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The Use of GIS Technology in The Creation of Local Revitalisation Programs as a Tool for Sustainable Urban Development

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Abstract. Revitalisation is a process of bringing degraded areas back from a state of crisis. It is carried out in a comprehensive way, through integrated activities for the local community, space and economy, concentrated territorially, led by revitalisation stakeholders and based on municipal (local) revitalisation programmes. The Municipal Council accepts the Revitalisation Programme in a resolution. It includes a detailed diagnosis of the revitalisation area, including an analysis of negative phenomena and local potentials in the area. Putting this purpose into practice makes use of GIS technology, which facilitates the process of gathering information about the area and preparing maps, and therefore is helpful to conduct urban inventories. GIS tools allow the location of concentrations of phenomena associated with the degradation of the urban space to be specified, such as crime, unemployment, areas where a large number of people have been excluded. These tools are helpful in indicating the development path for these areas. GIS tools can help find solutions to problem questions. They help justify the accepted solutions. Building multi-criteria decision-making models in a GIS environment, taking into account the social criteria, allows the revitalisation process of the area to proceed to fruition. The authors present the results of studies using the example of a local revitalisation programme in the City of Olsztyn.

Keywords: sustainable development, revitalisation, GIS.

Conference topic: Sustainable urban development.

Introduction

The purpose of this article is to examine the process of sustainable development of the city using urban revitalisation programmes as well as the identification of useful methods and tools for the efficient execution of these processes. According to Polish legislation, the sustainable development we understood as socio-economic development integrating political, economic and social actions, balanced with environmental protection and permanence of basic natural processes in order to ensure the possibility of satisfying the basic needs of individual communities or citizens in both the present generation and future generations (ustawa z dnia 27 kwietnia 2001). According to Papuziński (2006) it is a development related to the balance between economic growth and the status of natural ecosystems in order to ensure a high quality of life for society. In detail this means an indication of the need to respect environmental constraints in production and consumption, so that the production does not undermine the foundations of quality of life, understood as life in a healthy and aesthetic environment, and the consumption was acceptable from the point of view of resources and reasonable aspirations of all human inhabitants of the globe who participate in the use of these resources.

According to Lorens (2005), revitalisation is part of the concept of the sustainable development of cities and becoming "part of the new urban paradigm of postmodernism". Wołoszyn (2005) stresses that the balancing urban development is possible by such things as the urban revitalisation processes.

Sustainable development is linked to sustainable development indicators. They enable the creation of a statistical image of the country from the point of view of implementing the new paradigm of development. The base of the monitoring was a complementary description of the concept of development by identifying:

- the principles of sustainable development, which are the primary "filter" for the selection of indicators,
- the purposes, as positive states of targeted development, described in the various strategic documents,
- the domains: social, economic, environmental, and institutional-political.

Ogryzek (2014) took a similar position. In his opinion, the need to maintain a balance between social, economic and environmental governance as the measures of sustainable development was connected with the need to develop the optimal use of urban areas. He indicated the Simulator as a tool (an instrument) of space management planning (spatial management) and necessary gauges deciding about spatial planning in connection with sustainable development – an optimal development. That tool of choosing the optimal destination space allows the most beneficial solutions for your area to be selected, taking into account the aspects of the economic, environmental and human needs. Similarly, according to Strzelecka (2011) the sustainable development rules when implementing local policy should be implemented at the stage of the programming, planning and design processes of revitalisation, through investments

to improve the provisions for the protection of the environment, environmental impact assessments and observing the right to information and social participation in environmental decision-making. It is important to have at least a 15–25-year time horizon of revitalisation activities. Revitalisation, according to Polish legislation, is a process for bringing degraded areas out of a state of crisis, carried out in a comprehensive manner through integrated activities for the local community, space and economy, as well as geographically concentrated, led by revitalisation stakeholders based on a municipal revitalisation programme (ustawa z dnia 9 października 2015). Revitalisation means the process of spatial, technical, social and economic changes taken in the public interest. The aim of that process is to extract an area from a crisis situation, to restore its old features and create conditions for its further development through the use of endogenous features. (Heller 2002). In view of the above, the concepts of space management and spatial analysis are crucially important. In research on spatial management, the concepts of data and spatial information, known as geoinformation, are very important. The starting point for each analysis is reliable data input, and the results of the analyses are dependent on both the quality of that data and the selection of methods of analysis. Space development (management) is related to decision making. GIS technology is helpful for the information analyst, because it helps improve data analysis processes, which are most commonly connected with the acceleration of solutions, while you can get the same or similar results as in the case of other methods (Ogryzek 2015). GIS technology has been applied in a number of Communal Revitalisation Programmes (to 2015 they were carried out under the name: the Local Revitalisation Programmes) primarily for the visualisation of results, e.g. the LPR of Olsztyn and the LRP of Rzeszów. In municipal revitalisation programmes after 2015, a revitalisation layer has been added to the city's geographical information systems, e.g. the MSIPMO-urban spatial information system of the city of Olsztyn or Bolesławiec. The GIS contains tools for analysis and spatial modeling that allow you to conduct integrated vector and raster analyses, and they allow you to both generate new information based on existing data and to search information in multiple layers of data. An example of such an application might be the use of the raster model for the delimitation of crisis areas in cities (the method of delimitation of crisis areas for the needs of the ongoing revitalisation process, based on ArcGIS, has been developed by a team of the Institute of Urban Development in Cracow). Using the created calculation algorithm, and assuming various criteria relevant to the board of directors of the city, it is possible to pinpoint areas inside the city with an observed severity of negative socio-economic phenomena, such as a high level of unemployment, crime, or a high degradation of fixed assets. GIS also allows the visualisation and analysis of the data cross-referenced by time (which shows time trends), and for the data to be used for the purposes of spatial planning.

Rutyna (2007) uses a generalised image of phenomena. This is the process of GIS software counting a specific value for properties within a given radius. The result is the GRID, in the form of an array of pixels. Each pixel contains data, where their number in the length unit is the resolution parameter. This method was used for the initial presentation of the collected resources, as a background to show other groups of objects, and to the initial identification of areas in which there were cumulative adverse phenomena (unemployment, high crime or high poverty rate etc.). In turn, the counting technique can be used in urban units to investigate phenomena for representative areas with a similar degree of development. Urban units were formed by the divisions of urban residential areas to the homogeneous areas. These were objects that meet the criteria for similar architecture, time of origin and homogeneous urban layout. This makes it possible to both analyses taking into account the nature of the units, and analyses leading to indicating problem areas within a specific group of buildings. According to Topoczewska (2009), it is necessary to create an urban/municipal database. It could be used for analysis and assessment of the crisis phenomena in the spatial city, the delimitation of degraded areas, monitoring the degree of implementing individual projects and the entire revitalisation programme. Geoinformatic tools should be used, utilising GIS to specify the intensity of the crisis phenomena.

The methods of preparing the urban revitalisation programmes

A Communal Revitalisation Programme should be adopted by a resolution of the Council of the Municipality and it should be drawn up for the revitalisation area designated by the resolution, either at its own initiative or at the request of the the mayor of the city or commune. In accordance with the law (ustawa z dnia 9 października 2015), it includes:

- a detailed diagnosis of the revitalisation area, including analyses of negative phenomena and local potentials that occur within this area,
- description of the connections of a communal revitalisation programme with strategic documents of the municipality, including the development strategy of the municipality, the study of the conditions and directions of zoning municipalities and social problem-solving strategy,
- description of the state vision of the area after revitalisation,
- the objectives of the revitalisation and the corresponding courses of action to eliminate or reduce negative phenomena,
- a description of regeneration projects, in particular social and economic, environmental, spatial-functional or technical,
- mechanisms to integrate the activities and projects of revitalisation,
- an estimate of the financial framework for the municipal revitalisation programme, together with an indication of the estimated financial resources from public and private sources,

- a description of the governance structure for the implementation of the municipal revitalisation programme, an indication of the costs of the management and with a timetable for the implementation of the programme,
- a system of monitoring and evaluating the municipal revitalisationprogramme,
- a determination of the necessary changes in communal resolutions,
- an indication of whether a Special Revitalisation Zone should be established on the revitalisation area, together with an indication of the period of its validity,
- an indication of the implementation of a municipal revitalisation programme in spatial planning and zoning,
- an annex containing a graphics showing the direction of changes to the functional area of urban regeneration drawn up on a map specified in the Act.

The Act (ustawa z dnia 9 października 2015) imposes on the municipality an obligation to consult municipal revitalisation programmes or local revitalisation plans with stakeholders, and determines the overall form of interviewing. The consultations should be albe to give an indication of the needs and expectations of the citizens and businesses regarding the revitalisation of the area. They should be carried out in three stages: preparation, conduct and an evaluation of revitalisation. GIS technology can be used at this stage, and more precisely WebGIS. Stakeholders can report on feedback, make suggestions, offer expectations as to the specific needs of revitalisation on a map available to the public in an online system for spatial information. A form of e-social consultation is commonly used, for example in the preparation of civic budgets or in the reporting of different risks and are usually popular among local communities.

The next step is to determine the two categories of areas: the revitalisation area (Fig. 1) and the degraded area. Both are formed under a resolution of the Municipal Council. The designation of these areas must be supported by relevant diagnosis and analysis, which are annexed to the proposal. That cartographic presentation is currently done as a map for the purpose of revitalisation, and so in the GIS environment.

Figure 1 shows the area of the Municipal Revitalisation Programme. The cream colour marks the districts of Olsztyn covered by this programme. That map was attached to the urban spatial information system in Olsztyn (MSIPMO), it is displayed as one of the layers to choose from. All the maps made in the framework of a Municipal Revitalisation Programme in Olsztyn were also attached to MSPIMO. The revitalisation area includes all or part of the area that has been degraded, with a particular concentration of negative phenomena on which, in view of the vital importance for the local development, the municipality intends to carry out the revitalisation. The revitalisation area, as well as the degraded area, may be divided into sub-areas, but with certain limitations – namely it must not include an area greater than 20%, or an area with more residents than 30% of the population. All these analyses are possible in GIS technology.

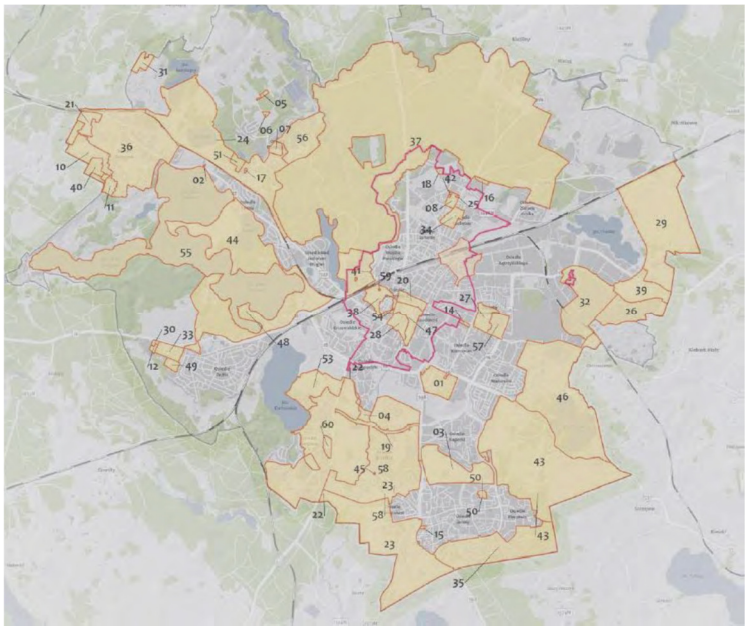

Fig. 1. The revitalisation area of the Municipal Programme of Revitalisation of Olsztyn
Source: www.msipmo.pl

A degraded area means an area in a state of crisis, due to the concentration of negative social phenomena (this includes unemployment, crime, low levels of education and social capital) and at least one of the other negative phenomena, such as:

- economic – e.g. the low level of entrepreneurship,
- environmental – e.g. exceeded environmental quality standards (Fig. 2),

- spatial-functional – e.g. a lack of access to services, the low availability or poor quality of the public areas, inadequate equipment in the technical or social infrastructure,
- technical – e.g. the degradation of technical construction.

Areas can be classified as degraded, but must first and foremost meet the social conditions and one of the above.

Fig. 2. The map of noise developed in the framework of the Municipal Programme of Revitalisation of Olsztyn
Source: www.msipmo.pl

Figure 2 shows a map of noise, drawn up as part of a Municipal Programme of Revitalisation in Olsztyn as a description of the environment. Noise road is shown going from green (the lowest) to red (exceeding standards).

Another important element is the relationship of sustainable development indicators with the revitalisation of cities. In the studies by GUS (2015), the indicators used are social, economic, environmental and humanistic-political. Out of all the indicators, it is possible to identify those that may have an impact on the revitalisation, and this information can be obtained by using GIS tools. These are:

- the risk of permanent poverty,
- the risk of poverty or social exclusion,
- inequality of income distribution,
- household debt,
- the unemployment rate and the rate of long-term unemployment,
- the employment rate of people with disabilities,
- the rate of crime detection,
- the employment rates,
- the built-up and urbanised areas,
- devastated and degraded land,
- new cases of infringements of EU law,
- aggregate involvement in social work.

The geovisualisation of the above indicators using GIS software refers to specific units such as: precinct geodetic, districts, streets, buildings or specific cadastral parcels. These indicators can be determined (calculated) on the basis of data about inhabitants, using the tools of GIS software ESRI-ARC. For example, Figure 3 shows a study visualising the indicator "**the risk of permanent poverty".**

The cartogram shows the numbers benefiting from social assistance because of poverty per km2, with a breakdown by Olsztyn districts. The data comes from a Municipal Programme of Revitalisation in Olsztyn 2020. The data are divided into five classes.

GIS software will also show the intensity of the phenomena described by point data.

For this purpose, both Hot Spot (Fig. 4) and Point Density (Fig 5) can be used. "Optimised Hot Spot Analysis" was used to visualize the density of services in Olsztyn (the place of high and low incidence of the phenomenon were indicated), while "Point Density" was used to determine the intensity of the elements of the road infrastructure in Olsztyn.

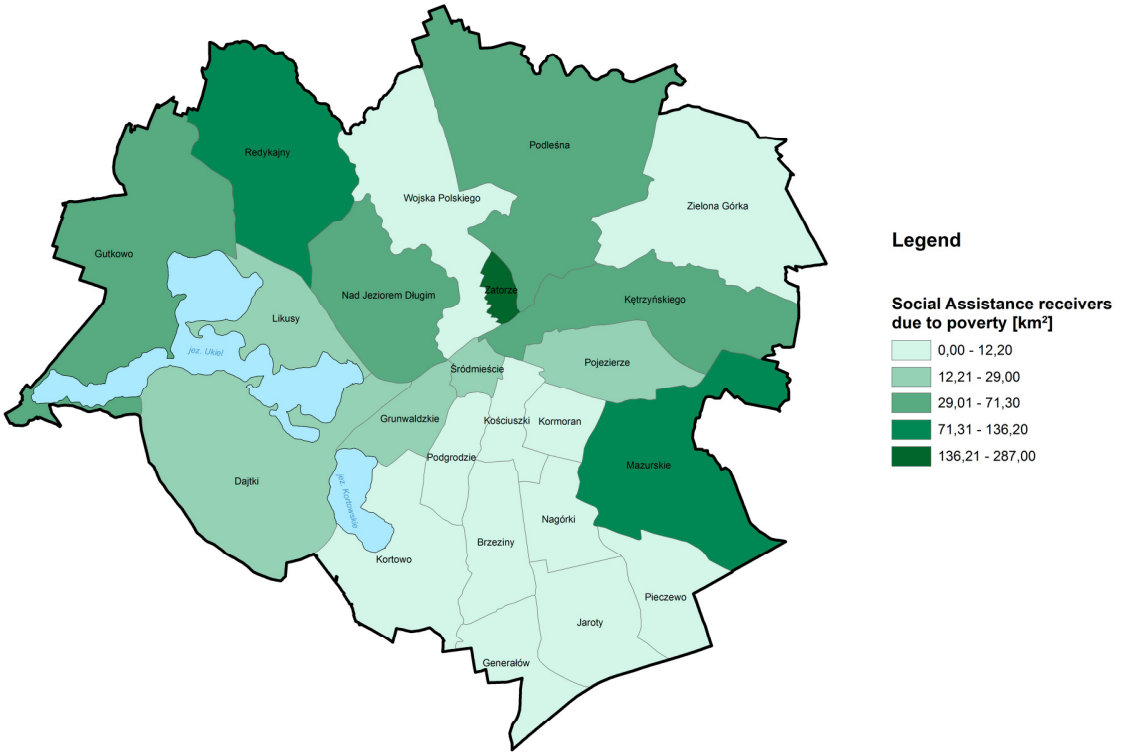

Fig. 3. The risk of permanent poverty
Source: own studies

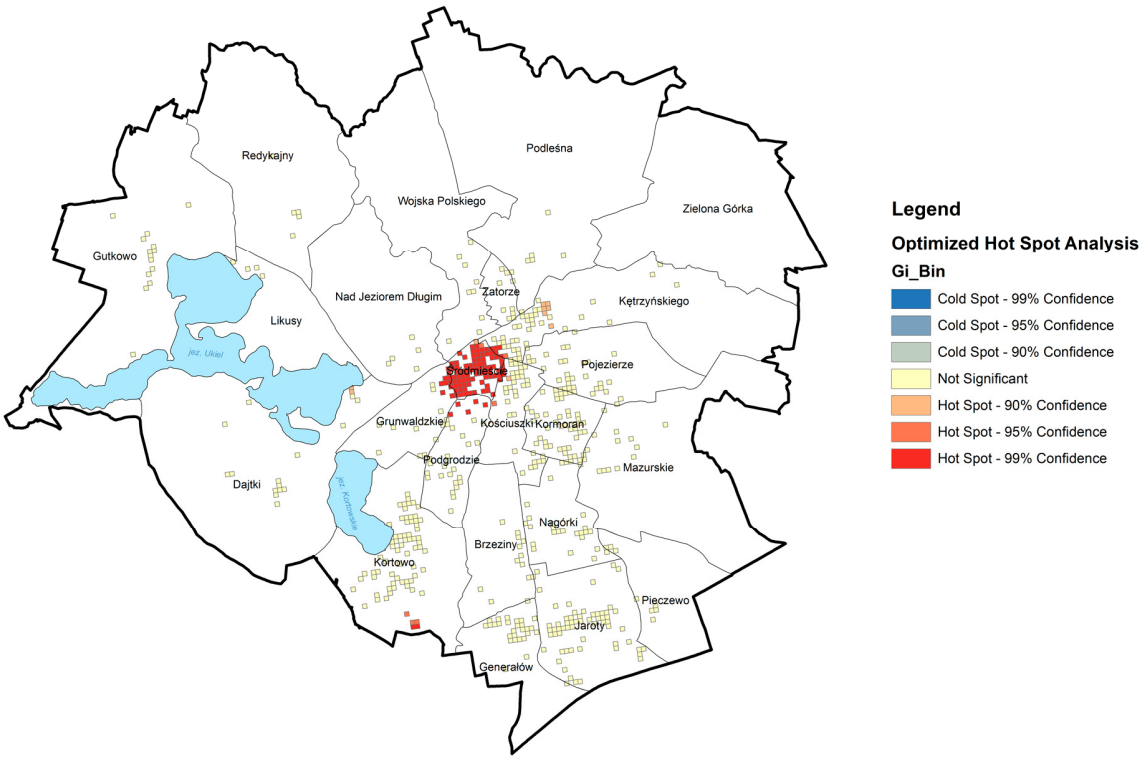

Fig. 4. The map of density of services in Olsztyn
Source: own studies

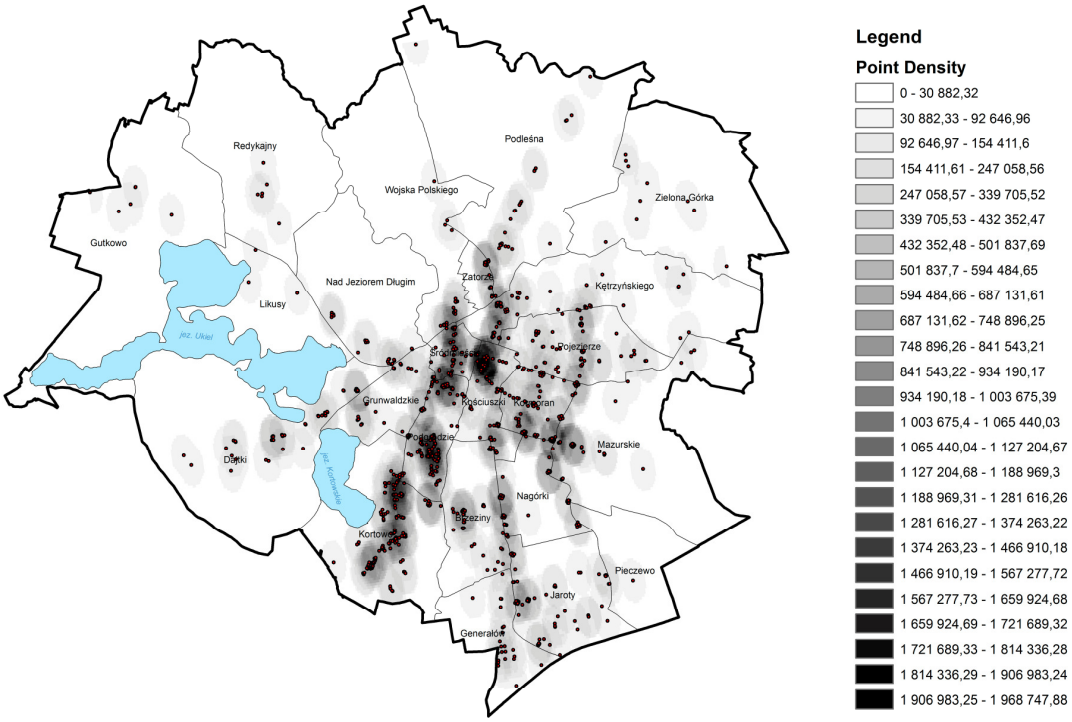

Fig. 5. The map of intensity of the elements of the road infrastructure in Olsztyn
Source: own studies

GIS tools can also be used to analyse the line data. For example, Figure 6 uses “Kernel Density”, which allows the public road network density to be shown.

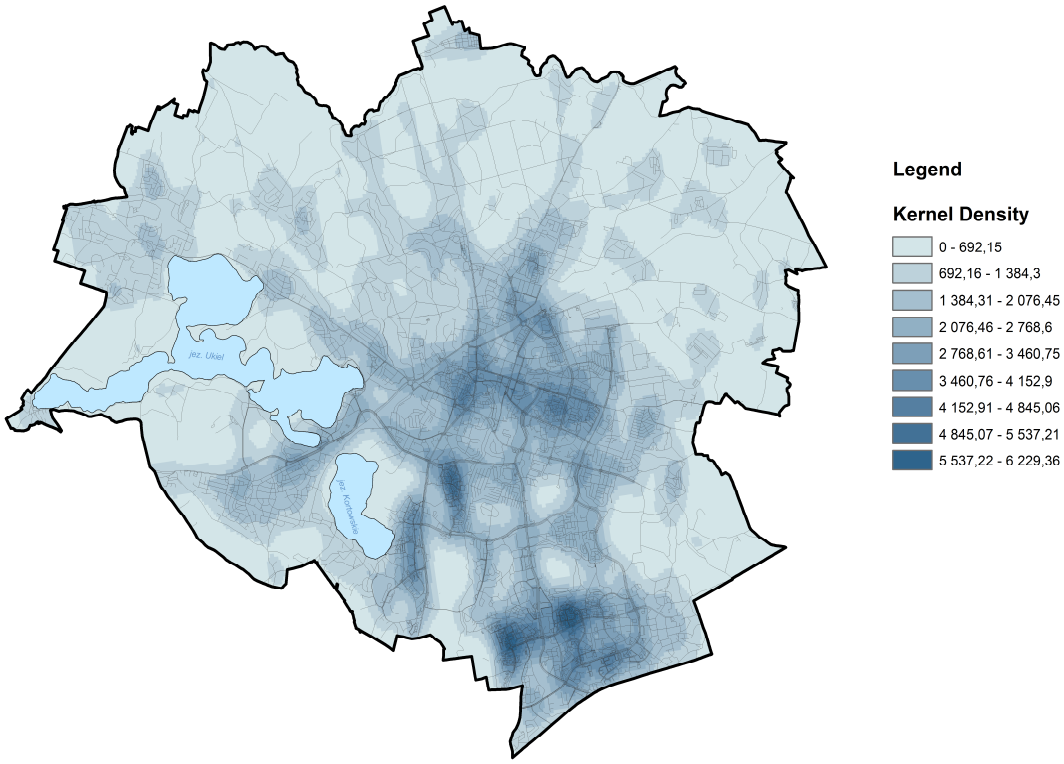

Fig. 6. The map of public road network density in Olsztyn
Source: own studies

Conclusions

As a result of the carried out analysis, we conclude, that GIS tools were not used in creating the Municipal Programme of Revitalisation of Olsztyn, to develop indicators of sustainable development. In this article the Authors pointed out specific GIS tools which can be used in creating the sample indicators of sustainable development as an alternative form of using GIS software.

In similar Municipal Programmes of Revitalisation in Poland, GIS tools are used only for visualization of results, and not to develop indicators, as was shown in the article.

GIS software contains a lot of data processing tools that can be used to develop indicators of sustainable development. These indicators can be (and should be) used in the process of urban revitalisation:

- Line Density,
- Average Nearest Neighbour,
- High/Low Clustering (Getis-Ord General G),
- Spatial Autocorrelation (Morans I),
- Grouping Analysis,
- Similarity Search,
- Hot Spot Analysis (Getis-Ord Gi*),
- Central Feature,
- Directional Distribution (Standard Deviational Ellipse),
- Linear Directional Mean,
- Mean Centre,
- Median Centre,
- Standard Distance,
- Geographically Weighted Regression,
- Collect Events,
- Erase,
- Identity,
- Intersect,
- Spatial Join,
- Symmetrical Difference,
- Union,
- Update,
- Clip,
- Split,
- Buffer,
- Create Thiessen Polygons,
- Multiple Ring Buffer,
- Near,
- Point Distance,
- Polygon Neighbours.

In this article, the authors examined the procedure for designating urban revitalisation programmes as a process of sustainable development. The authors identified more than 30 useful methods and tools in GIS, as proper instruments for performing the revitalisation process of the city. It has been shown that the application of GIS technology can not only improve the revitalisation process, but in addition to the mandatory elements, it allows other optional indicators to be added and used, such as: running business activity, ethnic and minorities groups or refugees.

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