Original Article

Visualization of Meteorological Data Sets with Open Source GIS

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Abstract - *In this paper, an open-source Web GIS application for visualization of optimized meteorological data is proposed. This application can visualize real-time data from private meteorological station and from open data resources as OpenWeatherMap platform and other. The private meteorological station is located near the city of Kresna, Blagoevgrad, Bulgaria. The application visualizes real-time data captured by the meteorological station and stored in a SQL database. The architecture of the open-source Web GIS application and its software realization is also presented. The presented application is developed with open-source software and tools.*

Keywords - *GIS, open-source, PostgreSQL, QGIS, Lizmap.*

I. INTRODUCTION

Geographical Information Systems (GIS) are becoming increasingly popular in processing, analyzing, and visualization of meteorological data. GIS is utilized to improve efficiency, decision making, and communication by integrating various multiple and complex sets of information. These systems provide a framework for the management, analysis, and representation of geographical information. There are three major components of GIS: the data sets and models which represent the raw information, the maps and globes in which this information is placed, and the processing and manipulation techniques that can be applied [1]. GIS can be divided into five components: hardware, software, data, people, and methods. All of these components need to be balanced for the system to be successful. No one part can run without the other [2].

QGIS is an Open Source Geographic Information System. The project was born in May 2002 and was established as a project on SourceForge in June the same year. QGIS currently runs on most Unix platforms, Windows, and macOS. QGIS is developed using the Qt toolkit and C++. This means that QGIS feels snappy and has a pleasing, easy-to-use graphical user interface (GUI). QGIS aims to be a user-friendly GIS, providing common functions and features. The initial goal of the project was to provide a GIS data viewer. QGIS has reached the point in its evolution where it is being used for daily GIS data-viewing needs, for data capture, for advanced GIS analysis, and for presentations in the form of sophisticated maps, atlases, and reports. QGIS supports a wealth of raster and vector data formats, with new format support easily added using the plugin architecture [3]. Direct integration of a WMS and WFS server into QGIS allows for a seamless crossover from desktop to the Web. Projects designed in QGIS Desktop are simply copied to the server. Layers styles and settings are automatically recognized by QGIS Server without any further modifications [4].

The Web GIS application is designed for the visualization of geospatial data and real-time data. The GIS software QGIS Desktop and QGIS Server play a key role in the development of the application. It processes digital data provided by a meteorological station located near the town of the Kresna region. Blagoevgrad, Bulgaria. Layers are created on the basis of digital data stored in a database and converted into geospatial data (layers). The created layers are uploaded to QGIS Server, from where the application reads and visualizes them. The application has the ability to update in real-time by adding new geospatial or digital data. The real-time update of the application is performed directly through the open-source GIS software QGIS Desktop.

II. THE ARCHITECTURE OF OPEN SOURCE WEB GIS APPLICATION FOR VISUALIZATION OF OPTIMIZED METEOROLOGICAL DATA

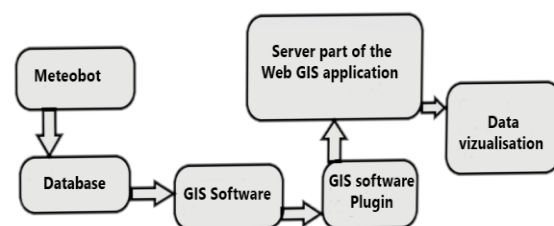The architecture for developing a Web GIS application includes (Fig.1):

Fig. 1 Architecture of Web GIS application for real-time data visualization

Meteobot-private meteorological station located in the study area that captures and stores real-time data.
Database stores the data captured by Meteobot.
GIS Software for processing the data stored in the database and transform them into geospatial data (layers).
GIS software Plugin-for fine setup of the application.

The server part of the Web GIS application-there is some components which are helping for storing, processing, and visualizing data.
Data visualization in a user-friendly form of GIS data in a web browser.

The developed web GIS application for visualization of meteorological data is dynamic. It is based on QGIS, and the administration is directly from the GIS software. The admin of the web GIS application has the ability to add new data in real-time.

Web GIS application for visualization of meteorological data is developed by open-source tools which are: QGIS, PostgreSQL, Lizmap QGIS Plugin, Apache server, QGIS server, NGINX server, PHP, JavaSript, Lizmap Web Client, and Open layers. The application is loading live data from OpenWeatherMap and live data from the meteorological station, which are stored in SQL database. Software implementation of the Architecture for developing a dynamic Web GIS application is presented (Fig. 2).
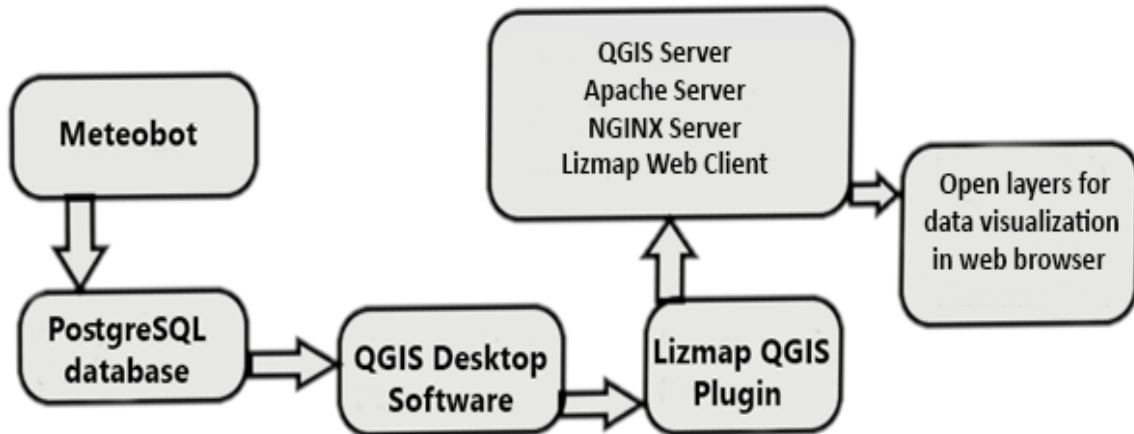
Fig. 2 Software implementation of the Architecture for developing a dynamic Web GIS application

Meteobot is a private meteorological station that delivers real-time data for air temperature, air pressure, wind speed and direction, air humidity, soil temperature and humidity, and others.

PostgresSQL database is for storing the data delivered by Meteobot [5].
QGIS Desktop GIS software is for processing the data and their stylization and visualization [3].
Lizmap QGIS Plugin is for setting up and fine-tune the GIS data layers processing to the server part of the application [6].
QGIS Server is for storing and visualization of geospatial data [4].
Apache Server is for running PHP and Javascript. They have been used for programming the main source code of the application [7].
NGINX Server delivers the administration of the web GIS application for visualization of meteorological data [8].

Lizmap Web Client generates a web map application (php/html/css/js) dynamically with the help of QGIS Server (QGIS as OGC Data Server) [9].
OpenLayers is an open-source JavaScript library for displaying map data in web browsers [10].

III. MAIN FEATURES OF OPEN-SOURCE WEB GIS APPLICATION

The application has the ability to switch the predefined layers and also the base map layers. The predefined layer's opacity can be changed, and also, there is a function to full layer extent. They ca be grouped. The predefined layers can be turned off or turned on. There are included real data layers from Open WeatherMap [11] for the current situation.

The base map layers are including the Street map and Stamen map, which can help in operational room analysis. Figure 3 are presented the main screen and layers list of the web GIS application for visualization of meteorological data.
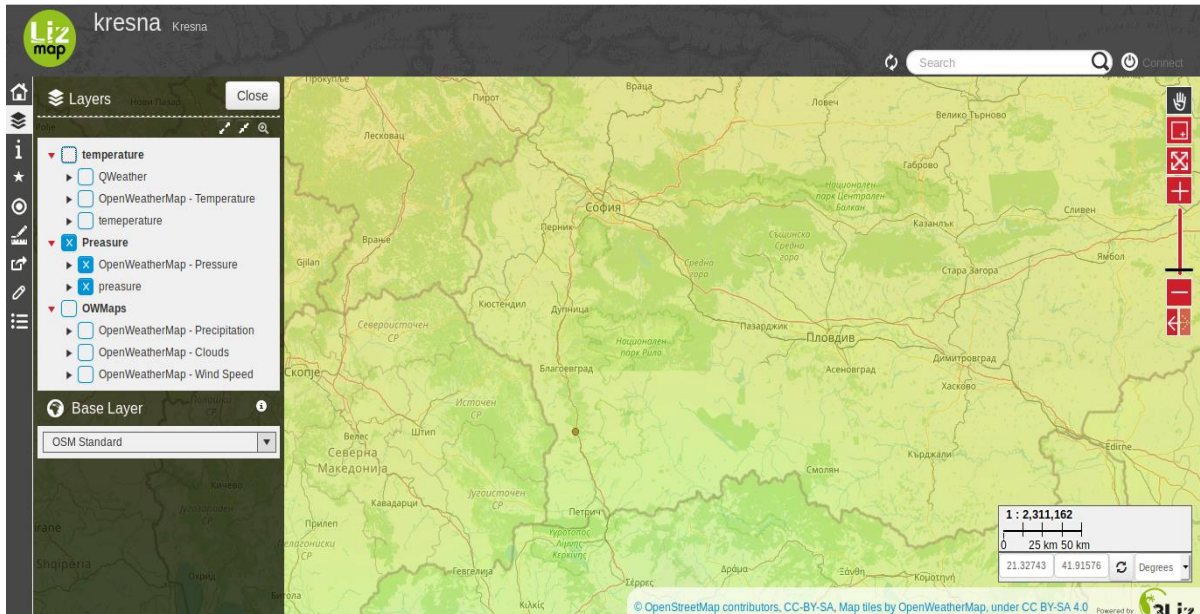
Fig. 3 Main screen and layers list

The application has different zoom features as zoom by rectangle, zoom in and zoom out buttons, and zoom slider. Measure and distance feature can be used to measure the distances and also can measure the size of the focused area. There is a Geolocation feature, Google search bar, and admin panel connection.

Draw feature (Fig.4) can be used by the users to draw in the application with different tools as box, point, line, polygon and etc. They can choose from different colors. Edit, erase, and hide the newly created layer and also export it into GeoJSON, GPX, and KML file format, and importing of KML and JSON files is included too.
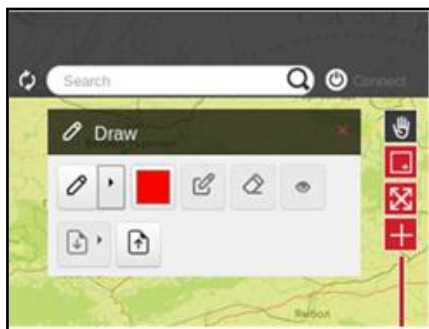

Fig. 4   Draw feature

IV. CONCLUSION

The developed web GIS application for visualization of meteorological data in real-time is visualizing data from the private meteorological station, which is located near the city of Kresna, Blagoevgrad, Bulgaria. It also visualizes real-time data from OpenWeatherMap for a more detailed analysis of the current situation in the area of interest. The architecture and its software realization with open source software and tools are presented. It has the ability to visualize not only meteorological data but and all kinds of geospatial data. The administration of Web GIS applications is easy. The users can add new data directly in the QGIS Desktop software and with easy steps to visualize it into the application. The visualized data can be used in different analyses. The application does not require specialized knowledge in the field of GIS and GIS software from its users.

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