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Hydrodata.Info: A Web Service For Hydrological Time Series Visualization

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HYDRODATA.INFO: A WEB SERVICE FOR HYDROLOGICAL TIME SERIES
VISUALIZATION

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This paper introduces the concept of a free web service for generating hydrologic time-series charts from any combination of data sources available in the Consortium of Universities for Advancement of Hydrologic Science (CUAHSI)'s Hydrologic information System. The CUAHSI's catalog of distributed services provides a growing volume of hydrological and meteorological data from many parts of the world using a standard WaterML format. By taking advantage of a Representational State Transfer (REST) API, the end user can specify the time period, data source, site and variable to be displayed in the chart. Several pre-defined charts frequently used in hydrology (logarithmic plot, rainfall accumulation plot, multiple season plot, combined rainfall-runoff plot) are supported by the API. Special care has been taken for handling periods of missing data, displaying sporadic observations, and combining multiple time series in the chart. The size, quality and format of the chart can also be specified by the user. Once a chart image is generated, it can be cached on the hydrodata.info server for improving the speed of repeated requests. The hydrological time series chart API is already used in the hydrodata.cz and grafy.plaveniny.cz web portals for providing user-friendly access to hydrologic information from the Czech Republic and neighboring countries.

INTRODUCTION

Fast, attractive and efficient visualization in the form of time series charts is important for communicating the results of hydrologic research to the public. Many desktop-based hydrologic software packages, for example HEC-RAS (Brunner et al. [1]), HydroDesktop (Ames et al. [2], and others, have built-in functionality for displaying time-series of observations or model simulations to the end user. The creation of customizable time-series charts is also widely supported by more general purpose statistical software environments such as Matlab or R. In recent years, it can be observed that many software tools that were previously only available on the desktop, have equivalent online versions on the web. While there are many popular tools and application programming interfaces (API's) for creating time-series charts on the web (Google charts [3], HighCharts [4]), none of these tools are specially tailored for hydrologic time-series observations and forecasts.

With increasing number of recorded observations in the hydrosphere and atmosphere, international efforts have emerged to make the data re-distributable and available to the public (open data initiatives) and to establish standards for data and metadata exchange. One of the

widely used standards is the WaterML format and WaterOneFlow web service which was standardized in the Consortium of Universities for Advancement of Hydrologic Science (CUAHSI)'s Hydrologic information System (HIS). The system is distributed. It consists of a data services that are registered at a central catalog (*Horsburg et al* [5]). By registering a data service at a catalog, the curating institution ensures that the dataset meets the agreed WaterML and WaterOneFlow standards. The unique feature of the HIS is the ability to search for individual time-series within the catalog across multiple data services. The search criteria can be geographical area (for example Hudson river basin), keyword (for example snow), time range (for example last year) and data provider (for example U.S. geological survey). The area criteria are required, and the other criteria are optional.

The search result returns a set of time series records that match the search criteria. A time series record is the unique combination of site and variable (for example snow depth at Fichtelberg mountain). It contains additional metadata about the site (site code, name, longitude, latitude and elevation), the variable (variable units, data type, value type, time step, no data value), and, most importantly, the URL of the original data service. By knowing the URL of the original data source, the site code, and the variable code, the user can issue a SOAP (Simple Object Access Protocol) to the WaterOneFlow web service at the original data source. The returned document is in the WaterML format. WaterML is a standardized schema of the XML. The document has three sections: SiteInfo (details about the site), VariableInfo (details about the variable) and Values (the actual time series data). Because it contains detailed metadata, the WaterML document itself provides sufficient information for determining the optimal visualization of the time series in the chart.

MATERIAL AND METHODS

The web service for time series chart visualization has been implemented using a Representational State Transfer (REST) interface. It uses a key-value convention for the query parameters.

The convention is: (base URL)? (for example http://hydrodata.info/graph/Handler2.ashx?) followed by parameters in table 1. The parameters are separated by the **&** character.

Table 1. The parameters of the time series chart web service

Parameter name	Explanation	Example parameter
siteCode	the HIS site code in NETWORK:SiteCode format	CHMI-D:52
variableCode	the variable code in VOCABULARY:VariableCode format	CHMI-D:8
startDate	the start date in yyyy-MM-dd format	2012-01-09
endDate	-the end date in yyyy-MM-dd format	2012-06-14
serviceURL	the WaterOneFlow SOAP or REST web service endpoint	http://hydrodata.info/CHMI-D/cuahsi_1_1.asmx
width	Width of the chart in pixels (optional)	600
height	Height of the chart in pixels (optional)	300
language	The language of the labels of the chart	en

A sample URL constructed using the above parameters, is shown below:

http://hydrodata.info/graph/Handler2.ashx?siteCode=CHMI-H%3A123&variableCode=CHMI-H%3APRUTOK&startDate=2013-05-24&endDate=2013-06-14&serviceURL=http%3A%2F%2Fhydrodata.info%2Fchmi-h%2Fcuahsi_1_1.asmx&width=600&height=400

In the above URL, the special characters in the serviceURL parameter have been url-encoded. For example, the character ":" is replaced by %3A and "/" is replaced by "%2F".
The current version of the web service is implemented using the C# programming language. At the core of the service is ChartEngine class, created by customizing the open source ZedGraph library [6].

RESULTS
The following examples in Figure 1, Figure 2 and Figure 3 show the time series charts automatically created by the web service for precipitation, snow depth, and streamflow at selected sites in the Bilina river basin in the north-west of the Czech Republic.
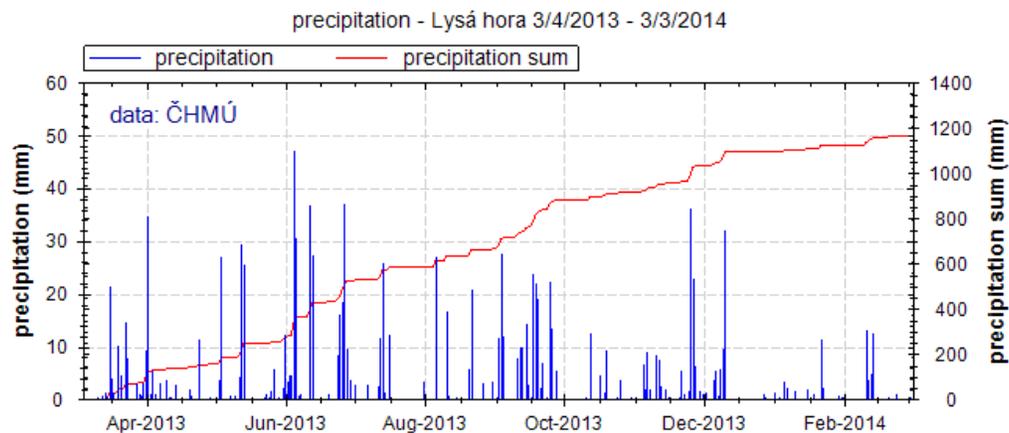

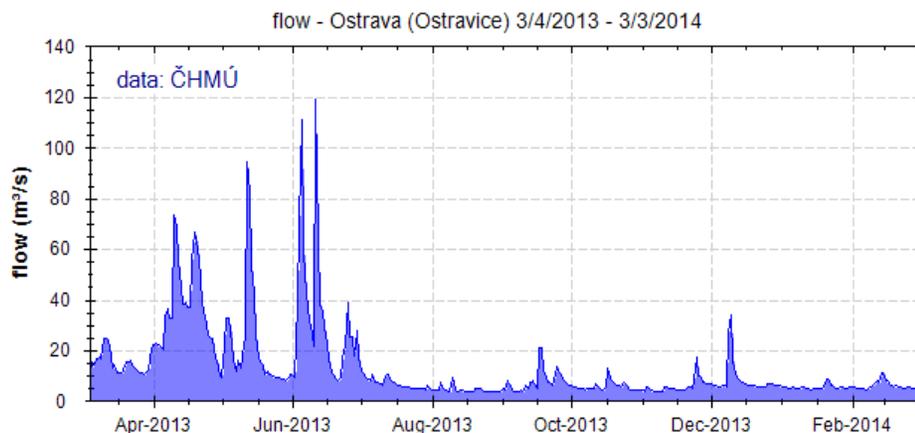Figure 1. Example of a precipitation chart. The intensity and the accumulated precipitation is shown.

Figure 2. Example of a streamflow time series chart.

DISCUSSION AND CONCLUSIONS

The time series chart web service is currently used by several end user applications. One of the applications is the public web portal *hydrodata.cz (Kadlec and Ames 2011 [6])*, which provides a customized search interface for finding hydrologic resources from the Czech Republic. Each time series can be identified by an unique URL. The hyperlink to the time series chart web service is also used in the Web Feature Service (WFS) specification for sharing hydrologic observations. In the WFS, each variable (such as streamflow, precipitation, snow depth..) is recognized as a *feature type* and each site is recognized as a *feature*. One of the feature's attributes is the graphURL that directly links to the chart image URL from the graph web service (*GEOSS group* [7]).

By using the web service concept, advantages of higher processing power (for example cloud service) can be utilized. Also, the chart creation logic can be reused across multiple web applications. Furthermore, the implementation is platform-independent. For example, alternative programming languages such as python (with the matplotlib library) or R could be used for generating the chart, without altering the client web applications that use the charts. The current implementation (on http://hydrodata.info/graph/) also has some limitations. It can only display a single time series in one chart and the language is limited to Czech and English. However, the source code of the web service is open-source. It is available on the public repository: https://github.com/jirikadlec2/hydrodata and it is open for re-distribution, further expansion and development.

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