

Monitoring real time the Arachthos River (Greece) using a Web GIS platform

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Abstract – Flood Risk poses a serious threat for communities living near rivers. The scope of this work is to present the design and the stages of a web-based GIS (Geographic Information System) regarding the flood potential of the river Arachthos in the Epirus region. All the technologies and equipment installed are presented in detail. All the components of the system can be monitored by a web page making it available to the public. This system will serve as a trustful and accurate provider of information regarding real-time monitoring of the river flow and the early warning in cases of possible floods.

Keywords – Floods; GIS; WEB-GIS, Environmental Monitoring

I. INTRODUCTION

Due to the rapid development of the computer industry and the improvement of Internet technology combined with the demand for GIS, it has become crucial for the GIS to utilize web techniques, publish spatial data and provide users with spatial data browsing, searching and analysis function. GIS that is based on internet technology is called WebGIS. The WebGIS advantage is that the information exchange via the world wide web between client and server[1] Unlike the desktop GIS, the user can access the WebGIS via their web browser from everywhere while the system's databases are stored on the cloud [2].

In 2015, the lowland area of Arta, Greece suffered from a flood near the area of the river Arachthos revealing the need for a tool to monitoring the area around the river.

The authors of this paper developed a WebGIS for the monitoring of the area with the creation and operation of an online database and with the use of special equipment that was installed in the area of interest as part of the WatchArachthos project. The information system provides targeted information for local authorities, citizens and multiple groups of stakeholders. The area of interest is the Arachthos River and its catchment area in the regional unit of Arta in northwestern Greece. Specifically, the area of interest is the section of the river downstream of the Pournari I Dam about 11 km long, as well as the Municipalities of Arta and Nikolaos Skoufas. Arachthos River is the longest river of Epirus with a length of 110km and drains into the closed Amvrakikos gulf [3].

The authors in this paper present their WebGIS and its functionalities.

II. SYSTEM ARCHITECTURE

The WebGIS platform consists of two parts, the front-end and the Back-end. The main component of the front-end is the client that is responsible for providing valuable

information about the flood condition of the area of interest. The back-end has three main components, the database that hosts all the data of the project, the web server that is responsible to handle the communication between the client and the database, and the data processing server that retrieves the data from various sources, process them and save them in the database.

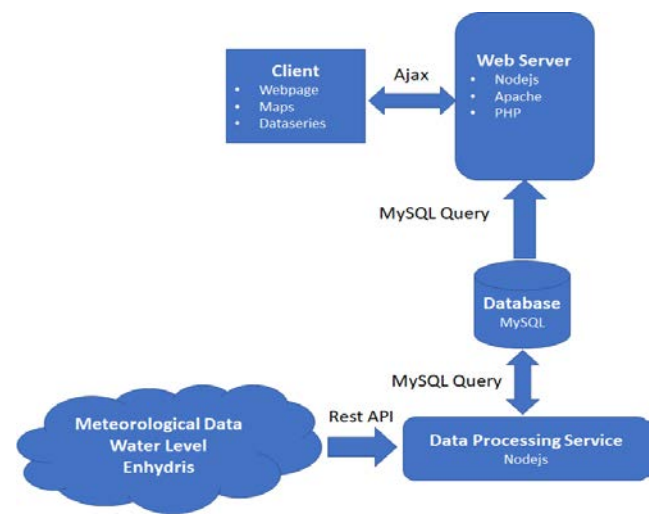


Fig. 1. The System Architecture

III. HARDWARE INSTALLATIONS

The WebGIS platform consists of two parts, the front-end and the Back-end. The main component of the front-end is the client that is responsible for providing valuable information about the flood condition of the area of interest. The back-end has three main components, the database that hosts all the data of the project, the web server that is responsible to handle the communication between the client and the database, and the data processing server that retrieves the data from various sources, process them and save them in the database.

A. Meteorological Stations

For the needs of the project, two meteorological stations were installed in vital locations. The meteorological stations were installed on the accommodation halls of the University of Ioannina in, Arta, Municipality of Arta and in community office of Agia Paraskevi, municipality of Nikolaos Skoufa (Figure 2). The meteorological stations that we are using are the Davis Vantage Pro 2. The Davis station provides its Application Programming Interfaces (APIs) that gives access to the current data. It can measure rainfall, pressure,

wind direction, wind speed and temperature that are used from the project [4].

The meteorological stations are set to upload their data every ten minutes in the open database of Enhydriis. Enhydriis is an open-source database system which provides meteorological and hydrological data from stations located all over Greece. Enhydriis provides an API that is used to retrieve the meteorological data [5]. The meteorological stations that are retrieved from Enhydriis API are the stations in Kampi, Kompoti and Kommeno.



Fig. 2 The Locations of the installed meteorological stations

B. Water Level

Two water level sensors were installed in the area of interest. The first sensor was installed in the Arta's Bridge municipality of Arta 16 cm above the bottom of the river. The second sensor was installed in Neoxori Bridge, Municipality of Nikolaos Skoufas 1.6m above the bottom of the river (Figure 3).

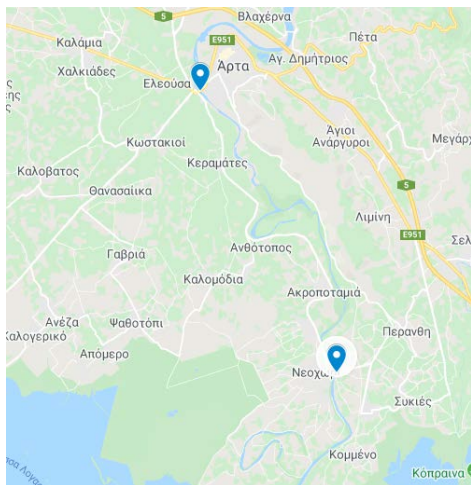


Fig. 3. Location of the water level sensors

The sensors were the SYMMETRON's Stylitis 20; which use a battery as power supply and sends the data via General Packet Radio Service (GPRS). The Stylitis sensor sends the water level of the river and the remaining voltage of the battery data every 30 minutes as text file. It also stores in the system memory data up to 4MB [6]. The data are stored as files in the server where they get processed by the data processing service and stored in a proper format in the database of the project.

IV. TECHNOLOGIES

A. Front-end Client

The front-end of the WatchArachthos is a modern Web-based GIS application that gathers and visualize useful information from satellite datasets, national datasets provided by the local authorities, as well as measurements from meteorological stations and water level sensors. The front-end component is divided into three main parts. The first part is the web page development and its design. The second part is the visualization of geographical data with the use of the Google Maps [7], on a responsive map. The third part of the client is the representation of the data retrieved from the meteorological station and the water level sensors. Those data include several weather parameters such as rainfall, wind speed, wind direction and barometric pressure retrieved from various meteorological stations all over the area of interest as well as the water level of the river from two different sensors installed in different locations.

1. Webpage

The front-end of the WebGIS was created with the use of the following scripting languages, Hypertext Markup Language(HTML) [8] /Cascading Style Sheets (CSS) [9]/ JavaScript [10] /jQuery [11]. With the use of those scripting languages the website created with a fully responsive design, ensuring the good viewing experience, to the user, using any device (mobile or tablet). The combination of CSS and jQuery were used to develop a responsive multi-dropdown menu. The menu (Figure 4), consists of the following four categories:

- **Meteorological Data:** This menu hosts the data that are received from the Meteorological stations and water level sensors.
- **Geographical Data:** This menu hosts different data layers that have been obtained from various sources. In case of emergency, local authorities can use that crucial information.
- **Historical Data:** This menu displays the layer of previous floods.
- **Flood Information:** This menu displays the data for the flood risk.

Each category contains several data as shown in the figure below. All the elements of the web site were developed with the HTML and was styled with the use of the CSS. JavaScript is a programming language that was created mainly for websites and was used in order to execute the scripts, that are attached in several elements of the WebGis and the jQuery was used in order to change the style of the elements on demand.

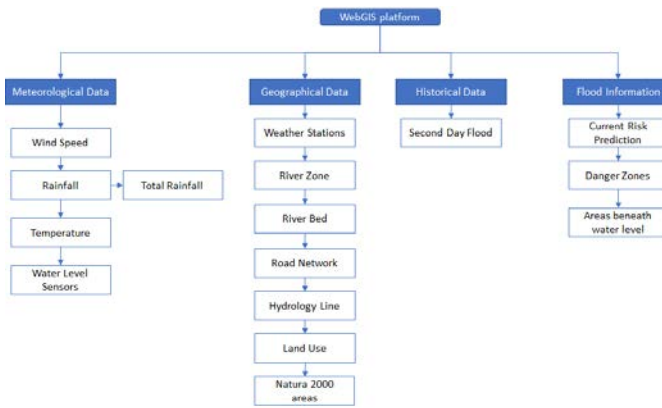


Fig. 4. Main Menu Options

2. Map

The Google Maps Platform is a set of APIs and Software development kit (SDKs) that allows developers to embed Google Maps in their applications. The WatchArachthos' webGIS is using the Google Maps API. The Google Maps API provides a set of tools to visualize data, and especially geographical data, on the embedded map. Those tools vary and help us to plot the different layers. GIS data can be separated into two categories, raster and vector data. The raster divides the spatial area into grids of the same size with each being assigned a specific value, representing different geo-referenced data. The vector data use points, lines and polygons to represent different spatial data [7]. The raster files in the webGIS are created from the data that are stored in the database and are updated every hour. The client is using Asynchronous JavaScript and XML (Ajax) from jQuery [11] to communicate with the server in order to read the raster file. The client is using the geotiff.js [12] library to parse the raster file and the plottyjs [13] to visualize the file (Figure 5).

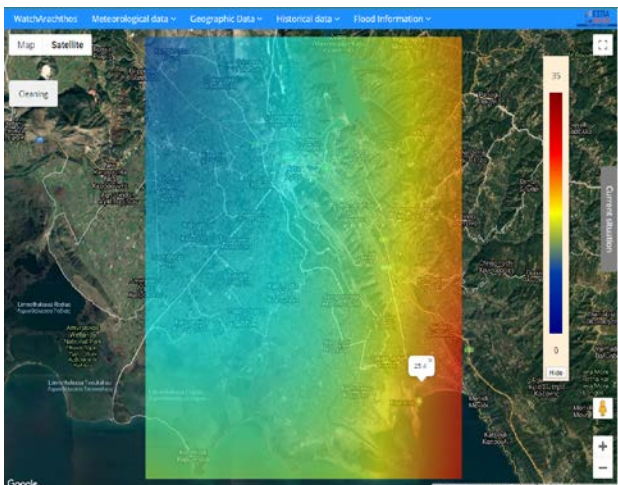


Fig. 5. Accumulated Rainfall displayed as a Raster

The vector data were retrieved from satellite and local authorities are stored in KML files [14] and are visualized with the use of the KmlLayer() constructor of the Google Maps API [15]. Figure 6 displays the polygon type KML of the river area as it is displayed in the WebGIS platform.

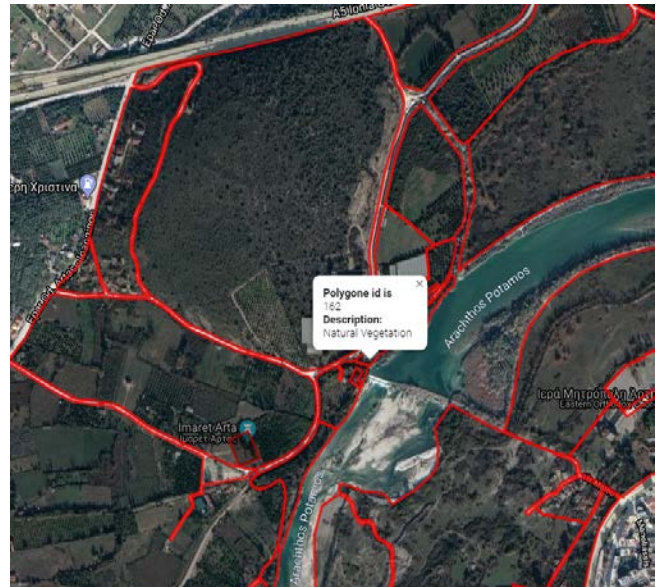


Fig. 6. Polygon KML of the river area

3. Data Series

Data from the five meteorological stations and the two water level sensors are stored in the database of the WebGIS. Each meteorological station provides data for rainfall, wind speed, wind direction and barometric pressure every ten minutes and the water level sensors provide the water level every thirty minutes. Those data are represented in the WebGIS in two ways. The first is with graphs and the second is a panel that shows the latest records of rainfall and the water level.

The client incorporates the Dygraphs library for plotting the data. Dygraphs is an open-source JavaScript library that provides a set of tools in order to create charts of the meteorological and water level data which are stored in the database [16]. Figure 7 displays the way that the data series are displayed in our WebGIS. Due to a large number of data that are received from the meteorological stations and water level sensors, a library that can handle dense datasets is required. A PHP: Hypertext Preprocessor (PHP) [17] service handles the communication between the database and the client. This service requires the parameters of date, data type and station name in order to retrieve the correct data from the server. Those data are processed and added in a multidimensional array. The array is used by the Dygraph to display them in a graph format.

B. Back-end

1. Data Series

The WatchArachthos project is using three data processing services to acquire and process data. The data acquired are from the water level sensors and the meteorological stations. Moreover, the rainfall data from the meteorological stations are summarized with the interval of one day, three days, five days and tens days and then stored in a different table. The services are created with the NodeJS, and they are using the Axios and File System library, that is used to read and write files from the server. The NodeJS is a JavaScript runtime designed to build scalable network applications [18].

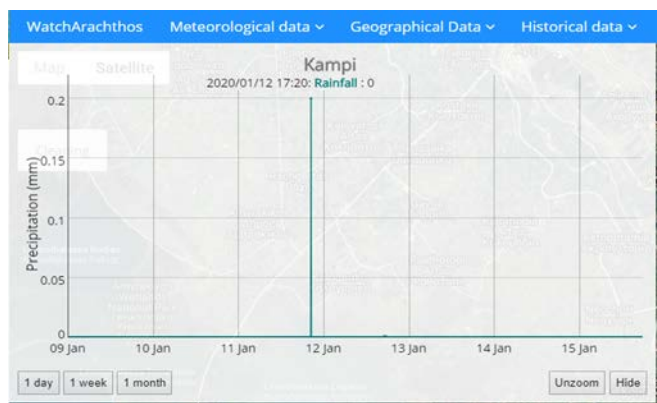


Fig. 7. Meteorological - water level data real time graph

2. Database

The watcharachthos uses MySQL relationship database to store the data. MySQL is free and open-source software that is used by many database-driven web applications including Drupal, Joomla and WordPress[19]. The data are separated into two types, data from the stations or sensors and data from static files such as KML. The web server handles the communication between the client and the database by providing SQL queries to the database. The results of the queries are used by the DygraphsJS or the Google API to visualize the data.

V. CONCLUSION

The WatchArachthos is a web GIS platform for monitoring the river flood of the riversides of Arachthos river. Authors have studied the area and they provided innovative technological solution [20][21]; here they propose an advanced system with new capabilities. The architecture and the technologies that were used to develop the platform are described. Moreover, there is a presentation on how to integrate and display different type of information.

The integrated information system of flood monitoring provides information to every interested party and is expected to encourage local authorities to monitor the river and its condition, improving the efficiency and promptness in flood crisis management for the area of Arachthos Basin.

ACKNOWLEDGMENT

This research is funded by the Operational Programme “Epirus” 2014-2020, entitled “Integrated information system for flood events monitoring, management and early warning in the wider area of Arachthos”, Priority Axis 2 “Environmental Protection and Sustainable Growth”, Co-financed by the European Regional Development Fund (ERDF).

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