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Geoportal: A Web-Based GIS Application

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Abstract — *Recent developments in computing have created the ability to collect, standardize, and analyze data in an automated manner, preparatory to visualizing this data in a Web-based, geospatial tool. The study involved development of a geoportal, which is a web-based application. Geoportal allows the users of the system to share and explore the information related to administrative boundaries, geography, demography, groundwater scenario, groundwater recharge, hydrological parameters etc. The developed application is hosted in Internet domain. The geoportal can be used simultaneously by a large number of users, as the knowledge of basic software is not necessary to handle web-GIS based modules.*

Keywords*: Geospatial, Geoportal, Internet, Web-GIS, Hydrological, Groundwater*

I. INTRODUCTION

Recent advances in information technology, databases, Geographical Information System (GIS), graphical user interface and the internet provide capabilities to design the information system for groundwater modeling and analysis.. The World Wide Web (www) provides GIS users an easy access to spatial data in a distributed environment through a simple browser interface or sometimes by a lightweight client side application. GIS is an effective tool to be utilized in decision making as it deals with spatial information that is required in most decision-making processes. The increasing popularity of the internet and the World Wide Web (WWW) over the past decade has created many opportunities for its use in local, regional and national democratic processes [5,9]. It provides opportunities to overcome the data, expertise, and access difficulties associated with any computer based tools. Web-GIS is the integrated product of GIS and Internet technologies [4]. Purpose of designing information system is to provide the user a decision-making environment that enables the analysis of geographical data in a flexible manner. The www provides GIS users an easy access to spatial data in a distributed environment through a simple browser interface or sometimes by a lightweight client side application.

GIS is defined as computer-based systems that can deal with virtually any type of information about features that can be referenced by geographical location. The GIS environment permits the synthesis, analysis and communication of data. Remote sensing provides representative measurements of several relevant physical parameters at scales from a point to a continent [2]. GIS provides an excellent tool to handle large amount of data and their integration for natural resource managemen [1, 3, 6, 10, 11]. The concept of web GIS is based on how the map is produced and responds to user interactions over the web. The publication and distribution of spatial data are increasingly important activities enabling organizations to share domain-specific dynamic spatial information over the web. Web GIS includes GIS functionality to a wide range of internet-based applications in government, business, research and education. It has several advantages such as worldwide access, dynamic data access and user-friendly interface. Web GIS is useful to any organization that deals with geographic information for decision support in a distributed environment. It becomes more important when the location-specific information is dynamic and decisions have to be made on real-time basis. Web applications in hydrology have been widely used. Applications like location information of critical area with respect to groundwater quantity and quality, areas critical to drought and flood are a few examples. The main advantage of web GIS is the real-time accessibility, ensuring its potential as an important medium for the dissemination of GIS functions and data. It promotes the participation of the public and customers which in turn result in the increased scale and profitability of many GIS projects. A web GIS system can be modeled using the client-server architecture. It is an integrated client/server network system where web browser application provides internet users to access GIS application software residing at server end. The client on web can work with GIS data interactively on the web browser without owning GIS software on the local machine.The purpose of this study is to contribute towards groundwater studies and management by utilizing the remote sensing and GIS in the assessment of groundwater resources in the Unnao district, Uttar Pradesh. With the help of geospatial techniques, it is possible to get the real-time information about the area so that a plausible solution can be determined for the problems in the affected areas.

1.1. Geoportal

Geoportal is a web-based portal that is used to find and access geographic information (geospatial information) and associated geographic functionalities (display, editing, analysis, etc.) via the internet. Its architecture illustrates web browser clients and server mechanism. The dataset is organized into database server as a repository. In the present study, the geoportal has been developed using open source tools and technologies for groundwater management.

1.2. OGC Web-Services

The Open Geospatial Consortium (OGC), an international voluntary consensus standards organization, originated in 1994 for the purpose of full integration of geospatial data and geo-processing resources. Its main mission lies in the development of advanced open standards in the field of GIS which can be available for use globally. It is feasible by using GIS based web services such as Web Map Services (WMS), Web Feature Services (WFS) and Catalogue Service for Web (CSW), etc. These web services use Geographic Mark-up Language (GML) to transfer the geospatial data from one system to another. Interoperability, the ability of making multiple environment systems and organizations to work together, is achieved by using the GIS server. The term was initially defined for information technology or systems engineering services to allow the information exchange among the systems.

1.3. Service Oriented Architecture for Geospatial Data

The Service Oriented Architecture is the geospatial technology evolving from monolithic GIS systems. It can be defined as a paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains. The main objective of the architecture is to make the loosely coupled, open standard distributed computing much more advanced so that its elements can be reused [7]. This becomes the basic requirement for the development of interoperable framework, in order to provide the functionality for accessing, integrating, analysing/processing and visualization of the geospatial data and also re-using the application services that are already developed.

II. SOFTWARE SYSTEM ARCHITECTURE

The Geoserver is an open-source server developed using Java that allows users to share process and edit geospatial data. The architecture of the system is shown in Figure 1. It illustrates the web browser client and server mechanism. Designed for interoperability, it publishes data from any major spatial data source using the open standards.

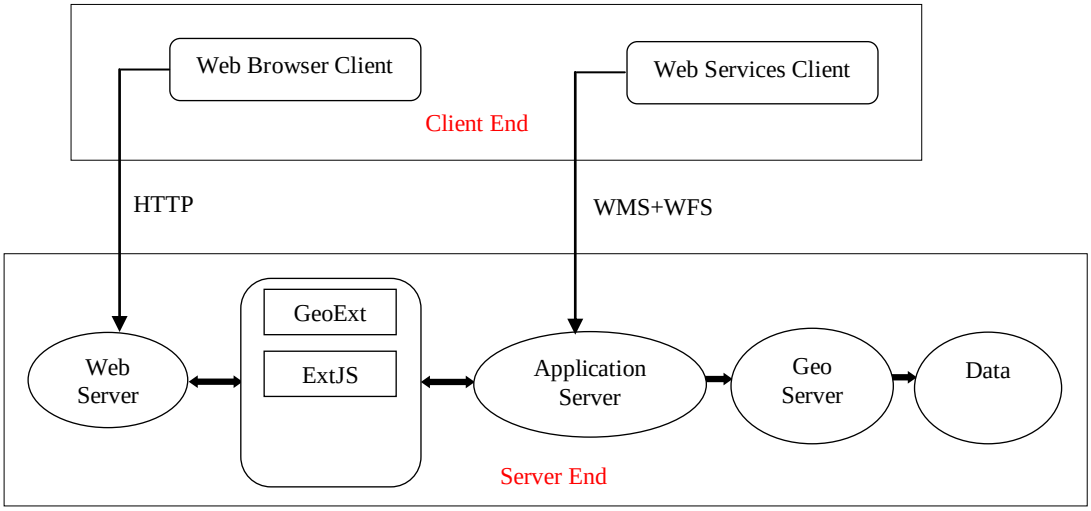

Figure 1. General architecture of Geosever

The main components/layers of the architecture are Web Client, Web Server, Web-services (Geoserver) and Database. The requests flow from any web client (any browser) and are serviced by the web-servers. The web servers cater to the request and invoke the specific web services of the geoserver in order to obtain the information. The geoserver obtains the spatial information from the data server and responds back up the layers. These datasets are stored as a repository in a database server. Open Layers, GeoExt and ExtJS are the set of open source JavaScript libraries being used for displaying map data in web browsers. It provides an API for building rich web-based geographic applications similar to Google Maps and Bing Maps. The request and the response are handled through the Hyper Text Transfer Protocol (HTTP), the underlying protocol used by the World Wide Web, which defines how messages are formatted and transmitted. It also defines what actions web servers and browsers should take in response to various commands. For example, when a user enters a URL in browser, this actually sends a HTTP command to the web server directing it to fetch and transmit the requested web page.

III. METHODOLOGY

The conceptual flow of the process, shown in Figure 2, elaborates the processes involved in developing the geoportal using the various open source tools and technologies. It provides a detailed depiction of each step from the request to response of any geo-spatial data. As depicted in the architecture, the process follows from the web-client → web-server → web-services and back. The GIS clients can be of two types: (i) Enterprise GIS client and (ii) Web-server Clients.

Enterprise clients are hosted inside a network and are specific tool based application, while a web-server client is a simple web-browser based application and can be used from anywhere. All the requests irrespective of Enterprise/Web will have to go through the firewall (network infrastructure built) in order to obtain the response. This ensures that the secure validated requests are only serviced and responded. The request is then processed by the web-server (hosted over Apache Tomcat) and invokes the geoserver web-services to process the request. The geoserver deployed in Apache Tomcat (web-server) is mainly designed for interoperability which is enhanced by the usage of the open source technology viz. GeoServer, OpenLayers, ExtJS, GeoExt, etc.

The geoserver obtains the spatial data from the database server which obtains the data from the actual database. The spatial data is stored into PostgreSQL [open-source Object-Relational DBMS] using PostGIS for better spatial database management and performance. The spatial data is then responded on the command given by the user. JavaScript APIs are used for developing rich web GIS Graphical User Interface (GUI). The spatial schema is published as a service using geoserver and also some additional services such as WMS/ WFS have also been provided using Open Layers APIs. The entire customized application has been performed on 3-tier architecture of client server computing environment where GeoServer works as a middleware and JavaScript APIs work as thick client while spatial database is used for data storage and management.

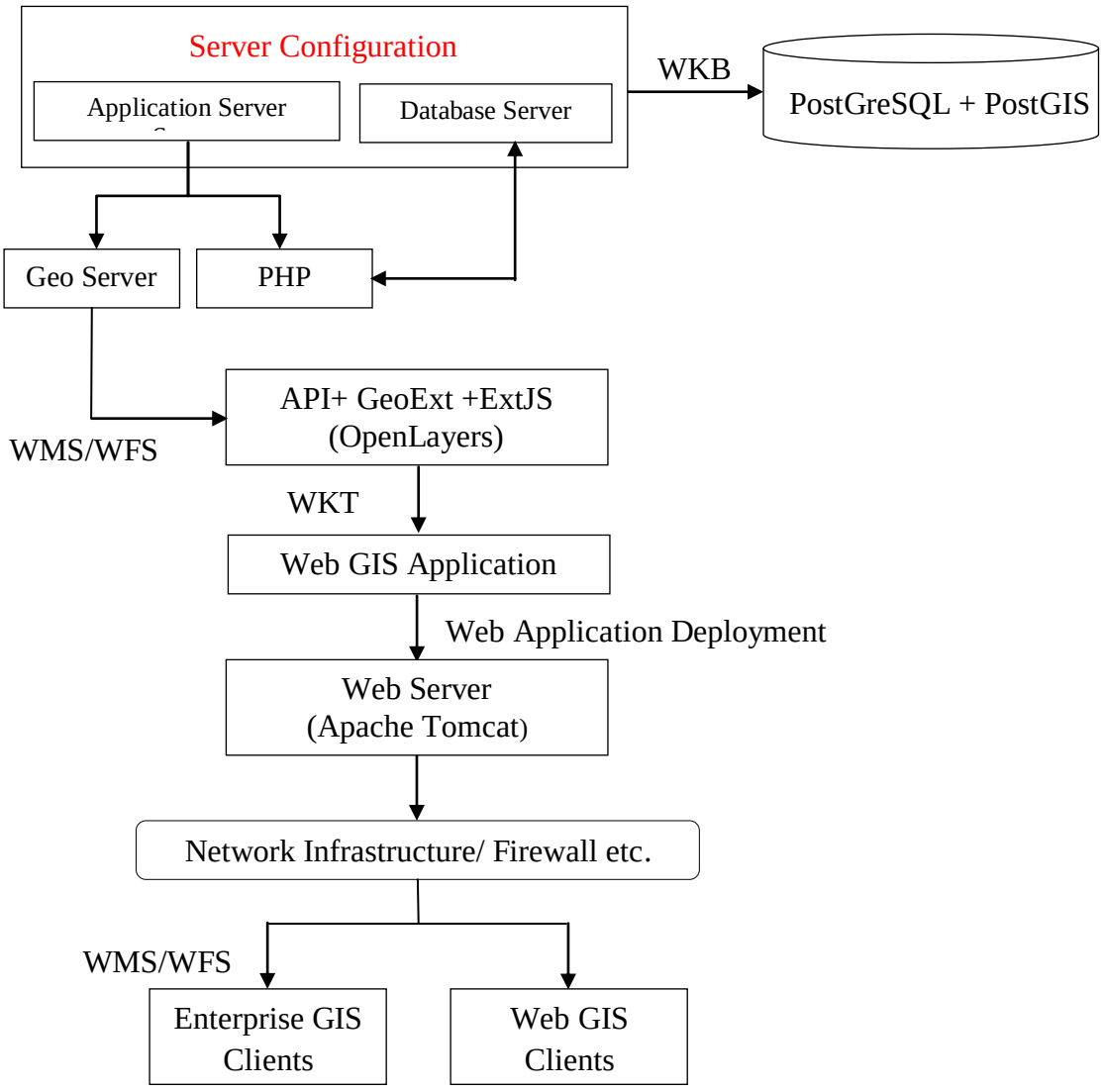

Figure 2. Implementation methodology for geoportal

For government and administration to recognize all the spatial information for decision making in many discipline, there is a need to develop geoportal (spatial data infrastructure) for efficiently accessing and coordinating geospatial information from multiple sources [8]. Geoportal can be classified as catalog portal and application portal. Catalog geoportal mainly provides emphasis on organizing and managing access from other catalog geographic information system using the OGC based catalog service for web. Application portal can be used for online dynamic geospatial web services for any specific requirement. It provides information in the form of identification, quality, URL online, spatial reference system and spatial and temporal extent.

IV. RESULTS AND DISCUSSIONS

Unnao Geoportal is an internet based geospatial data directory for the district that allows the users of the system to share and explore the information related to administrative boundaries, geography, demography, groundwater scenario, groundwater recharge, hydrological parameters etc. The main page of geoportal describes toolbars, legend panels and map window. The toolbar is used for controlling the map and making it as dynamic map. The layer control is performed by the legend panel as illustrated in Figure 3. The zoomed view depicting the study area location is shown in Figure 4. In the bottom right, the scale functionality is used for changing scale on the fly. The features such as canal, drainage, geomorphology, blocks, geology, soil, and all the GIS layers and their output such as groundwater potential zones, recharge etc are created in previous chapters, are deployed in geoportal.

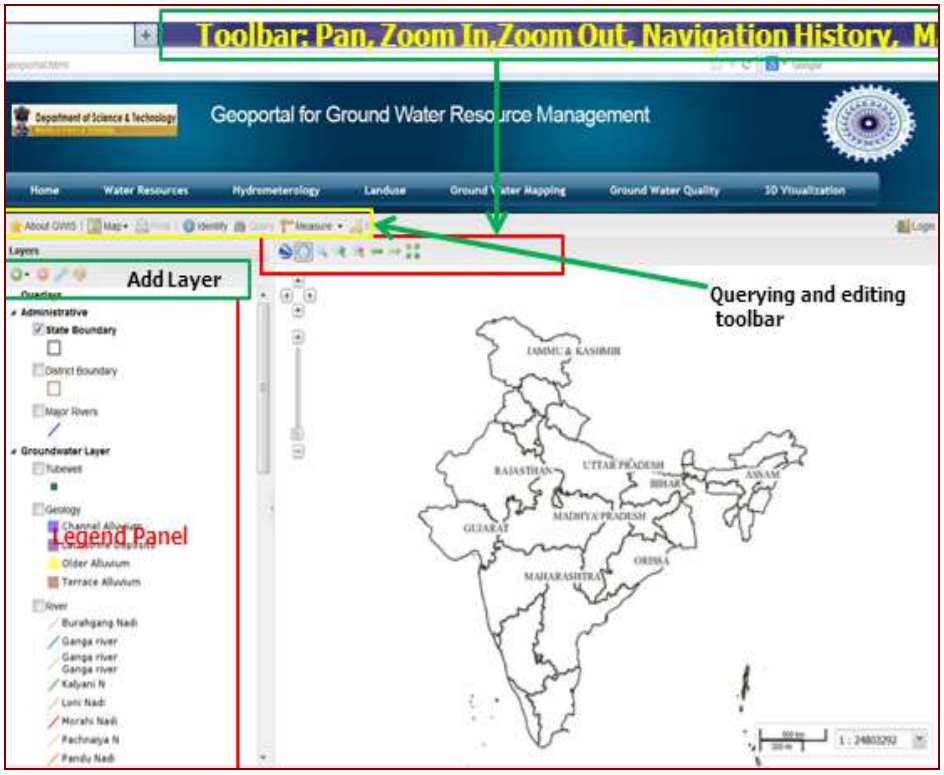

Figure 3. Geoportal main page

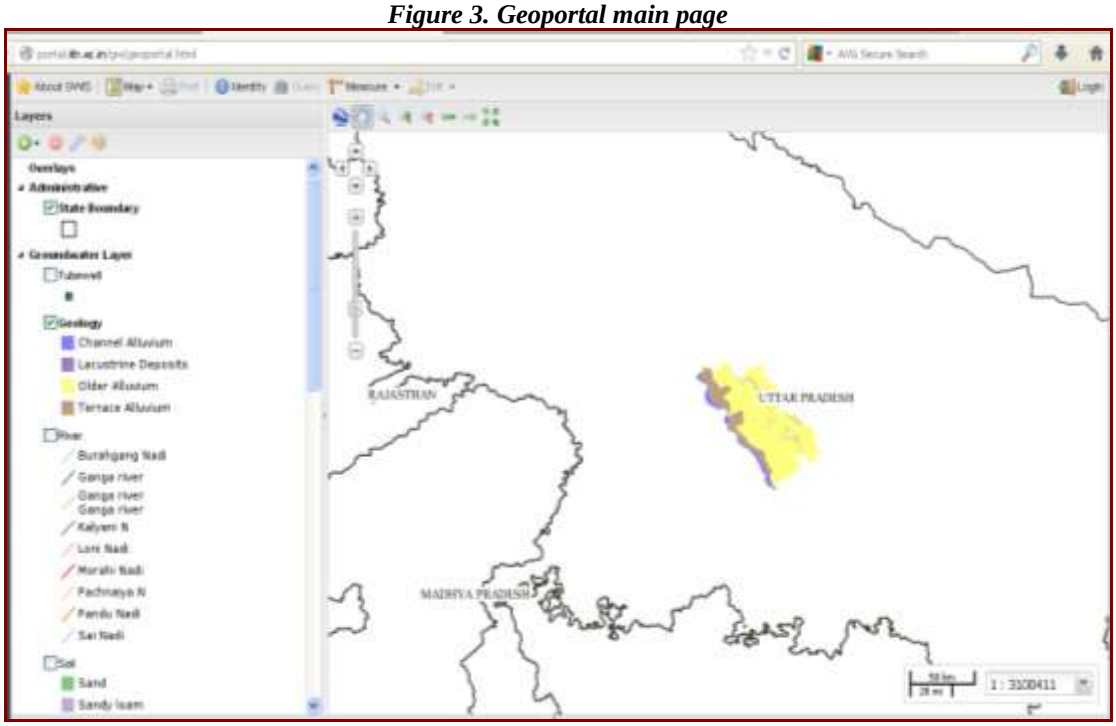

Figure 4. Zoomed view of study area on geoportal main page

The information about various features such as tube-well, geomorphology, administrative blocks, etc. can be displayed in a separate window by using the identify tool. This tool will present information about a specific location. For example, if user clicks on a block, the all information such as population, groundwater recharge, abstraction, groundwater levels are displayed. The data presented depends on the location clicked. Figure 5 represents the application of identify tool to display the information of any GIS layer.

Measurement of distances and areas can also be done by using the measure tool as shown in Figure 6. The system gives the distance estimation between two points after clicking on the points of interest when the measure tool is selected. The system automatically estimates an area for the user if the network of points forms a polygon. All these GIS functionalities can be performed over the web without installing GIS software in the user computer.

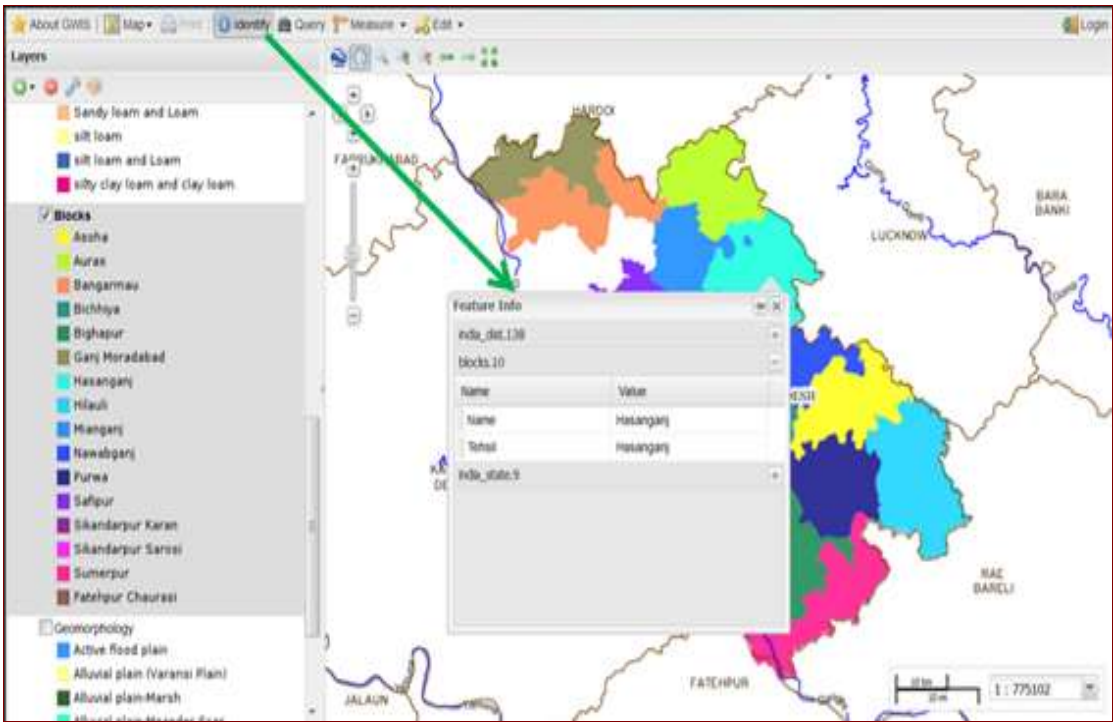

Figure 5. Identify tool gives information of the features

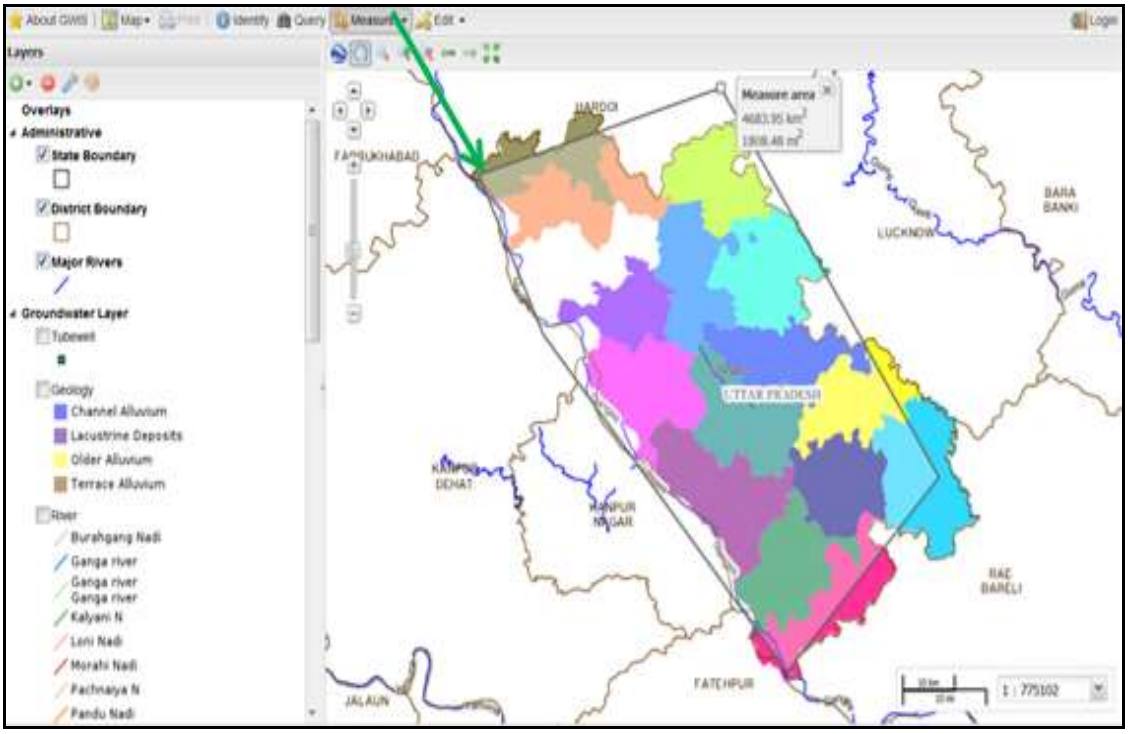

Figure 6. Measuring tool calculating the length and area

Web service is the technology for connecting applications from different locations. Here, the geospatial data is shared from remote server. The spatial query is performed based on the attributes and its matching criteria. It can be performed by adding number of conditions as shown in Figure 7. A non-spatial selection of a feature from the attribute data of features within a specific layer may also be done by using the query tool. The query tool presents the user with the option of defining the criteria for the query in a query dialogue box. When the criteria for the query are defined, the application queries the attribute data to find the features that satisfy the criteria defined by the user.

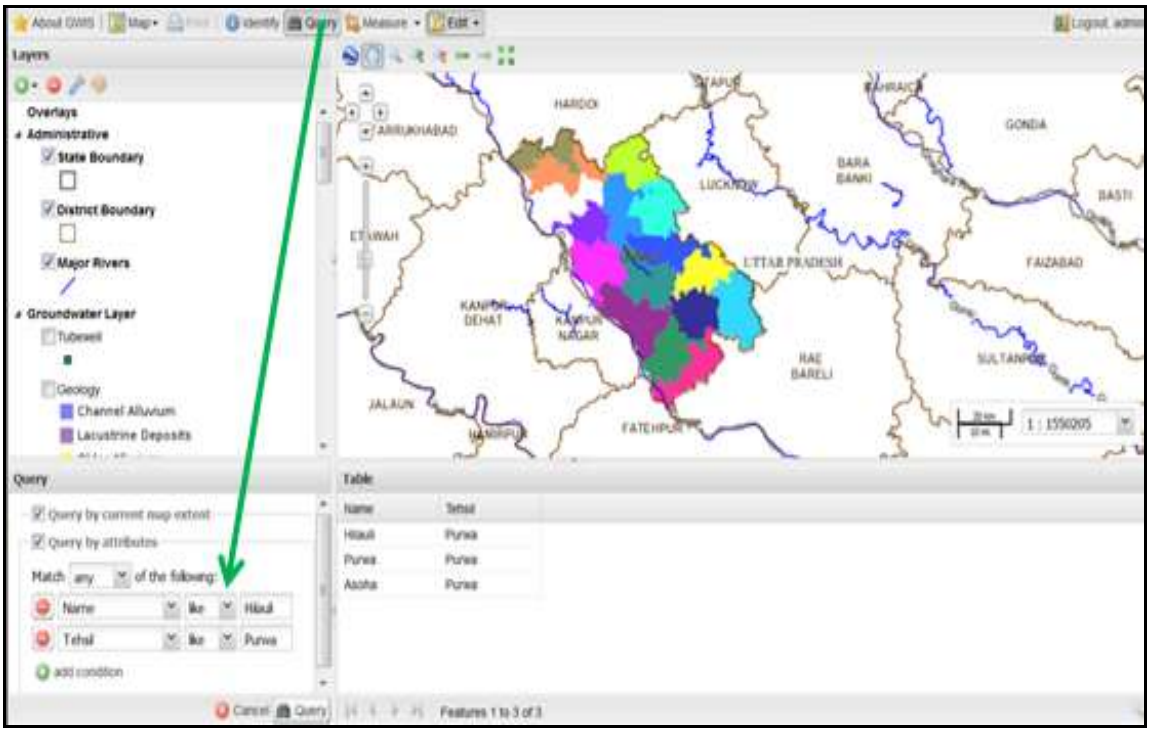

Figure 7. Spatial query

More layers can be added from local GeoServer or remote GIS server by adding URL of the particular server. Remote server adds all the layers mentioned in the repository. The advatnage is that single geoprotal can access the data from multiple remote server using the web services available. Figure 8 illustrates layers addition from remote servers.

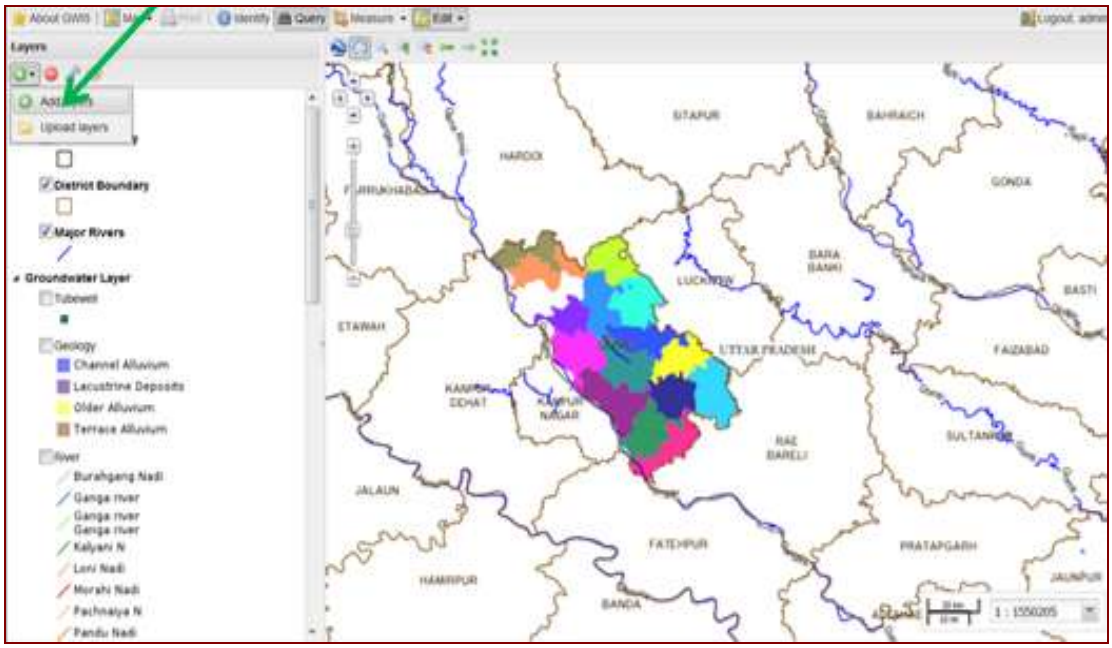

Figure 8. Add more layers from remote server and local server

V. CONCLUSION

The web GIS based application using open source GIS has been developed for groundwater management. The entire application has been developed using open source tools and technologies. Purpose of Unnao geoportal is to bring together geospatial information under a common platform which can be made available to the society, institutions and researchers. It provides spatial data dictionary and map directory for the district and to facilitate decision support system for planning at local level. This application can be further enhanced to provide a complete GIS solution in web browser environment. Web-GIS based software application for spatial query, analysis, and output generation on simple web browser environment. The GIS based geoportal provides a complete solution in a web browser environment. The information available on this portal is beneficial and useful for researchers, administrators and planners. Web-based geoportal help us to share the geospatial information among large community.

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