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Digital Climate Atlas of the Carpathian Region

I. Antolović[1], V. Mihajlović[1], D. Rančić[1], D. Mihić[2], and V. Djurdjević[2]

[1]Faculty of Electronic Engineering, Niš, Serbia
[2]Hydrometeorological Service of Serbia, Belgrade, Serbia

Correspondence to: D. Mihić (dragan.mihic@hidmet.gov.rs)

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Abstract. The main goal of the CARPATCLIM (Climate of the Carpathian Region) project is to construct the gridded climatological database for the region in a daily temporal resolution for the period 1961–2010 by using 0.1° spatial resolution. The solution of this requirement as well as one of the final products of the CARPATCLIM project is a Digital Climate Atlas which is designed as the main entry point for all the gridded data and maps generated during the project, together with metadata for all data sets (original data as well as data created during the project). With respect to the INSPIRE (Infrastructure for Spatial Information in the European Community) directive, the Digital Climate Atlas is developed as a rich Web GIS (Geographic Information System) application based on modern Web standards offering all necessary tools for climate data visualization and extraction. Another important product of the CARPATCLIM project is the Metadata Catalog which is designed as a tool for searching of climate metadata by various parameters (i.e. period, variable, region etc.).

1 Introduction

In the past years scientific community shows a constant growing demand for online digital climate information. Systems (Geoportal ARSO, 2013; Czech Republic Climate Atlas, 2013) that provide these kind of services are commonly implemented as specialized GIS (Geographic Information Systems) applications. These systems are designed as online Digital Atlas Web applications serving as entry points for efficiently accessing and querying climatology data.

In this paper we describe the Digital Atlas Web GIS application as a part of the CARPATCLIM (CARPATCLIM, 2013) project. The Carpathian Region has gained a lot of focus lately considering that the climate change is expected to result in important changes in the Carpathian climate, with consequence on natural ecosystems and human societies in the mountains and surrounding plains (Bartholy and Pongracz, 2007; Bartholy et al., 2008, 2009). The main aim of CARPATCLIM project is to improve the climate data information basis in the Carpathian Region for applied regional climatological studies such as drought monitoring (Oszlanyi et al., 2004). The service will improve the digital data basis at national meteorological services in the Carpathian Region, and will facilitate access to derived datasets by the wider scientific community. All this was achieved by improving the availability and accessibility of homogeneous and spatially representative time series of climatological data through data rescue, quality control and data homogenization, done on national level using common software MASH (Szentimrey, 1999, 2008). Additionally it was necessary to ensure Carpathian countries data harmonization with special emphasis on across-country harmonization and production of gridded climatologies per country, implemented by common software MISH (Szentimrey and Bihari, 2007, 2011). A direct product of this project is a gridded climatological database for the Carpathian Region (between 50° N and 44° N latitude and 17° E to 27° E longitudes, with a 0.1° spatial resolution) in a daily temporal resolution for the period 1961–2010.

Considering the long period of time and the need to organize and visualize data for various climate variables and indicators it was necessary to design an efficient infrastructure and tools for proficient management of vast amount of climate data. All these requirements are solved by designing a Web based Digital Climate Atlas application which will act as the main entry point for all gridded data and maps

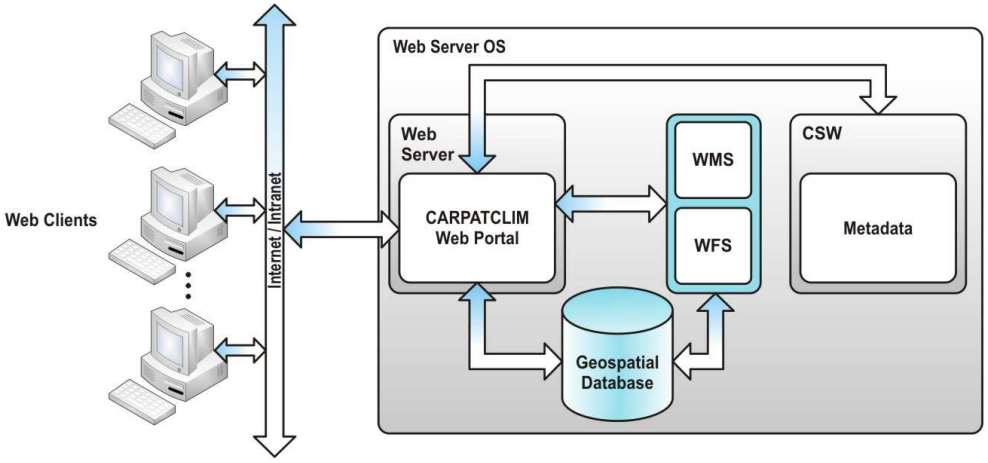

Figure 1. Digital Atlas Client-Server architecture.

generated during the CARPATCLIM project as well as metadata for all climate variables and indicators. With respect to the INSPIRE directive, the Digital Climate Atlas is developed as a rich Web GIS application based on modern Web standards offering all necessary tools for visualization and extraction of gridded climate data. Additionally the main gain of using modern Web standards was the compatibility with all major web browsers thus making the Digital Climate Atlas usable and accessible from wide range of platforms and users.

Fourteen essential meteorological variables (minimum, maximum and mean air temperature, precipitation, wind speed and direction, sunshine duration, cloud cover, global radiation, relative humidity, surface vapor pressure, surface air pressure, snow depth and snow water equivalent) and variety of climate indices (Palfai Drought Index, Standardized Precipitation Index, Reconnaissance Drought Index, Palmer Drought Severity Index etc.) are presented in the form of maps with possibility of downloading the gridded data as ascii files. These files are accompanied with the interpretation sheets that explain concisely the characteristics and the derivation of the data.

In this paper we further discuss and describe the architecture of the Digital Climate Atlas of the Carpathian Region. In the second part we present the components of the client-server architecture of the digital atlas, in the third part we examine the features of the Web GIS client, in part four we give a brief description of the metadata catalog and finally Chapter 5 presents the conclusions and directions for future research and development.

2 Digital Atlas Client-Server architecture

The Digital Atlas Client-Server architecture was designed with the goal to enable easy integration with standard OGC (Open Geospatial Consortium) Web services. The Client-Server architecture is shown in Fig. 1 and the main components of this architecture are:

- *Web Map Server* – this component integrates both WMS (Web Map Services) and WFS (Web Feature Service). The WMS service is used for map rendering while the WFS services is used for storing data relevant to meteorological stations (position, id, owner country etc.).
- *Geospatial database* – this component relies on the PostgreSQL database with PostGIS geospatial extension and it is being used for storing of climatological grid data.
- *Web server* – this component hosts the Carpatclim Digital Atlas Web GIS application which features rich user interface and geospatial data management. For the purpose of this project IIS7 (Internet Information Services) Web server was used.
- *CSW (Catalog Service for the Web) server* – for the purpose of this project Geonetwork open source Java based framework was used.

3 Digital Atlas Web GIS client

In order to maximize the user experience and provide rich user interface without the need to set up additional plugins the Web GIS client is based on HTML5 technology which also has the benefit of gaining compatibility with all major Web browsers.

The Digital Atlas Web GIS is a Web application which enables users to visualize and query geospatial data (Fig. 2). It is important to emphasize that this Web GIS client belongs to a group of medium thick clients which means that it combines advantages of a rich user interface with centralized data control. This is accomplished through the modular application architecture which is shown on Fig. 3. The Digital

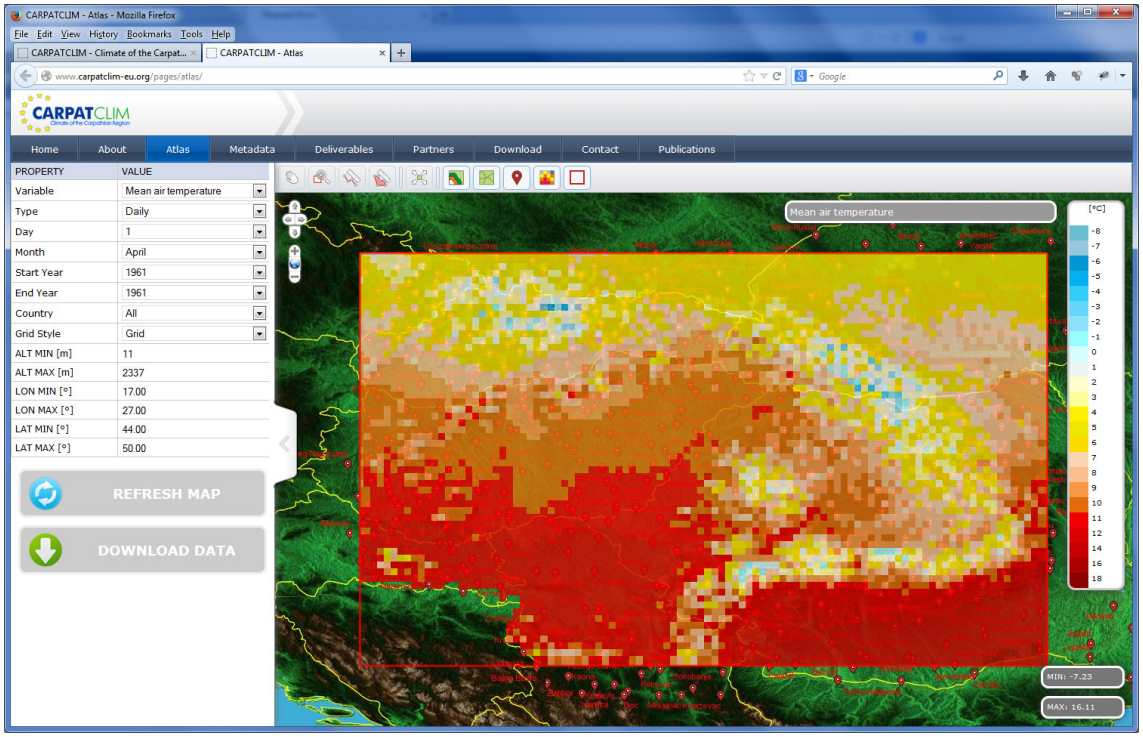

Figure 2. Digital Atlas Web GIS client.

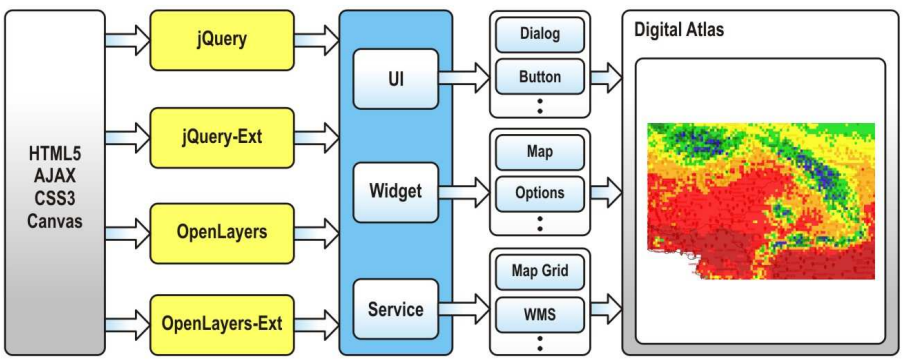

Figure 3. Digital Atlas Web application architecture.

Atlas Web GIS client relies on the GinisWeb AJAX framework (Bogdanović et al., 2011) which combines best qualities from several Web AJAX GIS libraries into a single high level application programming interface (API) framework.

The libraries which are included within the framework are:

– *OpenLayers* – is a framework for Web GIS application development and it is maintained by the Open Source Geospatial Foundation. This framework is used for easy prototyping of interactive Web GIS applications. Additionally it enables adding and displaying layers of various standard raster data sources (WMS, Google Maps. Bing Maps. Open Street Maps etc.) as well as vector layers based on SVG (Scalable Vector Graphics).

– *OpenLayersExt* – is a collection of custom OpenLayers extensions which, among other things, add support for Climate Grid layers (extended WMS layers with additional parameters for time periods, altitude threshold etc.)

– *jQuery* – is a library primarily designed for Document Object Model (DOM) manipulation and it is compatible with most current Web browsers. This library is an essential tool for building interactive HTML5 application therefore it is a very important part of the Digital Atlas core.

– *jQueryExt* – is a collection of jQuery extensions. These extensions include various third party addons which are not included in the official jQuery build (date/time controls, charting tools etc.).

Climate data related GIS functionalities include the following features:

– *Time span selection* – provides rendering of selected Daily/Monthly/Yearly time spans. For example the user can choose to render Tmax (Maximum temperature) Monthly grid for the time span from 1961 to 1971.

– *Per country filtering* – provides rendering of climate grid data only for selected countries,

– *Altitude filtering* – provides rendering of climate grid data only for regions which are above minimum altitude and below maximal altitude,

– *Data download* – provides easy download of grid data for selected parameters. The user downloads a compressed archive which contains three parts:

  – *Grid data values in ESRI GRID format* – the text format of the data enables easy reading and it is supported by wide range of GIS applications.

  – *Visualized grid data image in JPEG/PNG format* – in that way the image with rendered data can be uploaded to a web site.

  – *Interpretation sheet in PDF format* – this document contains all relevant information (origin, parameters etc.) which describes the downloaded grid data.

4 Metadata catalogue

An important step in creating the Climate Atlas of the Carpathian Region is building the metadata catalogue that describes the underlying datasets used in this project. Depending on different layers of data, four metadata groups were created:

– Metadata of the original climate observations listed in the data inventory, per country.

– Metadata of the climate datasets after data rescue, quality check and data homogenization, per country. This includes all relevant information to trace back the processing executed in order to arrive at the current datasets.

– Metadata of national gridded datasets.

– Metadata of all datasets and products of the Climate Atlas of the Carpathian Region.

The metadata catalog relies on the GeoNetwork CSW engine. This solution is chosen considering that Geonetwork is opensource and complies with various standards (e.g. ISO19115/ISO19119/ISO19110 following ISO19139, FGDC and Dublin Core). The above mentioned metadata was generated only once (encapsulating the ISO19139/19119 standard) from existing climate variable data contained in the PostgreSQL database. The generated metadata was then imported into the GeoNetwork database by using GeoNetwork embedded xml services.

5 Conclusions

The Digital Climate Atlas and the Metadata Catalog make a powerful online utility which offers a free, fast and easy access to Carpath Climate data. The Digital Atlas is a WebGIS based solution which relies on the HTML5 technology. As a result the Digital Atlas has rich graphic capabilities and runs on all modern Web browsers without the need for any kind of set up. The user interface of the Digital Atlas WebGIS application is designed to be highly intuitive. All necessary parameters (variable name, time frequency, time period etc.) for grid visualization can be customized on a standard Web form. The Digital Atlas is publically available thus usable not only to experts in the field of climatology, agriculture, water management, regional climate modeling etc., but to common users as well.

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