

Article

Study on the Sustainable Development of Popular Science Tourism Based on the SWOT Analysis for the Xiangxi UNESCO Global Geopark

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Abstract: The Xiangxi UNESCO Global Geopark (XUGG) contained the largest karst red stone forest landscape and the Global Standard Stratotype-section and Points (GSSPs) in the Cambrian System. Those geoheritage contribute to a better understanding of Earth's evolution. Therefore, it is of great significance to conduct geoscience research and geosciences popularization in the XUGG. In this study, we took the XUGG as the research object, and analyzed the situation of the strengths, weaknesses, opportunities and threats in the development process of geopark popular science tourism by using SWOT analysis method, in order to realize the sustainable development of geoparks in popular science tourism. The results show that: the XUGG continent possesses geoheritage, good facilities and unique advantages of popular science development. In the new era, we should optimize the development of popular science tourism in Geoparks, realize the two-way interactive participation of popular science, explore the community participation model of popular science tourism, and promote the development of rustic areas with unique geological resources. Then, it not only facilitates the broadcasting and popularization of earth sciences, but also contributes to the sustainable development of geotourism.

Keywords: Xiangxi UNESCO Global Geopark; SWOT analysis; geosciences popularization; geotourism



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1. Introduction

In the past few decades, geotourism has been widely concerned by many scholars. It was originally defined in the 1990s, as “the provision of interpretive and service facilities to enable tourists to acquire knowledge and understanding of the geology and geomorphology of a site (including its contribution to the development of the Earth sciences) beyond the level of mere aesthetic appreciation” [1]. Then, geotourism was reinterpreted by many academics with various focuses. However, it mainly focuses on four points: geo-conservation [2–4], geo-interpretation [5,6], geoeducation [7] and sustainable development [8,9].

Geoparks is an important tool to promote the development of sustainable geotourism [10]. Generally, “the UNESCO Global Geoparks are single, unified geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, education and sustainable development” [11]. Geopark, a natural geoscience popularization laboratory, preserves a large amount of geoheritage. It contains both the connotation of “geology” and the characteristics of “park”. Therefore, geoparks can service as an ideal platform for popularizing geoscience knowledge. [12].

Recently, the scientific popularization value of geoparks and geoheritage have attracted the attention of many scholars. For example, Nowlan [13] believe that geoparks should provide opportunities for public education of geological knowledge. Álvarez [14] considers that geopark is a good teaching tool to promote the popularization of geological knowledge through the geopark's educational and tourist infrastructures. Shu et al. [15] took Danxia geoheritage as an example, and suggested that we should promote geoconservation by

combining public education and geological practice, so that we can finally implement the sustainable development of resources.

Since the emerging of popular science tourism in geopark, people's concept of tourism has changed [16]. In terms of tourism experience, people are no longer just focused on sight-seeing, they are more eager to learn scientific knowledge while enjoying aesthetic pleasures [17]. Wang [18] and Zhang [19] believed that geological popular science tourism, aims at popularizing the geological knowledge, and transmitting geoheritage knowledge to tourists in the form of "combines education with fun". Notably, the UNESCO Global Geoparks was established in order to achieve three goals: geoheritage conservation, Earth science education and local sustainable development [20–22]. On one hand, popular science tourism can accelerate the dissemination of geoheritage knowledge to tourists and enhance the public's earth science literacy, thus, geotourism is beneficial to the realization of the goal of earth science education. On the other hand, popular science tourism in geopark can promote the economic development [23]. In addition, the improvement of the public understanding of geoheritage and education can contribute the geological protection, and further realize the sustainable development of geotourism [24].

At present, geopark popular science tourism is still in the early stage of development, and generally lacks the scientific connotation. For example, most tourism interpretation still stays in "pictographic" and "myth and legend" stage [25–27]. The XUGG is a representative region that integrates geological diversity, biological diversity and landscape diversity, and it was accepted in the Global Geoparks Network in 2020. It is urgent to explore the new model of geotourism and economic development, to develop tourism products with geological science popularization tourism as the main body, and build geological tourism industry chain with its own advantages [28–30].

In this study, the state of popular geological science tourism in the XUGG was examined using the SWOT analysis approach, then, the potential of this geopark for the development of popular science tourism was evaluated. In addition, some localized suggestions were provided to promote the sustainable development of geological popular science tourism.

2. Overview of Study Area

The Xiangxi UNESCO Global Geopark is famous for its unique regional scenery, due to the unique karst geomorphologic landscapes, stratigraphic sections, and the integration of Tujia and Miao minorities' cultures. It has extensive and far-reaching scientific connotation, popular science aesthetic value and research value [31].

The XUGG is located in Xiangxi Tujia and Miao Autonomous Prefecture, Hunan Province, China (N 28°06'49.23"–29°17'24.26", E 109°20'13.66"–110°04'12.55") (Figure 1a). It spans seven counties and cities including Jishou, Fenghuang, Guzhang, Huayuan, Baojing, Yongshun and Longshan, covering an area of about 2710 km². The geopark contains Luta, Furong Town, Red Stone Forest, Lvdong Mountain, Aizhai, Shibadong, Tianxing Mountain and other seven scenic spots.

The Master Plan of the Xiangxi Geopark (2017–2035) [32] pointed out that the geopark holds 90 geoheritage sites (Figure 1b). According to the "specification for geoheritage investigation" program of geological and mineral industry (DZ/T 0303-2017) People's Republic of China, the 90 geoheritage sites in the park can be divided into 3 categories, 7 types and 10 sub-types. (Table 1)

As seen in Figure 1, Xiangxi UNESCO Global Geopark is a comprehensive geopark composed of Ordovician red stone forest, GSSPs in the Cambrian system, diverse karst platform-canyon landscapes, integrating natural landscape, humanistic landscape and ethnic customs.

Xiangxi UNESCO Global Geopark is located in the southeastern margin of the Yangtze Block, and belongs to the Southeast Yunnan fold belt [33]. It records about 820 Ma evolutionary history of Yangtze Block. This region is characterized by large topographic fluctuations and strong tectonic activities. The main mountain ranges are coincident with the tectonic line, presenting NNE-SW or NNE-SW directions [34]. It has experienced multiple geological

tectonic events, paleo-glacial climate events, faunal extinction and other typical geological phenomena [35]. The geoheritage completely recorded the evolutionary history of the Yangtze Block including the breakup of the Yunnan-Guizhou Plateau, which is of great significance for understanding the history of the earth and exploring the mysteries of the evolution of organisms.

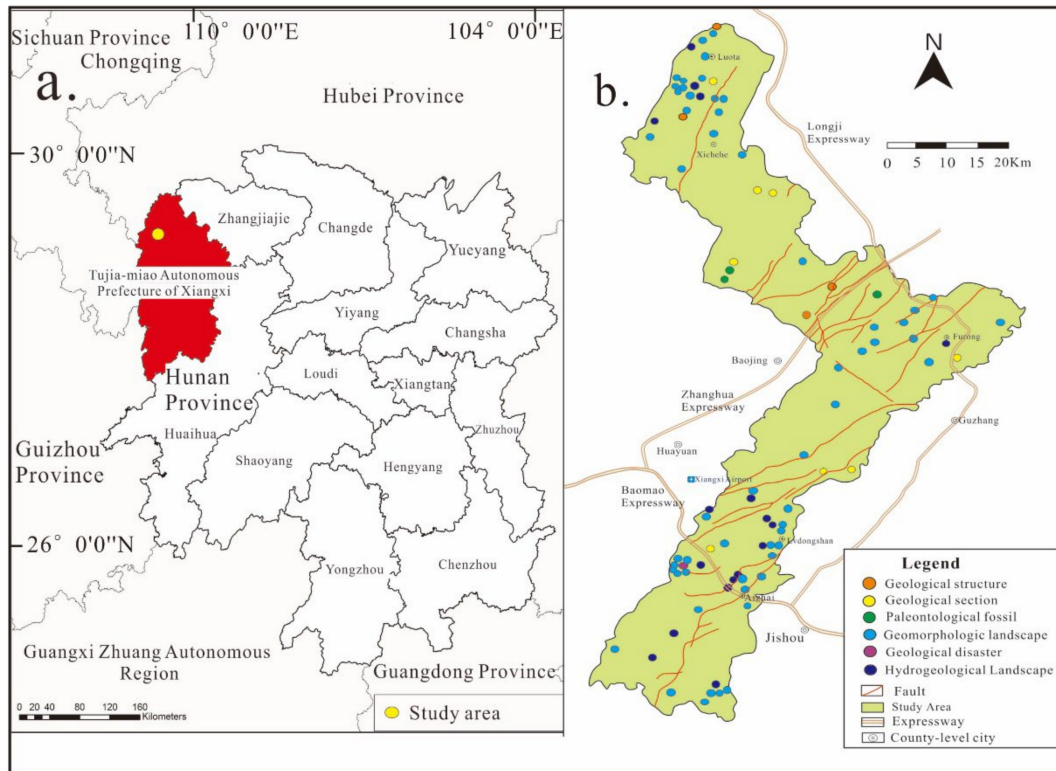


Figure 1. Location and distribution of geological relics in the study area (modified from [31]) (a). The location of the XUGG; (b). The distribution sketch of geoheritage sites of Xiangxi UN-ESCO Global Geopark.

Table 1. Summary of geoheritage sites and type classification.

Category	Type	Sub-Type	Name of the Geoheritages
Basic geology category of geoheritages	Geological section	GSSP	The Paibian GSSP, Furong Series, Cambrian System; The Guzhangian GSSP, Miaoling Series, Cambrian System
		Regional typical section	Section of Tillite in Snowball Earth Event in the Neoproterozoic Era; Section of Capped Dolomite in Ediacaran System; Section of Oceanic Red Bed in Silurian System in Xiqi; Section of Oceanic Red Bed in Silurian System in Purong; Section of Oceanic Red Bed in Devonian System in Dianfang; Section of Oceanic Red Bed in Silurian System in Luota
	Structural section	Unconformity surface	Section of Basal Conglomerate of Lake Facies in Cretaceous System in Zejia; Unconformity of Haixi Movement at Luota
		Fracture	Zhangjiajie-Huayuan Deep and Large Fracture; Mengxi River Fracture
	Paleontological fossils	Origin of paleontological fossils	Trilobite Fossil Group in the Ordovician Period in Liexi
		Paleontological site	Insect Trace Fossil Relics in the Devonian Period in Purong Town; Trilobite Fossil Group in the Silurian Period in Purong Town

Table 1. Cont.

Category	Type	Sub-Type	Name of the Geheritages
Geomorphological landscape of geheritages	geomorphology Rock landscape	Karst landforms(Carbonate geomorphology)	Luota Karst Platform; Shuanglong Karst Platform; Heku Karst Platform; Giant Sleeping Buddha; Jiating Karst Platform; Dehang Rock Wall-Rock Pillar Group; Pingnian Rock Wall-Rock Pillar Group; Rulai fozhang (Buddha's Palm) Rock Pillar; Luota Zimei (Sisters) Peak; Hualan Red Stone Forest; Zuokuba Red Stone Forest; Kebi Red Stone Forest; Liexi Red Stone Forest; Hualan Red Stone Forest; Nanzhu Stone Forest; Shanwan Stone Forest; Xigou Stone Forest; Yayou Red Karst Hill Group; Duishan Red Karst Hill Group; Nongche Karst Hill-Peak Cluster; Xishaping Polje; Zhijia Polje; Xiwu Polje; Lanhua Cave; Tian'egong Cave; Lianhua Cave; Yelang Shibadong Cave; Wuyan Cave; Tianguotan Cave; Tiandong Natural Bridge; Guidong Natural Bridge; Jipoling Natural Bridge; Lüdongshan Light through Cave; Yuechuanyan Light through Cave; Wangchuanyan Light through Cave; Xiangbishan Light through Cave; Lingdong Karst Window Group; Luota Long Tiankeng
	Tectonic landform	Valley	Youshui Valley; Donghe Valley; Dehang Grand Canyon; Gaoyanhe Canyon, Shibadong Canyon; Tianxingshan Valley; Sanmendong Valley; Paoshui Valley; Xichehe Valley; Mengxihe Valley; Naxilao Valley; Mengdonghe Valley; Baixi Valley; Tuzhahe Valley; Lülühe Valley; Dafengchong Valley; Jinlong Grand Canyon; Jinluohe Valley; Zuolong Valley; Luota Yixiantian Valley
	Hydrogeological landscape	Waterfall	Dalong Cave Suspended Waterfall; Xiaolong Cave Suspended Waterfall; Leigong Cave Suspended Waterfall; Buwa Clif Suspended Waterfall; Furong Town Cascaded Waterfall; Paoshuixia Cascaded Waterfall; Zhihuan (Ring) Waterfall; Tuofeng Waterfall; Liusha Waterfall; Jiulong Waterfall; Yuquan Waterfall; Jianduoduo Waterfall; Diaoshuikan Waterfall; Jiupuxi Waterfall; Atalao Waterfall; Jidu Waterfall
Geological disaster geological relics	Geological disaster relics	Wetland—marsh	Baxiandong Heavenly Lake
		landslide	Liziping Landslide

3. Materials and Methods

SWOT analysis is a common strategic analysis tool [36]. The term SWOT is an acronym that stands for strengths(S), weaknesses(W), opportunities(O), and threats(T). Reasonable development strategies can be formulated by objectively evaluating its strengths, weaknesses, opportunities and threats in external competition [37] and combining its own development. SWOT analysis is often used to study geological tourism [38,39], popular science tourism development [40–42] and sustainable development of geoparks [43–45]. For example, in Southern Moravia [46], Ecuador [45], Turkey [47] and Vietnam [48], SWOT analysis method has also been widely used in geotourism related studies.

SWOT analysis was generally conducted through field investigation and data collection to determine the strengths, weaknesses, opportunities and threats of the study area. As a supplement to SWOT analysis, the TOWS matrix is constructed [49]. In order to find out the relationship among strengths, weaknesses, opportunities and threats, and generate S-O, W-T, W-O and S-T strategies. Then, the research object can be studied comprehensively, systematically and accurately, and the corresponding development strategies and countermeasures can be formulated according to the research results.

In this work, SWOT analysis method was used to make a systematic analysis of Xiangxi UNESCO Global Geopark. The optimization development of popular science

tourism was subdivided into four parts, and the current situation of the development of popular science tourism in the geopark was comprehensively analyzed. Then the TOWS matrix is constructed on the basis of SWOT analysis, the results of previous analysis were transformed into development strategy by TOWS matrix. In order to put forward reasonable suggestions to promote the sustainable development of the XUGG.

4. Results

In order to comprehensively evaluate the development potential of popular science tourism in Xiangxi Geopark, we systematically analyzed the strengths, weaknesses, opportunities and threats of the region to formulate reasonable development strategies. The analysis results are shown in Table 2.

Table 2. The basic SWOT analysis for the study areas.

Strengths		Weaknesses	
1.	The Paibian GSSP and the Guzhangian GSSP	1.	Lack of professional personnel
2.	Rich types of geoheritage sites	2.	Management system is not perfect and limited opportunities for community public participation
3.	Integration of characteristic ethnic cultures	3.	The participation of popular science tourism is not strong
4.	Complete construction of geological museum		
5.	Superior geographical location and convenient transportation		
Opportunities		Threats	
a.	The implementation of the “double reduction” policy ushered in a new trend in popular science tourism industry	a.	Competition of the same resources type
b.	Promoting tourism plus poverty alleviation and promoting rural revitalization	b.	Balance between resource protection and tourism development
c.	Popular science tourism conforms to the needs of the times		

4.1. Strengths Analysis

4.1.1. Advantages of Popular Science Resources—Geodiversity

(1) The Paibian GSSP and the Guzhangian GSSP

“Global Standard Stratotype-section and Points” (GSSP) is an international standard for dividing the bottom boundary of the global chronostratigraphic basic working unit “stage” [50]. The XUGG is the only global geopark in China that has two GSSPs in the Cambrian system, including the GSSP for Guzhangian Stage and the GSSP for Paibian Stage. It has the typicality and uniqueness of popularizing science (Figure 2). The Paibian GSSP established in 2003, defines the lower boundary of two chronostratigraphic units, including Furongian series and Paibian stage with the first appearance datum of trilobite fossil *Glyptagnostus reticulatus* (Figure 2a,b) [51]. The Guzhangian GSSP established in 2008, defines the lower boundary of the Guzhangian stage of Miaolingian series with the first appearance datum of trilobite fossil *Lejopyge laevigata* (Figure 2c,d) [51]. The support of the two GSSPs is of great scientific importance to the popularization of GSSPs and the evolution of palaeogeographic environment in South China.



Figure 2. Pictures of GSSPs in the Cambrian system (a). The landmark of the Paibian GSSP; (b). The signs for popular science in the Paibian GSSP; (c). The landmark of the Guzhangian GSSP; (d). The signs for popular science in the Guzhangian GSSP.

(2) Rich types of geoheritage sites

The XUGG is located in the hinterland of Wuling in the eastern part of the Yunnan-Guizhou Plateau, with rich types of geological relics, geological profiles, geomorphological landscapes and paleontological fossils (Figure 3). Guzhang Red Stone Forest, a typical representative of karst geomorphology, is different from the previous gray-white carbonate rock forest, which has a peculiar shape (Figure 3d,e), diverse surface dissolution patterns, bright colors, and more ornamental value [52]. The red stone forest possesses the characteristics of ancient marine sedimentary environment, paleogeographic environment changes and karst geomorphic evolution in Xiangxi during the Ordovician period [53], which has high aesthetic value and popularization value [54]. In the Dehang area, tectonic fractures are developed, rocks on the edges of the fracture were dissolved by rainwater. The influence of weathering eventually creates a geological beauty with deep and steep canyons and staggered rock columns (Figure 3a,b). The karst canyon groups presenting various geomorphic forms include line-shaped, V-shaped and box-shaped canyon [55].

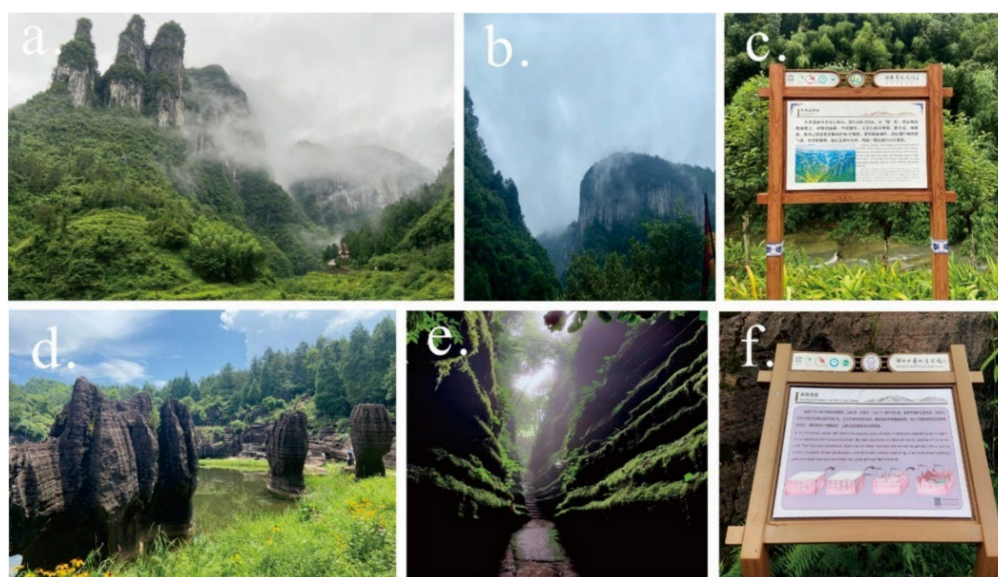


Figure 3. Pictures of Dehang Canyon and Red Stone Forest (a). The typical Rock pillar group in platform-canyon landscape; (b). Dehang Rock Wall; (c). Interpretive signage in the Dehang Canyon; (d). Typical flaming stone pillars in the red stone forest; (e). Wall-shaped red stone forest; f. Interpretive signage in the red stone forest.

(3) Integration of characteristic ethnic cultures

The XUGG has most dense karst canyon group in the world, where most areas of the terrain are dangerous and deep canyons. In response to the natural conditions, the indigenous people built unique stilted houses in the valley floor or on the terrace. They supported the houses from the ground with wooden piles, which kept the house dry and ventilated at the bottom. This kind of house became the traditional dwellings of the Tujia people. The complex geological structure, special topography, humid climate and good karst ecological environment in Xiangxi has created a very different style of ethnic culture such as “Miao Autumn Celebration” and “Tujia Crying Marriage Song”. “Miao Autumn Celebration” have been selected into the UNESCO list of representative works of human intangible cultural heritage. Due to the year-round humid climate, the people of Xiangxi have gradually developed a preference for a sour and spicy diet, which is a model of the dietary preferences and geology.

4.1.2. Advantages of Science Popularization Facilities—Complete Construction of Geological Museum

Xiangxi geopark museum lies in Furong town, Xiangxi Tujia and Miao Autonomous Prefecture, Hunan province. The total building area of the museum is 4875 m², including 2700 m² exhibition area. There are 8 exhibition halls, i.e., Hall of GSSPs, Hall of Red Stone Forest, Hall of Platform & Canyon, Hall of Mineral Resources, Hall of Biology & Ecology, Hall of History & Culture, Hall of Geopark & Community Development and Special Exhibition Hall of Global Geopark. It displays the unique geological structures, diverse biological species, characteristic minority culture and so on. The construction of science popularization venues, geological museums and other facilities is a conventional mechanism to ensure the development of science popularization, and also reflects the hardware level of science popularization subjects [56]. The construction of geological museum has laid a solid foundation for the development of popular science tourism.

4.1.3. Advantages of Popular Science Development—Superior Geographical Location

Xiangxi region is located at the junction of four provinces. The park is adjacent to the north-west of the Enshi prefecture in the Hubei province, to the west of the Chongqing city, to the southwest bordering of the Tongren city in the Guizhou province, to the southeast

near the Huaihua city in the Hunan province, and north east near the Zhangjiajie city in the Hunan province. Therefore, it is the gateway from the Hunan province to the Yunnan and Guizhou province and Chongqing city. In addition, it is an essential place for the economic and technological radiation from the eastern part of the country to the southwest and the flow of materials from the southwest to the east. The park is located in the middle of Changsha, Chongqing and Guiyang city, which are three major sources of tourists, and prefectures a 4-h economic circle with them. The three cities are about 400 km from Xiangxi. This is beneficial for the development of tourism in Xiangxi Global Geopark.

4.2. Weaknesses Analysis

4.2.1. Lack of Professional Personnel

There are many geoh heritage sites in the XUGG, such as GSSPs and trilobite fossils. This kind of geoh heritage contains profound geological knowledge. As a consequence, it is necessary to increase the proportion of science popularization personnel, with bachelor degree and even higher degree, to provide professional interpretation. In addition, the museum interpretation, logo design and other aspects also need the participation of professionals to make it easy to understand on the premise of ensuring the professionalism of popular science [56]. According to the survey, the departments involved in the popularization of science in the park are mainly geological relic protection department, museum, and ministry of education. The professional personnel of each department are available (Table 3). The geological professionals in museums and science popularization education department account for a relatively small proportion, and there is a big gap in professional talents. The educational support of science popularization tourism is slightly insufficient.

Table 3. Statistics of in-service personnel in relevant popular science departments of parks.

Related Science Popularization Department	Total Number of People	Number of Undergraduates and Above	Majors Related to Geology	Proportion of Geological Majors (%)
Geoh heritage protection division	2	2	1	0.5
Geological museum	30	9	1	0.03
Geological education division	2	2	0	0

4.2.2. Management System Is Not Perfect

The management system of XUGG consists of Xiangxi Tujia and Miao autonomous prefecture people's government, Xiangxi prefecture geopark management commission and Xiangxi prefecture geopark management office. The current statutory management body of the geopark is the XUGG management office, which manages the park in every detail. The management structure is mainly arranged in "top-down" model, with limited opportunities for community public participation and weak sense of responsibility for the protection of geological relics. The UNESCO guide to the operation of geoparks clearly identifies the active participation of local communities and indigenous populations as key stakeholders in the management of geoparks. Therefore, it is necessary to develop and implement common management systems in partnership with local communities.

4.2.3. The Participation of Popular Science Tourism Is Not Strong

The popular science tourism in geoparks is mainly sightseeing, supplemented by display and explanation in geological museums. In general, tourists lack the experience of popular science tourism. As the main place of popular science tourism, most geological museums are still in the static display stage. Visitors can only view some rock and mineral specimens and paleontological fossils through glass or at a distance, and interpret popular science knowledge through pictures and text explanation, since there is no hands-on and experiential activities. Especially for teenagers, they can not gain geological knowledge from the boring popular science activities. However, the current popular science tourism has not a tourism atmosphere of combining education with fun, thus, it still doesn't meet

the needs of tourists for interactive experience. For example, in the Lesvos Petrified Forest Geopark, more than 3000 students participate, understand earth knowledge during an interactive display of educational activities [57]. In comparison, through workshops [58,59] (e.g., simulated excavation, fossil excavation, interactive exhibits) and storytelling [60], visitors could gain knowledge of earth sciences.

4.3. Opportunity Analysis

4.3.1. The Implementation of the “Double Reduction” Policy Ushered in a New Trend in Popular Science Tourism Industry

In the new era, the General Offices of the Communist Party of China (CPC) Central Committee and the State Council issued the opinions on further reducing the homework and off-campus training burden of students in Compulsory Education on 24 July 2021, in order to effectively improve the education level of school. The implementation of the “double reduction” policy has changed the previous “cramming” and “exam-oriented” education in schools and made educators pay more attention to students’ quality education [61]. In addition, it promotes all kinds of popular science institutions to be the extension of school education, and to explore the construction of students’ holiday activity system and model. Geoparks, as natural laboratories for science popularization, undertake the obligation and responsibility of popularizing geological knowledge to the whole society. Popular science tourism in geoparks enables students to understand the evolution process of the earth in practice, and to learn to discover, observe and explain phenomena independently, realizing the transformation from exam-oriented education to quality-oriented education. In the context of the epidemic and “double reduction”, weekend trips will be favored. As a consequence, popular science tourism will usher in a new development trend.

4.3.2. Promoting Tourism Plus Poverty Alleviation and Promoting Rural Revitalization

Geopark is the best case of practicing the concept of “clear water and green mountains are gold and silver mountains”. It successfully realizes the transformation from ecological resources to economic benefits and helps mountainous areas get rid of poverty. In the new era, the increasing popularity of geopark tourism has played a great role in the realization of poverty alleviation in mountainous areas. Meanwhile, the opinions, proposed by the CPC Central Committee, the State Council on Comprehensively Promoting Rural Revitalization, Accelerating Agricultural and Rural Modernization in 2021 pointed out that the development of rural tourism is an effective way to implement the rural revitalization strategy. According to statistics, in 2013, there were 657,800 poor people in West Hunan, with the poverty incidence rate of 31.93%. In 2019, there were 15,700 poor people in west Hunan, with the poverty incidence rate of 0.65%. In 2020, 656,000 poor people were lifted out of poverty [62]. Tourism has become the leading industry in Xiangxi, where the total tourism revenue and the number of tourists has increased year by year. Through the association of tourism, people can get rid of poverty and become rich. In 2019, the added value of tourism and the related industries in Xiangxi accounted for 17% of GDP. Relying on the construction of geoparks, most poor areas have explored the development mode of “tourism + poverty alleviation” by virtue of the excellent geological relic, animal and plant resources, thus, most areas can get rid of the poverty cap and embark on the road of rural revitalization.

4.3.3. Popular Science Tourism Conforms to the Needs of the Times

Due to by the improvement of education level and life quality, the consumption demand of tourists has also been changed. Tourists are no longer satisfied with the “cursory” type of tourism experience, they are eager to know the cause of various geological phenomena such as strange peaks, grotesque rocks, mountains and lakes [14]. Popular science tourism can not only meet the aesthetic needs of tourists, but also enable tourists to learn scientific knowledge in the process of relaxation, and give full play to the educational function of tourism.

4.4. Threat Analysis

4.4.1. Competition of the Same Resources Type

There are two UNESCO Global Geoparks and eight national geoparks in Hunan province alone. Zhangjiajie UNESCO Global Geopark is located in the north of XUGG, with a distance of more than 100 km. The two geotourism resources are very similar, both of them have characteristic peak forest and karst landform. The aggregation of tourism resources in geographical space will lead to strong competition [63]. Tourism in Zhangjiajie area are developed earlier, and the infrastructure construction is relatively perfect after more than ten years of exploration. Tourism development in Zhangjiajie area is relatively mature, and has formed a unique business model. Meanwhile, the corresponding brand effect has been formed at home and abroad, with strong competitive advantages. In order to attract more passenger flow into Xiangxi, it must excavate the tourism resources of Xiangxi to make the infrastructure construction become perfect, and start the tourism brand of Xiangxi geopark.

4.4.2. Balance between Resource Protection and Tourism Development

As non-renewable resources, geoheritage wouldn't exist once destroyed. Most of the geoheritage in the geopark are located in remote areas, they are commonly inaccessible. Thus, it is necessary to build artificial walkways. To a certain extent, the accessibility of geological relics is realized, but the geological environment is destroyed. In addition, the environmental pollution and the uncivilized behavior of some tourists also disturbed the geoconservation. Therefore, it requires more scientific planning and management to achieve the balance between resource protection, tourism development and the sustainable development of geoheritage resources.

5. Discussion

As a supplement to SWOT analysis, the TOWS matrix is constructed [49]. The TOWS matrix transforms the strengths and weaknesses, opportunities and threats obtained in the SWOT analysis into sustainable development strategies. The strategies are shown in Table 4.

Table 4. TOWS matrix based on SWOT analysis.

Strengths—Opportunities(S-O) Strategy	Weaknesses—Opportunities(W-O) Strategy
<ul style="list-style-type: none"> - Each village relies on its neighboring geological resources to carry out geotourism business activities with ethnic minorities characteristics. (2, 3, b) - Actively cooperate with universities and scientific research institutes should be carried out to set up teaching and scientific research bases. (1, 2, 4, a, c) 	<ul style="list-style-type: none"> - Strengthen the construction of talent team, absorb more high-quality professional talents and regularly invite experts to give lectures. (1, c) - Explore the community participation model of popular science tourism, select local residents as geopark conservationists. (2, b) - Design interactive popular science tourism activities. (3, a, c)
Strengths—Threats(S-T) Strategy	Weaknesses—Threats(W-T) Strategy
<ul style="list-style-type: none"> - Make active use of big data to build a smart geopark, use Internet technology to innovate the way of science popularization. (1, 2, b) - Development of various types of science tourism derivatives. (3, 4, 5, a) 	<ul style="list-style-type: none"> - Mobilize multiple senses to participate in interpretation. (1, 3, a) - Humanization of interpretation. (3, a) - Optimize explanation content. (1, a, b)

5.1. Standardize the Construction of Geoparks

5.1.1. Strengthen the Construction of Talent Team

Considering the shortage of professional talents in the XUGG, we should recruit more high-quality professional talents related to geology and strengthen the protection and management of geological relics. In addition, we should improve the professional quality of tour guides, carry out regular training and assessment, and constantly improve the level of popular scientific explanation. It is necessary to invite relevant experts and scholars regularly, and hold professional knowledge lectures of geological popular science to explain

the scientific connotation of geological relics and highlight the scientific value of geological park. It is beneficial to cooperate with universities and scientific research institutes should be carried out to set up teaching and scientific research bases. This can contribute to the transformation of geological theoretical knowledge into geological field practice skills, and formation of a chain effect of production-learning-research popular science tourism.

5.1.2. Make Active Use of Big Data to Build a Smart Geopark

Under the background of 5G communication technology, it is important to make good use of the “internet + geological information” construction to build a smart geopark. The administrators of the geopark can integrate the science resources in the geopark, and the basic information (such as the location, quantity and protection status of geological relics), then, construct a list of geological relics and upload it to the big data platform of the geopark to facilitate the planning of science routes in the geopark in the future. In the context of the domestic and international tourism market plagued by the COVID-19, it is more important to conduct online publicity campaigns. (i) Using WeChat, Weibo and Tiktok platforms to carry out “cloud tourism” in geoparks, so that the public can understand geoparks, geological sites and geological environments intuitively and efficiently at home. (ii) Designing applications such as MoGeo App [64], which can provide diversified geological tourism information, combine geological sites (geological sites and geological routes) with other possible tourist sites (other sites of natural and cultural value) to respond to the diverse interests and needs of a wide audience. (iii) Introducing an interactive digital map [65] on the park’s official website. Then, people can use maps to query relevant information in geological constructions, and use 3D reconstructions [66,67] and augmented reality [68] to reconstruct pictures of geoheritage. By standardizing the construction of geological parks, the geological heritage is promoted and protected adequately towards the sustainable development of geopark.

5.2. Enhance Mutual Interaction and Participation in Science Popularization to Increase Tourists’ Experience

5.2.1. Design Interactive Popular Science Tourism Activities

In the context of the prevailing experience economy, science popularization needs to be transformed from “passive acceptance” to “active participation” [69]. In order to increase the participation of visitors, and to design different experience style of science popularization activities. Science popularization activities should be designed for tourists of different ages. Trilobite fossil excavation laboratory” can be carried out for teenagers to simulate the original state of paleontological fossils according to the paleontological fossil remains in the geopark, They can experience the whole process of fossil excavation and restoration in a substitute way, and explore the formation and identification process of fossils. While geological knowledge competition can behold for middle school students. Interactive models [65] are used to tell the mystery and evolution history of red stone forests, and design the related questions. Participation in educational games enhance the students’s understanding of the XUGG, then they would contribute to spread the popular science knowledge of Xiangxi geopark. The college students can participate in field trips in summer camps and geological investigations, to enhance their geological exploration abilities.

The mutual interaction and participation of popular science activities can impart geological knowledge and accept the feedback of tourists, realizing the unity of teaching and learning. we pass on the complex geological phenomenon and mechanisms in an easy-to-understand way to tourists, let them participate in the exploration of geological mysteries and have fun in the process, deepen their understanding of the geopark. In addition, we should choose widespread geological structures to carry out popular science activities. This not only protects the geoheritage, but also enables visitors to understand the geological phenomena around them [70].

5.2.2. Development of Various Types of Science Tourism Derivatives

The geotourism development is a complex process. It contains continuously exploring the characteristics of tourism geological resources, integrating the advantages of tourism geological resources, planning the tourism image and establishing the brand effect of tourism geological resources in tourist places. Geotourism development is an important part to push geological resources into the tourism market. Thus, the XUGG should create a complete science tourism industry chain of geological entertainment, geological exploration, geological sightseeing, geological cuisine, geological souvenirs and geological accommodations. For example, the Naturtejo Global Geopark in Portugal [71], innovates a range of geoproducts, such as, handmade trilobite line of jewellery and trilobite cookies. Geoproducts are innovative education and communication tools used in Geoparks, they can tell stories, illustrate landscapes, teach curiosities and bring memories [71]. We can develop various kinds of geological creations derivatives and design souvenir dolls to attract young tourists. Meanwhile, we can design scenic spot tickets as badge souvenir books, design special landscape badges for important geol heritage points, and get badges by answering simple questions to stimulate tourists' interest during visiting.

5.3. Optimize the Popular Science Interpretation Mode and Improve the Popular Science Effect

5.3.1. Optimize Explanation Content

Comparing to general tourism, geotourism has a strong professionalism of earth science in the interpretation content and objects. It is necessary to transfer the hidden knowledge and information of geoheritage to tourists, so that they can understand the formation process, causes and scientific value of geological landscape. Therefore, relevant management departments should optimize the content of popular science interpretation to make the interpretation professional and interesting. We should avoid the opposition of tourism and popular science, as well as the separation of professional and popularity. We pass on the complex geological phenomenon and mechanisms, through an easy-to-understand way to pass the knowledge to the tourists. Then, they feel the mystery and fun, and deepen their understanding of geopark. In the preparation of commentary, we should interpret the geoheritage from the perspective of geological history and landscape evolution [72], for example, we can cooperate with universities and scientific research institutions to spread the knowledge in professional way.

5.3.2. Mobilize Multiple Senses to Participate in Interpretation

The traditional interpretation mode of popular science is the "tour and interpretation" mode of tourists' single visual and auditory participation, which is easy to cause sensory fatigue and poor effect of popular science. Therefore, we should establish an experiential popular science interpretation mode, mobilize visitors' visual, auditory, tactile and other sensory participation, to enhance the experience of popular science interpretation. For example, augmented reality (AR) can conveniently bring kinesthetic field experiences to a broader audience, improving the quality of scientific interpretation [73]. With the help of virtual reality technology, we can make a 4D short film of geological evolution to introduce the formation process of GSSPs, so that visitors can understand the evolution history of the earth in an all-round way while listening to the explanation. A 3D visualization model is set up next to the interpretation board of large-scale geoheritage, then, visitors can observe the evolution of geoheritage in a broader perspective [74].

5.3.3. Humanization of Interpretation

Barrier-free travel of disabled people is often taken into account in most geoparks, but the needs of them for popular science interpretation are ignored [75]. Therefore, the braille can be engraved on the interpretation signs in the park for the visually impaired people. It is desirable to design special travel routes and engrave explanatory braille on the railings of the path. The design of the geopark's official website should also take into account the

needs of people with sensory disabilities by adding a web reader so that the website can be played with voice to meet their diverse needs.

5.4. Explore the Community Participation Model of Popular Science Tourism

Generally, the government forces the establishment of geological reserves and geopark without the participation of the local inhabitants, thus it is difficult to achieve desirable management effectiveness [76]. Most villages are located in the XUGG. Local residents as the aborigines of the geopark, are more aware of the local ecological environment and customs. Therefore, it is necessary to consider the survival and development needs of local residents in the management and development of the geopark. It is better to lead the inhabitants participation in the management of XUGG. We should establish a community participation model, in which government is the leader, enterprise provides fund, and the resident is the participant.

The content of community participation should be in terms of environmental protection, decision-making and planning, tourism and economic activities of the geopark, and the guarantee of community participation [77]. The large number of precious geoheritage sites in the XUGG only rely on government-led conservation policies, with minimal participation of residents, resulting in poor conservation results. Therefore, in the environmental protection of the geopark, it is advocated to select local residents as geopark conservationists to carry out daily patrols to prevent uncivilized behaviors, and to give appropriate rewards and remuneration to raise the residents' awareness of conservation, and increase the enthusiasm of participation at the same time. In addition, we can introduce the concept of ecomuseum, which is a tool for participatory management of the territory's natural and cultural heritage [78,79]. It can promote the spontaneous protection of geoheritage by local residents through the interpretation of geoheritage, and carry out publicity activities to truly achieve bottom-up community participation. In the planning and decision making of science tourism, government policy is the guide, local resident are the main body. The planning process reflects community participation, solicits community opinions, and meets community interest needs. The government plays an important role of macro-control in tourism economic activities. On the basis of thorough research and the development needs of tourism activities in Xiangxi, each village relies on its neighboring geological resources to carry out geotourism business activities with ethnic minorities characteristics. For example, more local residents can benefit from the development of characteristic geological products such as special Miao paintings and Miao embroidery. Community participation is guaranteed in all aspects such as policy, fund, organization system and cooperation agreement, fully reflecting the concept of "people-oriented" community participation.

6. Conclusions

In this study, we analyzed the potential for popular science tourism development in Xiangxi Geopark through the SWOT analysis and TOWS matrix, then proposed reasonable development strategies in the future.

The results show that the XUGG has rich types of geological resources as well as majestic and spectacular geological beauty. However, there are still shortcomings in the actual development process, such as lack of professional talents, imperfect management methods and weak participation in science activities. Therefore, in the future development of the geopark, the following measurements should be carried out. First, strengthen the construction of talent team and hold interactive science tourism activities; second, maintain resource advantages and standardize the construction of geoparks; third, optimize the science interpretation mode to spread science popularization; last, explore the community participation mode of science tourism to implement the benefit for the people.

In addition, it is important for other sites that preparing to be geoheritage or UNESCO site to grasp the development opportunities in the New Era. On the one hand, we should develop geotourism products with local characteristics based on the geoheritage and cultural landscape, and connect them with geological relics, innovative ways of geological

education and communication. On the other hand, we should build an interactive participation system for popular science tourism, drive rural development with geological resources, popularize earth science knowledge, and make geological science tourism a fulcrum to promote the protection of geoheritage, science popularization and economic interactive development.

In this paper, we used a qualitative research method—SWOT analysis method, which has certain limitations. In future research, we can use a combination of quantitative and qualitative analysis method (e.g., SWOT-AHP, RMP-AHP, IPA). Moreover, future research should pay more attention to the construction of geopark popular science tourism theory system.

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