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USING GIS IN THE MUNICIPALITY SUITABILITY ASSESSMENT FOR THE TOURISM AND RECREATION DEVELOPMENT

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ABSTRACT: The work presents the possibilities of implementing the GIS technology in assessing the tourist attractiveness of the selected municipality. In the study, a point classification method was used in the base fields 250×250 of size. The valorisation of the areas of the municipality was carried out based on considering selected elements of the natural environment such as the land form, land use, hydrographic conditions, forest areas and valuable natural areas. Based on the conducted research it has pointed out that about one quarter of the area of the municipality can be characterized by high and very high attractiveness in terms of tourism and recreation development, mainly due to the high altitude of the land form, favourable hydrographic conditions and the presence of forest areas.

KEY WORDS: GIS, tourism and recreation, valorisation

Introduction

Agritourism and rural tourism nowadays is perceived as an alternative form of tourism to mass tourism and its potential is seen with many local governments in fostering regional economic development (Lee et al., 2013). It can be distinguished by many advantages, the most important of which include the possibility of staying close to the natural environment, air purity and rich landscape values (Ziernicka-Wojtaszek, Zawora 2011).

For this reason, tourism is one of the most popular directions in a municipality development. However, to make the best choice of the areas of the greatest possible suitability for tourism, it is necessary to make valorization. Valorization is a way to determine the validity of the surveyed areas in terms of the established criteria. Performing this type of valorization in terms of tourism and leisure can indicate the best areas for its development (Tokarska-Osyczka, Iszkuło 2014).

Among the many methods of valorization of natural resources, the method of point classification in the basic fields is the one of the most widely used by researchers (Richling 1992). Despite various modifications of the discussed method, resulting from the purpose, the spatial scope of analysis and the availability of data, the analytical process includes the following steps (Cygan et al., 2011):

- the delimitation of the base field (artificial field, administrative units etc.);
- to designate a set of evaluation criteria;
- the assignment of points to base fields, according to the scale used;
- to sum points within the base fields and classify them into fixed ranges.

One of the computer-aided tools for supporting this type of analysis is Geographic Information Systems (GIS). Its field of application is very broad and one of them is the possibility to make spatial analysis, including valorization (Colosi et al., 2009; Varjú et al., 2014). With the use of GIS software, it is possible to create many cartographic studies that visualize partial evaluations and final valorization results. The publication of such studies may also contribute to the promotion of the tourism industry, which may have the effect of reversing the unfavorable trend of generating scarce revenue compared to its potential capabilities (Leszczyńska, 2003).

The purpose of this study is to carry out tourist and recreational valorization in the area of the Szypliszki municipality, and consequently to identify the most valuable areas suitable for tourist development, including the development of accommodation and catering facilities, agritourism farms, holiday villages and other tourism infrastructure.

Study area

The research area covered includes the Szypliszki municipality. It is a rural municipality, located in the north-eastern part of the Podlaskie Voivodeship, in the Suwałki Lake District (figure 1). The seat of municipality and at the same time the most compact built-up area it is there a small town Szypliszki. According to 2015 data, the municipality is inhabited by less than 4 000 people, and its total area is about 156.5 km², which implies that there are only 25 inhabitants per 1 km² (Local Data Bank, Central Statistical Office).

The area of the municipality of Szypliszki was analyzed due to its location in the valuable natural areas of the Suwalki Lake District. Unquestionable landscape values of this area make it necessary to design optimal spaces for meeting tourist and recreational needs as well as limiting building development and anthropopression in valuable areas. Such activities have their reflection in the records of planning documents at the level of the whole municipality. According to the changes introduced in 2011 to the Study of Conditions and Directions of Spatial Development of the Szypliszki municipality one of the most important priorities in the municipality is the concentration of activities related to tourism activation.

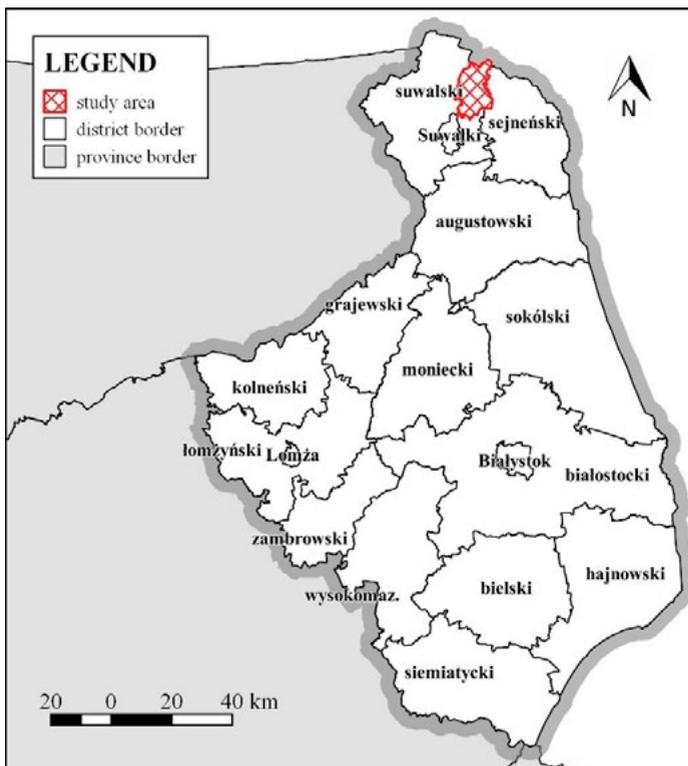


Figure 1. The localization of study area against administrative division

Source: author's own work based on data from CODGiK in Warsaw.

Materials and research methods

In the evaluation of tourism and recreation values of the studied municipality it was used a modified method of point classification in the basic fields. According to the methodology used, first, the site was divided into regular fields of 250×250m. As a rule, studies on tourism and leisure values are conducted in a 1×1 km grid (Lisiak et al., 2017). In this paper, it was decided to use a reduced primary field due to the use of detailed spatial data, including numerical spatial altitude data derived from Airborne Laser Scanning ALS. A grid of squares covering the entire municipality covers a total of 2707 primary fields.

When selecting a set of evaluation criteria, the attention was focused on the evaluation of selected elements of the natural environment, whose quality in a large measure determines the possibilities of tourism development in the studied area. In the final evaluation, five elements of the natural environment were included in which one or two evaluation criteria were selected (table 1).

The assessment criteria listed in table 1 are assigned in a 6-point scale (from 0 to 5). In the case of criteria related to the distribution of forests and the areas of natural value, the possibility of assigning an additional 1 point to the assessment was applied. With regard to the forest distribution an additional point was assigned in the case of appearing in the eye of the grid of forest that has a protective function or it is a partial reserve, and in the case of the criterion of areas of natural value, if a natural monument was identified in the eye of the grid, together with a high coverage of areas of high natural values (> 80%).

Table 1. The criteria of tourist and recreation attractiveness evaluation in the municipality of Szypliszki

Land form	Land use	Hydrography	Forest areas	The areas of the natural value
relative heights [m]	a land use class	the length of watercourses [m] the length of a shoreline of water reservoirs [m]	the length of a forest boundary [m]	the share of areas of high natural values

Source: author's own work.

The final evaluation of tourist and recreational attractiveness of the studied municipality was determined as the sum of points obtained in the primary field in the light of the used evaluation criteria. On this basis, the LAC (Landscape Attractiveness Coefficient) was determined of the following pattern (Chojnacka-Ożga, Gabryszewska, 2011):

$$LAC = \Sigma P_1 / \Sigma P_{\max}$$

where

ΣP_1 – the sum of points obtained by a spatial unit as a result of valorization

ΣP_{\max} – the sum of all possible points obtained by a given spatial unit

The values of the above coefficient are in the range from 0 to 1. With this in mind, the area of the municipality was segmented into the following classes (table 2).

Table 2. The valorization criteria of tourist and recreation attractiveness of the municipality of Szypliszki

LAC value	the valorization of a primary field in terms of tourist and recreation value
0,00-0,20	the areas of very low attractiveness
0,21-0,30	the areas of low attractiveness
0,31-0,40	the areas of moderate attractiveness
0,41-0,50	the areas of high attractiveness
>0,51	the areas of very high attractiveness

Source: author's own work.

Multi-criteria analysis of tourist and recreational attractiveness requires gathering and considering various spatial data sets, including:

- the database of topographic objects BDOT10k – obtained from the resources of the Regional Center for Geodetic and Cartographic Documentation in Białystok,
- a Digital Terrain Model DTM in the ARC/INFO ASCII GRID format, which measures the height of points in a regular grid of 1m mesh, interpolated based on a cloud of points from Airborne Laser Scanning (ALS) [an average height error is up to 0.2 m] – the Central Center for Geodetic and Cartographic Documentation (CODGiK – abbreviation for the name of the institution in Polish) in Warsaw,
- a digital orthophotomap with an area pixel size of 0.25 m – CODGiK in Warsaw,
- the data of the Central Register of Nature Conservation Forms, obtained from the resources of the General Directorate for Environmental Protection (<http://www.gdos.gov.pl/dane-i-metadane>),
- a layer of forest mapping derived from the Forest Data Bank (BDL – abbreviation for the name of Polish forestry spatial database) (<https://www.bdl.lasy.gov.pl/portal>),

- the data of the State Boundary Register – the Central Center for Geodetic and Cartographic Documentation (CODGiK) in Warsaw.

The analysis needed for tourist and recreational valorization was done in the environment of free and open-source QGIS software (Szczepanek, 2012).

The valorization of tourist and recreational attractiveness done by the method of point classification

Land form

The shape of the land form in the Szypliszki municipality is characterized by a fairly varied height structure. Its values vary from 136.77 m to as much as 252.22 m above sea level. On the other hand, the average height of the surveyed area is 190.82 m above sea level, and the standard deviation is of 18.00 m, which is a relatively small dispersion of values around the average height (figure 2). The largest elevations in the Szypliszki municipality take the form of a strip running from the south-western up to the north-eastern end of the studied area. However, a significant reduction in the terrain can be seen in the south-east.

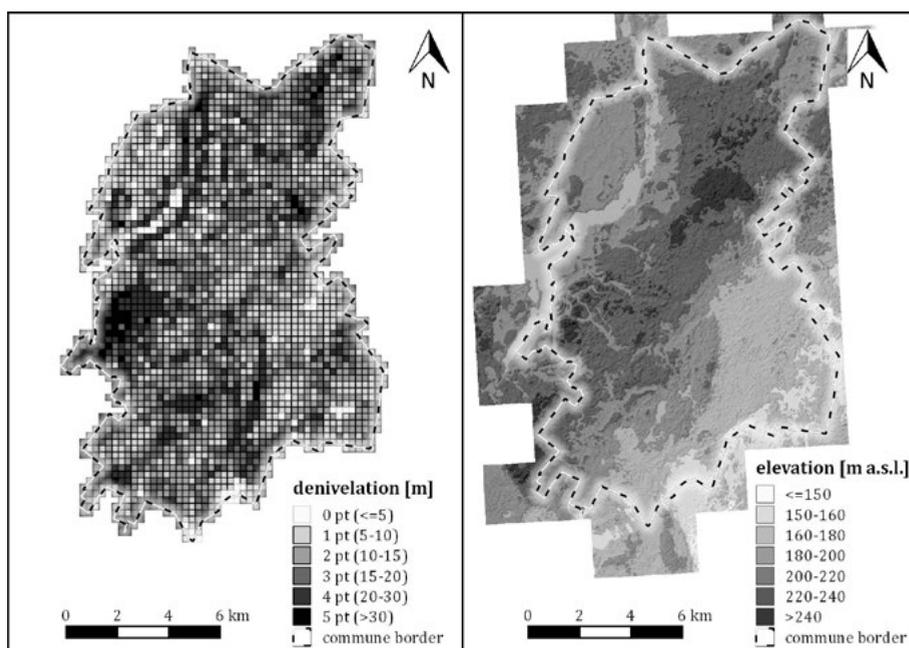


Figure 2. Land form point classification (on the left) and an altitude map of the studied area (on the right)

Source: author's own work based on data from CODGiK in Warsaw.

Land form valorization was performed using one parameter – field relative heights – determined as a difference between the highest and the lowest altitude points within the basic field of calculations. The large variety of young glacial terrain is reflected in the relatively large spatial polarization of the results. The assessment of the structure of the terrain in the municipality of Szypliszki showed that the areas with the highest values are in the south-west and the north-east part of the studied area. The lowest scores were awarded to flat areas in the north-west and south-east of the municipality. It is worth noting that the score of 0 occurred only 68 times (2.51%), and it was given mainly to the area within the lake of Szelmet Mały and the depression in the south-eastern part of the studied area.

Land use

Land use largely determines the way a potential tourist perceives the space, and indirectly influences other features such as, for example, the availability of points and view lines (Cygan and others, 2011).

The valorization of the area of the municipality of Szypliszki in terms of land use structure was based on the principle of visibility analysis and the smallest possible hiding of the landscape for an observer. Therefore, it was assumed that areas covered with tall and densely located objects (such as trees and buildings) are less desirable than open areas (such as meadows or arable land) and because of that they were rated lower (table 3).

Table 3. A list of the area of land use classes in the municipality of Szypliszki and their corresponding point values

Scoring	The class of land use	The object class code bdot10k	The area [ha]	The share [%]
-1	industrial areas and wasteland	PTGN, PTNZ, PTWZ	9.37	0.06
0	urban areas	PTKM, PTPL, PTZB	340.85	2.18
1	permanent crops	PTUT	28.98	0.19
2	forests and grassy vegetation	PTLZ, PTRK	2699.70	17.26
3	arable land	PTTR	6459.98	41.29
4	wetlands and surface waters	PTWP	92.60	1.87
5	meadows and pastures	PTTR	5813,25	37.16

Source: author's own work.

Point values in the primary fields were assigned according to the table below. Where there is more than one type of coverage in each mesh, the points in this field were determined in proportion to their surface area, and the result was rounded to integral numbers according to generally accepted mathematical rules.

The final result points to the high attractiveness of the municipality area in the light of this criterion. In the vast majority of cases (81.12%) the basic fields were of 3 or 4 points (successively 1025 and 1171 cases). These are mainly agricultural areas (arable land and grasslands) as well as occupied by surface waters. The analyzed area is characterized by a small degree of urbanization and industrialization, which results in the fact that fields that had been assigned 0 or 1 point, were present only 5 times (figure 3).

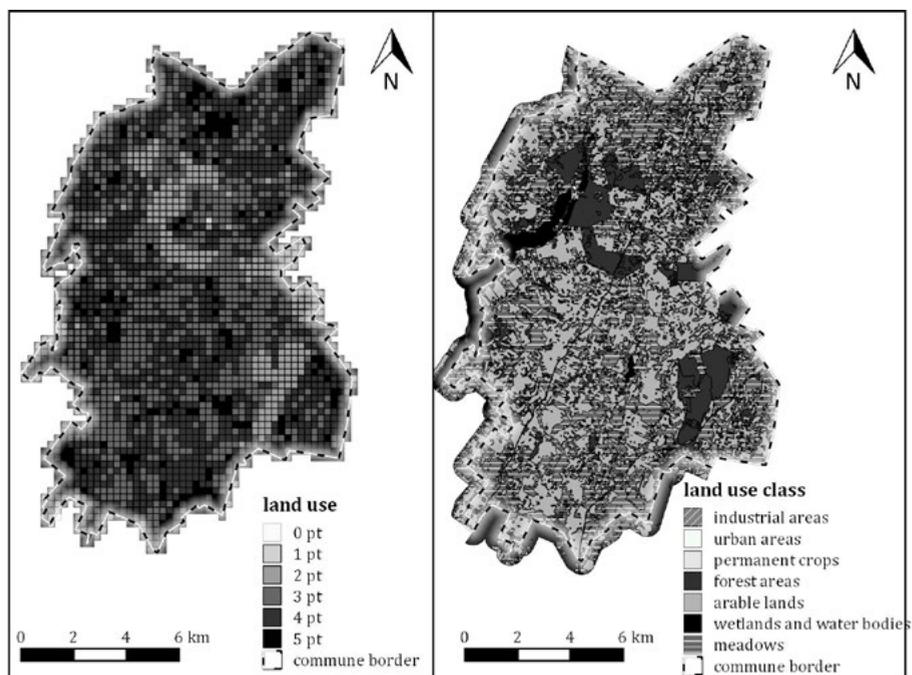


Figure 3. The point classification of land use conditions (on the left) and the map of land use classes (on the right) of the studied area

Source: author's own work based on data from CODGIK in Warsaw.

Hydrography

The influence of hydrographic conditions on the potential of the municipality of Szypliszki in terms of a tourist function development was assessed using two criteria: the length of watercourses and the length of the shoreline of water reservoirs in the respective primary fields.

The area of the studied municipality abounds in the presence of many water reservoirs located almost in the whole area, however, their area usually does not exceed 1 ha. The largest water reservoir is the lake Szelment Mały located on the eastern border of the analyzed municipality. The lake is characterized by its elongated shape and a strongly varied coastline. It is worth noting that in the analysis, water reservoirs of less than 0.1 ha were omitted, to limit the inclusion in the final assessment of unattractive reservoirs of anthropogenic origin (e. g. fish ponds). The river network is less varied and the total length of watercourses in the municipality is 82.83 km. Within the criterion of the length of watercourses in the primary fields, no linear man-made watercourses (meliorations) were considered. The point classification of hydrographical conditions and in terms of the range and the length of the shorelines of water bodies is presented in figure 4.

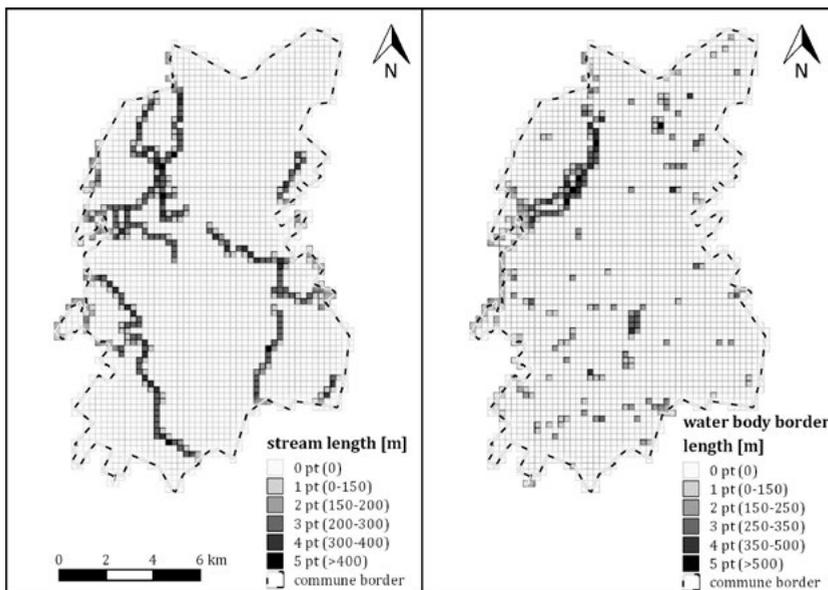


Figure 4. The point classification of hydrographical conditions in terms of the length of watercourses (on the left) and the length of the shoreline of water reservoirs (on the right) of the studied area

Source: author's own work based on data from CODGiK in Warsaw.

Within the evaluation of hydrographic conditions, the score in the range of 1-5 was obtained by a small number of primary fields. For the criterion of the length of watercourses, there were 348 fields, and in the relation to the criterion of the length of the shoreline of water bodies, there were 270 base fields. Detailed information on the frequency of occurrence of particular assessment points of hydrographical conditions is presented in figure 5.

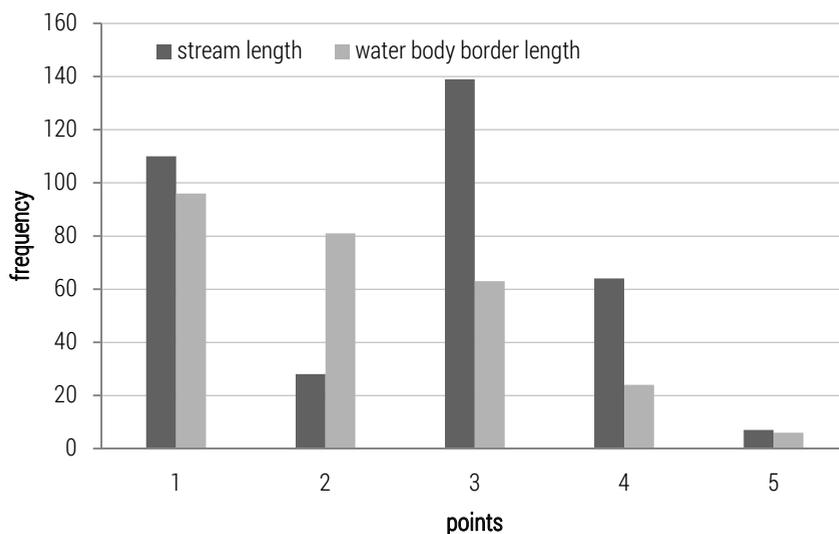


Figure 5. The histogram of the occurrence frequency of point values (≤ 0 points) within hydrographical conditions

Source: author's own work.

The distribution of forest areas

In the case of forest areas valorisation in the analysed municipality, it was assumed that the most attractive tourist attraction of the forest is in the place of contact with another form of land cover (so called ecotonal transition zone). Consequently, the length of the forest border was included in the analysis, but not the share of the forest area in the primary field. After assigning point values to the primary fields because of the length of the forest boundary, the selected meshes of the grid an additional 1 point was given due to the presence in their area of a forest that was a partial or protective reserve (e.g. soil-protective forest). The spatial distribution of values related to the distribution of forest areas is presented in figure 6.

Within the criterion of the length of the forest border and the distribution of protective forests, the highest points of the grid are located mainly in the central and northern part of the analyzed municipality (4-5 points). This is mainly due to the presence of numerous forest areas, including protective forests.

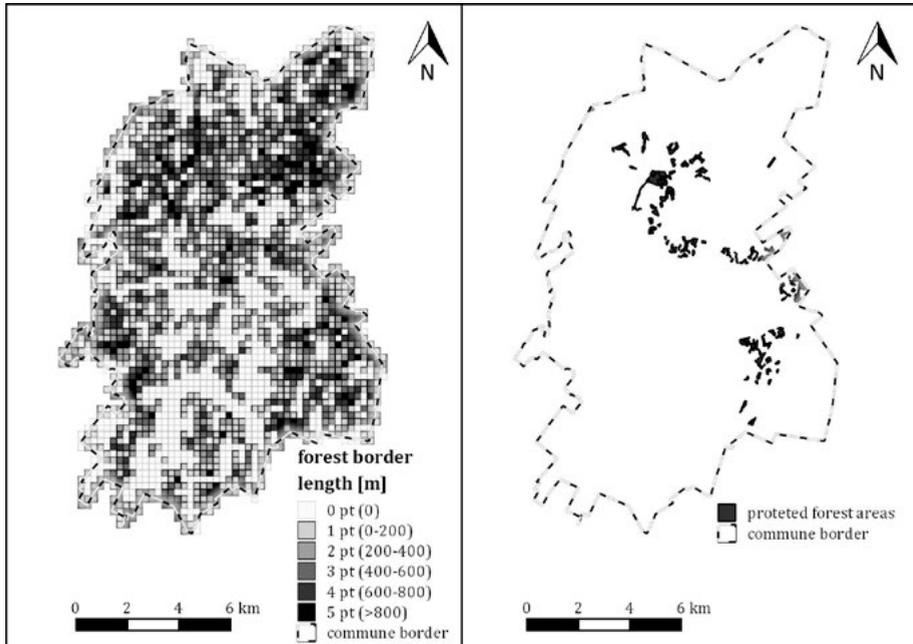


Figure 6. The point classification of forests in terms of the forest border (on the left) and the distribution of protective forests (on the right) in the studied area

Source: author's own work based on data from CODGiK in Warsaw and BDL.

The areas of natural value

The last criterion included in the analysis was the percentage coverage of primary fields with areas of high natural value. In this category, the following areas were included: ecological corridors, protected landscape areas, Natura 2000 sites, national parks, landscape parks and nature reserves. Percentage coverage of natural valuable areas was determined based on the vector mask generated from the layers listed above. The selected meshes of the distribution grid were given with an additional 1 point if there was at least one natural monument within them, while at the same time the covering with areas of natural value was of more than 80%.

The spatial distribution of the values associated with the distribution of valuable natural areas is presented in figure 7. In view of this criterion, the areas with the highest natural values are located in a belt extending from the north-western to the south-eastern ends of the studied area (figure 7).

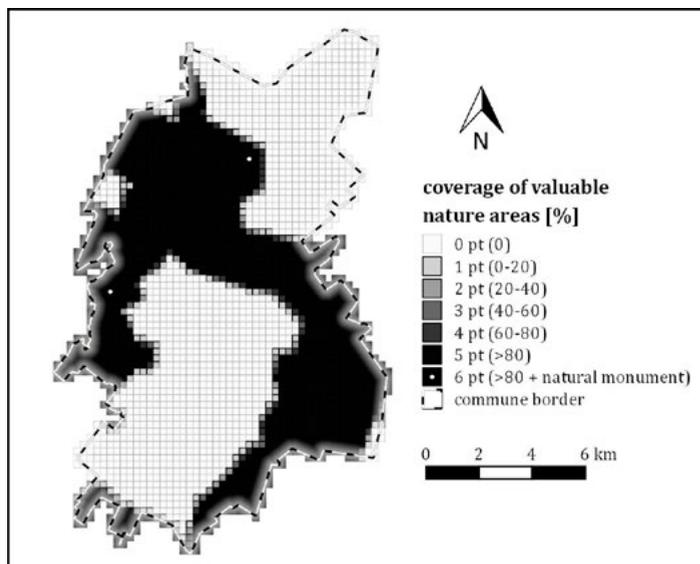


Figure 7. The point classification of the areas of natural value in the studied area

Source: author's own work based on data from CODGiK in Warsaw.

The final assessment

After determining the points in each field within the used evaluation criteria, it was possible to calculate the LAC (Landscape Attractiveness Coefficient), the distribution of which is shown in figure 8. The values of a LAC coefficient in the analysed area range from 0.22 to 0.78. the average value of the applied coefficient was 0.33, which corresponds to the moderate tourist and leisure attractiveness.

The most representative (862 cases) are the primary fields of low attractiveness in terms of tourism and recreation (figure 9). These are mainly agricultural lands located in the southern and northern parts of the studied area. Primary fields with moderate tourist and recreational attractiveness are the next largest group (29.48%). The primary fields with moderate attractiveness are in the south-eastern and central part of the research area. This category of primary fields is agricultural land with some share of forest areas raising the overall assessment of the areas of the municipality.

The next two most valued categories of primary fields (high and very high tourist and recreational attractiveness) account for a total of 26.30% of all cases. Based on the valorisation, two main localizations of the areas of the highest effectiveness can be identified. The first of them is the area located in the western and the north-western part of the research area around the lake Szelment Mały. The other one is the area located in the south-eastern part of the studied area within the large forest complex. The areas rated the highest are characterized by varied land forms and the presence of valuable elements of the natural environment (surface water tanks, watercourses, forests, and protected areas), (figure 8B and 8C).

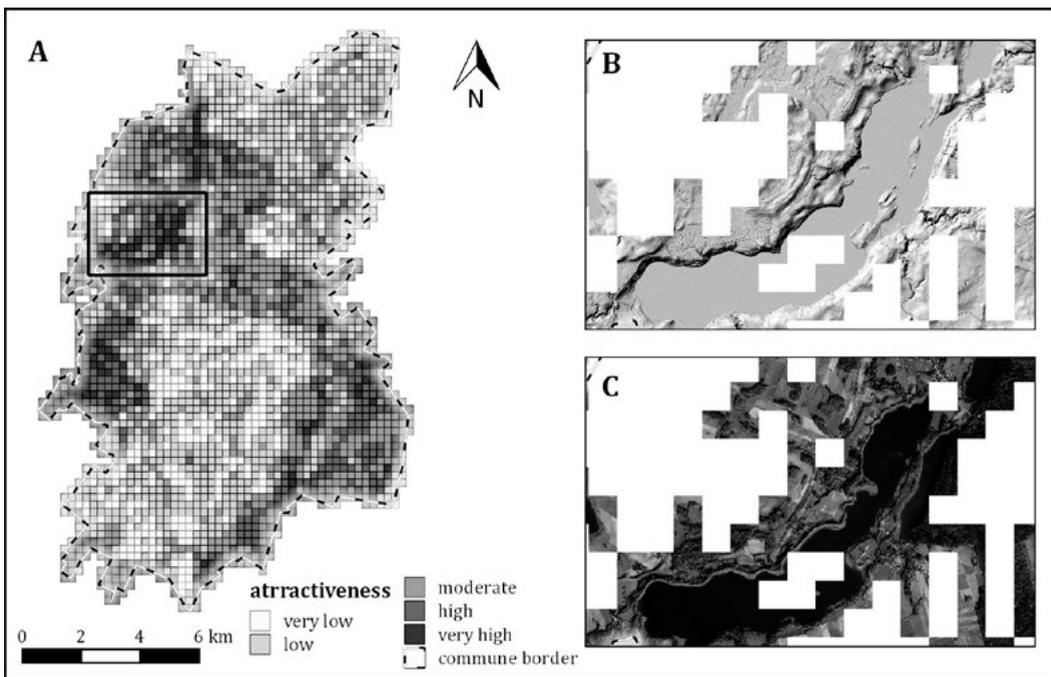


Figure 8. The suitability of the area of the municipality of Szypliszki in terms of tourism and recreation development (A) and the presentation of spatial conditions of the highest evaluated areas: land forms (B) and a digital orthophotomap (C)

Source: author's own work based on data from CODGiK in Warsaw.

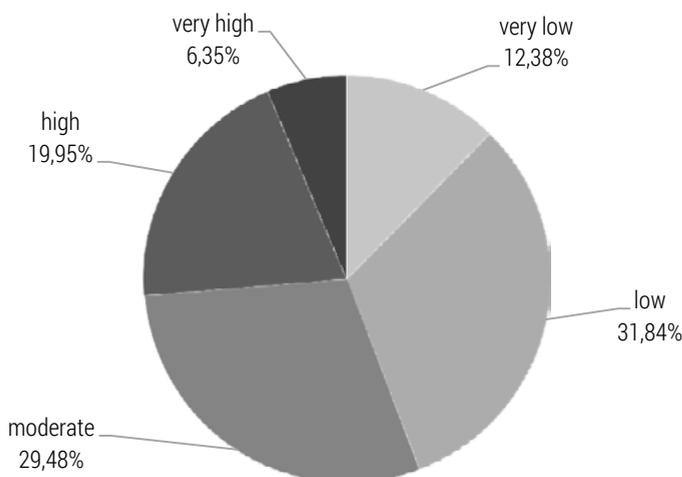


Figure 9. Percentage share of ranges of tourist attractions in the municipality of Szypliszki

Source: author's own work.

Summary

The use of GIS technology and selected spatial data sets allowed the development of a comprehensive valorisation of the municipality's area in terms of tourist and recreational attractiveness. This analysis considers selected elements of the natural environment, which have been identified as main factors that decide of attractiveness of an area. As a result, it was pointed out that nearly 25% of the area of the surveyed municipality was characterized by high and very high tourist and recreational attractiveness.

It is worth mentioning here that the analysis does not consider all the elements determining tourist and recreational attractiveness of the studied municipality. Undoubtedly, such elements are the conditions related to the cultural landscape and tourist infrastructure (accommodation, catering facilities and tourist attractions).

At present, the natural environment is an increasingly important component of the economic calculation. However, the introduction of natural capital into the economic calculation generates many informational challenges. The monetary valuation of the natural environment poses a complex problem, which requires the gathering and considering many detailed data. Their acquisition often entails considerable financial outlays, increasing in line with the size of the studied area. In this context, the methodological approach presented in this paper may be used, allowing for delimitation of areas of the

highest natural values to carry out monetary valuation (Becla, 2013; Zielńska, 2011).

Increasing availability of geospatial data collected in the state geodetic and cartographic resources, as well as GIS software (especially in a free license) means that the analytical approach presented in the paper can be successfully used to evaluate the potential of a selected municipality in terms of the development of a tourist function. The recognition of this type of conditions is particularly important in the process of planning and selection of directions of optimal spatial management in the municipality and at the stage of creation of strategy and development documents (e.g. the Development Strategy of the Municipality).

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The contribution of the authors

Monika Kolendo – 50%

Łukasz Kolendo – 50%

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