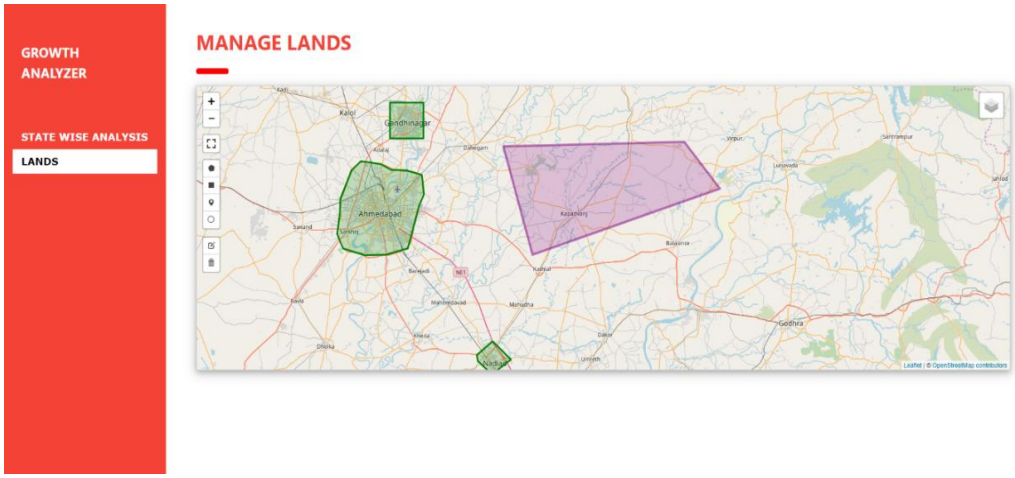


[Figure: 23] Output Page

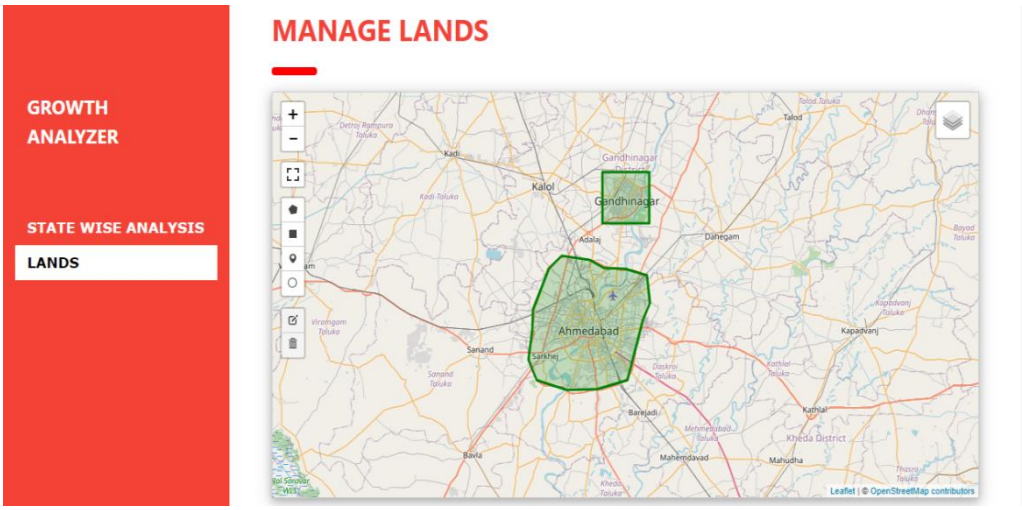
Lands:

In this another module of our system users are able to draw/remove/save the polygons. Same as polygons, there are functionalities available for drawing marker, rectangles and circle makers. System creates separate layer named as lands on map. User can select the regions from lands layer and can apply filter on it.

- This is the module where user can manage custom polygons/land.
- User can create new land on map by using the draw control displayed on the map.
- System creates the separate GeoServer layer for the data of lands database so that it can be used in the analysis

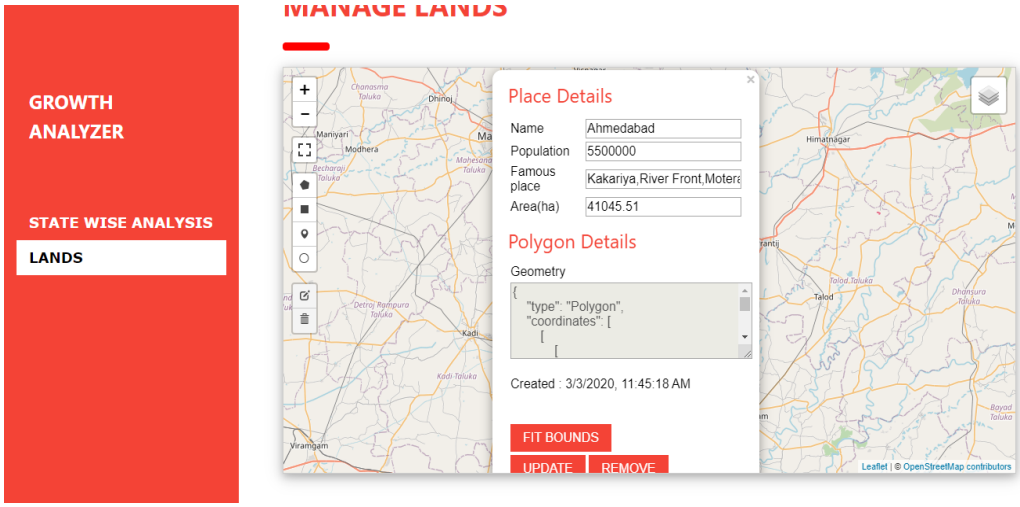


[Figure: 24] Drawing Polygon



[Figure: 25] Lands Page

Getting the details of the selected land:



[Figure: 26] Land details

4.3 Features of New System

The main purpose of this system is to analyze the development occurred in period time by using temporal OSM dataset. So main feature of this system is to plot the graph based on the user inputs. Below is the details of all the features and the functionalities we have developed.

- **Plotting data by Different properties**:

User will be able to see plotted data on map by selecting the specific year or time period, state and a particular property for example railway, tunnel, bridges. The selected year, state and property filters will be applied to the system and data will be fetched and it will be plotted on map and a detailed chart will be presented with the filtration of choosing colors. This feature is given by State wise Analysis. Total number of properties is 72. In a nutshell, we tried to overcome all the defects we realized while studying the current systems online.

- **Other features in our system are listed below:**

- User can draw polygons over the map and they can be saved.
- User's previously gathered data can be saved.
- Users will get suggestions and details on different properties.
- Zooming functionality is implemented in our system.
- Separation of different year data in the map is available by different color.
- Users can download the result in the format of pdf/jpeg/png.

Chapter 5

Implementation Planning

5 Implementation Planning

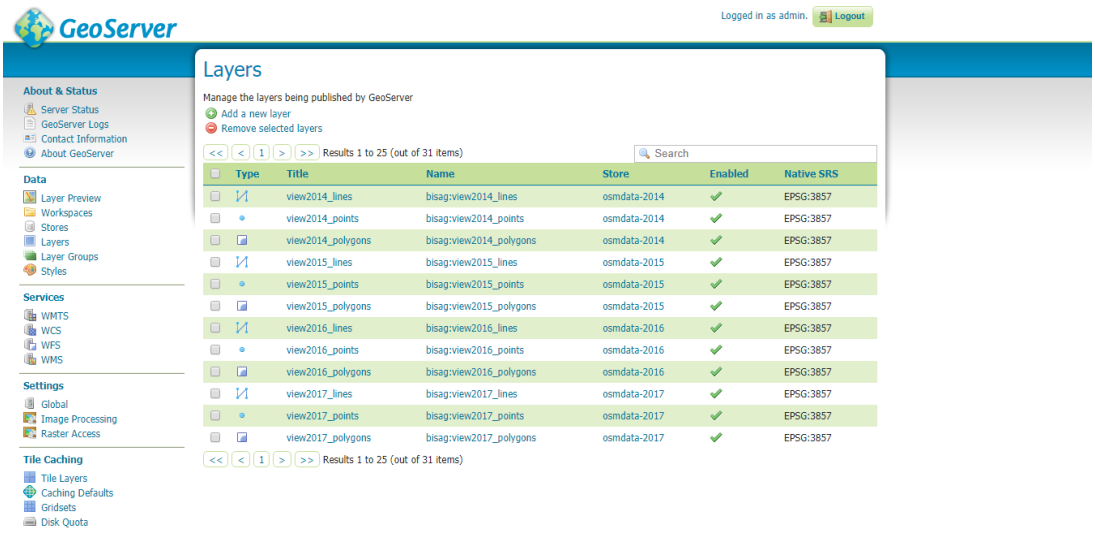
5.1 Implementation Environment

Toolkit Environment**:**

- **GeoServer**: Open Source, founded in *2001 by TOPP (The Open Planning Project)*
- **pdAdmin4**: founded in *1996 by PostgreSQL Global Development Group*

GeoServer Set-Up:

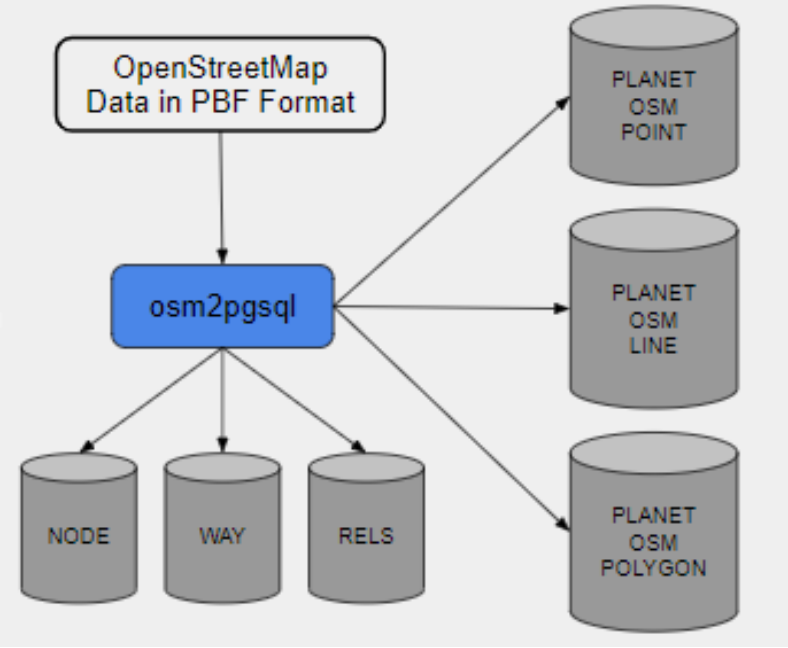
- System requires to create different layers for different tables for each year.
- System requires to create three different view in PostgreSQL database for each year.
    - View2014_lines
    - View2014_points
    - View2014_polygon
- Create new workspace in GeoServer.
- Add datastore of each year in GeoServer.
- Create different layer by associating PostgreSQL view to it. repeat this process for each year database in GeroServer.
- Create custom style for lines, points and polygons in GeoServer.
    - Style_line
    - Style_point
    - Style_polygon
- Below is the snapshot of layers created in GeoServer



[Figure: 27] Layers Created in GeoServer

Database Set-Up:

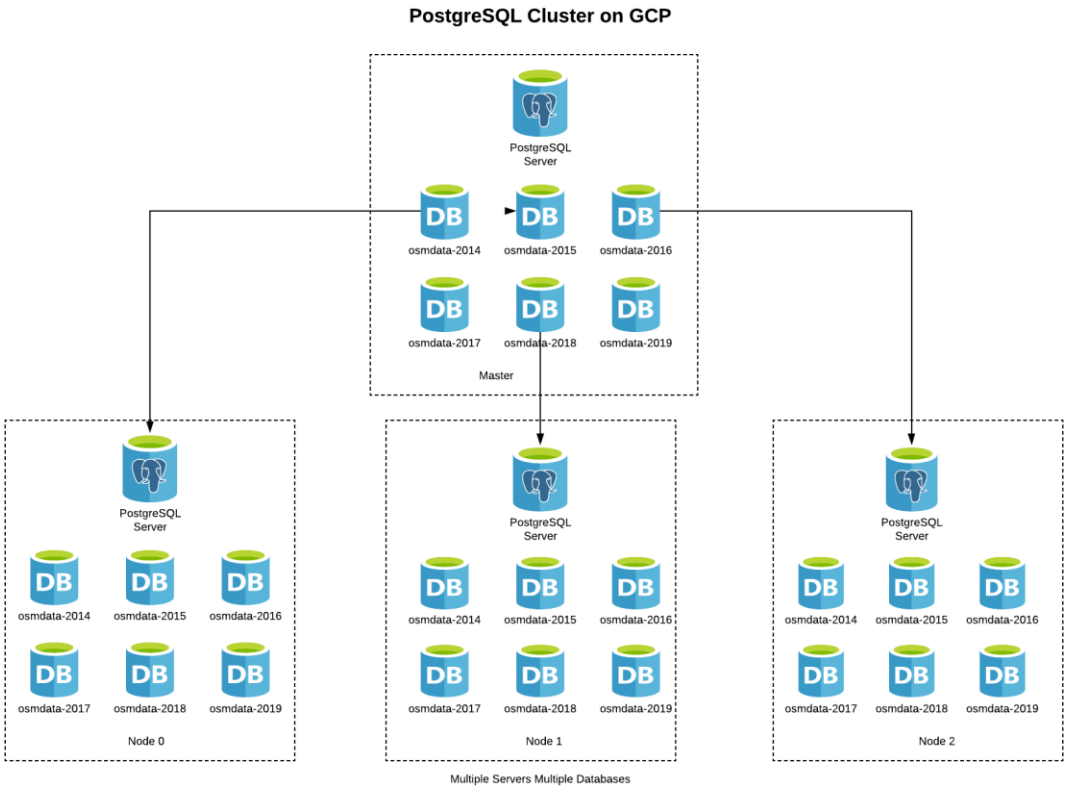
- Osm2pgsql tool is used to convert OpenStreetMap data to PostgreSQL databases.
- Osm2pgsql with slim mode generates 6 tables as described in the below figure



[Figure: 28] Osm2pgsql extraction

- This is the query which is used to generate database tables for each year
- osm2pgsql --slim -c -d osmdata-2019 -H `35.234.36.125` -U postgres -S default.style india-2014.osm.pbf –password -extra-attribute
- here –slim defines the mode of osm2pgsql.
- -d represents database
- -H represents host
- -U represents username
- -S represents style which is used to generate PostgreSQL database tables.
- To use the osm_user, osm_uid, osm_version, and osm_timestamp tags, you must use the osm2pgsql option --extra-attributes when importing.

Cluster Set-Up:



[Figure: 29] PostgreSQL cluster design

We created a cluster of PostgreSQL database on Google Cloud Platform (GCP). There is a one master node and six slave nodes. Data is replicated automatically from the master node to all slave nodes. The master node receives all write operations, while the slave node repeats the operations performed by the master node on their own copies of the data set and are used for read operation. This model improves the overall performance of the solution. It also simplifies disaster recovery, because a copy of the data is maintained on each node in the cluster.

5.2 Coding Standard

The language used in the development of this project is JAVA. Below are the coding standards for the same.

Components:

We have written components name by its purpose. This approach improves the readability and maintainability of code**.**

Classes:

Class names are noun starting with uppercase letter. If there are multiple words than every inner word starts with uppercase.

E.g.: String, StringBuffer**.**

Interfaces:

Interface names are adjective starting with uppercase letter. If there are multiple words, then every inner word starts with uppercase.

E.g.: Runnable

Java Bean:

A simple java class with private properties and public getter and setter methods.

Constants:

They are declared with public static and final modifiers. Usually, they are nouns. More than one words are separated with an underscore.
Just like these, every java coding standard is well maintained in our application.

Chapter 6

Testing

6 Testing

TEST NUMBER	TEST SCENARIOS	TEST STEPS	EXPECTED RESULT	RESULT
1	Finding growth of waterways in Gujarat state from 2014 to 2017	1. Year selection 2. Select Gujarat state 3. Select lines as table 4. Click on load properties button 5. Add waterway property 6. Click on filter button	Got the growth of waterways in Gujarat state	Passed
2	Finding growth of primary highways in Gujarat state from year 2014 to 2017	1. Year selection 2. Select Gujarat state 3. Select lines as table 4. Click on load properties button 5. Add highway property 6. Set highway property as primary 7. Click on filter button	Got the growth of primary highway in Gujarat state from selected timeline	Passed
3	Finding growth of highways in area which intersects the drawn polygon	1. Draw polygon using draw control on map 2. Click on filter button	Displayed the growth of highways in areas which intersects applied polygons	Passed
4	Applying color of output layer of 2014 year	1. Go to colors section of page 2. Click on 2014 color 3. Set color	Applies the picked color	Passed

		4. Click on apply button		
5	Applying growth filter on the custom land which is drawn by lands layer.	1. Enable lands layer 2. Click on the land which is going to use for filter 3. Enable select for filter button. 4. Click on filter button	Showed the growth of custom land which is drawn by lands layer	Passed
6	Draw polygon using coordinates and apply filter	1. Write the coordinates 2. Click on draw button 3. Click on filter button	Polygon is displayed on given coordinates	Passed
7	Add new custom land in lands layer for Ahmedabad area	1. Go to lands page 2. Draw polygon on map using draw control 3. Fill details about that land 4. Click on add button	New custom land gets added	Passed
8	Remove Ahmedabad land from lands layer	1. Go to lands page 2. Click on the land 3. Click on remove button	Selected Ahmedabad land from lands layer gets removed	Passed
9	Update Ahmedabad land of lands layer	1. Go to lands page 2. Click on the land 3. Change details 4. Click on update button	Ahmedabad layer gets updated	Passed
10	Apply cql filter on the output	1. Write the cql filter 2. Click on apply filter button	Getting the pe	Passed

Chapter 7

Limitation and Future Extension

7.1 Limitations:

- This project is limited to the data of the Indian region only.

7.2 Future Extensions:

- In the future, we will be considering using the data of the whole planet.
- Module of country and district wise analysis.

Chapter 8

Conclusion and Reference

8.1 Conclusion:

We have successfully completed the production of our application which is analysis of growth occurring in rural and urban regions. After adding other features to our application, it will be ready for corporate usage also. BISAG (Bhaskaracharya Institute of Space Application and Geo Informatics) has shown their interest of using our project to real-life development. Hence, we were able to use our application for analyzing the urban/rural regions of Gujarat with number of functionalities.

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Chapter 9

Report verification procedure