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Open Geodata for Developing Wine Tourism in Viticultural Regions in Serbia

Abstract

Serbia has favourable conditions for developing oenology and viticulture and, thus, wine tourism destinations. A study was conducted based on open data analysis and evaluation to determine the possibility of producing wine destinations in Serbia. The study uses environmental data (slope, altitude, climate, etc.) to build the Digital Elevation Model (DEM), land use data - CORINE Land Cover 2018 (European Environment Agency, n.d.) and hydrography. Open sources through social media were used to obtain socio-economic data, such as natural areas, hiking and cycling routes, etc. All data were geolocated and processed in natural-geographical and socio-economic groups with the ArcGIS 10.8 software package.

This research is a new contribution using geodata for the tourist valorisation of the vineyard area. By applying the Analytic Hierarchy Process (AHP) method and using Geographic Information Systems (GIS), results show the advantages of specific wine regions over others for developing wine tourism. These are the following wine-growing regions: Subotica, Fruška Gora (northern Serbia), Šumadija and Niš (central and southern Serbia) and wine-growing regions close to Belgrade.

Keywords: GIS, open data, tourism evaluation, wine-growing regions, wine tourism, Serbia

1. Introduction

The increasing amount of content on social media, such as reviews and comments, has provided access to vast information. Tourists can obtain this freely available information, known as "open data." Defined in 2005 by the Open Knowledge Foundation, open data are "data that can be freely used, shared, and built upon by anyone, anywhere, for any purpose." Maccani et al. (2015) and Pantano et al. (2017) highlight three principles: (1) availability and access (people can obtain data); (2) reuse and redistribution (people can reuse and share data); (3) universal participation (everyone can use the data).

Open data facilitates local authorities in planning and advertising for the needs of tourists. Mobile technologies have transformed mass tourism and influenced "one-to-one" marketing, enabling timely information about attractions and transportation. Longhi et al. (2014) argue that tourism is the first industry to engage with open data. Tourists increasingly seek quality in products and experiences, boosting the demand for open data in tourism and hospitality, available in XML, CSV, or JSON formats (Wu et al. 2014; Pantano et al. 2017). Tourist destinations can utilize open data to develop cultural content, transportation, marketing, and the environment (Wiggins and Crowston, 2011). Smart cities are the first to process open data for managing tourist destinations (Longhi et al., 2014; Buhalis and Amaranggana, 2013; Jovanović et al.,

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2023). Open tourist data is distributed through various websites and formats. Tourpedia, a transnational project of Spain, France, and Italy, creates a unique database of tourist accommodations and attractions, allowing for the integration of new open data sources from the public sector worldwide (Gazze et al., 2015; Lo Duca and Marchetti, 2019).

The characteristics of wine regions in tourism serve as a key resource and incentive for attracting visitors (Maracaja et al. 2024). In France, we find DataTourism, an open data portal for tourism, which collects data from the French government's local and regional tourism authorities. DataTourism currently contains 96 French departments in 14 different regions, publishing more than 385,000 points of interest and events (Gazze et al., 2015; Lo Duca and Marchetti, 2019). In Spain, there is Dataestur, a Segittur initiative that contains a selection of the most relevant data on tourism in Spain. The data added to Dataestur derive from different sources such as INE, Renfe or Segittur and are grouped into five categories for downloading, consultation and study (Gazze et al., 2015; Lo Duca and Marchetti, 2019).

In the context of travel and tourism, many people and tourists search for reviews (comments and ratings) and tourist experiences via TripAdvisor, Yelp, etc. This type of website dramatically influences the decisions of other travellers about many different aspects of their travels, e.g., choice of tourist destination, accommodation, and attractions to visit.

Serbia has two significant potentials for developing wine tourism: the most important is its long and rich tradition in wine production and viticulture. The tradition of wine and viticulture goes back in history to the days when Romans, Slavs, and Turks inhabited these regions. On the other hand, Serbia's wine regions are endowed with unique characteristics that allow for the creation of diverse wine tours and themed travel experiences. This diversity can cater to various interests and preferences of tourists, from lovers of traditional wines to those seeking modern wine styles. Serbian wineries offer tours of vineyards and opportunities to learn about the wine production process techniques and tastings. Some wineries also have the option of more extended stays. Self-evidently, a significant chance of promoting Serbian wine tourism is numerous wine festivals and events, which are combined with local gastronomic specialities and tours of cultural landmarks, further enhancing the tourist offer of Serbia's wine regions.

On the other hand, recent literature often focuses on developing wine tourism in Serbia from visitor preferences, market segments, promotional activities, brand awareness, wine quality, different types of services requested by tourists, tour guide services and wine tastings. Sekulić et al. (2016) explore tourist motivations for participating in wine tourism through a survey that focuses on wine tastings and visitors to wineries wine information. Tršić et al. (2020) analyze wine routes as a tool for sustainable tourism development in Vojvodina, looking atpromotional activities, travel networks, and winery locations. Kubat (2021) examines the potential of wine tourism in Šumadija as a component of regional development, looking at brand awareness, wine quality, and various types of services. Jovanović et al. (2015) analyse wineries and wine routes as tools for developing agritourism in Serbia, focusing on promotional activities, different market segments and wine tastings. Vladimirović and Jevtić (2022) investigate wine consumers' preferences, motives and attitudes in the Serbian market, considering visitor preferences, brand awareness and wine quality. Jević et al. (2020) study the motives for visiting wineries in the wine region of Vršac, focusing on wine tastings and social activities through visitor preferences, wine tastings and social activities. Radovanović et al. (2017) explore the impact of demographic factors on wine choice amongst consumers in Serbia, looking at visitor preferences, demographic characteristics and brand awareness.

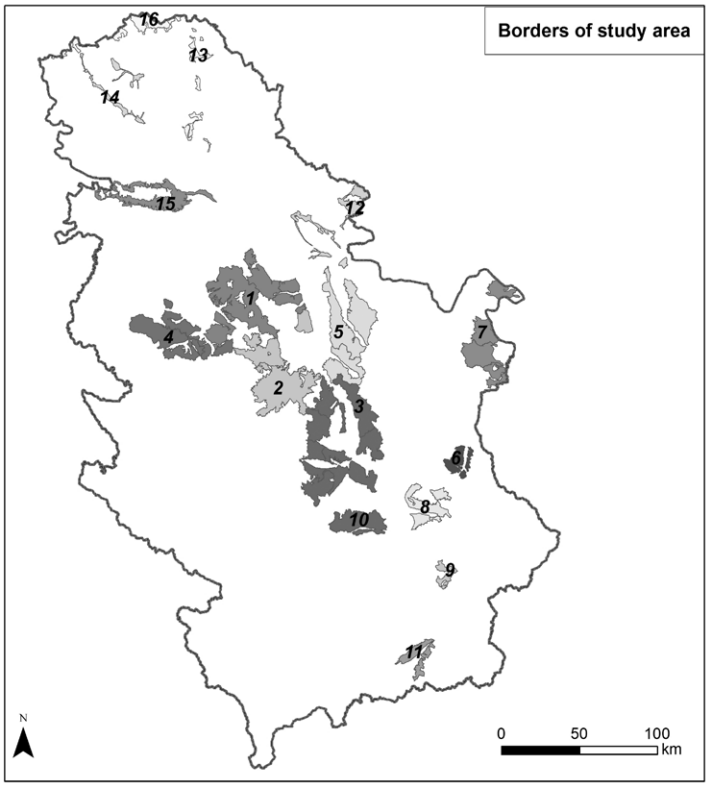
This article aims to illustrate how wine tourism in Serbia's vineyard regions might be improved through open data. One innovation in rating wine regions for tourism is using multi-criteria analysis and open data in a GIS setting.

2. Study area

The European Economic Community (EEC) and the International Organisation of Vine and Wine (OIV) define the rules for rezoning to protect the geographical origin of wines produced from grapes in controlled wine-growing areas based on climate, relief and soil characteristics. The rezoning of the wine-growing area of Serbia was carried out according to the criteria of the OIV and the EU in 1975 and 1976, with updates in 2015. The most represented white wine varieties in Serbia are Italian Riesling, Rhine Riesling, Chardonnay and Sauvignon Blanc, whilst the domestic varieties are Smederevka and Župljanka. As far as red wines are concerned, the dominant varieties are Cabernet Sauvignon, Prokupac, Merlot, and Burgundy (black), with Muscat Hamburg and Kardinal being the most common (Jovanović et al. 2022).

The study area includes 16 wine-growing regions in wine-growing areas in Serbia. (Figure 1).

Figure 1
Geographical location of the study area



Wine-growing regions in Serbia

1 Belgrade
2 Šumadija
3 Three Morava
4 Pocerina-Valjevo
5 Mlava
6 Knjaževac
7 Negotin
8 Niš
9 Leskovac
10 Toplica
11 Vranje
12 Južni Banat
13 Potisje
14 Teleč
15 Subotica
16 Srem

Source: Drawn up by the authors

To research natural elements, wine-growing Serbia was analysed, whilst for socio-economic elements, only vineyards where grapes are produced were identified because this is the starting point for developing a wine destination.

3. Data and methodology

The socioeconomic data available are those open on social media, and the variables available for analysis are chosen. The analysis proposal helps by proposing an analysis model of areas with the most potential for developing wine tourism activities.

Based on the data collected, processed, and classified and the goals defined, e.g., the issues and the formation of models and criteria are determined. The further evaluation process is carried out in a GIS environment where (re)classified maps are obtained. The result is obtaining the final maps of possibilities for tourism development in wine-growing regions in Serbia.

The data used in this study, such as the Digital Elevation Model (DEM), Hydro-meteorological Institute, OpenStreetMaps (OSM), and CORINE Land Cover, can aid in developing wine tourism. Data related to topography (elevation, slope, relief energy, etc.) assist in determining the ideal sites for vineyard establishment. South-facing slopes, which receive the most sunlight, can produce high-quality grapes. This is one of the key factors for attracting tourists to wine tourism. Hydrographic and climatic data (rainfall and air temperature) assist in planning wine routes that align with natural conditions. By understanding these data, organizers can avoid scheduling wine routes and events during extreme temperatures, in areas with frequent and heavy rainfall, and flood-prone river zones. Due to the lack of some of the information analysed, accessibility to certain wine regions may be challenging. When the temperature is comfortable and there is no rainfall, various outdoor activities such as wine tours, biking, hiking, boating, and fishing can be planned. These activities further enrich the tourism offerings of the wine region. Information about the state of the infrastructure is a crucial element of tourism content, including the availability of accommodation and hotels, the number of restaurants, shops, medical services, recreational facilities, and vineyards in the region.

For this research, data were collected using geodata open sources, field research, literature reviews and reviewing data available from the official websites of local tourist organizations and the Tourist Organization of Serbia of the Statistical Institute of the Republic of Serbia (2019) and the Hydrometeorological Institute of Serbia (2015) and analysis of popular websites (clubs, theatres, cinemas, etc.), social media etc.:

1. Data on topography elements were obtained from the Digital Elevation Model (DEM), which includes elevation, slope, relief energy, exposition, etc.
2. Data on temperature and rainfall (for the period 1960-2010) were obtained from the Hydro-meteorological Institute of the Republic of Serbia.
3. Hydrological data were obtained from OSM, digitalization from official topographic maps of the Republic of Serbia
4. Data on land use and land cover were obtained from CORINE Land Cover (2018).
5. General and tourist infrastructure data were obtained from Open Street Maps (OSM), field research through geotagging, social media, digitalisation, etc.

The Analytical Hierarchical Process (AHP) method was used to assess tourist potential and develop tourism in the vineyard areas of Serbia. This method, developed by Thomas Saaty (1980), considers a set of criteria and alternative sub-criteria to make the best decisions. Some requirements may be antagonistic, and the best option optimizes individual criteria whilst achieving the most suitable compromise. Each criterion is assigned a specific weight, indicating greater importance. The AHP method combines criteria weightings and consistently ranks options, resulting in a weighted sum of the influences of all criteria (Saaty, 2008; Crouch and Ritchie, 2005).

4. Results

1. The data of topography elements were obtained from the Digital Elevation Model (DEM) – Grapevines are grown in a variety of environments, from high mountains to coastal areas, from hilly terrains to alluvial plains, from arid to swampy areas, from granite rocks to limestone, from conglomerate to shale and volcanic rocks (Amato and Valletta, 2017). The diverse geological base, tectonics and relief of the wine-growing area constrain the various landscape formations of wine-growing Serbia.

Vines can be grown on slopes, hills, elevations, plains and river valleys. Vines are mostly grown on hilly terrain on south-facing slopes, as shown by examples of well-known wine-growing countries (France, Italy, Germany). Grapes from such terrains have better quality due to higher radiation, weak to moderate winds and less exposure to frost.

Based on the DEM, a height model of the terrain of the wine-growing areas of Serbia was obtained. Different methods and techniques are combined with Geographic Information Systems (GIS) in ArcGIS, Global Mapper and QGIS software packages. In this group, the following elements and layers are distinguished: elevation, slope, energy of the relief and exposition (exposure of the relief to sun rays).

A) Elevation - The evaluation of the altitude was carried out based on DEM. Elevation classes were evaluated based on landscape or topographic attractiveness for a significant type of tourism (Bunruamkaew, 2012). Relatively lower terrains are rated with lower values (value 3), while higher ones have the highest value (value 9) (Bunruamkaew, 2012; Aklıbasinda and Bulut, 2014; Jovanović, 2020).

B) Relief energy - Serbia's viticultural relief has a minor vertical breakdown. According to Bognar (1986, 1990), terrains up to 40 m/km² are poorly dissected. The most significant part of the vineyard area belongs to the category of plains, broken down to 5 m/km² (Jovanović, 2020).

Relief energy is significant in traffic accessibility and routing road paths for sports and recreation (pedestrian and bicycle). The different vertical breakdowns of the terrain promote various types of tourism. Terrains with more excellent breakdowns are suitable for more extreme types of tourism and sports.

C/D) Slope and Exposition - The slope and exposure of the terrain affect the intensity of light, heat, and humidity. In the wine-growing area of Serbia, the southern, southwestern, and southeastern sides are the brightest and warmest. Favourable exposures are eastern and western, whilst northern exposures are more incredible and less illuminated. Terrains with steeper slopes are susceptible to erosion and landslides, requiring additional investments for stabilization complicating the construction of buildings and infrastructure. Areas with gentle slopes (up to 2°) have a high potential for tourism development, whilst those with pronounced slopes (above 32.1°) are rated as having low potential. Sunlight on the slope sides also affects the microclimatic characteristics of the terrain. Warm sides (S, SW, SE) have the highest value, neutral sides (E, W) have a lower value, whilst cold sides (N, NE, NW) are rated the lowest. Relief exposure is essential for determining the location of tourist and sports complexes on adjacent sides (Sener et al., 2010; Feizizadeh and Blaschke, 2013; Jovanović, 2020).

2. Temperature and rainfall data (for the period 1960-2010) – The wine-growing area of Serbia extends 456.08 km from north to south and 295.5 km from east to west. This distribution is shaped by climatic conditions, particularly solar radiation and moist air masses. The terrain configuration and the openness of the Pannonian Plain allow for the penetration of cold air masses into the valleys of Velika and Južna Morava. At the same time, the interior of the wine-growing area experiences a warm Mediterranean influence from the south, which is reflected in temperature differences. Grades are assigned based on air temperature: the lowest temperatures receive the lowest rank, while the highest temperatures are assigned the highest grades. Temperatures between 3.2 °C and 10 °C indicate wine-growing regions with low-temperature potential, while temperatures between 11.9 °C and 12.3 °C are rated as regions with high potential for wine production and tourism (Suryabhagavan et al., 2015; Republic Hydrometeorological Institute of Serbia, 2015; Jovanović, 2020). Climatic characteristics of wine-growing Serbia are analysed based on multi-year data from meteorological stations. The most significant number of wine-growing regions is in the moderate-continental climate zone, while a smaller number can be found in the continental climate region (Feizizadeh and Blaschke, 2013; Suryabhagavan et al., 2015; Aklıbasinda and Bulut, 2014; Republic Hydrometeorological Institute of Serbia, 2015; Jovanović, 2020).

3. Hydrological data were collected from OSM, and digitalization was carried out according to Serbia's official topographic maps. In addition to the pedological cover and climatic conditions, hydrological characteristics are crucial for developing vines. Wine-growing areas with lower slopes and stable groundwater levels have a constant water supply, while additional investments are needed in areas with steeper slopes and lower groundwater levels. Springs, thermal springs, and mineral springs, characterized by abundance, solubility of mineral substances, and temperature, are essential in wine-growing areas. They provide a solid foundation for developing spa tourism, wellness centres, and hotels. The evaluation of rivers and lakes in the wine-growing regions of Serbia was based on distance zones from these bodies of water. Zones closest to rivers have distinct tourism potential, while more distant areas are rated moderate, and 5 km is considered less critical (Dashti et al., 2013; Jovanović, 2020).

4. Land use and land cover data - based on the works (Wanyonyi et al., 2016; Bunruamkaew, 2012), and to evaluate wine-growing Serbia, land use classes representing natural and semi-natural areas were determined. In the latter, the purpose of land use is the least modified, not so much disturbed and is of paramount importance in preserving the natural landscape of wine-growing Serbia. Such terrains have the most significant potential because they show the preservation (or partial preservation) of certain landscapes concerning terrains that have been changed and turned into artificial surfaces by man. Artificial creations, as such, have the lowest potential where the natural landscape has been changed a lot. Cultivated areas were graded with a transitional grade between natural and artificial areas. Water surfaces were not considered to evaluate land use, so they were treated as an elimination category (Sener et al., 2010; Feizizadeh and Blaschke, 2014; Jovanović, 2020).

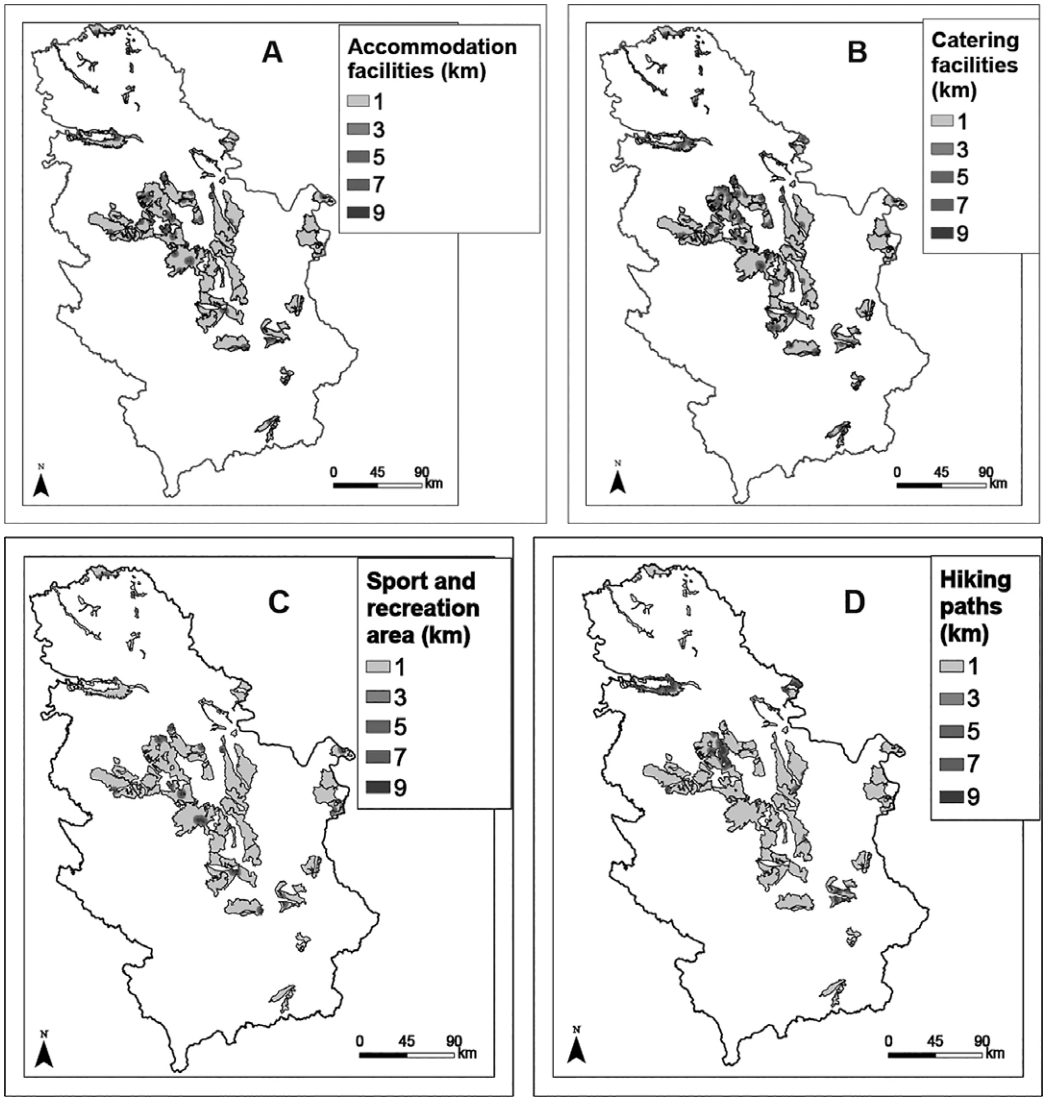
5. General and tourist infrastructure data - The general infrastructure includes equipping the tourist area with systems for adequate destination maintenance: traffic connection, water supply, wastewater removal, electrical and telecommunication networks, various food service systems, healthcare, etc. Concerning the general infrastructure, tourist infrastructure allows tourists a comfortable tour and a pleasant destination experience. Tourist attractions are elements of the natural and social environment that attract and motivate tourists to visit specific destinations. Tourist attractions play an essential role in forming tourist destinations, constituting a key motivation for visitors (Leask, 2010).

These data are divided into several subcategories:

A) Traffic accessibility data - The development of the transport system plays a crucial role in the country's economic activity. Improving the traffic network increases the attractiveness of tourist destinations, enhances the population's and tourists' mobility, and improves the quality of services. On the other hand, an insufficiently developed transport network can negatively impact tourist traffic and destinations (Figure 2). Good traffic connections enable better accessibility for tourists, especially when attractions are near the destination. Well-connected facilities and sites increase the value of destinations. Transport is a key prerequisite for tourism development, and it connects tourists to their destinations (Toth and Lorant, 2010). Transport is an essential part of tourist travel, and it enhances the achievement of recreational goals. Cutting travel costs and distances increases the travel demand (Halsall, 1992). Parameters such as the density of road and railway networks, categorized roads, airports, and river ports were used to evaluate the accessibility of wine-growing areas.

B) Data on essential places - evaluating the elements of the tourist infrastructure in certain wine-growing areas of Serbia was carried out based on zoning. All service facilities (buildings, museums, archaeological sites, accommodations, catering facilities for food and drinks, medical care, pharmacy, pumps, parking areas, banks, etc.) were evaluated based on moving away from the city centre towards the periphery to the wine-growing regions, where the zone rating decreases. The points located in the immediate centre, at a distance of up to 1 km, have the highest value (9) and vice versa (the most distant zone (5 km) was evaluated with the lowest score, 1). In the same way (by zoning), other elements of tourist infrastructure were evaluated: sports facilities and areas for recreation and entertainment, as well as pedestrian and bicycle paths (Figure 2).

Figure 2
Cartographic representation of tourist infrastructure data:



Source: Drawn up by the authors

C) Data on protected natural zones were obtained from the digitization of official topographic maps and maps of protected areas of the Republic of Serbia. The criterion for valorising natural tourist attractions is based on the Law on Nature Protection of the Republic of Serbia. Based on the Law on Nature Protection and Satie's scale, several categories of valuation of protected areas have been distinguished, where the highest value has national parks, which are in the category of the most protected areas, and the lowest rated natural monuments (national park, an area of exceptional quality, nature park, reserve and special nature reserve, protected plant species and parks as nature monuments).

D) Wine event data- Wine events have become popular in many regions and represent a unique combination of wine, special events and tourism activities, further influencing tourism and wine regions (Salter, 1998; Yuan et al., 2005). Wine events attract visitors and allow wineries and wine regions to promote the (tourism) product and destination (Houghton, 2001; Getz, 2000; Hoffman et al., 2001).

The ranking of wine events in Serbia is most authoritatively based on the number of visitors, although no detailed research has been conducted. According to Stanković (2000), events are categorized as local, regional, continental, national, and global. Based on this classification and the events identified at www.manifestacije.com, 31 wine events in certain wine-growing regions of Serbia have been classified.

A unique element in the evaluation of wine tourism destinations is the assessment of the landscape. Aesthetic assessment encompasses the observer's reflection on objects across different spatial and aesthetic dimensions (Feng et al. 2010). Aesthetic value can influence the experience of the destination and its ethical and economic value. An unattractive part of the landscape can create discomfort for tourists.

In the evaluation of visibility, there are three categories: high (over 10), medium (6–9), and low (1–5) visibility value. The highest value is rated at 9 points, the medium at 7, and the lowest at 5 (Bunruamkaew and Murayama, 2011; Suryabhagavan et al., 2015; Rizzo et al., 2015; Jovanović, 2020).

5. Discussion

Based on the "Programme for the Development of Viticulture and Winemaking of the Republic of Serbia for the Period 2021–2031," Serbian wines lack a solid strategy and definition for (national) marketing and promotion, as well as the absence of professional organizations for managing marketing efforts. One of the significant challenges is the lack of financial resources and poor planning. Only Belgrade affords a firm offer, providing a foundation for the growth of wine tourism in nearby subregions.

A significant issue in Serbia is the import of cheap, lower-quality wines from North Macedonia. The vineyard areas are scattered, affecting production costs, and no educational centres provide knowledge to grape growers and winemakers about modern trends. Moreover, inadequate accommodation options (such as wine hotels and resorts) for wine tourists should be located within wine regions (Programme for the Development of Viticulture and Winemaking of the Republic of Serbia for the Period 2021–2031).

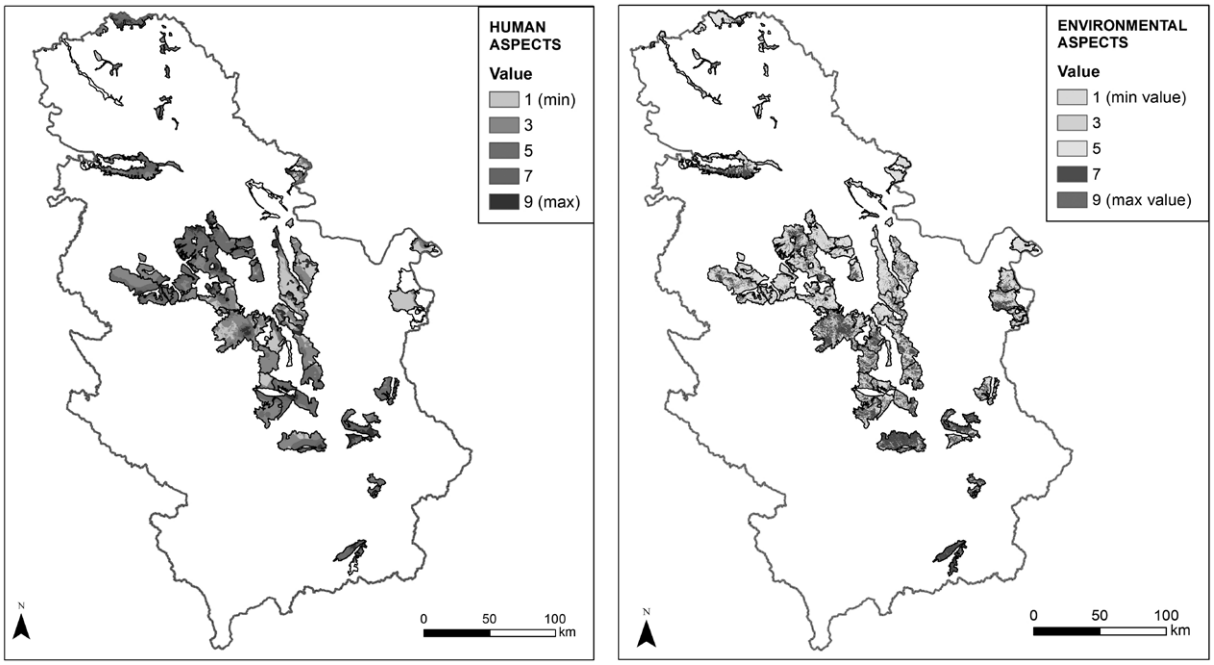
Compared to neighbouring countries with a tradition in wine tourism, such as Croatia and Slovenia, it can be concluded that Serbia does not have as popular wines, even though it possesses known and unique grape varieties (Prokupac and Tamjanika). These countries have developed networks of wine routes, wine events (festivals), and luxury wine resorts, especially near the coast, such as Istria and Dalmatia.

6. Conclusion

Open data has great potential for enhancing innovation and managing tourism destinations alongside existing examples of good practice. However, at this point, there are no well-defined methodologies or functions for success, necessitating further research. Serbia boasts unique varieties of grapes and wines, favourable geographical conditions, good relief features, diverse flora and fauna, gastronomy, and a rich cultural and historical heritage. The development of viticulture in Serbia has a long tradition. This paper illustrates the role of open and big data in tourism by evaluating and developing tourism destinations based on available potential (attractions), workforce, location, infrastructure, places of public importance, institutions, and cultural facilities, identifying environments with the most excellent prospects for development.

Open data can significantly enhance the innovation and management of tourism destinations, with existing examples of good practice; however, clearly defined methodologies are lacking, which requires further research. This paper presents the role of open data in evaluating and developing tourism destinations based on available potential, workforce, infrastructure, and cultural facilities, identifying environments with the highest prospects for development.

Figure 3
Final maps of the assessment of vineyard areas for developing tourism in Serbia



Source: Drawn up by the authors

The assessment of potential was made based on Satie's scale, which was adapted for the needs of this research. The range of values is from 1 (minimum value) to 9 (maximum value) to evaluate the tourist potential of the wine-growing area of Serbia. On both final maps (the human map and the natural map), the most significant tourist potential is achieved by wine-growing regions: Subotica (number from Figure 1. - 15), Fruška gora (16), parts of the Belgrade region (1), Niša (8). Natural potentials for the development of tourism stand out in the wine-growing areas of southern Serbia: Vranje (11), Leskovac (9) and Toplica (10).

After analysing the wine area of Serbia, we need to develop a market-oriented commercial strategy for tourism in wine-growing regions, including wineries, the local population, and all entities that can contribute to creating an offer that meets tourists' expectations.

Open data as a source of innovation in wine destinations represents a significant advancement through establishing national open data on tourism, covering topics such as culture, accommodation, tourist costs, and events. Open data would enable the development of APIs to collect information on tourism capacity, arrivals, and thematic information available to tourists.

Tourist organizations and local tourism should provide information on user-friendly websites, including GPS coordinates and operating hours. The availability of open data can lead to innovative tourism services and mobile applications, which are crucial for managing wine destinations. Wineries with non-operational hours often fail to attract enough visitors, and the share of tourism revenue in their total income is low.

The future of technology and the use of open data involves creating applications, namely digital assistants, that help tourists explore areas and obtain real-time information. Open data on weather conditions and geolocation may have limitations affecting long-term wine tourism predictions. In contrast, a lack of updated statistical data reduces the study's comprehensiveness. Research results can contribute to the recognition of Serbia's wine regions, enhance the tourism offer, and enable informed decision-making about the development of

wine tourism. Future research could focus on analysing the role of digital technologies and social media in promoting wine tourism to improve the visibility of wine destinations.

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