

Geoheritage and Climbing

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Geological and geomorphological heritage (geoheritage) is often found in mountain domains that also provide resources for climbing, mountaineering, bouldering, and canyoning. The relevant research is linked to geoconservation, geoeducation, the tourism industry, and tourism opportunities. Several methodologies for assessment of geoheritage and climbing sites are proposed. The world's highest peaks are essential for the relationship between geoheritage and climbing activities.

geoconservation

geotourism

geological resources

1. Introduction

Establishing the heritage value of geological and geomorphological objects contributes to understanding of natural resources, efficient planning of conservation activities, designation of protected areas, and improvement in human–environment relationships via tourism and education. The relevant ideas can be found in the fundamental works by Bentivenga et al. ^[1], Brilha et al. ^[2], Brocx and Semeniuk ^[3], Dowling and Newsome ^[4], Gordon ^[5], Gray ^[6], Henriques and Brilha ^[7], Henriques et al. ^[8], Pescatore et al. ^[9], Prosser ^[10], Prosser et al. ^[11], Reynard and Brilha ^[12], Štrba et al. ^[13], Thomas ^[14], and Wimbledon and Smith-Meyer ^[15]. Simultaneously, new issues, including those related to sustainability, arise together with the growth of societal awareness and exploitation of geological and geomorphological heritage (geoheritage). Particularly, some (if not many) peculiar landforms provide excellent opportunities for climbing activities, climbing sites boast exceptional visibility of rocks in cliffs, and climbing as a sport/recreation activity produces significant anthropogenic pressure on unique geological environments. Multiple relationships and feedback mechanisms exist in these cases.

Deciphering the above-mentioned issues relevant to geoheritage and climbing activities is not only interesting in a scientific sense due to the complexity of these issues, but it is also practically important. In particular, these issues are closely linked to geotourism development. Three lines of evidence in support of this statement are as follows. First, this tourism direction has become global and continues to grow ^{[4][16][17]}. Apparently, climbing activities can enrich the experience of geotourists and contribute to geoheritage accessibility. Second, geotourism requires attention to sustainability issues ^{[7][8][18][19][20][21][22]}. If coupled with climbing activities, it challenges sustainable development due to the above-mentioned environmental impact of humans. Third, geotourism development is strongly related to the international geopark movement ^{[7][23][24][25][26][27][28][29]}. Although geoheritage lies at the “core” of geoparks, functioning of the latter cannot be restricted to only geotourism and conservation procedures. These establishments should use their potential and infrastructure to allow environmentally responsible exploitation

of natural resources to satisfy their visitors and to support local communities. Climbing seems to be a highly plausible option for many geoparks.

2. Basic Terms and Ideas

2.1. Geoheritage

Geoheritage includes “pure” geological heritage and geomorphological heritage, i.e., the entity of unique features of the Earth’s crust that can be employed for the purposes of science, education, and tourism (cf. [30]). Although unique geomorphological features constitute a special type of geological heritage [31], studies of the former have become a significant and somewhat individual research direction [32] (see also Coratza and Hoblea in [12]), and are sensible to consider with a kind of separation from pure geological heritage studies. Geoheritage has different types and forms [11][30]. The former refers to the general essence of unique geological phenomena, and these are geomorphological, sedimentary, igneous, metamorphic, stratigraphical, palaeontological, palaeogeographical, mineralogical, tectonic, economical, engineering, pedological, geochemical, geocryological, geothermal, cosmogenic, hydro(geo)logical, geohistorical (or geoexploration), and complex types (the latter means the co-occurrence of two and more types). The forms include (but are not limited to) natural outcrops and landforms, quarries and mines (and entire deposits), road cuttings, mineral and fossil museum collections, and geological exhibits. Geoheritage requires conservation (geoconservation), which includes a broad spectrum of activities and formal procedures, including evaluation, monitoring, maintenance (also cleaning), protection, and promotion of unique geological and geomorphological features.

Geoheritage can be understood, very broadly, as essential characteristics of the unique geological environment. In this case, it is closely related to the idea of geodiversity [2][6][33][34][35][36][37][38][39]. However, of special importance are localities exhibiting geoheritage that are officially designated. Two main types of such localities are geosites and geoparks. The former are relatively small objects or areas representing unique phenomena (cf. [30]). These also include geomorphosites displaying peculiar landforms and/or geomorphological processes [32][40][41] (see also Coratza and Hoblea in [12]). Geoparks are areas specially designated for geoheritage exploitation for the purposes of tourism, education, and science, as well as for their conservation [7][23][24][25][26][27][28][29] (see also Brilha in [12]). These can be linked to single geosites with outstanding importance, several geosites, geodiversity hotspots, and geographical/geological domains boasting a concentration of geoheritage. Many geoparks tend to join national and international networks, including the United Nations Educational, Scientific and Cultural Organization (UNESCO) Global Geopark network [7] and the European Geoparks network [29]. Geosites and, in particular, geoparks are the key destinations for geotourists, and actual geotourism growth [4][5][7][13][16][17] has become the logical outcome of the extensive geoheritage exploration and the official designation of its manifestations.

In fact, geoheritage and geotourism are understood to have certain differences in the research community. Geoheritage can be restricted to only those unique features that are the subject of geoconservation. However, geoheritage seems to be also important as a resource for science, education, and tourism, and often its utility for these purposes creates its value and argues for the necessity of geoconservation. Such a broad, resource-based

vision is preferred in this paper. Geotourism can be understood as a broad range of activities linked to the natural environment. If so, it can exploit geoheritage together with other components of the environment. A narrower understanding of geotourism restricts it to those activities that are based on unique geological and geomorphological features, that is, those linked to the geological and geomorphological environment. To avoid confusion, such a vision of geotourism is preferred.

2.2. Climbing Activities

Mountainous geographical domains often host many high-angle slopes (“walls”) that are linked to peaks, cliffs, and river valleys. Such slopes are ideal for (almost) extreme tourism, sport, and outdoor recreation activities that are very generally known as climbing, but can be also defined using several other terms (e.g., mountaineering (=alpinism) is the main alternative term for rock climbing, but climbing is preferred provisionally as the main generic term in this paper). Millions of more or less trained visitors to mountains are involved in these activities on an annual basis (rock climbing is paired now by indoor climbing).

Rock climbing usually means “conquering” notable peaks and cliffs (at least, reaching high points), often with a preference for challenging routes and non-trivial solutions; these activities can be linked to tourism, sport, and outdoor recreation [42], and they require some physical training [43][44][45], risk-taking and pleasure satisfaction [46][47][48][49], and specific geographical vision [50]. Rock climbing also exerts a significant anthropogenic pressure on the environment, although the degree of this pressure depends on different parameters and conditions, and remains debatable [51][52][53][54][55]. Mountaineering is a slightly more general term referring to the broader spectrum of tourism, sport, and recreation activities in mountainous domains; essentially, it refers to the same activities as climbing, although emphasizing the outdoor character of these activities [42][56]. The on-line bibliographical database Scopus includes >320 papers mentioning rock climbing in their titles and >380 papers mentioning mountaineering (state as at mid-May, 2020; some of these papers deal with geoheritage, but the majority do not). In the literature, mountaineering is often treated in regard to industry and society [57][58][59] and places [60][61], but chiefly to personalities (physiology and emotions) [62][63][64][65][66][67][68][69][70][71].

Environmental effects are also documented [72][73]. Two other activities that are related to climbing are bouldering and canyoning. The former means short-distance, but difficult, route climbing on big boulders (megaclasts in geological terminology) or relatively small landforms (e.g., hillocks) with steep slopes. Bouldering is more a sport or outdoor recreation activity than tourism. In the literature, this activity is discussed in regard to human physiology and psychology [74][75][76], and the landscape context [77] and environmental effects of bouldering are also documented [78][79]. Bouldering sites also facilitate finding peculiar geological objects such as megaclasts [80]. Canyoning is a kind of adventure tourism in difficult-to-access river valleys (chiefly, these are canyons and gorges) [81][82][83][84]. Partly, it is based on climbing, and steep slopes constitute its main resource. Development of canyoning is also related to the issues of risk-taking and safety [85][86].

Climbing activities are strongly related to sustainability. On one hand, they challenge the latter via an increase in the anthropogenic pressure on natural environments [51][52][53][54][55][72][73][78][79]. On the other hand, these

contribute to sustainable development via generating additional income and jobs, planning improvement, social and political stability, etc. [\[87\]](#)[\[88\]](#)[\[89\]](#). However, the role of extreme/adventure tourism in the achievement of sustainability should not be exaggerated [\[90\]](#)[\[91\]](#)[\[92\]](#). Moreover, local sustainability is a factor in the development of climbing activities (e.g., [\[87\]](#)).

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