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Valuing Geodiversity in Patagonia Verde: A Fundamental Pillar for Developing a Future Geopark†

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Abstract: 91 geological sites of scientific, tourist and educational interest were inventoried, following a survey under the project "Development of geotourism products in the tourist destination Patagonia Verde". This project was developed between 2017 and 2019 to promote the values of geodiversity of the Patagonia Verde (southern Chile) territory and its sustainable use in tourism. A quantitative assessment of the sites supported the identification of management categories and the proposal of different action plans for the sustainable management of the identified geoheritage resources. Most sites can be used in education and geotourism initiatives and support the establishment and consolidation of the Patagonia Verde Geopark project.

Keywords: Patagonia Verde; Geodiversity; Geosite; Geoconservation; Geotourism; Guidelines

1. Introduction

Patagonia Verde is a territory of 19,212 km² that belongs to the Lake District (*Región de Los Ríos*) in southern Chile. The population density is close to one inhabitant per square kilometre, and National Parks and National Reserves protect 25% of its territory. The region is characterised by a pristine landscape, with small towns and villages that maintain their customs and traditions linked to fishing and cattle breeding. The outstanding natural diversity and ecological and cultural scenic values are recognised worldwide and visited by hundreds of thousands of tourists annually [1]. Geology and its diversity are prominent in the landscape. Colossal granite mountains, fjords, glaciers, rivers, hot springs, and volcanoes form a rugged landscape with unique ecosystems and life forms adapted to frequent volcanic eruptions, earthquakes, and landslides.

A project was developed between 2017 and 2019 ("Development of geotourism products in the tourist destination Patagonia Verde") to promote the values of geodiversity and its sustainable use in tourism. The main objective of this project was to select sites and define geotourism routes with local guides to offer alternatives to traditional nature tourism, generate informal education instances and boost the local economy [2]. Opportunities for collaboration were generated between the guides, the municipalities and professionals of the institutions of the territory, such as the National Forestry Corporation (CONAF), the National Geology and Mining Service (SERNAGEOMIN), and the National Tourism Service (SERNATUR). Moreover, the local tour operators of Patagonia Verde have formed an association that aims, among other issues, to promote the Patagonia Verde Geopark project. To this end, a systematic geoheritage inventory and the definition of guidelines for the sustainable use of the geological resources were fundamental steps to achieve this objective. The present work was developed in this context and sought to satisfy these territorial needs.

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2. Inventory

Using the information generated by the different reports and meetings framed in the "Geotourism in Patagonia Verde" project for each of the communes of Patagonia Verde, a territorial inventory proposal has been made. The workflow of this inventory was based on methodological procedures with well-defined stages [3, 4]: definition of the topic, the value, the scale, and the aim of the inventory; definition of geological contexts; background collection; site selection criteria; fieldwork: identification, selection and preliminary inventory of sites; inventory proposal quantitative assessment and data analysis. 91 sites were inventoried (Fig. 1) and the information collected was organised and analysed with a geological contexts' proposal based on Mourgues *et al*. [5, 6], on the regional geological information [7] and on the proposal made to the neighbouring region of Aysén [8].

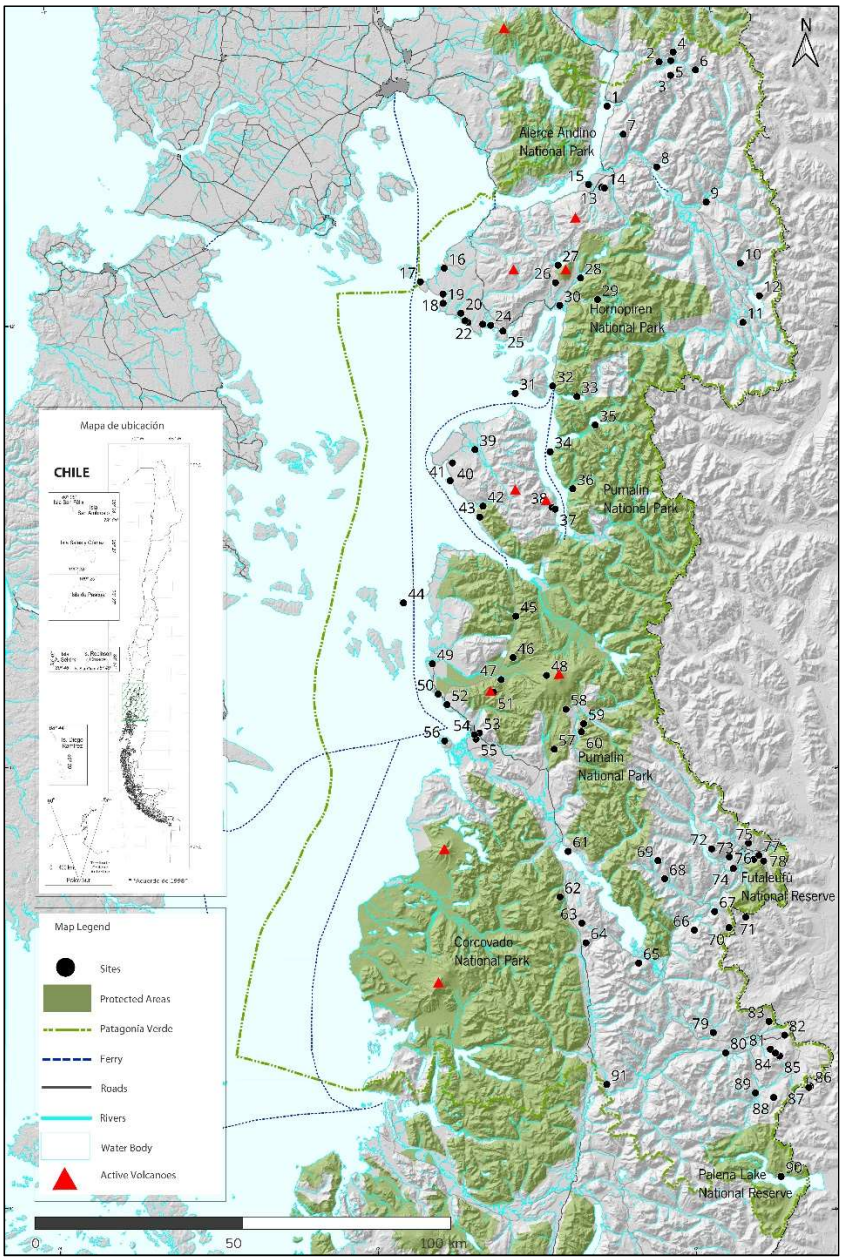

Figure 1. Location of the 91 sites inventoried in Patagonia Verde (Chile).

3. Quantitative Assessment

A quantitative assessment of the scientific value, the potential for educational use, the potential for tourism use, and the risk of degradation of the inventoried sites was performed, using criteria and indicators that minimise subjectivity [9]. The methodology followed parametric procedures, modified from Brilha [3].

The results on scientific value show that 55 sites scored high, despite the lack of scientific knowledge about the sites in the territory, which translates into an opportunity for more scientific research, improving the "key locality" criterion and turning some of these sites into national and even international references.

Regarding educational use, the sites have at least two geological elements with didactic potential, generally associated with secondary geological features where the source of origin is not necessarily discernible. Their study is mainly focused on teaching the fundamentals of geology.

Concerning geotourism, it is enough to have some notions of geological processes to understand the sites, and in almost all cases, it is possible to find recreational areas nearby. As a territory where tourism is developing, the attractions are not yet consolidated nationally. However, most of them present characteristics that are at least uncommon in the country, and at the regional level, they are sufficiently relevant to compete with natural attractions in neighboring regions such as Araucanía, Los Ríos, Aysén and Magallanes.

In Patagonia Verde, few sites are at high risk of degradation, with an average in the moderate range and almost half of the sites at low risk since most places are in or near National Parks. The population in Patagonia Verde is low, and access to sites often requires long journeys away from inhabited areas and main access roads. If accessibility and infrastructure conditions are improved in the future, it will be necessary to assess the impact this would have on each site.

4. Management Proposals

Inventorying geodiversity for scientific, tourism, educational and cultural purposes is important as it serves as an additional element in land-use planning. Thus, strategic conservation of geodiversity is necessary when it makes sense for a particular community and their well-being. This reasoning implies that there are sites with different scales, interests, dimensions of use, and conservation characteristics. The inventoried sites resulted from discussions with the different actors of the Patagonia Verde through workshops and meetings, using scientific knowledge to provide added value to places that were already relevant for the community. In this sense, to conserve the inventoried areas effectively, the active participation of the target public is necessary not as observers of the process but as co-creators of the inventory and its management.

The results obtained in the quantitative assessment were fundamental to establishing comparisons between the sites inventoried, classifying them into eight proposed management categories, as defined in other works [10, 11]. 67 sites correspond to Category I (Research), 22 to Category S (Science), 45 to Category E (Education), 43 to Category G (Geotourism), 16 to Category R (Regulation), 2 to Category P (Protection) and 13 to Category Sc (Secondary). In addition, 30 sites have been classified as geosites within Category Gs. Also, six sites have been added to this list without fulfilling the criteria.

Supported by the inventory and management categories, a management model is suggested. It is proposed that the Patagonia Geopark project should be formalised as an association and considered as management and decision-making bodies: the Geopark Association, the Geopark scientific-educational committee, the Local Board, and key partners. An integrated geodiversity management strategy called Patagonia Verde Geodiversity Action Plan (PVGAP) was proposed, based on Dunlop *et al*. [12]. Usually, geoparks projects have a bottom-up approach; this management model and action plans are a technical response to a need raised by the stakeholders of the territory.

5. Conclusion

Patagonia Verde has outstanding natural diversity. A rich diversity of geological elements, such as fjords, volcanoes, hot springs, glaciers, mountains, valleys and beaches, has a value that must also be recognized. This work aims to help this recognition under the figure of a UNESCO Geopark. To this end, 91 sites have been inventoried, and their attributes evaluated to identify their potential for use. Given the different threats to geodiversity characterized in this work and the quantitative assessment results, management categories and a management structure have been proposed. Implementing these proposals could help to consolidate the Patagonia Verde Geopark project and bring many other positive externalities.

Currently, the Association of Patagonian Guides is the leading promoter of the project, being the first association in Patagonia Verde that unifies the five communes and therefore has a territorial vision and work. It is expected that adequate management, monitoring and promotion of the inventory will improve the inhabitant opportunities, generating an alternative to the current nature tourism initiatives and mainly the extractivist development that most of the regions of Chile have acquired.

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