The developpement of an Interactif Forest Atlas using an Open Source Webmapping solution, case study of the wilaya of Mascara (West of Algeria)

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Abstract: Geographic information is central to any process of sustainable management. It is today an increasingly important in terms of economic growth.
To facilitate handling, a set of solutions have been proposed by the development of an inclusive technology called GIS. With the advent of computer networks and Internet, Web Mapping, or dissemination of cards via the Web is a growing field through the development of open source solutions.
This paper presents the result of work conducted on the design and implementation of a Forest Atlas as a Web Mapping application based on open source solutions. Around the inevitable Geoserver, the work was carried out in two phases. The first phase was to understand how GIS and design an architecture for the application. The second phase resulted in the completion of the application in open source environments.

Keywords: Forest atlas, GIS, Mascara, Opensource, webmapping

1. INTRODUCTION

Localized data find their place at present in many areas, where in last years, the spatial data was still poorly understood or even unknown. The map in digital form is not only a communication medium synthetic and attractive but also ergonomic input interface. Digital mapping thus allows players to interact within a given territory and thereby modifies the classical problems integrating a strong spatial dimension.
The expansion and development of communications technology and information dissemination were birth of a new technology: "web mapping" or WebMapping. Previously, the main distribution of the map was on paper. Now, with the development of computer networks and the emergence of several map services on the web, this technology has revolutionized the use of the map.

Several web mapping solutions are on the market. They are classified according to their availability and services, into two great classes: professional solutions and open source solutions. The latter have the advantage of being available free to anyone with an open and scalability a very effective solution to the problems and geographical needs.

2. STATE OF THE ART OF WEBMAPPING

Using the Web and the Internet as a distribution maps can be viewed as a major evolution of cartography. The Web is becoming a standard platform for Geographic Information Systems because it offers many advantages.

We talk about *webmapping* to evoke a set of dynamic and interactive mapping applications on the *web* primarily for a user to view maps containing more or less of geographic information. The term "dynamic" means functions such as zoom, the choice of the display of layers or gadgets such as tool tips are available **(Henri et al. 2008).**

We talk about ***GIS** and **Web GIS online*** when the functions include more attribute and spatial queries or even more sophisticated geoprocessing.

Under this generic term, it encompasses different types of applications ranging from simple map viewer tool for thematic mapping or GIS online. Their common feature is to be accessible through a Web browser. The transition to the dynamic web to exceed the download static maps and access geographic data contained on a map server (databases or GIS files), or to overlay layers of information to the data locally.

2.1 Maps' mode in webmapping (Antonio et al. 2008)

There are very different modes to make online mapping. It is possible to distinguish three:

- The distribution of static maps (in the form of images. Jpeg or. Bmp), sometimes accompanied by some areas to learn selectable points or areas that you want to highlight;
- Small applications of data mining (in. Svg or flash format) that allow you to zoom, select, and query the data in a much friendly as static maps, but not "dynamic" itself (there is no link to a remote database, cf. below);
- The dynamic mapping itself, which allows the user not only to explore and query the data online, but in some cases to change. This is possible due to the existence of a link between the Web interface and a remote geographic database (called a *map server).* Changes in the database (adding or removing fields or objects), by the administrator (or in some cases the user interface) are passed directly to the data available online.

2.2 Principle of webmapping

The most common currently in the field of online map data is created on the fly image corresponding to the user request. For this, it is most often uses a map server (Figure 1).
This is the communication protocol TCP / IP that allows networked computers to share information via a web browser or transfer files via FTP. The architecture is client / server that is to say that there is a series of computers called clients connected to a dedicated server that communicates itself to the outside or with particular servers through their IP address.
The user's local machine makes requests to request a specific map, the map server interprets this query and returns the map as a raster image (gif, jpg, png ,...) or vector (svg, flash). The map server is remote controlled by scripting languages that allow it to dynamically load a map in response to the request. The server computer can find this information in its own resources or on remote data servers.

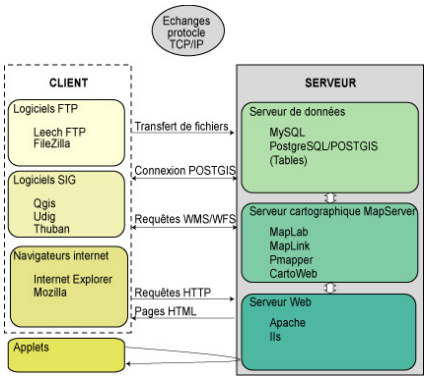

Figure 1: Principle of a map server

The consultation information essentially requires a facility with server-side software such as Apache or IIS (Internet Information Services) running in the background and allows map servers to access the Intranet and / or the the Internet. We must also add script interpreters and possibly a viewer to display the map on the client browser.
Typically, four components, or layers, are the most identifiable to upload mapping **(Stéphane et al. 2004):**

a. ***Client interface / browser:*** The client layer consists of a personal computer and a current browser. This layer provides the user interface and works by generating requests to the server via HTTP.
b. ***A mapping application:*** Basically two applications, one that runs on the server side and one on the client side as well as applications that use both techniques.
c. ***A web server:*** If we publish it on a network using TCP / IP, it is mandatory to include a Web server. This layer consists of a PC with a software called server. This intermediate allows communication and transfer of data locally or on another machine connected.
d. ***Data Layer:*** The data can be stored and managed in several ways:

- The data can be managed by a *DBMS*
- The data can be in the form of GIS file
- The data is included in a script

2.3 Online mapping solutions

The WebMapping is the dissemination of spatial data over the Internet. Two solutions are possible:

- A user, in front of his computer, with a GIS software can tell the software where are stored WMS data (Web Map Service) or WFS data (Web Feature Service). He give a URL and the software will display the data. This configuration is called **client-side solution.** The client must have a GIS software installed on his machine (ex: ArcGIS, GRASS, QGIS, uDig, etc.)..
- An user connects to the Internet (through a browser (Internet Explorer, Firefox, Opera, etc..)), loads a web page where it shows a dynamic map with a few tools (zoom, pan, selection, applications, etc..). The internaut has before him a limited GIS interface provided by the creator of the site. This solution is called **server-side solution.**

2.3.1 Client-side solutions

Client-side mapping solutions are GIS softwares (usually *open source)* evolving with features that make them advanced tools for viewing and editing geographic data remotely. There are a variety of solutions include for example: QUANTUM GIS, UDIG and GRASS...

2.3.2 Server-side solutions

a. **Owner software (often paid):** Several companies offer software ready to upload spatial data. These solutions are obviously paying. The advantage: do not spend time to program and modify the PHP code (which can cost a lot of money). Among these programs, we note such Geoclip EMC AspMap , Svg-Builder or Dynmap (including SVG-Builder) of Simal or ArcIMS and the very recent (September 2009) MapIT , two products completely dedicated to the ESRI WebMapping **(Namur 2004).**

b. **Free software (often free):** In practice these applications are not always entirely server-side as they may need to download a small *plugin* for the client. They all tend towards the provision of the functionality of a traditional GIS without achieve completely. Base, the *Open Source* server-side solutions provide the opportunity from a conventional web browser to view geographic layers dynamically generated. Currently, most advanced new features appear as the ability to add or change information online **(SIG en ligne 2011).**
Several solutions free and open servers are on line. The most popular are:
CHAMELEON, CARTOWEB, GEOSERVER, MAPSERVER...

3. METHODOLOGICAL APROACH

3.1 Presentation of the study area

The wilaya of Mascara is located in north-western of Algeria to 2 ° 11 west longitude and 35 ° 26 latitude extends over an area of 5889.11 km². It is subdivided into 47 municipalities and 16 daïras.
It is bordered to the north by the Wilaya of Oran and Mostaganem, to the east by the Wilaya of Tiaret and Relizane, to the south by the province of Saida and west by the Wilaya of Sidi Bel Abbes (Figure 2).

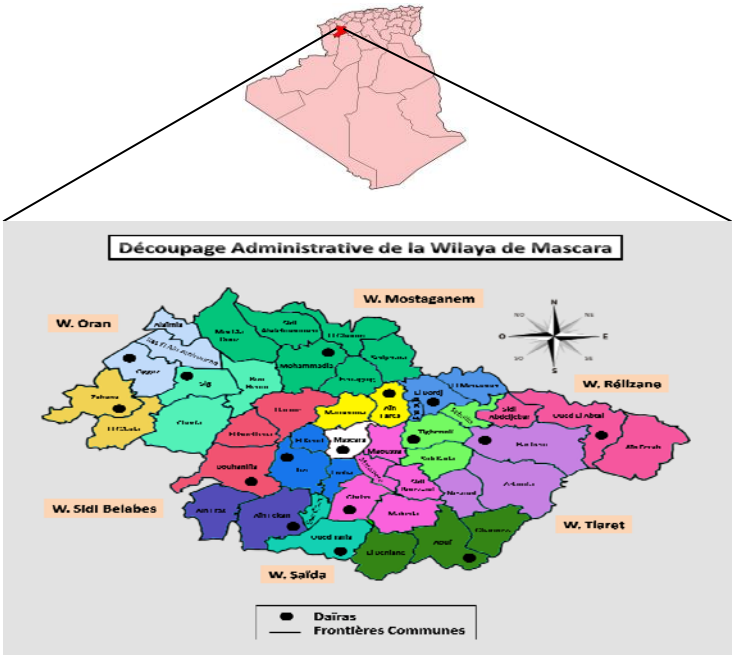

Figure 2: The location of the study area

The land use classes issued from the land use maps and those of forest formations map identified several classes of natural environment. These results show in particular that the land use of the province is as follows:
- Forest land (forest, scrub and plantations) occupy a total area of 84 404Ha corresponding to a rate of afforestation in the province of 15%.

- Agricultural land (crops associated with course) cover a large area of 366 881 ha or 65% of the total area of the province.
- Grass land cover an area of 94,318 ha or 17% of the total area of the province.
- Unproductive lands cover an area of 21,758 hectares or 3% of the total area of the province.

The general distribution of land use confirm the dominance of the agricultural and agro pastoral typology of the wilaya.

3.2 General methodology

To achieve our objectives at the beginning of this work, we followed a number of steps and methodological approaches. These begin with the preparation phase of the necessary data and end with the implementation of our interactive application.

The different phases are carried out represented by the figure 3.

3.3 Approach followed

Achieving our mapping application takes place in three essential steps. These steps are ordered as follows:

3.4.1 Preparation of data and information layers

This is the initial phase of our work. It is to collect all available data on the studied watershed and in relation to our problem. Then a phase of scanning and digitization of cartographic information from maps collected.

We can summarize all processing of this step by the following:

- The scanning of all maps available in paper format to be able to operate with a GIS software
- The calibration of scanned maps according to a reference map with the software Mapinfo
- The digitization of information layers on interest with our work using the same software
- The formatting information layers created
- The input of the object of geographic information attributes of each layer
- Layers transformation from Mapinfo Tab format to ESRI/Shape format with the Universal Translator of Mapinfo

3.4.2 Integration of cartographic data to the server

It is the most important stage of labor. It allows the integration and structuring of our data to our map server “Geoserver” for possible support to the request by the web page of our application.

Geoserver has a friendly interface for managing geographic data in various formats. The different approaches to the integration of information with Geoserver layer can be described as follows:

- Creating a workspace: it represents a working directory that serve only to store and consolidate our data (or warehouses).
- The creation of storage: the warehouse is a storage area of the same data format (vector or raster). Warehouses define a data source and define (text description and code page of source data).
- Creating layers: they are a way to represent the information warehouse, giving the coaching box (or bounding box coordinates of the bounding rectangle of the layer), and assigning a style of displayed data.

The styles are defined in the appearance of a display layer, using a standardized format widely used, the format SLD (Styled Layer Descriptor). We preview the layer with its style or set a default style (depending on the type of data), with the client OpenLayers included in the installation of Geoserver.

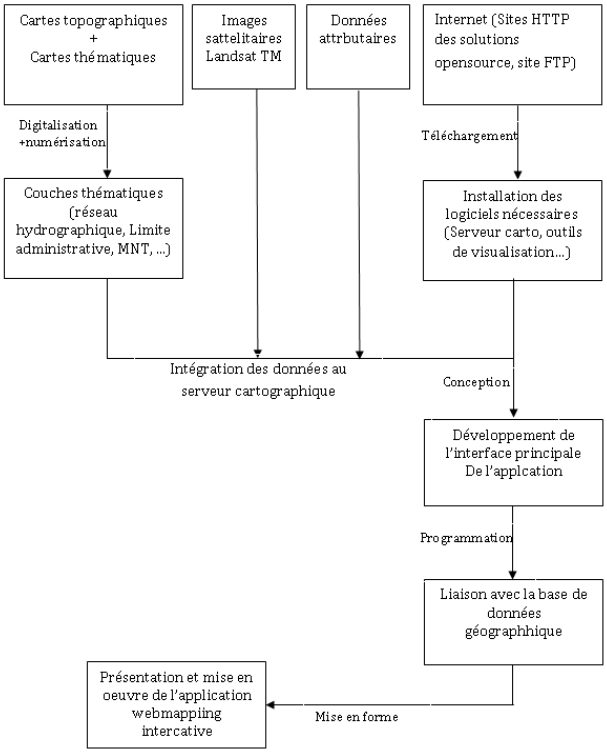

Figure 3: The organigram of the adopted methodology

3.4.3 Development of the interface of the application

This is the third and final step for this work. It involves the development of the main interface of our forest atlas and linking the web page with geographical data by the map server.
This step includes several tasks performed, which are:

- The development of a web page using HTML including the title, the format and style of this page
- The inclusion of Java script to the source code of the web page created earlier. These scripts are used to load the different information layers through the map server and store them in variables. These layers will be loaded and displayed as a map when loading the web page from a browser.
- Calling the Ext JS library inside the HTML source code to create dynamic objects of our map interface such as the legend and layers controller
- The development of a web interface with HTML and Java scripts makes our mapping application available with any web browser (Internet Explorer, Firefox, Chrome ...). The use of java script requires the installation of Java Runtime Environment (JRE) on the client which is a disadvantage of this type of solution.

4. RESULTS AND DISCUSSION

4.1 The integrated thematic layers

To achieve this work, we have exploited several thematic layers in direct or indirect relationship to our problem. These layers are:

a. The Administrative Boundaries layer
b. Forest layer
c. Land use layer
d. Road network layer
e. Basin edge layer
f. Satellite Image base layer

g. Landform layer base layer

4.2 The interface of the application

The web interface of our webmapping solution as a dynamic web page is represented by the following figure:

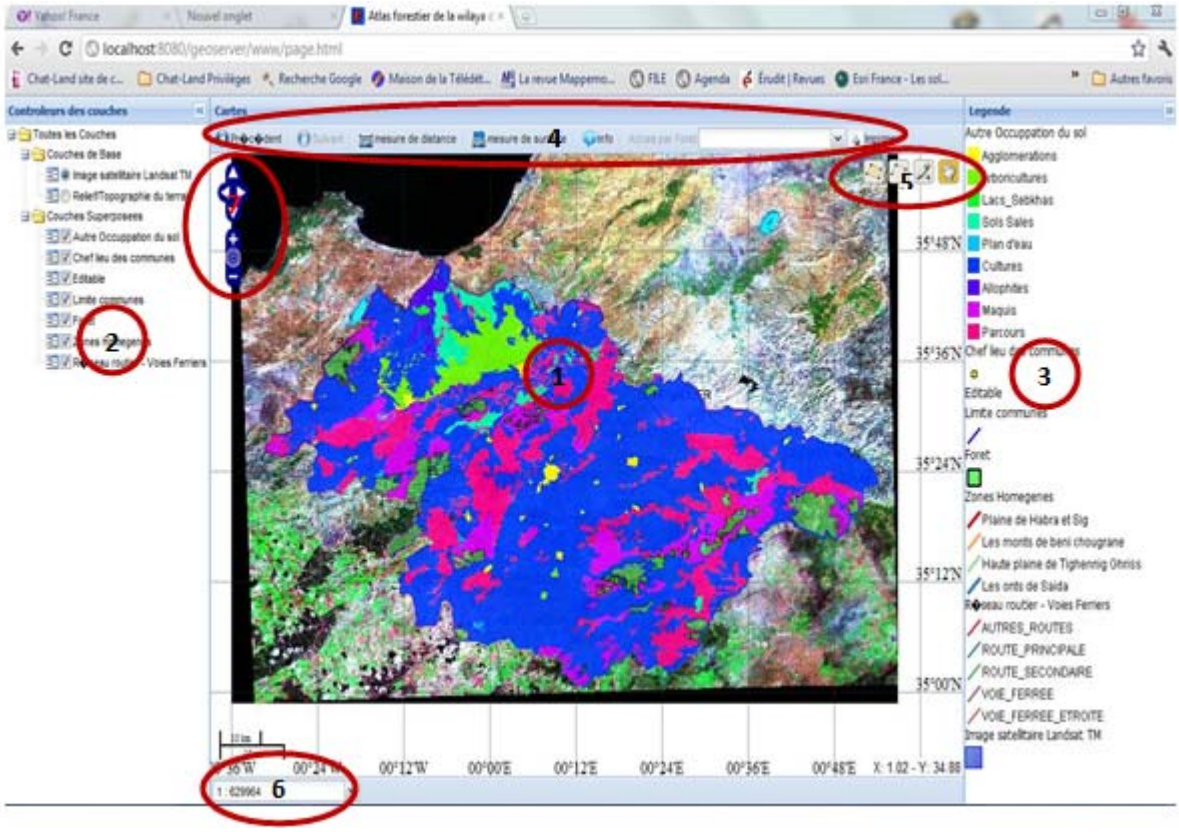

Figure 5: The main interface of the application

The web interface consists of several graphical objects described as follows:

1. **A map panel:** it is an area reserved for the display of various thematic maps. These maps are produced by the superposition of several information layers on a base map. The latter is a color composite image of Landsat TM sensor or a relief for the digital elevation model.
   A grid map, showing the geographical coordinates in decimal degrees, is also displayed in this panel.

2. **A layer controller:** a graphic object is used to control and manage the information layers to be displayed on the map. It contains two groups of layers according to their types: base map layer or overlay. The user has full ability to choose and to combine multiple layers on a basemap chosen for the production of a map as needed.

3. **A dynamic legend:** on the right of the map panel, a dynamic legend explains the symbols and colors used to display different layers. This legend displays dynamically the symbology used in direct contact with the selected layers in the layer controller.

4. **A toolbar:** it is located above the map panel. It has several buttons:

- **Two buttons to navigate** between different views. The first reads **"Back"** used to switch to the previous view, the second labeled **"Next"** is used to switch to the next (Figure 6).

Figure 6: The navigation buttons between the views

- **Distance Measure button:** this button which provides the user with a functionality of GIS to measure the distance on the map displayed using a control solution offered OpenLayers. The user only has to draw a line on the map using the mouse, and the result will be displayed in a new window Km (Figure 7).

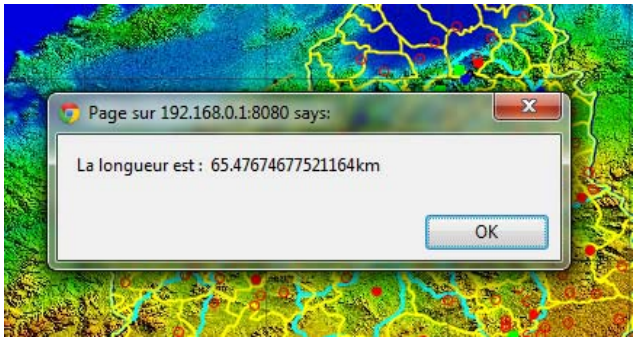

Figure 7: A Windows tool for measuring distance

- **An Area Measure button:** it is another button allowing the user to measure an area on the map. It offers the possibility to draw a polygon with the mouse. A new window will be displayed indicating the result of the measure in square Kilometer (Figure 8).

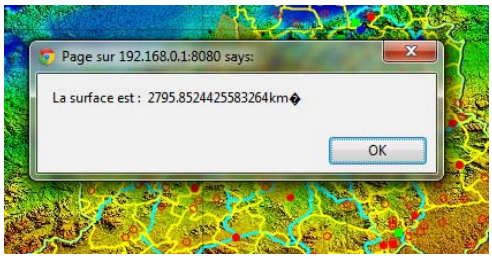

Figure 8: A Windows tool for measuring surface

- **Info button:** This button allows the user to query the database of graphical objects displayed on the map. With a simple click of the mouse on the map, a new window will appear containing the attributes of the objects pointed by the user

- **A Print button:** This button allows you to print the map in PDF format. If we click on this button, a new window will appear containing a navigation controller and zoom on the map and a button to start printing (Figure 9).

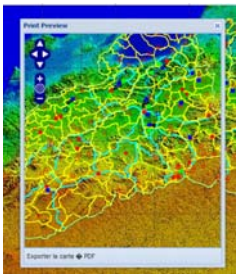

Figure 9: The Print preview window of the map

5. **An edit bar:** it consists of several tools that allow the user to draw vector objects on the map. These tools are:

- A tool for drawing vector objects as a polygon
- Another tool for drawing linear vector objects
- A third tool to draw point objects
- A final tool to drop the map with the mouse

6. A dropdown list containing different levels of zoom. Choosing an item from this list allows you to enlarge the map at a certain zoom level at the discretion of the user (Figure 10).

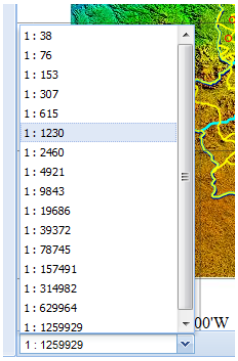

Figure 10: The list of different zoom levels

7. A navigation controller on the map and zoom controller. The first is used to move the map to the four directions (up, down, left, right) and the second allows you to enlarge (Zoom In) or decrease the map. Both tools are features offered by OpenLayers (Figure 11).
   Instead of using the mouse, you can use the keyboard to perform its controls: + to enlarge - to reduce, the arrow keys to move the map.

Figure 11: The navigation/zoom bar

4.3 The advantages and disadvantages of our application

Our webmapping solution developed during this work represents a very interesting tool in terms of thematic mapping of several types of information. This information seems to be very useful to manage forest resources of our study area.
Several advantages can be reported include:

- The provision of interactive mapping solution for creating maps according to our needs
- The presence of many features of GIS to facilitate the achievement of certain treatments without the need for GIS software on the computer
- Shared access to our application by multiple users through a computer network is possible in order to make available all geographic information which will need

However, disadvantages have been emerged depending mainly to the technical solution chosen. We can mention:

- The consultation of the application via a web browser requires the installation of JRE (Java Runtime Environment)
- The need to program all the necessary tools and mapping functions such as measuring tools, navigation, quick access ...

5. CONCLUSION

We choose, for the implementation and development of our solution, an open source mapping solution easy to implement.

We have developed an interactive mapping solution that integrates many interesting operations and GIS tools, and facilitates the display and manipulation of thematic maps at our discretion and according to our needs.

This work is a fairly powerful tool because of its management of mapping data, interactivity offered to the user and the many present GIS functions. It can be very useful for in terms of indicators of forest resources management.

We envision an extension of this work with:

- Integration of additional modules such as editing and secure updating geographic data ,
- The use of development tools more productive
- Publishing the application in the Internet Network for a better use by concerned users.

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