

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<sup>1</sup>, Nguyen Thi Mai Dung<sup>1</sup>, Dinh Bao Ngoc<sup>1</sup>,

Nguyen Dinh Ky<sup>2</sup>, Le Thi Kim Thoa<sup>2</sup>

<sup>1</sup>Hanoi University of Mining and Geology, 18 PhoVien, BacTuLiem, Hanoi, Vietnam <sup>2</sup>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.

🗆 🛄 taynguyen.sde
🗉 둼 taynguyen.DBO.CDDacLac_100
🗉 둼 taynguyen.DBO.CDDacNong_100
🗉 둼 taynguyen.DBO.CDGiaLai_100
🗉 둼 taynguyen.DBO.CDKonTum_100
🗉 둼 taynguyen.DBO.CDLamDong_100
🗉 둼 taynguyen.DBO.CDTayNguyen_250k
🗄 🖶 taynguyen.DBO.DacLac_100k
🗄 🖶 taynguyen.DBO.DacLac_25k
🗄 🖶 taynguyen.DBO.DacLac_50k
🗄 🖶 taynguyen.DBO.DacNong_100k
🗉 🖶 taynguyen.DBO.DacNong_25k
🗄 🖶 taynguyen.DBO.DacNong_50k
🗄 🖶 taynguyen.DBO.GiaLai_100k
🗄 🖶 taynguyen.DBO.GiaLai_25k
🗄 🖶 taynguyen.DBO.GiaLai_50k
🗄 🖶 taynguyen.DBO.KomTum_100k
🗉 🖶 taynguyen.DBO.KomTum_25k
🗄 🖶 taynguyen.DBO.KomTum_50k
🗉 🖶 taynguyen.DBO.LamDong_100k
🗉 🖶 taynguyen.DBO.LamDong_25k
🗉 🖶 taynguyen.DBO.LamDong_50k
🗄 🖶 taynguyen.DBO.TayNguyen 250k

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

			Atlas Điện Tử Tây Nguyên									A.*
Atlas Điện Từ Tay Nguyên	Bán đó phân bố dân cừ Tây Nguyên		Tim 10fm	Chu		( Dàn	DÀ				<b>▲</b> >00	Chilo: admin
×		€ Đảng Nhập 🛸 Hướng Đần Sử Dụng	n Trang quán tri	Chuy	en De	/ Бап	ĐŪ				9-05	ng xulit
<ul> <li>Bản đô dân cư Tây Nguyên</li> <li>Tổng dân số và lao động năm 2010</li> </ul>	P ± { { { { } { } { } { } { } { } { } { }	o e e e - 🔒	Let Oude tri Tin Túc Code tri Người Đông Cử Quân tri Danh Mục Hình Ânh	Thim Mo Lys chon 6 Hidn T	iản Đồ theo Đại N Tất Cả Chuyê	nh Myc n Đẻ / Đản Đỏ -			×			
880,500		• • • • • •	GP Guide of Hints Ann	Darn Sác	n Chuyên Dê / B	sán töö						
TONGLD			🖈 Quốn tự Liên Hệ	Show 1	o v entries					Search		
Towats			Chan th Cann Muc Chuyen Cértain Có Quain th Chuyên Dânida Gó	8TT_	Danh Muo Bán Dó 0	Tên Bản Đố ô	Anh Giel Thiệu 0	Nphy Vidt o	URL Bán Đó		Trang That 0	Thao Tác 0
				1	Vị Tri Địa Lý	Đản Đỏ Nên Tây Nguyên		5/4/2016 10:05:15 AM	nentaynguyen.aspx		D8 D8rg	ovie .
L				2	VI Tri Dia Lý	Đản Đỗ Nha Đặc Nông	1	5/3/2016 6/21/15 PM	nendaknong aspx		D8 D8rg	ovie .
<ul> <li>LD_DV</li> <li>Hật độ dân số phân bố theo huyện năm 2013</li> <li>Dựn tế người/km2</li> </ul>				9	5ở Dụng Đất Dai	Đản đó hiện trạng sử dụng đất Tây Nguyên 2013		5/12/2016 12:42:54 AM	ban_do_chuyen_delaynguyen/ba	ndoHT55DTN.aspx	D8 D8ng	or i m
50 - 90 ngutijikm2 100 - 149 ngutijikm2	ambodia	) T		4	Dân Cự - Lào Đông - Đội Sống	lián đồ phân bổ dân cư Tây Nguyễn	F 1	5/12/2016 12:39:42 AM	ban_do_chuyen_detaynguyen/bd	dancutaynguyen aspi	68 6årg	918 -
150 - 199 ngubi/km2 200 - 399 ngubi/km2				•	Thurong Mai - Du Lich	Bản Đỗ Đụ Lịch Tự Nhiên Tây Nguyên		5/12/2015 12:33.09 AM	ban_do_chuyen_delaynguyen/ba	ndodulich aspx	ta barg	010
Trên 600 người/km2				6	Thổ Nhưỡng - Vô Phong Hóa	Đản Đô Đất Tây Nguyên		5/12/2016 12:37:40 AM	ban_do_chuyen_de/taynguyen/da	ichataynguyen aspx	Di Ding	or i e
	0 50 100km 1648594.728981771416.081566			Showing	to 6 of 6 entries	•					Previous	1 Next
									est com i Resource (	anter I Sim Out I Helr		
Atlas Điện Tử Tây Nguyên		A.*.	(A)	reGIS Serv	er Manage			Services	Site Security	Loos		
Tim Kibm		🌢 Xin Chào: admin	Manage	Services	CGC Services	KML Notwork	Links		,			
Trang quản trị	quản trị Atlas điện tử Tây Nguyên	te Dâng xuất	Folders		💌 Se	rvices				Publish Service		
🔐 Quần trị Tin Tức			Site (ro	x)		9	Ban Do Du Li Bàn đã du lịch nh	ch Nhan Van án văn tây nguy	TayNouvenA2 / (Map Service)	aî ► = 0 ×		
🖩 Quản trị Người Dùng	4 🞽 3 🔼 3		<b>a</b> ct	taynguyen		5	Status: Instances Runnin	Started g: 1				
🕼 Quần trị Danh Mục Hình Ânh	In the Ngloriding	Denne	🗎 α	IN_8_5	6/×		Instances in Use: Maximum Instan	ces: 2				
CP Quản trị Hình Ânh	Xem chi tiết     Xem chi tiết	Xem chi tiết O	💼 ph	utho			BaoHiem TayN	ouvenA2 / (H	ap Service)	eî⊧≡ 0 ×		
🗲 Quần trị Liên Hệ			Sy	tem			bản đồ bào hiểm Status:	xã hội tây nguyi Stopped	in .			
A Cruzin Ini Danh Mur Chunin	19 0 6 O 3		💼 ta	nguyen			Instances Runnin Instances in Use:	g: 0 0				
ĐồiBản Đồ Danh	h mục chuyển để / Chuyển để / Bản Đồ Danh Mục Hình Ânh Bắn Đồ		💼 U.	lities			Noimum Instan	ces: 0				
(2) Quản trị Chuyên ĐếrBản Đố Xem chi tết	Xem ch tiết O Xem ch tiết O						BucXaOuanoHe Bán đó bức xạ qu Status: Instances Runnin Instances in Use:	D TayNouven ang hợp tây ngu Started D: 1 0	ng ✔ (Hap Service) yên	eî ⊨ = 0 ×		
						2	CacThanhPhan Bán dö các thánh Status:	ces: 2 KTe TayNouvy phân kinh tế Tả Started	<b>mA2 ≠</b> (Map Service) ly nguyên	eî⊧≡ 0 ×		

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

<b>Y</b>	TNOOTEN	TRANG CHÚ	HỆ THÔNG CHUYÊN ĐẾ	GIỚI THIỆU	TIN TỪC LIÊN HỆ
X C	S. SP				st.
Giới Thiệu Ass đơn thi lay Ngayên tố ci V tah bộ các cho số đã thủ đã V lấn Ngayên giản các có thông làn da V (12500), 15 chuyện ngiết là ngayên thống thờng tiến số người thống thờng tiến số thời thốn k thủ - đã k h	hộc, trự trờ, quản hộc, trự trờ, quản hộc gian của khủ ci doài trừng trụ của của trụ trự trự trự trự của của trừng trự của của trừng trự của của trừng trự của của trừng trự trự trự của của trừng trự trự trự trự của của trự trự trự trự trự trự của của trự trự trự trự trự trự trự của của trự trự trự trự trự trự trự trự trự trự trự trự trự trự trự trự trự trự trự	hống bản đồ Trực luyển ông các bản đã tự triện được ng theo nhân cán độ purc vậ ac tá củu và tim kên thông tr c cá bản ngam.	-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A		
CHUYEN DE MOI NHÂT				III Carih	mục các thuyện để
Die tob Cali Tân Novên Ngây đăng: Rispitorie 12:37:40 Al	A Bin Cô Da Uch Tơ Niện Ngày đàng trường trường tr	Tây Nguyên 133:00 AM	50 dán cu Tây Nguyên 192016 12:30:42 AM	Dân đó hiện trạng sử c Nguyên 2013 Ngày đáng, 5/12/2016	dung dát Tây 12.42.54 AM
TIN TỰC MỚI NHAT					anh mục các tri tức
The office Ap give not receive the state of	Try Nover tong that and the state of the sta	Joarnan     J	L Jak Lism viele vol 13p biog Guain Gál mi Go shu Gál Lis Ga sa bul ni Go shu Gál Lis Ga sa bul ruchai Gá sa Bul	Di Lat: Kinh donh Di Lat: Kinh donh Di do co te vi e dos midu tén, nhurp Naus téng tang sisi choi cètin	chúa tế bầu trời vàng phải là người không phải là người đa bàng.
LIÊN HỆ	TIN TỪC NỔI BẬT	BINH LUÁP	I GÂN ĐÂY	CHUYÊN DÊ N	101 NHAT
Allas dhin là Tây Nguyên Digi Chi	Thác châu Âu g Tây Nguyễn 50/2016 5.52:51 P	giữa nài rừng Tối cần xin t Atas diễn tố	hông 1n để xn cơ sở đũ tiêu 111 hỏi a?	Sán C	Dồ Đất Tây Nguyên 916 12 37 48 AM
Rhis vyk Tag Ngayen Tây Ngayên Tây Ngayên Riše Tingarritên 202 Alfii 444	Tâx Nouvên tro han bán 50/2016 5-18-28 19	na 'chảo bày' Atlas điện số thêm nhiều t	tây nguyên cần xây dụng trang bản đồ họn nữa	Mguy M120	Đỗ Dụ Lịch Tự Nhiên Tây ên 016 12 33 bệ AM
Fac: (003) 030 00 0 0	Tinh ûy Đất Liệ Tập đoàn viễn th sci2016 si4802 Ph	Altes diện tả công việc với ông Quân đối V	i Tây Nguyên rất hữu ích cho in tối	Sin Nguy 5/12/0	đồ phản bổ dân cư Tây ên 916 12:39:42 AM

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.