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Natural heritage analytical study of old beech forests and primeval beech forests as a potential for nature tourism sustainable development

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Abstract

Natural and cultural wealth in the tourism market plays a significant role in tourism development ideally in a sustainable way. The papers´ research evaluates the potential of old beech forests and primeval beech forests in Europe as targets for possible future nature tourism, emphasizing their ecological, aesthetic, and cultural significance. The analysis, which utilizes a combination of qualitative and quantitative methods including the Shapiro-Wilk normality test, Mann-Whitney test, Kruskal-Wallis test, and Spearman correlation coefficient processed through Gretl software, highlights the significant role these forests play in biodiversity conservation, climate regulation, and sustainable development in the context of the area of the country, where they are located. These forests, rated as premium destinations for nature tourism or ecotourism, should be integrated into broader tourism strategies. Their preservation and proper utilization can significantly contribute to the development of the local economy while also providing educational and recreational opportunities for residents and tourists.

Keywords: Beech forest, Biodiversity conservation, Natural potential, Sustainable development, UNESCO heritage list

1. Introduction

The European beech forests are distinctive in their richness of species and unsurpassed in their ecological beauty. The naturalness and originality of these environments and their ecosystems create the opportunity for the conservation of many species of plants and animals including a number of endemic and endangered species. Beech forests contain various ecosystems that have great biological diversity and complex relationships between individual organisms. They have developed in the absence of major human impact, which facilitates continuous development and the formation of diverse biotopes. These forests bear witness to the long ripening and uninterrupted succession of ecosystems on the European continent. Possessing uniqueness, a number of them have been included in the List of World Heritage Sites, since their nature is globally significant and needs to be preserved. This marvelous natural potential is important, especially with regard to the development of eco and nature tourism and the formulation of sustainable tourism development strategies.

1.1. Literature review

A term used to emphasize their importance, recognition of UNESCO World Heritage entails the prioritization of the protection and preservation of regions regarded as fundamental to human history and culture [1]. These areas possess unique universal values that can only be appreciated by the current and future generations. Such areas are not only recorded but are also preserved to protect their unique values. Particularly, they are also key sources of considerable biodiversity and ecosystem diversity, and they are the habitats of many species of plants and animals that are peculiar to the region, which are often in abundance [2]. The natural heritage as envisaged by world-followed organizations of culture and nature possesses extraordinary significance including landscapes of great natural beauty [3], [4]. Of course, such original places do not only have aesthetically irresistible sceneries or unique features, but they also have very significant attributes in terms of the biosphere's ecological systems [5]. The Intergovernmental Conference on the Preservation of Cultural and Natural Heritage takes into account the economic development of communities all the while supporting their environment's integrity [6]. The goal is to instill positive behavioral changes from active tourism practices while enhancing and safeguarding local environments and communities [7]. Diversity in the environment in the sense of wildlife preservation is one of the important aspects of social and economic development and ensures life in different forms. This includes the need to preserve not only individual species but also the natural systems and processes that maintain life [8]. There is a need to mention the benefits in terms of conservation of mountain beech stands as such forests not only help conserve biodiversity but also help in conserving soils and waters, regulating climate, and in carbon sequestration as well [9]. These forests are capable of rendering crucial ecosystem services that are vital for the life and well-being of people all over the world [10]. With the impacts of climate change and human pressure on resources increasing, mountain beech forests are likely to be strategic in helping prevent such impacts [11]. Their role in carbon capture, water cycle management, and the sustenance of a biological pool makes them indispensable in the global overarching goal of climate and biodiversity preservation [12].

As far as the management of beech ecosystems in the European beech forest, the scope is extended to explore their ecosystem's function, their significance in the conservation of biodiversity, and their use for commercial nature tourism [13]. Beech trees are an important component of temperate forests that possess an ecotourism potential because they are suited to the experience of nature with education and conservation in focus [14]. It is also argued by some that the establishment of ecotourism in the region can aid local economic development, job opportunities, and increased recognition of the importance of nature conservation [15]. It is desirable however that such development should be done in such a way as to uphold sustained tourism in order not to affect the ecological balance and the diversity of the forests. Such projects should be planned in a manner in which local communities are engaged and not exploited and where cultural heritage and customs are maintained [16]. The extending of nature tourism to the beech forests enables tourists to encounter beautiful natural areas that would otherwise be unavailable while enabling their conservation [17]. Ecotourism, which emphasizes the proper management of physical resources, can greatly enhance the economic well-being of residents, raise environmental awareness, and assist in the conservation of natural resources [18]. There is a twofold requirement for the formation of tourism to be truly ecological, but also to act as an economic asset [7]. This entails the execution of well-targeted integrated management measures that encompass effective capacity, education for users, and sustainable development measures [19]. There is a need for synergy among conservationists, the local populace, private operators in the tourism industry, and state bodies to sustain beech forest ecosystems and their tourism potential [20].

The development of nature tourism in beech forests can be shown in these examples from different European countries. From the forests of Slovakia to the hallowed beech groves in Germany, ecotourism opportunities abound, including hiking trails and programs designed to teach about nature and its preservation. The use of technology like virtual tours can expand outreach even further whilst causing the least physical intrusion to sensitive environments [21], [22], [23] [24]. Pitching ecotourism around beech forests using UNESCO projects

enables tourists to experience the wonders of nature and still engage in responsible tourism [25], [26]. They bring attention to the need for conservation as well as to nature through experiencing something different [15].

2. Research method

The World Heritage Convention is among the best and most successful international instruments for recognizing the most unique natural sites in the world, characterized by exceptional biodiversity, ecosystems, geology, and even amazing natural phenomena. In addition to its primary role, it carries with it a unique potential for identifying places where it is possible to develop efforts for eco-friendly or even sustainable tourism in the future. Their exceptionality predisposes them to special attractiveness and therefore they become the destination of the participants of the tourism industry. For a closer identification of the potential on a natural basis in terms of their further use, selected questions were set within the research, namely:

R.Q.1: What is the current state of beech forests in Europe?
R.Q.2: Are there any differences in the registration of beech forests in the UNESCO heritage?
R.Q.3: Does the area of the country have any connection with the area of old beech forests and beech forests of the Carpathians and other regions?

Based on the above-mentioned there was an aim to fulfil the following research aim:

To analytically evaluate the natural potential of beech forests using the example of old beech forests and beech forests of the Carpathians and other regions of Europe.

Subsequently, the sub-aims were stated:

- define the share of World Natural Heritage on total UNESCO World Heritage,
- list the countries with the potential of old beech forests and primeval beech forests of the Carpathians and other regions of Europe,
- identify the number of locations in each country,
- calculate the share of old beech forests and primeval beech forests of the Carpathians and other regions of Europe on the total area of the country.

Based on the mentioned aim the hypothesis was stated:

H1: There is an assumption that there is a statistically significant relationship between the area of the country and the area of old beech forests and beech forests of the Carpathians and other regions of Europe.

2.1. Methods and methodology

The main method used was the method of scientific abstraction. This was used to identify the potential of UNESCO World Heritage, with an appeal to UNESCO Natural Heritage on the example of beech forests. The analysis of UNESCO natural monuments in the countries of the European Union was carried out using information from documents of the UNESCO organization from the World Natural Heritage section. Specifically, it was about the documents of the UNESCO Natural World Heritage List and STATISTA - Number of monuments on the UNESCO World Heritage List as of 2021; STATISTICS - Number of the UNESCO World Heritage sites per region. Subsequently, the processing of the chronological process of registration of the old beech forests and beech forests of the Carpathians and other regions of Europe took place using the necessary data from the UNESCO World Heritage List, https://whc.unesco.org/en/list/?type=natural; more precisely, from the documents of the UNESCO World Natural Heritage List (section Old Beech Forests and Beech Primeval Forests of the Carpathians and Other Regions of Europe).

Subsequently, the analysis of secondary data took place. It served to synthesize the chronological process of recording the old beech forests and beech forests of the Carpathians and other regions of Europe. Subsequently, mathematical and statistical methods were used to process the numerical analysis of old beech forests and beech forests of the Carpathians and other regions of Europe in individual states. The share of the area of old beech

forests and beech forests in the total area of the countries where they are located was determined using the statistical program Gretl, which was used for the subsequent statistical evaluation of secondary data. The verification of the hypotheses and the drawing of the results of the analysis were the result of testing the normality of the selected variable, using the necessary correlation coefficient, and then presenting the results and drawing the conclusions. Methodological steps are shown in Figure 1.

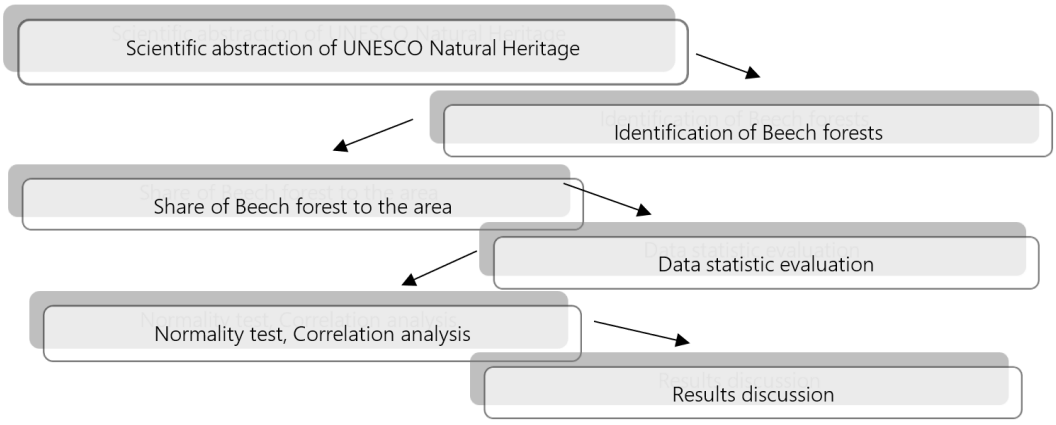

Figure 1. Methodology steps

3. Results and discussion

By December 31st, it was entered on the World Heritage List with 1154 unique sites, which the World Heritage Committee has decided to have unique world value. Specifically, there are 897 cultural monuments, 218 natural monuments, and 39 mixed sites in 167 countries of the world, according to the UNESCO World Heritage Center on its official website (www.whc.unesco.org 2021).

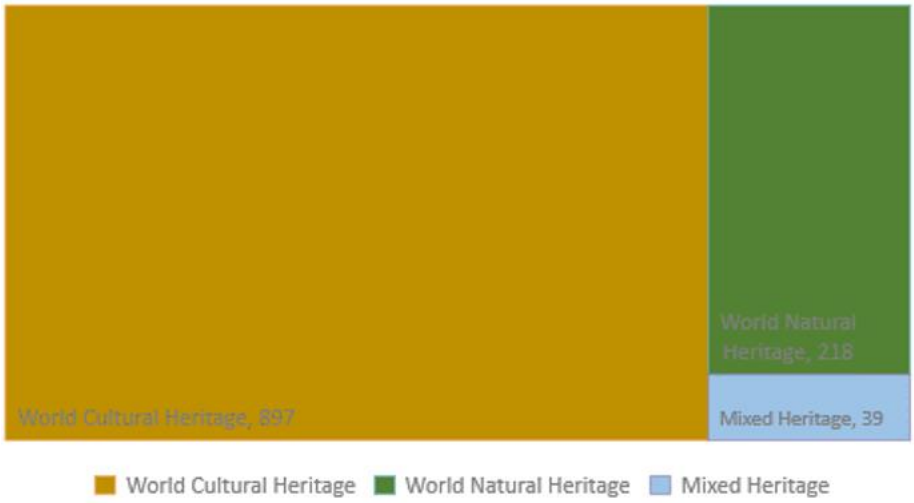

Figure 2. Share of UNESCO World Heritage types

Figure 2 shows the current state of the UNESCO World Cultural, Natural, and Mixed Heritage according to STATISTA - Number of monuments on the UNESCO World Heritage list as of 2021. It is clear from the chart that a significant number of monuments represent cultural world heritage. 218 sites make up the UNESCO natural heritage. The mixed world heritage is only 39 sites.

Figure 3 shows the status of UNESCO World Heritage in the world and regions. Based on statistical processing [27], Europe has up to 503 sites of UNESCO world natural, cultural, and mixed heritage. Europe represents the largest amount of UNESCO World Heritage in the world. In 2nd place with the largest number of world heritage sites is the Asia-Pacific region (so-called ASAP), which contains 277 UNESCO sites. Latin America, together

with the Caribbean, has 146 UNESCO sites on its territory, which represents the 3rd place with the largest number of UNESCO World Heritage Sites. Africa has 98 sites, the Arabic States have 88 sites, and in last place is the North American region, with 42 UNESCO World Heritage sites.

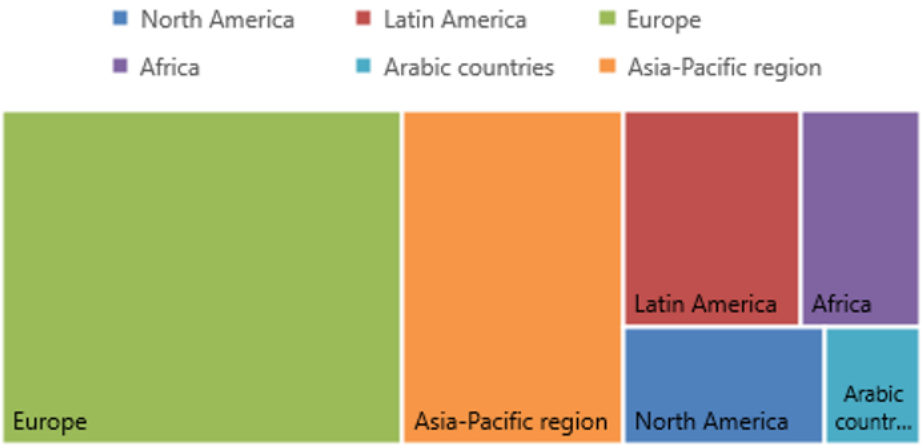

Figure 3. Distribution of UNESCO World Heritage potential according to the world regions

Special attention was paid to old beech forests and primeval beech forests of the Carpathians and other regions of Europe. Transnational property includes 93 parts in 18 countries (Albania, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czechia, France, Germany, Italy, North Macedonia, Poland, Romania, Slovakia, Slovenia, Spain, Switzerland, and Ukraine). More detailed information about this UNESCO natural monument is shown in Table 1.

Table 1. Old beech forests and primeval beech forests of the Carpathians and other regions of Europe

European country	Natural heritage UNESCO	Area (ha)	Year of registration	Expansion
Albania Austria Belgium Bosnia and Herzegovina Bulgaria Croatia Czech Republic France Germany Italy North Macedonia Poland Romania Slovakia Slovenia Spain Switzerland Ukraine	Old beech forests and primeval beech forests of the Carpathians and other region of Europe	98 124 98	2007	2017 2011 2021

Source: own processing according to the UNESCO https://whc.unesco.org/en/list/?type=natural

As many as 18 countries in Europe together have old beech forests and the Carpathian beech forests on the UNESCO World Heritage List. The given natural potential has a total area of 98,124.96 ha. It has been on the list since 2007. Later, this territory was expanded in 2011, 2017, and most recently in 2021. In 2023 there were made minor boundary modifications.

Table 2. Description of the history of the registration of old beech forests and beech forests of the Carpathians and other regions of Europe

Phase	Year	Name	Description	Number of locations in the country
Registration	2007	Carpathian beech primeval forests	initial bilateral Slovakia-Ukraine nomination	Slovakia: 4 Ukraine: 6
Expansion	2011	Carpathian beech primeval forests and old beech forests of Germany	trilateral Slovakia-Ukraine-German site	Germany: 5
Expansion	2017	Old beech forests the Carpathian primeval forests and other regions of Europe	multilateral location	Albania: 2 Austria: 5 Belgium: 5 Bulgaria: 9 Croatia: 3 Poland: 4 Romania: 12 Slovenia: 2 Spain: 6 Italy: 10 Ukraine: 9
Expansion	2021	Old beech forests and beech primeval forests in the Carpathians and other regions of Europe	new cross-border nomination	Bosnia and Herzegovina: 1 Czech Republic: 1 France: 10 Italy: 5 Montenegro: 2 North Macedonia: 1 Poland: 4 Serbia: 5 Slovakia: 6 Switzerland: 2
		Total		119 in total and 91 in EU

Source: own processing according to UNESCO (https://whc.unesco.org/en/list/?type=natural)

In the framework of natural heritage registration, for example, old beech forests and primeval forests, two years are crucial. In 2007, the extent of beech forests and primeval forests was identified in most countries. Subsequently, in 2011, 2017, and 2021 there was an expansion of many areas and an increase in the area of identified beech forests and primeval forests. The chronological procedure together with the total number of locations in individual countries, is shown in Table 2.

In connection with the geological development of the given countries on the territory of Europe, it is obvious that the lowlands occupy up to half of the area of Europe, which explains and brings many natural monuments, including old beech forests and primeval beech forests of the Carpathians and other regions of Europe. This fact brings meaning and perspective to the development of natural tourism, which can also lead to the preservation of the environment.

Figure 4. Old beech forests and beech primeval forests of the Carpathians and other regions of Europe; Source: Authors

To closely describe the size of the potential of the old beech forests and primeval beech forests, a calculation of the share of the size of the territory of the natural heritage of this kind in the size of the country was carried out. The numerator represented the size of the area of old beech forests and primeval beech forests of the Carpathians and other regions of Europe, and the denominator was the area of the EU countries where there are beech forests and primeval beech forests on the UNESCO World Natural Heritage List reflected using Formula 1 (Calculation of the share of old beech forests and primeval beech forests in the area of the country):

$$X = \frac{area\ of\ Old\ beech\ forests\ and\ primeval\ beech\ forests}{area\ of\ the\ country}$$

Belgium

$$X = \frac{area\ of\ Old\ beech\ forests\ and\ primeval\ forests}{area\ of\ the\ country} = \frac{2{,}6931}{30689}$$

$$\mathbf{Y = X * 10000km^2 = 0,8775\ SBLAP\ on\ 10\ 000km^2}$$

In Belgium the share of old beech forests and primeval beech forests on 10 000 km^2 is 0,8775 km^2.

Bulgaria

$$X = \frac{area\ of\ Old\ beech\ forests\ and\ primeval\ forests}{area\ of\ the\ country} = \frac{109{,}8891}{110994}$$

$$\mathbf{Y = X * 10000km^2 = 9,9005\ SBLAP\ on\ 10\ 000km^2}$$

In Bulgaria the share of old beech forests and primeval beech forests on 10 000 km2 is 9,9005 km^2.

Czech Republic

$$X = \frac{area\ of\ Old\ beech\ forests\ and\ primeval\ forests}{area\ of\ the\ country} = \frac{4{,}4481}{78871}$$

$$\mathbf{Y = X * 10000km^2 = 0,5640\ SBLAP\ on\ 10\ 000km^2}$$

In the Czech Republic, the share of old beech forests and primeval beech forests on 10,000 km2 is 0,5640 km^2.

Croatia

$$X = \frac{area\ of\ Old\ beech\ forests\ and\ primeval\ forests}{area\ of\ the\ country} = \frac{44{,}1067}{56594}$$

$$\mathbf{Y = X * 10000km^2 = 7{,}7935\ SBLAP\ on\ 10\ 000km^2}$$

In Croatia the share of old beech forests and primeval beech forests on 10 000 km2 is 7,7935 km^2.

France

$$X = \frac{area\ of\ Old\ beech\ forests\ and\ primeval\ forests}{area\ of\ the\ country} = \frac{25{,}2888}{543940}$$

$$\mathbf{Y = X * 10000km^2 = 0{,}4649\ SBLAP\ on\ 10\ 000km^2}$$

In France the share of old beech forests and primeval beech forests on 10 000 km2 is 0,4649 km^2.

Germany

$$X = \frac{area\ of\ Old\ beech\ forests\ and\ primeval\ forests}{area\ of\ the\ country} = \frac{43{,}9120}{357588}$$

$$\mathbf{Y = X * 10000km^2 = 1{,}2280\ SBLAP\ on\ 10\ 000km^2}$$

In Germany the share of old beech forests and primeval beech forests on 10,000 km2 is 1,2280 km^2.

Poland

$$X = \frac{area\ of\ Old\ beech\ forests\ and\ primeval\ forests}{area\ of\ the\ country} = \frac{34{,}7174}{312679}$$

$$\mathbf{Y = X * 10000km^2 = 1{,}1103\ SBLAP\ on\ 10\ 000km^2}$$

In Poland the share of old beech forests and primeval beech forests on 10 000 km2 is 1,1103 km^2.

Austria

$$X = \frac{area\ of\ Old\ beech\ forests\ and\ primeval\ forests}{area\ of\ the\ country} = \frac{71{,}1911}{83879}$$

$$\mathbf{Y = X * 10000km^2 = 8{,}4874\ SBLAP\ on\ 10\ 000km^2}$$

In Austria the share of old beech forests and primeval beech forests on 10 000 km2 is 8,4874 km^2.

Romania

$$X = \frac{area\ of\ Old\ beech\ forests\ and\ primeval\ forests}{area\ of\ the\ country} = \frac{239{,}8277}{238397}$$

$$\mathbf{Y = X * 10000km^2 = 10{,}0600\ SBLAP\ on\ 10\ 000km^2}$$

In Romania the share of old beech forests and primeval beech forests on 10 000 km2 is 10,0600 km^2.

Slovakia

$$X = \frac{area\ of\ Old\ beech\ forests\ and\ primeval\ forests}{area\ of\ the\ country} = \frac{42{,}8301}{49034}$$

$$\mathbf{Y = X * 10000km^2 = 8{,}7348\ SBLAP\ on\ 10\ 000km^2}$$

In Slovakia the share of old beech forests and primeval beech forests on 10 000 km2 is 8,7348 km^2.

Slovenia

$$X = \frac{area\ of\ Old\ beech\ forests\ and\ primeval\ forests}{area\ of\ the\ country} = \frac{7{,}9474}{20271}$$

$$\mathbf{Y = X * 10000km^2 = 3{,}9206\ SBLAP\ on\ 10\ 000km^2}$$

In Slovenia the share of old beech forests and primeval beech forests on 10 000 km2 is $3{,}9206\ \text{km}^2$.

Spain

$$X = \frac{area\ of\ Old\ beech\ forests\ and\ primeval\ forests}{area\ of\ the\ country} = \frac{8{,}8856}{505990}$$

$$\mathbf{Y = X * 10000km^2 = 0{,}1756\ SBLAP\ on\ 10\ 000km^2}$$

In Spain the share of old beech forests and primeval beech forests on 10 000 km2 is $0{,}1756\ \text{km}^2$.

Italy

$$X = \frac{area\ of\ Old\ beech\ forests\ and\ primeval\ forests}{area\ of\ the\ country} = \frac{36{,}6524}{301340}$$

$$\mathbf{Y = X * 10000km^2 = 1{,}2163\ SBLAP\ na\ 10\ 000km^2}$$

In Italy the share of old beech forests and primeval beech forests on 10 000 km2 is $0{,}2163\ \text{km}^2$.

Romania has the largest number of old beech forests and primeval beech forests with an area of 10.0600 km2 per 10,000 km2. In 2nd place is Bulgaria with an area of 9.9005 km2 of beech forests and primeval beech forests per 10,000 km2 and 3rd place belongs to Slovakia with an area of 8.7348 km2 of old beech forests and primeval forests per 10,000 km2. Spain ranked last with an area of old beech forests and primeval beech forests of 0.1756 km2 per 10,000 km2.

H1: There is an assumption that there is a statistically significant relationship between the area of the country and the area of old beech forests and beech forests of the Carpathians and other regions of Europe in the given country.

Normality testing:

1. Test for normality of land area:

Doornik-Hansen test = 3.88627, with p-value 0.14325
Shapiro-Wilk W = 0.867008, with p-value 0.0477099
Lilliefors test = 0.238634, with p-value ~= 0.04
Jarque-Bera test = 1.41344, with p-value 0.493259
Result: Since for land area p-value = 0.1433, which is more than the significance level □=0.05, we can conclude that the land area variable has a normal distribution.

2. Test for normality of area of old beech forests and beech forests of the Carpathians and other regions of Europe:

Doornik-Hansen test = 15.0641, with p-value 0.000535644
Shapiro-Wilk W = 0.70581, with p-value 0.000634747
Lilliefors test = 0.316688, with p-value ~= 0
Jarque-Bera test = 18.4546, with p-value 9.83192e-05
Result: Since for land area the p-value = 0.0010, which is less than the significance level □=0.05, we can conclude that the land area variable does not have a normal distribution.

Use of coefficient:

Spearman's correlation coefficient:
corr(Landscape areakmA, Forest areakmA) = -0.01969240
Under the null hypothesis of no correlation: t(11) = -0.065325, with two-tailed p-value 0.9491 H0: p=0 H1: p≠0
Coefficient size: -0.01969240, p-value=0.9491

Spearman's correlation coefficient is r = -0.0197. The associated p-value is 0.949, which is more than the significance level α=0.05. Pearson's correlation coefficient is not statistically significant. The hypothesis cannot be rejected. It can therefore be said that there is no statistically significant connection between the area of the country and the area of old beech forests and beech forests of the Carpathians and other regions of Europe in the given country.

The study highlights the unique territorial significance of old beech forests and primeval beech forests in Europe. These forests, characterized by high biodiversity and complex ecosystems, provide key services such as climate regulation, carbon sequestration, and habitat for numerous species. The research findings confirm the strong territorial potential of these forests which can support sustainable nature tourism, which can contribute to environmental protection and local economic development. The analysis showed that the significant area of these forests can serve as nature tourism destinations given their size relative to the size of the country. Moreover, the integration of these beech forests into broader tourism strategies is essential for promoting sustainable development, hand in hand with respecting extensive measures related to the protection of their potential. By leveraging their natural and cultural heritage, regions can attract more visitors, increase awareness of environmental issues, and support economic growth. The use of modern technologies, such as virtual tours, can enhance visitor experiences while minimizing physical impacts on fragile ecosystems.

The confirmation of beech forests use in tourism product creation can be seen in several countries. For instance, Germany, specifically the Hainich region in Thuringia, already incorporates its beech forests as part of its tourism offerings. Hainich National Park, a UNESCO World Heritage Site, provides visitors with opportunities for nature exploration along treetop walkways, thereby supporting ecotourism [28]. Other countries, such as Romania and Ukraine, also prioritize the protection of beech forests while promoting tourism activities that help raise awareness and appreciation of the need to protect these unique natural areas [29]. These examples demonstrate that in many European countries, beech forests are used for tourism in various environmentally friendly ways [30]. Tourists have the opportunity to experience unique ecosystems, including ancient beech forests and associated biodiversity, within the context of a sustainable approach to tourism that emphasizes hiking, educational nature conservation trips, and similar activities [31]. From the above examples, it can be assessed that this potential is usable for the development of tourism it and the creation of products in the form of services, despite its high level of protection. This also provides an opportunity for the Slovak Republic as a country to use this special natural potential for the development of nature tourism, bringing economic value while not disrupting the ecological value of the area.

4. Conclusions

Based on the mentioned facts regarding the area of the old beech forests and primeval forests, a high territorial potential for possible benefits in the framework of nature tourism with a focus on nature tourism in the European Union can be stated, regarding the old beech forests and the beech primeval forests of the Carpathians and other regions of Europe. The field of nature tourism would ensure the preservation of the natural environment on the territory of Europe - the European Union. However, the successful implementation of nature tourism development strategies requires careful planning and cooperation among conservation organizations, local communities, the tourism sector, and government agencies. Ensuring the fair distribution of tourism benefits and respecting local traditions and cultures are key to achieving long-term sustainability. Overall, this study underscores the importance of protecting and sustainably utilizing old beech forests and primeval beech forests. By preserving their ecological and cultural values, we can also harness their potential to support sustainable tourism and economic development in Europe.

Declaration of competing interest

The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper.

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Author contribution

The contribution to the paper is as follows: study conception and design: D. Matušíková, T. Dzurov Vargová, M. Švedová; data collection: M. Švedová, D. Matušíková, T. Dzurov Vargová; analysis and interpretation of results: D. Matušíková, T. Dzurov Vargová, M. Švedová; draft preparation: D. Matušíková, T. Dzurov Vargová, M. Švedová, M. Lukáč; finalization: T. Dzurov Vargová, D. Matušíková, J. Ganobčík. All authors approved the final version of the manuscript.

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