AN EFFECTIVE SOLUTION FOR SUSTAINABLE USE AND MANAGEMENT OF NATURAL RESOURCES THROUGH WEBGIS OPEN SOURCES AND DECISION-MAKING SUPPORT TOOLS

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ABSTRACT

In this paper, we will present a technological solution for sustainable use and management of natural resources problems by developing an open source- based webgis system and some decision- making support tools. While previous studies in this topic concentrated on map display functions only and/ or limited capabilites on GIS analysis and data sharing functions, our study has considered some ameliorative solutions on these points. For specific, we: (1) develop the most striking current open source webgis system based on MapServer/ OpenLayers javascript libraries by adding some analysis functions such as measuring, visibility,.. (2) build an on-line GIS sharing system which allows immediately displaying maps in web interfaces after uploading GIS data. (3) auto-generate new maps following by user- selection from original given layers and they can be printed for later use or exported in PDF format. (4) create some mathematical tools for decision- making in given GIS data. The total system is named as SWEBGIS.

As an illustration of the system, preliminary results of sustainable use and management of natural resources on Tam Dao National Park, Viet Nam are presented. Indeed, we present (5) a suitable data model design for this area. After using SWEBGIS to analyze data, we (6) make some notes as well as conclusions. These information are useful for local managers to bring some policies on using and exploiting natural resources in that area.

Keywords: WebGIS Open Source, Natural resource management, SWEBGIS.

1. INTRODUCTION

The natural resources play an important role in our lives. For example, the most important use of land to man is that it provides space for work. All activities of man take place on land whether it is agriculture, transport, industry, housing, mining etc. Oxygen in air is required for breathing by all human beings and animals. Moreover, around 71% of the earth's surface is covered with water. All life is impossible without it. It is used for household purposes, irrigation, transport, for producing tidal energy. Another example from forest where its uses to produce large amounts of oxygen and absorb large amounts of carbon dioxide, helping regulate the gases in Earth's atmosphere and reducing the climate change. Indeed, these are many examples showing the importance of this kind of resource.

From this perception, some exploitation of natural resources is an essential condition of the human existence. This refers primarily to food production and necessities. The exploitation of nature is often done unsustainably and is of increasing concern as the depletion of natural resources from economic growth and population growth ultimately threatens human existence. For example, many birds have become extinct as a result of human activities, especially birds endemic to islands, including many flightless birds (the Dodo, the Great Auk, etc). Bearing this problem in mind, a strong need of effective solutions for sustainable use and management of natural resource is required. Along with the development of GeoInformatics and its tools nowday, for instance WebGIS (Le Hoang Son, 2009), it is said that we are supported enough conditions to perform this task.

However, most of organizations involving to natural resource management have been using commercial GIS softwares in Desktop environment. As a result, it is too difficult to develop advance external GIS functions as well as immediately share information about natural resource exploitation and management at a specific time. Moreover, the main functions in current GIS systems for this problem are still displaying maps and limitary providing analysis operations. Besides, it does not support any tool for managers to make decisions. In addition to the early development of online maps making from (ESRI) which allows uploading a Shape file to pre-defined basic maps only, this motivate us to follow on this way. In specific, we will present an open-souce WebGIS solution so called SWEBGIS based on MapServer/ OpenLayers. Our system allows online sharing GIS data in Shape standards as well as auto-generating, printing maps for natural resource exploitation activities in reality. Some analysis functions and mathematic tools are also provided for managers to make decisions.

Our paper is organized as folows. Section 2 briefly presents the main characteristics of SWEBGIS framework. In section 3, we will describe how to apply our framework to manage natural resource in Tam Dao national park, Viet Nam through some specific scenarios. Finally, we will make conclusions and future works in the last section.

2. SWEBGIS FRAMEWORK

Our system is based on MapServer (M.N. K. Boulos, K. Honda, 2006) and OpenLayers javascript library (Lili Li, Dekui Lv2, 2008). MapServer is an Open Source platform for publishing spatial data and interactive mapping applications to the web while OpenLayers is a set of Javascript library files with purpose to put a dynamic map in any web page. It can display map tiles and markers loaded from any source. OpenLayers is completely free and developed and supported by a number of organizations around the world. It has run effectively on MapServer only and proved the advantage in comparison with other web mapping applications such as MapBuilder, CartoWeb, KaMap, etc (Figure 1).

	Free & 100% client-side		Free & client-serverside									proprietary& 100%client..
	OpenLayers	WMS Mapper	CartoWeb	Chameleon	GeoPortal	kaMap	Mapbender	MapBuilder	MapGuide Open Source	Mapping Widgets	p.mapper	Google Maps
	n.a.???	n.a.???	n.a.???	n.a.???	n.a.???	n.a.???	n.a.???	n.a.???	n.a.???	n.a.???	n.a.???	n.a.???
Version	2.3	0.03	3.3.0	2.4.1	1.2.1	1.0	2.4.1	1.0.1	1.1.0	0.3.1	3.0.1	2.79
last Update	21.02.07	k.A.	31.08.06	06.09.06	15.09.05	05.02.07	23.03.07	19.07.06	09.12.06	17.03.06	30.12.06	18.04.07
FS-License	BSD	AFL	GNU GPL	X11	GNU GPL	MIT	GNU GPL	GNU LGPL	GNU LGPL	GNU GPL	GNU GPL	-
Revision Administration	SVN	-	CVS	CVS	SVN	CVS	SVN	SVN	SVN	SVN	SVN	-
Developer Mailing List (ML)	✓	-	✓	-	✓[3]	✓	✓	✓	✓	-	-	-
Mails per Month[1]	85		16		49	11	55	120	168			-
Active Developers[2]	72		12		101	7	46	47	42			-
User Mailing List (ML)	✓	-	✓	✓	✓[3]	✓	✓	✓	✓	-	✓	✓
Mails per Month[1]	197		80	51	92	96	107	65	527		82	-[4]
Active Users[2]	150		86	63	106	121	98	78	297		61	-[4]
Overview Map	✓	-	✓	✓	-	✓	✓	-	-	-	✓	✓
Layer Overview	✓	-	✓	✓	-	✓	✓	-	✓[5]	✓	✓	✓
Legend	-	-	✓[5]	✓	-	✓[5]	✓	-	✓[5]	✓	✓	-
Scale Bar	✓/ -	- / -	✓/ ✓	- / ✓	- / -	✓/ ✓	✓/ ✓	✓/ -	✓/ -	-	✓/ ✓	✓/ ✓
Zoom Bar	✓	-	-	-	-	-	-	-	✓	-	✓/ ✓	-
Pan Navigation on map edge in PanZoom Bar	- ✓	- -	✓ -	✓ -	✓ -	- -	✓ -	- -	- ✓	- -	- -	- ✓
Zooming per Double-click	✓	-	-	-	-	-	-	-	-	-	-	✓
Mousewheel	✓	-	-	-	-	✓	-	-	-	-	✓	✓
Zoom Box (Shift-key)	✓(✓)	-	✓(✓)	✓(-)	✓(-)	✓(-)	✓(-)	✓(✓)	✓(✓)	✓(-)	✓(✓)	-
Panning with Overview Map	✓	-	✓	✓	✓	✓	✓	-	-	-	✓	✓
Zooming & Panning with Keyboard	✓	-	-	-	-	-	-	-	-	-	✓	✓
Tiling	✓	✓	-	-	-	✓	-	-	✓	-	-	✓

[1] Average monthly mail volume Oct 2006 - Mar 2007 (6 months)
[2] Total number of active developers/users in analyzed time period (Oct 2006 - Mar 2007; 6 months)
[3] User general user/developer ML of deegree
[4] Automatic analysis not possible in Google Groups
[5] Legend is integrated into layer overview

As of: May 15, 2007

Figure 1. Comparison between OpenLayers and other web mapping applications

All these objects can utilize online GIS sharing systems to perform sharing data, searching, collecting and mining them as well as making reports. From this, we initiate the framework of this kind of systems so called SWEBGIS framework (Figure 2).

In this framework, when users want to create online maps, they first share GIS data in Shape (SHP) standards (2). Please notice that the first version of SWEBGIS can support for Vector data (SHP) only. Later, another data such as Raster data, terrain data or even other standards of vector data should be supported. Through the interface of SWEBGIS, users can easily create maps from uploaded data and print, export them to PDF for specific purposes

(3). Moreover, they can exploit information in some pre-defined basic maps (1). The uploaded data are organized in central databases together with basic SHPs. In this database, basic SHPs are separate layers which form pre-defined basic maps for everyone to use, for instance the basic map of Tam Dao national park (5). We maintain UML designs for these data. Another type of data in this place is attribute data for each uploaded SHP layer (2). In fact, they are separate tables because their dynamic and online charcteristics, thence it is difficult to make relation between pre-defined and uploaded data. However, when turning the server from Main Server to Local Server (Figure 4), one step must be carried out, that is: re-organizes isolated tables and joins them to pre-defined UML designs. This can enhance the stability and performance of the system.

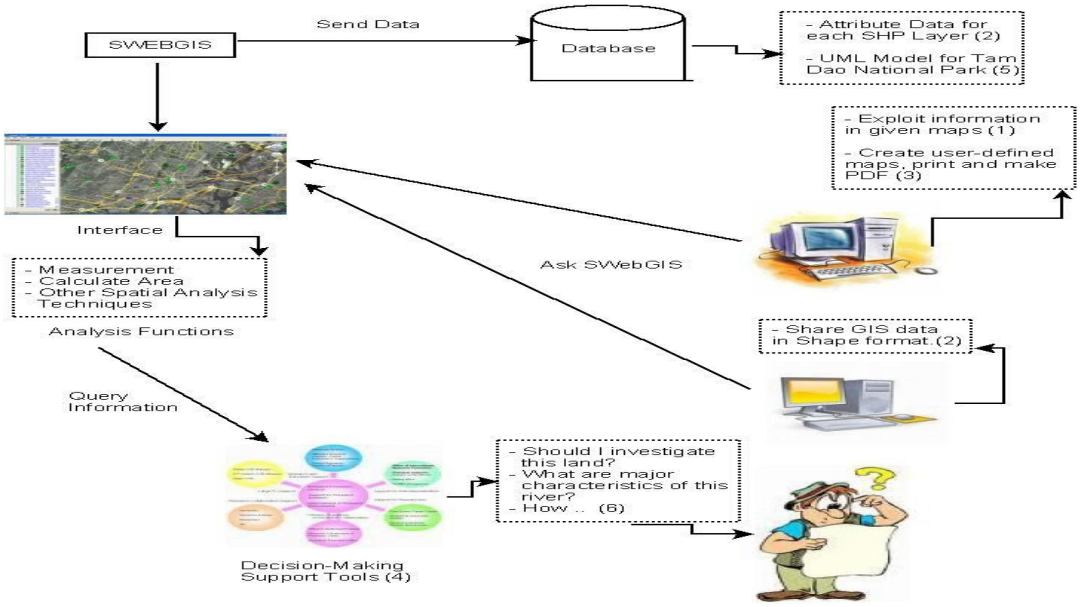

Figure 2. Description of SWebGIS Framework

Futhermore, some analysis operations such as measurement, area calculation, etc can be performed in these maps. One important function of SWEBGIS is to support decision-making through results of query information and some mathematical tools, for instance: statistics, in a graphical interface (4). This function may help managers answer some questions related to natural resource management problems (6).

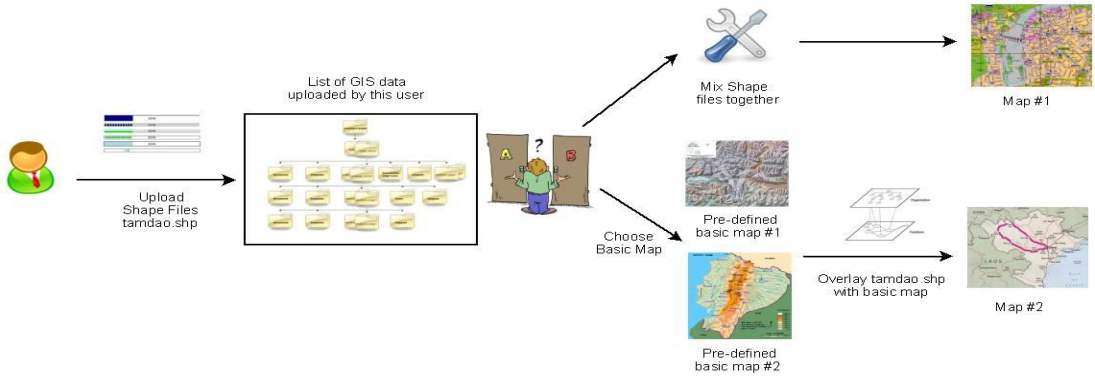

Figure 3. The 2-level sharing GIS data system

One point should be mentioned in this part is the mechanism of data uploading (Figure 3). For the first version of SWEBGIS, we limit the number of packages uploaded to server is

10. Each package contains 3 standards: SHP, SHX and DBF of a layer. After transfering through Secure HTTP (HTTPS), these data are located at private GIS data folder of users. At this time, they can either mix some SHPs together to form a new map (Ex: Map #1) or overlay a SHP to some pre-defined basic maps in the system to form another one (Ex: Map #2). This is a 2-level sharing mechanism in our framework.

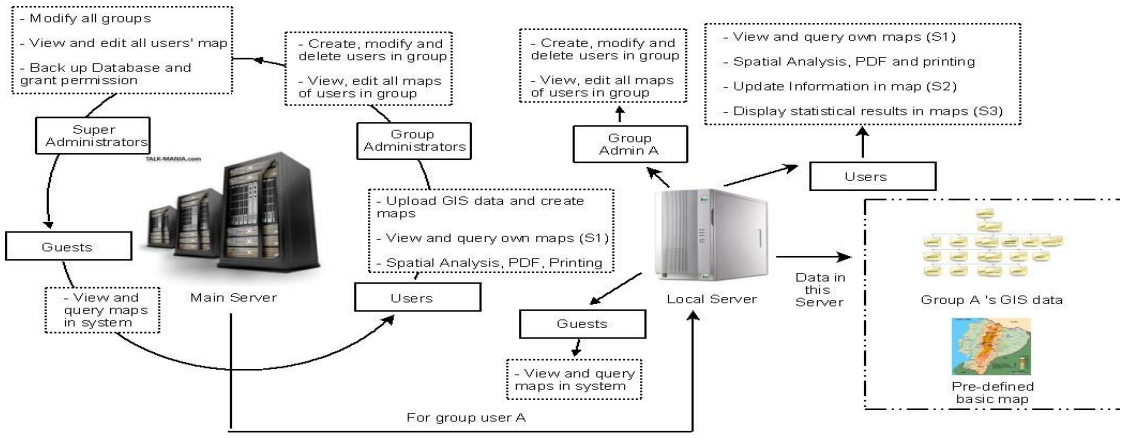

Figure 4. Main/ Local Servers and some types of user

3. AN ILLUSTRATION AT TAM DAO NATIONAL PARK

Being mentioned in previous parts, the Tam Dao National Park (TDNP) is the place to make experiments and test performance of SWEBGIS. Located at 21°21' to 21°42' North latitude, 105°23' to 105°44' East longitude, Tam Dao National Park is a protected area zone in North Vietnam. It was established in 1996, succeeding from The Conservation Forest Tam Dao which had been formed in 1977. The park is about 85 km northwest of Hanoi. There are 42 species endemic to Tam Dao National Park and also 64 other species considered rare. Hunting is a particular threat to the mammal populations of Tam Dao National Park. Wildlife is freely sold in the restaurants of Tam Dao town. Another problems at Tam Dao are logging and fire. The forest at Tam Dao National Park has been selectively logged for many years. All logging activities were conducted on a small scale by local people, and no private or state forest enterprises were involved (Anon, 1991). Obviously, there is a demand of effective solutions for sustainable use and management of natural resources through SWEBGIS system.

After uploading GIS data scatterly collected at Tam Dao National Park from 2005 to 2009 to SWEBGIS, we have driven an UML model for this problem (Figure 5). To test the system, some scenarios are described as folows.

- **Scenario 1 (S1)**: *Keep track of forest status quo of Tam Dao National Park to understand the distribution of forest in this area* (Figure 6). From this, we recognize that the medium and poor forests (green color) are the majority in Tam Dao while the rests contribute small percents only. Rich forest concentrates in the North while special one is located in the South. Perhaps, its reasons come from the natural conditions and impact of people.
- **Scenario 2 (S2)**: *Keep track and update information about violated areas in Tam Dao National Park*. For this scenario, we update the violated areas by adding points one after another on Tam Dao 's forest status quo presented in Figure 6. Then, the information such as violated types, methods, actors and violated time are inputed in accordance with each point. Later, a map containing violated areas is created (Figure 7). We can also use analysis tools in Toolbar such as measuring, etc for this

map or export it to PDF/printing forms.

- **Scenario 3 (S3)**: *Perform statistics from violation areas (KVBiXamPham-Figure 5) and display all groups in map*. A decision-making support tool is invoked in SWEBGIS when users perform attribute queries following by one of these conditions: violated types, time and area of violated places. These results are thence classified or grouped statistically to pre-defined groups. Moreover, users can define these groups, too. Eventually, all groups are displayed in a map with different colors showing the level of violated actions. From graphical results, managers can bring some policies about preventing violation in Tam Dao National Park to reality.

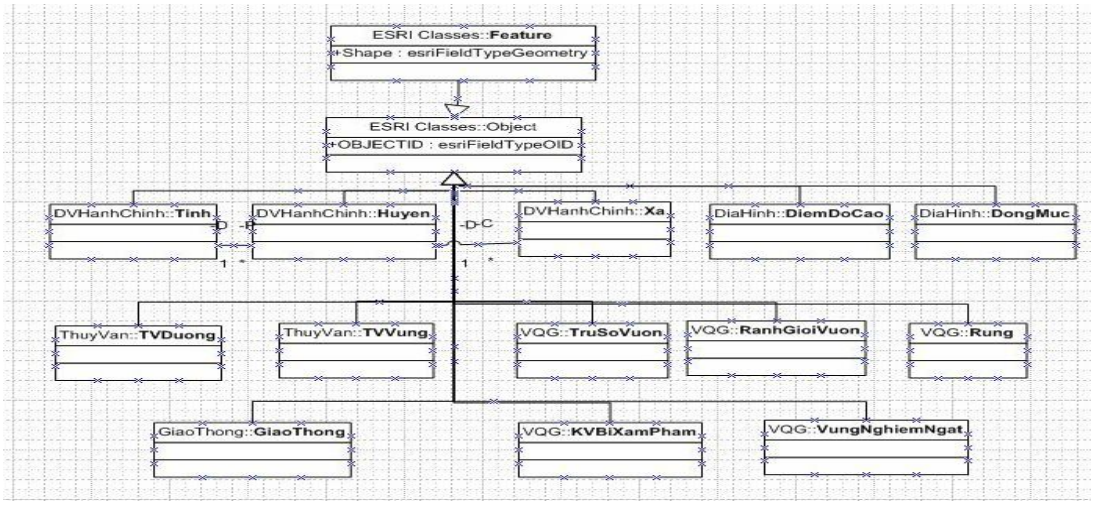

Figure 5. UML model for Tam Dao National Park 's Natural Resource Management

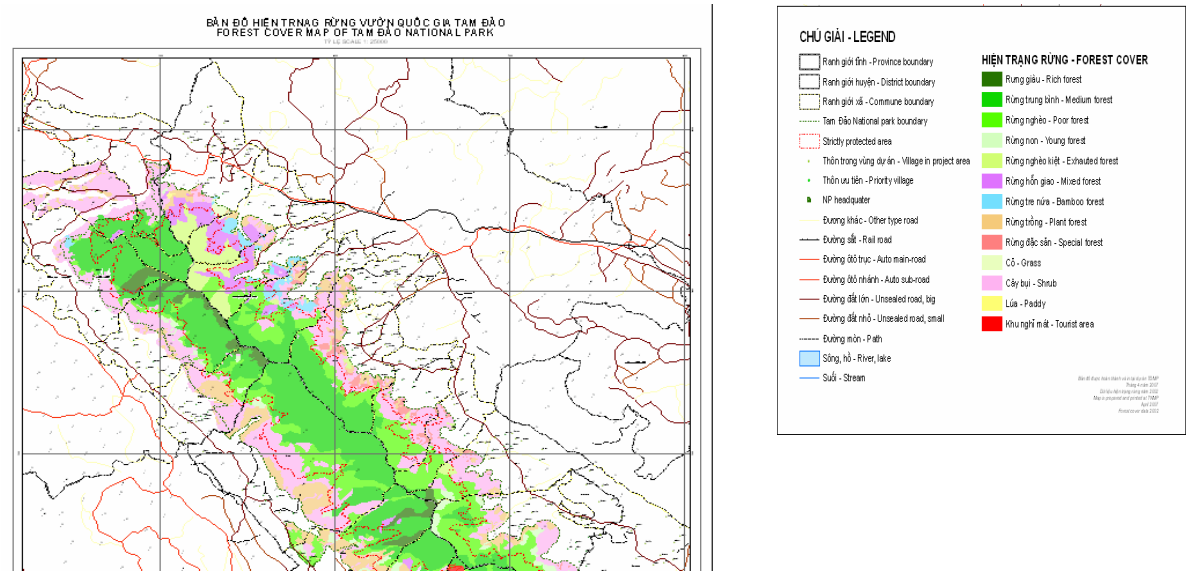

Figure 6. Tam Dao 's forest status quo

4. CONCLUSION AND FUTURE WORKS

In this paper, we have presented a solution to effective management natural resource through SWEBGIS framework based on WebGIS and Sharing technology. This framework is

equipped some spatial analysis as well as mathematic tools to support decision-making. Even though it is still in early stage, its efficiency is illustrated through applications at Tam Dao national park.

In the future, we will consider the hybrid solution between 2D sharing and 3D capabilities to integrate to SWEBGIS. Moreover, some improvements on security, download/upload methods, database administration are also mentioned. Finally, we will try to adapt our system to another areas for better versions.

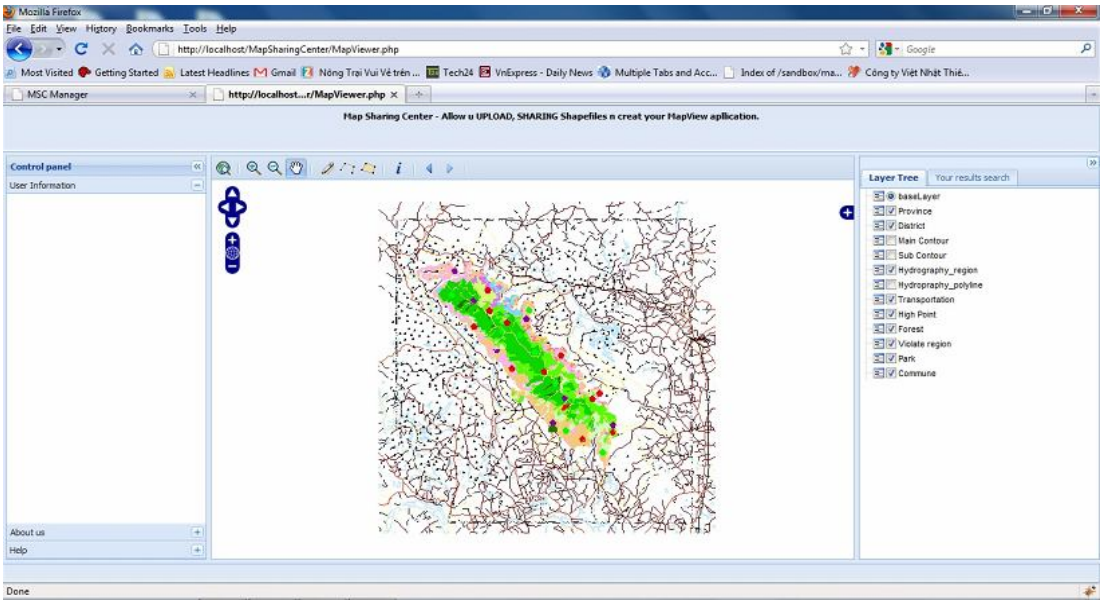

Figure 7. Update information about violated areas at Tam Dao

5. ACKNOWLEDGEMENT

The authors wish to thank to Professor Pham Van Cu, VNU, Dr. Vu Anh Tuan, VAST and Dr. Roberto Colonello, the Politecnico di Milano University for giving useful comments. This research is partly conducted as a program in Funds for Science and Technology by the Vietnam National University (VNU).

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