Available online at www.worldscientificnews.com

World Scientific News

An International Scientific Journal

WSN 111 (2018) 151-158 EISSN 2392-2192

SHORT COMMUNICATION

GIS analysis in uniformed public services

Michał Ogrodniczak*, Błażej Ryba

Faculty of Geodesy, Geospatial and Civil Engineering,
University of Warmia and Mazury in Olsztyn. Olsztyn, Poland

*E-mail address: michal.ogrodniczak@uwm.edu.pl

ABSTRACT

The article aims to show the possible use of geographic information system (GIS) and GIS software, namely various types of GIS analyses, in the uniformed public services. Such software enables the collection of spatial data that can then be associated with tabular information, the form in which data is stored by uniformed services. Using the collected data, public officials may perform different GIS analyses and visualize statistical data in the form of clear thematic maps. This allows, for example, to visualize and locate the number of road accidents or crimes. Thanks to such solutions, uniformed services could gather a consistent amount of information and therefore improve the quality of their work and insure more effective security, all for the benefit of society. The geographical information system should find a wider application within Polish public services

***Keywords*:** uniformed services, spatial analysis, geographic information system, thematic maps, police

(Received 14 September 2018; Accepted 27 September 2018; Date of Publication 28 September 2018)

1. INTRODUCTION

Providing security is a very important task of public services. Society wants to feel safe, so uniformed services need to take action. Having a team of forces and resources is essential to ensure safety and security, but the level of security depends to a large extent on the work of institutions appointed to the task [1, 2].

The geographical information system (GIS) is used to describe, explain, but also to predict various types of spatial phenomena. The usefulness of this type of system depends on the data collected, which is why the information needs to be as up-to-date and reliable as possible. GIS systems are becoming more and more important in several areas of life, because of an increased demand for new technologies from both private and public institutions. They should, therefore, become an important element of the work of uniformed services too. The system enables each department to keep statistics on different aspects of its activity, which can then be visualized on the map thanks to GIS analysis. Furthermore, GIS allows visualizing, searching and processing the information from the database.

2. UNIFORMED SERVICES IN POLAND

The work of uniformed public services is a fundamental factor in the proper functioning of the state. The services' work should in any case be directed to the realization of the common good. In Poland, such uniformed services are divided as follows: Police, Internal Security Agency, Central Anti-Corruption Bureau, Government Protection Bureau, State Fire Service, Border Guard and Municipal Guards [1, 3, 4].

One of the key uniformed services in Poland is the Police. The basic duties of the Police include the protection of the citizens' life, health and private property against any unauthorized violation of these rights, as well as the prevention of civil disorder. One of the basic duties of the police is therefore the social service, which is understood as helping to protect the population's health, safety and property or addressing the needs of those affected by crime. In the fight against crime, the police have two functions: the specialised function and another, more general function. The latter should include a series of systematic activities aimed to improve the work of the police force. Another general function is threat analysis, carried out to combat crime and thus to ensure public safety. general function. By allowing the visualization of the real world on the computer screen in the form of a relevant data model, the new technology - the Geographic Information System - plays an increasingly important role in this aspect of the police work. GIS analyses are growingly used in the work of this public force: their use ranges from the analysis of statistical data and the creation of maps of clusters of individual threats to the development of simulators in which officers can practice decision making in emergency situations [1, 5, 6].

Not only the police, but also all other uniformed services can benefit from the use GIS analyses; the results would be a more efficient work and an increased level of safety. Border guards could, for example, locate and analyse areas sensitive to border smuggling in order to provide increased protection in those places [7, 8]. The fire brigade can conduct research needed to carry out rescue services, such as the analysis of the propagation of a fire, while municipal police would benefit from the analysis of social problems occurring in the area they serve [9-12].

3. GEOPROCESSING TOOLS IN GIS SOFTWARE

One of the main branches of GIS software is geoprocessing. Thanks to geoprocessing, the geographic data can be modified in several different ways, which is the basic property of geoinformation systems. Geoprocessing includes many tools that are used for a variety of tasks, from simple operations consisting in searching for data from the set to more complex analyses based on schematics [13].

The basic geoprocessing tools include:

- Buffering, an operation consisting in determining an area within a defined distance from the selected object. The objects may be points, lines and polygons. The tool is very well suited for indicating the zones of impact of a given phenomenon on the geographical area.
- Trimming (or cutting) - With this tool, you can easily trim data to a given area.
- Intersection, the overlapping of two or more objects that will be used to determine the geometrical elements of the common area. It is a kind of multiplication where the layers are multiplied by each other. Attributes of all objects participating in the intersection are preserved and their form depends on the input objects.
- Aggregation, it consists in combining objects with each other, thanks to which new spatial units are created. The units are determined by the outer boundaries of combined objects.
- Joining, an operation combining the geometry and attributes of objects. It is very similar to the intersection tool, but in this case the sum of the objects is preserved, while in the intersection tool only the common part is considered [6].

4. THEMATIC MAPS

The thematic map presents one or several elements of geographical space, phenomena as well as the processes and results of analyses and syntheses. The content of thematic maps may include individual phenomena, their elements or aspects; as well as their structure and the connections between all these factors. Depending on the purpose of the map, the range of its content varies accordingly. Thematic maps can be divided in two main parts: the background content and the thematic content. The first part is the topographic map, the base, which contains topographic elements.

The user can choose which elements to select as well as the level of generalization depending on the thematic content. The thematic content has a primary function; it consists of one or several thematic layers superimposed over the background. To each thematic map should correspond a legend including basic information about the interpretation of the visualization and data grouping . Maps represent spatial relations that occur between objects, which implies that they also carry information about their geometrical, attribute and temporal relations. In general, maps generate a graphical representation of the real world using three types of vectors: points, lines and polygons [14, 15].

The mapping method can be determined by the way of proceeding in the selection of the cartographic representation of a given phenomenon as well as the relationship between the various occurrences. Each map contains in fact a number of graphical elements representing

spatial data [16]. The geometric shape of objects also affects mapping methods. The most common methods of mapping phenomena are:

- Cartographical sign method, this method is often used on topographic maps, where the signs are used to show, for example, the location of objects. Cartographic signs in this method can also display quantitative and qualitative information;
- Cartogram (map) - is a static method that represents the average intensity of a phenomenon in a specific area. The most common carto-diagram is the presentation of population density in a given area. When creating a diagram, special attention must be paid to the determination of the data classes, but also to the selection of the colour scale representing the phenomenon;
- Range method - this method is often included in the Cartographical sign method, where the qualitative feature of the area on the map is presented with the possibility of overlapping the range of various phenomena. With this method, different fillings of the range of phenomena (hatching) can be chosen, but it is important that the map remain readable [15, 16].

5. ANALYSIS OF STATISTICAL DATA

All uniformed services keep statistics of their work (road accidents, crimes, interventions or equipment at the disposal of the uniformed services and their operators etc.) and the data is organized in a tabular form. Each table with descriptive data can be attached to vector or raster data, however, the data must have at least one common attribute. This common element can be an address or a coordinate or even a field with numbering. An example of this is the vector map of the city of Olsztyn, divided into neighbourhoods, to which data about offences committed in 2015 were attached (Figure 1). In this case, they are linked by the name of the estate.

Figure 1 presents the data in a tabular form, on the left, and, on the right, their visualization in the form of a map. This is a characteristic feature of geographic information systems as the cartographic visualization of various types of data on a computer screen allows the user to easily capture the various relations between objects as well as to determine the nature of the phenomenon and its intensity . Such visualizations of the phenomenon allow for easier reading of the information. While data in tabular form contain only numbers, their representation on the map gives a better and more instinctive view of the given phenomenon. Geographical information systems have a huge range of tools that allow the user to select the representation of the desired objects on the map [17, 18].

Geolocation is a way of presenting data in a tabular form on the map. Another example of geolocation can be the display of points on the map (for example traffic accidents), in this case, they are based on geographical coordinates. The location can be obtained from GPS receivers placed in uniformed services vehicles. Often, when we deal with a table containing data in the form of addresses, geolocation can also be called “geocoding” [16, 17].

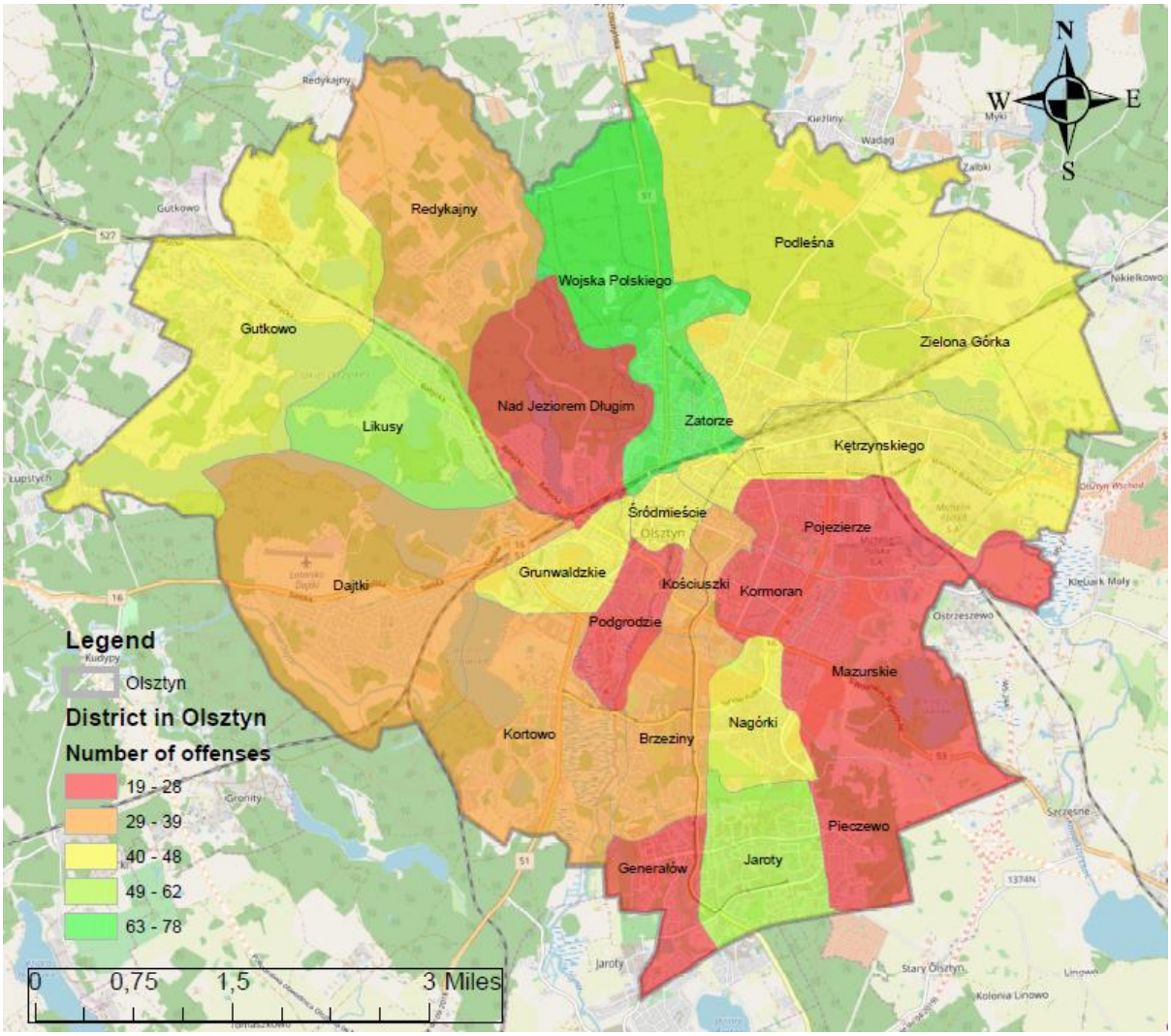

Figure 1. Misdemeanours in Olsztyn in 2015, divided into neighbourhoods, Poland
Source: Own study based on acquired materials

6. SEARCHING FOR RISK AREAS

The analysis can be conceived as the process of searching for hidden information in a data set, which can be divided into two stages. The first stage includes the choice of data, while the second includes the performance of mathematical activities. Geographic Information Systems (GIS) offer tools for analysing the location of objects and their attributes[18]. By carrying out spatial analyses, it is possible to obtain both quantitative and qualitative information and to answer some basic questions that relate to:

- the location of the object;
- meeting certain location conditions;
- the relations between objects;
- the results of modelling processes and phenomena.

One useful analysis is to search from the database that meet specific criteria. Queries that are based on attributes allow you to search for objects based on their descriptive characteristics. Police may use such enquiries to their database to search for crime broken down into specific categories and then visualize it on the map. Another analysis can be used to point out areas at risk (Figure 2). This type of analysis should be used by the uniformed services, especially by the Fire Departments, to indicate the areas that are most at risk. In one place, a fire brigade can combine, for example, distances from the closest roads, travel time or distance from water sources (water reservoirs or hydrants) and then "cut out" the overlapping areas, which will correspond to areas with difficult access, where a water deficit is also present.

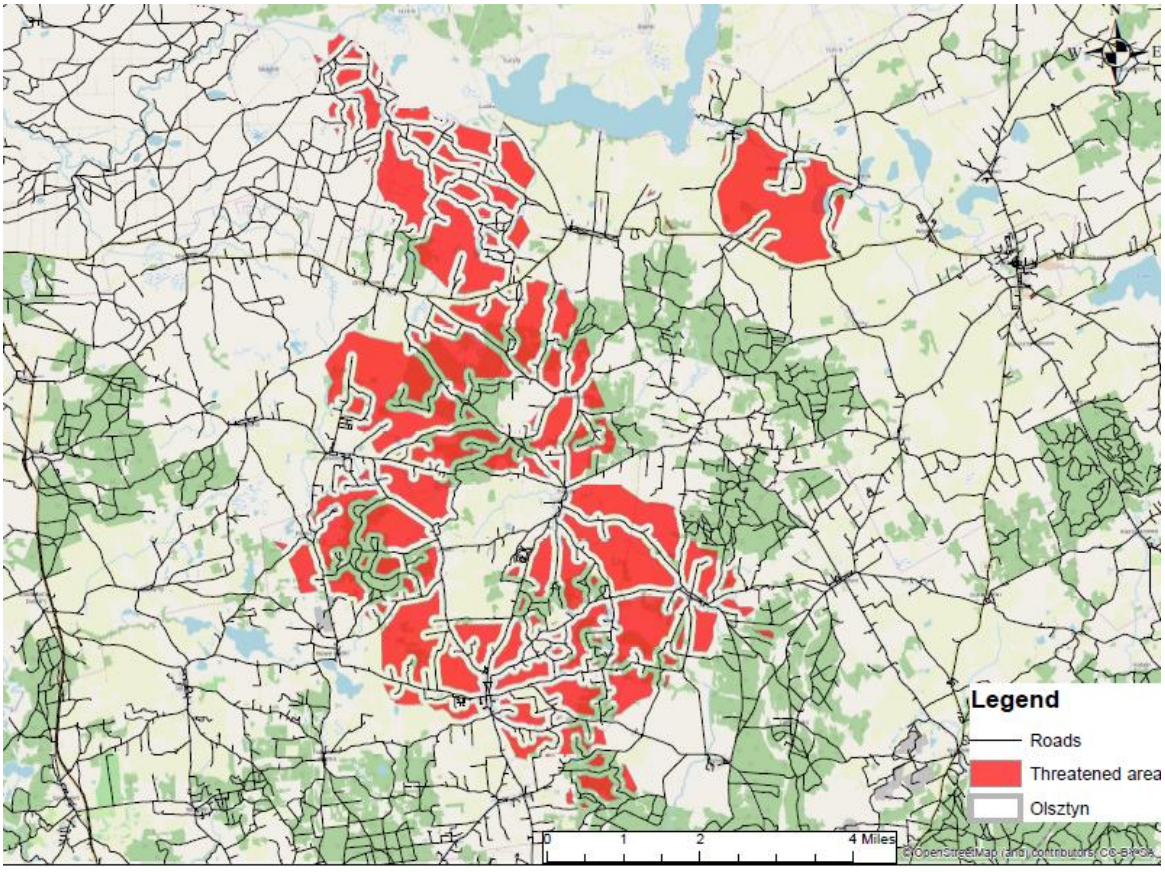

Figure 2. Areas over 20 minutes away from the fire department and over 200 meters from the road in the district Olsztyn, Poland.
Source: Own study based on acquired materials

7. CONCLUSIONS

Geographic information systems (GIS) provide versatile tools for managing a variety of spatial data sets. Thanks to GIS, experts from the uniformed services can carry out simple or more complex spatial analysis that can facilitate the decision-making process in many aspects of the activities of these services. The increased awareness of the emerging information

society and the increasingly important role of information technology has enabled the development of technologies in the field of GIS. The universality of these systems stems from the possibility of spatial analysis of the phenomenon, which transforms the raw data in relevant information. Uniformed services should invest in geoinformation systems, as the benefits of performing GIS analysis are enormous. The use of GIS systems allows collection, processing and sharing of data from the location appointed to them. Analysis can be performed by all services in accordance with the tasks they are assigned. In many situations, this analysis can serve as a tool to improve the efficiency of the public services and improve the safety of the citizens.

References

[1] M. Feldstein, Social security, induced retirement, and aggregate capital accumulation. *Journal of political economy* 82.5 (1974): 905-926.

[2] M. Vijaya, C. Chandrasekar, GIS technologies in crime analysis and crime mapping. *International Journal of Soft Computing and Engineering* 1.5 (2011) 115-121.

[3] F. Fajemirokun, A GIS approach to crime mapping and management in Nigeria: A case study of Victoria Island Lagos. Congress GIS Application. 2006

[4] R. C. Abah, An application of Geographic Information System in mapping flood risk zones in a north central city in Nigeria. *African Journal of Environmental Science and Technology* 7.6 (2013): 365-371.

[5] F. Jorge, P. João, J. Martins, GIS for crime analysis: Geography for predictive models, *Electronic Journal of Information Systems Evaluation* 15.1 (2012): 36.

[6] C. Spencer, L. Tompson, S. Uhlig, The utility of hotspot mapping for predicting spatial patterns of crime, *Security Journal* 21.1-2 (2008) 4-28.

[7] S. Peake, T. Moore. Analysis of distortions in a mental map using GPS and GIS, SIRC 2004 16th Annual Colloquium of the Spatial Information Research Centre, University of Otago, Dunedin. 2004.

[8] K. Raju, B. Sokhi. Application of GIS modeling for dengue fever prone area based on socio-cultural and environmental factors–a case study of Delhi city zone. *Int Arch Photogramm Remote Sens Spat Inf Sci* 37 (2008) 165-170.

[9] M. McCullagh, Crime, repeat victimisation and GIS, Mapping and analysing crime data(2001): 61-92.

[10] E. Erten, V. Kurgun, N. Musaoglu. Forest fire risk zone mapping from satellite imagery and GIS: a case study. XXth Congress of the International Society for Photogrammetry and Remote Sensing, Istanbul, Turkey. 2004

[11] R. K. Somashekar, Application of remote sensing and geographical information system in mapping forest fire risk zone at Bhadra wildlife sanctuary, India, *Journal of Environmental Biology* 31.6 (2010): 969.

[12] Z. Yue, D. E. Brown, Police patrol districting method and simulation evaluation using agent-based model & GIS, *Security Informatics* 2.1 (2013): 7.

[13] Shahebaz, K. V. Kale. Methods for crime analysis using GIS. *Int. J. Sci. Eng. Res* 5 (2014) 1330-1336.

[14] M. Ogrodniczak, J. Ryba, The implementation of the GIS tools in crisis management. *World Scientific News* 72 (2017): 211-218.

[15] V. Prasannakumar, Spatio-temporal clustering of road accidents: GIS based analysis and assessment. *Procedia-Social and Behavioral Sciences* 21 (2011): 317-325.

[16] G. Janbaz, B. Gholizadeh, O. M. Dashliburun, Forest fire risk zone mapping from geographic information system in Northern Forests of Iran (Case study, Golestan province), *International Journal of Agriculture and Crop Sciences* 4.12 (2012): 818-824.

[17] M. Ogrodniczak, J. Ryba, B. Ryba, Possibilities of the spatial information system usage by the Internal Security Agency. *World Scientific News* 57 (2016): 122-128.

[18] Shahebaz, K. V. Kale, Mapping and analysis of crime in Aurangabad city using GIS. *Journal of Computer Engineering*, July-Aug 16.4 (2014): 67-76.