# Development of Web GIS Based Digital Avalanche Atlas

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***Abstract*--** **Snow avalanche hazard mapping has the potential to reduce the risk by modelling, mapping and visualizing hazardous terrain using Geographic Information System (GIS). With the emergence of World Wide Web (WWW), GIS has revolutionized to provide information to a lot of people. Web GIS based applications have gained popularity because of its low cost, ease of use and availability to large population. Through browsers, Web GIS based applications can display map with useful information. Furthermore large amount of spatial data can be overlaid and analyzed on small screens. The design and development of highly interactive Web GIS based Digital Avalanche Atlas not only allow users to share content but also help in decision making. It makes use of open-source GIS tools, Postgre SQL/PostGIS (to manage spatial/non-spatial data), GeoServer (to connect the database to the client mapping application) and Client SDK & Apache Ant (to build and deploy the application). The maps are published through GeoServer with their associated information using JavaScript libraries (Open Layers and GeoExt). Further spatial analysis (editing, multi attribute query) can be done online. Thus, development of the application will help decision makers as well as other users to utilize information for the benefits of the country.**

***Keywords: Digital Avalanche Atlas, GIS, Web GIS, Postgre SQL, PostGIS, GeoServer, OGC services.***

## I. INTRODUCTION

In last three decades, Geographic Information System (GIS) applications have been developed, implemented, and enhanced by scientists in many fields including geography, computer science, environmental science and others. With emergence of internet and WWW, GIS applications got a new ride which brings them to the new era of web-based GIS applications. The focus of GIS research and development has shifted from spatial analysis tools to information retrieval, creating a gap between the outdated desktop GIS and the state-of-the art Web GIS [1]. The Web GIS provide basic GIS functions to users with browsers. The ability to pan, zoom, turn data layers on and off and, more importantly, to query and view attribute data linked to mapped objects, is widely available [2]. The positive development in this emerging area is adoptions of common international standards published by Open Geospatial Consortium (OGC) for GIS data and services. GIS services defined by the OGC are part of a larger effort to build distributed systems around the principles of Service Oriented Architectures (SOA). Such systems unify distributed services through a message-oriented architecture. Web Service standards are a common implementation of SOA ideals [3]. As avalanche management works usually involves a large number of different agencies and government bodies working in different areas to complete the need of detailed geographic information in order to make critical decisions. By utilizing Web GIS technologies, departments involved in the response can share information through databases in the form of digital maps, products and services at one location. Most avalanches don't allow time to gather data from different departments. Web GIS based Digital Avalanche Atlas can provide a mechanism to centralize for necessary analysis and visual display of critical data/ information during an emergency. The main objective of this study is to suggest a new development model for dynamic and interoperable Web GIS applications in the application of Avalanche management using open source GIS solutions.

## II. STUDY AREA

Banihal is a town of Ramban district in Indian state of Jammu and Kashmir. "Banihal" means blizzard in Kashmiri language. It has an average elevation of 1,666 m (5,466 ft). It is located some 37 km away from Qazigund of Anantnag district on NH 1A highway at $33.25^{o}$N $75.12^{o}$E.
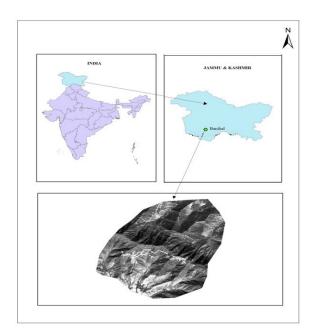
Figure1. Location map of Study Area

Banihal pass at 2,832 m elevation on PirPanjal Mountain connects Banihal with Qazigund on the other side of the mountain. The PirPanjal mountain range separates the Kashmir valley in the Indian state Jammu & Kashmir from the outer Himalaya and plains to the south.

## III. MATERIALS & METHODOLOGY

Emergence of new technologies and knowledge in open source has given impetus to the web based GIS. The software development environment for web based GIS application is also greatly simplify with easy-to-use development tools like Browser-side GIS APIs, such as the JavaScript Openlayer APIs, -Geoext. The GIS servers like Geoserver is providing very simple to use tools for publishing GIS data as OGC web services format in web browser environment. So the tools and technologies used in the development of Digital Avalanche Atlas are listed in table 1.

| S. No. | Technology | Purpose |
|--------|-----------|---------|
| 1. | PostgreSQL/Post GIS | Database Server with Spatial Extension |
| 2. | GeoServer | GIS Server for publishing OGC web services |
| 3. | PHP/JavaScript | Programming/Scripting Language |
| 4. | Openlayer/ GeoExt | 2D Visualization/Rich web GIS GUI |
| 5. | Opengeo Suite SDK | Tool for building web mapping application |
| 6. | Apache Ant | Java Library used to run built in tasks |

Table1. Used tools and technology

The Avalanche Spatial & non-spatial information are published using various GIS tools for decision analysis and information extraction with the implemented security. The application development for this atlas is done using open source GIS solution for web application. The general software system architecture is shown in "Fig 2".
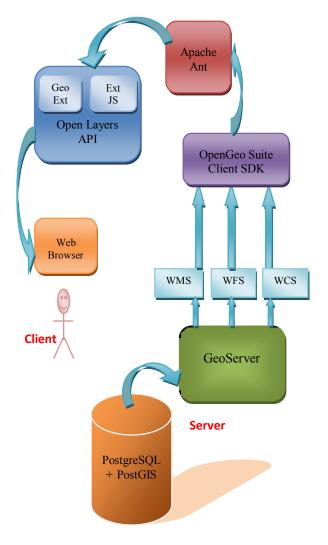


Figure2. Software System Architecture

## IV. CUSTOMIZED WEB GIS BASED APPLICATION RESULT AND DISCUSSION

Web GIS based Digital Avalanche Atlas offers the user different options through various buttons – Web Services, Overlay, Identify tool, Measurement tool, Printing option, Editing tools, Query Analysis, styling and uploading datasets.

## A. Login Panel

The application has interactive features to show all the avalanche information and helps in decision making. Without making a successful login, users can't visualize the data. There is different kind of users, few can access specific data, few can access all kind of data but can't edit the data and few have rights to edit the data also. This all depends on their access rights given to them.
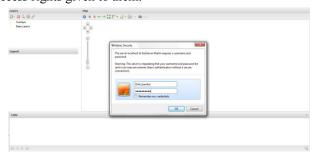


Figure3. Login Panel

## A. Overlay

This allows the user to overlay other layers on the map along with viewing the specific thematic layer. The overlay layers include – avalanche hazard zone, road near avalanche zone, aspect map, slope map, DEM and other maps. Users are given the change opacity option in overlay layer properties option to understand the temporal changes.
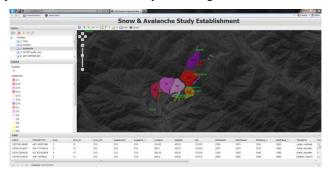


Figure4. Overlaying Data

## B. Identify Tool

This tool allows the user to get the information about a feature. Select this tool and click on a feature, a window will popup showing information about the feature.
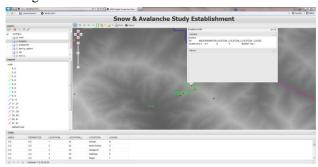


Figure5. Identify tool showing information

## C. Measurement Tool

This allows user to measure the length and calculate the area of polygon. Both tasks could be done by selecting length and area measurement tool.



Figure6. Measurement Tool

## D. Printing Map

This allows user to print a ".pdf" file of map with legends and scale on it which can be used when user is offline.



Figure7. Print Tool

## E. Query Analysis

This multi attribute query tool helps the user to analyse and query the thematic datasets along with visualization in contrasts. The output will be shown in table and through table it can be operated in map panel. This tool allows making a query in the map extent and also in the complete map.



Figure8. Query Analysis

## F. Styling Datasets

This styling tool allow user to create labels, to make changes in feature's colour, etc. But this could be done by the only user having administrative rights.

Figure9. Styling Datasets

### G. Creating & Editing

This tool helps user to create a new feature or to delete or edit the existing one. But this task can be performed by the only user having administrative rights.
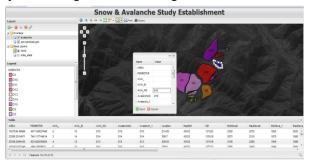

Figure10. Creating the feature

### H. Uploading Datasets

This allows the user to upload the spatial or non-spatial data from anywhere through internet but on one condition i.e. the user must have administrative access.
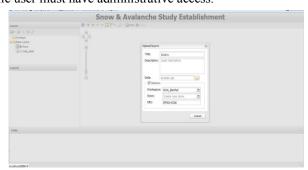

Figure11. Uploading Datasets

## V. Conclusions

Customized GIS solutions are very useful for the domain experts for improving the data management, visualization and decision making. The web GIS based application using open source has been developed and demonstrated. Many projects carried out before have used proprietary software which are costly and licensed like ESRI ArcIMS and ArcSDE. So in this project open source software are being used which are freely and easily available online will help in reducing cost of the project whether implemented in small scale as well as large scale projects.

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