A web based geoenvironmental data exchange information system

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Abstract: - Different geoenvironmental databases exist in European countries. They are dispersed and have various standards and languages applied. Thus their usefulness and availability are limited, although geophysical information may be very effectively applied, processed and interpreted for a wide variety of purposes. Processing will be enhanced if these databases are integrated in a certain level and accessed via the Internet, offering cross border, European-wide, unified electronic services, making geoenvironmental data much more available. In an effort to increase utilization of geoenvironmental data the MILDMAP-MEDIA consortium has developed an web based data exchange system that provides a convenient storage point for documenting, archiving and exchanging datasets. The users of the system can enter metadata that describe their datasets, upload their dataset files, edit their entries, search for data using specific criteria, browse metadata of datasets in the system and download datasets from the system. The functional design and implementation of this system are presented.

Key-Words: - data exchange, web based, information system, metadata, geoenvironmental

1 Introduction

The data exchange system is a component of a common decision support system which integrates different methodologies and techniques for monitoring, analysis and assessment of physical processes [1]. The objective is to improve the decisional chain for the control and prevention of natural hazards. Methods based on common procedures will be defined and will be applied by the operational institutions involved in the land and territory management of Mediterranean areas (figure 1). This effort is performed under the MILDMAP-MEDIA project which is funded by the EU program INTERREG IIIB Archimed.

The exchange system for geoenvironmental data is based on database catalog browsing services and allows easy access to all collections held by the involved project partners [2]. All data are described by metadata, ensuring the organized archiving and retrieval of files. The kind of data stored in the system are either raw data collected by earth observations, experiments, field measurements etc or processed data derived from simulations, modeling of conditions etc.

Fig. 1: Area of interest.

The importance of the existence and preservation of geoenvironmental data is the input they provide in the definition of policies, strategies and / or interventions for the land degradation control due to

the criticality of the territorial systems they refer to [3]. The objectives, specifications, design, architecture and implementation of the online data exchange system are presented in the following paragraphs.

The aim is to establish common methodologies by the synthesis and organization of all information directly obtained by the partners of the project. Modelers and experimentalists are often unaware of collaboration possibilities and invest significant resources in collecting data solely in order to meet their specific objectives. Immediately after the achievement of the objective, datasets produced or collected are often filed away with poor documentation and with no chance of reusing them. The implementation of a system that can store data with adequate documentation (metadata description system) will provide easy access for those who might want to use data again.

Internet database systems are an effective way of archiving and disseminating data because anyone with internet access can acquire them [4]. Moreover, low cost and public domain software are now available for developing such systems. The main issue is to design and implement a database system accessible through the Internet for all the geoenvironmental datasets which are acquired and processed by project partners. A fundamental requirement for this system is an easy to use graphical interface that must be provided to allow the input of search criteria for querying and exploring the database. Such criteria can be a scene location selection in a map, or date and type of a dataset. This graphical user interface (GUI) should show the user all the available datasets that satisfy the search criteria and should give the option to view their details and metadata. Finally, web technologies are used in order to enable the application server-side logic to efficiently store and retrieve both data and metadata.

2 System Architecture

The system's architecture is based on the two-tier design. It consists of three components distributed in two layers: client (requester of services) and server (provider of services). The three components are the graphical user interface, the processing / querying services and the database management section. The design allocates the graphical user interface exclusively to the client side, the database management section on the server and splits the processing management between client and server, creating two layers. Figure 2 shows the two tier software architecture [5].

The two-tier architecture has been chosen because the information processing is not time critical, the management and operations executed in the system are not complex and the data exchanged are not confidential. Another reason is that this design is used frequently in decision support systems where the transaction load is light. Two-tier software architectures require minimal operator intervention and have demonstrated that they work quite sufficiently and efficiently in relatively homogeneous environments with processing rules (business rules) that do not change very often.

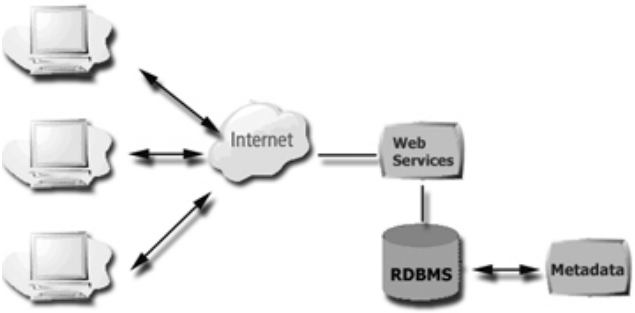

Fig. 2: System Architecture

In general, the client's graphical user interface invokes services from the database management server [6]. Clients communicate with the server through SQL statements or a call-level interface. This particular architecture improves system's flexibility and scalability by allocating the two tiers over the computer network. It also improves usability because it makes it easier to provide a customized user system interface.

Before the system implementation, the infrastructure of each partner was examined in order to employ a system that would be compatible with the technologies that are already in use. Almost all of the partners are using Microsoft operating systems and Microsoft database servers in their local networks. Therefore, the user interface was developed using Active Server Pages scripts (ASP; Microsoft Corp., Redmond, WA) and Hypertext Markup Language (HTML). The relational database was built using the database software Microsoft SQL Server 2005. The server's operating system is Windows 2003 Server (Microsoft Corp., Redmond, WA) and has installed the Microsoft's Internet Information Server 6.0 as its web server software (Microsoft Corp., Redmond, WA).

3 System Description

The data exchange system is administered by the MILDMAP-MEDIA project consortium. A relational database supports the system. In this database the uploaded files are stored along with their description based on the metadata description system as shown in figure 3. The data collections reside in various resources and network infrastructures of the member organizations. Partners are enabled to classify all information and either limit access to them within the project members or make them accessible from users outside the project. This enhances both the private and the public character of the project.

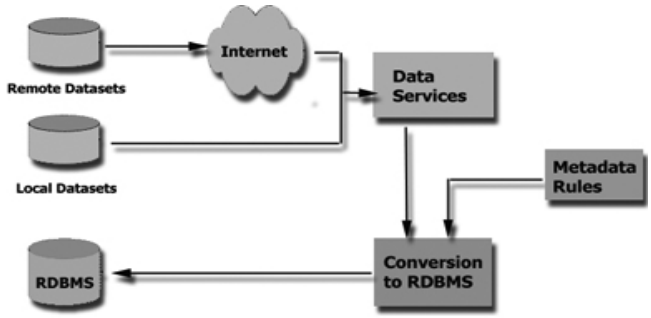

Fig. 3: Data System

4 Metadata

Metadata are data that describe other data. They provide information about a certain item's content. For example, an image may include metadata that describes how large the picture is, the color depth, the image resolution, when the image was created, who created the image file. A text document's metadata may contain information about how long the document is, who the author is, when the document was written or last modified and a short summary of the document.

Geoscience is a multidisciplinary science with numerous data types. Therefore, it is not feasible, by using only one uniform metadata standard, to describe and manage all these data resources. On the other hand, redefining such standards is not necessary because many of them have been used in practice. So, at present, designing the geosciences' metadata infrastructure should take two factors under consideration. First, the metadata must contain the most common elements of geosciences in order to be able to describe in an efficient manner the datasets. Second, the metadata must be extensible and satisfy the extending needs of the users of the system. According to the above, geosciences' metadata are composed of two parts. The first part is catalog information, which is used in the general description of datasets. The second part is metadata's detailed description of their content.

One of the most well developed element sets is the Federal Geographic Data Committee (FGDC) Content Standard for Digital Geospatial Metadata (CSDGM), officially known as FGDC-STD-001-1998 [7]. Geospatial datasets include topographic and demographic data, GIS (geographic information systems), and computer-aided cartography base files. They are used in a wide variety of areas, including soil and land use studies, biodiversity counts, climatology and global change tracking, remote sensing, and satellite imagery. The FGDC Content Standard is required for use with resources created and funded by the U.S. Government and is also being used by many state governments. An international standard, ISO 19115 [8], Geographic Information — metadata was issued in 2003. A technical amendment that will allow datasets to be both ISO and FGDC compliant is underway along with an implementation model.

A common method for describing and organizing the available content through the use of metadata was implemented facilitating the search, sharing and information exchange. Metadata, as defined in the context of the project and according to feedback from partners, provide information regarding data stored, such as format, size, method created, owner, area of interest and other essential information. This way, users may dynamically invoke on-line search, based on certain criteria or upload material describing it with the necessary metadata. A typical table of the metadata description system is shown in figure 4.

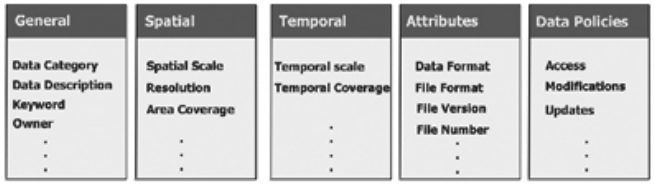

Fig. 4: Metadata Common Description System

Metadata and data files are stored in the system with a user friendly management tool. For the metadata entry, users complete an online form by using text fields, check boxes or pull down menus. Some of the metadata fields are mandatory and some of them are optional. The mandatory fields are denoted by an asterisk. Users cannot proceed in uploading a file unless these fields are completed.

Examples of required fields are owner name, contact information, dates of data collection etc (figure 5).

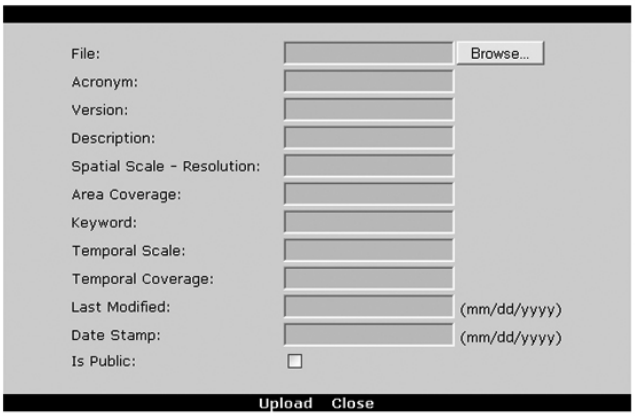

Fig. 5: Metadata Fields

5 Data Access

Data can be accessed either form the front end graphical user interface of the system or by the content management tool. The front end can be used from all users regardless whether they belong to the project consortium or not or whether they are registered or unregistered. Users that are not registered can only access data that are characterized as public (figure 5) and they have read-only rights. On the contrary, the content management tool is explicitly addressed to registered project members and allows them to manage their files. Partners have to login to that application as shown in figure 6.

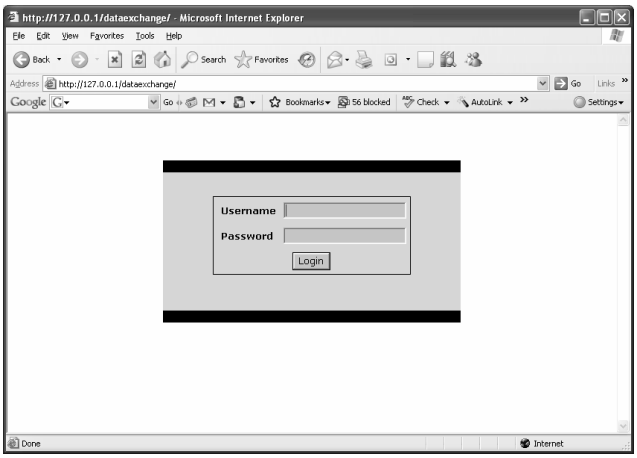

Fig. 6: Login form

There are different privileges and roles assigned to every partner and these are managed by the administrator of the system. Each user can alter the description of data (metadata) and the content only of the files they have uploaded, unless they are assigned such a role for more datasets by the administrator through the form shown in figure 7. Access to content can be granted at the content level and can be given to an entire group or an individual user, as desired. Access can be granted to view, edit, publish or even delete various data files.

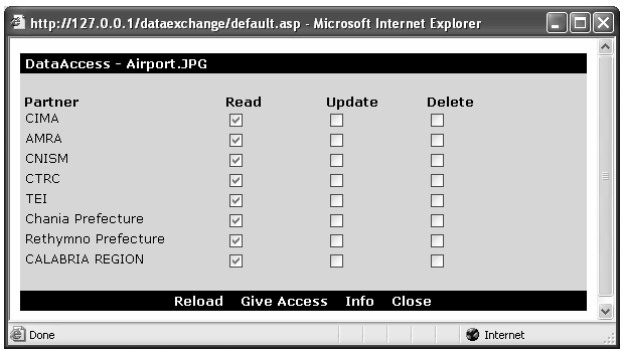

Fig. 7: Form for assigning privileges

6 Data search and download

When searching for data, users can customize their search by specifying parameters according to the metadata (figure 8). After the search criteria are entered, the system searches the database tables and returns - according to the access rights the user performing the search has - summary information for each dataset that matches the given criteria. If no criteria are entered, summaries for all data in the database are displayed (figure 9). Users can then select specific datasets in order to view their description or perform the available actions such as update / modify the data and metadata, delete the file etc.

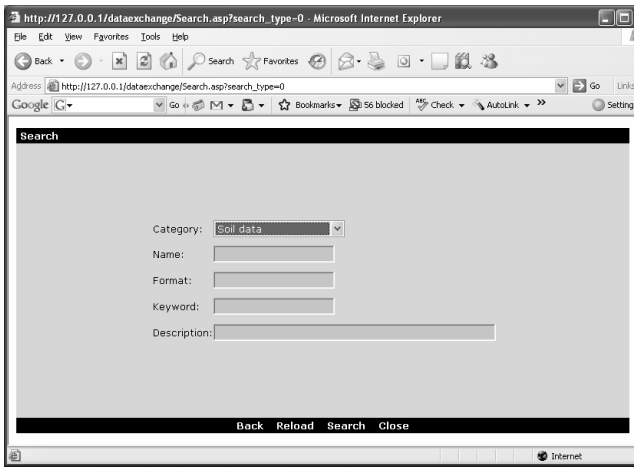

Fig. 8: Search form

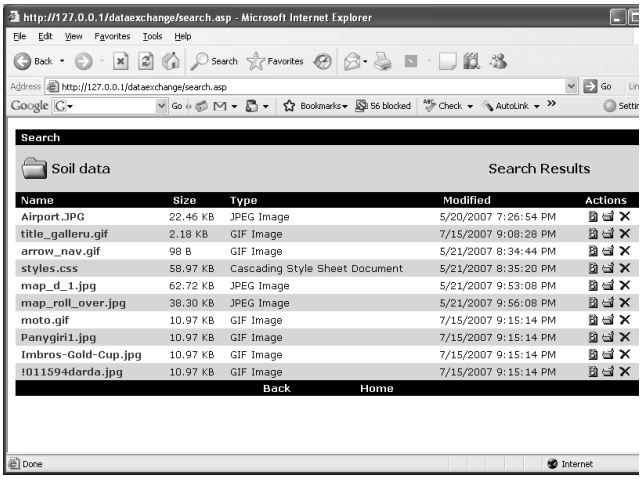

Fig. 9: Search results

Every file stored in the system is accompanied by download permissions as defined by its owner who has uploaded it to the system. Users can either open files or save them to their local disk drives (figure 10). A download link is displayed next to the filename if the user who is viewing it has appointed by the privilege to be able to download it. In the case that data files are not available, the data holder's contact information is provided so that the user can request access to the data or obtain additional information.

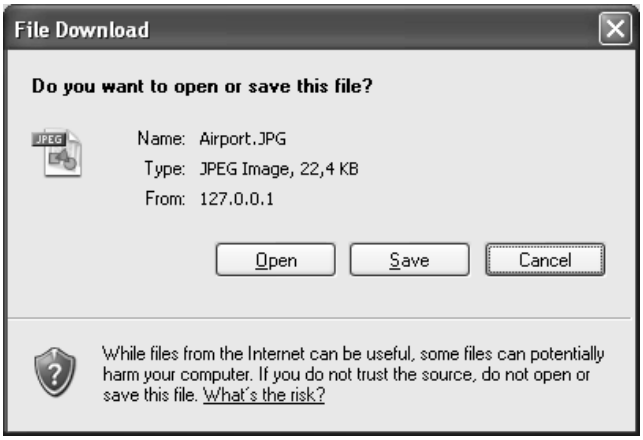

Fig. 10: File save window

7 Discussion

The MILDMAP-MEDIA data exchange system is convenient and easy to use because of its availability regarding accessing and archiving data at any time from any location. The system is accessible from any PC with Internet connection through a user friendly graphical interface and supports any type of web browser. It improves data availability and increases data reusability. This constitutes the backbone of the decision support system which is developed and applied for land degradation management and planning for the areas of interest.

A key element to this effort is that data are described by metadata. Although the data and metadata entry process can be accomplished via a simple user interface, it may sometimes deter data holders from performing this operation. Therefore, a further step of system development would be to automate metadata and data uploading to the database. One of the main purposes of the MILDMAP-MEDIA project is cooperation between scientists for sharing data, software applications, models and other entities. As the data exchange system becomes more robust and well known, it could become an important tool to those who are developing and applying decision support systems.

References:

[1]van Delden, H., van der Meulen, M., Engelen, G., 2003a. An integrated policy support system for land degradation and desertification in Mediterranean river basins. Framing Land Use Dynamics. *International Conference, Utrecht University,* The Netherlands, 16–18 April.

[2]Tochtermann, K., Riekert, W.-F., Wiest, G., Seggelke, J., Mohaupt- Jahr, B., 1997. Using semantic, geographical and temporal relationships to enhance search and retrieval in digital catalogs. Peters, C., Thanos, C. (Eds.) *Research and Advanced Technology for Digital Libraries.* First European Conference, ECDL'97*,* Pisa, September 1997.

[3]Gunther, O., 1998. *Environmental Information Systems*. Springer Verlag, Berlin.

[4] Gobel, S., Lutze, K., 1998. *Development of Meta Databases for Geospatial Data in the WWW.* Proc. ACM GIS'98, Washington, DC.

[5] Dickman, A., Two-Tier Versus Three-Tier pps. *Information week 553* November 13, 1995, pp. 74-80.

[6]Valacich, J.S., George, J.F., and Hoffer, J.A., *Essentials of Systems Analysis and Design, Prentice Hall*, Upper Saddle River, NJ, 2001

[7]European Commision DG Joint Research Centre-Institute for Environment and Sustainability, 2005-09-24, Requirements for the definition of the INSPIRE Implementing Rules for Metadata.

[8]ISO/CD 19115-2, Geographic information Metadata *Part 2: Metadata for imagery and gridded data*, ISO/TC 211 N 1931 dated 2005-11-14