Urban Geological Information System of Bhopal City: An Open Source Web-GIS Approach

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The geological data is very much significant in the context of an urban settlement. Geological data directly affects the urban developmental activities because the topography, rock types, geological structures, soil, surface and subsurface water plays an important role in the development and management of urban areas. The geological aspects related to urban areas are quite vast and may include studies related to seismicity, flooding, groundwater pollution, management, disaster management etc. The availability of geological data and information is still beyond the reach and general understanding of the common man. Further, the information, even if available, is not in an easily understandable format. The safety and durability of buildings and other civil structures depend on factors like type of underlying geological formations, structures, soil depth, drainage and terrain slope. The hydrological characteristics of the rocks directly or indirectly affect the quality of groundwater and consequently the life of the people living in the area. The availability of all the information related to the geological aspects of any urban area, is still an issue in India and this issue can be addressed by making integrated spatial databases accessible through the internet by developing Web-based GIS applications. "There is a growing need for web-based GIS for easy and fast dissemination, sharing, displaying and processing of spatial information which in turns helping in decision making for various natural resources based applications" (Puyam S. Singh et al.2012).

The objective of this work is to develop a Web-GIS based Urban Geological Information System (UGIS), with an objective of easy dissemination and integration of geological information in the urban context. The Bhopal (Latitude 23°09'35"N – 23°18'45"N and Longitude 77°18'05"E-77°31'15"E) city of Madhya Pradesh, India, has been chosen as the study area for the present work due to its widespread area (285 Sq. Km) and variation in lithology and topography. Topographically Bhopal city is rugged and undulated comprising of Cuesta, dissected plateaus and valley fills. Geologically the city is occupied by the Vindhyan sandstones, Deccan Basalts, Laterite, and Alluvium (DRM-Bhopal District, 2002). A geospatial database of Bhopal city was created, which includes the administrative boundaries (Municipal wards), road network, waterbodies, various geological aspects such as, lithology, geomorphology, drainage, soil types, hydrogeology, slope, and geotechnical aspects. The developed application will help users to visualize, query, analyse the spatial data through a web browser.

For the development of Urban Geological Information system (UGIS) open source geospatial software and development tools like QGIS, Postgres/PostGIS, Apache Tomcat server, GeoServer, and OpenLayers were used. "OSS projects on Quantum GIS, PostGIS, OpenLayers, MapServer, GeoServer, uDig etc. have created momentum among users and developers as they are at par in functionalities and capabilities to their proprietary counterparts" (Sonam Agrawal et al., 2014). The maps related to all the geological aspects mentioned above were created using QGIS and exported to the Postgres/PostGIS database. The GeoServer was used as a map server to fetch the spatial data from the Postgres database

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and serve the maps to the web application as WMS and WFS. The front end i.e. client was developed using OpenLayers and HTML. OpenLayers is a free and open source javascript library to display maps in a web browser. "OpenLayers easily supports a wide variety of various map sources –WMS, WFS, Google Maps, Microsoft's Bing, and many more" (OpenLayers Tutorial, 2009). The user-friendly interface of UGIS provides facility to interactively display and query vector data, along with the viewing of data using municipal ward boundaries. It provides an option to view the spatial layers of a particular municipal ward. The user can select the spatial layer and the ward from the drop-down box to see the map of the selected ward. A tabular summary of the selected ward is also displayed, with information of the area covered by different rock types, landforms, landuse classes and slope. The information about the groundwater potential, groundwater pollution vulnerability, population, drainage, and foundation characteristics are also shown. Looking at the increasing water demands, a module for estimation of roof water runoff is also developed, in which the user can trace the rooftop of building to get the runoff volume. For this module rainfall data and coefficient of runoff of material is needed as input. Thus this application can be helpful in generating useful data and providing geological information to the users for their area of interest in the city.

The purpose of this work is also to create awareness about the use of geological information by using free and open source geospatial tools for the better planning and management of the rapidly growing urban centers. The geospatial data presented through UGIS can also be used as a basic database and by adding other administrative and infrastructures related information to it, it can be used for disaster management in case of a natural disaster.

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Dr. Shailesh Chaure is alumnus of Department of Geology, Vikram Univeristy, Ujjain, India. Presently he is working as Asstt. Prof. of Geology at Govt. Holkar Science College, Indore, India. Involved in teaching Geology, Remote Sensing and GIS since last 30 years. Also involved in software application development related to geology since last 25 years. He has developed many desktop and web applications for teaching and learning geology and also for geological data analysis. He is charter member of OSGeo and is actively involved in training on open source GIS pan India. He acted as a resource person in Department of Science and Technology sponsored geospatial training programmes and conducted trainings on web-GIS. He also conducts short trainings on QGIS for Geology, Geography and Civil engineering students. He is technical expert for Web-GIS related projects at Madhya Pradesh Council of Science and Technology (MPCST), Bhopal. He has also developed Biodiversity Atlas of M.P. State India, which is a standalone desktop application developed in Lazarus (object Pascal). He received Young Scientists of Madhya Pradesh Award in 1989 and also received fellowship for In Service Young Scientists of M.P. (1993) from Madhya Pradesh Council of Science and Technology, Bhopal, India. Recently he has developed a QGIS Python plugin "TopoSheet Numbers Calculator", which is available in QGIS official plugins repository. Till date he has about 15 research publications in journals and conference proceedings. The software applications developed by him along with learning materials for GIS are available on his website (http://shaileshchaure.com).