Establishment of a Geoportal for the Management of the Operations of the Order of Surveyors of Cameroon

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ABSTRACT

Our work aims to design a tool that will facilitate the management of land operations in Cameroon. We have thus developed a Geoportal whose role is to allow access to geographical data on the operations carried out by members of the Order of Surveyors of Cameroon. Firstly, we established specifications which present the needs of the different land registry stakeholders in Cameroon, including clients requesting services in the land sector, land registry agents and OGEC expert surveyors. Subsequently, we designed sequence diagrams whose role is to highlight the different processes of the system that we have put in place. These diagrams made it possible to design a complete system deployment model. This shows how the different executables are structured within the platform. The third and final step consisted of setting up the server module. Here we have designed the different components of our Geoportal. It was about:

** Establish a geographic database on land information in Cameroon. For this, we used PostgreSQL which is an excellent object relational database tool. Its PostGIS extension allowed us to manipulate geographic information.*

** Design the web application. This plays the role of interface between the different users of the system. We therefore had to integrate all the functionalities mentioned in the specifications. To set it up we used the PHP5 scripting language.*

This Geoportal that we have set up allows easier access to land information in Cameroon through digitalization of it.

Keywords: *Geographic database, Land information, Order of surveyors, Server, Geoportal.*

INTRODUCTION

Information in today's world is of capital importance, as noted in the report of the 2005 World Summit on the Information Society in Tunis (UTSUMI, 2005). After the control of raw materials, energy and financial flows, that of "knowledge flows" is clearly becoming the major challenge of the coming decades. The fluidity of information and its proper management are among the major concerns of any serious administration. The Cameroonian cadastral administration, in line with this logic, has a land conservation department. But the latter is faced with difficult management of cadastral information due to the increasingly growing number of property title application files, problems linked to the communication of information relating to the rights registered in the land register, the publication of real real estate rights in the land book, the registration of all real rights in the land book, the delivery of certified topographical extracts, rapid urbanization leading to a plethora of cadastral files and cramped conditions or even the non-existence of archiving premises. The regional cadastre services, for their part, in addition to the information to be provided, provide considerable support and technical assistance to the tax assessment services, collection services and services for the conservation of land ownership and mortgages by making cadastral information available. The areas of competence of these services are very vast with a large number of graphic documents (cadastral plans) to update, edit and display. But access to these works remains a real mystery for users as noted in the PAMOCCA report. (ALPERTE, 2010).

- So, we can ask ourselves what tool should be put in place for efficient management of land operations in Cameroon?
- Research Objectives :
- The objectives set by our work are to:
- * Conduct a study on the current management of cadastral documents, the new methods to be put in place to facilitate access to cadastral information;
- * Ensure the security of said documents;

- * Dematerialize the land register: Set up a Land Information System allowing integrated and synchronized management of land data;
- * Improve access to land information: Allow all stakeholders in the sector (public, private and civil society) to have access to all information relating to land ownership in real time via an active internet portal; Make a secure investment channeling tool available to the private sector.
- * In other words, this study should lead to secure management of cadastral documents, easy and rapid access to cadastral information.

In order to set up a geoportal for the management of the operations of the Order of Surveyors of Cameroon, this work will be structured around three (03) chapters.

We will first present a review of the literature; then, we will see in detail the design methodology of the geoportal; and finally, we will bring out the results obtained after implementations. We will end this work with a general conclusion and perspectives.

METHODOLOGY

A geoportal is a public web portal allowing access to search and visualization services for geographic or geolocated data. The objective of this part is to establish an inventory of "application" solutions that facilitate the online posting and maintenance of geographic information. This expression "application solutions" actually covers different types of software, function libraries, sets of scripts. We will detail the most advanced software bricks that have been tested in our working environment. We will distinguish between the client side and the server side before discussing the results of these tests.

General principle of operation of the geoportal

The map server is the automatic teller machine that the user uses to display maps on their computer station. Using the Internet communications protocol, TCP/IP, computers connected to a network can exchange information via a Web browser or transfer files using the FTP protocol. The architecture is client/server, meaning that a server computer responds to requests from a series of client computers.

The user, from his terminal, makes requests to request the display of a specific map; the map server interprets this request and returns the map in the form of a raster image (png, jpg, etc.) or vector image (SVG, swf, etc.).

The map engine can be controlled by scripting languages such as PHP, Python or Perl which allow it to dynamically generate a map in response to a query prepared by a user interface. The map server can search for the information necessary to create the map in its own resources, but also on remote data servers. The distribution of information online requires a server-side installation with software such as Apache (Open Source project) or IIS (Internet Information Services, from Microsoft) which run in the background and provide access to the map servers at the same time. 'Intranet and the Internet. These server softwares often have their functions extended by script interpreters such as PHP or ASP. The map server relies on these elements to receive requests and return images and data. On the client side, a web browser is sufficient, possibly accompanied by a viewer (viewer in French), to display the map (see diagram below).

The data can be managed by specific software, RDBMS such as PostgreSQL, MySQL, Oracle, among others, which can be installed directly on the server containing the map server or on another, remote server. No matter the location, the important thing is to be able to consult and edit data remotely.

System deployment model

The deployment view shows how different executables are structured in the platform or different nodes. Figure 14 shows how the different components of the land information system that we have developed are distributed.

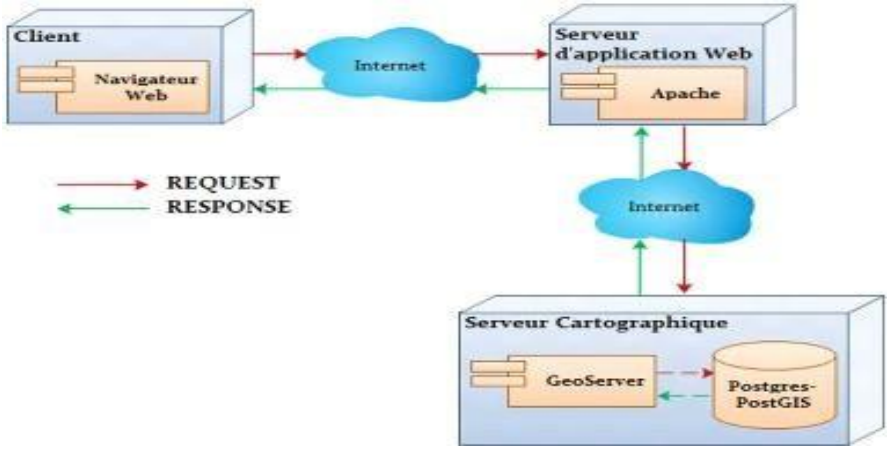

Figure 1: Application deployment diagram

The "map server" consists of a map server (GeoServer) meeting OGC specifications, coupled with a DBMS (PostgreSQL/PostGIS). The "web server" is responsible for communicating with the client and redirecting the client's geographic requests to the "map server". It should be noted that these different servers can be deployed on a single machine. However, for performance reasons the latter must be powerful enough to reduce response times. As an illustration, on an Intel® Pentium®4 CPU 2.80GHz machine with 1.30GB RAM, it takes on average 7.5 seconds to display the entire card.

The server module

The geographic database: PostgreSQL/PostGIS

PostgreSQL is a powerful object relational database management system (ORDBMS). It was released under the BSD-style license and is therefore free software. As with much free software, PostgreSQL is not controlled by a single company but by a community of developers and the companies that develop it. PostgreSQL was designed from the ground up with the potential need to be extended using specific extensions in mind. The ability to add new types and new functions. Thanks to this, a PostgreSQL extension can be developed by an independent development team.

PostGIS is an extension of PostgreSQL to manipulate geographic (spatial) information in the form of geometries (points, lines, polygons). It gives the PostgreSQL database management system the status of spatial databases by adding the following three supports: spatial data types, spatial indexes and spatial functions. Since it is based on PostgreSQL, PostGIS automatically benefits from all of its capabilities as well as compliance with the standards of this implementation.

Application data.

The application database is ported to the SGBRO PostgreSQL. The PostGIS extension has been added to manage spatial data. Figure 16 shows the application data class diagram. This model is made up of 06 tables representing, among other things:

* Owners: linked to their property (plot of land), with attributes corresponding to information taken from the land book,

* Transactions on land: subdivision, concession, mortgage, and inheritance are taken into account by the Land Transaction table,

* Administrative division: District, Department, Region.

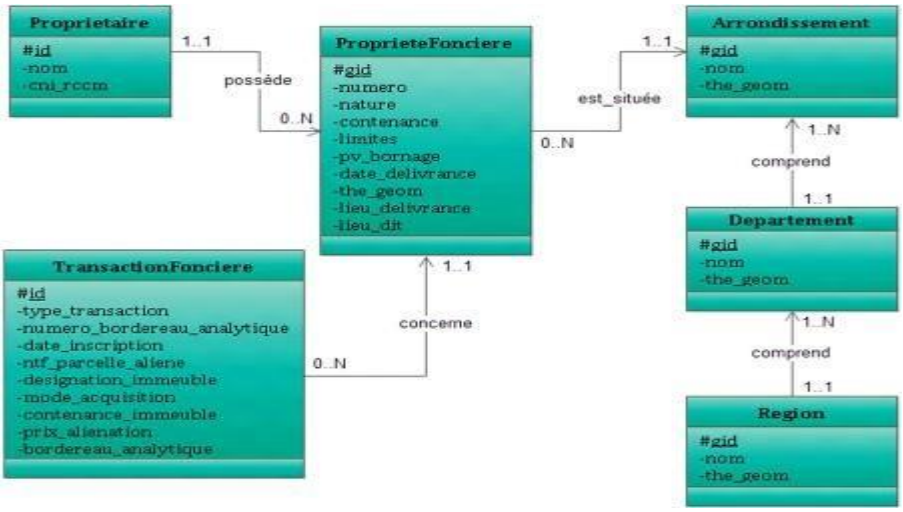

Figure 2: Class diagram of data processed by the application

Le serveur cartographique : GeoServer

The Mapserver : GeoServer
GeoServer is a cartographic server (released under the GPL 2.0 license) specialized in the management of geographic information. This system makes it possible to edit and store spatial objects made accessible through a network. It allows you to publish and modify a wide variety of open formats in the form of maps, images or even geographic data.

Among its qualities, we can note its ease of use and its compatibility with different databases (Oracle Spatial, ArcSDE, PostGIS), implementation of OGC standards, protocols (WFS, WMS) and cartographic files (SVG, KML, SHP) . Its transactional capabilities provide strong support for shared card editing.

Developed entirely in Java, GeoServer integrates libraries that facilitate and accelerate complex operations such as support for numerous cartographic data formats or even transformations and translations of spatial coordinate systems.

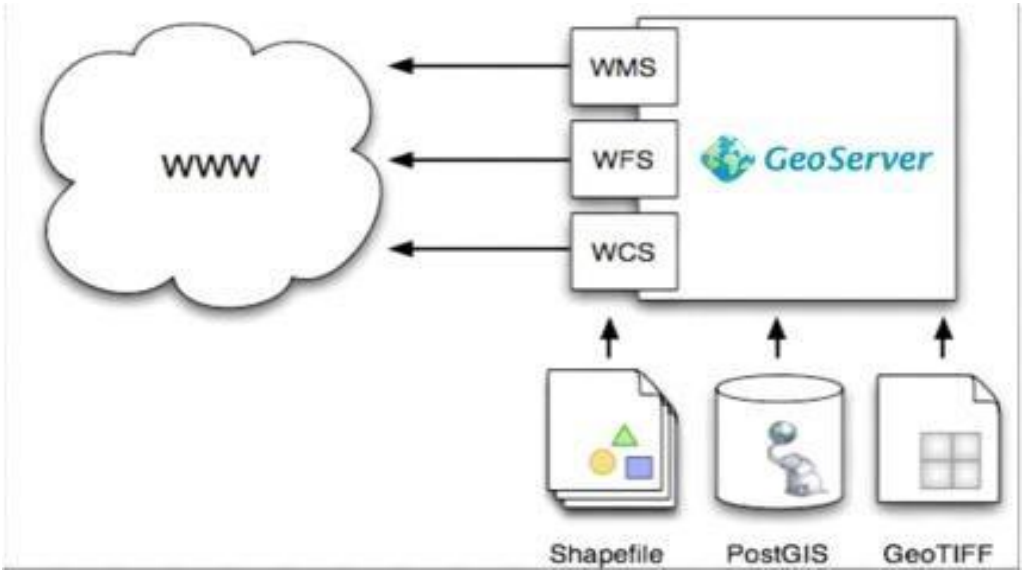

Figure 3: How GeoServer works

Figure 17 illustrates the operating principle of GeoServer. It delivers cartographic representations of geographic layers stored in files (Shapefile) or databases (PostGIS). Data is published on the web using the Web Map Service, the Web Feature Service, and the Web Capabilities Service.

In GeoServer the data is structured as follows:
* Workspaces: directories which only serve as means to group warehouses,
* Warehouses: data storage areas of the same format. Warehouses define a data source and describe it,
* Layers: layers are a way of presenting warehouse information, by specifying the coordinates of the area (bounding box), and by affecting a display style of this data.

The web application

The third component of our land information system is a web application. It is located as shown in the deployment diagram in the Apache application server. It is she who plays the role of interface between the users of the system. All the functionalities provided for in the specifications are implemented using the PHP5 server scripting language. The object-oriented capabilities of the latter were used to produce an application respecting the Model-View-Controller (MVC) design pattern.

Architecture: MVC

MVC is a user interface design pattern. Developed by Trygve Reenskaug in 1979, it allows the model (business logic and data access) to be decoupled from the views (data presentation). Figure 19 illustrates how the MVC design pattern works.

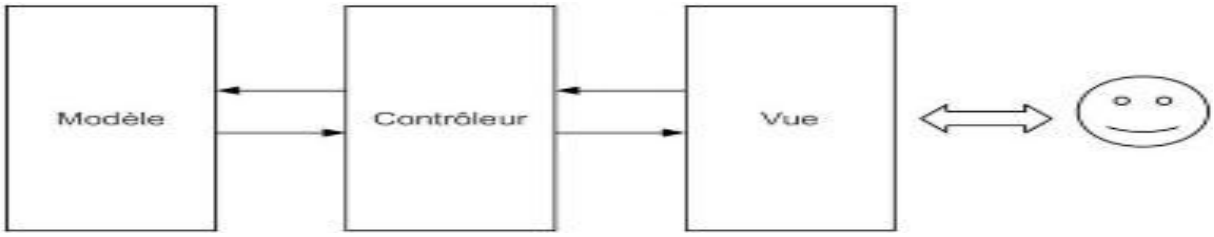

Figure 4:How MVC works

Designing a geoportal for land information management is a complex but crucial task to enable effective management of geospatial data. By following the methodology presented in this chapter, this geoportal will respond to the specific needs of users while ensuring the security and integrity of the data. This in fact detailed the different stages of designing the specifications and then the elements of the server module through which users can interact. In the following chapter, we will present the different results obtained and then we will evaluate the real impact that such a platform could have for the multiple stakeholders.

Our geoportal thus completed; we must present the results of our work. This part aims to evaluate the advantages and possible limitations of setting up such a platform in our context. As there are multiple actors in the land chain, it will be a question of evaluating the benefits gained by them thanks to this tool and identifying avenues for improvement.

Results and discussion

Easy access to land information

Remember that our mission is to set up a GIS for land ownership. One of the objectives of this mission being to facilitate access to land information, we propose to make a web portal available to all Cameroonians where they can consult information on land plots. The figure below represents the geoportal page.

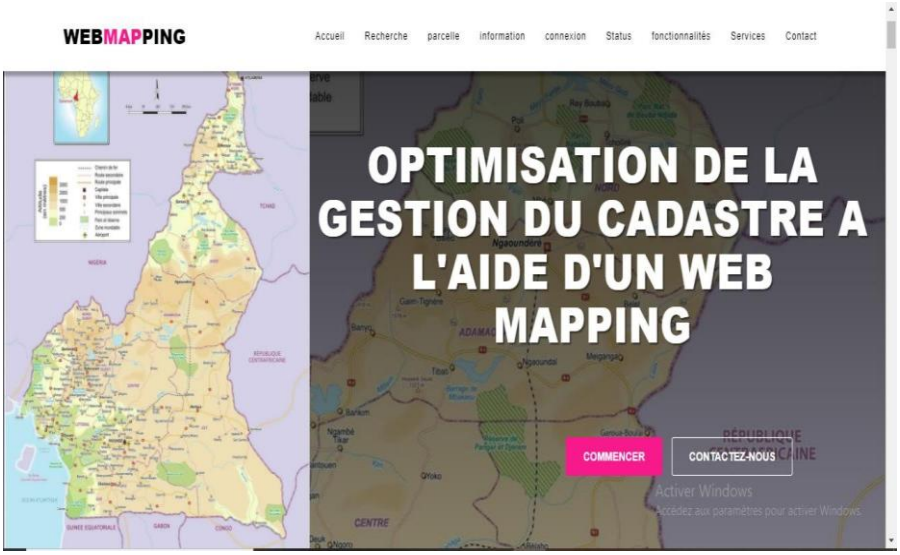

Figure 5: Home page of our geoportal

Emphasis was placed on the visibility of the map, a style was defined to give each region a unique color. The visitor has a quick access menu to features. At the top and far right is the LayerSwitcher which allows you to select which layers to view.

At the far left are: at the top the zoom controller, at the bottom a first block where information on a plot is displayed when the visitor clicks on the map and a second block where the position of the cursor appears (in longitude - latitude) and the scale of the map which varies depending on the zoom.

The digital land book

The land register is currently the only instrument used to record land titles and rights. The conservation of the land register is subject to numerous problems. We have set ourselves the objective of dematerializing this tool.

a) Security

First of all, it is essential to secure access to the land rights registration interface. Cadastral agents will each be assigned a unique identifier and password to access the system.

Figure 6 shows the user login interface.

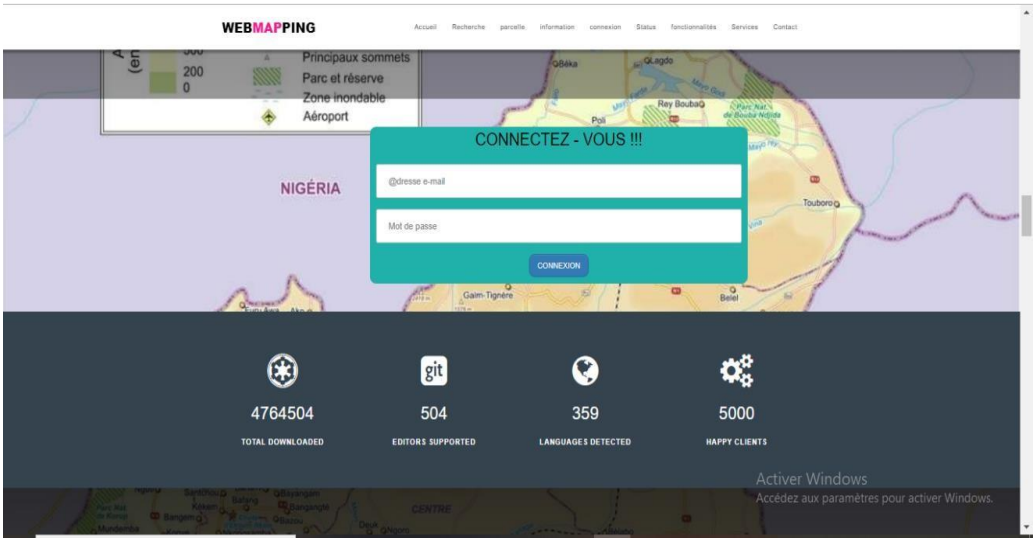

Figure 6: Geoportal connection interface

Once connected, the land registrar has access to the functionalities. b) Registration of land transactions A plot of land can undergo modifications.

The first two operations on land are the sale and the concession. They consist of completely transferring titled land to a third party for a sum of money or not.

The interface in the figure below allows the land registrar to record these two operations. He first selects the plot to be alienated (parent title) and then enters the information according to the land book model. The analytical form drawn up by the notary is also taken into account.

Figure 7: Concession and sales registration form

Application evaluation

The Land Information System that we put in place is intended to resolve the problems of management and access to land information in Cameroon. A specification (table 1) has been established for this purpose and must be respected. Table 3 shows the percentage of achievement of the functionalities defined in the specifications.

Table 1 :Implemented Features

N°	**Fonctionnalités**	**Completion percentages**
F1	Show/Disable Map	100%
F2	Zoom in on the map	100%

F3	Register a titled plot	95%
F4	Register a land transaction : fragmentation	100%
F5	Register a land transaction: concession	100%
F6	Record a land transaction: sale	100%
F7	Register a land transaction: mortgage	100%
F8	Register a land transaction: inheritance	100%
F9	Search for a plot	100%
F10	Layer selection	100%
F11	View plot information	100%
F12	Print the land book	50%
Average percentage of achievement		95,41%

Assuming that all features have the same degree of priority and applying an average calculation formula, we obtain the average percentage of completion of the application which is 95.41%. The partially implemented functionalities are grouped in Table 4 which specifies the missing elements.

Table 2 : Incomplete features

N°	Features	Missing elements
F3	Register a titled plot	Complete the overlay check function
F12	Print the land book	Implement reporting with the Report tool

Current Geoportal Limits

The geoportal that we have set up will need to be perfected and evolved. It also has many limits within it that it is good to know:

In terms of processing technical files

The land conservation and mortgage services register the files before transferring them to the Land Registry. If a collaboration platform is born between the IT departments of the
Cadastre and that of land conservation, the registration module could be improved by recording only the numbers received by the service, especially since the other information is already entered from the Land Conservation database.

In terms of backups

In order to respond to users' concerns about what to do in the event of a power outage at the Tower or in the event of a server failure. It would be interesting for us to say that the application will redirect to the backup server. But not yet having all the useful knowledge to make updates from the main server to the backup server and vice versa without altering the information, we suggest that the database administrator can do them manually every evening at the descent while waiting for us to have adequate training to handle it.

In this chapter, we evaluated the advantages of our geoportal as well as the limitations linked to its implementation. This makes it possible to facilitate access to land information through the creation of a digital land book in this case. We have thus satisfied more than 95% of the requirements of the specifications

established beforehand. However, difficulties related to the processing of technical files or a possible server failure may prevent optimal use of our platform.

CONCLUSION

At the end of our study, on the establishment of a geoportal for the management of the operations of the Order of Surveyors of Cameroon, we are very satisfied with the work carried out.

The Geographic Information System that we have developed is a tool used to record land rights based on the land book model and to facilitate access to land information by making it available on the internet. From an architectural point of view, it is composed of two modules: a cartographic server (GeoServer) associated with a DBMS (PostgreSQL/PostGIS) which provides basic cartographic services, and a web application which interacts with users. First category users can securely register land rights while second category users can consult land plot information through a web portal.

Furthermore, it should be noted that this application requires some revisions before being made available to its end users. In particular, at the level of the registration interface for new land parcels, the coordinate entry fields must be replaced by a component that can limit entry errors. To provide more details on the location of land parcels to the user, the maps used must be enriched by adding "roads" layers.

» and "places called". To complete the usefulness of this system, it would be interesting to add the legal texts which govern land ownership in Cameroon.

The results obtained are very encouraging for the continuation of the project. The study carried out during this period of work resulted in the creation of a prototype of the platform. This achievement highlighted web mapping technologies, particularly those of the free world.

We assessed the percentage of implementation of this system at approximately 95.41%. Improvements and additions to features can be made. However, the success of this project will depend on the one hand on the willingness of the public authorities to implement all the necessary means for the deployment of this system in the public services of the domain and the Cadastre, and, on the other hand, on the right use of this system by its users. Also, we know that this type of geoportal, which operates in certain cadastral services around the world, will be a way for the Cameroonian Cadastre to respond as quickly as possible to the various requests from both taxpayers and other users of the land chain.

In the same order of ideas,

· the monitoring of the processing of a technical file can be controlled. Therefore, this software will prevent loss of files.

The delivery of topographical extracts will be even more secure.

The cadastral files will be a little more secure.

Editing graphic media will be faster.

The possibility of reconstituting an archived technical file from the database is no longer an illusion.

Updating cadastral files and making them available in the database could improve the quality of the cadastral information obtained by the current GIS.

The possibility of saving the entire cadastral database on removable disk is a reality.

This dissertation work focused mainly on the design, but with a view to adopting this project, it would be relevant to also carry out a study on the cost of the latter, a study which would invest in the different pricing and of course in financing. which could come either:

· By the costs of submitting property title application files and the costs of the boundary sticker; · By the internal production of the land register.

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