Web-based Geographical Information System for Real-Time Flood Monitoring of the River Arachthos in Epirus Region, Greece

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Abstract— **The scope of this work is to present the design and the developmental stages of a Web–based GIS (Geographic Information System) for flood monitoring of the Arachthos river in the Region of Epirus. The system is designed to cover the specific river characteristics as well as the potential flood affection in the greater area along the riversides. The development of the WebGIS is based on the client–server model and uses Google Maps API (Application Programming Interface) services for data plotting. Specific scientific instrumentation for monitoring the height of the river water and the current meteorological conditions is connected automatically to the system, providing relative measurements in real-time basis. Modern methodologies are used so that to provide valuable information and to create a trustful and accurate system for real-time monitoring of river flow and the early warning of possible floods.**

Keywords- river floods; early-warning; monitoring; WebGIS.

I. INTRODUCTION

Natural hazard of floods, as well as its risk assessment is a major topic of interest among many scientific communities and the local/national governance, worldwide [1]. The main reason behind this global interest is the increase of storms in terms of frequency, magnitude and impact, which is partly owed to the climate change [2]. Therefore, it is important to analyze where these hazard events can occur, with what frequency, and which is the vulnerability of an area in cases of possible flooding and/or the river flow expansion beyond its riversides. The real-time monitoring, as well as the risk management and assessment includes suitable instrumentation, and automated methodologies for the estimation of the level of risk, followed by an evaluation of this risk level [3][4].

Geographical Information Systems (GIS) are already playing a major role in the flood risk assessment [5][6]. Nowadays, there are many technological advances, expanded Internet, GIS and relevant spatial information technologies along with great availability of open-source data and software. New methodologies and algorithms are able to process huge datasets and different types of information.

The modern GIS technologies allow instantaneous exchange of spatial information through Web-GIS platforms providing access to various research communities, experts, professionals and the wide public. GIS are able to present risk related information on various spatial and temporal scales. Such an integrated platform includes Decision Support System (DSS) to assist decision makers through interactive tools to better understand and handle risk management issues and at the same time to be the informative channels for local and regional agencies, as well as the wide public [7]-[13].

This study presents the design of a fully automated Web-based GIS platform, which is developed for river flood monitoring and risk prediction along the riversides of Arachthos (Figure 1). The short paper is organized as follows. Section II describes the study area and the main categories of data included in Web-based Geographical Information System for real-time flood monitoring. Section III presents the basic characteristics of the system and the expected final outcomes. We conclude the paper in Section IV.

II. DATA AND STUDY AREA

The Arachthos river is located in the northwestern Greece and it has the source in the mountain ridge of Pindus. This river is about 100-kilometers long and is the 8th biggest river in Greece. The river basin covers an area of 2.000 km^2. The climate of the greater area is characterized as typical Mediterranean with relatively mild and humid winter and very warm summer period. Arachthos delta is an area of great ecological interest and is protected by national / international legislation about ecosystems. Because of the geomorphology and the great water resources of Arachthos basin, two hydroelectric water dams have been constructed

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and used since 1981. The dams are located a few kilometers above the city of Arta, in the southern part of the river flow, which leads to the river delta in the Amvrakikos sea gulf. Although water dams could control the river flow, there are several flooding events. The analysis of river flow and estimation of flood risk is a complex process and highly dependent on the local topography. Thus, a careful collection of data with high-accuracy is needed along with a thorough pre-processing analysis. Table 1 presents the main datasets used to record the profile of the area and are covering all the needs for flood risk analysis.

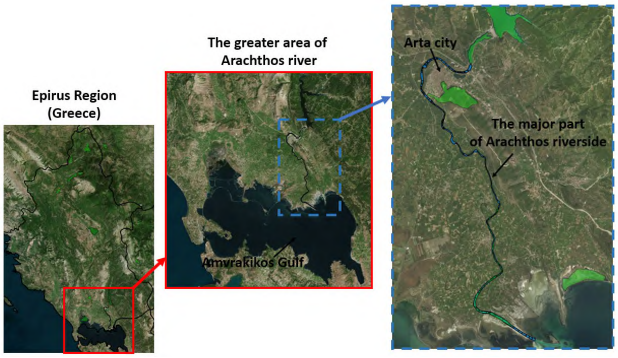

Figure 1. The Epirus region (on the left). In its southeastern part, the Arachthos river is located. The river flows out in the Amvrakikos gulf (on the right).

The data is obtained from official national databases, governmental agencies and organizations and have been evaluated by our science team members. The datasets are either in vector or raster format. These datasets have been already checked regarding their quality and they have been used to produce additional layers of information so as to enrich their quality, through spatial editing procedures. Additionally, specific instrumentation to measure the river height and the meteorological conditions along the river will be installed and will operate in real-time basis in order to monitor in real time the potential risk levels regarding the possibility of flood events.

TABLE I. PARAMETERS USED TO DEVELOP THE MAIN GUI AS WELL AS FOR THE MULTICRITERIAL ANALYSIS OF RISK LEVELS PREDICTION.

a/a	Parameter	a/a	Parameter
1.	Road network	6.	Precipitation
2.	Urban fabric	7.	Topography (height, slope)
3.	Hydrological network	8.	Census data (population)
4.	Drainage basins	9.	Land use/land cover
5.	Geological information	10.	river sides

III. SYSTEM DESIGN

The Web-based Geographical Information System (Web-GIS) is composed of the main parts displayed in Figure 2. It is consisted of the following basic components: the client, the Web server, the functions and the database. The client allows the interaction of the Web-GIS users with the Web server and provides spatial information display. It comprises an Internet browsing software, which provides the service requesting and result visualization platform to the users on the client side. The server consists of a Web server and a database server.

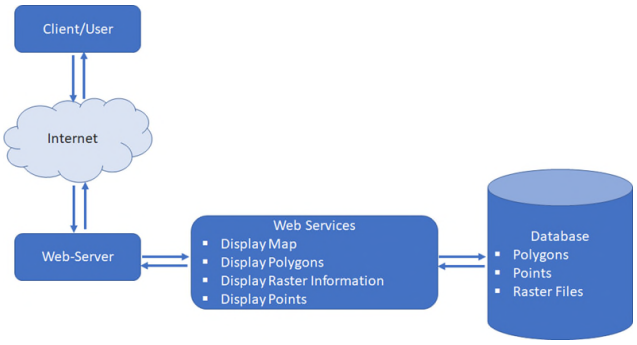

Figure 2. System architecture of the Web-GIS.

The Web server handles all the service requests and is responsible for transmitting the information back to the client. The Web server parses the HTTP requests from the clients and forwards them to the dedicated Web Service. The Web service query for the specific geospatial data from the database server and displays the data on the map. We use the Apache Web server, one of the most popular server development package and independent of the operating system (Apache, 2017). The scripting languages are PHP and Javascript. PHP (Hypertext Preprocessor) is a server-side scripting language designed for Web development and Javascript is a client-side scripting language, which creates interactive Webpages.

The database server is My-SQL (Structured Query Language), which is designed for high volume environments and it runs on all major operating systems. MySQL can contain both spatial and non-spatial data. It is able to handle high activity operations and provides support for geographic objects allowing location queries to be run in SQL [14].

The map display is based on Google Maps, which provides a geographically enabled base. In addition, the Google Map API [15] includes many built-in functionalities, which are used to create our own applications using the stored data. The viewer is composed of various data layer (functionalities), which will be included in the top frame, as well as in the side bar.

The flood risk layers of information will be provided at the advanced system through an automated multicriterial DSS, where real-time measurements will be integrated with the relative informational layer of Table 1, producing the final estimates. These flood risk layers will be automatically updated (dynamic layer of information) and will provide early-warning and decision support.

A few screenshots from the preliminary version of the Web-GIS platform are displayed below, Figures 3-5.

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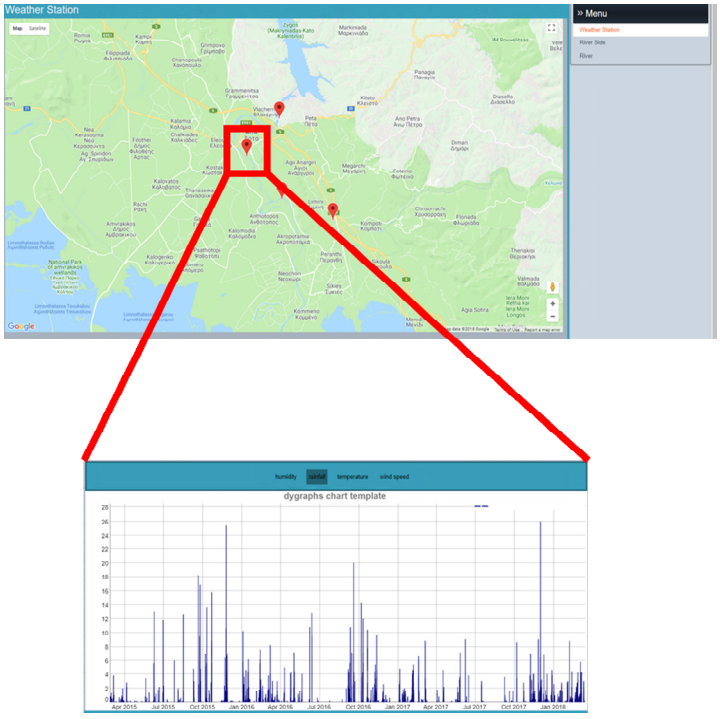

Figure 3. Display of Rainfall parameters of a metereological station based at Kampi, Arta.

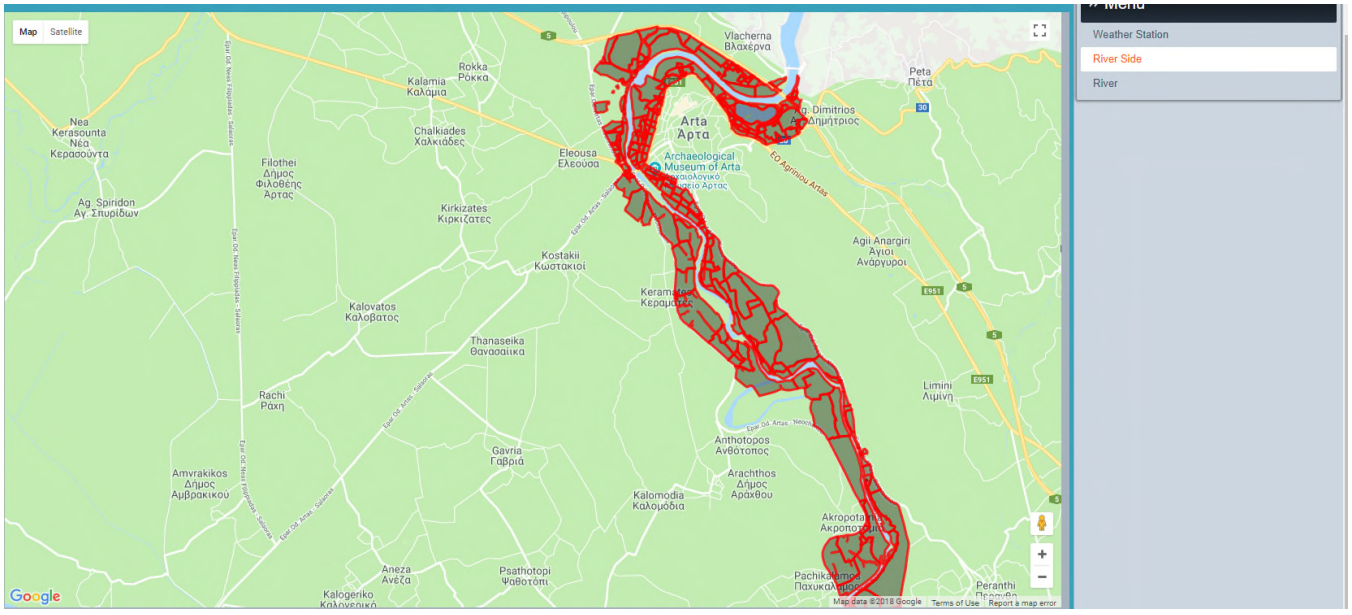

Figure 4. Display the River side of the river Arachtos, Arta.

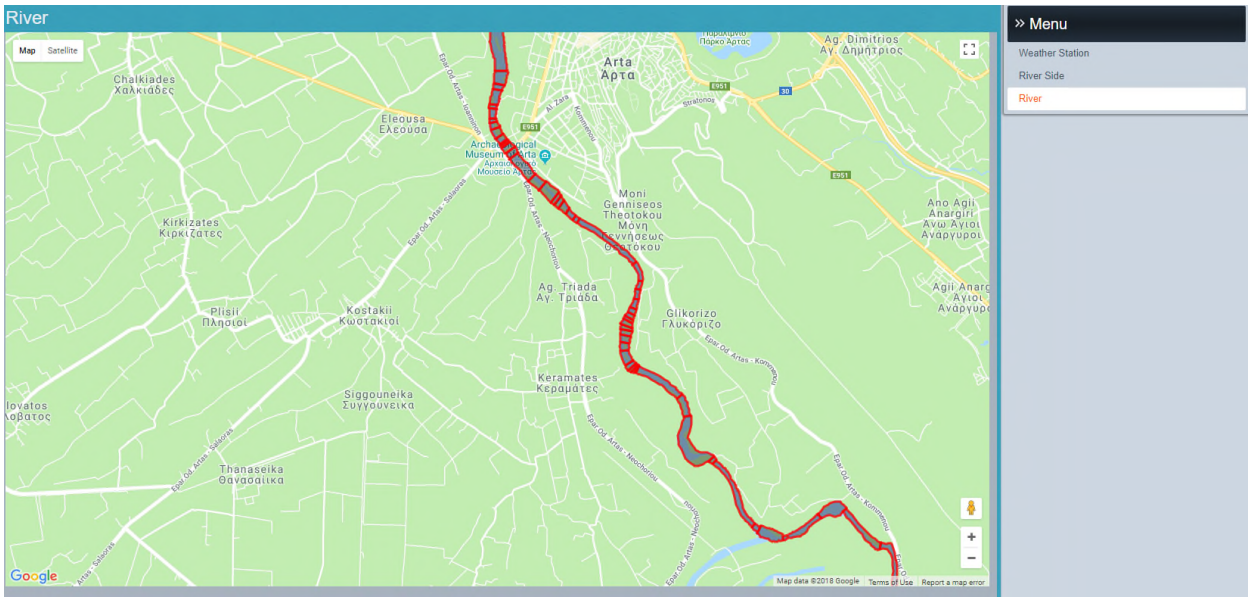

Figure 5. Display the River Arachtos, Arta.

IV. CONCLUSIONS

This study presents a Web-based GIS platform under development for monitoring the river flood and risk prediction along the riversides of Arachthos. Modern Information Communication Technologies (ICTs) are used to provide real-time information as well as early-warning risk levels regarding flood events.

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