Available online at www.humg.edu.vn

ESASGD 2016

GIS-IDEAS (2016)

Conference Title: International Conference on GeoInformatics for Spatial-Infrastructure Development in Earth & Allied Sciences (GIS-IDEAS)

A WebGIS System To Support Sustainable Development In Tay Nguyen

Nguyen Truong Xuan[1], Nguyen Thi Mai Dung[1], Dinh Bao Ngoc[1], Nguyen Dinh Ky[2], Le Thi Kim Thoa[2]

[1]*Hanoi University of Mining and Geology, 18 PhoVien, BacTuLiem, Hanoi, Vietnam*
[2]*Institute of Geography – Vietnam Academy of Science and Technology, 18 HoangQuocViet, CauGiay, Hanoi, Vietnam*

Abstract

Nowadays, WebGIS appears as important management tools in regard to monitoring, decision-making help and planning. This paper designed and developed the TayNguyen WebGIS to provide online access to information to support socio - economic and natural resource management. The web offers both digital geospatial data and information, incorporating text and multimedia elements, related to natural and man-made environment, biological environment, socio-economic and management in TayNguyen. Integrating the latest advances in web-based mapping techniques, the web is built around an interactive map, which allows anyone to identify, visualize, and query those datasets relevant to their interests. The TayNguyen WebGIS comprises of a number of tools and information on TayNguyen areas, thus providing the best single resource for finding and viewing existing TayNguyen data.

Keywords: TayNguyen, WebGIS, Web Atlas, Sustainable Development

1. Introduction

Geographic Information Systems (GIS) are not only a way of visualizing and analyzing data, but also of organizing both spatial and non-spatial information based on where the data were gathered, thereby providing a common field for database records. Combining the power of GIS and the Internet, WebGIS can be used to store data and help users to both enter and access information without the need for expensive GIS software, using any Web browser at virtually any time. This increased ease of access to information about natural resources and social-economic could further enhance public involvement in sustainable development.

Web GIS provides GIS users easy access to geographic information data, spatial information and GIS modeling and processing tools. It provides an open and distributed architecture for disseminating geospatial data and web processing tools on the Internet. This makes it easier for larger organizations to distribute maps and tools without time and cost restrictions to the end user. To provide a successful Enterprise Web GIS Solution, it is required to understand the complexity of the implementation as a process rather than a step (Alesheikh, Helali & Behroz, 2002).

WebGIS makes dynamic mapping available via the Internet. Targeted towards mid-level users, it allows people to access geographic information in data layers that may be turned off and on, mapping tools, and analytical tools as well. WebGIS applications usually depend on a combination of HTML (HyperText Markup Language), CSS (Cascading Style Sheet), Javascript and C# (ASP.NET) languages to provide users with Internet access to data that resides on a server. Most WebGIS design packages, such as the ArcGIS Server from the Environmental Systems Research Institute (ESRI), provide a combination of map design and server

software that can be used to build a customizable application.

In this paper, we set a goal of designing and implementing a WebGIS system - the Tay Nguyen Web Atlas - centralizing data on natural resources, environment and socio-economic areas of a region and serve as a tool for analysis and decision support throughout the many treatments and uses for which it could lend.

Implementing WebGIS not only facilitates the access and visualization of the existing data, but also facilitates the wide sharing of the data and effective use of the data, and therefore creates a more efficient system for the planning, management, and maintenance of the socio-economy, environment and natural resources.

2. ESRI ArcGIS Server

This section addresses proposed solutions to the problem and why ArcGIS Server was selected as a tool to develop the web-GIS application for this project.

The main advantages of sharing GIS resources on a GIS server are the same as sharing any data through any kind of server technology: the data is centrally managed, supports multiple users, and provides clients with the most up-to-date information.

ArcGIS for Server is software that makes your geographic information available to others in your organization and optionally anyone with an Internet connection. This is accomplished through web services, which allow a powerful server computer to receive and process requests for information sent by other devices. ArcGIS for Server opens your GIS to tablets, smartphones, laptops, desktop workstations, and any other devices that can connect to web services (ESRI, 2016).

Web applications that can be built in ArcGIS Server vary from a very simple out-of-the- box website that uses pre-defined defaults settings, to a more advanced custom website with multiple functionalities including editing data online. Table 1 summarizes the three main services and the associated functionalities that ArcGIS Server offers: displaying data, providing functionality, and providing data. Although not all of the ArcGIS Server functionalities were utilized, the ArcGIS Server online mapping application was chosen due to technology advancement and broader possibilities for future website development.

It is very important that the software products chosen integrate well within the enterprise workflow and enable staff to work with them seamlessly. Otherwise, it will have an adverse impact on the efficiency of enterprise operations, productivity, and project deliverables. This is one of the reasons to add ArcGIS Server and into our map server mix.

One other aspect of workflow we considered is the ability to support data management and editing in a multi user environment where large team of data analysts and editors work on the same data development project. ArcGIS Server and desktop tools with Oracle/ArcSDE data server supports this feature.

The ESRI framework is very tightly integrated and provides end to end solutions in GIS. Hence it provides ease in development starting from data preparation and processing using Arc Desktop tools, followed by publishing services through ArcGIS Server Manager Interface or ArcCatalog. Finally it provides several client development frameworks such as Web ADF, ArcGIS API for JavaScript, etc. Updating or editing existing data can be tricky; depending on the scale of the change the server may or may not pick up the changes. In these cases the server is forced to refresh or restart.

3. System Design and Implementation

3.1. Conceptual frameworks

The system architecture consists of three components: data acquisition, geodatabase design, and web GIS application. This project was designed as a three-phase process focusing on one component per phase. The entire system was built around ESRI's ArcGIS desktop application and ArcGIS Server technology.

- Phase One: Data Acquisition

The logical first step was to identify spatial and non-spatial data pertinent to this project. First, data inventory on existing data was conducted. Field data then was collected in the study areas. Finally, data was digitized from satellite image and Internet sources for application development purposes.

In this system, there are many kinds of data which can be divided into three categories: natural resources (topography, geology, geomorphology, soils, hydrology, land use, vegetation and so on), environment (landslides, floods), socio-economic (infrastructure, settlements, population, socio-economic data…).

- Phase Two: Geodatabase Design

Building a website application that successfully displays data required the creation of a functional geodatabase. An enterprise geodatabase was created to store spatial data in a logical and organized fashion so that users can easily add and retrieve data. It was stored and managed in Microsoft SQL Server. Subtypes and

domain were applied within the file geodatabase. The geodatabase integrated information from various sources, including existing data, newly collected field data, and digitized data.

- Phase Three: Web-GIS Application

The next step focused on developing the web-GIS application. This web-GIS application was created to support sustainable development in Tay Nguyen areas by distributing spatial information online.

In developing the TayNguyen WebGIS, the back-end and front-end developments were simultaneously made. The primary technology used for storing and managing spatial data was ArcGIS Server.

User interface and experience design were the main points in front-end development. Using HTML and CSS, the application's interface was created. The website was designed to accommodate varying screen resolutions making it more accessible and device compatible.

With the use of JavaScript and jQuery, element behaviors were managed. The map functions and capabilities were scripted using different JavaScript plugins.

3.2. Functional Requirements

Below are functional requirements that were established to conduct this project.

Geodatabase Design

- The geodatabase must intelligently synchronize spatial data from multiple sources.
- All vector and raster data in the geodatabase must have the same projection (VN2000).
- All vector and raster data in the geodatabase must have metadata.
- Tabular data must have consistent naming convention.
- The domain table must be editable in Excel Spreadsheet to accommodate clients' needs.
- Subtypes, domains, topology, and relationships must be clearly defined.
- Editable and non-editable data must be clearly distinguished in the geodatabase.

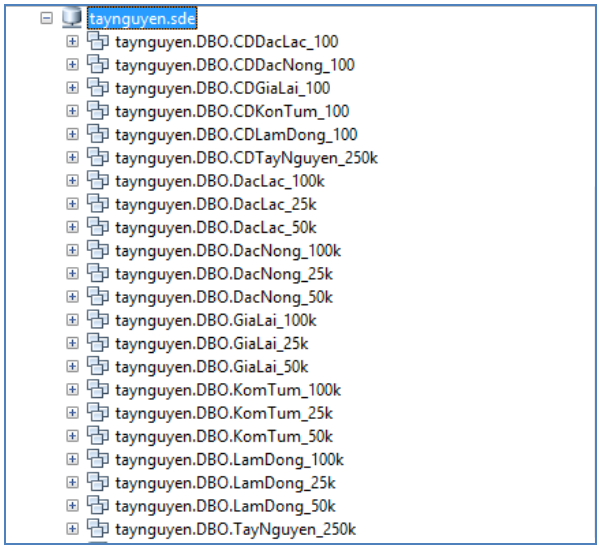

Fig. 1. (a) Enterprise Geodatabase of Tay Nguyen area

WebGIS Sercives

- The web interface will provide the audience about the environment, natural resources and socio-economy of region by displaying the following: an interactive map of the project site, table of contents that lists all the visible layers, data layers specified by the client, data layers with scale dependencies, links to external websites.
- The web interface will provide the Internet users with the following functionalities: basic tools (e.g., pan, zoom-in, zoom-out, identify, measure), turn on and off layers of interest, click on the photo points and retrieve associated images and information, auto zoom functionality into the user-specified ecotourism service location, auto zoom functionality into the user-specified trail.
- The web interface will allow Internet visitors to perform queries, create statistical analysis and report.

4. Tay Nguyen WebGIS Development

TayNguyen WebAtlas is composed of modules created for the backend, frontend and specific functions of the applications. The backend deals with server and data management while the frontend deals with the design and layout of the applications.

TayNguyen WebAtlas has five sections. They are: (1) the Home Section, landing page which displays a description of the project and the team, the partner organizations and institutions in the development and link of thematic map; (2) the Map Section, which presents a base map with corresponding functions such as pan, zoom, select, identify, etc. It also shows the help, which shows the manual and short description of each tool; (3) the Introduction Section, which descrips the general information of Tay Nguyen area;(4) the News Section, shows the related information with the project. (5) the Contact Section, which shows the contact information of the developers.

The website features were implemented containing the following tools:

- Layer Overlay –The user will be able to control which layers are visible.
- Legend –This will show the legend of the activated layers. The user can also turn off the legend of the active layer.
- Query – The query tool will have two other components, the site suitability calculator and the device to site identification tool.
- Map Tools – This will contain the other tools, which can be used by the client like point identification, zoom to extent, and print map.

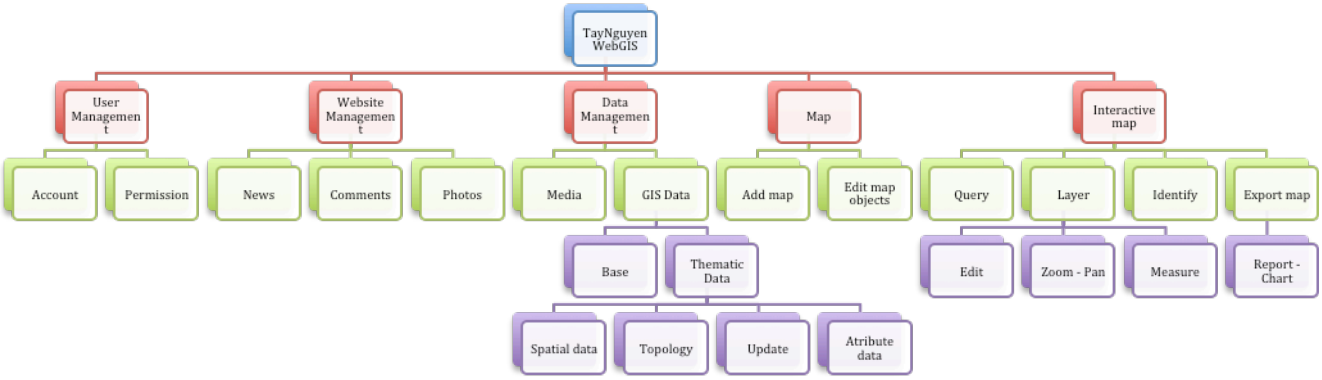

Fig. 2. Tay Nguyen WebGIS System: Business Function diagram

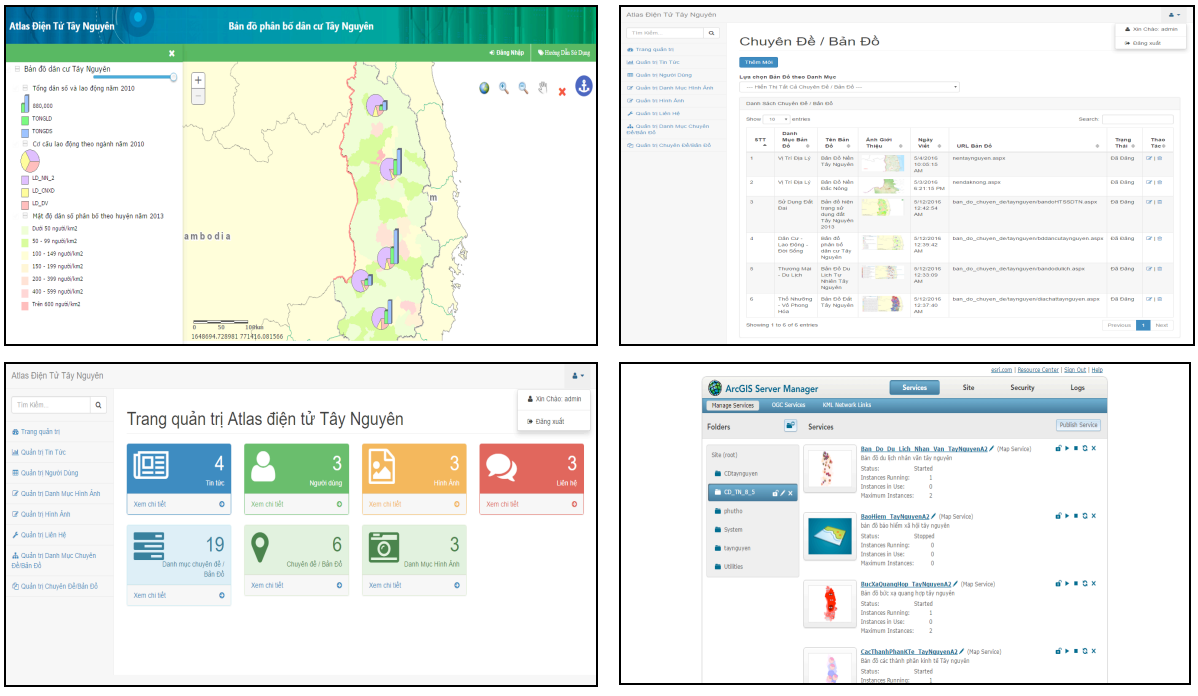

Fig. 3. Tay Nguyen WebGIS System (a) Map Display; (b) Map Management; (c) Administrator; (d) Map Services.

Fig. 4. Tay Nguyen WebGIS System

5. Conclusion

In the present paper, we described an approach for designing and generating WebGIS applications that combines the advantages of web-based mapping techniques. Developing a WebGIS-based tool such as Tay Nguyen WebGIS addresses the need for fast, easy access to multi-layered GIS data and tools to support sustainable development in TayNguyen area. The success system also access to the goal of Building GIS database and e-Atlas of TayNguyen area project, which belong to TAYNGUYEN-3 Program. Among the outputs of this study are base maps and thematic maps with considerations on physical, environmental and socio-economic factors. A result of the initial development shows that Tay Nguyen WebGIS is a promising tool for sustainable development. This will help experts and organizations plan the use of their natural resources and develop the socio-economy of region with more efficiency.

References

Adnan, L. P., 2010. *Developing Efficient Web-based GIS Applications*, UCL Centre for Advanced Spatial Analysis, vol. 153, p. 15.

Alesheikh AA., Helali H., Behroz HA., 2002. *Web GIS: Technologies and its Applications*. ISPRS Technical Commission IV Symposium 2002, Ottawa: Canada, p. 1-9.

Ky, N. D., Xuan, N. T., 2016. *Building GIS database and eAtlast in Tay Nguyen area*. T22/TN3, KHCN-TN3/11-15.

ESRI (2007a). *ArcGIS Server Manager Help (Version 9.2*) [Computer software]. Redlands, CA:

ESRI, 2016. http://server.arcgis.com/en/server/10.3/get-started/

Gkatzoflias, S. Z., 2012. *Development of a web GIS application for emissions inventory spatial*, Science Direct, p. 13.

Harper, E., 2006. *Open-Source Technologies in Web-Based GIS and Mapping*.

Li Qingxia, Qin Yong., 2008 *Design of WebGIS system based on service-oriented architecture*, Applied Science and Technology, vol. 35(8): p. 39-43.

http://help.arcgis.com/en/sdk/10.0/serveradf_net/conceptualhelp/index.html

Sèmiyou A. A. , Géraud A., 2013. *A WebGis System to Support Implementation of Sustainable Development Policies.* International Journal of Computer and Information Technology (ISSN: 2279 – 0764) Volume 02– Issue 04, July.