Journal of Coastal Research	SI 56	1504 - 1507	ICS2009 (Proceedings)	Portugal	ISSN 0749-0258

Modelling and Development of a Web System for Analysis and Manipulation of Spatial Data for Coastal Areas of the Rio Grande do Norte State, RN, Brazil

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ABSTRACT

FREITAS, C.C.M. de, AMARO V.E., CASTRO, A.F. de, JUNIOR, W.S. and OLIVEIRA, G.F., 2009. Modelling and development of a web system for analysis and manipulation of spatial data for coastal areas of the Rio Grande do Norte state, RN, Brazil. Journal of Coastal Research, SI 56 (Proceedings of the 10th International Coastal Symposium) 1504 – 1507. Lisbon, Portugal, ISSN 0749-0258.

The Northern coast of Rio Grande do Norte (RN) State is characterized by an intense coastal dynamics compared to other Brazilian coastal regions. In this area are installed the main socioeconomic activities of the RN State (the oil industry, salt companies and shrimp farms). The oil industry is the most affected by this dynamic that causes strong erosion on the shore and exposure of wells and pipelines installed along of the beach. This feature justifies the integration of multidisciplinary and detailed scientific studies to evaluate the evolution of the coastal environment. The main objective of this work is to develop an intelligent computational system where the main element is a Geographic Database with spatial data of the study area. Furthermore, the OpenSource technologies were included in the development of a Web system like: GeoServer as framework of the view; PostgreSQL as DataBase Management System; PostGIS spatial extension, and the Apache Web Server. This specific software architecture, allowed remote access to spatial and alphanumeric data of the RN State.

ADITIONAL INDEX WORDS: *Geographic database, geographic information system, coastal areas.*

INTRODUCTION

Databases treating environmental subjects are of increasing interest to the scientific community. Due to the constant expansion of human activities a consciousness about the importance of environmental studies has been improved. In this instance, the geoprocessing arises as a powerful tool to aid in rapid and effective treatment of environmental data to increase the implementation of such data processing methods and ensuring reliability of achieved results. This work aims to build an intelligent computational system web-based that allowed the remote access to spatial and alphanumeric of a geographic database for the northern coast of the Rio Grande do Norte State, Northeast Brazil.

The location of the Guamaré Petroliferous Pole and other industrial facilities in this area marked by strong dynamic coastal process justifies the development of an environmental database with geographic information system (GIS) to support decision-makers. It is functional to the environmental monitoring and risk assessment of areas where activities of prospecting, exploration and transport of oil occur. This environmental database will facilitate comparative studies of change over time and comparisons of one location to another. The database could be queried by different sorts of themes linked to effective environmental studies and in addition be available through the Web, so it would be accessible to specialists and the general public.

CHARACTERIZATION OF THE AREA

The study area is inserted in located in northeast Brazil, in the northern portion of the Rio Grande do Norte State involving counties of Macau, Guamaré and São Bento do Norte (Figure 1).

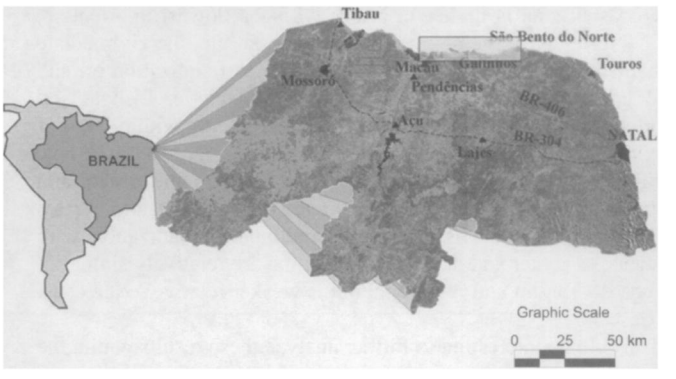

Figure 1. Location of the Study Area.

The local geological context is the domain of Potiguar Basin that allowed recognizing mainly its lithological units of fluvial sandstones of the Açu Formation (Cretaceous) and carbonate rocks correlated to the Jandaíra Formation (Late Cretaceous). These units are covered by the siliciclastic Barreiras Group (Tertiary) that prevails along the cliffs in vertical and lateral extent. Nearly to the coastal zone the covertures represent cenozoic deposits from coastal deposits systems as dunes, beaches, lagoons and tidal flats (CALDAS et al., 2006). The soil face is mostly composed by levels of sand and clay-sand soil that recover the cretaceous and tertiary rocks. In estuarine and tidal flats present systems dominate clay-sand alluvium with organic matter.

The geomorphology has a monotonous landscape near the coast marked by broad estuaries, tidal flats and marine cliffs type caused by directly wave action. The area is strongly affected by deposition and erosion coastal processes caused by wind, currents, waves and tides action (TABOSA et al., 2002).

METHODOLOGICAL APPROACH

According to Bahr and Karlsuhe (1999) geoprocessing can be used as a tool for management and control planning of environment as well as for decision support. It can be seen as the joint of a georeferenced database with techniques for acquisition, updating, processing and displaying results. Thus, it is not only the acquisition and data processing, but also a decision-making support system. The geoprocessing tools support the most complex decisions. Such tools like Geographic Information Systems (GIS) aid on the spatial analysis because it has the capacity for integration of alphanumeric data and geographic spatial data, thereby providing a basis for coherent analysis. In this way it is possible to access information from an area both by geographical location or its descriptive information. This paper focus in the main storage component of the GIS, the geographic database (GeoDB) and a web interface to access the data therein.

The development of the WEB system passes through processes of software engineering which follow a few steps (Figure 2).

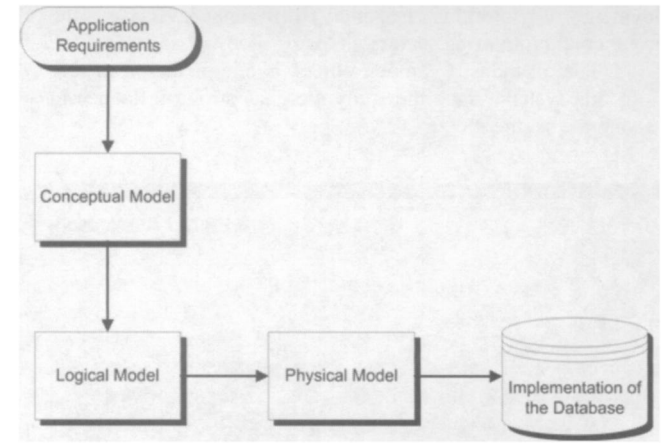

Figure 2.Development phases of a Web system.

Originally the first step is the conceptual model to determine which data to be stored. At this point, it is necessary to identify all objects in the real world, through a general description of these objects and their interrelationship. As a second step the logic model that aims to specify how the data will be represented computationally, a breakdown of how individual information will be stored in the system. Finally the physical model which is the implementation of previous models in computer system engineering. From the physical model we determine the architecture and technologies involved. OpenSource technologies as these technologies enable the customization of routines, and reduce costs with licensing of software. The Model-view-controller (MVC) was the chosen architectural pattern for software engineering. The main advantage of these patterns is that can isolate logic from user interface concern resulting in a welcoming application to modify either the visual form of the application or the underlying business rules. The model represents the information of the application, the view corresponds to elements of the user interface and the controller manages the communication of data and the business rules used to manipulate the data to and from the model (Figure 3).

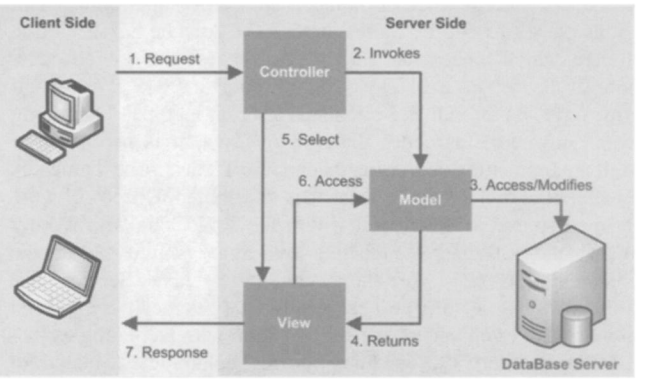

Figure 3. Diagram of MVC Architecture applied as a pattern to the system.

RESULTS

Adopting the methodological strategy of modeling the intelligent computational system created has the ability to sustain decision-making with more precise and updated results by web. After combining the technologies proposed, the system is able of accessing data stored in a GeoDB which provide a qualitative and quantitative, alphanumeric and spatial dataset query of the area.

Geographic Database (Geodb)

The general databases storage information from the real world and determine share conditions by a specific application. A database can be defined as a set of files structured in order to facilitate access to collections of information that describe certain entities of the real world. The concept of non-conventional database emerged from new data types (for instance, graphics, images, sounds, among others) actually used to describe environmental entities in the real world.

GeoDB belongs to the category of non-conventional databases and is characterized not only by data storage but also by their relationship with geographical positions. Mostly of GeoDB is part of a larger computational technology implicated in GIS.

The PostgreSQL was the chosen system database manager (DBMS) opensource that has support for standard SQL. In its context have all the features of the major DBMS such as complex commands, foreign keys, triggers, views, transactional integrity and control of simultaneity multiversion. It supports many programming languages, as Java, PHP, Perl and Python among others. Its constant development is done by developers from around the world (PostgreSQL Global Development Group 2005).

It has also a spatial extent, the PostGIS, which expands its capacity for storage and data management space. It has the architecture compatible with the specification of the Open GIS Consortium (OGC). This consortium is the architecture that defines the standard for the construction of GIS (BUEHLER & MCKEE, 1998).

Webserver Apache And Application Server Tomcat

As the web servers are the backbone of the Internet they serve as a basis for any kind of web application. In future, this trend should be accentuated, with dynamic web pages and web applications increasingly replacing the desktop applications. As a webserver, Apache is the most known and used. The reasons include its excellent performance, safety, compatibility with various platforms and all its resources. The Apache Server is free software which means that anyone can access the source code. The Apache server is able to execute code in PHP, Perl, Shell Script and even in ASP and can act as a server FTP, HTTP, among others. However, for codes that run on Java, it is necessary to install an application server in Apache, the Tomcat. The Tomcat is a Java application server to web. It is distributed as free software and open source as developed within the Apache Jakarta worthy project and officially endorsed by Sun as the Reference Implementation (RI) for the technologies Java Servlet and JavaServer Pages (JSP). Technically the Tomcat is a Web container, covering part of the specification with technologies like J2EE Servlet and JSP, and supporting technologies related to security and Realms, jndi Resources and JDBC DataSource. The Tomcat has the ability to act as a web server / HTTP, or can function integrated to a dedicated web server such as Apache HTTPD or Microsoft IIS. Some of the advantages of Java programming language is the fact that it is architecturally neutral, which means that you can use the Java programming language to write a program that will run on any platform, and it is a object-oriented languages (FARRELL, 1999; KNUDSEN & NIEMEYER, 2005). GeoServer is an open source software server written as a plugin of Java that allows users to share and edit geospatial data. Designed for interoperability, it publishes data from any major spatial data source using open standards and forms a core component of the Geospatial Web. GeoServer is the reference implementation of the Open Geospatial Consortium (OGC) Web Feature Service (WFS) and Web Coverage Service (WCS) standards, as well as a high performance certified compliant Web Map Service (WMS).

Figure 4 illustrates the integrated architecture to the computational system tools. The repository of data and metadata is maintained by PostgreSQL and PostGIS systems. GeoServer plugin let the visualization of data. This tool offer spatial data in diverse formats, providing the user the interoperability. Finally, the Apache allows users to view and analyze spatial data in interactive maps without necessarily having to download.

The environmental dataset derived from multivariate sources. Consequently, the model structure aims to fulfill some requirement without much change in the system according to standards set by the OGC. The next step aims to integrate the model with the viewer Geoserver, which established a class structure thus generating the application to be viewed by the user.Since the GeoDB interpretates the web server request, it sends the filtered resulting data to Geoserver that display and send it to the web server, which in turn will provide for the user. The user requests will use forms through application protocols (HTTP Request), but at the end of the process, the web server responds with the response protocols (HTTP Response).

CONCLUSIONS

The development of this work accomplishes some significant conclusions:

- The use of GIS proved to be essential because of the possibility of displaying the most diverse types of data, such as tables, graphs, images, maps, photographs, among others.
- An essential key component is the GeoDB because it is responsible for the storage and retrieval of geographical information.
- The conceptual modeling is an important step in GeoDB construction since in this stage defined the requirements and the entire structure of the data to be stored and their interrelationships.
- The proposal modeling can be applied to support environmental monitoring of any area performing studies that require this technology.
- The adopted technology is a robust applicative, manageable, customizable and at low cost, which enables the deployment of solutions in many different levels of the environmental monitoring sectors.
- The oil industry, among others, is one of the promising users to this system, since the study area has strong influence in this economic segment.

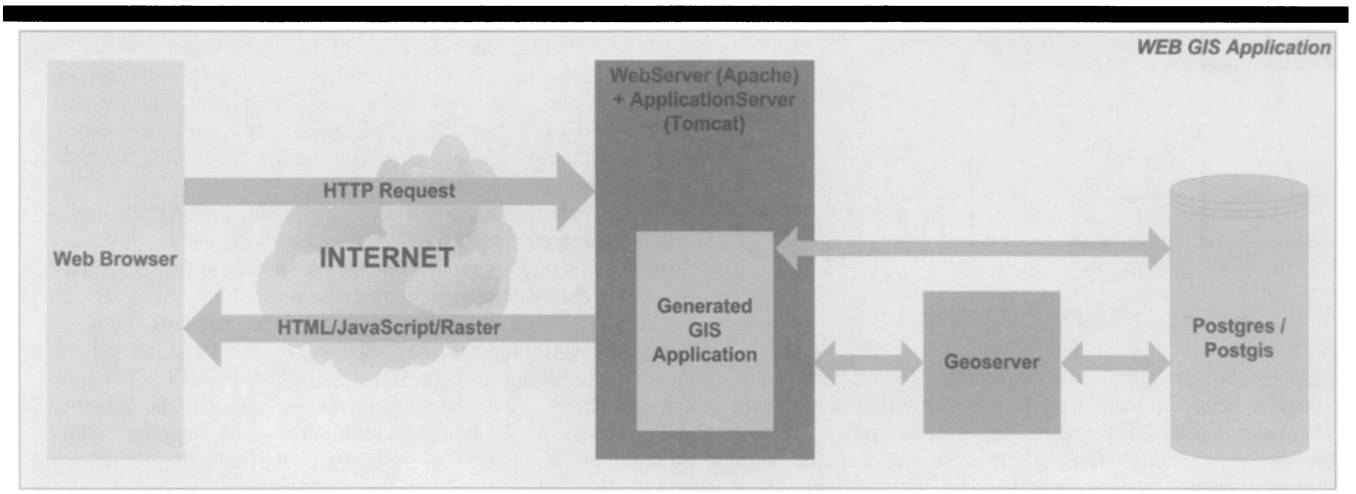

Figure 4. Schematic implementation diagram involving the technologies proposed to this work.

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ACKNOWLEDGEMENTS

The authors thank Project Environmental Monitoring of Risk Areas to Oil Spill and its Derivatives (PETRORISCO, FINEP/PETROBRAS/CNPq) and Project Monitoring the Environmental Changes and Hydrodynamic Influence in Beach Morphodynamic on the Serra-Macau Oil Field, Potiguar Basin (HIDROSEMA,FINEP/PETROBRAS/CNPq) for the financial support, as well as the National Council of Technological and Scientific Development (CNPq) by the scholarship to one of the authors.