WEB-BASED GIS SYSTEM: A CASE STUDY FROM SLOVENIA

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ABSTRACT

Large amount of geographical data have been used more and more in many areas in different application domains, such as government, telecommunications, utilities, cadastre, land management, environment and ecology. Recently, the internet technology is moving Geographical Information Systems (GIS) towards Web based applications, providing more visual information for the end users and simplifying the interaction between users and GIS. We present a web based information system that has been developed by the Slovenian Forestry Institute in order to promote the hunting community in Slovenia. This information system facilitates the hunting in terms of providing online up-to-date information on various dispossessions of species on different locations. The information is made available at three different levels i.e. Country level, where the information are aggregated at national level; Hunting region level where the information is aggregated at district-wise; and at Hunting communities level where the information is aggregated village-wise. The application follows OpenGIS Standards compliant for Web Feature Service (WFS) and Web Map Service (WMS). The data is stored in a spatial database. The output formats includes tables, graphs and maps products (Google Earth, GEORSS, Shapefiles, raster image formats, pdf, etc.). All presented data are extensively equipped with their metadata description, so as to enable delivery of exact information to the end user. Technologies like HTML and JAVA scripts are made use of for designing the client end interfaces. The Web GIS based applications constitute the new paradigm of distributed applications, that combines the best aspects of the development of components and the development web using standard GIS protocols and data formats of generalized use to obtain multiplatform integration.

Key word: Web GIS, WMS, spatial data, cartography, open source software.

1. INTRODUCTION

Large amount of geographical data have been used more and more in many areas in different application domains, such as government, telecommunications, utilities, cadastre, land management, environment and ecology. Along with process, the set of

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available GIS applications and its complexity is increasing as well. The applications have many advanced functionalities and capabilities that make them on one hand very easy and fast to use and very difficult for beginners especially having to deal with application specific menus and procedure steps.

Recently, the internet technology is moving Geographical Information Systems (GIS) towards Web based applications, providing more visual information for the end users and simplifying the interaction between users and GIS.

In this study, we present OSLIS Information System (Central Slovenian Hunting Information System), a web based information system that has been developed and maintained by the Slovenian Forestry Institute. The development of the system was guided by an initiative of the Ministry of agriculture, forestry and food of Slovenia to set up and provide public services i.e. to display and share information on the hunting activities and conditions in Slovenia. The system is based on two expertises (Jerina, 2008; Levanič and Stojanova, 2009).

The main objective of the system is connecting existing geographically-referenced information to the GeoWEB using open standards and operating as a node within a free and open Spatial Data Infrastructure (SDI). In addition, it promotes the hunting community in Slovenia by enabling access to game information for the general public. Instead of using the GIS functionalities of the expensive commercial solutions (such as Arcview/ ArcInfo, MapInfo, etc.), the system combines open-source Web GIS solutions and spatial database functionalities providing technical and data support for preparation of wildlife management plans and reports. OSLIS is available at http://oslis.gozdis.si.

The OSLIS system is an umbrella system, intentionally designed to serve as a platform for joining multiple external data about the game, collected by hunters on the field. The system architecture is intended to combine a large amount of data by receiving data from several databases once a day. The data is then integrated and stored in a spatial database, so it can be queried on the fly. Data entry and verification happens at the database level, thus OSLIS is not intended for data entering, data maintenance and does not guarantee data quality. The system is capable of aggregating and displaying the external data in an organized form, either as a map, graph or table. In this way, the users can exploit this advantage of using web services to interactively connect to the spatial data and use it in an efficient and flexible way.

The information is made available at three different levels i.e. Country level, where the information are aggregated at national level; Hunting region level where the information is aggregated at district-wise; and at Hunting communities level where the information is aggregated village-wise.

The system provides support for planners in the creation of wildlife management plans in a way that it provides outputs (maps, graphs and tables) in the range and quality that have not been available until now. In terms of preparation of the wildlife management plans, the system follows the *National Rules on the content of wildlife management plans*. Other wildlife management plans' activities like analysis of past management, evaluation of the status of populations and wildlife habitats, assessment of the ecological balance and consistency with the natural environment, can also be supported and simplified by the use and analysis of the output results of the system. In future, we expect that the system will support and follow the forthcoming national legislature for annual hunting region plans.

In the process of system development we were aware of the fact that the system is only as useful as the programs that underlie its operation, so we established OSLIS as an open-source system for which users do not pay licensing. Due to the use of open-source components, OSLIS is accessible to all users free of charge. The system is completely independent from the operating system. The access to the OSLIS system requires minimum software and GIS knowledge.

The paper is structured as follows. Section 2 gives a brief overview of the technology used to build the system. Section 3 describes the functionalities of the OSLIS system while Section 4 discusses our concluding remarks and further issues that are currently under investigation.

2. TECHNOLOGY

The OSLIS Information System is a Web GIS application build on free and open source platform Geoserver (http://geoserver.org/). GeoServer is a Java-based software server that allows for great flexibility in map creation and data sharing by using open standards set forth by the Open Geospatial Consortium (OGC) (http://www.opengeospatial.org/). GeoServer aims to operate as a node within a free and open Spatial Data Infrastructure (SDI).

The main characteristics of GeoServer include:

- Creation of maps in a variety of output formats (WFS, GML, KML, SVG, PDF, GeoRSS, *JPEG, PNG*, Geotiff, OGR Output – MapInfo Tab and MID/MIF, Shp, CSV, GeoJSON, etc.), by implementing the Web Map Service (WMS) standard. WMS is a standard protocol for serving georeferenced map images over the Internet that are generated by a map server using data from a GIS database.
- Quick and easy map generation enabled by OpenLayers, a free mapping library integrated in GeoServer.
- Publishing data from any major spatial data sources such as GeoTIFF, ArcGrid, MapInfo, external WFS, WorldImages, ImageMosiacs, Image Pyramids, Erdas Imagine, Shapefile, ArcSDE, GML, DB2, MySQL, SQL Server, VPF, PostGIS and Oracle.
- Sharing and editing data that are used to generate maps, by conforming to the Web Feature Service (WFS) standard. WFS specification is an interface allowing requests for geographical features across the web being highly interoperable.
- Freeing your data and permitting greater transparency. This allows distributed, decentralized structure of geospatial data.
- GeoServer can connect with traditional GIS architectures such as ESRI ArcGIS, MapInfo, etc.
- It is free software. This significantly lowers the financial barrier to entry when compared to traditional GIS products.
- It is also open source. Bug fixes and feature improvements in open source software are greatly accelerated when compared to traditional software solutions.

Having GeoServer as the major component, OSLIS incorporates all of the above mentioned characteristics. In particular:

- It employs WMS and WFS standards for map dynamic map creation and sharing.
- PostGIS (http://postgis.refractions.net) is used as a data source for web mapping. PostGIS is an extension to the PostgreSQL (http://www.postgresql.org/) open source object-relational database system that allows GIS (Geographic Information System) objects to be stored in the database. PostGIS data can be exported to several output GIS formats such as Shapefile and MapInfo.
- The output formats includes tables, graphs and maps products. The data is displayed on the popular mapping applications Google Maps, Google Earth and Yahoo Maps.
- All presented data are extensively equipped with their metadata description, to enable delivery of exact information to the end user.
- Technologies like HTML, XML and Javascript are used for designing the client end interfaces.

The main advantage of the OSLIS system is that it represents a WEB GIS application that combines the best aspects of the development of web components using standard GIS protocols and the data formats of general use.

Another advantage of the OSLIS system is that it incorporates all of the above mentioned characteristics of the Geoserver platform within a simple web portal solution. The user can take advantage of the technology aspects without any previous technological or GIS knowledge. The system is easy to use and the generation of maps on user request very fast.

3. FUNCTIONALITY

Web services are set up by the public sector for several reasons: to share information with other public sector organizations, to inform citizens and the private sector and to market public sector information.
Our system tends to promote the hunting in Slovenia in terms of providing online up-to-date information on various dispossessions of species on different locations and sharing information on the hunting activities to the general public as well to the hunting specialists. The general public has a limited access to the information while the professional public has unlimited access to all available information, protected via valid username and password.

The user can find information on the number of withdrawal:

- per hunting species, e.g. information on the number of withdrawal per animal species in particular period, the number of withdrawal per animal sub-category within a specific hunting species in particular period, the number of animals that died from a specific disease in particular period, the number of animals that were driven over on highways or railways in particular period, the period of maximum withdrawal per species, etc.
- on different hunting locations,
- for different type of loss, e.g. the number of animals that died from disease in particular period, the number of animals that were driven over on a highway or a railway in particular period, etc.
- per different type of disease,
- in comparison to the number of planned withdraw etc.

The information is made available at three different levels i.e. Country level, where the information are aggregated at national level; Hunting region level where the information is aggregated at district-wise; and at Hunting communities level where the information is aggregated village-wise. The system is capable of displaying information on the hunting activities in form of tables, graphs and interactive maps on all three levels.

The information is available in form of maps, graphs and tables:

- Cartographic printouts
- Tabular printouts
- Graphical printouts

3.1. Cartographic printouts

The map output consists of several vector and raster layers in different geo-reference coordinate systems, displayed one over another. The information on the withdrawal of the hunting species is given by vector point layer, while the information on the hunting communities, hunting regions and couture of the Slovenia is given by vector polygon layers, both in the Gauss-Krueger coordinate system. By default, the base layer is the Google's physical layer which is a natural map of roads, rivers and similar attributes given in World Geodetic System (WGS84). In addition, selection of more raster cartographical base layers is possible. Thus, the user can choose among Google's layers (satellite, terrain, streets and hybrid) with spatial resolution up to 0.5m and Landsat layers with 30 x 30 m resolution. Note that Landsat satellite image quality is very poor, especially it is not suitable for zooming options and detailed view.

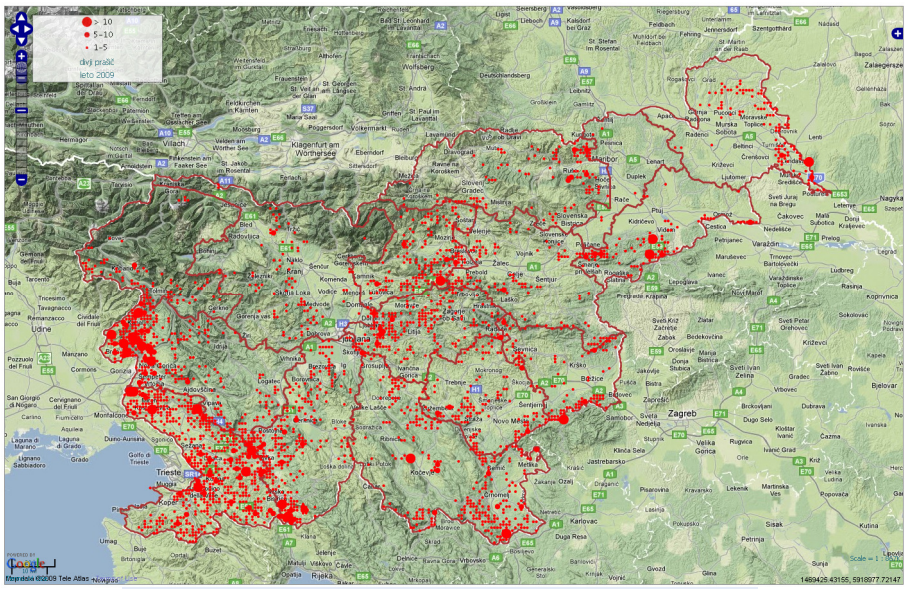

Figure1: A map for the withdrawal of wild boar in Slovenia in the year 2009. The size of the red dots shows the amount of withdrawal. The cartographical raster basis layer is the Google's physical layer.

The demonstration maps (Figures 1 - 2) present some of the possible maps generated by the OSLIS system. Figure1 presents the withdrawal of wild boar in Slovenia in the year 2009 whereas Figure2 presents the withdrawal of deer in Slovenia in the year 2009 in the Novo Mesto hunting region. The cartographical raster base layer given in Figure1 is the Google's physical layer whereas the base layer presented in Figure2 is the Google's hybrid layer. The amount of removal is illustrated with the size of a red dot. Minimum dot represents a withdrawal from 1-5 animals and the maximum red dot represents a withdrawal of more than 10 animals.

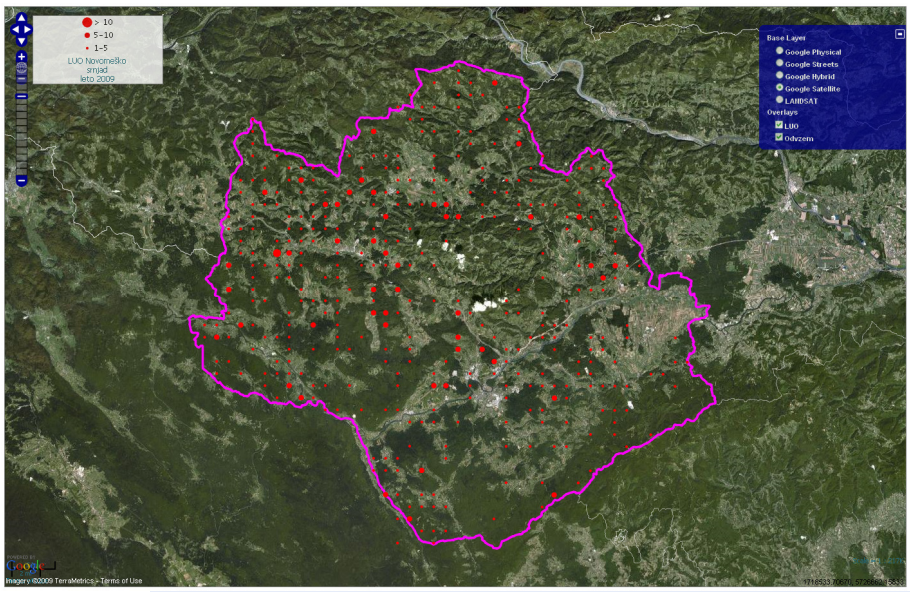

Figure2: A map for the withdrawal of deer in Slovenia in the year 2009 in the Novo Mesto hunting region. The size of the red dots shows the amount of withdrawal while the violet couture line shows the Novo Mesto hunting region. The cartographical raster basis layer is the Google's hybrid layer.

The user can adjust positioning and zooming options. It is possible to display and print maps up to A0 printer format, or to store them in several output formats such as PNG, EPS or PDF.

3.2. Tabular printouts

In addition to map printing option, the system also enables users to print and export tables according to predetermined criteria (e.g., geographical levels, species, type of disease, type of loss, etc). Tabular printouts are a good tool for analyzing different combinations of attribute and calculation data. Some predefined printouts are available to the general public while the experts have opportunity to choose among all possible different combinations supported by the system. Currently, the database contains data for the last 5 years. Data before 2005 are unreliable in spatial context as well as incomplete.

3.3. Graphic printouts

Similarly as the maps and tables outputs, the graphical printouts are possible for various combinations of possible attributes (type of disease, type of loss, type of of animal species, spatial level, time periods, etc.). The graphics can be exported into standard graphical formats like PNG, PDF or EPS. This allows very ease integration of high quality graphs in reports and expertise which is very important for the support of the wildlife management planning.

The structure of the fox withdrawal for the period from 2005 to 2010 in Slovenia is preseted in Figure 3. The male population withdrawal is given on the left group bar (labeled as *samci*) while the female population withdrawal is given on the right group bar of the graph (labeled as *samice*).

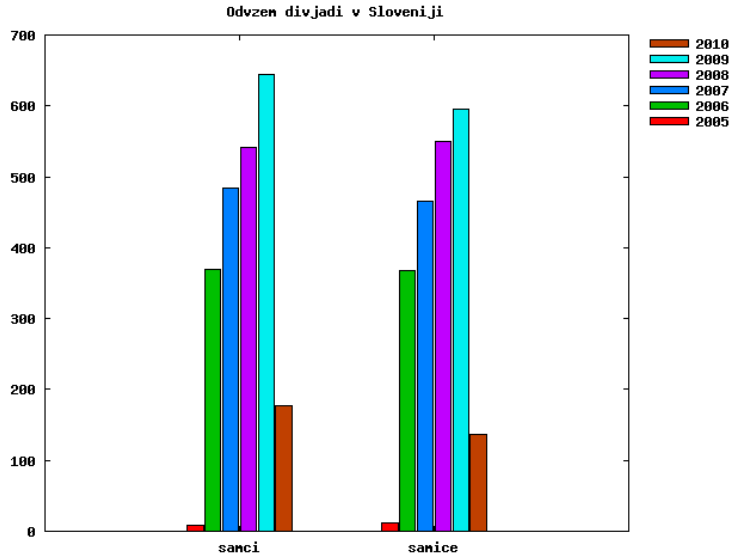

Figure3: The structure of the fox withdrawal for the period 2005-2010 in Slovenia. The male population withdrawal is given on the left group bar (labeled as *samci* = *male*) while the female population withdrawal is given on the right group bar of the graph (labeled as *samice* = *female*). Lower values in 2010 contain only data from January till April.

CONCLUIONS

Web services are set up by the public sector for several reasons: to share information with other public sector organizations, to inform citizens and the private sector and to market public sector information. In this study, we present OSLIS - a web based information system that has been developed and maintained by the Slovenian Forestry Institute. It is focused on connecting existing geographically-referenced information to the GeoWEB using open standards and operating as a node within a free and open Spatial Data Infrastructure.

The need for this kind of system has arisen from the need to share information on the hunting activities in Slovenia with the general public, inform the public about the

current status of the hunting activities as well as to promote and popularize them. Beside the general public, the system is also intended to serve to hunters and hunting specialists. All of them have different access rights to different kinds of information that are interesting and appropriate for them. The system encloses all kinds of species that can be found on the national territory of Slovenia. The species that are considered for hunting have been determinate by the official law of Slovenia.

We believe that information from the system can offer IT support to decision makers and wild management plan makers in both the long and short-term management plans for the game. The support provide from the system is prearranged in accordance with the *Rules on the content wildlife management plans*. In the segment of long-term plans, the data from the OSLIS may be utilized in the development of hunting region management plans and activities, assessment of the state population and in assessment of the ecological balance and consistency. On the level of short-term wildlife management plans, the use of the information support offered by the OSLIS system in directed in preparing short-term assessments, analysis, guidelines and measures.

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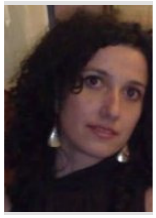
BIOGRAPHICAL NOTES OF THE AUTHORS



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