

## APPLICATION OF GIS IN TOURISM DEVELOPMENT PLANNING OF BIJAMBARE PROTECTED AREA

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*Original Scientific Article*

DOI: 10.35666/25662880.2021.7.70

UDC: 338.48[911.2:528GIS](497.6 Bijambare)

**Abstract:** The subject of the research is the application of GIS in tourism development planning, a case study of the protected natural area of Bijambare. The research aims to show the benefits of the application of GIS in the use of existing and the establishment of new tourism products within protected natural areas. Protected natural areas are a valuable tourist potential, but as such, they are often under significant tourist pressure, losing their original role - nature protection. Therefore, it is necessary to consider all elements of the environment when planning the development of tourism within them. The application of GIS has a very important role in the overall process of valorization of tourism potentials and tourism development planning. The identification of tourist potentials is the initial phase in the process of tourist valorization, which in the modern scientific concept of research includes the creation of databases that are thematically established. Tourist valorization is also based on spatial data that include natural geographic (characteristics of relief, the hydrography of area, etc.) and socio-geographical characteristics of the area (proximity of roads, the proximity of emitting centers, etc.), and the most adequate can be seen using modern geoinformation technologies. The implementation of the mentioned concept of tourism development planning, presented through the conducted research, will contribute to the reduction of anthropogenic tourist pressures within protected natural areas.

**Keywords:** protected areas, GIS, planning, tourism, environment, Bijambare

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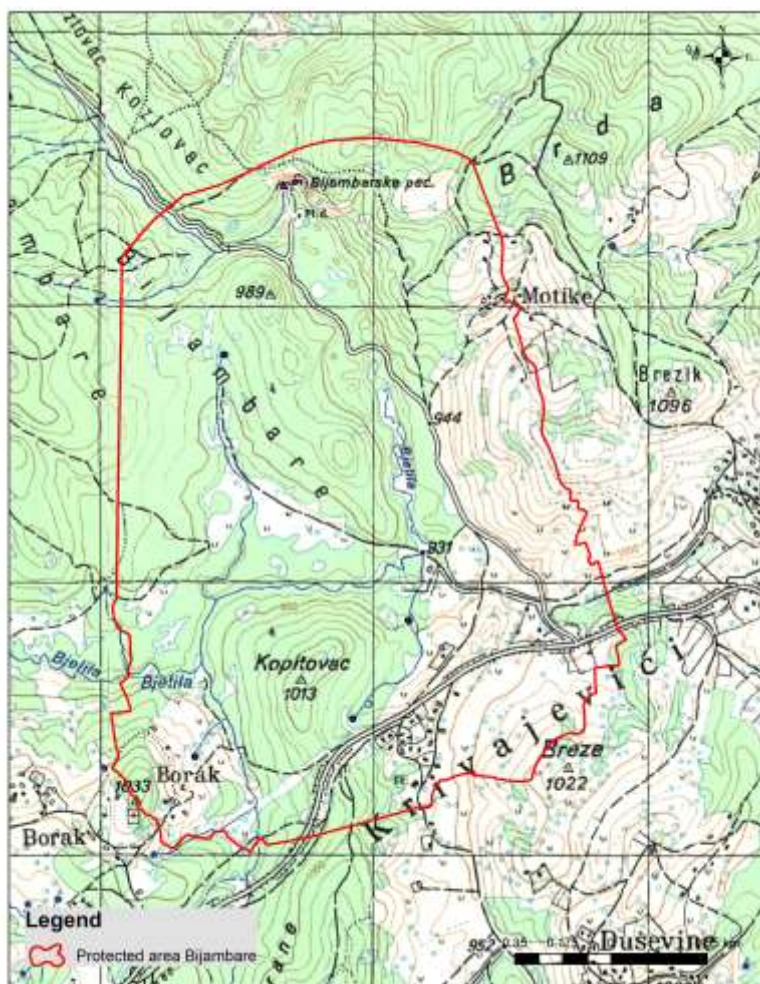
## INTRODUCTION

At the Assembly of the Canton Sarajevo session, held in 2003, the Law on the Proclamation of the Protected Area of Bijambare was passed. According to the IUCN categorization, the protected area of 370 ha belongs to the V category - protected landscape. The protected landscape of Bijambare is located in the area of Canton Sarajevo, in the municipality of Ilijaš, between the mountains Zvijezda in the north and northeast, Ozren in the south and southeast, and the Čemerska mountain in the west and southwest. It is located about 25 km as the crow flies north of Sarajevo, between the villages of Nišići and Krivajevići, in the northeastern part of the Crna Rijeka plateau (Fig. 1.).

In geotectonic terms, this area belongs to the area of the central Dinarides of Bosnia and Herzegovina. The diversity of the relief is a consequence of the different petrographic compositions of the rocks in which it was developed. Relief of mild and rounded shapes has been developed in shales, marls, sandstones, and alluvial deposits. A relief develops with a more pronounced relief component on the limestones: challenging to pass, on the surface covered with scrapes and sinkholes. The contact of limestone deposits with other rocks in this area is characterized by a steep ridge of resistant limestones along which softer Verfen deposits are washed and carried away through underground cracks in the limestones.

Geomorphologically, this area represents an intra-mountain depression, about 60 m lower than the passes Crna Rijeka and Čevljanovići. Along the peripheral part of the geomorphological depression, three caves were formed at different hypsometric levels, which indicates the polyphasic genetics of the depression. In addition to caves within the protected area, surface and underground relief forms have been developed - sinkholes, ravines, abysses, etc.

Underground geomorphological forms of relief - caves (Srednja, Gornja, Ledenjača, Ledenica, Dimišina, Đuričina, Donja, and Nova) represent especially valuable natural phenomena and are the primary motive for the establishment of a protected natural area.



**Fig. 1.** Geographical location of Protected Area of Bijambare

*(Source: Geo-database of GIS Center of Department of Geography, Faculty of Science, University of Sarajevo - Topographic maps of SFRY 1: 25.000, sheets Čamovine & Olovo Jug, adapted by the authors using ArcGIS [GIS software] Version 10.3.)*

Hydrologically, due to the limestone terrain, the area has a poorly developed surface river network. The Bjelila river drains the waters within the protected area. It flows through the central part of the Crna Rijeka plateau and enters the Bijambare valley through a shorter gorge carved between the hills of Kopitovac and Bijambare.

In terms of climate, at lower hypsometric levels, Cf climate dominates, while at higher hypsometric levels, Df climate prevails.

These terrain's geomorphological, hydrological and climatic specifics also influenced the creation of a specific and diverse vegetation cover and fauna. Many plant species are medicinal and honey-bearing, which contributes to the value of the protected natural area. A particular floristic value is the lower peat plants, with a high degree of representation of rare, endemic, sensitive, and endangered plant species. Of great importance in the value of the area are also large animals, birds, bats, and insects.

## **METHODOLOGY**

In order to analyze the possibility of applying GIS in the spatial planning of tourism development of the protected area of Bijambare, several methods were used:

- General scientific methods (spatial analysis method, geostatistical method);
- GIS method;
- Field observation method;
- Method of tourist valorization.

Valorization, combined with other mentioned methods, is one of the most important phases in the process of spatial planning of tourism. It represents a complex phase of research, i.e., a quantitative assessment of values of available motives. It is very difficult to assess the tourist significance of the motive objectively. Therefore, the valorization was done by applying modern geoinformation technologies for tourist elements in which spatial parameters are assessed (compatibility, traffic connections, distance from the emitting center, etc.).

The process of assessing the quality and importance of tourist motives in the protected natural area of Bijambare was carried out through several phases:

- Phase I (identification);
- Phase II (valorization);
- Phase III (ranking of tourist values and separation of tourist micro-regions).

## **APPLICATION OF GIS METHODS IN IDENTIFICATION AND VALORIZATION OF TOURIST POTENTIALS IN BIJAMBARA PROTECTED AREA**

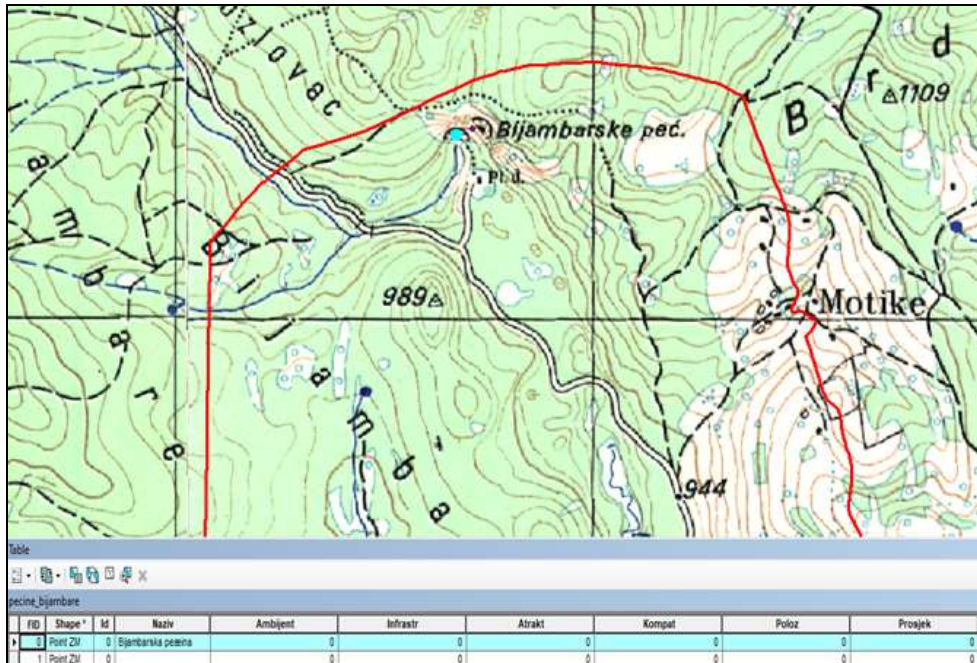
The application of GIS methods in the identification and valorization of tourist potentials in the protected area of Bijambare has been applied through several phases:

- Phase I (identification - field observation method and *GIS method*);
- Phase II (valorization - method of networked thinking (through surveys) and *GIS method - multicriteria analysis*);
- Phase III (separation of tourist zones - *GIS method - data interpolation*);
- Phase IV (possibility of establishing new tourist products (*planning - GIS method*)).

### **Identification of tourist potentials using GIS in Bijambare protected natural area**

The identification of tourist potentials is the initial phase in the process of tourist valorization (Drešković et al, 2015), which in the modern scientific concept of research includes the creation of databases that are established thematically. In addition to tourist motives, digitalization and the creation of databases for tourist infrastructure and superstructure were performed within this phase of work.

The next step is digitizing all tourism potentials and integrating them into a single interactive map linked to a previously created database. This database contains various information: from basic information about the attraction (name of the attraction) to its detailed description, possible visiting times, ticket prices, etc. Also, within the database are very important information or constitutive elements used in the process of tourist valorization: ambiance, infrastructure, attractiveness, compatibility, location, and average tourist value (Fig. 2.).



**Fig. 2.** Identification of tourist motives in the research area

*(Source: Geo-database of GIS Center of Department of Geography, Faculty of Science, University of Sarajevo - Topographic maps of SFRY 1: 25.000, sheets Čamovine & Olovo Jug, adapted by the authors using ArcGIS [GIS software] Version 10.3.)*

Identification of tourist motives in the protected natural area was performed based on: literature data sources, field observations, and cartographic - GIS methodology. Based on the available cartographic data sources, using modern geoinformation technologies, the identification of tourist potentials within the protected natural area of Bijambare was performed.

### **Tourist valorization using GIS in Bijambare protected natural area**

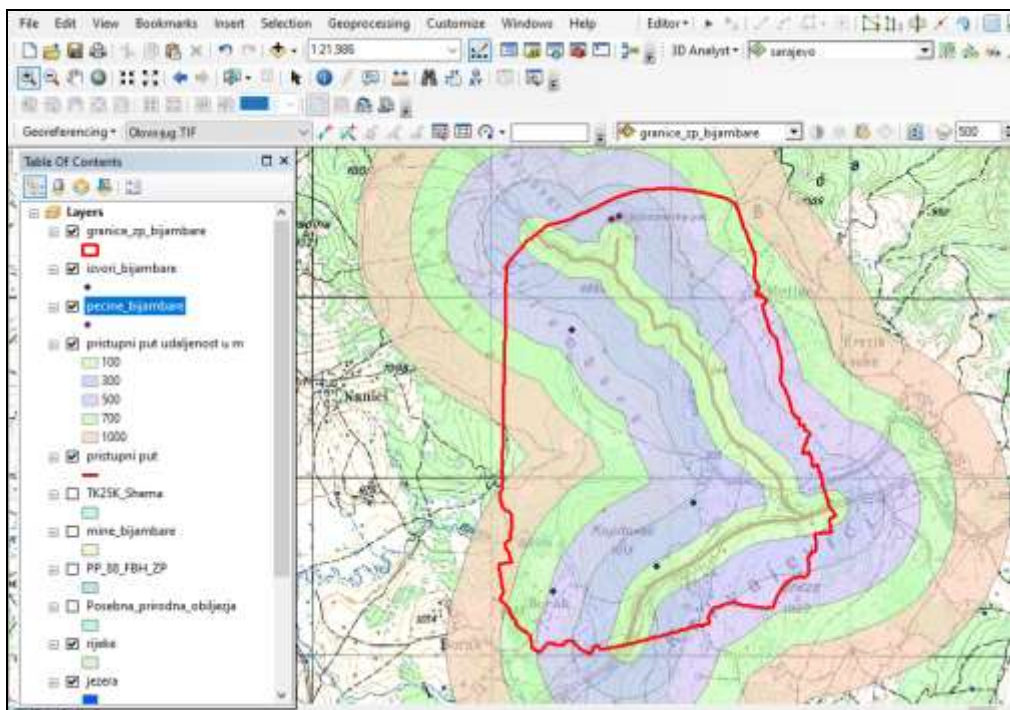
Tourist valorization means the evaluation, i.e., the qualitative and quantitative assessment of the tourist values of all previously listed motive values and other constitutive elements of the tourist potential. Valorization is one of the most important phases in the process of spatial tourism planning. However, at the same time, it is the most complex and most challenging phase, especially when it comes to assessing the values themselves, whose tourism significance is challenging to assess objectively. Valorization aims to assess the value of the elements of tourist potential (individually and collectively), i.e., to determine their use-value.



The process of valorization of tourist motives (natural geographical - hydrological and geomorphological) was performed for all constitutive elements of tourist motives (tourist position, ambiance, attractiveness, construction, and compatibility), with a grade of 1 to 5 points depending on its quality.

To achieve objectivity in the process of tourist valorization of tourist motives in the protected natural area of Bijambare, GIS technologies are applied in the analysis of spatial constitutive elements such as construction and compatibility.

Tourist valorization of the construction was performed by analyzing the distance of tourist motives from the access road using buffer zones (Fig. 3.).



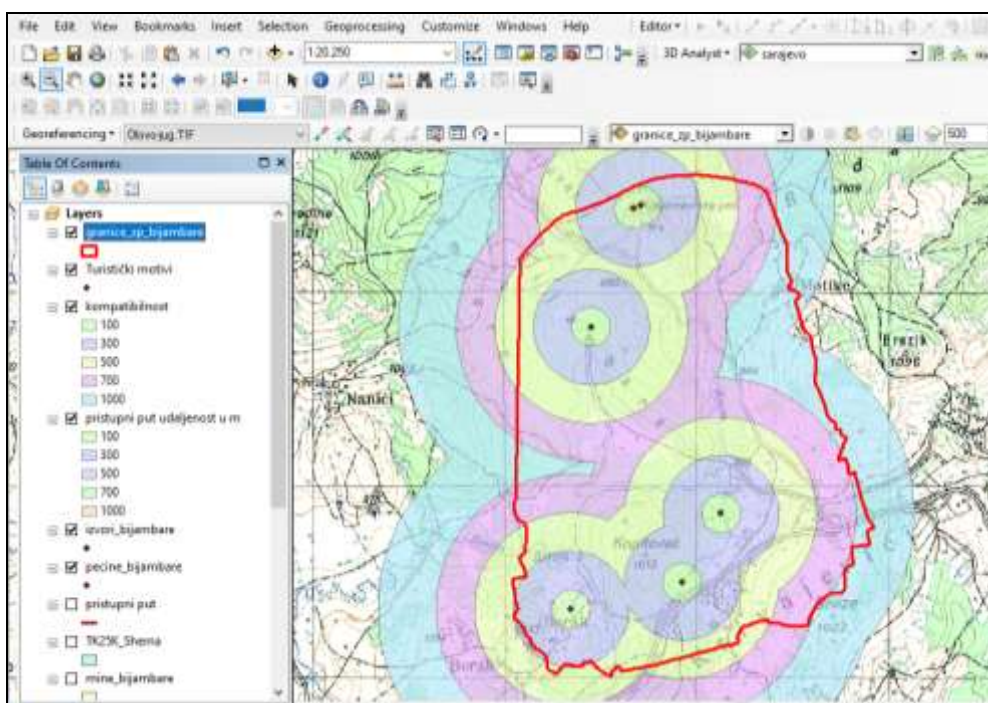
**Fig. 3.** Analysis of analyzing the distance of tourist motives from the access road using buffer zones

*(Source: Geo-database of GIS Center of Department of Geography, Faculty of Science, University of Sarajevo - Topographic maps of SFRY 1: 25.000, sheets Čamovine & Olovo Jug, adapted by the authors using ArcGIS [GIS software] Version 10.3.)*

The analysis of the area/tourist motives connected to the access roads or located in its immediate vicinity received a higher number of points than the motives further from the access roads.

Compatibility analysis and scoring were performed according to the same principle. Compatibility implies the interconnectedness/proximity of tourist facilities. Thus, motifs that are spatially located within one/nearest buffer zone have a higher value, according to this criterion, compared to motifs that are located in the farthest buffer zone (Fig. 4.).

Also, the application of GIS in the tourist valorization of the protected natural area of Bijambare was used in the analysis of unexploded ordnance. This analysis involved the use of previously established databases and .shp files. Based on the conducted research, in the areas marked as areas with unexploded ordnance, they are not proposed for touristic or any other use, regardless of the tourist attractiveness of the area.



**Fig. 4.** Compatibility analysis of tourist motives

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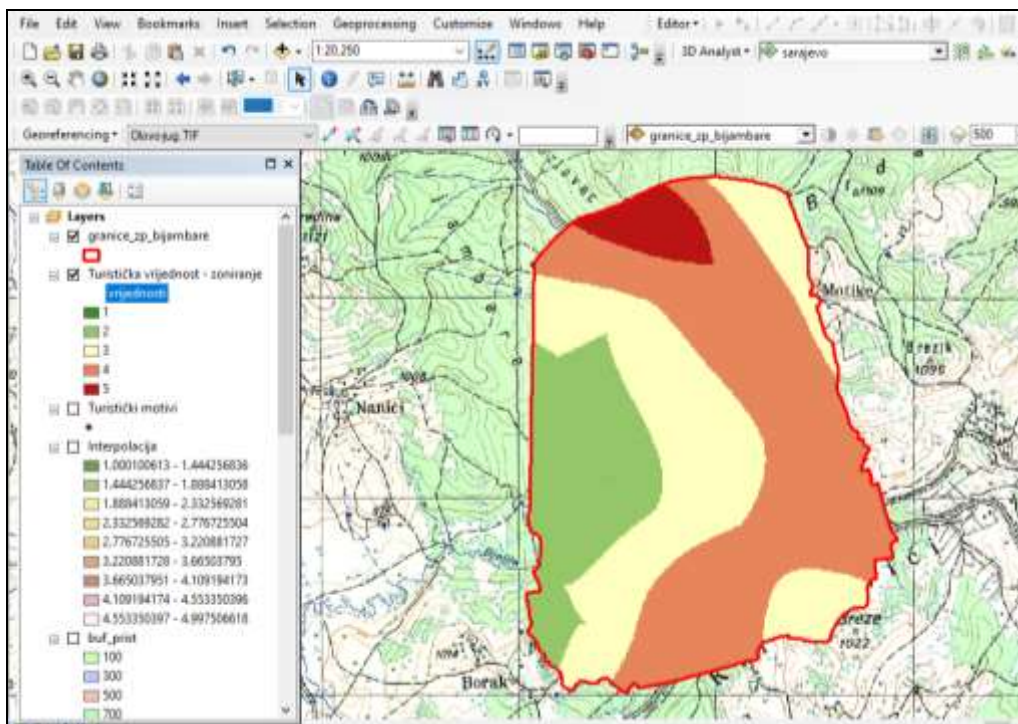


## **Ranking of tourist potentials and allocation of tourist zones within the Bijambare protected natural area**

Based on the point scale with which the valorization of tourist potentials was done (Fig. 5.), the ranking of tourist motives was performed based on the general tourist value defined in the categories:

- Rating 1 (insufficient quality) is not for tourist presentation and use;
- Rating 2 (satisfactory quality) has local tourist significance;
- Rating 3 (good quality) has regional tourism significance;
- Rating 4 (very good quality) has a broader regional significance;
- Rating 5 (excellent quality) has international tourism significance (Hrelja et al., 2012; Hrelja et al., 2014).

The general tourist value was obtained by analyzing the constitutive elements, their valorization, and the creation of databases and by calculating the average value for each motif separately.



**Fig. 5.** Allocation of tourist zones within the Bijambare Protected natural area

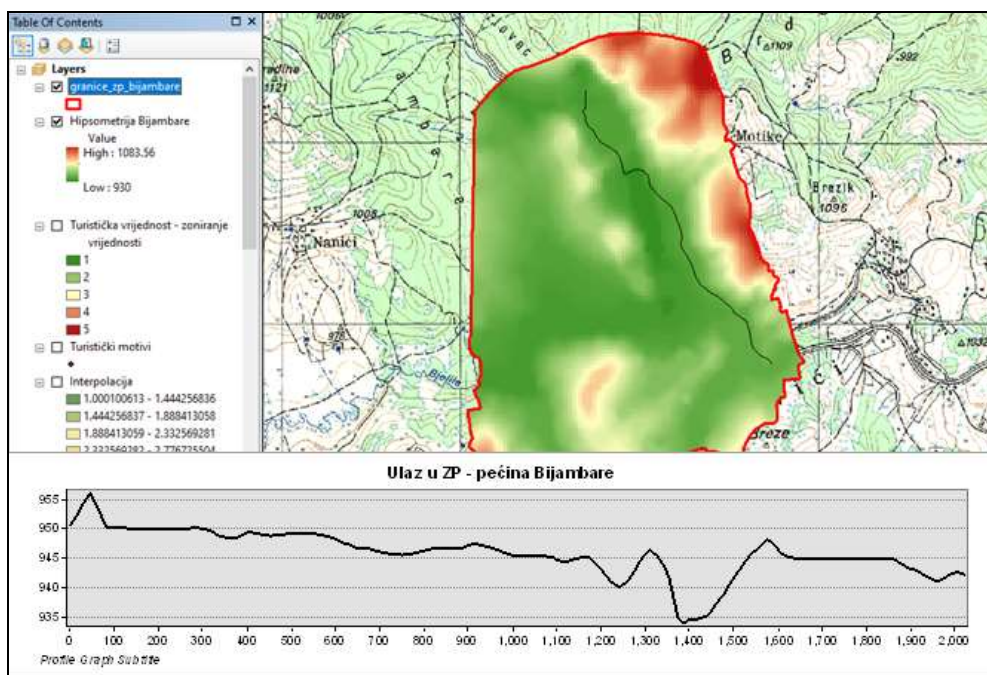
*(Source: Geo-database of GIS Center of Department of Geography, Faculty of Science, University of Sarajevo - Topographic maps of SFRY 1: 25.000, sheets Čamovine & Olovo Jug, adapted by the authors using ArcGIS [GIS software] Version 10.3.)*

Based on the general tourist value assigned to vector data/motives, by applying the interpolation of spatial data, raster data were obtained based on which the zones of tourist value of the entire area were separated. The natural neighbor is one of the most popular interpolation methods, with wide application in geographic modeling (Boissonnat and Cazals, 2001; Unger, 2003; Fan et al., 2005). It is a weighted average method that estimates value using the local coordinates of a natural neighbor (Kilibarda, M., Protić, D., 2018). The interpolated value used in the process of separating tourist regions is determined by the values of the measured points that surround it.

## APPLICATION OF GIS IN FINDING NEW FORMS OF TOURIST TRENDS

The application of GIS to find new forms of tourism trends is one of its most important functions in tourism development planning. Using GIS, databases, and cartographic representations of morphometric characteristics of the terrain (altitude, terrain slopes, vertical disintegration, and terrain exposures), hydrological characteristics, soil characteristics, biogeographical and climatic characteristics are created, which is the basis for all activities focused on creating new forms of tourist movements.

This includes determining the most suitable location for constructing new tourist sites and infrastructure or renovating existing ones, planning new zones for various tourist activities, and determining the maximum number of tourists in a given area for sustainable development. For the purposes of this research, the application of GIS in order to plan, establish and categorize hiking and biking trails is presented (Fig. 6.).



**Fig. 6.** Application of GIS in finding new forms of tourist trends

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The path from the entrance (eastern side of the area) to the protected natural area to the Middle Bijambare Cave has been digitized. Using GIS-based on a digital relief model, the longitudinal profile of the path is shown, based on which its slope of 0.20 was calculated. Longitudinal slopes are conditioned by the physical abilities of cyclists, technical and driving characteristics of the bicycle, wind speed, air resistance, and the quality of the traffic surface. On the profile of the mentioned path, based on the categorization of bicycle paths, it is possible to develop cycling for the purpose of recreation where it is possible to practice cycling for all age groups. Also, in addition to all the above, the application of GIS in analyzing the adverse effects of tourism development within protected natural areas is significant. This refers to monitoring changes in land cover, construction of tourist infrastructure and superstructure, defining the carrying capacity and area load, etc.

## **CONCLUSION**

The conducted research ultimately confirmed the set assumptions of the research. Based on the research results, it is possible to generalize the following concluding assumptions:

The application of GIS has a very important role in the overall process of valorization of tourism potentials and tourism development planning.

Using cartographic data sources and the application of modern geoinformation technologies makes it possible to identify tourist potentials. The application of geoinformation technologies complements the identification of tourist potentials, which was performed by consulting literature data and field observations. Identification carried out in this way implies the creation of thematically established databases and represents the basis for tourist valorization of an area.

Tourist valorization is based on spatial data that include natural geographical (characteristics of relief, the hydrography of area, etc.) and socio-geographical characteristics of an area (proximity of roads, the proximity of emitting centers, etc.). Some of the elements of tourist valorization (proximity to emitting tourist centers, construction, compatibility, etc.) can be most adequately considered by applying modern geoinformation technologies.

By applying geoinformation technologies with interpolation of spatial data, obtained by the method of tourist valorization, micro-regionalization of an area is performed, which distinguishes tourist zones ranked according to tourist value.

Multicriteria analysis of spatial data using GIS makes it possible to establish and spatially determine new forms of tourist movements. In addition to the above, it is possible to contribute to the reduction of anthropogenic tourist pressures within protected natural areas.

Based on all the above, it is possible to conclude that the great importance of GIS in the inventory, valorization, ranking of tourist potentials, as well as the possibility of establishing new forms of tourist movements and tourist activities within protected natural areas.

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