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Development of a web application for water resources based on open source software

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ABSTRACT

This article presents research and development of a prototype web application for water resources using latest advancements in Information and Communication Technologies (ICT), open source software and web GIS. The web application has three web services for: (1) managing, presenting and storing of geospatial data, (2) support of water resources modeling and (3) water resources optimization. The web application is developed using several programming languages (PhP, Ajax, JavaScript, Java), libraries (OpenLayers, JQuery) and open source software components (GeoServer, PostgreSQL, PostGIS). The presented web application has several main advantages: it is available all the time, it is accessible from everywhere, it creates a real time multi-user collaboration platform, the programing languages code and components are interoperable and designed to work in a distributed computer environment, it is flexible for adding additional components and services and, it is scalable depending on the workload. The application was successfully tested on a case study with concurrent multi-users access.

1. Introduction

While GIS has become, more or less, a standard integration framework for many water related applications (Cesur, 2007) the current developments are mainly about migrating similar solutions to the web (Choi et al., 2005; Rao et al., 2007; Horak et al., 2008; Delipetrev et al., 2010; Reed et al., 2010). With the explosive growth of the Internet and the subsequent enabled access to the web through a number of devices (computers, mobile phones, tablets) many organizations are turning to the Internet as a platform for software solutions. The applications are currently being offered as services accessible primarily via the web rather than as products to be obtained, installed and run on a computer as stand-alone applications. Recently, researchers have been dealing with development of web GIS applications (Gkatzoflias et al., 2012) based on web services, cloud computing platforms (Bürger et al., 2012) and mobile applications that depend critically on the same web orientation (Jonoski et al., 2012, 2013). Another group of researchers CUAHSI in the United States has developed the Hydrologic Information System – HIS[1] (Peckham and Jonathan, 2013) and is developing HydroShare[2] which are system for publishing and accessing water data and a collaborative environment for sharing hydrologic data and models respectively. Frequently, all implementation details are hidden from the end-users and the only software that they need is the all too familiar web browser. No knowledge regarding the location where the computing elements are stored, the platforms (or operating system) on which they run or their interconnectedness is required. Obviously, such an approach may significantly increase the number and the diversity of the users of these services.

While web orientation has been by now clearly recognized and elaborated on in research, this is not yet reflected in practice for varying reasons. The established practices of using software products in a traditional way seems to still be more convenient for consumers and more profitable for software producers. The lack of clearly formulated business models alongside the investment made in changing the existing software are additional concerns. Furthermore, the continuous and rapid change of many web technologies, often not followed by adequate standardization efforts may also discourage their adoption.

The existing software packages for water resources are often desktop-based, designed to work only on one computer and lack multi-user support. Portability of data and models in existing software packages depends on the versions and types of software. Usually the software packages are not scalable and it is difficult to connect them with other software and other components. The above mentioned factors are used in developing the research questions addressed in the research presented here: Is it possible to develop a web application for water resources using the latest ITC, web GIS standards and software

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[1] http://www.cuahsi.org/HIS.aspx.
[2] http://www.cuahsi.org/HydroShare.aspx.

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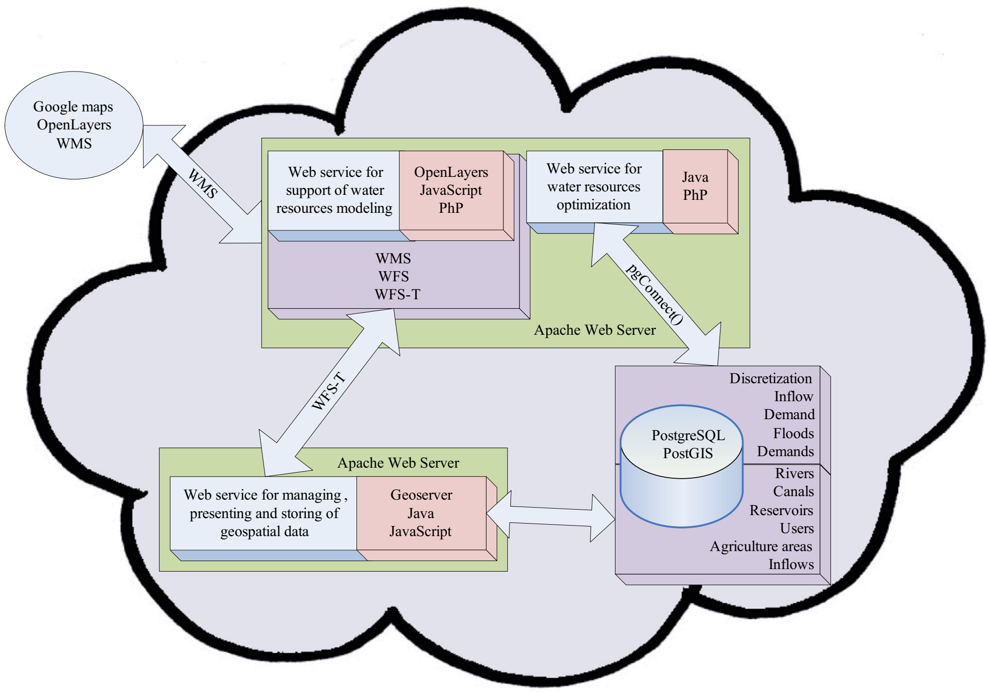

Fig. 1. Web application for water resources architecture.

that will be web based, and will support concurrent multi-user activity and provide a flexible platform that could be further upgraded? The web application rests on the primary objective, which stipulates that “only a web browser is needed to use the application”. The additional objectives are scalability, interoperability and the possibility to work in distributed computer environment.

The web application for water resources consists of a relational database, a middle tier for managing geospatial data, two web interfaces for the specialized services and other software components. The web application has three web services for: (1) managing, presenting and storing of geospatial data, (2) support of water resources modeling (WRM) and (3) water resources optimization.

The web application was successfully tested with data gathered from the hydro system Zletovica (located in the eastern part of the Republic of Macedonia) and with multi-users collaborating in real time. The test confirmed that the application is operational and can be used as a foundation for a modern web based software solution. It is important to highlight that the presented system is prototype software and does not provide *real* modeling or optimization capabilities. The web application's URL is www.delipetrov.com/his/; it includes a help page that contains web links with video presentations of the system components, guides about how to use the web services, etc.

2. Architecture and implementation

The web application architecture is shown in Fig. 1. The arrows represent the data communication links between the web service and the various components. The data communication is asynchronous or “on demand”. The available web services are described in the following three subsections.

2.1. Web service for managing, presenting and storing of geospatial data

The web service for managing, presenting and storing of geospatial data consists of two components: (1) the relational database named HMak that was created in PostgreSQL[3] and PostGIS,[4] which is a data repository; and (2) the web application GeoServer.[5] Six vector geospatial data layers currently are stored in HMak: (used by the web service for support of WRM): rivers, canals, users, agriculture areas, reservoirs and inflows together with their corresponding attribute tables. Also stored in the HMak are time series data and the storage discretization data for one existing reservoir. This data is used by the web service for water resources optimization, which is explained later on in this article.

GeoServer is a powerful open source web application for managing, storing and presenting of geospatial data on the Internet. GeoServer has a user web interface that allows for searching, presenting and downloading geospatial maps and data from the HMak database. The primary utility of the GeoServer is as a middle tier application that connects the relational database HMak with the developed web services. In the web application implementation, the GeoServer provides WFS-T interface connections for the web service to support the WRM.

2.2. Web service for support of water resources modeling (WRM)

The web application user interface (shown in Fig. 2) provides access to the web service for support of WRM and the web service for water resource optimization. The web interface has tools to work with the objects from the six vector geospatial layers that are representing water resources components and its infrastructure. These geospatial objects are the basic building blocks that create the WRM (thus the name of the service, “for support of WRM”). The existing stand-alone WRM applications have user interfaces for creating and editing such elements (building blocks) with corresponding attributes and associated data (see for example,

[3] http://www.postgresql.org/.
[4] http://postgis.net/.
[5] http://geoserver.org/.