GEOGRAPHICAL INSTITUTE "JOVAN CVIJIĆ" SASA
Nº 59 Vol. 1

JOURNAL OF THE ...
YEAR 2009

911:007

GLOBAL SPATIAL DATA INFRASTRUCTURE

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Abstract: In this paper, the explanation of the term and concept of spatial data infrastructure is represented. It is emphasized the role of global spatial data infrastructure to support the joint efforts, worldwide, for the sustainable development of environment protection and efficient decision-making. Geo-information technology and spatial data infrastructure have an important role in the modern world by providing the possibility of governments, local communities, organizations, business sector, academic community and ordinary people progress in solving many problems. Most of these problems have regional or global character. International organization and institutions around the globe provide and share global spatial data about the state of globe and its changes, stressing the importance of public access to information and international cooperation. Approach in building the global infrastructure of spatial data requires the culture of joint working and sharing of spatial data as a common good. Significant support to the global spatial data infrastructure provides cartographic initiative Global Map and the development of geo-information products and services prominent the Earth Viewers. The development of global spatial data infrastructure is undoubtedly a step forward civilization but further increase the problems of privacy, public and national security.

Key words: spatial data, spatial data infrastructure, global spatial data infrastructure.

Извод: У раду је дато објашњење појма и концепта инфраструктуре просторних података. Посебно је наглашена улога глобалне инфраструктуре просторних података као подршке заједничким напорима, на светском нивоу, одрживости развоја, очувања животне средине и ефикасном доношењу одлука. Геоинформационе технологије и инфраструктуре просторних података имају важну улогу у савременом свету, пружајући могућност владама, локалним заједницама, организацијама, пословном сектору, академској заједници и обичним људима за напредовање у решавању многих проблема. Већина тих проблема има регионални или глобални карактер. Међународне организације и институције широм света пружају и деле просторне податке о глобалном стању и променама, наглашавајући важност јавног приступа подацима и неопходност међународне сарадње. Приступ у изградњи глобалне инфраструктуре просторних података захтева културу заједничког рада и дељење просторних података као заједничког добра. Значајну подршку глобалној инфраструктури просторних података пружа картографска иницијатива Глобална

карта и развој геоинформационих производа и услуга, програма и апликација за посматрање планете Земље. Развој глобалне инфраструктуре просторних података несумњиво представља цивилизацијски искорак, али и додатно наглашава проблеме заштите приватности, јавне и националне безбедности.

Кључне речи: просторни подаци, инфраструктура просторних података, глобална инфраструктура просторних података.

Introduction

From the moment when they first started to collect spatial data and display on the map there is a tendency for them to be systemized and available. In a long historical period, the most effective way to view spatial data was analog map. Map was the original forerunner of spatial database and the original spatial information system and a method of spatial data infrastructure. Map allows the spatial reallocation, connection and mutual relations between objects and phenomena, as well as the qualitative and quantitative change of the state.

GIS technology has change all that. Geographic information and GIS technology integrated into other products and software applications, have become a product for mass market. Harbinger of spatial data infrastructure in the modern sense is probably the concept of integrated Networking and Networking of different thematic layers of data that comes from the 60th-of the last century. Thanks to information and communication technologies conventional way to present information about the area is in the past. Today, the spatial data are mainly collected, archived, processed, analyzed and presented in digital form through a large number of applications. Spatial data types provide the basic mechanisms of abstraction for modeling geometric structure of spatial data, their attributes, and operations over them, and relations between them.

The concept of spatial data infrastructure

The concept of Spatial Data Infrastructure (SDI) is often used to describe the basic set of technology, policy and institutional agreements with the goal of easier access to spatial data. Spatial Data Infrastructure in the organizational and technical sense, provides significant advantages in comparison to the standard spatial (geographic) database, and in it there are institutional and technical problems of divisibility and the availability of spatial data and interoperability. It should be noted that the spatial database is only one of the components and core infrastructure of spatial data. SDI is more than a simple set of spatial data and spatial database,

it means a lot of spatial data and attributes, just described (metadata), in terms of detection, visualization, evaluation of data (catalogs, Web Mapping) and other methods that provide access to spatial data. It includes additional services and applications designed for easier use of spatial data. Building functional SDI includes organizational arrangements necessary for the coordination and administration at the local, national and international level. Infrastructure provides an ideal environment for the connection of spatial data and applications through the application of minimum work standards and policies.

Spatial data can be divided into primary and others. Basic information from the beginning of the collection have a multi-use, while other thematic layers of data are collected for one purpose but of course can be used much more widely. Nature of spatial data is the foundation of a multidisciplinary infrastructure of spatial data is topographic and cadastral data. The primary goal of spatial data infrastructure is to facilitate access to a wide range of geographic information users in the public and private sector, for use at company level, local, state, national, regional and global level (Rakic, 2005).

The notion of infrastructure is usually related to the installation, resources or services necessary for the functioning of a system, organization or society. Infrastructure is the basis of any system or organization in the financial or organizational sense. The word infrastructure is used to promote the concept of a trusted environment that provides the transfer, transport or services. The concept of infrastructure can be related to the transportation and communication systems, financing systems, systems and services for water supply, electricity, gas (utilities), service institutions such as hospitals, health houses, schools, mail and so on. There is a clear delimitation between the spatial data infrastructure and other forms of infrastructure. As with roads or cables, SDI allows the transfer of virtually package of spatial data using the minimum practical standards, protocols and specifications. Spatial Data Infrastructure includes a set of spatial data, metadata, standards, the users, and interactive technologies that are related to the use of spatial data in an efficient and flexible manner. Some called the forum of producers and users of spatial data to develop the use of spatial data through a common system for the distribution and connectivity data. In general, spatial data infrastructure is a set of basic technology, policy and institutional arrangements which enable spatial data availability and access (Nebert, 2004). Synonyms for the infrastructure of spatial data are to them geoinformation strategy, the infrastructure of geospatial data and geo information infrastructure. It is from one side of a system for collecting spatial (geographic) information that describes the agreement and display the items, content, and attributes to appear on Earth, and on the other hand, and spatial information is accessible to a wide range of users.

The concept of spatial data infrastructure was originally developed in Canada in early 90 years previous century, and developed in detail in the study Cartographic Research Committee, National Science Foundation USA, and since then has become very popular in geo-information community. It represents the realization of the vision of the whole community geoinformation that the spatial data and tools easy to use and mass management and operation in a number of disciplines. Basic economic pragmatism and the development of information and communication technology is headed in the direction of spatial data infrastructure. The initiative for the development and implementation of spatial data infrastructure, mainly running the national government, government agency or significantly less, nongovernmental national and regional organizations.

There are different approaches to the concept of development and implementation of spatial data infrastructure, but essentially each approach involves a combination of organizational and technical components. The first step involves institutional agreement on the establishment of SDI as well as a number of primary care databases. It is also necessary to define the types of data used in most applications. This is usually about reference points, leveling and hydrographic data, addresses, administrative boundaries, air and satellite recordings, road network, information about the property and the like. The second step is to build information systems for metadata.
Metadata to help users finding the information they want. The development of the service metadata must be accompanied by raising awareness of the need for agreement on the issue of access to data, determining the price of services, licensing, copyright and similar. Internet and development portal for access to spatial data in the wide sense to provide users and providers. In parallel with these steps, it is necessary harmonization and coordination of spatial data with appropriate standards and norms. In technical terms the most important components of the technology and applications. Advances in technology have completely changed the way coming to the spatial information and their use. At the end of the implementation of spatial database and the establishment of national, regional (European) or Global Spatial Data Infrastructure (GSDI).

It is important to emphasize that the concept of spatial data infrastructure includes distributed access to the collection, maintenance, and download spatial data. Distributed databases are probably the biggest challenge for managers, designers and database analysts. They require solving the problem of choice "language", data distribution, communication processes, control, and distributed query processing, etc. Distributed system is a flexible, dynamic, decentralized and scattered. Such a system through proxy server provides customers easier, faster and cheaper access

to spatial data (Coleman, McLaughlin, 1997). Support the distributed approach has the organizational and economic justification. Requirements and easy access to data regardless of technology and software are based on the principle of interoperability. To access the spatial data are the responsibility of existing or newly established institutions.

Global Spatial Data Infrastructure

Spatial Data Infrastructure is built on the strong political support in many countries around the world. Since the mid-90th of the global community starts to benefices we realize validity of common standards and interoperability of spatial data, processes and systems. Those who make decisions in various spheres of economic and social life, from public and private sector, want to see more of the national borders. The result is that spatial data more and more countries and organizations agree to share their with others, and use spatial data on the other, and themselves. On the way civilization's transformation of the World in a global village deleted the national borders and interoperable systems such as the GSDI to promote cooperation within the global community bringing benefits users of geographic information in everyday life. World economy, society and environment to a large extent depend on the use of land, water, atmosphere and human resources. Geography provides a common framework, language and reference system for effective response and sustainable development. Without this common framework would not be able to build a system of accountability, coordination and sustainable development on Earth. Global Spatial Data Infrastructure is the best example of collective efforts to develop standards, guidelines and interoperable capacities of national, regional and international communities and agencies.

The GSDI initiative was created and is being developed as a result of progress in information technology and economic globalization. Technology is one of the main components of this large system is a global view of the Earth through the geographic information is always available, interoperable and web based geographical information systems and portals. Umbrella organization that connects professional and special interests through the promotion of international cooperation and supports the development of local, national and regional spatial data infrastructure is the GSDI Association (Figure 1).

This is a non-profit and nongovernmental organization which has members from more than 50 countries. The first meeting of the Association was held in Bonn (Germany) 1996. year and its growing influence is confirmed by global conference Chapel Hill (USA), Canberra (Australia), Cape Town (South Africa),

Cartagena (Colombia), Budapest (Hungary), Bangalore (India) and Cairo (Egypt). The basic idea is to build GSDI association as non-competitive, cooperative, open infrastructure for construction, which unification basic activities in the area of exchange and harmonization of geographic information.

On the second global conference in the United States, 1997, the GSDI is defined as a set of principles, organizations, information technology, standards, delivery mechanisms, financial and human resources necessary to implement projects at the regional and global role for achieving the desired goals (Coleman, McLaughlin, 1997). Project GSDI should support trans-national or global access to geographic information in response to the challenge of global sustainable development through the promotion of effective national and regional spatial data infrastructure.

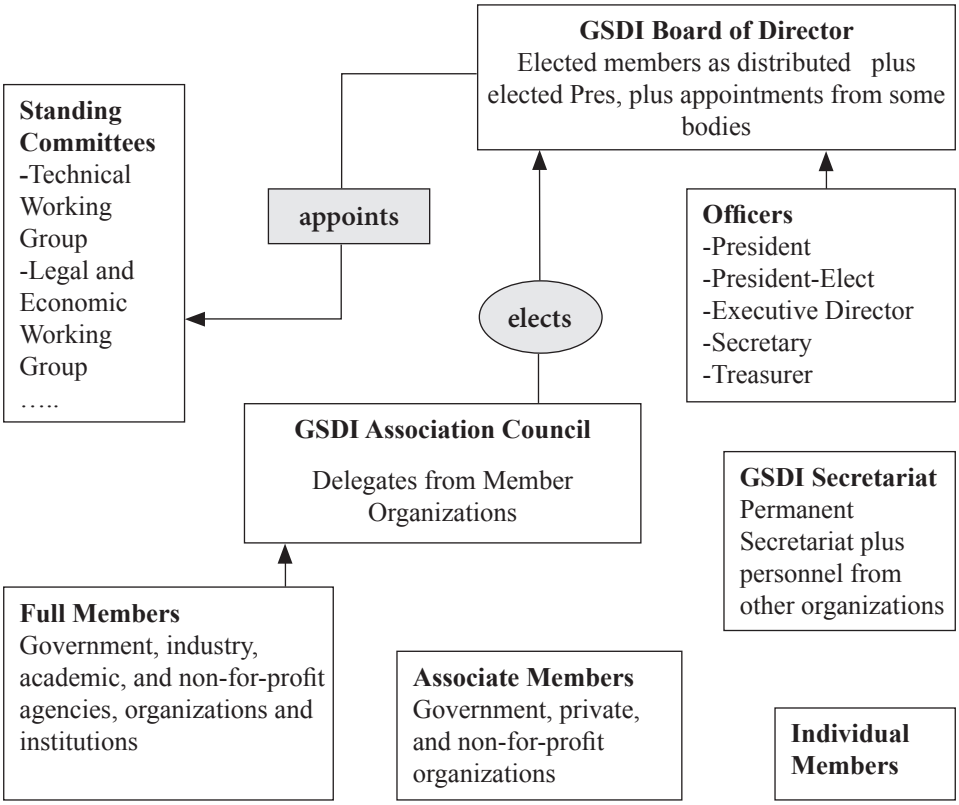

Figure 1. Organizational chart GSDI Association

The success of the idea of GSDI to a large extent depends of the degree of collaboration and international cooperation between national governments, national cartographic and other organizations and industry (Grunreich, 2007). A good example of cooperation at the regional level, European Umbrella Organization for Geographic Information (EUROGI), which is the goal of easier access to geographic information on the regional level. EUROGI represent the European view on the development of GSDI, and a European regional contact with GSDI. In general, this organization encourages greater use of geographic information in Europe through the removal of copyright and the economic constraints and the promotion of standards for the use of geographic information. It contributes to the development of strong national organizations in all European countries with special emphasis on the development of national organizations in Central and Eastern Europe (Maser, 2007).

As for the broader international cooperation, in accordance with its political, economic and technological power, the United States are imposed as a leader in the development and use of geographic information and related technology. In this sense, the American Federal Geographic Data Committee (FGDC), implemented a program to analyze spatial data infrastructure throughout the world. This analysis showed that there is an increasing number of countries developing or planning to develop the infrastructure of spatial data using to a large extent the existing model of spatial data infrastructure of the United States. In recent years, increasing interest in the FGDC relational events in international and the global community to ensure that spatial data and application of national infrastructures be useful for solving the transnational, regional and global problems. FGDC actively support the construction of GSDI, and bilateral agreements between countries in the field of exchange of geographic information.

National cartographic and other organizations have a crucial role in the creation of accurate and up date spatial data, the development and maintenance, and as such, a key role in the development of GSDI. There are many other organizations, agencies and institutions that collect and use spatial data. Between all of them is free to establish communication and to develop programs of cooperation on the principle of interoperability. One of the most successful examples of international cooperation is the Geo Connections, which is based on the interoperability of national spatial data infrastructure of the United States, Canada and Australia. Very important program of support to the development of GSDI is cartographic initiative Global Map launched by the Geo-Institute of Japanese geodetic, 1992.

The overall international cooperation is based on the information technology and services provided by industry. Industry plays a proactive role in the development

of GSDI way they influence, among other things, the adoption of global standards and specifications in the field of geographic information. American phenomenon of Google Inc. applications with Google Maps and Google Earth marks a revolution in the field of law geo-information in the global scale. Global Spatial Data Infrastructure aims to create conditions and mechanisms for long-term global approach and exchange of geographic information, regardless of political boundaries. Set goal is implemented through the coordinated activities in the promotion and implementation of complementary policies, common standards and effective mechanisms for the development and utilization of interoperabilnih digital spatial data and technology.

Cartographic initiative Global Map

Cartographic Map Global Initiative brings together national cartographic organizations from all over the world in establishing a global set of homogeneous geo-data through partnership between government, NGOs, producers and users of spatial data. The idea of geodetic Geo-Institute of Japan on the Global Map coincides with the recommendations of United Nations Conference on the Environment and Development (United Nations on Environment and Development-UNCED) held in Rio de Janeiro, 1992 year. In conclusion, the report from the conference pointed to the need for the development of the global map, public access to geographic information and international cooperation in this field. Since 1996 the International Steering Committee for Global Mapping (ISCGM) was founded in Japan, has a major role in the development of sets of spatial data for Global Map. This committee contributes to the exchange of institutional and technological experience, the exchange between the standards of many countries and is a relevant source of resources for the GSDI. Global Map now brings together several hundred cartographic organizations worldwide in the field of digital cartographic data. The main goal of the initiative is the creation of Global Map Network geo data in the form of maps that accurately show actual environmental contribution to sustainable development through the exchange of data.

Set of spatial data Global Map includes the entire country in the scale 1:1.000.000 and formed on the basis of technical instructions Global Map Specifications Version 1.2, based on recommendations ISO/TC211 (International Organization for Standardization/Technical Commitee211ISO/TC211). Set of spatial data is used to:

- system monitoring and early warning of natural disasters,
- monitoring of natural resources and management of these resources, such as water on the land, vegetation coverage and land, arable land, etc.,

- assess the trends in the change of environment, self-sufficient as soon as the conversion of soil in the desert, reducing the area under forests,
- development of the local, national and transnational spatial planning,
- preparation of data for decision-making on strategic issues related to land.

During the last ten years many countries, producers and academic institutions have accepted the concept of Global Map. Participation in this project is voluntary and each organization decides independently on the degree of their participation, which is divided into three levels:

- Level A: the organization prepares for its data set and another state,
- Level B: organization of data for your country,
- Level C: organizations collecting the necessary data and ISCGM prepare them for display.

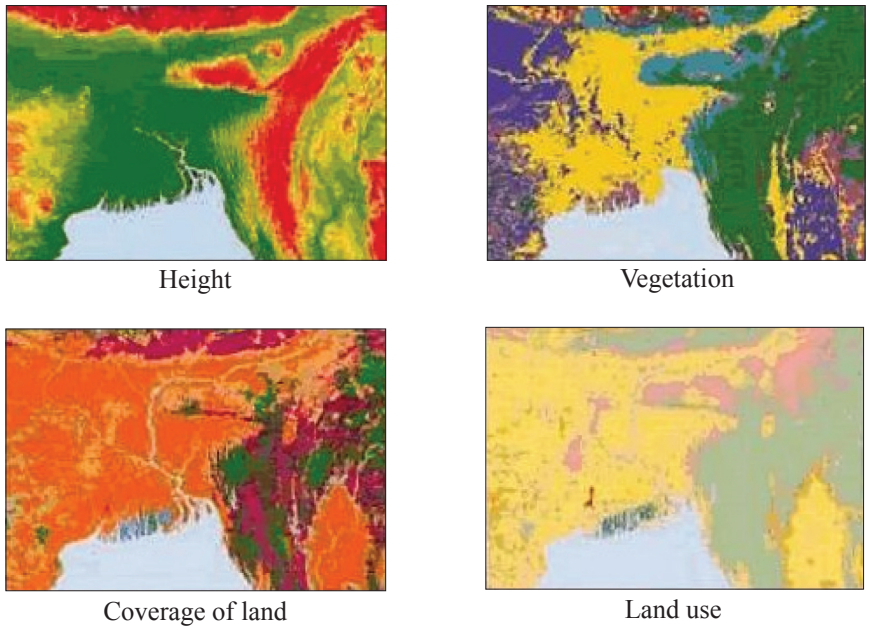

Figure 2. Global Map raster layers (http://www.iscgm.org/cgi-bin/fswiki/wiki.cgi)

Spatial objects are organized in thematic raster and vector layers and each layer contains the logic associated geoinformation. Global Map data set contains eight thematic layers, vector which is related to the information about roads, administrative boundaries, hydrograph, settlements and raster layers for height, vegetation, land cover and biophysical data on the use of land (Figure 2).

Metadata is delivered separately to each layer and comply with standard ISO 15046. Reference coordinate system for Global Map is International Terrestrial Reference Frame 1994 (ITRF94), and the longitude and latitude are defined on the ellipsoid GRS80 (Geodetic Reference System 1980). Position of objects and the phenomenon is described steam values longitude and latitude expressed in degrees with at least three decimals, while the southern hemisphere has a negative sign for latitude and west hemisphere has a negative sign for the longitude.

Global Map data sets are required for the solution of global, regional, and often transnational problems. In the past, assessment and monitoring at the global level have been significantly hampered due to lack of global and comprehensive spatial data sets, which is in the start disable integrated spatial analysis and modeling. Global Map data is in digital form and it is possible to apply different transformations and modeling hypothetic situation.
Potential application of spatial data sets Global Map is:
- assessment of the global environment (ozone layer, global climatic models, etc.)
- global, regional and national perspective,
- the development of the ecosystem, the question of drainage and assessment of the environment,
- quantification cross-border issues,
- the ability of fast response and prediction,
- setting priorities in the environment, analytical studies on large areas.

The combination of Global Map data set with other data can be to build different models and get to the assessment of trends in various areas such as water resources, floods, earthquakes, etc. The results of this modeling are used to taking preventive measures, disaster prevention, rescue, preservation of biodiversity, promotion of regenerative processes of the ecosystem, and the like. Access to spatial data sets Global Map is available via the Internet and is completely free for noncommercial use for commercial purposes, while the use of this data is subject to international laws on copyright.

Earth Viewers

The beginning of 2005 on the Internet appeared cartographic Google Maps that are on the territory of the United States, Canada, Great Britain and Ireland offer detailed city map with street names and direction of travel. A few months later appeared on the Google satellite pictures all over the world (except for areas of the ocean) in Google Earth, with the first resolution of 15 meters and then the lower of one meter for urban areas. That same year, Google Maps is integrated with another Google Local, which has enabled a search by geographic location user desire.

Figure 3. Hamburg shown in 3D (http://earth.google.com)

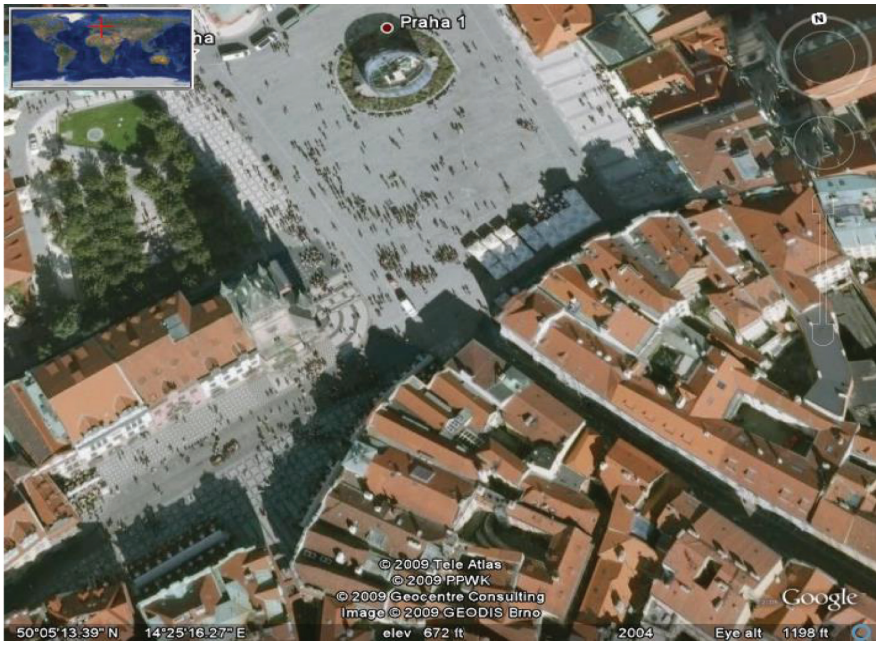

Figure 4. Aerial photography of Prague, resolution 0.10 m (http://earth.google.com)

Google Local has three possibilities screen: map, satellite image and map overlay via satellite image (superimposition). All of these products and services company Google Inc. known under the name of one Earth viewers. Google Local allows detailed search of certain sites and facilities.

So, for example, it is possible to search all the hotels or hospitals in some cities with access to additional information about the address, phone number, and link to the web address. As an additional service is available charted the direction of driving to the address and time that can be returned to the home position.

Google Earth free version has a slightly lower compared to the functionality of Google Earth Pro, which is intended for commercial use and offers more possibilities for an annual subscription of $400. Google Earth Pro contains additional software for movies, GIS data entry and advanced Printing module. For the most part of the Earth are available as 2D views for some parts there is a possibility of 3D visualization of satellite scene and aerial photography Google Earth uses a digital model of height taken from the NASA Shuttle Radar topography of Mission (SRTM). To use and manipulate 3D data is used geospatial Keyhole Markup Language (KML). Buildings and structures throughout the world can be displayed three-dimensional. In August, 2007, Hamburg has become the first city in the world which is fully shown in 3D, including the texture such as facade (Figure 3).

Google Earth satellite images in addition to high resolution and aerial photography for individual states and cities[1] (Figure 4) contains a number of layers that may include.

For the whole world to the boundaries and names of states, large cities, zoom are populated place a check in View option appears meridian and parallel networks. As a mathematical basis for determining the position of Google Earth using the internal coordinate system of Google Earth is geographic coordinates (latitude/ longitude) on the World Geodetic System of 1984 (WGS84) datum. Google Earth shows the earth as it looks from an elevated platform such as an airplane or orbiting satellite. The projection used to achieve this effect is called the General Perspective. This is similar to the orthographic projection, except that the point of perspective is a finite (near earth) distance rather than an infinite (deep space) distance. Check options terrain to get the 3D display regions, with the possibility of

[1] Territory of the Chez Republic is shown aerial photography spatial resolution of 0.2 meters and city of Prague in the 0.1 meter resolution.

Rotate and change the angle of observation. For the U.S. and more European cities are a number of layers that are related to hotels, schools, hospitals, restaurants, videos regions, streets and buildings, and various photos.

The special quality of Google Earth application that provides the user the possibility of the creation of active content in terms of adding different applications, layers and details. Are interesting examples of KML files that are using Google Earth and Google Maps created various organizations and users. With these files, it is possible to gain insight into the daily seismic changes in the Earth in real time, monitor the Earth's geological history and formation of continents through a period of 600 million years, explore the architectural history of London using the slider through time, analyze the spread of bird flu from Asia to Europe, etc. Images and data obtained using Google Maps and Google Earth is protected by copyright, and without a license can be used only in non-commercial purposes.
Minimum configuration for the latest 5.0 version of Google Earth is: Windows 2000, XP, Pentium III, 500 MHz, 128 MB RAM, a 12.7 MB of free disk space (400 MB for Linux), network speed 128Kbit / s, 3D graphics card 16 MB and 16-bit High-Color screen resolution 1024 x 768th This version is available since February 2009 on the 37 languages, including Serbian.

At the end of October 2008 the Google Inc. is offered on the market application Google Earth for Apple's iPhone mobile phone. Mobile version of Google Earth and allows users to tour the Earth thanks to satellite shots that are in the database on the server and the determination of current location using the iPhone with the integrated GPS-based. It uses multi-touch interface to move the Globe, Rotate and zoom views. Via the mobile phone can also read articles on some sites take images from Google's Panoramio[2] collections which are geographically indicated (geo tag) photos.

Google Earth has a number of critics of the special interest groups and state officials. Reviews are made in terms of violations of privacy and threats to public and national security. According to the writing of the London's Guardian in October 2007, the al-Aqsa Martyrs' Brigades are using Google Earth satellite images of the rocket attacks on Israel. According to some unverified reports from India are terrorists in preparation for the massacre in Mumbai 2008. The also use Google Earth to know the locations used in the attack. Charges to account for Google Earth and are coming from other countries like USA, China, Great

[2] Panoramio – Web page which enables anyone to add his or her georeferenced photographs for other to see.

Britain, South Korea, France, Australia, etc. Following such criticism Google Inc. has accepted to selective censure each satellite scene of nuclear plants, military facilities and installations.

According to the announcements to come from Google Inc. recently established cooperation with the NASA will in the near future to enable online viewing of certain sites in real time.

Conclusion

Knowledge and information are basic resources for development of humanity. The processes of globalization share the world into two zones, stagnation and development zone, crucially to determining the social, economic and political personality of an individual and society as a whole. Development at geoinformation technologies and services has important role in these processes. The present epoch is characterized by extremely rapid growth of digital geographic content and their under-use. International study[3] conducted for the European Commission showed that the geographic information market the last few years, grew at a rate of 15% to 20%. Multiple use of a collected spatial data is often difficult became of technological, legal, organizational, cultural and linguistic barriers that negatively affect on the price and the actual spatial information accessibility. Spatial Data Infrastructure is a safe way to overcome the above mentioned problems.

Global spatial data infrastructure is only one of the cornerstones of the digital era based on knowledge and information. GSDI brings realization of geographic reality within complex of the man and space. It promotes the culture of joint work based on the agreement, providing the possibility of every citizen, organization and nation to give the contribution to global access to geographic information and their exchange, regardless of political boundaries. Global Spatial Data Infrastructure will contribute to a clearer insight to the problems and make effective decisions related to strategic issues of sustainable development, environmental protection, access to natural resources, energy security, etc. Access to GIPP provides numerous economic and social benefits in terms of increasing efficiency and lowering costs of the organization in public and private sectors. National government should eliminate the institutional and political barriers in terms of access to geographic information enabling benefits a wide range of users. In the developed countries of the world there are institutions known as the Clearinghouses. These are the central

[3] PIRA International 2000, 8-9.

agencies for collection, classification and distribution of spatial data, organized as a decentralized server systems on the Internet. Geoinformation market development leads to the conclusion that Global Clearinghouse with links to the producers of spatial data, organizations and institutions in this domain will be formed in the years to come. Willingness to share information, knowledge and other resources is the basis of the progress of our civilization.

Geoweb services provide effective technical tools to facilitate the access and integration of multi–sourced spatial data. Global cartographic initiative Global Map and services companies like Google Inc. (Google Map and Google Earth) offer huge opportunities in the field of education, environmental protection, sustainable development, preventive action and the adoption of various decisions. Interactive programs with satellite and air recording of the Earth's surface are important for the development of global spatial data infrastructure. A large number of cities have already been presented on the Internet with high resolution satellite and air recordings. Easy access to these recordings over the Internet, a new problem for many national security agencies.

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