Bringing GEOSS Services into Practice

Delft, The Netherlands, 18th of April, 2011

The Black Sea regional training workshop series "Bringing GEOSS Services into Practice", sponsored by the European Commission's 7th Framework Programme (FP7) project enviroGRIDS, aims at teaching how to install, configure and deploy a set of open source software to publish and share spatial data and metadata through the Global Earth Observation System of Systems (GEOSS) using OGC web services & ISO standards.

GEOSS has been created as an international voluntary effort that connects geospatial and Earth Observation and information infrastructures, acting as a gateway between producers of environmental data and end users. The aim of GEOSS is to enhance the relevance of Earth observations and to offer public access to comprehensive, near-real time data, information and analyses of the environment.

This training workshop is planned within the framework of the enviroGRIDS project, that addresses the environmental problems surrounding the Black Sea Catchment. This area is known as one of ecologically unsustainable development, where inadequate resource management has led to severe environmental, social and economic problems. enviroGRIDS aims at improving this by building capacities for sharing and exchanging environmental data through GEOSS.

The training workshop will cover interoperability, hands-on experience with web portals, information access, open source software and spatial data sharing through web services and the GEOSS registries.

Date: Monday, 18th of April 2011, 9:30 – 12:45, Delft, The Netherlands.

The workshop will be held in English.

Participants will be required to bring their laptops to the training workshop (with at least Windows XP installed).

More information: www.envirogrids.net

http://hikm.ihe.nl/openwater_eg/

enviroGRIDS

www.envirogrids.net

PART 1: Introduction on Spatial Data Infrastructures

1. Introduction on Spatial Data Infrastructures

1.1 Responding to our changing environment, the need for data sharing

Today we are living in a globalized world where everything is changing rapidly (growing population, environmental deterioration,...) and where communication means have taken a remarkable place in our life. Everyday we access an enormous and continuous flow of information and much of it refer to a position or a specific place on the surface of our planet. This information is therefore, and by definition, georeferenced.

In the last 30 years, the amount of georeferenced data available has grown dramatically following the evolution of the communication means and due to the rapid development of spatial data capture technologies such as Global Positioning System (GPS), remote sensing images, sensors, etc (Philips et al., 1999). Over the last ten years, with the advent of applications like Google Earth, we have seen that geoinformation has been incorporated and routinely embedded into business and workflows of agencies at all levels of government, as well as in the private sector (Booz et al., 2005).

Despite the fact that administrations and governments are recognizing that spatial information is important and must be part of the basic information infrastructure that need to be efficiently coordinated and managed for the interest of all citizens (Ryttersgaard, 2001), this huge amount of geospatial data is stored in different places, by different organizations and the vast majority of the data are not being used as effectively as they should.

Moreover at the United Nations Conference on Environment and Development in Rio de Janeiro in 1992, the so-called Agenda 21 resolution fosters the importance of georeferenced information to support decision-making and management on the degradation and threats that are affecting the environment (GSDI, 2004). This means that there is a strong need for availability and access to appropriate information. The development of databases and exchange of information are the conditions for creating the basis for a sustainable development and to support the information management needs for implementing and monitoring sustainable development policies and goals like the UN Millennium Development Goals (UNGIWG, 2007).

Thus, geospatial information is a critical element underpinning decision making for many disciplines (Rajabifard and Williamson, 2001) and is indispensable to make sound decisions at all levels, from local to global. Experiences from developed countries show that more than two-third of human decision-making are affected by georeferenced information (Ryttersgaard, 2001).

However, geospatial information is an expensive resource, it is time consuming to produce, and for this reason it is of high importance to improve the access and availability of data, and promote its reuse. Many of the decisions that different organization need to make depend on good and consistent georeferenced data, available and readily accessible (Rajabifard and Williamson, 2001).

In 1998, the former vice-president of the United States, Al Gore, presented its visionary concept of a Digital Earth (Gore, 1998), “a multi-resolution, three-dimensional representation of the planet, into which we can embed vast quantities of georeferenced data”. As of today this vision is clearly not fully realized, but gives us an interesting support to our purpose as it is still actual.

Talking about geospatial data, Al Gore (1998) mentioned that the difficult part of taking advantage of this vast amount of information will be “making sense of it, turning raw data into understandable information” because at the moment we have more information than we can handle and it is stored in “electronic silos of data” , remaining mostly unused. He envisioned applications where “information can be seamlessly fused with the digital map or terrain data” allowing the user to move through space and time, but of course, to

achieve this vision, a collaborative effort (from government, industry, academia and citizens) is needed.

All the technologies and capabilities required to realize this vision and to build a Digital Earth are already available:

- computational science: even a simple desktop computer can process complex models and simulations. With the potential that technologies such as the Grid are offering new insights into the data are possible, giving us the ability to simulate phenomena that are impossible to observe..
- mass storage: storing tera-bytes of data on a desktop computer is not a problem anymore.
- satellite imagery: a lot of satellites are continuously observing the Earth offering high spatial and temporal observations.
- broadband networks: are already a reality giving the ability to connect different databases together.
- interoperability: this is a key point to allow communication and integration of distributed data, allowing the geospatial data generated by one software to be read by another.
- metadata: are important as they describe the data, allowing a user to evaluate and discover the data before using them.

Even if all technologies are ready, organizations and agencies around the world are still spending billions of dollars every year to produce, manage and use geographical data but without having the information they need to answer the challenges our world is facing (Rajabifard and Williamson, 2001). These authors also highlight the facts that most organizations and/or agencies need more data than they can afford, they often need data outside their jurisdictions, and the data collected by different organizations are often incompatible. This inevitably leads to inefficiencies and duplication of effort, and thus it is evident that countries can benefit both economically and environmentally from a better management of their data (UNGIWG, 2007; GSDI, 2004).

In consequence, it is now essential to make these data easily available and accessible in order to give the opportunity to the user to turn them into understandable information with a clear and broad benefits for the society and the economy because “working together, we can help and solve many of the most pressing problems facing our society...” (Gore, 1998).

It is clear that there are a lot of challenges to face, both tangible and intangible, when we start sharing data but we have to overcome them in order to improve our knowledge, share our experiences and try to build a better informed society. Achieving the goal of a sustainable development requires the integration of a large number of different types of data from different sources. Through agreed common standards and a clear political will, these data can be interchanged and integrated in an interoperable way, leading to a new collaborative approach to decision-making.

In conclusion, for Arzberger et al. (2004), ensuring that data are easily accessible, so that they can be used as often and as widely as possible is a matter of sound stewardship of public resources. Availability should be restricted only in certain specific cases like national security. These authors argue that “publicly funded research data should be openly available to the maximum extent possible”, because publicly funded data are a public good, produced in the public interest.

1.2 Spatial Data Infrastructure

1.2.1 Definition, concepts and rationale

The term Spatial Data Infrastructure (SDI) if often used to describe the mechanisms or the enabling environment, that supports easy access to, and utilization of, geographical data and information (UNECA, 2005). This definition is quite reductive as it gives the idea

that SDIs are essentially technical. The primary objective of SDIs is to provide a basis for geospatial data discovery, evaluation, and application for users and providers within all levels of government, commercial and the non-profit sectors, academia and citizens (GSDI, 2004).

This means that SDIs are more than just data repositories. SDIs store data and their attributes, and their related documentation (metadata), offering a mean to discover, visualize, and evaluate their fitness to different purpose, and finally provide access to the data themselves. In addition to these basic services, there are often additional services or software supporting the use of the data. Finally, to make an SDI work efficiently, it is necessary to include all the organizational agreements needed to coordinate and administer it.

In consequence, following Masser (2005) and GSDI (2004), we can give a more complete definition of what are SDIs:

A spatial data infrastructure supports ready access to geographic information. This is achieved through the co-ordinated actions of nations and organizations that promote awareness and implementation of complimentary policies, common standards and effective mechanisms for the development and availability of interoperable digital geographic data and technologies to support decision making at all scales for multiple purposes. These actions encompass the policies, organizational remits, data, technologies, standards, delivery mechanisms, and financial and human resources necessary to ensure that those working at the national and regional scale are not impeded in meeting their objectives".

Before going further in details, we have to explain the concepts underlying the rational of SDI, in particular geospatial data and information (also named geodata or georeferenced data). A geodata describes a location on Earth, giving through its attributes a comprehensive picture of the physical world both in term of spatial and/or temporal extent. Geodata are extremely valuable as users can build spatial relationships between features and data. For example, just after a flood event, one can overlay remote sensing images with existing georeferenced data of settlements to evaluate the extent of the damage and then focus humanitarian assistance. In consequence, geodata has a key role to play in our knowledge-based economy affecting directly or indirectly different sectors like forestry, urban planning, security, telecommunication, environmental protection, etc (fig.1).

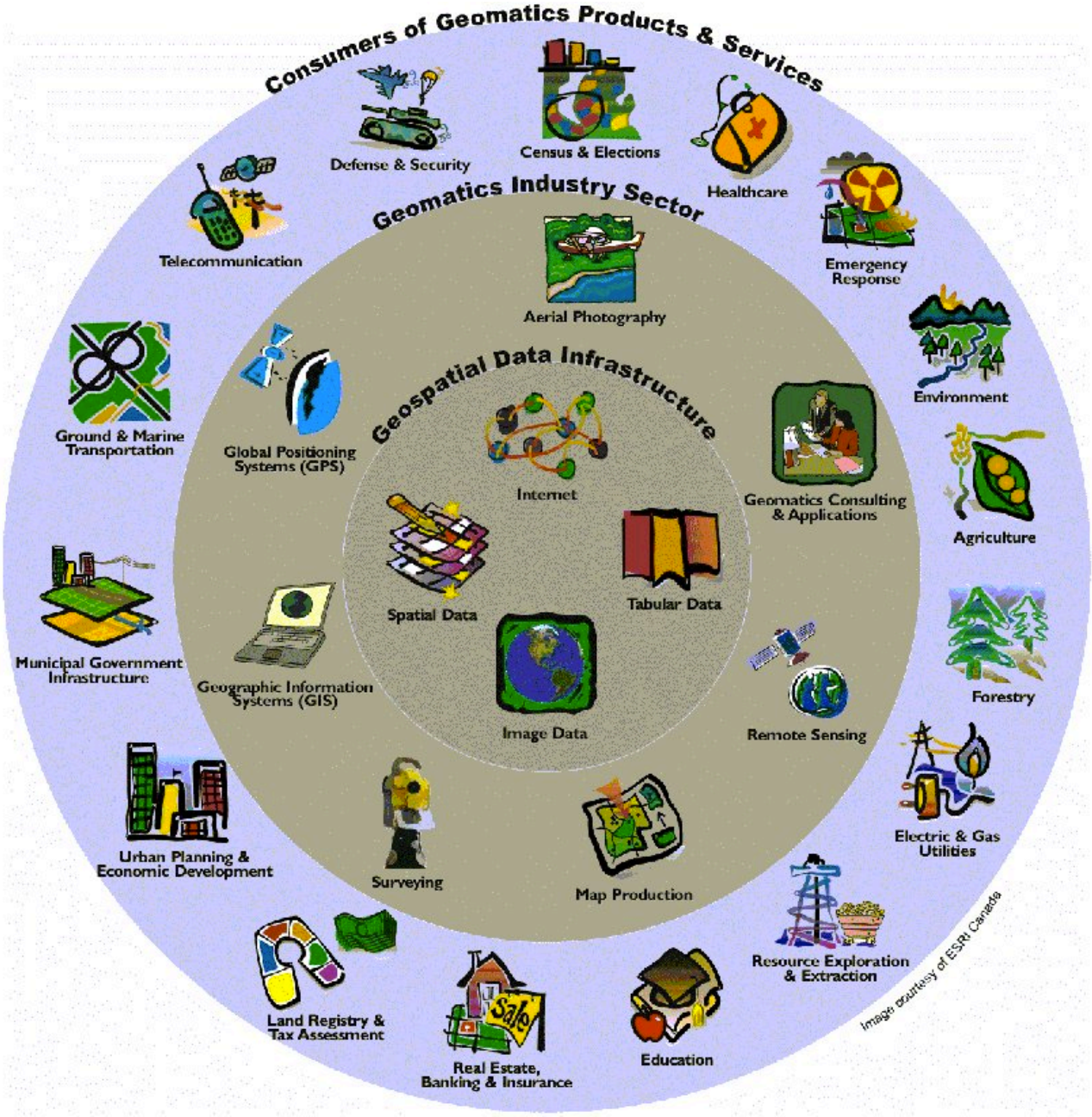


Fig.1: GIS and economy (Source: Geoconnections).

If, previously, geographical information was mostly presented in the form of paper maps, with the increasing means to capture information in digital formats, geospatial data are nowadays used and viewed within a Geographical Information System (GIS). This computer system is capable of assembling, storing, manipulating, and displaying geographically referenced information (UNECA, 2005).

A GIS gives the ability to merge different existing information from different sources facilitating collaboration in creating and analyzing data. Due to these new possibilities of reusing existing data and working on collaboratively greater scale, new challenges arise. When someone wishes to create a new information layer based on different data sets or different formats, with different terminology, and perhaps different projection, it is quite difficult to bring them together. Harmonizing geodata is a complex, costly and time-consuming task, but could be achieved by agreeing among data capturers before the work begins.

The growing recognition that once a geodata set has been created it could be used for public and private sectors (Ryttersgaard, 2001), reinforces the need to store data into

databases that are made accessible for different purposes (Philips et al., 1999). This leads to the concept that geodata could be a shared resource, which will be maintained continuously.

The advantage of having geographical data in a digital form (UNECA, 2005; UNGIWG, 2007) are:

- easy storage,
- easy dissemination,
- facilitation of data exchange/sharing,
- faster and easier updates and corrections,
- ability to integrate data from multiple sources,
- customization of products and services.

As a result of the previous considerations, the concept of the SDI was developed in order to facilitate and coordinate the exchange and sharing of geospatial data (Rajabifard and Williamson, 2001), encompassing the data sources, systems, network linkages, standards and institutional issues involved in delivering geodata and information from many different sources to the widest possible group of potential users (Coleman et al., 1997).

The vision of an SDI incorporates different databases, ranging from the local to the national, into an integrated information highway and constitutes a framework, needed by a community, in order to make effective use of geospatial data (UNECA, 2005).

1.2.2 Objectives

Following Masser's definition (2005) and the different considerations highlighted in the previous section we can list different objectives underpinning SDIs:

- The overall objective of an SDI is to maximize the reuse of geospatial data and information.
- SDIs cannot be realized without coordination (especially by governments).
- SDIs must be user driven, supporting decision-making for many different purposes.
- SDIs implementation involves a wide range of activities, including not only technical topics such as data, standards, interoperability, and delivery mechanisms, but also institutional arrangements, policies, financial and human resources.
- The term infrastructure is used to promote the idea of a reliable and supporting environment, analogous to a road or a telecommunication network, facilitating the access to geoinformation using a minimum set of common practices, protocols, and specifications (GSDI, 2004). This allows the movement of spatial information instead of goods.
- SDIs are all about (UNGIWG, 2007):
- re-use: of data, technical capabilities, skills developed, invested effort and capital.
- sharing: “sharing-not-wearing” the costs of data, people, technology,... helping to realize more rapid returns on investment.
- learning from others: avoiding the pitfalls experienced by others.
- Avoid duplication efforts and expenses and enables users to save resources, time and effort when trying to acquire or maintain datasets (Rajabifard and Williamson, 2001).
- SDIs are “about working smarter, not harder” (UNGIWG, 2007).
- Implies to scale from specific and monolithic (data-centric) towards independent and modular (service-oriented) information systems.
- Integrate these systems together into an information highway which both links together environmental, socio-economic and institutional databases and provides a movement of information from local to national and global levels.
- Encompass the sources, systems, network linkages, standards and institutional issues involved in delivering spatially-related information from many different sources to the widest possible group of potential users.

Altogether these objectives intend to create an environment that foster activities (fig. 2) for using, managing and producing geospatial data and in which all stakeholders can co-operate with each other and interact with technology, to better achieve their objectives at different political/institutional levels (Rajabifard and Williamson, 2004).

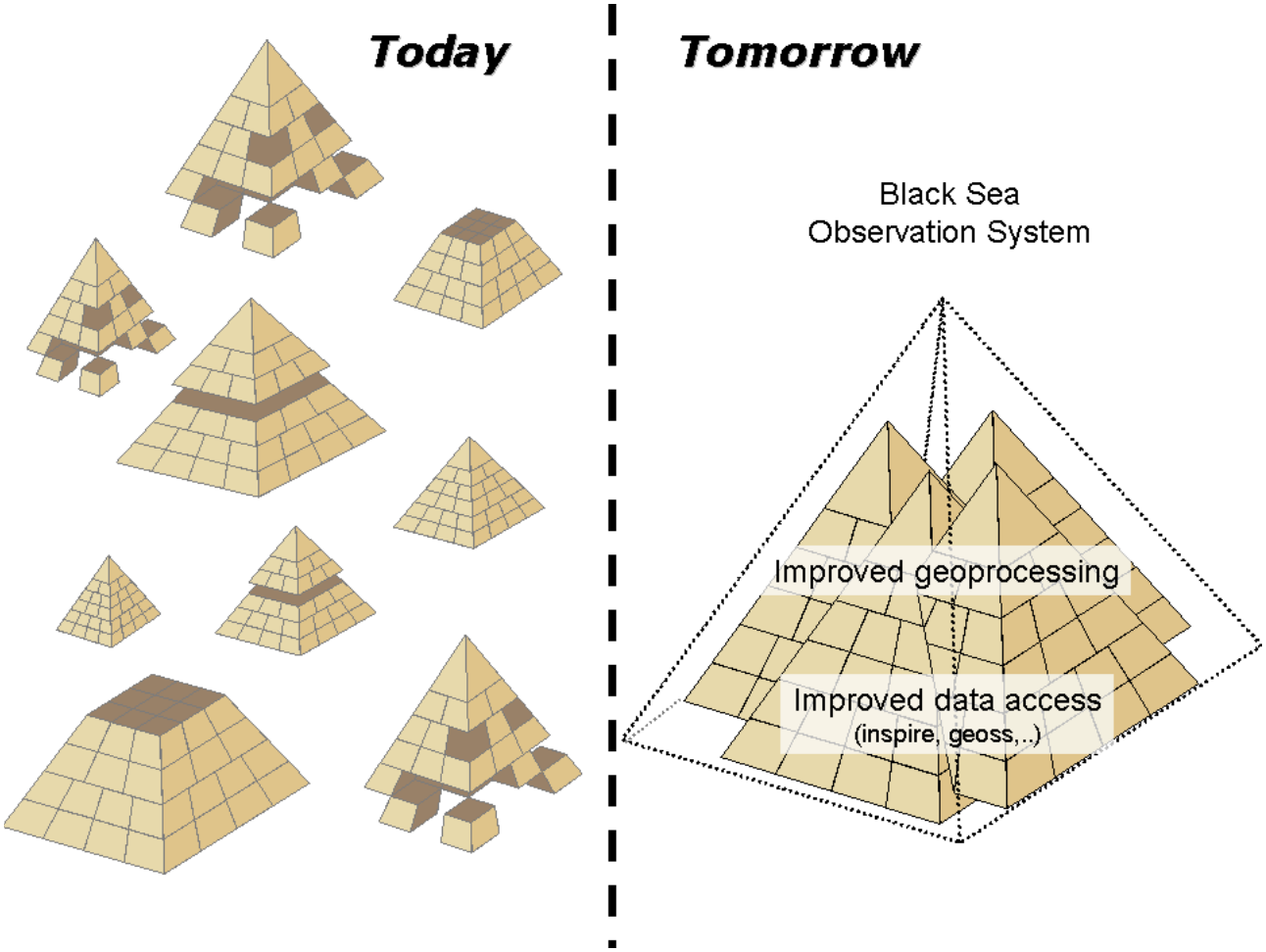


Fig.2: EnviroGRIDS aims

1.2.3 Components

Masser (2005) identifies the most important stakeholders with special interests in geoinformation/SDIs matters and shows the diversity both in terms of size and resource of the large numbers of players involved:

- Central government organizations,
- Local government organizations,
- Commercial sector,
- Non-for-profit/non-governmental organizations,
- Academics,
- Individuals.

Thus the temptation will be to create a centralized “one-size-fits-all” spatial database, in order to provide all the information needed by a country or a specific community of common interest. But as reported by UNECA (2005), UNGIWG (2007) and GSDI (2004) the existence of geodata and information does not alone ensure that it is used for decision-making. Different other factors are important to consider in order to ensure that information will be effectively used and reused:

- To be used, people need to know that the data exist, and where to obtain it.
- They need to be authorized to access and use the data.

- They need to know the history of the data capture, in order to interpret it correctly, trust it and be able to integrate it meaningfully with data coming from other sources.
- They need to know if the data depends on other data sets, in order to make sense of data.

Consequently, to leverage the full potential of geospatial data, an SDI must be made of different components to allow users to find, discover, evaluate, access and use these data, namely:

- A clearly defined core of spatial data.
- The adherence to known and accepted standards and procedures.
- Databases to store data and accessible documentation about the data, the so-called metadata.
- Policies and practices that promote the exchange and reuse of information.
- Adequate human and technical resource to collect, maintain, manipulate and distribute geospatial data.
- Good communication channels between people/organizations concerned with geodata, allowing the establishments of partnerships and share knowledge.
- The technology for acquiring and disseminating data through networks.
- Institutional arrangements to collaborate, co-operate and coordinate actions.

But as stated by Rajabifard and Williamson (2001), there is an important additional component represented by people. This include the users of geospatial data but also the providers and any other data custodians. For these authors, people are the key to transaction processing and decision-making. Facilitating the role of people and data in governance that appropriately supports decision-making and sustainable development objectives is central to the concept of SDI.

In order to meet the requirements of all stakeholders involved, an SDI must (Coleman et al., 1997):

- be widely available,
- be easy to use,
- be flexible,
- form the foundation for other activities.

In summary, Rajabifard and Williamson (2001) suggest that an SDI cannot be seen only as composed of geospatial data, services and users but instead involves other issues regarding interoperability, policies and networks.

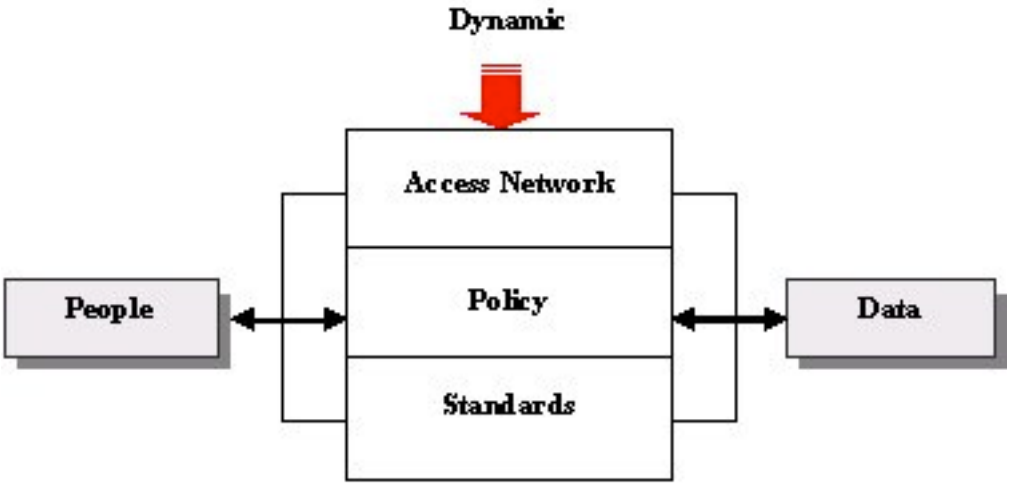


Fig.3: Nature and relations between SDI components (Source: GISCafe).

This shows that an SDI is by nature really dynamic as people who want to access data must interact with technological components (fig.3).

1.2.4 SDI hierarchy

As a result of the fact that SDI initiatives range from local to national and regional levels (Crompvoets, 2003; Masser 2007) and they all aim to promote economic development, to stimulate better government and to foster environmental sustainability (Masser, 2005), Rajabifard (2002) proposed a model of SDI hierarchy that is made of inter-connected SDIs developed at different levels (from local to global). Each SDI of a higher level is primarily formed by the integration of geospatial datasets developed and made available by the lower level (fig.4).

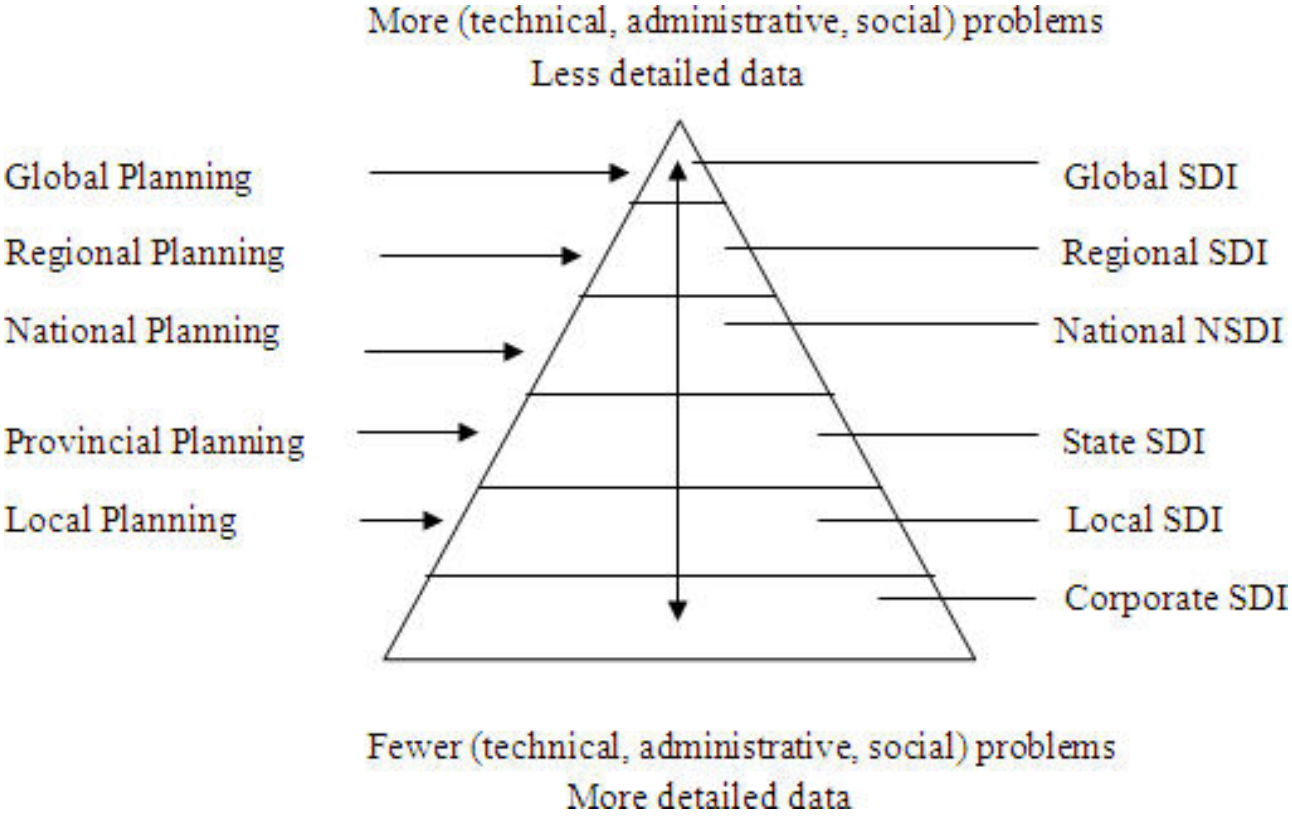


Fig.4: SDI hierarchy. (Source: GISCafe)

Such a hierarchy has two views: in one hand it is an umbrella in which the SDI at a higher level encompasses all the components of SDIs at levels below. On the other hand, it can be seen as the building block supporting the access of geospatial data needed by SDIs at higher levels. The SDI hierarchy allows to create an environment in which users working at any level can rely on data from other levels and integrate geospatial data from different sources (Mohammadi et al. 2007). Such a hierarchy is envisioned by regional and global initiatives like INSPIRE and GEOSS that will be further discussed.

For Masser (2006), the SDI hierarchy poses the challenge of a multistakeholder participation in SDI implementation because the bottom-up vision differs a lot from the top-down approach that is implicit in most of the SDI literature. The top-down approach emphasizes the need for standardization and uniformity while the bottom-up stresses the importance of diversity and heterogeneity due to the different aspirations of the various stakeholders. In consequence, it is necessary to find a consensus to ensure some measure of standardization and uniformity while recognizing the diversity and the heterogeneity of the different stakeholders performing different tasks at different levels.

1.2.5 SDI evolution and (emerging) trends

Different authors (Masser, 2005; Crompvoets, 2003) have studied the diffusion and evolution of SDI around the world and show that driving forces behind SDI initiatives are generally similar:

- promoting economic development,
- stimulating better government,
- fostering environmental sustainability,
- modernization of government,
- environmental management.

They all agree on the fact that, as of today, a critical mass of SDI users has been reached as a result of the diffusion of SDI concepts during the last ten to fifteen years. This provides a basic network of people and organizations that is essential for future development of SDIs.

Rajabifard et al. (2001) find that the first generation of SDIs, based on a product model, gave away to a second generation at the beginning of the years 2000, the latest being characterized by a process model. Indeed, the first generation of SDIs were product-based, aiming to link existing and future databases while the second generation aim to define a framework to facilitate the management of information assets allowing reuse of collected data by a wide range of people and/or organizations for a great diversity of purposes at various times. For Masser (2005) this evolution emphasis the shift from the concerns of data producers to those of data users and the shift from centralized structures to decentralized and distributed networks like the web.

The process-based model emphasizes the communication channel of knowledge infrastructure and capacity building towards the creation of an SDI facilitating cooperation and exchange of data and knowledge (Rajabifard and Williamson, 2001). They also highlight the fact that the characteristics of the social system strongly influence the approach taken to implement and develop a Spatial Data Infrastructure. They propose key issues and strategies to be considered for the design process:

- development of a strategic vision and associated implementation strategy,
- recognition that SDI is not an end in itself,
- key institutional strategy is to have all coordinating processes administered by one group.

Today's effort on the technical development of SDI components clearly focus on the exchange of geodata in an interoperable way (Bernard and Craglia, 2005) through services that allow efficient access to spatially distributed data. The shift towards an infrastructure offering services to answer requests rather than a “simple” network allowing to find, view and exchange geodata is highlighted by the concept of web services and the related Service Oriented Architecture (SOA).

Web services are a “new paradigm” (Comert, 2004) where different systems or providers offer some services for certain user groups, allowing an easy access to distributed geographic data and geoprocessing applications. The web services emphasize the necessity that systems involved could talk to each other and the provision of this talk should be easy and cost-effective for businesses to profit. In other words, web services relay on interoperability.

Web services enable the possibility to construct web-based application using any platform, object model and programming language. A service is no more than a collection of operations that allows users to invoke a service, which could be as simple as requesting to create a map or complicated as processing a remote sensing image.

In summary, web services are for application-to-application communication over internet and are based, in general, on open standards like XML (Comert, 2004). SOA is the basic principle concept supporting web services development. It promotes loose coupling between software components so that they can be reused (Sahin and Gumusay, 2008). In

a SOA, the key component is services. They are well defined set of actions, self contained, stateless, and does not depend on the state of other services.
There are three components on the web services architecture: service provider, service requester and service broker and three operations: publish, find and bind. A SOA relates the three components to the three operations to allow automatic discovery and use of services.

In a traditional scenario, a service provider hosts a web service and "publishes" a service description to a service broker. The service requester uses a "find" operation to retrieve the service description and uses it to "bind" with the service provider and invoke the web service itself (fig.5).

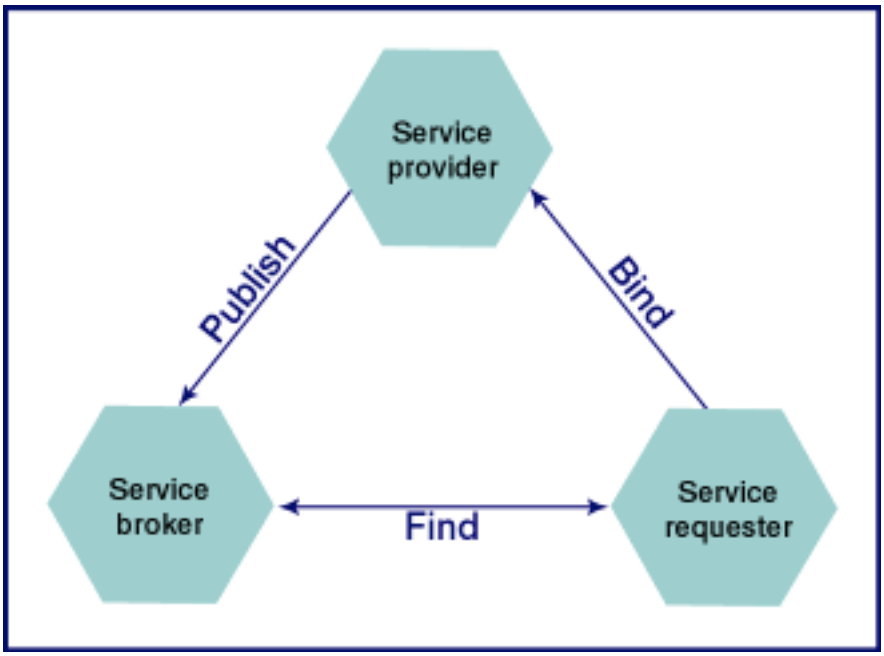


Fig.5: Basic operations in SOA (Source: IBM).

SOA is the underlying concept for an interoperable environment based on reusability and standardized components and thus is of high importance for SDIs allowing applications and related components to exchange data, share tasks, and automate processes over the Internet (OGC, 2004).

The OGC web services are, by far, the most important and relevant web services for our purpose and they will be discussed in details in an upcoming section of this introduction.

With the advent of web services into the SDI community new trends/opportunities could be foreseen:

- Actual SDIs are lacking of analysis capabilities, an essential task to turn data into understandable information. This means that processing geospatial data is done in general on desktop computers and thus limit the analytical capacities caused by the huge execution time that geoprocessing tasks require to process a vast amount of data. With the recently introduced Web Processing Service and the promises of high storage and computing capacities offered by Grid infrastructures, new opportunities are emerging within geosciences communities (Padberg and Greve, 2009)
- Semantic web developed vocabularies (called ontologies) for geospatial data with the goal to increase understanding of such data by machines, allowing automated process through web services (Boes and Pavlova, 2008; Vaccari et al., 2009).
- Web services are one aspect of the Web 2.0 revolution. The web 2.0 refers to a second generation of internet based services, that allow people to collaborate and share

information (Boes and Pavlova, 2007). GIS is also taking advantage of the web 2.0 revolution, with a good example being Google Maps that opened some of the more straightforward capabilities of GIS to the general public (Goodchild, 2007) and allowing, with other tools, the general public to create and generate news sources of data and information. This phenomenon is also know as Volunteered Geographic Information (VGI) (Boes and Pavlova, 2007; Coleman et al., 2009, Craglia, 2007). VGI offers new opportunities and perhaps will influence the development of SDIs and the production of data in a near future.

Finally, it is necessary to mention that building an efficient SDI is almost impossible without partnership because a single agency is unlikely to have all resources, skills or knowledge to undertake the development of all aspects of SDI (UNECA, 2005; UNGIWG, 2007). This is why different authors (Williamson et al., 2003, Rajabifard and Williamson, 2004) stress the importance of the capacity building component in the SDI implementation process.

1.2.6 Benefits

To conclude, we can highlight some of the (expected) benefits that SDIs can offer:

- universal (anywhere and anytime) access to geodata and related information,
- services and applications to discover and access distributed data sources,
- integration of different geospatial information to provide seamless visualization,
- seamless combination (chaining) of data, services and related applications,
- geospatial data update and maintenance made easy,
- sharing and reuse capabilities,
- collaborative activities,
- wide-scale interoperability, agreeing on open and common standards,
- development of partnerships, collaboration between different stakeholders.

The Canadian Geospatial Data Infrastructure (CGDI) claimed that developing applications using such an infrastructure allows to:

- Reduce costs: Applications can be built by reusing existing services.
- Reduce complexity: Service interfaces hide the underlying complexity.
- Permits less costly integration and interoperability: Standard interfaces simplify interconnection and integration.
- Allow direct access to current, authoritative source data.

Finally an effective and working SDI leads to:

- Inform decision-making: easy access to current information, knowledge and expertise.
- Increase efficiency: standards and specifications, as well as access to services, reduce duplication of effort.
- Enhance usability: providing reliable access to geospatial information to all levels, from the citizens to governments.
- Push for economic growth.

We would not depict SDIs as a “perfect tool” that can solve all problems. It is evident that SDIs represent a great opportunity and a framework with great perspective but as Masser reminds us (2005), SDIs can facilitate access to data to a wide range of users only if profound changes in “sharing spirit” take place. He also mentions the fact that building an SDI is a long term process. In order to be fully operational such a process depends on sustainability and commitment.

In addition, there are several others issues that could limit the implementation of SDI concepts such as: collaboration, funding, political stability, legislation, priorities, awareness, copyrights, privacy, licensing, capacity building and cultural issues (table 1).

Technical	Institutional	Policy	Legal	Social
Computational heterogeneity	Collaboration models	Political stability	Rights, Restrictions	Cultural
Semantic	Funding model	Legislation	Copyright,	Capacity builiding
Reference sys.	Linkage between data units	Priorities/ Sustainable dev.	Intellectual Property rights	Equity
Data quality		Awarness of data existence	Data access and prices	
Metadata			Privacy	
Format			Licensing	

Table 1: Integration issues (Williamson et al., 2006)

To conclude this section, it is important to keep in mind that data sharing and related SDI developments rely first on individuals (Craig, 2005) that have many interests in common. First, their idealism, their sense that better data will lead to better decisions. Second, their self-interest: by sharing, they got something in return even if it is intangible, they are viewed as cooperative partners, and finally they are involved in a professional culture that honors serving society and cooperating with others.

1.3 Interoperability and standards

1.3.1 Definition and concepts

Previously, we have seen that we are living in a world that is changing rapidly with communication means that are taking an increasing place in our everyday life. This communication revolution is mostly based on the Internet, whose successes are due to interoperability. Interoperability is “the ability of a system or a product to work with other systems or products without special effort on the part of the customer.” (OGC, 2004). This means that two or more systems or components are able to transmit or exchange information through a common system and to use the information that has been exchanged.

When systems are interoperable, it gives the user the ability to:

- find what he needs,
- access it,
- understand and employ it,
- have goods and services responsive to his need.

As of today, in a climate of economic constraint, interoperability and standardization have never been so important because a non-interoperable system impedes the sharing of data, information and computing resources (OGC, 2004), leading organizations to spend much more than necessary on data, software and hardware. Moreover being non-interoperable increases the risk for a system or an infrastructure to not deliver its expected benefit and in consequence to lead to a user disappointment and system failure.

In order to achieve interoperability, there are two approaches:

- adhering to standards
- making use of a "broker" of services that can convert one product's interface into another product's interface, "on the fly".

One good example of the first approach is the Web, where standards like HTTP, TCP/IP or HTML have been developed by organizations that wish to create standards to “meet everyone's needs without favoring any single company or organization” (OGC, 2005).

The great advantage of interoperability, and that is why it is an essential building block for the GIS and SDI industry, is that it describes the ability of locally managing and distributing heterogeneous systems to exchange data and information in real time to provide a service (OGC, 2004). This allows the users to maximize the value of past and future investments in geoprocessing systems and data.

As a response to the need of GIS standards to support interoperability, the OGC aims to tackle the non-interoperability caused by the diversity of systems creating, storing, retrieving, processing and displaying geospatial data in different formats. In addition to this, software vendors often did not communicate among themselves to agree on how data should be structured and stored and how systems must exchange information, leading inevitably to a non-interoperable environment, isolating geospatial data in “electronic silos” and resulting in expensive duplication of data and difficulty in sharing and integrating information (OGC, 2004).

The OGC (2005) has pointed out the general user needs:

- Need to share and reuse data in order to decrease costs (avoid redundancy collection), obtain additional or better information, and increase the value of data holdings.
- Need to choose the best tool for the job and the related need to reduce technology and procurement risks (avoid being locked in to one vendor).
- Need to leverage investment in software and data, enabling more people to benefit from using geospatial data across applications without the need for additional training.

The OGC believes that responding to the users needs of interoperability will have a profound and positive impact in the public and private sectors, opening the doors of new business opportunities and new human activities.

In summary, interoperability enhances: communication, efficiency and quality for the benefit of all citizens allowing them to access data in a good, consistent and transparent way.

1.3.2 Types of interoperability

There are two types of interoperability (OGC, 2004):

- syntactic (or technical): when two or more systems are capable of communicating and exchanging data, they are exhibiting syntactic interoperability. Specified data formats and communication protocols are fundamental. In general, XML or SQL standards provide syntactic interoperability. Syntactical interoperability is required for any attempts of further interoperability.
- semantic: Beyond the ability of two or more computer systems to exchange information, semantic interoperability is the ability to automatically interpret the information exchanged meaningfully and accurately in order to produce useful results as defined by the end users of both systems. To achieve semantic interoperability, both sides must defer to a common information exchange reference model. The content of the information exchange requests are unambiguously defined: what is sent is the same as what is understood (eg. explaining why INSPIRE is producing data specifications).

Different types of geoprocessing systems (vector, raster, CAD, etc.) producing different types of data, different vendors geoprocessing systems using internal data formats and producing proprietary formats, different vendors systems using proprietary libraries and interfaces and reducing the possibilities of communication between systems...

are all causes of syntactic non-interoperability while different data producers using different metadata schemas and/or different naming convention lead to semantic non-interoperability.

The World Wide Web and its associated technologies offer a great opportunity to overcome both syntactic and semantic non-interoperability because it is an almost universal platform for distributed computing and it provides facilities to semantically process structured text. The web is thus a key enabler for interoperability, by increasing access to geospatial data and processing resources, which in consequence increases the value of those resources (OGC, 2004).

To ensure effective interoperability, it is not only a matter of technology but also and often it requires a change of philosophy, of spirit to go “open”. This is classified under human or legal/policy on the following table summarizing the different types of interoperability (table 2).

Technical	**Semantic**	**Human**	**Legal/Policy**
Machine to machine connections	Common understanding concepts, terms, ...	Cooperation	Digital rights, ownerships
Software interaction	Inter-disciplinary vocabularies	Training	Responsibility
APIs			
Formats			

Table 2: Different types of interoperability.

As expressed by the OGC (2004) “if an organization does not fully embrace the tenets of interoperability and interoperable architectures, then long-term success in integrating geospatial processes into an organization's overall business processes may be problematic”.

In consequence, organizations will need:

- commitment to interoperability and geospatial standards,
- commitment to collaboration,
- commitment to define a geospatial interoperability and information framework that meets the requirements of the organization,
- commitment to the collection and maintenance of geospatial metadata,
- commitment to training and education

Through all these commitments, an organization will be truly interoperable, maximizing the value and reuse of data and information under its control and will be able to exchange these data and information with other interoperable systems, allowing new knowledge to emerge from relationships that were not envisioned previously.

1.3.3 Interoperability enablers

To enable effective interoperability, we have already seen that the Internet and standards are probably the most important components at a technical level but here are a

lot of other possible enablers, both human and technical, that could help an organization to promote its commitment to interoperability:

- web and networks,
- standards,
- infrastructure,
- metadata,
- support for multiple: languages, views, data formats, projections, datums,...
- sharing of best practices,
- cooperation and collaboration,
- business models,
- business agreements,
- policy framework,
- copy and access rights,
- authorization,
- ...

Altogether they will contribute in a way or another to a successful implementation of the geospatial interoperability by reaching a consensus between the users' need for compatibility with the autonomy and heterogeneity of the inter-operating systems (OGC, 2005).

1.3.4 Standards

Standards are documented agreements, used in public contracts or international trade, containing technical specifications or other precise criteria to used consistently as rules, guidelines, or definitions of characteristics, to ensure that materials, products, processes and services are fit for their purpose (Ostensen, 2001). In other words, standardization means agreeing on a common system (OGC, 2005).

The existence of non-harmonized standards for similar technologies contribute to the so-called “technical barriers to trade”, avoiding a user to share data, information or services.

Although developing standards is a long and complex process, involving many organizations, based on a consultative approach and aiming to find a consensus between all the parties involved (UNECA, 2005), organizations and agencies are increasingly recognizing that standards are essential for improving productivity, market competitiveness, export capabilities (GSDI, 2004), and lowering maintenance and operation costs over time (Booz et al., 2005; Craglia and Nowak, 2006; Almirall et al., 2008).

We can summarize the functions of standards as follow:

- help to ensure interoperability,
- promote innovation, competition, commerce and free trade,
- increase efficiency,
- make things work,
- affect every aspect of our life (widespread use of standards).

1.3.5 Benefits

After discussing what are standards and interoperability, we can give an overview of the (expected) benefits of a truly interoperable architecture.

1. Allow sharing and reusing of data: gives access to distributed and heterogenous sources of data.
2. Avoid data duplication: data are collected and maintained at the most appropriate place.
3. Reduce the costs: of maintenance, of operations and of course of production.
4. Integration: As Mohammadi et al. (2007) shows multi-source data integration could only be achieved with an effective interoperability.
5. Reduce the complexity: through common knowledge, standards offer a set of rules that every data provider can follow, understand and become familiar with. Moreover when a user shares a data in a standardized way, another will be immediately able to use it.
6. Increase efficiency.
7. Vendor neutral: avoid the fact to be locked in to one vendor.
8. Improve decision-making: offering standardized access to a vast amount of data and information and to used them as effectively as they should.
9. New opportunities and knowledge: open the doors to new activities and relations that were not foreseen before.

Finally, as OGC (2005) stated:

Changing internal systems and practices to make them interoperable is a far from simple task. But the benefits for the organization and for those who make use of information it publishes are incalculable".

1.4 Initiatives

Different initiatives at the regional and global level are influencing and promoting the creation of Spatial Data Infrastructures and the use of open standards. They all are concerned about data access, harmonization, standardization, interoperability, seamless integration and services. They coordinate actions that promote awareness and implementation of complimentary policies, common standards and effective mechanisms for the development and availability of interoperable digital geographic data and technologies to support decision making at all scales for multiple purposes. These actions encompass the policies, organizational structures, data, technologies, standards, delivery mechanisms, and financial and human resources necessary to ensure that those working at the global and regional scale are not impeded in meeting their objectives.

1.4.1 Infrastructure for Spatial Information in the European Community (INSPIRE)

Website: http://inspire.jrc.ec.europa.eu/

The Infrastructure for Spatial Information in the European Community, namely INSPIRE, is of particular interest for the EnviroGRIDS project. INSPIRE is a European Directive (entered into force in May 2007 and fully operational by 2019) that aims to create a European Union Spatial Data Infrastructure. This will enable the sharing of environmental spatial information among public sector organizations and better facilitate public access to spatial information across Europe (EU, 2007). When fully implemented, it will, theoretically enable data from one Member State to be seamlessly combined with data from all other States. This is particularly important for activities relating to the environment.

The main purpose of INSPIRE is to support the formulation, implementation, monitoring, and evaluation of Community environmental policies (EU, 2008). Therefore the spatial information considered under the directive is extensive and includes a great variety of topical and technical themes and will be based on Spatial Data Infrastructures established and operated by the Member States.

This initiative wishes to overcome the barriers affecting data access and exchange in Europe, including (EU, 2008):

- inconsistencies in collection of georeferenced data: geodata are often missing and/or incomplete, or are collected twice by different organizations.
- lacking of documentation, description (metadata) of the data.
- geodata are often incompatible and thus cannot be combined.
- infrastructures used to find, access and use geodata often function in isolation and are incompatible.
- barriers to sharing: cultural, linguistic, institutional, financial and legal.

In order to overcome these barriers, it has been recognized that it would be necessary to develop a legislative framework asking the Member States to coordinate their activities and to agree on a set of requirements, common standards and processes. In consequence, INSPIRE is unique in the sense that it is an important collaborative and participative process to formulate the directive, create implementing rules and develop relative specifications and services.

INSPIRE seeks to create a European SDI and the INSPIRE Directive defines it: "infrastructure for spatial information means metadata, spatial data sets and spatial data services; network services and technologies; agreements on sharing, access and use; and coordination and monitoring mechanisms, processes and procedures, established, operated or made available in accordance with this Directive". (EU, 2004)

The end users of INSPIRE include policymakers, planners and managers at the local, national and regional levels, and the citizens and their organizations.

INSPIRE is based on common principles (EU, 2007):

1. Data should be collected only once and kept where it can be maintained most effectively.
2. It should be possible to combine seamless spatial information from different sources across Europe and share it with many users and applications.
3. It should be possible for information collected at one level/scale to be shared with all levels/scales; detailed for thorough investigations, general for strategic purposes.
4. Geographic information needed for good governance at all levels should be readily and transparently available.
5. Easy to find what geographic information is available, how it can be used to meet a particular need, and under which conditions it can be acquired and used.

A step by step approach is used to implement and develop the infrastructure because such an initiative cannot be built from one day to another and is asking Member States to drastically change their existing infrastructure. Thus the implementation of services has been stated just after the adoption of the Directive, whereas the harmonization of INSPIRE data themes will be made in three phases up to 2013.

The European Commission Joint Research Center (JRC) plays a major role in this initiative as it has supported the development of the proposal and now endorses the responsibility of the overall technical coordination of the Directive, providing support to the preparation of the technical rules on implementation, data harmonization, documentation and the required services to discover, view and download data.

The Directive provides five sets of Implementing Rules (IR) that set out how the various elements of the system (metadata, data sharing, data specification, network services, monitoring and reporting) will operate and to ensure that the spatial data infrastructures of the Member States are compatible and usable in a Community and transboundary context. The Drafting Teams now working on these IRs are composed of international experts and the process includes open consultation – particularly with Spatial Data Interest Communities (SDIC) and Legally Mandated Organizations (LMO).

The Directive specifically states that no new data will need to be collected. However it does require that two years after adoption of the Implementing Rules for data

sets and their related services each Member State will have to ensure that all newly collected spatial data sets are available in conformity with the IR. Other data sets must conform to the Rules within 7 years of their adoption. Implementing Rules will be adopted in a phased manner between 2008 and 2012 with compliance required between 2010 and 2019 (EU, 2008).

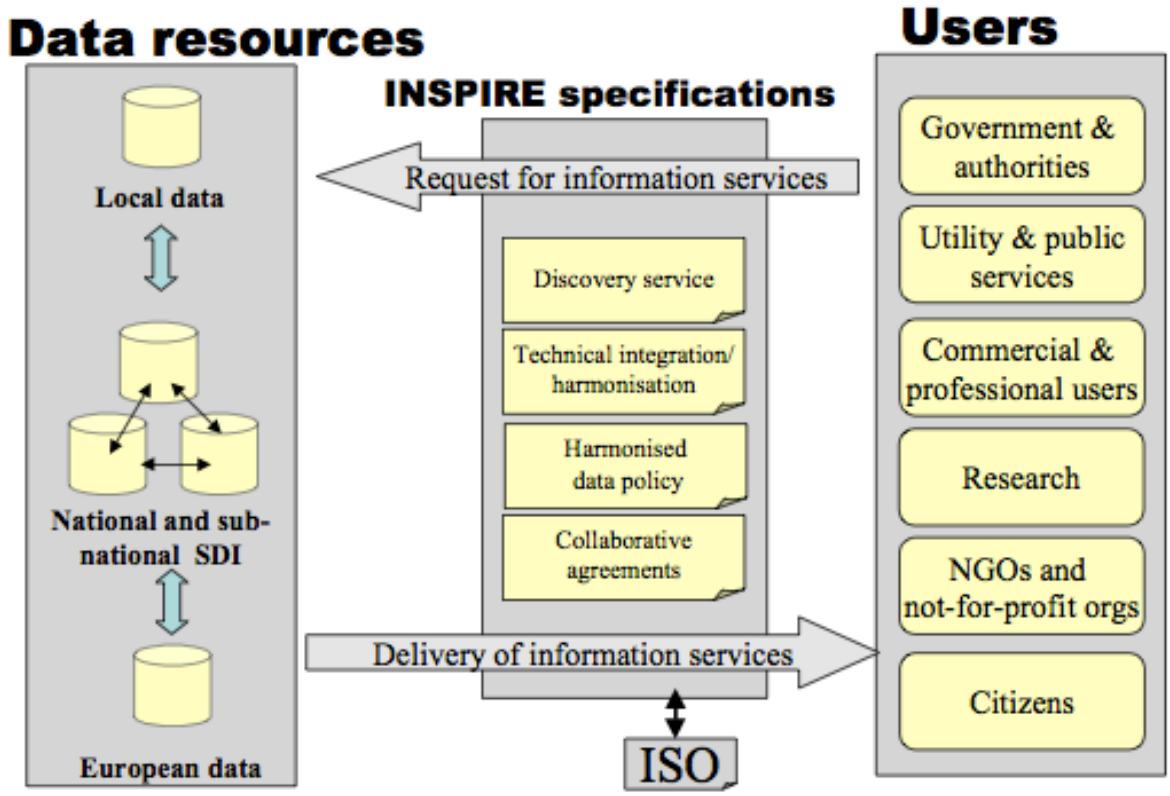


Fig.6: Data and information flow within the INSPIRE framework (Source: INSPIRE).

The envisioned interoperability in INSPIRE is a possibility offered to the user to combine geospatial data and services from different sources across the European Community in a consistent way without involving specific efforts of humans or computers (fig.6). Thus users will spend less time and efforts to integrate data delivered within the INSPIRE framework.

The Directive (EU, 2007) defines 34 “spatial data themes” that have been defined in three Annexes sorted in order of priority. Annex 1 datasets cover the ‘basic’ spatial building blocks such as spatial referencing systems, geographic names, addresses, transport networks, hydrography and land parcels. Because of the range of data types involved, the impact of INSPIRE is comprehensive. Annex 1 datasets have to be prepared and made available from 2011, with the other Annexes at later dates. In order to enable full system interoperability across the EU, each spatial data theme is described in a data specification. As mentioned on the INSPIRE website “The process for developing harmonized data specifications is designed to maximize the re-use of existing requirements and specifications, in order to minimize the burden for Member States’ organizations at the time of implementation. The consequence of this is that the process of developing Implementing Rules for interoperability of spatial datasets and services may be perceived as being complex: it involves a large number of stakeholders, with many interactions and consultations”.

Finally, all the data, information and services shared within INSPIRE would be accessible through the INSPIRE Community Geoportal. For Luraschi et al. (2009) because the geoportal does not store or maintain data and metadata, it could be seen as a gateway

aggregating a number of instances of specific geospatial information services distributed across the Europe and maintained by the organization responsible for the data.

According to the INSPIRE network architecture (EU, 2008), Member States shall establish, operate and provide access to the following network services (fig.7):

- discovery services: support discovery of data, evaluation and use of spatial data and services through their metadata properties
- view services: as a minimum, display, navigate, zoom in/out, pan, or overlay spatial data sets and display legend information and any relevant content of metadata.
- download services: enabling copies of complete spatial data sets, or parts of such sets, to be downloaded.
- transformation services: enabling spatial data sets to be transformed (projection and harmonization).
- invoke spatial data services: enabling data services to be invoked.

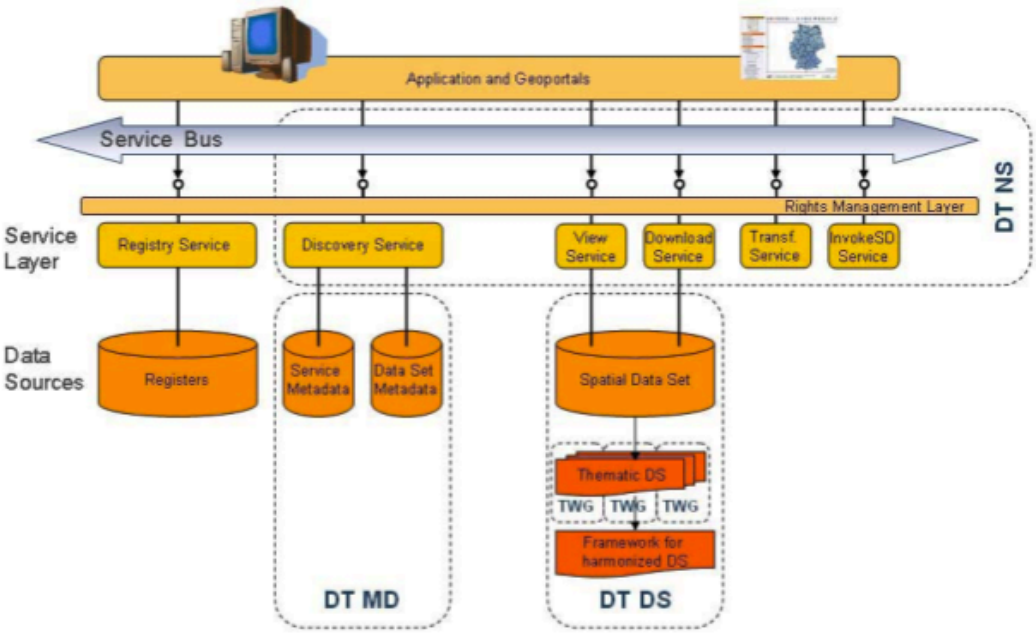


Fig.7: INSPIRE network architecture (Source: INSPIRE).

1.4.2 Global Earth Observation System of Systems (GEOSS)

Website: http://www.earthobservations.org

The GEOSS is being established by the intergovernmental Group on Earth Observations (GEO) and is a worldwide effort to build a system of systems on the basis of a 10-Year Implementation Plan for the period 2005 to 2015 (GEO, 2005). GEO is voluntary partnership of governments and international organizations where membership and participation is contingent upon formal endorsement of the Implementation Plan mentioned above.

GEOSS is an effort to connect already existing SDIs and Earth Observations infrastructures and thus will not create and/or store data but rather works with and build upon existing systems. GEOSS, through its developing GEOportal, is foreseen to act as a gateway between the producers of environmental data and the end users, with the aim of enhancing the relevance of Earth observations for the global issues and to offer a public access to comprehensive, near-real time data, information and analyses on the environment (GEO, 2007).

GEOSS aims to provide a broad range of so-called Societal Benefits Areas (GEO, 2005):

- Reducing loss of life and property from natural and human-induced disasters,

- Understanding environmental factors affecting human health and well-being,
- Improving the management of energy resources,
- Understanding, assessing, predicting, mitigating, and adapting to climate variability and change,
- Improving water resource management through better understanding of the water cycle,
- Improving weather information, forecasting and warning,
- Improving the management and protection of terrestrial, coastal and marine ecosystems,
- Supporting sustainable agriculture and combating desertification, and
- Understanding, monitoring and conserving biodiversity.

The mechanisms for data and information sharing and dissemination are presented and described in the 10-Year Implementation Plan Reference Document (GEO, 2005) where information providers must accept and implement "a set of interoperability arrangements, including technical specifications for collecting, processing, storing , and dissemination shared data, metadata and products. GEOSS interoperability will be based on non-proprietary standards, with preference to formal international standards. Interoperability will be focused on interfaces, defining only how system components interface with each other and thereby minimizing any impact on affected systems". GEOSS is based on existing technologies using internet-based services.

Moreover members must fully endorse the following data sharing principles:

1. There will be full and open exchange of data, metadata, and products shared within GEOSS, recognizing relevant international instruments and national policies and legislation.
2. All shared data, metadata, and products will be made available with minimum time delay and at minimum cost.
3. All shared data, metadata, and products being free of charge or no more than cost of reproduction will be encouraged for research and education.

These principles push data owners to go "open" and to share their data using standards and thus becoming interoperable.

1.4.3 United Nations Spatial Data Infrastructure (UNSDI)

Website: http://www.ungiwg.org/unsdi.htm

The United Nations Spatial Data Infrastructure in an initiative conducted by the United Nations Geographic Working Group (UNGIWG) that aims at building an institutional and technical mechanism to establish a coherent system to exchange data and services concerning geospatial data and information within the United Nations, and also supporting SDI development activities in the Member Countries.

As stated in the UNSDI Compendium (UNGIWG, 2007), "Historically, the production and use of geospatial data have been accomplished within the United Nations by its component organizations, in accordance with their individual needs and expertise. But concordant with the recent, rapid increase in the use of geospatial data for UN activities is the need for greater coherence in its management system-wide".

This initiative aims to contribute to the general mission of the United Nations to maintain peace and security, to address humanitarian emergencies, to assist sustainable development and support achievement of the UN Millennium Development Goals. The hope is to facilitate efficient access, exchange and utilization of georeferenced information in order to make the UN system more effective, increase the system coherence and support its "Delivering as One" policies.

The UNSDI provides an institutional and technical foundation of policies, interoperable standards procedures and guidelines that enable organizations and technologies to interact in a way that facilitates spatial discovery, evaluation and applications (UNGIWG, 2007).

1.4.4 Global Monitoring for the Environment and Security (GMES)

Websites: http://www.gmes.info/ and http://ec.europa.eu/gmes/

The GMES is a European programme, coordinated by the European Commission and European Space Agency, for the implementation of a European capacity for Earth observation with the objective to monitor and better understand the environment and thus contribute to the security of every citizen. This initiative aims at providing decision-makers and other users who rely on strategic information with regard to environmental and security issues an autonomous, independent and permanent access to timely, reliable and accurate data and services.

The objective is to integrate data on atmosphere, oceans and continental/land processes giving an overview of the state of health of our planet and to deliver information through five thematic areas (served by different services) covering:

- land,
- marine,
- emergency,
- atmosphere,
- security.

allowing policy and decision-makers to prepare legislation (at different level) on environmental topics and to monitor the implementation of such laws.

To gather data and information on Earth Observation, GMES proposes to build and infrastructure around four components:

- space: environmental satellites
- in-situ measurements: ground-based and airborne sensors
- data harmonization and standardization
- services to users.

Like various other data sources, Earth-observation-based services already exist in Europe but are dispersed and fragmented at national and regional level avoiding a sustainable observation capacity (meaning that long-term availability of information is not guaranteed). In consequence, GMES is the answer of the European Commission to develop a reliable and sustainable Earth Observation system and also contributing the GEOSS initiative.

GMES stated that “By securing the sustainability of an information infrastructure necessary to produce output information in the form of maps, datasets, reports, targeted alerts, etc…, GMES helps people and organizations to take action, make appropriate policy decisions and decide on necessary investments. GMES also represents a great potential for businesses in the services market, which will be able to make use of the data and information it provides according to a full and open access principle.” (GMES, 2009).

1.4.5 Global Spatial Data Infrastructure (GSDI)

Website: http://www.gsdi.org

The mission of the GSDI Association, a world-wide inclusive body of organizations, agencies, firms and people, is to “promote international cooperation and collaboration in support of local, national, and international spatial data infrastructure developments that will allow nations to better address social, economic and environmental issues of pressing importance” (GSDI, 2004).

Its purpose is to focus on communication, education, scientific, research and partnership efforts to support all societal needs for access to and use of spatial data.

This is an association, guided by a board and funded by membership fees, to:

- serve as a point of contact and effective voice for those in the global community involved in developing, implementing and advancing spatial data infrastructure concepts,
- foster spatial data infrastructures that support sustainable social, economic, and environmental systems integrated from local to global scales, and

- promote the informed and responsible use of geographic information and spatial technologies for the benefit of society.

The GSDI community aims to truly develop and achieve the goal of a Global Spatial Data Infrastructure relying on international and open standards, guidelines and policies to enhance data management and access, and support global economic growth, and associated social and environmental objectives (UNGWIG, 2007), through interoperable standards-based services, systems, softwares and products that operate in a web-based environment.

This vision is guided by five goals (Stevens, 2005):

- Continue to promote and develop awareness and exchanges on infrastructure issues for all relevant levels from local to global.
- Promote and facilitate standards-based data access/discovery through the Internet.
- Promote, encourage, support, and conduct capacity building.
- Promote and conduct SDI development research.
- Collaborate with others to accomplish its Vision and Goals.

To support this vision, the GSDI association acts as a platform and offers a vast choice of publications, conferences, workshops, projects and programs allowing people interested in SDI to learn, exchange, share their knowledge and expertise, because capacity building is one of the key points of SDIs.

1.5 Standards organizations relevant for GIS/SDI

In the field of geomatics there are several organizations involved in publishing standards to effectively achieve the goal of interoperability. Such standards are increasingly important in the geospatial community allowing the increase of interoperability between systems and data and thus to “geo-enable” the Web.

1.5.1 Open Geospatial Consortium (OGC)

Website: http://www.opengeospatial.org

The Open Geospatial Consortium (OGC) is a non-profit, international, voluntary consortium of more than 380 companies, government agencies and universities that is leading the development of standards for the geospatial community. Its approach is based on a member-driven consensus process to develop open and publicly available standards and software application programming interface for the geospatial community (UNGIWG, 2007). These standards offer to the developers the possibility to create complex georeferenced information and services accessible to a wide variety of applications and share data in a standardized and interoperable way.

The OGC standards are based on a generalized architecture presented in the Abstract Specification and Reference Model (OGC, 2007). On top of the Abstract Specification, there is a set of standards that have been developed and/or proposed to serve specific needs of the Geographical Information community in order to be interoperable.

These standards are mostly based upon the use of the http protocol to interact through messages over the Internet. In the last two years, the OGC members have been looking with interest to a more common approach used in the Service Oriented Architecture using SOAP protocol and WSDL bindings. There is also work in progress around the Representational State Transfer (REST) protocol for web services.

The OGC is also closely working with the International Organization for Standardization (ISO) through a partnership with the ISO Technical Committee 211 (TC211) to promote and endorse the OGC standards to a higher level of standardization becoming part of the ISO 19100 series. For example, the WMS or the GML are now ISO standards.

The OGC vision is the realization of a full societal, economic and scientific benefits of integrating electronic location resources into commercial and institutional processes worldwide. Its mission is to serve as a global forum for the collaboration of developers and users of spatial data products and services, and to advance the development of international standards for geospatial interoperability.
More specifically the OGC aims to (http://www.opengeospatial.org/ogc/vision):

- Provide free and openly available standards to the market, tangible value to Members, and measurable benefits to users.
- Lead the creation and establishment of standards that allow geospatial content and services to be seamlessly integrated into business and civic processes, the spatial web and enterprise computing.
- Facilitate the adoption of open, spatially enabled reference architectures in enterprise environments worldwide.
- Advance standards in support of the formation of new and innovative markets and applications for geospatial technologies.
- Accelerate market assimilation of interoperability research through collaborative consortium processes.

It must be noticed that the OGC and its members want to help users and developers to make usage of OGC's standards offering them different resources (e.g. technical documents, training, best practices) through the OGC Network (http://www.ogcnetwork.net/).

1.5.2 International Organization for Standardization (ISO)

Website: http://www.iso.org

The International Organization for Standardization (ISO), the world's largest developer, publisher and promoter of international standards, is a non-governmental organization made of a network of more than 160 countries representatives (one per country) with a central secretariat based in Geneva (Switzerland) that coordinates the system.

Even if the main focus of ISO is the development of technical standards, they have an important impact on the economy and the society because many members are coming from a governmental structure or from the private sector. Therefore, ISO is an ideal place to build consensus and solutions that meet the needs and requirements from both the economy and the society.

Within the ISO system there is a Technical committee (http://www.isotc211.org/) whose main area of interest are the Geographical information and the Geomatics aiming to establish a structured set of standards for information concerning objects or phenomena that are directly or indirectly associated with a location relative to the Earth.

At the present day, they have more than 55 standards in the field of Geographical information specifying methods, tools and services for data management (including definition and description), acquiring, processing, analyzing, accessing, presenting and transferring such data in digital/electronic form between different users, systems and locations.

1.5.3 The World Wide Web Consortium (W3C)

Website: http://www.w3c.org

The World Wide Web Consortium (W3C) is an international consortium where members, organizations, staff and the public work together to create and develop Web standards, protocols and guidelines. Since 1994, the W3C has published more that 110 Recommendations (the W3C standards) aiming to " lead the World Wide Web to its full potential by developing protocols and guidelines that ensure long-term growth for the Web", accommodating the growing diversity of people, hardware and software and

ensuring the core principles and components of these standards would be supported by everyone.

For the W3C it is crucial to reach the goal of the “web interoperability” allowing the Web to reach its full potential by using technologies that must be compatible with one another and allowing any hardware and/or software to access the Web. By publishing open and non-proprietary standards, the W3C seeks to avoid market fragmentation and thus Web fragmentation.

Therefore the W3C engages in education and outreach, develops software and interoperable technologies that support this mission and acts as an open and vendor-neutral forum for discussion about the Web.

1.5.4 Organization for the Advancement of Structured Information Standards (OASIS)

Website: http://www.oasis-open.org/

The Organization for the Advancement of Structures Information Standards is a non-profit, global consortium (with 5000 members coming from more than 600 organizations in 100 countries) that drives the development, convergence and adoption of open standards for the global information society, the so-called e-business. OASIS produces different web standards concerning the following categories: Web Services, e-Commerce, Security, Law & Government, Supply Chain, Computing Management, Application Focus, Document-Centric, XML Processing, Conformance/Interop, and Industry Domains.

1.6 Standards Description

ISO and OGC are providing a lot of different specifications regarding geographical data but in the context of the EnviroGRIDS project we propose to concentrate on those that are mostly used in the geospatial community. The aim is to place the first building blocks of a regional SDI for the Black Sea catchment.

The general aim of these standards is to abstract data delivery mechanisms from physical storage formats and offer services that could be consumed by applications through different interfaces.

The OGC defines a general architecture for the geoportal (OGC, 2004) called The Geospatial Portal Reference Architecture. It provides the basis for an open, vendor-neutral portal that is intended to be a first point of discovery for geospatial content in the context of designing and implementing the Spatial Data Infrastructures. The Geospatial Portal Reference Architecture is founded on the tenants of a Service Oriented Architecture (SOA). An SOA is an architecture that represents software functionality as discoverable services on a network yielding the following benefits:

- Easier extension of legacy logic to work with new business functionality
- Greater flexibility to change without the need to constantly re-architect for growth
- Cost savings by providing straight-forward integration.

The Geospatial Portal Reference Architecture specifies also four services that are needed for creating a interoperable and standardized geoportal (fig.8):

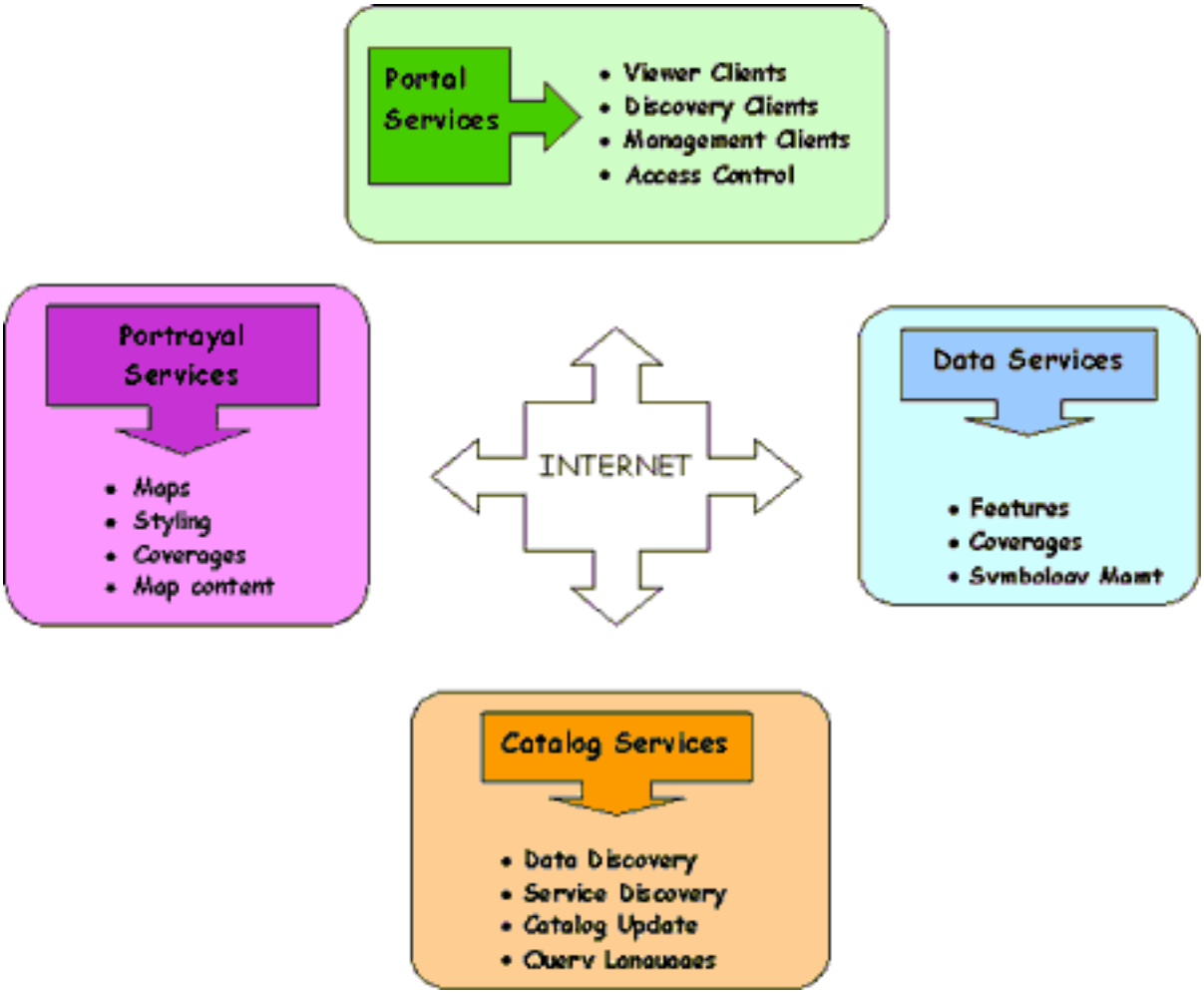


Fig.8: Geospatial Portal Reference Architecture (Source: GeoNetwork).

- Portal Services: provide the single point access to the geospatial information on the portal. In addition, these services provide the management and administration of the portal.
- Catalog Services: used to locate geospatial services and information wherever it is located and provide information on the services and information if finds to the user.
- Portrayal Services: used to process the geospatial information and prepare it for presentation to the user.
- Data Services: used to provide geospatial content and data processing.

To implement and deploy these different service classes, the OGC propose to use web services that are applications running on a computer connecting to a remote web service via a URL allowing access to distributed data and services. As stated by the CGDI "Web service architectures provide a distributed environment in which you can deploy and invoke services using standard Internet protocols. In this context, a service is a collection of operations, accessible through one or more interfaces, that allows you to evoke a behavior of value to you." (http://www.geoconnections.org/publications/Technical_Manual/html_e/s4_ch10.html#10.1)

Using such a Service Oriented Architecture (SOA) provides a distributed computing platform over a network, typically the Internet, allowing to publish standardized services no matter how it is implemented or on which platform it is executed. This is leveraging the full potential of the interoperability and thus web services to be seamlessly coupled, reusable and available for a variety of applications.

A traditional open web service must have the ability to describe its capabilities and provide a standard way to communicate with it, enabling applications and other web

services to communicate and interoperate. Through OGC standards, different GIS softwares and/or components can interoperate, work together and exchange information over a network by means of agreed standards.

For example, when two softwares implement the same OGC standard, they can immediately work together without the necessity to develop new components to translate from one file format (used in one software) to another file format (used in a second software). This means that in a SOA environment that implement OGC standards, a user can access in a transparent way the data stored in different databases, with different formats, and running on different Operating Systems.

Without interoperability and standardization, accessing and integrating different data sources is really difficult or in the worst case impossible. This leads to a fragmentation of geospatial data sources and limit organizations to work only within a single software package.

1.6.1 Catalogue Service for the Web (CSW)

OGC Catalogue Service Specification: http://www.opengeospatial.org/standards/cat

The Catalogue Service defines an interface to publish, discover, search and query metadata about georeferenced data, services and related resources. CSW uses queryable properties, which enable clients to search for geospatial resources by subject, title, abstract , data format, data type, geographic extent, coordinate reference system, originator, publisher, purpose,...

Fig.9: GeoNetwork, a catalogue system using CSW.

1.6.2 Web Map Service (WMS)

OGC Web Map Service Specification: http://www.opengeospatial.org/standards/wms

The Web Map Service defines an interface that allows a client to retrieve maps of georeferenced data. In WMS context, a map means a graphical representation (jpeg ,gif or png files) of a geospatial data meaning that a WMS service does not give access to the data itself. It is used for mapping purposes and can be combined with other WMS services.
A traditional WMS interface, invoked by a URL, consists of the following operations:

- *GetCapabilites:* answer to a client telling him what kind of layers are available and which one are queryable.
- *GetMap:* produce a map as a picture showing selected layers,
- *GetFeatureInfo:* answer simple queries about the content of the map

As seen on the following examples, invoking a WMS service need to specify different parameters (mandatory or optional) in the URL. For the purpose of this guideline we will focus our attention on the basic operations of the service that provides map layers in predefined styles (made available by the data provider) thus we will not discuss the Styled Layer Descriptor (SLD) capabilities.

- Example of a WMS URL with a GetCapabilites request:
http://metafunctions.grid.unep.ch:8080/geoserver/ows?service=WMS&request=GetCapabilities&version=1.3.0

The GetCapabilites operation returns to the user an XML document describing the service and the data sets available from which either desktop and/or web clients may request maps. This operation is common for all the OWS and is presented in details in the OpenGIS Web Service Common Implementation Specification (OGC, 2007). To invoke the operation, the user has only to define the service and the request parameters.

```
- <wfs:WFS_Capabilities version="1.1.0" xsi:schemaLocation="http://www.opengis.net/wfs http://preview.grid.unep.ch:8080/geoserver/schemas
  /wfs/1.1.0/wfs.xsd" updateSequence="262">
  - <ows:ServiceIdentification>
      <ows:Title>enviroSDI Web Feature Service</ows:Title>
    - <ows:Abstract>
        enviroSDI is the Spatial Data Infrastructure of the UNEP/DEWA/GRID-Europe (http://www.grid.unep.ch). This is the reference
        implementation of WFS 1.0.0 and WFS 1.1.0, supports all WFS operations including Transaction.
      </ows:Abstract>
    - <ows:Keywords>
        <ows:Keyword>enviroSDI</ows:Keyword>
        <ows:Keyword>UNEP</ows:Keyword>
        <ows:Keyword>GRID</ows:Keyword>
        <ows:Keyword>EUROPE</ows:Keyword>
        <ows:Keyword>WFS</ows:Keyword>
        <ows:Keyword>GEOSERVER</ows:Keyword>
      </ows:Keywords>
      <ows:ServiceType>WFS</ows:ServiceType>
      <ows:ServiceTypeVersion>1.1.0</ows:ServiceTypeVersion>
      <ows:Fees>NONE</ows:Fees>
      <ows:AccessConstraints>NONE</ows:AccessConstraints>
    </ows:ServiceIdentification>
  - <ows:ServiceProvider>
      <ows:ProviderName>UNEP/DEWA/GRID-Europe</ows:ProviderName>
    - <ows:ServiceContact>
        <ows:IndividualName>Gregory Giuliani</ows:IndividualName>
        <ows:PositionName>enviroSDI coordinator</ows:PositionName>
      - <ows:ContactInfo>
        - <ows:Phone>
            <ows:Voice>+41 22 917 84 17</ows:Voice>
            <ows:Facsimile/>
```

Fig.10: Example of the XML file returned after a GetCapabilites request.

- Example of a WMS URL with a GeMap request:
http://preview.grid.unep.ch:8080/geoserver/wms?bbox=84.95293,19.82194,-74.13126,23.19403&styles=&Format=image/

png&request=GetMap&version=1.1.1&layers=preview:cy_buffers&width=640&height=309 &srs=EPSG:4326

The GetMap operation is the most important of the three basic operations of the WMS interface as it returns to a client request a map of selected geospatial layers.
In comparison of the GetCapabilities request that needs only two parameters, we can see on the above example that GetMap operation needs several parameters (also mandatory or optional) that we describe hereafter:
Mandatory parameters for the GetMap operation:

- BBOX: coordinates of the bounding box following minx,miny,maxx,maxy,
- STYLES: list of style names separated by a comma. It's necessary to have an exact correspondence between the number of layers and the number of styles. If this parameter has a empty value, the default style provided by the data custodian will be applied.
- FORMAT: graphical format of the returned map (eg: image/png, image/gif, image/jpeg).
- REQUEST: value “GetMap”, this the request itself to invoke the specific operation.
- VERSION: the version of the specification.
- LAYERS: list of selected layers separated by a comma.
- WIDTH: specify the width of the returned map (in pixels).
- HEIGHT: specify the height of the returned map (in pixels).
- SRS: identifier of the Spatial Reference System.

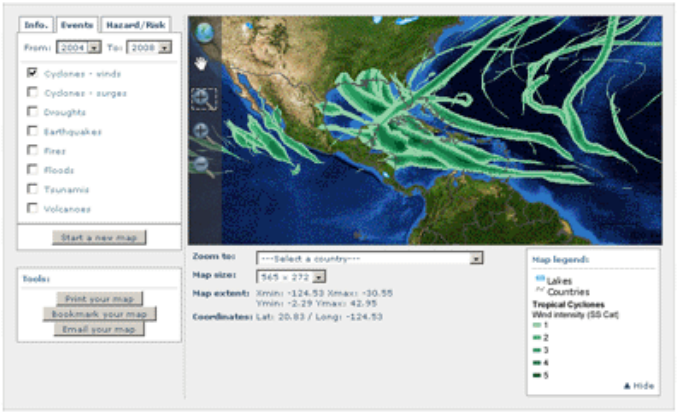


Fig.11: Returned image after a WMS request.

- Example of a WMS URL with a GetFeatureInfo request:
http://webmapping.mgis.psu.edu/geoserver/wms?version=1.1.1&request=getfeatureinfo&layers=topp:states&styles=population&SRS=EPSG:4326&bbox=-125,24,-67,50&width=400&height=200&format=text/html&X=100&y=100&query_layers=topp:states

The GetFeatureInfo operation is used to query the attribute table of a selected layer and get information on a specific feature. For example, a user can click on point of a map (retrieved by a GetMap request) and he obtains more information.
Mandatory parameters for the GetFeatureInfo operation:

- VERSION: the version of the specification.
- REQUEST: value “GetFeatureInfo”, this the request itself to invoke the specific operation.
- LAYERS: list of selected layers separated by a comma.
- STYLES: list of style names separated by a comma. It's necessary to have an exact correspondence between the number of layers and the number of styles. If this

parameter has a empty value, the default style provided by the data custodian will be applied.
- SRS: identifier of the Spatial Reference System.
- BBOX: coordinates of the bounding box following minx,miny,maxx,maxy.
- FORMAT: the format of the returned information (text/xml, text/html, text/plain)
- X,Y: coordinates of the clicked point on the map (in pixels). The origin is at the upper left corner.
- QUERY_LAYERS: list of selected layers to query separated by a comma.

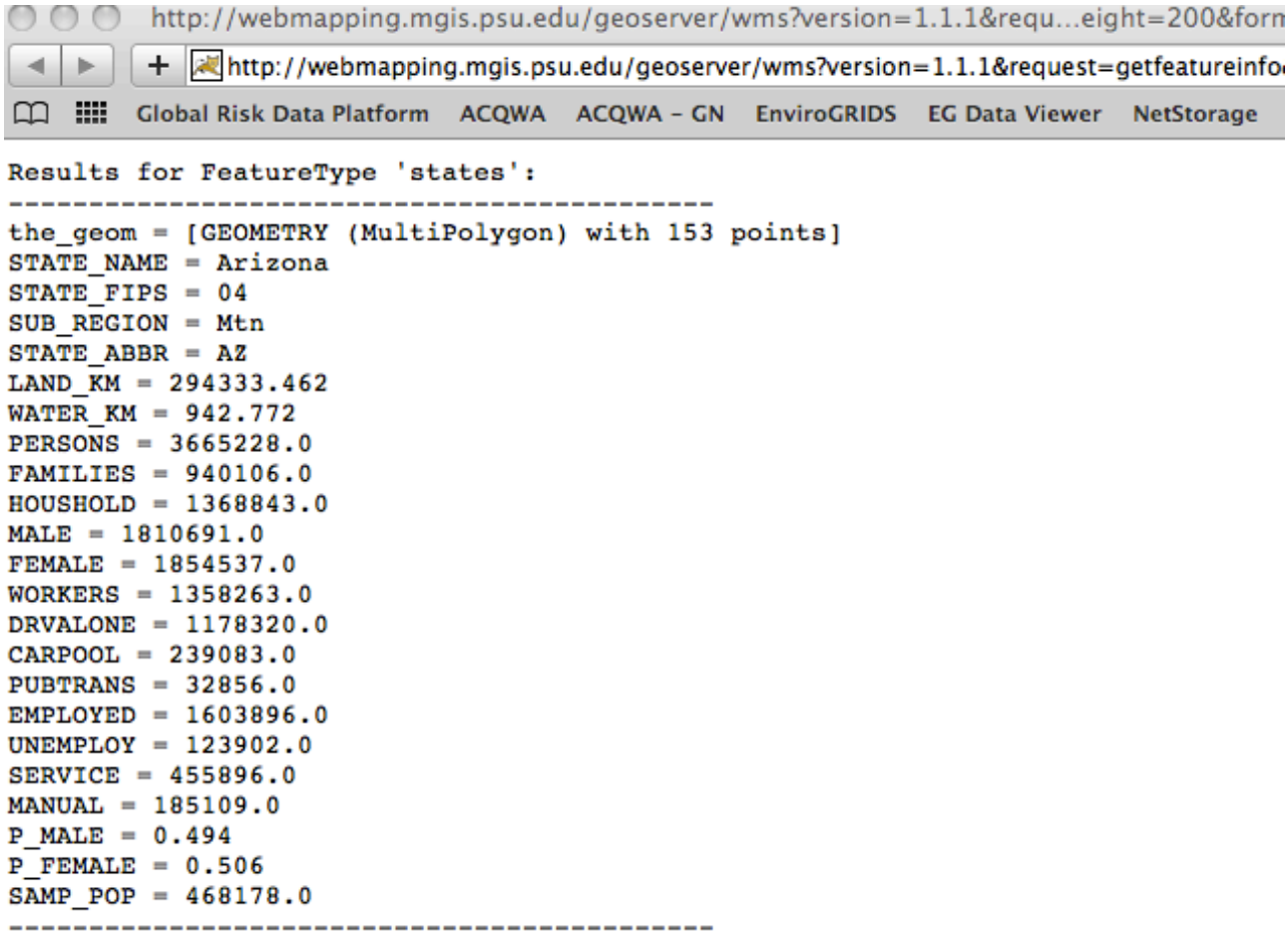


Fig.12: Result of a GetFeatureInfo query.

1.6.3 Web Feature Service (WFS)

OGC Web Feature Service specification: http://www.opengeospatial.org/standards/wfs

The Web Feature Service defines an interface that allows a client to retrieve and update features of georeferenced data encoded in Geography Markup Language (GML). The main difference between WMS and WFS is that WFS gives direct access to the geometry and the attributes of a selected geospatial data, meaning that a user can work with a dataset provided by WFS. In brief, the WFS is the specification to access vector datasets.

Similar to the WMS, a WFS interface is invoked by a URL and can perform a certain number of operations allowing a client to manipulate the data. Following the type of operations needed to manipulate the data, we can define two classes of WFS services:
- Basic WFS: a client can retrieve and/or query features,
- Transactional WFS: a client can create, delete or update a feature.

A transaction is defined as one or more data manipulation operations that form a logical unit.

The concept of a geographic feature is described in the OGC Abstract Specification (OGC, 2009) and the retrieved or created data are encoded in the Geographic Markup Language (OGC, 2007).

- Example of a basic WFS URL:
http://preview.grid.unep.ch:8080/geoserver/wfs?bbox=-84.95293,19.82194,-74.13126,23.19403&styles=&request=GetFeature&version=1.0.0 &typename=preview:cy_buffers &srs=EPSG:4326

Like the WMS, WFS service is supported by a set of defined operations:
- *GetCapabilites:* answer to a client describing its capabilities. It tells the client which kind of features are available and what operations are supported on each feature.
- *DescribeFeatureType:* describe the structure of a selected feature (point, line, polygon).
- *GetFeature:* retrieve a selected feature encoded in GML. The client can constrain the query both spatially and non-spatially and also specify the feature properties to fetch.
- *Transaction:* this type of request is made of operations that allow a client to modify features: create, delete and/or update operations. In addition, a client can invoke the LockFeature, in order to be sure that only one user is updating a specific feature, avoiding the risk of multi-edition at the same time.

1.6.4 Web Coverage Service (WCS)

OGC Web Coverage Service specification: http://www.opengeospatial.org/standards/wcs

Like the WFS allows a client to access vector datasets, the Web Coverage Service allow a client to access raster datasets. By rasters we mean data that are represented as a matrix of cells in continuous space organized in rows and columns where each cells contains a value. Thus WCS service provide access to different types of gridded data such as Digial Elevation Model (DEM), remote sensing imagery, etc... It must be noted that WCS gives only access to the raw data and does not have transactional capabilities.
Like all the OGC Web Services, a WCS interface consists of different operations:
- *GetCapabilities:* answer to a client describing its capabilities. It tells the client which kind of raster data (or coverage) are available.
- *DescribeCoverage:* describe the structure of a selected coverage.
- *GetCoverage:* retrieve the selected coverage.

- Example of a WCS URL with a GetCapabilites request:
http://preview.grid.unep.ch:8080/geoserver/ows?service=WCS&request=GetCapabilities

The GetCapabilites operation returns to a client an XML document describing the service and the data sets available from which either desktop and/or web clients may request coverages.

To invoke the operation, the user has only to define the service and the request parameters.

- Example of a WCS URL with a DescribeCoverage request:
http://preview.grid.unep.ch:8080/geoserver/wcs?service=WCS&request=DescribeCoverage&version=1.0.0&coverage=preview:cy_frequency

The DescribeCoverage operation returns to a client an XML document describing selected coverages. The information provided must be sufficient for a client to assess the fitness for

use of the data. It gives different useful pieces of information such as the supported raster formats, supported SRS, supported interpolation methods, etc...
Mandatory parameters for the DescribeCoverage request:

- SERVICE: value “WCS”, this is the name of the invoked service.
- REQUEST: value “DescribeCoverage”, this is the request to invoke the specific operation.
- VERSION: the version of the specification.
- COVERAGE: list of selected coverages separated by a comma.

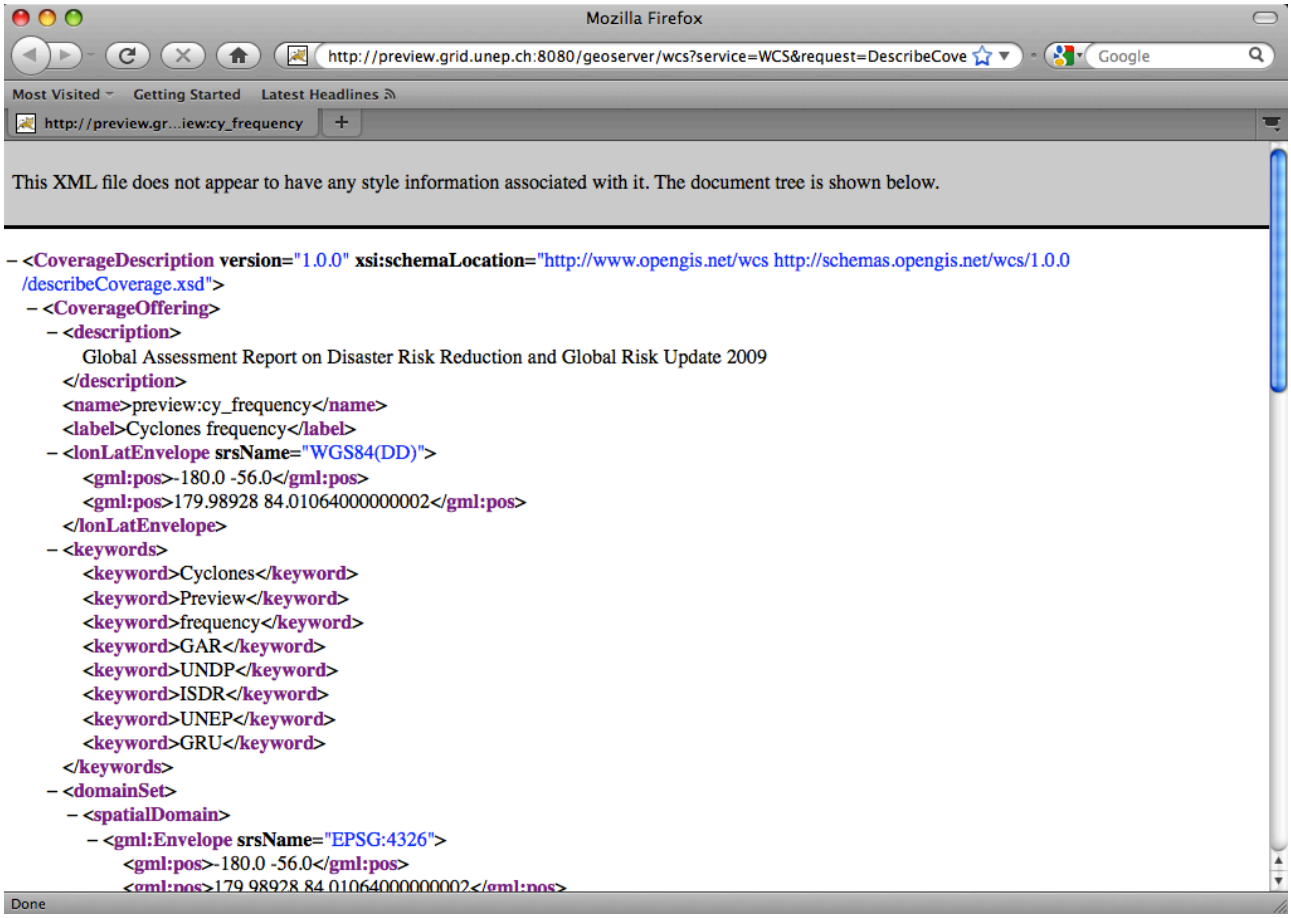


Fig.13: WCS DescribeCoverage

- Example of a WCS URL with a GetCoverage request:
http://preview.grid.unep.ch:8080/geoserver/wcs?bbox=-84.95293,19.82194,-74.13126,23.19403&service=WCS&styles=&request=GetCoverage&version=1.0.0&coverage=preview:cy_frequency&width=640&height=309&crs=EPSG:4326&Format=GeoTiff

The GetCoverage request returns to a client the requested raster data. The syntax and the parameters of the URL are similar to those used in a WMS GetMap resquest.
Mandatory parameters for the GetCoverage request:

- BBOX: coordinates of the bounding box following minx,miny,maxx,maxy
- SERVICE: value “WCS”, this the name of the invoked service.
- STYLES: list of style names separated by a comma. It is necessary to have an exact correspondence between the number of layers and the number of styles. If this parameter has an empty value, the default style provided by the data custodian will be applied.

- REQUEST: value “GetCoverage”, this the request to invoke the specific operation.
- VERSION: the version of the specification.
- COVERAGE: name of a single selected coverage.
- WIDTH: specify the width of the returned coverage (in pixels).
- HEIGHT: specify the height of the returned coverage (in pixels).
- CRS: identifier of the Coordinate Reference System.
- FORMAT: the desired format to be used for returning the coverage (eg: GeoTiff, ARCGRID, GTOPO30,...)

If a request is validated then a coverage is extracted (using the BBOX, FORMAT and the different parameters set in the URL) from the selected coverage and sent to the client. If the client is a web browser then the user can download the coverage file. If the request is sent through a Desktop GIS client like ArcGIS then the user gets the coverage directly into it.

1.6.5 Web Processing Service (WPS)

OGC Web Processing Service specification: http://www.opengeospatial.org/standards/wps

The two previous discussed standards are focusing on data accessibility: WFS allows a client to access vector data while WCS allows a client to retrieve raster data.
Now we need to extend our capabilities in order to process data available using the recently introduced Web Processing Service (OGC, 2007) that provides access to processing and calculations on geospatial data. A WPS service can offer, through a network access, a vast variety of GIS functionalities ranging from a simple calculation to complex models. It acts as a sort of middleware between the client and the process that runs the calculations. It allows users to know which processes are available, to select the required input data and their formats, to create a model and run it, to manage processes (status, storage for the output, …) and to return the output once the computation is completed.
Like the others OWS, the WPS specification includes a set of operations:

- *GetCapabilites:* answer to a client describing its capabilities. It tells the client which kind of process are available.
- *DescribeProcess:* describe the parameters a selected process.
- *Execute:* execute a selected process.

The WPS differs a bit from the others OWS because these operations can be invoked either by SOAP or the traditional http-get and http-post.

- Example of a WPS URL with a GetCapabilites request:
http://localhost/wps/wps.py?service=WPS&request=GetCapabilities

The GetCapabilites operation returns to a client an XML document describing the service and the processes available for execution.
To invoke the operation, the user has only to define the service and the request parameters.

- Example of a WPS URL with a DescribeProcess request:
http://localhost/wps/wps.py?service=WPS&request=DescribeProcess&version=1.0.0&identifier=soil_process

The DescribeProcess operation returns an XML document describing what are the mandatory, optional and default parameters needed for a selected process, as well as the data formats for inputs and outputs.
Mandatory parameters for this operation:

- SERVICE: value “WPS”, this is the name of the invoked service.
- REQUEST: value “DescribeProcess”, this is the request to invoke the specific operation.
- VERSION: the version of the specification.
- IDENTIFIER: the name of the selected process to run.

- Example of a WPS URL with an Execute request:
http://localhost/wps/wps.py?version=1.0.0&service=WPS&request=Execute&identifier=soil_process&datainputs=http://localhost/wps/soil_param.xml

The Execute operation allows a client to run a selected process using values entered by the client for the required parameters (if needed) and reference the datasets location. Once the process is completed, the result is returned to the client as a new dataset.

1.6.6 Sensor Observation Service (SOS)

OGC Sensor Observation Service specification: http://www.opengeospatial.org/standards/sos

The OGC Sensor Web Service provides an interface for managing sensors and retrieving data from them. This standard is part of the suite of standards called Sensor Web Enablement (SWE) that are presented in details in the deliverable D2.3.

1.6.7 ISO 19115/19139

ISO 19115, Geographic information – Metadata: http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=26020
ISO 19139, Geographic information – Metdata- XML schema implementation:
http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=32557

The ISO 19115 standard defines (with more than 400 metadata elements, 20 core mandatory elements) how to describe a georeferenced information and to provide information about the content, the identification, the quality, the spatial and temporal extent, the access and rights and the spatial reference.
This standard is applicable to:

- the cataloguing of datasets, clearinghouse activities, and the full description of datasets,
- geographic datasets, dataset series, and individual geographic features and features properties.

The main applicability of ISO19115 is for digital data but its principles can be extended and applied to other forms of geospatial data such as maps, charts and textual documents as well as non-geographic data (ISO, 2003).

The ISO 19139 standard complements ISO19115 by defining an XML encoding schema implementation specifying the metadata record format and may be used to describe, validate, and exchange geospatial metadata prepared in XML.

1.6.8 ISO 19119

ISO 19119, Geographic information – Services:
http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=39890

The ISO 19119 identifies and defines the architecture patterns for service interfaces used for geographic information, defines its relationship to the Open Systems Environment model, presents a geographic services taxonomy and a list of example geographic services placed in the services taxonomy. It also prescribes how to create a platform-neutral service specification, how to derive conform platform-specific service specifications, and provides guidelines for the selection and specification of geographic services from both platform-neutral and platform-specific perspectives. In other words, ISO

19119 specifies the form and content of the XML document that describes the capabilities of a geospatial web service (eg, the answer to the GetCapabilities request).

1.6.9 Keyhole Markup Language (KML)

OGC Keyhole Markup Language specification: http://www.opengeospatial.org/standards/kml

The KML format is an XML based language schema for describing geographical objects in web-based viewer (the so-called geobrowser). It has been developed and popularized by the Google Earth application and due to its success was turned into an OGC standard.

1.6.10 Geographic Markup Language (GML)

OGC Geographic Markup Language specification: http://www.opengeospatial.org/standards/kml

The GML is a very complete XML based language used to describe all geographical features and objects and provides a standard mean for representing geographical features (properties, relationships, geometries, …). GML differs from KML as it is not only used for data visualization (which is the main focus of the KML specification) but serves also as a modeling language as well as an open and interoperable exchange format over the Internet. It is mostly used in the Web Feature Service to send geographical features between servers and clients.

The GML core schema does not contain definitions of features (because it is impossible to describe all features) but could be rather seen as a grammar providing means to define concrete features through GML Application Schemas that are created by users. Although GML is easily readable, it will be mostly used and generated by software or web services answering a specific request and then receiving the result as a GML dataset.

The real advantage of using GML is that XML technologies are available meaning that information stored in a GML file could be easily shared with other information and then specialized application domains could reuse, extend and/or refine GML components in an application schema in order to develop a specific data model.

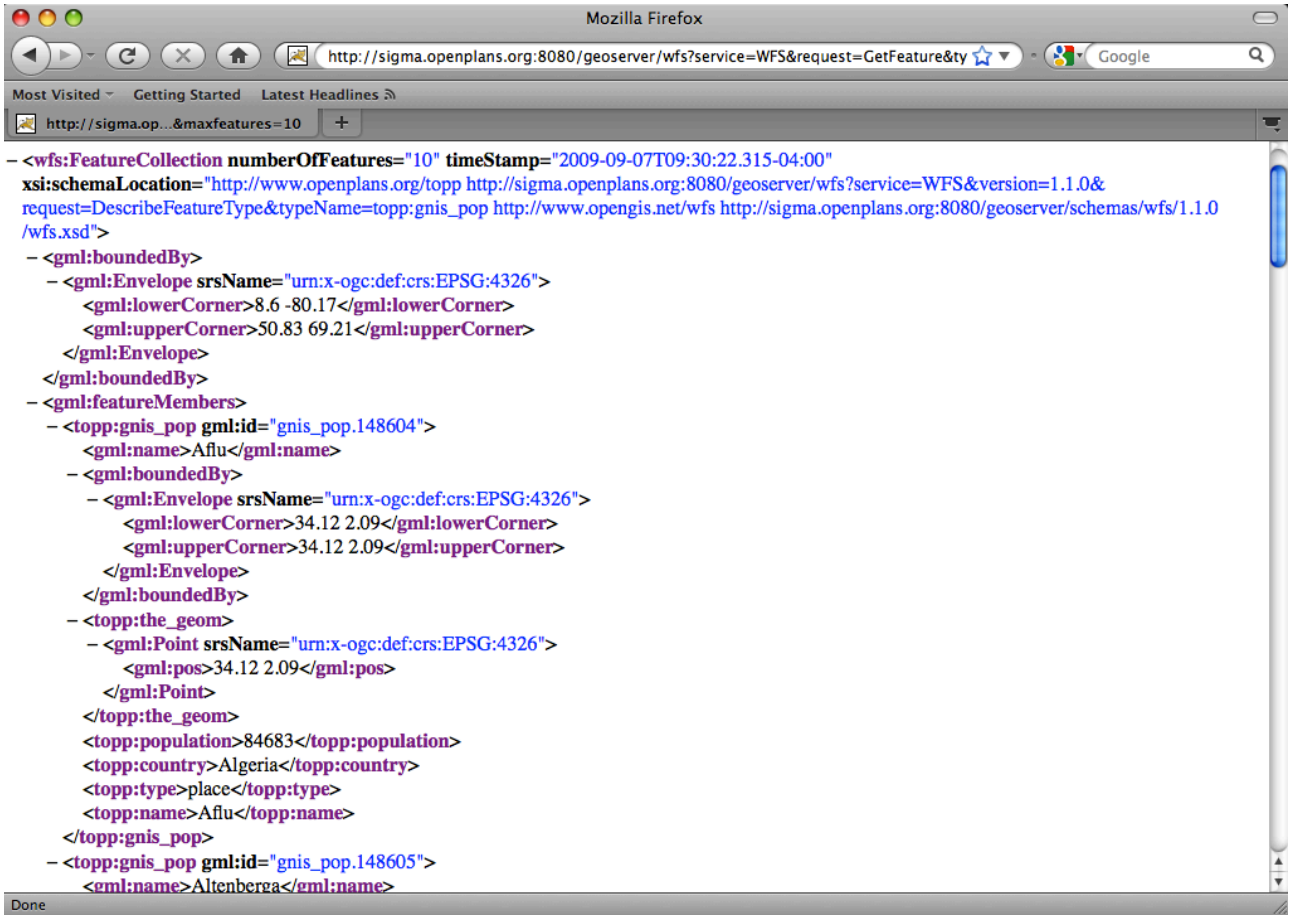


Fig.14: Example of GML returned after a WFS request.

More information available at: http://www.w3.org/Mobile/posdep/GMLIntroduction.html

1.7 Tools

After reviewing the set of OGC and ISO standards relevant for our purpose it is important to present a selection of tools that implement those standards, allowing the user to produce standardized and interoperable web services. Note that none of these softwares integrate all standards at once. Instead each of them is a building block of a Spatial Data Infrastructure following the OGC Reference Architecture (OGC, 2004; OGC, 2008).

1.7.1 OGC web services

1.7.1.1 Mapserver

Website: http://www.mapserver.org
Supported OS: Windows/Linux-Unix/Mac

MapServer is an open source geographic data rendering engine and development environment for building WebGIS applications and sharing data through OGC standards. It can run as a CGI program or via Mapscript which supports several programming languages.
MapServer is now a project of OSGeo and is maintained by a growing number of developers from around the world.
Mapserver main features are:

- Advanced cartographic output: scale, labels, reference map, classification,...
- Support for different scripting and development environments: PHP, Python, Perl, Java and .NET

- Cross-platform support: Linux, Windows, Mac, Solaris, …
- OGC web services: WMS (client/server), WFS (client/server), WCS, GML, SLD, SOS, …
- Multitude of raster and vector formats: GeoTiff, shp, PostGIS, ArcSDE, … via GDAL/OGR
- Map projection support: up to 1000 projections through the Proj.4 librabry.

1.7.1.2 Geoserver

Website: http://www.geoserver.org
Supported OS: Windows/Linux-Unix/Mac

Geoserver is an open source server designed to publish data from different major data sources using OGC standards and allowing the users to share their data. Unlike Mapserver, Geoserver has no mapping capabilities, it is only used for publishing data in an interoperable and standardized way.
Geoserver is a community-driven project sponsored by OSGeo.
Geoserver main features are:

- Java-based.
- Support of WMS, WFS, WCS and KML specifications.
- Various raster and vector formats: PostGIS, Oracle spatial, ArcSDE, DB2, MySQL, shp, GeoTiff, ECW, MrSID and Jpeg2000.
- Production of: KML, GML, shp, GeoRSS, PDF, GeoJSON, JPEG, GIF, SVG and PNG.
- Editing capabilities using WFS-Transactional.
- Includes an OpenLayers client for previewing data layers.

1.7.1.3 Deegree

Website: http://www.deegree.org/
Supported OS: Windows/Linux-Unix/Mac

Deegree is an open source framework, sponsored by OSGeo, offering the main building blocks of an SDI. Its entire architecture is developed around OGC and ISO standards.
Deegree main features are:

- Java-based.
- Support of WMS, WFS, WCS, WPS and CSW.
- Storage formats: PostGIS, Oracle, shp, GML, jpeg, gif, png, bmp, geotiff.
- Simplified installation and configuration.
- SLD support.
- Envisioned support of Sensor Observation Service (SOS) and Web Terrain Service / Web Perspective and View Service (WTS/WPVS).
- Security implementation using Web Authentication (WAS) and Web Security Service (WSS).
- Built-in web-geoportal.

1.7.1.4 PyWPS

Website: http://pywps.wald.intevation.org/
Supported OS: Linux-Unix

PyWPS in an implementation of the Web Processing Service specification. The great advantage of PyWPS is that it has been written with a native support of GRASS GIS software, meaning that accessing the GRASS modules via web interface should be really easy. Process can be written using either GRASS or other programs like R, GDAL or PROJ.
PyWPS main features are:

- Support of WPS specification.
- Simple configuration files.

- Method for custom process definition.
- Support for multiple WPS servers.
- Python based

1.7.1.5 52 north WPS

Website: http://52north.org/maven/project-sites/wps/52n-wps-site/
Supported OS: Windows/Linux-Unix/Mac

52north WPS is another implementation of the WPS specification that aims to create and design an extensible framework (with plug-in mechanism) for providing, orchestrating and executing processes as well as Grid computing on the internet.
52north WPS main feature are:

- Java-based
- Support of WPS specification.
- Pluggable framework for algorithms and XML data handling and processing frameworks
- Build up on robust libraries (JTS, geotools, xmlBeans, servlet API, derby)
- Supports full logging of service activity (exception handling, storing execution results, ..)
- Clients: basic implementation for accessing the WPS & plug-in for uDig and JUMP.
- WPS invocation: synchronous/asynchronous, http-get, SOAP, WSDL
- Supported data types: GeoTiff, ArcGrid, GML.

1.7.1.6 ArcGIS Server

Website: http://www.esri.com/software/arcgis/arcgisserver/index.html
Supported OS: Windows

ArcGIS Server is part of the ArcGIS family and is the component to provide web-oriented and OGC standardized spatial data services. Since version 9.2, ArcGIS Server also includes the Spatial Data Engine (ArcSDE) that geo-enables databases and allows the user to store their data into popular database system like PostgreSQL or Oracle.
ArcGIS Server main features:

- .NET and Java frameworks.
- ArcGIS Server services can be consumed by web browsers, mobile devices and desktop clients.
- Full implementation of WMS, WFS (basic and transactional), WCS, KML specifications.
- Services: mapping, geocoding, geodata management, geoprocessing, virtual globes, network analysis.
- SOAP and REST API.
- Additional SDKs to build web applications: JavaScript, Flex, Silverlight, ...

1.7.2 Metadata editor and catalog system

1.7.2.1 GeoNetwork Open Source

Website: http://geonetwork-opensource.org/
Supported OS: Windows/Linux-Unix/Mac

GeoNetwork is an open source project, sponsored by the UNSDI (UNGIWG, 2007) initiative and supported by several UN agencies (FAO, UNEP, OCHA and WFP) as well as the OSGeo. GeoNetwork implements both the Portal component and the Catalog database of a Spatial Data Infrastructure (SDI) defined in the OGC Reference Architecture (OGC, 2004) allowing a user to search, discover, evaluate, publish, manage and edit metadata on spatial data and related services through the internet.
The main goal of GeoNetwork is to improve the accessibility and thus enhance the data exchange and sharing in a standardized and consistent way between the organizations to avoid duplication, increase the cooperation and coordination of efforts in collecting data and make them available to benefit everybody, saving resources and at the same time preserving data and information ownership.

Main features of GeoNetwork are:
- Instant search on local and distributed geospatial catalogues
- Support of CSW, Z39.50 and OAI protocols.
- Uploading and downloading of data, documents, PDF's and any other content
- An interactive Web map viewer that combines Web Map Services from distributed servers around the world
- Online map layout generation and export in PDF format
- Online editing of metadata with a powerful template system
- Scheduled harvesting and synchronization of metadata between distributed catalogues
- Groups and users management
- Fine grained access control.

1.7.3 Data storage

1.7.3.1 PostgreSQL/PostGIS

Website: http://www.postgresql.org/ & http://postgis.refractions.net/
Supported OS: Windows/Linux-Unix/Mac

PostgreSQL is a popular and powerful open-source relational database management system (RDBMS) allowing the user to store data and their relations in the form of tables.
A RDBMS itself cannot store geographical information and thus to geo-enable a database system like PostgreSQL it is necessary to install a middleware to add support for geographic objects into the database. Two softwares are able to work in conjunction with PostgreSQL and add specific tables and functions that extend the capacities of a traditional RDBMS:
- PostGIS: follows the OGC Simple Features Specification for SQL (OGC, 200x).
- ESRI ArcSDE: that implements the powerful geodatabase system.

PostGIS main feature are:
- Geometrytypes for points, line, strings, polygons, multipoints, multilinestrings, multipolygons and geometry collections.
- Spatial predicates for determining the interactions of geometries
- Spatial operators for determining geospatial measurements like area, distance, length and perimeter.
- Spatial operators for determining geospatial set operations, like union, difference, symmetric difference and buffers.
- Powerful spatial indexes for high speed spatial querying.
- Index selectivity support, to provide high performance of query plans for mixed spatial/ non-spatial queries.
- No support (for the moment) of raster data.

1.7.3.2 PostgreSQL/ArcSDE

Website: http://www.esri.com/software/arcgis/geodatabase/storage-in-an-rdbms.html
Supported OS: Windows/Linux-Unix

ArcSDE is the second software that could “geo-enable” a RDBMS and implements the powerful concept of the geodatabse allowing to store vector and raster data in a central data repository for easy access and data management. It can be leveraged in dekstop, server and mobile applications and is the common data storage and management system of the ArGIS family of softwares products.
In the latest version 9.3 of ArcGIS Server, ArcSDE in now a component of that and offers an integrated environment. Geospatial data is managed as a database accessible by the users using a desktop client and can be easily published on the internet. It allows query, mapping, analysis and editing in a multi-user environment.

ArcSDE main features are:
- Store a rich collection of spatial data in a centralized location.
- Apply sophisticated rules and relationships to the data.
- Define advanced geospatial relational models (e.g., topologies, networks).
- Maintain integrity of spatial data with a consistent, accurate database.
- Work within a multiuser access and editing environment.
- Integrate spatial data with other IT databases.
- Easily scale storage solution.
- Support custom features and behavior.
- Support DB2, Informix, SQL Server, Oracle and PostgreSQL.

1.7.3.3 File system

The simplest way to store data is probably under a file system arborescence. The inconvenient is that the arborescence must be well structured and self-explainable in order to rapidly find the desired data. We do not recommend to use file system because it is a complex and not efficient system to manage and maintain geographical data. The only advantage is that a user can see a small increase in performance when accessing data but this advantage disappears as soon as he works in a environment where there is a concurrent accesses.

1.7.4 Web Mapping

1.7.4.1 Open Layers

Website: http://openlayers.org/
Supported OS: Windows/Linux-Unix/Mac

OpenLayers is and open-source JavaScript API for creating web-mapping application.
Main features are:
- load map data from many sources: WMS, WFS, GeoRSS, …
- Support for displaying geographic features, with markers and popups
- Easy mouse/keyboard navigation.
- Layers selection.
- Easy build configuration, designed to help build OpenLayers into other applications

Javascript API to allow full control over OpenLayers-powered map from within Javascript on a web page.

1.7.4.2 Mapfish

Website: http://www.mapfish.org
Supported OS: Windows/Linux-Unix/Mac

MapFish is JavaScript API and web-mapping framework using the latest web 2.0 technology and integrates different components like OpenLayers, ExtJS and GeoExt.

1.7.4.3 Google Maps

Website: http://code.google.com/apis/maps/
Supported OS: Windows/Linux-Unix/Mac

Google Maps and its JavaScript API are free services provided by Google and allow developers to embed Google Maps into their web pages using their own data. The API provides a number of functionalities for manipulating maps, adding content and allowing to create simple and robust maps applications.

1.7.4.4 Mapserver

As already discussed previously MapServer can produce OGC web services but has also cartographic capabilities using different scripting languages like PHP, Perl or Python.

1.8 Abbreviations & acronyms

BMP: BitMaP
CSW: Catalog Service for the Web
ECW: ERMapper Compress Wavelets
EGEE: Enabling Grids for E-scienceE
EO: Earth Observation
GEO: Group on Earth Observations
GEOSS: Global Earth Observation System of Systems
GDAL: Geospatial Data Abstraction Library
GIF: Graphics Interchange Format
GIS: Geographic Information System
GML: Geographic Markup Language
GPL: General Public Licence
GPS: Global Positiong System
GRID: Global Resource Information Database
GSDI: Global Spatial Data Infrastructure
INSPIRE: Infrastructure for Spatial Information in the European Community
ISO: International Organization for Standardization
IR: Implementing Rules
IT: Information Technology
JPEG: Joint Photographic Experts Group
JSON: JavaScript Object Notation
KML: Keyhole Markup Language
OAI: Open Archive Initiative
OASIS: Organization for the Advancement of Structured Information Standards
OGC: Open Geospatial Consortium
OWS: OGC Web Services
PDF: Portable Document Format
PNG: Portable Network Graphics
RDBMS: Relational DataBase Management System
REST: Representational State Transfer
RPC: Remote Procedure Call
RSS: Really Simple Syndication
SDI: Spatial Data Infrastructure
SDK: Software Development Kit
SHP: Shape File
SLD: Styled Layer Descriptor
SOA: Service Oriented Architecture
SOAP: Simple Object Access Protocol
SOS: Sensor Observation Service
SQL: Structured Query Language
SVG: Scalable Vector Graphics
SWE: Sensor Web Enablement
TIFF: Tagged Image File Format
UN: United Nations
UNEP: United Nations Environment Programme
UNECA: United Nations Economic Commission for Africa

UNGIWG: United Nations Geographical Information Working Group
URM: Uniform Resource Management
VGI: Volunteered Geographic Information
WAS: Web Service Authentication
W3C: World Wide Web consortium
WMS: Web Map Service
WFS: Web Feature Service
WCS: Web Coverage Service
WSDL: Web Service Description Language
WSS: Web Security Service
WPS: Web Processing Service
WPVS: Web Perspective and View Service
WTS: Web Terrain Service
XML: eXtended Markup Language

1.9 References

Almirall G., Bergada M.M, Ros P.Q., Craglia M. (2007) The Socio-Economic Impact of the Spatial Data Infrastructure of Catalonia, JRC Scientific and Technical Reports, 61p.
http://inspire.jrc.ec.europa.eu/reports/Study_reports/catalonia_impact_study_report.pdf

Arzberger P., Schroeder P., Beaulieu A., Bowker G., Casey K., Laaksonen L., Moorman D., Uhlir P., Wouters P. (2004) Promoting Access to Public Research Data for Scientific, Economic and Social Development, Data Science Journal, Vol.3, pp.135-152

Bejar R., Latre, M.A., Nogueras-Iso J., Muro-Medrano P.R., Zarazaga-Soria F.J. (2009) Systems of Systems as a Conceptual Framework for Spatial Data Infrastructures, International Journal of Spatial Data Infrastructure Research, Vol.4, 15p.
http://ijsdir.jrc.ec.europa.eu/index.php/ijsdir/article/view/124/105

Bernard L., Craglia M. (2005) SDI - From Spatial Data Infrastructure to Service Driven Infrastructure, Workshop on Cross-learning on Spatial Data Infrastructures (SDI) and Information Infrastructures (II), 8p.
http://www.ec-gis.org/sdi/ws/crosslearning/papers/PP%20Lars%20Bernard%20-%20Max%20Craglia.pdf

Boes U., Pavlova R. (2007) The Web 2.0 - A New Challenge For GIS And Cartography, Conference on recent problems in Geodesy and related fields with international importance, Sofia, Bulgaria, 10p.
http://www.rgz.sr.gov.yu/DocF/Files/intergeo-east-2007/n11.pdf

Boes U., Pavlova R. (2008) Is there a Future for Spatial Data Infrastructures?, GI Days 2008: Interoperability and spatial processing in GI applications, 10p.
http://www.gi-tage.de/archive/2008/downloads/acceptedPapers/Papers/Boes,Pavlova.pdf

Booz Allen Hamiltion (2005) Geospatial Interoperability Return on Investment Study, NASA, Geospatial Interoperability Office, 47p.
http://www.egy.org/files/ROI_Study.pdf

Coleman, D.J. and J.D. McLaughlin and S.E. Nichols (1997) Building a Spatial Data Infrastructure, Proceedings of the 64th Permananent Congress Meeting of the Fédération Internationale des Géometres (FIG), pp. 89-104, Singapore, May.

Coleman D.J., Georgiadou Y., Labonte J. (2009) Volunteered Geographic Information: the nature and motivation of produsers, GSDI-11 Conference Proceedings, 20p.
http://www.gsdi.org/gsdi11/papers/pdf/279.pdf

Cömert C. (2004) Web Services and National Data Infrastructure (NSDI), ISPRS Conference, 6p.
http://cartesia.org/geodoc/isprs2004/comm4/papers/365.pdf

Craglia M., Novak J. (2006) Assessing the impacts of Spatial Data Infrastructures, Report of International Workshop on Spatial Data Infrastructures' Cost-Benefit / Return on Investment, Ispra, Italy, 12-13 January, 57p.

Craglia M. (2007) Volunteered Geographic Information and Spatial Data Infrastructures: when do parallel lines converge?, VGI Specialist Meeting, Santa Barbara, USA, 3p.
http://www.ncgia.ucsb.edu/projects/vgi/docs/position/Craglia_paper.pdf

Craig W.J. (2005) White Knights of Spatial Data Infrastructure: The Role and Motivation of Key Individuals, URISA Journal, Vol.16, pp.5-13
Crompvoets J., Bregt A. (2003) World Status of National Spatial Data Clearinghouses, URISA Journal, Vol.15, pp.43-50

De Longueville B., Ostländer N, Keskitalo C. (2009) Addressing vagueness in Volunteered Geographic Information (VGI) – A case study, GSDI-11 Conference Proceedings, 21p.
http://www.gsdi.org/gsdi11/papers/pdf/221.pdf

European Commission (2007) Directive 2007/2/EC of the European Parliament and the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE), 14p
http://eur-lex.europa.eu/JOHtml.do?uri=OJ:L:2007:108:SOM:EN:HTML

European Commission (2008) Commission regulation (EC) No 1205/2008 of 3 December 2008 implementing Directive 2007/2/EC of the European Parliament and of the Council as regard metadata, 19p.
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:326:0012:0030:EN:PDF

European Commission (2008) INSPIRE Generic Conceptual Model, 109p.
http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/DataSpecifications/D2.5_v3.1.pdf

European Commission (2008) INSPIRE Network Services Architecture, 29p.
http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/network/D3_5_INSPIRE_NS_Architecture_v3-0.pdf

European Commission (2007) INSPIRE Technical Architecture - Overview, 12p.
http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/network/INSPIRETechnicalArchitectureOverview_v1.2.pdf

GEO (2005) Global Earth Observation System of Systems 10-Year Implementation Plan Reference Document, 209p
http://www.earthobservations.org/documents/10-Year%20Plan%20Reference%20Document.pdf

GEO (2005) The Global Earth Observation System of Systems (GEOSS) 10-Year Implementation Plan, 11p
http://www.earthobservations.org/documents/10-Year%20Implementation%20Plan.pdf

GEO (2006) GEO Capacity Building Strategy, 13p.
http://www.earthobservations.org/documents/committees/cbc/capacity_building_strategy.pdf

GEO (2007) The Full Picture, 143p.
http://www.earthobservations.org/documents/the_full_picture.pdf

GEO (2008) White Paper on the GEOSS Data Sharing Principles, 93p.
http://www.earthobservations.org/documents/dsp/Draft%20White%20Paper%20for%20GEOSS%20Data%20Sharing%20Policies_27Sept08.pdf

Goodchild M.F. (2007) Citizens as sensors: The World of Volunteered Geography, Workshop on Volunteered Geography Information, Santa Barbara, USA, 15p.
http://www.ncgia.ucsb.edu/projects/vgi/docs/position/Goodchild_VGI2007.pdf

Gore A. (1998) The Digital Earth: Understanding our planet in the 21st Century, 5th international Symposium on Digital Earth, 5p.
http://www.isde5.org/al_gore_speech.htm

Lehmann A. (2009) EnviroGRIDS, Document of Work, 131p.

Liping D., Chen A., Yang W., Zhao P. (2003) The Integration of Grid Technology with the OGC Web Services (OWS) in NWGISS for NASA EOS Data, , 10p.

Masser I. (2006) What's Special about SDI Related Research, International Journal of Spatial Data Infrastructures Research, Vol.1, pp.14-23

Masser I. (2005) The Future of Spatial Data Infrastructures, ISPRS Workshop on Service and Application of Spatial Data Infrastructure, Oct.14-16, Hangzhou, China, 9p.
http://www.commission4.isprs.org/workshop_hangzhou/papers/7-16%20Ian%20Masser-A001.pdf

Masser I. (2007), Building European Spatia Data Infrastructures, ESRI Press, 91p.

Mohammadi H., Rajabifard A. Williamson I.P. (2007) Multi-source Spatial Data Integration within the Context of SDI Initiatives, 18p, Internation Journal of Spatial Data Infrastructures Research, 18p.
http://ijsdir.jrc.ec.europa.eu/index.php/ijsdir/article/view/74/34

Muresan O., Pop F., Gorgan D., Cristea V. (2006) Satellite Image Processing Applications in MedioGRID, Satellite image processing application in mediogrid, pp.253-262

Open Geospatial Consortium (2005) The Importance of Going “Open”, OGC White Paper, 8p.
http://portal.opengeospatial.org/files/?artifact_id=6211&version=2&format=pdf

Open Geospatial Consortium (2004) The Havoc of Non-Interoperability, OGC White Paper, 7p.
http://portal.opengeospatial.org/files/?artifact_id=5097&version=3&format=pdf

Open Geospatial Consortium (2004) Integrating Geospatial Standards and Standards Strategies Into Business Process, OGC White Paper, 7p.
http://portal.opengeospatial.org/files/?artifact_id=5098&version=2&format=pdf

Open Geospatial Consortium (2004) The Spatial Web, OGC White Paper, 8p.
http://portal.opengeospatial.org/files/?artifact_id=3859&version=2&format=pdf

Open Geospatial Consortium (2007) OpenGIS Web Service Common Implementation Specification, 153p.
http://www.opengeospatial.org/standards/common

Open Geospatial Consortium (2007) OpenGIS Geography Markup Language (GML) Encoding
Standard, 437p.
http://www.opengeospatial.org/standards/gml

Open Geospatial Consortium (2009) The OpenGIS Abstract Specification Topic 5: Features, 50p.
http://www.opengeospatial.org/standards/as

Open Geospatial Consortium (2008) OpenGIS Reference Model, 35p.
http://www.opengeospatial.org/standards/orm

Open Geospatial Consortium (2004) Geospatial Portal Reference Architecture, 23p.
http://portal.opengeospatial.org/files/?artifact_id=6669

Ostensen O. (2001) Global geomatics standards supporting sustainable geospatial data infrastructures, GSDI 5 Conference Proceedings, 6p.
http://gsdidocs.org/gsdiconf/GSDI-5/papers/Olaf%20Ostensen-paper.pdf

Padberg A., Greve K. (2009) Gridification of the OGC Web Processing Service: Challenges and Portential, AGILE Workshop, 5p.

Paluszynski W., Iwaniak A., Sliwinski A., Kubik T. (2007) Building Spatial Data Infrastructure At County Level Using Open Software, SDI-East Africa, 11p.
http://dewa03.unep.org/sdi-ea/system/files/BUILDING_SPATIAL_DATA_INFRASTRUCTURE_AT_C.doc

Phillips A., Williamson I., Ezigbalike C. (1999) Spatial Data Infrastructure Concepts, The Australian Surveyor, Vol.44 No1, p20-28
http://www.sli.unimelb.edu.au/research/publications/IPW/SDIDefinitionsAusSurv.html

Rajabifard A. and Williamson I.P. (2001) Spatial Data Infrastructures: Concept, SDI Hierarchy and Future directions, in Proceedings, of GEOMATICS'80 Conference, Tehran, Iran., 10p.
http://repository.unimelb.edu.au/10187/1247

Rajabifard A. (2002) Diffusion of Regional Spatial Data Infrastructures: with particular reference to Asia and the Pacific, Ph.D thesis, Department of Geomatics, Faculty of Engineering, The University of Melbourne, 213p.

Rajabifard A. and Williamson I.P. (2004) SDI Development and Capacity Building, GSDI-7 Conference on Spatial Data Infrastrcture for a Sustainable Futures, 12p.
http://www.geoinfo.ait.ac.th/download/SCOSA2007/1_DrAbbas/4-SDIDevelopmentCapacityBuilding.pdf

Ryttersgaard J. (2001) Spatial Data Infrastructure, Developing Trends and Challenges, International Conference on Spatial Information for Sustainable Development Proceedings, Nairobi, 8p.
http://www.fig.net/pub/proceedings/nairobi/ryttersgaard-TS1-1.pdf

Sahin K., Gumusay M.U. (2008) Service Oriented Architecture (SOA) based Web Services for Geographic Information Systems, ISPRES Congress 2008, pp.625-630
http://www.isprs.org/congresses/beijing2008/proceedings/2_pdf/5_WG-II-5/03.pdf

Sayar A., Pierce M., Fox G. (2005) OGC Compatible Geographical Information Systems Web Services, Indiana University , Departement of Computer Science, Technical Report, 64p.
http://www.cs.indiana.edu/pub/techreports/TR610.pdf

Stevens A.R, Onsrud J.H, Rao M.(2005) Global Spatial Data Infrastructure (GSDI): Encouraging SDI Development Internationally, ISPRS Conference on Service and Application of Spatial Data Infrastructure, 14-16 October, Hangzhou, China, 10p.
http://www.commission4.isprs.org/workshop_hangzhou/papers/309-312%20Abs&Papr%20GSDI%20China%2014Oct05.pdf

UNECA (2005) SDI Africa: An Implementation Guide, 120p.
http://geoinfo.uneca.org/sdiafrica/default1.htm

UNGIWG (2007) UNSDI Compendium - A UNSDI Vision, Implementation Strategy and Reference Architecture, 150p.
http://www.ungiwg.org/docs/unsdi/UNSDI_Compendium_13_02_2007.pdf

Vaccari L., Shvaiko P., Marchese M. (2008) An emergent semantics approach to semantic intergration of geo-services and geo-metadata in Spatial Data Infrastructures, IJSDIR, 23p.
http://ijsdir.jrc.ec.europa.eu/index.php/ijsdir/article/view/107/113

Williamson I.P, Rajabifard A., Enemark S. (2003) Capacity Building for SDIs, Proceedings 16th UN Regional Cartographic Conference., 14p.
http://repository.unimelb.edu.au/10187/1171

Williamson I., Rajabifard A., Binns A. (2006) Challenged and Issues for SDI Development, International Journal of Spatial Data Infrastructures Research, Vol.1 pp.24-35

Wilson M., Von Hagen C., Howard C. (2009) SDI in East Africa - Leveraging the UN presence, International Journal of Spatial Data Infrastructure Research, Vol.4, pp.1-23
http://ijsdir.jrc.ec.europa.eu/index.php/ijsdir/article/view/109/112

PART 2: Tutorials on OGC web services for data & metadata[1]

[1] All the material is issued from GeoServer, GeoNetwork, uDig and OpenLayers websites and adapted by the enviroGRIDS consortium.

2. Tutorials on OGC web services for data & metadata

2.1 GeoServer

Website: http://www.geoserver.org

GeoServer is an open source software server written in Java that allows users to share and edit geospatial data. Designed for interoperability, it publishes data from any major spatial data source using open standards.
Being a community-driven project, GeoServer is developed, tested, and supported by a diverse group of individuals and organizations from around the world.
GeoServer is the reference implementation of the Open Geospatial Consortium (OGC) Web Feature Service (WFS) and Web Coverage Service (WCS) standards, as well as a high performance certified compliant Web Map Service (WMS). GeoServer forms a core component of the Geospatial Web.
GeoServer aims to operate as a node within a free and open Spatial Data Infrastructure. Just as the Apache HTTP Server has offered a free and open web server to publish HTML, GeoServer aims to do the same for geospatial data.
Designed for interoperability, it publishes data from any major spatial data source using open standards. GeoServer has evolved to become an easy method of connecting existing information to Virtual Globes such as Google Earth and NASA World Wind as well as to web-based maps such as Google Maps and Windows Live Local. GeoServer functions as the reference implementation of the Open Geospatial Consortium Web Feature Service standard, and also implements the Web Map Service and Web Coverage Service specifications. (Sources: Geoserver website & Wikipedia)

System requirements

GeoServer can run either on MS Windows, Linux or Mac OS X.

Some general system requirements for the software to run without problems are listed below: Processor: 2 GHz or higher Memory (RAM): 1 GB or higher

Disk Space: 200 MB minimum. However, it is suggested to have a minimum of 1 GB of free disk space. Additional space is required depending on the amount of spatial data that you expect to upload.

Other Software requirements: A Java Runtime Environment (JRE 1.5.0). For server installations, Apache Tomcat can be used instead of Jetty and McKoiDB respectively.

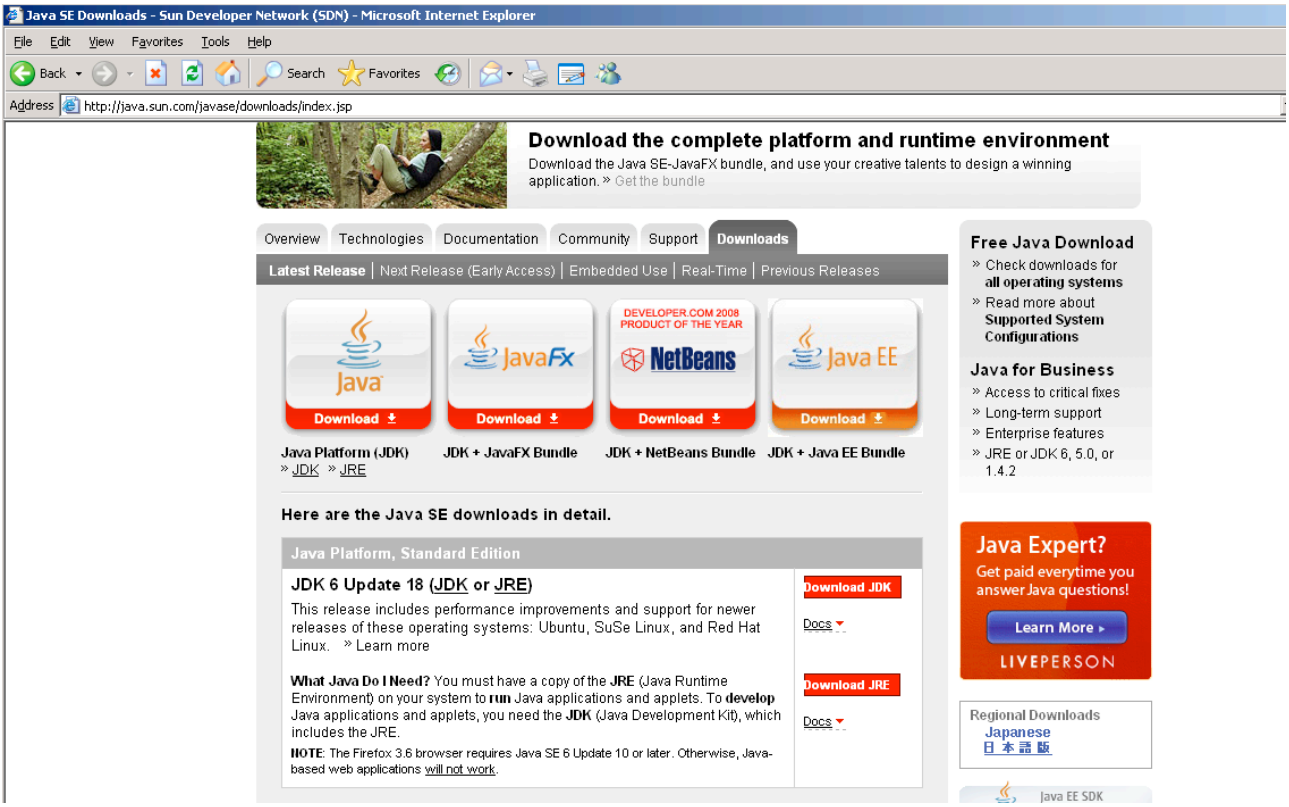
2.1.1 Installation

2.1.1.1 Installing the Java Development Kit

1. Download the latest Java JDK version:

    http://java.sun.com/javase/downloads/index.jsp

NB: the latest version is also available on the CD-ROM.

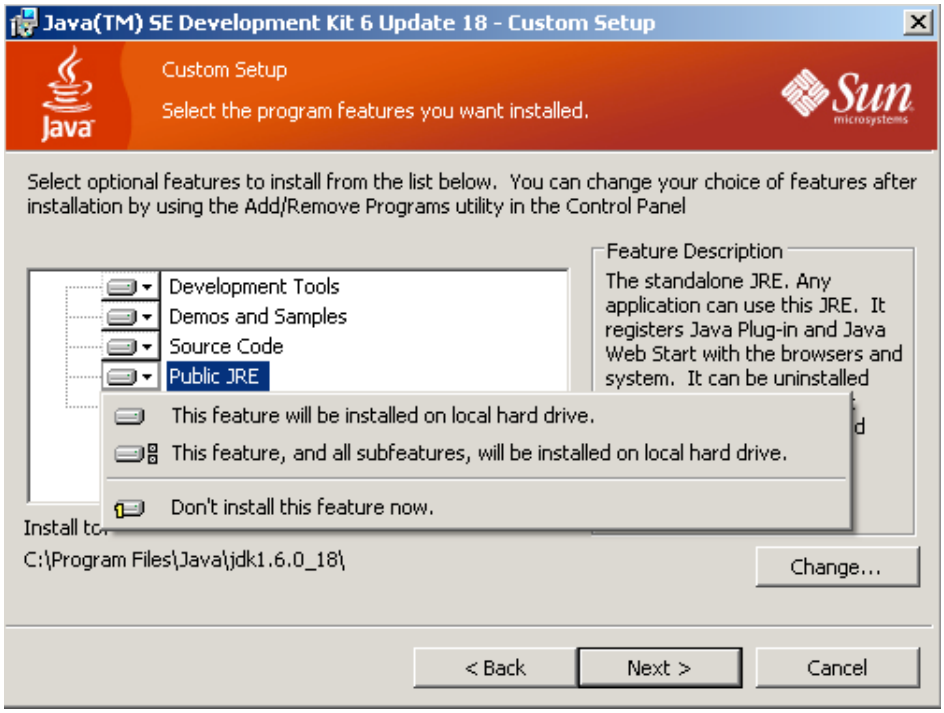


2. Run the executable file you downloaded.

3. Accept the license agreement and click **Next**

4. On the “Custom Setup” screen:

- Disable the Public Java Runtime Environment (JRE)



- Select your installation directory (the default one)

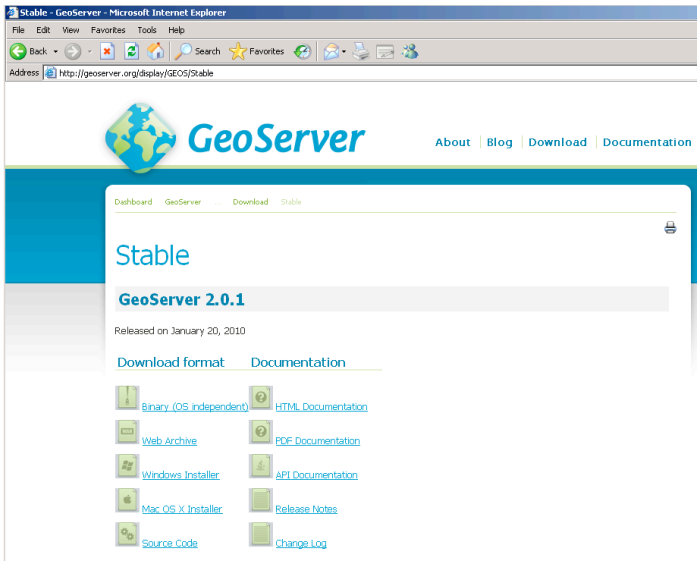
- Click **Next**

5. Click **Finish** once installation is complete

2.1.1.2 Download GeoServer

Go to the Download page and get the latest Stable release:

http://geoserver.org/display/GEOS/Stable



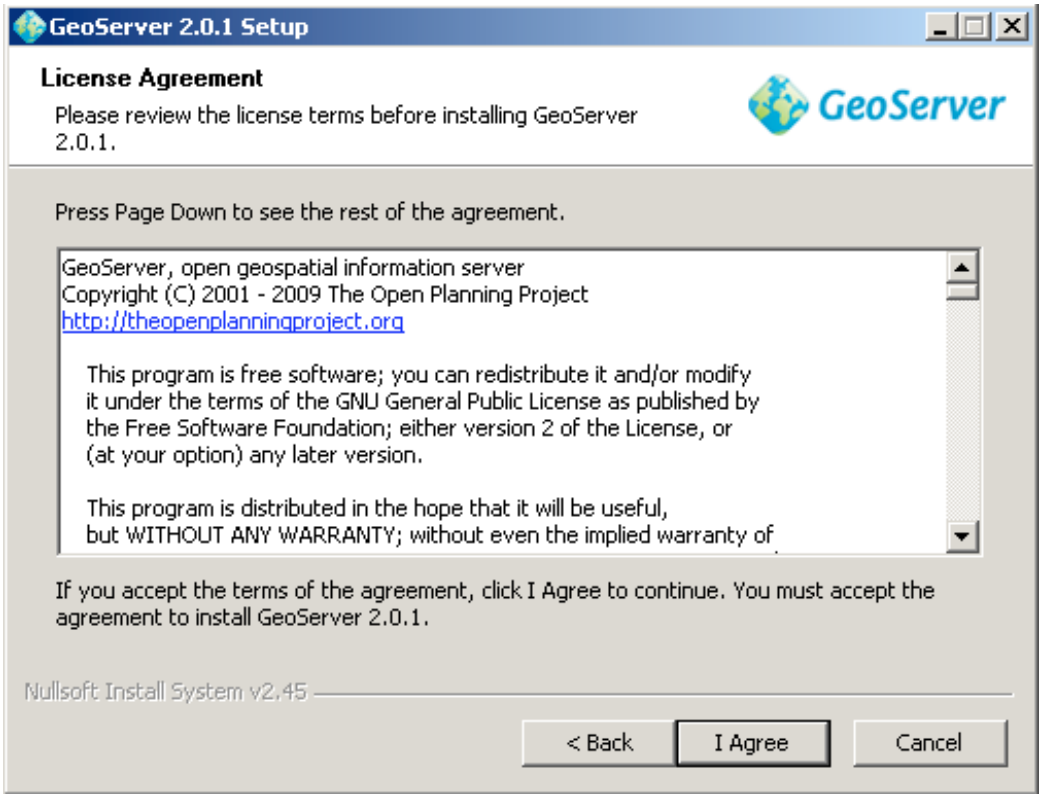
In our case, download the “Windows Installer”.

NB: the latest version is also available on the CD-ROM in folder “servers/geoserver”.

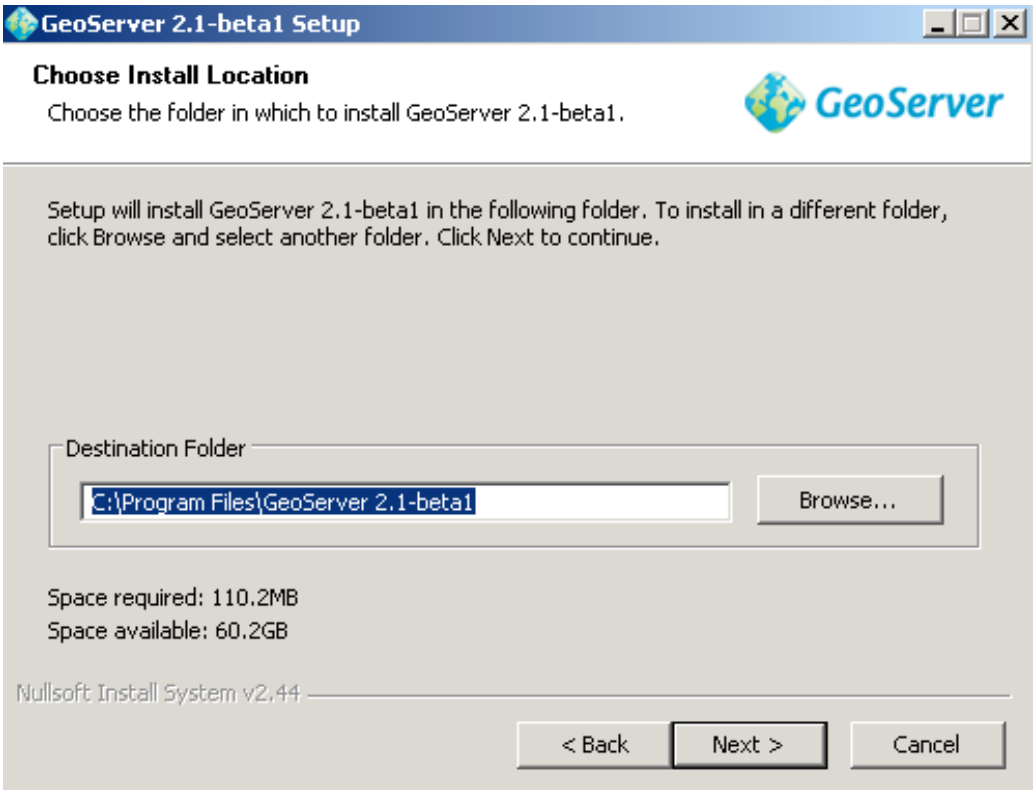
2.1.1.3 Run the Installer

Double click on the GeoServer executable that you just downloaded to start the installer.

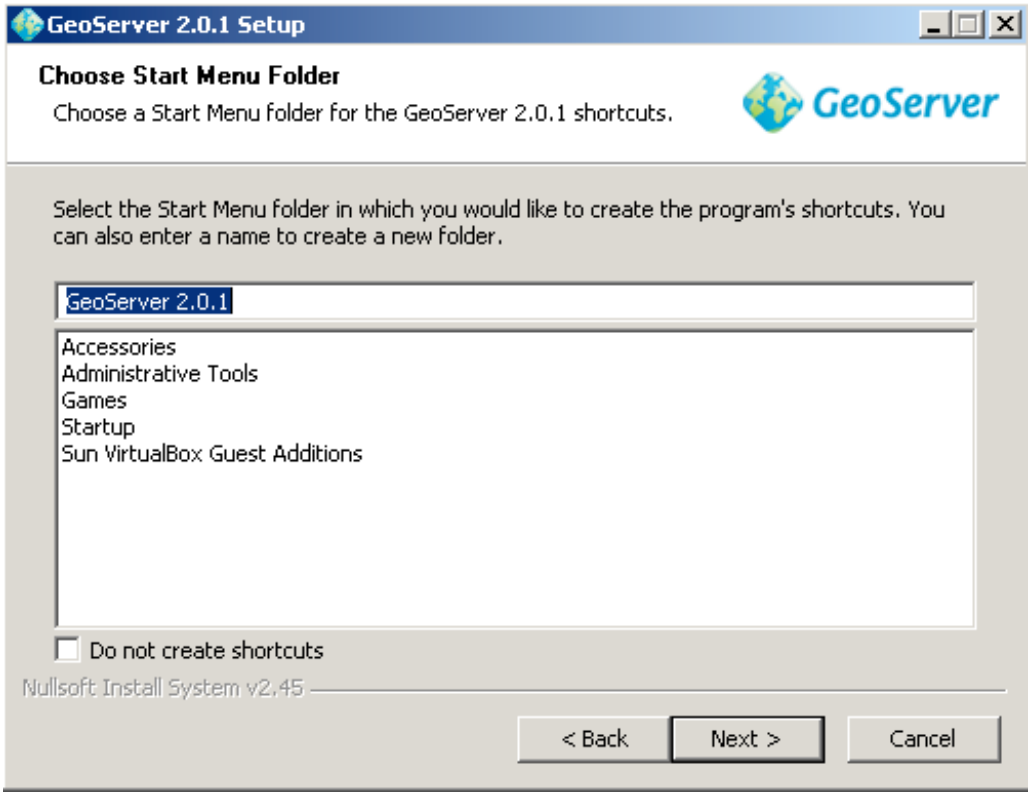
1. Read the GPL license and click **I Agree**.



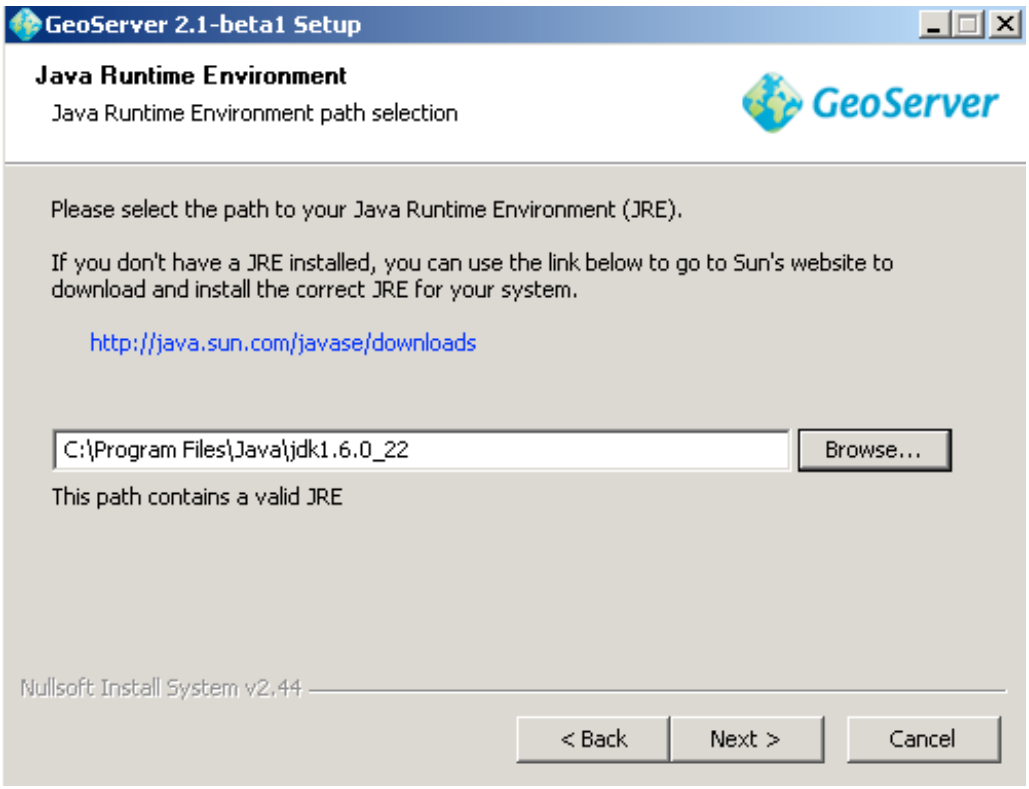
2. Choose your install location and click **Next**. You can leave this in the default directory or change as you would like.



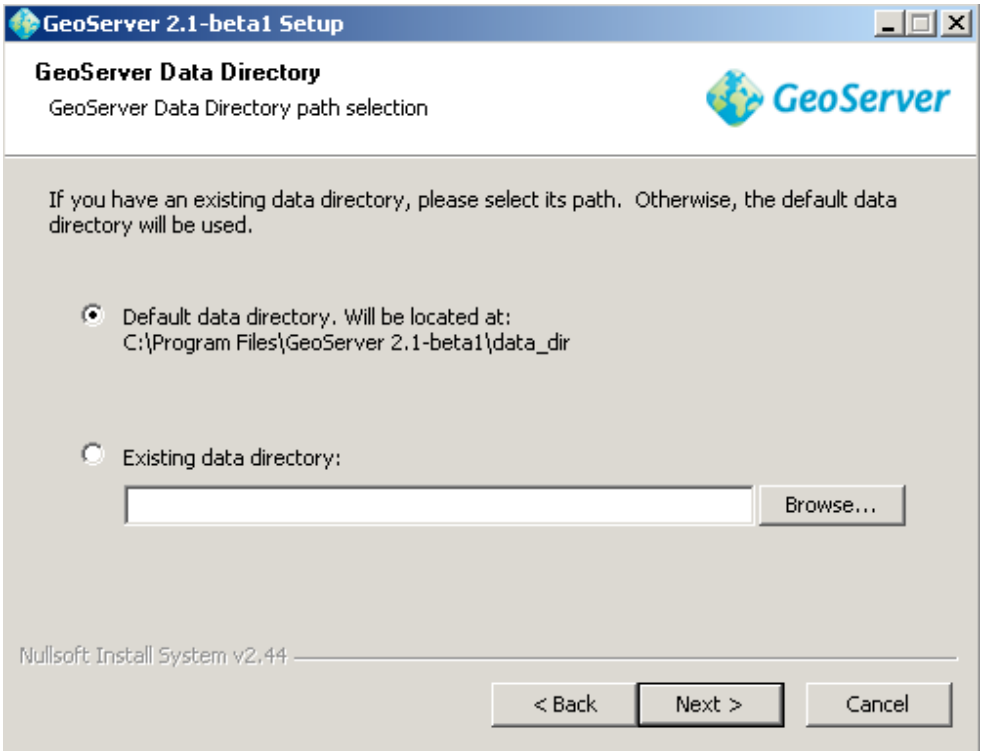
3. Choose the name of the Start Menu folder and click **Next**. Usually this can be left to its default values.



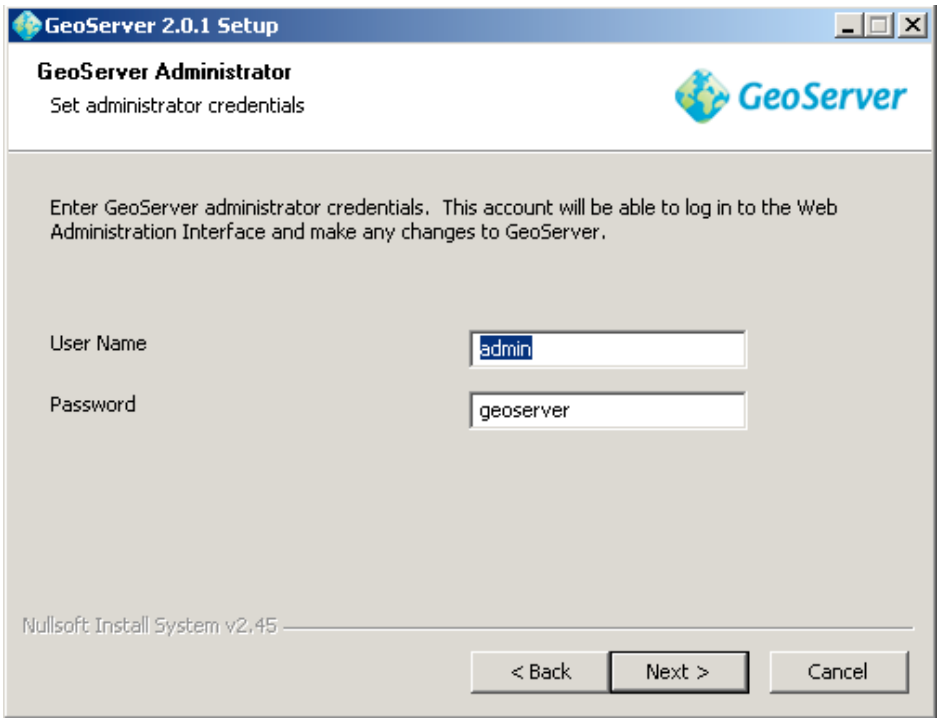
4. Define, by browsing, the path to your JDK install directory. Click **Next**.



5. The next page asks you where your data directory is. If this is your first time installing, just hit next. If you have a previous version of GeoServer and you want to use your existing data directory, enter the path to that data directory. Click **Next**.

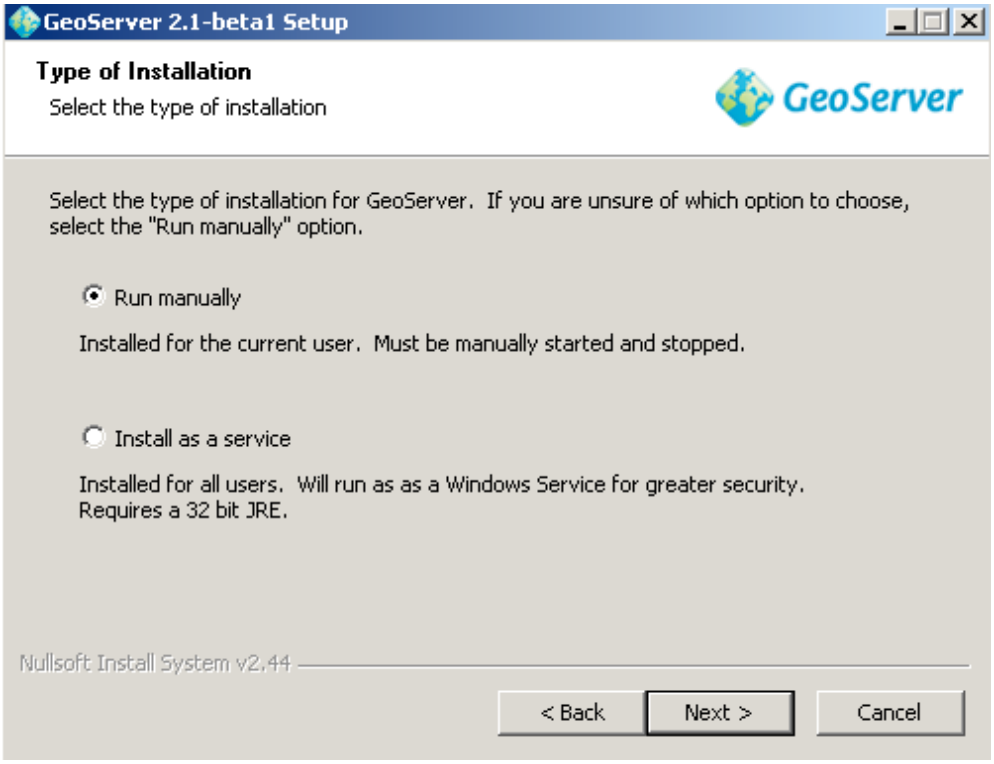


6. Define username and password for administrator account. You can leave the default values (`admin:geoserver`) or change as you would like. Click **Next**.

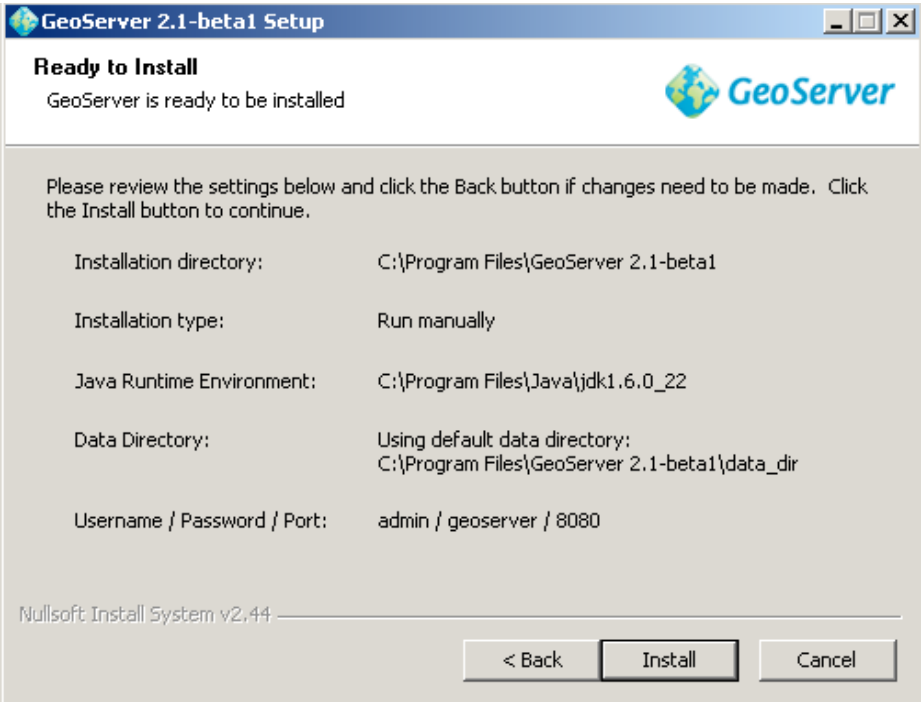


7. The next window allows you to select the port number on which GeoServer will run. You can leave it as it is (port: 8080).

8. Choose the type installation. In our case select **Run manually**.



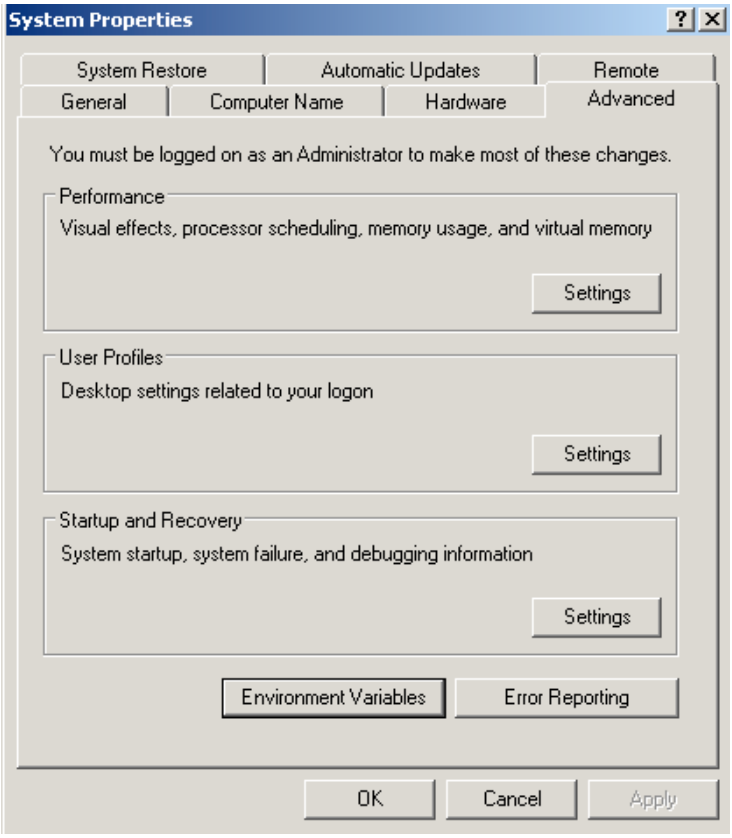
9. Finally your ready to install GeoServer. Click **Install**.



10.On completion shortcuts will appear in the Windows Start menu.

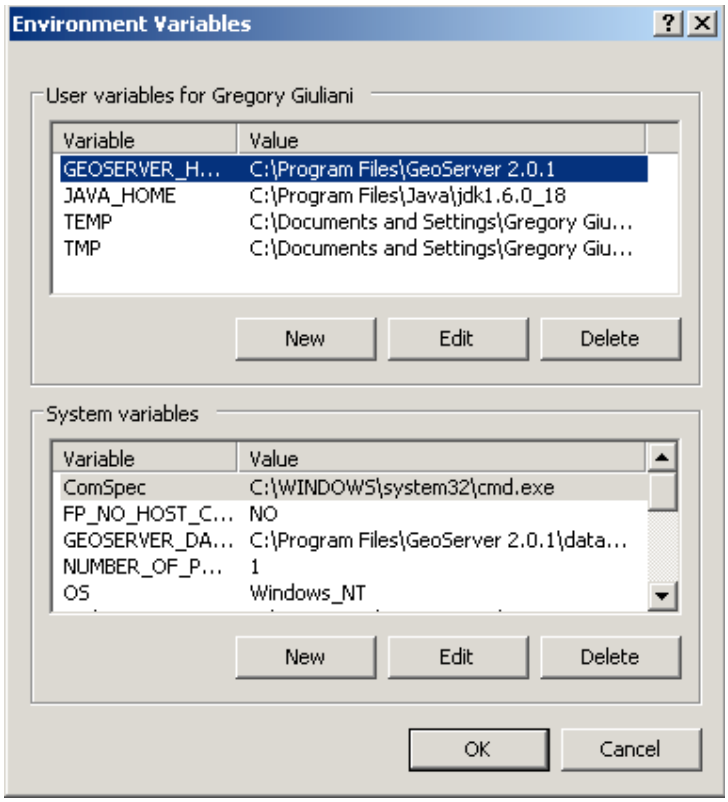
2.1.1.4 Start GeoServer

1. Before starting GeoServer you must define **JAVA_HOME** and **GEOSERVER_HOME** environment variables. These are the path to the install directory of JDK and GeoServer. For that go to: *Start > Settings > Control panel > System*, click on **"Advanced"** tab and click on the **"Environment Variables"** button.



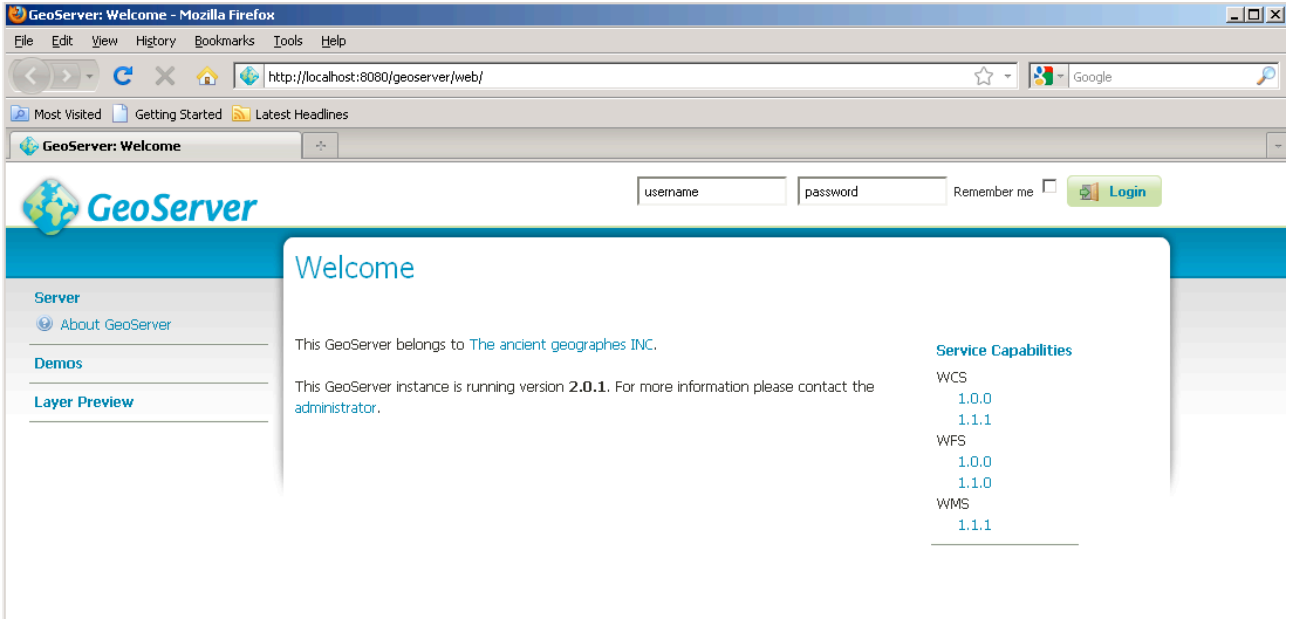
2. Under **"User variables"**, click on **New** and define first your **JAVA_HOME** variable and then your **GEOSERVER_HOME**.

```
JAVA_HOME: C:\Program Files\Java\jdk1.6.0_24
GEOSERVER_HOME: C:\Program Files\GeoServer 2.1-RC4
```



3. Go to *Start > Programs > GeoServer 2.1-RC4 > Start GeoServer*. A DOS window will appear (and leave it open) indicating you that GeoServer has started.

4. After startup, the administration interface should be available through the GeoServer Administration link in the Start Menu or by pointing your web browser to http://localhost:8080/geoserver .



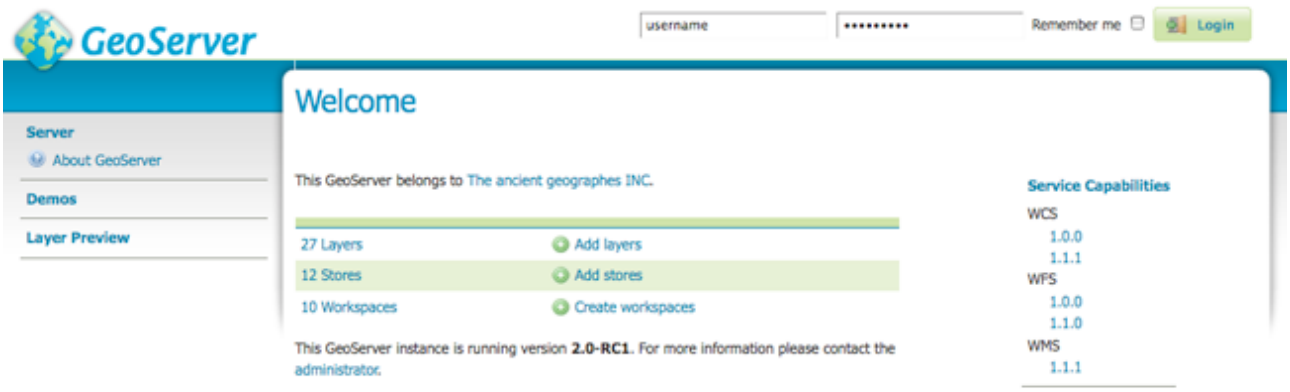
2.1.2 Getting started

2.1.2.1 Web administration interface

The Web Administration Tool is a web based used to configure all aspects of GeoServer, from adding data to tweaking service settings. The web admin tool is accessed via web browser at `http://<host>:<port>/geoserver/web`.

In our case, running on a local computer the URL will be:

http://localhost:8080/geoserver



2.1.2.2 Logging In

In order to change any server settings or configure data a user must first be authenticated. Navigate to the upper right hand corner to log into GeoServer.

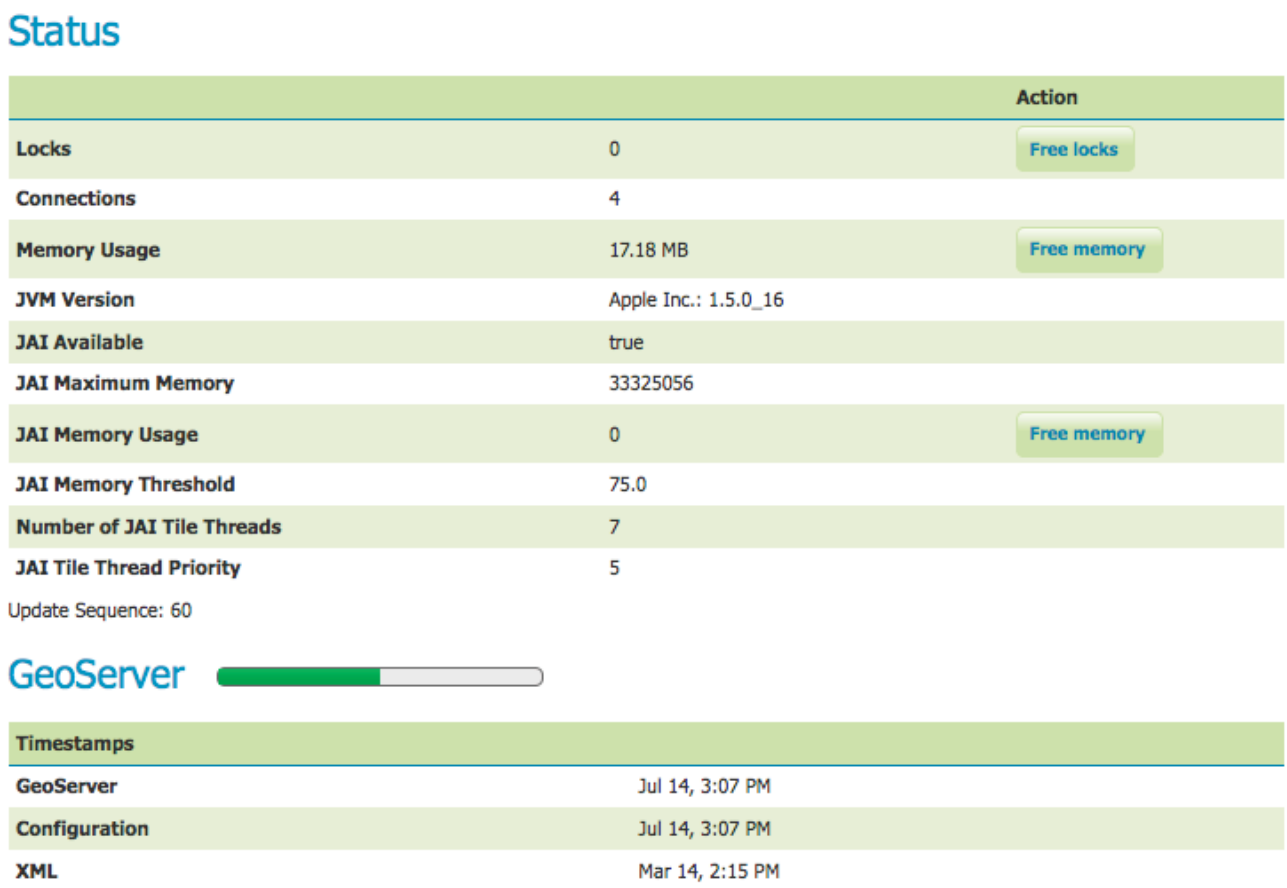
The default username and password is `admin` and `geoserver`.

These can be changed only by editing the security/users.properties file in the GeoServer Data directory.

2.1.2.3 Server

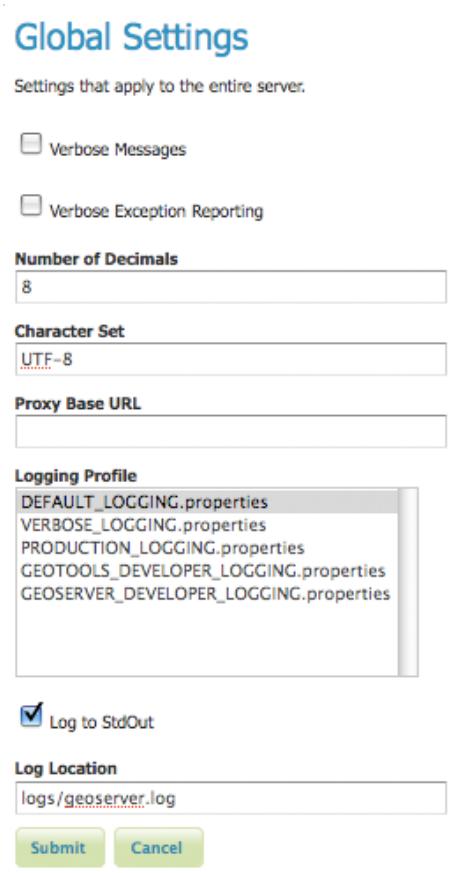
The Server section of the web admin provides access to GeoServer environment information. It is a combination of diagnostic and configuration tools, and can be particularly useful for debugging.

The **Server Status** page offers a summary of server configuration parameters and run-time status.

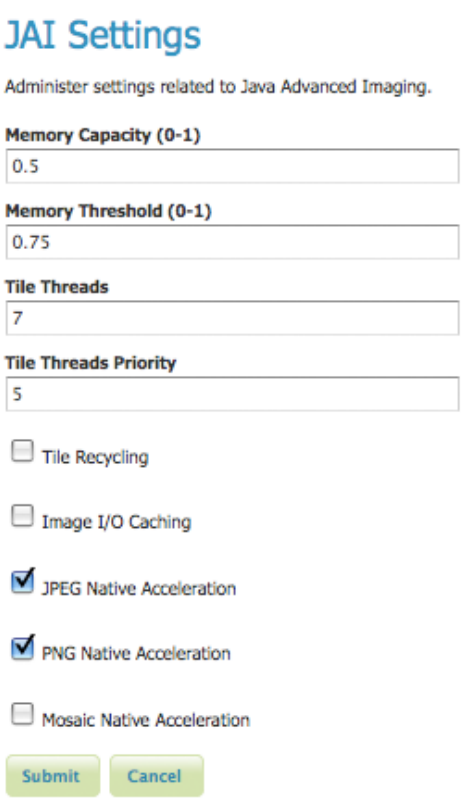


The **Contact Information** section sets the public contact information in the Capabilities document of the WMS server.

The **Global Settings** page configures messaging, logging, character and proxy settings for the entire server.



The **JAI Settings** page is used to configure several JAI parameters, used by both WMS and WCS operations.

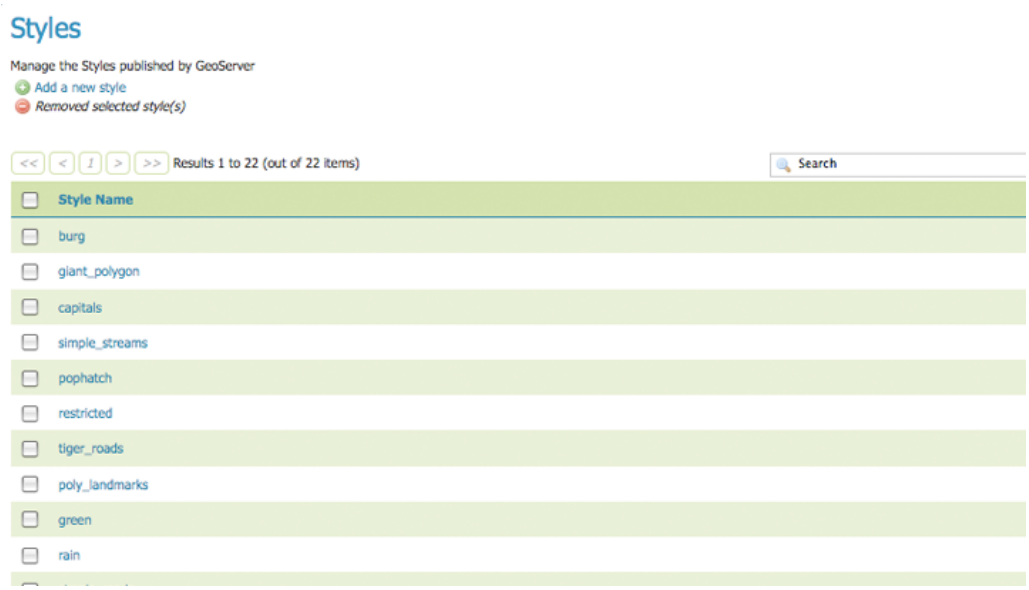


2.1.2.3 Services

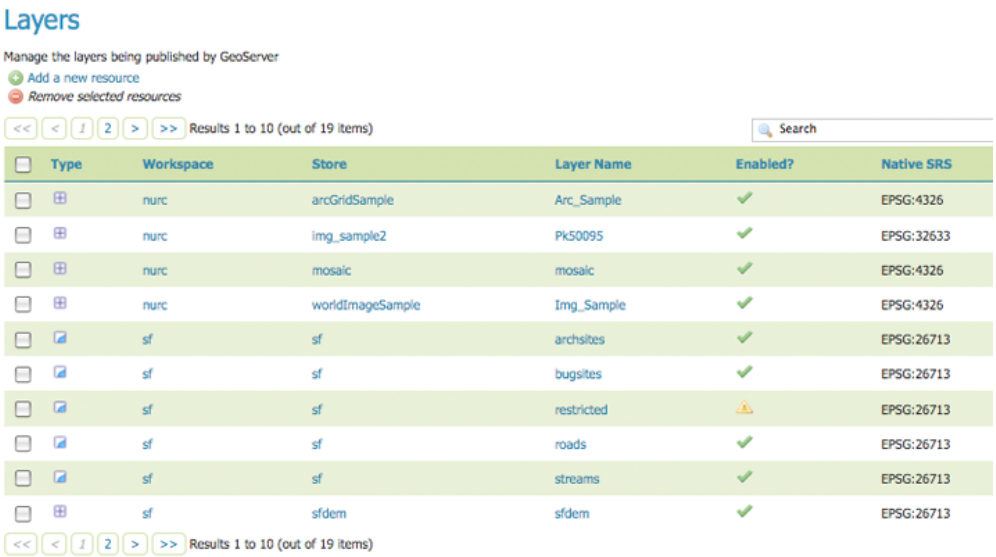
The Services section is for advanced users needing to configure the request protocols used by GeoServer. The Web Coverage Service (WCS) page manages metadata information, common to WCS, WFS and WMS requests. The Web Feature Service (WFS) page permits configuration of features, service levels, and GML output. The Web Map Service (WMS) page sets raster and SVG options. Geo Web Cache (GWC) is an advanced tile cache for WMS servers.

2.1.2.4 Data

The Data links directly to a data type page with edit, add, and delete functionality. All data types subsections follow a similar workflow. As seen in the Styles example below, the first page of each data type displays a view page with an indexed table of data.

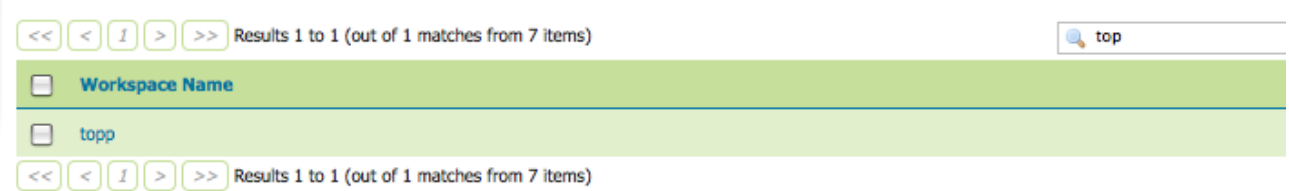


Each data type name links to a corresponding configuration page. For example, all items listed below Workspace, Store and Layer Name on the Layers view page, link to its respective configuration page.

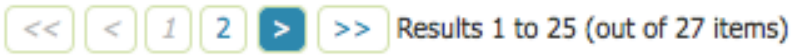


In the data type view panel, there are three different ways to locate a data type–sorting, searching, and scrolling .

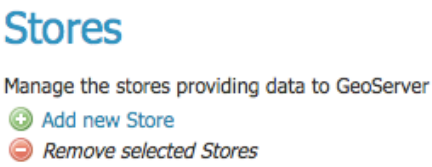
For simple searching, enter the search criteria in the search box and hit Enter.



To scroll through data type pages, use the arrow button located on the bottom and top of the view table.



As seen in the Stores example below, the buttons for adding and removing a data type can be found at the top of the view page.



To add a new data, select the Add button, and follow the data type specific prompts. To delete a data type In order to remove a data type, click on the data type's corresponding check box and select the Remove button. (Multiple data types, of the same kind, can be checked for batch removal.)

2.1.2.5 Security

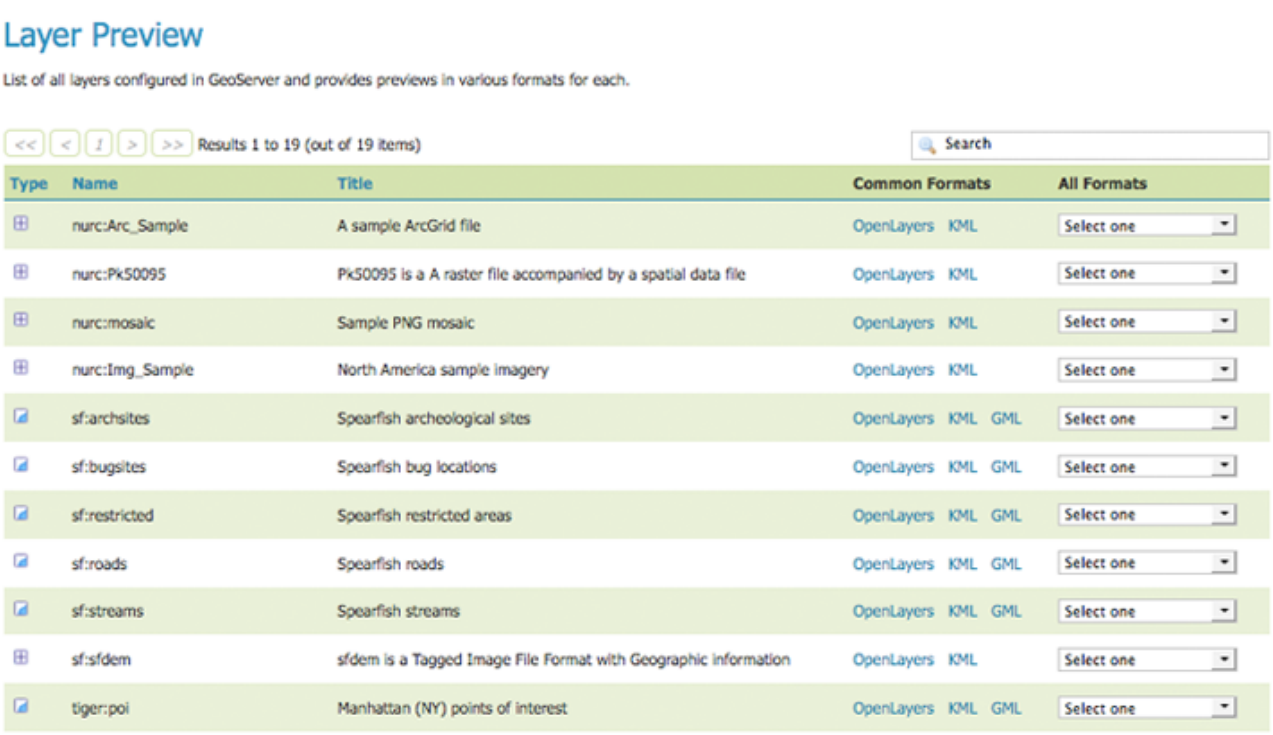
The Security section allows the administrator to create/update/delete new users account and maintain different security settings.

2.1.2.6 Demos

The Demos page contains links to example WMS, WCS and WFS requests for GeoServer as well as a link listing all SRS info known to GeoServer. You do not need to be logged into GeoServer to access this page.

2.1.2.7 Layers preview

The Layers Preview page provides layer views in various output formats, including the common OpenLayers and KML formats. This page helps to visually verify and explore the configuration of a particular layer.



Each layer row consists of a type, name, title, and available formats for viewing. Name refers to the Workspace and Layer Name of a layer, while Title refers to the brief description configured in the Edit Layer Data panel. Common Formats include OpenLayers and KML output, while the All Formats include additional output formats for further use or data sharing.

More information about the Web Administration Interface are available on:

http://docs.geoserver.org/stable/en/user/webadmin/

2.1.3 Adding a shapefile

2.1.3.1 Getting the data

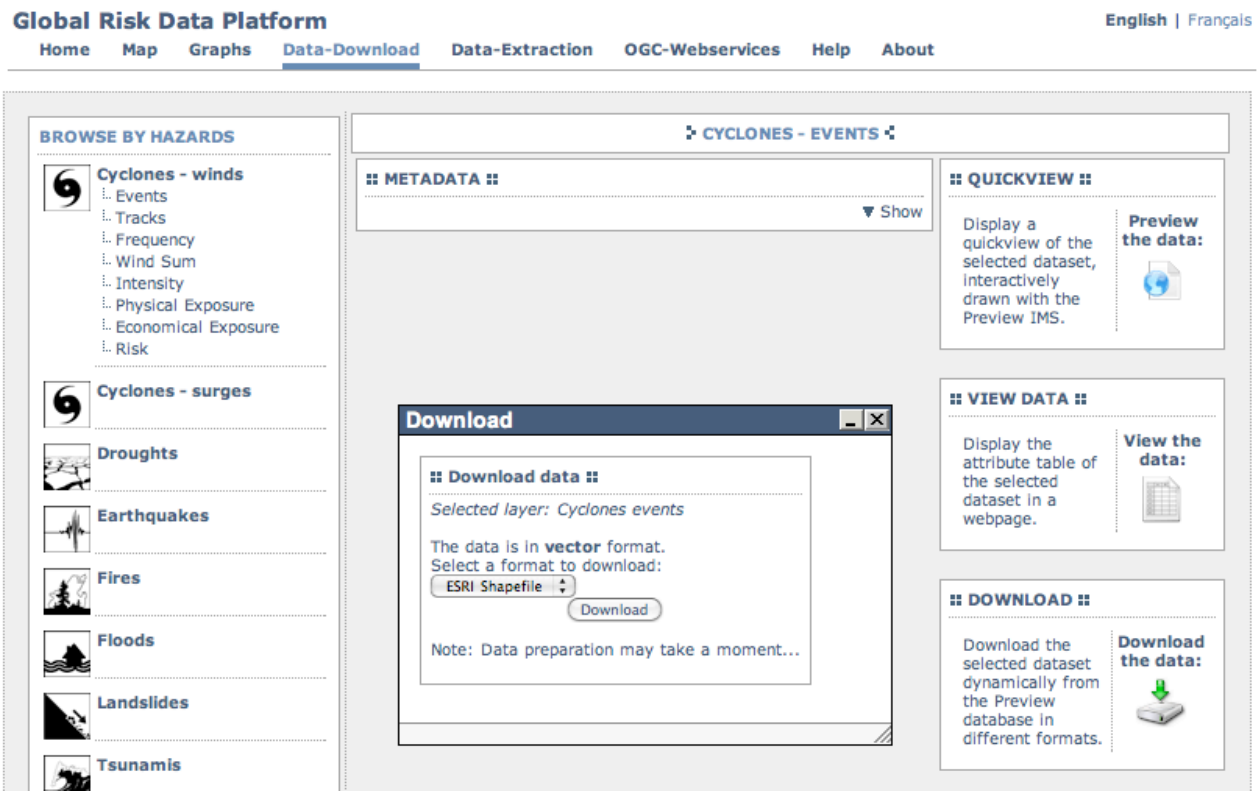
1. Go to the PREVIEW Global Risk Data Platform “Data-Download” section:

http://preview.grid.unep.ch/index.php?preview=data

and select the “Cyclones - winds” events layer.

NB: the data set is available on the CD-ROM.

2. Click on “Download the data” and choose the “ESRI Shapefile” format



3. Download the data. This file contains a shapefile of cyclones buffers that will be used during this tutorial.
4. Unzip the cy_buffers_shapefile.zip. The extracted folder consists of the following four files:

   `cy_buffers.dbf`

   `cy_buffers.shp`

   `cy_buffers.shx`

   `cy_buffers.xml`

5. Create a folder called *cy_buffers* into <GEOSERVER_DATA_DIR>/data where GEOSERVER_DATA_DIR is the root of the GeoServer data directory. If no changes were made to the GeoServer file structure, the path should be:

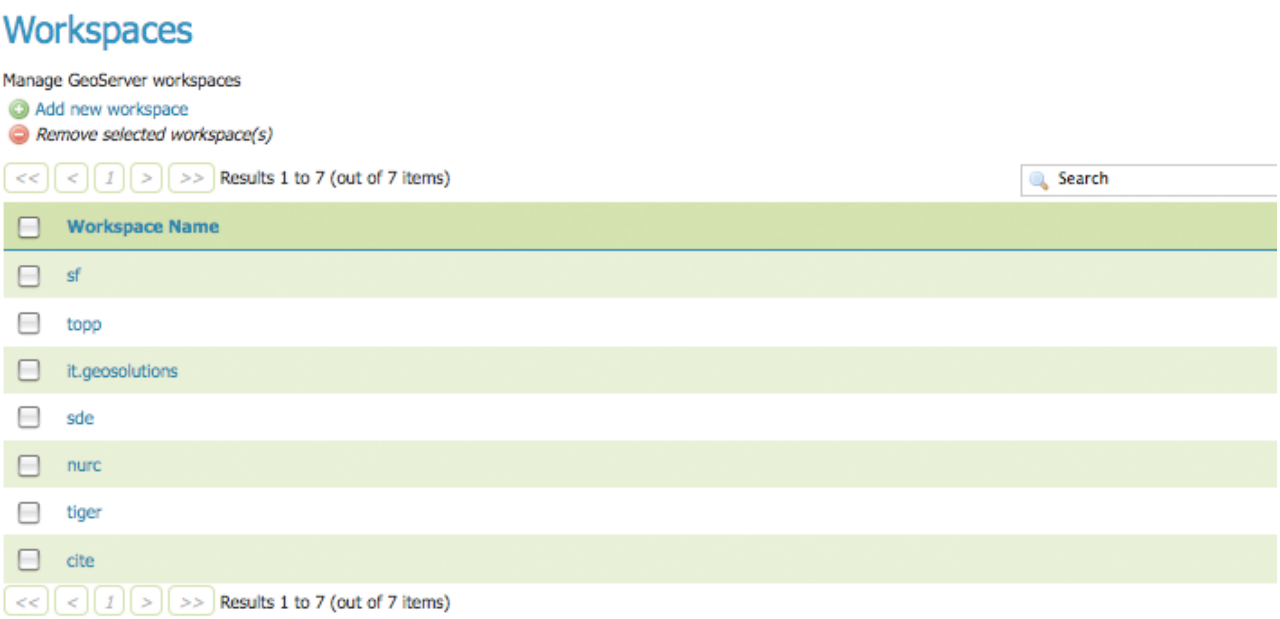
   `C:\Program files\GeoServer2.1-RC4\data_dir\data\cy_buffers.`

6. Paste the four extracted files in the cy_buffers directory.

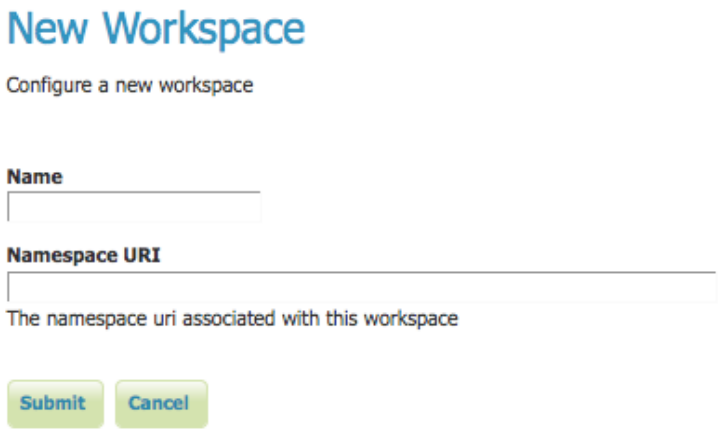
2.1.3.2 Create a new workspace

The first step is to create a workspace for the Shapefile. The workspace is a container used to group similar layers together.

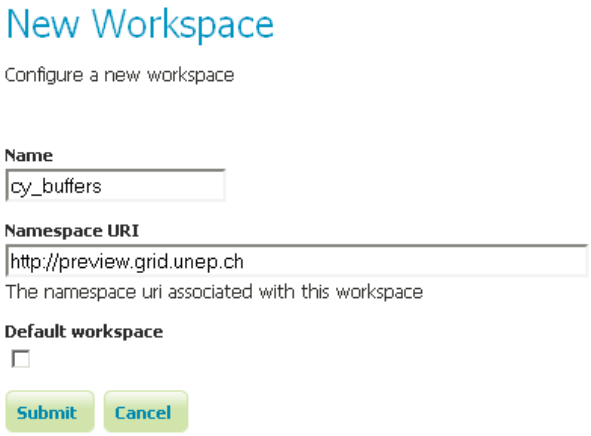
1. In a web browser navigate to http://localhost:8080/geoserver/web.
2. Log into GeoServer as described earlier.
3. Navigate to `Data▸Workspaces`.



4.To create a new workspace click, select the **Add new workspace** button. You will be prompted to enter a workspace Name and Namespace URI.



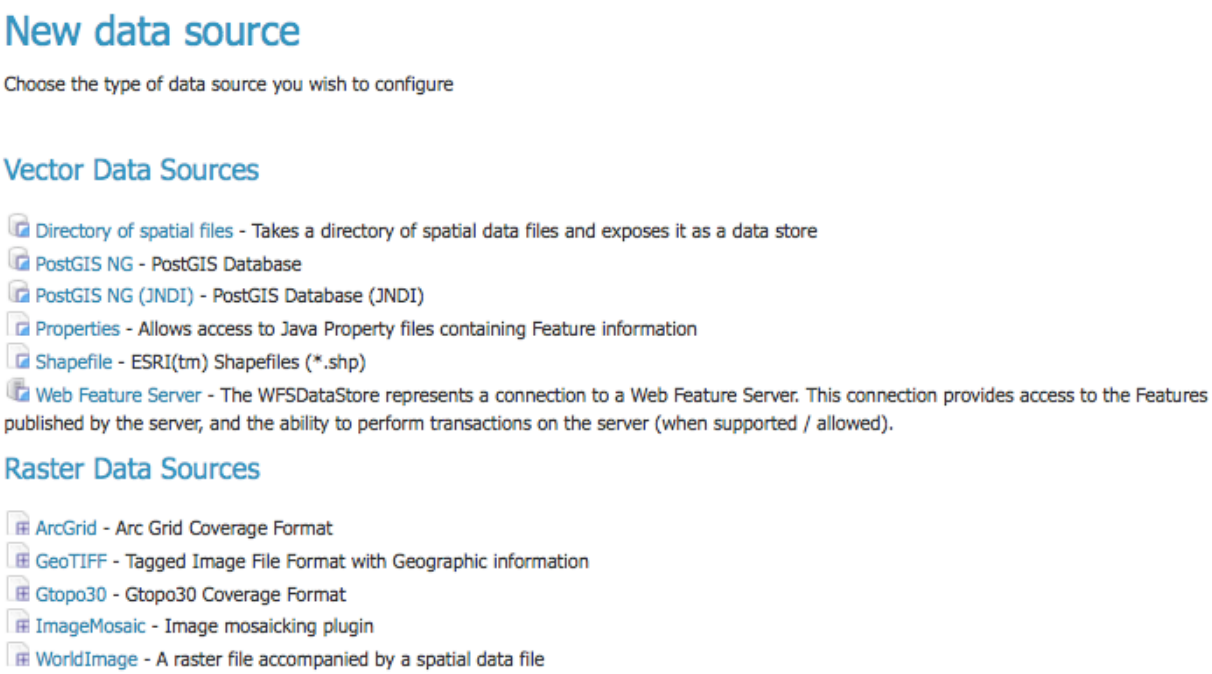
5. Enter the name `cy_buffers` and the URI `http://preview.grid.unep.ch`. A workspace name is a name describing your project and cannot exceed ten characters or contain a space. A Namespace URI (Uniform Resource Identifier), is typically a URL associated with your project, with perhaps a different trailing identifier.



6. Click the **Submit** button. GeoServer will append the cy_buffers workspace in the Workspace View list.

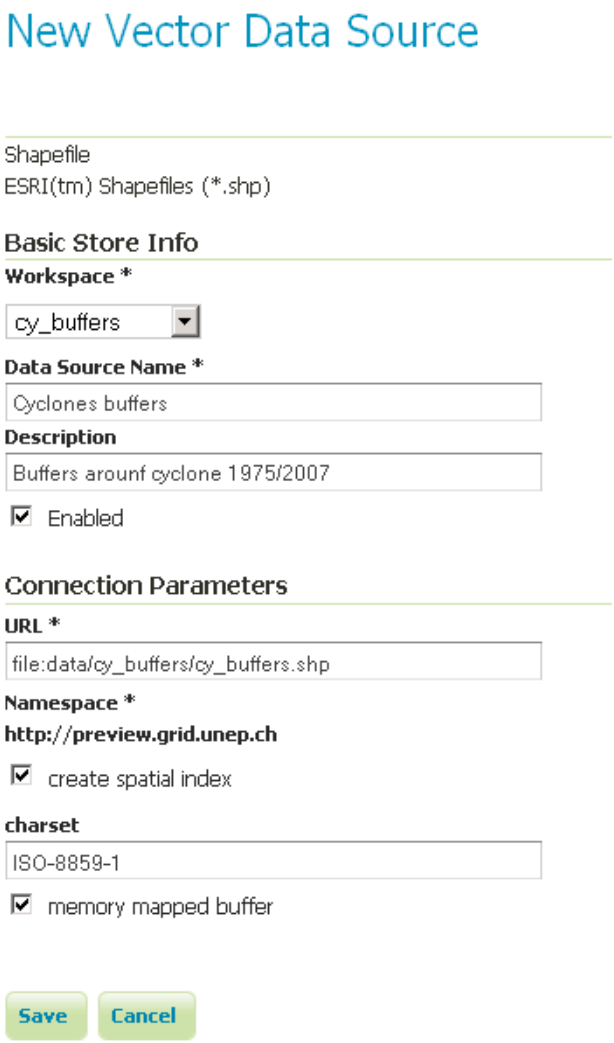
2.1.3.3 Create a store

1. Navigate to `Data‣Stores`.
2. In order to add the *cy_buffers* data, we need to create a new Store. Click on the **Add new store** button. You will be redirected to a list of data types GeoServer supports.



3. Because cy_buffers is a shapefile, select **Shapefile: ESRI(tm) Shapefiles (.shp)**.
4. On the New Vector Data Source page begin by configuring the Basic Store Info. Select the workspace `cy_buffers` from the drop down menu, type `Cyclones Buffers` for the name and enter a brief description, such as Buffers around cyclones 1975-2007.
5. Under the Connections Parameters specify the location of the shapefile:

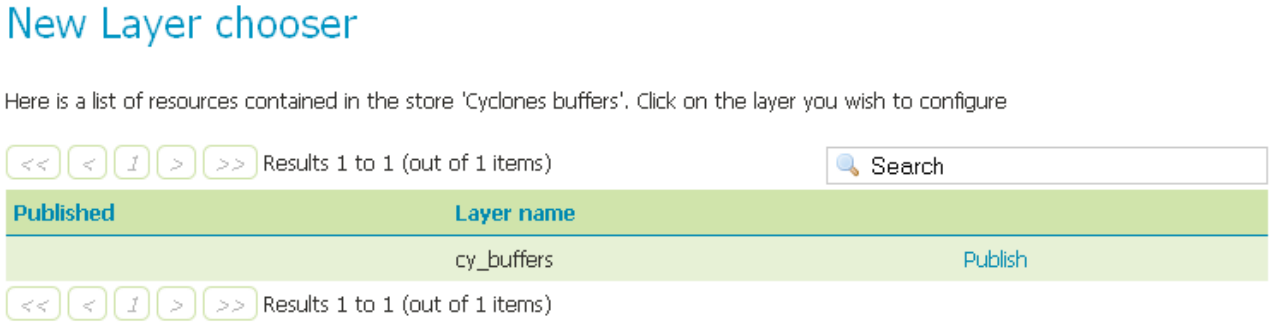
```
file:data/cy_buffers/cy_buffers.shp
```



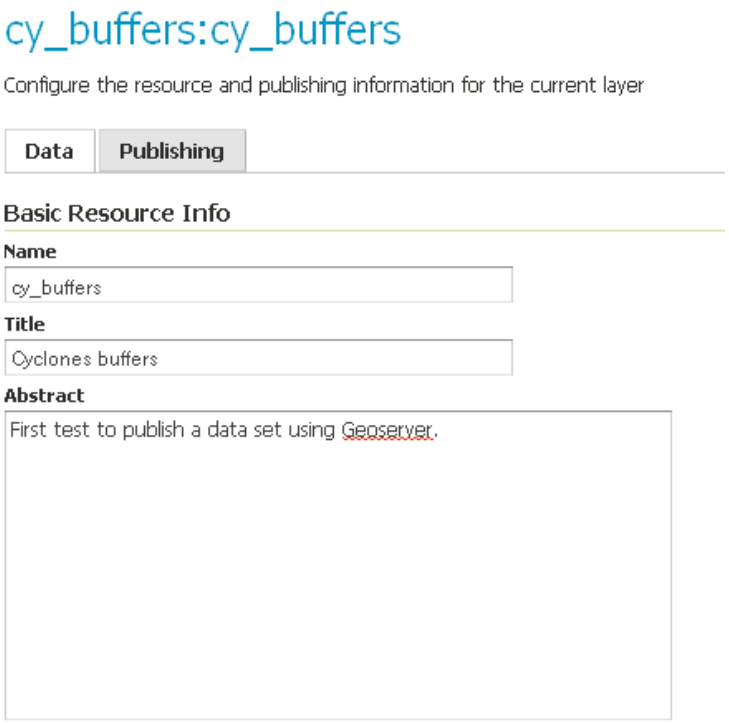
6. Press **Save**. You will be redirected to New Layer chooser page in order to configure cy_buffers layer.

2.1.3.4 Layer configuration

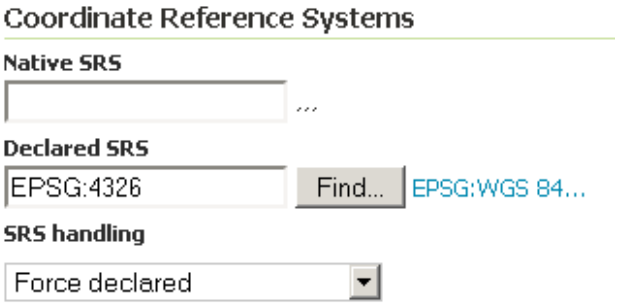
1. On the New Layer chooser page, select the Layer name cy_buffers and click **Publish**.



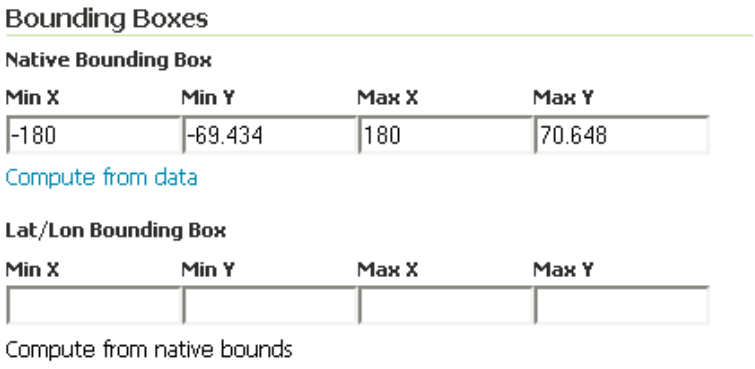
2. The following configuration define the data and publishing parameters for a layer. Enter a short Title and Abstract for the cy_buffers shapefile.



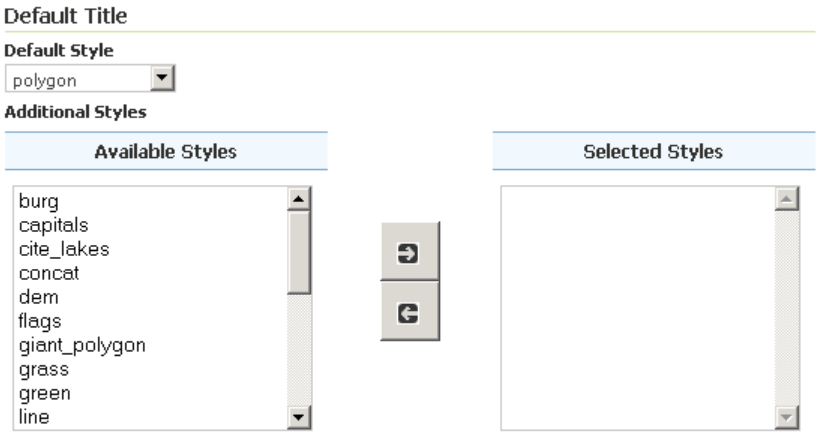
3. Under “Coordinate Reference Systems” - “Declared SRS”, add the EPSG:4326 code.



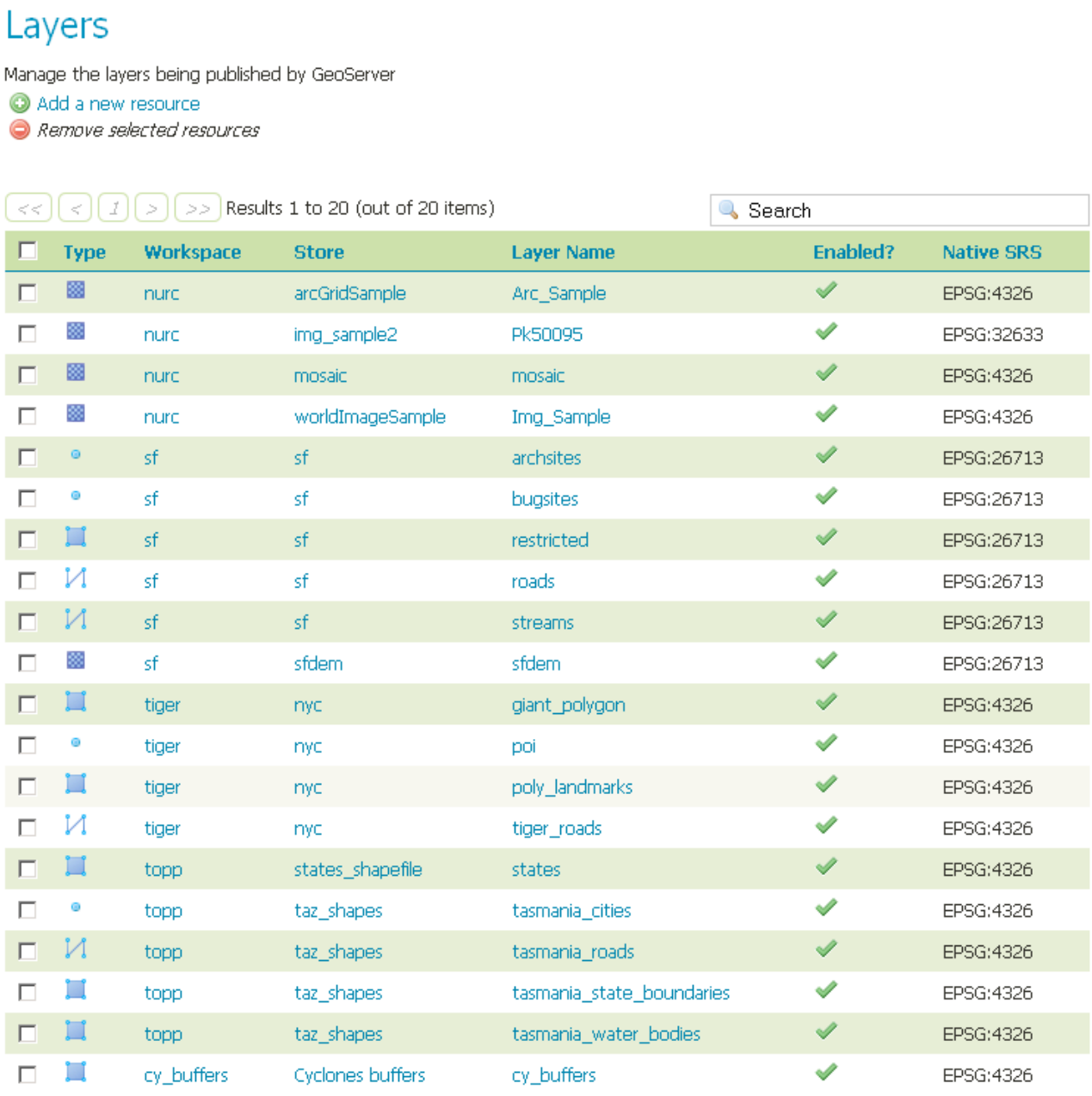
4. Under “Bounding Boxes”, generate the shapefile’s bounds by clicking the **Compute from data** and then **Compute from Native bounds**.



5. Set the shapefile’s style by first moving over to the Publishing tab.
6. The select `polygon` from the Default Style drop down list.

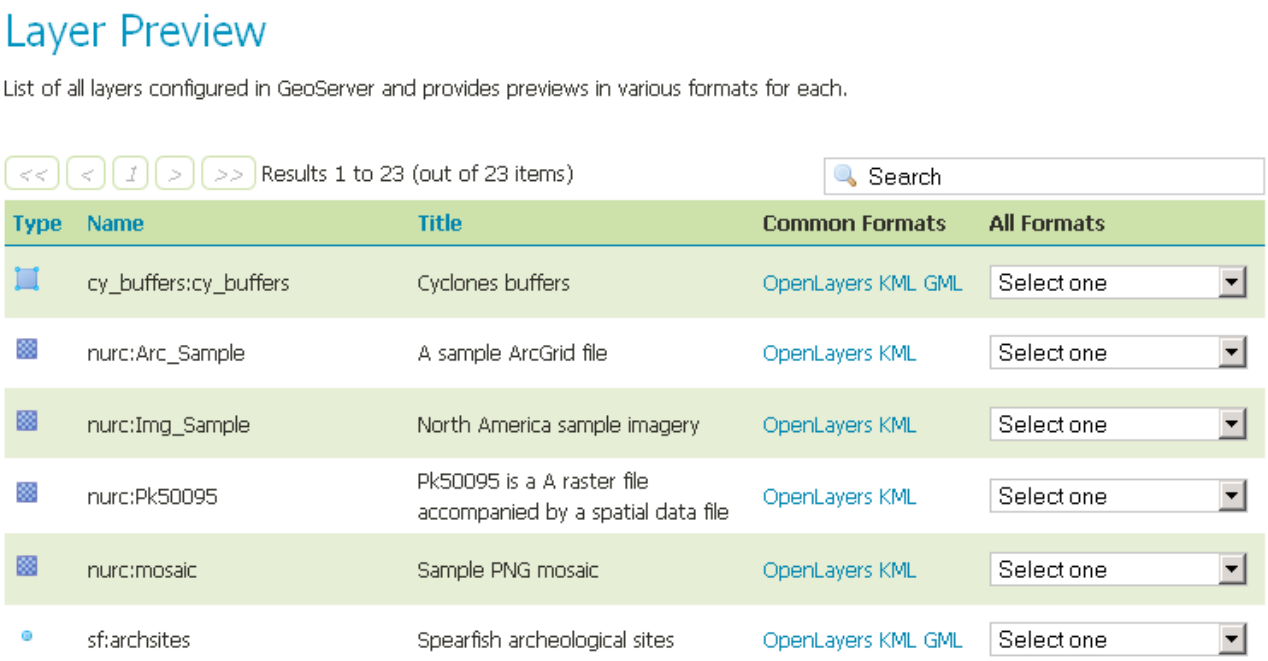


7. Finalize your data and publishing configuration by scrolling to the bottom and clicking **Save**. Now the added layer is visible in the Layers list.

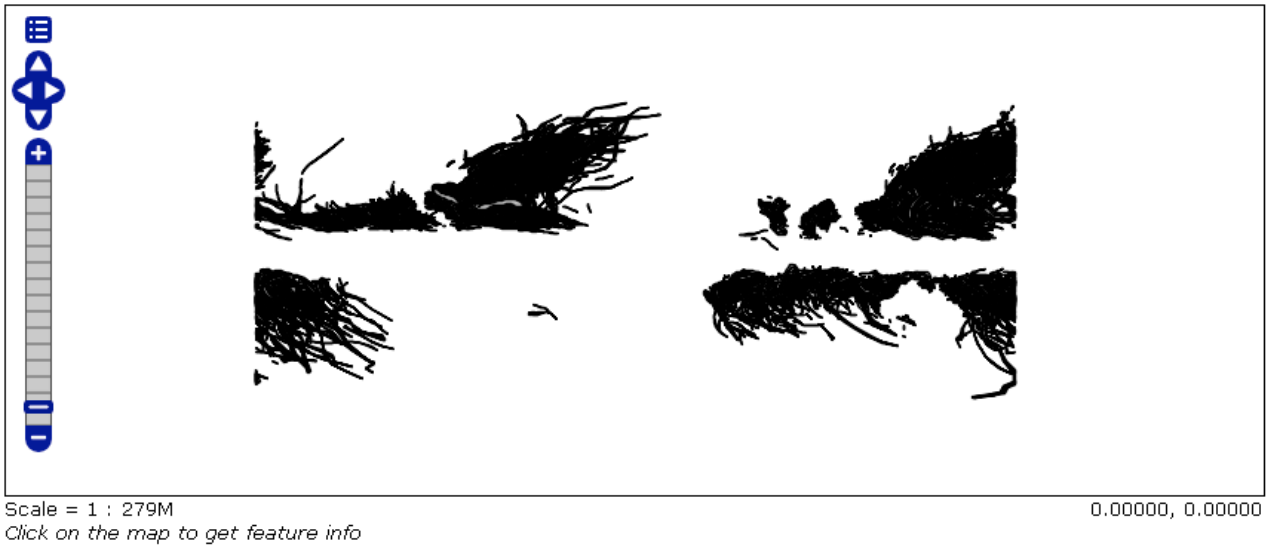


2.1.3.5 Preview the layer

1. In order to verify that the cy_buffers is really published we will preview the layer. Navigate to the Map Preview and search for the `cy_buffers:cy_buffers` link.



2. Click on the **OpenLayers** link under the “Common Formats” column.
3. Congratulations! An OpenLayers map should load with the default polygon style.



2.1.4 Adding a raster

Adding a raster file is very similar to the previous example.

2.1.4.1 Getting the data

1. Go to the PREVIEW Global Risk Data Platform “Data-Download” section:

http://preview.grid.unep.ch/index.php?preview=data

and select the “Multiple Hazards” risk layer.

NB: the data set is available on the CD-ROM.

2. Click on “Download the data” and choose the “GeoTiff” format
3. Download the data. This file contains a raster of multiple risk that will be used during this tutorial.
4. Unzip the ml_risk.zip. The extracted folder consists of the following four files:

   `ml_risk.tfw`

   `ml_risk.tif`

   `ml_risk.xml`

5. Create a folder called *ml_risk* into <GEOSERVER_DATA_DIR>/data where GEOSERVER_DATA_DIR is the root of the GeoServer data directory. If no changes were were made to the GeoServer file structure, the path should be:

   `C:\Program files\GeoServer2.1-beta1\data_dir\data\ml_risk.`

6. Paste the four extracted files in the ml_risk directory.

2.1.4.2 Create a new workspace

The first step is to create a workspace for the GeoTiff. The workspace is a container used to group similar layers together.

1. In a web browser navigate to http://localhost:8080/geoserver/web.
2. Log into GeoServer as described earlier.
3. Navigate to `Data‣Workspaces`.
4. To create a new workspace click, select the **Add new workspace** button. You will be prompted to enter a workspace Name and Namespace URI.
5. Enter the name `ml_risk` and the URI `http://preview.grid.unep.ch`. A workspace name is a name describing your project and cannot exceed ten characters or contain a space. A Namespace URI (Uniform Resource Identifier), is typically a URL associated with your project, with perhaps a different trailing identifier.
6. Click the **Submit** button. GeoServer will append the ml_risk workspace to the bottom of the Workspace View list.

2.1.4.3 Create a store

1. Navigate to `Data‣Stores`.
2. In order to add the ml_risk data, we need to create a new Store. Click on the **Add new store** button. You will be redirected to a list of data types GeoServer supports.
3. Because ml_risk is a raster with a tfw file, select: **WorldImage - A raster file accompanied by a spatial data file**.
4. On the New Raster Data Source page begin by configuring the Basic Store Info. Select the workspace ml_risk from the drop down menu, type `Multiple risk map` for the name and enter a brief description, such as “Risk map from multiple hazards”.

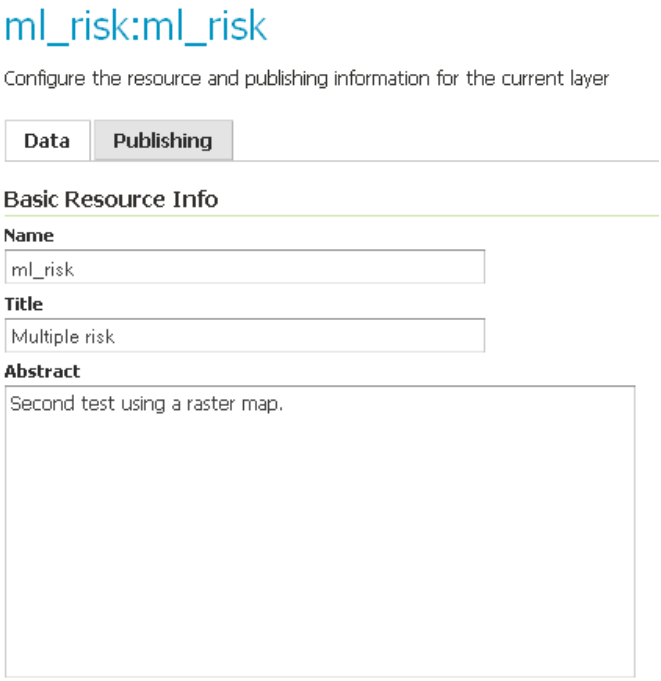
5. Under the Connections Parameters specify the location of the raster:

```
file:data/ml_risk/ml_risk.tif
```

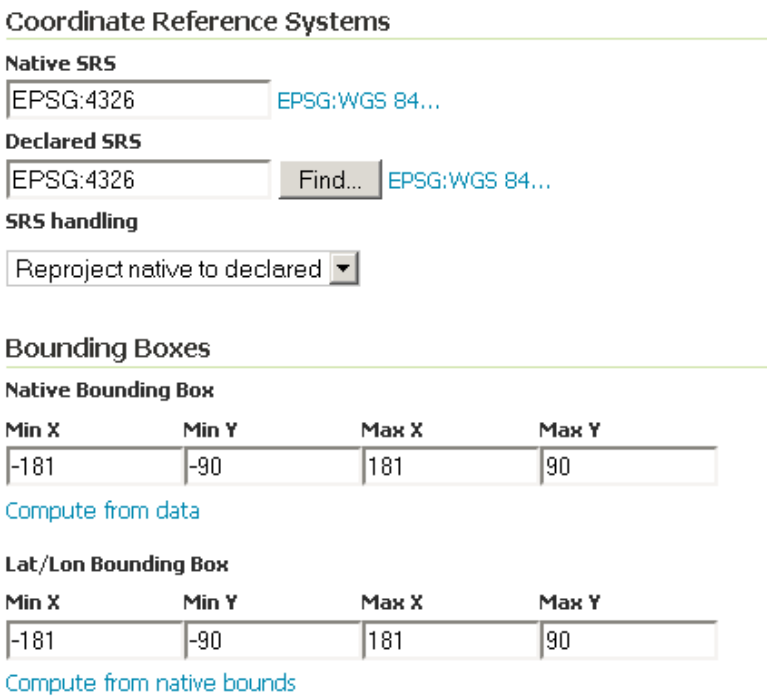
6. Press **Save**. You will be redirected to New Layer chooser page in order to configure ml_risk layer.

2.1.4.4 Layer configuration

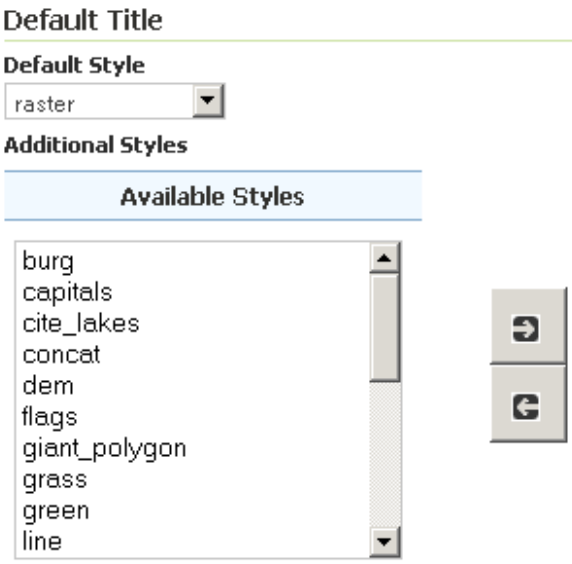
1. On the New Layer chooser page, select the Layer name ml_risk. Click **Publish**.
2. The following configuration define the data and publishing parameters for a layer. Enter a short Title and Abstract for the ml_risk raster.



3. Under “Coordinate Reference Systems” - “Declared SRS”, add the EPSG:4326 code.
4. Under “Bounding Boxes”, generate the raster’s bounds by clicking the **Compute from data** and then **Compute from Native bounds**.



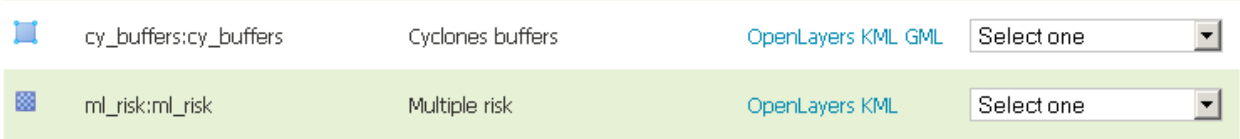
5. Set the raster's style by first moving over to the Publishing tab.
6. The select `raster` from the Default Style drop down list.



7. Finalize your data and publishing configuration by scrolling to the bottom and clicking **Save**. Now the added layer is visible in the Layers list.

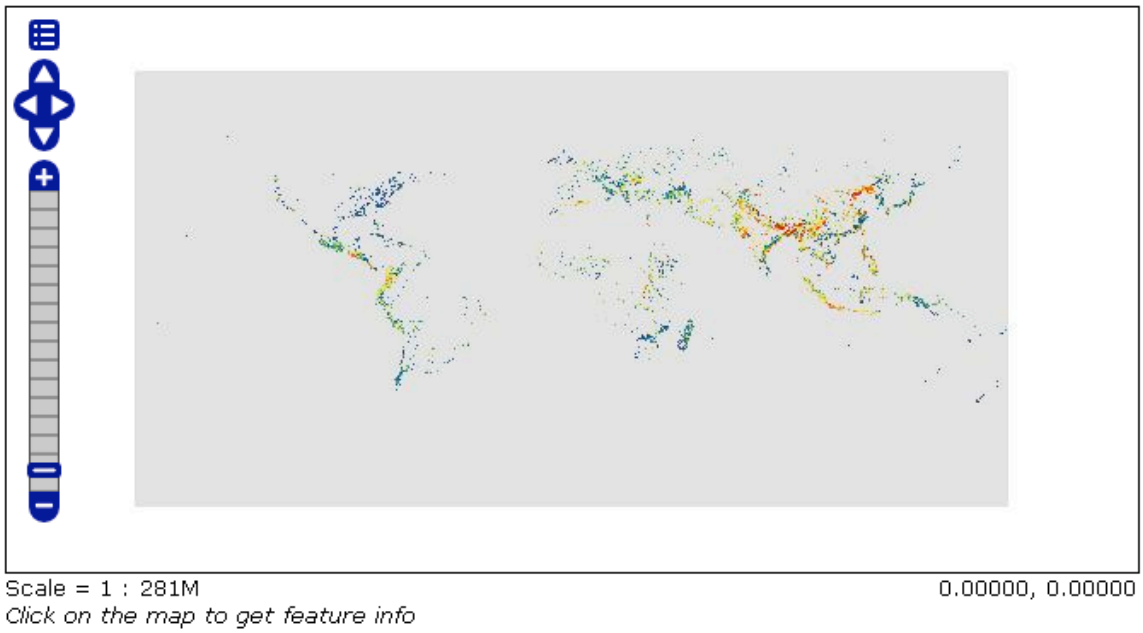
2.1.4.5 Preview the layer

1. In order to verify that the ml_risk is probably published we will preview the layer. Navigate to the Map Preview and search for the ml_risk:ml_risk link.



2. Click on the `OpenLayers` link under the Common Formats column.

3. Congratulations! An OpenLayers map should load with the default raster style.



More information about the different data stores on:

http://docs.geoserver.org/stable/en/user/data/

2.1.5 Styling a map

When a new dataset is added to GeoServer the layer for it is usually assigned a very basic style. To properly visualize the data a style specific to that data must be created.

This tutorial walks through the steps to create a new style in GeoServer and provides an introduction to the Styled Layer Descriptor (SLD) styling language.

Geospatial data has no intrinsic visual component. In order to see data, it must be styled. This means to specify color, thickness, and other visible attributes. In GeoServer, this styling is accomplished using a markup language called Styled Layer Descriptor, or SLD for short. SLD is an XML-based markup language and is very powerful, though it can be intimidating. This page will give a basic introduction to what one can do with SLD and how GeoServer handles it.

2.1.5.1 Types of styling

Data that GeoServer can serve consists of three classes of shapes: Points, lines, and polygons. Lines (one dimensional shapes) are the simplest, as they have only the edge to style (also known as “stroke”). Polygons, two dimensional shapes, have an edge and an inside (also known as a “fill”), both of which can be styled differently. Points, even though they lack dimension, have both an edge and a fill (not to mention a size) that can be styled. For fills, color can be specified; for strokes, color and thickness can be specified.

More advanced styling is possible than just color and thickness. Points can be specified with well-known shapes like circles, squares, stars, and even custom graphics or text. Lines can be styled with a dash styles and hashes. Polygons can be filled with a custom tiled graphics. Styles can be based on attributes in the data, so that certain features are

styled differently. Text labels on features are possible as well. Features can be styled based on zoom level, with the size of the feature determining how it is displayed. The possibilities are vast.

2.1.5.2 Geoserver and SLD

Every layer (featuretype) registered with GeoServer needs to have at least one style associated with it. GeoServer comes bundled with a few basic styles, and any number of new styles can be added. It is possible to change any layer's associated style at any time in the Layers page of the Web Administration Interface. When adding a layer and a style to GeoServer at the same time, the style should be added first, so that the new layer can be associated with the style immediately. You can add a style in the Styles menu of the Web Administration Interface.

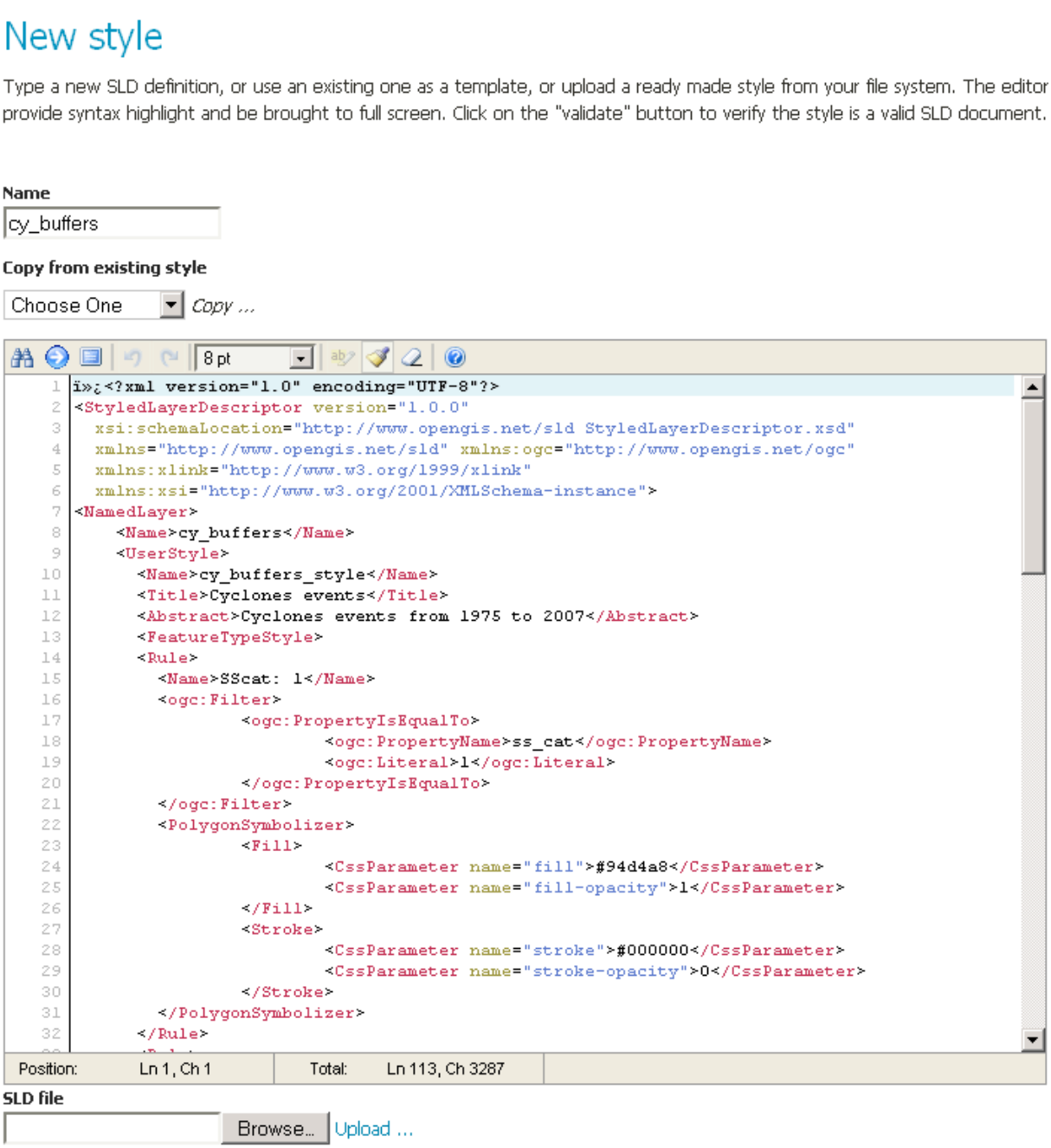
More information about styling are available on:

`http://docs.geoserver.org/stable/en/user/styling/`

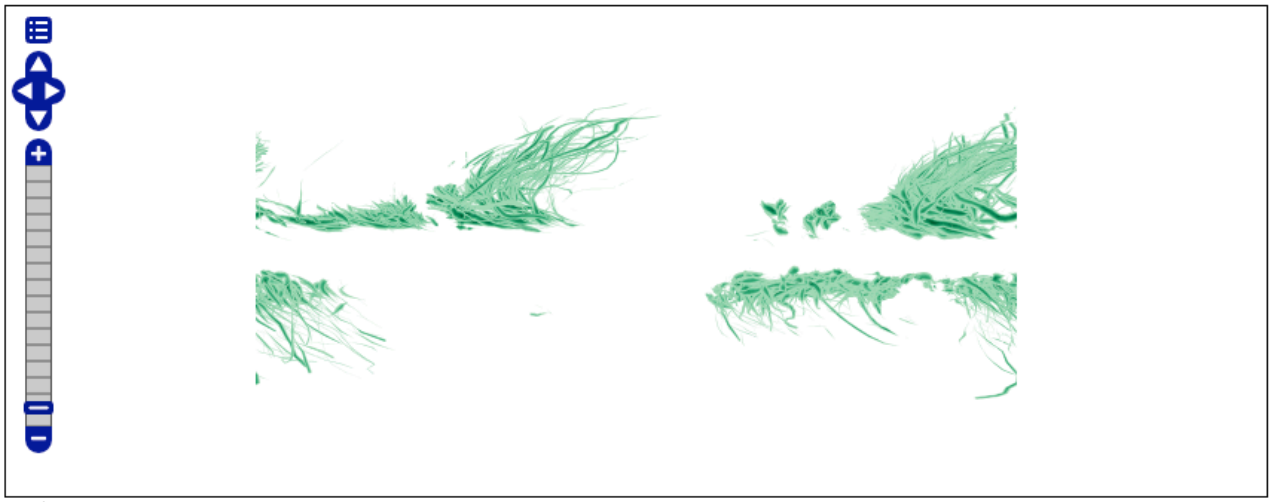
2.1.5.3 Create a new style

In this example, we will improve the rendering of the cy_buffers layer. Indeed as we have seen earlier, the look of the vector layer is not very suitable.

1. Click on **Styles** link, to open the Styles page.
2. Click on **Add a new style**.
3. This will open a new style page. Give a name to your style, for example, `cy_buffers_style`.
4. After click on the **Browse** button, on bottom of the page. And go to the file `cy_buffers.sld` available on the data folder of the CD-ROM.
5. Click on **Upload** link.
6. This will import the sld file in the text editor.



7. Click on **Submit**. Now your style is saved and appears in the list of styles available.
8. Now click on **Layers** in the Data section. And edit cy_buffers layer by clicking on his name.
9. Go to the `Publishing` tab and change the default style by selecting the new cy_buffers. Click on **Save**.
10. Finally go back to **Layer preview** and click on the `OpenLayers` link under the Common Formats column of cy_buffers:cy:buffers
11. Congratulations! You must have now a styled map of the Cyclones buffers layer.



2.1.6 Accessing WMS, WFS, WCS and KML services

IMPORTANT: If you want to secure your web services, by adding a username/password, please refer to the section “Security” of GeoServer documentation:

http://docs.geoserver.org/stable/en/user/security/index.html

2.1.6.1 Web Map Service (WMS)

GeoServer provides support for Open Geospatial Consortium (OGC) Web Map Service (WMS) version 1.1.1. This is a standard for generating maps on the web - it is how all the visual mapping that GeoServer does is produced. Using a compliant WMS makes it possible for clients to overlay maps from several different sources in a seamless way.

GeoServer’s implementation fully supports most every part of the standard, and is certified compliant against the OGC’s test suite. It includes a wide variety of rendering and labeling options, and is one of the fastest WMS Servers for both raster and vector data.

The WMS implementation of GeoServer also supports reprojection in to any reference system in the EPSG database, and it is also possible to add additional projections if the Well Known Text is known. It also fully supports the Styled Layer Descriptor (SLD) standard, and indeed uses SLD files as its native rendering rules.

The Web Map Service (WMS) is a standard created by the OGC that refers to the sending and receiving of georeferenced images over HTTP. These images can be produced from both vector and raster data formats. The most widely used version of WMS is 1.1.1, which GeoServer supports. The Styled Layer Descriptor (SLD) standard specifies extensions to WMS to control the styling of the WMS over the web, and GeoServer supports all these additional operations as well.

An important distinction must be made between WMS and Web Feature Service, which refers to the sending and receiving of raw geographic information, before it has been rendered as a digital image.

1. Benefits

WMS provides a standard interface for how to request a geospatial image. The main benefit of this is that clients can request images from multiple servers, and then combine them in to one view for the user. The standard guarantees that these images can all be overlaid on one another as they actually would be in reality. Numerous servers and clients support WMS.

2. Operations

WMS can perform the following operations:

- *GetCapabilities:* Retrieves a list of the server's data, as well as valid WMS operations and parameters.

http://localhost:8080/geoserver/ows?service=wms&version=1.1.1&request=GetCapabilities

- *GetMap:* Retrieves the image requested by the client

http://localhost:8080/geoserver/wms?bbox=-180,-89,180,84&styles=&Format=image/png&request=GetMap&version=1.1.1&layers=cy_buffers:cy_buffers&width=640&height=309&srs=EPSG:4326

- *GetFeatureInfo (optional):* Retrieves the actual data, including geometry and attribute values, for a pixel location
- *DescribeLayer (optional):* Indicates the WFS or WCS to retrieve additional information about the layer.
- *GetLegendGraphic (optional):* General mechanism for retrieving generated legend symbols

More information about WMS in Geoserver:

http://docs.geoserver.org/stable/en/user/services/wms/

2.1.6.2 Web Feature Service (WFS)

GeoServer provides support for Open Geospatial Consortium (OGC) Web Feature Service (WFS) versions 1.0 and 1.1. This is a standard for getting raw vector data - the 'source code' of the map - over the web. Using a compliant WFS makes it possible for clients to query the data structure and the actual data. Advanced WFS operations also enable editing and locking of the data.

GeoServer is the reference implementation of both the 1.0 and 1.1 versions of the standard, completely implementing every part of the protocol. This includes the Basic operations of GetCapabilities, DescribeFeatureType and GetFeature, as well as the more advanced Transaction, LockFeature and GetGmlObject operations. GeoServer's WFS also is integrated with GeoServer's Security system, to limit access to data and transactions. It also supports a wide variety of WFS output formats, to make the raw data more widely available.

GeoServer additionally supports a special 'versioning' protocol in an extension: WFS Versioning. This is not yet a part of the WFS specification, but is written to be compatible, extending it to provide a history of edits, differences between edits, and a rollback operation to take things to a previous state.

The Web Feature Service (WFS) is a standard created by the OGC that refers to the sending and receiving of geospatial data through HTTP. WFS encodes and transfers information in Geography Markup Language, a subset of XML. The current version of WFS is 1.1.0. GeoServer supports both version 1.1.0 (the default since GeoServer 1.6.0) and version 1.0.0. There are differences between these two formats, some more subtle than others, and this will be noted where differences arise. The current version of WFS is 1.1. WFS version 1.0 is still used in places, and we will note where there are differences. However, the syntax will often remain the same.

1. Benefits

One can think of WFS as the "source code" to the maps that one would ordinarily view (via WMS). WFS leads to greater transparency and openness in mapping applications. Instead of merely being able to look at a picture of the map, as the provider wants the user to see, the power is in the hands of the user to determine how to visualize (style) the raw geographic and attribute data. The data can also be downloaded, further analyzed, and combined with other data. The transactional capabilities of WFS allow for collaborative mapping applications. In short, WFS is what enables open spatial data.

2. Operations

WFS can perform the following operations:

- *GetCapabilities:* Retrieves a list of the server's data, as well as valid WFS operations and parameters.

http://localhost:8080/geoserver/ows?service=wfs&version=1.1.0&request=GetCapabilities

- *DescribeFeatureType:* Retrieves information and attributes about a particular dataset
- *GetFeature:* Retrieves the actual data, including geometry and attribute values

http://localhost:8080/geoserver/wfs?bbox=-180,-89,180,84&styles=&request=GetFeature&version=1.1.0&typename=cy_buffers:cy_buffers&srs=EPSG:4326

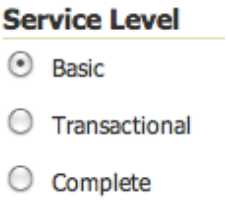
- *LockFeature:* Prevents a feature type from being edited
- *Transaction:* Edits existing featuretypes by creating, updating, and deleting.
- *GetGMLObject:* (Version 1.1.0 only) - Retrieves element instances by traversing XLinks that refer to their XML IDs.

A WFS server that supports transactions is sometimes known as a WFS-T. GeoServer fully supports transactions.

More information about WFS in Geoserver:

http://docs.geoserver.org/stable/en/user/services/wfs/

IMPORTANT: By default GeoServer WFS service is in transactional mode. If you want to avoid this option, select the "Basic" value under Services/WFS of GeoServer Web Administration interface.



2.1.6.3 Web Coverage Service (WCS)

GeoServer provides support for Open Geospatial Consortium (OGC) Web Map Service (WCS) versions 1.0 and 1.1. One can think of WCS as the equivalent of Web Feature Service, but for raster data instead of vector data. It lets you get at the raw coverage information, not just the image. GeoServer is the reference implementation for WCS 1.1.

The Web Coverage Service (WCS) is a standard created by the OGC that refers to the receiving of geospatial information as 'coverages': digital geospatial information representing space-varying phenomena. One can think of it as Web Feature Service for raster data. It gets the 'source code' of the map, but in this case its not raw vectors but raw imagery.

An important distinction must be made between WCS and Web Map Service. They are similar, and can return similar formats, but a WCS is able to return more information, including valuable metadata and more formats. It additionally allows more precise queries, potentially against multi-dimensional backend formats.

1. Benefits

WCS provides a standard interface for how to request the raster source of a geospatial image. While a WMS can return an image it is generally only useful as an image. The results of a WCS can be used for complex modeling and analysis, as it often contains more information. It also allows more complex querying - clients can extract just the portion of the coverage that they need.

2. Operations

WCS can perform the following operations:

- *GetCapabilities:* Retrieves a list of the server's data, as well as valid WCS operations and parameters.

http://localhost:8080/geoserver/ows?service=wcs&version=1.1.1&request=GetCapabilities

- *DescribeCoverage:* Retrieves an XML document that fully describes the request coverages.
- *GetCoverage:* Returns a coverage in a well known format. Like a WMS GetMap request, but with several extensions to support the retrieval of coverages.

http://localhost:8080/geoserver/wcs?bbox=-180,-89,180,84&service=WCS&styles=&request=GetCoverage&version=1.1.1&coverage=ml_risk:ml_risk&width=640&height=309&crs=EPSG:4326&Format=GeoTiff

More information about WCS in Geoserver:

http://docs.geoserver.org/stable/en/user/services/wcs/

2.1.6.4 Keyhole Markup Language (KML)

1. Viewing a layer

Once GeoServer is installed and running, open up a web browser and go to the web admin console (Interface basics). Navigate to the Layer Preview by clicking on the Layer Preview link at the bottom of the left sidebar. You will be presented with a list of the currently configured layers in your GeoServer instance. Find the row that says topp:states. To the right of the layer click on the link that says KML.

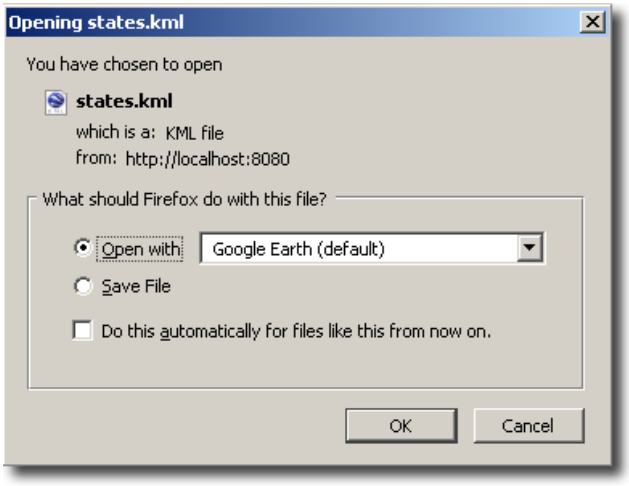
Layer Preview

List of all layers configured in GeoServer and provides previews in various formats for each.

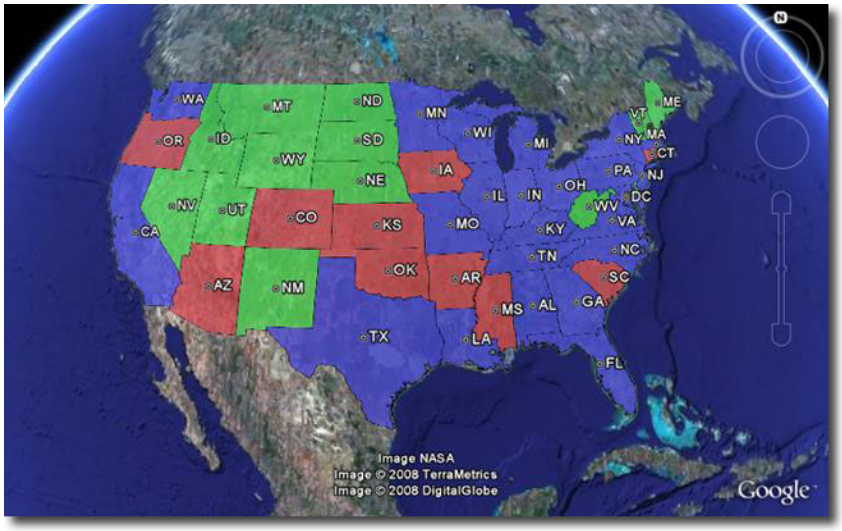
<< < 1 > >> Results 1 to 19 (out of 19 items) Search

Type	Name	Title	Common Formats	All Formats
	nurc:Arc_Sample	A sample ArcGrid file	OpenLayers KML	Select one
	nurc:Pk50095	Pk50095 is a A raster file accompanied by a spatial data file	OpenLayers KML	Select one
	nurc:mosaic	Sample PNG mosaic	OpenLayers KML	Select one
	nurc:Img_Sample	North America sample imagery	OpenLayers KML	Select one
	sf:archsites	Spearfish archeological sites	OpenLayers KML GML	Select one
	sf:bugsites	Spearfish bug locations	OpenLayers KML GML	Select one
	sf:restricted	Spearfish restricted areas	OpenLayers KML GML	Select one
	sf:roads	Spearfish roads	OpenLayers KML GML	Select one
	sf:streams	Spearfish streams	OpenLayers KML GML	Select one
	sf:sfdem	sfdem is a Tagged Image File Format with Geographic information	OpenLayers KML	Select one
	tiger:poi	Manhattan (NY) points of interest	OpenLayers KML GML	Select one

If Google Earth is correctly installed on your computer, you will see a dialog asking how to open the file. Select Open with Google Earth.



When Google Earth is finished loading the result will be similar to below.



2. Direct access to KML

All of the configured FeatureTypes are available to be output as KML (and thus loaded into Google Earth). The URL structure for KMLs is:

```
http://GEOSERVER_URL/wms/kml?layers=<layername>
```

For example, the topp:states layer URL is:

```
http://GEOSERVER_URL/wms/kml?layers=topp:states
```

More information about KML in Geoserver:

http://docs.geoserver.org/stable/en/user/googleearth/

2.2 GeoNetwork

Website:http://geonetwork-opensource.org/

GeoNetwork is a standardized and decentralized spatial information management environment, designed to enable access to geo-referenced databases, cartographic products and related metadata from a variety of sources, enhancing the spatial information exchange and sharing between organizations and their audience, using the capacities of the internet. This approach of geographic information management aims at facilitating a wide community of spatial information users to have easy and timely access to available spatial data and to existing thematic maps that might support informed decision making.

GeoNetwork implements both the Portal component and the Catalog database of a Spatial Data Infrastructure (SDI) defined in the OGC Reference Architecture. It provides tools for managing and publishing metadata on spatial data and related services. GeoNetwork allows a distributed search providing access to a huge volume of metadata that come from different Clearinghouses and also provides a web-based interactive map viewer that allows people to composite maps picking layers from distributed servers on the internet.

(Source: GeoNetwork website)

System requirements

GeoNetwork can run either on MS Windows, Linux or Mac OS X.

Some general system requirements for the software to run without problems are listed below: Processor: 2 GHz or higher Memory (RAM): 1 GB or higher

Disk Space: 200 MB minimum. However, it is suggested to have a minimum of 1 GB of free disk space. Additional space is required depending on the amount of spatial data that you expect to upload into the internal geodatabase.

Other Software requirements: A Java Runtime Environment (JRE 1.5.0). For server installations, Apache Tomcat and a dedicated JDBC compliant DBMS (MySQL, Postgresql, Oracle) can be used instead of Jetty and McKoiDB respectively.

2.2.1 Installation

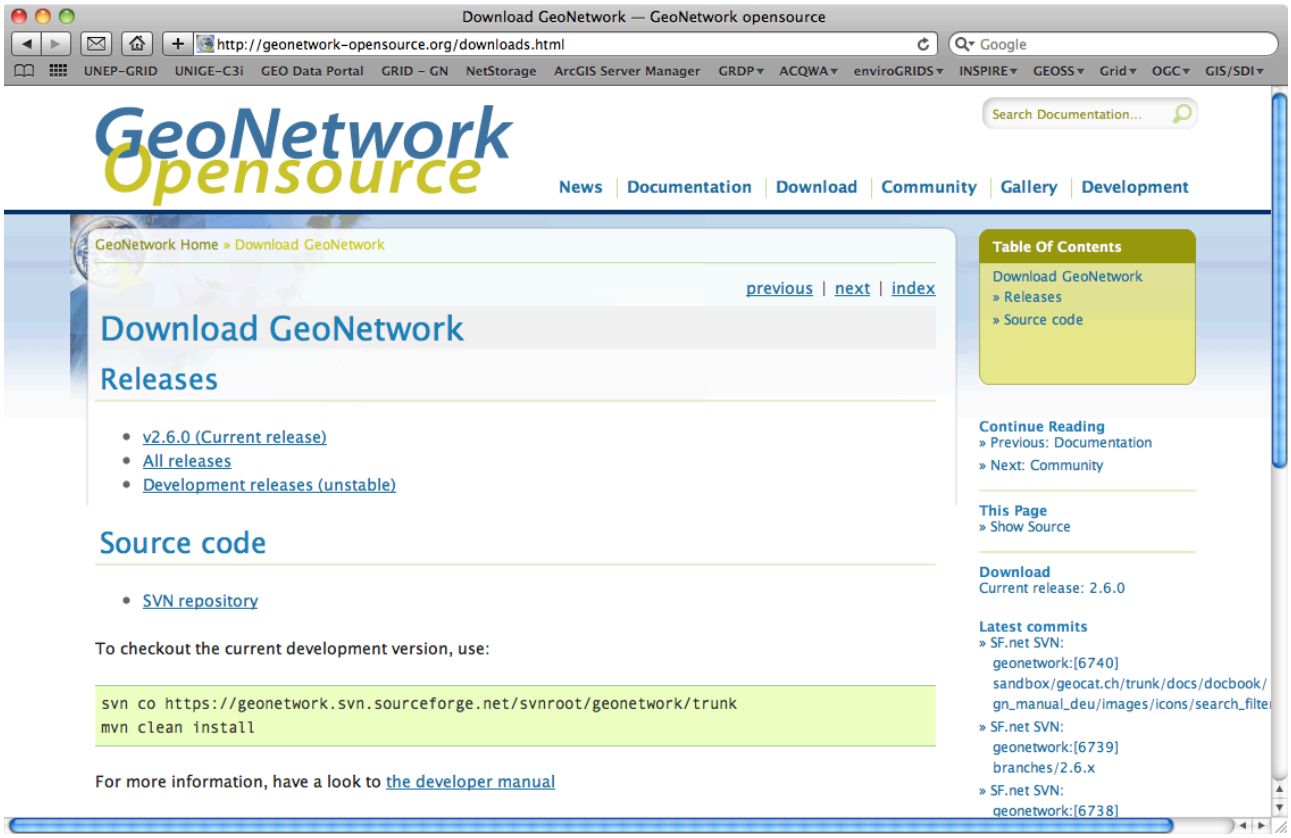
2.2.1.1 Installing the Java Development Kit

If you don't have already installed the latest JDK version, please install it, referring to the related topic on the installation of GeoServer.

2.2.1.2 Download GeoNetwork

Go to the download page and get the latest Stable release:

http://geonetwork-opensource.org/downloads.html

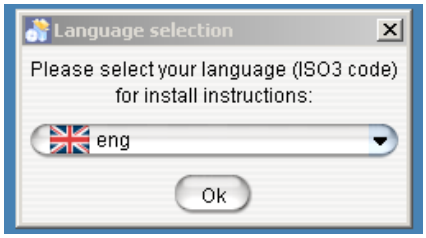


In our case, download the "GeoNetwork opensource for Windows".

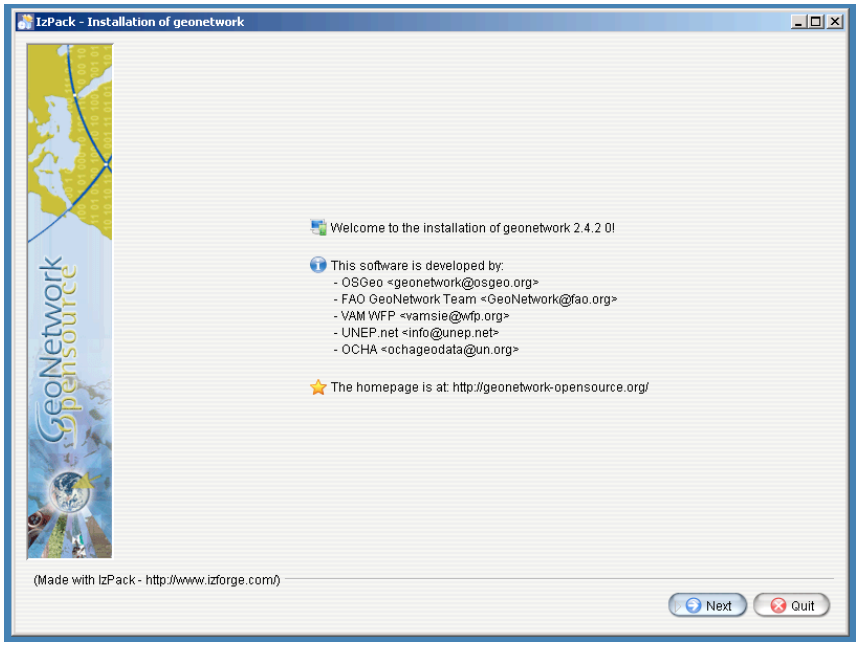
2.2.1.3 Run the Installer

Double click on the GeoNetwork executable that you just downloaded to start the installer.

1. Choose the language you want for install instructions. We suggest to choose **"English"**. Click **OK**.

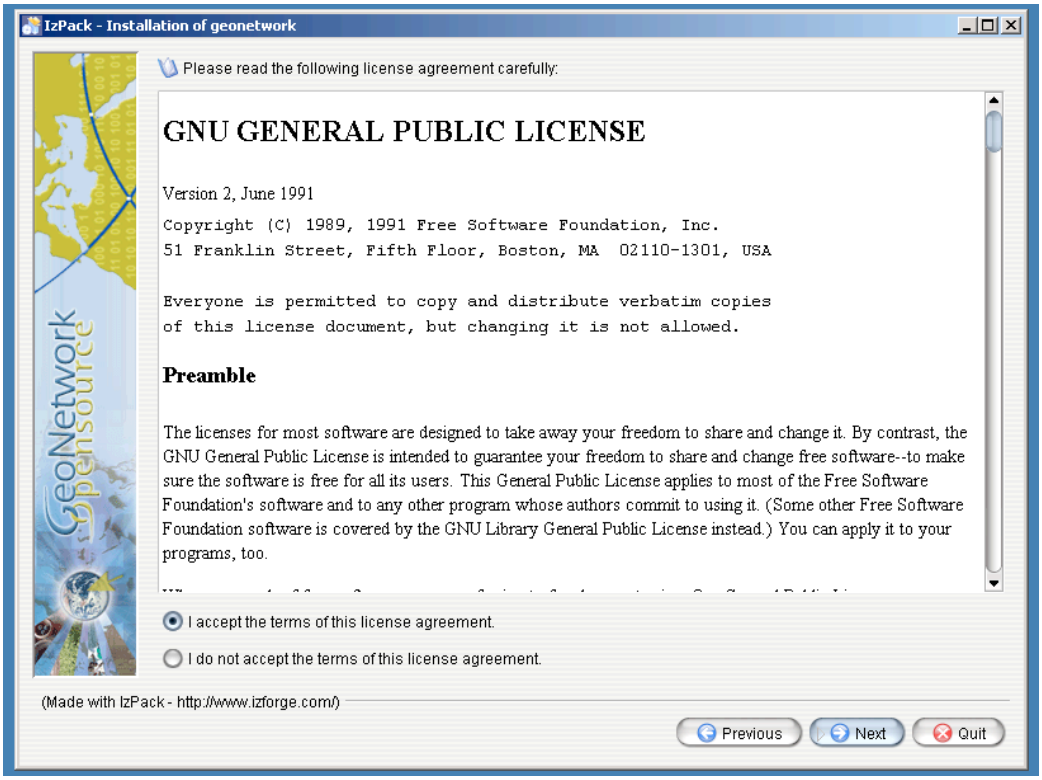


2. You get the Welcome page of the installer.

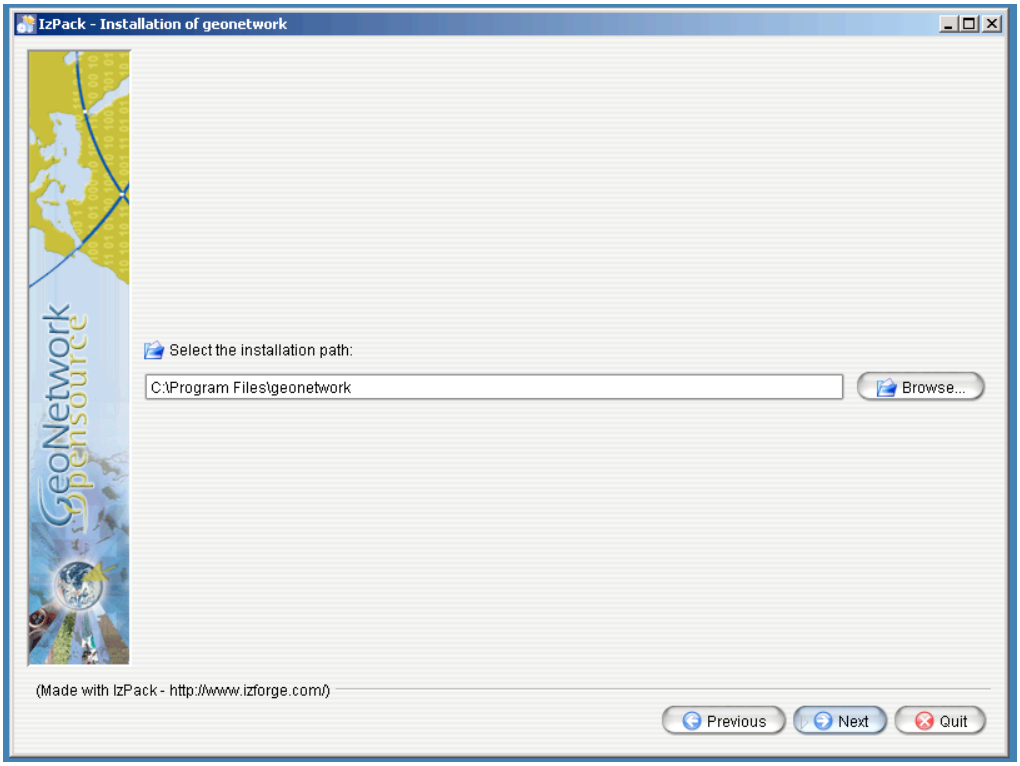


Click **Next**.

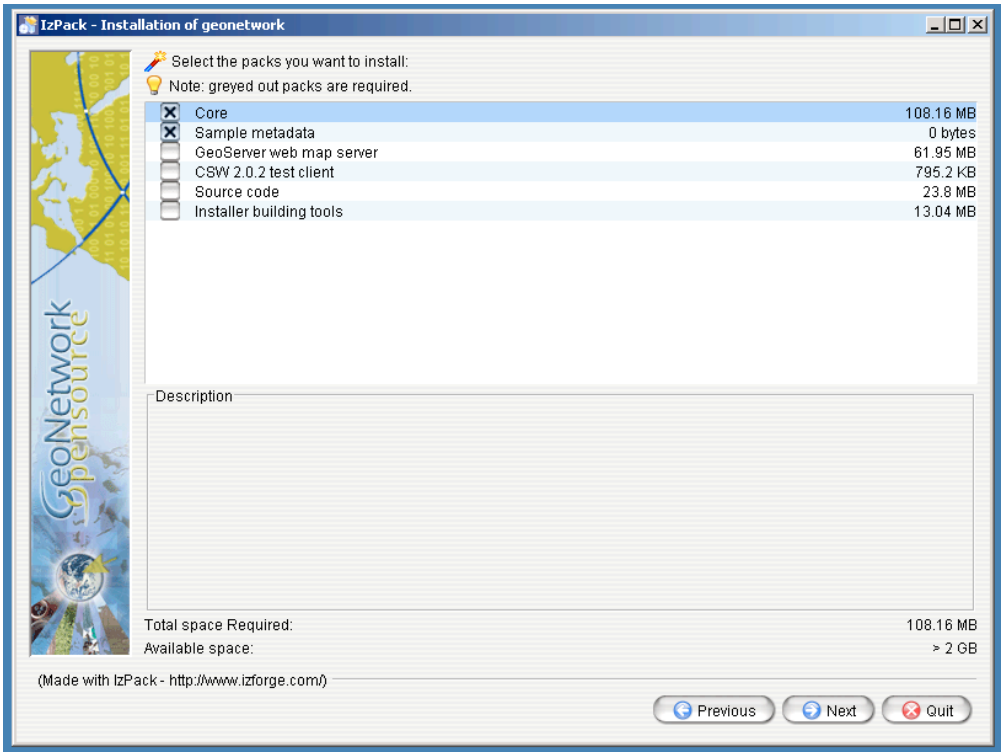
3. Read the GPL license and choose **"I accept the terms of this license agreement"**. Click **Next**.



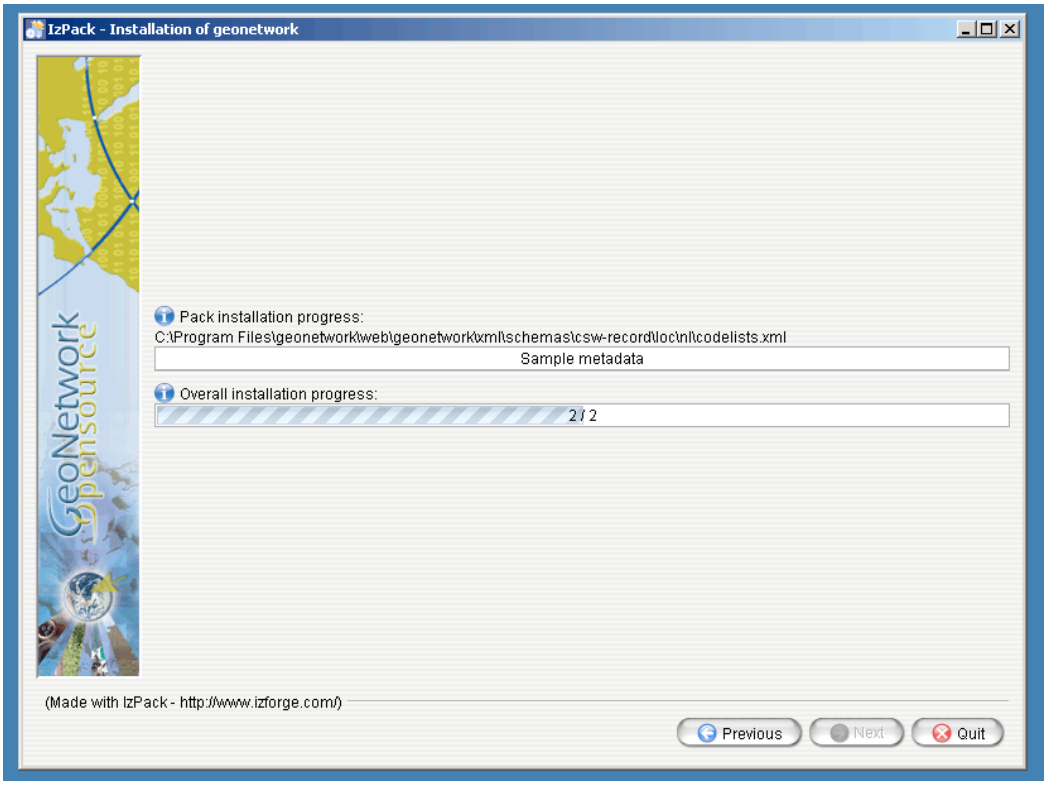
4. Choose your install location and click **Next**. You can leave this in the default directory or change as you would like.



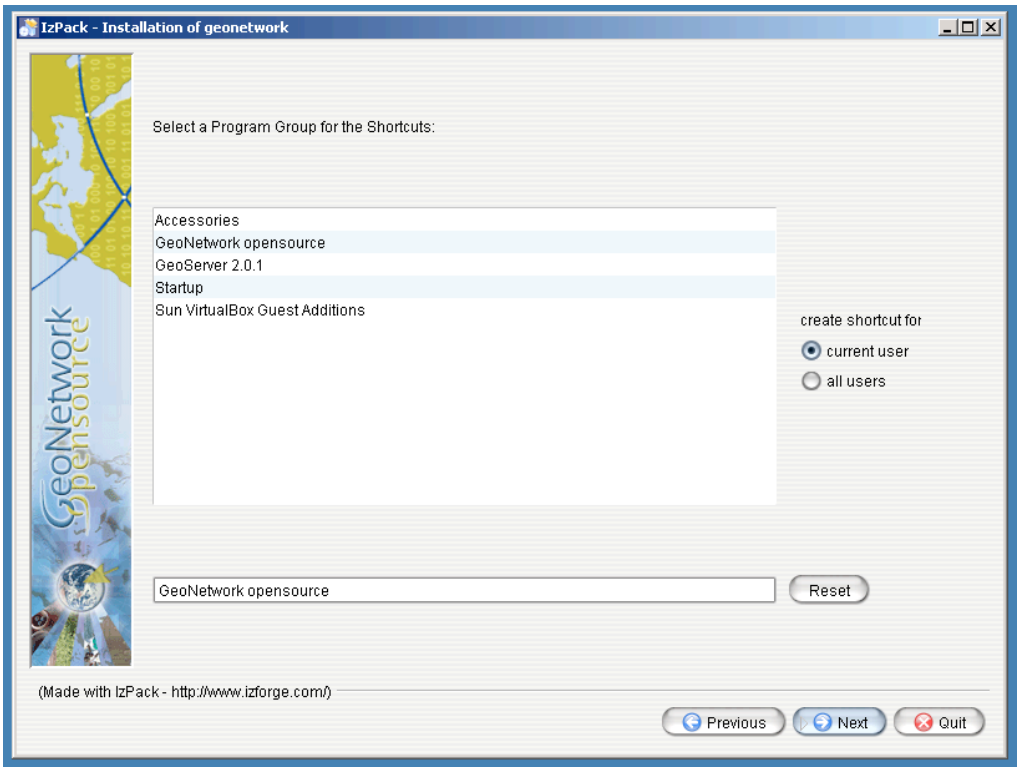
5. Select the packages you want to install. In our case, choose “Core” and “Sample metadata”. If you have already installed GeoServer you have to deselect this package. Click **Next**.



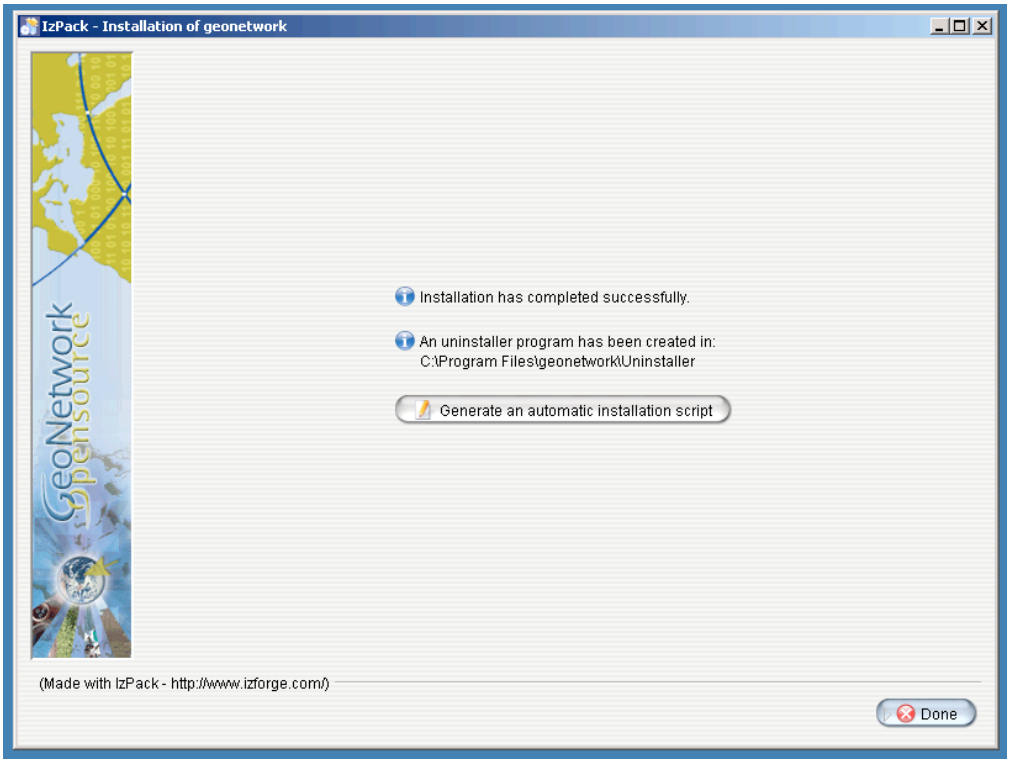
6. The installation starts. On completion, click **Next**.



7. Choose the name of the Start Menu folder and click **Next**. Usually this can be left to its default values.

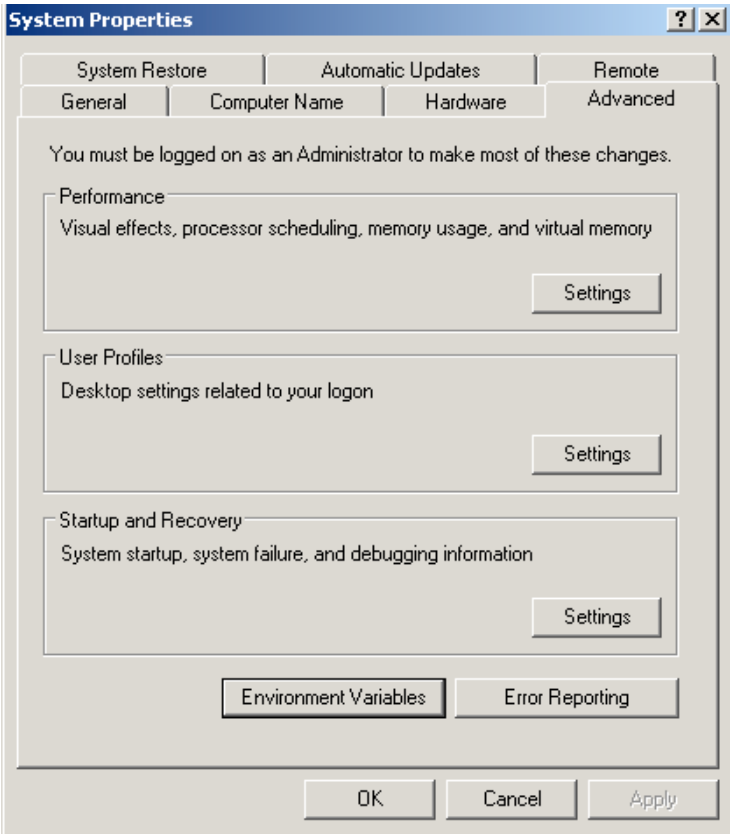


8. Congratulations you've successfully installed GeoNetwork and you're ready to use it. Click **Finish**.



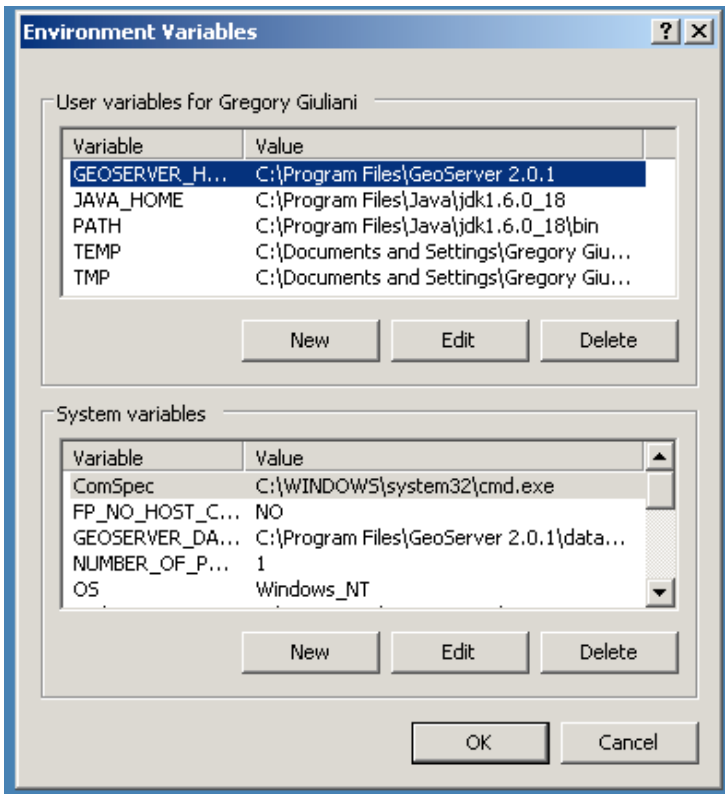
2.2.1.4 Start GeoNetwork

1. Before starting GeoNetwork you must define **PATH** environment variables. This is the path to the bin directory of JDK. For that go to: *Start > Settings > Control panel > System*, click on "Advanced" tab and click on the "Environment Variables" button.

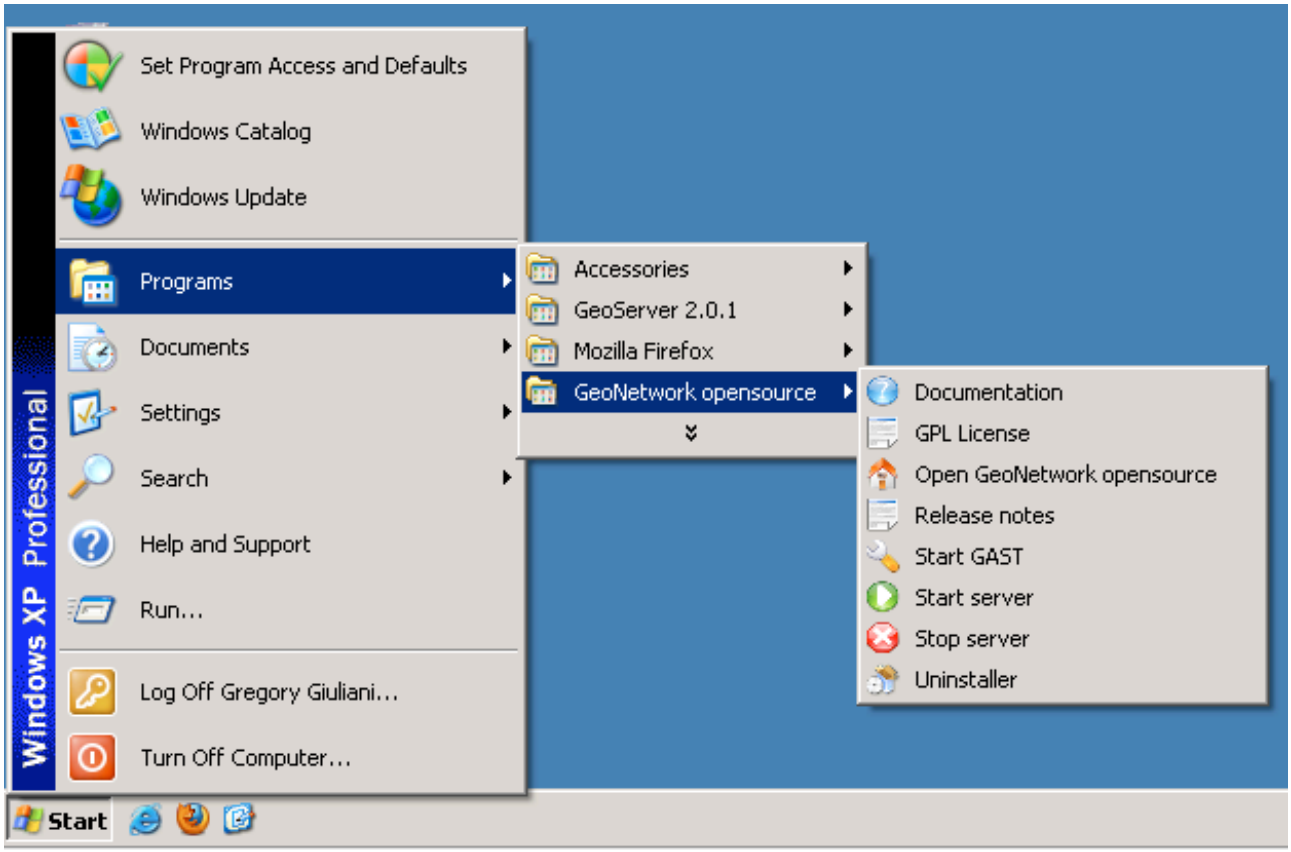


2. Under "User variables", click on "New" and define the **PATH** variable.

`PATH: C:\Program Files\Java\jdk1.6.0_24\bin`

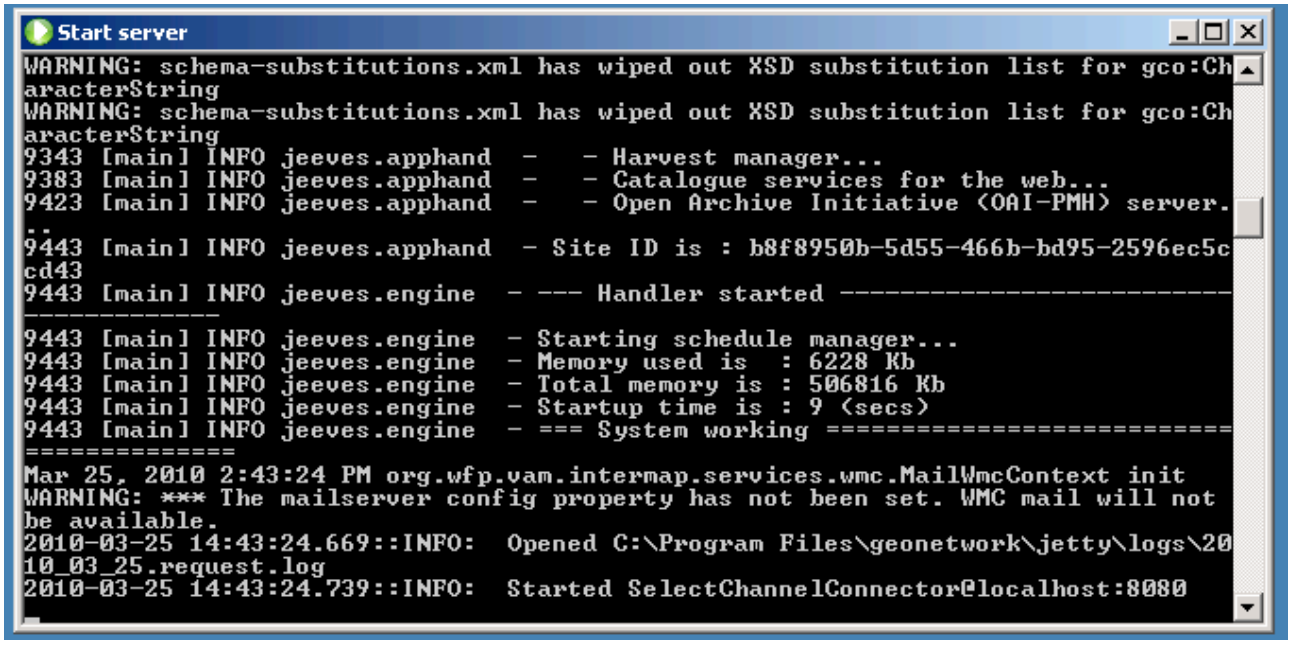


3. Go to Start > Programs > GeoNetwork opensource and click on **Start server** link.

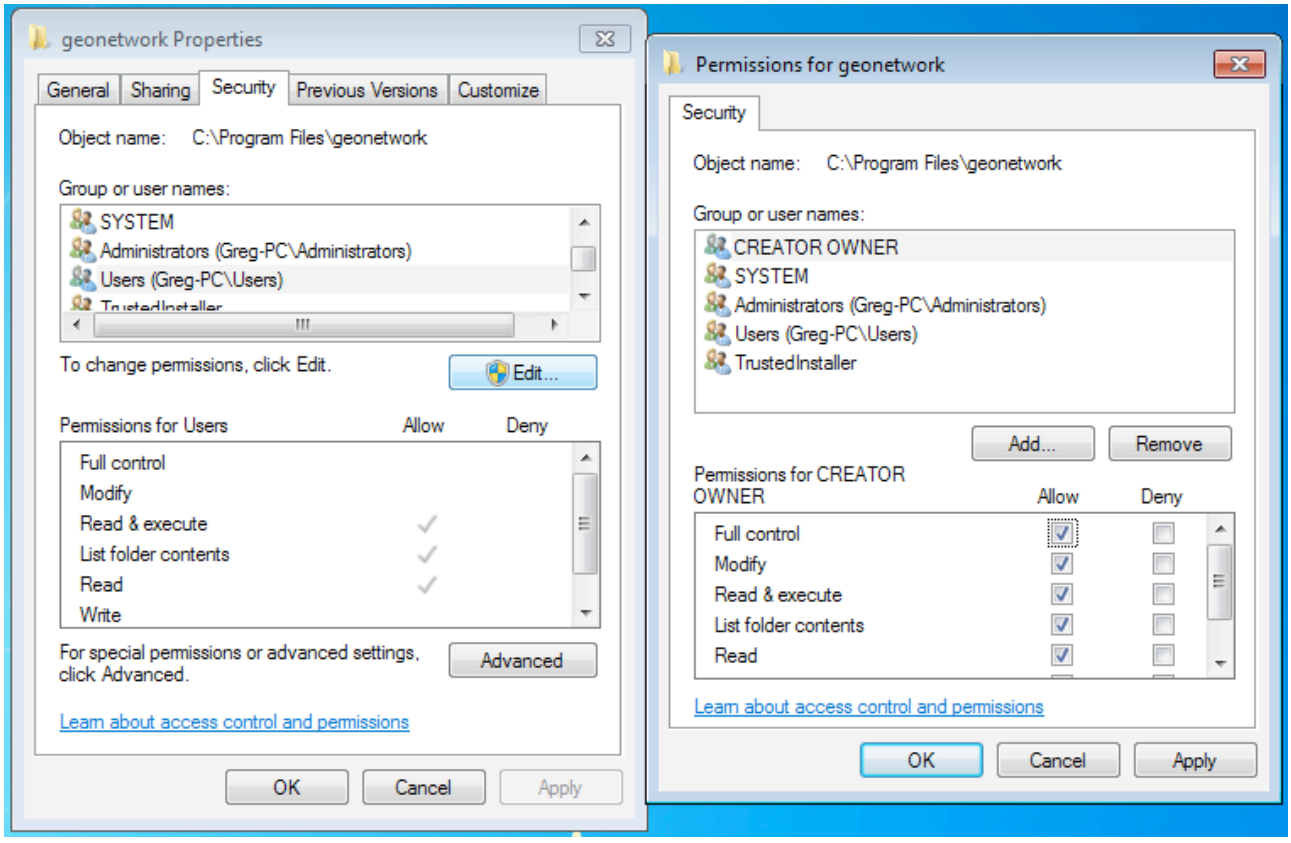


A console window will appear with some information to monitor the start up of the server that runs GeoNetwork. To stop the server, click on **Stop server**.

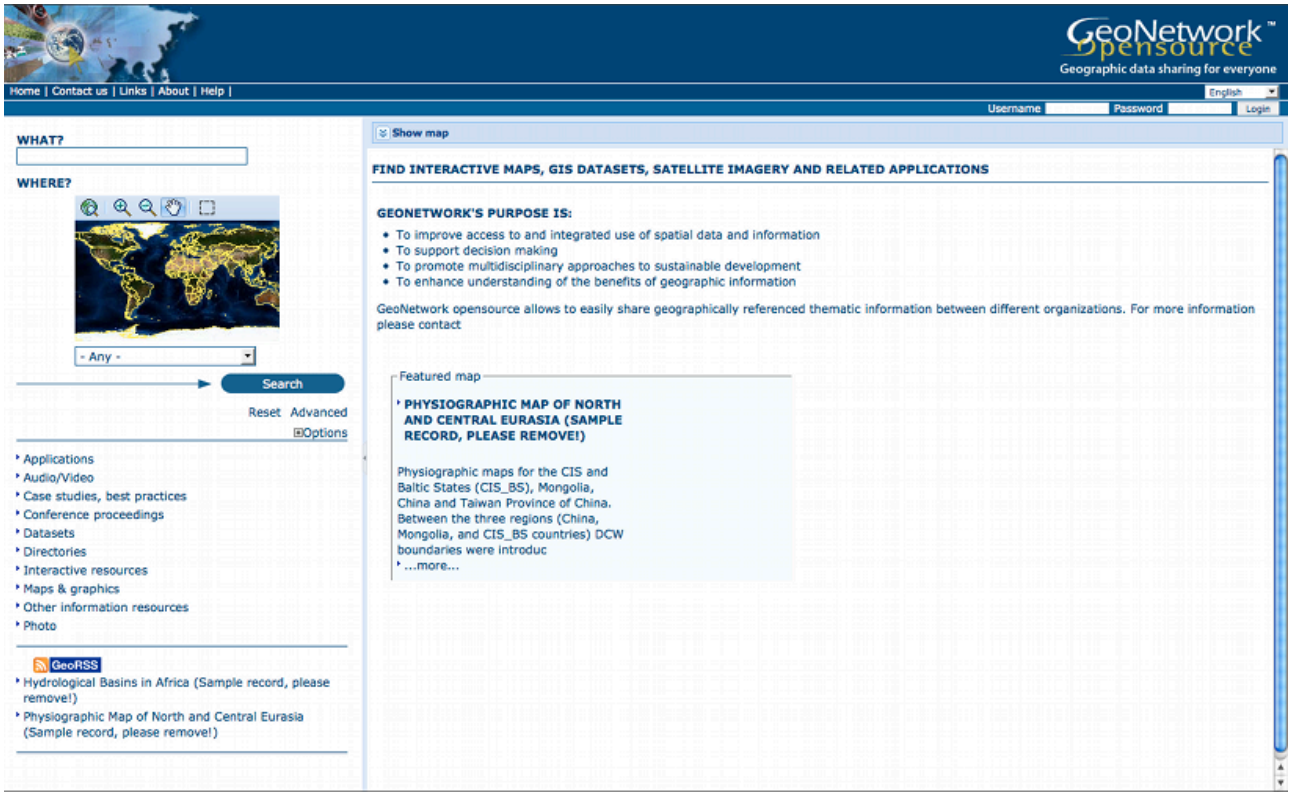
IMPORTANT: GeoServer must be stopped.



IMPORTANT: On Windows 7, for security reasons, GeoNetwork could not start. To solve this problem open the Explorer and navigate to `C:\Program Files\` and right-click on the *geonetwork* folder. Click on "Properties" item. Under the "Security" tab, select your user and click on the **Edit** button. Under *Allow* column, click **Full control** and **OK**.



4. Once the server is started, the GeoNetwork application should be available through the "Open GeoNetwork opensource" link in the Start Menu or by pointing your web browser to `http://localhost:8080/geonetwork`.



2.2.2 Getting started

2.2.2.1 Web administration interface

The Web Administration Tool is a web based used to configure all aspects of GeoNetwork, from adding metadata to tweaking service settings. The web admin tool is accessed via web browser at `http://<host>:<port>/geonetwork`.

In our case, running on a local computer the URL will be:

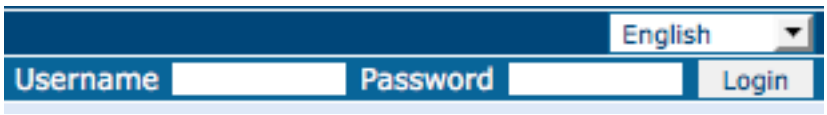
http://localhost:8080/geonetwork

2.2.2.2 Logging In

In order to change any server settings or insert metadata a user must first be authenticated. Navigate to the upper right hand corner to log into GeoNetwork

The default username and password is `admin` and `admin`.

These can be changed in the “Change password” of the Administration menu.



2.2.2.3 Administration interface

To get to the Administration interface, you must be logged on as administrator first and click on the administration page.

Metadata section allows users to manage metadata (insertion, importation, thesauri, ...).

Personal info allows you to change your password and your information.

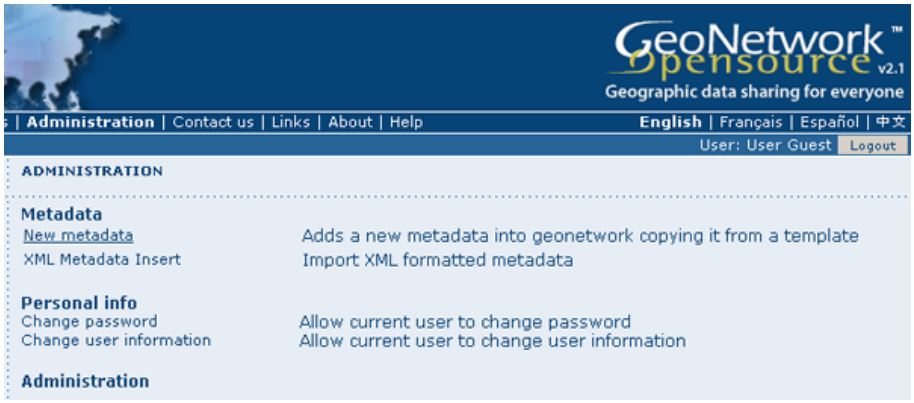
Administration gives access to users to all GeoNetwork system configuration parameters (users, groups, categories, harvesting, testing capabilities, ...).

IMPORTANT: Select **all templates** and click on **Add templates.**

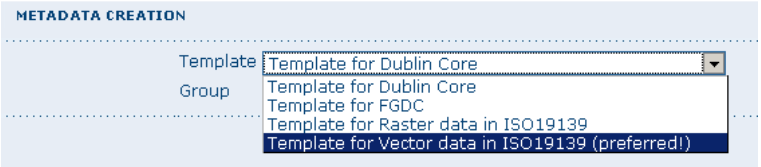
2.2.3 Adding a metadata

1. Enter your username and password and click on the login button. The system will identify you and assign the correct privileges to work with. In our case, you can use Username: `admin` / Password: `admin`

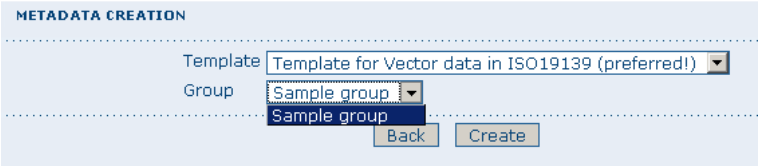
2. Open the Administration page by clicking the Administration button in the banner and then click on the **New metadata** link.



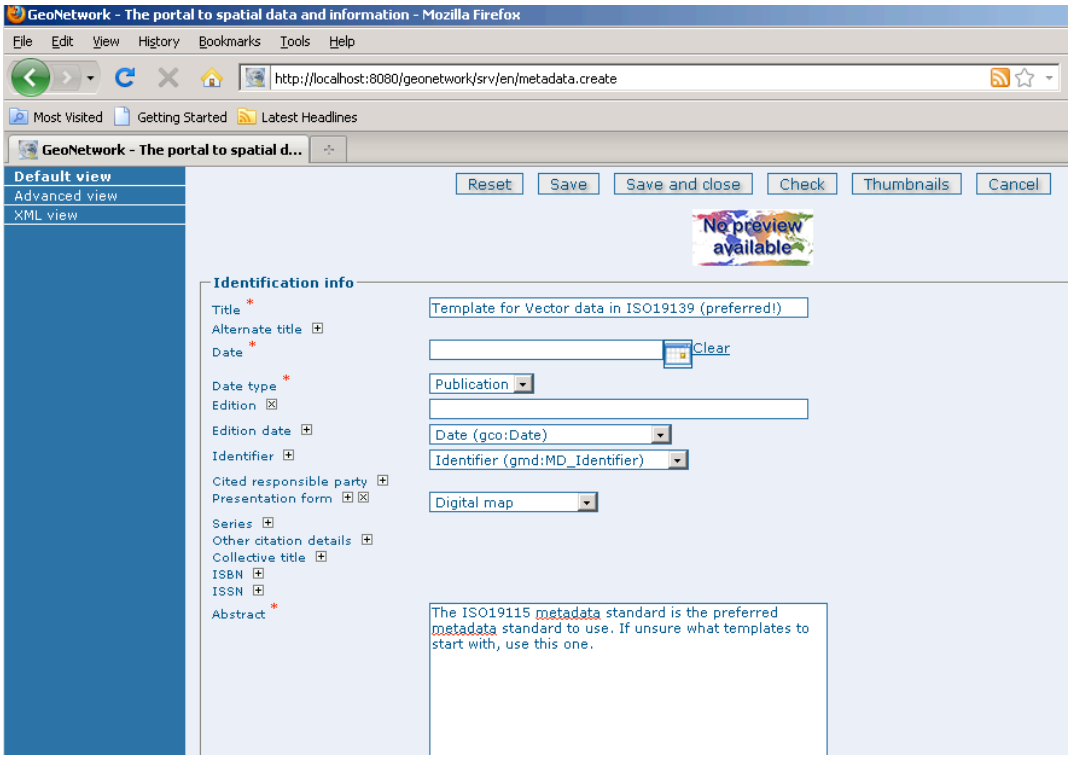
3. From the metadata creation page, select the metadata standard to use from the drop-down list.



4. After selecting the correct template, you should identify which group of users the metadata will belong to and finally click on **Create**.



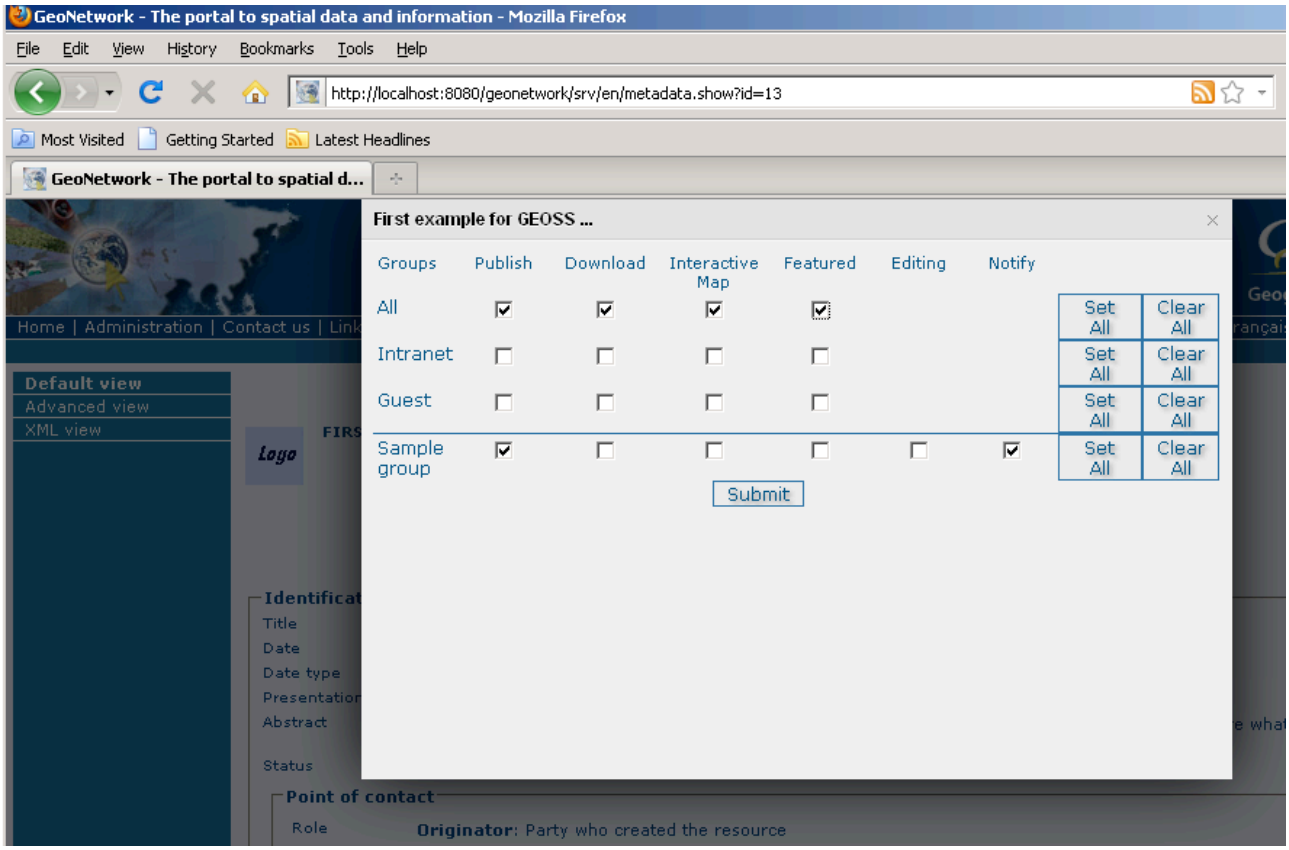
5. A new metadata form based on the selected template will be displayed for you to fill out. In the left column, you can choose if you want to use the ISO minimum, ISO core or ISO All.



6. Once you have finished to fill the form, click on **Save and close button**. Your metadata is now saved into the database and is ready to be published.

To publish your entered metadata and make it publicly available, you need to set privileges. Otherwise this metadata will be accessible only for registered users. This is an important step of entering metadata to your data. This means that you will identify which work groups have which privileges, i.e. view, download, etc. for your particular map. For instance, you can define if the information and related services is visible to all (Internet users) or just to internal users only (Intranet). Privileges are assigned on a per group basis. Depending on the user profile (Registered User, Editor, Content Reviewer, User Administrator and Administrator) access to these functions may differ on a per user basis.

7. Click on the **Privileges** button. This will open the privileges settings window. You can assign certain privileges to specific groups by selecting or deselecting them from this page. Simply click on the small box next to the privilege to place or remove a checkmark. Set All and Clear All buttons allow you to place and remove the checkmarks all at once. Once finished, click on **Submit** button. You're privileges have now been assigned.



Below is a brief description for each privilege to help you identify which ones you should assign to which group(s).

Publish: Users in the specified group/s are able to see the map, i.e. if searching with matching criteria.

Download: Users in the specified group/s are able to download the map.

Interactive Map: Users in the specified group/s are able to get an interactive map. The interactive map has to be created separately using a Web Map Server, which is part of the GeoNetwork opensource application.

Featured: When selected, the map is placed in the Features Maps of the home page and it appears there randomly.

Editing: When selected, the editors of the group(s) concerned can edit the respective metadata record. Notify: A notification email is send to the emailaddress of the group, informing that the map has been downloaded.

2.2.4 Importing a metadata

If you are working with a software like ArcGIS, you are familiar with ArcCatalog and the fact that each data is associated with a metadata record written in a XML file.

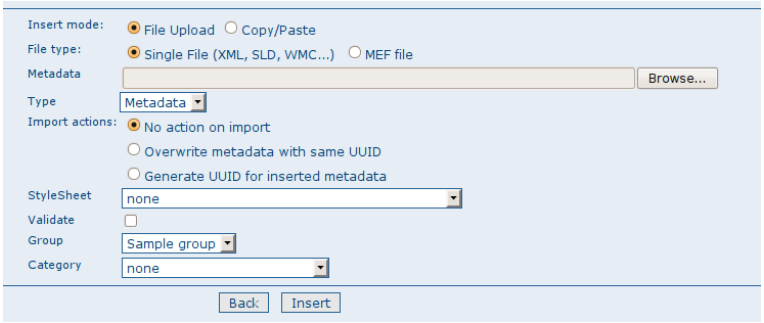
You will be probably interested to publish this metadata XML file directly into GeoNetwork.

For that, you can use import facilities of GeoNetwork.

The file import facility allows you to import metadata records in XML format or MEF format or copy/paste XML metadata to insert. In order to use this facility, you have to be logged in as an administrator. After the login step, go to the administration page and select the Metadata insert link.

Clicking the link, you will reach the metadata import file's page. You have to specify a set of parameters to make the import working. Depending on the insert type you will perform.

1. Assuming that you are still connected, open the Administration page by clicking the Administration button in the banner and then click on the **Metadata insert** link.

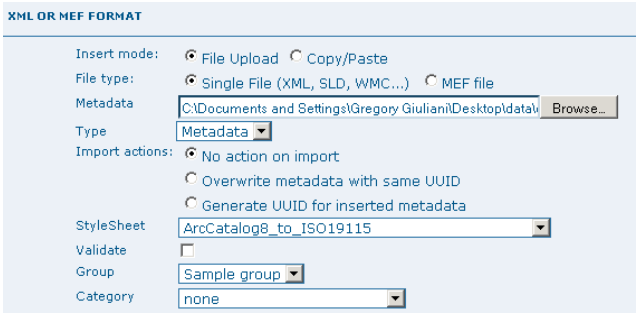


For both, XML and MEF file import, you could choose actions to be performed at import. Import actions options are: No action on import (nothing done during import process), Overwrite metadata with same UUID (this option will delete existing metadata with the same UUID, and add the new one), Generate UUID for inserted metadata (this option will force a new UUID for each metadata inserted).

Stylesheet option: This is a powerful option because allows you to specify a stylesheet for an XSL transformation. The drop down control is filled with files taken from the web/xsl/conversion/import folder: all XSL files you put there will be made available. This is a dynamic process so you don't have to restart GeoNetwork. The purpose of this option is to allow the conversion of a metadata into a suitable format that is supported by GeoNetwork. Validate option: This is a simple validation step that you can choose to perform. The metadata is validated against its schema. Group option: You have to select a group to associate to the imported metadata. Usually the group is the creator of the metadata set. Category option: You can specify one category to associate to your metadata in order to simplify the search.

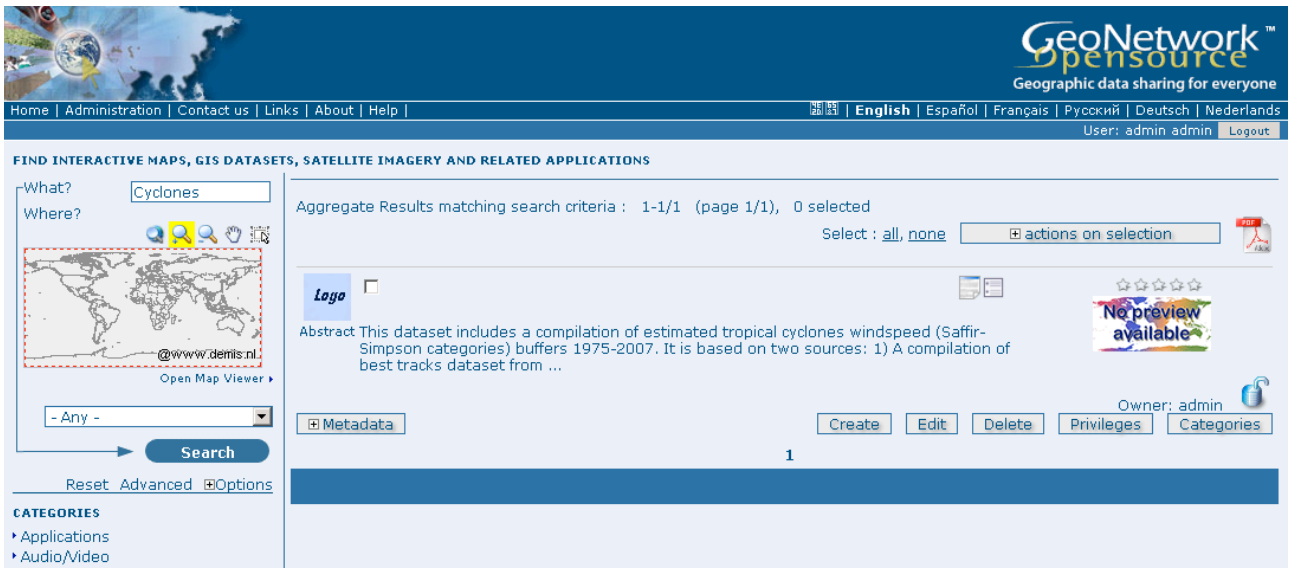
2. Insert mode: choose **File upload**.
3. File type: choose **Single File**.
4. Metadata: click on Browse button and navigate to your data folder used previously to store cy_buffers data: `C:\Program Files\GeoServer 2.0.1\data_dir\data\cy_buffers`. In this folder there is a file called `cy_buffers.xml`. This is the file with the metadata to import. Select it and click **OK**.
5. Type: choose **Metadata**.

6. Import actions: choose **No action on import**.
7. StyleSheet: select **ArcCatalog8_to_ISO19115**.



8. Click on **Insert** button.
9. In the metadata is successfully uploaded you will get a message telling you that a new metadata as been inserted.

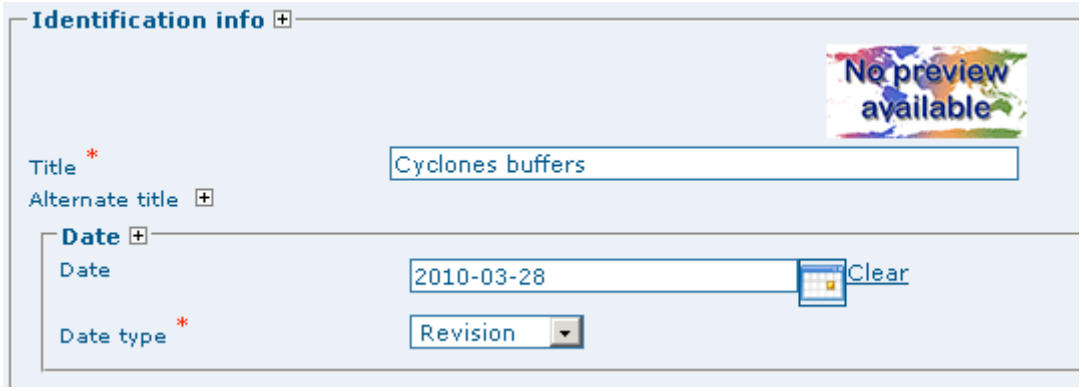
10. You can go to the homepage and type cyclones in the search box. You will get as a result the metadata you've just inserted. You will notice that the metadata misses a title.



11. To correct that issue, click on the **Edit** button.
12. Click on the **Advanced View** mode (on the left menu).

13. In edition mode, click on “+” close to the item *Citation*.

14. Enter a title, a date, and a date type.



15. Click on **Save and close** button. Your modifications are registered.

2.2.5 Searching and viewing metadata

2.2.5.1 Default search

The default search allows you to search text within the entire record, such as keywords of the metadata and/or geographic location.

Free text search. Type a search term in the What? field. You can type anything here (free text). You can use quotes around text to find exact combinations of words.

Text and operators (and, or, not) are not case sensitive.

Geographic search. For the geographic search, two options are available for selecting a particular region to limit the search:

You can select a region from a predefined list.

You can select your own area of interest in a more interactive way. A small global map is shown on the screen from which you can drag and drop the frame of your location area. Just click on the button on the upper right of the map screen.

Perform search. Both types of search, free text search and geographic search can be combined to restrict the query further.

Click the Search button to proceed and show the results.

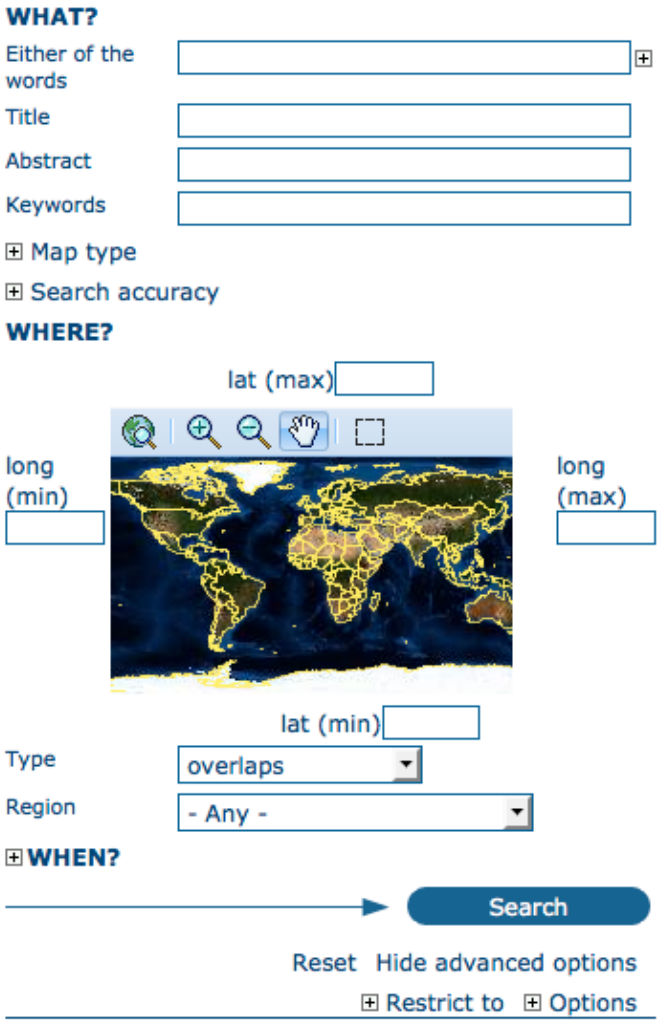
2.2.5.2 Searching by categories

An additional way to search data within the GeoNetwork database, from the home page, is searching by Category. A list of categories is provided to the user to identify data at a more generic level: Applications, Audio/Video, Case study and best practises, Conference proceedings, Datasets, Directories, Interactive resources, Maps and graphics, Other information resources, Photo.

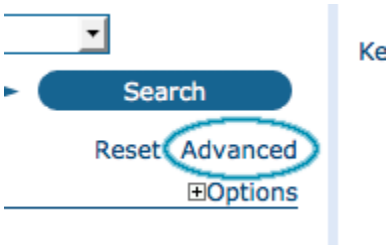
To search only for maps, click on Maps and Graphics. A list of maps will be displayed from which you may view details of every single map; just clicking on the Metadata button of the map you wish to review.

2.2.5.3 Advanced search

The advanced search option works similarly to the default search. However, you can be more specific in your search criteria as it offers different elements to look for data, each of them focusing one of the following aspects: What?, Where?, When?



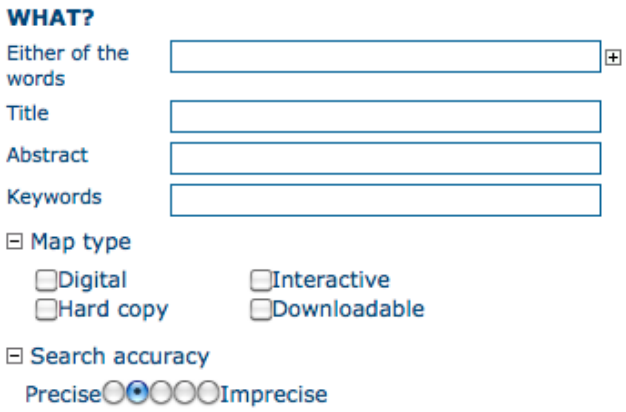
To perform an advanced search , from the home page click Advanced just below the search bottom.



In the **WHAT?** section the elements are all related to the data content. Through them, in addition to searching only free keywords in the entire metadata content, you can also search directly in the title or abstract fields and add more keywords to customise your search further. You can also specify the level of accuracy you wish to reach in performing your search.

• To search by Title, Abstract, Free Text, or Keyword(s) type any text into the respective field. You can enter information in one or multiple field(s). If you do not want to search by a given field, simply leave it blank;

• You can choose the accuracy of your search, in terms of spelling words, from Precise = 1 to Imprecise = 0.2, through 3 more consecutive steps which are equal to 0.8, 0.6, 0.4.

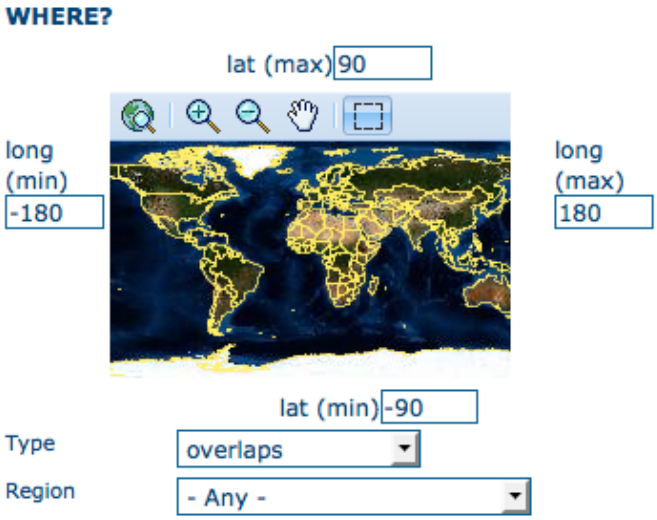


The **WHERE?** parameters, which are related to the spatial extent, allow you, as in the default search, either to select your own area of interest or to select a predefined region from the drop-down list. In this section you can also type the geographic coordinates of a specific location that is not available from the above list.

• To select your own area of interest, drag and drop the frame of your area on the global map using the appropriate tool on the bottom left of the map screen;

• To use free coordinates, type the lat-long geographic references in the appropriate fields around the map screen, without any limitation of decimal figures;

• To use the coordinates of a predefined region, select the region from the drop-down list.



Whatever type of geographic search you decide to perform, in the Spatial search type field, you can choose from different options: is, overlaps, encloses, is fully outside of. If you use this field, be cautious as this limits your output data as follows:

• If you choose Spatial search type is “Country”, only maps for the selected country will be displayed. In other words, a city map within that country will not show in the output results.

• If you choose Spatial search type overlaps “Country”, all maps with the bounding box overlapping that country will be displayed in the results, i.e. the neighbouring countries, the continent of which that country is part of and the global maps.

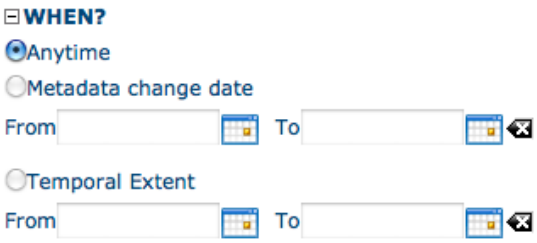
• If you choose Spatial search type encloses “Country” you will get, in the output results, maps of that country first and then all maps within its bounding box.

Similarly,if you choose Spatial search type is fully outside of a selected region, only maps that follow that exact criteria will show in the output results.

The **WHEN?** section gives you the possibility to restrict your search in terms of temporal extent, indicating a specific range of time referred to the data creation or publication date.

• To specify a range of time, click on the date select or button next to From–To fields. Make use of the symbols > and >> on top of the calendar to select the month and the year first and then click on the exact day; a complete date will be filled in using the following standard order: YY-MM-DD.

• To clean the time fields, simply click on the white cross on their right; the box Any will be automatically selected and the search will be performed without any restriction on the time period.



Finally, the advanced search allows you to apply further restrictions on the basis of additional parameters as data source, data categories and data format.

• To limit your queries to only one Catalogue out of those made available by the installation through the harvesting process, highlight the catalogue of preference or just keep Any

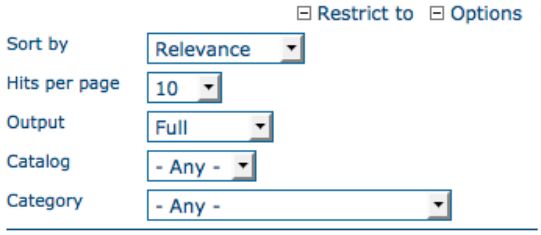
selected to search all sites. (See more info about data harvesting in Section 4 Chapter 1 of these guidelines).

• To search for data organized by Category, such as Applications, Datasets,etc., simply highlight the category you wish to search in from the related drop-down list, otherwise we suggest to leave this field in Any Category.

• You can search for Digital or HardCopy maps. To search in one or the other, simply check the box next to the one you wish to search. If no box is checked, all content will be searched.

At last, you can customize the number of output results per page in the Hits Per Page field. Simply highlight the number of records to be displayed or leave the field set on the default number (10).

• Click the Search button.

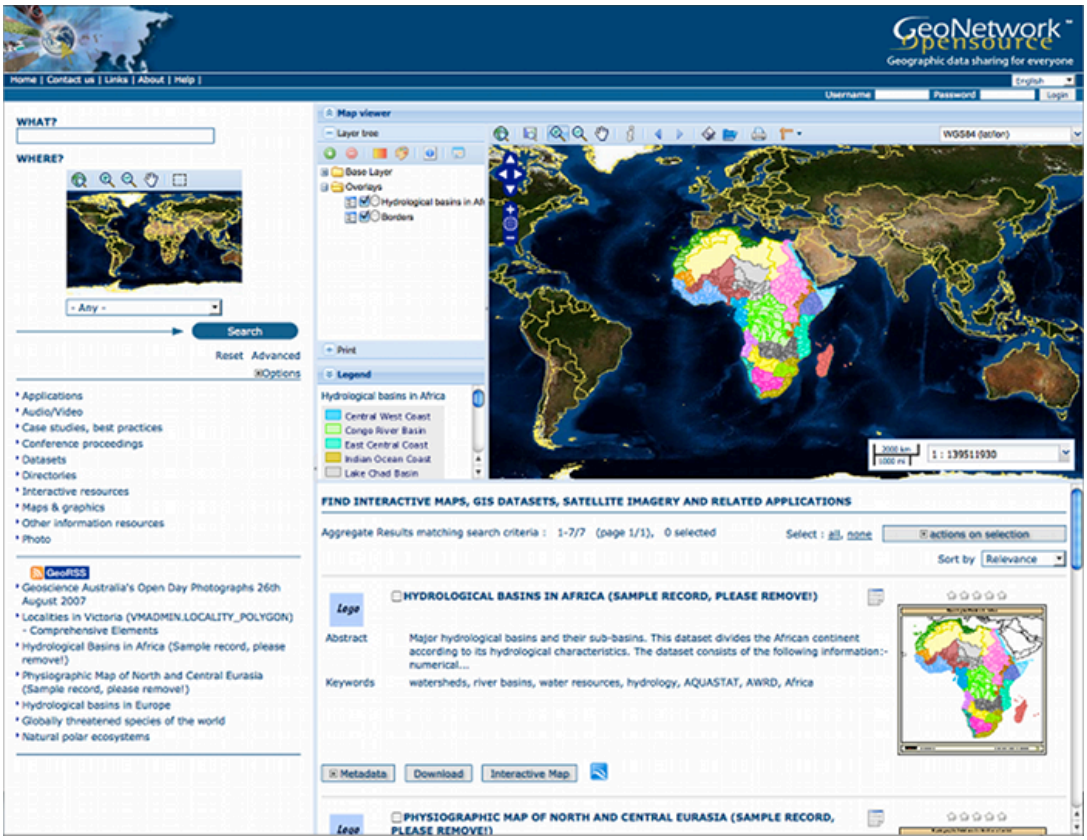


2.2.5.4 Viewing metadata

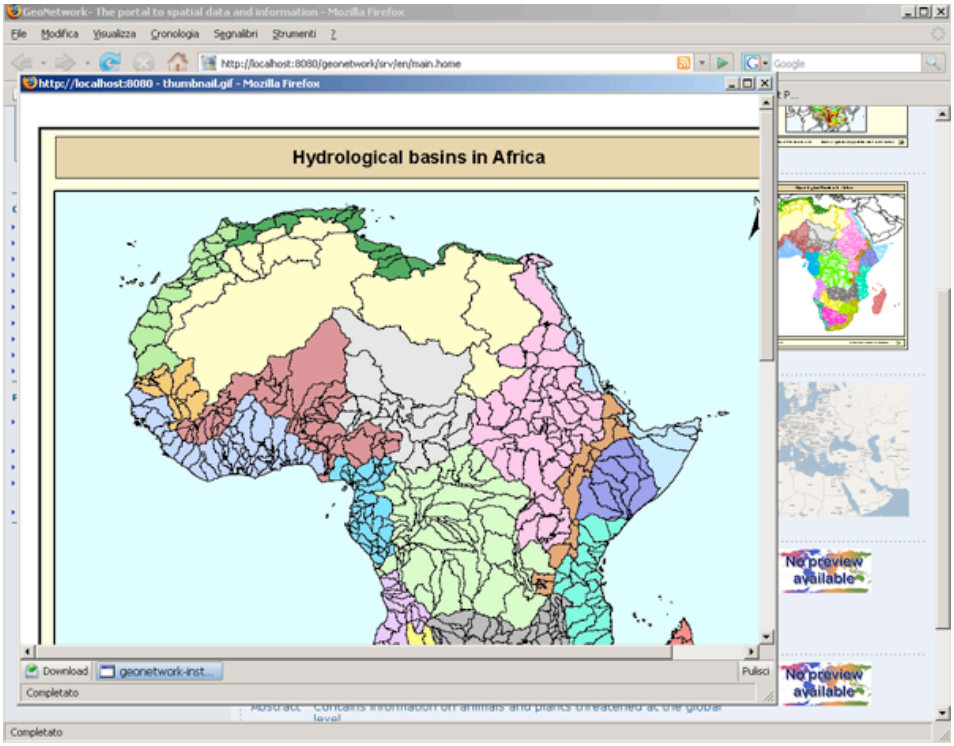
The output of a search provides you a list of the metadata records that should fit your request. For each record, the result page shows the title, an abstract and the keywords. According to the privileges that have been set for each metadata, a maximum of four sections can be consulted, as shown below.

1. *Metadata:* The metadata section describes the dataset (e.g.: citation, data owner, temporal/spatial/ methodological information) and could contain links to other web sites that could provide further information about the dataset.
2. *Download:* Depending on the privileges that have been set for each record, when this button is present, the dataset is available and downloadable. The process for retrieving data is simple and quick by just clicking the download button or by using the proper link in the specific metadata section for distribution info in the full metadata view.

3. *Interactive Map:* The map service is also optional. When this button is shown, an interactive map for this layer is available and, by default, it will be displayed on the map screen of the simple search. To better visualise the map through the map viewer, click on Open Map Viewer on the bottom left of the map screen.



4. *Graphic Overviews:* There are small and large overviews of the map used to properly evaluate usefulness of the data, especially if the interactive map is not available. Simply click on the small image to enlarge it.



2.3 OpenLayers

Website: http://www.openlayers.org

OpenLayers is an open source (provided under a modified BSD license) JavaScript library for displaying map data in web browsers. It provides an API for building rich web-based geographic applications similar to Google Maps and Bing Maps.

(Source: Wikipedia)

2.3.1 Download OpenLayers

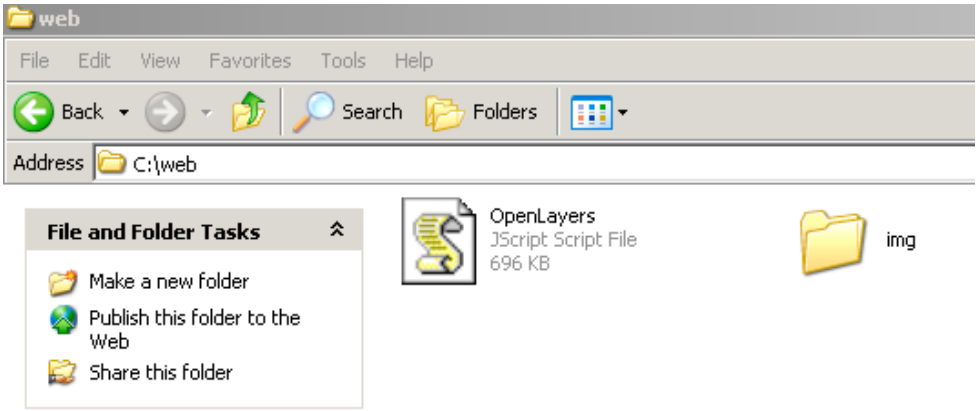
On the OpenLayers homepage there is a link to download the latest stable release:

http://www.openlayers.org

2.3.2 Install OpenLayers

Create a directory called "web" under disk C. You can now access it under `C:\web`

Unzip the downloaded file and copy the **OpenLayers.js** and the **"img" directory** in the root of your folder.



2.3.3 Build a simple dynamic map web page

IMPORTANT: GeoServer must be running.

2.3.3.1 Creating your first map

The OpenLayers API has two concepts which are important to understand in order to build your first map: 'Map', and 'Layer'. An OpenLayers Map stores information about the default projection, extents, units, and so on of the map. Inside the map, data is displayed via 'Layer's. A Layer is a data source – information about how OpenLayers should request data and display it.

2.3.3.2 Crafting HTML

Building an OpenLayers viewer requires crafting HTML in which your viewer will be seen. OpenLayers supports putting a map inside of any block level element – this means that it can be used to put a map in almost any HTML element on your page.

In addition to a single block level element, it is also required to include a script tag which includes the OpenLayers library to the page.

Open a **text editor** (e.g. Notepad) and copy the block of code below. Once finished, save the document with the **.html** extension.

```
<html>
<head>
  <title>OpenLayers Example</title>
    <script src="OpenLayers.js"></script>
    </head>
    <body>
      <div style="width:100%; height:100%" id="map"></div>
    </body>
</html>
```

2.3.3.3 Creating the map viewer

In order to create the viewer, you must first create a map. The OpenLayers.Map constructor requires one argument: This argument must either be an HTML Element, or the ID of an HTML element. This is the element in which the map will be placed.

```
var map = new OpenLayers.Map('map');
```

The next step to creating a viewer is to add a layer to the Map. OpenLayers supports many different data sources, from WMS to Yahoo! Maps to WorldWind. In this example, the WMS layer is used. The WMS layer is an example provided by MetaCarta.

```
var wms = new OpenLayers.Layer.WMS(
  "OpenLayers WMS",
  "http://labs.metacarta.com/wms/vmap0",
  {'layers':'basic'} );
map.addLayer(wms);
```

The first parameter in this constructor is the URL of the WMS server. The second argument is an object containing the parameters to be appended to the WMS request.

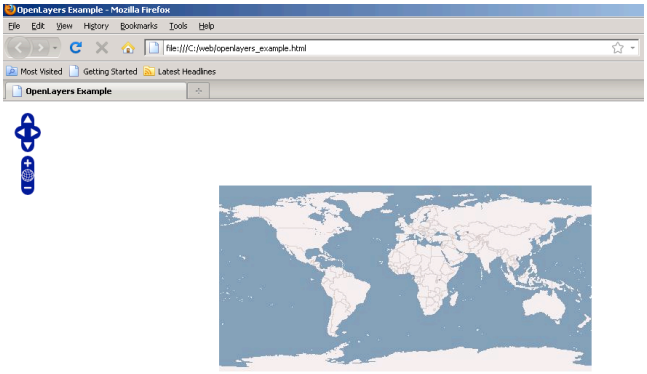
Finally, in order to display the map, you must set a center and zoom level. In order to zoom to fit the map into the window, you can use the zoomToMaxExtent function, which will zoom as close as possible while still fitting the full extents within the window.

2.3.3.4 Putting it all together

The following code block puts all the pieces together to create an OpenLayers viewer.

```
<html>
<head>
  <title>OpenLayers Example</title>
    <script src="OpenLayers.js"></script>
    </head>
    <body>
      <div style="width:100%; height:100%" id="map"></div>
      <script defer="defer" type="text/javascript">
        var map = new OpenLayers.Map('map');
        var wms = new OpenLayers.Layer.WMS( "OpenLayers WMS",
            "http://labs.metacarta.com/wms/vmap0", {layers: 'basic'} );
        map.addLayer(wms);
        map.zoomToMaxExtent();
      </script>

</body>
</html>
```



2.3.3.5 Adding an overlay WMS

WMS layers have the capability to be overlaid on top of other WMS layers in the same projection. There are several ways to mark a layer as an overlay, rather than a base layer. With WMS, the best way to do this is by setting the 'transparent' parameter to 'true'. The example here uses a political borders WMS to demonstrate overlaying a transparent WMS.

```
var twms = new OpenLayers.Layer.WMS( "Cyclones buffers",
            "http://localhost:8080/geoserver/wms?",
            {layers: 'cy_buffers:cy_buffers', transparent: 'true'});
map.addLayer(twms);
```

Using the transparent: 'true' parameter sets two flags automatically:

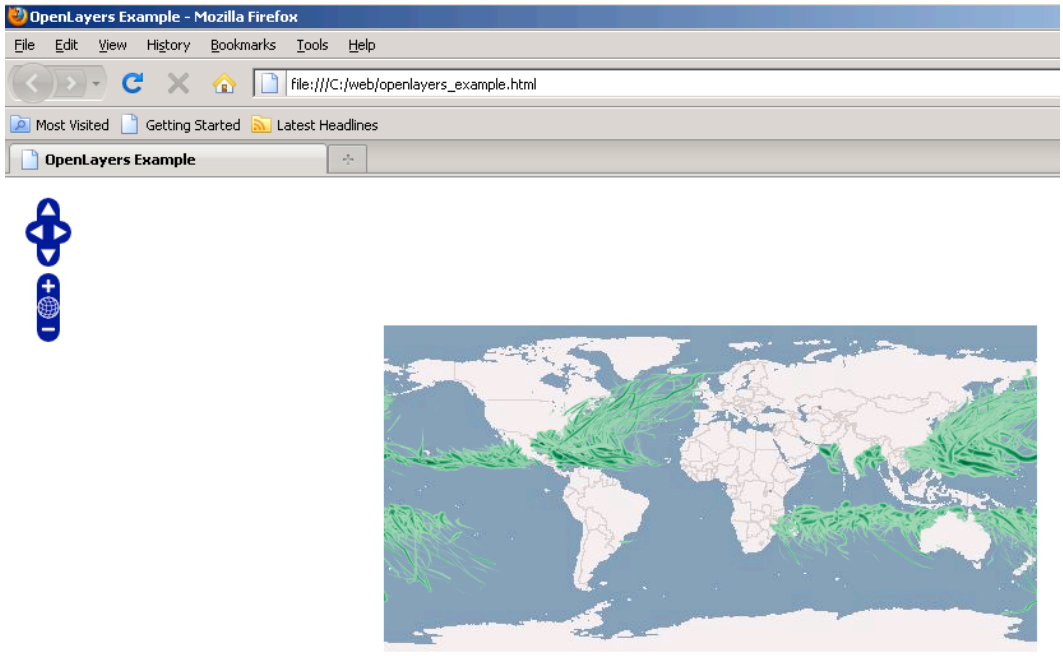
- format parameter. The format option of the WMS layer is set to image/png if the browser supports transparent PNG images. (This is all browsers except for Internet Explorer 6.) In Internet Explorer 6, this will instead be set to image/gif.
- isBaseLayer option. The isBaseLayer option controls whether the layer can be displayed at the same time as other layers. This option defaults to false for the WMS layer, but setting transparent to true changes it to true by default.

Putting this code together with our earlier example, we get the following:

```
<html>
<head>
  <title>OpenLayers Example</title>
    <script src="http://openlayers.org/api/OpenLayers.js"></script>
    </head>
    <body>
      <div style="width:100%; height:100%" id="map"></div>
      <script defer="defer" type="text/javascript">
        var map = new OpenLayers.Map('map');
        var wms = new OpenLayers.Layer.WMS( "OpenLayers WMS",
            "http://labs.metacarta.com/wms/vmap0", {layers: 'basic'} );
        var twms = new OpenLayers.Layer.WMS( "Cyclones buffers",
            "http://localhost:8080/geoserver/wms?",
            {layers: 'cy_buffers:cy_buffers', transparent: 'true'});
        map.addLayers([wms, twms]);
        map.zoomToMaxExtent();
      </script>

</body>
</html>
```

One thing to note here is that we have used addLayers on the map object to add both layers at the same time. This allows us to save a line of code in this case, and may be useful in other cases when you need to add multiple layers to the map at the same time.



2.4 uDig

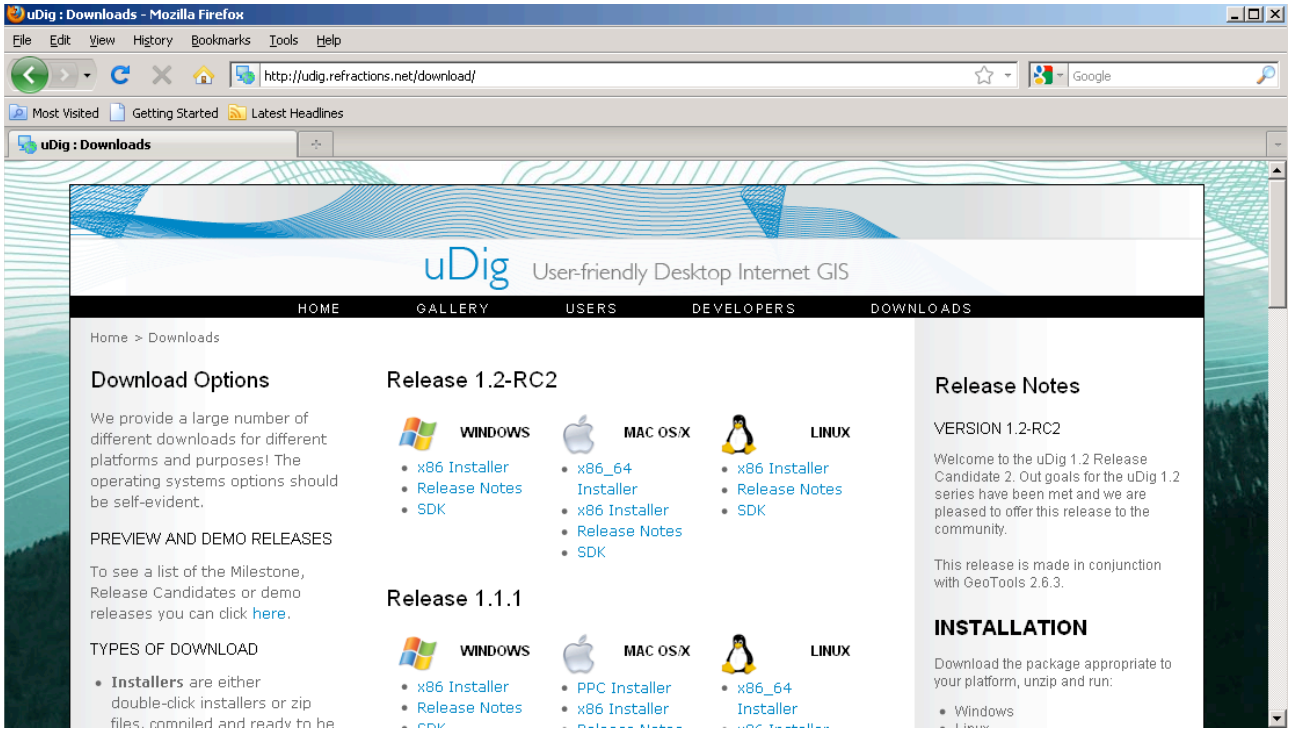
Website: http://udig.refractions.net

uDig is an open source desktop GIS application framework that can be used as a stand-alone application or can be extended with plug-ins.

(Source: uDig website)

2.4.1 Download uDig

Go to `http://udig.refractions.net/download` and get the last stable release for you preferred platform.

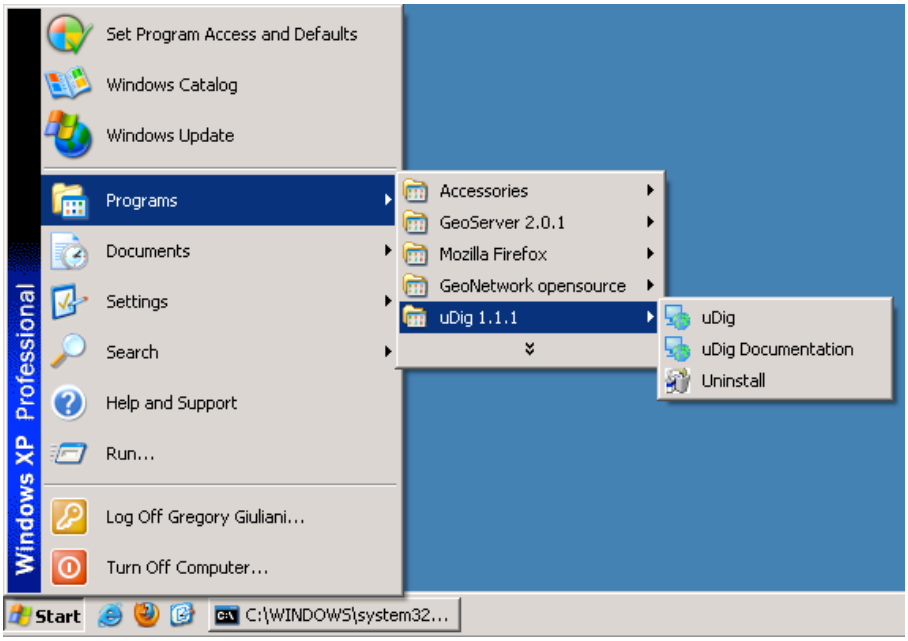


2.4.2 Installing uDig

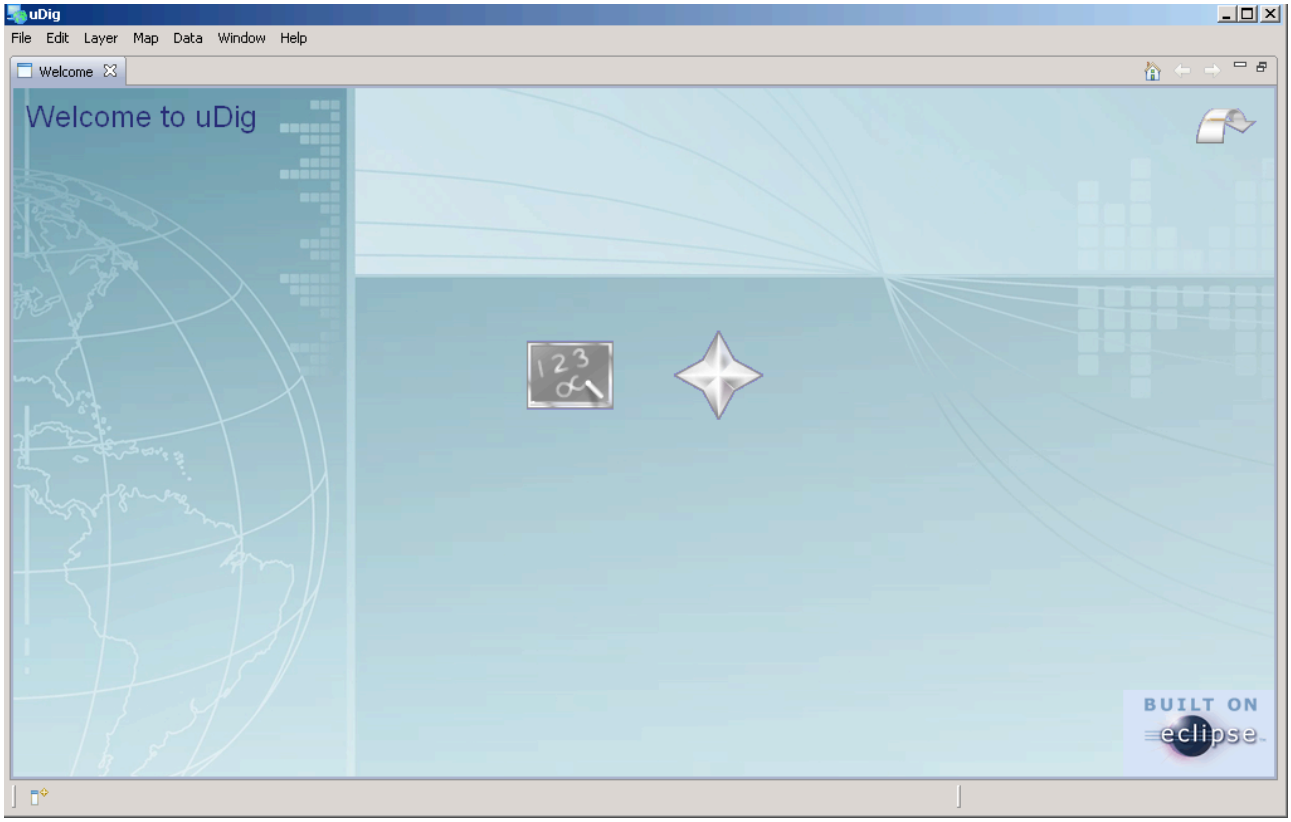
1. Double-click the uDig installer
2. The installer will allow you to install uDig into the directory of your choice.
3. Read and accept license agreements.
4. By default uDig will be installed into your Program Files directory.
5. Shortcuts will be created in your start menu.
6. Wait while uDig is installed.
7. Congratulations you have installed uDig!

2.4.3 Getting started

1. After completing the installation, run the uDig application from the Windows *Start > Programs menu*.

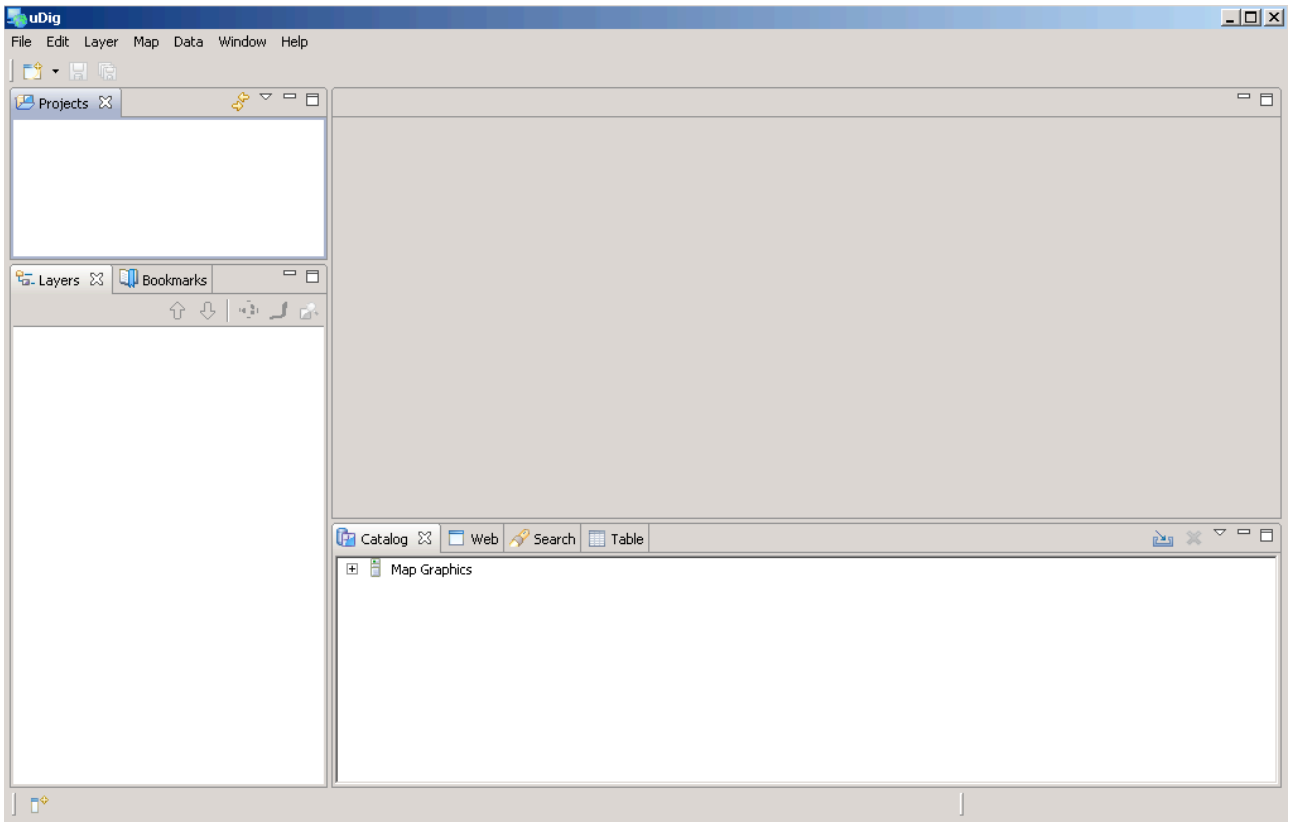


2. Initially you are presented with the welcome screen.
3. The welcome screen contains a link to the Getting Started tutorial from the online documentation and a link to the Official Website.



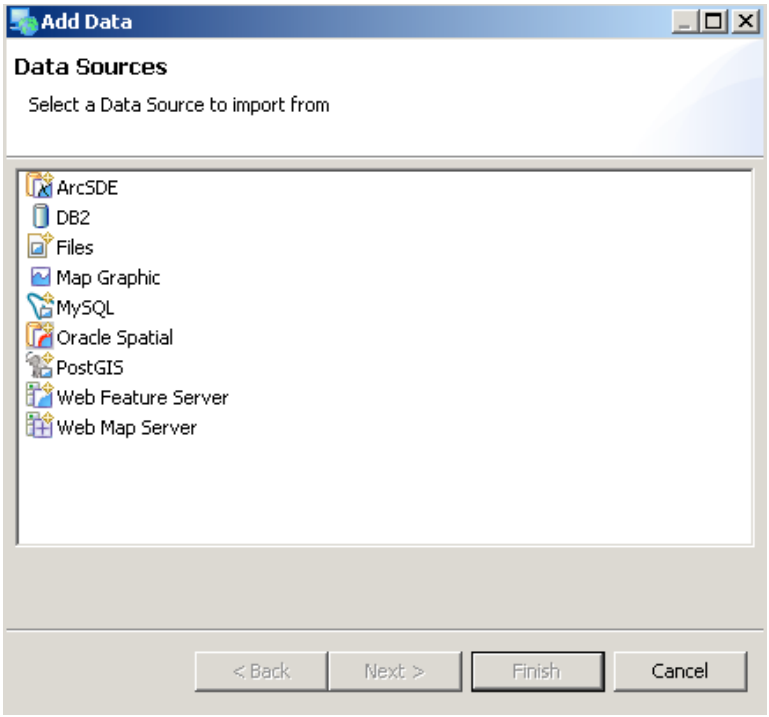
4. To continue click on the Workbench arrow in the top right corner of the uDig welcome screen.

5. You are now ready to start to work with uDig.

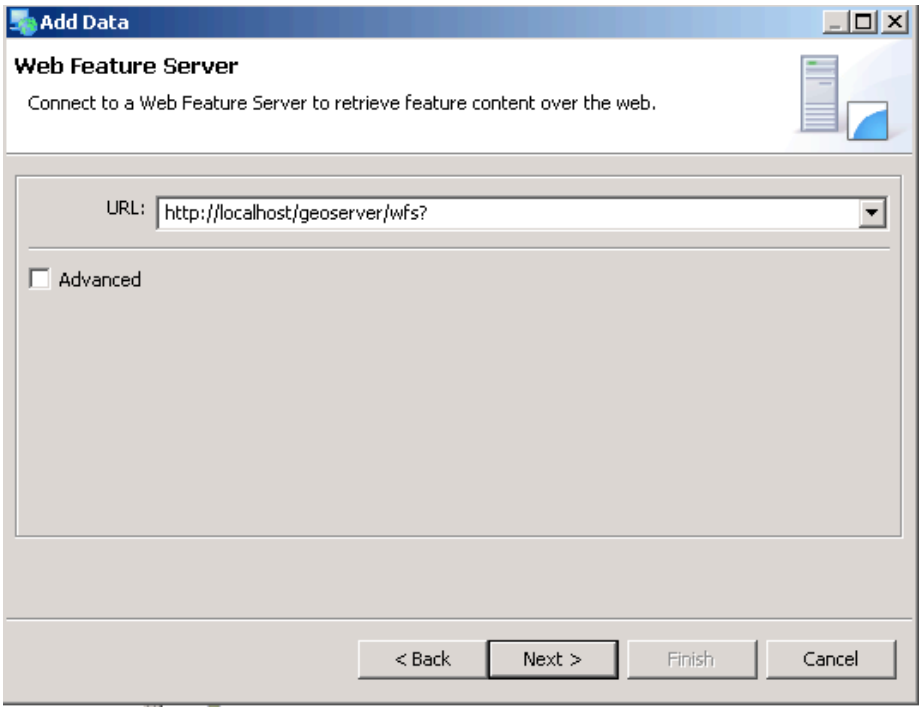


2.4.4 Accessing and editing WFS data into uDig

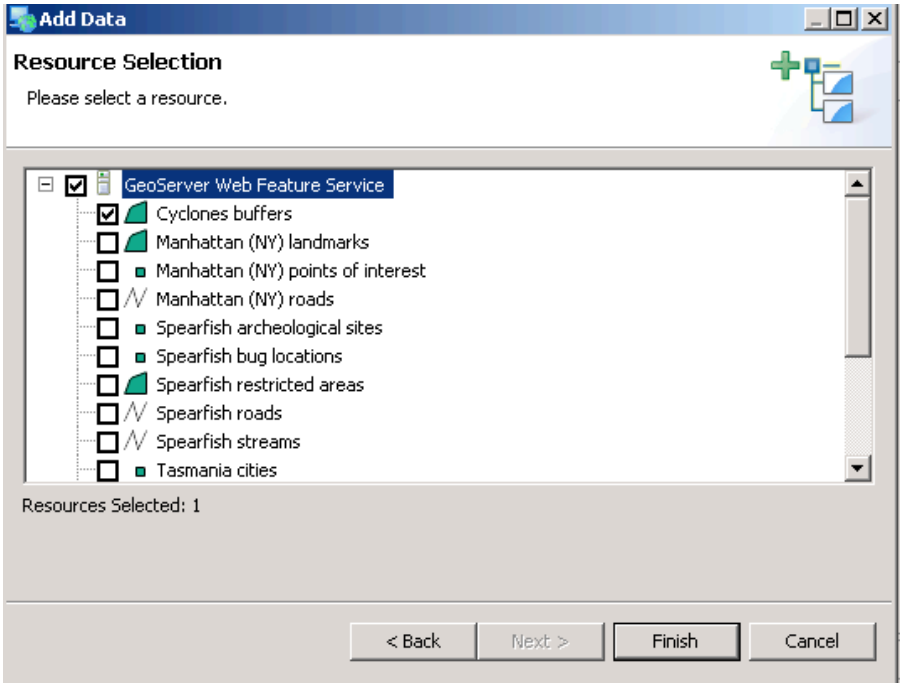
1. Start uDig, under the File menu select *New > New Map* to create a new map.
2. Make sure your local GeoServer is started and ready to go.
3. Select *Layer > Add*
4. This will bring up a Wizard allowing you to choose which Data source you want to use.. Select **Web Feature Server**.



5. This open a window where you have to insert the URL of a web feature server you want to access. In our case type: `http://localhost:8080/geoserver/wfs?` and click **Next**.



6. You have now access to all WFS layers available on our GeoServer. Select `Manhattan (NY) landmarks` and the press the **Finish** button. The layer will be drawn on your map.



7. Select *Navigation > Show All* from the menu bar.
8. Zoom to a specific buffer
9. Select `Manhattan (NY) landmarks` in the Layers view.
10. Choose to the Edit Geometry tool from the tool bar

11. Use the Edit Geometry tool to select a buffer. The buffer will change color and develop "vertex handles".
12. Move the vertex handles as you want.
13. Once finished, press the **Commit Changes** button in the tool bar to send your changes off to the Web Feature Server.

14. Your changes have been registered.

PART 3: Registering services into GEOSS[2]

[2] All the material is issued from the GEO website.

3. Registering services into GEOSS

Website: http://www.earthobservations.org

The GEOSS is being established by the intergovernmental Group on Earth Observations (GEO) and is a worldwide effort to build a system of systems on the basis of a 10-Year Implementation Plan for the period 2005 to 2015 (GEO, 2005). GEO is voluntary partnership of governments and international organizations where membership and participation is contingent upon formal endorsement of the Implementation Plan mentioned above.

GEOSS is an effort to connect already existing SDIs and Earth Observations infrastructures and thus will not create and/or store data but rather works with and build upon existing systems. GEOSS, through its developing GEOportal, is foreseen to act as a gateway between the producers of environmental data and the end users, with the aim of enhancing the relevance of Earth observations for the global issues and to offer a public access to comprehensive, near-real time data, information and analyses on the environment (GEO, 2007).

GEOSS aims to provide a broad range of so-called Societal Benefits Areas (GEO, 2005):

- Reducing loss of life and property from natural and human-induced disasters,
- Understanding environmental factors affecting human health and well-being,
- Improving the management of energy resources,
- Understanding, assessing, predicting, mitigating, and adapting to climate variability and change,
- Improving water resource management through better understanding of the water cycle,
- Improving weather information, forecasting and warning,
- Improving the management and protection of terrestrial, coastal and marine ecosystems,
- Supporting sustainable agriculture and combating desertification, and
- Understanding, monitoring and conserving biodiversity.

The mechanisms for data and information sharing and dissemination are presented and described in the 10-Year Implementation Plan Reference Document (GEO, 2005) where information providers must accept and implement “a set of interoperability arrangements, including technical specifications for collecting, processing, storing , and dissemination shared data, metadata and products. GEOSS interoperability will be based on non-proprietary standards, with preference to formal international standards. Interoperability will be focused on interfaces, defining only how system components interface with each other and thereby minimizing any impact on affected systems”. GEOSS is based on existing technologies using internet-based services.

Moreover members must fully endorse the following data sharing principles:

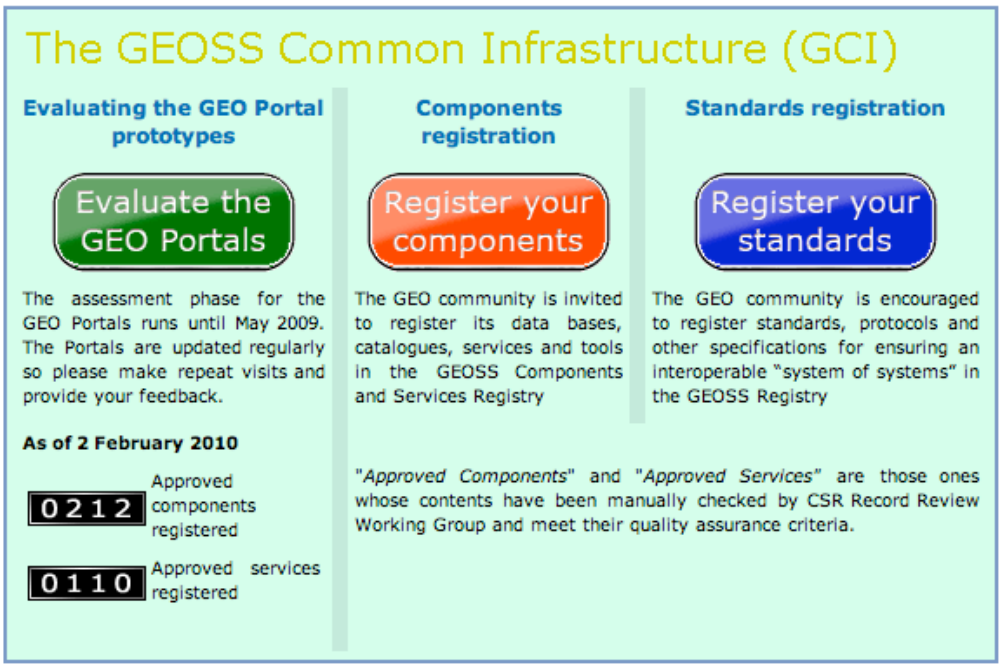
1. There will be full and open exchange of data, metadata, and products shared within GEOSS, recognizing relevant international instruments and national policies and legislation.

2. All shared data, metadata, and products will be made available with minimum time delay and at minimum cost.

3. All shared data, metadata, and products being free of charge or no more than cost of reproduction will be encouraged for research and education.

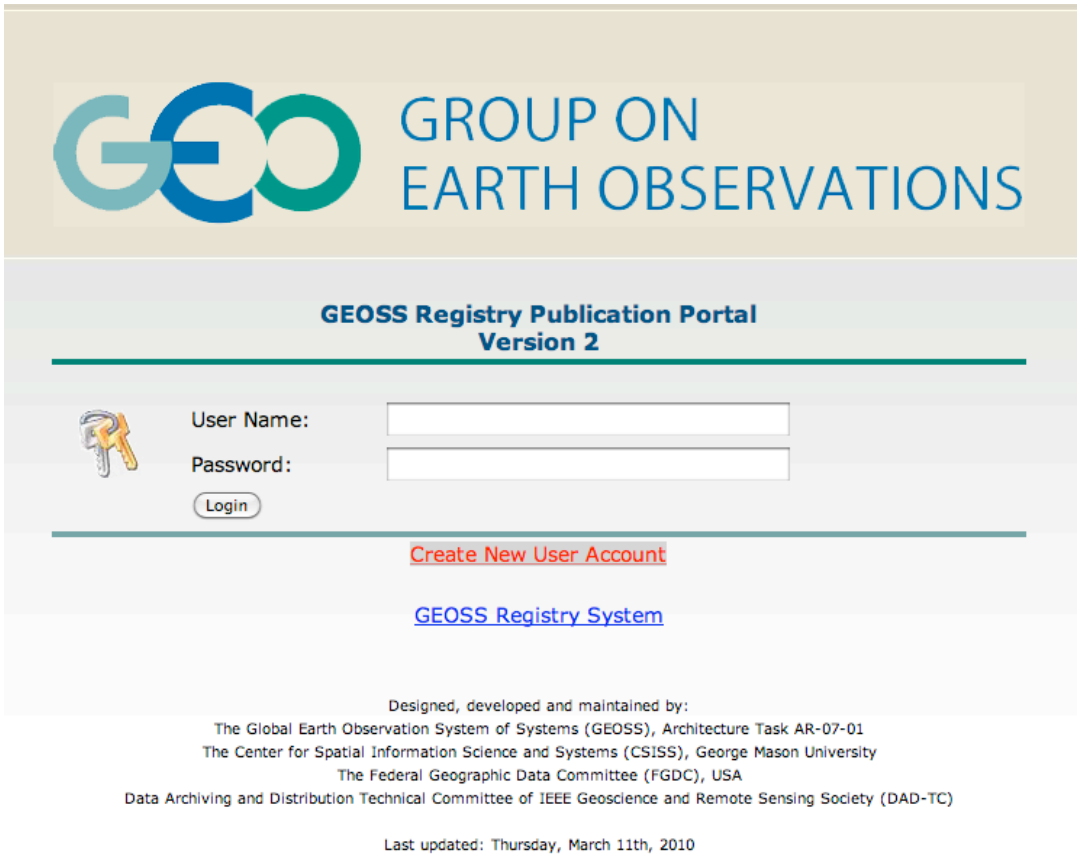
These principles push data owners to go “open” and to share their data using standards and thus becoming interoperable.

3.1 Creating a new user account



Go to http://www.earthobservations.org/gci_cr.shtml

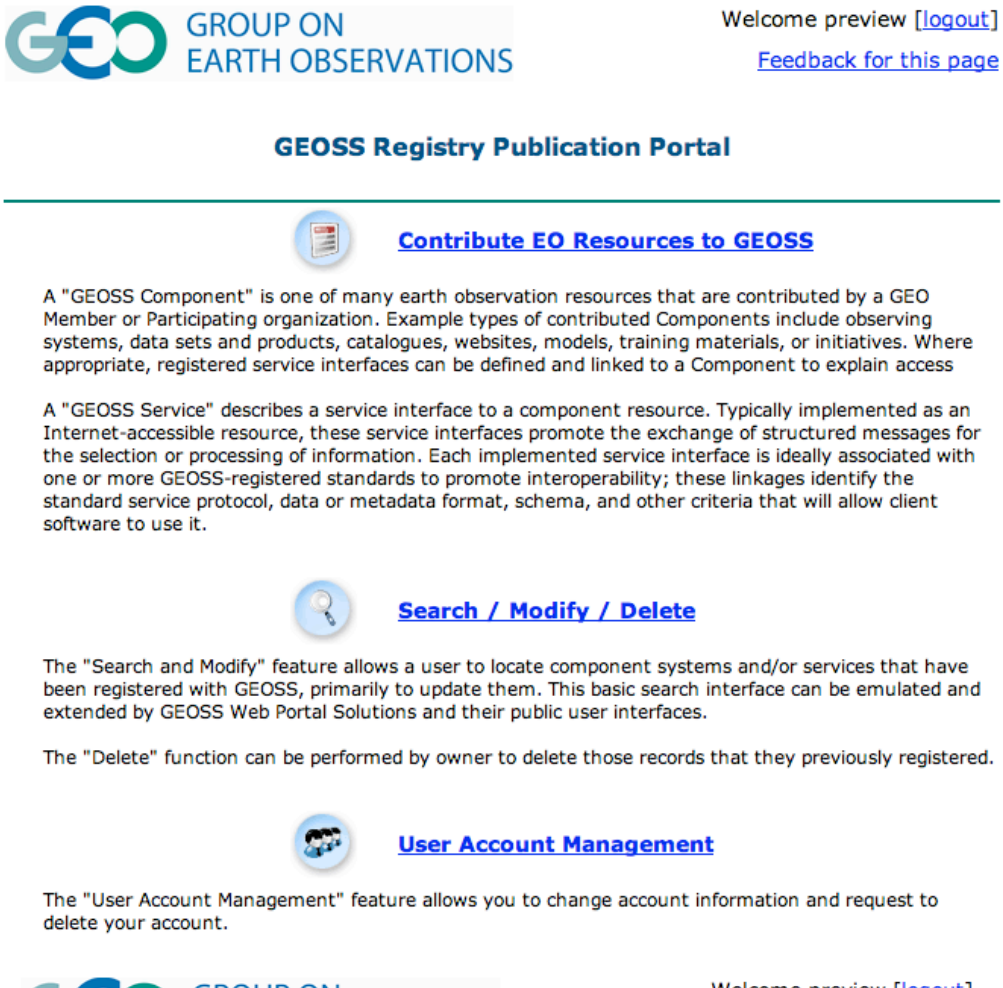
The GEO community is invited to register its data bases, catalogues, services and tools in the GEOSS Components and Services Registry.



http://geossregistries.info/geosspub/

Create a new user account

After that LOGIN to register your component and related services.



3.2 Registering a component

A "GEOSS Component" is one of many earth observation resources that are contributed by a GEO Member or Participating organization. Example types of contributed Components include observing systems, data sets and products, catalogues, websites, models, training materials, or initiatives. Where appropriate, registered service interfaces can be defined and linked to a Component to explain access

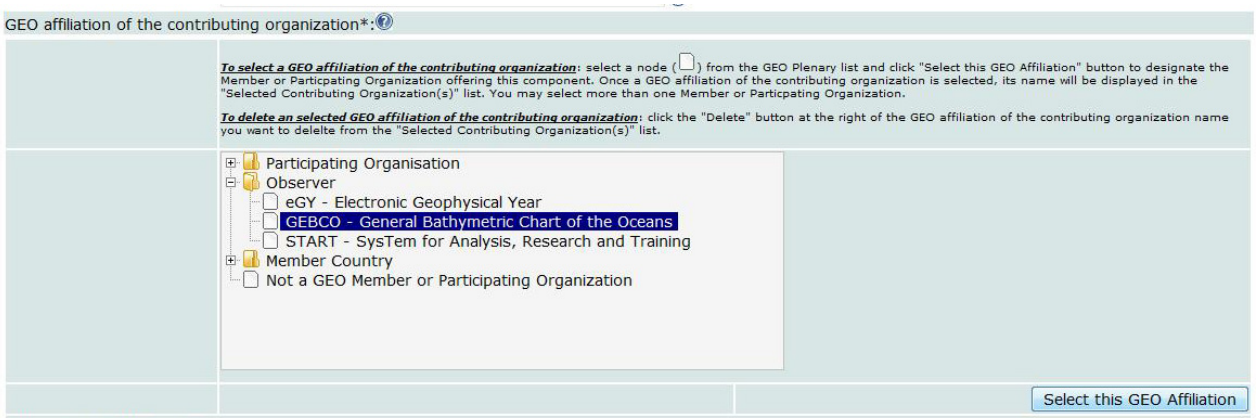
1. Log into GEOSS Component and Service Registry System with username and password. Click "Contribute EO Resources to GEOSS" from the main page after login. In the next page, click "Register your EO Resource (Component)" to proceed to Resource (Component) registration page.

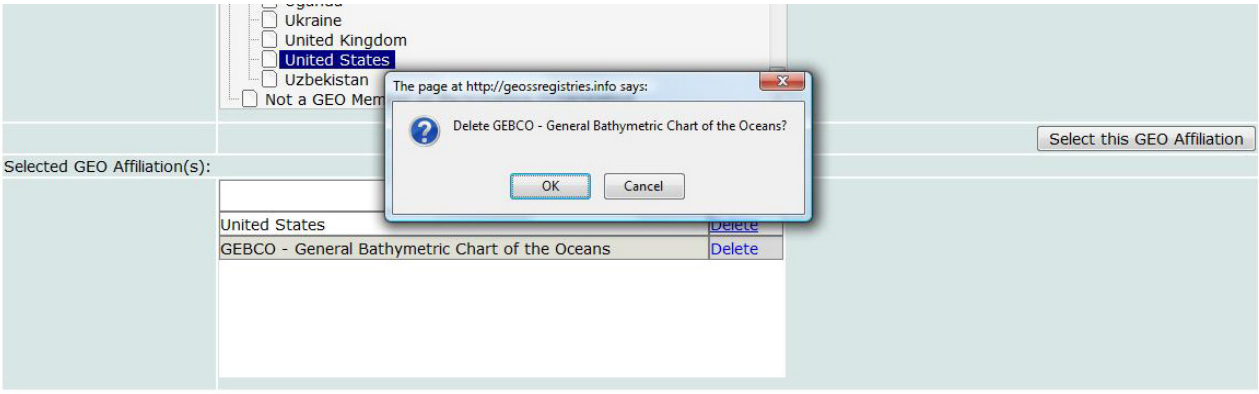
If you have saved a Resource (Component) registration draft, you may continue with the saved registration process by click the draft Resource (Component) Name, or click "Start a new Component Registration" to register a new Resource (Component).

2. In the registration page, specify Resource (Component) name, description, GEO affiliation, URL to Resource, contact name, email respectively.

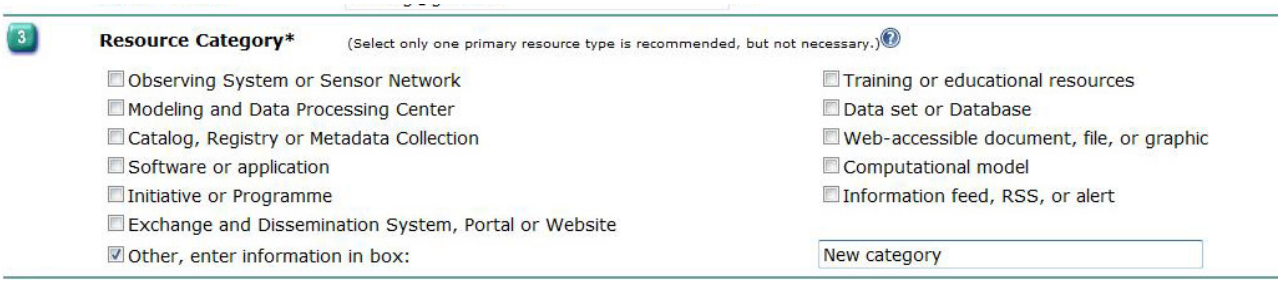
To select a GEO affiliation of the contributing organization: select a node () from the GEO Plenary list and click "Select this GEO Affiliation" button to designate the Member or Participating Organization offering this component. Once a GEO affiliation of the contributing organization is selected, its name will be displayed in the "Selected Contributing Organization(s)" list. You may select more than one Member or Participating Organization.

To delete an selected GEO affiliation of the contributing organization: click the "Delete" button at the right of the GEO affiliation of the contributing organization name you want to delete from the "Selected Contributing Organization(s)" list.





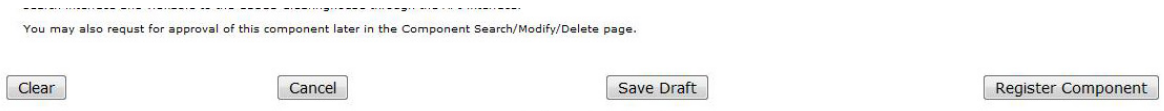
3. Then, select resource category from the ten types listed or specify your own category if none of the predefined categories matches your resource. To specify a new category, click other, and enter the new category name in the text box.



4. Societal Benefit Areas and Resource Availability are also required field for Resource registration. Select all relevant social benefit areas for your resource and specify the availability.

5. At the bottom of the page, you may find a check box of "Also send out a "Request for Approval" notice to the GEOSS CSR Record Review Working Group.". By choose this option, you allow the GEOSS CSR Record Review Working Group to manually review this record. Only approved record will be listed in the CSR holdings page, searchable through the public search interface and viewable to the GEOSS Clearinghouse through the API interface. You may also request for approval of this component later in the Component Search/Modify/Delete page.

6. You may save the process at any time of your registration by clicking the "Save Draft" button at the bottom of the registration page. When a registration draft is saved, you will find when next time you come to the Resource registration module with the same user name you are using. Click "Register" button to register the Resource when all the required information are ready.



7. If the Resource is successfully registered, you will be redirected to a confirmation page. You may go ahead and register a Service Instance for this Resource by clicking the

button "Register a Service for this Component" or go back to main page by clicking the button "Go Back to GEOSS Component System and Service Registration Page".

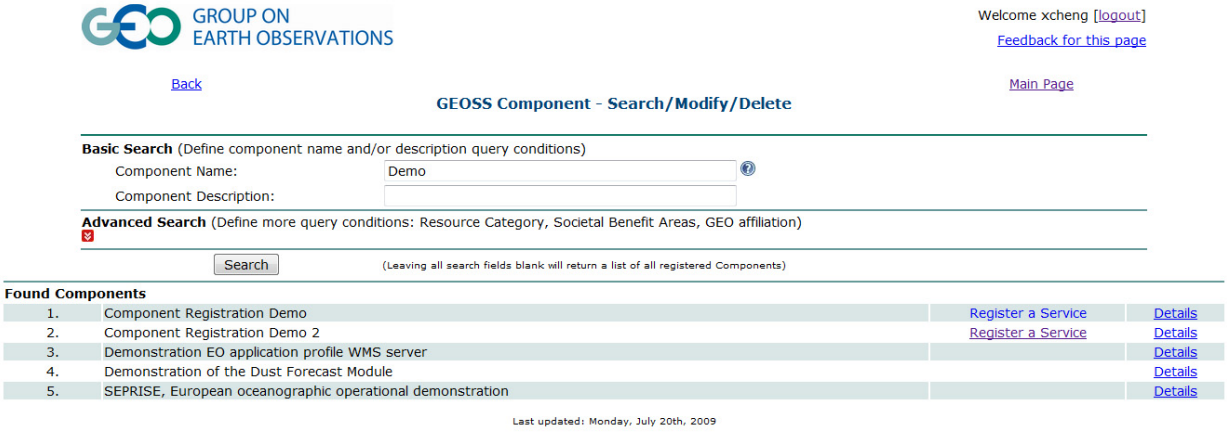
3.3 Registering services

A "GEOSS Service" describes a service interface to a component resource. Typically implemented as an Internet-accessible resource, these service interfaces promote the exchange of structured messages for the selection or processing of information. Each implemented service interface is ideally associated with one or more GEOSS-registered standards to promote interoperability; these linkages identify the standard service protocol, data or metadata format, schema, and other criteria that will allow client software to use it.

1. Log into GEOSS Component and Service Registry System with username and password. Click "Contribute EO Resources to GEOSS" from the main page after login. In the next page, click "Register your Service Interfaces" to proceed to Service Instance registration page.

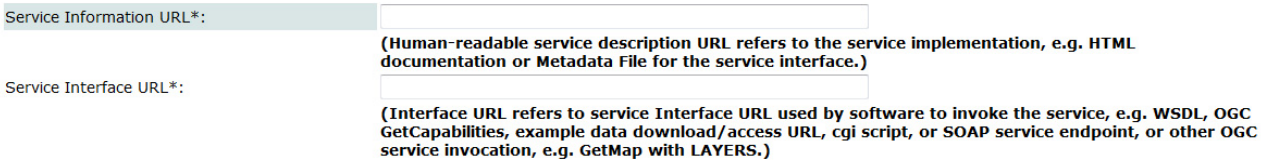
If you have saved a Service Instance registration draft, you may continue with the saved registration process by click the draft name, or click "Start a new Service Instance Registration" to register a new Service Instance.

Before registering a Service Instance, you have to register a Resource (Component) or find your registered Resource (Component). To find a registered Resource, click "Already have a Component? Find it" button. In the next page, find the resource first and click "Register a Service" button defined the Resource you want to associate this Service Instance with. Please note that, you can only register Service Instance for the Resource you have registered before.



2. Specify Service Instance Name, Service Description, Service Information URL, Service Interface URL and Service Contact Information respectively. You may also describe more detailed information about the Service Instance such as Abbreviation, Service Geographic Extent, Service Time Period of Information Content in the registration form.

Please notice the difference between Service Information URL and Service Interface URL. Service Information URL is a human-readable service description URL refers to the service implementation, for example HTML documentation or Metadata File for the service interface. Service Interface URL is interface URL refers to service Interface URL used by software to invoke the service, such as WSDL, OGC GetCapabilities, example data download/access URL, cgi script, or SOAP service endpoint, or other OGC service invocation, e.g. GetMap with LAYERS.



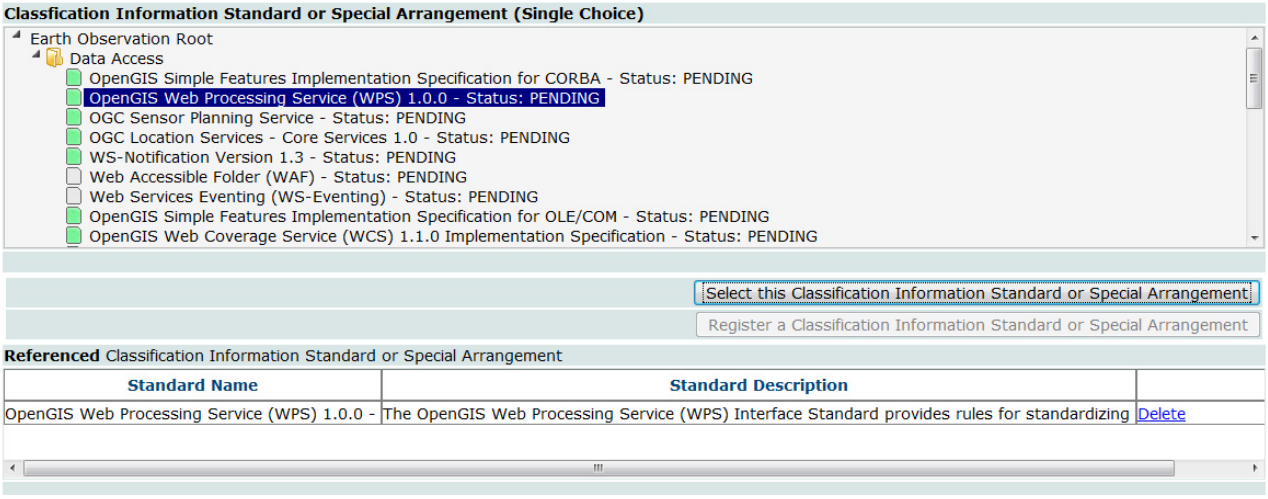
3. If this Service Instance is implemented in compliance with GEOSS registered Standards or "Special Arrangements" (ad hoc or community specifications), they should also be referenced by this Service Instance. GEOSS Component and Service Registry system (CSR) has been integrated with GEOSS Standards Registry System (SIR) so that all the registered GEOSS Standards and Special Arrangements records are retrieved from SIR dynamically during the CSR Service Instance ,registration, modification or search.

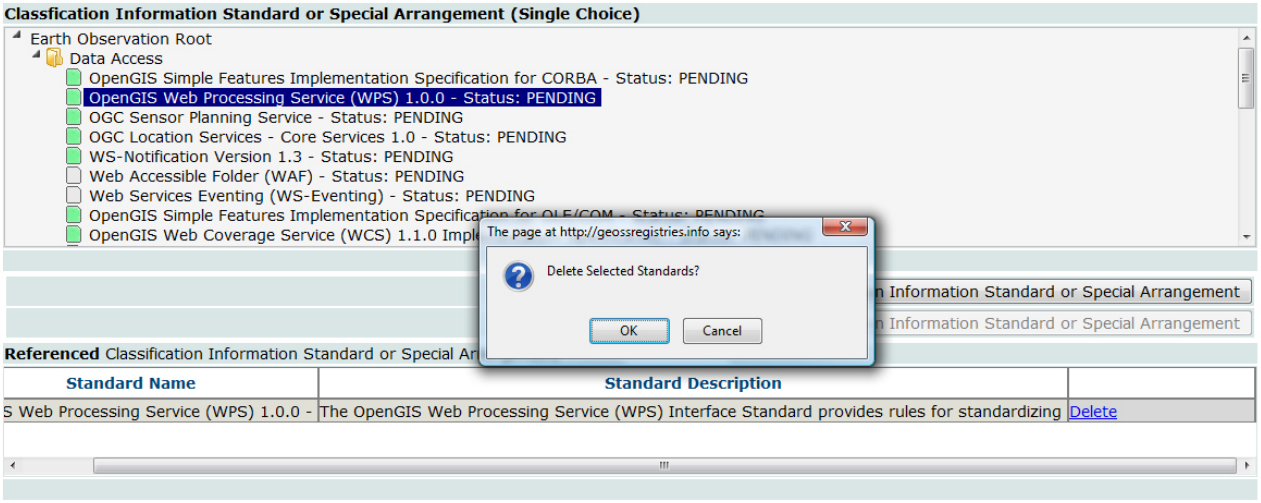
GEOSS Standards and Special Arrangements have been divided into Classification Information Standards or Special Arrangements and Supportive Information Standards or Special Arrangements. For one specific Service Instance, no more than one Classification Information Standard or Special Arrangement could be referenced, but reference of multiple Supportive Information Standards or Special Arrangements is supported.

To associate a Standard or Special Arrangement, select a Standard or a Special Arrangement from the Standards/Special Arrangements list, then click "Associate Classification Information Standard or Special Arrangement" or "Associate Supportive Information Standard or Special Arrangement" button to associate it with the Service Instance to be registered.

To remove a referenced Standard or Special Arrangement, click "Delete" button in corresponding row of the "Referenced Classification Information Standard or Special

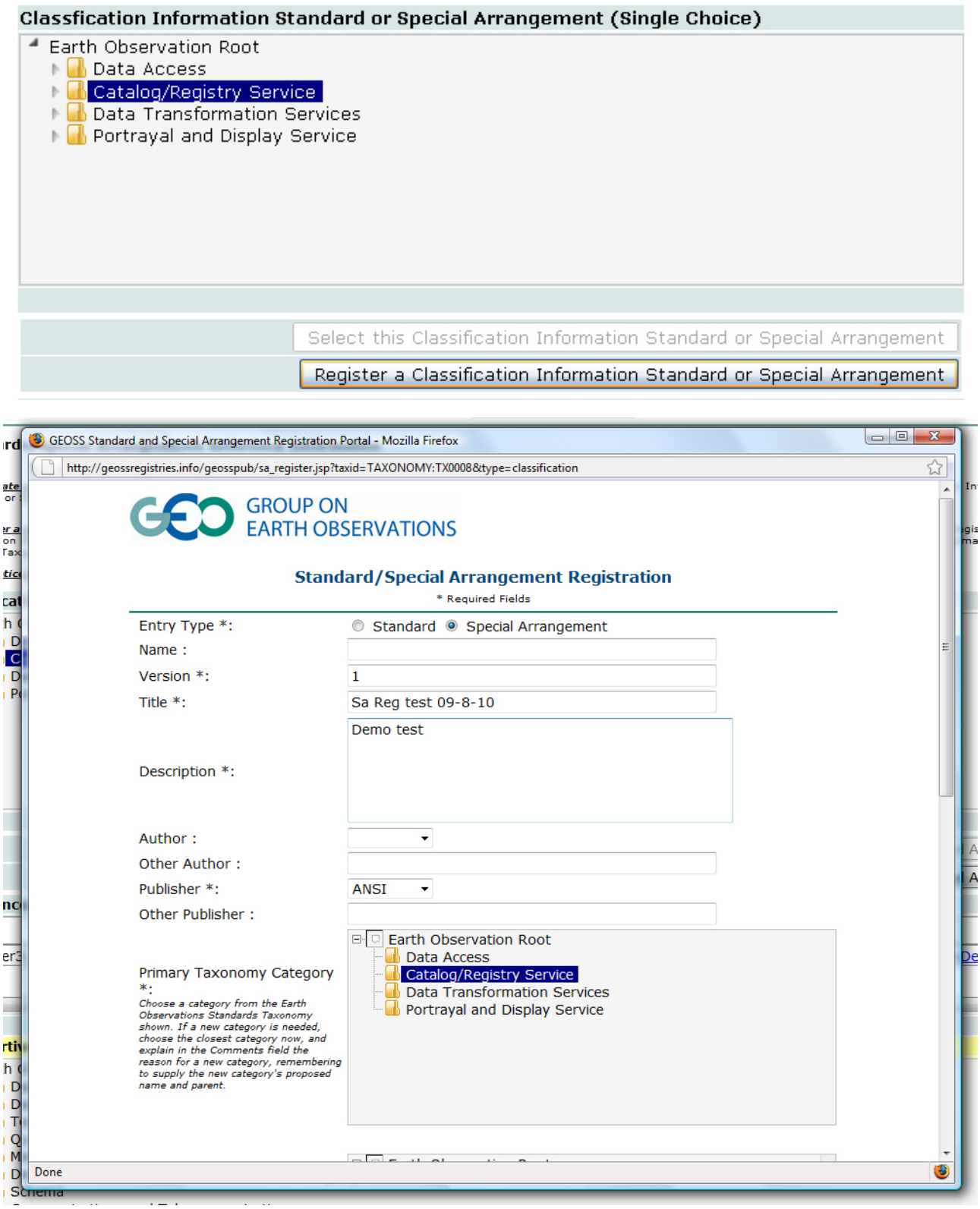
Arrangement" or "Referenced Supportive Information Standards or Special Arrangements".



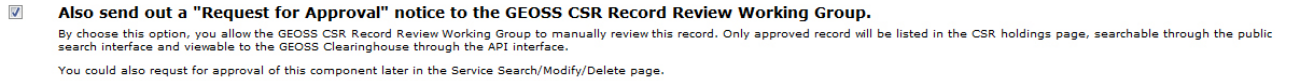


4. If the Standards or Special Arrangements you build the Service Instance with is not listed, you may registered it into SIR during Service Instance registration process in CSR. CSR provides portal to register a new Standard or Special Arrangement into SIR, and the newly registered Standards or Special Arrangements will be referenced by your Service Instance automatically.

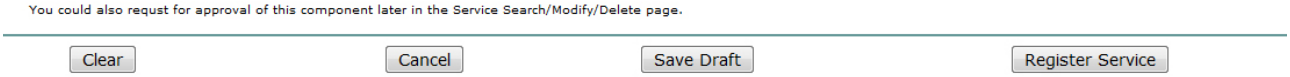
To register a new Standard or Special Arrangement, select a a high-level Classification or Supportive Information Node from the Standards/Special Arrangements list, then click "Register Classification Information Standard or Special Arrangement" or "Register Supportive Information Standard or Special Arrangement" button to register a new Standard or Special Arrangement whose primary category is the selected Taxonomy. In the following pop-up page, provide all required information to proceed. The newly registered Standard or Special Arrangement will be associated with the Service Instance to be registered automatically.



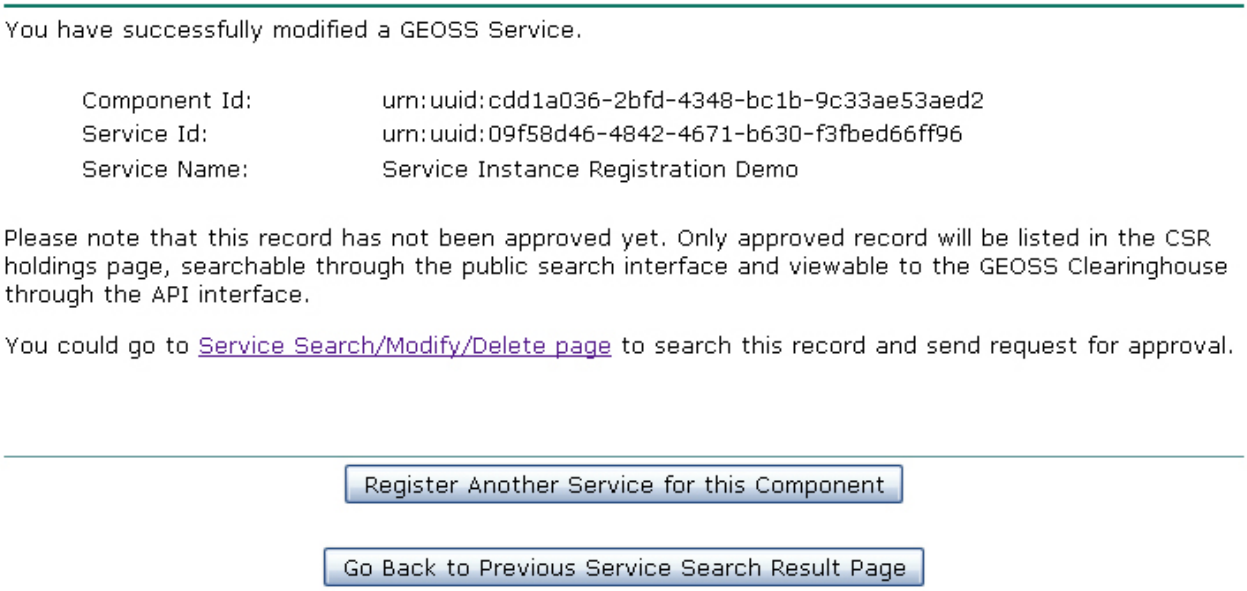
5. At the bottom of the page, you may find a check box of "Also send out a "Request for Approval" notice to the GEOSS CSR Record Review Working Group.". By choosing this option, you allow the GEOSS CSR Record Review Working Group to manually review this record. Only approved record will be listed in the CSR holdings page, searchable through the public search interface and viewable to the GEOSS Clearinghouse through the API interface. You could also request for approval of this component later in the Service Search/Modify/Delete page.



6. You may save the process at any time of your registration by clicking the "Save Draft" button at the bottom of the registration page. When a registration draft is saved, you will find when next time you come to the Service Instance registration module with the same user name you are using. Click "Register Service" button to register the Service Instance when all the required information are ready.



7. If the Service Instance is successfully registered, you will be redirected to a confirmation page. You may go ahead and register another Service Instance for this Resource by clicking the button "Register another Service for this Component" or go back to main page by clicking the button "Go Back to GEOSS Component System and Service Registration Page".



PART 4: Using enviroGRIDS URM geoportal

Using enviroGRIDS URM geoportal

Website: http://www.envirogrids.cz

Karel Charvat, Stepan Kafka, Petr Horak, Premysl Vohnout, Martin Vlk, Jachym Cepicky, Tomas Chvatal, Tomas Mildorf, Karel Janecka

Uniform Resource Management (URM) provides a framework in which communities can share information and knowledge through their description, which is easy understandable inside of the community. In order to effectively share information and knowledge, there has to be a standardized schema, which will support uniform description of information and knowledge including common vocabularies. A schema defines the meaning, characteristics, and relationships of a set of properties, and this may include constraints on potential values and the inheritance of properties from other schemas. The schema specification language is a declarative representation language influenced by ideas from knowledge representation (e.g. semantic nets, frames, predicate logic) as well as database schema specification languages and graphic data models.

Geoportal is a place which allows users to search, view, examine and share spatial and non-spatial data. Geoportal is based on interoperability standards (OGC, W3C, OASIS, ISO) which are connected to other resources on web and helps to create distributed structure of information and knowledge based on spatial localisation. Geoportal should not be closed central storage of spatial data without possibility of redistribution of this data. Geoportal should not be a solution that doesn't support searching of data and information and their viewing and using by external sources.

The Envirogrids URM Geoportal is a new, integrated solution being designed as combination of previous technologies - Uniform Resource Management, Geohosting and new technological development of a visualization client based on HSLayers. The URM Geoportal is not one integrated solution, but set of modules and services, which are able to communicate through interoperable services (OGC, W3C). The solution is modular and could be easy modifying for different purposes. URM Geoportal is based on Open Source technologies, but it could be integrated with different technologies like MS SQL or ArcSDE. Uniform Resource Management (URM supports validation, discovery and access to heterogeneous information and knowledge. It is based on utilization of metadata schemas. The URM models currently also integrate different tools, which support sharing of knowledge. Geoportal contains common visualization, data sharing, metadata and catalogue functionalities. Additional parts of solution could be also tools for management sensor observation and spatial data transformation and processing.

The URM Geoportal contains these parts:
- Authorization
- Simple Content Management System – Simple CMS
- Catalogue client
- Visualization client
- Metadata Editor
- Geohosting
    - MapMan
    - DataMan
- Metadata Extractor

The applications are working relatively independently, main communication is done through metadata system.

Geoportal

Geoportal has three basic levels of users:

- Guests
- Registered users
- Administrator

Guest functionality

Guest can access the information accessible through the Home page, which is prepared using SimpleCMS and he can also discover information and services and view information, which are publicly accessible through portal or interconnected portals. Detail information about discovery and visualization is in parts focused on Catalogue and Map (HSLayers client).

You can also login from the Guest menu (see part of authorization).

Registered users

Registered users can:

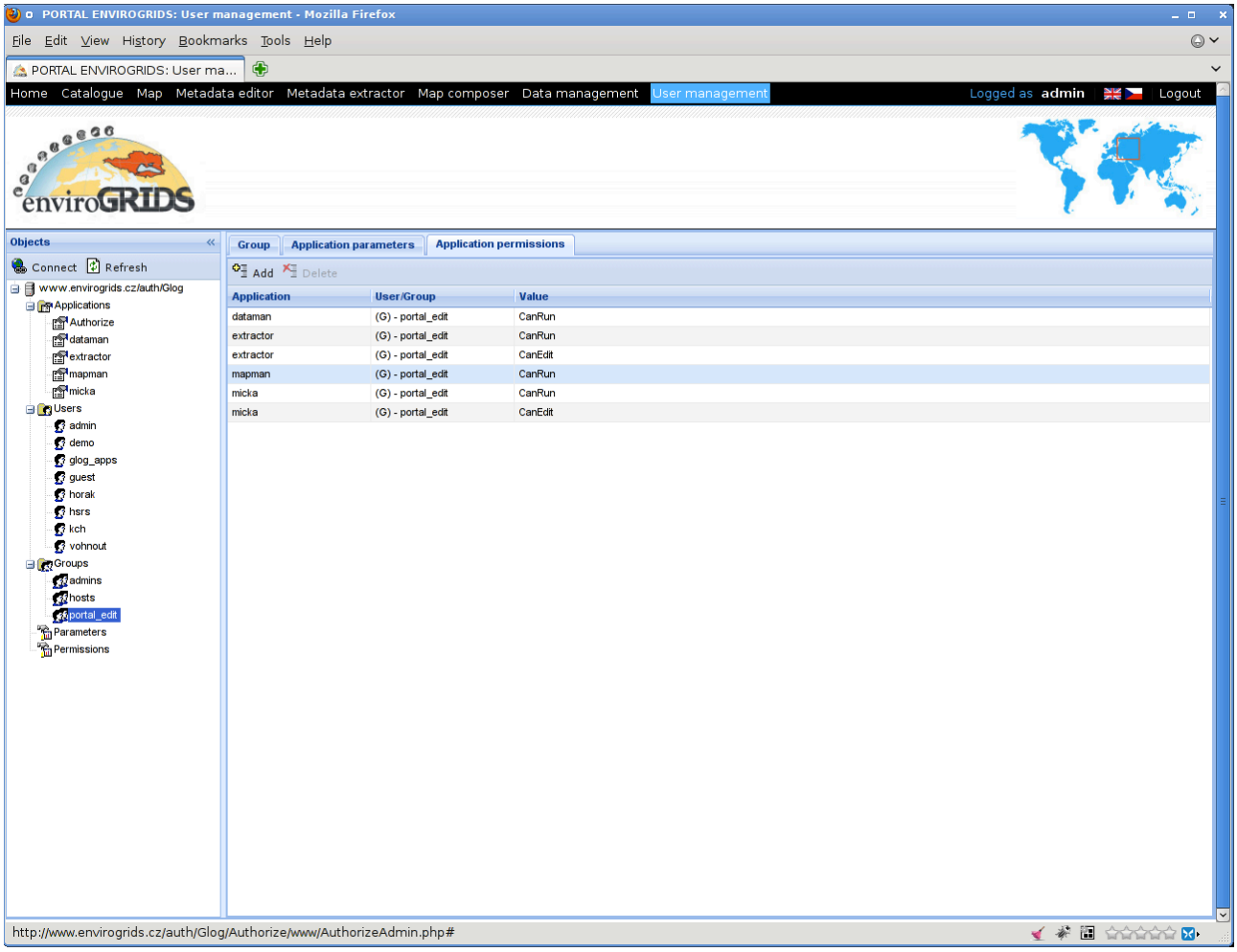
- Use all functionality of Guest users (they have access also to authorized context additionally)
- Edit metadata using metadata editor (MiCKA = Metadata editor).
- Upload data on the server and manage databases (DataMan = Data Management as part of Geohosting).
- Publish data and prepare data composition (MapMan = Map composer as part of Geohosting).
- Publish non-spatial information (using Metadata extractor).

Detail information about all functionalities are presented in the next sections.

Administrator

Administrator has the following functionality:

- All functionality of registered users
- Modifying of Home part of portal using SCMS tool
- Managing of users of portal



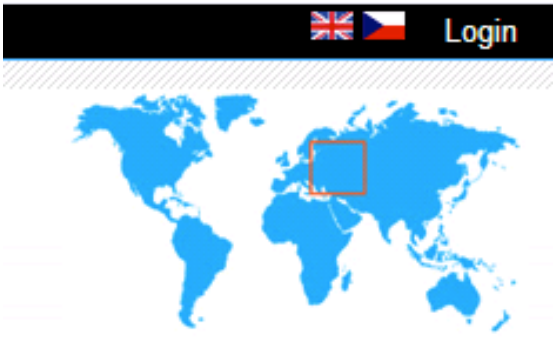
Authorization

As was mentioned in the previous chapter, there are three basic levels of users:

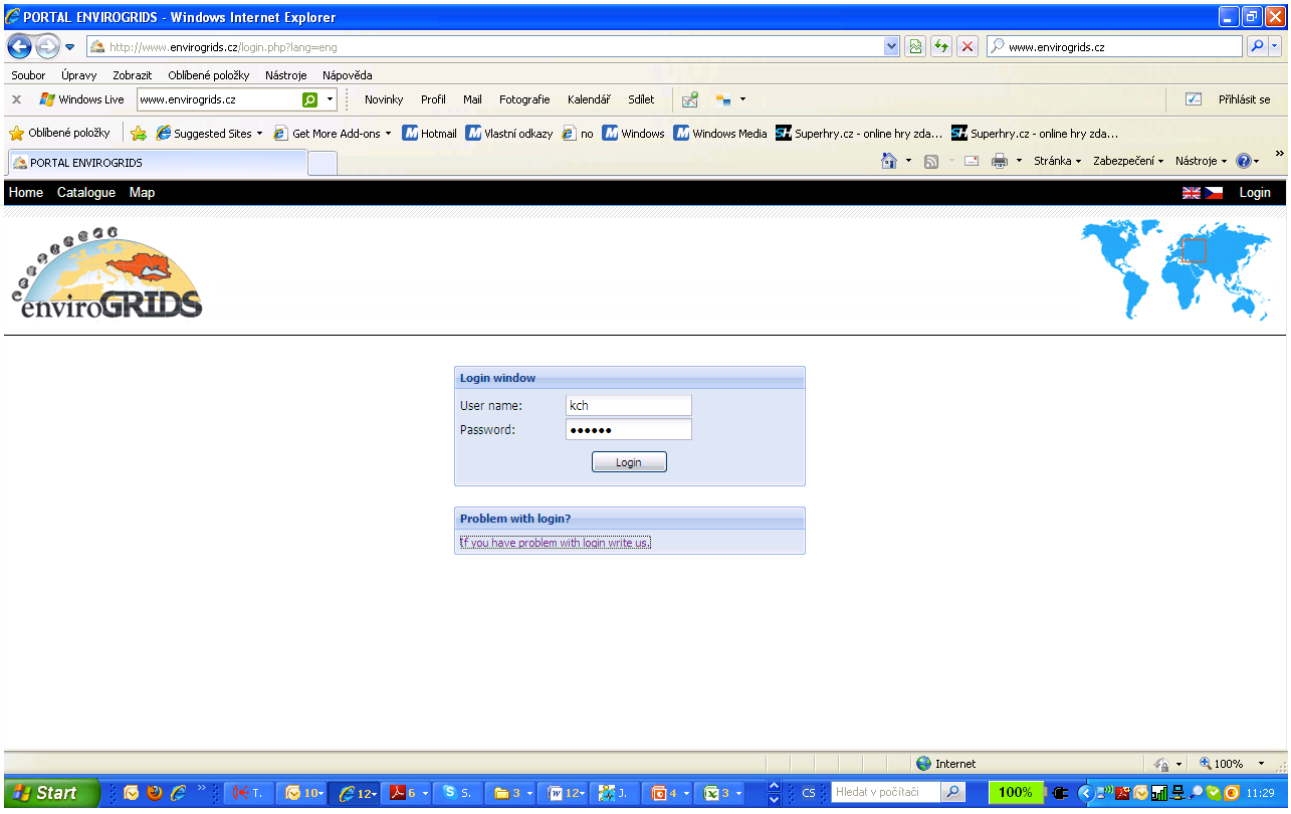
- Guests – with possibility of discovery and visualization.
- Registered users - with possibility of discovery, visualization, data management and data publishing.
- Administrator - with possibility of discovery, visualization, data management and data publishing, modification of home page and user management functionality.

There is also possibility to make mix of privileges because they are set for every application separately. Users can be put into groups and then given permissions to this group.

Users have to push login button on the top-right side to login.



After this Login page will be opened.



You have to fulfill User Name and Password and press the login button.
For Logout use the button on the top-right side.

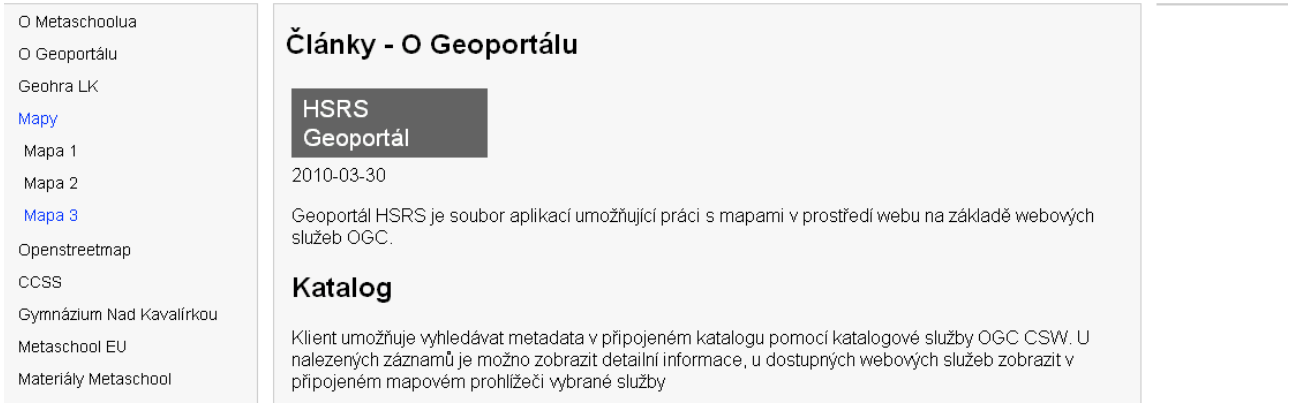
4.1 Simple Content Management System (CMS)

Simple CMS allows editing of home page of URM portal. This function is dedicated to administrator. SCMS allows the following:

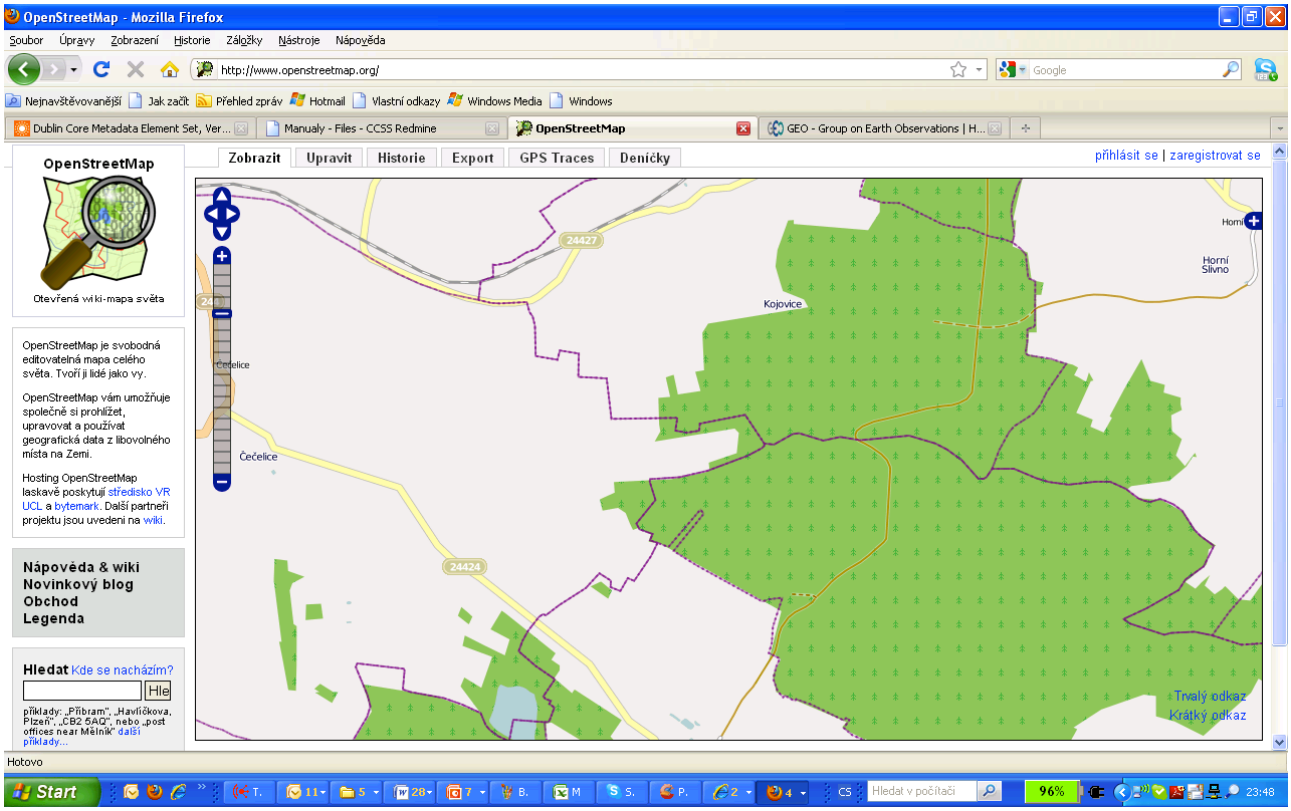
- Define content and system of menu for home page
- Publish articles on home page
- Publish external links in menu on home page
- Publish predefined map composition from MapMan on home page
- Order information on home page
- Remove information from home page
- Publish RSS channels on home page

For guest or normal users only a predefined context is accessible.

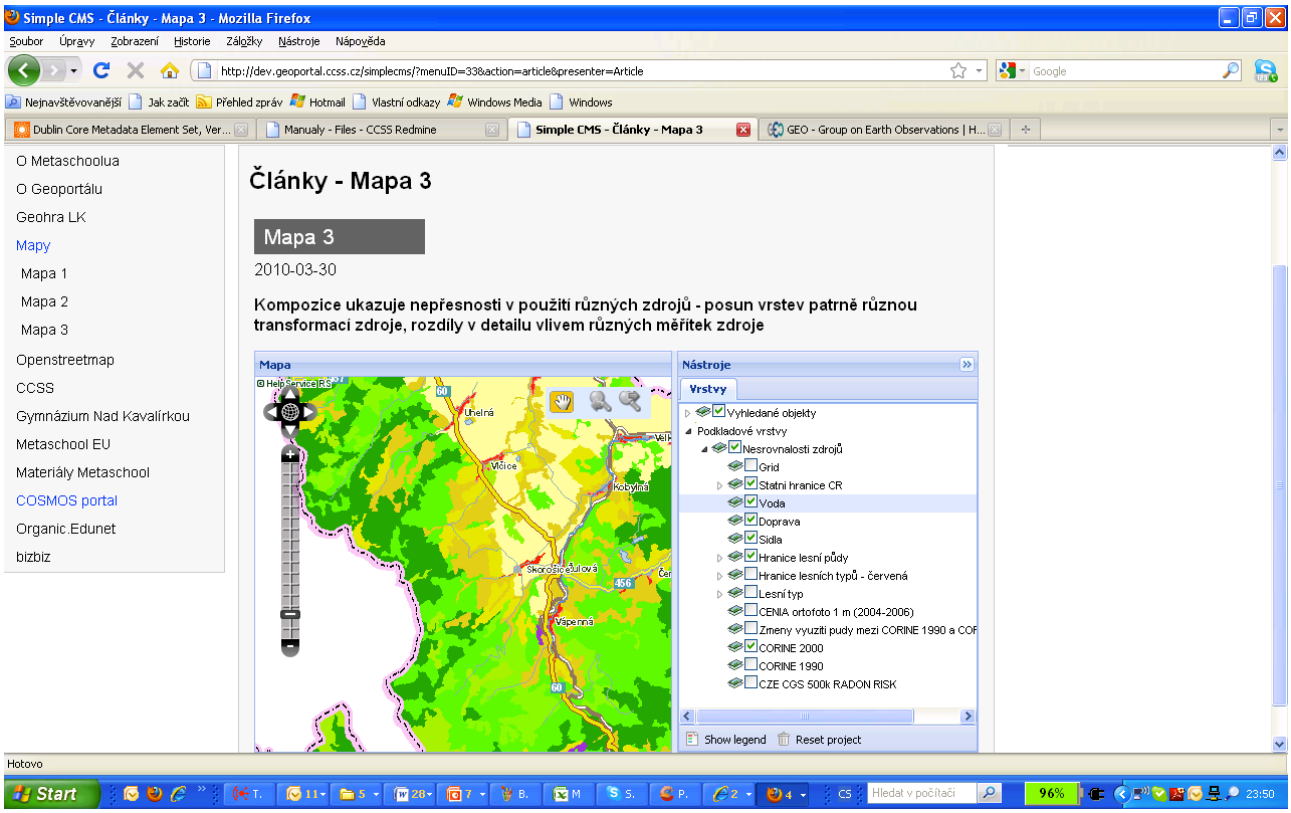
It can be articles…



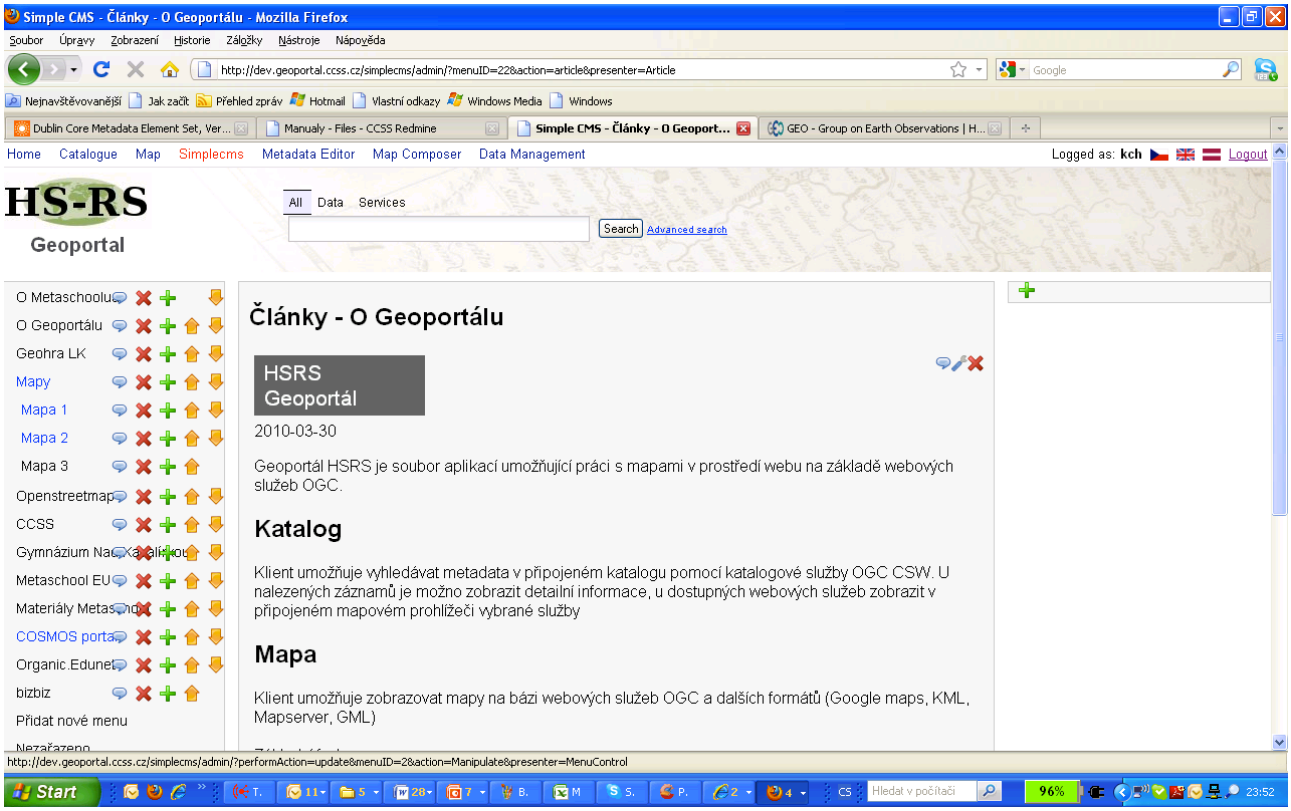
… or links on external web pages…



…or map information can be displayed directly on home page.



Administrator after login to portal can edit the context of home page.



With the buttons in Menu the administrator is allowed to:

Edit Menu 

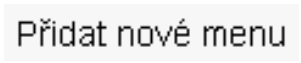
It is possible to edit menu or only edit the name of menu item.

Or under the name insert external link in menu

Delete menu 

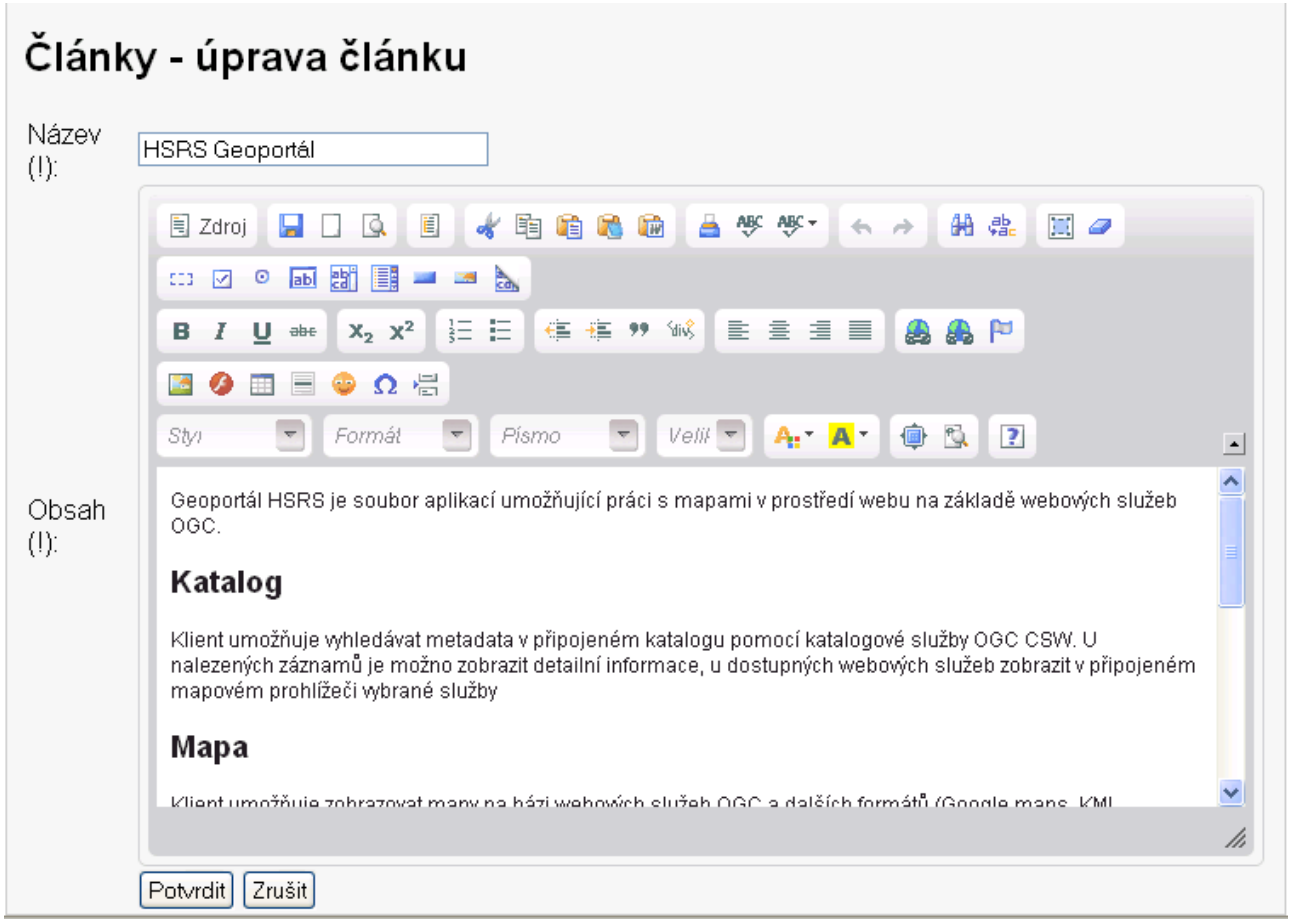
Add submenu 

Move the menu up  or down 

He can also add a quite new item to Menu 

For every Menu item it is possible to:

Edit Articles 



If you would like to insert into article map composition from MapMan you have to use html code generated by MapMan and insert this code into the text window.

Add articles into other Menu items 

Or delete articles 

You can also add a new article by pushing 

If you would like to add the new RSS channel, you have to push the button  and then you can edit new RSS channel.

4.2 Discovery services

Catalogue services are the key technology for locating, managing and maintaining distributed geo-resources (i.e. geospatial data, applications and services). With OGC catalogue services, client applications are capable of searching for geo-resources in a standardized way (i.e. through standardized interfaces and operations) and, ideally, they are based on a well-known information model, which includes spatial references and further descriptive (thematic) information that enables client applications to search for geo-resources in very efficient ways.

Whereas interfaces and operations of OGC catalogue services are well defined, it is left up to the developer of the system to define a specific information model which a catalogue service instance provides. This includes, but is not limited to, the information which can be inserted in the catalogue, supported query languages, available search terms, response/ result sets, etc. This point is of major importance with respect to interoperability between different catalogue service instances.

Catalogue services are based on metadata system Micka. It is based on OpenGIS® Catalogue Services Specification – profile Catalogue Service for Web (CSW) and OpenGIS® Catalogue Services Specification 2.0.2 - ISO Metadata Application Profile standards.

Supported operations:

- Basic: GetCapabilities, DescribeRecord, GetRecords, GetRecordById
- Editing: (CSW-T): Transaction, Harvest
- Multiple search trough many catalogues
- Inquiry items: according to standards
- Extensions: export to GeoRSS and KML
- Open Web Search

Functionalities description

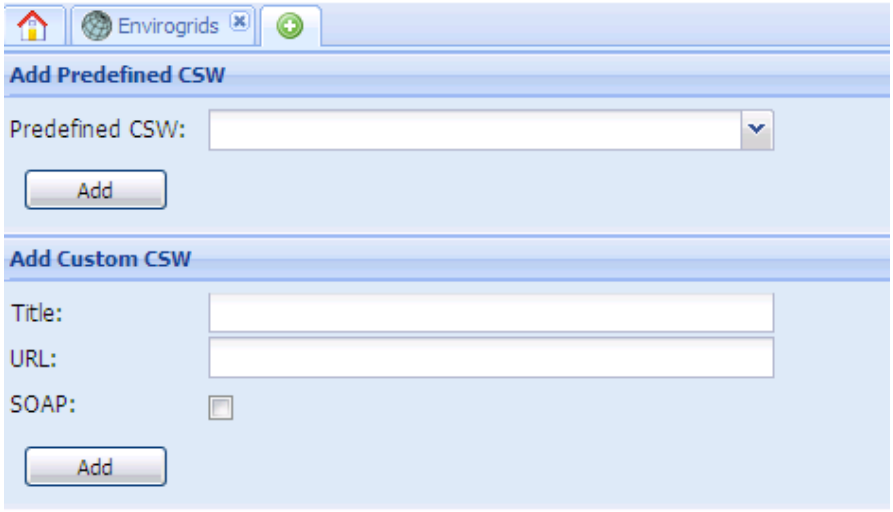
Catalogue client support the following functionality:

- Adding New catalogues services
- Basic search

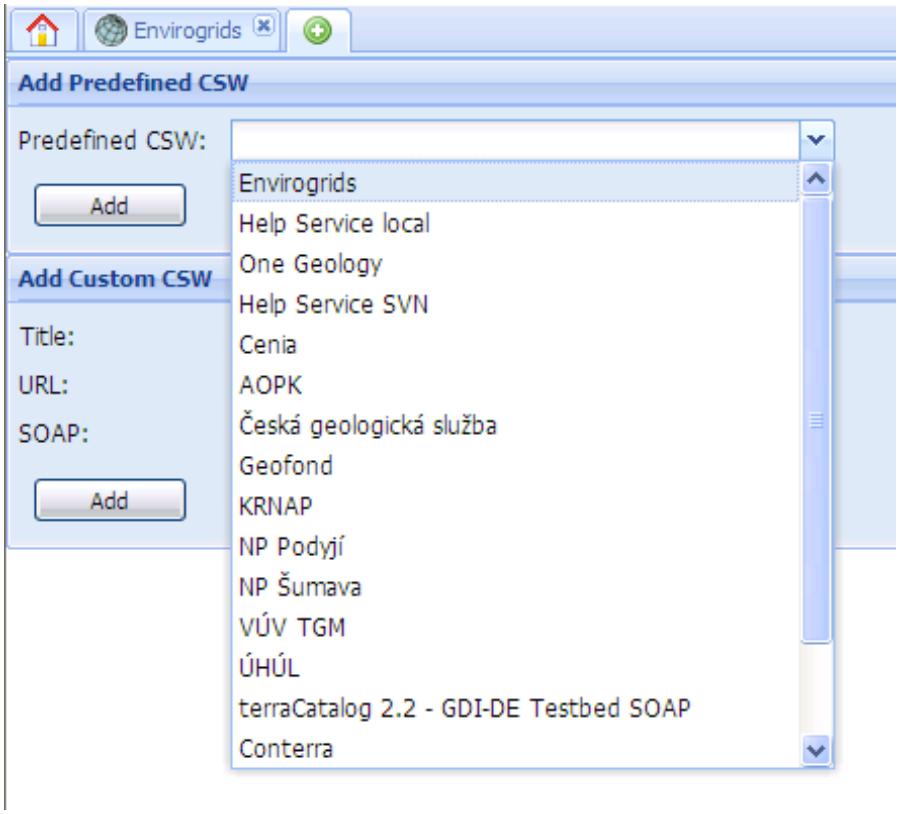
- Advanced search
- Metadata visualization
- Viewing of information

Adding New catalogue Service

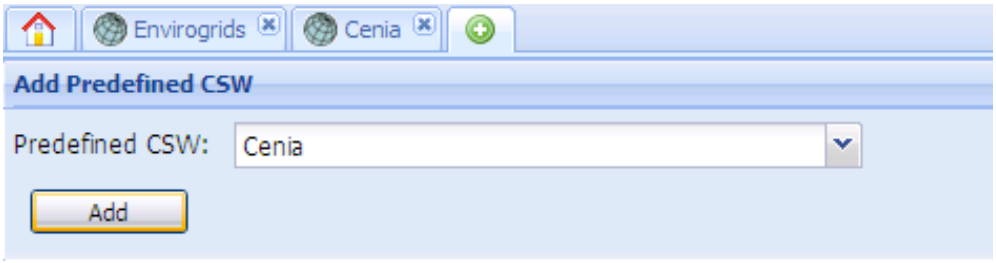
As it was already mentioned, the system supports multiple search using catalogue services. Every user can define which catalogue has to be searchable during discovery of information. He can click on  button. Then opens the dialog for adding new catalogues.



User can fill in the title and the URL of catalogue service or select some catalogue from predefined list.

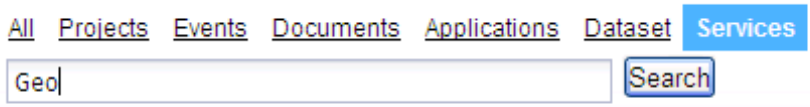


After selecting of the catalogue and pressing the button Add, new catalogue folder is added into the menu.



Simple search

Simple search is similar to Google search. User can put free text (it is used for all items in metadata) and can select type of objects, which has to be discovered.

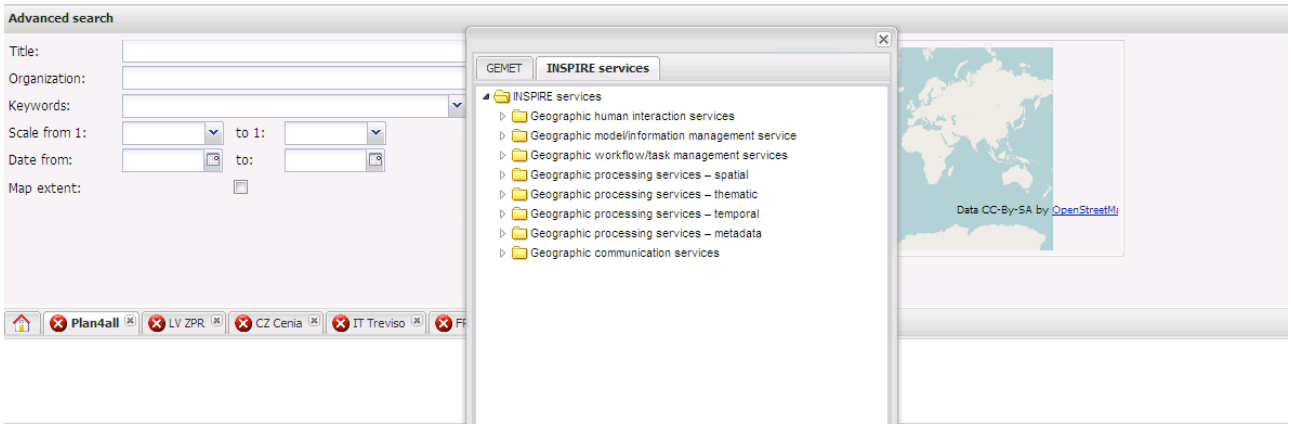


Pressing the Search button starts the search trough all selected catalogues.

Advanced search

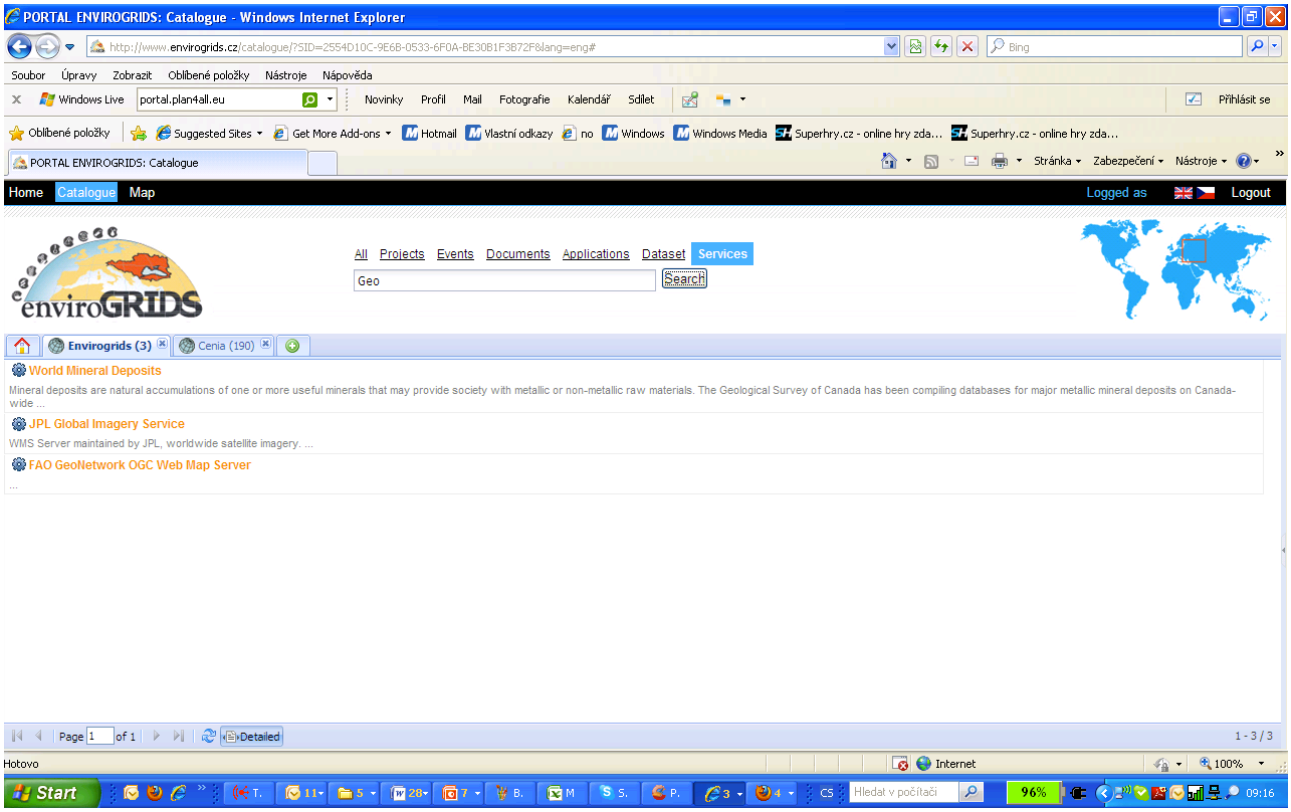
To extended search could be switched using button extended search on the right side from search window.
Then new dialogue for advanced search is open.

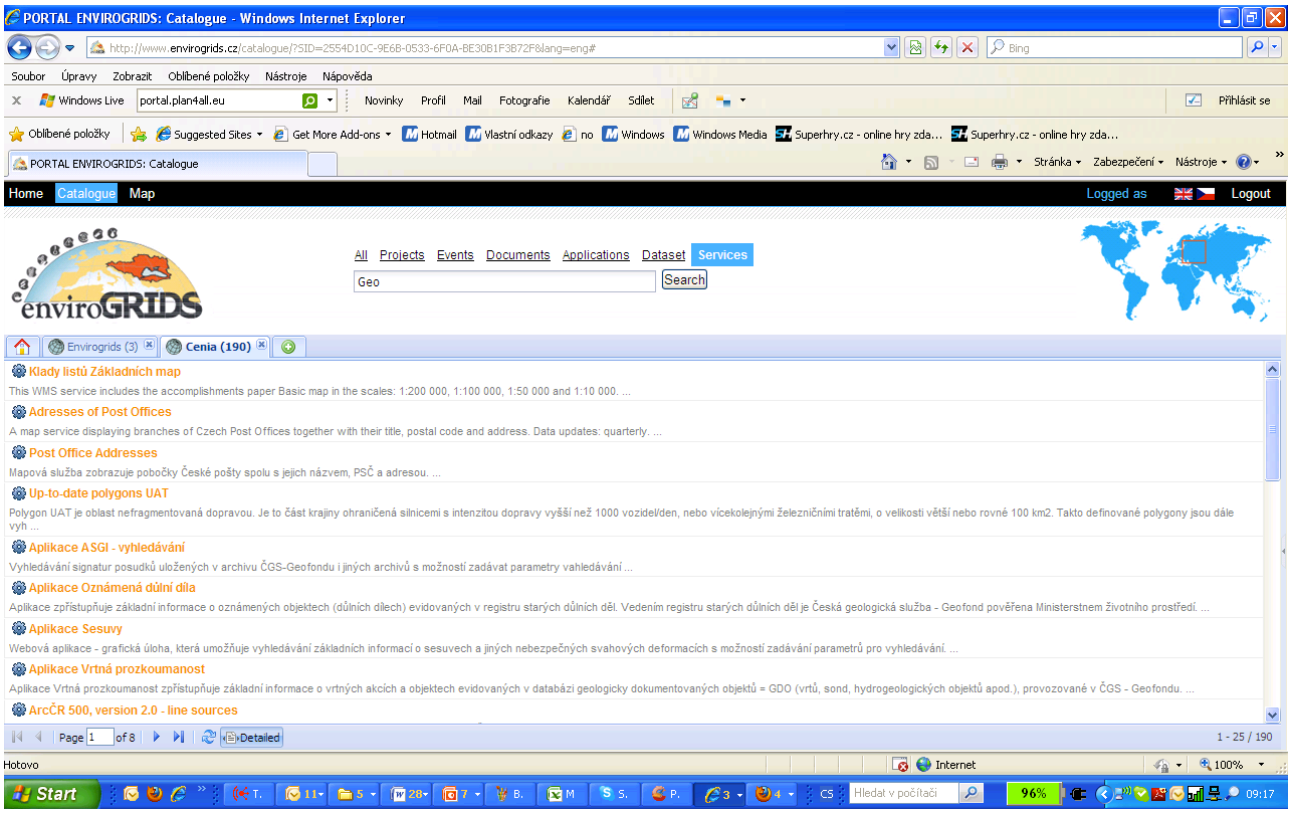
User could define Title, Organisation, Key words, Scale Time extent and Map extent. For Key Words could be used GEMET client for searching using GEMET thesaurus or INSPIRE categories.



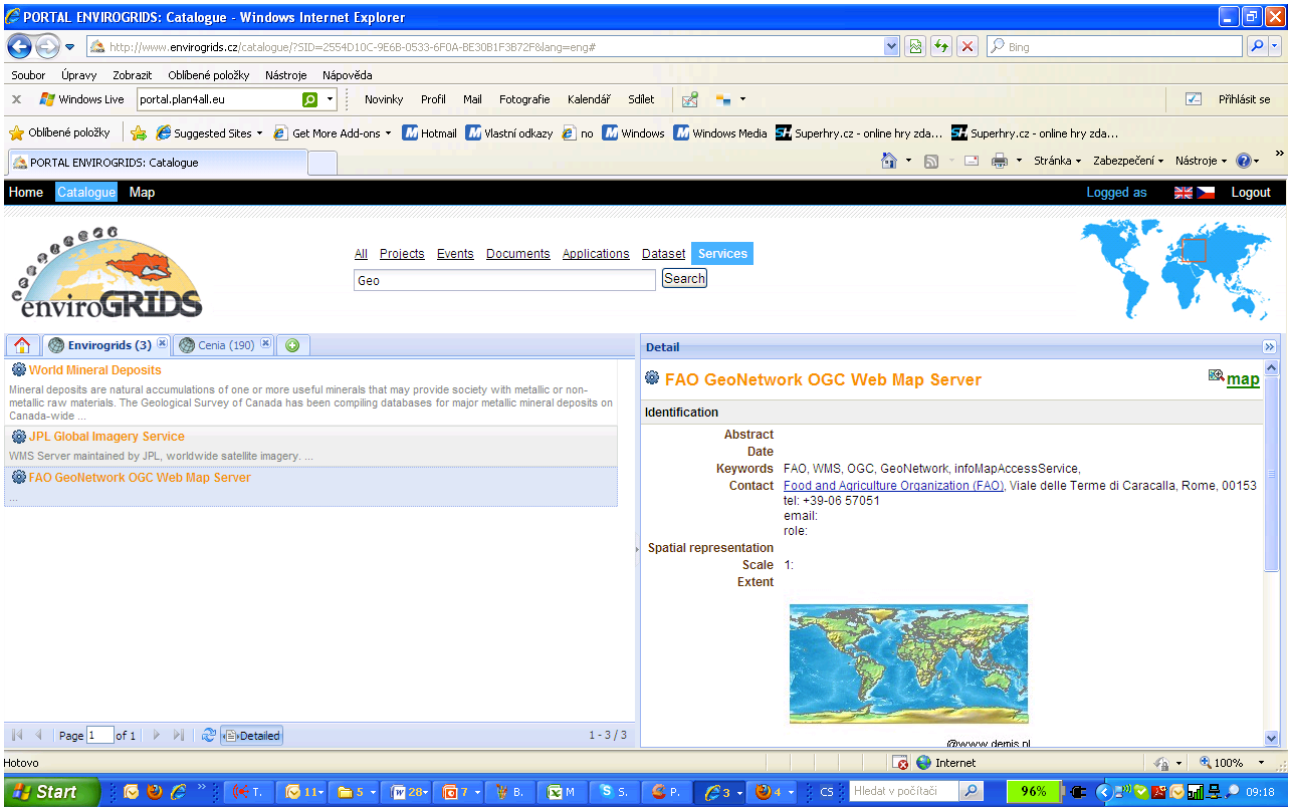
Metadata visualization

After starting the search, the client sends request to all selected servers. Servers are returning response. User can select server and see the list of metadata for the selected catalogue.



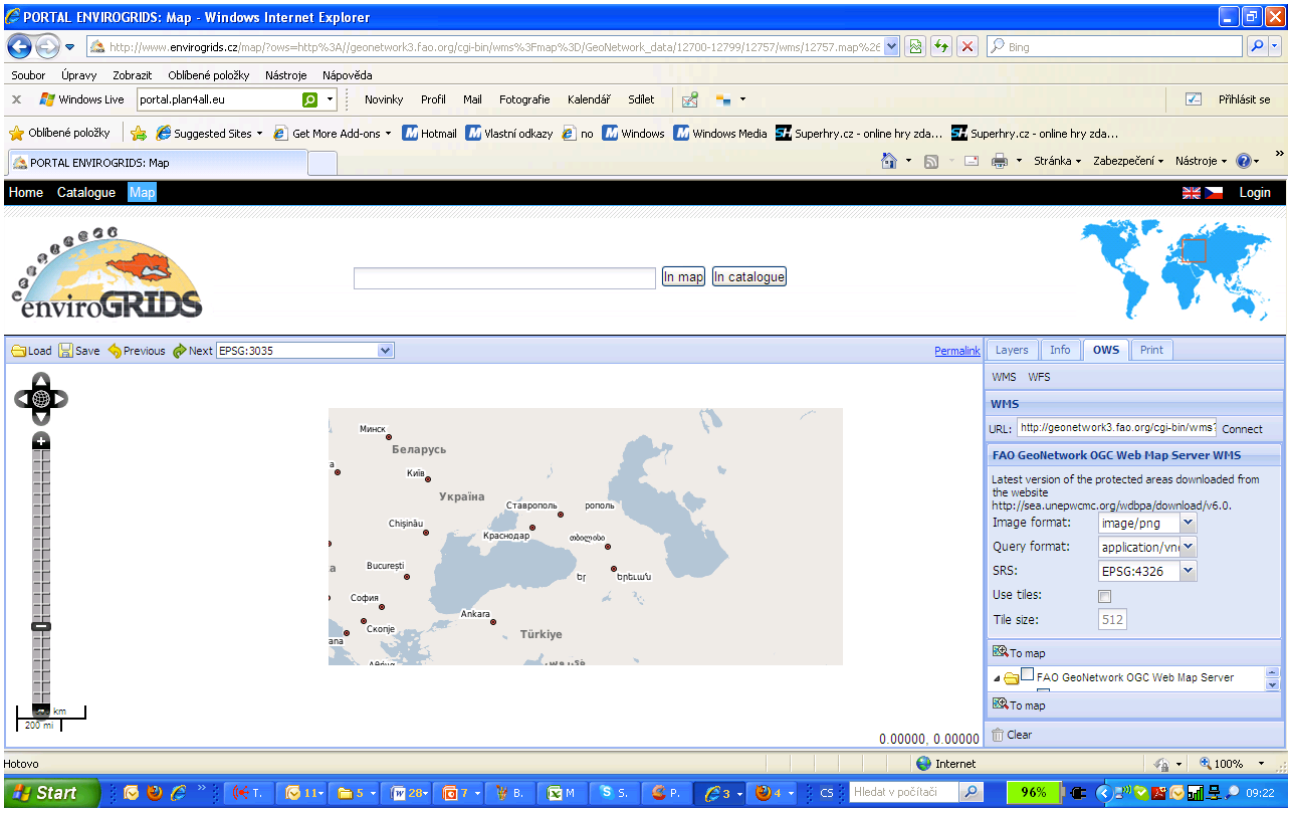


Clicking on metadata item a new window is opened containing metadata detail.

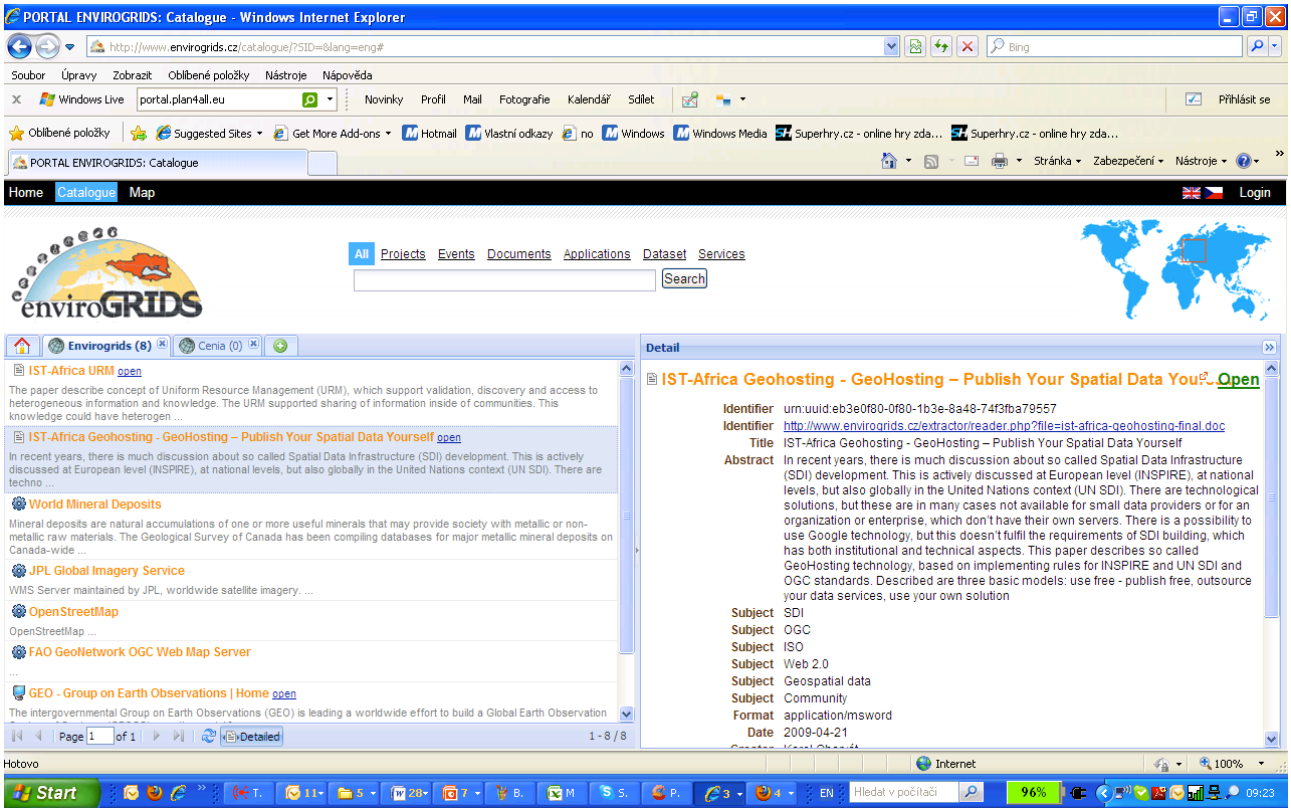


Content visualization

If the metadata record describes online accessible content (WMS, WFS, MapMan composition, external links, stored files, stored html pages) in Metadata window, on the top right there are displayed buttons Map, WMS, WFS, Open. By pressing one of these buttons related action is provided. As a services for example HSlayers. OWS service window supporting displaying selected layers.



In the case of documents the document is opened.



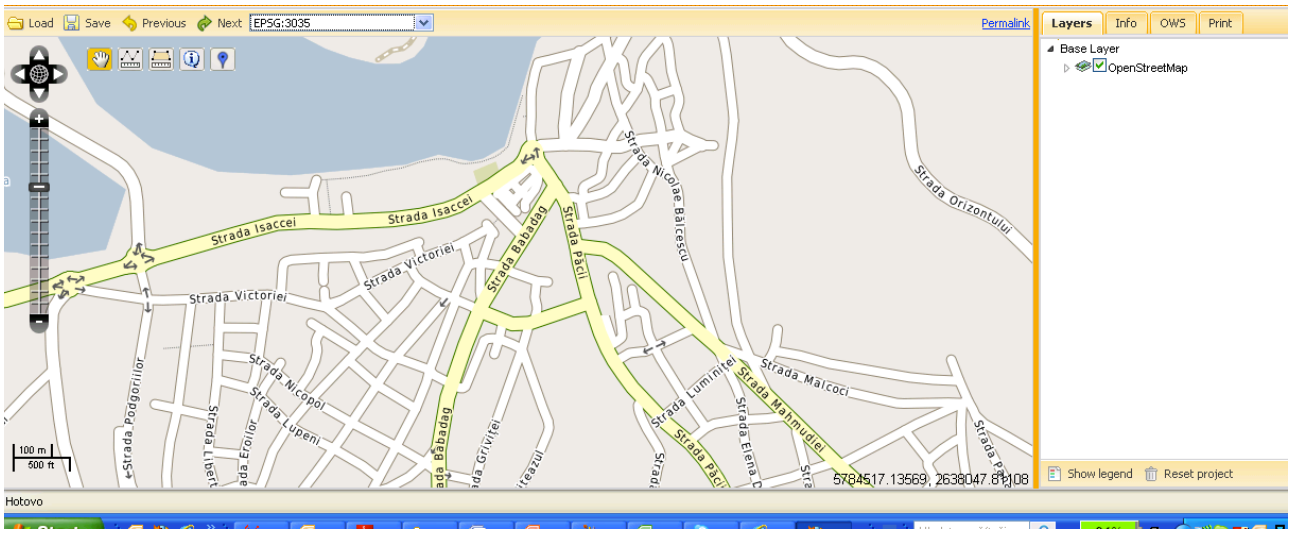
4.3 Map visualization

HSLayers (Help Service + OpenLayers) combines capabilities of ExtJS and OpenLayers and several helping scripts to establish truly Web GIS applications. Development started in 2007. In 2009, after 2 years of development, it was released under conditions of GNU General Public License 3.

OpenLayers is a JavaScript toolkit for creating of mapping applications in the web browsers. OpenLayers is more powerful than Google Maps toolkit. It has abilities for showing maps based on various raster and vector formats. It has connectors to many standards and quasi-standards such as MapServer, OGC Web Mapping Service, ArcIMS, simple Image layer, GML, GeoRSS, KML, Text and others and Google, Yahoo and VirtualEarth for commercial data providers. The user – creator of mapping application – does not need to take care about differences between various web browsers and their JavaScript implementation or between various data formats.

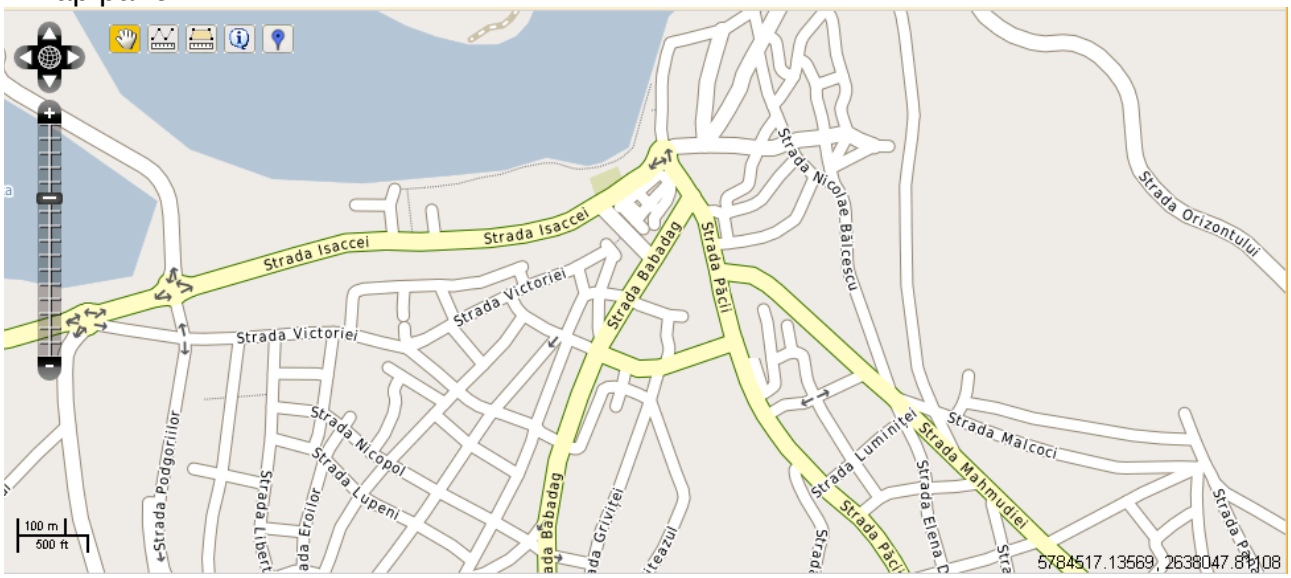
ExtJS is a multi-browser JavaScript library for building of rich internet applications. It consists from customizable User Interface widgets, ready to be used by designers of Graphical User Interface, similar to desktop widgets, which among others are text field and text area input controls, date fields with a pop-up date-picker, numeric fields, list box, radio and checkbox buttons, wysiwyg html editor, text grids, suitable for spreadsheets, trees, tab panels, toolbars, menus and sliders. ExtJS was originally built as an add-on library extension of Yahoo UI, but now it is the standalone project.

Working with HSLayers

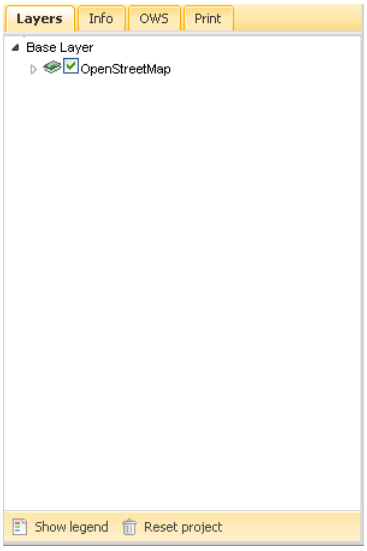


HSLayers client application is divided into three independent parts:

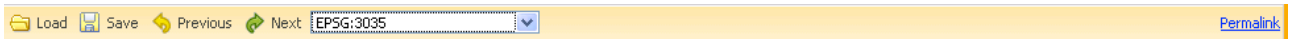
- Map panel



- Management panel



- Tools box

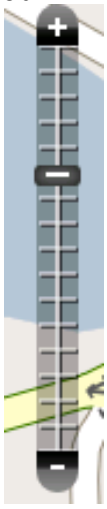


Map panel

Map panel displays maps, but also contains buttons for working with maps. The zooming, moving, queering and measurement in maps is supported by functions related to single buttons in window.

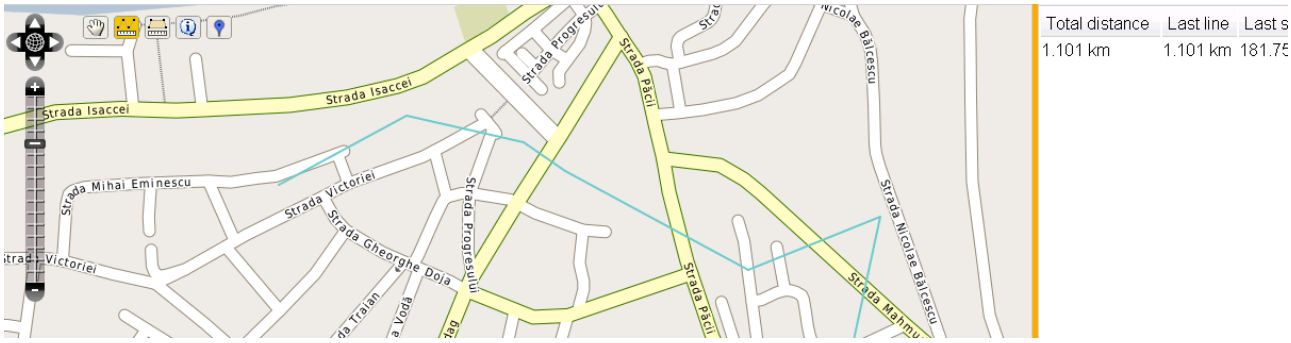
- Moving button supports moving maps on left, right, up and down and displaying the whole extent of maps (clicking on globe)

- Zoom button supports zooming in and out

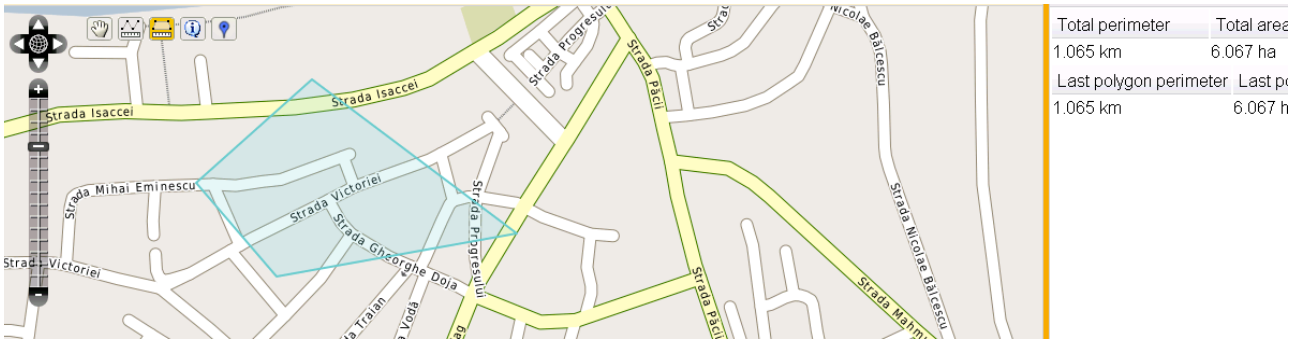


- Hands button allows moving maps using the left mouse button. The combination of the Left mouse button together with CTRL allows select map window for visualization

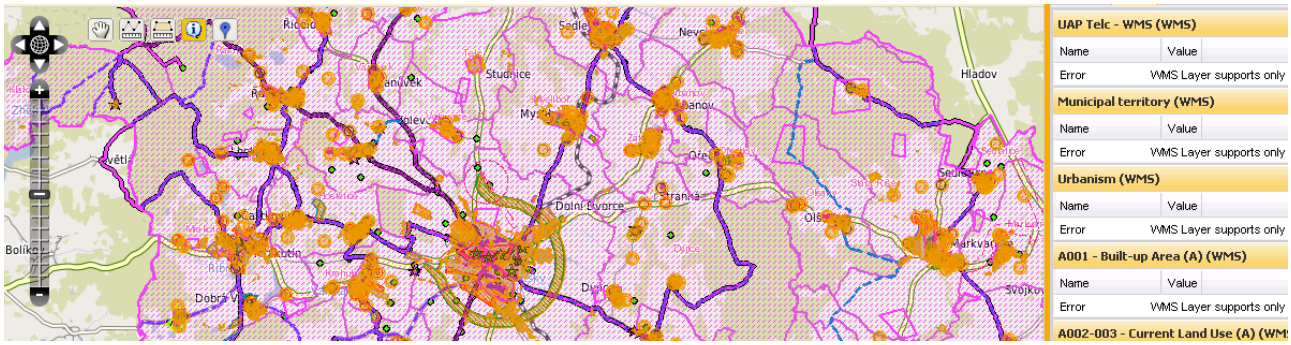
- Distance measure button  allows measuring of distances in maps clicking on map. Information about distances is visible in Management panel in Info layer. Measurement is finished by double click.



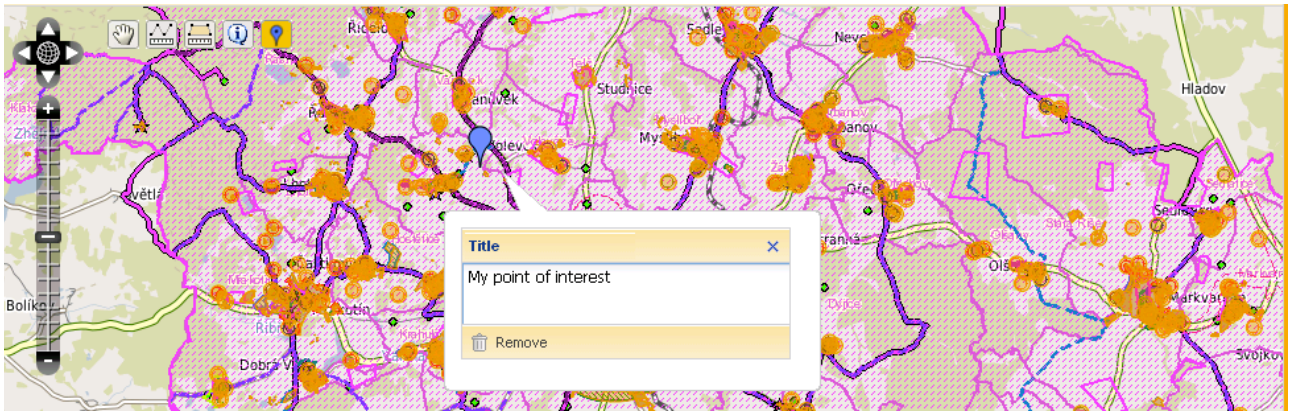
- Area measurement button  allows measuring of areas in maps. Information about areas is visible in Management panel in Info layer. Measurement is finished by double click



- Info button  allows querying of objects in map (including WMS services). You can ask by clicking in single point or using rectangle (CTRL + left mouse button). Information is visible in Management panel in Info layer



- Pin button  allows adding a point of interest into the map



- There is also information about scale 

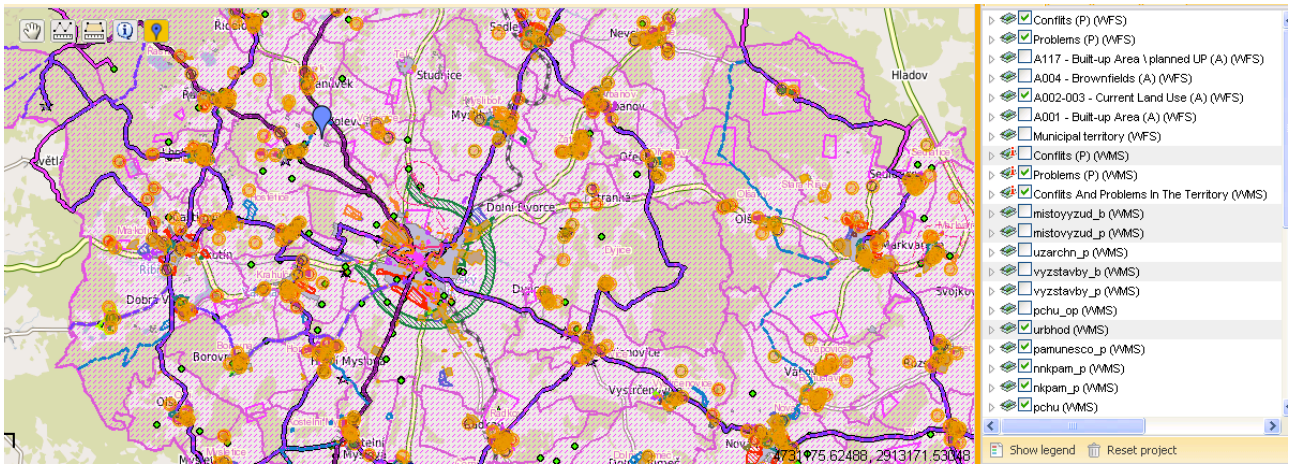
and actual coordinates in Map window

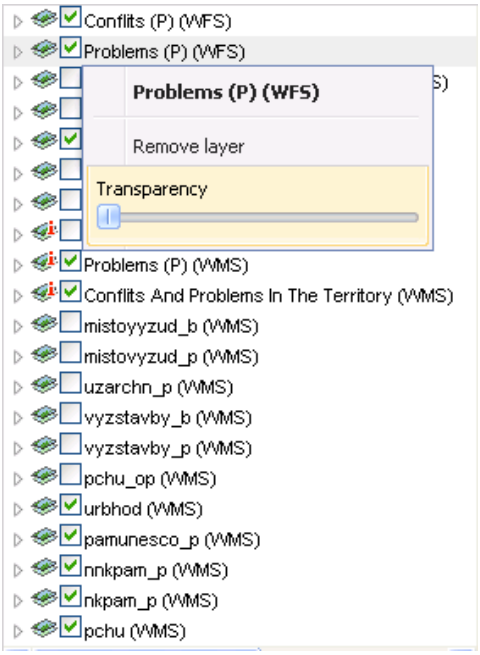
Management panel

Management panel contains four bookmarks:
- Layers
- Info
- OWS
- Print

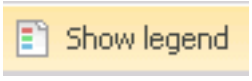
Layers bookmark

By check layers bookmarks you can switch on or off single layers in map composition.

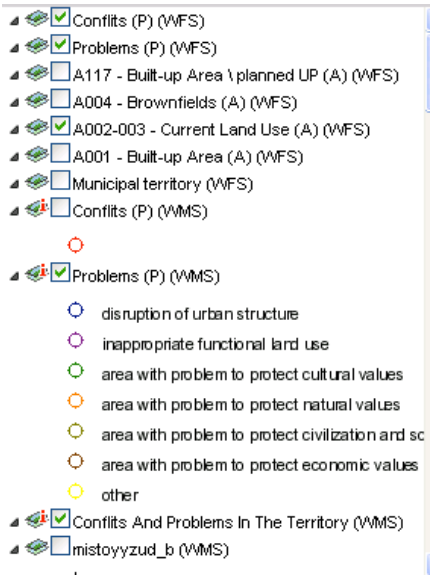




To change transparency of selected layer or remove layer from composition click right button on selected layer.

By clicking the 

button you can display legends of layers in composition (including WMS and WFS if it is available).



By clicking the 

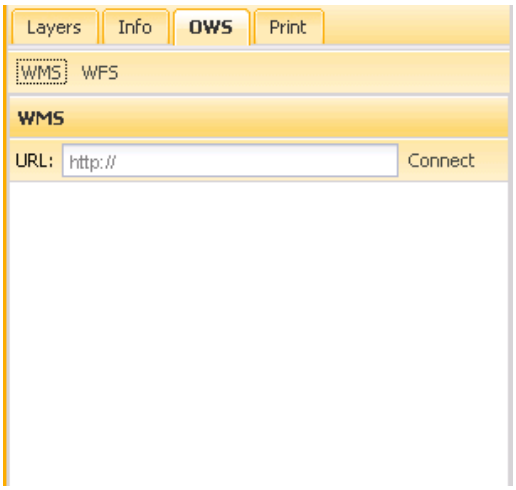
button you will restore initial composition (see also OWS bookmark).

Info bookmark

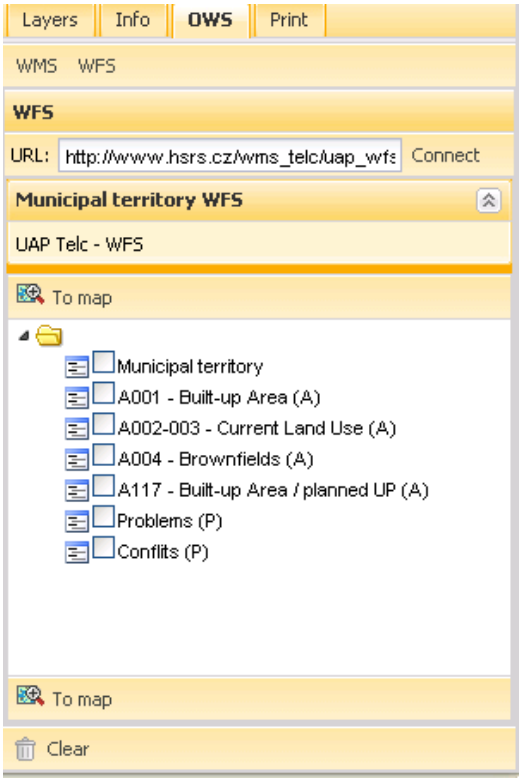
Info bookmark opens Info panel. It is a passive panel used by measurement and info functions of Map window.

OWS bookmark

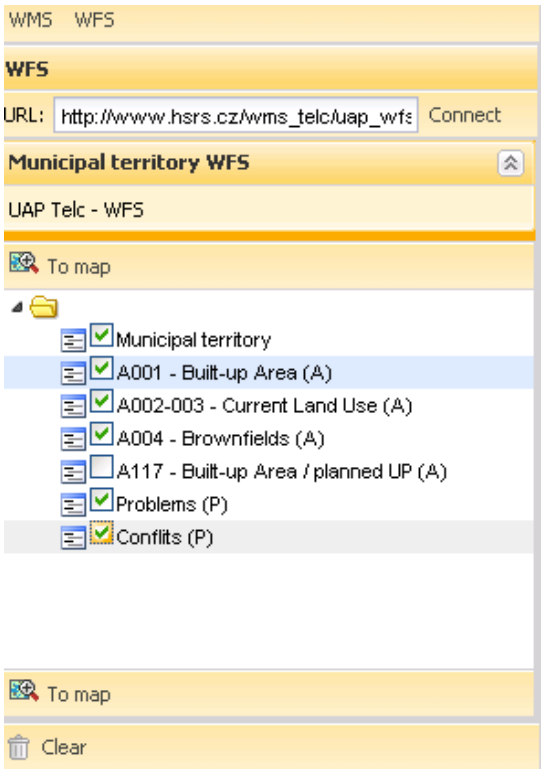
OWS bookmark supports adding of new layers into Map Window using Web Mapping Services or Web Feature services.

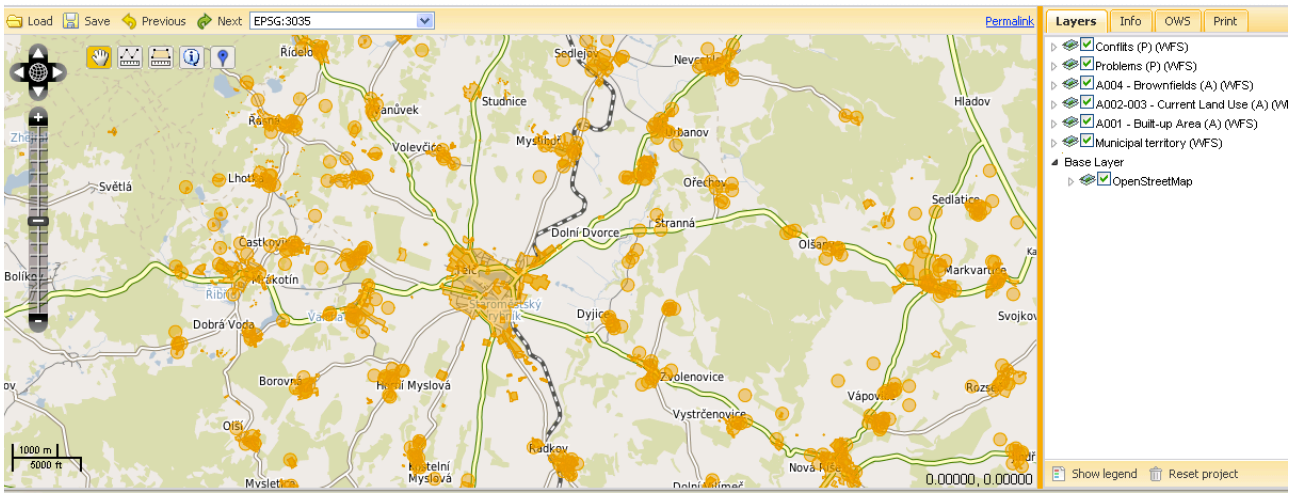


After editing URL address (this address could be also fulfilled using catalogue services - see next chapter) and by pushing the Connect button get capabilities of selected service will be displayed.

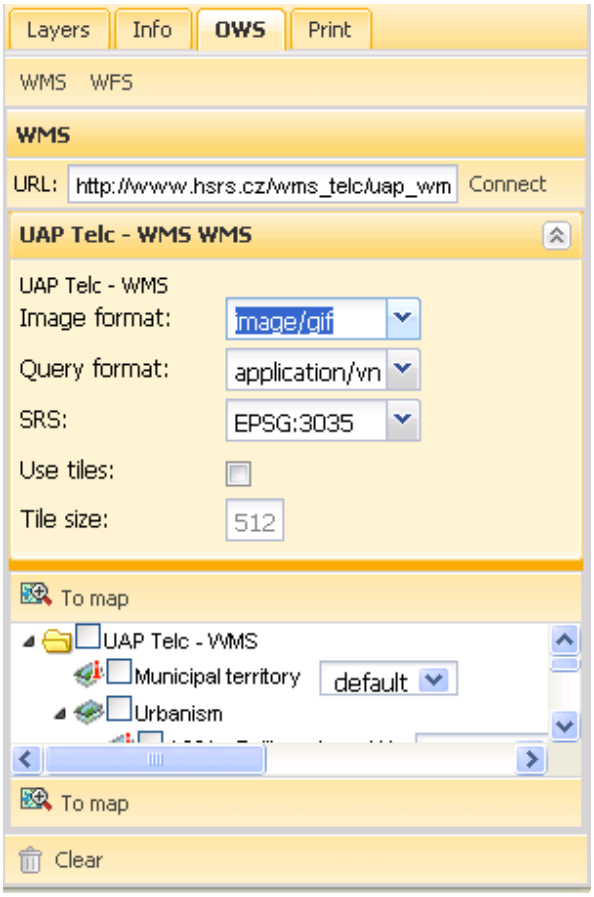


After selection of layers and by pushing the 'to Map' button the selected layers will be added into the list of layers and displayed in Map window.

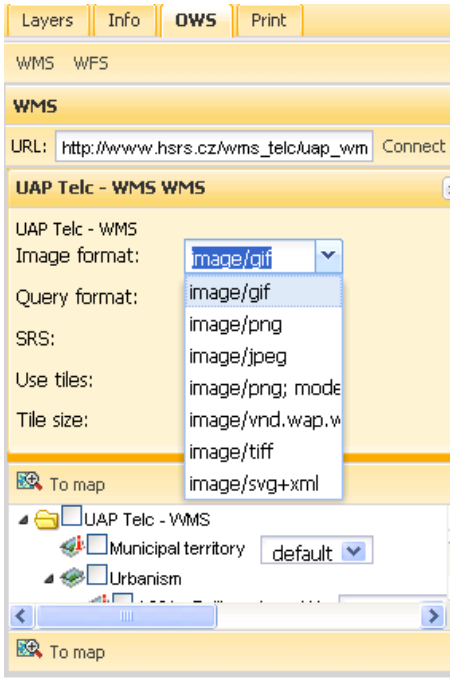




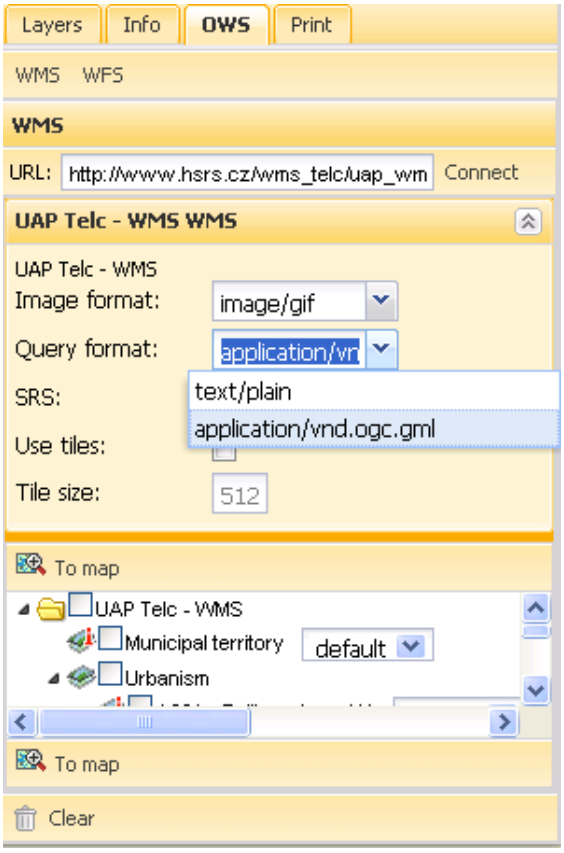
There is additional functionality for WMS services:



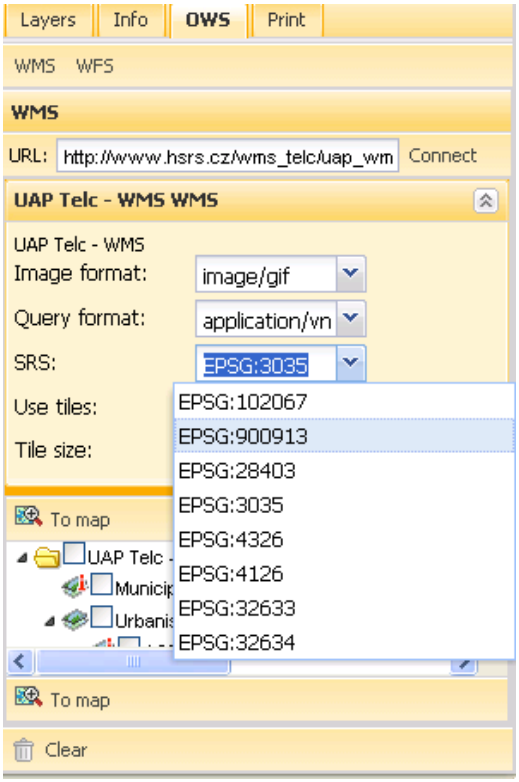
It is possible based on get capabilities of services to define image format for WMS services:



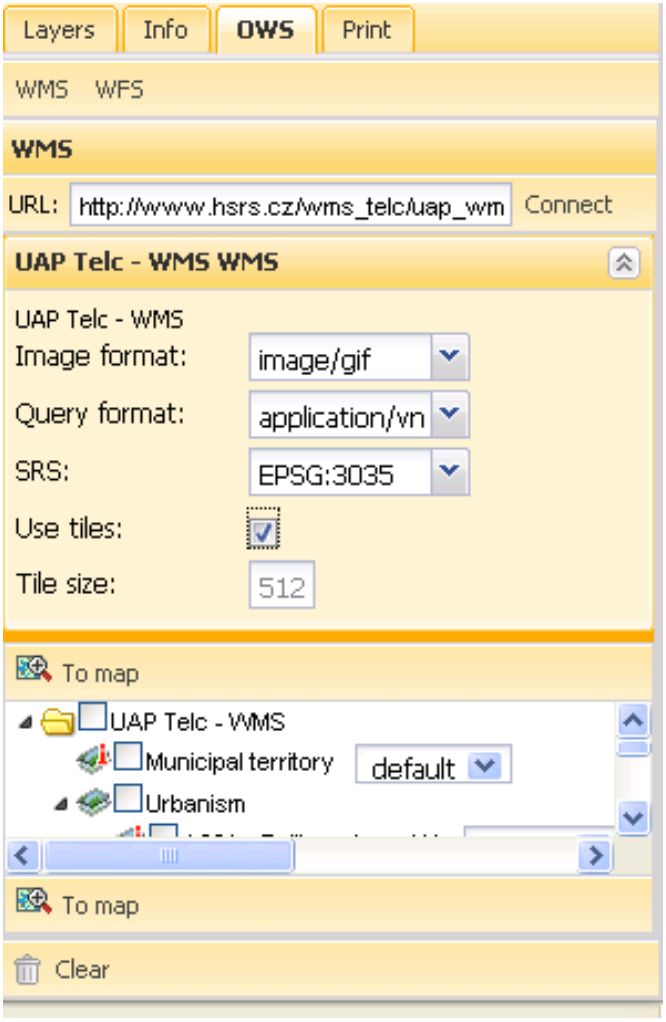
It is possible to define query format for selected WMS:



Finally, for selected services it is possible to select a coordinate system from the list of available coordinate systems:

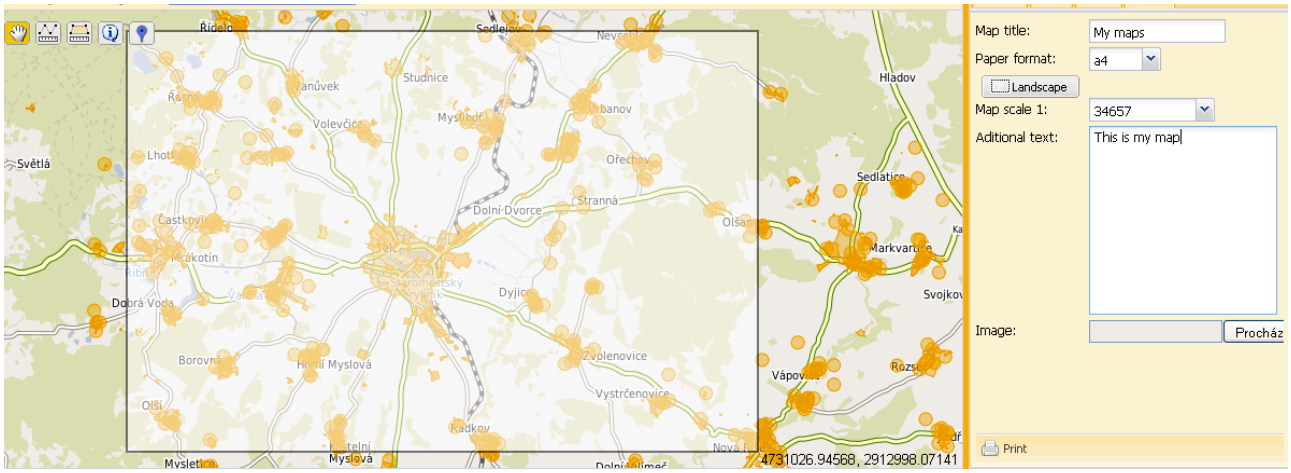


Last but not least you can also choose if tile caching will be used for this WMS.

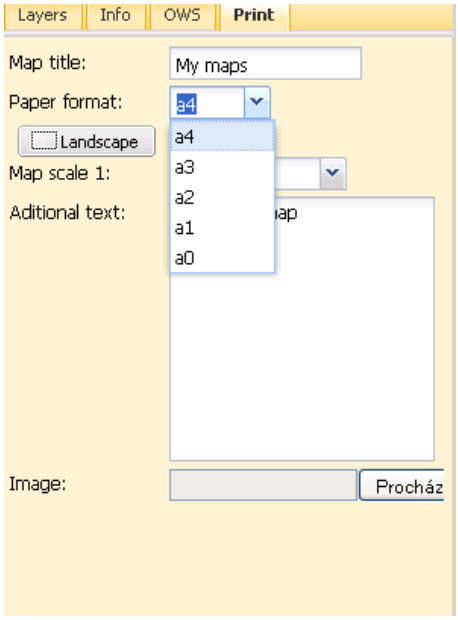


Print bookmark

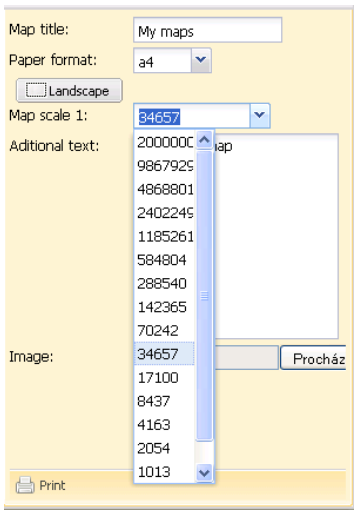
Print bookmark supports printing of the selected map composition into the output pdf file.



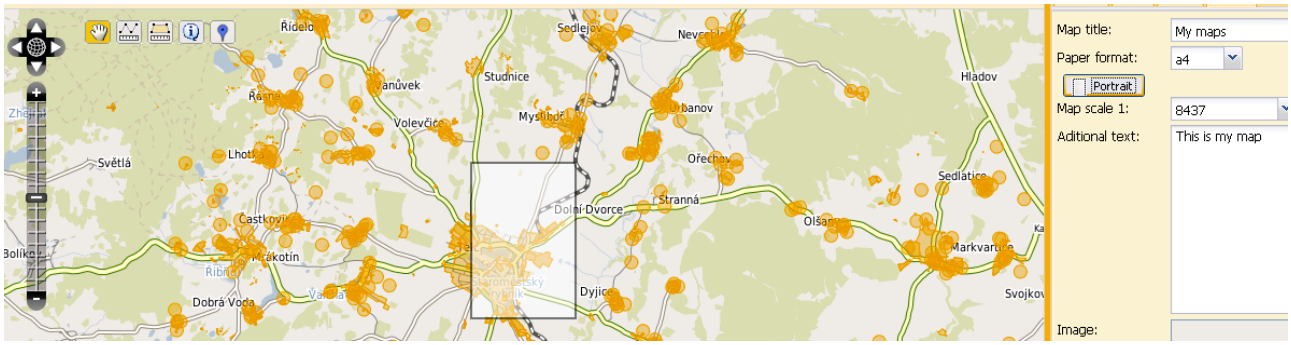
The printing settings can be defined, in particular: description of map and additional text, paper format...



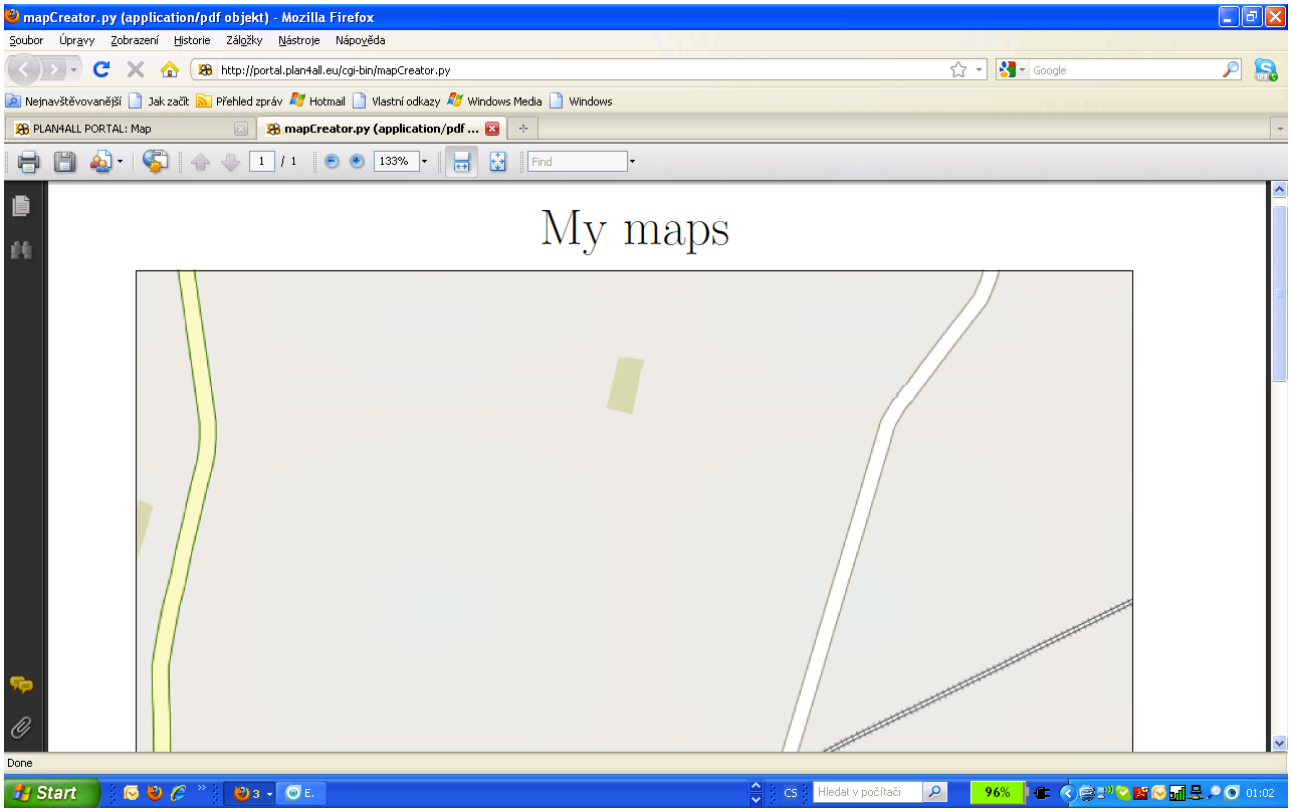
...scale...



... and it can be also defined, if the print will have portrait or landscape format:

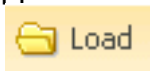


By pushing the ‘print’ button a pdf map is printed according the defined parameters.

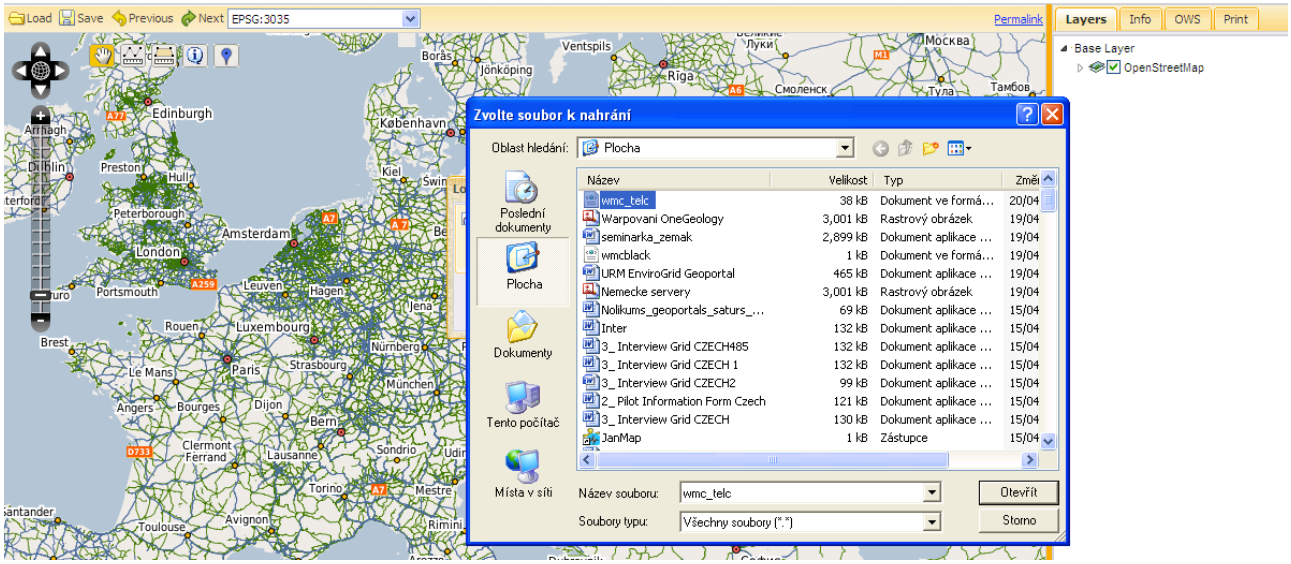


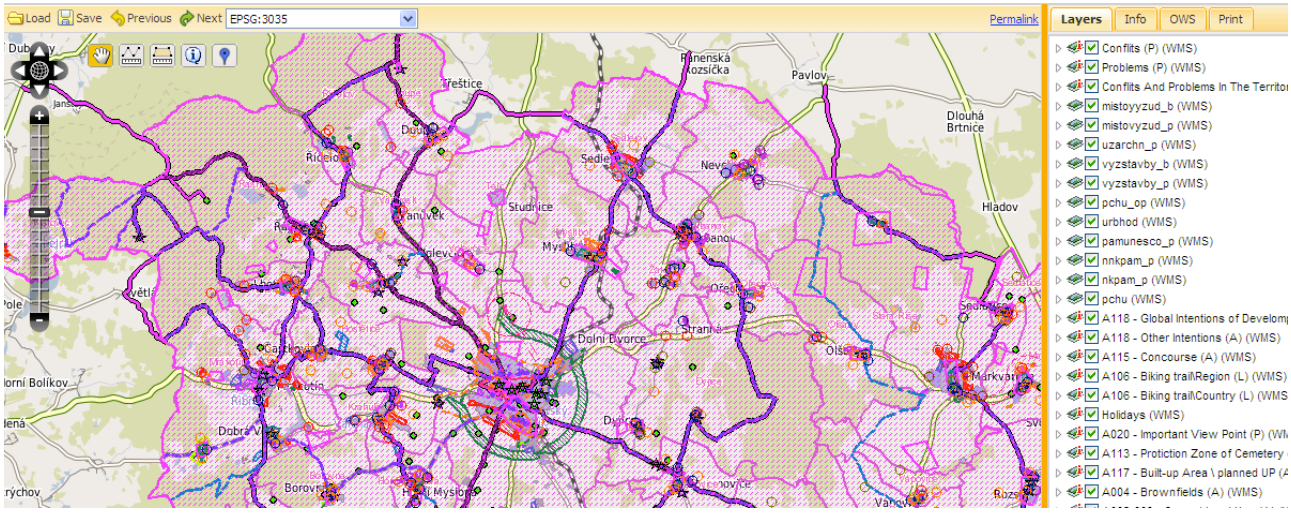
Tools box

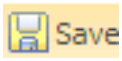
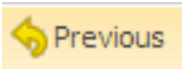
Tool box support next functions:

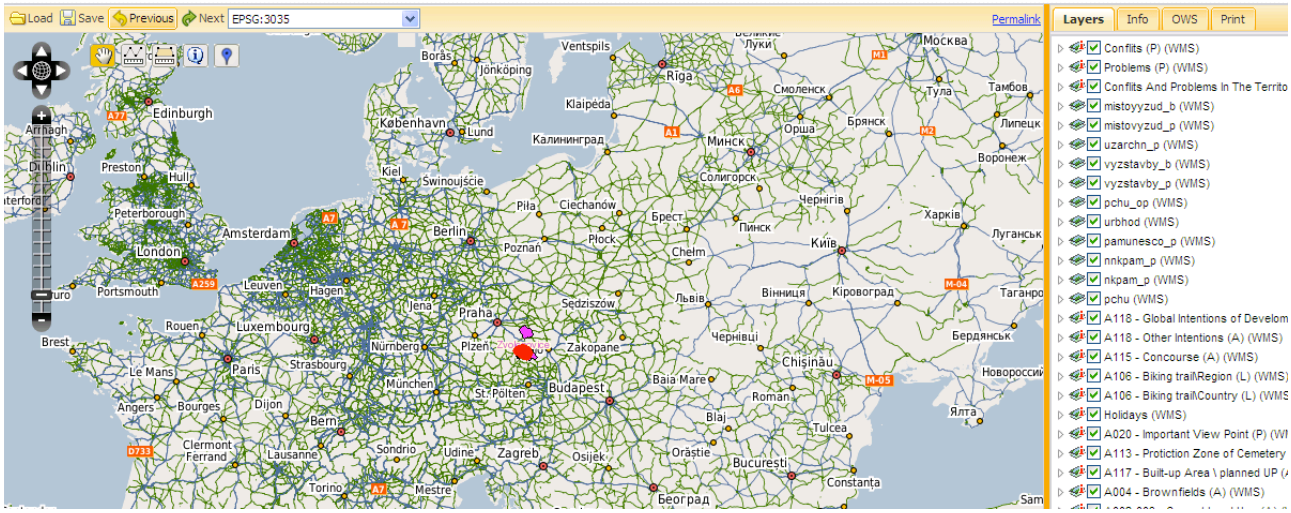
- The Load 

button allows to add additional levels stored in xml files on the hard disk into the existing map composition and so to describe map composition according to the Web Map Content (WMC) standard. Further it allows using of visualization parameters from WMC and also cut out as defined in WMC file.

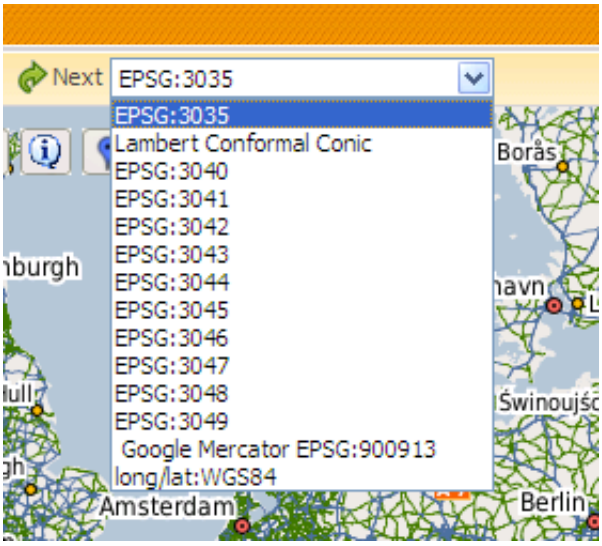




- The Save  button allows to store WMC of currently used WMS in map and currently cut out and visualization parameters as WMC.
- The Previous  button will switch on the previous cut out.



- The Next button will switch on the next cut out.
- The Rollout menu supports selection of projection parameters for visualization.



- The Permanent link button allows by clicking of the right mouse button to copy URL of current map window.

4.4 Metadata editor

MIcKa is a complex system for metadata management used for building Spatial Data Infrastructure (SDI) and geoportal solutions. It contains tools for editing and management of metadata for spatial information, web services and other sources (documents, web sites, etc.). It includes online metadata search engine , portrayal of spatial information and download of spatial data to local computer.

MIcKA is compliant with obligatory standards for the European SDI (INSPIRE). It can be connected with other metadata catalogues that are compliant with these standars too (its compatibility with pilot European geoportals is continuously tested).

MIcKA supports:
- metadata for spatial data (ISO 19115);
- metadata for services (ISO 19119);
- Dublin Core metadata (ISO 15836);
- Feature catalogue (ISO 19110);
- OGC CSW 2.0.2 (catalogue service);
- INSPIRE metadata profile;
- metadata user profiles.

Functions:
- Web interface for metadata editing;
- Multilingual (both user interface and metadata records). Currently following languages are supported: Czech, English, German, French, Latvian, Polish. It is possible to dynamically extend the system for other languages;
- Context help (multilingual);
- Import of the following metadata formats are supported:
  - ESRI ArcCatalog,

- ISO 19139,
- MIDAS
- OGC services (WMS, WFS, WCS, CSW)
-Feature catalogue XML

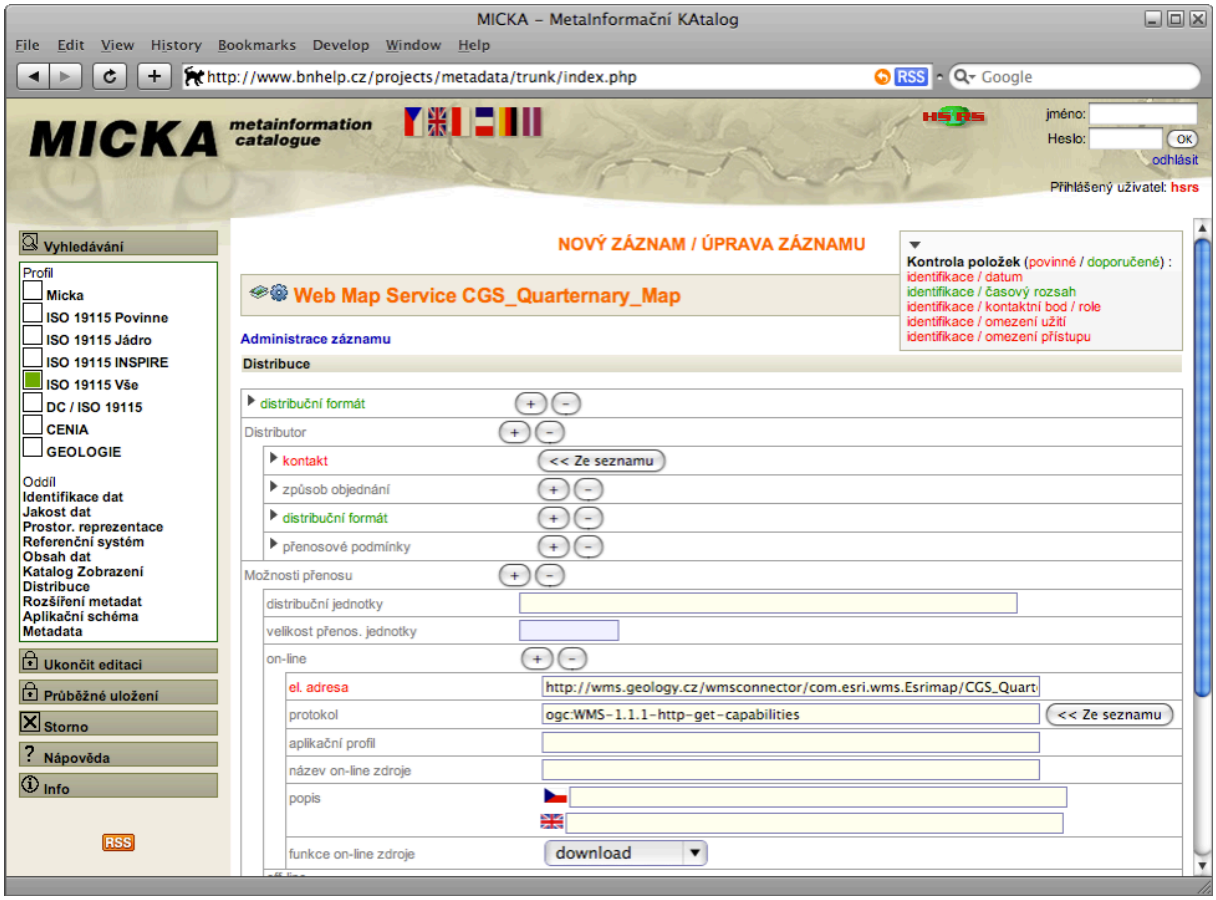
- Export – ISO 19139, GeoRSS
- Support of thesauruses and gazetteers.
- Display of changes by using GeoRSS
- User templates for appearance and functionality management.
- Possibility of map client connection for display of on-line map services.

System requirements

- Relational database (ORACLE >= 9, PostgreSQL >= 8.0, MS-SQL >= 2005, or other SQL databases)
- PHP >= 5.2, support of XSLT
- Operating system independence

Metadata editing

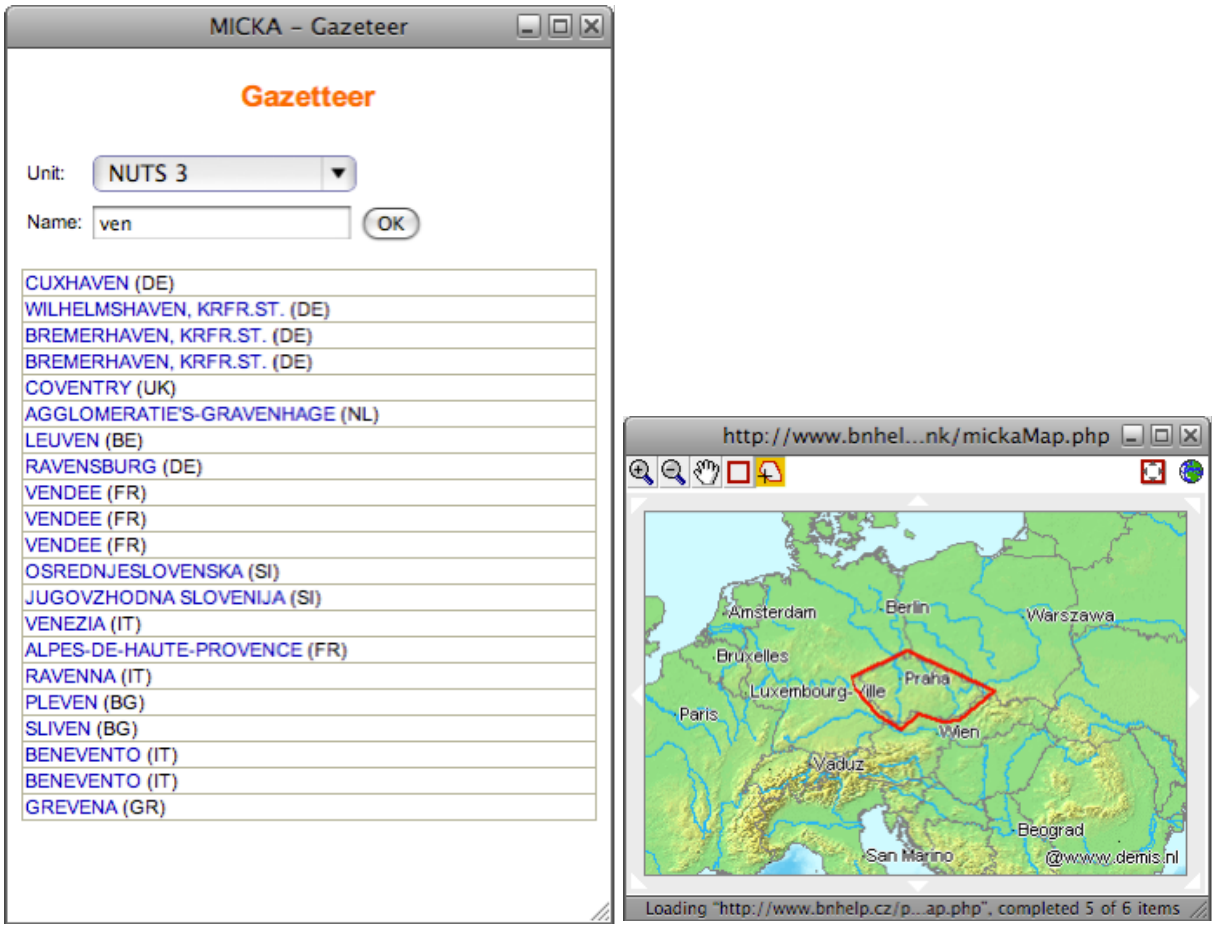
Metadata are stored in a relational database and edited by dynamically generated forms. Therefore it is possible to amend other standards or profiles. It is possible to switch between profiles while editing. Individual profiles can be distributed into sections. With help of control elements it is possible to double individual items, choose from code list or connect supporting applications. Control of mandatory filled items is enabled while editing.



Concept of work with spatial data

MIcKA enables to enter spatial extent of metadata:

- By choosing bounding box directly in map. All maps (for coordinates input or metadata extent display) are realised through connected WMS. Any WMS server can be connected.
- By search in gazetteer. Access to gazetteers is realised through connection to WFS server. By default WFS from HSRS server is connected. It serves administrative division of the Czech Republic and Europe (up to NUTS3 level). It is possible to connect the software to any WFS server.

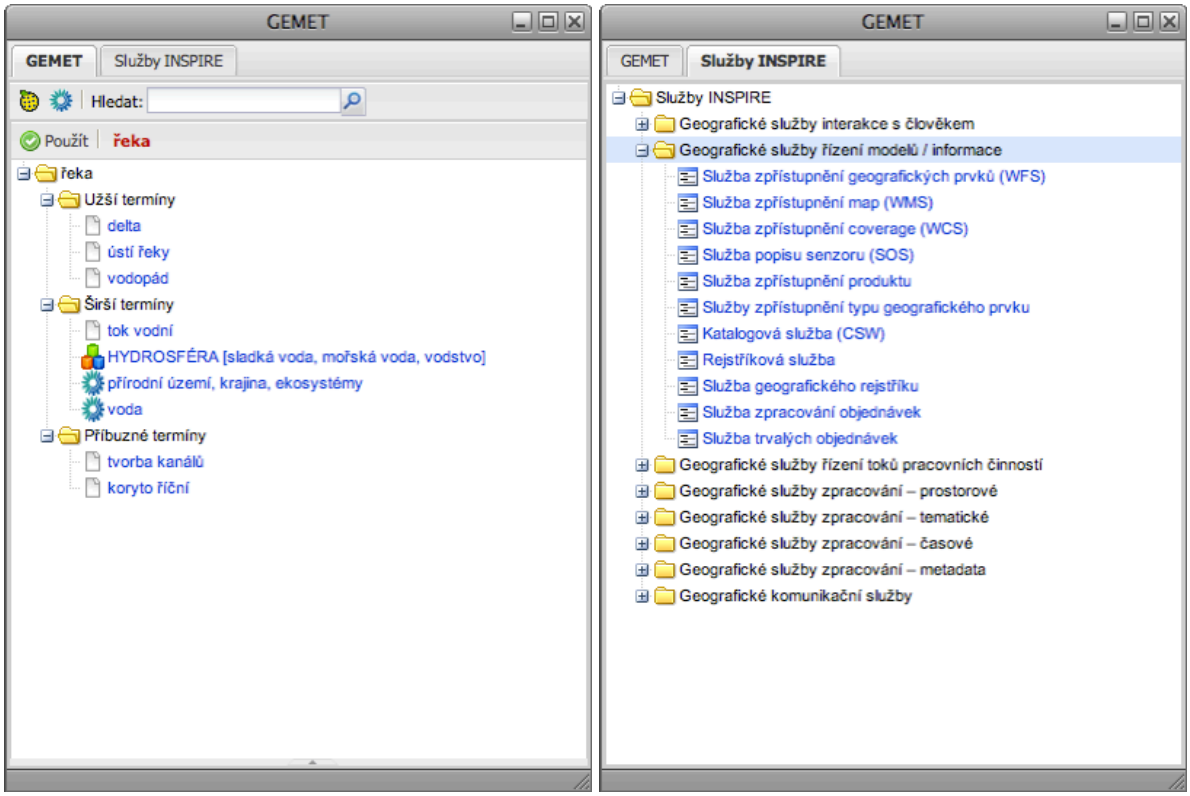


Concept of work with key names

The system enables standard classification of records according to:
- Thematic ISO categories (mandatory for datasets)
- Key words:
  - entered by user (arbitrary)
  - chosen from thesaurus

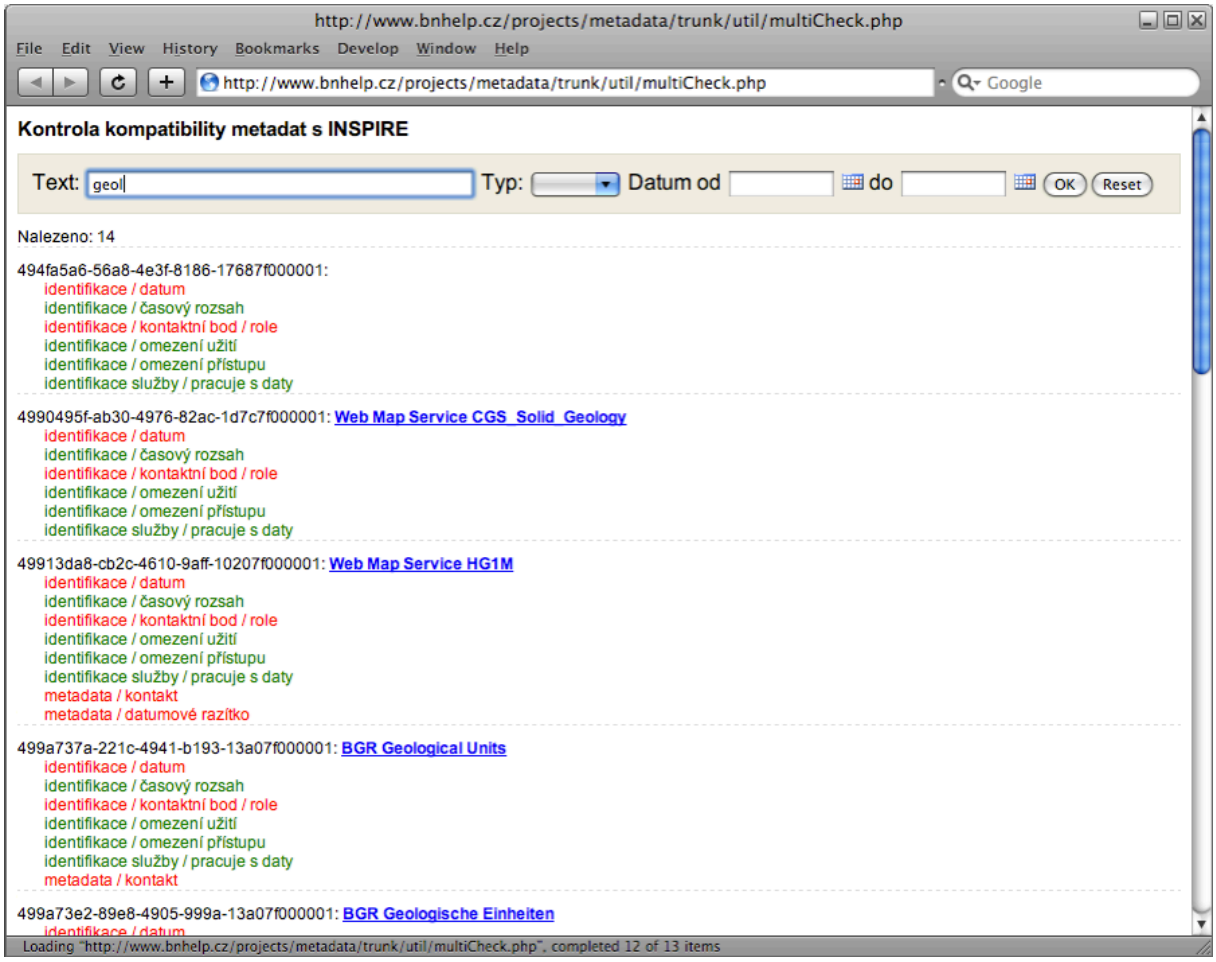
The system is compliant with the INSPIRE requirements. There are the following parts of the system:
- GEMET thesaurus service client - data classification;
- service code list.

Key words are inserted in order to enable multilingual search.



Compatibility with the INSPIRE Directive is ensured by:

- INSPIRE metadata profile is part of the system;
- Choice from key words from GEMET thesaurus;
- Choice from key words from code list of INSPIRE services;
- Continuous control of metadata completeness according to the INSPIRE profile;
- Batch control of completeness of INSPIRE profile;
- Implementation of catalogue service according to OGC CSW 2.0.2 standard.



Catalogue service:

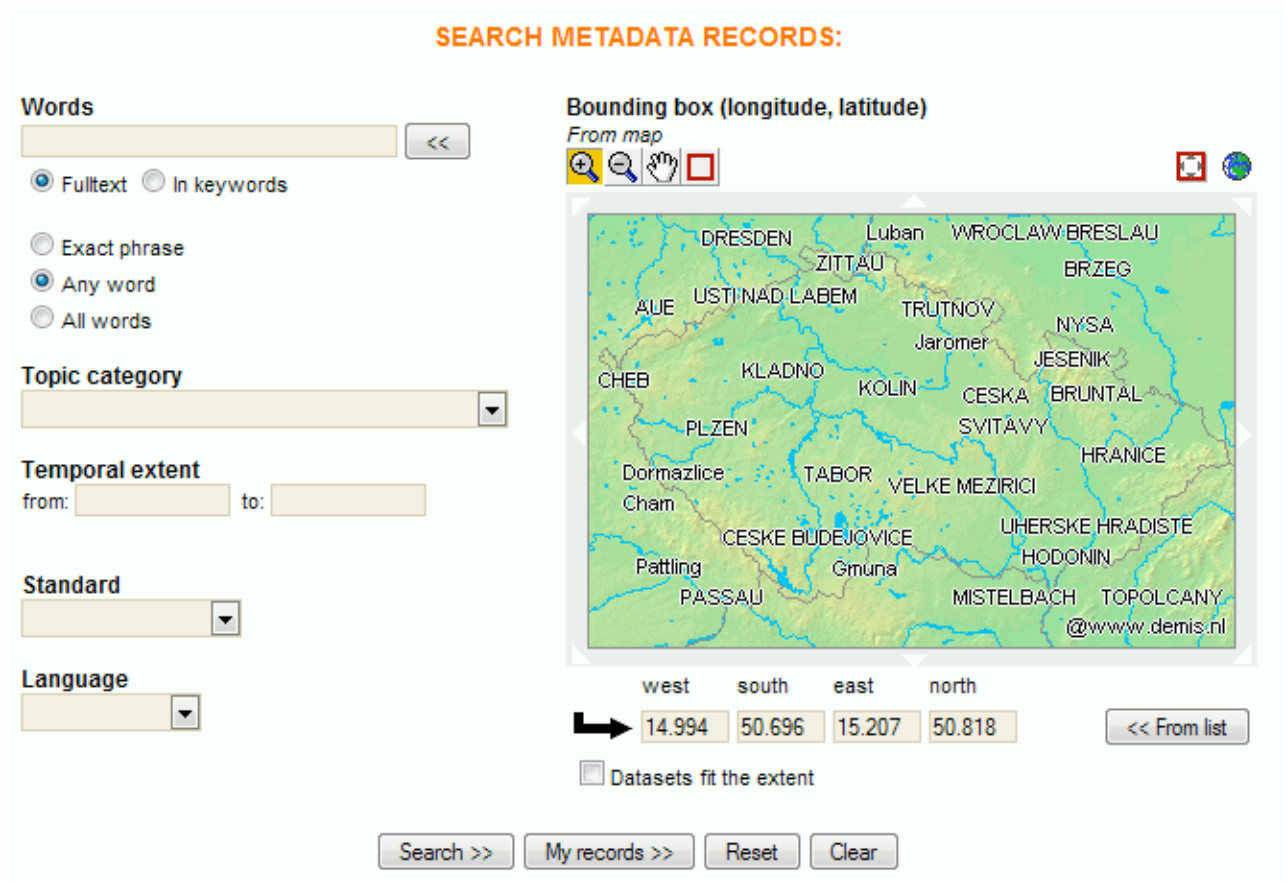
Catalogue service is a part of the system.It is based on OpenGIS® Catalogue Services Specification – profile Catalogue Service for Web (CSW) and OpenGIS® Catalogue Services Specification 2.0.2 - ISO Metadata Application Profile standards.

Supported operations:
- Basic: GetCapabilities, DescribeRecord, GetRecords, GetRecordById
- Editing: (CSW-T): Transaction, Harvest
- Inquiry items: according to standards
- Extensions: export to GeoRSS and KML

How to work with Micka

Metadata querying
The application enables basic metadata querying. More complex queries are enabled via catalogue service (OGC CSW 2.0.2), which is a part of the application.

This query form is activated by pressing the Search button in left menu.



Words: Text search. There are several options:
- To search text - fulltext search.
- To search keywords. You may use thesaurus for the search.
- Exact phrase - search for full text phrase in metadata.
- Any word - search metadata containing at least one of the words
- All words - search metadata containing all words in any order.

Topic category: Topic categories according to ISO 19115.
Temporal extent: Enter the date in the YYYY[-MM[-DD]] format, e.g. "2006-02-19", "2006-02" or "2006".
Standard: Select one of the listed standards.
Language: Set the main metadata language.
Extent: Set the search extent in term sof territory (bounding box)You can set the extent by entering the longitudes and latitudes values of the bounding box or by selection of the bounding box directly in the shown map.
Datasets fit the extent : Searched datasets are within the extent of the bounding box.

Map control:
- Zoom in
- Zoom out
- Pan
- Set the bounding box
- Get search extent (longitude and latitude values) from the map extent (bounding box drawn in map)
- Full extent

ATTENTION: Query is intersection of all filled in search options (logical AND).

Results are displayed as:

where

- is a type of the record. Record types may be distinguished by these icons:
  - Spatial data Metadata (ISO 19115)
  - Dublin Core Metadata (ISO 15836)
  - Spatial Service Metadata (ISO 19119)
  - Feature Catalogue (ISO 19110)
- <user> is a system user name of the metadata creator. It is displayed only when user has the editing rights.
- are buttons for editing/deleting records. They are displayed only hen the user has the editing rights.

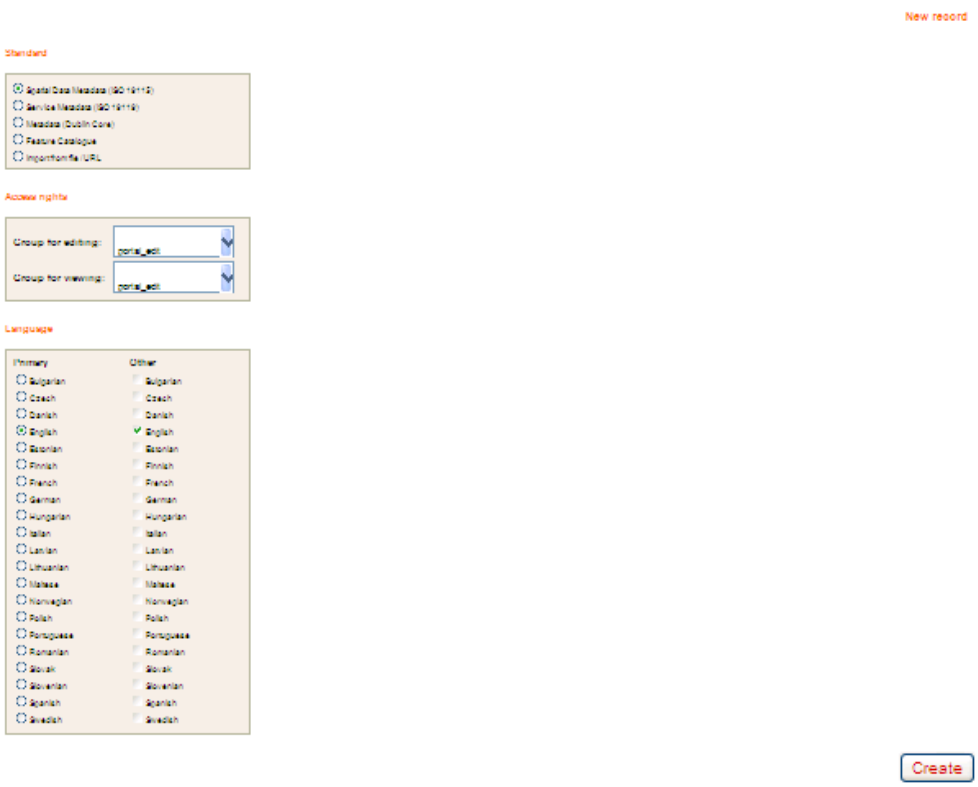
Record types are distinguished by background color: private / public . More in metadata editing.

The summary metadata are displayed by clicking on the record title. The full metadata can be displayed by "View detail" button on the summary page.

Metadata editing

Create a new record:

If you are authorized to edit, press New record button in the left menu. Then choose the metadata standard. Afterwards the following options are displayed:



You can set the following items:

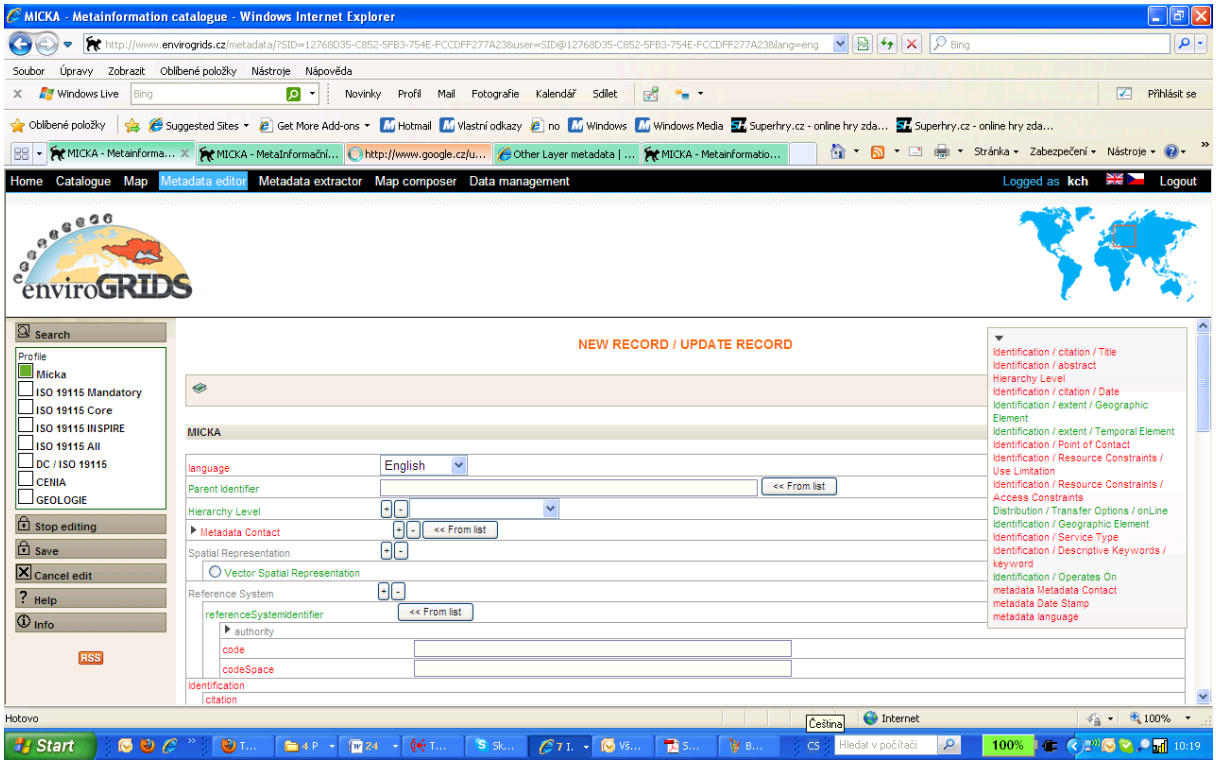
- template with pre-filled data (More about the templates can be found in the section Working with templates).
- groups for viewing and editing of the record.
- languages in which metadata will be collected (metadata record is multilingual). In the first column tick used languages, in the second column choose “main language” (This choice is needed for import, optionally for metadata export in XML).
- Import of files or URL services from which the data sources will be imported. In this case the template is not used. More can be found in the section Data import.

After choosing the template and language the interface for the record editing is displayed (information about individual elements are obtained by click on appropriate element).

Description of individual form elements for the record editing:

Profile choice – it is possible to switch between predefined profiles.

Section choice – in case of ISO 19115 in full standard the record length is too long. It is possible to display individual parts - sections. Data are stored by switching between sections.



Record administration –the dialog for administration is displayed. Here you can set:

- whether it is a template (More in section about Working with templates).
- the set of rights – group for editing and viewing
- public access (record will be visible for all users)
- the choice of the language (Attention! if the user cancel any language, appropriate data will be deleted

This dialog is accessible only if data were already stored !

Names of elements –tree structure of XML document corresponding to the standard. They are distinguished by colors:

- Compulsory elements (They are compulsory in a particular context, e.g. when facultative element A contains compulsory element B, it means that if whichever subordinate element is filled to element A it must be filled as well to element B. Example: when we fill in whatever on-line information to contact place there must be filled electronic address as well) There are only few compulsory items in the standard and they are contained in the compulsory core. Their control runs while saving in public record regime.
- Conditional compulsory elements (These element are compulsory under particular conditions, e.g. spatial extent must be filled either by bounding box or by extent description)
- Facultative elements

If you place cursor above the description field a context help occurs. It is taken directly from definitions of individual items of the standard, optionally supplemented by another description.

Field types of the forms – in the forms data types are distinguished by several colors:

- Text items – They can contain arbitrary characters. Generally they can be in arbitrary length. Abcdefgh, ijkl, 12
- Number items – They can contain only numbers. 999.999
- Date items – They can contain date in format "YYYY", "MM.YYYY" or "DD.MM.YYYY" (for Czech). In the other languages the format is according to ISO norm ("YYYY", "YYYY-MM" or "YYYY-MM-DD"). 25.9.2005

Adding / removing of recurrent elements – The standard enables multiple recurrence of element in many places. By the help of these buttons you can add and remove marked elements (including all sub-elements).

The choice from lists – All relevant code-lists for given standard are offered as lists including translations into national languages.

Another dialog windows – the system has a possibility to define various choices from predefined values, optionally integration with other programs (gazetteers, thesauruses, maps) through web services. By the help of these buttons you open new window for communication with auxiliary programmes. ATTENTION! If you want to use these functions, pop-up windows in your viewer must be allowed for this domain.

Metadata import:

The system enables data import from files for these metadata formats:

- ISO 19139 – exchange format XML for metadata
- MIDAS/ISVS – cancelled exchange format for metadata according to ISVS 2001 standard. Data are not loaded in full extent due to uncompatibility of list-codes and structures.
- ESRI - Profile ESRI-ISO that is generated by metadata editing in ArcCatalog (It is needed to set ISO norm in ArcCatalog!).
- Feature catalogue - XML file containing feature catalogue description according to ISO 19110 (Feature catalogue).

The file is imported by the button for file selection.

Web services metadata are possible to import by entering URL into corresponding line and by choosing the corresponding type of service. These OGC services are supported:

- WMS

- WFS

Gradually other services will be also implemented.
After import the metadata will be displayed in the editing mode.

Working with templates

The system enables to create template from the record that is possible to use for further filling your metadata records. Create your new record and fill all data that you think will be common for your metadata filling (E.g. contact data, spatial extent, reference system etc.). Save the record in template mode (set in caption of the page).

If you now want to create a new record the template is offered for you under the name you created it. If you choose the template all pre-filled items are copied into the new record. It is possible to edit whichever item of course. Similar function has record duplication where data from the selected record are copied into a new record.

It is possible to work with templates as with whichever other records including searching, if the user is authorized to the template.

Instructions how to complete the metadata according to ISO 19115

This document is intended as a help for creating “proper” metadata records in MICKA metadata catalogue. It takes into account INSPIRE metadata profile (DT Metadata – Draft Implementing Rules for Metadata 2007-02-02) as well as core ISO 19115/19119 elements (and corresponding parts of other ISO 191xx standards). In addition to these some elements which we consider important are included. All elements in the profile are subset of ISO 19115/119 standards.

Common rules:
For filling metadata basic metadata record use ISO 19115 norm and then select MICKA profile (it is default in some sites). The description of particular elements you can find in the table below. If you want to add elements beyond this profile, please select full ISO 19115/19 profile.

Meaning of its columns:

Element	Element name in MICKA application
L	Level: 1= INSPIRE metadata discovery level 1 (basic elements), 2= INSPIRE metadata discovery level 2, 3= other ISO 19115 core elements 4,5= elements added by Help Service Remote Sensing
Path	Path to element in document (similar to XPath)
Description	Element description
M	If the element is multilingual (for textual elements). It implies that user should fill the element in all set languages. (The languages may be defined in record creation or during editing process by Record administration)
Example	Example(s)
Note	Note(s)

Mandatory elements are marked with red color (ISO/INSPIRE), conditionally mandatory (explained in text) green. INSPIRE required queryable elements are bold.

How to fill metadata about data:

If you are logged as user with editing rights, you may create new record by clicking “New record” in left menu. Then choose ISO 19115 standard, click next. In the next page you may

- set the template (refilled record you may data copy from)
- select group (group of users who may browse the records)
- select chown (groups of users who may edit the record)
- set the metadata languages (left column is for selection all languages, right for setting “main” language – needed for some imports and ISO 19139 representations)

You also may import metadata from ESRI ISO metadata file. In this case select proper format and select file for upload.

Then you press [NEXT >>] button. Blank form is shown. Then you select “Data identification” radio button. Now you may edit metadata.

Element	L	Path	Description	M	Example	Note
title	1	Identification/Data Identification/citation/ title	Dataset name well known in organisation.	M	ZABAGED	*Must be unique in the rank of organisation.*
date	1	Identification/Data Identification/citation/ date/date	Date of creation, publication etc...		2007-01-15	*More dates may be filled (creation, revision ...) At least one date must be specified.*
date Type	1	Identification/Data Identification/citation/ date/dateType	What event is presented by date.		publication	
resource identifier	2	Identification/Data Identification/citation/ identifier/code	Source identifier		527c4cac-070c-4 bca-9aaf-92bece 7be902	*Mandatory, if exists. In the rank of INSPIRE unique identifier system will be defined.*
abstract	1	Identification/Data Identification/abstract	Abstract describing the dataset.	M	Middle scale topographic map with road network, main cities an main water bodies.	*The abstract similar to*
Point of Contact	1	Identification/Data Identification/poit of contact	Contact data for the	M	John Smith, 123 Long rd., New City, cze	*Compound element. It may be filled from predefined contact list which is maintained centrally for the application (click “From list” button). The list may be directly edited by authorised users at this point in popup window.*
keyword	1	Identification/Data Identification/ DescriptiveKeywords/ Keyword	Keywords representing the dataset	M	Coal, energy, mineral	*Mandatory in INSPIRE profile (may be changed in future). We recommend to use thesauri if exist. More keywords may be used for narrowing the theme.*

use Limitation	2	Identification/Data Identification/ Resource Constraints/ legal constraints/ access Constraints	Access Constraints applied to assure	M	Not usable for navigation	
Resource Constraints	2	Identification/Data Identification/ Resource Constraints/ legal constraints/ access Constraints	access constraints applied to assure the protection of privacy or intellectual property, and any special restrictions or limitations on obtaining the resource or metadata		copyright	*If not filled it is assumed having no restriction.*
Spatial representation Type	3	Identification/Data Identification/Spatial Representation	Spatial representation of data in the dataset.		Vector/grid	*GISS data will be represented usually with "vector" or "grid" value, sometimes "tin" for elevation triangular irregular network models.*
Character set	3	Identification/Data Identification/ character set	Character set of the dataset if the dataset consists textual information.			*Character set of the dataset not metadata!* *For eg. raster data doesn't have meaning.*
Equivalent Scale	2	Identification/Data Identification/Spatial Resolution/Equivalent scale/denominator	Scale factor corresponding to resource map scale.		50000	*If it is possible use this value rather than distance.*
distance	2	Identification/Data Identification/Spatial Resolution/distance	Distance corresponding to minimal size of distinguished map objects.		5 m	*Compound element. Fill in the size and corresponding units of measure. For raster data (e.g. aerial photos) fill the pixel size.*
language	1	Identification/Data Identification/language	Dataset languages if dataset consist textual information		cze, eng, ger, ita, ...	*Mandatory if textual data are present in the dataset. Does not have sense for aerial photos etc.*
topic Category	1	Identification/Data Identification/topic Catelgory	Basic thematic classification.		elevation	*More categories may be set. It is very rough basic classification. Keywords and thesauri based are recommended.*
Geographic extent	1	Identification/Data Identification/ extent/ GeographicElement/ GeographicBoundingBox	Spatial extent. Typically minimal extent bounding WGS 84 lat/lon box.		15.42, 50.14, 15.63, 50.57	*Basic geographic extent. You may take it from map or from connected gazetteer client.*
Temporal extent	1	Identification/Data Identification/ extent/ TemporalElement// extent	Time extent where dataset is valid		1990-06, 2001-12-31	*Fill, please the beginning and end (significant eg. for administrative units). If the data corresponds to time snap, use instant (eg. for aerial photos). Fill the date and/or time.*

purpose	5	Identification/Data Identification/ purpose	summary of the intentions with which the resource (s) was developed	M	census	
status	5	Identification/Data Identification/status	Status of development of the resource		completed	*Indicates is the dataset is full or under development etc.*
resource format	5	Identification/Data Identification/resource format/	Data format in which data are store in organisation		ORACLE SDO	*Compound element – format and its version. It has importance for internal organisation purposes. For distribution the distribution format is to be filled*
Distribution						
linkage	1	Distribution/ TransferOptions/ onLine/linkage	URL to further information about data or for datadownload		http:// www.mysite.com/data/ myDataset file://C$/mydata/ boudary.shp	*For local files here may be path in your LAN. The function is "download"*
function	3	Distribution/ TransferOptions/ onLine/function	Function of on-line resource		download	
description	3	Distribution/ TransferOptions/ onLine/description	Textual description of on-line source	M	Home page	
format	3	Distribution/Distribution format/format	Data format name		SHP, GeoTIFF	*Data may be offered in several formats.*
format version	3	Distribution/Distribution format/version	Data format version		6.0	
Data content						
Feature catalogue	4	Content/feature catalogue description	Feature catalogue citation			*Here is connecting point to dataset structure description introduced by Feature Catalogue. Please, fill the Feature catalogue first, then you may select corresponding Feature catalogue and Feature Types from here by clicking "From List" button. The system will fill the needed sub-elements.*
Reference system						
Ref. system	3	Reference System/ reference System Identifier/	Reference system of dataset. Dataset may be offered in more ref. syst.		EPSG:4326	*Compound element. It is recommended to use EPSG codes. May be filled from predefined list. Also source citation may be included. (important if not EPSG code)*
Quality						

lineage	2	Data Quality/lineage/ statement	general explanation of the data producer's knowledge about the lineage of a dataset	M	Measured with hanheld GPS with overall position accuracy 1 m in free space, 5 m in built-up areas.	*Textual description of data quality and all notes describing data creation which may illustrate data quality for user.*
conformance	2	will be set ...	Conformance data quality with INSPIRE requirements			*Will be described in INSPIRE*
scope	3	Data Quality/scope/ level	Scope on data quality description.		dataset	*Mandatory if quality is filled. Usually "dataset".*
Spatial representation						
Geometric Object Type	4	Spatial Representation/vector/ geometricvObjects/ geometricObjectType	Geometric object types contained in dataset.		point, surface	*Relevant only for vector data. One dataset may have more geometric objects types.*
Metadata						
Metadata – contact point	1 - 2	metadata/contact	Party responsible for the metadata record.	M		*Similar to dataset point of contact*
Hierarchy level	4	hierarchy level	What hierarchy level is described by metadata. typically dataset.		dataset, service	*We may describe different levels of the dataset, eg. Features. INSPIRE makes it mandatory using "dataset", "series" and "service". For Applications metadata use "software".*
parent Identifier	4	parent identifier	identifier of dataset or series which current dataset if part of		7d71c480-c480-1d71-af63-c88088beb3f3	*You may build hierarchical binding between metadata records. You may choose identifier of dataset contained in the database clicking on button "from list" or fill the identifier manually (it may come from different location and may be found via catalogue services during query process subsequently).*

Note: date stamp and metadata language are set by the software.

If you want to fill in other elements, you have to select "full" ISO 19115 metadata profile.

How to fill applications metadata:

Similar to data metadata but set hierarchy level to "software"

How fill service metadata:

If you want to start with blank form, select “service identification”. OGC Services metadata can be imported directly from service address filling its URL in field in the new record form. (Only WMS (Web Map Service) and WFS (Web Feature Service) are supported now.)
Then you may fill in other elements similar to dataset metadata. In table below are important elements:

Service type	1	Identification/ ServiceIdentification/ service Type	Standard type name of the service.		WMS	*INSPIRE recommends simple names (WMS, WFS etc.). Select from list.*
operation name	2	Identification/ ServiceIdentification/ containsOperations/ Operation metadata/ operation name	Provided operation name		GetCapabilities, GetMap	*When importing service metadata from GetCapabilities request,*
Connect point	1	Identification/ ServiceIdentification/ containsOperations/ Operation metadata/ connectPoint/linkage	location where the operation may be called		http:// www.bnhelp.cz/ cgi-bin/crtopo	*Generally each operation may have different address. Mostly all operations run on the same address.*
service type version	2	Identification/ ServiceIdentification/ containsOperations/ Operation metadata/ version	Service type version		1.1.1	*Mandatory, if the operation is well know type (OGC service)*
DCP	2	Identification/ ServiceIdentification/ containsOperations/ Operation metadata/DCP	Connection type (Distributed Computing Platform).		webServices	*In most cases WebServices*

Note: Other elements (contact point etc) are similar to dataset identification.

How to fill dataset structure description (attributes etc.):

Because ISO 19115 doesn’t describe dataset structure (features, attributes etc), Feature Catalogue is needed to describe it. ISO 19110 brings it standard structure. In MICKA, ISO 19110 subset is used for quick description of dataset structure.
How to describe dataset structure:

1. Create new Feature catalogue record and fill its name, description etc.
2. Fill Feature types and its attributes description (hierarchical structure). The description of the element if in table below:

name		feature catalogue/name	Name of feature catalogue	M	ZABAGED FC	*Should be unique in the organisation*
scope		feature catalogue/scope	C	M	Topographic map	*Keywords*
version number		feature catalogue/ version number	The number of catalogue version		1.5	
version date		feature catalogue/ version date	Date of version release			
producer		feature catalogue/ producer	Organisation responsible for feature catalogue			*Compound element – the same as metadata*
Feature						

Name		feature catalogue/ feature Type/type name	Name of the feature		LAKES	*It should be machine-system name, not the user title.*
definitio n		feature catalogue/ feature Type/definition	Description of the feature	M	Water basins - natural or artificial.	
code		feature catalogue/ feature Type/code	The code of the feature type		A015	*Alphanumeric code. It is known from DIGEST and other FC.*
Attribute (describes one feature attribute)						
Name		feature catalogue/ feature Type/ featureAttribute/ memberName	Name of the attribute		NAME	*Should be machine-system name, not user title.*
definice		feature catalogue/ feature Type/ featureAttribute/ definition	Description of the attribute	M	Lake name	
datový typ		feature catalogue/ feature Type/ featureAttribute/value data type	Date type of the attribute		Integer, float, text, ...	*There is not some dictionary for date types. Depends on platform.*
jednotky		feature catalogue/ feature Type/ featureAttribute/value Measure unit	Units of measure of the attribute.		km, kg etc.	*SI units recommended*
Attribute Value (describes attribute domain if defined by value list)						
label		feature catalogue/ feature Type/ featureAttribute/ attributeValue/ valueLabel	Label of the class	M	school	*Simple label describing the attribute value matching class.*
code		feature catalogue/ feature Type/ featureAttribute/ attributeValue/ valueCode	Code of the attribute		7	*Code value representing the class*
definitio n		feature catalogue/ feature Type/ featureAttribute/ attributeValue/ valueLabel	Description of matching class	M	Buildings used for education purposes.	

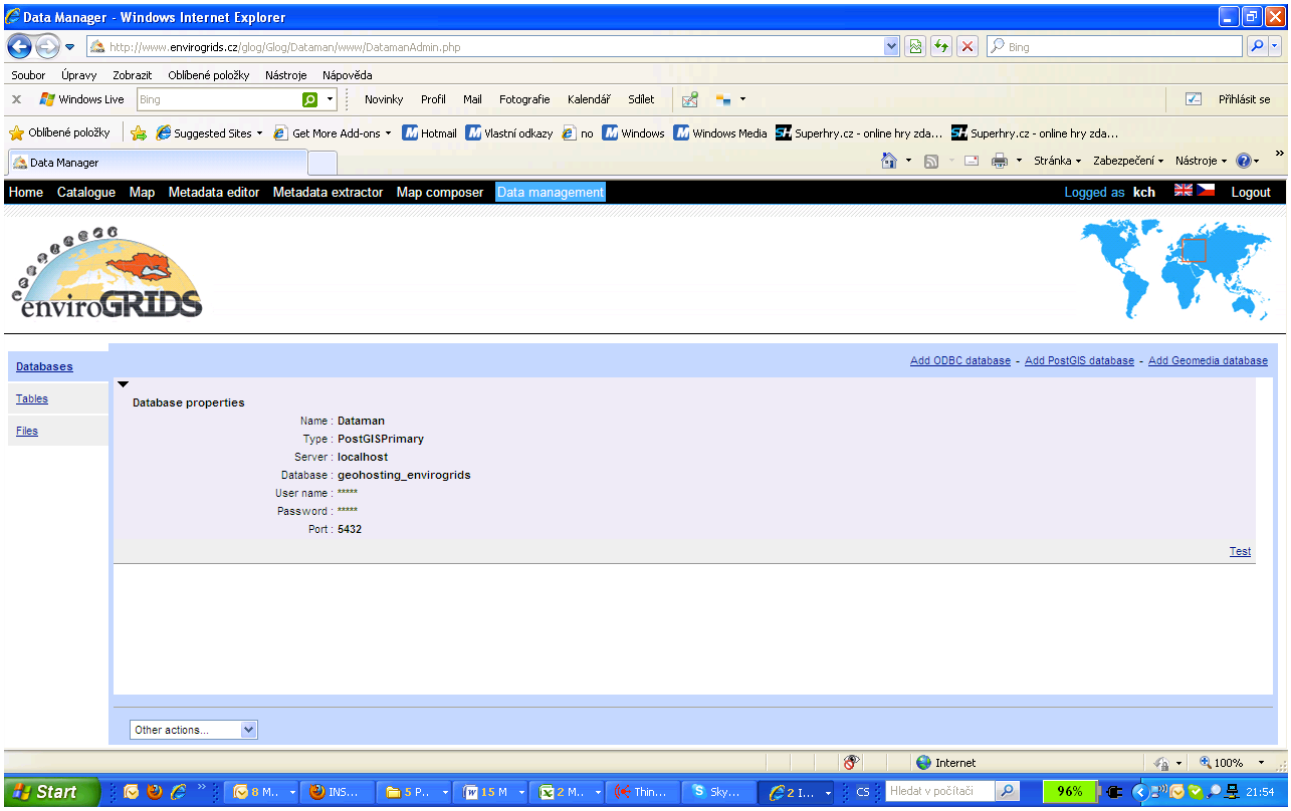
Attribute cardinality is not necessary to fill, if not filled We presume cardinality=1.

During metadata editing link to correspondent Feature Catalogue may be set.

4.5 Geohosting

DataMan

DataMan is an application that allows you to upload files to a data repository, but also to work with databases for geospatial data.



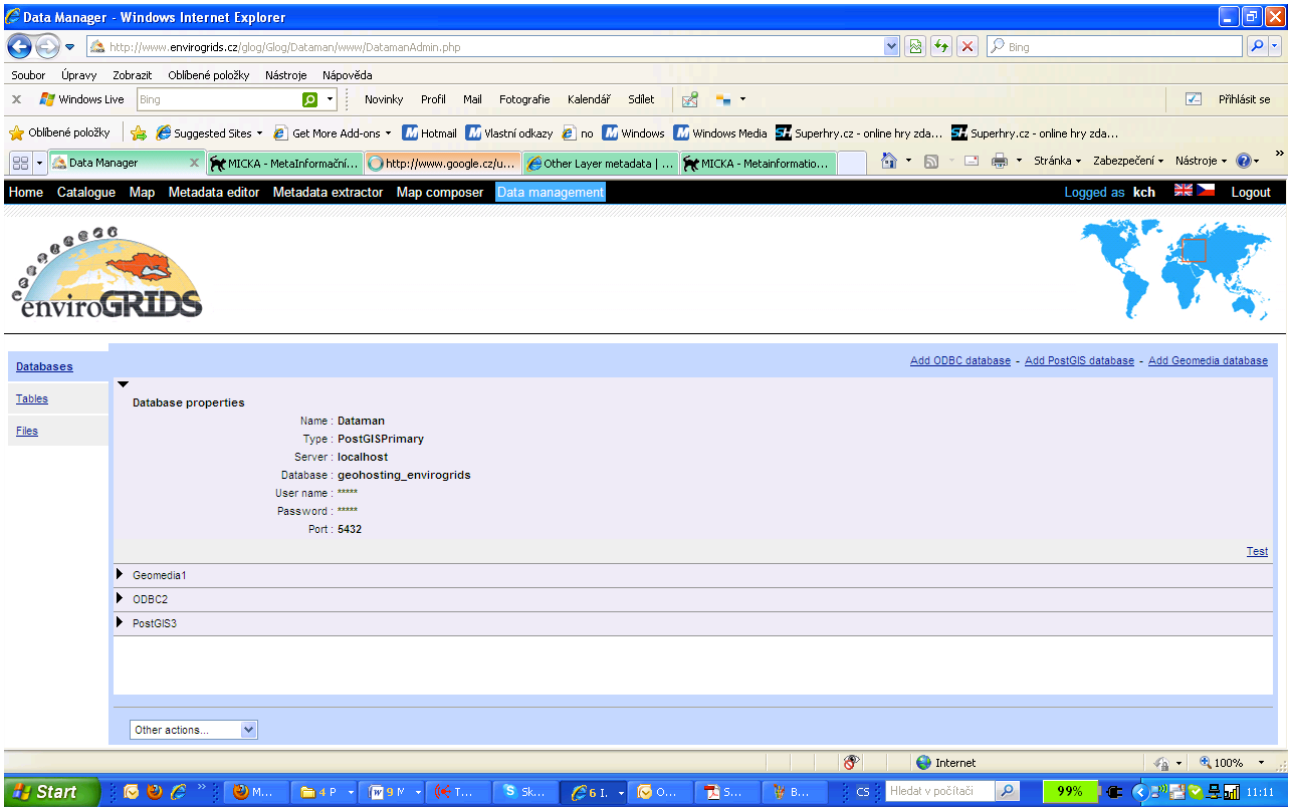
DataMan application menu (left) allows the operation of databases with different database tables and files imported to the server.

Submenu for each item can be displayed / hidden using the arrow symbol.

Databases

DataMan allows to work with any number of existing databases. For database there are the following operations:

- Adding references to ODBC database
- Add a reference to the PostGIS database
- Add a reference database, GeoMedia

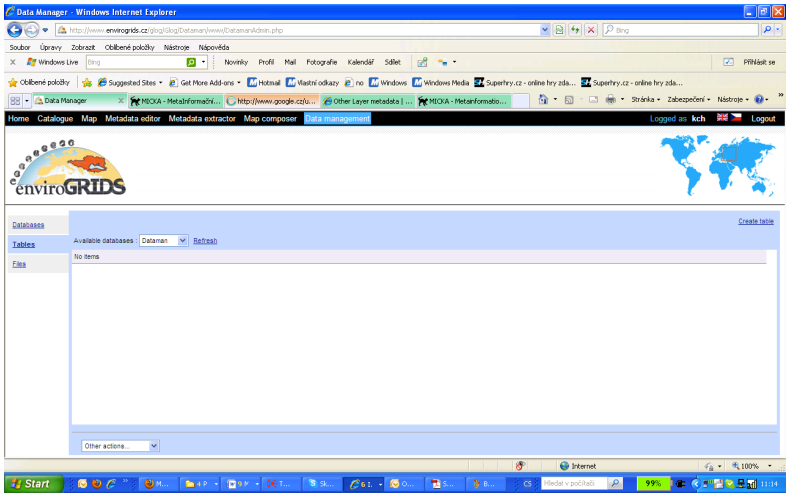


The procedure for adding references to databases:

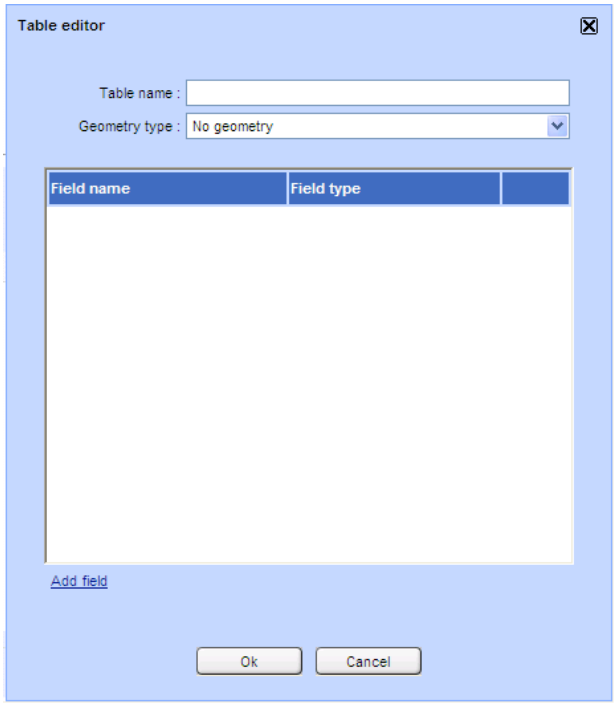
- To add references to the database click on the link "Add database xxx" for the type of database
- Fill in the parameters and let the database store
- Testing of the connection by clicking on "Test"
- Deleting references clicking on delete

Tables

In the attached database you can create or edit a table:



- Select the database
- To create a new table click on "Create table" – it opens "Table Editor"

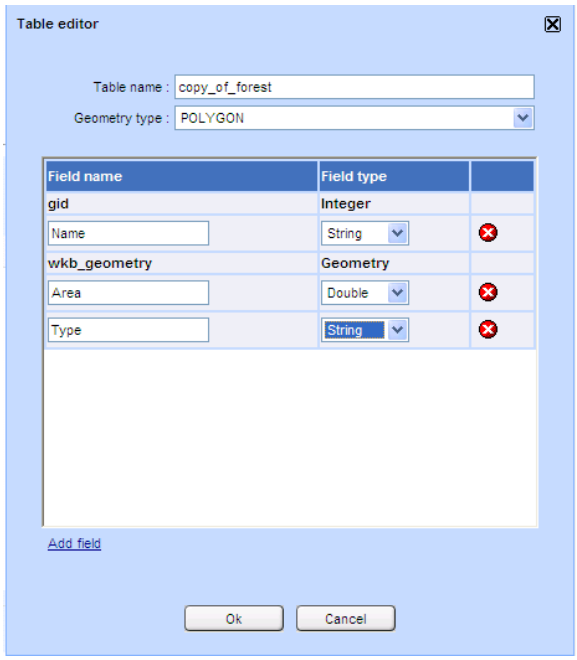


- Enter the name of the table
- Select the type of geometry or table without geometry
- Add additional items of the table by clicking on the link "Add Item"
- Table ready to confirm with "OK"

For existing tables in the database it is possible to:

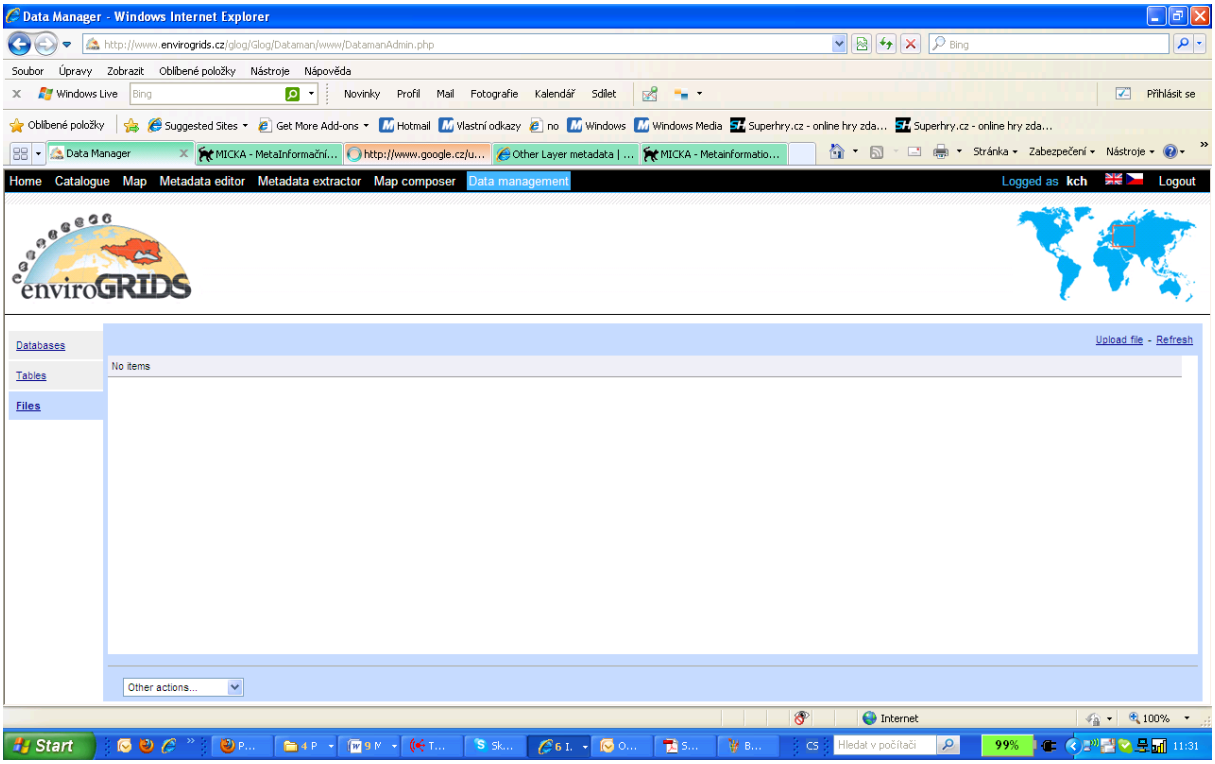
- browse the structure - icon
- delete - icon
- change the structure - the icon

- view the map (in the case of geographic data) - icon 



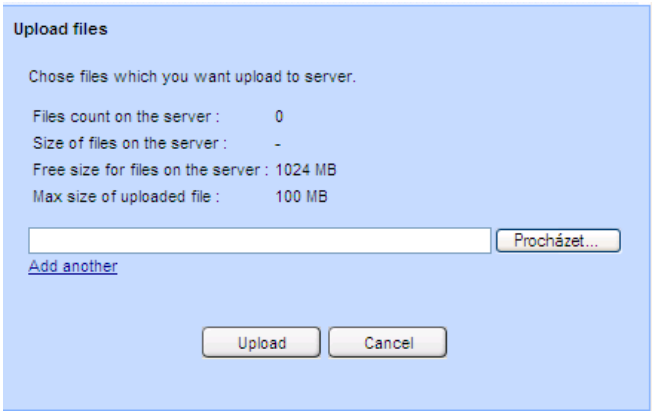
Files

After clicking on "Files" in the left menu of DataMan you can see a list of available files on the server and available tools.

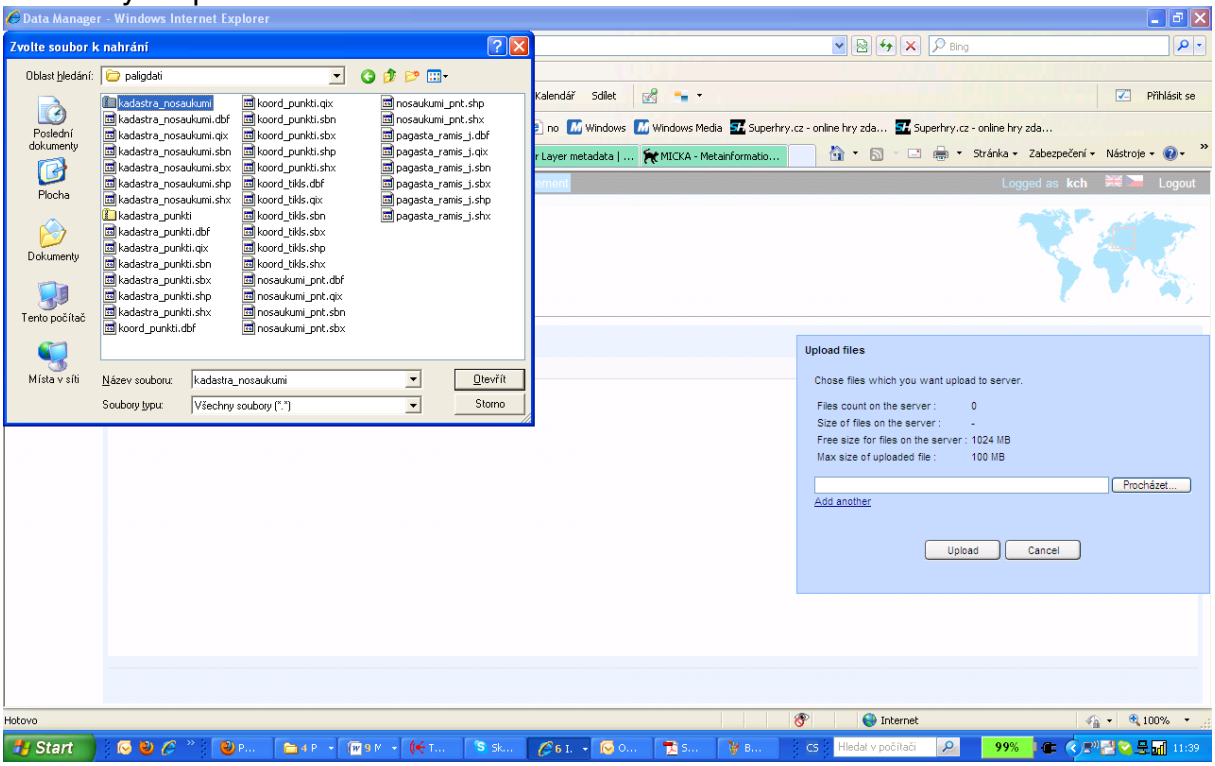


For uploading files to a server (provide next steps)

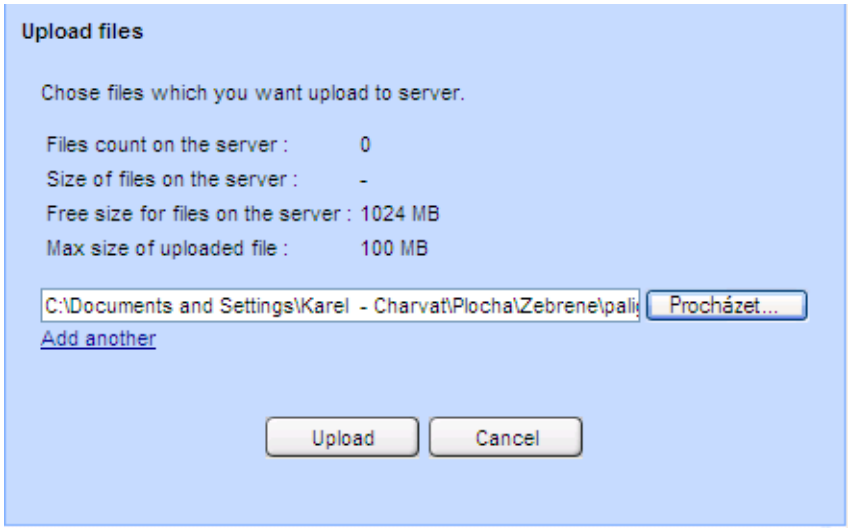
- click on "Upload file" – it will display a window with information about free space on the server



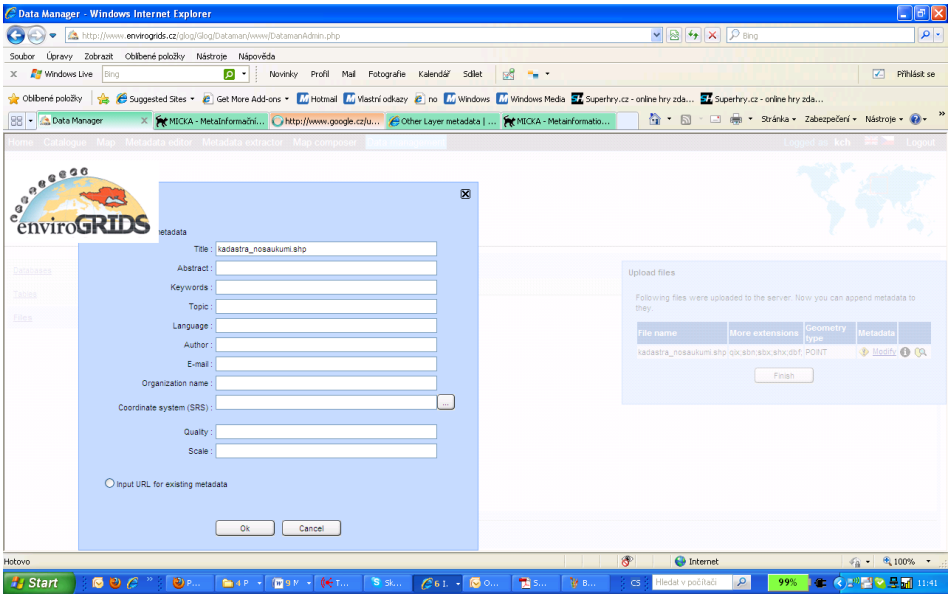
- click on the search button
- select your preferred file



- upload the file to the server

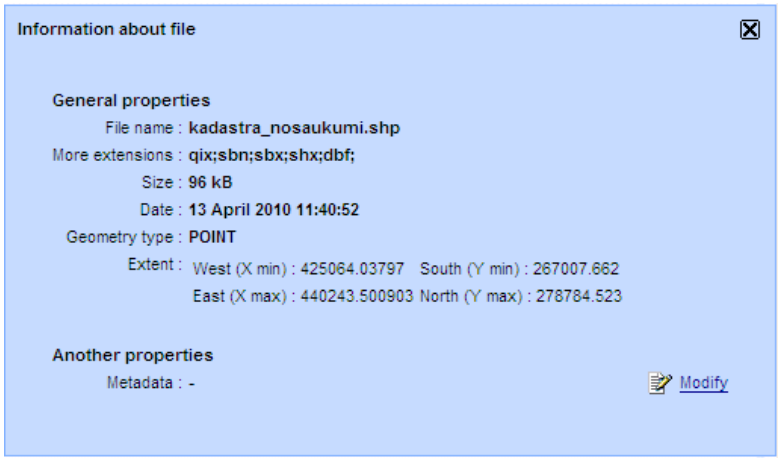


- the uploaded file to add metadata



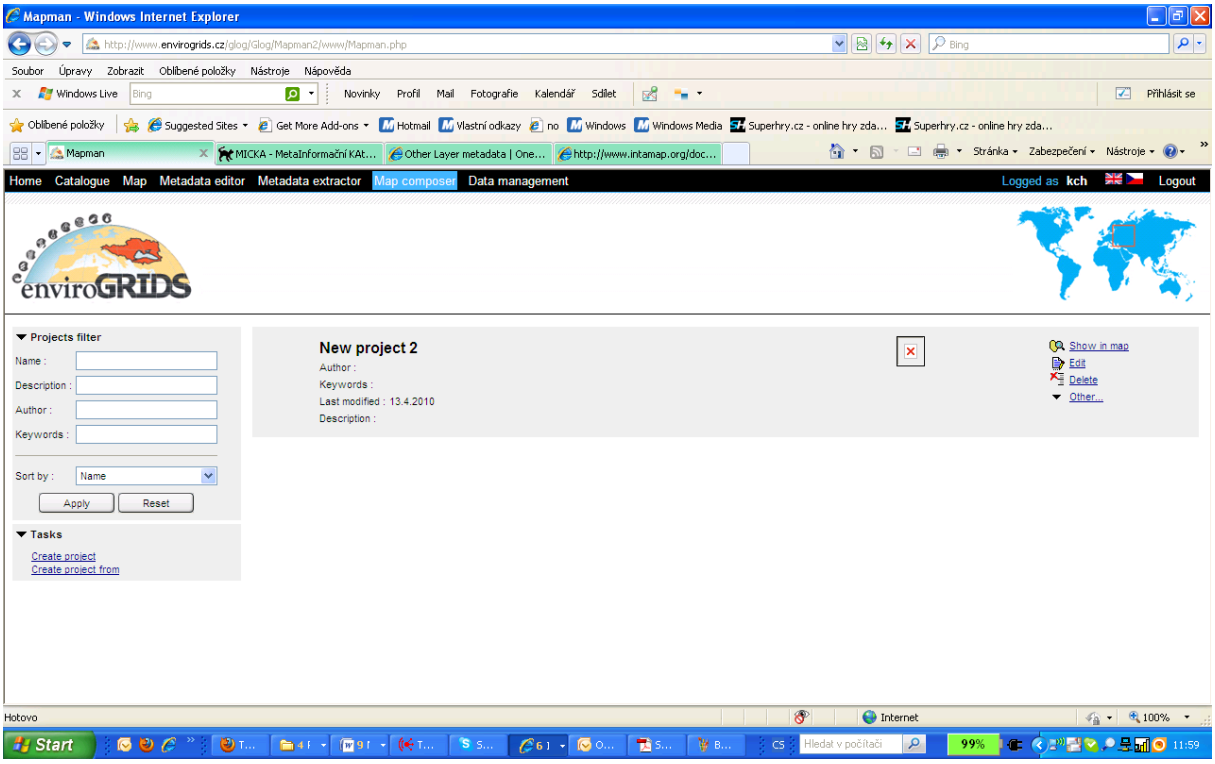
For the files on the server, you have the next functions:

- view information about a file - icon
- download the file to your computer - icon
- delete a file from the server - icon
- preview file in map window (for geo-data) - icon
- import the file into a database (currently only the vector data in SHP files) - icon
- transform the file into another coordinate system / projection - icon



MapMan

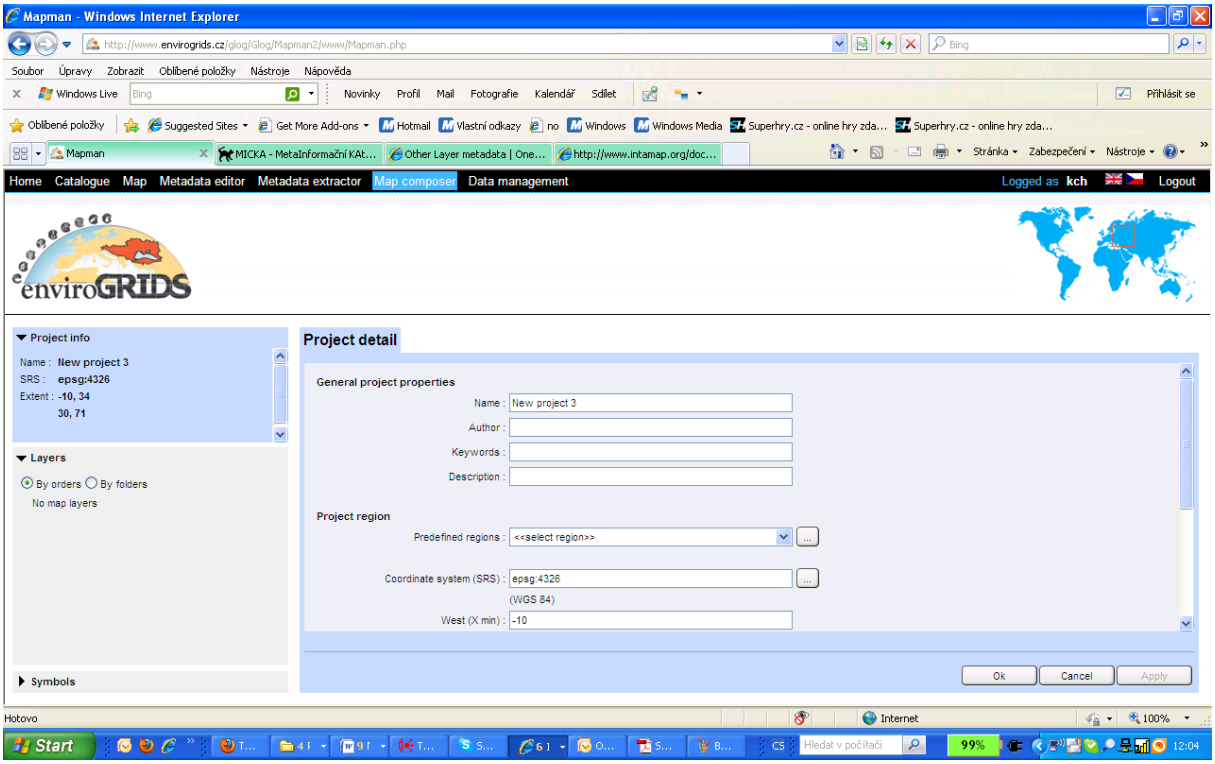
MapMan allows integration of data accessible through standard web services (WMS, WFS), together with spatial data stored in databases and files on internal servers. All these data sources can be used for creating map compositions in a web environment. Such newly created composite map can be displayed by the user in several ways - either in standard web browsers (Open Layers, GoogleMap, DHTML client) or on a desktop browser (GoogleEarth). Important is the opportunity to publish these new compositions as a completely new web service - WMS or WFS.



You can edit Map composition or selecting existing composition from the list or clicking on button Create project.

Creating new composition

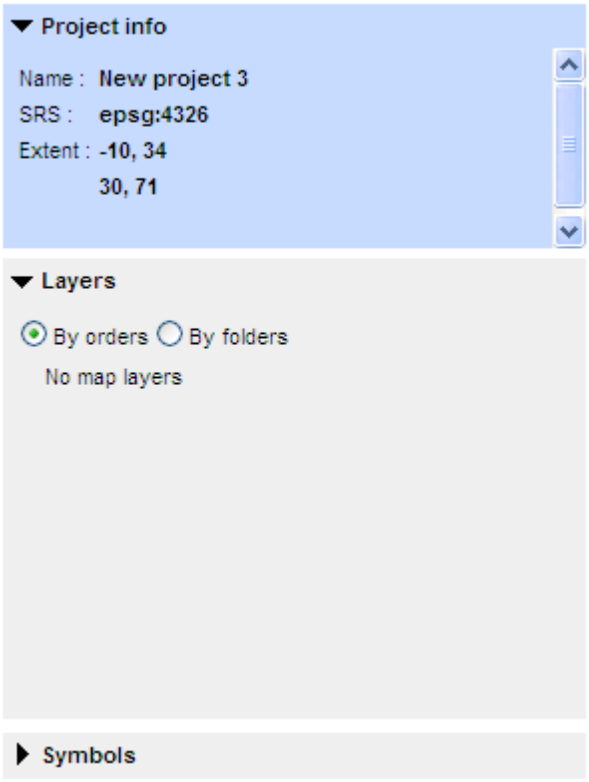
After you click on "Create Project" you can edit basic information about the composition.



There are 3 basic components:

- Information about the project
- Layers - definition of content composition

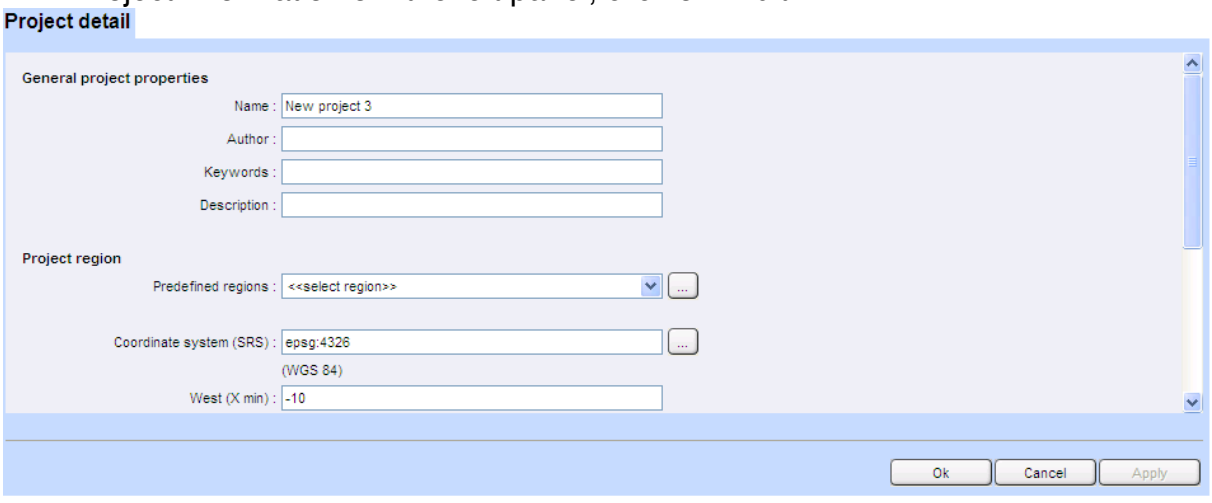
- Symbols- definition of project presentation



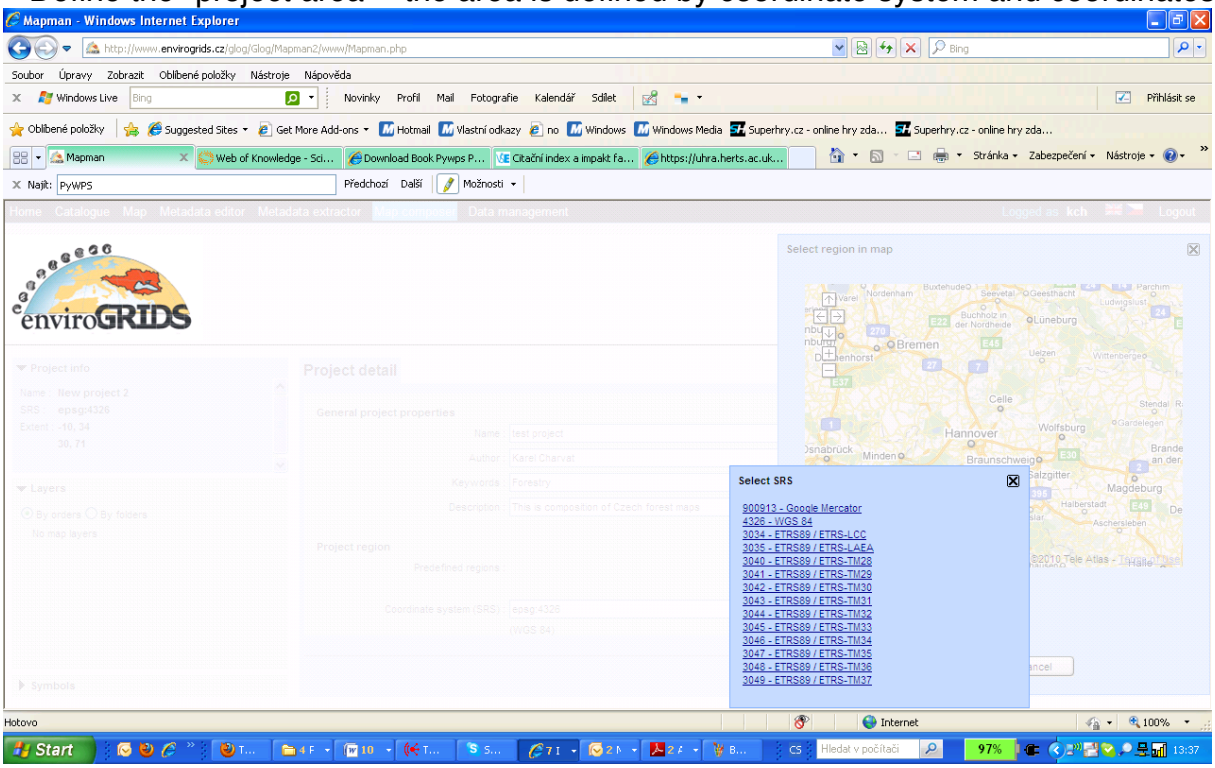
The link "Show Map" allows viewing of the processed project in a separate map window using HSLayers. In working window the processed parameters are displayed.
Important: At the bottom is the "Save" button. Any changes you make in the project will be stored after confirmation that button! If, for example, you close the browser window without saving changes, changed data will be lost!

The new composition is created in three main steps:
- Specification of the basic parameters of the project (description, location, coordinate system, display type)
- Retrieving and adjustment layers (the choice of a variety of sources and parameters)
- The form of the publication project

Specification of the basic parameters of the project:
- in "Project Information on the left panel, click on "Edit"



- Fill in the Project Title, Author, Keywords and Description Composition (abstract)
- Define the "project area" - the area is defined by coordinate system and coordinates



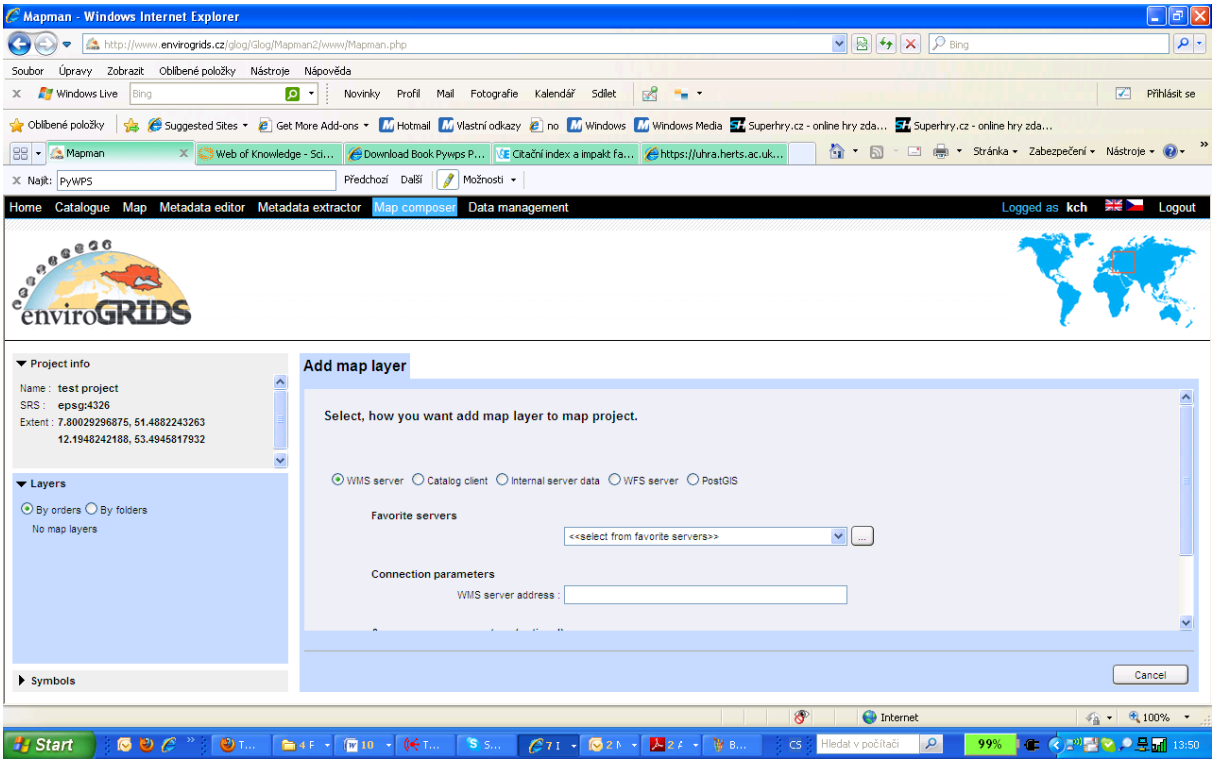
- Or you can cut and coordinate system to define themselves
  - EPSG code directly by entering the coordinates EPSG code can be entered numerically or choose from a predefined list
  - Or definition of the map window
    - Select the map
    - Select EPSG code
    - Confirm with "OK"
    - Coordinates and EPSG code will automatically be added to the project description.
- Define "Other Properties" - select the output image format – this can affect the quality and speed of visualization.
- Define "Access to project" - determining who can view and edit. Not for publication outside the application!
- To confirm the completed "information about" press "OK"

Layers

This section allows you to add data layers to the composition from different sources (local and external) and use them in the map compositions.

Adding a new layer

- In the left column under "Layers", click on "Add layer"

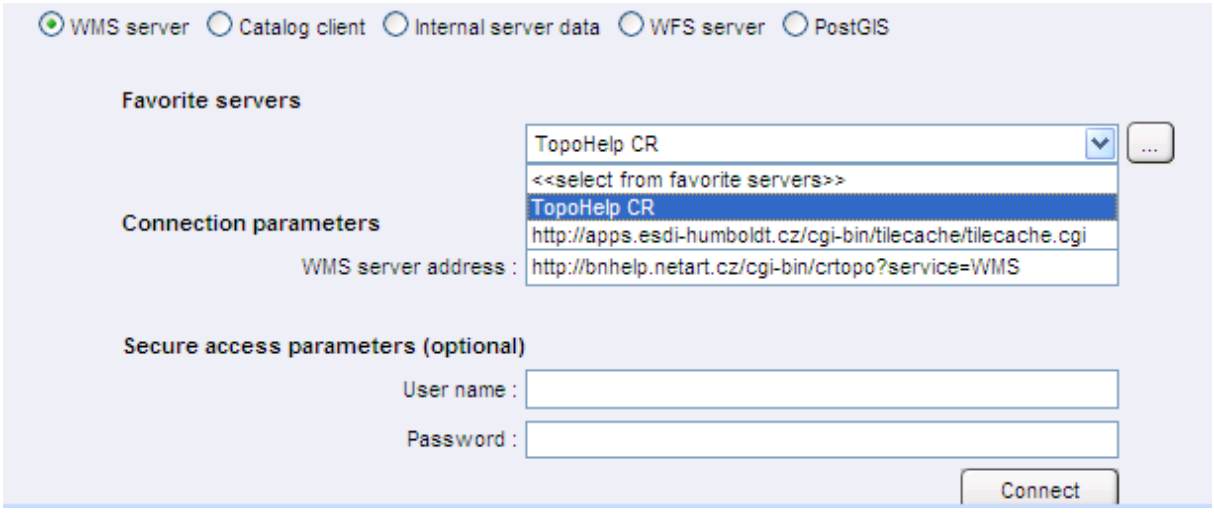


There is a list of sources from which you can add data to composition:

- WMS servers
- Catalog Client
- Internal data on a server
- WFS servers
- PostGIS database

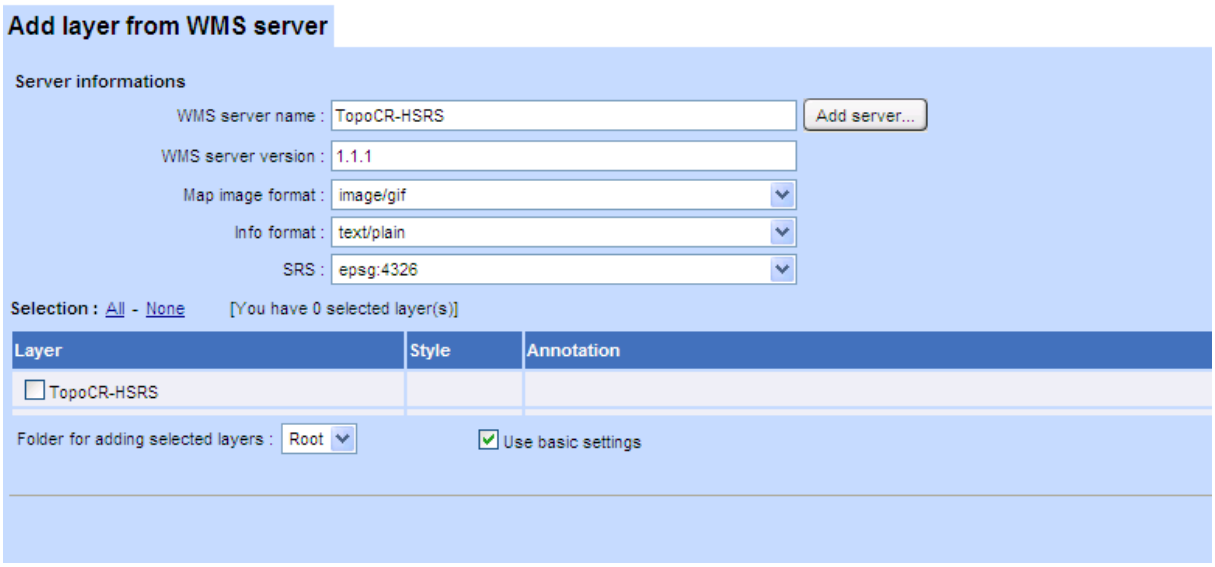
Select the data source for adding a layer to locate the relevant data

Adding data from a WMS or WFS server

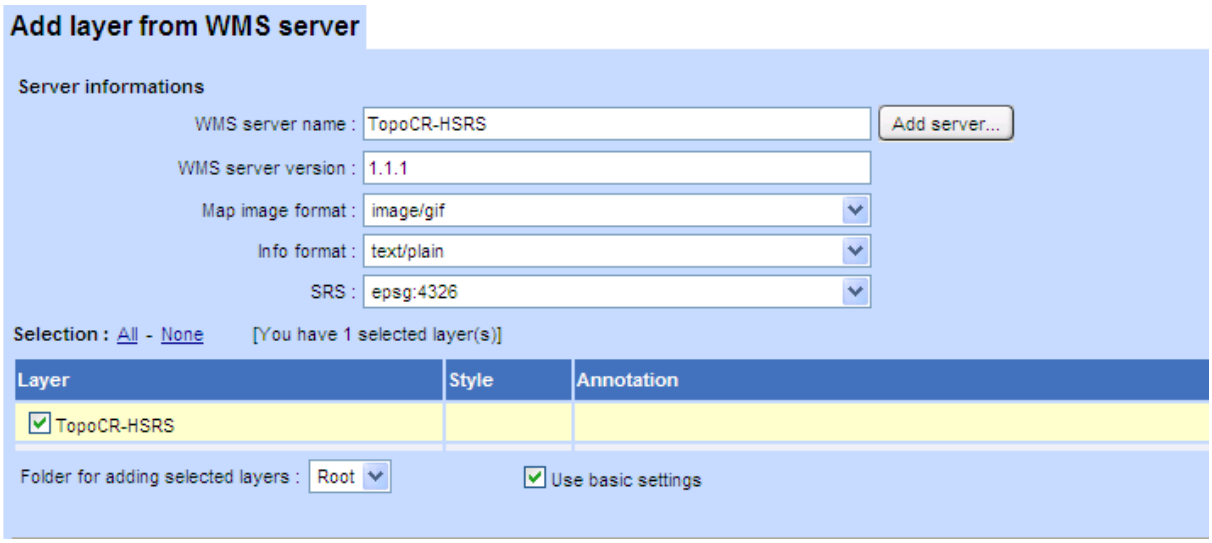


- As a source, select WMS server (analogically for WFS services – all next steps are the same for both types of services)
- Select address of the WMS server
- If access to data require logging, fulfill login parameters
- You can also choose WMS server from a t list of favorites servers

If server is successfully connected, you'll see a list of available data

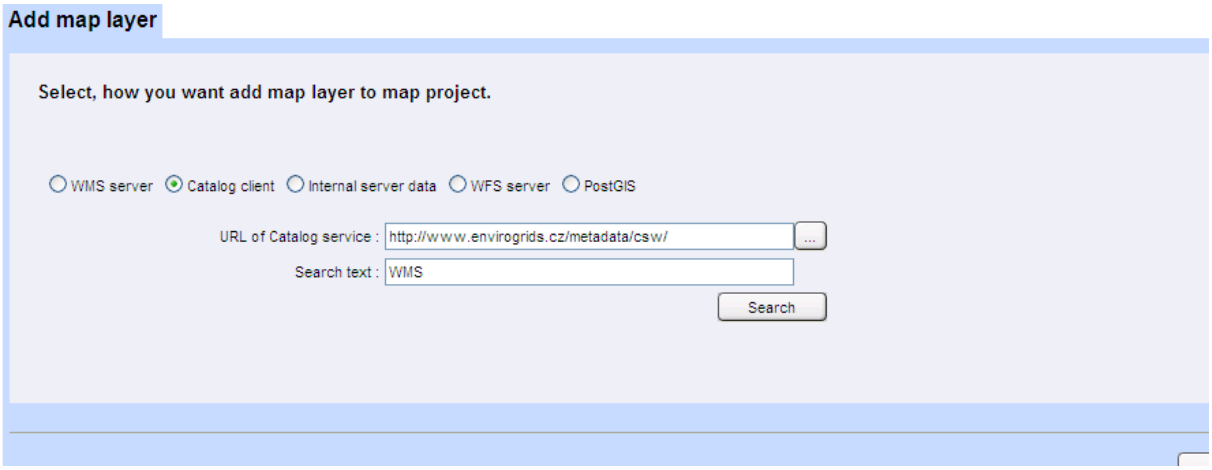


In the upper part of the working window, you can select format and coordinate system for publishing the data service.
If you use this service frequently in various projects, you can save URL in the list of "Favorite Sites" clicking on "Add Server". Then you will be able to select this server from the drop-down menu in the selection of WMS.
For each layer, you can view basic information or preview on the layer in the map window
Select the check box on the left for layers you want to add to the map composition.

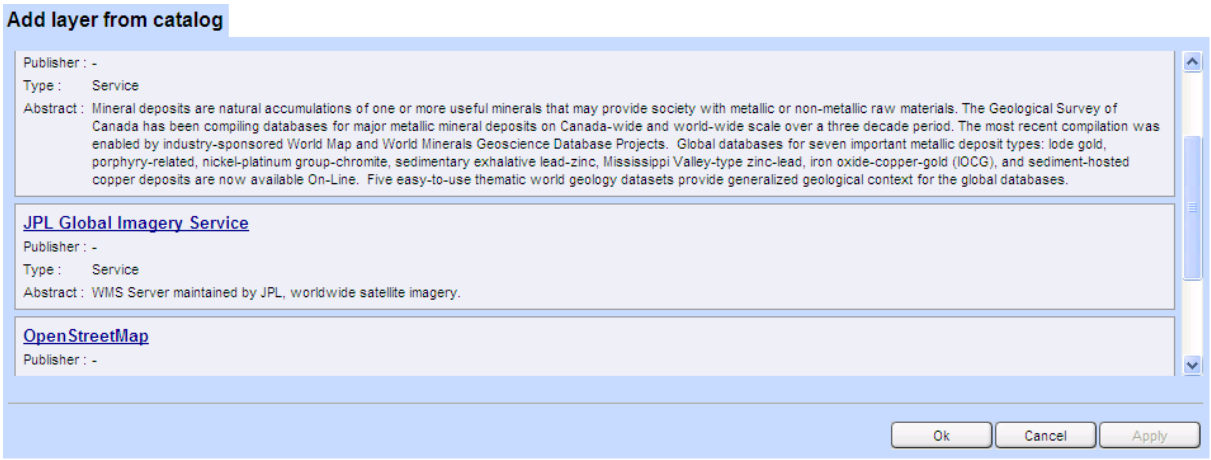


For creating folders (tree structure for the layers) see below select the folder for layers

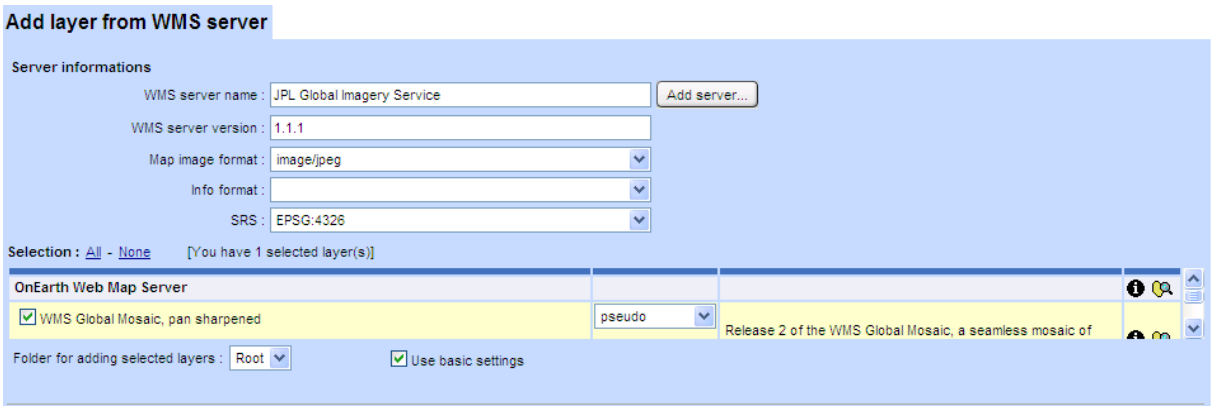
Adding data from the client's catalogue
If you do not know the address of the WMS or WFS server for the requested data, you can search using catalogue services. Click the "Add layer" and as a source select "Catalogue Client"



In the field "URL catalog services" write the address of the used catalogue service or choose this from the menu. Catalog services must conform to standard OGC CSW. Enter search text and press "Search". Service returns the available data layers.



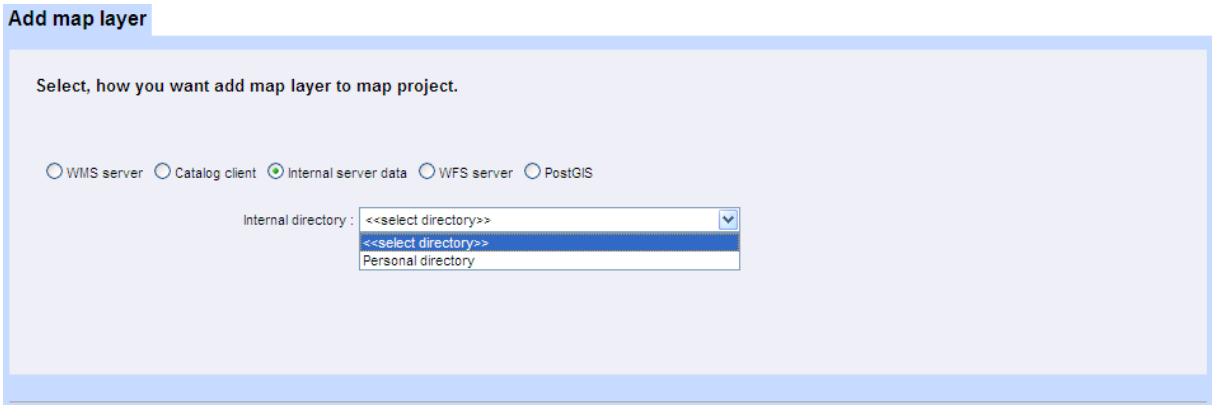
Click on the selected layer. It will subsequently appear in the standard window for adding a layer which you can paste into your project



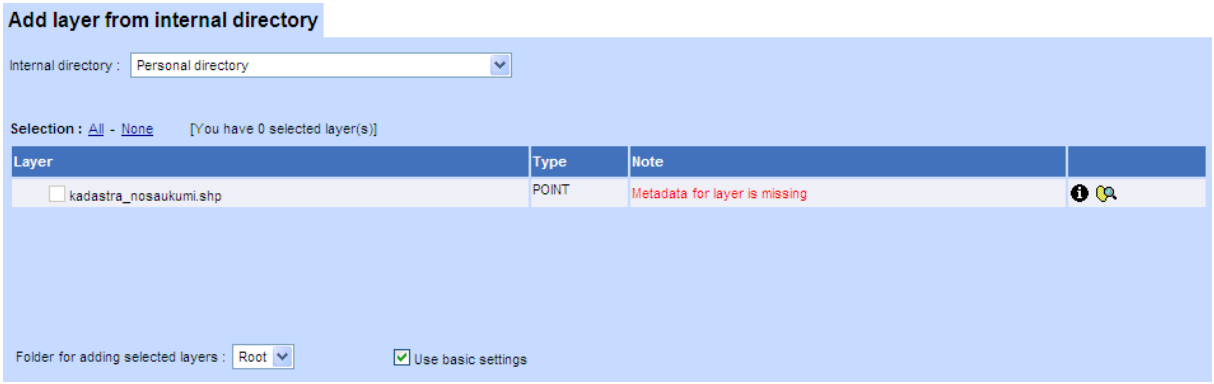
Adding internal data

The data that you have available on the server (e.g. data that you uploaded via DataMan) could be added to the composition by the next steps.

Click on "Add layer" and a source select "Internal data on a server". From the menu, select the internal directory and click on "Upload"

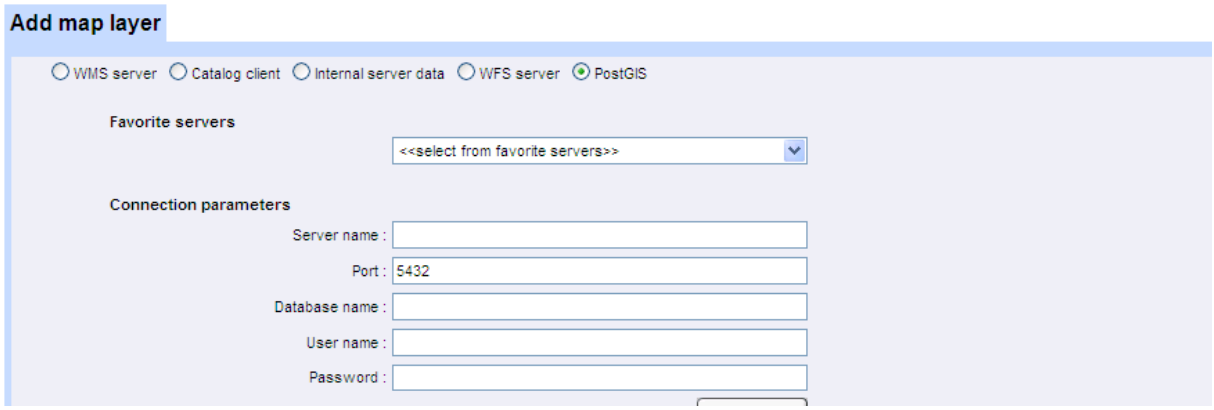


For each layer, you can view basic information or preview on the layer in the map window

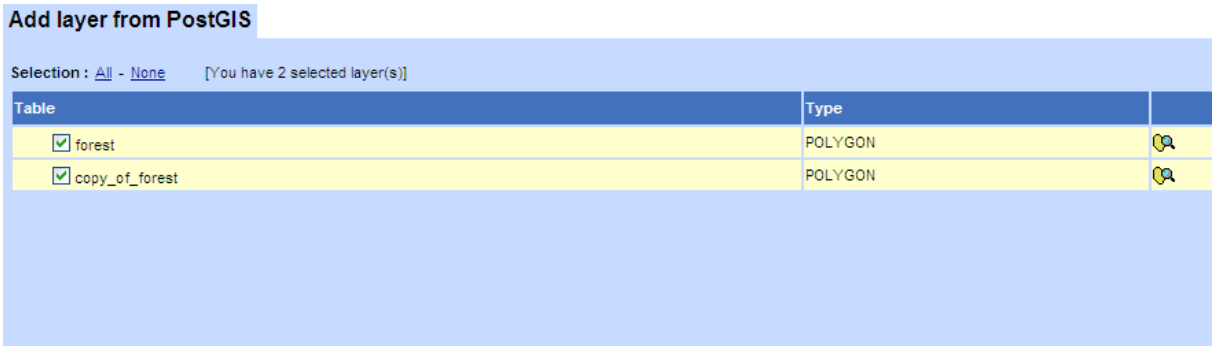


Select the check box on the left for layers, which you want to add to the map composition.
If you have a project with folders (tree structure for the layers - see below), the right to choose which folder to add the selected layer .
Select all the layers you want from your server to use and click "OK"
Selected layers will be added to your project

Adding data from the database
The current version can be added to the project data from the database Postgre / PostGIS.
Click the "Add layer" and a source select "PostGIS"

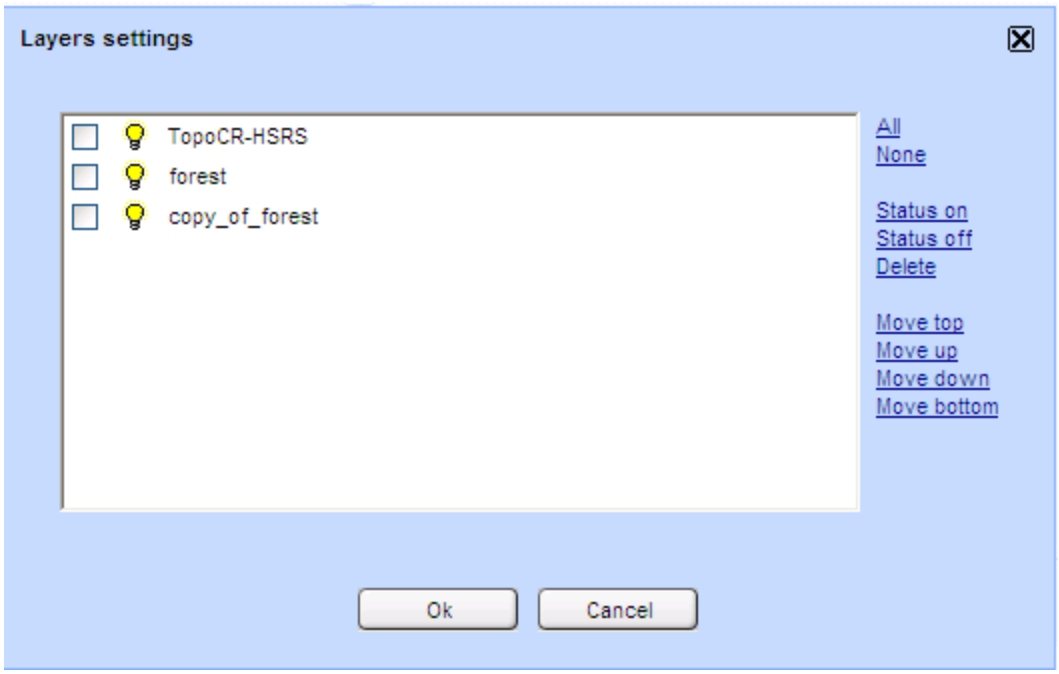


Enter the server parameters, or select from your favourite sites
The result will be the list of available layers.



Each layer, you can preview in the map window
Select the check box on the left for layers, which you want to add to the map composition.
If you have a project to create folders (tree structure for the layers - see below), the right to choose which folder to add the selected layer
If you have a project with folders (tree structure for the layers - see below), the right to choose which folder to add the selected layer
Select all the layers you want from your server to use and click "OK"
Selected layers will be added to your project
Working with layers in the map composition
With the data layers in composition you can provide next operations.
Layers can be:

- sorted
- deleted from the composition
- grouped into folders
- set as enabled / disabled

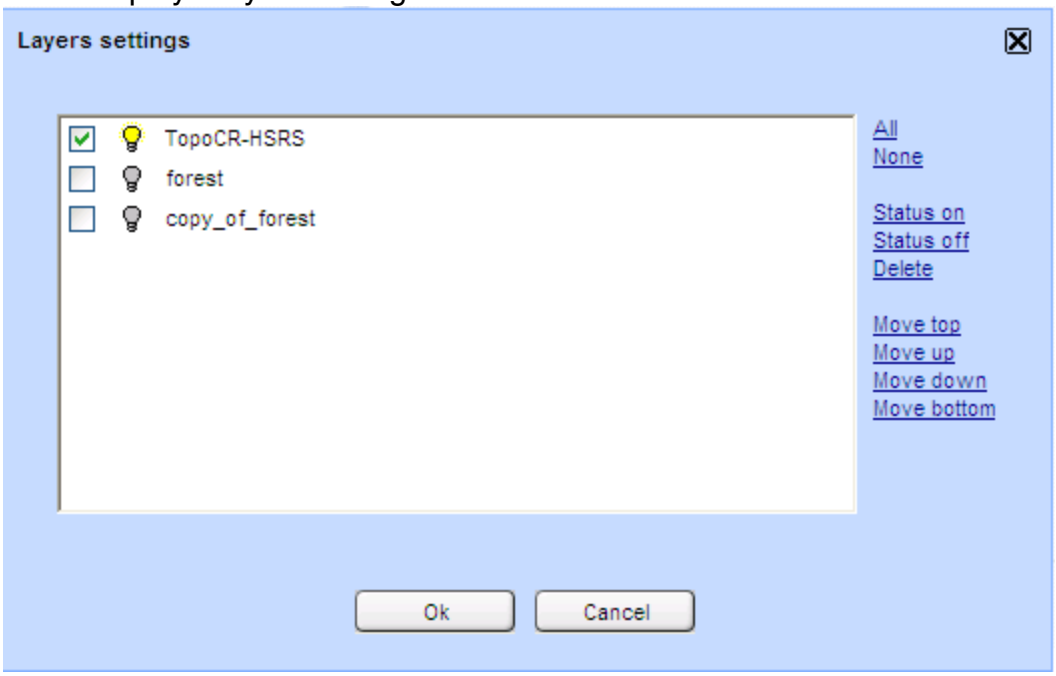


Layers can be grouped into different components. However, since the use of folders cannot maintain order, which affects the visibility of each layer is display a list of layers and their configuration is divided into two types:

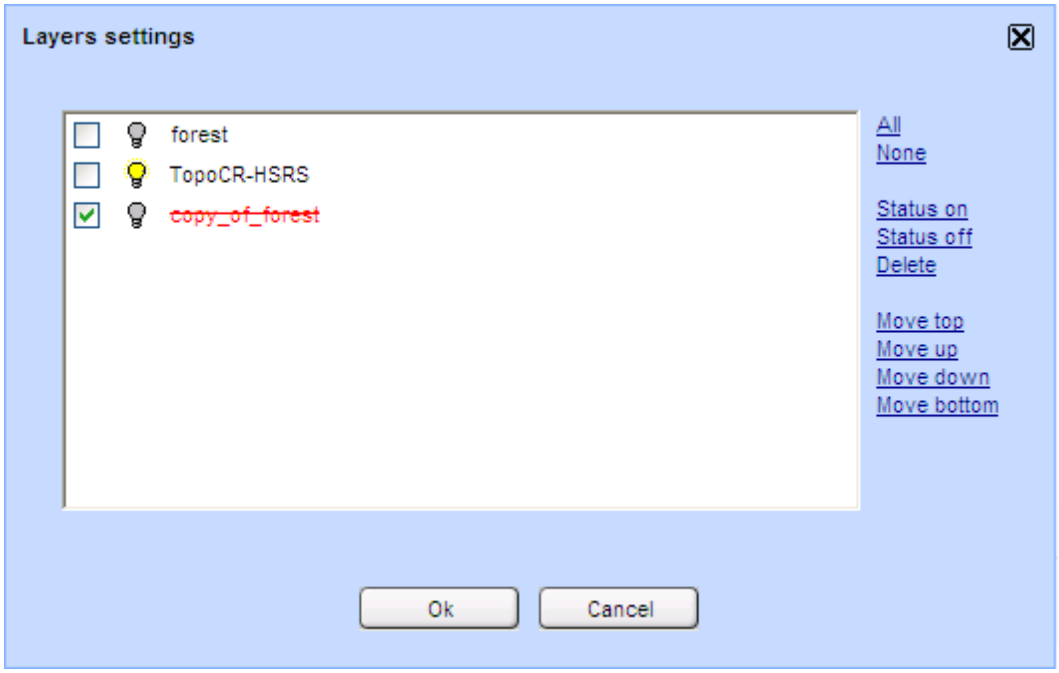
- by orders
- by folders

Viewing layers by order:
Layers are arranged in the same order as they are displayed in the final composition in the map window. Enable means that the layer is visible immediately after loading the project. In case that disabled layer is added to the list of layers in the project, it will not be displayed.
Reordering layers

- Select the layer "In turn"
- Window will display "Layers settings"



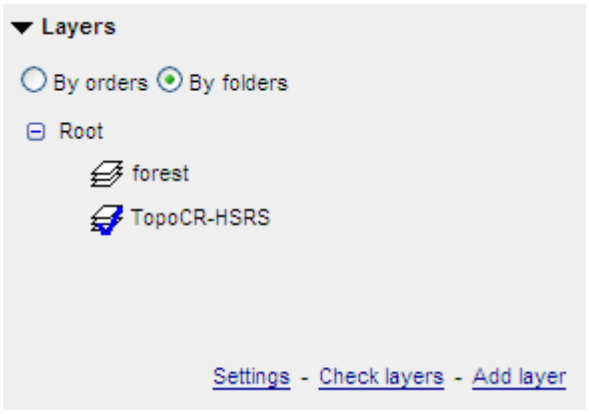
- Layers can be moved by mouse.
- Clicking on the bulb you can determine if the layer will or will not be turned on when you first load the project into the map window
- You can also select the layer and move or turn on / off using the link on the right side
- Layer can be highlighted and deleted - clicking on the "Delete" , the selected layer are marked as deleted



Note - the actual deletion occurs only after confirmation "OK" button.

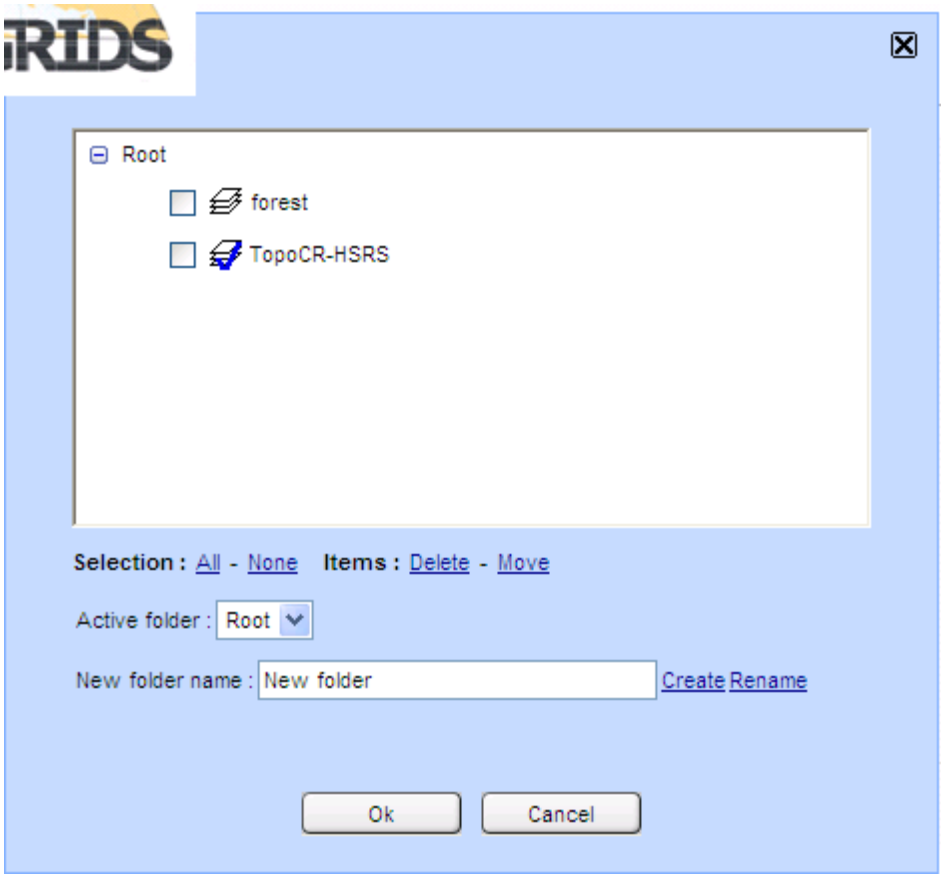
Working with folders

If you want to view layers ordered by folders, select "By folders"

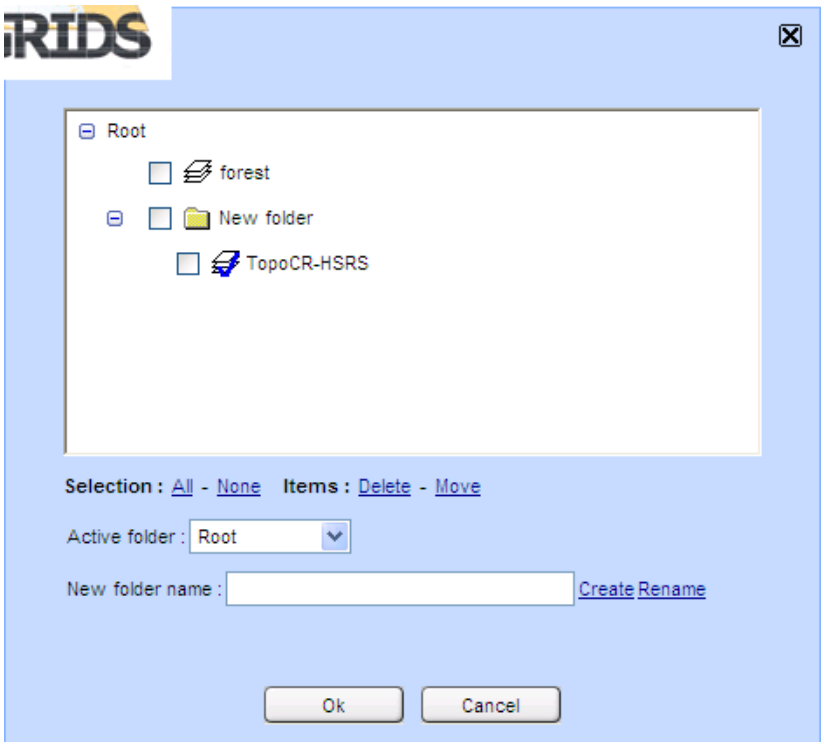


- To create a presentation folder, click on "Settings"

- To create a new folder, type "New folder name" and click on" Create "



- To move layers to the folder select the layers you want to move and select the "Active folder", Click on "Move"

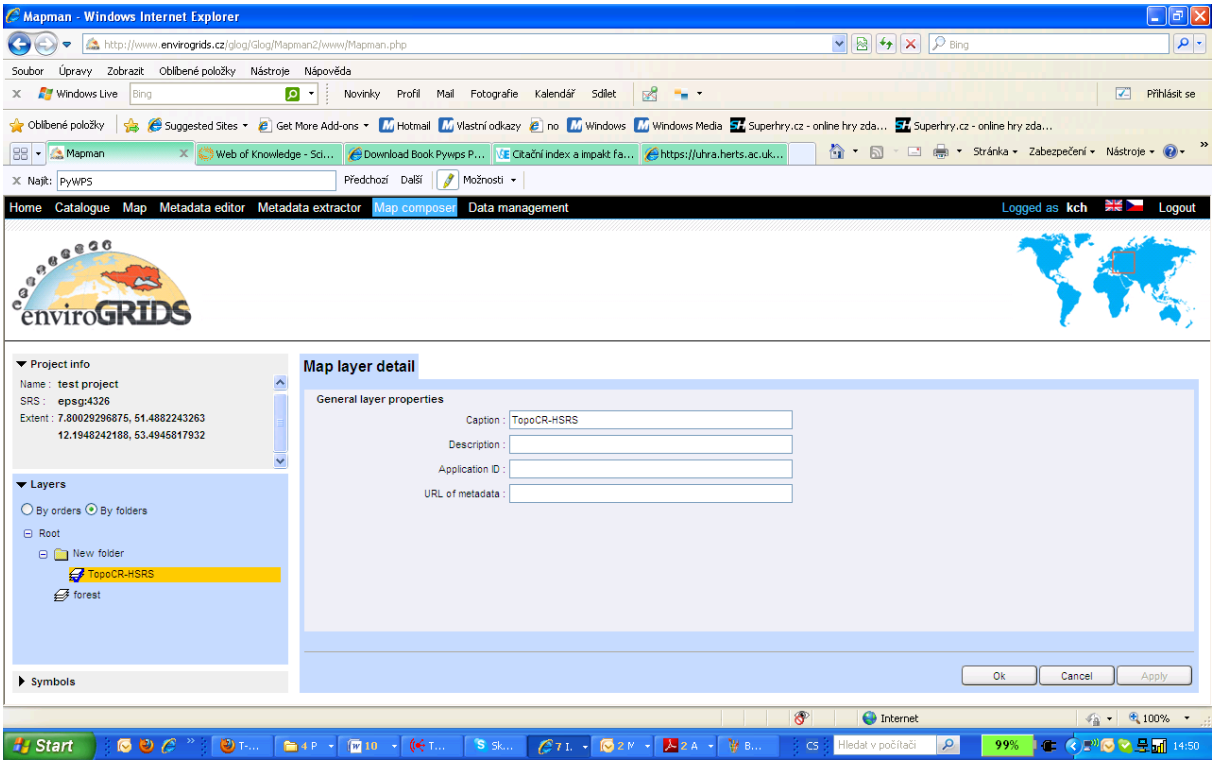


- In this setting, you can also delete layers - select the layer and click on "Delete." Layers are marked as deleted. They will be deleted after confirming the settings with "OK"

Display parameters of layers

For each layer in the map composition you view and edit their properties. Parameters could be changed by clicking on the layer in the layers list.

The range of parameters depends on the type of data (vectors, bitmaps) and also on whether you use option " Basic settings"
Example of parameters of WMS using basic settings:



In the basic parameters you can change the layer's title, descriptions of the layer, add the URL of metadata record and assign an ID if you will use in other applications with JavaScript API.
For the advanced settings for each layer must be defined the following parameters:

- Title
- URL Web Services
- Name (not changed)!
- Format
- Coordinate system (projection)
- Status (On / Off when you load the map window)

As optional parameters for WFS can be defined as:

- description layer
- ID for use in other applications
- URL of metadata
- Format of descriptive information
- Minimum scale display
- Maximum scale display
- Expiration time for connection

- Style
- Transparency
- Distance

When using vector data from the internal server, you can define your own display parameters for each layer. For vector data it is possible to identify the different styles, these styles can be grouped into complex symbols, and sorted into various classes.

Previewing the project

During the work with the map composition is possible to view maps click on the link "View Map" at the bottom of the working window. A new window opens with a HSLayers map client and composition will be displayed

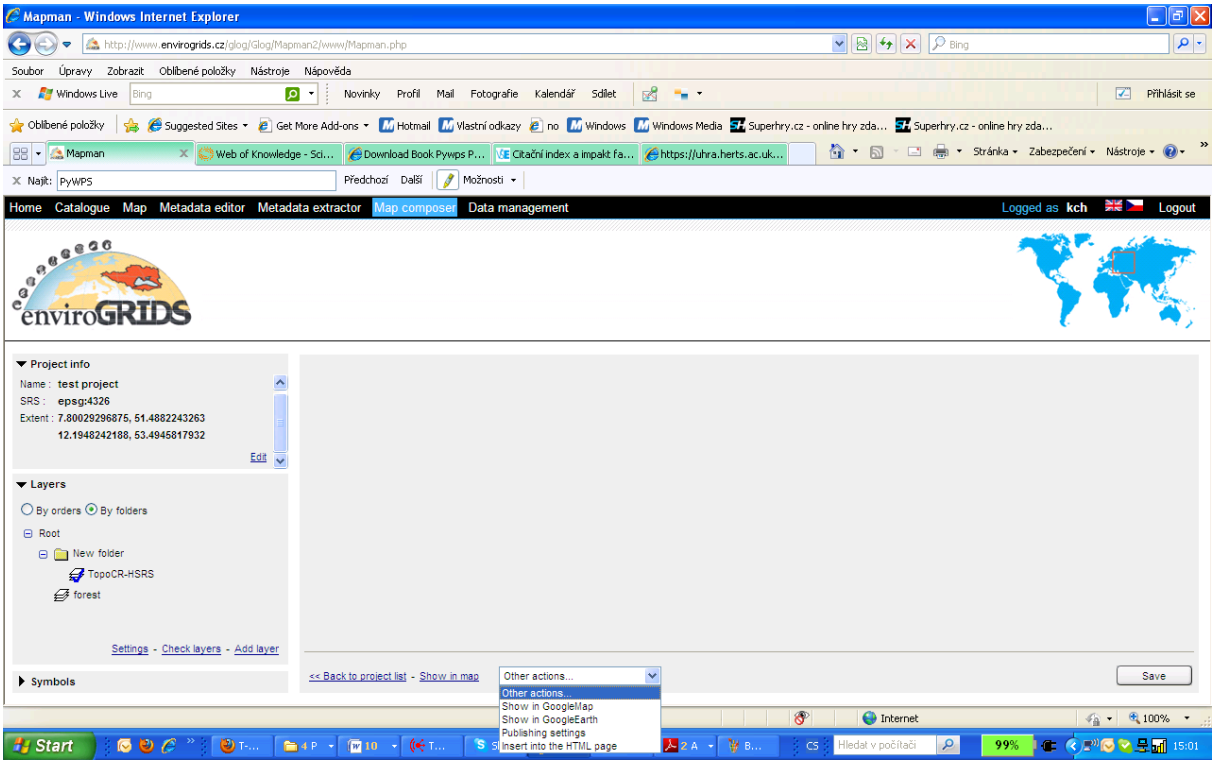
Displaying and publication of map compositions

Processed map composition, you can view:

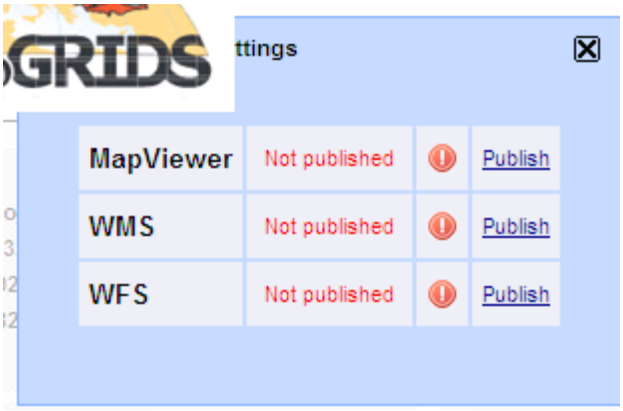
- in HSLayers
- in GoogleMaps
- in Google Earth where these applications installed on your PC

Composition can also be published in other forms:

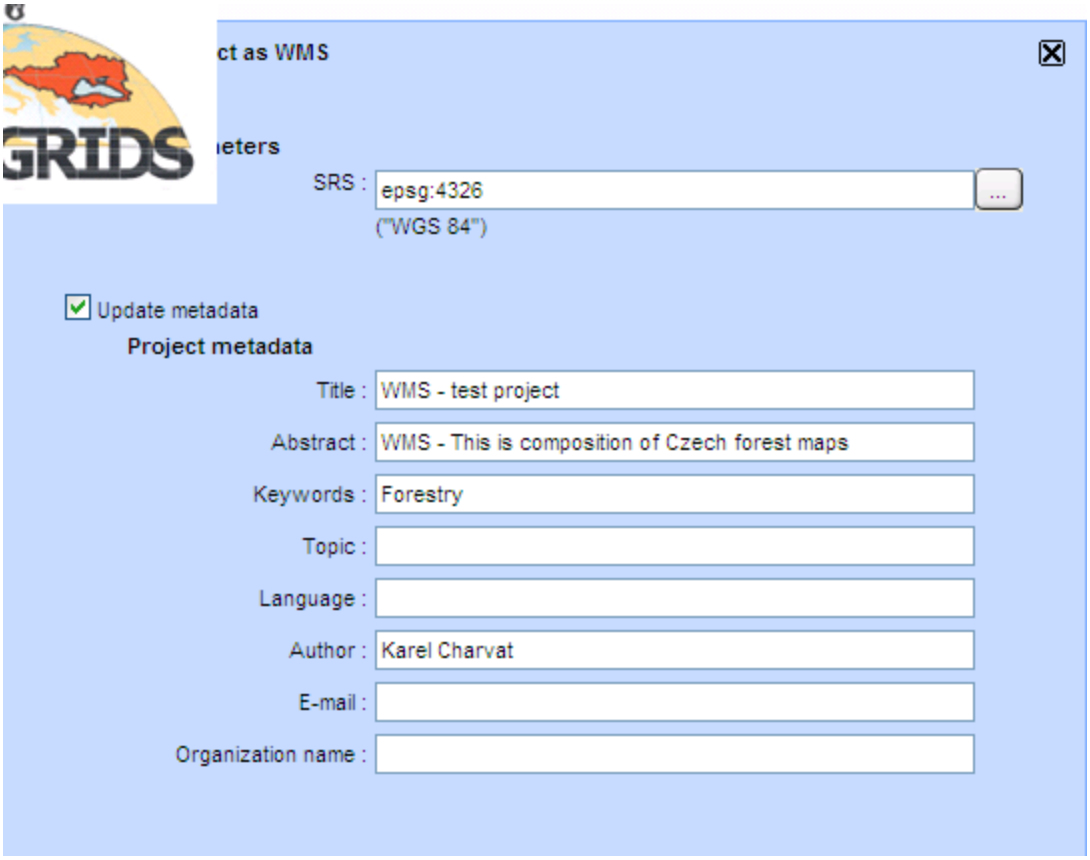
- mapping client HSLayers
- Web Map Service (WMS)
- Web Feature Service (WFS) - only the vector data
- Separate components for insertion into the site



View Options, and publishing are available in the dropdown menu "Other Actions"
Publishing:
In the "Other Actions" menu, select "Publishing Settings"

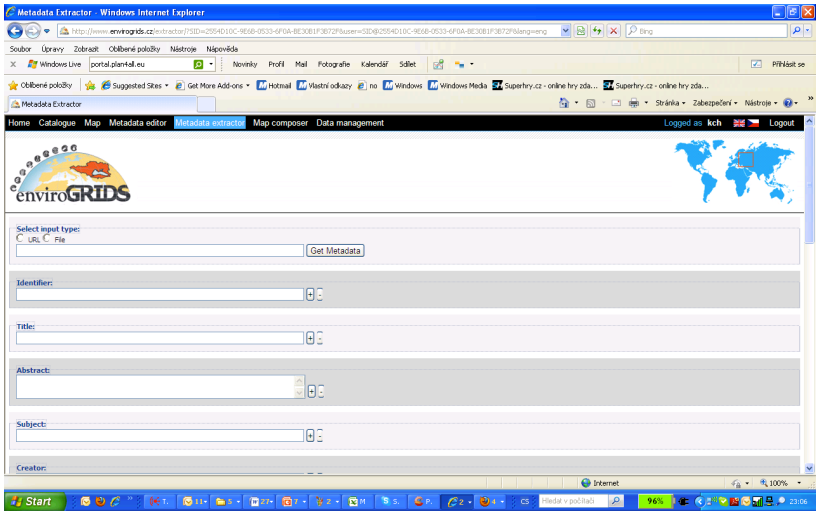


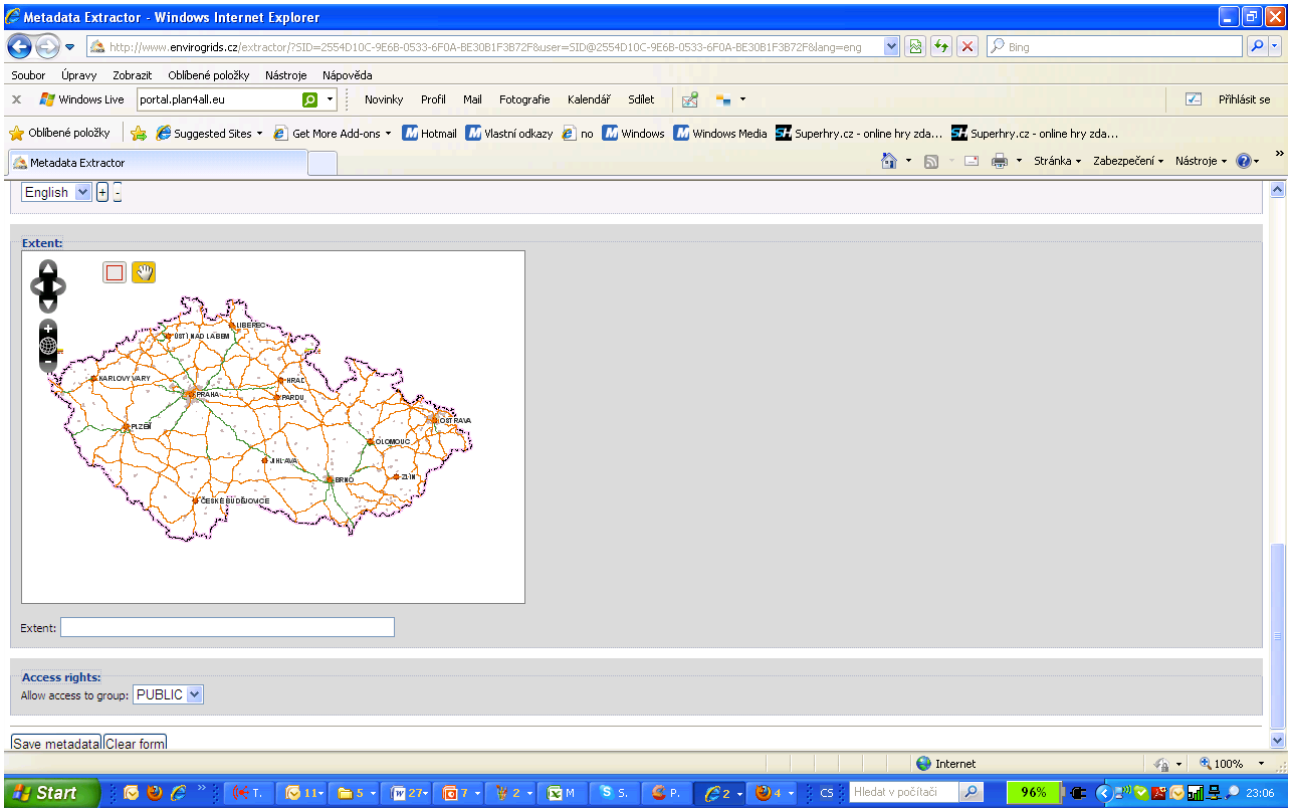
Select how to publish and click on "Publish" and fill in the metadata



4.6 Metadata extractor

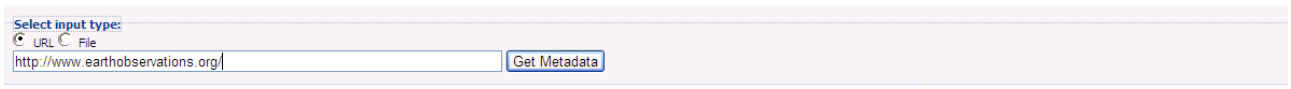
Metadata extractor is tool, which supporting extraction of available metadata directly from different files (documents, presentation, etc.), editing this metadata and publishing of metadata and files on URM portal. Other possibility is extract metadata (and then edit) directly from existing URL addresses and store metadata on URM portal. Access to information is then trough direct URL addresses.



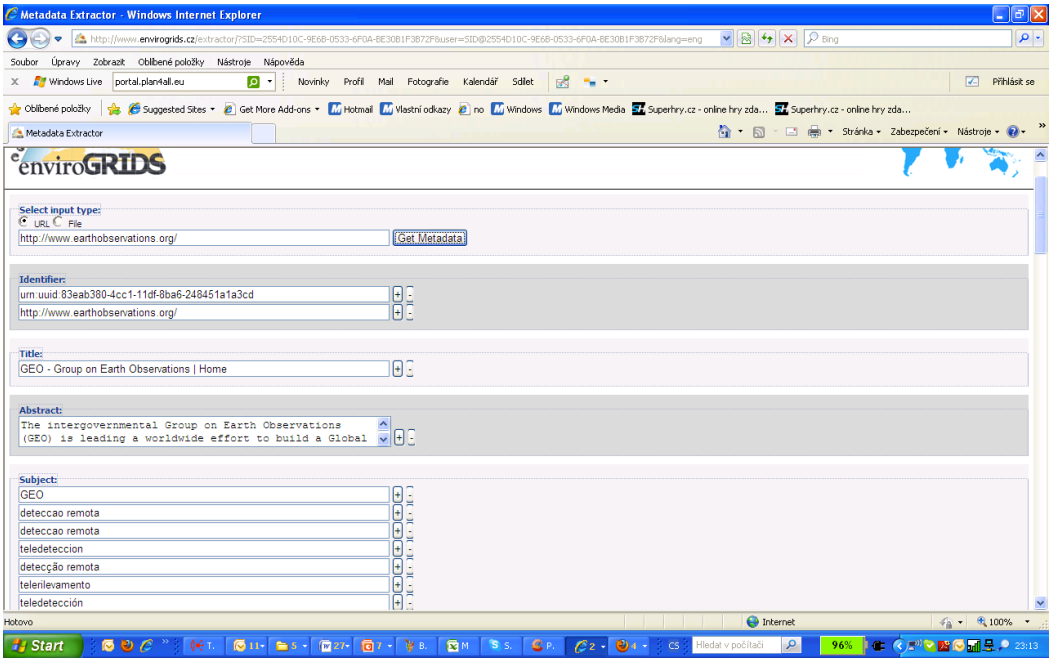


URL publishing

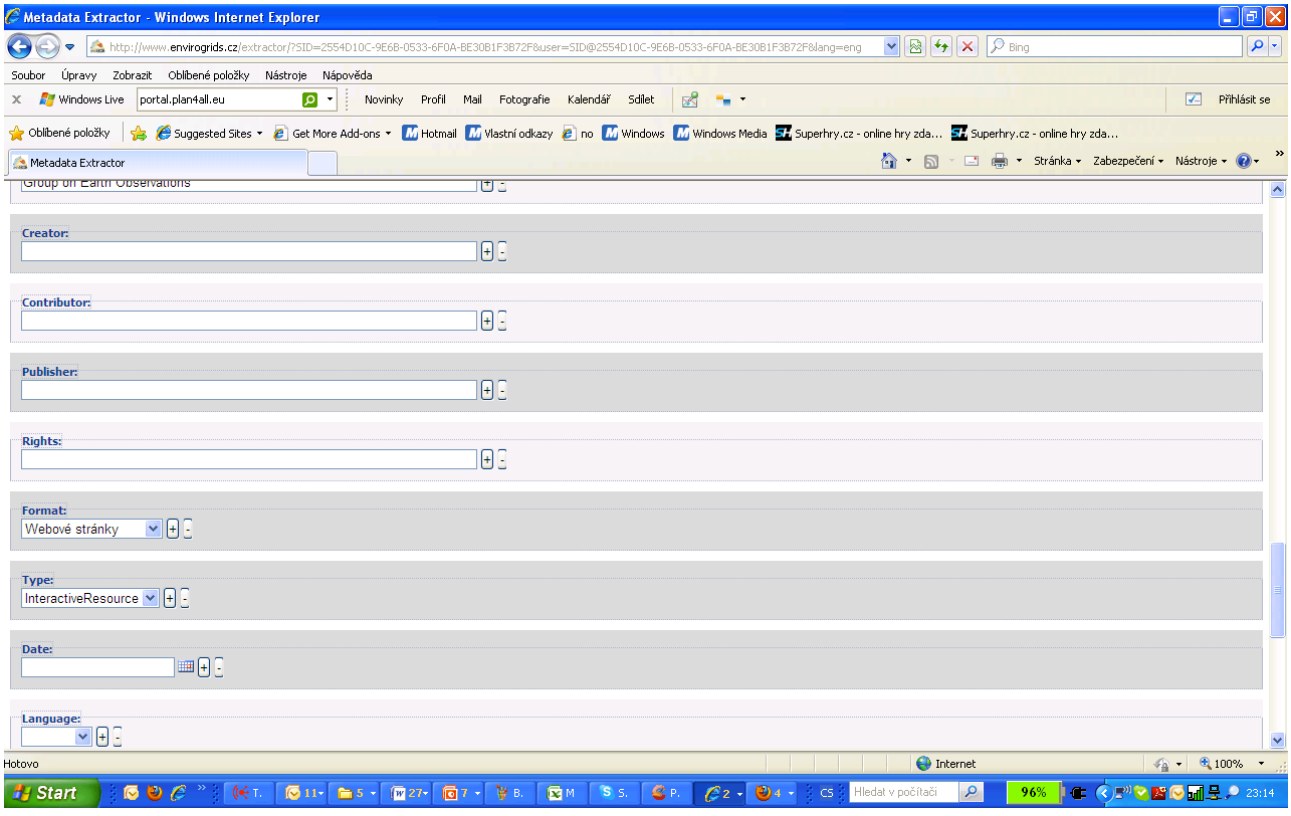
URL publishing allow to put into metadata system link to external information sources. Publishing start to switch on button URL and fulfilling the address of external resource.



After pushing button Get Metadata, metadata extractor extract available metadata information directly from information source.



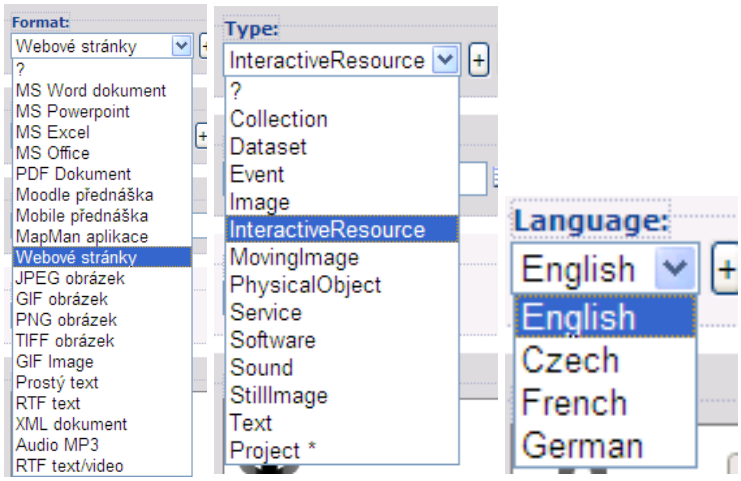
The information, which are not extracted from information source has to be edited manually.



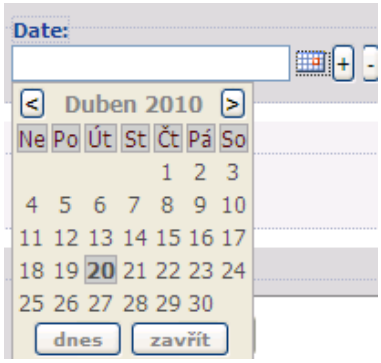
Every item could be multiplied pushing button +

Or again reduced pushing button –

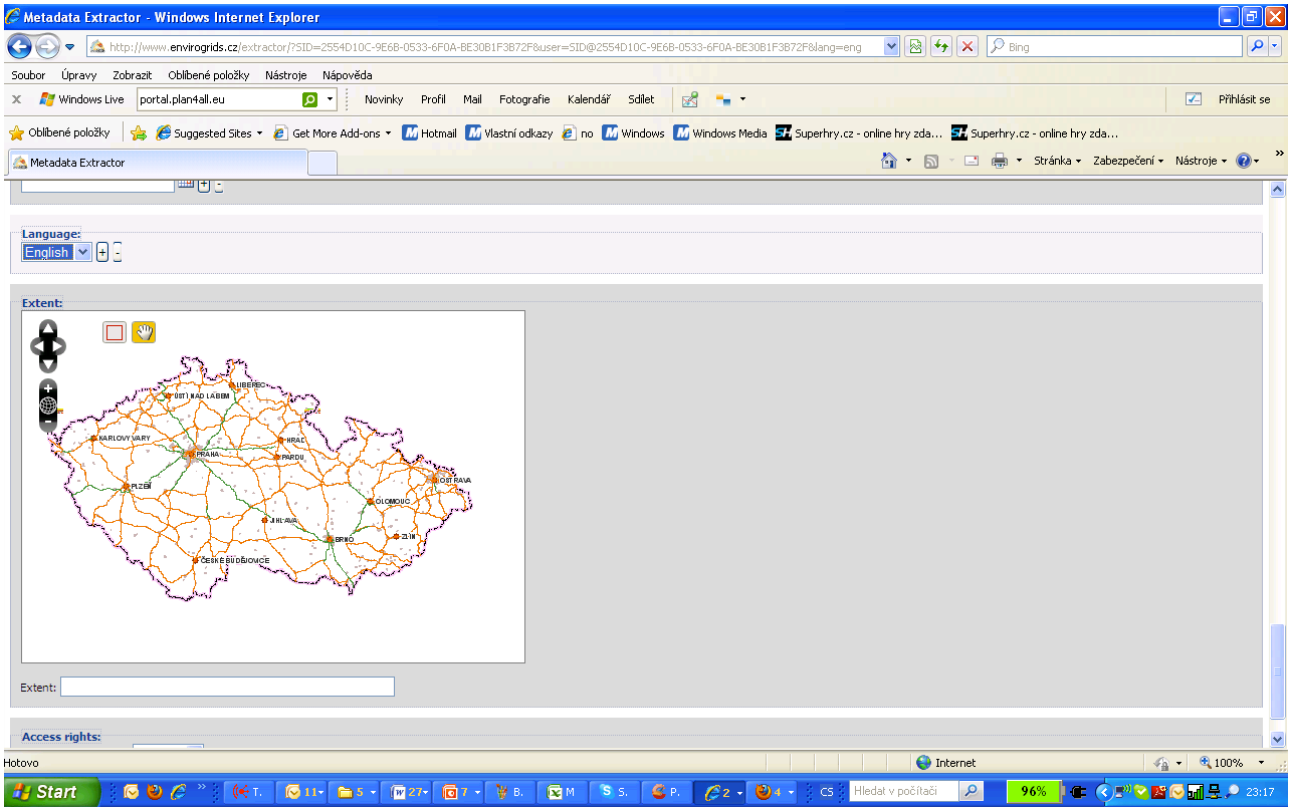
Formats, types and languages are selected from predefined lists



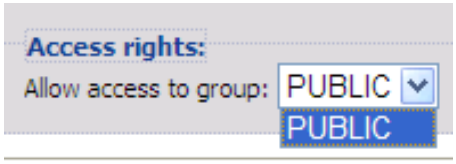
Dates are selected from Calendar



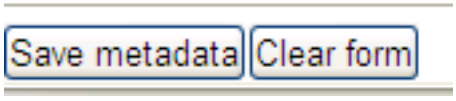
For information, which have spatial representation could be used spatial extent.



It is also possible to define access rights.

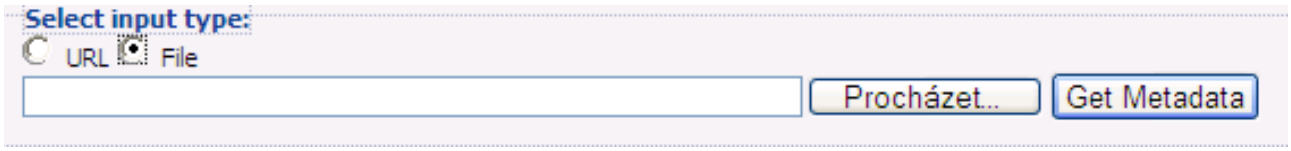


The publishing is provided pushing button Save metadata. It is nor required, that all items has to be fulfilled.

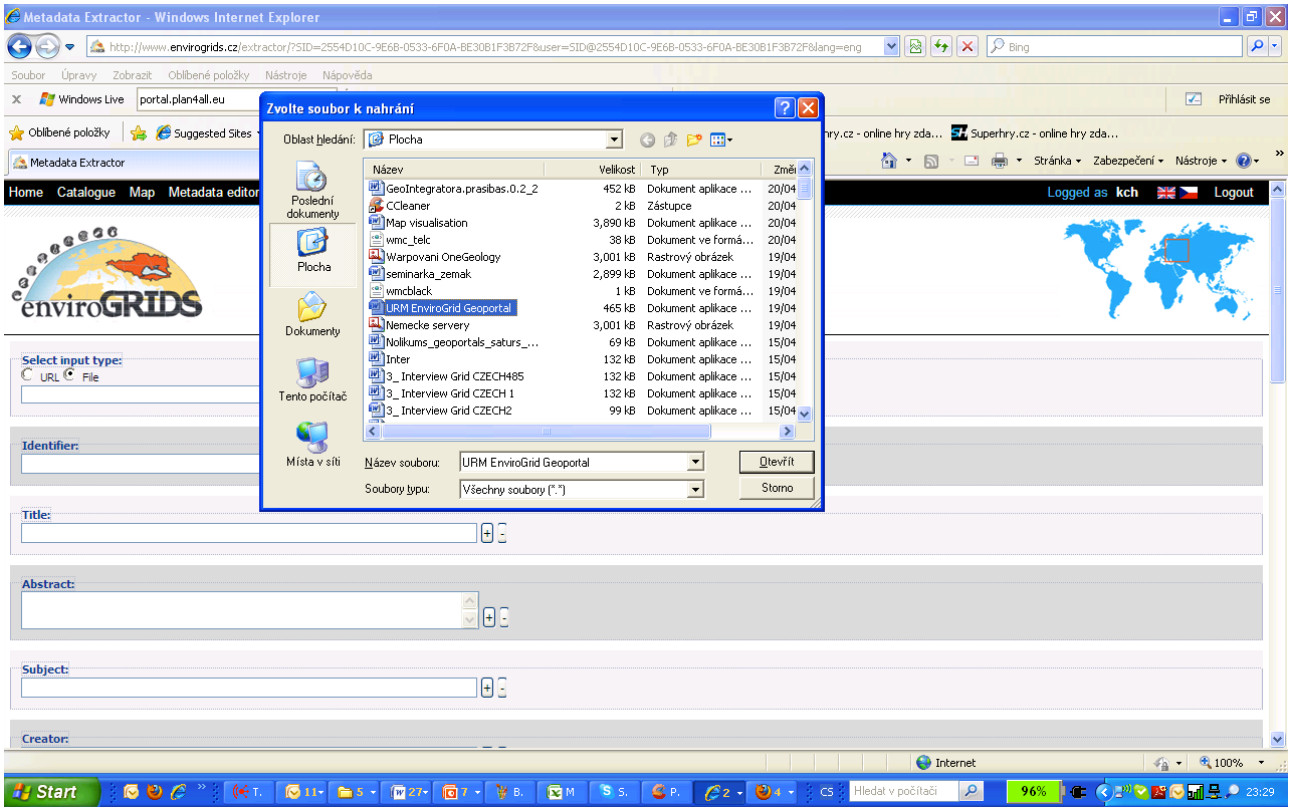


File publishing

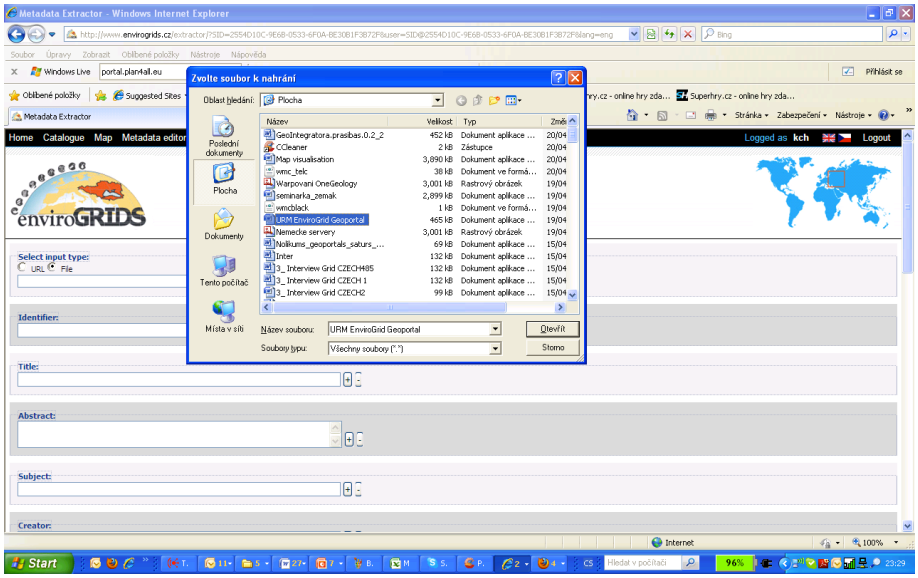
For file publishing you have switch button file publishing.



After pushing button search, the window, which allows to find required file on your computer is open.



After pushing button Get metadata, metadata are extracted from the selected file.



The rest of editing is the same as for URL. Only difference is, that on server are stored not only metadata but also selected file. In principle you can selected any type of file. You can also publish HTML presentation using this method. Only condition is, that such presentation has to by zipped into zip file. After publishing on server information is automatically extracted.

A Dublin Core elements description is available at:
`http://dublincore.org/documents/dces/`