RURAL DEVELOPMENT THROUGH NATURE: THE POTENTIAL OF HIKING TRAILS ON THE MOUNTAIN STARA PLANINA

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Abstract

This article presents an analysis of the existing hiking trails leading to the falls at Stara Planina, identifying gaps in the mapped trails, specifically waterfalls in the basin of the Jelovac River. This study aims to propose an optimal route using a minimum cost route approach through integration of GIS and digital elevation models (DEM).The proposed route connects unidentified waterfalls from different river basins. It stretches for 5.04 km with an elevation difference from 1,356 to 1,769 m, effectively linking the Orlov Kamen waterfalls in the basin of the Dojkinci River and the waterfalls in the basin of the Jelovac River.

The method involves calculating distance and slope to determine possible walking trails. Analysis shows that many micro-watersheds in the basin of the Jelovac River in particular is often unmapped and disconnected from nearby watersheds. The maximum distance measured between the Orlov Kamen and the adjacent waterfalls is 2.3 km. This study emphasizes the importance of developing a trail network not only to promote public health and recreation, but also to enhance the quality of life. It also tried to bolster rural development by promoting the natural heritage of the area. This can lead to economic sustainability and community cohesion since investing on infrastructure and community engagement is critical to improving Stara Planina's accessibility and conserving its natural resources.

Key words: *development, hiking trail, Jelovac-Dojkinci rivers, Stara Planina, tourism potential, waterfalls.*

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Introduction

With the increasing interest in cultural and historical heritage, hiking tours have become an important form of tourism, especially among local communities (Veverka, 1998). Organizing hiking tours in nature, similar to trekking and backpacking, is often done by specialized professional or commercial tour agencies. The origins of this form of tourism dates back to the 18th Century.

What makes hiking attractive for every hiker is the simplicity of walking, the pleasantness of walking, the perception of attractiveness, comfort, convenience, etc. (Moudon & Lee, 2003). Today, hiking tours generally refer to walking over long distances. The most famous routes are found in England and Wales (The National Trails), the United States (The National Trail System), France (The Grande Randonnée), the Netherlands (Lange-afstand-wandelpaden), Portugal (Grande Rota), and Spain (Gran Recorrido).

The Alpine mountain range is one of the most important tourist destinations, attracting millions of visitors each year. Such tourist destinations provide significant benefits to both the tourism industry and local communities (Kelfaoui et al., 2021; Petrevska & Dimitrov, 2018). In 2016, the Alpine region recorded 508 million overnight stays, with approximately 7.5 million beds available for tourists. These figures highlight the dominance and importance of attracting visitors to mountain areas (BAK Economics AG, 2018; Tempesta & Vecchiato, 2018). Through the development of hiking trails, outdoor recreation, sports, and leisure activities, both the natural and cultural landscapes of the region can be explored. Increasingly, the focus is placed on ecological tourism, which can directly contribute to rural development (Datta & Banerji, 2015; Kling et al., 2017). Moreover, hiking trails can help alleviate poverty in disadvantaged communities by utilizing local cultural and natural resources for community-based tourism (CBT), a strategy that has shown positive results when properly implemented (Mnguni & Giampiccoli, 2017; Tempesta & Vecchiato, 2018).

A good example of how hiking trails play an important role in rural development and attracting tourists is the Veneto Region in Italy. In 2001, the region recorded around 9 million recreational activities. By 2015, this number increased to nearly 13 million, indicating a growing demand for recreational activities in Alpine areas (Tempesta, 2004; Petrevska & Dimitrov, 2018). On the contrary, there are regions where natural conditions, terrain topography, and landscape features allow the development of hiking trail networks, but

the lack of financial resources and insufficient commitment from local communities limit the potential of these areas. In North Macedonia, many hiking trails lack adequate facilities and resources, as well as infrastructure, to meet the needs of the growing number of visitors (Petrevska & Dimitrov, 2018). Local authorities need to focus their efforts on developing and promoting new tourism offerings. Additionally, it is essential to invest in trail maintenance and the construction of necessary facilities to ensure sustainable tourism development in rural areas (Kelfaoui et al., 2021).

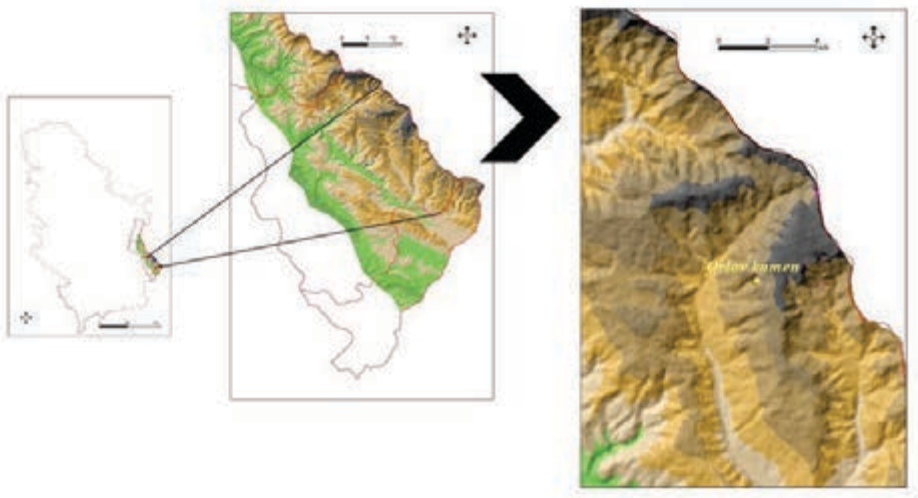
However, the scene has dramatically changed over the last decades due to abandonment of agricultural activities and reforestation, enhancing the aesthetic and recreational values for these areas too (Thiene & Scarpa, 2009; Tempesta & Vecchiato, 2018). These impacts are countered by the Common Agricultural Policy of the European Union to aid in the development of mountain areas by way of restoring hiking trails and meadows, among others, through funding and infrastructure development programs provided for under Regulation (EU) No. 1303/2013 of the Commission (Tempesta & Vecchiato, 2018).

The main objective of the paper is to determine the hiking trail of waterfalls belonging to different watersheds of Dojkinci and Jelovac rivers. The hiking trails are designed around attractive scenic spots and connected to each other, forming a network of trails (Li, Ge, & Liu, 2005). The most attractive part is certainly the waterfalls, of which there are many on Stara Planina, and the network of hiking trails began to form only at the beginning of the last century, when most of the waterfalls on this mountain were discovered.

Study area

Stara Planina spans the southeastern part of Serbia, part of the Carpathian-Balkan system, with a natural border towards Bulgaria along the ridge of Stara Planina. The highest peak is Midžor (2,165 m), and the lowest point is the exit from the valley of Prlitski Stream. The northernmost point is in the valley of Prlitski Stream, the southernmost in the valley of Nišava, the westernmost at the confluence of the Trgoviški and Svrljiški Timoks, while the easternmost point is the summit of Srebrna Glava (1,933 m above sea level) (Milovanović, 2010).

Map 1. *Geographic location of the study area*



Source: *Elaborated by Authors*

This area was analyzed in the 19th Century by Jovan Cvijić, who studied the tectonics and geology of this region (Cvijić, 1896), particularly the area from Temska to Topli Do and Midžor. The route from Temska to Topli Do is the location with the highest number of identified waterfalls, but Cvijić, from that period, described Ripaljka (Ozren mountain, Soko Banja) as the highest waterfall with a height of 420m. Based on recent measurements from the Faculty of Mining and Geology, University of Belgrade, the highest waterfall in Serbia today is the Kopren waterfall (103.5m) on Stara Planina (Map 1).

Methodology

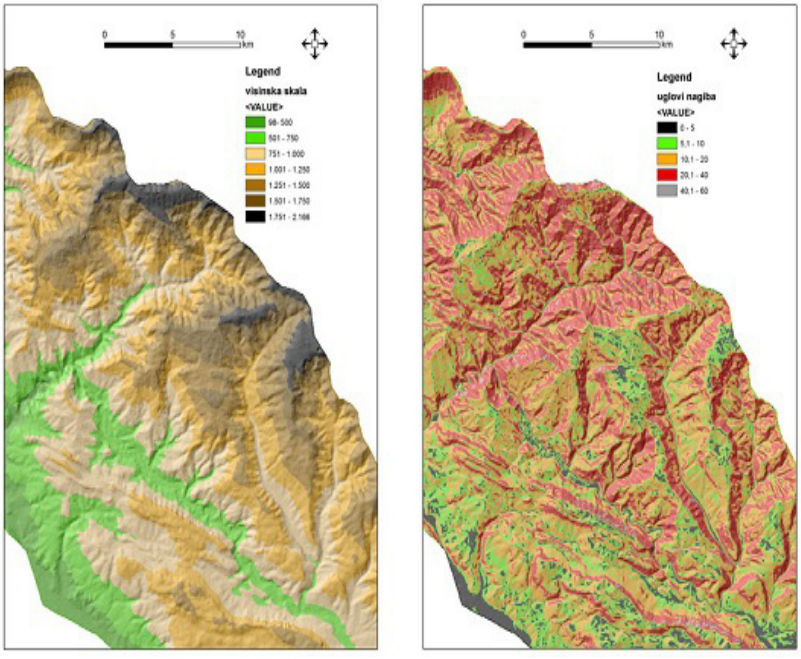
The least-cost method is based on the definition of "cost surface," which represents a raster map where each cell is assigned values reflecting the "costs" of passing through them. These costs are not necessarily of an economic nature (Bagli et al., 2011). Instead, they may encompass various factors, such as terrain slope, transportation infrastructure, and land use. This method is often applied in the planning of infrastructure projects such as roads, pipelines, canals, and power lines, as well as for recreational purposes, such as the development of hiking trail systems. The least-cost method is used to determine the optimal path between two points, taking into account various possible routes

and minimizing the overall costs, which may include factors defined by the user (Kim, 2012).

The starting criteria for determining the hiking trail of the waterfall were the terrain elevation and slope angle within the study area. Calculating the optimal hiking trail using the least-cost method represents the most efficient approach, utilizing Geographic Information Systems (GIS). Hypsometric and slope angle maps were obtained by combining the Digital Elevation Model (DEM) with GIS technologies (Map 2). Through further analysis and the application of the least-cost method, the most favorable route, i.e., the hiking trail, was defined.

The starting point was taken as the point of interest, which is closest to the hiking trail Jelovica – Široke Luke – Kopren waterfall. Based on the slope angle map and further reclassification, distance costs for each raster cell were obtained. The necessary costs determine the best path, which is related to the direction depending on the slope, through a predefined function. The distance cost values were lowest closer to the source, i.e., the starting point of interest, and as the distance increased, the costs grew (Map 3).

Map 2. *Hypsometric map and slope angle map of the analyzed area*

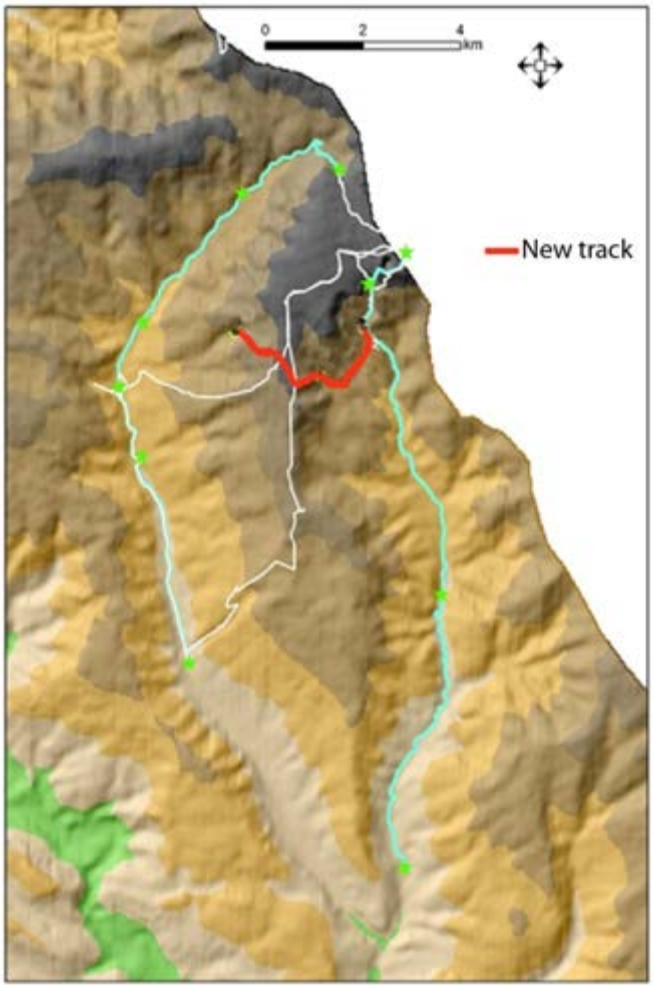


Source: *Elaborated by Authors*

Results

After analyzing the existing trekking routes and the cartographic representation of the waterfalls on Stara Planina, it was observed that the majority of waterfalls that are not mapped within the hiking trails belong to the route from Jelovica to Široka Luka. The only waterfall that does not belong to the Jelovac River basin is the Orlov Kamen waterfall, which is part of the Dojkinac River basin (Map 3).

Map 3. *The new hiking route obtained using the least-cost method from the Jelovac River waterfall to the Orlov Kamen waterfall*



Source: *Elaborated by Authors*

The obtained hiking trail connecting the waterfalls of Jelovac River with the Orlov Kamen waterfall is 5.04 km long, with an elevation difference ranging from 1,356 m to 1,769 m. GIS analysis showed that the greatest distance was measured between the Orlov Kamen waterfall and the Upper Šošina Vunija waterfall, at a distance of 2.3 km. All subsequent distances are less than 1 km, with the distance between the Lower Šošina Vunija waterfall and the Upper Šošina Vunija waterfall being 0.65 km. The shortest distance was measured between the Javorski Do River waterfall and the Lower Šošina Vunija waterfall, at a distance of 0.2 km (Map 3 and Map 4).

Map 4. *Visualization of the obtained trail via Google Earth*

Source: *Elaborated by Authors*

The potential development of this mountain could be focused on expanding the network of hiking trails. This paper presents only some of the mapped walking trails located in the part of Stara Planina that belongs to Pirot. On the Knjaževac side, there are trails around the newly built hotel complex and future ski trails. The Pirot part of Stara Planina is richer in waterfalls, many of which are relatively new and have not been fully explored yet. Some of these waterfalls are located in inaccessible areas, and some dry up during the dry season, making them both inaccessible and invisible. By locating, mapping,

and marking them in the field, these waterfalls can become accessible to every hiker. Some information is already available to tourists and hikers through the internet, but with economic investment from local communities into infrastructure and greater promotion, Stara Planina could, over time, evolve from its current level of recognition into a region known for its hiking routes, similar to destinations like the Great Smoky Mountains (USA), Cinque Terre (Italy), etc.

Conclusion

Through such research, rural areas can benefit from enhanced tourism, creating jobs and economic opportunities while preserving their natural heritage. This is particularly important for regions with limited economic perspectives. The integration of geospatial technologies, local knowledge, cultural practices, and community decision-making is crucial to ensure that the benefits of tourism are fairly distributed and that natural resources are managed sustainably. The hiking trail connecting the Jelovac River waterfalls and the Orlov Kamen waterfall, 5.04 km long with an elevation difference of 413 m, illustrates how such projects can contribute to sustainable development. GIS analysis revealed that the greatest distance is between the Orlov Kamen waterfall and the Upper Šošina Vunija waterfall, measuring 2.3 km, while all other distances are less than 1 km. This data allows for effective planning and sustainable management of natural resources, which is key to the long-term sustainability of rural tourism. Future research can significantly contribute to strengthening rural development through sustainable tourism, using hiking trails as an important resource for revitalizing rural communities and preserving cultural heritage. However, current research suffers from a lack of data on actual number of tourist visits and their impacts. Furthermore, there is potential to improve route efficiency. Research should focus on preserving natural resources and improving the quality of life for local communities, while involving all relevant stakeholders in the planning and implementation of strategies.

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