Open Source Web GIS Application for Decentralized Planning: A Case Study of Devikulam Taluk

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Abstract: *The widespread access to the Internet, the ubiquity of browsers and the explosion of commoditized geographic information has made it possible to develop Web GIS, it is a form of multimedia geo- representations on the Web. Geographic Information Systems for the web (Web GIS) are being implemented for different purposes. In this context, one of the greatest challenges is to integrate different sources of geographic data, as well as the visualization of this information using maps in an interactive environment. In this study, web GIS framework has explored to provide a practical solution for the sharing of dispersed geospatial data and visualization of vector geospatial data on the web. A vector spatial data management and visualization system was designed and constructed based on the framework using open source software such as Geoserver, Geoexplorer, QGIS etc. These geographical data hosted in the open source web server namely Geoserver and Geoexplorer web interface will help to take best decision by government sectors, stakeholders, entrepreneurships and scientist in this ecologically sensitive regions. The study area is basically a rugged hilly terrain with lack of amenities. According to Western Ghats Ecology Expert Panel (WGEEP) and High Level Working Group (HLWG) also known as Kasturirangan Committee named this area as natural landscape, needs to be considered for conservation while the rest of the area, referred to as cultural landscape, is opened for any kind of development. Infrastructure facility is poor in this area and 38564 peoples are MGNREGA (Mahatma Gandhi National Rural Employment Gurantee Act) card holders. Annual work plan can be done on the basis of available resource and number of MGNREGS card holder. More over anyone can access these data, view, measure, identify, overlay, query and connect with Google street map and satellite map directly.*

Keywords: Open Source, WebGIS, Geoserver, Geoexplorer

1. Introduction

Geographic Information System are tools for acquiring, managing, analyzing and presenting spatially related information (Coors, 1998). GIS convert diverse data into easy–to–read and easy-to-access maps and information. Accessing data without hindering end users with complicated and expensive software was the major problem faced by the GIS professionals in the past. The integration of GIS with the internet technology was the answer for this problem. Web GIS is a technology that is used to display and analyze spatial data on the internet. It combines the advantages of both the internet and GIS. It offers public anew means to access spatial information without owing expensive GIS software (http://www.igi-global.com/dictionary/webgis/32458). It comprises at least one server and a client, where the server is a GIS Server and the client is a web user (Fig.1). The fusion of Internet and the Web with GIS created a new discipline called Web GIS. In the present day so many GIS servers provide web enabled services, most of them are commercial and economically very expensive. Some other services like Geoserver, MapServer, and Adobe Flex etc, are open source technologies that are free of cost. At present GIS capabilities go beyond mapping. GIS offers a rich set of analytical functions that can reveal hidden relationships, patterns, and trends that are not readily apparent, enabling people to think spatially to solve problems and make smart decisions. Expansion of the computer systems and developments in internet related technologies extended GIS in to a new horizon. GIS still has great potential that has not been fully realized. In the present study an attempt has made to evaluate the impact of open source GIS server in grass root level planning. Devikulam taluk has been taken for this resource evaluation.
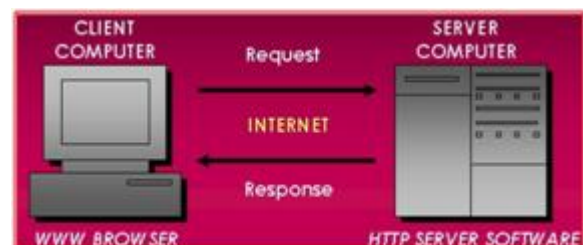

Figure 1: Web GIS Model

2. Review of Literature

A number of studies have been conducted worldwide on the application of Web GIS on various fields. Some of them are: A.A Alesheikh, et. al (2002) examined current Web GIS technologies with emphasis on its architecture. The study also discussed Web GIS development strategies, starting from requirement analysis, and ending in GIS use and maintenance. It also contains a case study, which has been developed in which the Iranian road information has been disseminated to the internet following the identified strategies. The major observation of the study is to treat the implementation phase of Web GIS as a process rather than a step for success. Shunfu Hu, (2002) briefly analyzed the principles of Web- based GIS applications and multimedia technology. The study mainly focuses on the development of Web-based multimedia GIS that links GIS and multimedia technologies on the internet and the main objective of the

study was to provide the user with user-friendly tools to visualize both spatial data and associated multimedia information on the Internet. The work includes a case study of Everglades National Park to demonstrate the use of Web-based multimedia GIS, which allows the users to explore digital maps and associated multimedia information on the Internet. Fang YIN and Min Feng (2009) explored a WebGIS framework to provide a practical solution for the sharing of dispersed geospatial data and visualization of vector geospatial data on the Web. The framework adopted four levels structure: application layer, service layer, function layer, and storage layer. A vector spatial data management and visualization system was designed and constructed based on the framework, using Open Source software such as PostgreSQL, GeoServer, GeoTools, Open layers, Tile Cache etc. Garagon Dogru. A et.al focuses on development and implementation of a web-based GIS application for earthquake information. A dynamic map browser type of web mapping applications was designed for interacting with the earthquake information. Mapobjects ActiveX software component and Mapobjects Internet Map Server (MOIMS) software are used in the study. Windows XP is choosed as the operating system and Microsoft Internet Information Server (IIS) is its web server. Mapobjects is used to build the GIS application and MOIMS is used as a gateway program. This application provides users easy access to GIS data and basic functions on the internet with low technological requirements. By integrating various data generated from different sources, this study aims to provide public users can access information about earthquakes. This application enables easy data management including maintenance and updating. Harshitha .S et.al (2015) focus on web GIS through web browser displays the solution on the map for vehicle parking which can handle huge amount of data. Geographical locations and slots available from the Global Positioning System (GPS) in a web based system and give an user with easy and compatible application which helps the user to get the parking location based on the current location. The conversion of GPS data into GPX format was done using software like GPS Babel or QGIS. Geospatial data was stored in open source Geoserver. Java applications have used to develop postgis database to add layers onto the map as WFS services. Different plugin tool was developed on QGIS for locating the best location for parking based on the current position. Eros AGOSTO et.al (2007) used open source tools and web GIS to define the architecture and components of a suitable information system for the management of excavation data and for the provision of innovative services to the visitors of archaeological sites in the Mediterranean area. Rakesh Kumar et.al (2014) explains GIS has considerable impact on the economics of local, regional and national governance and development by creating greater efficiency, more visual communication, and better decision making with the "integration" of maps, images and attribute data. Current advances in computational speed, storage, World Wide Web and software provide great opportunities to develop Spatial Decision Support Systems with the advantage of information dissemination for decision makers and program integration. Richard Scaria et.al (2011) used recent technologies such as GIS and GIS based application developed through .NET and ASP.NET and C# used for rural development planning. In this context, Chalavara Panchayat in Palakkad District is chosen for the exploiting the scope of spatial information techniques in groundwater acgmentation plan, land use model for food self sufficiency, flood and drought management and also focuses on the prospects and problems of the MNREGS (Mahatma Gandhi National Rural Employment Gurantee Scheme). To improve MNREGS work efficiently, new GIS software package was developed. The name of the software is SPSRD (Software Package for Sustainable Rural Development) which illustrate annual work plan with spatial detail and also paved the way for credible, achievable and sustainable gram panchayat level planning and live up to "Grama Swarajya" (Sustainable village economy). Akhilesh Kumar Singh et.al (2012) studied about reducing congestion, environmental problem, ensuring uniform utilization and increasing safety on the road network through web based GIS route finder system. Different algorithm had used in this route finder namely Dijkstra algorithm, Floyd Warshall algorithm. This route finder application facilitate different route finder option like shortest path finder, facility based path finder, alternate path finder, top-k shortest path finder and multimodal path finder with the help of java programs, postGIS database and Geoserver. Sheng Gao (2010) has designed new architecture based on open standards and web services to provide better solutions in health information sharing with web-based GIS. Three problems in health information sharing have been studied. They are data heterogeneity, resource deficiency and health information representation. Independent XML format was utilized in the implementation of this model, and maps can be generated from this XML format for visualization and analysis. This architecture has demonstrated its effectiveness in an infectious disease information mapping application across international borders.

3. Current Open Source Web Mapping Technologies

The most obvious advantage of the open-source technologies is that they are free. Their downsides as compared to their commercial counterparts are that it is typically harder to get a site up and running, technical support is not as good, and the sites themselves often lack a "professional" look and feel. Some of the open source geospatial servers are
- MapServer
- GeoServer
- OpenLayers
- Scaleable Vector Graphics (SVG)
- Adobe Flex (actually partially open, partiallly proprietary)
Among Various Geoserver, Open GeoSuite which contains different server and give option to edit the layer, display the layer, customized the layer etc

4. Architecture of Geosuite

- PostGIS
- Geoserver
- Geowebcache
- Geoexploer
- Client SDK

4.1 PostGIS

PostGIS is an open source software program that adds support for geographic objects to "spatially enables" the PostgreSQL open source relational database. The database can then be used to store and query spatial data (points, lines and polygons). Thus allowing it to be used as a backend spatial database for Geographic Information Systems (GIS).

4.2 Geoserver

GeoServer is an open source software server written in Java that allows users to share and edit geospatial data and is the realm of GIS. Geoserver implements the web map service (WMS) to display the spatial information as raster images (Maps). It supports a variety of data formats, including Post GIS, Shapefiles, Geotiff, JPEG 2000, ECW, Arc SDE, DB, My SQL, Oracle Spatial etc.

4.3 GeoWebcache

Maps are often static. As most mapping clients render WMS (Web Map Service) data every time they are queried, this can result in unnecessary processing and increased wait times. GeoWebCache optimizes this experience by saving (caching) map images, or tiles, as they are requested, in effect acting as a proxy between client (such as Open Layers or Google Maps) and server (such as GeoServer, or any WMS-compliant server). As new maps and tiles are requested, GeoWebCache intercepts these calls and returns pre-rendered tiles if stored, or call the server to render new tiles as necessary. Thus, once tiles are stored, the speed of map rendering increases by many times, creating a much improved user experience.

4.4 Geo Explorer

GeoExplorer is a web application, based on the *GeoExt* framework, for composing and publishing maps. With GeoExplorer we can quickly assemble maps from GeoServer or any *OGC* Web Mapping Server (*WMS*) and integrate with hosted maps such as Google Maps and Open Street Map. We can also edit map styling information, embed the maps you compose in any web page, or output the maps in PDF format.

4.5 Client SDK

The gxp components and data utility classes extend map related functionality to equivalent classes in Ext. The API reference here documents the properties, methods, and events that are extensions or modifications to the Ext parent classes. Documentation for each class contains links to the Ext parent class, and for a full picture of the API, it is essential to have a copy of the Ext API Documentation at hand. gxp classes are typically configured with OpenLayers or GeoExt objects.

5. Study Area

The area selected for the present study is Devikulam Taluk of Idukki district in the state of Kerala is located on the eastern slopes of Western Ghats (Map.1). The study area stretches between the latitudes of $9^056'56''$N to $10^021'29''$N and longitudes of 77^0 48' 31''E to $77^016'14''$E covers an area of 1140 Km^2 and is inhabited by 1,75,000 persons (2011). It is one of the fascinating destinations in the God's own country with its breathtaking scenic views and its bestowed with the green mountain slopes, springs, waterfalls, touching the skies, hushed clusters of willowy red and blue gum trees, fragrance of wild flowers and rare herbs. The nature, absolutely untouched has led to the christening of this place of 'Virgin Hill Station' in the tourism industry. Increasing fame and the growth of visitors may soon account to deletion of this description. In Adimali before 1980, the main crops under cultivation were rice as well as pepper and cardamom. Now almost 90% of the paddy fields have been modified for other purposes such as residential land, rubber plantations, banana fields. Most of the native flora and fauna of Devikulam have disappeared due to severe habitat fragmentation resultant from the creation of the plantation. However, some species continue to survive and thrive in several protected areas especially known for several threatened and endemic species including Nilgiri Thar, Grizzled Giant Squirrel and the Gaur etc,. Now it is considered as one of the sixteen threatened ecological locations in the world. The annual mean temperature is also gradually increasing due to some climatic phenomena but it is mainly because of land cover changes. Landslide vulnerability, poor groundwater potential, flood etc., are the major natural hazards occurring in this study area. Tourism is a major economic source in this region, tourism based information also very much needed. Concern to basic amenities, munnar hill station people reported inadequate infrastructure and poor management in the existing resource like road network. Almost 38564 people registered in MGNREGS. These problems demand proper scientific approach and local people participation. Now open source Web GIS emerged as a new Spatial Information Technology have act as Decision Support System (DSS). With the help of that information we can take good decision on that basis of spatial referenced data.
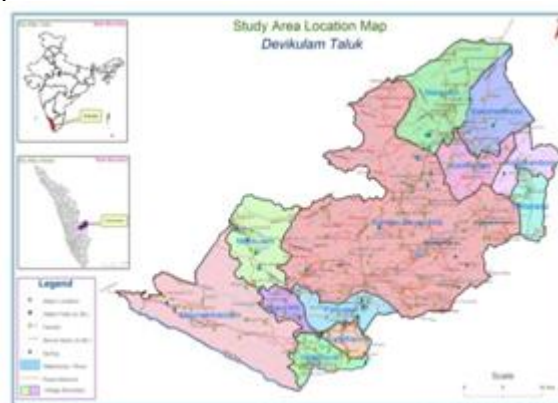

Figure 2: Study Area Map

6. Methodology

The main aim of the present study is intended to publish a map of Devikulam taluk's spatial data in open source GeoServer. Different layers representing taluk resource such as hamlet, road network, waterfalls, benchmark, geomorphology, geology, soil, stream and land use land cover were imported to the GeoServer. First a workspace

was generated for map publication process. Here enter the basic meta-information and it is just like a folder for containing all the works have to be done. Then all the spatial data are brought into GeoServer by adding new store. Stores are related to any one data source (shapefiles, databases, geotiff or other). Here the shapefiles of each spatial data was retrieved from the shapefiles placed on the subdirectory in the data directory. After that the layer was edited and published. Before publishing the layer, select the correct projection (EPSG32644) and define bounding boxes. Layer Preview provides list of all layers and the preview of map in open layers and other solutions of Google Earth and GeoExplorer. The layer imported into GeoExplorer was

designed and customized. The symbols colour, label style etc. was added based on the purpose and relevance of data and it was superimposed to the Google map. After completing these basic preprocessing steps, the spatial data become accurate representation of the corresponding study area in all the means of spatial coding. Similarly all the layers are published and they were integrated. Such a data was finally published in the Web based geospatial server. These enable the clients to give queries and collect data according to their interest. It provides the Web Feature Services, Web Coverage Services and Web Map Services. Fig.1 shows the step by step procedure and Geosuit architect
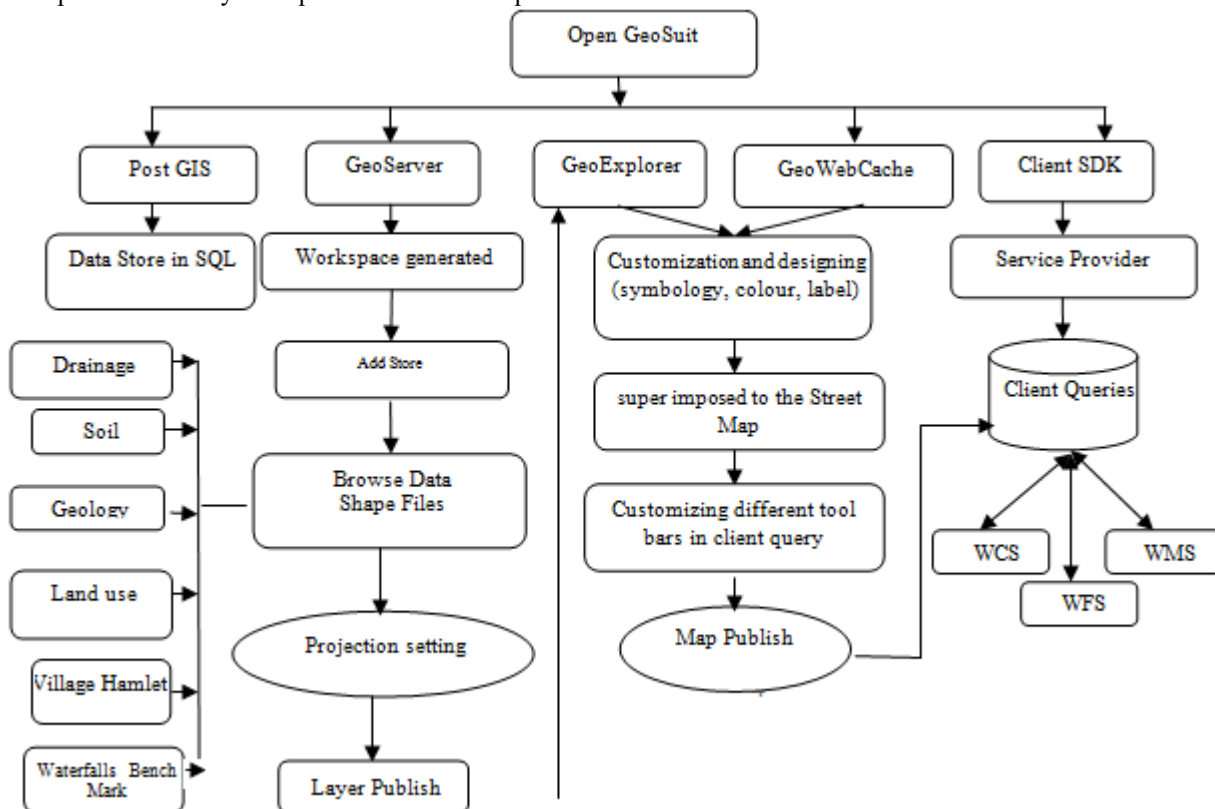

Figure 3: Methodology and Geosuite Architect

7. Results and Discussion

In this study, geospatial layers such as Village boundary, Landuse, lithology, Geomorphology, Soil, Stream, Road network, Hamlet, Benchmark and waterfalls are hosted in Web GIS. Anyone can access the map using this html code:

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<iframe style="border: none;" height="400" width="600"
src="http://localhost:8080/geoexplorer/viewer/#maps/7"></iframe>
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Open source Geoserver and Geoexplorer webservers are mainly used to disseminate these resource information to the people at grass root level for supporting decision making and developmental planning and provide software support for data management. Moreover planning at grass root level aims at inclusive, participatory and coordinated approach in decentralized manner for local area development to ensure that each village or local body is treated as a planning unit. This will equipped with better and scientific management of the land and its resources at grass root level in the planning

process. The entire geospatial application is web based and can be accessed through any standard web browser with user friendly navigational approach. Query, Identity, Measure, Print, Edit, Style Manager, Multi layer viewing option, open street map, google earth application, zoom in, zoom out, pan, scale bar, display option etc available in user friendly manner.
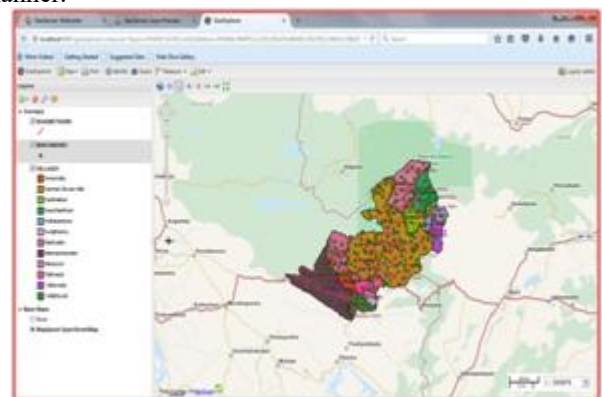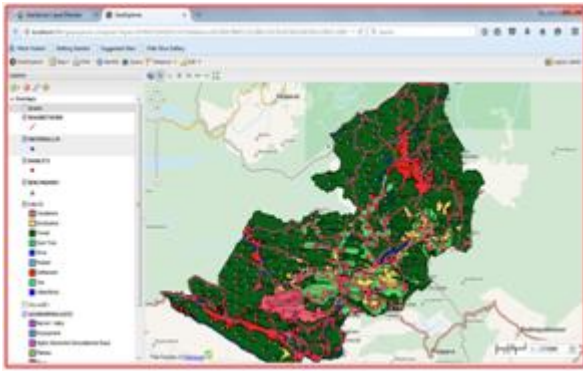

Figure 4: Village, Hamlet in Geoexplorer

Figure 5: Land Use Map in Geoexplorer

Figure 6: Soil layer query and identity in Geoexplorer

8. Conclusion

Open Source based web GIS (Geoserver and Geoexplorer) provides a browser based access to spatial information preserving the inherent nature of GIS data model (Vector / Raster) such as scale, coordinate systems, geometry and attributes while completely safe guarding the original data as such. That means the user will have access to the data for viewing and querying, but will not have the physical access to the data. This model helps to analyze the various stages of information flow in web GIS applications. This model suggests different stages of web GIS; Information Selection, transformation and presentation. In the final stage the user is sees an image of the requested data. This application will demonstrate and promote the user to use these spatial data technologies for local level planning, provide software support for data management, modeling and operation research and promote research activities in spatial data technology.

9. Acknowledgement

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