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Dissemination of environmental and socio-economical information on the web using a model based on free tools

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ABSTRACT

The article presents a model based on the use of free tools aiming at the publication of socioeconomic and environmental data and dissemination of information on the internet. The structure of this model makes it possible to present information as tables, graphs, pictures or web maps. The choice of a particular presentation format is determined according to the goals of the developer. As a result of this work the user will create a virtual geographic database for the generation of static information and interactive web maps. The main tools used are the Spring geographic information system, MySQL relational database, PHP script and Apache HTTP server.
Key words: Web mapping, free tools, Spring Web, Geographic Information System.

RESUMO

DIVULGAÇÃO DE DADOS AMBIENTAIS E SOCIOECONÔMICOS NA INTERNET USANDO UM MODELO BASEADO NO USO DE FERRAMENTAS LIVRES. Um modelo baseado no uso de ferramentas livres é apresentado, visando à publicação de dados socioeconômicos e ambientais e divulgação de informações na internet. A estrutura deste modelo permite que as informações sejam apresentadas sob a forma de tabelas, gráficos, fotos ou mapas para a web. A escolha de um determinado formato de apresentação da informação é determinada de acordo com os objetivos do desenvolvedor. Como resultado do trabalho, o usuário criará um banco de dados geográficos virtual para gerar informações estáticas e mapas interativos para a web. As principais ferramentas utilizadas foram o sistema de informações geográficas Spring, banco de dados relacional MySQL, PHP script e o servidor Apache HTTP.

Palavras-chave: mapeamento via Web, ferramentas livres, Spring Web, Sistema de Informação Geográfica.

INTRODUCTION

Nowadays, there is a huge amount of information on the internet and there are many ways to publish it. The possibility to link information from different sources, stored in a single database with remote access to the internet, allows users with different interests to use the same information with many purposes, such as educational, industrial, commercial, and political, among others.

In a short time the internet has become the best and preferred option of data dissemination. It is present worldwide and its costs keep decreasing, motivating the development of new systems with different characteristics in relation to the predecessors (Casanova *et al.*, 2005).

Socioeconomic and environmental information consists of a data set with social (Index of Socio-economic Development – IDESE, Index of Human Development – IDH, Mortality Rate, Illiteracy Rate, etc.), economic (Gross Domestic Product – GDP, Energy Consumption, Total Amount of Public Revenue, Unemployment Figures, etc) and environmental indexes (Endangered Animal Species, Level of Pollution on a River, Industrial Solid Waste, etc.), which can be directly or indirectly inter-related.

A way of disseminating information on the internet that has started to increase its power are digital maps, because they allow users to interact in an easy way with spatial information, in other words, with information that is related to a point with x, y coordinates on the Earth surface. According to Mitchell (2005), an easy way to make non-technical users to use digital maps is through internet sites that can be visualized in a static (fixed images) or interactive format (made up of selectable layers).

According to Câmara *et al.* (1996), the spatial information can be classified as

thematic (separated in classes – e.g. soil maps, vegetation maps), cadastral (table records linked with map features – e.g. points of sample data, polygons with data on cities), networks (lines with associated attributes – e.g. electrical grid, roads network), digital elevation models (grid of points with x, y, z information – e.g. 3D surface, map of soil contamination based on sample points) and images (grid of pixels – e.g. satellite image, aerial photograph).

Free tools are software without cost that can be acquired with no restrictions, respecting their copyrights. Free software can be open source or not, but their distribution should have no cost, even though open source software might have their distribution free or over license costs (GNU, 2009).

This paper presents a model based on the use of free tools to publish socioeconomic and environmental information on the World Wide Web, allowing the developer to choose which dissemination format is more adequate to their objectives.

AVAILABLE TOOLS

To store socioeconomic and environmental data, the MySQL relational database was used. MySQL is the free database most used in the world, due to its fast and consistent performance, high security and easy usability (Greenspan and Bulger, 2001; MySQL, 2007). This database is the fundamental part of the model proposed in this paper, because it allows the integration between the SPRING Geographic Information System (GIS), the Apache Web Server and the PHP script language.

The SPRING (Geo-referenced Information Processing System) is a free GIS developed by INPE (National Institute of Spatial Researches) and other partners (Câmara, 1996). The database architecture of SPRING is dual, or in other words, alphanumeric data are stored in MySQL and spatial data are stored in a hard disk folder.

Casanova *et al.* (2005) highlight that the main features of a GIS are:

- Inserting and integrating spatial and conventional information from different sources (census, urban and rural cadastre, satellite images, vectorial data, GPS surveys) in a single database.
- Offering mechanisms allowing to combine a lot of information, through algorithms of manipulation and analysis, as well as to query, recover and visualize the geographic database content.

According to Silberschatz *et al.* (1999), a GIS is a Geographic Database because it is a spatial database able to store geographic information. Thus, despite being an information system, a GIS is also made up of a set of data related to a set of programs to access these data, such as MySQL.

The PHP (Hypertext Preprocessor) is a script language built-in HTML (HyperText Markup Language). Its syntax has its own characteristics and others borrowed from C, Java and Perl languages. The PHP offers support to the main web servers, particularly the Apache and Microsoft IIS. It also has API extensions for MySQL, ODBC, IMAP, LDAP and others (PHP, 2007).

The Apache HTTP server has an open source and is a project of the Apache Software Foundation. Apache has the support of the most modern operational systems, including UNIX and Windows and its goals are to supply security, efficiency and services according to HTTP (HyperText Transfer Protocol) current standards (Apache, 2007).

PROPOSAL OF A MODEL

The model for the publication of socioeconomic and environmental information on the web is made up of: a server that stores the MySQL database, the Spring Web files, HTML pages, images and PHP files, PHP script, FTP server and the Apache HTTP server. The model is also made up of a computer with the software GIS SPRING, HTML editor and PHP files, and a FTP client. The developer can work directly on the server or on the computer, but this choice will depend on which tasks will be executed (Figure 1). Notice that server and computer could be dissolved in a single hardware, but this decision depends on the infrastructure of each organization. Regarding the operational systems, all software can be executed through Windows and/or UNIX.

The selected data from a structured project on SPRING can be easily exported to the Spring Web format. This process generates a set of compiled files in Java language that are database and system independent; in other words, the files are read by the Java Client directly from the web page and the user does not need the software MySQL and SPRING to visualize them. However each folder with a set of Spring Web files should contain the file "*springclient.jar*" because it establishes the interface between the user and the server data (Spring, 2007).

Differently from HTML, images, tables and graphics in PHP files, the files in web mapping format from Spring Web require that the computer, besides having a browser (Internet Explorer, Netscape, Mozilla) to access the internet pages, should also have a Java client installed.

The web mapping format allows users to interact with maps and related data through a Java interface that is executed inside the user's machine. Figure 2 shows an example on Spring Web from the map of the Rio dos Sinos Hydrographic Basin (RSHB), with its boundary, main drainage, secondary drainages and main wetlands.

The PHP script establishes an interface between the MySQL database and information presented on the web page, allowing the dynamic creation of tables and graphics that can have their information regularly updated, without the need of rewriting the PHP script.

In order to create graphics in PHP, the JpGraph library has to be installed on the server, because it is possible to create dynamic graphics through it, since it is a PHP script. JpGraph makes it possible to create many types of graphics, giving predefined examples that make

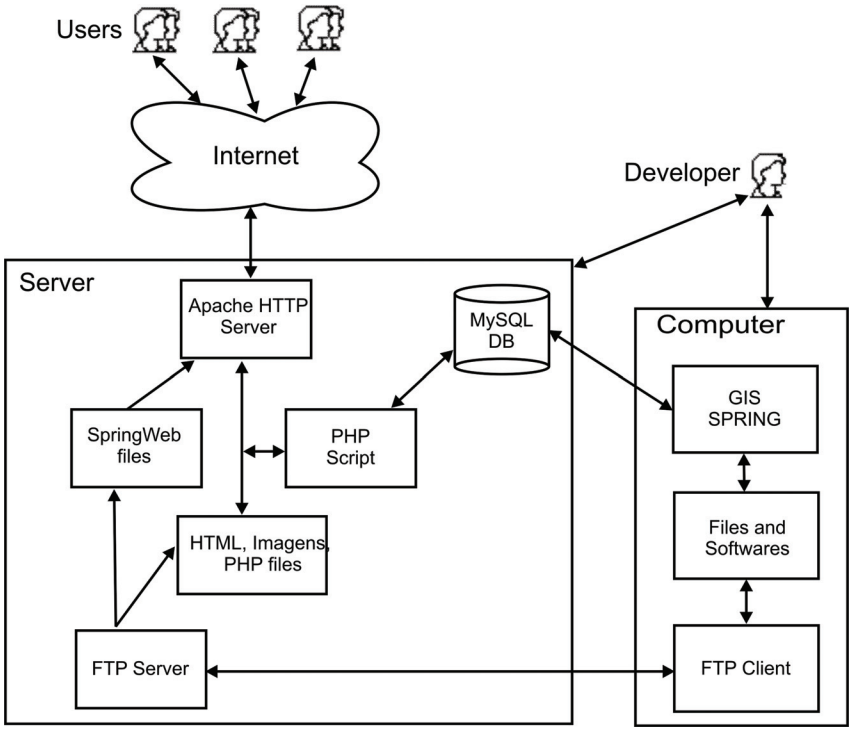

Figure 1. Model for socio-economic and environmental publication of information on the web.

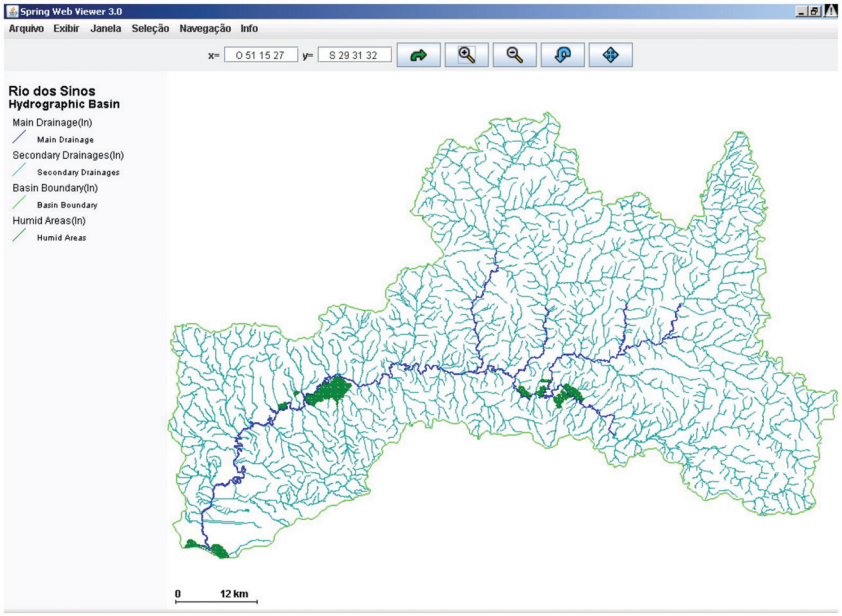

Figure 2. Example of map in Spring Web environment to the Rio dos Sinos Hydrographic Basin, RS, Brazil.

it easier to understand their structure (JPGRAPH, 2007).

Greenspan and Bulger (2001) emphasize that before employing any PHP script, the developer should know how to model a database, create tables and query their information through the SQL (Structured Query Language).

MySQL does not have any relevant restrictions related to its tables and field names, having its restrictions oriented by SPRING. Some restrictions regarding table importation in a SPRING database are:

- The table name cannot have more than eight characters;
- The table and field names should be preceded by letters to be able to include numbers;
- Special characters cannot be used in table and field names (e.g. #, $, %, &, *, (,), {, }, [,], /, \, |, ;, :, -, @, !, ?, <, >, =, +).

In Figure 3 is shown a table dynamically created in PHP, with environmental data related to the percentage of dissolved oxygen, in some points of the Sinos' River and in the period from 1990 to 2006. The graph in Figure 4 was also created dynamically in PHP and contains the total average from each of the water quality indicators proposed by FEPAM/RS (http://www.fepam.rs.gov.br).

The constant computing advances allow servers to execute many applications at the same time at an increasing speed (Silberschatz *et al.*, 1999). This enables web applications to aggregate more functionality without losing performance.

Miranda (2004) highlights some of the Spring Web qualities: it does not use proprietary data format, it offers strong operational analysis (statistics, research, grouping, and cartograms), easy usability, and its performance to realize spatial analysis is better than other applications of public domain with the same purpose. Figure 5 shows an example in Spring Web, using the municipalities that form the Rio dos Sinos Basin, for which a grouping query with information related to the mu-

Percentage of Dissolved Oxygen in dos Sinos River (Average from period 1990 - 2006)

River sample points	Excellent	Good	Regular	Bad	Very bad
Arroio Portão	14	12	18	26	30
Headsprings	93	5	2	0	0
Novo Hamburgo	57	21	14	6	1
São Leopoldo	46	20	17	16	1

Source: FEPAM/RS

Figure 3. Example of table dynamically created in PHP.

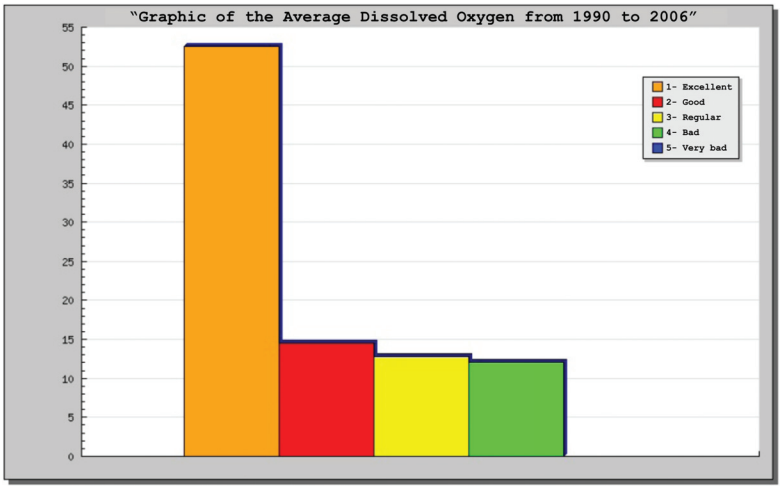

Figure 4. Example of a graphic dynamically created in PHP using the JpGraph library.

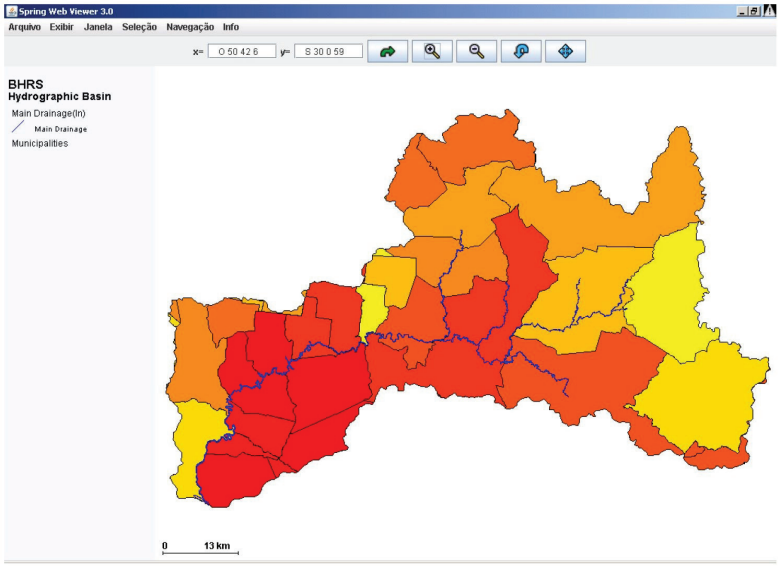

Figure 5. Example of grouping query in Spring Web.

nicipalities' population in 2009 was performed. The minimum and maximum number of inhabitants was divided in seven intervals, varying from yellow to red. It was possible to observe that the highest population concentration (red color) is located next to the capital of the State of Rio Grande do Sul.

In Figure 6, an example in which a cartogram operation over the municipalities from BHRS is applied, allowing checking the concentration of values in a numeric field, in this case the Gross National Product (GNP) of each municipality is shown. Therefore, a bigger yellow point in the map indicates a higher GNP index for the respective municipality.

Finally, Figure 7 shows a query done with the research operation (window "Pesquisa na Tabela Atual"), where a restriction to select only municipalities with revenue per capita above R$ 3,000.00 (window "Tabela de Atributos") was defined. The statistic operations in Spring Web was not shown because of the large amounts of information that is shown in pizza graphs.

Despite being more limited if compared to a GIS, web mapping applications allow more users to have contact with spatial information.

DATA SOURCES

There are many reliable sources of environmental, social and economical data on the web. Socioeconomic information can be obtained through pages from the National Confederation of Municipalities (http://www.cnm.org.br), the Civil Defense Department of the state of Rio Grande do Sul (http://www.defesacivil.rs.gov.br), Foundation of Economics and Statistics – FEE (http://www.fee.tche.br), Brazilian Institute of Geography and Statistics – IBGE (http://www.ibge.gov.br) and Ministry of Cities (http://www.cidades.gov.br). Environmental information can be obtained through pages from Rio Grande do Sul Sanitation Company – CORSAN (http://www.corsan.com.br), Ministry of the Environment

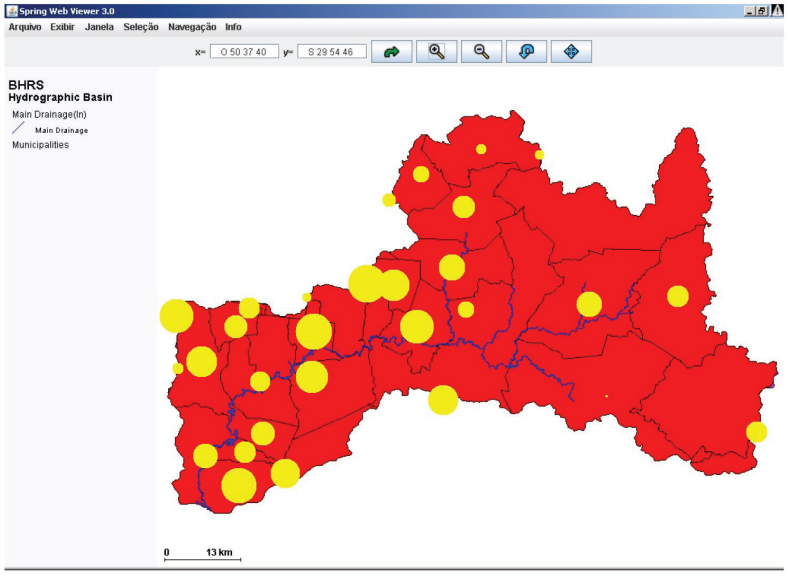

Figure 6. Example of cartogram operation in Spring Web.

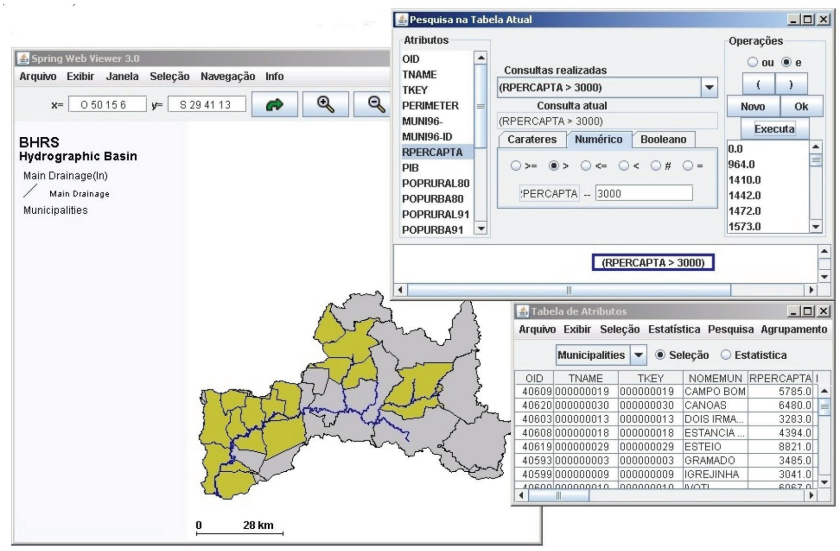

Figure 7. Example of quest operation in Spring Web.

– MMA (http://www.mma.gov.br), and State Foundation of Environmental Protection Henrique Luis Roessler – FEPAM (http://www.fepam.rs.gov.br).

Other information, as digital maps and satellite images, can be obtained from IBGE, National Institute of Spatial Researches – Division of Imagery Processing – INPE/DPI (http://www.dpi.inpe.br) and Department of Geography from University of Maryland (http://glcfapp.umiacs.umd.edu).

CONCLUSION

To offer interaction with geographic information to a larger number of users and allowing to organizations, educational institutions, and governmental bodies to use interactive maps in order to publish their information through the internet are strong reasons that justify the employment of the aforementioned techniques.

This paper's intention was to demonstrate how to create a single model for disseminating static and interactive information on the internet using maps, charts and tables. The model can also be quickly modified or updated, according to the users' necessities.

It is important to point out that there are advantages and disadvantages between using a GIS already known in the market (e.g. ArcGIS, SPRING) and an open source one (e.g. OpenGIS, MapServer). In this paper the software SPRING 4.2 was employed and even being a complex GIS, it offers many advantages compared to other GIS, such as connection with the client/server relational database, importation and exportation of many data formats, metric operations, queries, spatial analysis, relationship between objects and database tables, images processing, decision making support and spatial statistics and many other functions.

A relevant aspect of the proposed model is the facility in finding tutorials and tips on the web concerning the distinct software mentioned in this paper. Good knowledge about cartography, GIS and logic programming is needed, since the user will have to use and edit map features, data tables and structured queries.

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