Effective Establishment Of Local Infrastructure Of Spatial Data With The Use Of The Knowledge Bases

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Abstract:
Spatial data is a very important resource and as such, much more attention should be paid at the local level, since they are mostly collected in local government units (municipalities and cities). In this paper, we are considering the establishment of a local spatial data infrastructure in Bosnia and Herzegovina, supported by knowledge bases and a semantic web. Here we use the Protégé editor, an open source code for updating knowledge that enables: reading and saving knowledge. The idea is to point out to all future local spatial data infrastructure implementers how quickly they can get some of the necessary knowledge to make it more efficient. We could not present all the necessary knowledge here because this would overcome the needs of this work.

The local spatial data infrastructure defines the basics for finding and using spatial data, and it is the basis for building a quality national spatial data infrastructure.

1. Introduction

The problem with spatial data in Bosnia and Herzegovina (BiH) is their fragmentation and inaccessibility, lack of coordination, mismatch, insufficient use of standards and the like, making it difficult to identify, access and use existing spatial data. Data distribution takes place via analogue media, cards and records, and a little bit through digital media and networks. Unclear procedures for access to data, no information on the existence of data, spatial data disparity is evident, there are no harmonized data exchange procedures, and the like.

Spatial data is a very important resource and as such must be treated differently. Spatial data management is conditioned primarily by economic development and socio-economic parameters. When creating a spatial data management strategy, it should be taken into account that the role of spatial data is related to the development of BiH as a whole. In creating a spatial data management strategy, care should be taken of the fact that they are / are:
- Area information is a public good.
- Cadastre parcels part of the land:
  - belonging to the same owner,
  - located in a cadastral municipality,
- Cadastral plots basic elements of the space:
  - for spatial data management
  - for keeping records of ownership of real estate,
- Cadastre parcels are a basic element of urban planning and landscaping:
  - allows monitoring history of changes in space;
- For the cadastral parcel related attributes that describe the characteristics of the space:
  - fertile land (fields, meadows, pastures)
  - infertile land - (construction sites, landfills, cemeteries),
  - zone of urban construction land,
  - on the boundaries of administrative and spatial units;
- Buildings and floors of buildings (flats, business premises, etc.),
- Spatial data are very important and have economic value,
- The planning and management of spatial data must be carried out integrally at the level of BiH,
- The use and use of space data should be rational,
- All spatial data should be managed efficiently and permanently,
- The necessary legal infrastructure should be provided in a timely manner.
Spatial data has one of the most significant roles in a large number of human activities. It is impossible to imagine effective work in urban planning, construction, public administration, design of transport infrastructure, architecture and the like, without spatial data. It is believed that about 80% of all available information contains a spatial component in itself.

In order to be able to observe a different approach to monitoring and implementation of new ideas that need to be introduced in the work of local self-government units (municipalities and cities), we will introduce some more concepts that are necessary for us. These are primarily semantic web and knowledge base. The term semantic web was introduced by Tim Berners Lee (2001) as a clear structure of the content of the website. It was created as a need for more efficient finding of certain information and knowledge. It is based on the idea that information on the web becomes machine-readable. Instead of documents related to hyperlinks, they should use interconnected data (information) that has the specified structure and meaning.

The semantic web represents a group of methods and technologies that enable computers to understand the meaning or semantics of information on the web (Sladić, 2012). The semantic web is the expansion of the web through the standards defined by the World Wide Web Consortium (W3C). According to W3C, the semantic web provides a common framework that allows data to be exchanged and used in different applications and systems. It includes the use of languages designed for the Data Resource Description Framework (RDF), Web Ontology Language (OWL), and Extensible Markup Language (XML).

Ontologies are a formal way of describing taxonomies and as such they essentially determine the structure of knowledge from different domains. Ontologies solve the problem of semantic heterogeneity due to the existence of distributed information sources of the same domain based on different syntax, structure, and semantics (Sladić et al, 2013). They are used to determine what properties a domain possesses by performing new knowledge from proven facts, provide semantic representations of knowledge about a domain, allowing people to define concept sets, the connection between concepts and rules of conclusion. Its role is to provide a common vocabulary within a domain.

Here we use the Protégé editor, an open source code for updating knowledge that enables: reading and saving knowledge. Editor Protégé provides a rich set of modeling structures and activities that support the creation, visualization, and manipulation of data and information that are represented in different formats.

We will use the Protégé editor here to provide future implementers of local spatial data infrastructure with a quicker part of the necessary knowledge. We could not present all the necessary knowledge here because this would overcome the needs of this work. We use the Protégé editor, an open source platform to update the first necessary knowledge related to the aforementioned "Spatial Data Management Strategy" (Figure 1).
2. Spatial Data Infrastructure

Spatial Data Infrastructure (SDI) can be viewed as a product of interconnected spatial data bases, and as a comprehensive process of building a national strategy for spatial data management. In any case, in both respects, the importance of spatial data for the economic development of each country is very common.

When conducting the analysis of spatial data infrastructure, the following should be considered:

• The existence of a spatial data infrastructure in a particular form, for a certain period of time and at a certain level,
• Justification of investments in improving spatial data infrastructure,
• Participation and contribution of public and private sectors in improving specific spatial data infrastructure.

With the use of Protégé editors in the knowledge base, we updated the part of the knowledge that needs to be taken into account when conducting the analysis of the spatial data infrastructure (Figure 2).
In the research of spatial data infrastructure, it is necessary to collect certain data on a global and national level in order to provide the appropriate basis for making an analysis of improvements. The core spatial data infrastructure consists of the following parts:

- Catalogs
- Metadata
- Spatial data
  - Basic
  - Others
- Cooperation and association
- Standards

I will use the Protégé Editor to update knowledge related to the core of the Spatial Data Infrastructure (Figure 3).

Spatial Data Infrastructure (IPP) includes:
- spatial data sets,
- metadata and spatial data services,
- network services and technologies,
- agreements on the sharing, access and use of data,
- mechanisms for coordination and supervision, processes and procedures, established, guided or made available to certain data.

Protégé editor, open source platform, will be used to update knowledge about what we mean by IPP (Figure 4).
It should be kept in mind that IPP develops hierarchical, at different levels: local, state, regional and global. Given the hierarchical spatial data infrastructure on a global scale, the data are less detailed, while at each lower level it is more detailed. The most reliable data are kept at the level of local self-government units (municipalities and cities) and therefore in this paper we are dealing with "Local Infrastructure of Spatial Data". All these data should be an integral part of the spatial data infrastructure.

National Spatial Data Infrastructure (NSDI) Nebert, (2004), allows the integration and exchange of harmonized data and services from different sources from different data owners and makes it easily accessible to users via the Internet in order to increase the benefits to the society as a whole. NSDI is a set of technologies, rules, standards and human resources necessary for the collection, processing, storage, distribution and effective use of spatial data. The purpose of the integrated infrastructure is to achieve better availability of geoinformation for users and to enable public institutions and other users to exchange data efficiently.

The national spatial data infrastructure falls into a group of important strategic information systems, and it should exist in each country for faster economic development. National Spatial Data Infrastructure is one of the most important links in the hierarchical model of spatial data infrastructure. It should provide:

- storing geospatial data,
- their proper availability,
- maintaining them at the appropriate level,
- the possibility of combining spatial data from real sources,
- sharing them between users and gossiping applications.

It should be kept in mind that data collected at one level of government should be shared with all other levels, and access and finding should be effective and effective. Every user should have easy access to all the information and information they need.

Part of the author, Tosta (1997) argues through various discussions that the national spatial data infrastructure is not in their own right. Such attitudes have a certain theoretical meaning, but in practice the owners are actually those who invest in the creation and maintenance of the spatial data infrastructure. This primarily refers to the production and maintenance of spatial data for which significant financial assets should be allocated.

Spatial data infrastructure is not created in a styth, but requires a clear, effective and effective vision that must be based on Masser's organizational, human and financial resources (2005). In Bosnia and Herzegovina, instead of the term "National Spatial Data Infrastructure", only the term "Spatial Data Infrastructure" (IPP) is used, and it includes a set of basic technologies and policies, and provides accessibility and access to geospatial data. Spatial Data Infrastructure provides a basis for searching, evaluating and applying spatial data for users and service providers at all levels in the country and beyond.

The goal of establishing IPP in BiH is to create preconditions for efficient data collection, and that isolated data islands are standardized so that they can be networked and efficiently used. Good linking of different information that is georeferenced, will provide all users with complex searches and analyzes. This will provide the preconditions for efficient management of space and spatial resources.

3. Local Infrastructure Of Spatial Data

In addition to the "Spatial Data Infrastructure (IPP)", "Local Spatial Data Infrastructure (LIPP)" is also an important part, providing a basis for searching and exchanging spatial data, their assessment and application for users and data producers, or all participants at the local level.

It is known that "Spatial Data Infrastructure" or "National Spatial Data Infrastructure" is based on local level data, which means that the quality of data in them will depend on the quality of "Local Spatial Data Infrastructure".

Information on spatial data at the level of local self-government units (municipalities and cities), and especially at a lower level, are specific and significant. Local spatial data infrastructure has
a special impact on local authorities. They need to decide which data will be collected, and what grand data these will be. The national spatial data infrastructure is based on data from the local level of government, and its quality depends on the quality of the local spatial data infrastructure.

Spatial data at the local level are the most detailed data on a certain area, data with the same scale. Since it is the most detailed data, it should be kept in mind that they are the most expensive in terms of collection, processing and maintenance. Spatial data at the local level requires frequent updates because the changes in space are first noticed in them. Data from a local level is the basis of data for each higher hierarchical level of the spatial data infrastructure.

Many world-wide experiences (Kelly (2007)) on the issues of implementation and establishment of local spatial data infrastructure indicate:

- immature institutional governance in user / data relations relations,
- discrepancy in availability and quality of reference spatial data,
- inconsistent policy in accessing and using reference spatial data,
- poor awareness and ignorance of the availability and quality of existing geospatial data,
- Lack of good practice in using the necessary technologies.

According to Gonzalez Perez (2004), the biggest problems identified in the construction of local IPPs are:

- lack of quality staff, which limits the development and organization of planning,
- lack of financial resources
- lack of "culture" of spatial data exchange; a certain set of spatial data is produced, maintained by local governments or by a company, without any knowledge of that potential by other potential users; When requesting these data, there are high costs, it is often the case that certain units of local self-government know only about one type of spatial data and that they do not know anything about neighboring data, they do not know whether there are data in digital form and how they can be obtained.

With the use of Protégé editors in the knowledge base, it did not identify the identified problems in building local IPPs (Figure 5).

The efficient and effective development of local spatial data infrastructure is the basis for building a quality national spatial data infrastructure.

At the present time, local government (local self-government units (cities and towns)) usually move from different positions if the development and implementation of new information and communication technologies (ICT) is in question. Some of them already use new technologies and new tools efficiently, and others do not. The need for information about the land or their management is usually different. Sometimes these are organizational reasons, and sometimes they are financial,
staffing or some other reasons. All these reasons must be taken into account when developing a strategy for establishing or improving the spatial data infrastructure at the local level, Mueller (2005).

Plans for the development of local spatial data infrastructures must be well-designed to be sustainable in the implementation of new or enhancement of existing local spatial data infrastructures. According to Kelly (2007), development plans are divided into:

- managing the development of local spatial data infrastructures,
- access to data - enable users to find and access data,
- data quality - enable users to easily determine the quality of data,
- interoperability - using the best world practice in interoperable technologies,
- Integrability - spatial data must meet common standards, in order for this integration to provide efficient and effective solutions for users.

It is important to keep spatial data up to date in order to keep the local spatial data infrastructure permanently viable. The best solution for managing and maintaining local spatial data infrastructure is via Web services.

There is a significant number of available sets of spatial data relevant to the implementation of local spatial data infrastructure, which are located in various bodies of local self-government units. The problem in Bosnia and Herzegovina is that most of these data are in analogue and smaller in digital form. These data refer to cadastral and topographic map data, spatial planning, road and traffic data, agriculture, water management and forestry, environmental protection, tourism, health, cultural heritage protection, statistics, hydrometeorological data, civil protection data, geological data, and many others. The problem is that these data are often not followed by metadata sets.

Local spatial data and information infrastructures should be designed to ensure:

- geospatial data is stored in one place,
- that they are available,
- to be maintained in the most appropriate way,
- to enable consistent combining of spatial data from different sources.

Figure 6. How to design a LIPP.

In Bosnia and Herzegovina, before the emergence of new technologies, the data administration system was based on analogue registers. Data updates have been carried out manually in different organizations and institutions. This led to inconsistencies in real estate data.

The rapid development and application of information and communication technologies has led to the need for their greater application in data management.

Local spatial data infrastructure defines the basics for finding and using spatial data, and is under the jurisdiction of the land administration. Spatial data infrastructure includes the following services:

- Spatial data services and associated attributes,
- Services for access to spatial data,
- Spatial data processing and analysis services.
The applications that are used should provide a three-tier service architecture. The first layer should contain user applications that require services from a second-layer service, and they need to rely on third-layer databases.

The goal of implementing the local spatial data infrastructure is:

- Enable users to easily, quickly, cheaply and securely access spatial data,
- Integrate spatial data,
- Data to collect and maintain where it is the most efficient,
- Enable coordinated cooperation between all stakeholders,
- Enable efficient and economical management of resources,
- Enable continuous combining of spatial data from different sources,
- Secure data sharing between all interested users.
- Establish an appropriate spatial data service,
- Improve the fundamentals of good governance.

Using the Protégé editor into the knowledge base, we introduced some knowledge related to the goal of implementing LIPP (Figure 7).

![Figure 7. Goal of LIPP implementation](image)

3.1. Legislation

It should be emphasized that there is a significant number of laws and legal acts in Bosnia and Herzegovina related to the use of spatial data, which often obligate certain institutions to strengthen IPP. These laws regulate the copyright and the right to access information, as well as the manner of collecting, storing, processing and presenting spatial data, regulations in the field of physical planning, environmental protection, water and agricultural land regulations, forest regulations, statistics, and regulations and acts related to sharing and sharing data at all levels of government, and many others. A good part of these and other unnoticed legal solutions can be found on the Internet or within individual ministries, administrations or administrative organizations. There are also many regulations at the level of the cantons, municipalities and cities. What is significant is the many recommendations, standards and solutions adopted by the European Commission, which can be taken fully.

"Law on Spatial Planning and Land Use" at the level of the Federation of Bosnia and Herzegovina (SL.Novine Federation FBiH number: 2/06, 72/07, 32/08, 4/10, 13/10, 45/10), provides for the establishment and maintenance of the "Unified Information System", which should include the area of geopathatics and information. In accordance with Article 31 of the Law on Spatial Planning and Land Use at the level of the Federation of Bosnia and Herzegovina, the "Regulation on contents and holders of a unified information system" has been adopted, as well as the methodology of data collection and processing, as well as the unique forms on which records are kept.
There is adequate legal regulation that is significant and necessary for the implementation of local spatial data infrastructure in BiH.

4. Instead Of Conclusion

The use of new technologies in BiH varies considerably in individual municipalities / cities. Often investments in new technologies were related to donations or within international projects. International consultants have had a significant influence on the selection of technologies, and they are special for the quality of employee training and the way of establishing certain business procedures. It was felt that some local governments changed technologies or procedures several times, which depended on current projects or from investors. A small number of them have high-quality IT staff and a clear IT strategy to effectively influence the choice of solutions. It can be said that the state of software and hardware solutions is characterized by heterogeneity, so this situation is often accompanied by insufficient utilization of existing IT systems and the inaccessibility of individual data. Those local government units that have established a central database can easily implement web services, and in the next stage on-line GeoPortal and integrated web services. A small number implemented them, and a large number of them are only considering this possibility.

Using OntoGraf (Figure 8) we present a spatial data management strategy.

![OntoGraf Diagram](image)

**Figure 8. OntoGraph**

**Referentes**

March (International Federation of Surveyors FIG – Article of the Month, May 2007)