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Geoportal of the Universidad Técnica del Norte for the visualization of geospatial information of thematic maps de Ecuador

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Pablo Andrés Landeta López, Jorge William Vásquez Rojas, Tatyana Katherine Saltos Echeverría, Xavier Mauricio Rea Peñafiel
Faculty for Engineering in Applied Sciences - Degree of Computer Engineering - Universidad Técnica del Norte, Ibarra – Ecuador
palandeta@utn.edu.ec, jwvasquez@utn.edu.ec, tksaltos@utn.edu.ec, mrea@utn.edu.ec

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ABSTRACT.

The implementation of a Geoportal has importance to Ecuadorian so- ciety since it allows to know the geospatial information of varying nature and application. The present research focuses on the development of a Geoportal which includes a map visualization where it is possible to see in detail the varied layers of important aspects of Ecuador. It allows the user to observe thematic maps according to diverse areas. The administrative module allows to manage the layers of the database by specifying to which topic they belong, therefore the process of generating and sample of the spatial information are automated. To implement the Geoportal, a platform with free software was used. Linux Centos 7 was selected as the base operating system. The technology used as map server was MapServer 7.0.1. For the map viewer, Pmapper 5 was chosen because of its ease of use and because it allows to include OpenLayer. Finally, the portal was developed using the Yii and Bootstrap framework. The research poses challenges to end users because when using this type of tools it is easy to obtain geospatial information very quickly.

Keywords. Spatial Data Infrastructure, Geographic Information System, Geo- portal, Pmapper, MapServer

Resumen. La implementación de un Geoportal tiene importancia para la sociedad ecuatoriana ya que permite conocer la información geoespacial de variada naturaleza y aplicación. La presente investigación se enfoca en el desarrollo de un Geoportal que incluye una visualización de mapas donde es posible ver en detalle las variadas capas de aspectos importantes del Ecuador. Permite al usuario observar mapas temáticos según diversas áreas. El módulo administrativo permite manejar las capas de la base de datos especificando a que tema pertenecen, por lo tanto el proceso de generación y muestreo de la información espacial son automatizados. Para la implementación del Geoportal se utilizó una plataforma con software libre. Se seleccionó Linux Centos 7 como sistema operativo base. La tecnología utilizada como servidor de mapas fue MapServer 7.0.1. Para el visor de mapas se eligió Pmapper 5 por su facilidad de uso y porque permite incluir OpenLayer. Por último, el portal se desarrolló utilizando el framework Yii y Bootstrap. La investigación plantea retos a los usuarios finales ya que al utilizar este tipo de herramientas es fácil obtener información geoespacial de forma muy rápida.

Palabras clave. Infraestructura de Datos Espaciales, Sistema de Información Geográfica, Geoportal, Pmapper, MapServer

Autor de correspondencia:
Pablo Landeta; palandeta@utn.edu.ec

Introduction

The advancement of internet technologies allows for the rapid growth of GIS (Geo- graphic Information Systems), which has then allowed a collection of information to be disseminated around the globe. [1].

It is in thus that learning the location and characteristics of places and regions on a map is an activity made possible thanks to the comparison and visualization of information and geospatial data. This has now become an important aspect in the deci- sion making at the local, regional and national level.

To make geographical decisions, spatial analysis is needed to understand the envi- ronment through the use of analytic and visualization tools that synthesize the refer- enced information. These tasks are very complex because they must perform an exam- ination of patterns and processes; including the interaction between space and time. This is one of many examples of the advantages of the use of GIS in the sciences. [2]

The integration of spatial data and GIS should be applied to a wide frame so that these could be useful to a diversity of users (individuals, groups and organizations, at national and international levels). One of the requirements posed by the Spatial Data Infrastructure (SDI) consist of the capacity to work with spatial data produced by others and look beyond the data models and technological dimensions. In this respect, the SDIs have proved to be innovative and many governments have launched important initiatives in this field. [3].

The following article is oriented towards the comparison of geospatial information of Ecuador and all its provinces. Therefore, it constitutes a significant tool to understand the basic aspects of the development in the territory regarding economic, social, cul- tural, demographic issues, among others.

The main goal of the present study is the development of a Geoportal in Universidad Técnica del Norte with the support of students and teachers of the university and with the use of free software that will be used for the analysis of geographic information that allows local and regional.

FOUNDATION

Spatial Data Infrastructure (SDI)

The Spatial Data Infrastructure (SDI) consists of a system comprised of a gamut of resources of varying nature (data, software, hardware, metadata, services, standards, personal, organizations, legal framework, agreements, policies, users, etc.), established with the intention of sharing Geospatial Information (GI) through the web as efficiently and simple as possible. [4]

The SDI, sometimes called Geographic Information Infrastructure (GII), consists of a virtual structure in the integrated network comprised of data and geographic infor- mation services (described through their metadata). Access to this infrastructure occurs through the internet following standards and agreements (mutually shared) which reg- ulate and guarantee the interoperability of the geographic information [5]. Fig 1 shows the elements of an SDI.

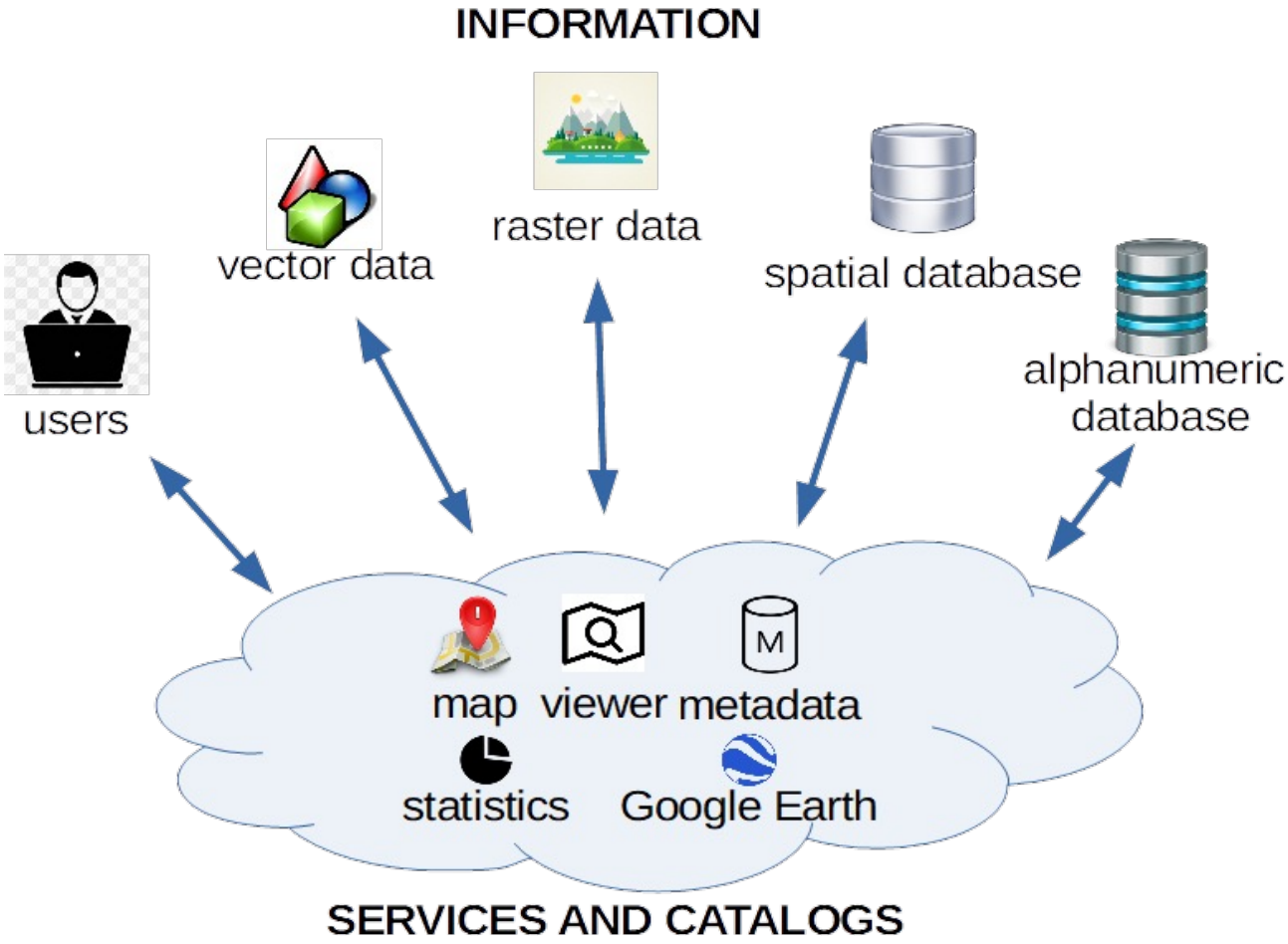

Fig. 1. Elements of an SDI [5]

Spatial Database

The Geographic Information Systems are designed with the purpose of managing and analyzing the spatial data presented in graphic form. This data is presented in layers and can be presented over a map for better visualization. [6]

The Metadata

The data over data are known as geospatial metadata, which describe the content, quality and origins of the geospatial data. The presentation of metadata is fundamental to the process of submitting data online as it allows the users to find, understand and reuse sets of data produced by others. [7]

Geoservices of an SDI

Open Geospatial Consortium (OGC) is an international organism that establishes the standards for SIGs (Spanish acronym for Graphical Information Systems) with the goal of ensuring that the special data is more interchangeable across the web. [8].

OWS (OCG Web Services) are standards created by OCG and used in web applica- tions. The proper distribution of the data is ensured by OWS via the HTTP protocol and request-response sending methods commonly using XML. The most significant stand- ards in this context are [9]:

Web Map Services (WMS): Used to create maps dynamically and which are generally presented in raster format (JPEG, PNG, etc.).

Web Feature Services (WFS): They are interfaces for the data access operations.

Catalogue Services (CSW): They are services used for geo data publication and search based on available metadata.

MATERIALS AND METHODS

For the development of this project, applied research has been used, since the geoportal is intended to be matured to be used with layers that show the reality from the local and regional geographic scope.

Tools

Free open source tools were used for the implementation of this research. They are briefly presented below:

1. Server Operating System: The Centos 7 operating system was installed in the server [10].

2. Database: PostgreSQL 9.5 was the database engine used [11] and the PostGIS 9.2 module was used for the support of geographical objects for the object-relation database PostgreSQL [12]

3. Spatial data management software: The free to use software QGIS 2.14.5 was used to create the maps. It also includes a plugin to export information to map format. It should be noted that the connection from the database to this manager was config- ured in a way that allows the spatial and alphanumeric data to be available directly from the database.

4. Map and spatial data web publication platform: Mapserver 7.0.1[13] was selected as the main map server.

5. Map visualization framework: Pmapper 5[14] was used. This is a framework that fuses perfectly with Mapserver and that is based in the PHP programming language and also in MapScript.

6. Programming language for portal development: The main portal was developed us- ing the PHP language and the MVC (Model View Controller) architecture. The improved presentation for the portal module was made with the Bootstrap frame- work with the goal of integrating the HTML5 technology.

7. Administrative module framework: The development of the administrative module was done using the Yii object-oriented framework which works in the MVC archi- tecture and allows the automatic generation of code for the CRUD (Create, Read, Update and Delete) applications needed for the administration of layers for the UTN Geoportal.

Map visualizer architecture development

MapServer is the center of the architecture for map visualization which connects with Pmapper with the goal of coordinating the presentation of maps obtained from Postgis, OpenStreetMap, and Google. The geospatial information is presented using the Apache server via the Mapscript module for the PHP language. The information is presented to the user via a web browser. Fig. 2 shows the map visualization architecture.

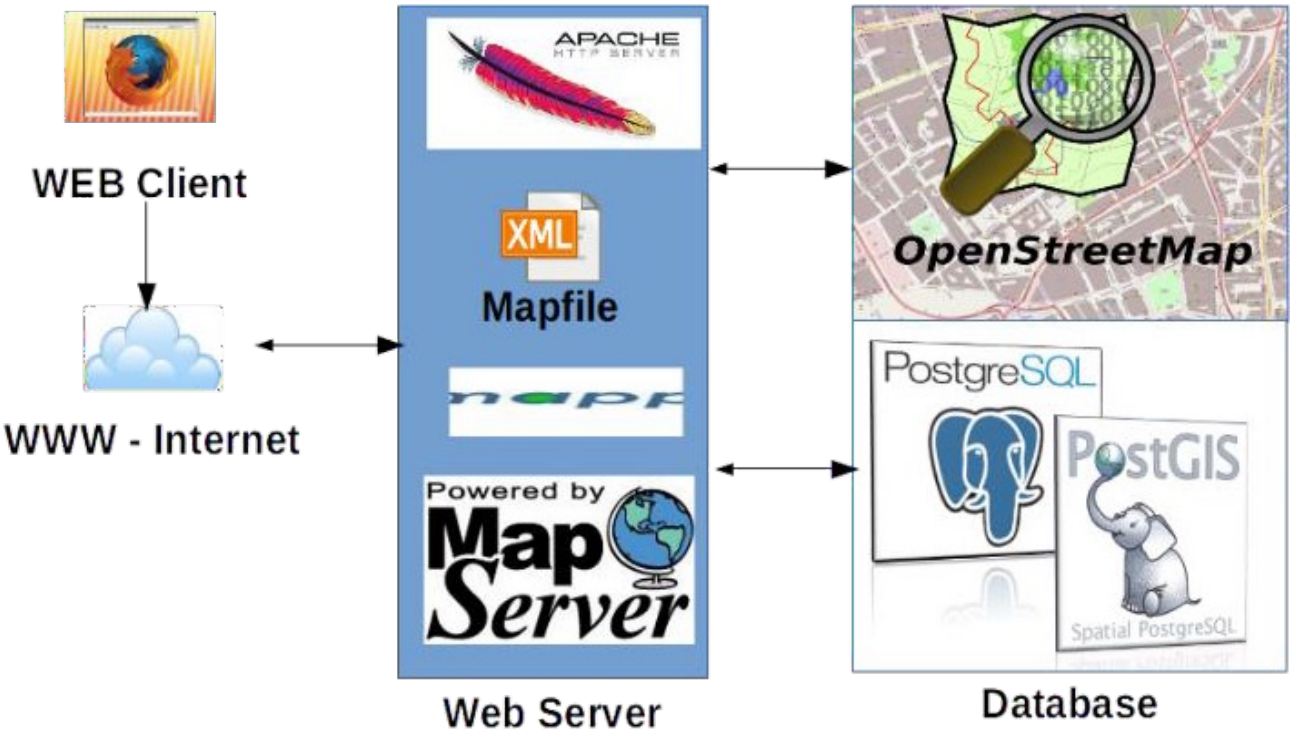

Fig. 2. Map visualization architecture

3.3 Geoportal architecture design

The architecture used to implement the Geoportal is MVC. The user makes a request using a web browser and communicates with MVC. This Controller then calls the Model looking for entities that are obtained directly from the Database. The information is returned to the Controller which processes the response and sends the data to the Viewer giving the user the requested information. Fig. 3 shows the Geoportal Archi- tecture.

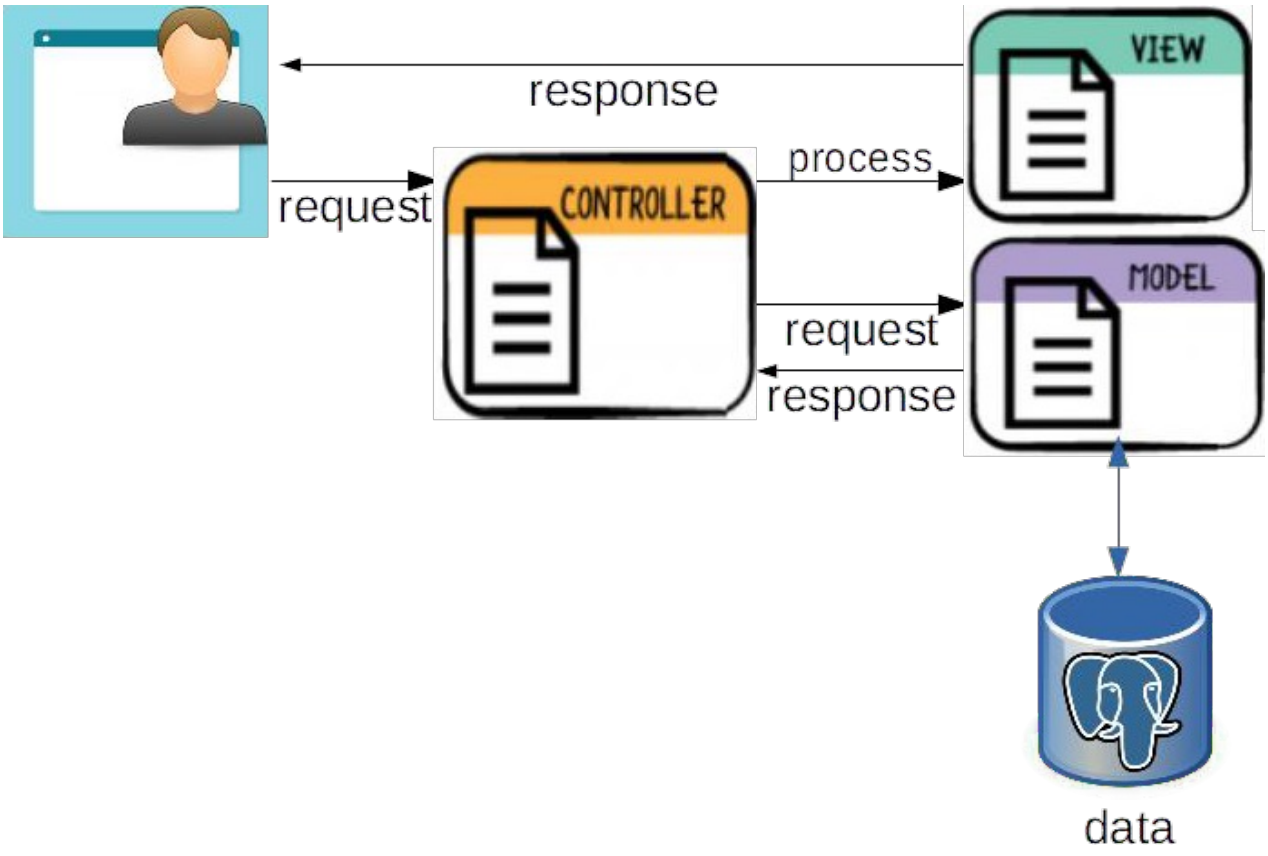

Fig. 3. Geoportal Architecture

Data model design

The catalog module allows the storage of information of spatial layers to allow for the automatic generation of the XML files conforming with the menu that each user con- tains. The generation takes place via stored processes. Fig. 4 shows the model for cat- alog database. This model allows the creation of geographic catalogs to organize infor- mation in an orderly manner by themes and categories.

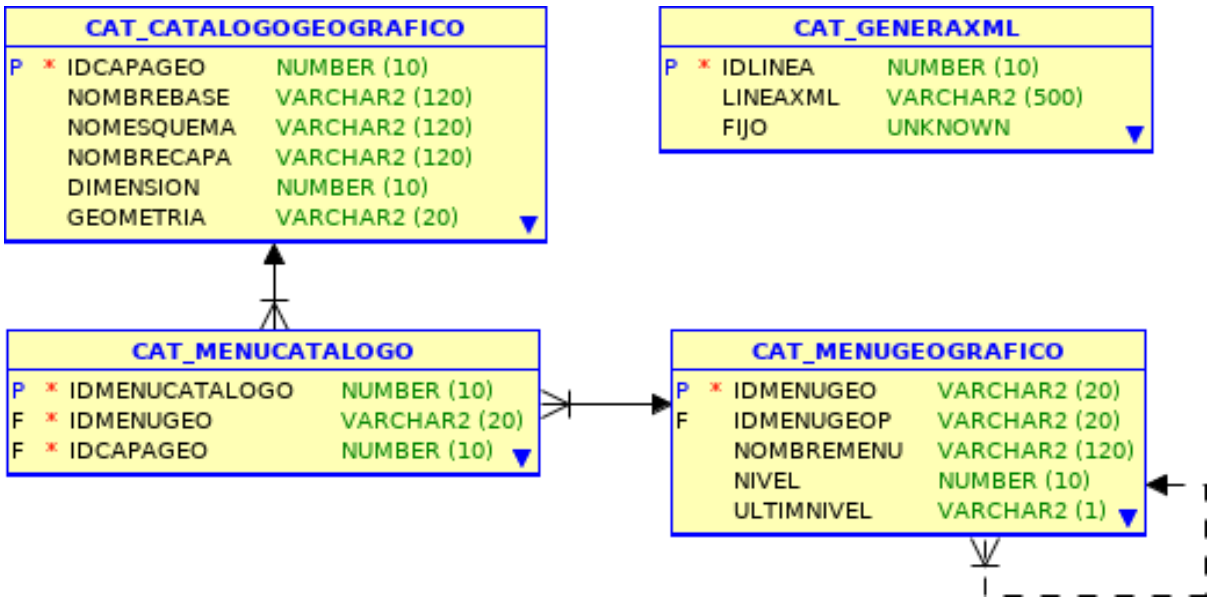

Fig. 4. Model for the Catalog Database

The linking model for the imported geographic layers to the database was also designed in contrast with the standardized alphanumeric information. Fig 5 shows the model used to deploy the layers of Ecuador with a political division by provinces.

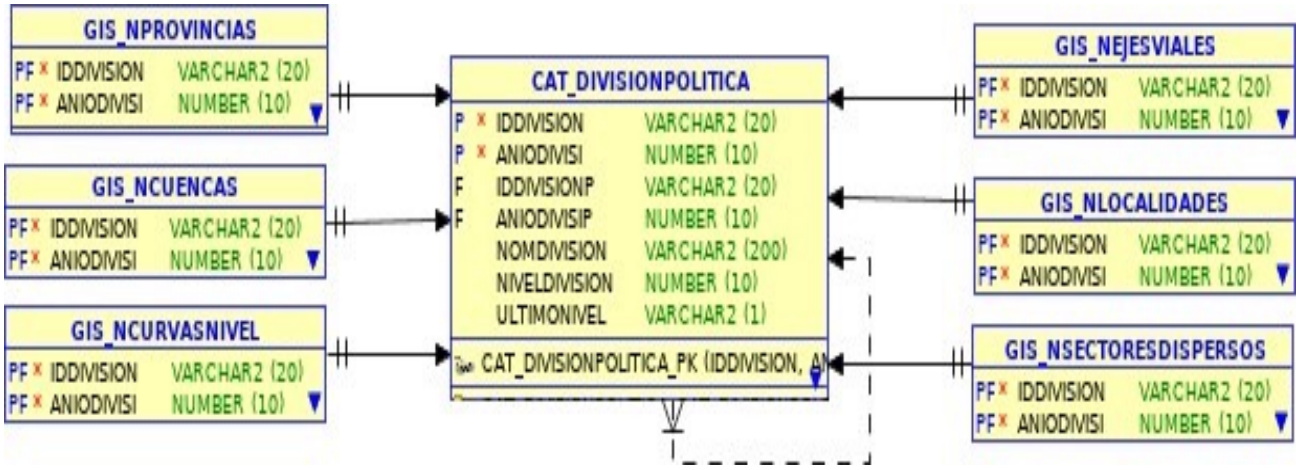

Fig. 5. Model Database for National Layer

Platform implementation

The next procedure was used during testing: i) installation of Linux Centos 7 in a server,

ii) installation and configuration of the Apache server, iii) installation and configuration of PostgreSQL and PostGIS, iv) database creation in PostgreSQL, v) loading of infor- mation to the database from Quantum GIS, vi) installation and configuration of MapS- erver, vii) installation and configuration of Pmapper, viii) development of the Geoportal on the PHP language.

RESULTS

Verification of the visualizer operation

When the configuration of the map visualization platform was completed, its proper operation is then tested. In Fig. 6 below, the options menu can be observed with the different layers stored in the database and the layers based on Google and Open- StreetMaps. The map is located in the center of the visualizer.

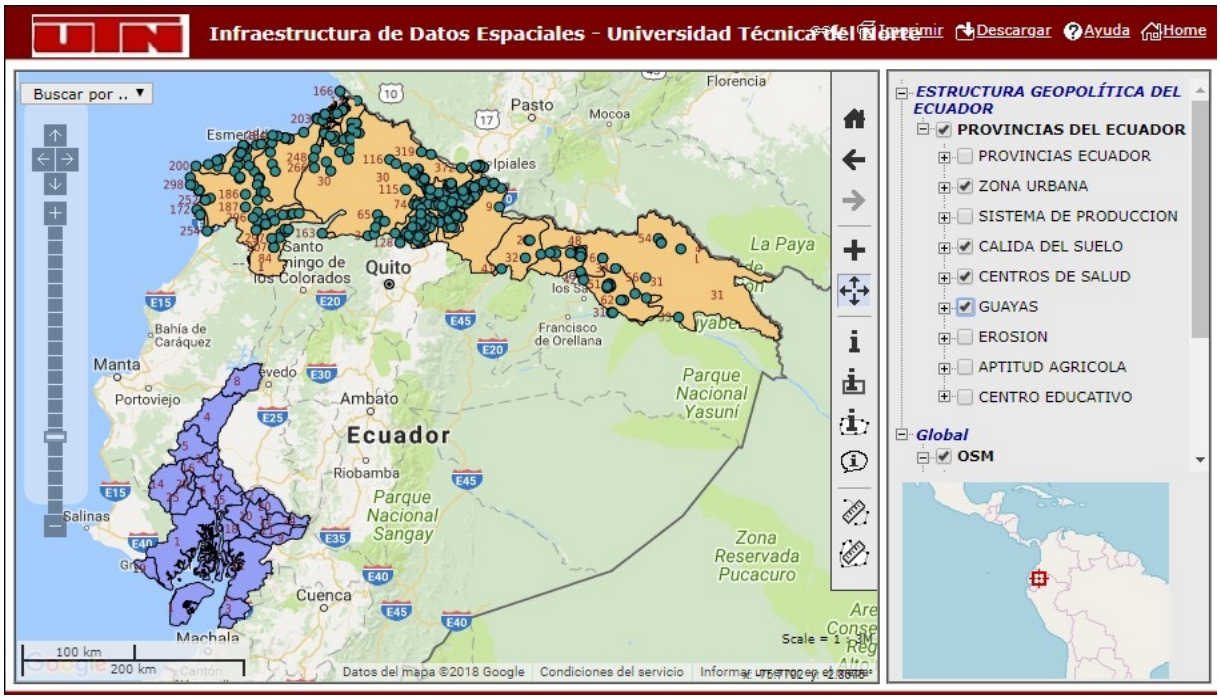

Fig. 6. SDI UTN Visualizer

Verification of the Geoportal operation

Once the Geoportal was developed with the MVC architecture, its verification then follows which determines the completion of the automatization required for the topical maps. This achieves that the application configures the file config_default.xml with the layers desired by the user. Fig. 7 shows the structure of a geographic catalog ordered by topics where it is possible to choose the layers to be visualized.

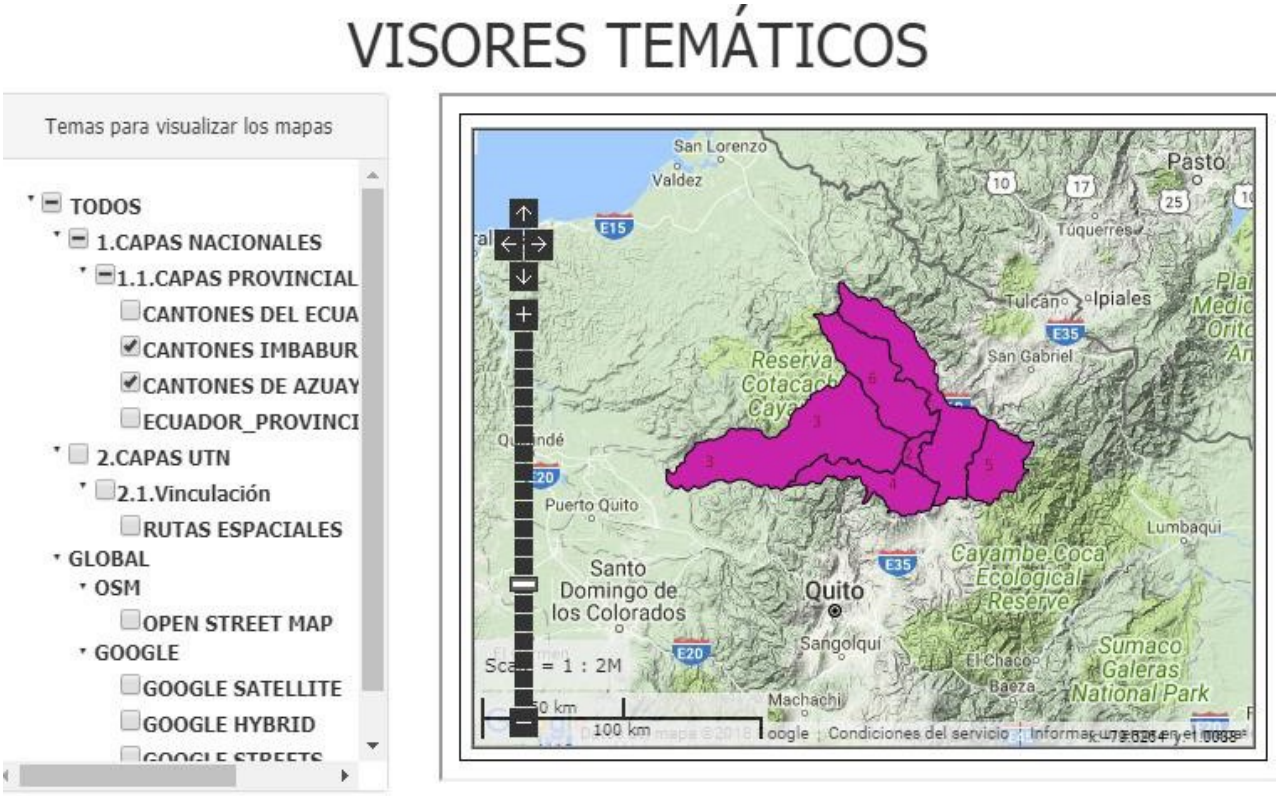

Fig. 7. SDI UTN Geoportal

Verification of the Geoportal Administration Module

Finally, the corresponding administrative module tests are run to manage the layers in a centralized manner without the need of the spatial data manager QGIS. Fig. 8 shows part of the administrative module, which allows the management of geographic cata- logs.

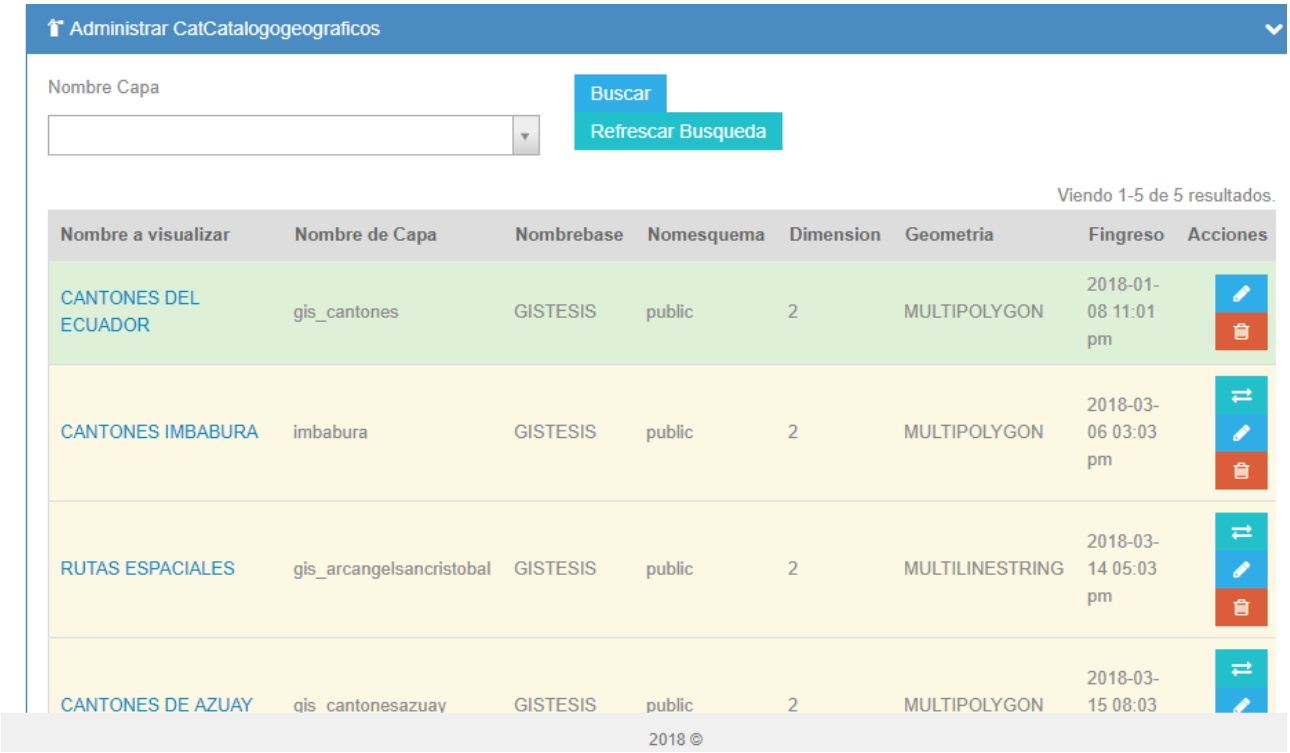

Fig. 8. UTN Geoportal Administrative Module.

DISCUSSION

Based on the obtained results, it can be observed that this tool has a significant impact in information acquisition because reality is reflected in a visual form rather than in text form. A fundamental factor of the research corresponds to the automation of the gener- ation of the XML and MAP files based on the layers that a user uploads to the database. The xml file allows to display geographic catalogs in an orderly way, while the MAP file allows you to save data from the geographical layers that have been uploaded to the platform. This allows to automate the platform, because to update the catalogs it is not necessary to directly manipulate the information in the database, to do this, from the administrative tool these catalogs can be updated. In the same way, the layers that are uploaded to the platform update the MAP file automatically and the layers can be dis- played in a correct way.

Finally, it is noted that the map server MapServer and the visualizer based on Pmap- per performed in acceptable way against the parameters with which they were config- ured.

RELATED WORKS

In the academic and scientific communities there exists a great deal of interest in creat- ing projects that publicly expose the geographical information of the different localities. A work worth mentioning is one done in the Bari Polytechnic [15]. In it, Mapserver is used along with Pmapper to demonstrate the map visualizer, show pollution infor- mation, and monitor the weather in the Puglia region in Italy.

Another research paper that brings value is one proposed by researchers in India [16]. They utilize an open source GIS system with agricultural purposes such that the population can determine with detail how the plantations are distributed as well as the climate parameters needed for their crops.

A comparable work is the research presented by a team in Nagarjuna, India [17], who uses MapServer and Pmapper to show maps regarding the quality of underground water and its contaminants which allows for the proposal of future solutions to this problem.

In the work proposed by professionals in the Zhongzhou University in China [1]. They have created an SDI to expose information regarding the education system of the area so that the education centers can be clearly identified.

7 CONCLUSIONS AND FUTURE WORK

Through this research, it is shown that the automatic generation of XML and MAP files is possible using stored processes. Likewise, the visualization of the topical maps al- lows the user to choose the desired information to be viewed from the set of stored topics.

Another aspect to be considered is that the technologies OpenStreetMap and Google Street Maps can recreate the maps in a more user-friendly form.

This paper proposes, for future research, the analysis required to be able to incorpo- rate layers with georeferenced points with the goal of learning the exact location of specific sites in Ecuador which is part of this study. This way, these layers can be shown in the UTN Geoportal and contribute to research in different subjects.

Additionally, it is recommended that another investigation is performed which would consist of incorporating raster type images raised and shown in vector form. To obtain a better resolution for these types of images along with lower cost, unmanned aerial vehicles (UAV) or drones can be used.

Another investigation needed in the future is the incorporation of additional detailed standards in the OCG such as WMS (Web Map Service), WFS (Web Feature Service), etc. This in order to add value to the platform and provide new services for local and regional development and benefit.

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