International Journal of Natural and Engineering Sciences
E-ISSN: 2146-0086 12 (1): 57-62, 2018

General Conditions of Spatial Data Infrastructures

Bashkim IDRIZI
University Mother Teresa– Skopje; University of Prishtina & Geo-SEE Institute

***Corresponding Author**
E-mail: bashkim.idrizi@yahoo.com

Received: February 15, 2018
Accepted: March 30, 2018

Abstract

The impact of global trends has a large importance in all human life fields. As one of the most important aspects is fully recognition of the environment from micro-regional up to national, regional and global level. Right management with spatial objects and natural phenomena has direct impact on society developing, which means direct impact on human life also. Unsustainable are environmental analyzes with non-organized or non-standardized organized spatial data by the responsible state institutions for data collecting, structuring, archiving, and sharing. The general principle for casting of responsibilities between the state relevant institutions in a field of spatial data, are the principles of multi-usable official data and no-duplicate the same data by two or more institutions. Those are the basics of more rentable utilization of spatial data, i.e. rentable functioning of whole state system.

Within the specter of spatial data infrastructures from local up to global, in a national (state) level it is necessary developing of National Spatial Data Infrastructure (NSDI), as synthesis of sub-national infrastructures from one site, national interests from other site, and their compatibility in regional-global level in the third site. Integrating of spatial data in to one unique standardized spatial data infrastructure in a national level known as NSDI, generate the simple and faster access to needed spatial data, more transparency, high level of cooperation between responsible institutions, increasing of the conscience for importance by spatial data, and wide spatial data utilization by stake holders, clients and customers, i.e. many and multi utilization for scientific, practical and commercial purposes.

Setting up of the NSDI has a direct impact on the way of organizing of local (sub-national) spatial data infrastructures. This is due to the hierarchy principle from up to down, which means that all local infrastructures have to be organized to be fully compatible with NSDI.

Keyword: INSPIRE, NSDI, GSDI, GIS, infrastructure, spatial data.

INTRODUCTION

The geographical information systems (GIS) technology has a wide utilization on all processes of managing with spatial data. Its right implementing has a various positive impact, for example:

- faster managing and updating of spatial data,
- fewer financial needs,
- more comfortable work environment,
- developing spatial data with higher quality,
- extracting various GIS databases from one unique database,
- automatic transformation of coordinate system,
- stored data is more rentable, and
- it is usable for preparing of various type of maps.

In other site have been recognized two very important "negative" aspects from GIS usage in a field of SDI:

- GIS expert must be familiar with many related fields (IT, database, remote sensing, coordinate systems, environment etc.), and
- nonprofessional "GIS experts" setting up GIS databases without caring out for whole principles-standards!

Positive and "negative" aspects which defined upper, have a direct impact on developing spatial data infrastructures (SDI's).

Nowadays, almost every country develops its own SDI's in a various level, from local up to national, with aim to incorporate them in international level. Most important aspect during developing of SDI's is the fully recognition of micro regional data from one site, and the national/international needs-standards from other site.

The general principle for casting of responsibilities between the state relevant institutions in a field of spatial data, are the principles of multi-usable official data and no-duplicate the same data by two or more institutions. Those principles can be realized by utilization of the latest GIS technology, based on integrating between information and communication technology, the real needs and on day situation, as three main components for developing Spatial Data Infrastructures (SDI's) of all levels, from sub-national (local) up to global level. Those are the basics of more rentable utilization of spatial data, i.e. rentable functioning of whole national system.

In comparing between the SDI's of all levels, regional and local SDI's develops even faster than national, continental and global ones, because of much more complex procedures for harmonizing data collected from many sources with different standards and included big number of actors. National spatial data infrastructure (NSDI) can be developed by own standards defined by different countries, or can be utilized the international/continental initiatives as EU INSPIRE directive, euro maps by EUROGEOGRAPHICS, global map Australia ext., as well as the transcontinental/ global initiatives, as global spatial data infrastructures (GSDI), global mapping ext.

Spatial Data Infrastructure

The impact of global trends has a large importance in all human life fields. As one of the most important aspects is fully recognition of the environment from micro-regional

up to national, regional and global level. Right management with environment has direct impact on society developing, which also means direct impact on human life. Unsustainable are environmental analyzes with non-harmonized or non-standardized organized spatial data by the responsible state institutions for data collecting, structuring, archiving, and sharing.

Spatial Data Infrastructure (SDI) encompasses policies, institutional framework, organizational guides, data, technologies, standards, delivery mechanisms, as well financial and human resources, to acquire, process, store, distribute, improve utilization, then to increase access, availability, and sharing georeferenced spatial data, and to realize and foster services for citizens [1]. From this definition of SDI, it is so clear that the basic elements of SDI are:

- Institutional framework, including
  - legislation, organization, policies and practices
  - rules for financing and pricing and for handling of security, vulnerability and integrity.
- Standards, including methods for
  - describing spatial data
  - searching spatial data
  - ordering and transferring spatial data
- Fundamental spatial data sets, including
  - geodetic frame
  - official digital map data
  - data on real properties, population, buildings and more; and
- Technological framework including
  - human and technical resources
  - meta data and catalogue services
  - information network, data distribution, services which makes it easy for users to search, order and collect spatial data.

Most important aspect during developing of SDI's is the fully recognition of micro regional data from one side, and the regional, national and/or international needs-standards from the other side. Based on the level of included data and covered area, the hierarchy of SDI's can be categorized in many levels, which are listed below and shown in the figure 1 [2]:

- Global Spatial Data Infrastructure (GSDI);
- Regional Spatial Data Infrastructure (RSDI);
- National Spatial Data Infrastructure (NSDI);
- State or Provincial Spatial Data Infrastructure (SSDI);
- Local Spatial Data Infrastructure (LSDI); and
- Corporate Spatial Data Infrastructure (CSDI).

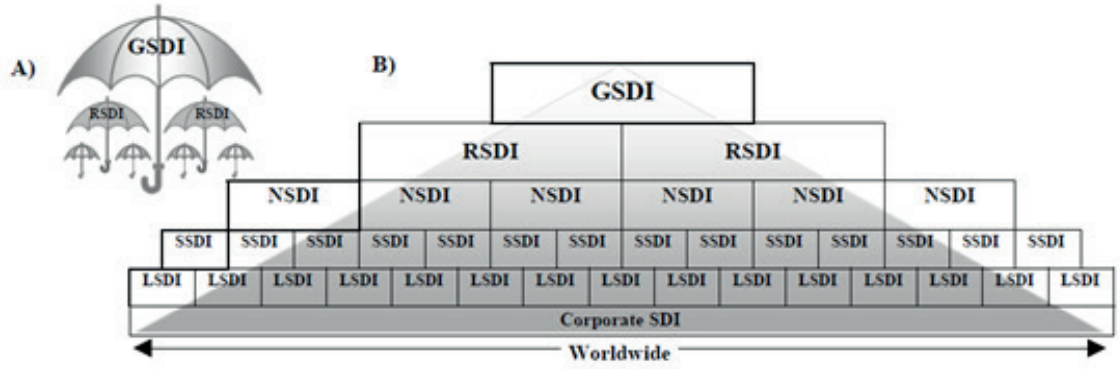

Fig. 1. *Hierarchy of SDI's: a) umbrella view, b) building block view* [2]

In the link of SDI's from local up to global level, the separate countries NSDI's should be developed with the same standards by using of regional/continental or global ones. In this way the European Union (EU) has already established own standards called INSPIRE (Infrastructure for spatial information in Europe), as a base and obligatory framework for all its members during developing their NSDI's. Same continental standards have been powered in other continents also, which can be seen in the figure 2.

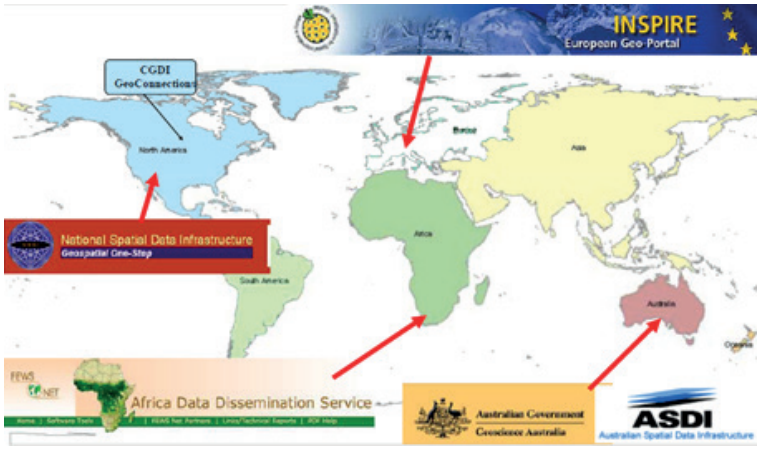

Fig. 2. *Continental initiatives for NSDI's with unique standards* [3]

Partnership among various levels of stakeholders that is essential to realize sound decision - making for sustainable global development is facilitated through the sharing structured data, followed by related information and knowledge within the Global Spatial Data Infrastructure (GSDI). The GSDI supports ready global access to geographic information, achieved through the coordinated 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. *GSDI encompass the policies, organizational remits, 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* [4]. GSDI is applicable for solving major global problems through creating monitoring and early warning systems for natural disasters, monitoring and management of natural resources changes, assessment of the trends of environment changes, then local, national and multinational physical development planning, informed decision-making of policy makers with a strategic database ext. Advanced capabilities of researching based on Global Map (international project which supports GSDI) data set are [5]:

- all data of Earth is in one place,
- with the same attributes,
- in the same format,
- in the same coordinate system
- in the same scale, and
- with similar accuracy.

Standardization And Some Sdi Initiatives

Right management with spatial data has direct impact on society developing, which means direct impact on everyday human life, which appears that unsustainable are environmental analyzes with non-organized or non-standardized organized spatial data by the responsible state institutions for data collecting, structuring, archiving, and sharing. Standardization on organizing spatial data generates below effects:

- standardization lets peers communicate,
- minimizes cost of uptake of new information,
- maximizes utility and stability of information products, and
- permits more applications to operate under known conditions!

Standardization carries out by the international standardization organizations which aims to harmonize the data sharing and utilization of spatial data through sub-national and national SDI's in a international/global level, and the national responsible institutions which aims to establish own standards within the country. First three organizations in below list are involved in defining international/global standards in relation with SDI's, and within the last one can be put all national institutions which develop the local standards in a national level.

- International Organization of Standardization (ISO TC 211, TC 204, JTC-1),
- World Wide Web Consortium (W3C),
- OpenGIS Consortium (OGC), and
- National Standards Organizations.

With aim to realize the objectives for developing SDI's in a standardized way and based on best practices, there are many international initiatives as [6]:

- INSPIRE (infrastructure for spatial information in Europe)
- GMES (global monitoring environmental and security)
- SEIS (shared environmental information system)
- GEOSS (global earth observation system of systems)

The INSPIRE directive came into force on 15 May 2007 and will be implemented in various stages, with full implementation required by 2019, aims to create a European Union (EU) 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. A European Spatial Data Infrastructure will assist in policy-making across boundaries, therefore the spatial information considered under the directive is extensive and includes a great variety of topical and technical themes [7].

GMES is the European Initiative for the establishment of a European capacity for Earth Observation. The main objective of GMES is to monitor and better understand our environment (How our planet is changing? Why is it changing? How this might influence our daily lives?) and to contribute to the security of every citizen. GMES will provide decision-makers who rely on strategic information with regard to environmental and security issues with an independent and permanent access to reliable data [8].

The Shared Environmental Information System (SEIS) is a collaborative initiative of the European Commission and the European Environment Agency (EEA) to establish together with the Member States an integrated and shared EU-wide environmental information system. This system would tie in better all existing data gathering and information flows related to EU environmental policies and legislation. The underlying aim of SEIS is also to move away from paper-based reporting to a system where information is managed as close as possible to its source and made available to users in an open and transparent way [9].The Group on Earth Observations (GEO) is coordinating international efforts to build a Global Earth Observation System of Systems (GEOSS), launched in response to calls for action by the 2002 World Summit on Sustainable Development and by the G8 (Group of Eight) leading industrialized countries. GEOSS emerging public infrastructure is interconnecting a diverse and growing array of instruments and systems for monitoring and forecasting changes in the global environment. This "system of systems" supports policymakers, resource managers, science researchers and many other experts and decision-makers [10].The GEOSS, INSPIRE and GMES an Action in Support (GIGAS) promotes the coherent and interoperable development of these initiatives through their concerted adoption of standards, protocols, and open architectures by recommendations to increase architectural coherence, strengthened EU contribution to international standardization, and agenda for further strategic research [11].The GIGAS will achieve the objectives set through an interactive and consensus-based approach which includes:

- Analyze the gaps between the different initiatives and propose strategies to overcome them
- Highlight best-practice examples from finished FP6, FP7 or ongoing HORIZON 2020 projects relevant for the identified gaps
- Initiate a consensus process on a broad basis for public consultation and consensus building

- Shape the initiatives by providing short term action items
- Influence the relevant standardization bodies to ensure the long-term action
- Provide an agenda for further strategic research areas to ensure investigation on the problems that are unsolved today.

From Microregional Data Up To Gsdi

Structuring of spatial data in local, national and global datasets can be realized based on two main ways, "bottom up approach" and "top down approach" (figure 3). The first approach generally is in use during developing local SDI's based on specific micro-regional data with aim to include all local data within the dataset, while the second way utilized in a case of developing national, regional and global datasets where the database should include all necessary data according to the type of data infrastructure. Those ways are enabling with the latest GIS technology, based on integrating between information and communication technology, the real needs and on day situation. Detailed recognition of those three components is necessity during developing of spatial data infrastructures of all levels, from sub-national (local) up to global. Before detailed explanation of SDI and NSDI characteristics, first we have to define what those are.

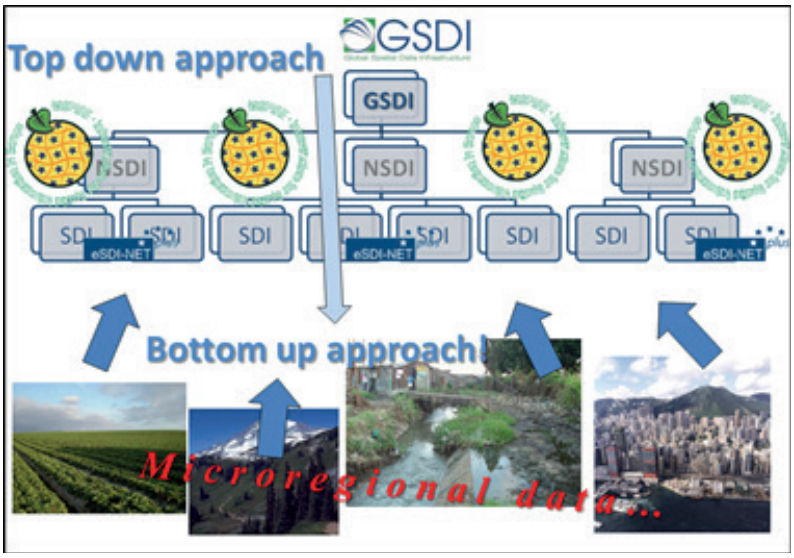

Figure 3. *From micro-regional data up to GSDI, through SDI's and NSDI's*

Within the specter of spatial data infrastructures from local up to global (in world level), in a national (state) level it is necessary developing of National Spatial Data Infrastructure (NSDI), as synthesis of sub-national infrastructures from one site, national interests from other site, and their compatibility in regional-global level in the third site. *NSDI incorporates ICT technology, data collection technologies, legislation and management, within the framework of establishing e-government aimed at enabling effective gathering, managing, transfer and utilization of georeferenced spatial data, which encompasses the establishment of metadata system, spatial data sets, spatial data services, and networking services and technology, as well as transfer of spatial data, access, utilization, coordination, monitoring, processes and procedures (Idrizi 2009).* Integrating of spatial data in to one unique standardized spatial data infrastructure in a national level known as NSDI, generate the simple and faster access to needed spatial data, more transparency, high level of cooperation between responsible state institutions, increasing the conscience for importance by spatial data, and much utilization of spatial data by all stake holders, clients and customers, i.e. many and multi utilization for scientific, practical and commercial purposes. Setting up of the NSDI has a direct impact on the way of organizing of local (sub-national) spatial data infrastructures. This is due to the hierarchy principle from up to down, which means that all infrastructures has to be organized to be fully compatible with NSDI, as well harmonizing of all phases from data collecting up to data shearing. NSDI consider as solid framework for land administration, where the interest of public and private sectors are guarantee ownership and security of tenure, reduce land disputes, provide security for credits, develop and monitor land markets, support for land property taxation, protect state lands, facilitate land reforms, promote land investments, improve urban planning and infrastructure development, support environmental management, produce statistical data municipal administration - supply and disposal systems ext (figure 4).

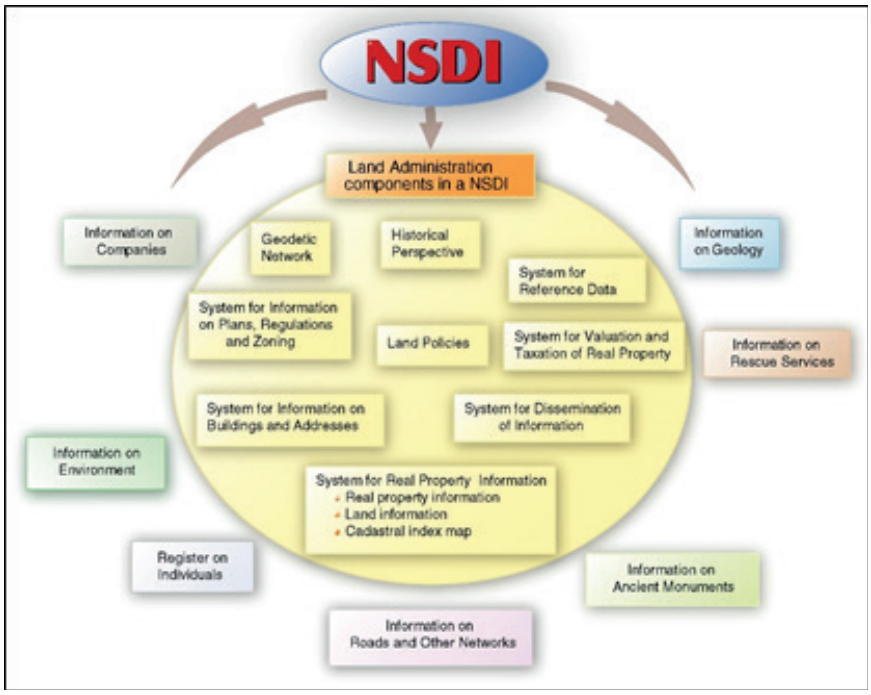

Figure 4. *NSDI components* [12].

Developed countries have started with developing NSDI very earlier, in earlier 90's. USA's NSDI was powered on April 11th 1994. Despite them, developing countries are working still in developing of their national SDI's, or some of them did not start yet. Both categories (early and late runners) have positive and negative aspects in the same time. In a next table (table 1), are given the results from comparing between early and late NSDI runners.

Table 1. *Comparing between early and late NSDI runners* [13].

Early runners	Positive-negative aspect	Late runners	Positive-negative aspect
GIS systems in place	*Positive*	GIS systems under development	*Negative*
Data available	*Positive*	Data not jet available	*Negative*
Services are in use	*Positive*	Expectations of society are high	*Negative*
Earlier technologies	*Negative*	In position to use newest technologies	*Positive*
Harmonization needed requiring lot of energy	*Negative*	Able to save energy used for harmonization	*Positive*

In the link of SDI's from local up to global level, the separate countries NSDI's should be developed with the same standards by using of regional/continental or global ones (figure 5). In this way the European Union (EU) has already established own standards called INSPIRE (Infrastructure for spatial information in Europe), as a base and obligatory framework for all its members during developing their NSDI's. INSPIRE is a Directive proposed by the European Commission in July 2004 setting the legal framework for the establishment and operation of an Infrastructure for Spatial Information in Europe. The purpose of such infrastructure is to support the formulation, implementation, monitoring activities and evaluation of Community policies linked with the environment at all levels, European, national and local, and to provide public information [7].The rules defined on ISNPIRE directive has to be followed by all European countries which are not member of EU also, as one of the conditions for their membership in it. The development of the INSPIRE initiative has been a complex process involving many groups of people since its inspection in September 2001, which can be divided in to five stages: main antecedes, initial development of INSPIRE from September 2001 to the end of 2002, public consultations and impact assessments that took place during 2003 prior to publication of the draft directive in July 2004, processes leading to its approval in November 2006, and preparations for its implementation [14].

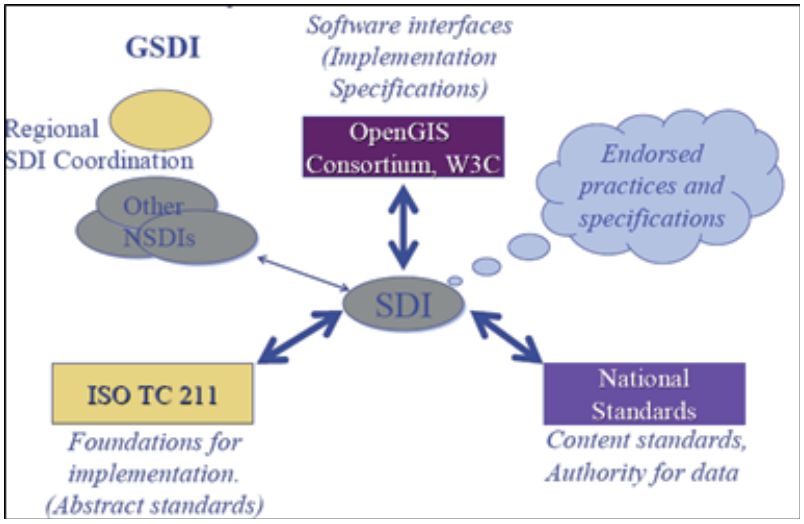

Figure 5. *Local SDI as link point between standards, practices, specifications, software, NSDI's, regional SDI's and GSDI*

CONCLUSIONS

Comparing the SDI's of all levels, the regional and local SDI's are developing even faster than national, regional and global ones, because of much more complex procedures for data harmonizing which comes from many sources with different standards and included big number of actors. National spatial data infrastructure (NSDI) can be developed by own standards defined by different countries, or can be utilized the international/continental initiatives as EU INSPIRE directive, euro maps by EUROGEOGRAPHICS, global map Australia ext., as well as the transcontinental/ global initiatives, as global spatial data infrastructures (GSDI), global mapping ext.

Structuring of spatial data in local, national and global datasets can be realized based on two main ways, "bottom up approach" and "top down approach". The first approach generally is in use during developing of local SDI's based on specific micro-regional data with aim to include all local data within the dataset, while the second way can be utilized in a case of developing of national, regional and global datasets where the database should include all necessary data according to the type of data infrastructure.

Within the spectrum of spatial data infrastructures from local up to global level, in a national level it is necessary developing of National Spatial Data Infrastructure (NSDI), as synthesis of sub-national infrastructures from one side, national interests from other side, and their compatibility in regional-global level in the third side.

Integrating of spatial data in to one unique standardized spatial data infrastructure in a national level known as NSDI, generate the simple and faster access to needed spatial data, more transparency, high level of cooperation between responsible state institutions, increasing the conscience for importance by spatial data, and much utilization of spatial data by all stake holders, clients and customers.

REFERENCES

[1] **Idrizi B.,** et all (2009): Developing of National Spatial Data Infrastructure of Macedonia according to global standardization (INSPIRE & GSDI) and local status; Conference of Nikodinovski; FON University; Skopje.

[2] **Rajabifard A., Chan T.O., Williamsom I.P.** (1999): The nature of regional spatial data infrastructures; AURISA 99; Blue Mountains NSW; Australia.

[3] **Crompvoets J.** (2011): Introduction to INSPIRE. Wageningen. The Netherlands.

[4] *"Global Spatial Data Infrastructure Association",* Web site: http://www.gsdi.org, April 2012.

[5] **Idrizi, B.** (2006): Developing of globally homogeneous geographic data set through global mapping project. Cartography and Geoinformation Journal. Zagreb. Croatia.

[6] **Pichler, G.,** 2009. The importance of SDI in the context of sustainable development. Thessaloniki, Greece. Workshop SEESDI09. eSDI NET+ & SEERC.

[7] "İnfrastucture *for spatial information in Europe"*, Inspire Knowledge Base, Web site: http://inspire.jrc.ec.europa.eu, 10.04.2009.

[8] *"GMES (Global Monitoring for Environment and Security"*, Web site: http://www.gmes.info, 10.04.2009.

[9] "*European Commission Enviroment Life Programme*", Web site: http://ec.europa.eu/environment/seis, 05.04.2009.

[10] *"Group on Earth Observation"***,** Web site: http://earthobservations.org, 16.04.2009.

[11] "GEOSS, INSPIRE and GMES an Action in Support", Web site: http://www.thegigasforum.eu, 14.04.2009.

[12] **Shroder, J.,** 2007. SDI concept and principles. Gavle. Sweden. Lantmateriet.

[13] **Bacic, Z.,** 2007. Croatian geoportal – cornerstone of Croatian NSDI. GDUC 2007. Opatija. Croatia. GISDATA.

[14] **Masser, I.,** 2007. Building European Spatial Data Infrastructures. California. ESRI.