Међународна конференција
Савремена достигнућа у грађевинарству 24.-25. април 2014. Суботица, СРБИЈА

APPLIANCE OF THE NEW TECHNOLOGIES AT CARTOGRAPHY AND VISUALISATION OF GEOSPATIAL DATA

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UDK: 007.5:528.9
DOI: 10.14415/konferencijaGFS2014.140

Summary: *This paper deals with issues of the technological changes and its impact on cartography, apropos on visualisation and dynamics of geospatial data. So far they have been implemented, and will continue to be often used geographic maps for displaying and analyzing. However, the advent of new technologies are changing the way of their creation and use, and therefore cartography as science constantly undergoes the process of changing. There is a need to realize and accept the new technological challenges and opportunities in cartography, especially the internet as a medium for communication, distribution and representation of spatial reality. Namely, the geospatial data in digital (raster or vector) format becoming more current and available to interested parties for their usage. Digital cartographic representations that have been created are not only graphic-art expressions or geographical maps, but must have some potential interactivity capabilities, dynamics, animations and multimedia considering representation and communication with users.*

Keywords: *New technologies, digital cartography, web cartography, visualisation of data, INSPIRE.*

1. INTRODUCTION

Geographic maps exist for many centuries in the same or less the same, the classical (analogical) form. Such, they have many drawbacks. Firstly, they represent a “frozen” data state, and therefore are unsuitable for wider usage and expensive for maintenance. At the same time, during the usage of those maps is almost impossible to transform from one coordinate system or projection into another, from one scale to other, or to change any content on the map. Third, geographic maps exist as separate sheets, which complicates their conjunction and usage, especially at the corners, where are mutually interrelated. Namely, geographic maps represent cartographic images overviews, allowing simple browsing but not more efficient analysis and changing spatial data that refers to (Robinson et al., 1995).

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The main problem of this paper is just on the effects of new technologies and its impact on dynamics and content of cartographic representations. One of the most important requirements for successful and efficient usage of cartographic information and, generally, geospatial information distribution, is just their digital form availability. However, the more current and interesting global information system is called the *World Wide Web* (*web*). This system uses standard techniques and procedures, which substantially facilitates access to end users. It also allows anyone with network access to represent own data to others or to easily access geodata that someone else creates and delivers.

2. THE DEVELOPMENT AND TRANSITIONS IN OUR OFFICIAL CARTOGRAPHY

Through the development of cartography and science and technology in general, there was a constant need for foreseeing and describing near by and further geospatial environment. At the beginning, there were only simple sketches and drawings that reflected the spatial reality, as they were experienced by the individuals themselves and drawers.

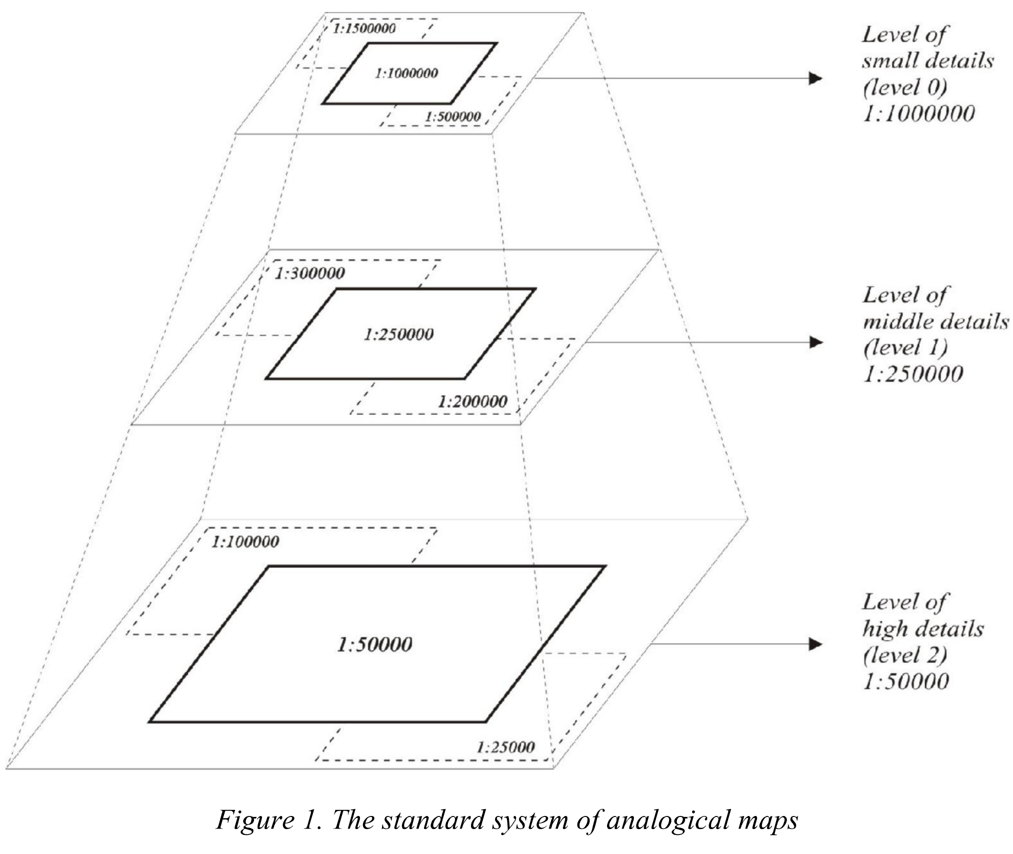

Figure 1. The standard system of analogical maps

Exemplars were drawn by freehand and on a solid material (stone, slab, paper). Later, with the development of science, geodesy and cartography in particular, there were the first scientifically-based approaches and techniques of cartographic representation of state territory. Therefore, those were the first geographic and topographic maps that appeared and were rare specimens at the beginning, too. However, with the advent of reproductive technology and the press, there was a duplication possibility in large number of copies. This was the era of **classical (analogical) cartography** and it had had the longest history, but also the least effectiveness in the production and usage of geographic maps. Namely, geospatial data frame is contained mainly in cartographic materials and geographical maps. There are some different levels of data and it depends of scale and data content which are required for specific consideration levels, analisys i decision making. In our national cartography is common information pyramid, or standard spatial cartographic representations levels which are published and looks like it is shown in Figure 1.

However, at the end of the last century there were great technological innovations and those changes had a significant influence on the further development and status of cartography. Novelties are primarily reflected in the methods of collection, visualization and distribution of geospatial data. Namely, cartographic activity has a new assignment to create amount of digital data regarding facilities and conditions at the Earth's surface and the shape of its relief, and that this information is maintained and make available to interested users. This is the era of **digital cartography**. One way to understand the technological and chronological order of all the previous changes in cartography, is shown in Figure 2, where could be seen three major epochs and two transitional periods. Thus, the first fundamental transition in cartography relates to the transition from analog to digital cartography. It was occurred in our cartography in 1995., when the first digital geographical map at scale 1:1000 000 (DGM1000) was made in Military Geographical Institute, Belgrade (Figure 2).

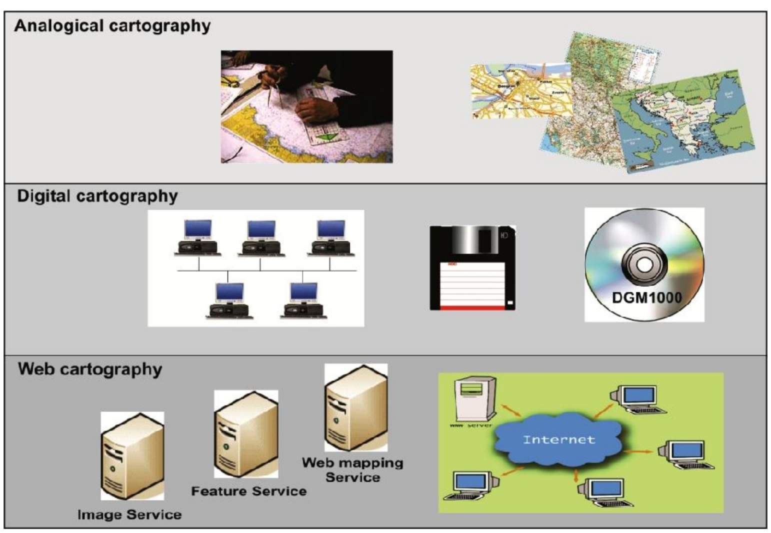

Figure 2. Epochs and transitions in our official cartography

With the advent of digital cartography and technology, there has been a desire and a constant challenge of finding and applying new methods and techniques of rapid sending and faster delivering with the diverse content as much as possible. Nowadays this challenge is still ongoing, but with a different approach and technologies that substantially are altering the basic concept and philosophy of cartography. Specifically, it reduces the subjectivity and participation of experts for the final mapping product, and increasingly affecting the computer technology and created software solutions. Recently, a new system for distributing and visualizing geospatial reality is developing **web cartography** as a service system for producing cartographic representations (Figure 2). It is a modern web service surroundings used for representation and distribution of geospatial data. Distributable because the files that are invoked do not have to be on the same server where is located the file from which is being invoked. Transfer to new technology is the second transition in cartography and it is transfer from digital to web cartography.

3. THE POSSIBLE TECHNIQUES USAGE OF GEODATA AT DIGITAL CARTOGRAPHY

Digital geographical maps can be represented in two ways: as raster and vector data. With distinction to vector maps, where graphic representation is consist of points, lines and mathematical curves which are very flexible for shape changing without loosing its quality, raster or scanned maps are based on pixels and have fixed content and resolution. They are limited with capacity and can have good representation usually when raster type obtained by geographic maps scanning or with formation of raster files using tools for processing cartographic materials. In the other words, scanned maps have the best appearance if represented or printed with original size.

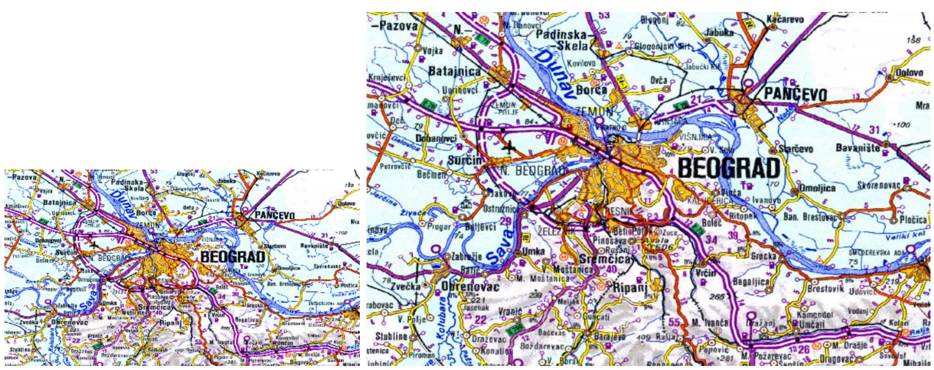

Figure 3. Static cartographic representation and linear zooming

Those are maps where there is no possibility of obtaining additional information and content cannot be changed, but only for viewing. The amount and content of data which are represented on conventional geographic maps primarily depends on the chosen scale. However, scanned maps are one of the most dominant cartographic representations on the web. Especially are interesting those geographic maps which are old and unavailable, but using this principle become available to many users. Moreover, it can be applied two representation methods. Firstly, during the static continuous zooming cartographic representation is linearly increased, but the content remains the same (Figure 3). Secondly, during the static discretized (gradual) zooming process there is available a series of maps of the same area, but each designed for different scales (Figure 4).

When zooming in, software automatically selects the most appropriate map for the required scale. Thereat, this option is widely used either for displaying the multi-layer data structure, or for displaying the content according to scale, where static representation and a raster format is basis. Therefore, this kind of static representation defines the possibility of a pyramid representation of cartographic data and content which is preliminary cartographically generalized and shaped.

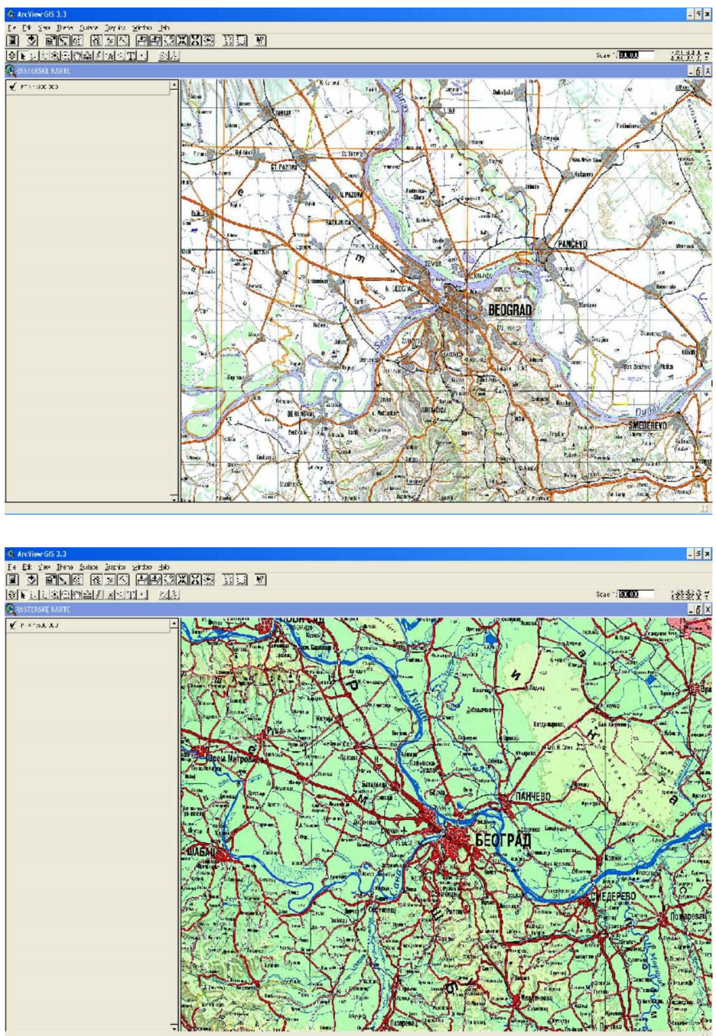

Figure 4. Static cartographic representations and gradually (according to scale) zooming

However, vector graphic have to be structured according to certain automated procedures, apropos express geometrical and topological model data. The process of structuring vector data is based on simple (geometric) and complex (topologic) models. Also, there is an interactive relationship between displaying scale and available cartographic data and symbols in the cartographic symbols libraries. This provides an adequate cartographic representation in accordance with dynamic and selected scale (Figure 5).

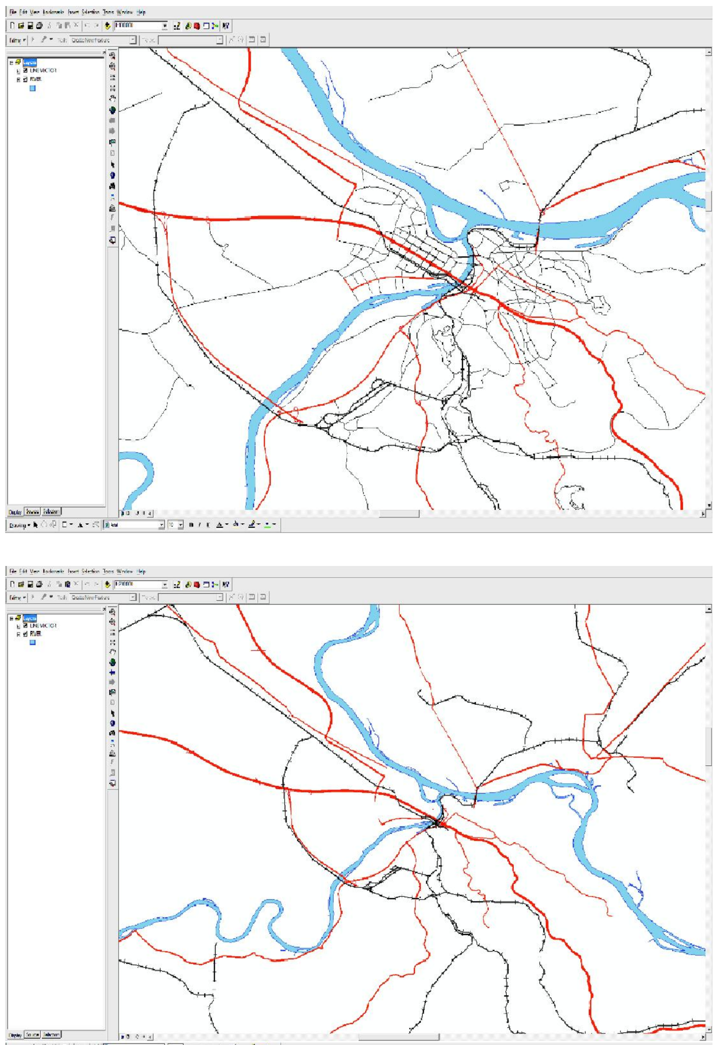

Figure 5. Dynamic cartographic representation of content and scale changes

Therefore, during a dynamic zooming process there is adjusted relationship between the mapping scale and map content. The larger scale, the more details will appear on a map and vice versa. Particularly, a direct link between representation and database is necessary. Also, vector data can be selected, moved, modified and cartographically processed without loosing quality. Dynamic purview represents content changing derivation of one or more map thematic layers which represent generalized content according to certain automated procedures, apropos express cartographic representation in accordance with a scale and purpose of visualisation.

Attributes of NASELJE_poligoni

Shape	Id	Br_republ	Maticni_op	Naziv_opst	Maticni_na	Naziv_nase	Ind	Ukupno
Polygon	12000	7	70114	BEOGRAD-VRA~AR	791024	Beograd-Deo	G	69680
Polygon	12001	7	70211	BEOGRAD-RAKOVICA	791083	Beograd-Deo	G	97752
Polygon	12002	7	70254	BEOGRAD-^UKARICA	791113	Beograd-Deo	G	120910
Polygon	12003	7	70220	BEOGRAD-SAVSKI VENAC	791091	Beograd-Deo	G	47682
Polygon	12004	7	70106	BEOGRAD-VO`DOVAC	791016	Beograd-Deo	G	143042
Polygon	12005	7	70149	BEOGRAD-ZVEZDARA	791032	Beograd-Deo	G	140483
Polygon	12006	7	70203	BEOGRAD-PALILULA	791075	Beograd-Deo	G	111693
Polygon	12007	7	70246	BEOGRAD-STARI GRAD	791105	Beograd-Deo	G	70791
Polygon	11011	8	80438	SUBOTICA	804614	Subotica	G	100386
Polygon	11012	8	80276	NOVI KNE`EVAC	802689	Novi Kne`evac	G	8062
Polygon	11048	8	80195	KAWI`A	802107	Horgo{		7201
Polygon	11049	8	80195	KAWI`A	802018	Kawi`a	G	11541
Polygon	11050	8	80276	NOVI KNE`EVAC	802638	Banatsko Aran\elovo		1912
Polygon	11076	8	80276	NOVI KNE`EVAC	802654	Kistur		1552
Polygon	11077	8	80438	SUBOTICA	804592	Pali}	G	7375
Polygon	11080	8	80047	APATIN	800198	Kupusina		2500

Figure 6. Multimedia cartography and visualisation of geodata (city)

Also, new cartographic visualisations become multimedia, where maps, images, text, etc (Figure 6). It can be structured and descripted by some of meta languages (*Unified Modeling Language - UML, eXtensible Markup Language - XML, Geography Markup Language - GML*).

3.1. The new technologies and results of visualisation of geospatial data as cartographic animation

As new technology significantly involved in the creation and distribution of geospatial information, there are several approaches to making presentations to a wider range of users and the usage of standard formats for virtual reality representation. Particular advantage of the system to represent geospatial data is in the user interface. Such systems are intuitive and recognizable to a user who has some idea of geospatial reality. And one of the ways is animated cartographic representation of more raster images as one, with defined appearance image time period, respectively representation sequence (Cartwright et al., 2007). Application of this animation type can be seen at many internet sites, for example, that deal with registration and weather conditions monitoring. Considering possible changes types, there are, until now, three cartographic animation types that represent:

- State and changes that occur over time, ie. chronologically;
- State and changes in one location (object), but modifying attributes; and
- Changing observation position (location) and moving in space.

New possibilities in terms of application development and usage protocol data, apropos, searching and navigating through documents and geographic bases, provide otherwise conception against hitherto. New concept basis represent so called hyperlinks, which enable positioning in certain places that allows transition to the next page of the same document or in another document or cartographic representation in dependence on the period and changes in terrain over time ie. time series of Belgrade (Figure 7).

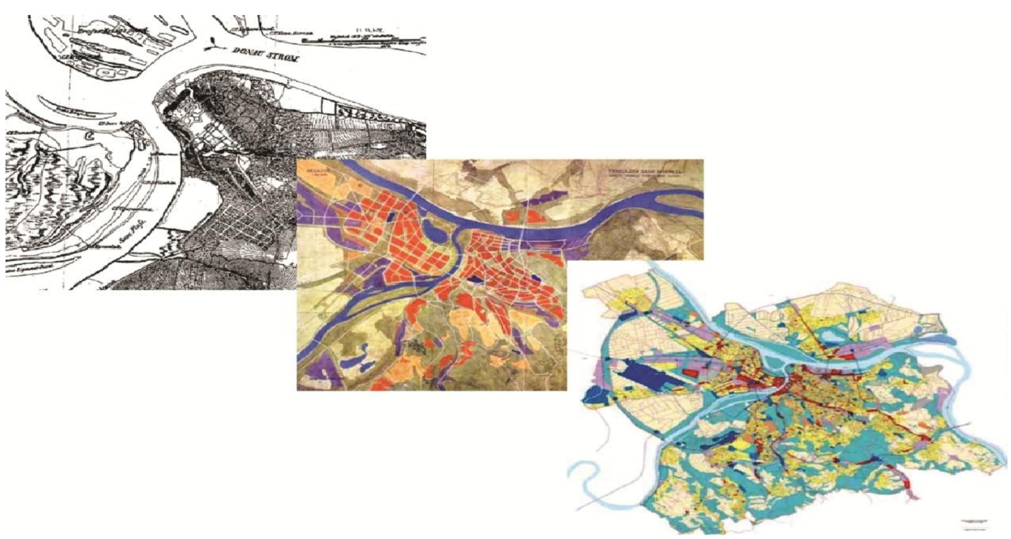

Figure 7. Animation - area of city changes through time (chronologically)

In cartographic animation of the same area but with the change of attributes, according to the given parameters (for example, changing a density of the population or growing in some period of history) is obtained new representation at the same location (Figure 8). In this type of animation, the spatial component is fixed, while changing attributes (Cartwright, 2007). Namely, data cartographic representation animation takes place through selection processes, filtering, generalizing and data visualization in a specific geospatial environment or to a selected object system.

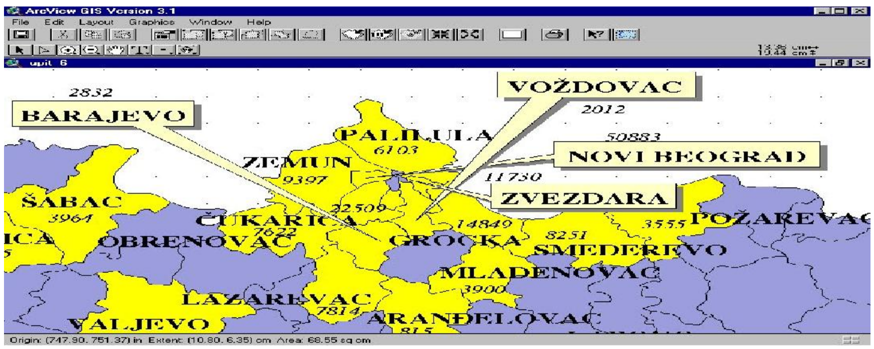

Figure 8. Animation - attributes changes in content of features (interactivly)

Likewise, animation can be achieved by using video and changing the position and movement in space. With this type of animation, attribute and time are fixed, and position changes are achieved by video motion (Cartwright et al., 2007). Apllaying of some software (ArcGIS-ArcScene), it can be linked of many pictures in very short interval time, and in this way we can get effect of movement in space. Here are interactivity obtained through possibility to stop at a particular video sequence, reversing or switching reversals ahead against to the current sequence. Many of created animations give a free choice movement through an open virtual world, or approaching, rambling, as example of moving to Avala tower (Figure 9).

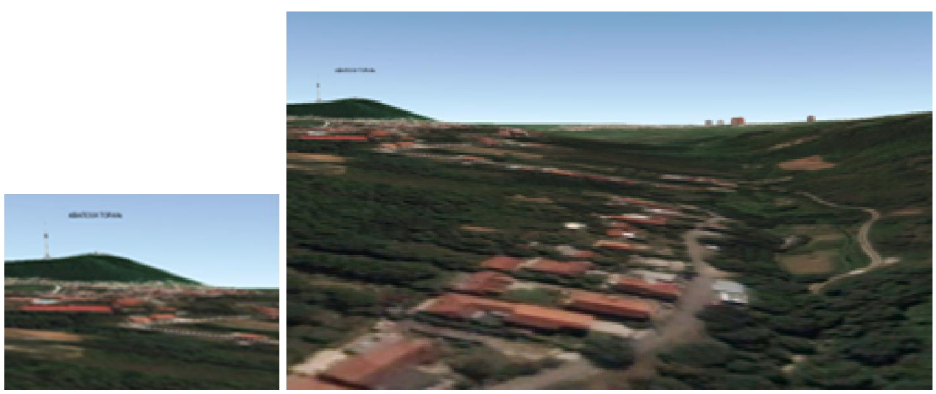

Figure 9. Animation - position changes in geospace (flight)

It is obvious that animations are trend in cartography, which allow user changing a content, symbology, or what is especially important degree of detail and movement through space and time. Cartographic animations are, moreover, more meaningful and more dynamic than interactive cartographic representations. For example, weather maps change every few hours. Also, map user is no longer limited to only one "view" that offers a classic example, but it can be tried a variety of alternative representations which may create a better environment purview, state and a process. Thus cartographic data more efficiently are routed to as many interested people.

4. THE WEB CARTOGRAPHY AND GEOPORTALS

Web cartography and web maps have characteristics that make them different from print maps or other on-screen maps. Further to many maps, a web map is a map and related content presented in an online environment with an appropriate interface and optional functionality for queries and reports. Also, a web mapping application refers to both the script that is created to define the interface and the elements and functions provided through the interface. Since the web environment is well suited for interaction, more information can be immediately shared using mouse-overs, tooltips, information boxes, labels and hyperlink (Buckley, 2012).

Figure 10. Geoportal of Republic Geodetic Authority

The map can be linked to databases that report attribute information, display images, play sounds when users clic related map features or perform analyses by accessing geoprocessing functionality. Web maps can also be portals for downloading or uploading content. Users expect current data and sometimes continuously updated data. They also expect interactive maps that support zooming at a minimum but also potentially support query, analysis and customization. For larger scale maps, users expect detail and realism. It can see on the site www.geosrbija.rs. They may even expect the data used to make the map to be downloadable and free. As with print maps, data should be complete, consistent and authoritative.

Modern society requires high quality geospatial data for optimal resource management, efficient determination of adequate solutions and continuous development. Spatial data today represents a key element in decision making processes, for optimal resource management, data exchange and communication and sustainable development. Development of technology contributed in making geoinformation compulsory elements of a modern society. This technology will only reach its full potential when governments decide to maximize access to geospatial information through spatial data infrastructure (SDI). Geospatial information unified within a common infrastructure provides a multitude of possibilities for upgrading public services, while disabling data duplication and data inconsistency.

Directive's purposes is definition of the basic regulations aimed at implementing spatial information infrastructure in the European Union (INSPIRE), for the purposes of Union's ecological policies and policies that may affect the environment (Figure 10). The INSPIRE directive is aimed at implementing infrastructure for European spatial information, offering an integrated spatial information service to final users. This service should enable users to identify and access spatial or geographic information from a variety of sources, from local to global level, in an inter-functional manner used by a myriad of clients. The aim is to make relevant quality geospatial data accessible, making a basis for gradual implementation of a harmonized spatial data structure, aimed at formulation, implementation, monitoring and evaluation during decision making processes on EU level, from a territorial influence aspect. The INSPIRE is an interesting model for developing not only a technological infrastructure, but also shared practices and working methods, through collaboration and partnership. Geospatial data infrastructure should be established with respect of following INSPIRE principles (www.geosrbija.rs):

- Data should be gathered once (from single source) and maintained at level where this can be done most effectively;
- Combination of seamless spatial data from different European sources should be enabled, distributed between users and applications;
- Information should be gathered at one level of government and shared between all levels;
- Spatial data necessary for efficient administration should not be made available only if their mass use is limited;
- It is necessary to enable easy access to available spatial data, assessment of whether they are appropriate for use and goal achievement, together with facilitating conditions for their acquisition and further use;

- Geospatial data should be simple to understand and interpret since they will be combined in an appropriate manner, allowing visualization in certain contexts, adjusted to suit the users.

Republic Geodetic Authority has started initial activity to establish SDI in Serbia in compliance with the European initiatives and trends. Also, National Spatial Data Infrastructure (NSDI) represents an integrated geospatial data system, enabling users to identify and access spatial information acquired from different sources, from local, via national to global level, in a comprehensive manner. Aim of the strategy is to establish an infrastructure, providing support to a high-quality and stable environmental development, coupled with economic growth, through efficient services, fulfilling the needs and demands of the public and private sectors, as well as citizens at large. The strategy presents a framework within which detailed policies can develop to ensure wide use of geoinformation to avoid duplicated effort and reduce administrative burden (www.geosrbija.rs).

5. CONCLUSION

Today, many geospatial data sets are increasingly available to a wider audience, and cartographic representations become more dynamic and can be changed at the user's request. For these reasons, it is essential to understand and accept new processes and concepts in cartography, apropos, interactive, dynamic, multimedia and animation images in cartography, which include:

- Static and dynamic interactive cartographic representations;
- Visualisations of cartographic data in accordance with the user's requirements; and
- Cartographic animations, apropos different criterions of practice visualisations.

Continual computer and communication technologies development caused the demand for a new dimension of making and using cartographic representations. Firstly, the advent of computers has changed significantly cartographic maps creation and representation technology. And secondly, the era of global communication and greater access to information and geospatial data has started, allowing their greater utilization value and cartographic representations distribution (ISO/TC, 2009). Also, the web makes it easier for maps and geoportals to reach far more people, but knowing how to design maps specifically for the web will help you create maps with immediate and wide appeal that readers will find useful, interesting and notable.

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http: //www.vgi.mod.gov.rs
http: //www.geosrbija.rs

ПРИМЕНА НОВИХ ТЕХНОЛОГИЈА ЗА КАРТОГРАФИЈУ И ВИЗУАЛИЗАЦИЈУ ГЕОПРОСТОРНИХ ПОДАТАКА

Резиме: *У раду се разматрају одређене технолошке новине и њихов утицај на промене у картографији, односно примена нових технологија на визуализацију и динамику геопросторних података. До сада су се примењивале, а и убудуће ће се различите географске карте користити често за приказ и анализу простора. Међутим, са појавом нових технологија мења се начин њиховог креирања и употребе, па самим тим и картографија као наука стално је у процесу промена. Наиме, потребно је прихватити нове технолошке изазове и могућности приказа у картографији, а пре свега, интернет као медијум за комуникацију, дистрибуцију и приказ просторне стварности. Подаци о простору у дигиталном (растерском или векторском) облику постају све више актуелни и доступни заинтересованим корисницима за њихову свакодневну употребу. Картографски прикази у дигиталној форми нису графичко-ликовни изрази или обичне географске карте, већ поседују одређене потенцијалне могућности интеракције, динамике, анимације, па и мултимедијалности у приказу и комуникацији са корисницима.*