A CENTRALLY MANAGED GIS SYSTEM FOR PROTECTION OF THE ROMANIAN ARCHAEOLOGICAL SITES, ENSEMBLES AND HISTORICAL MONUMENTS

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***Abstract**: **Abstract:** The Romanian Archaeological Sites, Ensembles and Historical Monuments Inventory application is a centrally managed GIS system designed to provide the functionality to maintain an advanced analysis of the geospatial data, and produce maps and reports using a national-wide archaeological and historical monuments geodatabase that represents the "List of the Historical Monuments" from Romania. The main purpose of this application is to facilitate the regional branches collaboration, to support of the integrated resource planning at the district (called ''judet'') and national government level. The Archaeological Sites Geoportal application could also represent an advanced support and framework of the National Spatial Data Infrastructure activities for discovery, query, and use of geospatial data and services.*

Keywords: **GIS, standards, metadata, archeological sites**

1. Introduction

During the last decades the geospatial technologies evolved rapidly and very diversified. The ***G**eographic **I**nformation **S**ystems* (GIS) participated in the development of these technologies, influencing also other technologies, such as geospatial data collection technology, management technology and representation of this information technology.

2. Integration of the different spatial technologies

Integration of the spatial technologies has focused on the core GIS technology, this feature being very common in many types of applications and research areas. ***G**lobal **P**ositioning **S**ystems* (GPS), another type of geospatial technology are used in different classes of geospatial applications, often integrated with wireless communication technologies, allowing user access to land navigation.

Another geospatial technology has evolved rapidly in the last period of time is Remote Sensing, evolution manifested in increased availability in the cost of data acquisition and resolution of these data. A standard technology for achieving geospatial data is SAR *Interferometry* (***S**yntethic **A**perture **R**adar*), digital models obtained with this technology based on satellite information allow obtaining spatial data for large coverage areas. A technology similar to SAR and Photogrammetry is ***Li**ght **D**etection and **R**anging* (LIDAR) technology, a technology based on aerial scanning. Also, Photogrammetry has grown recently, largely due to the evolution of advanced technologies used for data collection and processing.

One of the technology that have experienced a great evolution during the last years is related to *Server* dedicated to geospatial data based on Internet / Intranet networks, technologies which offer new opportunities for representation and distribution of spatial

information and for achieving a ***G****lobal* ***S****patial* ***D****ata* ***I****nfrastructure (GSDI),* ***N****ational* ***S****patial* ***D****ata* ***I****nfrastructure (NSDI)* or local. Considerations of using these geospatial technologies should represent different advantages and disadvantages obtained.

Information quality means quality decisions, GIS software offering this capability by transforming simple data into useful information (obtained from query and analysis of data) and leading them to access interactive. Today, government bodies and local decisions, business environment, increasingly relies on exploiting geospatial data (geographic data). In most cases you need a decision it is constrained, influenced or dictated by geographical factors.

Visualization and analysis tools of geographic data known as ***G****eographic* ***I****nformation* ***S****ystems*, is today an area with a spectacular evolution. Specific ***G****eographic* ***I****nformation* ***S****ystems* operations on spatial database make these systems not only effective tools to produce maps, especially as indispensable tools for analyzing information relating to land area. Existing data to be reused, are converted into digital format, one of the main purposes of introducing GIS's is because it is very effective in creating opportunities for maintenance and updating of data. In any device used for storing or processing data there must be some way of representation. The huge volume of information refers to geographical data are handled within a GIS by computer, it represents a set of technical and organizational people, equipment norms (rules) and methods (algorithms), with the main functions: collection, validation, storage, display and data processing for get information. It follows from the above definition that is characterized by computer systems that process data in order to obtain information.

Use of the word "*geography*" is justified by the fact that GIS work mainly with geographical or spatial elements, objects - no matter their physical, cultural or economic nature-being specified by their precise position in space. Spatial representations of objects in the surrounding world through symbols, colors or line styles, used for different spatial features on a two-dimensional format, have a map as a final GIS project result. By definition, a ***G****eographic* ***I****nformation* ***S****ystem* is an organized collection consists of hardware, software, geographic data, personal and procedures for acquisition, storage, and updating, processing, analysis and display geographic information according to the specifications of applied field. The major components of a computer system are: people, equipment (hardware), data (data collection), programs (software) and procedures.

The value of GIS technology is conditioned also by the trained personal whose are responsible for system maintain/management and to develop the strategies for applying technology to solve different problems around the world. The GIS applications are running on a wide range of devices: from central servers, to individual workstations or in the type of network configurations.

The data are integrated and analyzed by a GIS from various sources, namely topographical plans, thematic maps, photogrammetry data, remote sensing data, demographic data, information based on GPS measurements, etc., influencing the criterion regarding the options in choosing hardware and software components. For a simpler way of accessing information stored at the system level, it is recommended that existing information to be stored at a single database.

Software is the component that provides data processing. This component provides some basic functions with general application and at the same time allows extension to any specific application. Software component must provide data processing algorithms in accordance with algorithms specific to the system used.

GIS is the only solution that can be solve rationally, intelligently and efficiently more difficult problems related to the use of land resources through spatial data processing and analysis, both conventional data and remote sensing data, integrated into complex databases,

heterogeneous. Applicability of GIS is unlimited most human activities have as an important feature the location in space. Information quality means quality decisions. GIS software, integrating distributed database and providing, by data processing and analysis, support in decision making is an indispensable tool to any organization. Decisions are needed in the management of any complex organization with multiple tasks interdependent.

3. National Spatial Data Infrastructure

At created a spatial geodatabase must be specify and theoretical notions on the ***N**ational **I**nfrastructure of **S**patial **D**ata*, detailing the concepts of standards, interoperability and the benefits resulting from their use, presented some general notions on spatial data infrastructure, the role of standards in achieving a spatial data infrastructure, types of standards and their role in the applications and in the end some conclusions on infrastructures spatial data. All these technologies offer new opportunities for distribution and representation of geospatial information and a spatial data infrastructure globally (GSDI), national (NSDI) or local.

It is important to understand the concept of *Service-Oriented Architecture* (SOA) and how to integrate business processes associated with the control and management of technological changes required by a Web services-oriented architecture. Today, organizations that implement an SOA infrastructure enjoy enormous benefits by ensuring an efficient productivity and performance. Through the implementation of a Web services oriented architecture, three important characteristics are met: *open access to existing information, continuity and portability, this leading to the achievement of a geospatial data infrastructure*.

It is clear, that it is necessary a change in how the systems approach to the implementation of GIS-based organization (enterprise), allowing interoperability with other information systems and fields of application. This is an essential condition in the context of transposition of the European Directive establishing an Infrastructure for Spatial Information in the European Community (INSPIRE).

Standards for databases and Web technology offers new opportunities for a better management and support for faster access of the users to large volumes of geospatial data resources. Web services and rich XML communication protocols available is increasing the migration of data between databases, distributed and centralized storage locations. The Web search engines and standardized Web services mapping provides the resources necessary to discover and consume other products, integrated geospatial information and published from a common medium-portal-with data supplied from a variety of locations of distributed data.

The purpose of standards and technologies related to interoperability is to allow users of GIS technologies to design systems that can be implemented in accordance to the IT directions. Standards in the field of information technology provide support for interoperability in the field of GIS. In this respect, interoperability standards and specifications in the field of GIS should be within the context of industrial standards in the field of information technology. Over the past 25 years have evolved the concepts and standards related to the implementation of GIS technologies and interoperability. The need for standards is required and creation of metadata for geospatial data is addressing the support for them. Metadata provides essential information for the user and enable the exchange of data about the data. Identifing metadata standards and metadata which standardizes the user needs for management and data sharing, as well as to promote global interoperability.

Because of the crucial importance of metadata in spatial infrastructures, building a GIS uses metadata communities and develops metadata servers that allow users to identify and evaluate data from different sources and different formats. GIS applications allow

creating, managing and editing metadata stored in XML format in accordance with the *Federal Geographic Data Commitee* (FGDG) on Digital Geospatial metadata content (Digital Joaquim Metadata), or according to the Geographic Information Metadata Standard ISO 19115 metadata-on. With the help of specialized applications in Metadata Services, users can create a central database – online-enabling metadata publishing and distribution via the Internet.

4. The archaelogical and historical monuments geodatabase model

The *geodatabase model* is the model for storing and managing spatial data in ArcGIS (including and behavior data), maintaining a collection of geographic datasets of different types. There are three types geodatabase: File, Personal and ArcSDE Geodatabase.

The geodatabase model of the official *List of Historical Monuments* published in 2004 and updated in 2010 is under development to effectively manage this country-wide archaeological, architectural and historic resources. *The file geodatabase model* identifies the following requirements: a) identify the location of the historic resources (historical monuments, archaeological sites and ensembles) by coordinate feature; b) identify geometry of feature; c) category of the historical resources; d) dates (discovered year, epoch, culture), e) building type and others.

The structure geodatabase used in the developed application is a structure file geodatabase that stores the information at the folder level and supports all data types that can be used in ArcGIS (Fig.1).

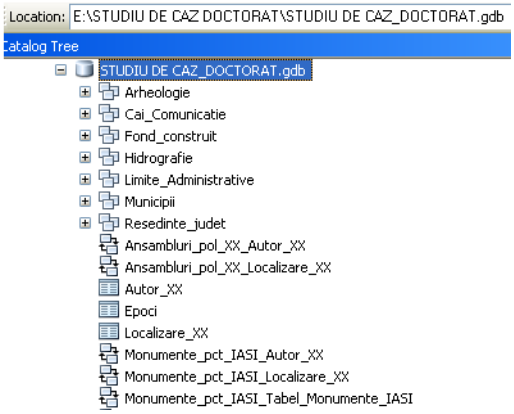

Fig 1. Geodatabase model for application

The geodatabase model contains information regarding archaeological sites and historical monuments, classified as historical monuments, organized in three large categories, in accordance with the methodology regarding the inventory of the historial monuments, who established the principles of the listed/unlisted historical monuments as: monuments, assemblies and archaeological and architectural sites. In addition, in accordance with the Law no. 422/2001, the LHM are structured in four category: archaeology, architecture, funerary-memorial architecture and public.

The geodatabase consists of the following: a) a set of feature datasets: *Arheologie, Cai_Comunicatie, Fond_Construit*, *Hidrografie, Limite_Administrative*, *Municipii, Resedinte_judet* which contains feature classes with her attributes; b) related with defined relationships classes, subtypes and domains: *Autor_XX, Localizare_XX, Tabel_XX, Tabel_Monumente_IASI_Ci, Tabel_situri_arheologice_Cucuteni;*c) and allows also business rules, relationships and behaviours to be associated with a combination of spatial and tabular data and administered through the same structure.

The main feature dataset of the geodatabase model called *Arheologie* contains the following feature classes:

- *Ansambluri_pol_XX*: a polygon feature class identifying the extent of archaeological ensembles as polygons;
- *Monumente_pct_IASI*: a point feature class representing historical monuments as points from county Iasi;
- *Monumente_pct_XX*: a point feature class representing historical monuments as points;
- *Monumente_pol_XX*: a polygon feature class representing historical monuments as polygons if delimited is possible;
- *Situri_arheologice_pct_Cucuteni*: a point feature class including archaeological sites as points from Cucuteni;
- *Situri_arheologice_pct_IASI*: a point feature class including archaeological sites as points from county Iasi;
- *Situri_arheologice_pol_Cucuteni*: a polygon feature class including archaeological sites as polygons from Cucuteni;
- *Situri_punct_XX*: a point feature class including archaeological sites as points;
- *Situri_pol_XX*: a polygon feature class including archaeological sites as polygons if delimited is possible;

Other feature classes which are stored in the geodatabase model consist of the following:

- *Cai ferate*: a line feature class representing the railroad network;
- *Drumuri*: a line feature class representing the road network;
- *Statii_CF*: a point feature class representing railroad stations;
- *Strazi_XX*: a line feature class representing the street network;
- *Localitati*: a polygon feature class representing the settlements (towns, villages, communes, Bucharest capital);
- *Judete*: a polygon feature class identifying the extent of the administrative limits (municipalities limits);
- *Rauri*: a line feature class identifying the hydrographic network as lines;
- *Lacuri*: a polygons feature class identifying the hydrographic network as polygons;
- *Bazine hidrografice*: a polygon feature class identifying the extent of the hydrographic basins as polygons;
- *Limita_Bazin_Bahluiet*: a polygon feature class identifying the extent of the hydrographic basin - Bahluiet – extend of the Cucuteni, as polygon;
- *Dunarea*: a polygon feature class representing the Danube Delta.

Associated tables carry out most of the attribute information related to:

- *Autor_XX*: table including the reference date of the author;
- *Epoci*: table including the list of historical epoch used as domain at geodatabase level for the archaeological sites, ensembles and historical monuments;
- *Localizare_XX:* table including the reference data:
- *Tabel_Monumente_IASI_Ci:* table including the reference information for historical monuments of the Iasi county;
- *Tabel_situri_arheologice_Cucuteni* Tabel: table including the reference information for archaeological sites of the Cucuteni from county Iasi.

Between the most important attributes for feature classes which to be public and referenced features are: *COD_RAN,* and *COD_LMI_2004* (primary keys)*, Denumire, Adresa,*

Latitudine, Logitudine, Epoca, Grupa, Categorie, Descriere, Cod_Ansamblu, Nume_Ansamblu, cod *SIRUTA, Localitatea, Județul*, and others. Domains assist in standardizing the sites information.

5. The Archaeological Sites Geoportal application

The Archaeological Sites Geospatial Portal application is representing also a useful, concrete first step in implementing a comprehensive spatial data infrastructure at the national level. This Geospatial Portal is implemented with GIS standards-based commercial off-the-shelf (SCOTS) technology and provides a mechanism for distributing the existing geospatial data resources to a broader community of users, such as: National Institute of Historical Monuments (INMI), the County of Culture, Religious Affairs and National Heritage (DJCCPCN), Department of Historical Monuments of the Ministry of Culture and National Heritage (Fig. 3).

Fig.3 – HOME Page of Archaeological Sites Geospatial Portal

The Archaeological Sites Geospatial Portal application is designed for the sharing of geospatial data, maps and services between government-to-government agencies and government-to-citizens. The proposed Archaeological Sites Geospatial Portal has to be a complementary component of the Romanian Spatial Data Infrastructure.

The central focus of the Archaeological Sites Geospatial Portal case study is to implement a framework that allows for discovery, query, and use of geospatial data and services. This case study results in an Spatial Data Infrastructure Portal that:

- is standards-based, built on the existing information technology standards and ISO and OGC specifications
- is open/interoperable, allowing choice of databases, hardware, networks, GIS software and web browsers
- is engineered using SCOTS software
- creates horizontal and vertical integration opportunities to discover and use of geospatial data and web services
- is scalable to millions of users
- facilitates ISO TC 211 compliant metadata tool use
- is extensible to include government ministries and departments as well as non-governmental and private sector participants and
- implements a common architecture that could be implemented on both open citizen-centric e-government networks and secure networks for the national security requirements.

The major components of the Archaeological Sites Geospatial Portal are: a) web site, b) accessibility, c) content management and d) administration.

- Web site provides the functional capabilities to publish and search metadata and visualize and directly connect to geospatial data and services over a distributed network. Subcomponents of the web site include interaction interface, home page, data categories, about this site and an information center.
- Access gives the ability to explore, query and use data and services through metadata catalog, metadata search functionality, search results process and a *map viewer* component (Fig.3).

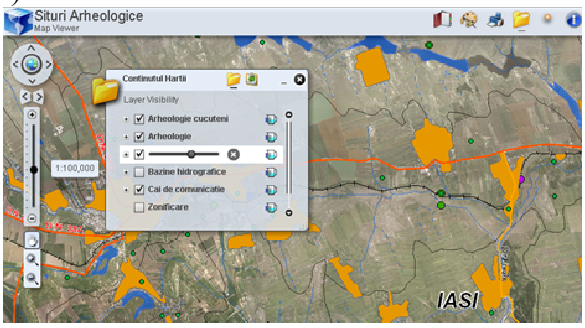

Fig 4. *Map Viewer* component

- Content management that allows users to participate in the Archaeological Sites Geospatial Portal using XML files and metadata harvesting
- Administration consists of the user account management and geospatial administration component.

The Archaeological Sites Geospatial Portal provides wider access to geographic data and services and can serve as a catalyst for advancing Spatial Data Infrastructure activities in Romania.

The Archaeological Sites portal implementation provides users with a set of tools to easily discover, query, and access information on geospatial data holdings and services, including the ability to interactively display and query the data and services. In other words, the structure provides a set of tools to:

1. Publish metadata from data providers to the Archaeological Sites Geospatial Portal
2. Search metadata in the Portal metadata catalog
3. Connect data and services amongst providers to users.

In many cases, the key data sets have already been created within specific agencies or departments. More often than not, a variety of technology platforms are being used to create and manage these data sets and services. As such, one of the key technical challenges in implementing a coordinated Romanian Spatial Data Infrastructure involves collaboration and interoperation among a variety of systems, providing access to the wealth of existing spatial data resources.

This case study of the operational Archaeological Sites Geospatial Portal will allow for the easy discovery, query, and use of geospatial data, Web services, and organizations from existing national, county, and local geographic information system assets.

6. Conclusions

The Romanian Archaeological Sites, Ensembles and Historical Monuments Inventory application represents a centrally managed GIS system to create and implement an enterprise GIS system that could be applied to the national historic resources inventory. Building a

national geospatial infrastructure regarding to the cultural heritage seems to be a stringent necessity and, in the same time a future desire for the local authorities. Using a geodatabase model will allow them a better management of the National Archaeologic Directory and also the List of the Historical Monuments".

The major benefits of the Archaeological Sites Geospatial Portal application are described below:

- A performant tool for decision makers at the national level to eficiently manange the cultural heritage resources.
- A centralized archaeological geodatabase allows users to modify the geodatabase schema, or to integrate new information according to their needs into the application.
- Advanced ArcGIS users are able to directly access the geodatabase model for advanced spatial analysis and mapping.
- All departmental staff are able to work in a centrally managed GIS environment and fulfill business processes for multiuser viewing, editing, and dissemination of cultural heritage resources in a timely way.
- Implementing a centralized management system using GIS technology will allow us to support also the geospatial specifications and standards required by European Community;
- The geodatabase model offers a better support to take the right decisions to follow the administrative, rehabilitation and preservation tasks and also to promote our national cultural heritage resources.

The Archaeological Sites Geospatial Portal application is a useful tool for research and planning purposes at a variety of scales. The geodatabase model provides practical benefits, including more efficient planning, and incorporation of cultural resources early in the local and country-wide planning process. The ultimate goal is to reduced disturbance of cultural resources and increase our knowledge of the past.

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