Research Article

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# The significance of karst areas in European national parks and geoparks

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**Abstract:** Karst terrains have varied abiotic and biotic values. However, due to their unfavourable conditions for human settling, they are relatively sparsely populated areas. Thus, karst terrains merit and are suitable for nature protection. In this paper, partly or mostly karstic European national parks (NP) and geoparks (GP) are studied. We compiled a dataset based on official information and internet sources, and analysed NPs and GPs by location, morphology and timeline. Nowadays, there are 106 partly or mostly karstic NPs in Europe, that means 23% of all NPs. Many of the karst terrains became protected before the terms of geotourism and geopark came into being. 49% of all GPs contain karst terrains, which means that karsts are key issues in the study of geoheritage and geotourism. Tourism into karstic NPs and GPs can be considered sensu lato geotourism, since tourists travelling to these locations generally visit caves, gorges, travertine lakes and other karst features. Adventure tourism is also significant in karstic NPs and GPs. The most popular NPs host several millions of visitors a year, that implies economic benefits, but also poses environmental problems, thus certain parks already reached their carrying capacity, while other parks plan to increase their visitor numbers.

**Keywords:** geotourism, geoheritage, show cave, gorge, canyon, visitor number

## 1 Introduction

Karst terrains form a significant part of European land. According to recent map-based estimations, 21.6% of European land surface is characterized by carbonate rocks [1]. While karst terrains generally have spectacular surface morphological features, exciting caves and other geological values, they are rather unfavourable for traditional agriculture and settling [2]. In our previous research [3–5], we studied the effects of karst settings on certain social features using the case examples of Montenegro, Aggtelek Karst, Slovak Karst and Apuseni Mountains. We found that due to their morphological, hydrological, pedological and ecological features, karst landscapes are often underdeveloped areas from a social-economic viewpoint, except their tourism potential. In other words, karstlands are frequently characterized by low population density, natural decrease and emigration [6, 7]. However, besides the above disadvantages, karst terrains are often key areas for water resources [8] and geotourism [9–11]. Limestone itself is also an important resource for construction industry, and quarrying has always been present on most karst areas. Quarries are on the one hand wounds in the landscape, but at the same time they explore the rock layers or the hidden caves, help geological research and work as "geoattractors" [12]. As for geotourism, the special features and sights of karsts (caves and landforms) provide a solid basis. According to [9], show caves are presently the most important geotouristic targets all over the world and they represent an important economic resource for many of the still developing countries. The documented start of karst geotourism goes back to as early as 1633, when tourists already had to pay for the entrance into Vilenica Cave (Slovenia, [13]). By now, due to the worldwide boom in nature-based tourism, the social situation of certain karst areas significantly transformed as gorges, collapse sinkholes, caves or massive rock walls became popular tourist destinations. Geotourism in the broader sense is unambiguously a significant segment in the tourism of karst terrains [14–16], but adventure tourism (canyoning, caving, climbing, rafting) has also excellent possibilities in karsts [17–21]. Moreover, we note that the spectacular landforms of karsts are reflected in different type of artistic works from literature (folk legends, novels about caves) to paintings, thus cultural tourism is also present on karst areas [22–24].

In addition to the rich geoheritage, karst areas have outstanding biotic values as well [25, 26] due to the high number of karst-specific, calciphilous plant species [27]

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and the special habitats they provide for animals [28]. Moreover, given the low population density of many karst areas, their landscapes remained relatively undisturbed. As a result, many karst terrains became protected areas taking into consideration their biotic and abiotic values as well as their inherent sensitivity and vulnerability. The best-known type of protected areas is the national park (NP) category, whereas geoparks (GP) are more recent innovations, which aims at the preservation of geoheritage, the promotion of geotourism and the contribution to sustainable development of local communities [29]. The aims and functions of NPs have been modified several times during the last one and a half century since the foundation of the Yellowstone NP in 1872 [30]. The main elements of the present-day NP concept (IUCN Category II, [31]) are the conservation of pristine nature, ecological integrity and biodiversity; the management of tourism and recreation without causing degradation; the preservation of cultural landscapes and historical heritage; the promotion of scientific research; education and the expression of national identity. In addition, nowadays, it is increasingly emphasized, that NPs can be tools of local development in economically deprived areas [15, 32, 33]. Nonetheless, there are critical opinions too, which underline that this economy-driven views may cause the degradation and cultural homogenization of vulnerable territories [34, 35]. As for GPs, sustaining local communities and help rural areas has been among the objectives since the beginnings [36]. The history of European geoparks started in 2000 when four geoparks (Haute-Provence, Lesvos Petrified Forest, Gerolstein/Vulkaneifel, Maestrazgo) were set aside [37].

The issues studied in this paper are the following: calculating the proportion of karstic NPs and GPs within the total number of European NPs and GPs; determining the spatial distribution of these karstic NPs and GPs within Europe; outlining the historical development of karstic NPs and GPs in Europe; classifying karstic NPs and GPs by their morphogenetical types; and exploring the forms of geotourism present in karstic NPs and GPs. Further on, using selected cases, we present the significance of geotourism in karstic NPs and GPs, discuss their economic benefits and potential harm to vulnerable karst terrains.

We do not know any previously published article about this issue in relation with NPs. Ruban [10] created a similar analysis about GPs, but his study did not focus on Europe and did not include NPs. Thus, in our work, we emphasize the similarities and differences in the development and present settings of European karstic NPs and GPs.

# 2 Methods

## 2.1 Data collection about NPs and GPs in Europe

In case of NPs, there does not exist any official list of NP data. Although the IUCN provides certain principles about what can be called a NP (Category II protected area), but this organisation has no legal authority on the use of the „national park" title, so each country has its own definition. As a result, several of the so-called NPs do not fit the IUCN Category II definition because they are too small, too densely inhabited or the NP lands are in private ownership [30]. We collected NP data from different open internet sources, general pages and the NPs' own websites.

As for UNESCO Global GPs, we used the official list provided by the organization itself [38] as the main data source. However, not all GPs in Europe are member of the UNESCO Global GPs, therefore GPs data was also completed by different internet sources. Most of the geoparks, which are not included in the UNESCO network, are found in countries, where geotourism has relatively longer traditions like in Germany or in the UK. Many of the non-members are aspiring geoparks at present, while some others are former members excluded from the network for different reasons. Finally, there are geoparks at national levels, which have never been members of the European Geopark Network (EGN) and do not aspire either. We note here that all GPs recognised by the EGN are also members of the UNESCO Global Geoparks Network.

Based on the above data sources, first, we have created a compilation of all European NPs and GPs including the areal extent and the year of foundation. It is noted that the total numbers depend on how we delimit Europe. Here we used the classical physical geography based delimitation, *i.e.* the Caucasian countries, the Asian parts of Russia and Turkey as well as the overseas territories of Denmark, France and Spain are not included in our analysis.

## 2.2 Categorization of NPs and GPs by their proportion of karst terrains

Based on karst literature (*e.g.* [8, 39]) and our own field experiences, we selected NPs and GPs, which contain karst terrains. We also marked if a NP or a GP is mostly karst-based or the karst is only a part of its territory. We used the term „mostly karstic" if the geological descriptions of the given park mentioned mostly limestones and dolomites and if the geosites of the park are generally linked to

karstic features (caves, gorges, sinkholes). If the geological descriptions mentioned other rock types and/or the geosites of the park included several non-karstic features then we categorized the park as „partly karstic". If neither limestone nor karst-related features were mentioned, then we categorized the park as „non-karstic". Comparing our categories to that of Ruban [10], we can say, that our "mostly karstic" category is theoretically the same as Ruban's "fully karst-based", and our "partly karstic" category is a combination of Ruban's "partly karst-based" and "occasional karst-involving" categories.

### 2.3 Categorization of karstic NPs and GPs by their morphology

Thereafter, we categorized the partly or mostly karstic NPs and GPs according to their morphology. There exist several classifications in karst morphology. Here, we applied the following general categories, which are widely used in the karst literature [8, 40, 41] and which are present in European territories: doline karst (medium mountains or hilly areas including a range of morphology from holokarst to fluviokarst), alpine karst, arctic glaciokarst and coastal karst. Thereafter, we calculated the distribution of NPs and GPs in these types.

### 2.4 Presentation of historical changes in the number of NPs and GPs

Based on the above data, we analysed how the number and area of NPs and GPs changed in Europe since the establishment of the first NPs and GPs. We have calculated average increase rates of the number of NPs and GPs for different periods.

### 2.5 Demonstrating the economic benefits of karstic NPs and GPs

In some selected cases, where visitor numbers or visitor spend data are available, we briefly demonstrate that karst-related tourism may result in significant economic benefits. We note here that in the USA, most NPs operate an entry ticket system, thus visitor numbers are registered and publicly available. On the contrary, the majority of European NPs or GPs do not operate such entry systems, because free entry to NPs is a basic principle in several countries [42]. As a result, visitor numbers are not registered in general, only in special cases, where caves or visitor centres are visited by the tourists [34].

## 3 Results

The classification of European NPs and GPs according to their karst areas can be seen in Tables 1-2. The whole dataset can be downloaded as a supplementary xlsx file. A summary of European NPs and GPs by countries are presented in Table 3 and Figures 1-2. The first NPs in Europe were established at the beginning of the 20th century [30]. In 1909, nine NPs were set aside in Sweden all at once (Abisko, Ängsö, Garphyttan, Gotska Sandön, Hamra, Pieljekaise, Sånfjället, Sarek, Stora Sjöfallet), and among them, Abisko NP incorporates some limestone and dolomite terrains. The Schweizerischer NP founded in 1914 in Switzerland also contains some limestone and dolomite areas, but the first really karstic NPs, where karst morphology is predominant were established in Spain in 1918. Ordesa y Monte Perdido and Picos de Europa NPs include mainly alpine glaciokarst terrains, so they are the oldest, large area karstic NPs in Europe [43]. Up to now, 461 NPs were established in Europe with a total area of 280,730 $km^2$, and 106 out of them are partly or mostly karstic with a cumulative area of 48,007 $km^2$.

As for the GPs, the first four European Geoparks were established in June 2000, and two of them (Reserve Geologique de Haute-Provence, Maestrazgo) can be considered mostly karstic. At present, 50 of the 102 existing GPs are partly or mostly karstic with a cumulative area of 93,039 $km^2$ out of the 197,399 $km^2$ of all GPs. It means that nowadays, geoparks contain significantly larger karstic terrains than national parks.

By looking at the timeline of NP foundations (Figure 3) it can be observed that until the end of the second world war, the number of NPs increased at low pace. Between 1950 and 1990 there was a quicker linear increase with 4.2 new NPs a year on the average, and between 1990 and 2010, there was an even faster thrive with 11.5 new NPs a year on the average. However, this trend was slowed down after that. The post 1990 thriving can be partly explained by the creation of new states in Europe and the transformation of the political system in the formerly communist countries. Between 1950 and 1990, the number of partly or mostly karstic NPs also increased at a higher pace, but this rate did not significantly accelerate after 1990. Consequently, the proportion of karstic NPs was the highest during the 1950-1990 period, rising up to 35-40% of all NPs. However, since 1990, this proportion has gradually

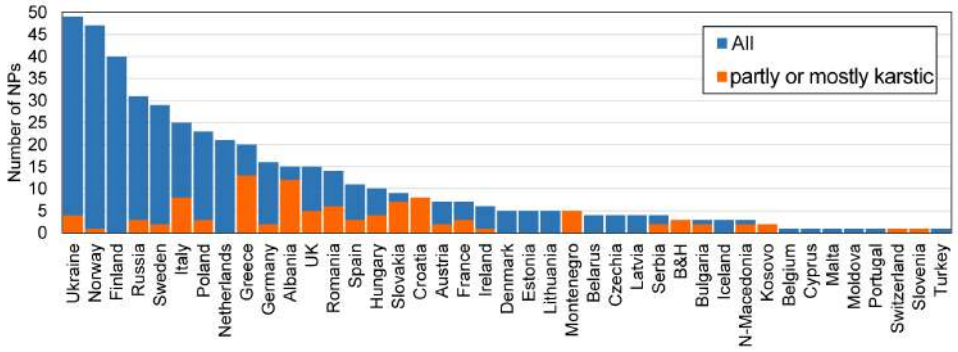


**Figure 1:** NPs in European countries

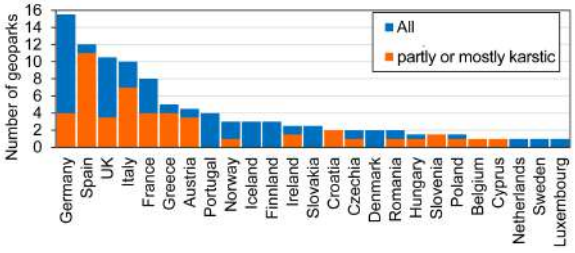


**Figure 2:** GPs in European countries

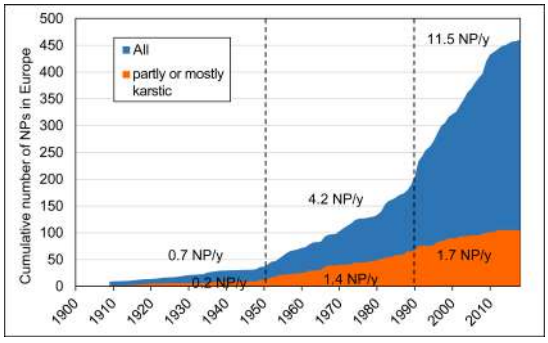


**Figure 3:** Timeline of NP foundations in Europe with the yearly increase rates

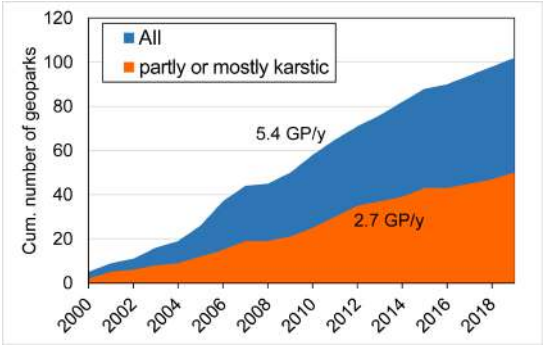


**Figure 4:** Timeline of GP foundations in Europe with the yearly increase rates

decreased to the present 23%. As for the area, the partly or mostly karstic NPs make up for 17% of all NPs. The aforementioned timely changes support the idea that karst terrains got to the NP category relatively early, and well before the terms and definitions of geotourism and geoparks came into being [13, 33]. Since the foundation of the EGN in 2000, the increase rate of GPs was roughly uniform and relatively high (5.4 GP/y), even if this rate is somewhat lower than that of the NPs (Figure 4). This fact is understandable as bioconservation is generally considered more significant than geoconservation [44]. Nevertheless, the increase rate of partly or mostly karstic GPs was remarkable with 2.7 new foundations a year, that surpassed the increase rate of partly or mostly karstic NPs. As a result, partly or mostly karstic GPs make up for 49% in numbers and 47% in area of all GPs, that underlines the outstanding role of karst terrains in geoheritage and geotourism. Moreover, if only UNESCO Global Geoparks are considered, then the proportion of partly or mostly karstic GPs goes up to 60%.

NPs show an uneven spatial distribution in the map of Europe (Figure 5). This can be explained partly by natural reasons, but economic, social and political factors also played a significant role [27]. The sheer number of NPs is extremely high in Ukraine, Norway and Finland. On the other hand, France and Portugal for example, have very few NPs with respect to their country area and varied natural settings. The spatial distribution of partly or mostly karstic NPs is also uneven, but it is mainly due to geological reasons. A significant proportion of the partly or mostly karstic NPs are found in the Balkan, as Greece, Albania and Croatia have the highest numbers of partly or mostly karstic NPs. Naturally, there are large differences among partly or mostly karstic NPs in terms of size, karst morphology, caves and visitor numbers. In certain cases, the foundation of the NP can be linked to political factors, but in general, the motivations are nature protection and tourism [28, 31, 45].

**Table 1:** List of mostly or partly karstic European NPs

| mostly karstic NP | partly karstic NP |
|---|---|
| Aggtelek (HUN) | Abisko (SWE) |
| Ainos (GRE) | Abruzzo, Lazio e Molise (ITA) |
| Alonnisos (GRE) | Balaton-felvidéki (HUN) |
| Archipiélago de Cabrera (SPA) | Bashkiriya (RUS) |
| Berchtesgaden (GER) | Vóreias Pindou (GRE) |
| Bjeshkët e Nemuna (KOS) | Biogradska Gora (MNE) |
| Brecon Beacons (UK) | Buila-Vânturariţa (ROM) |
| Bredhi i Hotovës-Dangëlli (ALB) | Karpatskiy (UKR) |
| Brijuni (CRO) | Mavrovo (NMA) |
| Bükk (HUN) | Centralen Balkan (BUL) |
| Burren (IRE) | Cilento, Vallo di Diano, e Alburni (ITA) |
| Calanques (FRA) | Đerdap (SER) |
| Cévennes (FRA) | Duna-Ipoly (HUN) |
| Cheile Bicazului-Hăşmaş (ROM) | Lake District (UK) |
| Cheile Nerei-Beuşniţa (ROM) | Mariy Chodra (RUS) |
| Dolomiti Bellunesi (ITA) | Llogarasë (ALB) |
| Domogled-Valea Cernei (ROM) | Malá Fatra (SLK) |
| Durmitor (MNE) | Bredhi i Drenovës (ALB) |
| Gargano (ITA) | Galičica (NMA) |
| Gesäuse (AUS) | Jasmund (GER) |
| Gran Sasso e Monti della Laga (ITA) | Làhko (NOR) |
| Kalkalpen (AUS) | Nízke Tatry (SLK) |
| Karaburun Sazan (ALB) | Olympus (GRE) |
| Kornati (CRO) | Parnitha (GRE) |
| Kozara (BIH) | Peak District (UK) |
| Krka (CRO) | Pindou (GRE) |
| Lovćen (MNE) | Pirin (BUL) |
| Luginës së Valbonës (ALB) | Podilski Tovtry (UKR) |
| Lurë-Mali i Dejës (ALB) | Pollino (ITA) |
| Majella (ITA) | Pyrénées (FRA) |
| Malet e Sharrit (KOS) | Shebenik Jabllanicë (ALB) |
| Malit te Dajtit (ALB) | Qafë Shtamës (ALB) |
| Malit te Tomorrit (ALB) | Sochinskiy (RUS) |
| Mljet (CRO) | South Downs (UK) |
| Monti Sibillini (ITA) | Schweizerischer/Suisse/Svizzero/Svizzer (SWI) |
| Muránska planina (SLK) | Tatrzański (POL) |
| Oeta (GRE) | Troodos (CYP) |
| Ojców (POL) | Uzhanskiy (UKR) |
| Ordesa y Monte Perdido (SPA) | Vadvetjåkka (SWE) |
| Paklenica (CRO) | Veľká Fatra (SLK) |
| Parnassos (GRE) | Vikos–Aoös (GRE) |
| Piatra Craiului (ROM) | Yavorivskiy (UKR) |
| Picos de Europa (SPA) | |
| Pieniński (POL) | |
| Pieninský (SLK) | |
| Plitvička jezera (CRO) | |
| Prespës (ALB) | |
| Prespes (GRE) | |
| Prokletije (MNE) | |
| Risnjak (CRO) | |
| Samaria (GRE) | |
| Semenic-Cheile Caraşului (ROM) | |
| Sjeverni Velebit (CRO) | |
| Skadarsko jezero (MNE) | |
| Slovenský kras (SLK) | |
| Slovenský raj (SLK) | |
| Sounio (GRE) | |

**Table 1:** ...continued

| mostly karstic NP | partly karstic NP |
|---|---|
| Sutjeska (BIH) | |
| Tara (SER) | |
| Thethit (ALB) | |
| Triglavski (SLV) | |
| Una (BIH) | |
| Yorkshire Dales (UK) | |
| Zakynthos (GRE) | |

**Table 2:** List of mostly or partly karstic European GPs. *Italics*: GPs, which partly overlap with a NP. $^{n}$: not members of the EGN

| mostly karstic GP | partly karstic GP |
|---|---|
| Alpi Apuane (ITA) | Adamello Brenta (ITA) |
| Causses du Quercy (FRA) | *Bakony-Balaton (HUN)* |
| Chelmos-Vouraikos (GRE) | Bayerisch-Böhmische / Česko-bavorský (GER-CZE) $^{n}$ |
| Cilento, Vallo di Diano e Alburni (ITA) | Burren and Cliffs of Moher (IRE) |
| Comarca de Molina - Alto Tajo (SPA) | Catalunya Central (SPA) |
| Famenne-Ardenne (BEL) | Colline Metallifere Grossetane (ITA) |
| Fforest Fawr (UK) | Conca de Tremp-Montsec (SPA) |
| Haute-Provence (FRA) | Costa Vasca (SPA) |
| Idrija (SLV) | English Riviera (UK) |
| Karavanke / Karawanken (SLV, AUS) | Erz der Alpen (AUS) |
| Karnische Alpen (AUS) | *Harz-Braunschweiger Land-Ostfalen (GER)* |
| Las Loras (SPA) | Iskar-Panega (BUL)$^{n}$ |
| *Luberon (FRA)* | *Kielce (POL)*$^{n}$ |
| Madonie (ITA) | Kyffhäuser (GER)$^{n}$ |
| Marble Arch Caves (UK, IRL) | Maestrazgo (SPA)$^{n}$ |
| *Massif des Bauges (FRA)* | Montañas do Courel (SPA) |
| Pollino (ITA) | North Pennines (UK) |
| Psiloritis (GRE) | Papuk (CRO) |
| Schwäbische Alb (GER) | *Parco Geominerario Storico Ambientale della Sardegna (ITA)* |
| Sierra Norte de Sevilla (SPA) | Ţinutul Buzăului (ROM)$^{n}$ |
| *Sierras Subbeticas (SPA)* | *Trollfjell (NOR)* |
| Sitia (GRE) | Westerwald-Lahn-Taunus (GER)$^{n}$ |
| Sobrarbe (SPA) | |
| Steirische Eisenwurzen (AUS) | |
| Troodos (CYP) | |
| *Vikos-Aoos (GRE)* | |
| Villuercas-Ibores-Jara (SPA) | |
| Viški Archipelago (CRO) | |

**Table 3:** Number of NPs and GPs in European countries with the number of partly or mostly karstic NPs and GPs (Some European countries have NPs or GPs on non-European terrain, those are not included in this table). B&H is Bosnia and Herzegovina

| Country | All NPs | partly karstic NPs | mostly karstic NPs | All GPs | partly karstic GPs | mostly karstic GPs |
|---|---|---|---|---|---|---|
| Albania | 15 | 4 | 8 | 0 | 0 | 0 |
| Austria | 7 | 0 | 2 | 4.5 | 1 | 2.5 |
| B&H | 3 | 1 | 2 | 0 | 0 | 0 |
| Belarus | 4 | 0 | 0 | 0 | 0 | 0 |
| Belgium | 1 | 0 | 0 | 1 | 0 | 1 |
| Bulgaria | 3 | 0 | 2 | 1 | 1 | 0 |
| Croatia | 8 | 2 | 6 | 2 | 1 | 1 |
| Cyprus | 1 | 0 | 1 | 1 | 0 | 1 |
| Czechia | 4 | 0 | 0 | 1.5 | 0.5 | 0 |
| Denmark | 5 | 0 | 0 | 2 | 0 | 0 |
| Estonia | 5 | 0 | 0 | 0 | 0 | 0 |
| Finland | 40 | 0 | 0 | 3 | 0 | 0 |
| France | 7 | 3 | 0 | 8 | 0 | 4 |
| Germany | 16 | 1 | 1 | 16 | 3.5 | 1 |
| Greece | 20 | 6 | 7 | 5 | 0 | 4 |
| Hungary | 10 | 0 | 4 | 1.5 | 1 | 0 |
| Iceland | 3 | 0 | 0 | 3 | 0 | 0 |
| Ireland | 6 | 0 | 1 | 2.5 | 1 | 0.5 |
| Italy | 25 | 4 | 4 | 10 | 3 | 4 |
| Kosovo | 2 | 1 | 1 | 0 | 0 | 0 |
| Latvia | 4 | 0 | 0 | 0 | 0 | 0 |
| Lithuania | 5 | 0 | 0 | 0 | 0 | 0 |
| Luxembourg | 0 | 0 | 0 | 1 | 0 | 0 |
| Malta | 1 | 0 | 0 | 0 | 0 | 0 |
| Moldova | 1 | 0 | 0 | 0 | 0 | 0 |
| Montenegro | 5 | 2 | 3 | 0 | 0 | 0 |
| Netherlands | 21 | 0 | 0 | 1 | 0 | 0 |
| N-Macedonia | 3 | 2 | 0 | 0 | 0 | 0 |
| Norway | 47 | 0 | 1 | 3 | 1 | 0 |
| Poland | 23 | 2 | 1 | 1.5 | 1 | 0 |
| Portugal | 1 | 0 | 0 | 4 | 0 | 0 |
| Romania | 14 | 4 | 2 | 2 | 1 | 0 |
| Russia | 31 | 0 | 3 | 0 | 0 | 0 |
| Serbia | 4 | 0 | 2 | 0 | 0 | 0 |
| Slovakia | 9 | 4 | 3 | 2.5 | 0 | 0 |
| Slovenia | 1 | 1 | 0 | 1.5 | 0 | 1.5 |
| Spain | 11 | 1 | 2 | 12 | 5 | 6 |
| Sweden | 29 | 2 | 0 | 1 | 0 | 0 |
| Switzerland | 1 | 0 | 1 | 0 | 0 | 0 |
| Turkey | 1 | 0 | 0 | 0 | 0 | 0 |
| UK | 15 | 0 | 5 | 10.5 | 2 | 1.5 |
| Ukraine | 49 | 2 | 2 | 0 | 0 | 0 |
| Total | 461 | 42 | 64 | 102 | 22 | 28 |

GPs have a much more uneven spatial distribution since several countries do not have GPs at all (Figure 6). Germany, Spain, UK and Italy are the leading countries in the number of GPs. If only UNESCO GPs are counted, then Spain and Italy are the first countries. In addition, Spain and Italy are also rich in partly or mostly karstic GPs, since most of their GPs are partly or mostly karstic. It can be also observed in the maps that there are several karstic regions, which are not represented in either the NP (*e.g.* Ardennes) or in the GP category (*e.g.* Carpathian karsts). An interesting contrast between the two maps is that the Balkan is rich in NPs, while GPs are rare (except Greece). We suppose that this fact is due to the following two reasons. Firstly, geoparks are initiated by local communities who are aware of the potential benefits of geotourism, and as [46] states "geotourism as a special interest form of travel does not exist in this region". On the other hand, national parks are founded by the state, and the term "national park" has a strong symbolic meaning [30]. The above facts can explain the disparity in the number of NPs and GPs in the Balkan. However, this situation will presumably change in the future. An example is that Đerdap is on the way of becoming a geopark.

It is also observed that there are partial overlaps between GPs and NPs. For example, the Vikos-Aoos Geopark partially overlaps the Pindou NP, or the Bakony-Balaton Geopark partially overlaps the Balaton-felvidéki NP. Altogether, there are 13 overlapping cases (see Table 2).

Based on their predominant karst morphology, we distributed the partly or mostly karstic NPs into the following categories (Figure 7-8).

1. Doline karsts (*i.e.* medium mountains or hills with doline-dotted surfaces, Figure 9): 46% of the partly or mostly karstic NPs belong to this group, whereas 62% of GPs are in this category. Examples are Bükk and Aggtelek (Hungary), Muránska planina and Slovenský kras (Slovakia), Tara (Serbia), Papuk (Croatia), Schwäbische Alb (Germany).
2. Alpine karsts (Figure 10): 38% of the partly or mostly karstic NPs belong to this group, but only 26% of the GPs are in this category. Examples are Triglav (Slovenia), Sjeverni Velebit (Croatia), Durmitor (Montenegro), Ordesa y Monte Perdido and Picos de Europa (Spain), Gran Sasso e Monti della Laga (Italy), Kalkalpen and Karnische Alpen (Austria), Massif des Bauges (France).
3. Arctic glaciokarsts (Figure 11): 8% of the partly or mostly karstic NPs belong to this group, and 10% of GPs are in this category. Examples are Burren (Ireland), Yorkshire Dales, Peak District and Fforest Fawr (UK).
4. Coastal (island) karsts (Figure 12): 8% of the partly or mostly karstic NPs belong to this group, but only 2% of GPs are in this category. Examples are Archipiélago de Cabrera (Spain), Calanques (France), Kornati, Brijuni and Viški Arhipelag (Croatia).

It is normal that doline karsts form the majority in both NPs and GPs. The relatively higher proportion of doline karsts and also the relatively smaller proportion of alpine karsts within the GPs can be explained by the fact that the alpine karsts became protected earlier in the 20th century as they are both spectacular and sensitive areas, so they were already NPs by the time, when GPs started to evolve.

Furthermore, it is reasonable to characterize NPs and GPs from a tourist point of view by their most outstanding (brandmark) karstic features, which make them well known for the large public. Obviously, a NP can be put into several categories according to this viewpoint. We mention here some of the most typical karst features, which can make an area attractive and recognized, and we provide some examples (of many) for each feature.

(a) Caves are the most typical special karst features, *e.g.* Baradla-Domica Cave (Aggtelek and Slovak Karst), Aven Armand Cave (Cévennes), Ingleborough Cave (Yorkshire Dales), Marble Arch Cave, Caves of Han (Famennes-Ardenne).
(b) Gorges are also very popular, *e.g.* Tarn (Cévennes), Danube (Đerdap), Hornad (Slovenský raj), Bicaz (Cheile Bicazului-Hăşmaş), Vikos (Pindou), Samaria (Samaria), Salza (Styrian Eisenwurzen), Verdon (Haute-Provence).
(c) Limestone pavements are mostly specific to arctic glaciokarst, *e.g.* Burren, Yorkshire Dales, Peak District, North Pennines.
(d) Polje lakes are rare but fascinating phenomena: Skadarsko jezero NP, Prespa NP.
(e) Travertine lakes and cascades are extremely popular, *e.g.* Plitvička jezera NP, Krka NP, Una NP.

These settings have a strong impact on the potential tourist activities of a given karst terrain. Naturally, hiking and trekking is possible and supported in almost all partly or mostly karstic NPs and GPs, but caving, climbing, canyoning, rafting and diving are also possible in many partly or mostly karstic NPs and GPs. According to available tourist information, 57% of NPs and 74% of GPs provide caving possibilities, climbing is typical in 41% of NPs and 38% of GPs, rafting is present in 16% of NPs and 24% of GPs, whereas canyoning is popular in 8% of NPs and

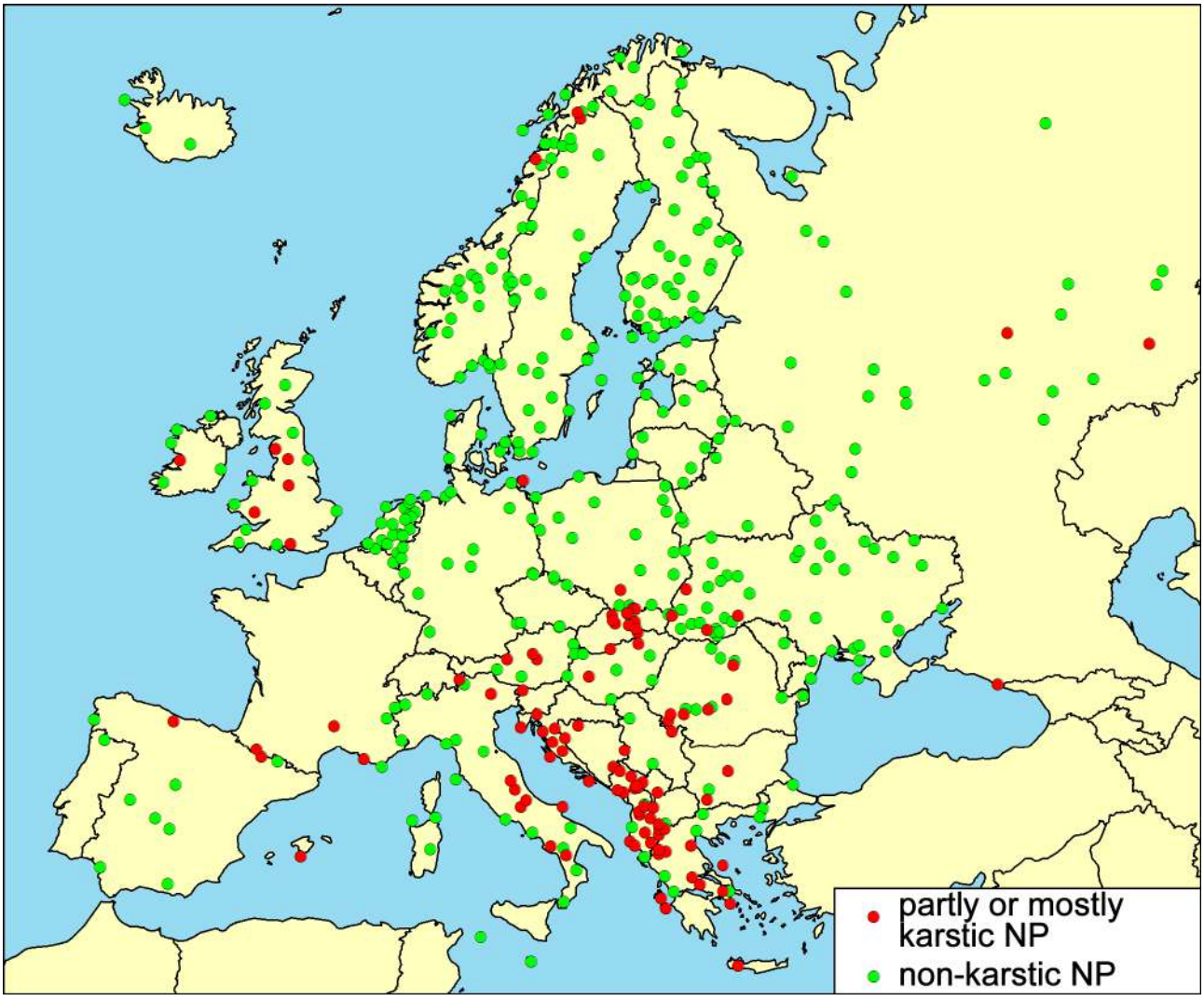


**Figure 5:** Location of NPs in Europe

in 12% of GPs. These numbers also reflect that GPs popularize the active forms of tourism slightly more than NPs. Karst terrains have varied geoscientific values, too, including exogeneous and endogenous karst forms, and the limestone layers often document interesting periods from the Earth's history. These values are very important for "sensu stricto" geotourists, but certainly, these geotourists are significantly less in numbers than those tourists, who enjoy aesthetic, recreational or adventure values of karst areas [19, 47–49].

## 4 Discussion

The tourist opportunities of karstic NPs and GPs are influenced by many factors. The surface area of NPs and GPs varies between extreme values. In general, larger area NPs have a more varied morphology. The smallest karstic NP is the Mljet NP in Croatia with only 5.4 $km^2$ area. In spite of its small size, it is rich in biological values including marine life, but its geoheritage is also special as it is an area, where karst landforms are partly flooded due to the post-glacial sea level rise. On the contrary, the largest partly or mostly karstic NP is the Lake District NP (UK) with an area of 2,362 $km^2$. This NP has high geodiversity including mostly Palaeozoic sedimentary, igneous and metamorphic rocks. In addition, it has mountains and valleys with lakes formed by Quaternary glacial processes, and glaciokarst landforms are typical in some parts of the NP.

GPs are generally larger than NPs, and the smallest karstic GP is the Marble Arch Caves (Ireland) with 180 $km^2$ and the largest one is the Schwäbische Alb with 6,688 $km^2$. The large and diverse territory of a park makes it possi-

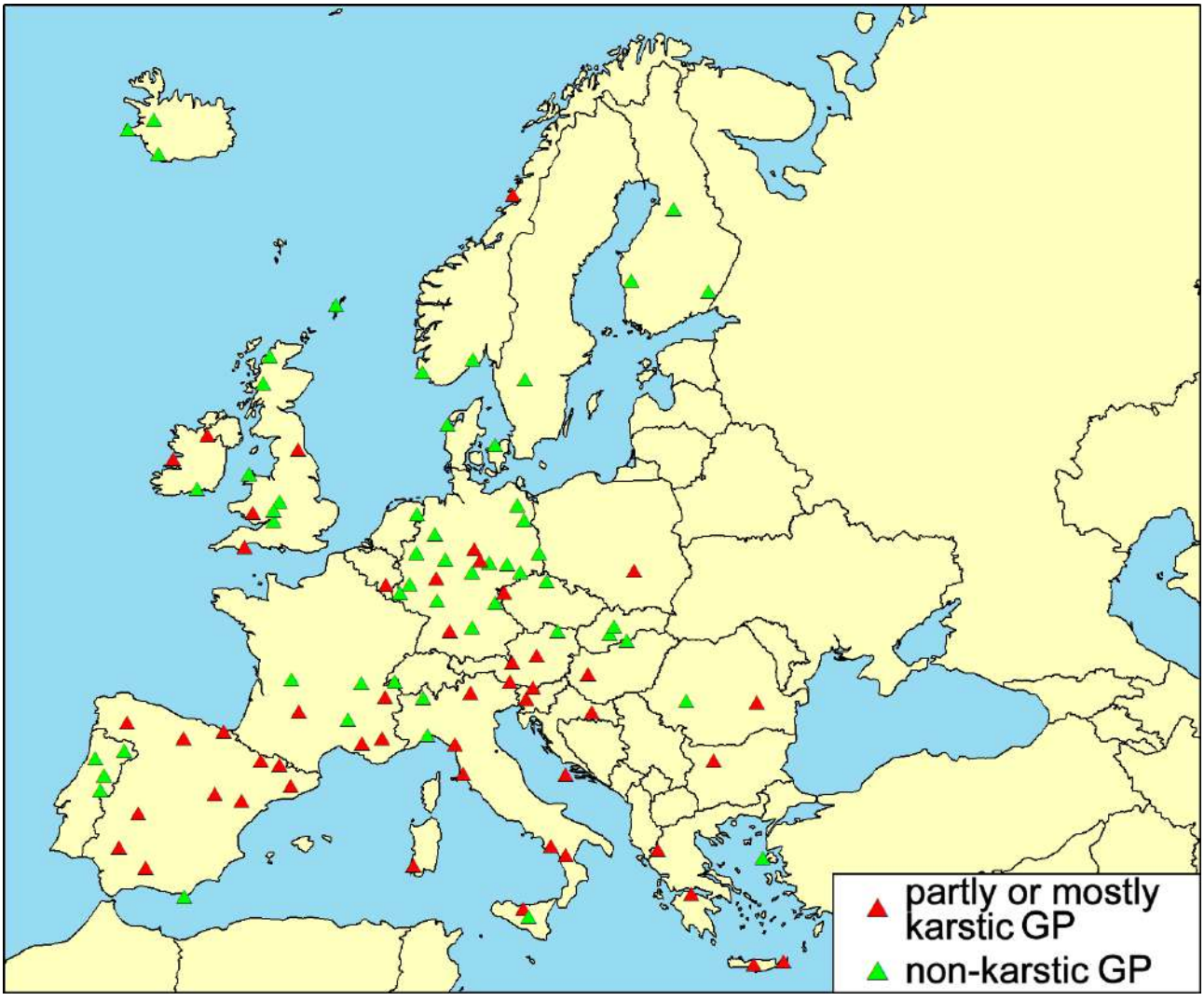


**Figure 6:** Location of GPs in Europe

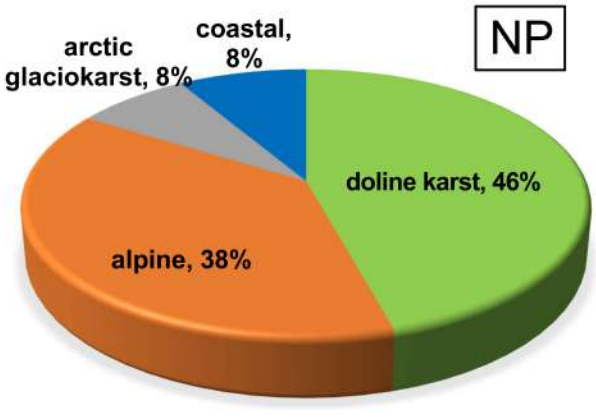


**Figure 7:** Distribution of different karst types in European NPs

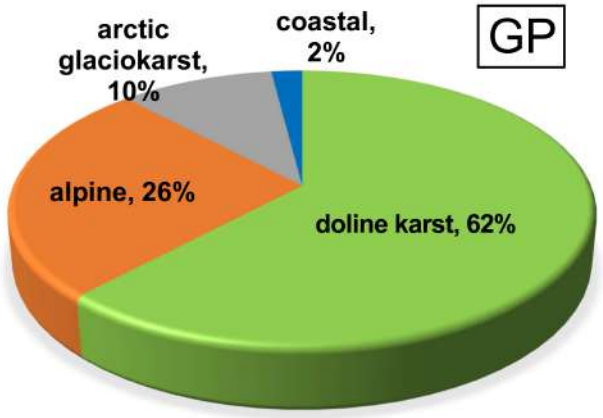


**Figure 8:** Distribution of different karst types in European GPs

**Figure 9:** Example of a doline karst: Tara NP (Serbia)

**Figure 10:** Example of an alpine karst: Triglav NP (Slovenia)

**Figure 11:** Example of an arctic glaciokarst: Yorkshire Dales NP (UK)

ble to create different zones according to nature protection and tourist interests. Besides the sheer area, the geological composition can be also a significant factor. For example, mixed (allogenic) karsts usually have higher geodiversity than autogenic karsts, and more types of geological/geomorphological phenomena can be observed in the former case. A GIS-based quantitative method of karst

**Figure 12:** Example of a coastal karst: Kornati NP (Croatia)

geodiversity assessment was presented in [50], and the authors concluded that areas of high geodiversity index strongly correlate with areas which are currently promoted for geotouristic and educational purposes. The awareness and the visitor numbers of a NP or a GP can be significantly increased if there is a show cave in the territory. In addition, besides natural settings, the proximity of other (cultural or recreational) tourist destinations can be also a very significant factor in the actual tourism potential of a karstic NP or a GP [51, 52].

Just to mention a few concrete examples, there are karstic NPs, where the number of visitors is extremely high, like Picos de Europa NP, which attracts 1.5-2 million visitors a year [15], or the Plitvička jezera NP, which attracts 1.5-1.7 million visitors a year, or the Krka NP, where tourists can swim in the natural basins dammed by travertine, the visitor number reached 1.3 million in 2017 [53]. Although the increase of visitor number implies significant economic benefits, it may also lead to environmental problems, since karst terrains are sensitive and vulnerable areas, and overtourism can harm both the biotic and abiotic values of these places, and even deteriorate visitors' perceptions [13]. Treading by tourist crowds can change infiltration and runoff conditions, the weak soils may be eroded and waters may become polluted [25]. The 1.5 million visitors to Plitvička jezera for example, arrive mostly in the summer months. The narrow valley becomes congested with tourists and it is impossible to peacefully look around, enjoy the beauty of the landscape or make photographs without disturbances. Thus, the management has to solve the problem by some kind of visitor limitation system. In the Pindou NP, the area of Vikos gorge became highly popular in the recent decades. However, the abrupt increase of visitors was not followed directly by infrastructural development, and the clean waters became polluted by organic material, which lead to occasional eutrophication in cer-

tain years [54]. The Krka NP already had to limit the number of tourists at Skradinski Buk waterfalls, *i.e.* they allow a maximum of 10,000 tourists to the waterfalls at any given time. On the contrary, there are less visited NPs, where the management makes serious efforts to increase the number of tourists. The Burren NP (Ireland) is nowadays visited by 75,000 tourists a year. However, when the management planned a new visitors centre at Mullaghmore to drastically increase the visitor number, nature protection activists argued that the area is too vulnerable for this investment and the project was finally cancelled [35].

The fact-based demonstration of all economic advantages and drawbacks of tourism is an extremely complex task, therefore only few data (if any) is available about this issue in most countries [42]. However, a good exception is the UK, where NPs provide data about visitor numbers and visitor spend [55]. Both the annual visitor numbers (4.15–16.4 million) and the annual visitor spends (333–1146 million pounds) are extremely high in the partly or mostly karstic NPs of Great Britain, even if one takes into account that these NPs have areas between 1,351 and 2,362 $km^2$. Nevertheless, the tourist crowd is distributed both in space and time, due to the large area and the fact that most visitors come here for recreation not only during the summer months. Thus, the seasonality of tourism is less characteristic than in case of the Mediterranean countries [56]. Another specificity of the British NPs is that they are densely inhabited with lots of settlements within the NP area. For instance, the total population of Lake District NP is 41,000 people, and the visitor numbers and visitor spends include the statistics of every settlements within the NP. On the contrary, in many other European countries, NPs have only few or no settlements at all within their administrative boundaries.

It is found that the proportion of partly or mostly karstic NPs within all NPs is 23%, that is very similar to the 21.6% proportion of karst terrains within the land of Europe [1]. It means that NPs provide a representative sample of karst areas within Europe. As for the GPs, the large (49%) proportion of partly or mostly karstic GPs means that karst terrains constitute in fact one of the most important segment of our geoheritage due to their tourist attractiveness. As the foundation of GPs, in principle, can be initiated by locals and not by state administration, we can interpret the high proportion of karst in the GP category, that people living on karst are aware of the values of their geological environment, and they hope that they can benefit from geotourism targeting karst features.

Comparing our results and database to those of Ruban [10], we found several differences in the categorization of GPs. Just some examples, we put several GPs from the "partly karst-based" class of Ruban to the "mostly karstic" category of our own classification (*e.g.* Steirische Eisenwurzen, Schwäbische Alb). Further on, we found several partly or mostly karstic GPs, which were not at all on the list of Ruban [10], *e.g.* Karnische Alpen, Pollino, Bakony-Balaton. However, even Ruban [10] found that 37% of UNESCO Global GPs contain some karst resources worldwide. Even if he missed some partly or mostly karstic GPs, his work also demonstrates that karsts are very significant constituents of the Global GPs Network. Further on, Ruban [10], page 3 stated that "karst resource is chiefly exploited in combination with other geological heritage". Given our numbers, we would modify "chiefly" to "sometimes" in that statement.

In spite of the fact that karst areas are well represented in NPs and GPs, there are still many prominent karst areas in Europe, which do not belong to neither a NP, nor a GP. Some of them are protected by other institutional forms, but some of them are not protected at all. Among other categories, we have to mention first the UNESCO World Heritage List, which includes several karstic sites or areas (see [22, 57]). In addition, regional parks, nature parks, nature monuments, protected landscape categories also incorporate spectacular karst features. Here we mention some (of the many) famous and picturesque karst features, which do not belong to any NP or GP as yet, *e.g.* Škocjan Cave, Eisriesenwelt, Dachstein Gebirge, Kras Plateau, El Torcal de Antequera. However, as new GPs are planned continuously, more and more karst objects become parts of GPs. The longest and probably the most visited show cave in Europe is Postojna Cave, which is also the most visited tourist attraction in Slovenia. It is not part of any NP or GP. Since its opening as a show cave in 1819, 38 million tourists visited the cave [58], and the daily record (on 14 Aug 2018) exceeded 14,000 people [59]. Besides the obvious scientific and aesthetic excellence of Postojna Cave, its favourable location close to crowded tourist paths also contributed to the rapid increase of its visitor numbers [13].

The management of karst terrains requires specific knowledge. The visitor capacity of caves has been investigated by many researchers [60, 61], but other forms of tourism (*e.g.* different types of adventure tourism) also raise questions. The tourist carrying capacity of surface karst forms has been studied by few authors [62, 63]. Water resources, the mitigation of pollution also need special approach in case of karsts [64]. The methodology of Environmental Impact Assessment (EIA) in karst areas has been elaboretad by Veni [65]. Another type of methodology to evaluate human impact on karst is called Karst Disturbance Index (KDI) developed by Van Beynen and Townsend [66]. Several options exist in the management

of protected karst terrains: there are places where tourism and related incomes are favoured, while in some other places, strict nature protection is the rule [18]. However, in most cases, the balance between these two end-options is the goal.

The proportion of geotourists is difficult to estimate in karstic NPs and GPs. At many locations, even the total number of tourists is unknown, and the proportion of geotourists is also indefinite. Further on, it also depends on how the term "geotourist" is defined [14, 48]. Briefly, there are two basic geotourist types with a range of transitions between them, but these types are differently called by different authors: non-dedicated vs dedicated users, geoamateurs vs geo-experts, general vs pure geotourists, etc. [19, 46]. We believe that in case of karst terrains we should not limit the definition of "geotourist" to people who are interested primarily in geological phenomena (*i.e.* "pure geotourists"). Instead, the whole spectrum who enjoys the caves and the spectacular geomorphology of karst terrains should be included. In that meaning, we can state that karstic NPs and GPs are among the most significant geotourist targets.

The motivations of cave tourists have been studied by several authors [67–69], who found that the typical motivations are: escape from daily routine, knowledge and wonder seeking and socialization. Božić and Tomić [19] analysed tourism to gorges and canyons. They used only two main tourist categories and found that most people (69%) are general geotourists, whereas 31% are pure geotourists. The above results also support that the management of karstic NPs and GPs should take into consideration that several types of geotourists exist, but at most popular geosites, the majority are usually general geotourists. Vasiljević *et al.* [46] studied characteristics of geotourists visiting Fruška Gora NP, and they identified the following geotourist attitudes by factor analysis: local community oriented, environmentally aware, nature-based traveller and Plog psychocentric (a person, who is more focused on well-known destinations and prefers to travel with an experienced tour operator).

# 5 Conclusions

Based on our analysis, we found that 23% of all NPs in Europe are partly or mostly karstic, which roughly fits the proportion of carbonate rocks within European land surface. In turn, the partly or mostly karstic geoparks make up for 49% of all GPs in Europe that emphasizes the outstanding role of karst in geoheritage and geotourism.

Map analysis demonstrated that the spatial distributions of NPs is uneven in Europe, and for GPs, it is even more uneven. The reasons for unevenness are partly social, partly geological. Most of the karstic NPs are found in the Balkan, whereas the karstic GPs are the most frequent in Spain and Italy. The majority of either NPs or GPs are located on doline karsts, while about one third are on alpine karsts, one tenth on arctic glaciokarsts and only few of them are coastal karsts.

From a geotourist viewpoint, the most popular features are caves, gorges, limestone pavements, polje lakes and travertine lakes with cascades. Karstic NPs and GPs provide varied tourist offer including adventure tourism possibilities (caving, climbing, rafting, canyoning and diving). We argued that all people who enjoy karstic features can be considered geotourist in a general meaning, thus karstic NPs and GPs are among the most significant geotourist targets.

On the other hand, the preservation of the sensitive and vulnerable karst terrains should remain always fundamental, therefore, the carrying capacity should be determined. Nowadays, there are several methods for calculating cave carrying capacity, but further research is necessary to develop methods for the calculation of the carrying capacity of surface objects such as gorges or lakes. In certain regions, the carrying capacity is not a problem yet, instead, the increase of geotourism is the goal. In these NPs and GPs, the study of geotourist profiles by questionnaire survey can be an important step to improve geotourism marketing and to develop new geotourism products.

Finally, as for the economic benefits of NPs and GPs, this is the most complex question with the less data available at present. Further research should focus first on case studies, which may lead to more fact-based conclusions in the future. However, even with the limited data available at present, we can state that in most cases, the benefits from tourism are of utmost importance for local people living in or near karstic NPs and GPs, and in certain cases, the NP or the GP can in fact help to change the disadvantaged social situation of the given karst area.

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## References


[1] Chen Z., Auler A.S., Bakalowicz M., Drew D., Griger F., Hartmann J., Jiang G., et al., The World Karst Aquifer Mapping project: concept, mapping procedure and map of Europe. Hydrogeol. J., 2017, 25, 3, 771–785, doi: 10.1007/s10040-016-1519-3

[2] Ciglič R., Hrvatin M., Komac B., Perko D., Karst as a criterion for defining areas less suitable for agriculture. Acta Geogr. Slov., 2012, 52, 1, 61–98, doi: 10.3986/AGS52103

[3] Telbisz T., Bottlik Z., Mari L., Kőszegi M., The impact of topography on social factors, a case study of Montenegro. J. Mt. Sci., 2014, 11, 1, 131–141, doi: 10.1007/s11629-012-2623-z

[4] Telbisz T., Bottlik Z., Mari L., Petrvalská A., Exploring relationships between Karst terrains and social features by the example of Gömör-Torna Karst (Hungary-Slovakia). Acta Carsologica, 2015, 44, 1, 121–137, doi: 10.3986/ac.v44i1.1739

[5] Telbisz T., Imecs Z., Mari L., Bottlik Z., Changing human-environment interactions in medium mountains: the Apuseni Mts (Romania) as a case study. J. Mt. Sci., 2016, 13, 9, 1675–1687, doi: 10.1007/S11629-015-3653-0

[6] Pejnović D., Husanović-Pejnović D., Causes and consequences of demographic development in the territory of Velebit Nature Park, 1857–2001. Period. Biol., 2008, 110, 2, 195–204

[7] Vogiatzakis I. (Ed.), Mediterranean Mountain Environments. John Wiley & Sons, Chichester, 2012

[8] Ford D., Williams P.D., Karst Hydrogeology and Geomorphology. John Wiley & Sons, Chichester, 2013

[9] Cigna A.A., Forti P., Caves: the Most Important Geotouristic Feature in the World. Tour. Karst Areas, 2013, 6, 1, 9–26

[10] Ruban D., Karst as Important Resource for Geopark-Based Tourism: Current State and Biases. Resources, 2018, 7, 4, 82, doi: 10.3390/resources7040082

[11] Antić A., Tomić N., Marković S., Karst geoheritage and geotourism potential in the Pek River lower basin (eastern Serbia). Geogr. Pannonica, 2019, 23, 1, 32–46, doi: 10.5937/gp23-20463

[12] Stefano M., Paolo S., Abandoned quarries and geotourism: An opportunity for the Salento quarry district (Apulia, Southern Italy). Geoheritage, 2017, 9, 4, 463–477, doi: 10.1007/s12371-016-0201-4

[13] Tičar J., Tomić N., Valjavec M.B., Zorn M., Marković S.B., Gavrilov M.B., Speleotourism in Slovenia: balancing between mass tourism and geoheritage protection. Open Geosci., 2018, 10, 1, 344–357, doi: 10.1515/geo-2018-0027

[14] Dowling R.K., Newsome D. (Eds.), Geotourism. Routledge, 2006

[15] Serrano E., González Trueba J.J., Environmental education and landscape leisure. Geotourist map and geomorphosites in the Picos de Europa National Park. Geo J. Tour. Geosites, 2011, 8, 2, 295–308

[16] Miccadei E., Sammarone L., Piacentini T., D'Amico D., Mancinelli V., Geotourism in the Abruzzo, Lazio and Molise National Park (Central Italy): the example of Mount Greco and Chiarano Valley. Geoj. Tour. Geosites, 2014, 13, 1, 38–51

[17] Lukac G., Hrsak V., Influence of visitor numbers on breeding birds in the Paklenica National Park, Croatia. Ekológia, 2005, 24, 2, 186–199

[18] Duval M., Tourism and Preservation Policies in Karst Areas: Comparision Betwen the Škocjan Caves (Slovenia) and the Ardèche Gorge (France). Acta Carsologica, 2007, 35, 2–3, 23–35, doi: 10.3986/ac.v35i2-3.225

[19] Božić S., Tomić N., Canyons and gorges as potential geotourism destinations in Serbia: comparative analysis from two perspectives–general geotourists' and pure geotourists'. Open Geosci., 2015, 7, 1, 531–546, doi: 10.1515/geo-2015-0040

[20] Dollma M., Geotourism potential of Thethi National Park (Albania). Int. J. Geoheritage Parks, 2019, 7, 2, 85–90, doi: 10.1016/j.ijgeop.2019.05.002

[21] Dollma M., Canyons of Albania and geotourism development. Acta Geoturistica, 2018, 9, 2, 28–34

[22] Hamilton-Smith E., Karst and world heritage status. Acta Carsologica, 2007, 36, 2, 291–302, doi: 10.3986/ac.v36i2.198

[23] Gordon J.E., Geoheritage, Geotourism and the Cultural Landscape: Enhancing the Visitor Experience and Promoting Geoconservation. Geosciences, 2018, 8, 4, 136, doi: 10.3390/geosciences8040136

[24] Valjavec M.B., Zorn M., Ribeiro D., Mapping War Geoheritage: Recognising Geomorphological Traces of War. Open Geosci., 2018, 10, 1, 385–394, doi: 10.1515/geo-2018-0030

[25] Bárány-Kevei I., Vulnerability and auto-restoration capacities of karst geoecosystems. Z. Für Geomorphol. Suppl. Issues, 2016, 60, 2, 235–255, doi: 10.1127/zfg_suppl/2016/00302

[26] Bátori Z., Vojtkó A., Keppel G., Tölgyesi C., Čarni A., Zorn M., Farkas T., et al., Anthropogenic disturbances alter the conservation value of karst dolines. Biodivers. Conserv., 2019, doi: 10.1007/s10531-019-01896-4

[27] Ewald J., The calcareous riddle: Why are there so many calciphilous species in the Central European flora? Folia Geobot., 2003, 38, 4, 357–366, doi: 10.1007/BF02803244

[28] Pipan T., Culver D., Forty years of epikarst: what biology have we learned? Int. J. Speleol., 2013, 42, 3, 5, doi: 10.5038/1827-806X.42.3.

[29] Henriques M.H., Brilha J., UNESCO Global Geoparks: a strategy towards global understanding and sustainability. Episodes, 2017, 40, 4, 349–354, doi: 10.18814/epiiugs/2017/v40i4/017036

[30] Frost W., Hall C.M. (Eds.), Tourism and national parks: international perspectives on development, histories and change. Routledge, London, 2015

[31] IUCN Category II: National Park. https://www.iucn.org/theme/protected-areas/about/protected-areas-categories/category-ii-national-park

[32] Mose I. (Ed.), Protected Areas and Regional Development in Europe: Towards a New Model for the 21st Century. Ashgate Publishing Ltd., Aldershot, UK, 2007

[33] Petrić L., Mandić A., Visitor management tools for protected areas focused on sustainable tourism development: the Croatian experience. Environ. Eng. Manag. J., 2014, 13, 6, 1483–1495

[34] Kalisch D., Klaphake A., The dilemma of recreational use versus nature protection – Responses from National Park authorities in Austria, Germany and Switzerland. Manag. Prot. Sustain. Dev. Fourth Int. Conf. Monit. Manag. Visit. Flows Recreat. Prot. Areas, 2008, 404–408

[35] Healy N., McDonagh J., Commodification and conflict: what can the Irish approach to protected area management tell us? Soc. Nat. Resour., 2009, 22, 4, 381–391, doi: 10.1080/08941920801978622

[36] Farsani N.T., Coelho C., Costa C., Geotourism and geoparks as novel strategies for socio-economic development in rural areas. Int. J. Tour. Res., 2011, 13, 1, 68–81, doi: 10.1002/jtr.800

[37] Zouros N., McKeever P.J., The European geoparks network. Episodes, 2004, 27, 3, 165–171

[38] UNESCO Global Geoparks http://www.unesco.org/new/en/natural-sciences/environment/earth-sciences/unesco-global-geoparks/
[39] Gunn J. (Ed.), Encyclopedia of Caves and Karst Science. Taylor & Francis Books, New York, 2004
[40] White, W., Culver, D. (Eds.), Encyclopedia of Caves - 2nd Edition. Academic Press, Amsterdam, 2012
[41] Veress M., Telbisz T., Tóth G., Lóczy D., Ruban D.A., Gutak J.M. (Eds.), Glaciokarsts. Springer, Cham, 2019
[42] Mayer M., Müller M., Woltering M., Arnegger J., Job H., The economic impact of tourism in six German national parks. Landsc. Urban Plan., 2010, 97, 2, 73–82, doi: 10.1016/j.landurbplan.2010.04.013
[43] DeLucio J., Múgica M., Landscape preferences and behaviour of visitors to Spanish national parks. Landsc. Urban Plan., 1994, 29, 2–3, 145–160, doi: 10.1016/0169-2046(94)90024-8
[44] Brilhá J., Geoconservation and protected areas. Environ. Conserv., 2002, 29, 3, 273–276, doi: 10.1017/S0376892902000188
[45] Tourism and national parks: issues and implications. Butler, R.W., Boyd, S.W., Eds.Wiley, Chichester, 2000
[46] Vasiljević Đ.A., Vujičić M.D., Božić S., Jovanović T., Marković S.B., Basarin B., Lukić T., et al., Trying to underline geotourist profile of National park visitors: Case study of NP Fruška Gora, Serbia (Typology of potential geotourists at NP Fruška Gora). Open Geosci., 2018, 10, 1, 222–233, doi: 10.1515/geo-2018-0017
[47] Reynard E., Scientific research and tourist promotion of geomorphological heritage. Geogr. Fis. E Din. Quat., 2008, 31, 225–230
[48] Hose T.A., Towards a history of geotourism: definitions, antecedents and the future. Geol. Soc. Lond. Spec. Publ., 2008, 300, 1, 37–60, doi: 10.1144/SP300.5
[49] Štrba Ľ., Analysis of Criteria Affecting Geosite Visits by General Public: a Case of Slovak (Geo)Tourists. Geoheritage, 2019, 11, 2, 291–300, doi: 10.1007/s12371-018-0283-2
[50] Stepišnik U., Trenchovska A., A new quantitative model for comprehensive geodiversity evaluation: the Škocjan Caves Regional Park, Slovenia. Geoheritage, 2018, 10, 1, 39–48, doi: 10.1007/s12371-017-0216-5
[51] Bao J., Zhang C., The TALC in China's Tourism Planning: Case Study of Danxia Mountain, Guangdong Province, PRC. In: *The tourism area life cycle*; Channel View Publications, Clevedon, 2006; pp. 107–115
[52] Gessert A., Nestorová–Dická J., Sninčák I., The dynamics of tourist excursion ratios in Slovakia show caves from 2000 to 2014. Geogr. Tidsskr.-Dan. J. Geogr., 2018, 118, 2, 173–183, doi: 10.1080/00167223.2018.1503552
[53] Gojmerac M., Održivi razvoj turizma Nacionalnog parka Krka. PhD ThesisKarlovac University of Applied Sciences. Business Department.2018
[54] Telbisz T., Stergiou C.L., Mindszenty A., Chatzipetros A., Karst features and related social processes in the region of the Vikos Gorge and Tymphi Mountain (Northern Pindos National Park, Greece). Acta Carsologica, 2019, 48, 1, 29–42
[55] Lake District National Park http://www.lakedistrict.gov.uk/learning/factsandfigures
[56] Butler R.W., Seasonality in tourism: Issues and implications. In: Baum, T., Lundtorp, S. (Eds.), Seasonality in tourism, Routledge, London, 2001, 5–21
[57] Williams P., World heritage caves and karst. IUCN Gland, 2008
[58] Postojnska Jama 1 https://www.postojnska-jama.eu/en/media-centre/news-and-press-releases/postojna-cave-welcomes-its-38-millionth-visitor/
[59] Postojnska Jama 2 https://www.postojnska-jama.eu/en/media-centre/news-and-press-releases/a-historic-day-for-postojna-cave/
[60] Cigna A.A., Burri E., Development, management and economy of show caves. Int. J. Speleol., 2000, 29, 1, 1–27
[61] Šebela S., Turk J., Pipan T., Cave micro-climate and tourism: towards 200 years (1819–2015) at Postojnska jama (Slovenia). Cave Karst Sci., 2015, 42, 2, 78–85
[62] Yin X., Li J., Lei Y., Assessment of the forest park's tourism environmental carrying capacity - a case study of Chongqing Huangshui National Forest Park. Hum. Geogr., 2013, 28, 2, 154–159, doi: 10.13959/j.issn.1003-2398.2013.02.005
[63] He F.Y., Zhang Y., Peng P.H., A Study on Measurement of Tourism Environmental Carrying Capacity of Geoparks-A Case Study of Xinwen Karst World Geopark. In: Proceedings of the Advanced Materials Research, Trans Tech Publ, 2013; 726, 4061–4064, doi: 10.4028/www.scientific.net/AMR.726-731.4061
[64] Van Beynen, P.E. (Ed.), Karst management. Springer, Dordrecht, New York, 2011
[65] Veni G., A geomorphological strategy for conducting environmental impact assessments in karst areas. Geomorphology, 1999, 31, 1, 151–180, doi: 10.1016/S0169-555X(99)00077-X
[66] Van Beynen P., Townsend K., A Disturbance Index for Karst Environments. Environ. Manage., 2005, 36, 1, 101–116, doi: 10.1007/s00267-004-0265-9
[67] Kim S.S., Kim M., Park J., Guo Y., Cave tourism: Tourists' characteristics, motivations to visit, and the segmentation of their behavior. Asia Pac. J. Tour. Res., 2008, 13, 3, 299–318
[68] Allan M., Dowling R.K., Sanders D., The motivations for visiting geosites: the case of Crystal Cave, Western Australia. Geoj. Tour. Geosites, 2015, 16, 2, 141–152
[69] Hurtado H., Dowling R., Sanders D., An exploratory study to develop a geotourism typology model. Int. J. Tour. Res., 2014, 16, 6, 608–613, doi: 10.1002/jtr.1954

## Supplemental data

European National Parks and Geoparks classified by their karst resources and karst types, with scientific references.

The file "*TelbiszMari_EuropeanNationalParksAndGeoparksTable_OG.xlsx*" contains data of all partly or mostly karstic European National Parks and Geoparks (name, area, year of foundation, karst resources, karst type, some scientific references).