AN INTEGRATED FRAMEWORK FOR THE IMPLEMENTATION AND CONTINOUS IMPROVEMENT OF THE ROMANIAN SPATIAL DATA INFRASTRUCTURE

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Abstract: This paper provides an overview of the first version of the Romanian NSDI GeoPortal. Geospatial data availability, interoperability and integration remain is still a problem of the current spatial data infrastructures (SDIs). The Romanian INIS GeoPortal, an ANCPI's special IT project, has aimed to address those challenges today. This online GeoPortal application enables easy, open, seamless, and on demand discovery, access, retrieval, visualization and analysis of distributed geospatial data, information, applications and web services from any member of the NSDI INIS Council. Challenges must still be resolved, but a mature next release of the Romanian INIS GeoPortal will produce tremendous benefits for the Romanian society and our National Spatial Data Infrastructure implementation.

1 INTRODUCTION

The Romanian INIS GeoPortal is designed to facilitate the discovery and exchange geospatial data resources to a broader community of users.

By the end of 2009, the National Center for Geodesy, Cartography, Photogrammetry and Remote Sensing completed a complex project which is a major milestone of the NSDI building efforts compliant with the INSPIRE Directive of the European Union (2007/2/EC). These efforts motivated us to develop the initial release of the Romanian INIS GeoPortal by the National Agency for Cadastre and Real Estate.

The associated growth in geospatial data collection activities by the National Agency for Cadastre and Real Estate and its subordinated institutions and other government organizations has a real potential and major benefits to improve decision making process and operations at all national levels through the Romanian INIS GeoPortal application.

A centralized national metadata system and the national geographic data system based on a uniform reference data model and standards are provided via the Romanian INIS GeoPortal application.

Web 2.0 era provides new principles and technologies that facilitate information sharing and collaboration and encourage user-generated content, including bottom-up flow of information, open and interoperable Web services, Web-oriented architecture, mashups, geobrowsers, cloud computing. All these technical advances are working in favour of our National Spatial Data Infrastructure (NSDI) implementation.

The feasibility and benefits of building the new generation of our NSDI by expanding the use of the Web 2.0 technologies are reflected also in our initiative at the national level and demonstrated by the success of the Romanian INIS GeoPortal application.

The geospatial resources published in our online Geoportal application are shared as open, standardized and easy-to-consume Web services as much as possible to facilitate being easily reused and remixed via mashups, geobrowsers and other applications.

The published Web services are made available to other members of the NSDI INIS Council in accordance to their access rights and to citizens when appropriate, thus maximizing the value of the existing geospatial resources.

With the Romanian INIS GeoPortal the search time is reduced from days to seconds. As a broker

between the INIS Council data providers and the users, we do consider that our INIS GeoPortal represents an important and highly visible component of the National Spatial Data Infrastructure, serving as the "face" of Romanian Spatial Data Infrastructure.

2 INSPIRE DIRECTIVE AND ACTIVITIES ON NSDI DEVELOPMENT

2.1 Organizational Aspects

The National Agency for Cadastre and Real Estate (ANCPI) is a state administrative organization dealing with administrative and professional tasks related to cadastre, geodesy, cartography, real estate, remote sensing and spatial data infrastructure. ANCPI is organized in Central Office, County Offices of Cadastre and Real Estate and Local Offices which are organized as decentralized public services with headquarters in the municipality of each county.

The National Center for Geodesy, Cartography, Photogrammetry and Remote Sensing (CNGCFT) is a public organization which is subordinated to ANCPI. ANCPI represents Romania in EuroGeographics organization as an active member and developed the national datasets to support the EuroBoundaryMap, EuroGlobalMap, EuroRegionalMap and EuroDem projects.

During 2008-2010, the National Agency for Cadastre and Real Estate was building the ROManian POsitioning System (ROMPOS). The national system is being built using the most advanced GNSS technological solutions. ROMPOS was launched on September 8th, 2008, and has already been used by the professionals and other commercial users from Romania.

The National Agency for Cadastre and Real Estate was also one of the main initiators to support SDI activities in Romania as part of the first INSPIRE work group in 2005.

By the end of 2009, the National Center for Geodesy, Cartography, Photogrammetry and Remote Sensing (CNGCFT) completed a complex project which is a major milestone of the NSDI building efforts compliant with the INSPIRE. CNGCFT's efforts allowed ANCPI to define a strategy and implement a centralized cartographic and mapping production system which led to establishing of Topographic Information System

(TOPRO5), at scale 1:5.000.

Through TOPRO5 project ANCPI standardized the topographic datasets and has defined detailed solutions of the national topographic information system in domain of data models, metadata rules and procedures, accuracy, ways of presentation, topological rules and sharing methods.

2.2 National Legal Aspects

The "Law of Cadastre and Real Estate Publicity" (Law no. 7/1996) represents an important law for the NSDI implementation framework. It regulates the activities in the domains of cadastre, geodesy and cartography. ANCPI (former the National Office of Cadastre, Geodesy and Cartography) was founded by this law.

The ANCPI is a public institution which is organized according to the Romanian Government Decree No.1038/1996 and of its subsequent modifications (Romanian Government Decree No. 98/1999). The ANCPI has been brought under the Ministry of Interior and Public Administration on July 1st, 2001. Before July 2001, the ANCPI was linked to the Ministry of Agriculture. ANCPI's role in the central public administration is to organize, manage and coordinate the cartography, geodesy, photogrammetry, remote sensing and cadastre activities at national level according to the legal settlements in these domains.

Directive 2007/2/EC of the European Parliament and of the Council of 14th March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) entered into force on the 15th May 2007 and operated by the 27 Member States of the European Union. The transposition into the Romanian legislation was January 2010 and is published in the Romanian Official Journal on January 29th, 2010–OG 04/2010.

In the context of INSPIRE, an open and transparent process for the national stakeholder participation has been set up. Stakeholders are part of the INIS Council which is under the coordination of ANCPI as a Legal Mandated Organization in INSPIRE.

INIS Council includes 19 organizations which are composed of Technical Working Groups experts for developing the technical specifications for each spatial theme in annexes that they are responsible for – Table 1. ANCPI plays a central role in reviewing and testing the draft implementing rules and in assessing their potential impacts in respects to both costs and benefits.

Table 1: INIS Council roles-key data themes addressed by INSPIRE.

Responsible public authority	Annex no. Spatial data theme
Ministry of Interior and Public Administration - ANCPI	I.1 Coordinate reference systems
	I.2 Geographical grid systems
	I.4 Administrative units
	I.5 Address
	I.6 Cadastral parcels
	II.3 Orthoimagery
	III.2 Buildings
	III.6 Utility and governmental services
Ministry of Environment and Forests	I.8 Hydrography
	I.9 Protected sites
	II.2 Land cover
	III.7 Environmental facilities
	III.8 Production and industrial facilities
	III.11 Area management/restriction/regulations zones and reporting units
	III.13 Atmospheric conditions
	III.16 Sea regions
	III.17 Bio-geographical regions
	III.18 Habitats and biotopes
	III.19 Species distribution
Ministry of National Defence	I.3 Geographical names
	II.1 Elevation
Ministry of Agriculture and Rural Development	III.3 Soil
	III.9 Agricultural and aquaculture facilities
National Institute of Statistics	III.1 Statistical units
	III.10 Population distribution - demography
Ministry of Regional Development and Tourism	III.4 Land use
	III.12 Natural risk zones
Ministry of Transportation and Infrastructure	I.7 Transport networks
Ministry of Education, Research, Youth and Sports	II.4 Geology
Ministry of Health	III.5 Human health and safety
Ministry of Economy, Trade and the Business Environment	III.20 Energy resources
National Agency for Mineral Resources	III.21 Mineral resources

2.3 Challenges

An important challenge is to maintain a high level of commitment of all stakeholders and their experts to contribute to the development of INIS. This is not trivial and requires a notable amount of expertise, money, time and commitments as resources to ensure a more effective implementation.

ANCPI is nominated as a contact point with the European Commission and is in the process to set up an appropriate coordinating mechanism inside INIS Council. The difficult financial climate of this period makes it potentially more challenging to support investments in new IT infrastructures, education and training services.

At the local level many public sector administrations still have limited or no knowledge of INSPIRE Directive due to an insufficient dissemination efforts. We will see their local and regional involvement to be more directly involved when the data themes INIS's organizations are responsible for, mainly in Annex I and II are addressed by INSPIRE.

2.3.1 Technical Challenges

Very few people understand or use the complexity of the technical documentation of the INSPIRE architecture. Even in using the guidelines for the creation of metadata files that are compliant both with the INSPIRE Implementing Rules for Metadata, as well as relevant European and international standards for geographic information represent a technical challenge at this moment.

The capacity to sustain the training process, technical competencies, consistence of training materials and translation into Romanian language have to be build up immediately. ANCPI have been significant efforts in respect to the IT infrastructures and signed an Enterprise License Agreement with ESRI for three years to sustain coordination of the INIS Council activities.

Another challenge during the implementation of the Romanian INIS GeoPortal is creating and hosting geospatial Web services requires more GIS servers. Hosting Web services and keeping them available with high performance and scalability twenty-four hours a day requires appropriate infrastructure. ANCPI is still in discussion to partner with other government agency to have them host the data as Web services or to have its data aggregated to the partner's infrastructure via real-time data replication services or periodic ETL (extract, transform, and load) processes.

3 ROMANIAN INIS GEOPORTAL

3.1 Generalities

The Romanian INIS GeoPortal (Figure 1) developed by ESRI Romania is designed to facilitate the discovery and exchange geospatial data resources to a broader community of users. By the end of 2009, the National Center for Geodesy, Cartography, Photogrammetry and Remote Sensing completed a complex project which is a major milestone of the NSDI building efforts compliant with the INSPIRE.

Figure 1: Romanian INIS GeoPortal home page.

The first version of the Romanian INIS GeoPortal provides access to the following resources: Romanian Base Map-TopRo5, at 1:5.000 scale, orthophotos at 1:5.000 scale, raster datasets including scanned maps, topographic maps and digital elevation models, network services and applications (Figure 2).
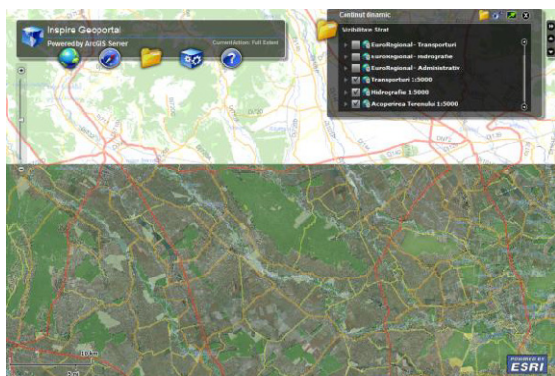

Figure 2: Romanian INIS GeoPortal – first published resources.

Geographic data available covers most of the themes of the INSPIRE Annexes I and II. Orthopotos at 1:5.000 scale has been used free by all public and local authorities, Ministry of Agriculture for the Land Parcel Information System and Ministry of Environment as a decision support for the Natura2000 and the following environmental sectors: nature conservation, industrial pollution control and risk management, air quality and noise, waste management and water quality.

The Romanian INIS GeoPortal connect users to other databases, services and geoportal applications and serve as a catalyst for advancing Spatial Data Infrastructure activities in Romania.

The associated growth in geospatial data collection activities by the National Agency for Cadastre and Real Estate and its subordinated institutions and other government organizations from INIS Council has a real potential to improve decision making process and operations at all national levels.

3.2 Major Components

The Romanian INIS GeoPortal has four major components: a) web site, b) accessibility, c) content management and d) administration.

The web site component provides the functional capabilities to publish and search metadata and visualize and directly connect to geospatial datasets and services over a distributed network.

The second component – accessibility - gives the ability to explore, query and use environmental datasets and services through metadata catalogue, metadata search functionality, search results process and different map viewers.

Inside the Romanian INIS GeoPortal was developed a customized map viewer presented below in Figure 3, dedicated for the INIS Council users.
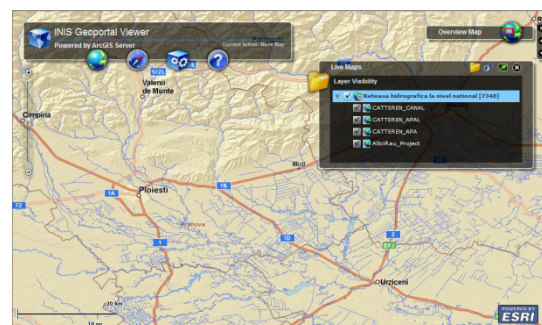

Figure 3: Romanian INIS GeoPortal – customized map viewer.

Content management of the Romanian INIS GeoPortal allows INIS Council users to participate in using XML files and the last component consists of the user account management and geospatial administration component.

There are four different types of users with different roles accommodated by the Romanian INIS GeoPortal: anonymous, registered, publisher and administrator. In order to get access to the specific functionalities or to save searches and publish metadata, the user should be registered through a unique account based on username and password. If the user would like to request publisher access to the Romanian INIS GeoPortal, it should use the Feedback link to contact the GeoPortal Administration.

The main goal of the Romanian INIS GeoPortal is to provide a powerful tool that allows INIS Council's users to publish, discover and browse for GIS resources. The GIS resources that are identified in the first version of the Romanian INIS GeoPortal are:

- Live Data and Maps - under this category are:
  - ArcGIS Server Services: Geodata Services; Mapping Services; Network Services; Image Services; Geoprocessing Services and Geometry Services;
  - OGC Web Mapping Service;
- Data Source - under this category are: OGC Web Feature Service; OGC Web Coverage Service; Downloadable data and Offline data;
- Models and Tasks - under this category are: ArcGIS Explorer Tasks; ArcGIS Toolbox and OGC Web Processing Services;
- Map Files - under this category are: ArcMap Document; ArcGIS Explorer Document; ArcMap Layer and OGC WebMap Context Document;
- Static Image Maps – under this category are: Scanned maps and exported maps.
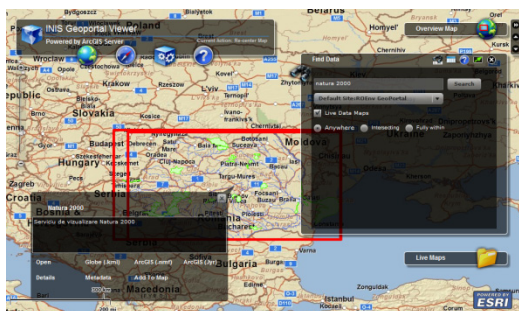

Figure 4: Romanian INIS GeoPortal published resources available – Live data and maps.

3.3 Discovery Services

Searching through the INIS Geoportal's metadata catalog is a quick way to find the data by the users. If the users are registered in the Romanian GeoPortal, it is possible to save their search criteria.

There are two search options available in the Romanian INIS GeoPortal: a) basic and b) advanced. The basic option (Figure 5) is accessed directly from the GeoPortal home page and the results will display in the search results page.

Figure 5: Romanian INIS Geoportal search type – basic option.

The advanced search option provides more search functionality - based on a text, spatial criteria or combination of both criteria, enabling to define more details for the user search.

Registered users in the Romanian INIS GeoPortal have the option of saving the search criteria so the search can be loaded again quickly in the future by clicking the "My Saved Searches" link and naming the search. Each returned record has options associated with it.

The users could double click the metadata record to expand its information section and see the following options: Open, Preview, Website, Details, Metadata, Zoom To and Thumbnails.

At the bottom of the search result page (Figure 6), there are six options: GEORSS, ATOM, HTML, FRAGMENT, KML and JSON that enable users to see their search results through the REST API.
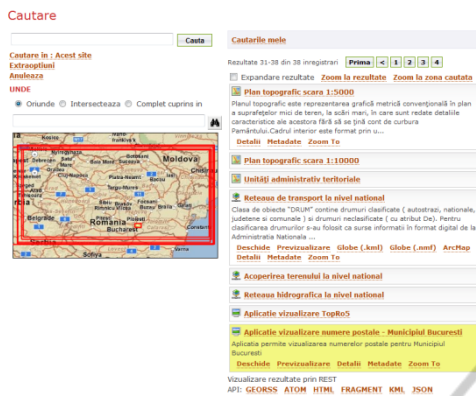
Figure 6: Romanian INIS GeoPortal search results – REST API interface.

3.4 Metadata – Publish, Manage and Access Rights

The success of the Romanian INIS GeoPortal depends on the quality of metadata records it hosts. The ISO standards – ISO 19115:2003 and ISO 19119:2005, respectively for metadata for datasets and services are published and approved before it can be discovered. Publishers can upload metadata or create metadata to publish it to the Romanian INIS GeoPortal.

At the moment of this published document, there are approximately two hundred of metadata records published. The validation is very important because an invalid metadata will not be published. The application schema for datasets and services used for validation inside the Romanian INIS GeoPortal is from ISO repository.

Figure 7: Romanian INIS GeoPortal – metadata.

Metadata is managed through the Administration section in the Romanian INIS Geoportal. A publisher user can only view and manage the records he owns and the Geoportal administrator can view and manage all the records uploaded by all publishers and himself. Validation (Figure 9) is very

important because an invalid metadata will not be published.

The Romanian INIS GeoPortal identifies the standard and then use the record's definition XML file to determine what elements are mandatory. All mandatory elements must be presented for the document in order to be published to the Romanian INIS GeoPortal.

Publishers registered to the Romanian INIS GeoPortal designate what kinds of users see their records in accordance to the access policy configured by ANCPI and controlled at the record level.

3.5 Data Download and Transformation Services

The Romanian INIS GeoPortal allows the users to download data from a published map service through the Data Download interface.

This functionality is implemented by a tool which allows the users to specify the layers of data that want to be downloaded, the map projection of the data, the output file format they want to receive it, and the desired spatial extent. The downloaded data are emailed to the user in a zipped file.

Transformation services available in the Romanian INIS GeoPortal during the first phase allow users to: a) transform coordinates from one coordinate system to another and b) to transform data using Data Interoperability capabilities from different data formats to another.

3.6 Testing INIS GeoPortal

The Romanian INIS GeoPortal was tested according to test items and test cases described in the Test Plan document. The test cases identification and design has been designed to perform and analyse the functional specifications and requirements, to identify test items and to design test cases that covered all test items.

The initial process of the Test Plan included eleven test cases and several sub-test cases consisting of:

- Basic user interface-oriented functions in the browser window;
- Search metadata using specific criteria;
- Retrieval of metadata search results;
- Client map viewer functions;
- Client map viewer interoperability;
- Publish and retrieve metadata, as an authenticated user;
- User related information management;

- Metadata administration functions;
- Browser compatibility;
- Geoportal application server capabilities and
- Standards compliance for data and metadata.

During the testing process of the Romanian INIS GeoPortal application has occurred only one failure related to the multiplicity of the metadata element, as defined in the INSPIRE implementing rules and ISO 19115/19119. This issue is planned to be solved this summer when ANCPI is launching the next release of the Romanian INIS GeoPortal.

3.7 GeoPortal Case Studies

In Romania, there are several developed geoportals that can be classified by their usage, theme or content format.

This section presents three different Romanian Geoportal designs that can be categorized as personal (Table 2), organizational (Table 3) and national (Table 4) implementation, depending on their usage. By theme, these three case studies of geoportals have more specific orientations such as biodiversity, environmental policies and general subjects. By format, these geoportals range from only Web services to other formats and combinations of data and Web services.

Table 2: Personal geoportal - design considerations.

Usage	Personal geoportal
Address	http://www.geoportal-mediu.ro
Characteristics	Convenience and seamless integration with the proprietary tools that biodiversity community use are focused. National standards are less important.
Metadata	Comply with ISO 19115/19119 standards.
Publishing method	Online form, XML upload, batch publishing and harvesting are available.
Administration	Automatic.
Security	Varies with specific requirements related to three levels: custodian, Ministry of Environment and public users.
Discovery method	Search or browse.
Result ranking	Not important due to a small numbers of records.
Performance tuning	Not an issue with the small number of habitats and species records.

Table 3: Organizational geoportal - design considerations.

Usage	Personal geoportal
Address	http://www.roenv-geoportal.ro
Characteristics	National and international standards (ISO metadata and OGC Web services) are important.
Metadata	Comply with ISO 19115/19119 standards.
Publishing method	Online form, XML upload, batch publishing and harvesting are available.
Administration	Manage accounts and metadata.
Security	Varies with specific requirements related to four levels: anonymous, registered, publisher and administrator.
Discovery method	Search or browse.
Result ranking	Important.
Performance tuning	Very important when the size of the metadata catalog is increasing for each of the following environmental sectors (nature conservation, industrial pollution control and risk management, air quality and noise, waste management and water quality).

Table 4: National geoportal - design considerations.

Usage	Personal geoportal
Address	http://geoportal.ancpi.ro
Characteristics	National standards and INSPIRE Directive (ISO and OGC international standards) are very important.
Metadata	Comply with ISO 19115/19119 /19139 standards.
Publishing method	Online form, XML upload, batch publishing and harvesting are available.
Administration	Automatic.
Security	Varies with specific requirements related to four levels: anonymous (public users), registered (44 INIS Council), publisher (15 INIS Council) and administrator.
Discovery method	Search is critical and browse is also available.
Result ranking	Very important. A search result may return hundreds or more matching records available.
Performance tuning	Very important when the catalog is increasing.

4 CONCLUSIONS

One of the most important benefits of the Romanian INIS GeoPortal is GeoRNS (Geographic Resources Naming System) which assign a unique identification number for a published geospatial resource. The GeoRNS web service is available via SOAP and REST interfaces. This novelty of the developed geoportal application allows us versioning and easy tracking of the published geospatial resources.

The second phase of the development of the Romanian INIS GeoPortal will address the following issues:

- Sustainable efforts to complete the metadata records describing all existing geospatial information resources
- Harmonization of key spatial data themes across INIS Council to support environmental policies
- Agreements on network services and technologies to discover, view, access and download information resources
- Policy agreements on data sharing and access, including electronic licensing and eCommerce to support whole processes online
- Coordinating and monitoring Quality-of-service mechanism at the national, local and regional level
- Availability of the advanced transformation services
- Advanced security and access control

The Romanian INIS GeoPortal implements a framework that is standards-based, built on the existing information technology standards and ISO and OGC specifications and it is open/interoperable, allowing choice of databases, hardware, networks, GIS software and web browsers. It is scalable to millions of users and creates horizontal and vertical integration opportunities to discover and use of geospatial data and web services.

Lessons learned from this application research and new technologies in the future can improve the quality of the geospatial Web services in support of easy, fast, reliable, scalable and secure any Geoportal application. This will serve to maximize the return on geospatial investment for the Romanian society as a whole.

The deployment of the Romanian INIS GeoPortal will improve knowledge sharing, reduce duplication of effort, direct people toward the best available data, and improve the overall quality of geospatial data and information of the National Spatial Data Infrastructure.

ACKNOWLEDGEMENTS

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