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Review

Worldwide Trends in Methods and Resources Promoting Geoconservation, Geotourism, and Geoheritage

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Abstract: This study aims to provide a systematic analysis of the literature of methods and resources supporting geoconservation and geotourism worldwide, while identifying current and future trends in the field. This paper offers a comprehensive bibliometric analysis which comprises the period of 2011–2021 after an in-depth systematic literature review of 169 papers, using Web of Science. The volume of research on these topics is growing rapidly, especially in Italy, Poland, Brazil, Russia, and China; these constitute the most productive countries. The main identified geomorphological environments are sedimentary, volcanic, aeolian, coastal, fluvial, and karstic. We discovered that the main methods for evaluating geoconservation and geotourism are geomorphological mapping, the study of economic values for geotourism, field work as a research tool, geoheritage management, documentation, exploration, and inventories of geoheritage at a regional level. The main determined resources are UNESCO Geoparks, educational activities, digital tools, geomanagement, economic values, geoitineraries, and geoeducation programs. To our knowledge, this is the first study dealing with methods and resources publicizing geoconservation and geotourism, worldwide. Knowing about the most successful methods and resources for promoting geoconservation and geotourism can definitely be useful for future endeavors in countries where geoheritage studies are starting to be developed.

Keywords: geoheritage; geodiversity; geoconservation; geotourism; Web of Science; bibliometric analysis; co-citation analysis

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1. Introduction

Over the last 30 years, growing scientific interest has emerged in geoconservation, geotourism, and geoparks [1,2]. In fact, it was at the International Symposium on the Conservation of Geological Heritage in 1991 that the term geoheritage was used for the first time, and numerous conceptualizations have been proposed and established from that moment on [3]. The concept relates to the preservation of the characteristics of the planet that are important for geosciences such as landforms, geological outcrops, and their main traits [4]. Hence, geoheritage constitutes the geological heritage of a site and a new paradigm for physical geography [5].

Geoheritage has been relegated to the background in international events such as the Earth Summit in Rio de Janeiro and Agenda 21, the Millennium Declaration. The same occurred in 2015 when the United Nations adopted the Sustainable Development Goals, yet geosciences were not included, leaving aside the importance of geodiversity for sustainable development. The World Tourism Organization (UNWTO) has followed the same path, with some resolutions that leave geotourism aside [1,6].

The panorama is different in international organizations such as the International Union for the Conservation of Nature (IUCN) and the United Nations Educational, Scientific, and Cultural Organization (UNESCO), which have proposed the topics of geoheritage/geodiversity in the program of their international forums. In 2014, a group of geoheritage specialists was established within the World Commission on Protected Areas.

In addition, UNESCO created the International Geoparks Program and other individual initiatives emerged such as the International Association for the Conservation of Geological Heritage (ProGEO) to promote the academic scientific development of geoconservation. Moreover, the International Association of Geomorphologists (AIG) presented a specific group of researchers working on geoheritage. Additionally, the International Union of Geological Sciences established the International Commission on Geoheritage [1].

The scientific interest in geoheritage, geoconservation, and geotourism studies has grown, due to the interest in its scientific, academic, historical, social, cultural, and aesthetic values [4]. Many of these values are exposed in the geodiversity worldwide. Geodiversity encompasses elements of abiotic nature such as geology, geomorphology, soils, and hydrology [7,8]. This concept has been widely applied in geoconservation and geoheritage contexts, in addition to the attributed values by society to aspects of the abiotic, natural environment, due to their historical importance. Moreover, geodiversity increases the quality of the relations between diverse processes and interrelations of the Earth system.

Geodiversity is considered the core of national geoheritage strategies, assessments, and geological conservation, which supports biodiversity and geosystem services such as geotourism [9–11]. As a global, regional, and local concept, geodiversity has contributed to the formation of new knowledge and new avenues of research and results [12]. Geosites are the representative elements of geodiversity and have been made known through geotourism and in initiatives such as the UNESCO Global Geoparks for a decade [13]. There is a logical succession from geology, science through geological heritage, and the identification of sites of geoheritage importance, to the determination of geosites or geopark establishment, then to geoconservation, which leads to geomanagement, geoeducation, and geotourism [14,15].

The interest in geoconservation has been increasing since the 1990s, and the IUCN has promoted initiatives to integrate geodiversity and geoheritage [16,17]. This is defined as the policies, approaches, and efforts aimed at geoconservation. It is a tradition that differs in time and space, since countries such as the United Kingdom and Australia have protected their geoheritage for 70 years, while in the rest of the countries it is a recent and partial process [18]. The main objectives of geoconservation are protection and sustainable use of exceptional elements of geodiversity [19,20].

The growing interest in geoconservation has been demonstrated by the numerous site inventories that have been carried out in different countries [21,22]. The scientific community has focused its efforts on the formulation of various qualitative and quantitative methodologies to evaluate geosites for conservation [23–25]. Geosite inventories and assessment provide a basis for the protection and use of geoheritage, and are considered basic steps in geoconservation strategies and a management support tool [26–28].

Geotourism started as a scientific discipline that emerged in the line of geological engineering in geotourism, and that migrated towards the study of geoheritage. It is in a phase of exponential growth of research, with scientific productivity and the diversification of information covering research trends such as geosites, geoheritage, and geoparks [20]. Geotourism is a specific form of nature tourism focused on the discovery of geology and geomorphology revealed through scientific research, promoting the protection of geodiversity and the awareness of visitors [29,30]. It is one of the most recent concepts within tourism studies today [31]. These studies focus on identifying, describing, and evaluating geoheritage and its geotourism potential on different scales. A small number of researchers are interested in tourists, local communities, and sustainable development [32,33]. It has therefore been positioned as a strategic route for the promotion of sustainable tourism [34,35]. It is also an effective method of bringing geosciences to a wider audience [36] and a way to generate social, economic, and environmental benefits [20,37,38], especially in rural areas of developing countries with strong human pressures relating to natural resources [39,40].

The growth of geotourism is evident with the expansion of the UNESCO World Network of Geoparks initiative [31]. Geotourism activities are promoted, with geoparks being the basis for the development of geotourism and new geoparks proposals around

the world [39–41]. Geoparks expose and contain the geological, geomorphological, hydrographic and edaphic values, and the geological diversity, historical structures and traditional culture which are resources for many tourist activities [42]. Geo-education in the geological and environmental sciences, and sustainable regional development are key factors for integration into geotourism studies [30,43,44].

There are many bibliometric analyses and systematic literature reviews dealing with geoheritage [13,30], geodiversity [5], geoconservation [45,46], geoparks [47–49], and geotourism [13,31,32,38,50]. We hypothesize that, despite the many reviews of geoheritage that have been carried out, a systematic literature review of the methods and resources promoting geoconservation and geotourism has not been performed. Considering the global scientific growth of geoheritage, geoconservation, and geotourism, we present a systematic literature review of the main world trends in the methods and resources that promote geoconservation and geotourism. In addition, we present some data on how the investigative literature has been produced around geoheritage, geoconservation, and geotourism. As far as we know, this is the first study dealing with methods and resources publicizing geoconservation and geotourism.

2. Materials and Methods

Systematic literature reviews have demonstrated successful identifying trends, prospective study fields, research gaps, and unstudied geographic areas in several knowledge fields. The reviews have also discussed detailed analyses related to geoheritage [51–53], geodiversity [5,8,12], geoconservation [46], and geotourism [13,38].

We used the Web of Science Advanced Research Query Builder, specifically the All Web of Science Citation Index Expanded. We used the following query expression:

(ALL = (“geotourism” AND “geoconservation” AND “geoheritage”)) AND (LA==(“ENGLISH”)) (1)

The query was configured to show the last 10 years of studies; that is, from 2011 to January 2022 (including all of 2021). Therefore, the bibliographic sources and a tab-delimited text file (.txt) were obtained. We only used study cases, not including review papers. With the help of an Excel spreadsheet, a bibliographic database was designed with authors, title, journal of publication, keywords, abstract, country of study, corresponding author, corresponding country, publication year, Web of Science category, and research area. The methods, resources, and environments were extracted by reading all the abstracts of every paper. We split all the determined environments and summed them independently for each of their environments. From these data, frequency analyses were performed to determine the bibliometrics. Subsequently, using the VOSviewer version 1.6.18 program, the tab-delimited text file (.txt) was loaded to generate bibliometric maps of country of correspondence, country of study, environment, methods, year of publication, resources, journal, and authors. The results served to corroborate both the manual bibliometric analysis in Excel and the automated one from VOSviewer. Our goal is to map the current state of the art with the different tools used in recent years to promote geoconservation and geotourism. Our primary intention is to uncover hidden patterns and provide support to stakeholders in order to bring new directions and visualize the interconnectedness of specific subject areas. Rather than providing a critical evaluation of each research paper, we aim to simply showcase the current progress in terms of methods and resources promoting geoconservation and geotourism.

3. Results and Discussion

3.1. Methods to Promote Geoconservation and Geotourism

Global trends around methods that promote geoconservation and geotourism demonstrated three broad generalities (Figure 1). First of all, there is still a research trend and tradition related to the inventory and evaluation of geoheritage in general. Moreover, those evaluations for the promotion of geotourism have been made through SWOT analysis, the application of surveys to visitors and the description of geoheritage. In addition, the issue

of geoconservation through proposals and management plans of geoheritage have been supported by the cartographic discipline and the inventory and evaluation of geosites for the promotion of geotourism.

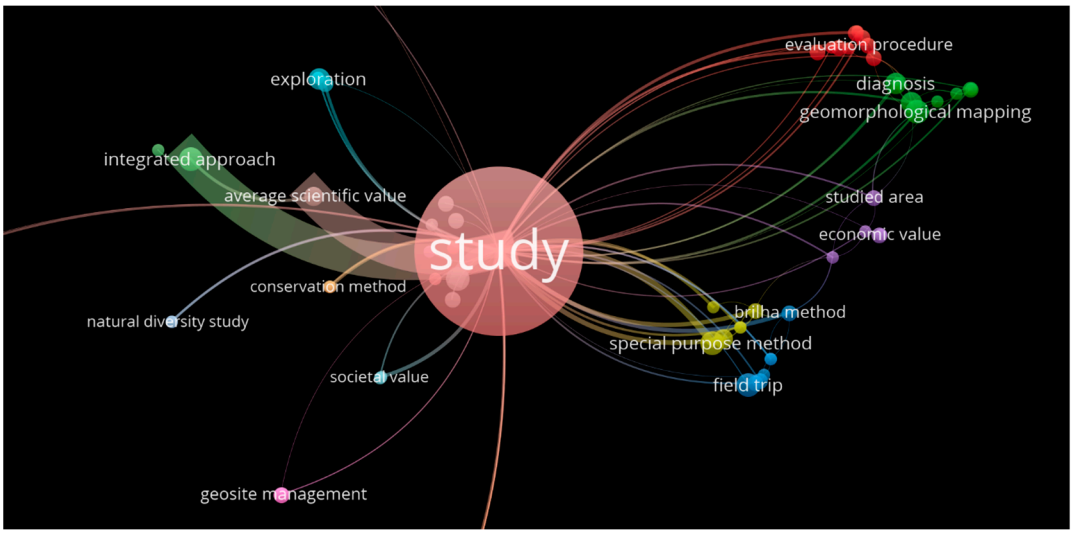

Figure 1. Global trends in methods for promoting geoconservation and geotourism.

The studies are divided into procedures for the evaluation of geotourism, geomorphological mapping, the study of economic values for geotourism, field work as a research tool, geoheritage management, documentation, exploration, and inventories of geoheritage at the regional level. In each of the commented-upon methods, the literature exposes proposals and new quantitative methods for geological interpretation. The geomorphological mapping support diagnoses that in turn allow the valuation of geotourism and later the geoconservation and monitoring plans in relation to the values of the geological heritage.

The methods and world resources that are the trend for promoting geoconservation and geotourism have not been worked on, and therefore the present academic exercise is novel, and it is difficult to develop a comparative analysis of the results with previous experiences at the level of bibliometric reviews of the literature. From the results, it is possible to identify the perspectives of some methods in authors such as Duarte et al. [38], who, using the Scopus database, indicate that the geoheritage inventory and evaluation processes are still scarce, but an excellent method is used in the first steps of promoting geoconservation and geotourism. The authors also highlighted studies that analyze and evaluate the experience of visitors in projects associated with geoconservation and geotourism. In this light, they become relevant to our results, as the SWOT analysis and the application of visitor surveys appear to be important methods for the evaluation of geoheritage and its relationship with visitors. Ólafsdóttir and Tverijonaite [32], using Scopus, Web of Science, and Science Direct indicated that, in research into geotourism management, new models and approaches to evaluating geosites and their forms of promotion regain importance. Farsani [49] highlighted the figure of the geopark as a resource and the need to inventory and evaluate geoheritage as a method, prior to these projects. Reynard [18] showed how the IAG (International Association of Geomorphologists) has created guidelines for mapping and making geoproducts, another of the results discussed in this research (Figure 1).

Numerous publications by the scientific community on geoheritage have indicated that UNESCO Geoparks are the main way to promote geotourism and geoconservation. Duarte et al. [38] identified numerous studies explaining the topic of geoparks, finding an important relationship with issues of socioeconomic development and local economy, which is discussed by Ólafsdóttir [31] in the case of the rural socioeconomic development associated with geotourism. Galvão [50] also found this association in the literature on the topic of geoparks, and Farsani [49] mentioned how geoparks are related to the issue

of geoeducation and geoconservation of local communities. Moreover, social media has a huge impact on the decision-making of future visitors of different geotouristic destinations [54,55]. The integration of local/regional knowledge of geosites, the integration of local stakeholders, public and private sector decision-makers, and the proper use of technologies such as GIS and social media could enhance the promotion of geoheritage sites.

3.2. Resources in the Promotion of Geoconservation and Geotourism

The systematic literature review indicates that the global promotion of geosites is one of the most used in studies related to geoconservation and geotourism worldwide (Figure 2). Trends show that the main route for geotourism and geoconservation uses the concept of UNESCO Geoparks. These trends also relate to the educational activities in schools and universities that propose to integrate geosciences into the academic field to make people more aware of the importance of geoheritage and its protection. Geoparks can provide socio-economic benefits to local communities in line with sustainable development for both developed and developing countries [51].

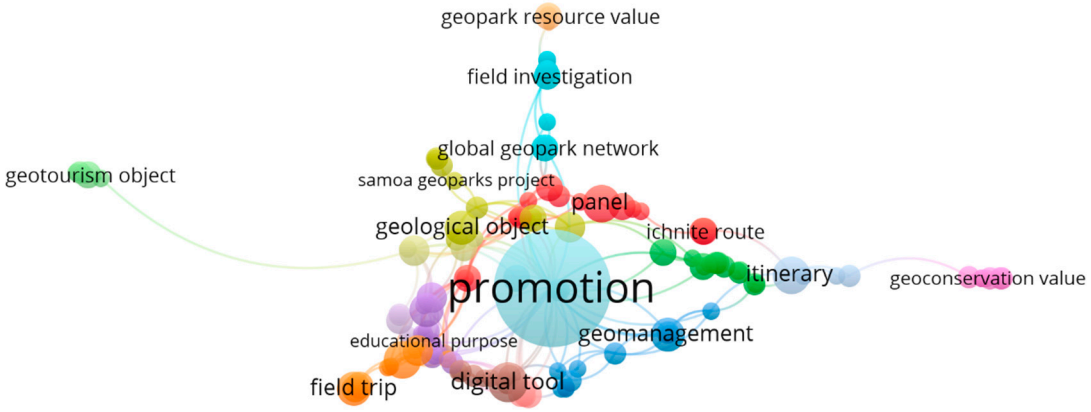

Figure 2. Most used resources that expose the main trends in the promotion of geotourism and geoconservation.

Another trend we found has to do with the digital tools which become the key support for geomorphological and geological mapping to technologies in mobile devices that allow the promotion of educational and geotourism activities. Another major link in these conflicting trends contrasts with the geomanagement related to the proper administration of geosites that attract tourists around the world and that, without proper regulation, puts much of the world's geoheritage at risk. This also permeates the economic values and the development of geotourism in a sustainable way. Digital tools have improved geolocation, geointerpretation and geomodelling in the promotion of geoheritage and geoconservation worldwide [56].

The figure of modern geotourism supported by geoitineraries that make the most relevant geosites and their values available, allow geotourism to be promoted through field guides that expose geodiversity and, in turn, involve geoconservation at a local level, contributing to the protection of geosites. Geotourism projects are closely related to geoeducation programs through technologies such as information panels and web pages, which affect the popularization of geoheritage. At the academic level, the role of geotourism is very important in field research to obtain the most detailed information and to be able to carry out an adequate promotion of geotourism and geoconservation. Somma [57] has identified the fact that interactive, didactic earth-science activities can enhance geoconservation for a broader audience.

Some of the most important resources gaining prominence in the processes of promoting geotourism and geoconservation are technological and digital tools. These are related to processes such as geomorphological and geological mapping and technologies associated with mobile devices that allow projects to be promoted, as well as the different

educational and geotourism activities. From this perspective, Williams [45] in interviews with global professional experts in geoconservation and geotourism in 2018, indicated that 25% of them used geographic information technologies to support decision-making and communication.

3.3. Country of Correspondence and Study

The research derived from an analysis of the countries with more than two appearances per frequency (Figure 3) of the main authors on topics related to geotourism, geoconservation, and geoheritage, are from countries such as Italy, Poland, Brazil, Russia, and China. We found an association of co-citation among the various countries, leaving out some countries such as Turkey, Greece, Romania, among others.

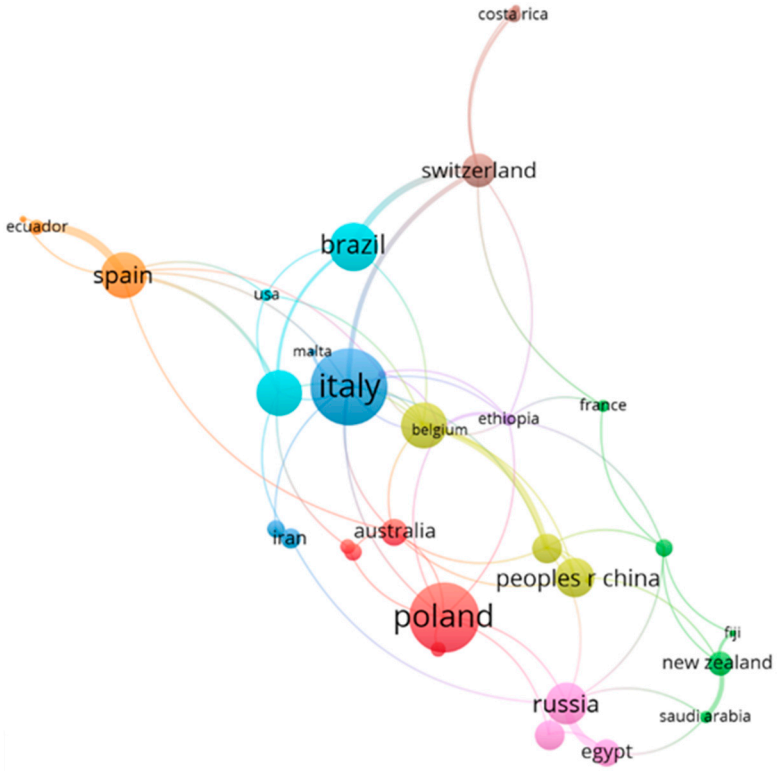

Figure 3. Network visualization in the VOSviewer program. The size of the circle and label are proportional to the frequency in number of studies per country of correspondence. The intensity of the lines shows the strength of the association between co-citations and the colors show the groups of co-citations among authors of each country.

As for the country of the study, the trend varies very little. We found that the countries with the most studies in their territory relating to geoheritage, geoconservation and geotourism are in descending order: Italy, Brazil, China, Poland, and Egypt (Figure 4). Russia is displaced by Egypt as the fifth country, mainly due to the great geological and archaeological interest that surrounds it. The complete data are located in the Supplementary Material. When it comes to the country of correspondence and the country of the study [38] of geotourism, we found high production in Brazil, Australia, and Italy. In terms of geotourism, most of the studies correspond to Europe, supporting the idea that Italy, followed by Poland, Serbia, the United Kingdom, and Slovakia are the countries of correspondence par excellence. The author also indicated that the case of the Asian continent is headed by Iran, followed by China. In Africa, Egypt leads and is followed by Morocco and Cameroon. In the case of Australasia, it is led by Australia followed by New Zealand. In America, Brazil and the United States stand out. Ruban [51] showed that geotourism has been researched mainly in the Middle East, Europe, South America, and East Asia, finding leading researcher communities in Italy, Brazil, China, and Poland. Herrera et al. [20], using the

Scopus database, also indicated that geotourism and geosites also coincide in countries such as Italy, Spain, China, Portugal, and Brazil. The future of geoconservation and geotourism will include the appearance of several countries with alluring places and geosites to be valued and promoted through evaluation, geoparks, and international recognition. Many developing countries and regions will find in geotourism an innovative, sustainable, and profitable way to generate income for their population.

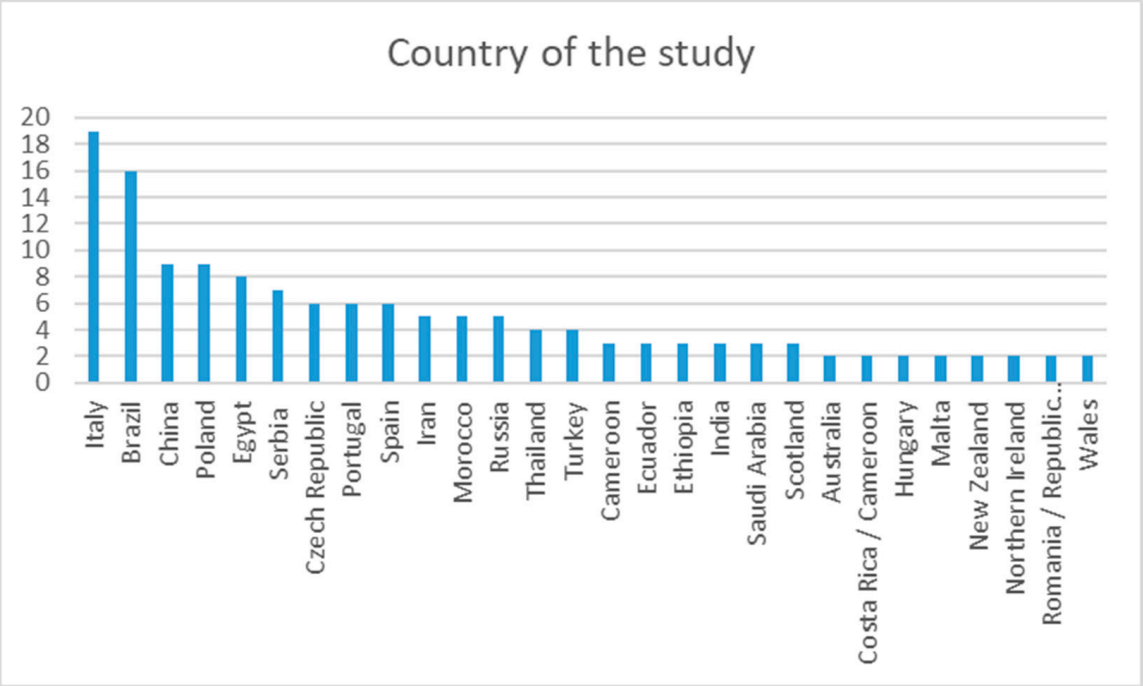

Figure 4. Graph showing the number of studies related to geoheritage, geoconservation and geotourism worldwide, with respect to the 169 articles analyzed.

3.4. Authors

From 661 authors, the authors who published the most on topics related to geoheritage, geoconservation and geotourism were Ruban Dmitry A, Kubalikova Lucie, Reynard Emmanuel, Coratza Paola, and Hose Thomas A (Figure 5), whereas the most cited are Hose Thomas A, Henriques María Helena, dos Reis Rui Pena, Kubalikova Lucie, and Reynard Emmanuel. In the case of the authors with more publications on topics related to geotourism, geoheritage and geoconservation, the results showed some variation, which may be due to the different search parameters and topics covered in each particularity. For example Duarte et al. [38], for authors associated with the topic of geotourism and territorial development, found in descending order those such as Hose, TA, Newsome, D, Dowling, R, Farsani, NT, Poiraud, A and Reynard, E Herrera et al. [20]. In the analysis of the literature regarding geoheritage and geosites they identified that among those associated with geotourism, Ruban D stands out, while in geoconservation it is Brilha J. Herrera et al. [20], indicating that the authors with most publications on geotourism, in descending order, are Ruban DA, Hose TA, Marković SB, Migoń P, and Farsani NT The complete data is located in the Supplementary Material. The number of authors working on geoheritage is growing rapidly, and these names may change in the near future, due to the specialization of researchers in different approaches of geoconservation and geotourism.

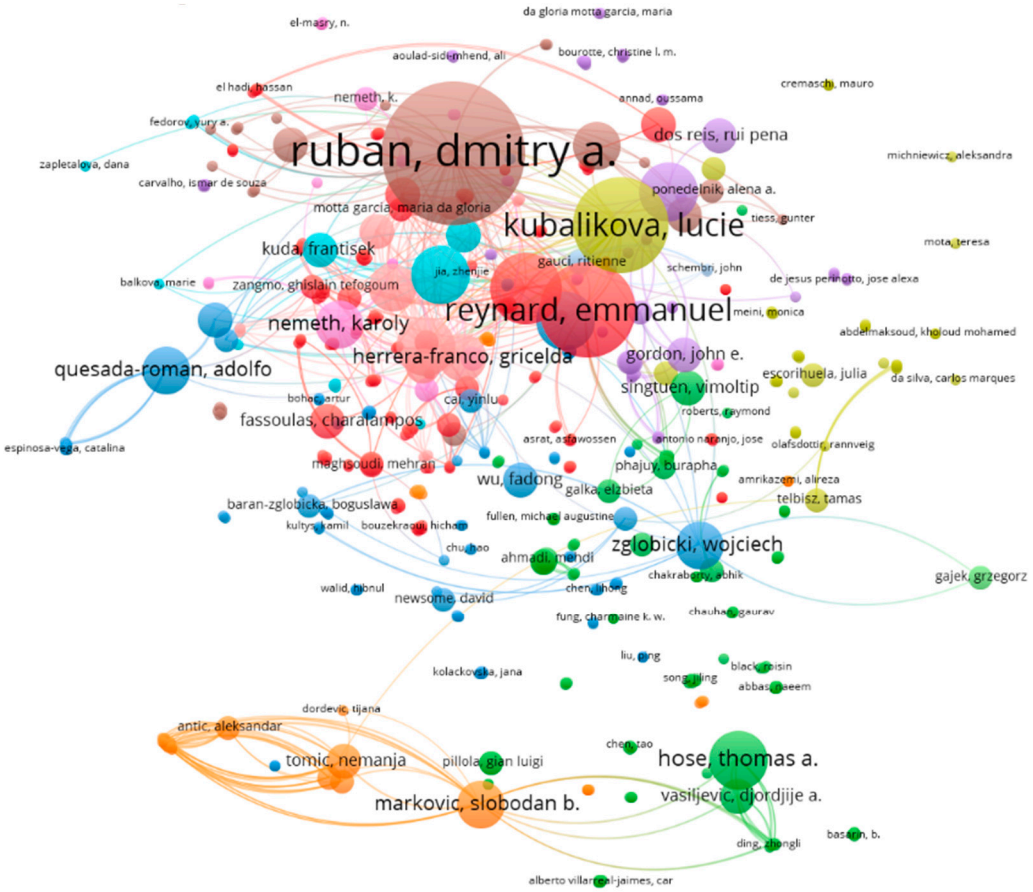

Figure 5. Most-productive authors dealing with methods and resources promoting geoconservation and geotourism.

3.5. Scientific Journals

The bibliometric analysis highlighted the fact that the first five most-used journals in publications related to geoheritage, geoconservation and geotourism issues are *Geoheritage*, *Sustainability*, *Quaternary International*, *Resources*, *and Proceedings of the Geologists Association*. The complete data are located in the Supplementary Material. The results obtained from the main scientific journals are comparable with those obtained by Herrera et al. [20] where *Geoheritage* journal tops the list, with the most publications and citations. The *Quaternary International* journal is second in terms of number of publications. Duarte et al. [38] found an association of geoheritage studies with the journal *Geoheritage*, followed by the journal *Vulcanology*, then the journals *Geotourism* and *Global Geotourism Perspectives*. Ruban et al. [53] in their article on the unique and climbing geology also found the *Geoheritage* journal to be the main journal for geoheritage issues. Ólafsdóttir and Tverijonaite [32] determined that the main journals related to the topics of geoheritage and geotourism are the *Geoheritage* journal, followed by the *Geojournal of Tourism and Geosites*. There is an increase in the number of journals publishing articles related to geoheritage worldwide. This opens up a plethora of options for publishing to authors worldwide and from different disciplines, enhancing the inclusion of different technologies, approaches, and methods to value, spread, promote, and protect geosites worldwide.

3.6. Geomorphological Environment

The study allowed us to identify the current and formative environments in which research on geoheritage, geoconservation and geotourism has been developed, particularly volcanic environments, valleys, and coasts (Figure 6). We used sedimentary environments because there were several environments in the same study. Sometimes, these sedimentary

environments are linked to fluvial, glacial, gravitational, karstic, metamorphic, coastal, and even volcanic environments. Therefore, we find studies in sedimentary environments that largely involve deserts, valleys, and coasts around the world where fluvial, aeolian, and karstic geomorphology are well represented. The most frequently mentioned geographical features are sinkholes, karstic formations, deposits such as loess fields, mines, islands, and Jurassic coasts. Formations and environments of volcanic origin from both effusive and intrusive events are also well represented. Examples of these are plutonic morphologies or volcanoes.

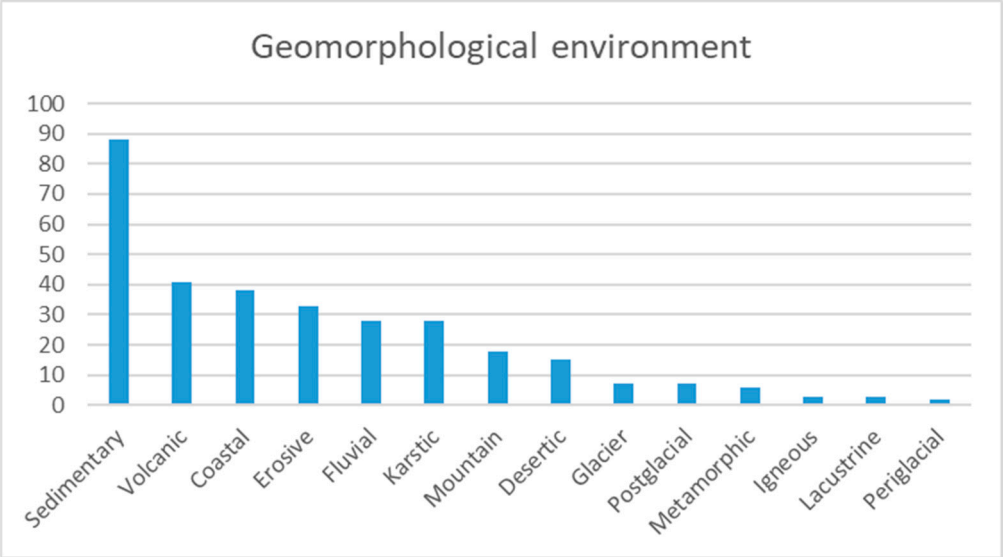

Figure 6. Main study environments of geoheritage, geoconservation and geotourism around the world.

The studies referring to the geomorphological environments analyzed by various scientific publications do not differ significantly from those found in our research. In the case of Ólafsdóttir and Tverijonaite [32], volcanic-formation environments, mountainous areas, followed by urban geoheritage, quarries, and mining areas are the main contexts where research on geotourism and geoconservation has focused. The authors added that in mountain areas, geomorphosite evaluations predominate. These areas require particular mapping techniques in order to generate good baseline information for geoheritage purposes [58]. In the case of caves, the main avenue of research is to examine tourist motivations, and geotourism management is analyzed in the volcanic and loess contexts. Quesada et al. [59] determined that in Central America volcanic environments, coastal areas, karstic environments, glacial, and fluvial environments are the most common in the region. The opportunity to enhance different geomorphic environments in order to study geosites, is immense. There are large regions of the world where geoheritage studies are still scarce, which possess incredible landforms, processes, and landscapes.

4. Conclusions

We have presented a systematic literature review of methods and resources supporting geoconservation and geotourism worldwide. We used 169 scientific articles based on the Web of Science between 2011 and 2021. We found that Italy, Poland, Brazil, Russia, and China are the most productive countries for these topics. We determined that the main methods used to promote geoheritage are procedures for the evaluation of geotourism, geomorphological mapping, the study of economic values for geotourism, field work as a research tool, geoheritage management, documentation, exploration, and inventories of geoheritage at the regional level. The main defined resources for socializing and supporting geosite visualization and their use are UNESCO Geoparks, educational activities, digital

tools, geomanagement, economic values, geoitineraries, and geoeducation programs. Future studies should include less-studied regions, through collaborative studies with those countries and their researchers. A huge number of alluring geosites and potential geoparks are invisible to national and international audiences. The inclusion of innovative methods and resources to promote geoconservation and geotourism will definitely generate an economic production chain which will generate more and more diversified incomes on a local and regional scale in both developed and developing countries, with a sustainable approach such as is geoheritage.

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Data Availability Statement: Data will be available in the Supplementary Material and on request to the authors.

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