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# THE USE OF GEOGRAPHIC INFORMATION SYSTEMS IN PUBLIC SERVICES

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With the further development of information and communication technology and a growing use of smart phones, the significance of Geographic Information System - GIS will indisputably continue to grow. This is supported by the fact that in the last decade geotechnology has been identified as one of the fastest growing technologies, along with biotechnology and nanotechnology. Even though GIS is increasingly being utilized in the Republic of Serbia, it appears that its use with some providers of public services is mainly deduced to showing spatial data with quite limited possibilities for a further analysis - which represents the essence of the use of GIS. The paper uses the examples of good practice in the sphere of the health system, public safety, rescue services and local government. The covered examples show that the use of the analytical component of GIS in everyday activities of the mentioned public services can make their work not only more transparent to the public, but considerably more efficient as well. This way, the analytical component of GIS enables decision-makers to improve the management of frequently limited available resources, while proving a higher level of the service quality to citizens as the final users.

**Keywords:** geographic information system (GIS), health system, emergency response, local government

JEL Classification: L80

## INTRODUCTION

As J. T. Coppock and D. W. Rhind (1991, 21) suggest, there are rather few written traces on the beginnings of the geographic information system (GIS). Nevertheless, the first modern use of GIS can be associated with the Canadian government efforts made in the mid-1960s (Haklay, Antoniou, Basiouka, Soden & Mooney, 2014, 11). This endeavor included the census of Canadian land resources in order to understand how the land was used at that time, and also to have a better idea on how to use inventoried land in the future. The mentioned project is considered to be the first GIS project, whereas the first use of the term GIS is associated with the project's director R. Tomlinson (Longley & Batty, 2003, 2). Interestingly enough, this GIS project did not

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have any capacity to visualize the data, but only to show alpha-numeric outcomes in the form of a table. In spite of this shortcoming, this approach utilized by R. Tomlinson and his team was soon recognized by the Harvard Laboratory for Computer Graphics - which has designed and developed a multi-purpose GIS platform - creating in that way the foundation for the development of the first GIS software based on a synergy between a digital map and data.

However, according to P. Longley, M. Goodchild, D. J. Maguire and D. W. Rhind (2001, 11) the main driving force for a further development of GIS occurred during the 1980s, when the hardware prices went down enough to support significant development of GIS software. At that time, a decent computer system -rather modest compared to modern computers - could have been purchased for about $250,000, and the appropriate software was available at the price of about $100,000. Even at these prices, the benefits of GIS significantly overcame the costs. With a further decline in prices, computers became more available, whereas the GIS software market was growing at a steady pace, as a logical result of the fact that there was a growing community of those who understood the benefits of GIS.

Nowadays, the implementation of GIS is quite disseminated - ranging from its application in cadaster bureaus to the very sophisticated business applications intended for the needs of analyzing customers and their demographic characteristics. Therefore, it should not come as a surprise that defining GIS is not an easy task to do. Commonly, it can be heard that GIS has as many definitions as applications. Yet, one of the frequently used definitions suggests that GIS represents an organized set of hardware, software and processes devised to allow the saving, editing, managing, handling, analyzing, modeling and visualizing of spatially referenced data, with an objective to solve complex issues in planning and management (Voerkelius, Glavina, Specht-Mohl & Schilcher, 2008, 14).

Although GIS is used at an advanced analytical level by some scientists and practitioners - mainly those whose work is connected to geography and related disciplines - it seems that scientific and practicing communities in the Republic of Serbia (RS) are relatively modestly conversant with the means of the implementation of the analytical capabilities of GIS when providing public services. The search of SCIndeks (Serbian Citation Index) reveals that there are only a few papers that deal with utilizing the analytical aspects of GIS in the context of proving public safety services, whereas such an advanced use of GIS is almost non-existent when speaking of the other types of public services. Therefore, the main objective of this paper is to highlight the analytical component of GIS as the tool that has an outstanding potential to improve the efficiency of some very important public service by using a set of the examples of good practice in the different fields of providing public services.

The next section of the paper will discuss the most frequent uses of GIS in RS today by the providers of public services. Thereafter, a number of the examples of good practice with respect to the analytical aspect of GIS in the domain of public health, public safety, rescue service, as well as local government are presented. In the final section of the paper, the most important implications, the shortcomings of the paper and new directions for further research will be stressed.

## THE USE OF GIS IN THE REPUBLIC OF SERBIA

Even though the intensive utilization of GIS in developed countries is related to the 1980s, the more substantial use of GIS in RS has been occurring in the last 15 years. Certainly, the assumptions of an extensive use of GIS in RS existed during the 1990s (Jovanović, Đurđev, Srdić i Stankov, 2012, 172), which is supported by the fact that a course entitled "Geographic Information Systems" already existed within the Department of Spatial Planning at the Faculty of Geography - University of Belgrade. Unfortunately, the economic isolation of RS, among other negative effects, resulted in a delayed implementation of GIS on a greater scale in our country. Upon the lifting of the

economic embargo, the most important providers of GIS software solutions significantly stepped up their presence in the Serbian market. That mainly resulted in the education of a wider auditorium of potential users and a better understanding of the capabilities that GIS offers in different fields.

Nowadays, GIS has become a tool that is mainly used in everyday work of many city cadasters and city planning bureaus throughout RS. Recognizing the benefits of GIS, many cities have commenced the implementation of their own "city GIS" projects. For the most part, "city GIS" involves web platforms with digital maps, with the option of showing different sets of thematic maps, as well as a certain level of interaction with available maps. In most cases, "city GIS" includes the maps of administrative units, streets and the address system, roads, natural resources, general urban plans, cadaster data and, in some instances, even the air quality in certain parts of the city.

At the national level, in compliance with the Infrastructure for Spatial Information in Europe Initiative (INSPIRE) guidelines, the Republic Surveying Authority has established the National Spatial Data Infrastructure (NSDI). The main goal of the NSDI is to create an integrated system of spatial data, while allowing users to access with ease various types of spatial data, regardless of whether its source is of a local, national or global character (Vlada Republike Srbije, 2010, 1). This certainly is a big step forward towards conducting various analyses or providing location-based services, especially if we speak of delivering a large number of different public services.

Nevertheless, an impression is that some providers of public services in RS either do not fully understand the importance of GIS for their everyday activities or simply do not have adequate human/technical resources for integrating GIS in their activities - in the majority of the cases it is a combination of both factors. Namely, if we speak of health services, public safety, or rescue services, it can be implied that the use of GIS for analysis or decision-making is at best very limited, with certain exceptions. On the other hand, even though the concept of "city GIS" exists in many Serbian cities, it seems that local governments do not recognize the numerous possibilities of GIS in the context of attracting investors or improving the business climate in their communities, thus being unable to create added value for investors through the use of the analytical component of GIS, although the conditions for this exist.

## THE USE OF GIS FOR PUBLIC HEALTH SERVICES

A long tradition of spatial studies in public health goes back to the 19th century (Setia, Singh, Mathur, Makkar & Pal, 2017, 2). Numerous recent studies have utilized traditional tools for visualizing, as well as data research methods and their modeling that was taken from statistics and epidemiology. Simultaneously with the studies in the domain of spatial epidemiology, a number of other research efforts that were taking place were less within the paradigm framework common for natural sciences, but more within the context of social sciences, including above all the studies on health disparity and variations by regions that were taking into consideration not only health conditions, but also access to and the quality of the rendered health services. Certainly, what is common for both paths of research is the recognition that space and location are of significant importance.

In the previous years, we witnessed the frequent occurrence of epidemics and pandemics, such as the avian flu or A (N1 H1). Taking into consideration the fact that an epidemic outbreak can be followed in space, the application of GIS becomes apparent in the domain of improving public health and preventing the events that can lead to fatal consequences for the population's overall health, which has resulted in the appearance of geomedicine (Blatt, 2015, 102) and spatial epidemiology.

Spatial epidemiology can be defined as the analysis of the spatial occurrence of disease risks and incidence (Ostfeld, Glass & Keesing, 2005, 328). This type of analysis allows the identification of the

population groups with the relatively high levels of a predisposition for catching certain diseases and can significantly assist in isolating the potential source factors of an illness for further analysis. Spatial analysis can also be of great significance in the case of some types of disease that do not have epidemic roots, such as respiratory diseases and cancer. This is especially true when similar results are being confirmed at different times and in different locations, allowing for implications about the etiology of the given disease (www.who.int, 2017).

One of the good examples is a research study by L. A. Williams, C. M. Ulrich, T. Larson, M. H. Wener, B. Wood, P. T. Campbell, J. D. Potter, A. McTiernan, and A. J. De Roos (2009, 373), who did research in the correlation between living close to streets with heavy traffic and the condition of the immune system. The research focused on obese women in postmenopause - a population particularly at risk if exposed to the polluted air. The results of the study revealed that the women living up to 150 meters away from roads with heavy traffic have 21% fewer cytotoxic lymphocytes in comparison to the women who lived farther away from such roads. The authors of this study conclude that such results can have significant implications for a future policy on the use of the land that is near to heavy traffic spots. On the other hand, the next step that could be taken is that related to creating targeted campaigns focused on informing the population that already lives near heavy traffic locations about the importance of having more frequent health check-ups.

Another interesting use of GIS in the domain of health services is a consequence of the Internet's rapid growth. The dissemination of maps in the web environment can assist decision-makers to a great extent, especially when speaking of the prevention and control of, and reaction to the occurrence of certain diseases. As presented in the previous example, the phenomenon of the disease is closely related to the spatial and temporal factors. The Web-based GIS enables us not only to show data in real time, but also to present new information on a given disease in a dynamic manner. Therefore, it comes as no surprise that in the last twenty years the Internet has become an important medium for the public health institutions dealing with the overall health conditions, as well as for the general population demanding more pieces of information on the state of public health. It could be stated that the Internet has become the main technology for monitoring public health.

Data on the appearance (and spreading) of diseases are no longer reported exclusively through the official statements made by health institutions, but are more frequently so reported via the less formal channels that include anything from newspaper reports, blogs, chat rooms to the statistical analysis obtained from web searches. All these channels together create a brand new approach to understanding the overall state of public health that can be significantly different from what is presented by traditional means. These less formal means of informing significantly shorten the time needed for disease recognition, preventing the government authorities from covering up information on epidemics, while allowing a faster reaction to epidemic outbreaks.

Nowadays, web applications can search, categorize, filter and visually present on the map all the developments related to an epidemic occurrence and disease spreading in real time. A good illustration is the Health Map that is publicly available on the web portal (www.healthmap.org) for the purpose of informing on public health matters, which uses data from various sources in order to create an overview of the currently active infectious diseases at the global level. The sources from which the Health Map obtains pieces of information on epidemic outbreaks are of different confidence, varying from the information that can be found on Google News and ProMED to the official and credible information that comes from the World Health Organization. This web portal (www.healthmap.org) has over 100,000 users on a daily basis, including government health institutions, physicians and those who are planning international trips. Other similar systems include MediSys, Argus, EpiSPIDER, BioCaster and Wildlife Disease Information Node (Brownstein, Freifeld & Madoff, 2009, 2154).

A particularly interesting application of the GIS-based epidemiology was developed by Walgreens.

Namely, the company has created The Walgreens Flu Index™ that is based on a number of purchased flu medications in over 8,000 Walgreens' stores across the United States. Based on the number of the purchased medications, Walgreens generates the maps on a weekly basis that show which segments of the country's population are the most affected and even more significantly it does so faster than the Center for Disease Control and Prevention, whose main objective is to inform the population about health risks as early as possible.

Nevertheless, in the medical context, GIS is not only used for studying the epidemiology and spread of diseases, but also for representing any system that has a spatial component, including the processes that occur within the body of an individual patient (ESRI, 2008a, 5). This is especially true in the case of the bio-medical imaging that shows organs at a micro level. In that respect, GIS based on vector images can be used successfully to examine the blood flows in micro-vascular networks (Roth & Kiani, 1999, 44).

## THE USE OF GIS BY PUBLIC SAFETY SERVICES

Services dedicated to maintaining public safety (such as the police, the judicial system and other relevant institutions) are faced with numerous tasks and challenges in their daily efforts to protect human lives and property. Given the fact that almost every task they are facing has a spatial component, GIS presents itself as an invaluable resource for the daily activities of these public safety services. The GIS-enabled fast access to data and their processing and visualizing allow for a quick and efficient allocation of the needed resources. For public safety, data on the crime location, an incident, a suspect or a victim are of utmost importance in determining the means and scale of reaction. Furthermore, GIS may be utilized for generating information of critical importance for response units, which have to react at the moment's notice. Nowadays, modern public safety services cannot be imagined without the use of GIS technologies. Response teams are not only able to react faster to critical incidents, but they are also able to achieve the highest possible levels of efficiency in the use of available resources (ESRI, 2006, 4).

The backbone of every analysis begins with entering the exact locations where human lives and property have been endangered. Based on such data, we can find out a great deal about the type and occurrence of such events. A quite interesting example where GIS has been used to record criminal activities is the CLEAR Map of the Chicago Police Department (CPD). Namely, the CPD has created a web portal that can assist citizens to track the criminal activity in their neighborhoods.

This web-based application is publicly available and allows the citizens of Chicago to search the CPD's database that contains all of the recorded events related to public safety. The application allows the citizens to view the thematic maps categorized by the type of criminal offense. The database itself contains the records of all of the events in the last year that can be searched by the time periods of 90, 180, 270 and 365 days, whereas the data are updated on a daily basis. By utilizing the GIS software and other technologies, the CLEAR Map's database can generate the maps that show almost all different variations of the location where an offense was committed or other relevant pieces of information, where every piece of data can simultaneously be shared with officers in the Command Center, as well as with the citizens, via the web portal. Such visualizations are useful and very effective additions to those rendering public safety services, allowing those in charge to identify, discuss and note the patterns in the domain of public safety.

The true value of one such system in terms of public safety can be seen through the cases in which GIS assists to establish where next crime will occur, based on historic data. One such example is a Los Angeles case dating back in 1998 (Geggie, 1999, 111). Namely, detectives were looking into a series of three robberies, where the offender attacked the victims and robbed them as they were walking to their parked cars. The mentioned attacks occurred in three completely different locations within the range of several kilometers.

The idea was to use the historical data, as well as the way in which the crime was committed, in order to predict the time and the location of the next attack. This was done by mainly relying on the statistical methodology that used the mean values (μ) and the standard deviation (σ) of the attacks. This methodology took into account the times of the attacks and the locations where they had occurred (shown as dots in Figure 1). Assuming the normal distribution principle, it was determined that there was an 68% probability (i.e. within 1σ) that the next attack would occur between January 25th and February 6th, in a time period between 20:45 and 23:45, in some of the locations marked with the smaller rectangle. By using the same logic, there was a 95% probability (within 2σ) that the next attack would occur in longer time spans and in the locations that were marked within the larger rectangle, as is shown in Figure 1.

The fourth attack occurred within the expected time and location frameworks that had been predicted based on the first three attacks. Following the fourth attack, new predictions were made and the police units were distributed in the field with an objective to capture the offender. During the fifth attack, the suspect was spotted, but after the chase the criminal managed to escape. Even though the offender ran away, the objective was partially achieved given the fact that after the last attack there were no similar incidents in that part of the city.

## THE USE OF GIS BY RESCUE SERVICES

Emergency rescue services are responsible for protecting human lives and property, but quite often they are faced with limited resources in the context of the people and equipment. RS is no exception to this rule. Namely, there is a major shortage of firemen - according to the European standards, RS should have about 7,000 firemen in service, but instead there are currently only about 3,100 in service („Koliko Srbiji nedostaje vatrogasaca?", 2016).

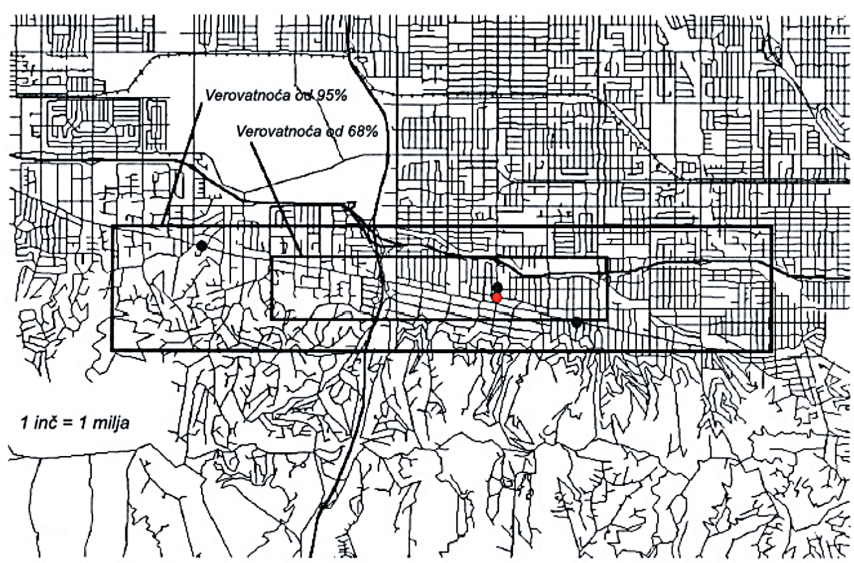


**Figure 1** Map of LA where attacks occurred

*Source:* Geggie, 1999, 112

Firefighting is far more than mere reaching the location of fire. Nowadays, firefighting assumes a holistic approach to a given situation and possible scenarios. GIS offers a set of tools for work with tactical, location-based information, such as - what it is in the immediate surroundings that may have an effect on the course of action. In that sense, urban environments pose a special challenge (Forkuo & Quaye-Ballard, 2013, 32). Facilities including schools, shopping malls, warehouses with dangerous substances, factories or gas stations, may additionally complicate intervention in the field and determine its course. Access to such information while the response units are on the way to the location of an accident allows firefighters to secure the area faster and more effectively, taking into consideration possible threats to the population and the units in the field.

Indeed, the incoming information can be "fed" into the GIS application that can provide an overview of the potential threats that are in the immediate vicinity of an accident in real time, as is shown in Figure 2(a). For instance, sparks from a nearby electrical substation can ignite the flammable gases already present in the air, eventually causing an explosion of a larger scale.

The unique value of such an "intelligent tool" for rescue service is reflected in the fact that it allows those in charge to make an estimate of the number of the people living near the endangered zone. That is possible based on the census data that are already in the GIS database. Although such estimates may not have perfect accuracy, they do enable the planning of certain activities, such as the evacuation of certain city neighborhoods. It is particularly important to stress that such a GIS facilitates the prompt anticipation of events and taking all the necessary measures for minimizing and eliminating the unwanted effects for the local population (Andrienko & Andrienko, 2007, 901), as is seen in Figure 2(b).

Another good illustration is a study by T. J. Cova (1999, 53), who has developed a "tool" that enables local communities to assess the probability of traffic jams during evacuation efforts. The application uses the GIS database that contains information on the dissemination of the population within a community, as well as the streets network. The final result is the "vulnerability map" that points to potential traffic-related bottleneck points during evacuation. Given the fact that the scale of an accident cannot be determined in advance, this method is based on the principle of the worst possible scenario in a given location.

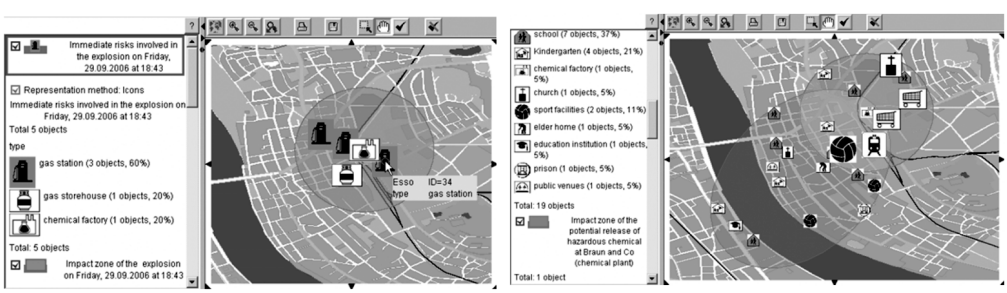


**Figure 2** The potential sources of risk in the immediate surroundings

(a) The map shows the other potentially dangerous facilities that are in an immediate vicinity;

(b) The map shows which objects will be under a direct impact in the case of some of the potential scenarios - specifically, the emission of chemicals from a local factory

*Source*: Andrienko & Andrienko, 2007, 902

We can assume that a certain neighborhood is threatened by a forest fire and that evacuation is necessary. Furthermore, we can assume that only one vehicle is needed to evacuate the entire family from one household. If the households are located in a dead-end street, then all inhabitants have to use the same street exit. The method used by T. J. Cova (1999) is designed to take into account the entire network of roads/streets so as to determine the bottleneck - the section that will suffer the greatest traffic congestion during evacuation. In the neighborhood with a dense network of roads/streets, traffic will flow towards several exit options, minimizing the bottleneck effect. However, densely populated areas with the limited road/street infrastructure can lead to serious issues during evacuation, if the situation demands the prompt evacuation of the entire area.

Figure 3 shows the map of one part of Santa Barbara, California. The streets are displayed in different colors, depending on the bottlenecks, based on the previously explained method used by T. J. Cova (1999). The streets are assigned different colors, depending on the expected number of the vehicles that should go through the critical bottlenecks during the evacuation effort, taking into consideration the worst possible scenario. The dark-colored locations represent the places where it is estimated that over 500 people will pass during evacuation, thus creating potentially dangerous standstills, wasting precious evacuation time.

By analyzing such maps, firefighters (and other rescue services) can have an overview of the most critical locations during the evacuation effort and consequently plan to dispatch the units in those spots so as to facilitate the flow of traffic. On the other hand, such analyses allow for the better planning of the traffic infrastructure that can take into account bottlenecks and try to minimize their number.

## THE USE OF GIS BY LOCAL GOVERNMENTS

One of the most frequent uses of GIS can be found in the domain of local government (Campbell & Masser, 1992, 529). City managers make decisions on a daily basis that directly or indirectly have an impact on the quality of the life of every single citizen that works and resides in a given city or community. Nevertheless, citizens are quite aware of the fact that wrong decisions made by local authorities may have a negative effect on the quality of their lives - starting from traffic jams to protecting the natural environment. Therefore, citizens start to demand that decisions made by local governments should


**Figure 3** The map of the street bottlenecks in Santa Barbara, California

*Source*: Cova, 1999, 53

be justified and supported by adequate data. In that way, not only will the risk of making wrong decisions be minimized, but non-functional and often financially unjustified projects will be prevented from commencing.

In fact, citizens increasingly demand that the offered actions should result in improved efficiency in solving their problems, generating sustainable value, a further enhancement of the community's development capacities, as well as the better management of the city's infrastructure and resources. Hence, it comes as no surprise that a growing number of local governments (Jacoby, Smith, Ting & Williamson, 2002, 305) and utility companies operating at the city level invest in GIS and in building databases - whose synergy can significantly facilitate decision-making.

The fact is that those who create policies at a local/regional level have a talent for suggesting rather complicated solutions. Prior to the introduction of GIS, the costs of testing such solutions and their evaluation were quite high in terms of money, effort and time. In other words, GIS has enabled the testing of complex solutions through a set of scenarios using data from the real world and their implementation starts only after it has been determined that a particular solution is acceptable for all stakeholders.

The general acceptance of GIS technologies implies the value that this tool has in the process of reaching many important decisions. Indeed, nowadays, GIS is used in almost all aspects of planning a community's development or following the trends occurring within it. City architects and cadasters need as detailed information as possible on the classification of land parcels and available land resources in specific parts of a city or a region. Civil engineering needs to plan a network of roads, define the building of timeframes and forecast all costs associated with road construction. Also, it should not be forgotten that all large-scale infrastructure installations, such as sewage, the water system or telecommunication, demand spatial data in order to establish efficient maintenance or a faster response in the case of issues or when planning to add new users to the existing service network. Numerous public services have recognized the possibilities that GIS offers. Thanks to GIS, many spatial analyses are conducted in order to attract new and support the existing businesses that, in turn, create new jobs - thus strengthening a city's tax potential, or in order to improve the planning and implementation of large-scale works.

In addition to the said, the synergy between the increasingly more available Internet, on the one hand, and digital maps, on the other, defines the new types and levels of the services that local authorities can offer to their citizens. Generally, the services based on the GIS technologies offered by local governments can be classified into the following three categories: a) the services aimed at business users, b) the services aimed at the local population, and c) the services aimed at other governing bodies. In the next section of the paper, only the first category will be briefly covered.

## Local Government Services Aimed at Business Users

These types of services are usually related to fostering economic development, information on land use in certain urban zones, the efficient processing of various requests and the issuance of permits. Potential investors can access all relevant data on a 24/7 basis, locate the city areas where the construction of manufacturing facilities, shopping malls or residential/office buildings is permitted, or have the visualization and analyze the demographic or economic data collected from the last population census for certain city areas.

In the domain of supporting economic development, GIS technology is used dominantly as an efficient way to attract new investors. In fact, the mere existence of GIS in a given city can be said to already be creating a favorable climate and a desirable location for hi-tech companies. However, in order to attract additional capital, or to convince the existing companies not to relocate their production facilities, the GIS of a local government needs to be completely adjusted to the business needs of the investors themselves. For numerous investors, seeking efficiency leads

towards not only finding an optimal location, but also towards obtaining an absolutely transparent picture of a given potential location. Today's investors prefer getting a complete image, taking into consideration the traffic and telecommunication infrastructures, the community's image, the skills of the local labor force, the market size, sustainability and plans for a further development of local communities.

Hence, in order to remain competitive, many cities (and entire regions as well) develop their own GIS infrastructures that should be able to give answers to all of these - and many other - questions to the prospective investors. The Savannah Economic Development Authority (SEDA) represents an example of good practice. SEDA was founded in the mid-1990s, with an objective to improve the living standard of the population that resides in the Savannah and Chatham counties, Georgia, USA, through stimulating economic development by attracting investment capital, generating new jobs and providing an adequate support to the companies that had already been located in that region.

SEDA is certainly aware of the fact that, in the competitive environment that is becoming increasingly tougher on a daily basis, it is impossible to offer prospective investors the papers with a list of available real estate and their square footage. To investors, it is of vital importance to know where the potential site is exactly located - how far from the port, the train station, the highway or the local airport. Above all, investors want to know all of these things even prior to making the initial contact with the local authorities.

Understanding these demands, SEDA has introduced a GIS portal (http://www.savannahsitesearch .com/) with a database containing all of the available manufacturing facilities, office spaces and parcels that range between 500 $m^2$ to 250 hectares. At every moment, SEDA has at its disposal over 150 real estate locations that it can offer investors. SEDA offers its potential clients all the available data via the Internet portal, and much more beyond that. Indeed, through the GIS use, a connection between spatial and non-spatial data has been established, thus creating an efficient geo-database for managing resources, while shortening the search time. Clients can conduct their search as per available real estate, select the one that matches their need and perform various types of demographic and business analyses (ESRI, 2008b, 2). In addition to this, SEDA has the capability of overlooking all changes in real time and offering its clients the data that are always up-to-date.

A study on the economic impact SEDA had on the development of the local economy revealed that, in the period between 1996 and 2007, in collaboration with the state and local partners, SEDA had helped to create 15,320 new jobs and had generated $1.8 billion in investments (SEDA Annual Report, 2007). The study also showed that without these jobs mainly attracted by SEDA, the region would not have reached this level of development until as late as 2020.

## CONCLUSION

The main contribution of this paper is reflected in the fact that, in RS, there are only a few studies of the use of analytical GIS in the domain of public services. Through the examples of good practice, the paper stresses an important role that analytical GIS can play for different providers of public services, given the fact that the numerous activities that they perform on a daily basis and the issues that they are faced with both have a pronounced spatial component. On the other hand, it should not be forgotten that, nowadays, providers of many public services are under growing pressure to deliver the best services possible to the general public with the limited time, financial, operational or human resources. In order to do so, they turn to GIS as an indispensable technology that allows those who plan and deliver public services to achieve improved information processing, design better decision-making processes and reduce overall costs, while simultaneously improving the quality of life in their communities.

Certainly, one of the shortcomings of this paper is related to the fact that it does not provide a more precise overview of the current state in terms of the

utilization of analytical GIS among the mentioned providers of public services in RS. Namely, certain assumptions were made primarily on the publicly available data, which does not exclude a possibility that certain types of analytical GIS are carried by the providers of public services addressed in this paper. In fact, this shortcoming provides one possible direction for future research, and that is the study of the level of the integration of GIS and its analytical capacities into the day-to-day activities of the analyzed providers of public services in RS. Such a study would allow for a much better understanding of the current state when the analytical component of GIS is concerned, and identify future steps for a faster adoption of this technology, with the end goal of creating new services and also improving the quality and transparency of the already existing public services for citizens.

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