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TECH4CULTURE - TECHNOLOGIES FOR CULTURAL HERITAGE

Tesi di Dottorato

LANDSCAPE AS HERITAGE: RECONCILING SUSTAINABILITY, GEODIVERSITY AND CULTURAL APPROACHES

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Where must we go,
we who wander this wasteland,
in search of our better selves?

George Miller, *Mad Max: Fury Road*

Abstract

The interconnection between mining and agricultural landscapes is a global occurrence. Mining activities are often located in rural areas, where the extraction of minerals and resources are also suitable for agriculture. This relationship is particularly significant in Minas Gerais State, South East Brazil. However, unplanned development and poor mining and agricultural practices have significantly impacted the landscape of Minas Gerais. The extraction of minerals has left scars on the landscape, such as open-pit mines and tailings piles. Agricultural practices based on industrial approaches and monoculture have also had negative impacts, including soil erosion and the overuse of pesticides.

This Ph.D. thesis consists of two peer-reviewed articles: (i) Agricultural Heritage: Contrasting National and International Programs in Brazil and Italy, and (ii) A Framework for Geoconservation in Mining Landscapes: Opportunities for Geopark and GEOfood Approaches in Minas Gerais, Brazil, in which mining and agricultural landscapes were assessed based on heritage approaches (i.e., Globally Important Agricultural Heritage Systems (GIAS), and geoconservation strategies, respectively), and a final chapter entitled "Development of geopark, GEfood, and climate change actions: perceptions of rural communities from Serra da Canastra, Brazil". In this way, the studies discuss how heritage approaches have become increasingly relevant in the past decades, as the need for sustainable management and conservation of biodiversity and geodiversity has become more pressing. In addition, we explore the central concepts related to the selected heritage designations, including GIAS, UNESCO Global Geoparks (UGGp) and GEOfood. Finally, we discuss the practical applications of the results to implementation in landscape heritage programs and public policies, including their importance for protecting natural and cultural resources and promoting a sustainable environment for present and future generations.

Contents

Chapter 1

1. Introduction

1.1. Landscape ecology

Landscape is a complex and dynamic system that encompasses both natural and human-made components (Turner, 2005). It provides different types of resources for human well-being and health while supporting a wide range of biotic and abiotic components of ecosystems (Turner, 2005). In the 1930s, the German geographer and botanist Carl Troll, began to develop a holistic approach to landscape analysis that emphasized the interconnectedness of ecological and sociocultural components of landscapes (Troll, 1971). He is highly regarded as the pioneer of landscape ecology. The "*landschaftsökologie*" (landscape ecology) is characterized by a strong focus on historical and cultural dimensions of landscapes (Turner, 2005; Tress et al., 2005). Historically, European landscape ecologists emphasized the importance of cultural heritage, aesthetics, and social values in landscape management and conservation. European landscape ecology also tends to be more focused on small-scale landscapes and the interactions between humans and nature at a local level (Tress et al., 2005).

In the 1970's, the concept of landscape ecology gained further prominence with the work of American ecologists such as Eugene P. Odum and Richard T.T. Forman (Turner, 2005b). In contrast to *landschaftsökologie*, the American landscape ecology was historically shaped by the influence of geography and remote sensing technologies (Wu, 2013; Kienast et al., 2021). They have tended to focus on larger-scale landscapes (e.g., watersheds and biomes), the use of spatial analysis tools to understand landscape patterns and processes, ecological processes and functions, and less on the cultural and social dimensions of landscapes (Wu, 2013; Kienast et al., 2021). Meanwhile, Eastern landscape ecology, which has developed primarily in China and other parts of Asia, has its own distinct traditions and approaches, which reflect the unique region-specific ecological and cultural practices, including the high human population density in many parts of Asia and the region's history of intensive land use and management practices (Wu, 2013).

The concept emerged as a Western discipline in the 1970s. Initially, the focus was on characterizing the patterns of land use and the spatial arrangement of habitats across the landscape, and understanding the implications of these patterns for ecological processes (Turner, 2005). It continues to evolve over time, from being viewed simply as physical features of the environment to a more holistic and integrated system (Kienast et al., 2021).

In the 1980s, there was a shift towards examining the dynamics of landscape change, including human-driven changes such as urbanization and deforestation, leading to the incorporation of spatial data analysis tools and the development of landscape ecology modeling techniques (Turner, 2005).

In the 1990s, there was a growing recognition of the importance of integrating spatial scale and multiple scales in the field of landscape ecology research, which led to the development of concepts such as hierarchical patch dynamics and the scale-dependent effects of landscape structure on ecological processes (Newman et al., 2019).

In the 2000s, landscape ecology research expanded to include the study of ecosystem services and the role of landscapes in supporting human well-being, including the social-ecological dimensions of landscapes and the importance of incorporating human perceptions and values into landscape management and conservation strategies (Turner, 2005; Wu, 2013).

In recent years, landscape ecology has emphasized the need for interdisciplinary and transdisciplinary research, and the integration of multiple disciplines and stakeholders in landscape management and conservation. These interdisciplinary studies integrate ecological, social, and economic perspectives to understand the in-depth interactions between human activities and the natural environment (Mayer et al., 2016; Roa-Fuentes et al., 2020). This has led to the emergence of new research approaches, such as participatory landscape planning and adaptive management, which aim to foster collaboration and shared decision-making among diverse stakeholders in landscape management, in order to address the unique challenges and opportunities of landscapes particularly in regions that have been historically marginalized and underrepresented in landscape ecology research (Roa-Fuentes et al, 2021; Santos et al., 2021).

While landscape ecology evolved and has traditionally focused on temperate and developed regions in the northern hemisphere, the global south encompasses a wide range of diverse ecosystems and cultural landscapes, including tropical forests, savannas, deserts, and coastal areas. Landscape ecology in the global south is an emerging field in the southern hemisphere. One of the key issues is the need to balance conservation and Sustainable Development Goals (UN, 2023), particularly in regions where poverty and economic development are major concerns. This requires a nuanced understanding of the social-ecological systems that shape landscape dynamics, and the development of management strategies and public policies that are tailored to the needs and priorities of local communities (Santos et al., 2021; Ocelli Pinheiro, 2021).

Another important focus is the need to incorporate local, indigenous and traditional ecological knowledge (or TEK) into landscape management and conservation. Many communities in the global south have developed sophisticated and sustainable land-use practices that have been refined over generations, and these practices can provide valuable insights into landscape dynamics and conservation strategies (Roa-Fuentes et al, 2021; Santos et al., 2021). This type of knowledge can provide unique insights into ecological processes and can inform the development of sustainable land-use practices and conservation strategies that are grounded in local cultural and social contexts (Gómez-Baggethun et al., 2013). It can also contribute to the understanding of the impacts of human activities on landscapes and their ecological processes, and can provide insights into how to manage landscapes in ways that are culturally appropriate and socially equitable (Ocelli Pinheiro, 2022; Sinthumule, 2023). The integration of TEK into landscape ecology research and practice is not without challenges. There can be layers of differences in worldview, language, and communication styles between researchers and local communities, and the appropriation of TEK without proper acknowledgment, ethical approach and respect for knowledge holders can lead to exploitation and cultural erasure (Sinthumule, 2023). It is important for landscape ecologists to approach the integration of TEK with respect and a willingness to learn from and collaborate with indigenous and local communities. This can involve building trust and strong relationships with knowledge holders, acknowledging the contributions and ownership of TEK, and ensuring that research and management decisions are made in partnership with local communities (Ludwig & Phil Macnaghten, 2020; Robinson et al., 2021).

The multidiscplinary field within landscape ecology offers exciting opportunities for combination and integration, expanding the scope and relevance of the concept in order to address important ecological and social challenges not only from the Northern Hemisphere, but also the most diverse and dynamic landscapes around the world. Nowadays, the complexity of the field lies in understanding the intrinsic relationships between patterns, structures, processes, and functions in landscapes.

Patterns refer to the spatial heterogeneity of landscape components, such as landforms, distribution of vegetation types, topography, water bodies and land use, at different spatial scales. It is a crucial part for understanding the ecological and social processes that occur in landscapes and their effects on biodiversity, ecosystem functioning, and human well-being. Their characterization and analysis can be done using a range of techniques, including remote sensing, geographic information systems (GIS), and spatial statistics. These techniques allow researchers to quantify landscape patterns and generate spatially explicit maps that can inform conservation and management decisions (Turner, 2005). Consequently, different landscape patterns have different socio ecological implications. For example, fragmented landscapes, where natural habitats are broken up into smaller, isolated patches, can lead to reduced connectivity and gene flow among populations, which can increase the risk of extinction and reduce ecosystem functioning and processes (Fahrig, 2003). On the other hand, heterogeneous landscapes with a diversity of habitat types can support a wide range of species and ecological processes, contributing to the maintenance of ecosystem functioning and resilience (Fahrig, 2003; Turner, 2005).

Landscape structures describe the spatial arrangement of the components and the connections between them, referring to the physical characteristics of the landscape that determine its overall composition and organization. These characteristics can include the arrangement of land cover types, the size and shape of patches and infrastructure, and the connectivity of habitats. Understanding landscape structure is important because it can affect ecological processes such as nutrient cycling, water flow, and species interactions (Cushman et at., 2010). One common method for quantifying landscape structure is through the use of landscape metrics, or numerical measurements that describe various aspects of landscape pattern and configuration, such as the amount of edge habitat, the degree of fragmentation, and the size and shape of patches (Karimi et al., 2021). Landscape metrics can be used to compare or to track changes in different landscape structures over time. For example, a certain type of landscape structure which can affect the movement of organisms and the spread of diseases (Keesing et al., 2010).

Processes refer to the fundamental biological and physical interactions that occur within ecosystems and shape their structure and function (e.g., nutrient cycling, energy flow, succession, disturbance, migration, and several population dynamics) and how they are influenced by external factors that operate at different spatial and temporal scales, landscape structure and human activities (e.g., climate, topography, and human activities) (Turner, 2005). For example, climate change can have different effects on ecological processes, such as altering the timing of seasonal events and the distribution of species across landscapes (Parmesan & Yohe, 2003).

Functions describe the roles that landscapes play in providing different eco/geosystem services. Those are the material and nonmaterial benefits, goods, and services dependent on the structure and processes of the landscape, such as regulating air and water quality, supporting biodiversity, providing food and fiber, and offering recreational opportunities (MEA, 2005). These services are crucial for human well-being and health. For example, vegetation plays a key role in regulating air quality by absorbing carbon dioxide and other pollutants and releasing oxygen. Meanwhile, wetlands and riparian zones are known for their importance to filter and clean water, reducing sedimentation and nutrient pollution, while protecting the land (Groot et al., 2002). Ecosystems also support biodiversity and geodiversity by providing habitats for a variety of species, while the structure and composition of the landscape can influence the distribution and abundance of species, as well as their interactions with each other and their environment (MEA, 2005).

1.2. Cultural Landscape

Landscape and culture are two interconnected concepts playing significant roles in defining our relationship with the natural world and the built environment. A cultural landscape refers to a landscape that has been shaped and modified by human activity, reflecting the interaction between people and their environment over time. It is a concept that emerged in the field of cultural geography and has been widely adopted in landscape studies and heritage conservation. They encompass a wide range of landscapes, including agricultural, rural/urban, mining, historic, sacred, and traditional territories of indigenous communities. Not just physical spaces but they also carry deep cultural, social, and historical meanings and values for the communities that inhabit or identify with them (UNESCO, 2013).

1.2.1. The human component

Cultural landscapes are a product of human activities and interactions with the environment, resulting in their distinctive character, form, and functions. Understanding the extent and nature of human influence is essential for comprehending the significance of cultural landscapes and devising effective conservation and management strategies. Human influence on cultural landscapes encompasses several activities, including: (i) Land use and agriculture: Human settlements and agricultural practices have significantly altered the natural landscape, transforming it into cultivated fields, terraces, and pastoral lands. Agricultural practices have left lasting imprints on the landscape's structure and composition, shaping the spatial arrangement and connectivity of different land cover types; (ii) Settlement patterns and urbanization: Human settlements, towns, and cities are prominent features of cultural landscapes. Urbanization has led to the construction of buildings, infrastructure, and transportation networks, profoundly altering the landscape's character and ecological processes; (iii) Cultural and spiritual sites: Cultural landscapes often encompass sacred sites, places of worship, and cultural rituals. Human activities associated with these sites have contributed to their unique cultural and historical significance, fostering a profound sense of place and identity; (iv) Industrialization and resource extraction: The expansion of industrial activities and resource extraction has left substantial marks on cultural landscapes. Mining, logging, and extraction of natural resources have altered landforms, habitats, and ecological dynamics; (v) Historic sites and monuments: Cultural landscapes frequently include historic sites and monuments that hold immense cultural and architectural value. Preservation efforts of such landmarks are vital to maintaining the authenticity and integrity of the landscape's cultural heritage; (vi) Traditional land management practices: Indigenous and local communities have employed traditional land management practices for generations. These practices often promote biodiversity, ecosystem resilience, and sustainable resource use.

Human influence is not solely limited to the physical transformation of landscapes; it also extends to the intangible cultural elements that shape landscapes, such as beliefs, values, and traditional knowledge. The continuity of cultural landscapes over time is a testament to the persistence of human-nature interactions and the adaptability of human communities to changing circumstances.

Recognizing the human influence component in cultural landscapes is crucial for fostering a holistic approach to landscape management and conservation. Integrating cultural perspectives, social values, and traditional knowledge into conservation strategies ensures that cultural landscapes are safeguarded in a manner that respects the interests and aspirations of the communities that inhabit or identify with them. By acknowledging the dynamic and reciprocal relationship between human activities and the landscape, cultural landscapes can be preserved as living repositories of cultural heritage and as vibrant ecosystems that sustain biodiversity and human well-being.

1.2.2. Heritage and identity

Another crucial aspect of landscapes that embodies the cultural, social, and historical significance of landscapes to the communities that inhabit or identify with them. Cultural landscapes are attached with intangible values, beliefs, and traditions that reflect the collective memory and cultural identity of past and present generations. They serve as living repositories of a community's cultural heritage. They bear witness to the historical evolution of human societies, recording the diverse ways in which people have interacted with and shaped the landscape over time. Through tangible features, such as historic sites, buildings, and artifacts, and intangible elements like traditional practices and oral traditions, cultural landscapes preserve the collective memory of a community and its connection to the land (UNESCO, 2013).

The sense of place fosters a deep emotional attachment and belonging among the people who inhabit or have historical ties to the landscape. It is a powerful connection that goes beyond physical or utilitarian aspects, evoking a strong emotional response and a feeling of homecoming. The landscape becomes a part of one's identity and a source of comfort and security (Wu, 2013).

Throughout history, many societies have also placed cultural significance within cultural landscapes such as sacred sites, ceremonial grounds, and places of worship. These locations hold profound spiritual and cultural significance, serving as gathering places for ceremonies, rituals, and communal events. Such sites are central to the preservation of cultural traditions and sacred practices, perpetuating tangible connections to the past, fostering a sense of reverence and spirituality (Berkes, 2012).

Preserving the heritage and identity component of cultural landscapes is a critical aspect of their conservation and management. Recognizing and respecting the cultural values, beliefs, and knowledge embedded in the landscape are paramount. This involves engaging local communities in decision-making, integrating traditional knowledge into conservation strategies, and fostering a sense of stewardship and ownership among the people connected to the landscape (Palang et al., 2018). By safeguarding the heritage and identity embedded within cultural landscapes, we ensure the preservation of cultural diversity, collective memory, and the intangible cultural legacy that enriches human societies and strengthens our understanding of the past, present, and future.

1.2.3. Continuity and change

The continuity and change component are defining features of cultural landscapes, reflecting the dynamic nature of human-environment interactions over time. Cultural landscapes respond to new challenges, embrace innovations, and navigate the forces of globalization. The balance between continuity and change is critical for the sustainable preservation and management of these landscapes. Those landscapes are the stage of human traditions, practices, and beliefs that have persisted over generations. The continuity aspect represents the enduring connection between communities and their ancestral lands, reflecting the intergenerational transmission of knowledge, customs, and values (Balee, 2016). Traditional land-use practices, such as agroforestry, terracing, or rotational grazing, are examples of cultural continuity in the landscape. These practices have not only contributed to landscape formation but have also sustained local livelihoods and supported biodiversity conservation over extended periods (Palang et al., 2018).

Amidst the forces of change, cultural landscapes also exhibit adaptive capacity. Communities evolve their practices, technologies, and ways of life to respond to environmental, economic, and social shifts. Cultural adaptation allows communities to maintain their connection to the landscape while embracing new knowledge and practices (Berkes & Folke, 1998). For instance, urbanization and industrialization have brought significant changes to cultural landscapes, leading to the development of cities and the transformation of traditional land uses. In response, communities may integrate modern agricultural techniques or engage in cultural tourism, effectively adapting to changing economic and social conditions (Maffi, 2010).

At the same time, the interplay between continuity and change poses a challenge for heritage conservation in cultural landscapes. Striking a balance between preserving the traditional cultural practices and embracing appropriate innovations is essential to safeguard the landscape's cultural integrity (Palang et al., 2018). Conservation efforts need to acknowledge the significance of cultural continuity, respecting and preserving traditional knowledge, practices, and sacred sites. However, they must accommodate changes that align with sustainable development and support community well-being. Achieving this balance requires engaging local communities, fostering participatory decision-making, and recognizing their role as stewards of the landscape (Maffi, 2010). The integration of local communities and their sense of place nurtures a strong sense of environmental stewardship and responsibility. The emotional connection to the landscape compels individuals and communities to protect and preserve it for future generations. The landscape's well-being becomes inseparable from the well-being of the community (Palang et al., 2018).

1.3. Drivers-Pressures-State-Impacts-Response (DPSIR)

Drivers-Pressures-State-Impacts-Responses (DPSIR) is a comprehensive framework and widely used environmental assessment tool in the next generation of sustainable policy implementation (Shane et al., 2023). It provides a structured approach to analyze and understand the complex interactions between human activities, environmental pressures, and their consequences on ecosystems (Zhao et al., 2018; Bux Khoso, 2023). By leveraging the DPSIR approach, we can gain valuable insights into the challenges and opportunities agricultural and mining landscapes present, guiding us towards sustainable and informed decision-making.

Drivers correspond to the underlying factors that influence human activities and land use in agricultural and mining landscapes. These driving forces can include economic, social, political, and technological factors that drive agricultural expansion, mining operations, or changes in land use. For agricultural landscapes, factors such as population growth, food demand, and market trends drive changes in land use and agricultural practices. In mining landscapes, economic incentives, resource demands, and technological advancements may be the driving forces behind mining activities.

The Pressure component of the DPSIR framework identifies the direct impacts of human activities on the environment within these landscapes. In agricultural landscapes, pressures may manifest as soil degradation, water pollution from agricultural runoff, or the conversion of natural habitats into farmlands. In mining landscapes, pressures can include habitat destruction, soil erosion, water contamination, and air pollution from mining operations.

The State component assesses the current condition of the environment in agricultural and mining landscapes based on the identified pressures. For agricultural landscapes, this may involve assessing soil health, water quality, and biodiversity levels. In mining landscapes, it may involve evaluating the impact on geological formations, biodiversity, and water bodies.

Impacts explore the consequences of the pressures on the environment and society within these landscapes. For agricultural landscapes, impacts may include reduced agricultural productivity, loss of biodiversity, and negative effects on human health due to pesticide exposure. In mining landscapes, impacts may involve habitat destruction, water scarcity, and social disruption in communities near mining sites.

The final component of the DPSIR framework focuses on the responses and measures taken to address the identified pressures and mitigate the impacts. Responses may include the implementation of sustainable agricultural practices, the restoration of degraded ecosystems, or the adoption of responsible geoconservation strategies in mining operations. Additionally, policies and regulations may be formulated to guide land use and resource management decisions. This component plays a crucial role in guiding management and conservation in many agricultural and mining landscapes.

Heritage designations and geoconservation strategies emerge as powerful and complementary approaches within the context of responses for DPISIR. International heritage designations such as Globally Important Agricultural Heritage Systems (GIAHS) or the UNESCO World Heritage Sites, recognize the biocultural significance of specific landscapes, providing international recognition and protection (UNESCO, 2013). Integrating different levels of heritage designations with responses in these landscapes can foster a sense of pride and stewardship among local communities, promoting sustainable practices and fostering a commitment to preserve their unique heritage for future generations. Additionally, the combination of geoconservation strategies and heritage designations, exemplified by the UNESCO Global Geoparks network in this study, focus on safeguarding the geological heritage and landscape geodiversity. These types of responses can leverage the dual benefits of preserving cultural and natural heritage, reinforcing the landscape's resilience and integrity against the pressures posed by agricultural and mining activities. The alignment of responses with heritage and geoconservation initiatives presents a potent mechanism to harmonize human activities with landscape conservation, ensuring a balanced and sustainable future for these vital landscapes.

1.4. Agricultural and mining landscapes

Departing from the concepts of landscape heritage (a concept rooted in social, cultural, historical, economic, political, and environmental values) and the DPSIR framework, this study emerges as a testament to the dynamic relationship between communities and their surroundings. In this context, mining and agricultural landscapes stand as the examples encapsulating the impacts of human activities on the land. The convergence of mining and agricultural practices presents a wide range of challenges, as resource extraction and intensive cultivation can significantly alter the landscape's ecological and cultural aspects. The need for sustainable land management and conservation strategies has become ever more pressing in the face of rapid urbanization and global resource demands.

This thesis delves into the interconnection between mining and agricultural landscapes, recognizing the delicate balance between exploiting natural resources and preserving the landscape's heritage. The complex relationship between these practices demands a more comprehensive examination of their environmental, social, economic, and political implications. By exploring the intricate interactions between resource extraction and land use, this research seeks to shed light on potential conflicts, gaps, and synergies that may arise from heritage programs and their implementation/development. Following this line, heritage conservation programs are promising tools for safeguarding the integrity of bio/geo-cultural landscapes. These initiatives have proven successful in preserving cultural landscapes, acting as guardians of traditional knowledge, customs, and practices deeply rooted in the land. By extrapolating from these strategies, the study aims to discern how heritage programs can be effectively applied to agricultural (in Brazil and Italy) and mining (in Brazil) landscapes. It seeks to understand how the heritage perspective can contribute to reconciling the seemingly disparate goals of resource exploitation and landscape conservation. The research will delve into case studies and national and international practices of heritage conservation (i.e., Important Agricultural Heritage Systems, UNESCO Global Geoparks, and GEOfood) examining how these programs have addressed the challenges posed by resource extraction and intensive agriculture. By analyzing several examples, the thesis endeavors to identify key principles and mechanisms that could be adapted to protect landscapes facing mining and agricultural pressures.

Ultimately, this study endeavors to contribute to a holistic approach to landscape conservation, one that recognizes and embraces the intrinsic and multidisciplinary value of landscape heritage. Through the integration of heritage programs, the thesis envisions a path towards sustainable resource management that respects the cultural, environmental, and social dimensions of the landscape, and at the same time highlighting the importance of the abiotic components for them. By preserving our heritage, we not only secure a resilient future for our landscapes but also honor the wisdom of the past and the bonds between humanity and nature that shape our world.

Chapter 2

2. Agricultural Heritage: Contrasting National and International Heritage Programs in Brazil and Italy

2.1. Introduction

This chapter refers to the first article derived from the thesis and published in an ISI journal (Sustainability) entitled "Agricultural Heritage: Contrasting National and International Heritage Programs in Brazil and Italy" by Raphael Ocelli Pinheiro, Luiza Fonseca and Marco Giardino, included in this work as Annex 1. The article provides a comprehensive analysis of agricultural heritage programs in two distinct contexts (i.e., Brazil and Italy), showcasing the diverse approaches adopted by each country in safeguarding their unique agricultural landscapes and traditions. The historical, cultural, and ecological significance of agricultural landscapes in both Brazil and Italy are highlighted among with their vital role in shaping the identities of rural communities and fostering biodiversity conservation. By examining the distinct national heritage programs in each country, the article sheds light on how their respective policies and strategies aim to protect and promote the agricultural landscapes' integrity.

Chapter 3

3. A Framework for Geoconservation in Mining Landscapes: Opportunities for Geopark and GEOfood approaches in Minas Gerais, Brazil

3.1. Introduction

As an integral part of this thesis, Chapter 3 is correspondent of Annex 2, which presents the second article derived from this thesis and published in an ISI journal (Resources) entitled "A Framework for Geoconservation in Mining Landscapes: Opportunities for Geopark and GEOfood approaches in Minas Gerais, Brazil" by Raphael Ocelli Pinheiro, Sara Gentilini, and Marco Giardino. The article offers a comprehensive and innovative approach to addressing the conservation challenges posed by mining activities in different sites of the Minas Gerais State, in Brazil. The framework seeks to reconcile the often conflicting goals of resource extraction and sustainability by integrating geoconservation strategies. By incorporating geopark and GEOfood approaches, the framework aims to harness the potential of mining landscapes for sustainable land use and geoconservation.

Chapter 4

4. Development of geopark, GEfood, and climate change actions: perceptions of rural communities from Serra da Canastra, Brazil.

4.1. Introduction

Finally, the fourth and final chapter of this thesis consists of a test survey (online) done in the beginning of 2023 in the *Canastra* region, Brazil (see Chapter 3 for detailed information about the area). The study was initially planned as a comprehensive survey spanning several months, face-to-face and online, to collect extensive data on the perspectives of the local and traditional communities in regards to environmental issues (i.e., geohazards, climate change, mining related challenges) and geoconservation strategies (i.e., UNESCO Global Geoparks and GEOfood brand) within the Canastra region and its 9 current municipalities. Through the comprehensive survey, the study investigates the local community's understanding of climate change impacts on both environmental and cultural heritage, as well as their willingness to participate in actual and future geoconservation efforts. This part of the research aims to provide valuable insights into the community's perspectives on climate change, its effects on the region's biodiversity, geological features, and cultural heritage. Additionally, it explores the potential of UNESCO Global Geoparks as an effective response strategy (from DPSIR) in promoting sustainable landscape conservation in the face of climate change and geohazards. However, only the test part was completed, due to the lack of financial and human resources and the COVID-19 pandemic. Consequently, the findings of this Chapter are preliminary results found from this modified sampling strategy and future efforts will focus on the extended area and the addition of face-to-face interviews, providing richer insights into the communities' perceptions and dynamics.

4.1. Materials & methods

The study used semi-structured interviews (Galletta, 2013) with residents and visitors in one municipality of the Canastra region (i.e., Bambuí). Broadly, the study comprises qualitative and quantitative approaches. In total 235 online respondents were considered, being 153 locals (people who lived inside the Canastra region) and 82 visitors (the ones who did not). The test initiated with the purpose of the research and an invitation to take part in an interview to discuss aspects related with the development of the Canastra region. Interviews were scheduled to take approximately 15-20 minutes. After their oral authorization and acceptance to join the study, interviewees were provided with the first section of questions. This first section first consisted of (i) questions regarding their socio-demographic background, (ii) to the COVID-19 pandemic and how each responded perceived its impacts on the region’s activities, and (iii) their knowledge about “g-terms” (i.e., geodiversity, geoheritage, geopark, and geoproducts). Regarding the impact of COVID-19, the following aspects were taken into account: local investments, local jobs, diversity and inclusion in the job market, price of goods, price of services, availability of goods, availability of services, regional infrastructure development, population growth, migration from rural to urban areas, migration from urban to rural areas, and effects on local biodiversity. Each responded was asked to each to rate whether if it had an effect based on a five-level scale (i.e., ‘very negative’, ’slightly negative’, ’no impact’, ’slightly positive’, or ‘very positive’).

After they were done with the first section, the second one started with an explanation of the same terms, followed by questions regarding the implementation and development of geoconservation strategies in the area. A Likert scale was used to assess their preferences about the following: (i) geoproducts, (ii) events, and (iii) geosites. Each respondent was asked to rate each item from the respective list according to the Likert scale from ’1′ to ’5′, with ’1′ indicating “strongly dislike” and ’5’ indicating “strongly like”. In relation to the ‘sources of trustful information about climate change' we asked about their notion of trust and distrust (a three-level scale with 'distrust, 'in between', and 'trust' alternatives was used). The list containing each item evaluated is available below (Table 1).

Table 1: Checklist containing all the itens from the four different questions in regards to geoproducts, events, geosites, and source of information.

Geoproducts	Events	Geosites	Source of information
Canastra Cheese	Canastra Music Festival	Casca D'anta (lower part)	Family members or friends
Honey	Food Festival *(Aromas e Sabores)*	Casca D'anta (upper part)	Scientists
Cachaça	Canastra Cheese Festival	Chinela waterfall	Park members
Dolce de leche	São Roque Festival	Recanto da Canastra waterfall	State members
Spices and sauces	Folia de Reis	Stone Stockyard	Mining company
Sausages and smoked meat	Hot Air Balloon Festival	Chapadão da Canastra observatory	Environmental Organizations
Jelly	Winter Festival	São Francisco River historical site	Media (tv/radio/newspaper)
Donuts		Poço dos Rolinhos (lower part)	Social network
Coffee		Poço dos Rolinhos (upper part)	
		Rasga Canga waterfall	
		Cerradão waterfall	
		Nego waterfall	
		Antônio Ricardo waterfall	
		Gurita/Jota waterfall	
		Fundão waterfall	
		Parida waterfall	
		Treasure grotto	
		Capão Forro waterfall	
		Orchid well	
		Chinela/Zé da Lata waterfall	
		Lavrinha waterfall	

A three-level scale (i.e., 'low ', 'medium', or 'high') was used to address the following questions: (i) What is your level of flexibility to adapt your service/product to the new demands of tourists?; and (ii) What is your level of flexibility to adapt your service/product to new demands if the region becomes a UNESCO Global Geopark? The rest of the nominal data collected were simple yes/no questions (Table 2).

Table 2: Checklist containing all yes/no questions address during the interviews

Questions
Do you find it interesting that your municipality becomes part of a unified UNESCO Geopark?
Do you find it interesting that the Canastra region becomes a unified UNESCO Global Geopark?
Do you believe that as a UNESCO Geopark, the Canastra region would experience better economic, social, and environmental development?
Do you believe that as part of a UNESCO Geopark, your municipality would experience better economic, social, and environmental development?
Do you believe that the "canastreiros" (or traditional producers in the region) are recognized through public policies/initiatives/actions by local administrators?
Do you believe that the "canastreiros" (or traditional communities in the region) could gain greater recognition through public policies/initiatives/actions by local administrators if the region becomes a UNESCO Geopark?
Overall, do the local commercial activities in the region seem to adapt to the new and modern needs of tourists?
Would you be interested in promoting/selling your product/service alongside the GEOfood brand, in case the park becomes a UNESCO Geopark?
What is your opinion about mining activities LEGALLY occurring within the park areas?
Have you heard of any type of ILLEGAL mining activity within the park area?
Have you heard of any type of LEGAL mining activity within the park area?
What is your opinion about LEGAL mining activities occurring within the park areas?
If mining activities were to occur in the park, would you be interested in visiting possible mining sites to learn more about the geological aspects involved?
Have you heard about climate change before this questionnaire?
Are there warning systems in place to alert the population (e.g., vulnerable communities) about the occurrence of certain natural disasters (such as wildfires, heatwaves, cold waves, landslides, floods, etc.)?
Are there procedures and/or plans for managing natural risks within the cities and during periods of higher tourist influx?
Are there awareness campaigns to expand knowledge about sustainability and climate change in the park area?
Is there openness to questioning related to sustainability and climate change by local administrations?
Do you know about any scientific/educational partnerships of the park with research institutes, universities, NGOs, etc.?

4.3. Results & discussions

4.3.1. Respondents

There was a reasonable balance between the number of women and men who responded, with 141 female and 94 male interviewees (representing 60% and 40% of all respondents, respectively), all between the ages of 18 and 64 years old with the highest percentage (54.3%) between 25-34 years old. Thirty-four percent of users completed their Bachelor's degree, followed by 28.6% and their Master's degree. These high educational numbers can be explained by the people invited to participate in the test study, which are mostly composed of students from the area, local entrepreneurs, and administrative groups (Table 3).

Table 3: Table with information about users' characteristics. Users include both locals and tourists.

Sex	Percentage (%)	Age	Percentage (%)	Education	Percentage (%)
female	60	18-24	11.4	Secondary school	11.4
male	40	25-34	54.3	Technical	11.4
		35-44	11.4	Bachelor's degree	34.3
		45-54	14.3	Master's degree	28.6
		55-64	8.6	Ph.D.	8.6
				Illiterate	5.7

4.3.2. Interest and expectations regarding geoconservation strategies

The majority of respondents find it interesting that both their municipality (97.1%) and the Canastra region (94.3%) become part of a unified UNESCO Global Geopark. This indicates a high level of interest and support for the idea of obtaining UNESCO Geopark status, independent of their origin. Similarly, a significant proportion of respondents (94.3%) believe that the Canastra region would experience better economic, social, and environmental development under the UNESCO Global Geopark label. Additionally, a majority (85.7%) also believe that their municipality would experience improved development.

Regarding the recognition of *canastreiros* or local producers in the region, the data shows that only 40% of respondents believe they are currently recognized through public policies/initiatives by local administrators. This suggests that there might be room for improvement in acknowledging and supporting the contributions of these traditional communities. An essential part of the implementation of a geopark is the involment of these communities in the decision-making processes and governance structures, empowering them to voice their needs and aspirations. This can be achieved through participatory planning, training and capacity-building programs to community members can enhance their skills and knowledge, enabling them to actively engage in economic, social, and environmental initiatives.

At the same time, if the region becomes a UNESCO Geopark, 80% of respondents believe that the *canastreiros* could gain greater recognition through public policies/initiatives by local administrators. This indicates that respondents see the UNESCO designation as a potential avenue for enhancing the visibility and support for traditional communities. Along with the local administration, geoconservation strategies can work as pillars to ensure and secure land tenure and resource rights for locals, protecting them from displacement and exploitation by formalizing land rights and establish mechanisms to manage resources sustainably (Kasimbazi, 2017; Mergele & Pietsch, 2017; Holland et al., 2022). Even more, if communities feel that their voices are heard and their needs are considered in geopark planning, it reinforces a sense of ownership and active participation. Demonstrating this in the dossier signifies a democratic and inclusive approach, which aligns with UNESCO's sustainable development goals.

4.3.3. The G-terms

In general, most of the g-terms examined received roughly similar levels of recognition, except for GEOfood (Table 4). It is evident that these concepts had lower levels of recognition and acknowledgment among the respondents. The lack of familiarity with these terms can be attributed to several factors. Firstly, g-terms are relatively specialized and may not be commonly used or well-known outside specific academic or professional circles. Additionally, the complexity and interdisciplinary nature of these concepts may have contributed to their limited recognition, as they require a deeper understanding of geology, heritage preservation, sustainable tourism, and agro-food systems. Furthermore, the lack of public awareness campaigns and educational initiatives on the area about g-terms may have contributed to the respondents' unfamiliarity with these concepts. Moving forward, efforts to raise awareness and promote the significance of g-terms in the context of geoconservation strategies, geoproducts and sustainable development could foster greater recognition and understanding among locals and the broader community, which is also one of the goals of this type of study, especially in regards to the GEOfood brand (the lowest percentage). A high level of g-term comprehension within these communities showcases their active involvement in geoconservation related initiatives, and their ability to engage with scientific and educational aspects of geology. This can be used and highlighted in the UNESCO’s dossier to demonstrate the community's preparedness to contribute to geoscientific and educational activities within a geopark area.

Table 4: Table with information about users’ perceptions about g-terms. Users include both locals and tourists.

Geodiversity	**Percentage (%)**	**Geoheritage**	**Percentage (%)**	**Geopark**	**Percentage (%)**	**GEOfood**	**Percentage (%)**
Yes	48,6	Yes	48,6	Yes	40	Yes	17,1
No	51,4	No	51,4	No	60	No	82,9

4.3.3. Awareness, attitudes, and interest in mining activities

Approximately two-thirds (65.7%) of the respondents stated that they had never heard about illegal mining activities in the region, while 34.3% reported being aware of such activities. Similarly, a majority of respondents (71.4%) indicated that they had never heard about legal mining activities, with only 28.6% reporting awareness of legal mining operations.

A significant majority (80%) of respondents expressed opposition to mining activities in the region, while a smaller proportion (20%) indicated support for such activities. This suggests that the majority of respondents are cautious or concerned about the potential impacts of mining on the region's environment, social fabric, and cultural heritage.

On the topic of visiting geosites in mining sites, 65.7% of respondents expressed interest, while 34.3% indicated no interest. This suggests that a considerable portion of the respondents find value in exploring geosites within mining areas, possibly indicating a desire to understand the geological aspects involved in mining operations.

Overall, the data reveals that a significant portion of the respondents have limited awareness of both illegal and legal mining activities in the region. Additionally, a clear majority opposes mining activities, indicating concerns about the potential adverse effects on the area's environment and communities. However, there is notable interest in visiting geosites within mining sites, possibly reflecting a curiosity about the geological aspects associated with mining operations.

These findings provide valuable insights into the perspectives and attitudes of the respondents regarding mining in the region and can inform decision-making processes and public awareness campaigns related to mining activities. Their active involvement in preserving geological and environmental heritage, whether through land stewardship, educational programs, or scientific monitoring/visits, showcases their dedication to the geopark's core objectives.

4.3.4. Economics: geoproducts and geoservices

In general, the respondents' perspectives on the adaptability of local commercial activities to the modern needs of tourists are relatively evenly split. Fifty-four percent of respondents believe that local commercial activities do adapt to these new demands, while 45.7% think otherwise. This indicates a somewhat mixed perception among respondents regarding the level of adaptation of general businesses in the region.

When asked about their own level of flexibility to adapt their service/product to the new demands of tourists, the majority of respondents (71.4%) indicated a low level of flexibility. This suggests that a significant portion of respondents may face challenges or constraints in adjusting their offerings to meet changing tourist demands, many of them were addressed in this discussion.

Moreover, the data shows that respondents' level of flexibility to adapt their services/products to new demands decreases further (74.3% with a low level of flexibility) if the region becomes an UGGp. This indicates that respondents may perceive additional difficulties in adapting to the specific demands and requirements associated with a heritage designation. The argument is valid, considering that despite the positive and recognizable benefits and improvements of heritage designations around the world, many concerns and limitations related to their argument are still being analyzed and looked up (Gonzalez-Tejada et al., 2017; Segala et al, 2018; Brownell, 2023; see more examples in previous chapters).

In regards to geoproducts, the Canastra cheese, dulce de leche, and coffee received the highest scores among respondents, indicating that these geoproducts are widely recognized and appreciated in the region. On the other hand, donuts and sauces received the lowest scores, suggesting that they are less popular or less known among the respondents. A significant majority (85.7%) of respondents are aware of Canastra cheese winning international championships over the years. This high level of awareness suggests that Canastra cheese's achievements have gained considerable recognition and reputation both locally and internationally. It indicates that the achievements of those local products, have contributed to their prominence among respondents.

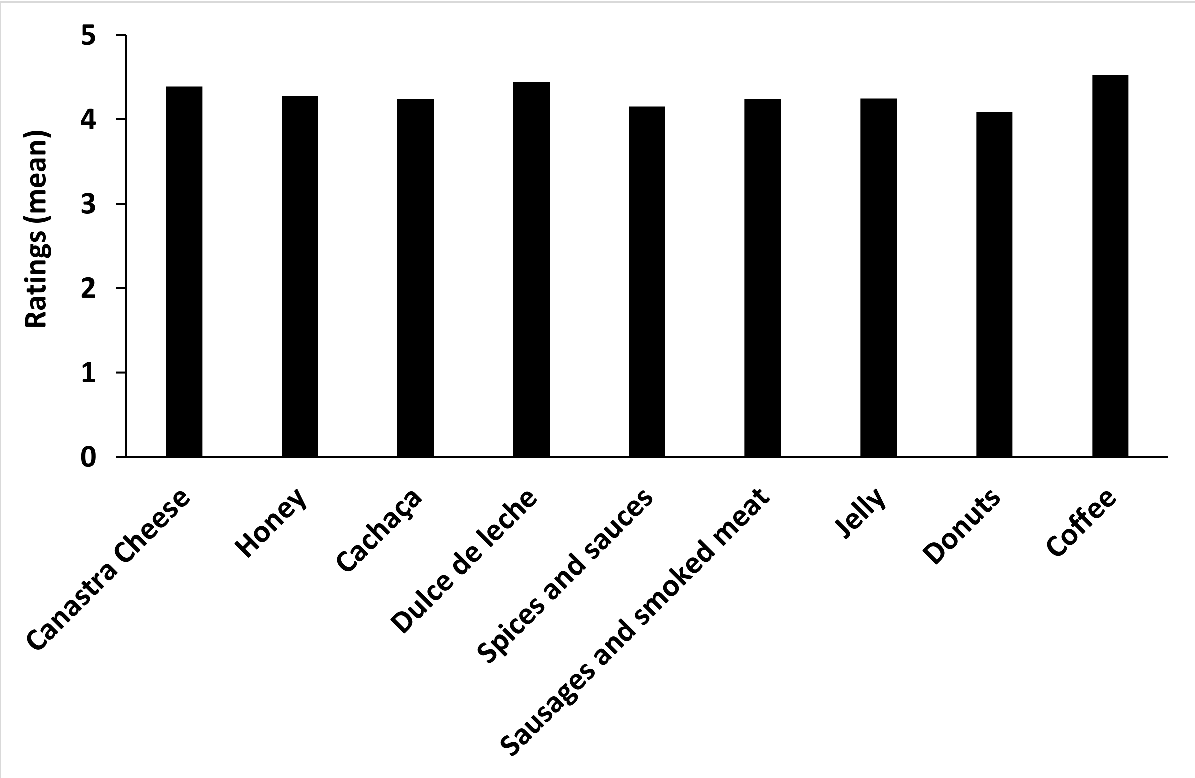

Figure XX: Ratings (mean values) ranging from 1 to 5 given by respondents about the geoproducts from the Canastra region.

Despite a substantial portion of respondents' awareness regarding the Canastra cheese's success in international contests, only 22.9% expressed interest in adding the GEOfood label to their geoproducts. This indicates that a smaller proportion of respondents are actively interested in promoting their geoproducts under the GEOfood brand. There may be various reasons behind the lower interest, such as the cost of obtain/maintain the label, specific target markets, or a preference for other labelling strategies that are already circulating the minds of the region's stakeholders, such as the Protected Geographical Indication (PGI) and Protected

Designation of Origin (PDO). Here, it is important to highlight that the GEOfood brand requires a one-time payment fee for the addition of the UGGp in the network and does not charge from the local producers. Moreover, the brand can co-exist with other product labels, meaning that the new label will not interfere with the previous ones. Those elements were not specifically address in this test phase.

It is evident that some respondents never heard nor are familiar with the GEOfood initiative and express concerns about its formalization and economic impact. Respondents stated their reservations are related to potential external investments and support for local entrepreneurship, which may pose risks to smaller or subsistence producers. Some respondents also question whether large partnerships may harm small-scale producers, potentially affecting their market presence. They seek to better understand how GEOfood-related activities can benefit local producers and ensure a fair distribution of financial gains. Therefore, it is crucial to ensure that the implementation of the GEOfood brand strike a careful balance between economic development and the preservation of the region's natural and cultural resources.

These findings highlight the importance of supporting and encouraging businesses in the region to enhance their adaptability and responsiveness to evolving tourist demands, especially if the region aims to leverage the UGGp status. The results also provide valuable insights into the preferences and awareness of respondents regarding geoproducts and can be utilized by producers and policymakers to inform marketing strategies, product development, and potential collaborations to enhance the promotion and recognition of geoproducts in the Canastra region. Their willingness to participate and engage with local enterprises and geoconservation strategies related to business, can also be presented into the dossier as a testament to their commitment to the geopark's economic sustainability, while preserving local traditions and livelihoods.

4.3.5. Geotourism and geosites

The ratings show respondents preferences for certain events ($p < .001$) and for certain geosites ($p < .001$)(Fig. XX and Fig. XX). Chi-square values can be found as Annex 3. Understanding user preferences is a crucial aspect in geotourism research, planning and development (Ólafsdóttir and Tverijonaite, 2018; Tomić et al., 2021).

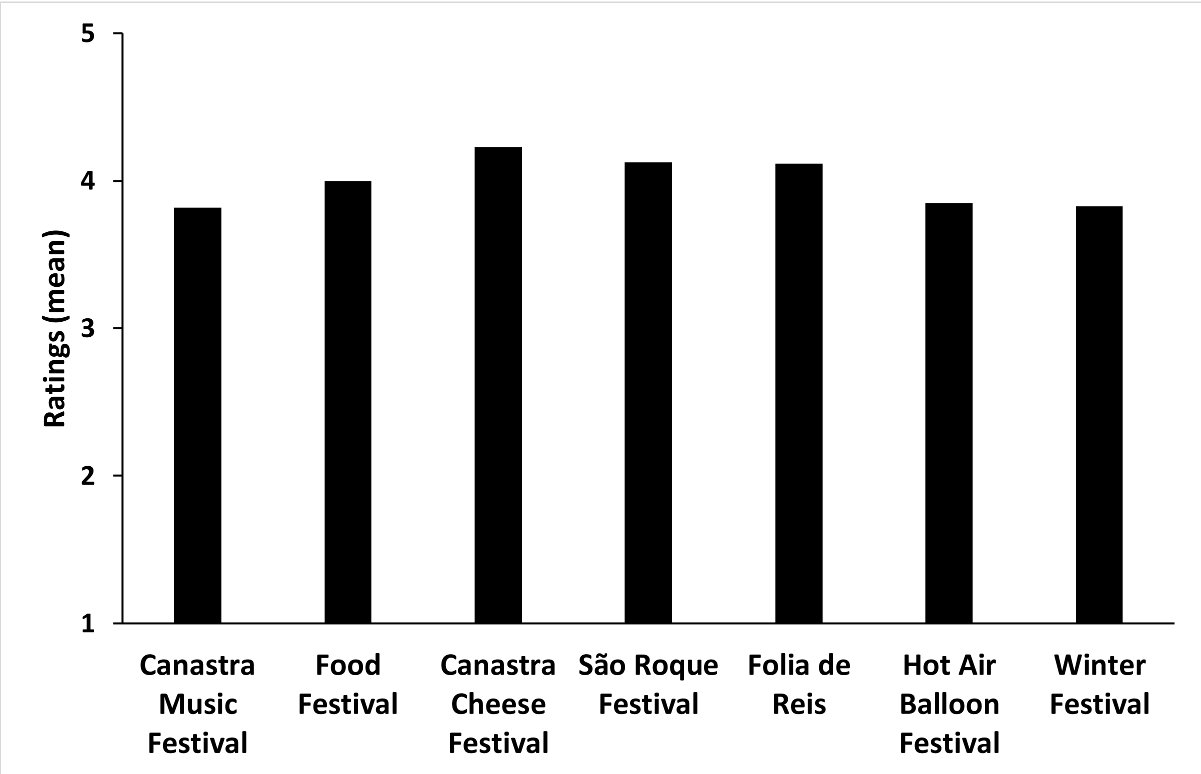

Figure XX: Ratings (mean values) ranging from 1 to 5 given by respondents about the events occurring in the Canastra region.

For the events, the Canastra Cheese Festival, Food Festival, Folia de Reis, and São Roque Festival, got the highest ratings from the respondents. They represent how valuable is the dynamic sociocultural and gastronomic tourism in the area and how insightful they could be in future in-depth analysis. These preferences are often presented by the respondents by a combination of factors, including the intrinsic appeal of the event, cultural significance, culinary diversity, and accessibility. Notably, the Canastra Cheese Festival and the Food Festival tends to attract aficionados of artisanal dairy products and connoisseurs of the regional cuisine, offering a rich cultural experience rooted in the tradition of the *Canastreiros*. The Folia de Reis, with its religious and cultural roots, appeals to those seeking a deeper connection to local traditions and rituals. The festival is a traditional Brazilian folk celebration, featuring lively music, dance, and processions, often performed during the Christmas season (Souza & Araújo, 2020). Many of these events are designated part of the Minas Gerais state heritage by the Artistic and Historical Heritage State Institute.

Remarkably, the events in general have garnered consistently high ratings (i.e., all surpassing 3.8 in mean values). This underscores their collective significance and appeal within the sociocultural landscape of the Canastra region, and as a compelling evidence of the exceptional quality of geoservices and geoproducts available in the area as perceived by the respondents. It is worth noting that some events may have not appeared in this study. In addition, some respondents presented difficulties to provide ratings for some of the events due to a general lack of familiarity, once again emphasizing the importance of robust promotional efforts to expand awareness and participation.

These events are essential to the sustainable fabric of the Canastra region, meaning that authorities and managers must continue accommodating a diverse range of interests and preferences to boost the region's geotourism sector further. This suggests a potential reservoir of untapped events and festivals in the region, signifying the need for in-depth research focusing in specific events.

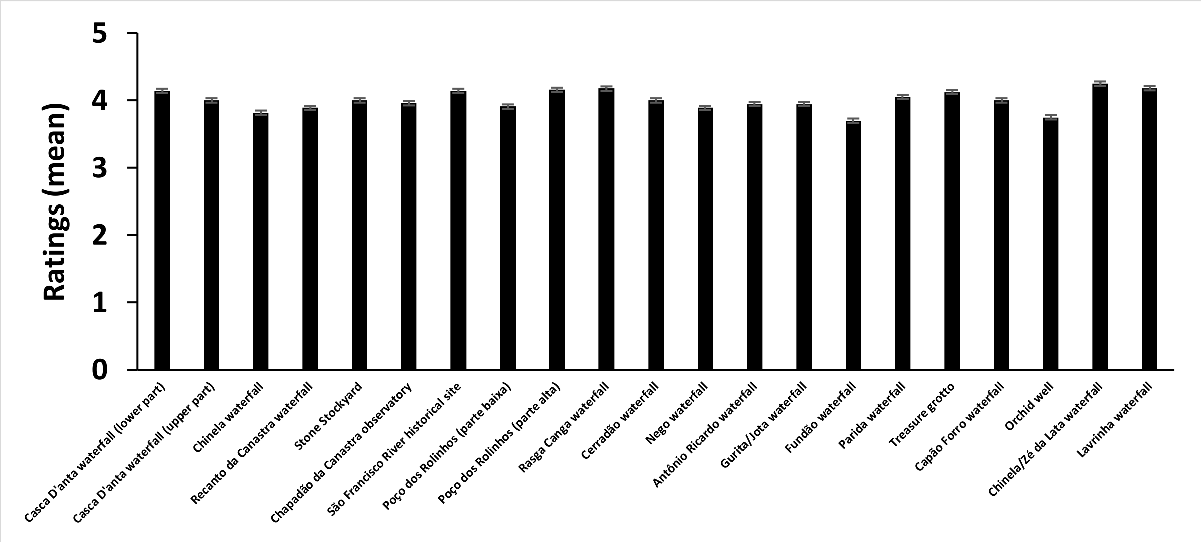

Figure XX: Ratings (mean values) ranging from 1 to 5 given by respondents about the geosites in the Canastra region.

In the analysis of the geosites, the Lavrinha Waterfall, Chinela/Zé da Lata Waterfall, Rasga Canga Waterfall, Treasure Grotto, Capão Forró Waterfall, and Orchid Well, received the highest ratings and reveal distinct patterns in user choices. The specificities related to each geosite were not taken into account in this study, but the general preferences often revolve around a combination of natural aesthetics, recreational potential, accessibility, and geoecological significance. For example, waterfalls like Lavrinha, Chinela/Zé da Lata, and Rasga Canga tend to attract individuals seeking immersive natural experiences, characterized by serene landscapes and opportunities for swimming and photography. In contrast, the Treasure Grotto, with its underground formations, tends to appeal to those with a fascination for geological wonders, subterranean exploration, and adventures. Capão Forró Waterfall and Orchid Well, due to their unique ecosystems, botanical diversity, and easy accessibility. To enhance geotourism, it is essential for site managers and policymakers to consider and balance the diversity of users' preferences in the development and preservation of these geosites.

A significant observation arising from the interviews and analysis is that a notable portion of respondents often exhibit a lack of awareness or interest in certain geosites. This could be attributed to various factors, including inadequate promotion and marketing of lesserknown sites, limited accessibility, or a general lack of information, which can be also associated with the geoaspects evaluated before (e.g., half of the respondents reported not knowing about geoheritage). In some instances, respondents may not recognize the geosites by name, despite their proximity or potential significance. Such lack of awareness can be a challenge for geotourism promotion, as it hinders the equitable distribution of tourist flows and, subsequently, the economic and cultural benefits that can be derived from these sites (Nunes et al., 2022). This underscores the importance of concerted efforts to raise awareness and educate the public about the various geosites within a region, ensuring that they are not overlooked due to unfamiliarity or disinterest. Ultimately, the need for a diversified geotourism marketing strategy and community engagement are core facets to unveil the Canastra's hidden treasures to a broader audience, enriching the overall geotourism experience.

4.3.6. Climate change

Regarding the perception of the community concerning trusted sources of information about climate change, scientists emerged as the most highly regarded (76%). This outcome corroborates the pivotal role of scientific expertise in shaping public perceptions and knowledge dissemination pertaining to climate change, even for rural communities. Environmental organizations attained a notable trust level, with 56% of respondents acknowledging them as reliable sources of information. This recognition signifies the influential role of organizational bodies dedicated to environmental advocacy, outreach, and research promotion in facilitating climate change awareness and education within rural communities. Furthermore, park members of the region held a significant degree of trust among respondents (41%). The diverse array of trusted sources reflects the multifaceted approach required to promote environmental awareness and climate action, demonstrating that the interconnectedness of scientific expertise, institutional support, and community engagement in addressing the challenges posed by climate change within rural settings are fundamental.

The lowest scores went to mining companies (65%) and state members (47%). Mining companies are a significant presence in many rural areas cited in this thesis. This outcome likely reflects concerns regarding the environmental impact and potential conflicts of interest associated with mining activities for rural regions. State members are not that different. This lack of trust from governmental representatives and officials might stem from past experiences of ineffective policy implementation, bureaucratic barriers, false promises, or a perceived misalignment between the interests of the state and those of the rural communities.

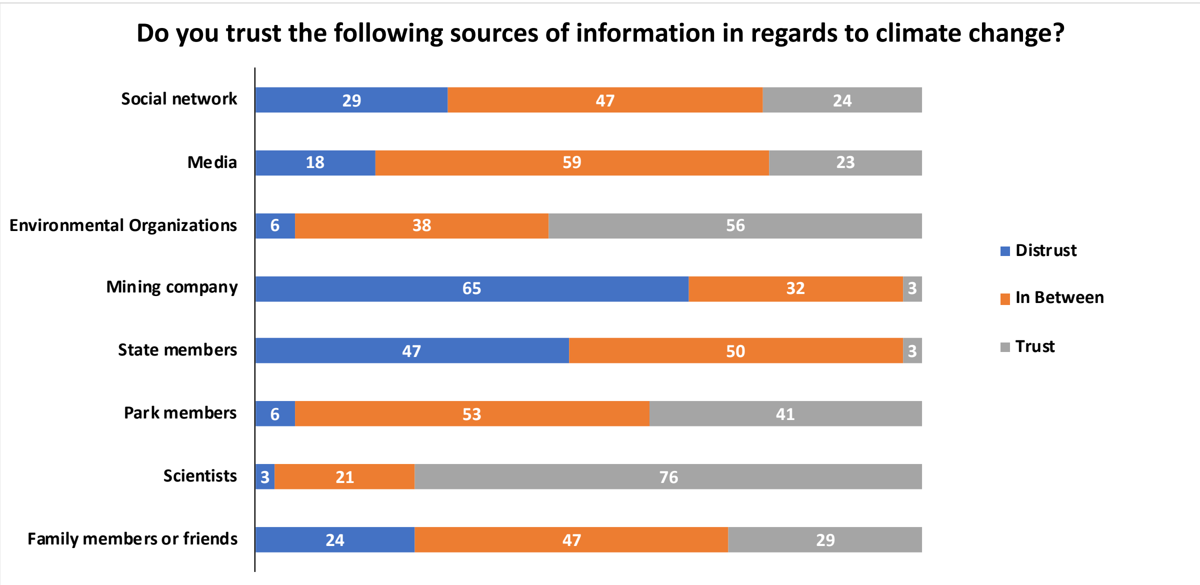

Figure XX: Respondents to the climate change survey reveal their trusted sources of information. Percentages owing to rounding.

5. Final Considerations

The findings from this final chapter will contribute to the development of adaptive measures and innovative geoconservation actions that align with the needs and aspirations of the Canastra region, while offering broader implications for similar landscapes globally. Due to the presence of the Canastra National Park and ecotourism, the region presents good infrastructure conditions for geotourism development, including the establishment of an UGGp. The consistently positive perceptions from the respondents affirm that the Canastra region excels in delivering top-notch geoservices and geoproducts, ultimately enriching the overall geotourism experience and solidifying the region's status as a premier destination for sociocultural and geodiversity exploration. Nevertheless, the unplanned development has generated many related issues.

Preliminary results have shown the important contribution of geoconservation-related concepts for protection of geological and cultural sites (even in areas where protected areas were previously implemented) along with the availability of the communities to engage in sustainable development initiatives. During the interviews, we found out that a current assessment is being developed by SICOOB Sarom (a local cooperative bank) and SEBRAE (Brazilian Service of Support for Micro and Small Enterprises) and represents a significant step toward defining and delineating the Canastra region by its geological and ecological attributes. This collaborative effort uses the same approaches applied in the Uberaba – Terra de Gigantes Geopark Project and seeks to harness empirical methods to present the unique geological and ecological features that make the Canastra region an exceptional candidate for the implementation of a Geopark. Along with this work, the assessment serves as a foundational tool, enabling experts to delve even deeper into the region's geological heritage, identifying unique rock formations, fossil records, etc. Furthermore, it delves into the ecological treasures encompassing rare flora and fauna species, intricate biodiversity patterns, and the fragile balance between human communities and the environment.

The data and insights derived from this thesis have the potential to contribute significantly to the preparation of a comprehensive dossier for UNESCO's consideration. By understanding their perceptions in relation to g-terms, planning and decision-making, business undertakings, and their willingness to participate in geoconservation actions, the dossier will showcase a substantiated case for UGGp status. The Canastra prime example can propel the region into the global spotlight, attracting nature enthusiasts, researchers, and tourists while simultaneously promoting environmental conservation, education, and sustainable development.

A future opportunity in regards to this preliminary study can involve utilizing multivariate analysis to gain a comprehensive understanding of the relationships between different respondent groups (e.g., local and visitors) and their specific levels of knowledge. By employing multivariate statistical techniques, we can examine how various groups of participants are associated with specific knowledge outcomes. This will allow us to discern patterns, trends, and variations in knowledge across different demographic categories or affiliations. The future analysis can encompass a range of statistical methods, including clustering, principal component analysis, and discriminant analysis, to identify any underlying structures in the data and explore how these structures relate to the respondents' knowledge levels. Those type of results can provide valuable insights to inform tailored interventions, enhance knowledge dissemination strategies, and ultimately contribute to more effective decision-making processes in the context of this research and a final dossier to UNESCO.

In conclusion, this thesis has endeavored to explore and shed light on the intricate web of themes encompassing land-use. Agriculture, as well as industrialization and resource extraction, are integral components of cultural landscapes all over the world. In Brazil, the State of Minas Gerais presents profound relationships with these types of land-use. They constitute a research area with a considerable demand for scholarly work and academic engagement due to the controversies, contradictions, and disputes it generates. This topic also intersects with the understanding of development, employment generation, income, sustainability, social interests, etc. These perspectives are fundamental for comprehending regional dynamics and the associated social stigmas. Hence, it becomes evident that there is a pressing need to reconsider the modes of territorial development, with the aim of ensuring, for the traditional and local populations that have historically inhabited these regions.

In this thesis we also introduce a range of questions necessitating in-depth analytical scrutiny, both through supplementary research and theoretical deliberations. It becomes patently clear that a comprehensive grasp of the multifaced relationships among agricultural concerns, mining activities, and sustainable development initiatives is imperative. Many aspects of this thesis were brought based on Brazilian landscapes. However, challenges must be addressed beyond country or regional borders, and include extensive international cooperation and networks (EEA, 2020). Achieving this will require a flexible and mutually intelligible framework for clear communication across research disciplines, political cultures and regions.

The UGGp network offer an interdisciplinary response strategy within the DPSIR framework. They provide educational opportunities to enhance understanding of geological and environmental issues. As they are designed to engage local communities and promote sustainable land use practices, which can help mitigate driving forces and pressures by fostering eco-friendly tourism, sustainable agriculture, and environmental protection. Additionally, the geological expertise within geoparks is instrumental in understanding and addressing geohazard vulnerabilities, improving response measures, and enhancing landscape resilience.

Above all, this study main achievement is to facilitate the transition of populations from passive objects to active subjects of their own reality, granting them agency in shaping the fate of their territories through value-driven decision-making.

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Agricultural Heritage: Contrasting National and International Programs in Brazil and Italy

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Abstract: Agricultural systems comprise an interdisciplinary field that studies the complex dimensions of agriculture. They should not be characterized only by their agricultural value, as they are part of several social, cultural, geological, and historical domains. We carried out quantitative and qualitative research to present and compare the current state of agricultural heritage programs and their development in Brazil and Italy, contrasting with the Globally Important Agricultural Heritage Systems (GIAHS) by the Food and Agriculture Organization (FAO). To this end, the history and the extension of these programs and sites were recovered. Moreover, the agricultural landscape diversity, the development of the regions, research and outreach, along with the communities, entities and government bodies involved were identified. Through a combination and quality of technical assessment and communities' description, the analyzed agricultural heritage programs prove to be an endless source of useful information to the definition of policies aimed at rural areas, in addition to serving as a monitoring tool for many issues regarding biocultural diversity in landscape. Moreover, it shows where there is room for improvement while the countries are committed to engaging in national policies and entities on the promotion of agricultural heritage programs as major steps for investing in the "greening" of agricultural policies at different levels.

Keywords: agriculture; traditional and indigenous communities; GIAHS; NIAHS; IAHS; planning and management; landscape; public policies; biocultural diversity

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1. Introduction

The Neolithic Revolution elevated agriculture as the foremost economic activity for the constitution and maintenance of the societies as we know [1]. Presently, many of the rural and urban practices are still subordinated to the rural environment, with around 2.6 billion people on Earth drawing their livelihoods either partially or fully from agriculture [2,3] and leading different sectors to finally recognize all its multifunctional roles [4]. The efficiency, complexity, and robustness associated with local, traditional and indigenous agriculture are topics involved in current global discussions. The Food and Agriculture Organization of the United Nations (FAO) defines them as traditional agricultural systems (TAS), a combination of agricultural biodiversity and resilient ecosystems with valuable sociocultural heritage [5]. They are constituted by interdependent elements that are part of agricultural systems (AS), a term to refer to the broadly interdisciplinary field that studies the complex dimensions of agriculture [6–8]. That is, AS ranges from types of cultivated plants, livestock, management practices, and landscape to social networks, culture and food systems. Moreover, it interacts with many other components such as geological, political, historical and economic, constructing unique combinations of knowledges and practices that are commonly used by farmers, agricultural researchers, and policy makers (for example organic agriculture, agrifood systems, permaculture and ecologically based agricultural systems [8–10]).

By understanding AS through those variety of elements and not only by *stricto sensu* agricultural values, AS sheds light on distinct sociocultural, economic and environmental problems that rural areas and their communities are facing. There are 370 million indigenous peoples recognized in the world, constituting 15% of the people living in poverty, and in terms of land surface they are responsible for maintaining 80% of global biodiversity [2]. Nevertheless, biodiversity and ecosystem services related to traditional agricultural landscapes that support peoples' lives and livelihoods continue to be at risk of loss and degradation [11,12]. Those communities play a central role in ensuring the conservation and sustainable use of plant genetic resources for food and agriculture, emphasizing the historic and current role of TAS in generating innovation in AS, especially in terms of human health and well-being [13–15]. In addition, traditional and indigenous farmers guarantee conservation and adaptation of crops to numerous climatic and environmental conditions, creating a diversification of the genetic basis for agricultural production threatened by the advance of modern agriculture and/or rural exodus [13–15]. In this way, they protect pollinators in their landscapes, bringing multiple cultural, ecological, economic, and quality of life benefits either locally or globally [16]. In many ways, the close—and in many aspects dependent—relationship these farmers have with nature ranges from survival to cultural and spiritual attachment [16,17], developing a complex knowledge about ecosystems known as biocultural diversity [18].

In the last years, biocultural diversity started to understand the sociocultural layers involved in the demanding challenges related to AS, such as climate change, new technologies, pandemic scenarios, social and political transformations, food and livelihood security, among others for example [18–20]. These challenges are represented on the recent 2030 Agenda for Sustainable Development, an initiative that aims to ensure a more prosperous, equitable, and healthy planet by 2030 [21]. Given that 43.85% of the world's population (around 3.4 billion people) currently lives in rural areas across the globe—and they represent 80% of the people living in poverty—most of these rural populations live in what are considered economically developing countries [22,23]. These households face higher rates of food insecurity, unemployment, lower education, and limited services such as healthcare, recreation, and mobility [24]. Meanwhile, the youth living in rural areas travel to larger cities to study or work and often show no interest in continuing traditional practices related to the environment. These depopulation processes result in the abandonment of farmlands, land-use decline, loss of local communities and traditional knowledge, and creates an urgent need to educate the new generations to act towards the importance of local conservation and regeneration [25,26]. Furthermore, the COVID-19 pandemic has led almost the entire planet to a health and humanitarian crisis. It brings to the upfront questions related to the way goods and services are produced and consumed in the world, and the relationship humans maintain with different ecosystems. According to the United Nations [27], indigenous and traditional peoples depending on their lands for livelihood have become even more vulnerable during the pandemic, due to factors such as their food insecurity, lack of access to effective monitoring, early-warning systems issues, and inadequate health and social services. The World Bank [23] also expresses concerns for the upcoming years, whereby new generations living in poverty will be more involved with informal services and manufacturing, and even less in agriculture. They will also be attached to overpopulated urban settings, meaning that they will be working in the sectors most affected by lockdowns and mobility restrictions in possible pandemic scenarios.

Coping strategies aimed at vulnerability reduction and territorial development of those communities, in many cases, depart from assessment, valuation, and conservation of local resources—material and immaterial—anchored in culture and landscape, specific to a given region. Thus, initiatives or collective actions based on public policies, government programs, international agencies and, above all, social organizations are gaining relevance. One of the main strategies in supporting knowledge production activities of TAS shared between institutions and sectors is their integration into public policies and governmental initiatives, fostering the strengthening of the world's cultural and natural heritage. In this case, visualizing TAS from a "heritage point of view", means assessing the dynamics of production and reproduction of the several elements that constitutes AS, the knowledge and activities that encompass them, and the way that they are and have been constantly reworked, in time and space [9,10]. Through the Globally Important Agricultural Heritage Systems (GIAHS), a program created by FAO in 2002, TAS are institutionally part of a global heritage program, involved in a long-term international network of support, conservation, and survival of numerous traditional and indigenous communities, particularly interested in developing actions towards these Sustainable Development Goals' 2030 Agenda: SDG 1 (No poverty), SDG 2 (Zero hunger), SDG 8 (Decent work and economic growth), SDG 12 (Responsible consumption and production), SDG 13 (Climate action), SDG 14 (Life below water), and SDG 15 (Life on land). As a result, they are globally identified and safeguarded, along with the landscapes associated with them and their biocultural diversity, promoting dynamic conservation and sustainable management. The communities that comprise the GIAHS have continually adapted themselves to the potentials and constraints of the environment, shaping their biodiversity and geodiversity to different degrees, and accumulating experience, practices and knowledge over generations [28].

As of May 2022, 62 GIAHS are recognized in 22 different countries around the world: 7 in Europe and Central Asia region (2 in Italy: Soave Traditional Vineyards and the Olive Groves of the Slope between Assisi and Spoleto), 3 in Africa, 8 in the Near East and North Africa, 40 in the Asia and Pacific region, and only 4 locations in the Latin American and Caribbean region, with Brazil having its first recognized GIAHS in 2020 (the Espinhaço Mountain Range TAS) [29]. Following this line, many countries adapted the agricultural heritage designation concept by developing their own Important Agricultural Heritage System (IAHS) or Nationally Important Agricultural Heritage System (NIAHS), which can receive a specific denomination according to the government bodies responsible for their adherence. These heritage programs are consolidated in Asian countries (China, Japan, and Korea) when compared to other places in the world in terms of research, acknowledgment, outreach, and dynamic conservation [30]. China is one of the countries which has shown impressive progress since 2005, and nowadays, 91 NIAHS have been designated by the Ministry of Agriculture and Rural Affairs of the People's Republic of China, with 18 Chinese NIAHS designated as 15 GIAHS (GIAHS Rice Terrace in Southern Mountainous and Hilly areas systems consists of four Chinese NIAHS) [30,31]. Nevertheless, despite the positive and recognizable benefits and improvements that the GIAHS model brings to communities and landscapes through landscape conservation, food security, and strengthening and valuing local cultural identity and practices [32,33], many concerns and limitations are still being analyzed and looked up, for example, institutionalization of traditional sites and knowledge, differences between residents and tourists expectations, youth exodus, and limited participation of communities in decision-making processes [33,34].

All the same, considering the characterization and consolidation of IAHS and how they support adaptive management, providing achievements in conservation and sustainable development, we selected Brazil and Italy in this study, based on the similarities they share about their long historical background on agricultural practices, and at the same time, different territorial occupation and land-use. Italy, a country from the Global North, had in its territory several societies throughout the history of humanity. On the other hand, the Brazilian territory—located in the Global South—was occupied until 1500 A.D. by indigenous peoples, and only after that, with European colonization, the territory began to be occupied by other societies and presented different land-use. Furthermore, they also share similarities in their agricultural heritage timeline development.

Thus, this study aims to (i) contrast the current state of agricultural heritage programs and their development in Brazil and Italy, respectively, and compare them to the GIAHS by FAO. More specifically, we dig into the main documents and registers involved, considering their selection criteria and administrative and designation features; (ii) to identify and describe the type of strategies and procedural tools that were suggested and applied in each country, as which barriers they addressed, and (iii) to highlight knowledge gaps and priorities, as the basis for future assessment and application by the communities, providing contribution to different regions, sites, entities and governments.

2. Materials and Methods

2.1. Study Area

2.1.1. Brazil

The TAS of Brazil are interconnected landscapes composed of rich biodiversity, geodiversity and sociocultural aspects, where farmers—in many cases members of traditional and/or indigenous communities—manage and conserve a significant variety of ecosystems, used in different ways as goods, services, and functions [35]. Currently, Brazil has more than 300 indigenous peoples and approximately 4000 *quilombola* (maroon) communities identified [36]. In addition, more than 20 traditional peoples and communities are recognized by government bodies, such as traditional fishermen, river-dwellers, and people of the countryside, forest, among others [37].

The recognition of a TAS at the national level (Brazilian NIAHS or B-NIAHS) is conducted through the National Institute of Historical and Cultural Heritage (IPHAN) in partnership with the Brazilian Agricultural Research Corporation (EMBRAPA) and include these systems in the category of intangible heritage. Currently, only two TAS are recognized as B-NIAHS: *Rio Negro* (Black River, designated in 2010) and *Vale da Ribeira* (designated in 2018). In 2019, the IPHAN, EMBRAPA, FAO, and other entities, rewarded and registered 26 different TAS in a catalog called "The Brazilian traditional agricultural systems" (Figure 1).

The catalog recognizes them as good practitioners when it comes to the safeguarding and dynamic conservation of cultural and immaterial assets associated with biocultural diversity, present on Brazilian TAS (see Table A1 for the complete list). For instance, the *Rio Negro* TAS is known to domesticate various edible plants, in which pepper species are one of the most remarkable. Peppers are widely distributed throughout the Amazon [38] and the basin is considered the center of domestication of the genus *Capsicum* (Solanaceae family, the same one of tomatoes and eggplants). Traditionally, pepper occupies a prominent place in the social and spiritual life of the indigenous communities living in the area, and especially the Baniwa people, because in addition to cooking and cosmetic use, it is fundamental in initiation ceremonies, rituals for healing, and protecting the body and soul [39]. Nowadays, Baniwa pepper is commercialized, and the product is the result of the traditional knowledge of the Baniwa woman whose cultivation, processing and consumption practices are anchored in ancestry [40]. Baniwa pepper is considered by some authors to be a total social fact [41], an entire system that is related to a diversity of political, religious and cultural events.

After decades of extraordinary growth due to the availability of natural resources, important public policies, the competence of farmers and the organization of production chains, Brazil is now a major player in the production and export of agricultural products. The agricultural movement of the rural areas has contributed significantly to the country's economic, social and environmental development. The Brazilian Institute of Geography and Statistics (IBGE) describes urban and rural environments based on population density at the municipal scale, where 45% of the country's municipalities display low degrees of urbanization, 28% are considered rural, and 8% remote areas. The farmers living in these areas are considered the true guardians of Brazilian agrodiversity, living on the margins of public policies that barely recognize their territories and their traditional strategies for living with ecosystems [42,43]. However, the rural areas of Brazil can be summarized by continuous episodes of struggle for land, and the efforts in maintaining their traditional agricultural practices, their historical and cultural heritage. These territories are often the scene of social and environmental issues (for example, climate change, social and administrative conflicts) and those related to land ownership. The destruction of its natural resources and environmental degradation by deforestation, illegal fire, and pollution are associated with different levels of environmental crimes and federal neglect [42,43]. As an example of territorial dispute, it is cited the *Movimento dos Trabalhadores Rurais Sem Terra* (Brazil's Landless Workers Movement, MST; https://mst.org.br/; accessed on 20 March 2022), a Brazilian political and social activism movement, which fundamentally seeks the redistribution of unproductive lands (agrarian reform). The MST points to the fact that agribusiness has depended on artificially favored conditions—strong subsidies and government credits—to produce frequently in environmentally unsustainable, ecologically harmful and socially excluding conditions. In contrast, this movement is a great supporter of family farming [44], which carries with it the premise that food is memory, culture and affection, which in its trajectory produces life, equality and justice, revealing identities and people's ways of life.

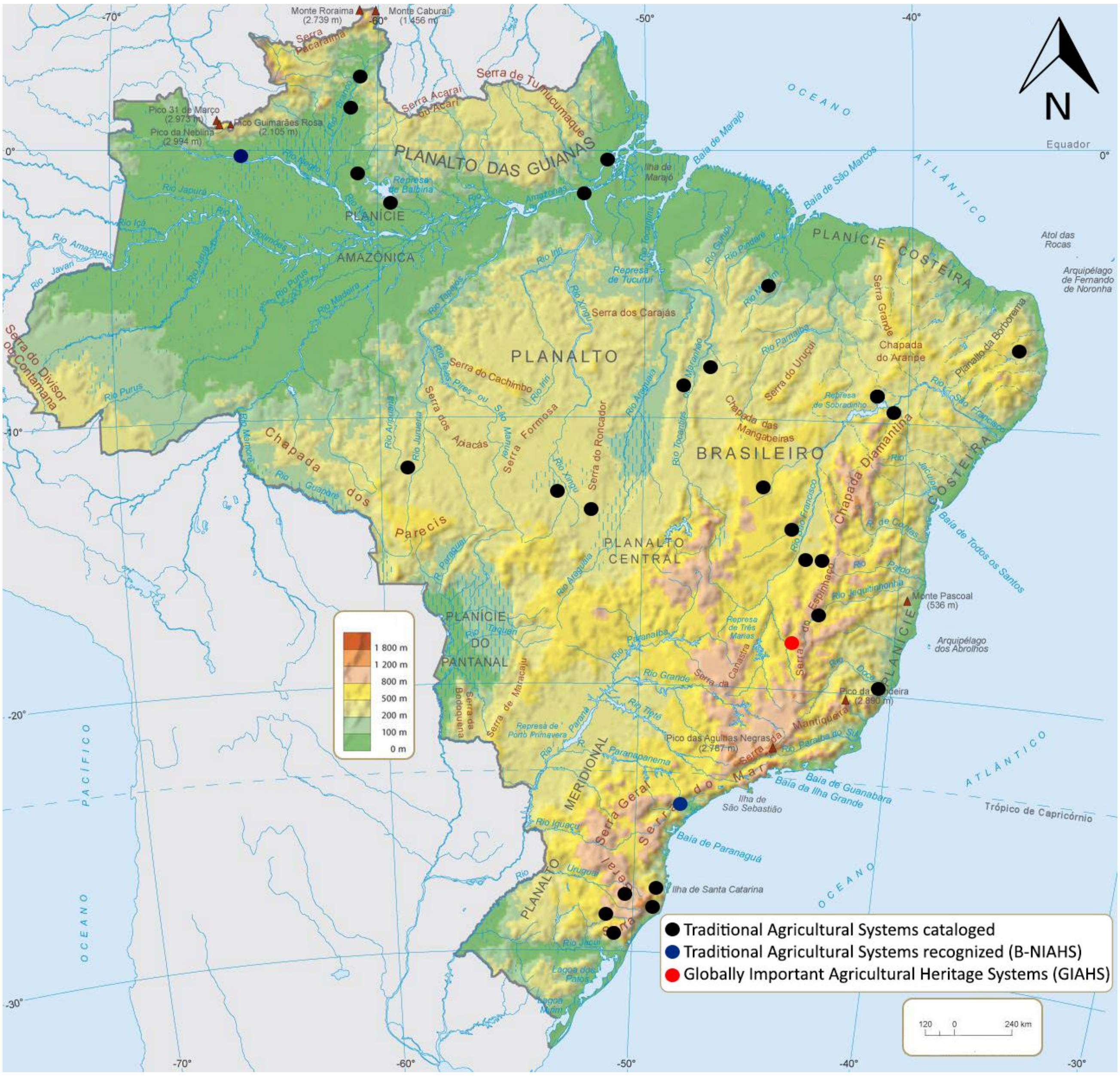

Figure 1. Topographic map of Brazil in respect to the location of all 29 different types of designated traditional agricultural systems (red, black and blue dots).

2.1.2. Italy

Over the centuries, the Italian agricultural landscape has been molded by an incomparable number of farmers representative of different societies that have been in its territory (e.g. Romans, Arabs), thus, developing infrastructure and agricultural technology that are notorious elements in Italy's history, cultural identity, and heritage [28,45]. After the Second World War, Italian agricultural landscapes were submitted to strong national and European policy-driven interventions, supporting agricultural intensification to the detriment of the less productive traditional farmlands [46]. The rural areas of Italy, especially on marginal territories, also faced a decrease in the communities engaged in traditional practices related to agriculture, followed by the closure of some public services, private businesses, and investments in rural areas [47].

An assessment from 2013 [48] classifies the Italian territory as composed of the following landscapes: 8.8% of peri-urban, 20.3% of specialized agriculture, 29.1% of intermediate rural areas, and 41.8% of areas with rural development problems. Furthermore, they classified forested/wooded areas—mostly placed on mountains—as remote areas, considered not less important as they provide livelihood to different ranges of communities and are associated with a variety of products such as cheeses, nuts, mushrooms and truffles.

The Ministry of Agrarian and Forestry Policies established the National Register of Historical Rural Landscapes and Traditional Agricultural Practices (Italy-NIAHS or I-NIAHS), identified and cataloged 123 traditional rural landscapes or landscapes of historical interest connected to traditional practices and knowledges [48,49] (Figure 2).

The catalog is used by national entities, UNESCO, and FAO as a source of important reference and support for the development of Italy's national landscape conservation policy, with the sites' extension varying from 218 ha to 5750 ha [49,50]. As of May 2022, besides the 2 already mentioned GIAHS recognized in Italy, there are 2 I-NIAHS part of UNESCO World Heritage Sites (Low-growing Terraced Vineyards of Tramonti and The Itria Valley), and one part of an UNESCO Man and Biosphere Reserve (Sheep-tracks in the Upper Molise), see Table A2 for the complete list of sites.

Furthermore, these AS are characterized by a remarkable variety of cultural landscapes and aesthetic values, within the relatively small Italian territory, where geomorphological and geographical aspects combined with a rich history and culture have favored their emergence [47]. In general, the GIAHS sites in Europe are not recognized by their high biodiversity and polyculture systems such as others GIAHS have shown around the world, and in fact, the main products derived from TAS in Italy are wine and oil [47,48]. Nevertheless, the landscapes are strongly associated with society and culture, acknowledging local and traditional knowledge, social organizations, and their evolution, since they stage the several networks that strengthen, promote, and preserve knowledge systems and practices, as well as the tools and infrastructure they use to keep the sustainable management of natural resources [51]. Positively, these aspects have shown vital results in Italian agricultural systems, creating new opportunities for agritourism and organic farming, frequently coexisting in farms (e.g., the combination of family farming and aesthetic values) [47,51]. These exceptional assets linked with agricultural heritage are gaining recognition and becoming of great interest to tourists, institutions, and companies related to agricultural business, but at the same time being subject to multiple threats [51–54].

Figure 2. Topographic map of Italy in respect to the location of all of the areas selected for the National Catalog of Historical Rural Landscapes and the Globally Important Agricultural Heritage Systems (black and red dots, respectively).

2.2. Methodology

In order to present and compare the contrasting situations of current agricultural heritage programs and their development in Brazil, Italy, and the global one by FAO, we used qualitative literature analysis and archival research, providing a basis for elementary questions, establishing debates on forms and mechanisms, and allowing for new perspectives on how shifts on social, historical, and political aspects are affecting different programs [55,56]. We considered the application documents from: (i) the Brazilian agricultural heritage program by IPHAN; (ii) the National Register of Historical Rural Landscapes and Traditional Agricultural Practices by the Italian Ministry of Agrarian and Forestry Policies; and (iii) the GIAHS by FAO. Along with the official documents provided by each part, several TAS applications, peer-reviewed papers, articles, and journals were considered in the comprehensive review as well. To this end, the history, extension, and development of these programs were recovered, the agricultural landscape diversity, as well as strategies, tools, entities and government bodies involved were also identified. In addition, we examined how the use of these strategies and tools addressed the contextual global changes, in particular the COVID-19 pandemic, and have evolved to adapt the different governance contexts.

All data was tabulated under the following categories: (i) main summary, (ii) subitems related to the main criteria, and (iii) administrative actions, and then compared and analyzed for similarities and complementarities across programs. If the selection fails to address one specific item, and it could not be verified nor substantiated with other official sources, then it was considered a "no" in the table and addressed specifically in the text. All findings related to the analysis are presented in Section 3 and the tables are discussed in-depth throughout the text.

Furthermore, for a quantitative approach on mapping educational, research, and innovational development related to agricultural heritage in both countries (Brazil and Italy), we used a bibliometrics analysis [57] on the Web of Science database, ranging from 1993–2022, in English language. The first analysis verified in the database the general number of publications on agricultural heritage by searching the keyword "agricultural heritage" on all fields. Secondly, we combined the keywords "agricultural heritage" plus "Brazil", and then "agricultural heritage" plus "Italy" on both "title" or "topics" fields, respectively. Therefore, we established the publication trend about the subject in both countries in the years analyzed.

3. Results and Discussion

3.1. Registry, Application, and Administrative Actions

To begin, it is necessary to understand the specificities on how the countries established their NIAHS and implemented in different ways. In relation to how the areas and TAS are selected to be included in the agricultural heritage programs, Italy presents a work through—a collaboration of Italian universities and international research bodies—a comprehensive catalog that started the I-NAHS. The implementation stage of the I-NIAHS was based on a top-down model, which is consisted of only two subjects that interfered in this process (developers and enablers), thus excluding other political subjects that may be impacted by this policy. This type of model is controversial for certain public policies since it can be considered hierarchical, as it results from the demands of a certain organized group, excluding others from the process [58]. Nonetheless, the I-NIAHS provided a detailed description of the characteristics, with several studies, historical background, and production related to each rural landscape. The nationwide assessment took into account three criteria: (i) historical value, (ii) typical products, and (iii) critical issues and threats. Brazil went on an opposite direction, only after the creation of the B-NIAHS that the federal institutions involved decided to create a catalog. Meanwhile, in order to be included in both the Brazilian catalog and/or B-NIAHS it is necessary to undertake an application process. This can be considered a bottom-up model, where the implementation stage depends intimately on the interaction between government bodies and stakeholders involved in the application. This model seeks a more harmonious relationship during the implementation of public policies, taking into account the subjects and variables involved as fundamental parts of the process, setting public policy creation at the actual level of its execution [58]. In this stance, the implementation of NIAHS throughout the advances in public policies, should be understood as the result of a process of interaction between its context and the organizations responsible for its implementation. In Brazil, five criteria are considered in the selection of the best TAS practices: (i) community participation, (ii) social organizations, (iii) cultural and landscape identity, (iv) agrobiodiversity dynamic conservation, (v) establishment/strengthening of community network. For the GIAHS, the program is established under five criteria in their application process: (i) food security, (ii) agrobiodiversity conservation, (iii) traditional knowledge, (iv) social organizations, and (v) cultural landscape. Nowadays, the GIAHS program only takes applications and does not have a list or screen for possible new areas. However, it is under discussion the development of a list by FAO, targeting globally important agricultural heritage areas from the entire world. A summary compiling all elementary information about the three programs can be found in Table 1.

Table 1. Summary of Brazilian, Italian, and FAO heritage programs. * Total numbers, including all types of designation.

Name	The Brazilian Traditional Agricultural Systems (B-NIAHS)	The Italian National Register of Historical Rural Landscapes (I-NIAHS)	Globally Important Agricultural Heritage Systems (GIAHS)
Number of criteria	5	3	5
Start	2010	2012	2002
Numbers	29 *	123 *	62
Report	N/A	N/A	Once in 4 years

Unraveling the main criteria, the subitems subjected to evaluation in the selection process also vary from program to program. Each IAHS analyzed here uses their own subitems to translate their criteria into more pragmatic measures related to context and elements that support and incentive actions/programs for biocultural diversity conservation in their rural landscapes. The main criteria for each program are treated in detail in the complete list of items (Table 2). In general terms, all three programs have most of the information required for a base study of the area, in relation to practices, tools, practitioners, products, and biocultural diversity involved, as the items in Table 2 confirm. The following items are the ones differentiating in each IAHS. For item 2, Italy does not have a requesting agency due to the fact that they are not taking new applications for their catalog. For item 7, besides being very detailed in terms of structure, not all rural landscapes of Italy provided a summary of the activities taking place. As for item 13, GIAHS and Italy do not require specific information or actions regarding the involvement of new generations in traditional agricultural practices. A recent study [59] from Sado Island in Japan has shown that 77.3% of traditional farmers feel uninvolved in or unsure about the GIAHS designation; moreover, that the program does not promote youth involvement. It is important for IAHS to understand the demands and future trends associated with new generations in TAS. They need even more training to be able to compete in an increasingly disputed market. The development of permanent and continuous educational processes must be aimed at training rural youth, as a way of promoting their maintenance in rural areas, promoting quality of life and the development of TAS' communities. Items 14–17, are treated separately in the next section (see Section 3.2. Dynamic conservation and action plan). Items 18–23 are related to the people, practitioners and organizations included in communities related to TAS. Brazil requires very detailed information (even more than FAO) on the quantity of people, their information and specific roles, the same for all organizations/groups directly and indirectly involved in all TAS activities. Finally, for Item 25, even though there are cases of traditional knowledge being addressed in focus by the catalog, Italy is still behind when compared to the other two programs in the level of details. As discussed before, one of the main challenges for IAHS in general is the elevation and conservation of traditional knowledge and heredity, for example, conservation of genetic resources or practices to overcome natural adversities (such as seedbanks and mountainous agriculture in hilly regions, respectively).

Table 2. Comparison of the items included in each selection process of the analyzed agricultural heritage program in Brazil, Italy and FAO. Abbreviations—B-NIAHS: Brazilian Nationally Important Agricultural Heritage Systems; I-NIAHS: Italian Nationally Important Agricultural Heritage Systems; GIAHS: Globally Important Agricultural Heritage Systems. Note: Differences between the programs are highlighted in red.

Item	GIAHS	B-NIAHS	I-NIAHS
1. General information	Yes	Yes	Yes
2. Requesting agency	Yes	Yes	**No**
3. Map	Yes	Yes	Yes
4. Protected areas (PA)	Yes	Yes	Yes
5. Executive summary	Yes	Yes	Yes
6. TAS structure	Yes	Yes	Yes
7. TAS activities	Yes	Yes	**No**
8. Practices/technologies	Yes	Yes	Yes
9. Products/agrifood systems	Yes	Yes	Yes
10. Commerce/trade information	Yes	Yes	Yes
11. Historical background	Yes	Yes	Yes
12. Educational practices	Yes	Yes	Yes
13. Involvement of new generations	**No**	Yes	**No**
14. Threats and challenges	Yes	Yes	Yes
15. Action plan/dynamic conservation	Yes	Yes	**No**
16. Cultural practices	Yes	Yes	Yes
17. Communities' description	Yes	Yes	Yes
18. Collective actions	Yes	Yes	**No**
19. Number of people directly involved in TAS	**No**	Yes	**No**
20. Public policies available	Yes	Yes	Yes
21. Landowner issues	Yes	Yes	Yes
22. Institutions/groups involved	Yes	Yes	Yes
23. Social organizations (gender/age/groups)	Yes	Yes	**No**
24. Contributions to safeguard agrodiversity and sociodiversity	Yes	Yes	Yes
25. Contributions to strength traditional knowledge	Yes	Yes	**No**
26. Contributions to communities	Yes	Yes	Yes

Having more or less items in their criteria list does not necessarily mean that certain designation is better or worse. Even though Italy has less criteria compared to the other two, the landscape related issues of many areas are addressed in all their complexity. According to the assessment conducted by Agnoletti et al. [48], most of the identified areas in Italy have the necessary characteristics to be included in the GIAHS program and in several other UNESCO designations, as they are, for instance, composed of a high number of different cultivations and land-use presenting universal values and good examples of adaptation to global changes.

Both countries offer a very solid base on which it is possible to see results that they have already accomplished and most probably represent some cases of other countries not involved in this study [60]. As for the rest of the administrative actions (Table 3), some conferences and seminars on TAS and GIAHS are gaining recognition in Brazil, especially now that the country is reopening again, little by little, after the pandemic. In Italy, the institutions and FAO kept in contact with the GIAHS and the historical rural landscapes. Even during the pandemic, most of the activities still took place through virtual meetings and conferences. More details on Action 2 and 3 can be found on Sections 3.3 and 3.5. Regarding Action 4, Brazil and Italy have no original logo to represent their designations as brands. In terms of sustainable development, branding is important because it represents the image of the program, how the public recognizes and identifies the actions related to NIAHS. For locals and tourists, the strength of the brand can engage emotions, evoke personal beliefs and prompt eco-friendly stewardship when the brand's core values are appropriately expressed [59]. This can also be expressed through Action 5. Besides both countries having their own specific website (Brazil: https://www.gov.br/agricultura/pt-br/assuntos/agricultura-familiar/sipam/sistemas-agricolas-tradicionais-sats-de-relevancia-nacional; accessed on 20 March 2022 and Italy: https://www.agriculturalheritage.com/the-national-observatory-of-rural-landscapes/; accessed on 20 March 2022), and provide to the public a few official data and documents, the information found on the menus are very generic, which could use a more user-friendly approach, studies and detailed information such as that proposed by the GIAHS' website (https://www.fao.org/giahs/en/; accessed on 20 March 2022). Details about Actions 6 to 9 are more disclosure in Sections 3.3–3.5.

Table 3. Comparison of administrative actions related to the implementation of each agricultural heritage program in Brazil, Italy and FAO. Abbreviations—GIAHS: Global Agricultural Heritage Systems. Note: Differences between the programs are highlighted in red.

Administrative Actions	Brazil	Italy	GIAHS
1. Catalog	Yes	Yes	**No**
2. Conference, symposium, seminar.	Yes	Yes	Yes
3. Educational program	Yes	Yes	Yes
4. Original logo	**No**	**No**	Yes
5. Website	Yes	Yes	Yes
6. Certificate program	Yes	**No**	Yes
7. International links	Yes	Yes	Yes
8. Funding (research, implementation)	Yes	Yes	Yes
9. COVID-19 response	**No**	Yes	Yes

The above-mentioned items and actions show the commitment of these countries in engaging national policies and entities on the promotion of agricultural heritage programs as major steps for investing in the "greening" of agricultural policies at different levels. Even though programs related to agricultural heritage systems are often excluded from land use management and planning [60]. In whatever way these programs were institutionalized, they can certainly be improved, altered and adapted according to their function, context, demands, and public machinery. Even so, it is necessary that they can verify and validate the data provided to be considered a solid and trustful instrument capable of differentiating between the systems and communities who are really engaging in actions and activities for sustainable management [60–62]. In this case, the right implementation approach, plus the combination of forces from different stakeholders and sectors can take these actions to the next level [63–65].

3.2. Dynamic Conservation and Action Plan

For Brazil and FAO, each TAS that went through the selection process and was established as part of the program was required to provide an action plan for dynamic conservation. The action plan is an important, feasible and economical tool included in these heritage programs that provides a general overview and framework on policies, strategies, actions and outcomes which are already under implementation or will be implemented in the area for monitoring the fluctuations of environmental conservation [66]. The I-NIAHS catalog only presented them as a source of identification and verification of the rural and historical landscapes. Even with a solid description of specific challenges and threats, the cultural aspects and the communities for a great part of the list, the content sometimes lacks essential information on how each area is (or will be) managing and tackling specific challenges and threats. Nevertheless, it is important to state that the Italian National Rural Development Plan (2007–2013) [48] has already developed guidelines and promoted actions in which some regions can rely on to address specific landscapes' issues. In this perspective, all work involved in agricultural heritage programs should combine a multidisciplinary task force, combining the spheres of agricultural, biodiversity, geodiversity, sociocultural, and heritage approaches in order to fully address contemporary threats to TAS [65–67].

Regardless, it is important to pay attention to catalogs that exist as merely "declaratory", as it could be the case propagated by some government entities responsible for their implantation in national territories, in the sense that they are not anchored by qualification, verification, and validation procedures of the data inserted in it. Moreover, emphasize the importance of a dynamic conservation plan, that will prevent systems that are not qualified nor have structured a management system compiled to the formatives to function under the current designation frameworks. Adopting concrete qualitative and quantitative measures allows public managers to structure integrated policies based on enhancing the objectivity and feasibility of agricultural heritage values [65–67]. Due to the financial costs, time, human and natural resources involved, the instrument that allows for identifying the beneficiaries of the policy cannot be flawed in a way that differentiation becomes uncertain or questionable.

3.3. Research, Innovation and Education

For the first bibliometric analysis on the Web of Science, results were obtained for the frequency of each country (Brazil and Italy) in relation to the origin of articles indexed with the keyword "agricultural heritage" (Figure 3). In total, the Web of Science found 195 publications. Italy is placed second, with 26 entries (representing 13.33%), only after China with 76 (representing 38.97%). The prominent work coming from China can be explained by the numbers of the seminal author (Min QW) and many other authors who subsequently continued the studies are from China or are related to research centers in that region. Italy, as the birthplace of FAO, has great contemporary relevance to the theme—especially in the works of Agnoletti M. and Santoro A.

Brazil had 0 entries, which shows that despite some development linked with agricultural heritage, the country still lacks a commitment on participating in international research, assessment and monitoring related to agricultural heritage. However, when adding the word "Brazil" in the search field, it retrieves an article called "Heritage and urban agriculture in Recife: analysis and guidelines for the Varzea neighborhood" by de Carvalho & Branduini (2017), which was cited 23 times but it was published under the Polytechnic University of Milan, in Italy. The paper proposes the use of a framework developed by the COST Action—European Urban Agricultural Heritage for conservation and regeneration in tangible and intangible rural heritage sites in Recife, Brazil.

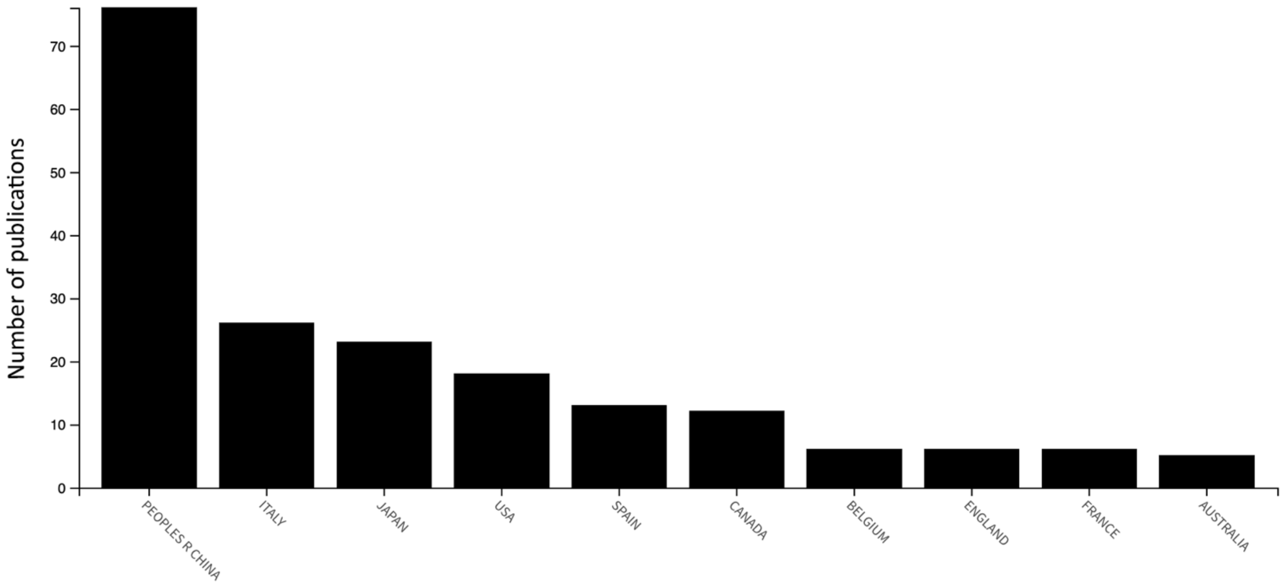

Figure 3. Total number of publications on "agricultural heritage" per country found on Web of Science (between 1993–2022).

The second analysis, in which we verified the number of publications on "agricultural heritage" in the last 10 years found on Web of Science (Figure 4), shows an increasing trend year on year, showing the highest figure in 2021 (34 in total). As of May 2022, the database already found 8 publications for this year alone.

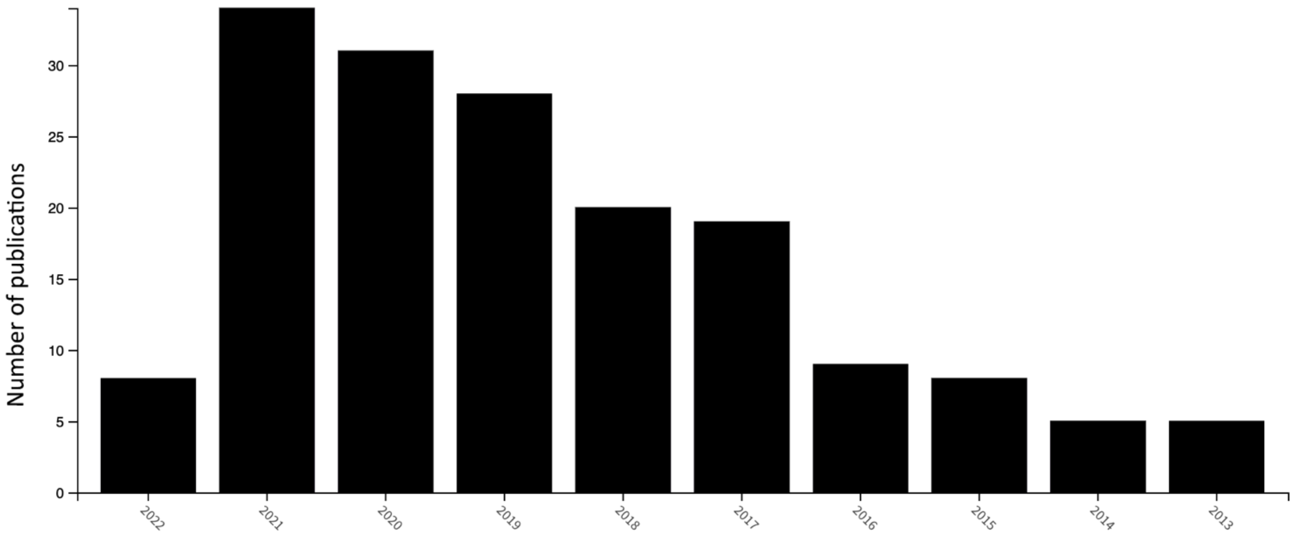

Figure 4. Total number of publications on "agricultural heritage" found on the Web of Science, per year (in the last 10 years).

For Italy, the years with most of the publications were concentrated in 2021, with 7 publications (representing 26.92% of their total) and 2020 with 10 publications (representing 38.46% of their total) (Figure 5). The most cited Italian publication is "Multi-Sensor UAV Application for Thermal Analysis on a Dry-Stone Terraced Vineyard in Rural Tuscany Landscape" by Tucci G. et al. (2019) with 31 citations. It addresses thermal characterization of a dry-stone wall terraced vineyard in the Chianti area (Tuscany, Italy), detecting possible microclimate dynamics induced by dry-stone terracing.

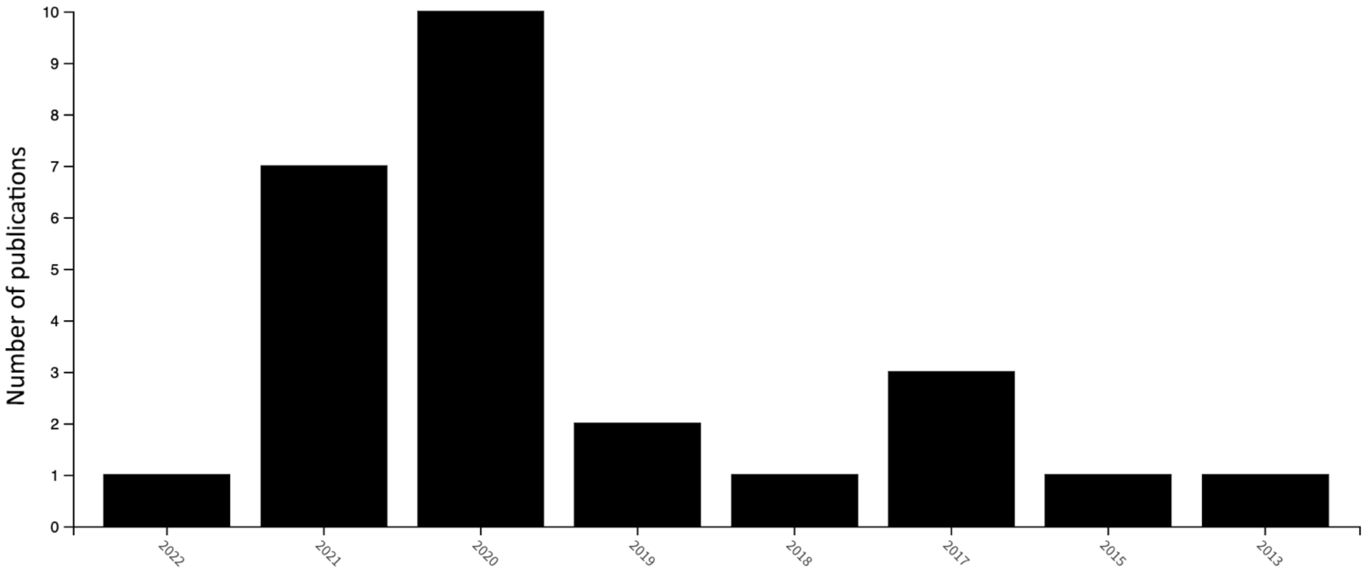

Figure 5. Number of Italian publications on "agricultural heritage" found on the Web of Science, per year (in the last 10 years).

In terms of education, many programs and initiatives have been integrated in local communities and schools in GIAHS sites all over the world [59,60,66]. The educational aspect brought in by GIAHS is known to promote healthy eating habits through the inclusion of the topic in local discussions and the engagement of different governments policies. In addition, it encourages traditional and local production, promotes family farming, and increases the potential of agriculture as an option for employment of the future generations. For the new generations, IAHS should focus on promoting educational aspects of AS related to biocultural diversity, for example, ethics, agroecology, social organizations, market, environment and food security, in addition to models designed for entrepreneurship, minorities and rural empowerment, and access/development of public policies.

In Italy, The University of Florence has a master's degree program (https://www.agriculturalheritage.com/giahs-international-master-course/; accessed on 20 March 2022), where students have been working hand in hand with IAHS sites, studying agricultural heritage focused on the effective management and identification of agricultural heritage systems and landscapes. The interdisciplinary heritage aspect of AS is still a new topic in Brazilian educational systems, while most bachelor's degrees and specializations dedicated to agriculture are still purely focused on production, economics and/or environmental processes of rural territories, which was reflected in the previous analysis of publications related to agricultural heritage. Another possible explanation for the low number of Brazilian's outreach programs is that many academic publications are still closed to international publications, developing many publications in Portuguese and centered on national scenarios.

3.4. Report, Certification and Rewards

Distinct from GIAHS, both Brazil and Italy do not require that the TAS included in their NIAHS provide periodic official reports to the entities responsible in order to keep their designation. On the other hand, GIAHS does not provide information on how the sites should interpret and report their achievements, leaving to their own interpretation and assessment. The analyses and perspectives presented in this work could contribute in a future GIAHS' general report development.

Moreover, the catalog created by EMBRAPA and IPHAN in Brazil rewards the best practices on TAS related to agricultural heritage with a monetary prize and work as a base to encourage a comprehensive survey of potential sites and for the implementation in the country of future GIAHS (such as what happens in the I-NIAHS). Meanwhile, Italy does not offer any type of monetary or specific compensation/certification for the TAS included in their catalog. In terms of rewarding, TAS that are ready to be included as designated NIAHS should gain notorious certification and compensation for the same reasons. As more countries can convert these programs into the largest number of agricultural policies, the more effective they become, as the set of awards and incentives expands and more communities and institutions will feel recognized and encouraged to work together with the programs and networks, valuing above all those directly working and protecting AS [62]. Moreover, it can work to prevent the outflow in rural areas, especially farmers and the new generations, who move to larger cities looking for new opportunities.

The fact that agricultural heritage policies are a brand-new instrument for different communities in many countries is not the only weakness. The reality is that many state environmental and cultural agencies, the ones responsible for its implementation, are not strengthened with the necessary human, material nor financial resources. Therefore, the application and processes are compromised, unlikely to have quality and, what is worse, they will hardly be analyzed and even less monitored. Over the last years in Brazil, IPHAN has been harmed by the shortage of specialized workers, the lack of funding and resources and is under investigation for organized crimes [68]. The case has been aggravated under the recent Brazilian government, where intangible heritage assets such as the traditional agricultural heritage systems, and indigenous knowledge and landscapes issues are given less importance. Recent articles have shown that public policies and funding related to the affirmation of these values were deployed by the recent federal government [68]. Nevertheless, EMBRAPA and FAO Brazil are, in some way, still engaged with the communities in the activities related to the recognition and promotion of these landscapes and their heritage, as affirmed by the recent Brazilian approval in the GIAHS program.

3.5. COVID-19 Response

The COVID-19 pandemic situation in Brazil intensified during the past two years, interrupting all events and meetings related to the first Brazilian GIAHS, except for the certification meeting [69,70]. The effects on traditional and indigenous farming and the supply of local markets were stronger at the beginning when there were restrictions on trade and the circulation of people and products and were exacerbated in relation to pre-existing challenges and vulnerabilities [71,72]. That was because the responsible government bodies did not get involved in the creation of public policies and actions aimed at the consequences of the pandemic for those communities. Studies emphasized that measures concerning investments and strengthening of primary health care aspects and the Brazilian Public Health System (SUS) in these areas must be considered by government officials and health professionals, guaranteeing the rights of indigenous and traditional peoples [73,74]. Along with that, the creation and delivery of better tools for diagnostics, treatment and vaccines, are efforts IAHS designations can contribute for prevention and to detect outbreaks in earlier stages.

As Italy is also the host country of FAO, the two have been working closely during the COVID-19 pandemic, including the creation of the COVID-19 Food Coalition, with many countries joining the initiative and projects to safeguard food security, nutrition, and promote sustainable agri-food systems transformation. Besides those, many other challenges faced by GIAHS' communities in managing the impacts were discussed by FAO's representatives during several seminars and conferences, such as economic risks due to market uncertainty, shortage of agricultural inputs, equipment and machinery due to limited access and availability, the low number of visitors in GIAHS areas, traditional crafts and liquors sale drop, among others. Some of these factors may not necessarily be addressed as primordial, but it is important to discuss because GIAHS' communities in Italy are very economically dependent on their vineyards and the products they offer [74]. Furthermore, tourism based on ecological and cultural heritage represents only a small part of the economy in most traditional and indigenous communities, such as in Brazil [26,75]. At the same time, Italy, China, and other Asian countries have demonstrated that tourism in GIAHS sites can play an important role for incomes and conservation [74,76]. Tourism can be a very useful mechanism in the preservation of agricultural heritage, without falling into the trap of converting its key elements—such as culture and landscape—into mere assets of tourism [76,77].

In general, the organization has been discussing how the resiliency of GIAHS, in such crisis, can foster opportunities for recovery and rebuilding. The idea of establishing global networks—based on heritage designations—for dealing with pandemics in a faster and more precise response should be integral part of these programs now. This aspect was addressed in-depth in a recent study from Agnoletti et al. [78], expressing the importance of understanding the different levels of the pandemic consequences based on each area and landscape, considering the type of development and intensity of rural activities. Most of the time, this level of research requires more specific data—which is something official authorities did not address at the beginning of the pandemic—and are essential to tackle all layers of the pandemic aftermath.

4. Conclusions and Future Perspectives

In this case study, through the combination of technical assessment and communities' description, the analyzed agricultural heritage programs proved to be an endless source of useful information to help defining new policies aimed at rural areas. This is also corroborated when mapping publications related to agricultural heritage, where one can see an exponential study development in the last years. Therefore, it is important to understand how agricultural heritage branches out within the layers of AS, since it is studied in different ways within the field and there is still much room for development [33]. In this case, the results highlighted many aspects of policy implementation and variables in relation to the Global North and South, but they should be replicated in other contexts and cultures, aiming a greater generalization. For example, many studies in agricultural heritage were carried out in the East, where biocultural diversity aspects and policies differ in several ways from those in the West.

Nevertheless, in order to make agricultural heritage instruments viable, there must be adequate ways of monitoring dynamic conservation in those sites. Biocultural diversity should be recognized as a key property in assessment of IAHS, as it does not just favor social and economic equity, but it reinforces, as shown in this study, their role as contributors to models for technological innovations, and knowledge conservation in the future of agriculture. It can serve as a monitoring tool for many cultural landscape challenges (e.g., food security, climate change, geohazards, deforestation), and with this respect, we highlight possible future improvements within AS assessment by introducing the neglected concept of geodiversity [79] for understanding its relationships of IAHS and abiotic ecosystem services [65,80]. We understand farmers made their livelihood on diversification of management practices also based on the physical properties of the landscape and their dynamics. The challenges of the present-day climate warming suggest a comprehensive approach to agricultural landscapes combining biodiversity and geodiversity matters [81,82], particularly for enhancing sustainability practices within TAS.

Agricultural policies can work as a vector for sustainable development through heritage programs, incorporating existing institutions, policies, and communities. The idea is that the recognition of these programs and the implementation of lists and catalogs kick-start the mapping of TAS throughout national territories, giving nations the opportunities to develop their own NIAHS, while giving the communities the rights to be nationally and internationally recognized by FAO or any other international model. Beyond a heritage approach, these policies can ignite discussions in many communities who are not safe with just heritage designations but also worried about their land rights and livelihood.

The so-called new regions for GIAHS—and especially the smallest one Latin America and Caribbean—need to insert themselves into the multifunctionalities and sustainability related to IAHS, elevating to the next level the importance of keeping close ties to time, territories, knowledge, culture and biodiversity. That means IAHS networks can contribute using their extensive experience to aid the sustainable expansion and transformation of less favored regions, encouraging countries and their communities to adhere to new agricultural heritage policies, creating new support networks and maintenance forms. The existing networks today are not flawless examples, but their experiences are very useful for inspiring new formats and development of heritage programs at different levels. Assuming that biocultural diversity related to AS has indicated a path where there is an increasing need for public policies, it should be conducted with the direct participation of interested communities, recognizing and respecting their practices and them as protagonists in all stages, we propose two recommendations: (i) at the national level, the creation of a national program steering committee, with participatory management for the good performance and monitoring of these initiatives; and (ii) implementation of public calls for existing programs, at both national and international levels, taking into consideration that the work should not be restricted to these calls. Therefore, turning the process less bureaucratic to communities and creating new forms for the applications to be processed (presentation of projects by cooperatives, social organizations and universities).

Before the COVID-19 pandemic, the world was still struggling to achieve many of the Sustainable Development Goals, especially the SDG 1 (No poverty) and SDG 2 (Zero hunger). The diversity of products and opportunities presented in IAHS are very important for global food security and sustainable development, as it guarantees not only farmers autonomy, but also comprises a source of plant genetic material [83]. In order to enhance food security and economic growth, it is important to develop in society the consciousness that food is also an exercise of citizenship and an expression of social inequality. Through the combination of these values, agricultural heritage programs that promote and invest in goals of the 2030 Agenda for Sustainable Development—and especially the concept of biocultural diversity—provide an economically viable alternative for the post-COVID-19 era, preserving food heritage and contributing to healthy diets. If humanity is to thrive in the future, we need to make our food production systems more diverse, resilient and environmentally sustainable.

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Appendix A

Table A1. All current Brazilian designations on agricultural heritage systems.

Name	Designation	Location	Year of Designation
Black River Traditional Agricultural System	B-NIAHS	Barcelos, Santa Isabel do Rio Negro e São Gabriel da Cachoeira—Amazonas State	2010
Quebradeiras de Coco-Babaçu Traditional Agricultural System	Cataloged	Lago do Junco—Maranhão	2017
Vazanteiro Traditional Agricultural System	Cataloged	Matias Cardoso—Minas Gerais State	2017
Vale do Ribeira Traditional Agricultural System	B-NIAHS	Eldorado—São Paulo State	2017
Areais da Ribanceira Traditional Agrifood Systems	Cataloged	Imbituba—Santa Catarina State	2017
Fecho e Fundo de Pasto Traditional Agricultural Systems	Cataloged	Pilão Arcado, Correntina, Campo Alegre de Lourdes, Canudos, Casa Nova, Remanso, Curaçá, Sento Sé, Uauá, Sobradinho, and Juazeiro—Bahia State	2017
Alto Xingu Traditional Agricultural System	Cataloged	Canarana—Mato Grosso State	2017
Roça de Toco Traditional Agricultural System	Cataloged	Biguaçu—Santa Catarina State	2017
Iery Behe Traditional Agricultural System	Cataloged	Novo Airão, Urucará, Presidente Figueiredo—Amazonas State; Rorainópolis, and São João da Baliza—Roraima State	2017
Arraoil do Bailique Agroforestry System	Catalogued	Macapá—Amapá State	2017
Gerazeira de Água Boa Agricultural System	Cataloged	Rio Pardo de Minas—Minas Gerais State	2017
Guarani Boapy Pindó Agroforestry System	Cataloged	Aracruz—Espírito Santo State	2017
Serra Catarinense Pinion Agroforestry System	Cataloged	Lages, São Joaquim, Painel, Urubici, Bom Retiro, Bocaina do Sul, Correia Pinto, São José do Cerrito, Cerro Negro, Campo Belo do Sul, and Anita Garibaldi—Santa Catarina State	2017
Sobrado Community Traditional Agricultural System	Cataloged	Rio Pardo de Minas—Minas Gerais State	2017
Creole Maize Traditional Agricultural System	Cataloged	Pacaraima, Boa Vista—Roraima State	2017
Alto Jequitinhonha Seed Bank	Cataloged	Turmalina, Minas novas, Chapada do Norte, and Veredinha—Minas Gerais State	2019
Seara Agrifood Systems	Cataloged	Seara—Santa Catarina State	2019
Krahò Traditional Agricultural Systems	Cataloged	Itacajá—Tocantins State	2019
Porto de Moz Agrifood Systems	Cataloged	Porto de Moz—Pará State	2019
Borborema Family Farming Territories	Cataloged	Borborema—Paraíba State	2019
Ikioakakwa Traditional Agricultural System	Cataloged	Comodoro—Mato Grosso State	2019
Fecho de Pasto Traditional Agricultural System	Cataloged	Correntina—Bahia State	2019
Potreiros Traditional Agricultural System	Cataloged	Vacaria, Monte Alegre dos Campos, Ipê, São Francisco de Paula, and Campestre da Serra—Rio Grande do Sul State	2019
Southern Espinhaço Mountain Range Traditional Agricultural System	B-NIAHS GIAHS	Diamantina—Minas Gerais State	2020

Table A2. All current Italian designations on agricultural heritage systems.

Name	Designation	Location	Year of Designation
Sant'Antonio Woods	I-NIAHS	Pestocostanzo—Abruzzo Region	2012
The Open Fields of Baronia di Carapelle	I-NIAHS	Santo Stefano di Sessanio, Calascio, and Castelvecchio Calvisio—Abruzzo Region	2012
Terraced Fields and Hills of the Majella	I-NIAHS	Roccamorice, Lettomanoppello, and Abbateggio—Abruzzo Region	2012
Olive Orchards of Loreto Aprutino	I-NIAHS	Loreto Aprutino—Abruzzo Region	2012
Fucino Plain at Ortucchio	I-NIAHS	Ortucchio—Abruzzo Region	2012
Plateaus of Aielli	I-NIAHS	Pizzoli and Barete—Abruzzo Region	2012
Chestnut Groves of the Vulture-Melfi Area	I-NIAHS	Atella, Barile, Melfi, Rapolla, and Rionero in Vulture—Basilicata Region	2012
Pastures of the Murgia Materana	I-NIAHS	Matera—Basilicata Region	2012
Olive Orchards of Ferrandina	I-NIAHS	Ferrandina—Basilicata Region	2012
Vineyards of Aglianico in the Vulture	I-NIAHS	Rionero in Vulture, Barile, Rapolla, Melfi, Ginestra, Ripacandida, Atella, Maschito, Banzi, Genzano, Forenza, Acerenza, Venosa, Lavello, and Palazzo San Gervasio—Basilicata Region	2012
Sila Plateaus	I-NIAHS	Spezzano della Sila, Spezzano Piccolo, and Serra Pedace—Calabria Region	2012
The Grass Fields of Isola Capo Rizzuto	I-NIAHS	Isola Capo Rizzuto—Calabria Region	2012

Table A2. *Cont.*

Name	Designation	Location	Year of Designation
Reventino Chestnut Groves	I-NIAHS	Cicala, Serrastretta, Gimigliano, San Pietro Apostolo—Calabria Region	2012
The Costa Viola	I-NIAHS	Palmi, Seminara, Bagnara, Scilla, and Villa S. Giovanni—Calabria Region	2012
Monumental Olive Trees at Gioia Tauro	I-NIAHS	Gioia Tauro, Rizziconi, and Taurianova—Calabria Region	2012
Bergamot Plain	I-NIAHS	Brancaleone—Calabria Region	2012
The Riviera dei Cedri	I-NIAHS	Diamante and Santa Maria del Cedro—Calabria Region	2012
Historical Terraced Orchards on Mount Somma	I-NIAHS	Somma Vesuviana—Campania Region	2012
Mixed Hill Cultures of Lower Irpinia	I-NIAHS	Montemiletto, Taurasi, Torre le Nocelle, and Lapio—Campania Region	2012
Terraced Lemon Orchards of the Amalfi Coast	I-NIAHS	Minori—Campania Region	2012
Terraced Hazelnut Groves of the Vallo di Lauro and the Baiano Area	I-NIAHS	Baiano—Campania Region	2012
Terraced Orchard-Gardens on the Hills of Naples	I-NIAHS	Naples—Campania Region	2012
Historical Afforestations in the Sele Basin	I-NIAHS	Bagnoli Irpino, Nusco, Lioni, and Caposele—Campania Region	2012
Vite Maritata of the Phlegraean Volcanic Plain	I-NIAHS	Giugliano in Campania—Campania Region	2012
Chestnut Groves of the Lavino Area	I-NIAHS	Monte San Pietro and Sasso Marconi—Emilia Romagna Region	2012
Valli Le Partite Reclamation District	I-NIAHS	Mirandola—Emilia Romagna Region	2012
Olive Orchards of the Lamone Valley	I-NIAHS	Brisighella—Emilia Romagna Region	2012
The Partecipanze Centopievesi	I-NIAHS	Pieve di Cento and Cento—Emilia Romagna Region	2012
The San Vitale Pinewoods	I-NIAHS	Po Delta Park—Emilia Romagna Region	2012
Diamantina Estate	I-NIAHS	Ferrara—Emilia Romagna Region	2012
The Hills of Polazzo in the Carso	I-NIAHS	Fogliano Redipuglia, Doberdò del Lago/Obcina Doberdob e Ronchi dei Legionari—Friuli Venezia Giulia	2012
The Plasencis Countryside	I-NIAHS	Mereto di Tomba and San Vito di Fagagna—Friuli Venezia Giulia Region	2012
Rosazzo Abbey Hill	I-NIAHS	Manzano and Corno di Rosazzo—Friuli Venezia Giulia Region	2012
The Ampezzo Forest and the Lumiei Valley	I-NIAHS	Ampezzo, Sauris, and Forni di Sotto—Friuli Venezia Giulia Region	2012
The Magredi of Vivaro	I-NIAHS	Vivaro and Maniago—Friuli Venezia Giulia Region	2012
Casette e Prati di Cottanello	I-NIAHS	Cottanello—Lazio Region	2012
The Chestnut Groves of Canepina	I-NIAHS	Canepina—Lazio Region	2012
The Farnesiana	I-NIAHS	Allumiere—Lazio Region	2012
Gorges of the Farfa	I-NIAHS	Sabina area—Lazio Region	2012
Terraced Olive Orchards of Vallecorsa	I-NIAHS	Vallecorsa—Lazio Region	2012
Cavaliere Estate	I-NIAHS	Rome (V Municipio) and Guidonia Montecelio—Lazio Region	2012
Chestnut Groves in the Alta Val Bormida	I-NIAHS	Calizzano, Murialdo, Bardineto, Osiglia and Massimino—Liguria Region	2012
Wooded Olive Groves of Lucinasco	I-NIAHS	Lucinasco—Liguria Region	2012
Terraced and Irrigated Chestnut Groves and Vegetable Gardens in Upper Valle Sturla	I-NIAHS	Borzonasca—Liguria Region	2012
Peri-urban Vegetable Gardens in the Valley of the Entella River	I-NIAHS	Chiavari, Lavagna, Cogorno, Carasco, and San Colombano Certenoli—Liguria Region	2012
Wooded Meadows and Pastures in the Santo Stefano Cheese Area	I-NIAHS	Santo Stefano d'Aveto—Liguria Region	2012
Terraced Hazelnut Groves of Tigullio	I-NIAHS	Mezzanego, Borzonasca, Ne, San Colombano Certenoli, and Leivi—Liguria Region	2012
Low-growing Terraced Vineyards of Tramonti	I-NIAHS UNESCO World Heritage	Cinque Terre National Natural Park, Porto Venere Regional Natural Park, and the Porto Venere-Riomaggiore—Liguria Region	2012
The baulati Fields of Casalasco	I-NIAHS	Piadena, Calvatone, and Tornata—Lombardia Region	2012
The Banina Hill	I-NIAHS	San Colombano al Lambro, Graffignana, Inverno, Monteleone, and Miradolo Terme—Lombardia Region	2012
Morenic Hills of the Lower Garda Lake	I-NIAHS	Ponti sul Mincio, Monzambano, Cavriana, and Solferino—Lombardia Region	2012
Lemon Houses on the Garda Lake	I-NIAHS	Salò, Gardone Riviera, Toscolano Maderno, Gargnano, Tignale, Tremosine, and Limone—Lombardia Region	2012
The marcite of the Irrigated Plain	I-NIAHS	Bernate Ticino, Morimondo, Vigevano, Albairate, Buccinasco, Calvignasco, Lacchiarella, Melzo, Noviglio, Peschiera Borromeo, Settala, and Zibido San Giacomo—Lombardia Region	2012
Bird-catching Sites in Lombardy	I-NIAHS	Colli di Bergamo, Val Seriana, Val Brembana, Val Gandino, and Val Cavallina—Lombardia Region	2012
Val Muggiasca	I-NIAHS	Vendrogno—Lombardia Region	2012

Table A2. *Cont.*

Name	Designation	Location	Year of Designation
Terraced Vineyards of the Valtellina	I-NIAHS	Sondrio, Montagna, Poggiridenti, and Tresivio—Lombardia Region	2012
The Plateau of Macereto	I-NIAHS	Ussita and Visso—Marche Region	2012
Hills of Maiolati Spontini	I-NIAHS	Maiolati Spontini, Scisciano, Monte Roberto, and Castelbellino—Marche Region	2012
Olive Orchards of Coroncina	I-NIAHS	Caldarola—Marche Region	2012
Piagge of Ascoli Piceno	I-NIAHS	Ascoli Piceno—Marche Region	2012
Polycultures of Loretello	I-NIAHS	Arcevia—Marche Region	2012
Sasso Simone and Simoncello	I-NIAHS	Piandimeleto, Frontino, Carpegna, and Pennabilli—Marche Region	2012
Cereal Farming in Melanico	I-NIAHS	Santa Croce—Molise Region	2012
La Pista at Campomarino	I-NIAHS	Campomarino—Molise Region	2012
The Olive Orchards of Venafro	I-NIAHS	Venafro—Molise Region	2012
The Springs of Monteroduni	I-NIAHS	Monteroduni—Molise Region	2012
Sheep-Tracks in the Upper Molise	I-NIAHS UNESCO MAB	Collemeluccio and Montedimezzo—Molise Region	2012
Pastures of Raschera	I-NIAHS	Chiusa di Pesio, Punta Marguareis, Frabosa Soprana, Frabosa Sottana and Magliano Alpi—Piedmont Region	2012
The Plateau of the Vauda	I-NIAHS	Barbania, Front, Vauda Canavese, San Carlo Canavese, San Francesco al Campo, Lombardore, Rivarossa and Rocca Canavese—Piedmont Region	2012
The Baraggia Land in the Vercelli and Biella Area	I-NIAHS	Baragge Natural Oriented Reserve—Piedmont Region	2012
Wood of Sorti della Partecipanza di Trino	I-NIAHS	Trino—Piedmont Region	2012
The San Michele Farmhouse	I-NIAHS	Bosco Marengo—Piedmont Region	2012
The Wooded Pastures of Roccaverano	I-NIAHS	Olmo Gentile, Roccaverano, San Giorgio Scarampi and Mombaldone—Piedmont Region	2012
Historical Polyculture of Valle Uzzone	I-NIAHS	Castelletto Uzzone, Pezzolo Valle Uzzone, Bergolo, Levice and Gottasecca—Piedmont Region	2012
The Galarei Vineyard	I-NIAHS	Serralunga d'Alba and Diano d'Alba—Piedmont Region	2012
Monumental Turkish Oak Woods of Valle Ragusa	I-NIAHS	Monte Sant'Angelo—Puglia Region	2012
The Citrus-Grove Oasis in the Gargano	I-NIAHS	Rodi Garganico, Vico del Gargano, and Ischitella—Puglia Region	2012
Olive Orchards of the Serre Salentine	I-NIAHS	Alessano—Puglia Region	2012
The Pastures of the Upper Murgia	I-NIAHS	Gravina and Spinazzola—Puglia Region	2012
Terraces in the Gargano	I-NIAHS	Mattinata and Monte Sant'Angelo—Puglia Region	2012
The Itria Valley	I-NIAHS UNESCO WHS	Martina Franca—Puglia Region	2012
The Vineyards of the Lecce Tavoliere	I-NIAHS	Salice Salentino—Puglia Region	2012
Olive Groves of Monte Oro	I-NIAHS	Sassari—Sardegna Region	2012
Rural Landscapes of Asinara	I-NIAHS	Porto Torres—Sardegna Region	2012
Planted Silvo-pastoral Systems of Monte Minerva	I-NIAHS	Villanova Monteleone, Padria, and Monteleone Rocca Doria—Sardegna Region	2012
The Citrus Orchards of Conca D'Oro	I-NIAHS	Palermo—Sicilia Region	2012
The Mixed Orchards of the Valley of the Temples	I-NIAHS UNESCO WHS	Agrigento—Sicilia Region	2012
The Ficuzza Woods	I-NIAHS	Corleone, Godrano, and Monreale—Sicilia Region	2012
Enclosed Fields with Carob Trees on the Monti Iblei	I-NIAHS	Ragusa—Sicilia Region	2012
Manna Ash Woods	I-NIAHS	Pollina, Castelbuono, San Mauro Castelverde—Sicilia Region	2012
Pantelleria's "dry-stone" Landscape	I-NIAHS	Trapani—Sicilia Region	2012
The Pistachio Orchards of Bronte	I-NIAHS	Bronte and Adrano—Sicilia Region	2012
Polyculture on the Slopes of Etna	I-NIAHS	Maletto, Bronte and Randazzo—Sicilia Region	2012
The Fir Forest of the Monastery of Vallombrosa	I-NIAHS	Reggello—Toscana Region	2012
The *Biancane* of the Val d'Orcia	I-NIAHS	Pienza, Montepulciano, Chianciano and Sarteano—Toscana	2012
The Monumental Chestnut Groves of the Scesta Valley	I-NIAHS	Bagni di Lucca—Toscana Region	2012
Hill of Fiesole	I-NIAHS	Fiesole and Florence—Toscana Region	2012
The Montagnola Senese of Spannocchia	I-NIAHS	Chiusdino—Toscana Region	2012
Landscape Mosaic of Montalbano	I-NIAHS	Pistoia—Toscana Region	2012
Silvo-pastoral Landscapes of Moscheta	I-NIAHS	Firenzuola—Toscana Region	2012
Terraced Vineyards of Lamole	I-NIAHS	Chianti—Toscana Region	2012
The Fir and Spruce Woods of Val Cadino	I-NIAHS	Valfloriana, Castello-Molina di Fiemme, and Cavalese—Trentino Alto Adige Region	2012

Table A2. *Cont.*

Name	Designation	Location	Year of Designation
The vineyards of Val di Cembra	I-NIAHS	Cembra, Lisignago and Giovo—Trentino Alto Adige Region	2012
Alto Adige	I-NIAHS	N/A	2012
The Meadows and Wooded Pastures of Salten	I-NIAHS	San Genesio—Trentino Alto Adige Region	2012
Terraced Vineyards of Santa Maddalena	I-NIAHS	Santa Maddalena—Trentino Alto Adige Region	2012
The Plestini Plateaus	I-NIAHS	Foligno, and Serravalle di Chienti—Umbria Region	2012
Spelt Fields at Monteleone di Spoleto	I-NIAHS	Monteleone di Spoleto—Umbria Region	2012
The Hills of Montefalco	I-NIAHS	Montefalco—Umbria Region	2012
Plateaus of Castelluccio di Norcia	I-NIAHS	Foligno and Nocera Umbra—Umbria Region	2012
The Poggi di Baschi	I-NIAHS	Baschi and Montecchio—Umbria Region	2012
The Rock of Orvieto	I-NIAHS	Terni—Umbria Region	2012
Stepped Olive Groves	I-NIAHS GIAHS	Spello, Foligno, Trevi, Campello sul Clitunno, and Spoleto—Umbria Region	2012
High-Mountain Pastures at Dame de Challant	I-NIAHS	Brusson, Gressoney-Saint-Jean, Challand-Saint-Anselme, Challand-Saint-Victor, Issime, and Gaby—Valle D'osta Region	2012
The "Heroic Viticulture" of the Dora Baltea Area	I-NIAHS	Pont Sant Martin, Donnas, and Bard—Valle D'osta Region	2012
Plateau of Tretto	I-NIAHS	Tretto—Veneto Region	2012
The Forest of Cansiglio	I-NIAHS	Farra d'Alpago, Tambre, Cordignano, Sarmede, Fregona, Budoia, Caneva and Polcenigo—Veneto Region	2012
Wine Hills between Tarzo and Valdobbiadene	I-NIAHS	Tarzo, Refrontolo, Cison di Valmarino, Follina, Pieve di Soligo, Miane, Farra di Soligo, Vidor, and Valdobbiadene—Veneto Region	2012
The Fief of the Counts of Collalto	I-NIAHS	Susegana—Veneto Region	2012
The Palù of Quartier Piave	I-NIAHS	Moriago della Battaglia, Sernaglia della Battaglia, Vidor, and Farra di Soligo—Veneto Region	2012
The Ca' Tron Farm	I-NIAHS	Roncade—Veneto Region	2012
The Vineyards of Fonzaso	I-NIAHS	Fonzaso and Arsiè—Veneto Region	2012
Soave Traditional Vineyards	GIAHS	Soave, Monteforte D'Alpone, Colognola ai Colli and Roncà—Veneto Region	2018

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A Framework for Geoconservation in Mining Landscapes: Opportunities for Geopark and GEOfood Approaches in Minas Gerais, Brazil

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Abstract: The continuous processes of mining development, since the very beginning of Minas Gerais State's development, have been giving new attention and meaning to valuable pre-existing features (i.e., cultural, social, and physical-environmental), impacting and recharacterizing not only its municipalities but their essential local or native sociocultural components. At the same time, mining, as one of the central pillars of the Brazilian development model, has put different communities, natural and cultural heritage, and mineral and water resources at risk. The wide concept of geodiversity and the related geoheritage emerge as an alternative for conservation, territorial planning, and sustainable development, to reconcile these spheres. This study developed a comprehensive framework for geoconservation within selected areas of mining landscapes, contributing to insights for the creation of a catalog about geoheritage in the state of Minas Gerais, discussing and analyzing well-established strategies and opportunities based on UNESCO Global Geoparks (UGGp) and the GEOfood brand. We concluded that the mining landscapes of Minas Gerais must be administered as a viable possibility for economic and environmental dynamic actions and activities, strengthening the maintenance of municipalities from the very beginning to after the end of operational activities. Heritage programs such as UGGp and GEOfood enable knowledge sharing and engagement with geoheritage, improving the comprehension and management of the short- and long-term impacts of mining, while elevating geodiversity as a major source of information in the "greening" of mining policies.

Keywords: geodiversity; geoheritage; mining landscapes; geoconservation; geoparks; geofood; planning and management; landscape; public policies

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1. Introduction

Globally, Brazil is among the five largest mineral producers, with the mining sector representing approximately 8% of the Brazilian Gross Domestic Product (GDP) [1]. Located in Southeastern Brazil, Minas Gerais (MG) is the largest ore-producing state, representing 47.01% of national production and houses $\frac{1}{4}$ of the largest Brazilian mines [1]. The state is home to 482 municipalities that depend, almost exclusively, on taxes and jobs generated directly or indirectly by the sector (more than half of the total number of municipalities in the state), but the sector only constitutes 4% of the state's GDP [1,2]. Historically, the discovery of minerals (i.e., gold and ore) in MG started with the Portuguese exploration more than 400 years ago and changed the entire political, economic, social, cultural, and religious scenario of colonial Brazil [3]. Those mining activities outlined regulations for different types of operations and guidelines for the nation's economic development as the countryside was being rapidly populated, transforming and molding the landscapes. The mining identity is considered a symbolic landmark for the state and is even included in its name (in Portuguese, "minas" means "mines"). In 2021, the state had the largest increase in the royalty collection and is also the one that will attract most of the investments for the sector until 2025 (approximately 10.2 billion USD) [1]. In a certain way, mining activities boosted Brazil's economy and are globally recognized today as essential for economic development and well-being [4]. However, there are many controversies over how mining is practiced all over the world, particularly in Brazil and economically developing countries.

In general, mining, as one of the central pillars of the Brazilian development model, has put natural and cultural heritage, and mineral and water resources at risk [5]. These territories—where the extraction and processing of minerals take place—are often the scene of social and environmental crimes and challenges (e.g., climate change, social and administrative conflicts, landowners), as well as the degradation of natural resources through deforestation, pollution, and, most recently, by the two major tailing dam catastrophic failure tragedies in the country's mining history. The events that occurred in the municipalities of Mariana (in 2015) and Brumadinho (in 2019) left hundreds of deaths, destruction in different communities, and expressive damage and pollution to the environment [5,6]. Furthermore, debates and investigations around the importance of the sector for the country's economy were reignited, trying to find out how dependent the state is on mineral activities and which ones are responsible for the crimes that occurred [5,7]. Internationally, 84% of the top 25 ranked countries producing mineral resources are rated as weak, poor, or failing in terms of the quality of their extractive sector governance. Considering MG, statistics have shown expressive poverty rates in large-scale mining municipalities, suggesting that there is a lot of room for the improvement of socioeconomic benefits from the local mineral resources and public policies [8–10]. Additionally, mining operations repeatedly ignored the widely perceived intrinsic natural and sociocultural values of the environment that was once there [7,11].

Furthermore, Brazil, and specifically MG, has great potential in terms of geodiversity, with studies showing the country among the top five in scientific contributions related to the variety of elements and values of abiotic nature [12]. In the last two decades, approaches related to nature conservation, territorial planning, and sustainable development have been gaining a new look with the term geodiversity [13–15]. According to Gray [16], geodiversity is creating a multifaceted and evolving concept, comprehending the wide range of geoscientific paradigms or the 'Gs' (i.e., geology, pedology, geomorphology, geosystem services, geoheritage, and geotourism). Rooted in the 'Gs' framework [17], we structured a possible geoconservation framework for mining landscapes (Figure 1), progressing from geodiversity components, which include their assemblages, structures, systems, and contributions to landscapes, to how mine development has been shaping landscapes, thus creating the mining landscape. This "recently molded place" was the subject of an intensive mining process, upbringing new values and meanings, giving new attention to different aspects of the sociocultural, economic, and environmental contexts, and emphasizing the capital value attributed to mineral resources [18]. This area, under the operations of a company or enterprise, is now a complex engineering work that not only comprises sources of industrial activities (i.e., infrastructure, facilities, machinery, and open pits) but also many elements of earth's abiotic nature that have considerable scientific, sociocultural, historical, and/or aesthetic values, the so-called geoheritage. Moreover, the exceptional values attributed to geoheritage elements are usually protected under several forms of instrumentalities and laws. Therefore, an alternative, systematic approach is needed for reconciling conservation activities, territorial planning, and sustainable development. Within the geoconservation framework, three types of efforts emerge as crucial elements: (i) systematic inventory of geodiversity and geoheritage, (ii) use of the geosystem services approach for interpreting the role of abiotic nature within ecosystems, and (iii) the development of strong legal frameworks for environmental protection. The first effort is related to data collection and analysis methods that consider the elaboration of specific geological categories to determine places of interest (i.e., geosites) and produce qualitative and quantitative assessments and indicators. The second one is the goods and services related to geodiversity, which is equivalent to the ecosystem services framework [16]. Finally, the third one relates to legal measures, statutory protection, environmental laws, and conservation and management strategies designed based on geoheritage planning. Combined, the three efforts promote the maintenance of geoconservation, a ground for the creation of UNESCO Global Geoparks (UGGp) and subsequently, the GEOfood brand.

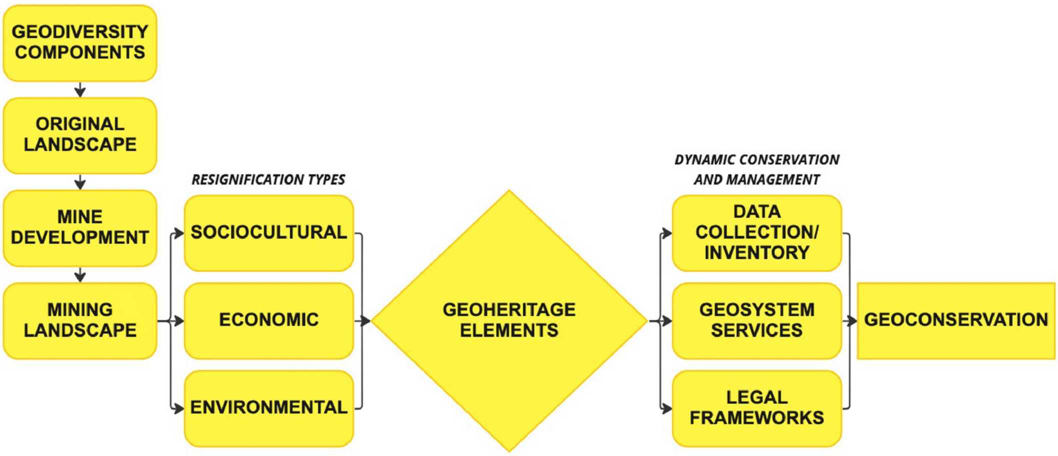


Figure 1. Flowchart of geoconservation framework for mining landscapes.

Created in 2004, under the heritage umbrella of UNESCO, the Global Geopark Network (GGN) currently comprises 177 UNESCO Global Geoparks ("UGGps") in 46 different countries, supported by exchange and cooperation actions contributing to the following sustainable development goals (SDGs) of the 2030 Agenda for Sustainable Development: SDG 1 (no poverty), SDG 4 (quality education), SDG 5 (gender equality), SDG 8 (decent work and economic growth), SDG 11 (sustainable cities and communities), SDG 12 (responsible consumption and production), SDG 13 (climate action), and SDG 17 (partnership for goals) [19].

In addition to the network and following the objectives proposed by the 2030 Agenda, a Scandinavian partnership created the GEOfood brand (coordinated by Magma UGGp in Norway), a project that incorporates and certifies the so-called "edible geoproducts", made from raw materials coming directly from UGGps territories (which is the main criteria for the brand). GEOfood products must follow sustainable practices of production such as: reducing packaging, protecting workers' rights, safeguarding geoheritage based on local values, and processing and promoting connection with geodiversity [20]. GEOfood intensifies sociocultural values and enhances territorial development by developing narratives for awareness about geological heritage through local and traditional communities, involving them in entrepreneurship, and ensuring sustainability.

As of October 2022, GEOfood is present in 34 UGGps in 21 different countries, working with more than 100 local restaurants, farmers, and schools, ranging from small to medium-sized enterprises [21]. In addition, the brand has also turned into a project team approved in 2021 and awarded by The International Geoscience Programme (IGCP-project 726) Council—a UNESCO hub to facilitate international scientific cooperation in geosciences—which includes 54 partners from 26 countries, comprising researchers from UGGps, universities, institutes, and aspiring geoparks and projects, along with all GEOfood members and partners, which aim to develop the brand and implement it in UGGps all over the world. The project will run for five years, developing tools for the implementation and monitoring of the GEOfood brand worldwide. The results are displayed on the webpage of the project (www.geofood.no; accessed on 1 October 2022), the first project baseline has been developed, and the GEfood board game has been released as well.

Geoparks and GEOfood are expected to play an important role in learning about and experiencing sustainable development [22–24]. However, Brazilian initiatives related to the creation of them are still emerging, with only three UGGps officially recognized (i.e., Araripe UGGp, Cânions do Sul UGGp, and Seridó UGGp) and several other projects in development all over the country. The main difficulties in establishing geopark actions in Brazil lie in understanding the geographical concept and values of its territories and the lack of official entities, strategic planning, outreach, and specific legislation related to UGGps [25–27]. For GEOfood, two initiatives are currently taking place in Brazil: UGGp Seridó and Canastra Geopark Project;while Araripe UGGp has also expressed interest in joining the initiative soon. In addition, the complications are based on the main criteria that require the establishment of a UGGp for implementation of the brand, along with acknowledgment and acceptance. Today, the establishment of UGGps in Brazil is compromised by the lack of specific planning and geoheritage policies, mainly because geoparks are not included in any Brazilian legislation, which leaves their own implementers to develop them in accordance with the Geopark Program institutionalized by the Brazilian Geological Service (CPMR) [27,28]. The program is dedicated to the identification, description, diagnosis, and wide dissemination of areas with potential for future geoparks in the national territory, as well as the inventory and quantification of geosites. This is not the case for other forms of UNESCO designations in Brazil, such as the Man and Biosphere Reserves (MAB), which have specific directives included in the National System of Protected Areas (SNUC). As discussed by different authors [25,27], this absence can cause confusion and controversies for implementers, communities, stakeholders, and policymakers, which can even be the case for other countries as well [29]. Nevertheless, it corroborates the concepts of UGGps and geodiversity [16,19]—in which the framework previously formulated was grounded—in the sense that the territory is seen as an essential part of the multifaceted and evolving concept, being reformulated, and adapted to local realities and policies around the world. There are two main implementation strategies that have been used as the base for supporting UGGp initiatives in Brazil and in MG; they are in accordance with the demands of UNESCO, facilitate the implementation process, and address the challenges stated before: (i) territorial/administrative borders and (ii) association management (e.g., consortium/multimunicipality management). The first can be summarized by an approach in which the geographical borders of geoparks will follow existing legal limits, for example, municipalities or protected areas. The second comes from UNESCO's demand for having an agency/legal person responsible for the general management of actions and funds related to all operations. In addition, UNESCO allows for geopark initiatives to come from both the public and private sectors, meaning that, beyond public policies or actions by the state or institutions, companies inserted in these territories can take part in it or even make the first move.

In this article, fundamentally based on the comprehensive framework we developed in the introduction, we discuss and analyze geoconservation in mining landscapes of MG, exploiting the combination of the following approaches: the UGGp label and the GEOfood brand. The state of MG was selected as the study area of this work due its several sites of international geoheritage interest, the currently aspiring UGGps and projects emerging (even though none of them are officially recognized), and the importance the state has as the main representative of mining activity in Brazil. Thus, by a combination of methods, this study aims at: (i) creating a comprehensive catalog to assess and discuss the extent of municipalities' achievements, (ii) exploring the opportunities, activities, and future initiatives related to geotourism, geoconservation, UGGp label, and the GEOfood brand for the same municipalities, (iii) highlighting knowledge gaps and priorities, as a base for future assessment and application by the communities, providing contribution to different regions, sites, entities, and governments. Additionally, we explore how the framework we created can contribute toward the development of public policies overseeing the sustainable use of mining landscapes throughout the challenges that MG and Brazil need to face, together with the importance of their protection and management, in order to expand the participation of this type of landscape in heritage programs.

2. Methodology

The methodology can be divided into two different parts based on archival research and literature analysis: (i) a combination of an inductive method (i.e., the geoconservation approaches for mining landscapes we introduced in Section 1) with the bibliographic and document analyses presented in this section; (ii) analysis of the existing geosites' studies contrasted with the identification of mechanisms that contribute to geoconservation. This innovative combination of methodologies provides a timely opportunity to develop a better understanding of the historical, cultural, geological, conservational, and social aspects of mining within the broader context of industrialization, urbanization, and population change in MG. Specifically, we selected 6 areas in MG (Figure 2), which have been categorized based on the following criteria: (i) areas that are currently developing geopark initiatives (aspiring UGGps and projects); (ii) areas that were previously assessed for geopark development by research groups/institutions; (iii) areas that are notable for their remarkable geological features but are not previously included in geopark initiatives. All of them are located in wider areas of mining activity (legally or not). Respectively, four areas have geopark projects under the criteria i (i.e., Canastra (CA), Quadrilátero Ferrífero (QF), Morada Nova de Minas (MN), and Uberaba (UB)), one under the criteria ii (i.e., Coromandel-Vazante (CV)), and one under the last criteria (i.e., Arcos-Pains (AP)) (Table 1).

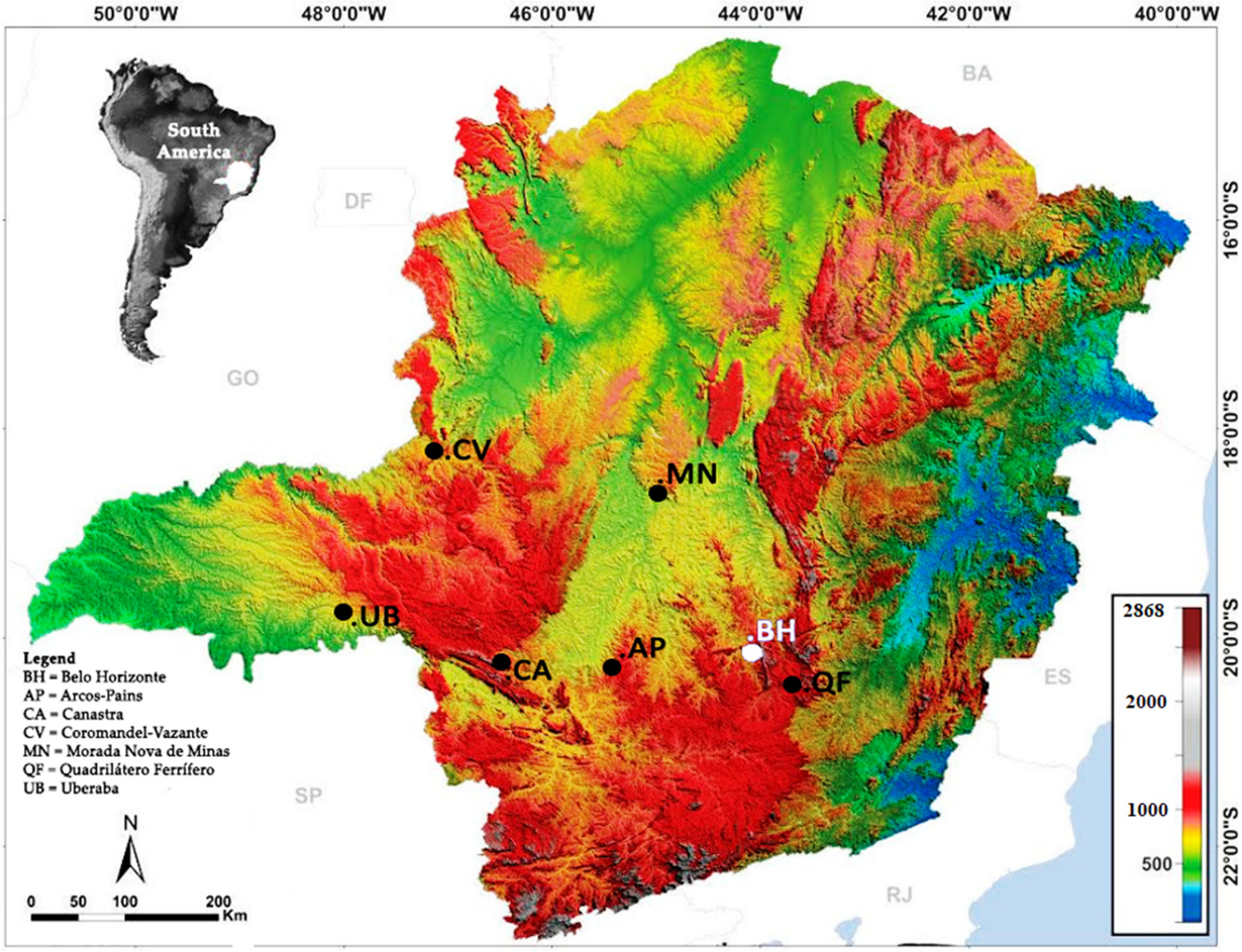


Figure 2. Topographic map of the Minas Gerais state with its capital (Belo Horizonte) and the 6 selected areas for this study. Site abbreviations: BH = Belo Horizonte, AP = Arcos-Pains, CA = Canastra, CV = Coromandel-Vazante, MN = Morada Nova de Minas, QF = Quadrilátero Ferrífero, and UB = Uberaba. Note: the surrounding translucent abbreviations (i.e., SP, RJ, ES, BA, DF, and GO) correspond to neighboring states and districts.

Table 1. Overview of selected areas in the state of Minas Gerais and their categorization based on the study's criteria.

Category and Criteria	Name of the Area/Geopark Project
i. Sites developing UGGp initiatives	Canastra geopark project Morada Nova de Minas geopark project Quadrilátero Ferrífero geopark project Uberaba—Terra de Gigantes geopark project
ii. Site previously assessed for geopark development by research groups/institutions	Coromandel-Vazante
iii. Site notable for their remarkable geoheritage features but not previously included in any UGGp initiative	Arcos-Pains

2.1. Literature Analysis

Based on the application of our framework and the check of UGGp creation stages at each area, we identified geosites and possible resources/opportunities for enhanced geoconservation in MG and discussed the creation of new geopark projects. Assessing and quantifying the elements of geodiversity is not a simple task, and the methodologies used for this purpose can involve the evaluation of geological contents based on quantitative and qualitative approaches [30–32], the elaboration of maps and their comparative analysis [33,34], and the study of scientific literature and technical reports to assess the state of the art and identify knowledge gaps [32,35–37]. Therefore, our extensive analysis considered official information sources provided by each part (i.e., dossiers, evaluation reports, application files, websites), available peer-reviewed papers, and interviews (i.e., phone calls and oral conversations with managers and stakeholders). First, we describe each selected area and the characteristics and state of the geosites (i.e., regional historical geotourism development, extension, and landscape diversity), and the development of these programs along with the institutions, companies, and government bodies involved. Secondly, we carried out a critical analysis on policies, legislation, and organizational guidelines related to UGGp and GEOfood proposals and offers in Brazil, evaluating their development and implementation in accordance with national and global trends. Finally, we cataloged and reported administrative actions, knowledge advancements and gaps, and the engagement of geodiversity and geoconservation concepts within mining landscapes.

2.2. Geosites Analysis

For the inventory and analysis of geosites, we collected data for each area in accordance with their official presentation documents/websites. If not available, data were collected from peer-reviewed papers and information materials. The classification consisted first of the interpretation of potential interests for each geosite; after that, data were contrasted with information available on the GEOSSIT's platform by the Brazilian Geological Society (CPRM). GEOSSIT is a Brazilian public platform (http://www.cprm.gov.br/geossit/; accessed on 16 October 2022) and an extensive database for registering geological sites and materials (in situ and ex situ) in Brazil [25,37–40]. The inventory, under collaborative progressive construction, includes the quantification of the geoscientific interest taking into account the representativeness, uniqueness, rarity, expression, and integrity of the geological aspects of these places and elements, in addition to the clarity in portraying relevant themes, facts, processes, phenomena, or geological events. The quantification is represented by tabs that correspond to the characterization of the following attributes: aesthetic (AE), educational (ED), scientific (SC), economic (EC), cultural (CL), touristic (TO), religious (RE), and historical (HI), along with the risk of degradation, the classification of the sites according to their relevance, and their specific recommendation for protection and conservation. Obtaining the classification and values related to each site is carried out by assigning weights to predefined parameters, generating a number that is automatically calculated by the platform. Carrying out geoheritage inventories in a region or country is a complex activity, mainly involving consultation with experts through lists of previously established criteria [40–43].

We classified all information in a table based on what was found in the platform according to their interest and status: “in analysis”, when the geosite was already submitted for evaluation; “consisted”, when the geosite was already approved; finally, “N/A”, when there was no information regarding the selected geosite. Finally, we highlighted the ones presented in both the in-depth literature analysis and GEOSSIT’s platform. The main purpose is to recognize and identify the different Brazilian geological values in their different natures and locations.

3. Description of Case Studies in the State of Minas Gerais

Among the five largest states in Brazil, Minas Gerais is in the southeastern region of the country with an area of 586,528 square kilometers, with Archean to Phanerozoic age sequences occurring in the most varied tectonic and metamorphic context. An eroded plateau comprises most of the region, with several mountain chains surrounding the state, including peaks that can reach approximately 2800 m a.s.l., which differs from other regions of the country due to the diversity of the morphological conditions present [44] (see Supplementary Material S1 for a complete geodiversity map of the state).

Mainly composed of *cerrado* (Brazilian savanna) and Atlantic Forest, the region also presents other tropical biomes such as broadleaf rainforest, desert shrub, rupestrian fields (*caatinga*), and Atlantic Forest, holding a high diversity of fauna and flora [44,45]. Despite being the second largest biome in South America, only 8% of the whole *cerrado* is considered protected areas, with 3% at the highest level of protection [46]. The state numbers are even worse. The total area under full protection corresponds to 1.96% of the state’s territorial extension, still far from the 10% that is the state’s goal [45]. At the same time, a great part of the outstanding biodiversity and geodiversity of the state is seriously threatened by human actions [46]. Approximately half of the *cerrado* is converted into agricultural or fragmented land, while the Atlantic Forest is the most vulnerable biome in the state, with the lowest proportion of remaining vegetation (23%) and the lowest percentage of areas under full protection (1.1%) [44–46]. In addition, the impressive geomorphological landscapes, hydrological resources, and speleological and archeological sites are home to many hydroelectric and mining activities, ranging from small to large-sized operations [31,46]. Nowadays, the MG state has an intense predatory exploitation of natural and mineral resources, with numerous animals and plants at risk of extinction; it is estimated that 20% of the native and endemic species in the region no longer exist in protected areas [46,47].

3.1. Arcos-Pains Karst Region

The Arcos-Pains karst region is in midwestern MG; due to its carbonate bedrock, it presents a karst landscape of relevant geographic interest since the 19th century, both scientifically and economically, given its importance in the karst/speleological scenario [48] (Figure 3). Comprising the municipalities of Pains, Arcos, Doresópolis, Iguatama, Córrego Fundo, and Formiga, it is characterized by the constant presence of rugged reliefs associated with limestones and smooth and wavy shapes from claystone [48]. Pains is known as the world’s capital of limestone. The landscape is also known for its outstanding aesthetic values, mostly composed of canyons, caves, and water resources, and is included even in Brazilian films (e.g., *Faroeste*, directed by Abelardo de Carvalho).

There are several studies on the area, especially related to the geological, speleological, and biological aspects. The region is famous for its unique speleothems, archeological sites with stromatolites, cave paintings, and artifacts that date back to the history of the primitive peoples who lived there. Beyond the usual species that are found in the *cerrado* landscape, the fauna and flora have their habitat and ecological niche intrinsically related to natural caves. The most impressive finding is an endemic species of anura (*Ischnocnema karst*), which is included as an endangered species in Brazil [49].

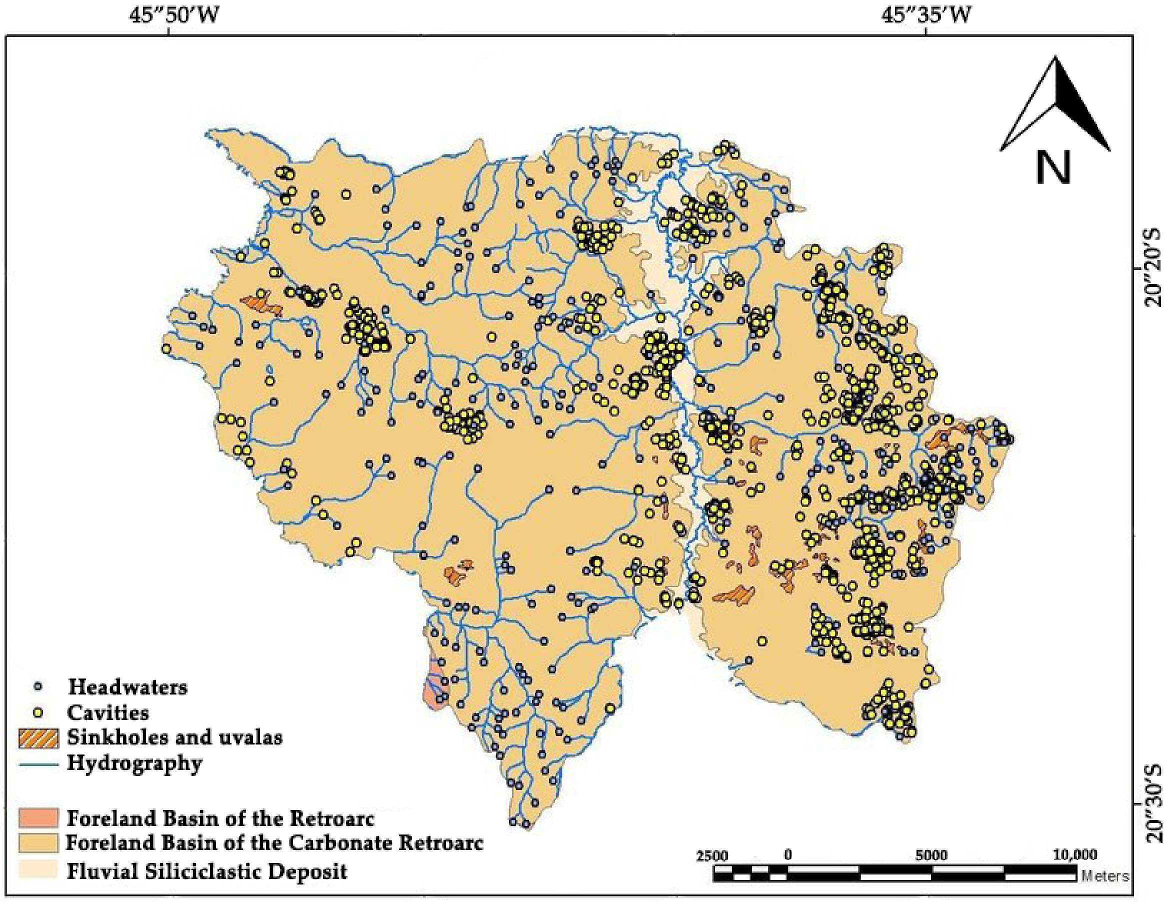


Figure 3. Geological and hydrological map of Pains, Minas Gerais State (modified from [50]).

Altogether, it is an area subject to intense mining operations and deposits, both legal and illegal. Pollution and degradation are often exacerbated. On top of that, illegal fishing practices, deforestation, and water abstraction pose environmental threats and challenges to the region's ecosystem.

3.2. Canastra Geopark Project (CG)

In midwestern MG is the Serra da Canastra National Park, designated in 1972 by the Chico Mendes Institute for Biodiversity Conservation (ICMBio), with an area of 200,000 hectares, of which approximately 85,000 hectares are protected [45]. It preserves the sources of the São Francisco River, which is approximately 3000 km long, the fourth largest river in South America, with several other exceptional geological and geomorphological features covering the territories of six municipalities: São Roque de Minas, Capitólio, Vargem Bonita, São João Batista do Glória, Delfinópolis, and Sacramento. The initial proposal of developing the Canastra UGGp revolves around previous assessments and work conducted in the region proposed by the Brazilian Geological Survey [26,51,52] and established with the help of upcoming interest from scientists, professors, stakeholders, and communities of the region, especially the Instituto Federal de Minas Gerais—IFMG Bambuí (officially engaged with the park in several research and educational activities), a partnership with the University of Turin (in Italy), and the IGCP 726 (despite the GEOfood brand being exclusive to UGGp sites, the project is already introducing its concept, events, and assessments).

The landscape is characterized by the presence of a rich biodiversity and outstanding aesthetic values, such as many native species and the vegetation mainly based in *cerrado*, patches of the Atlantic Forest, and rupestrian fields [45,47]. Not only does the region draw attention for its biodiversity, but its geodiversity and geoheritage provide an unusual variety of international geological significant elements, such as hydrographic features (many springs, waterfalls, rivers, and streams), archeological, and monumental sites, such as the Casca d'Anta waterfall, which is approximately 186 m high and one of the park's main attractions, and the Chapadão da Canastra (or Diamante), which is a set of mountains and plateaus resulting from geological processes and phenomena that date back to the Proterozoic, ranging from 900 to 1500 m in height (Figure 4) [47].

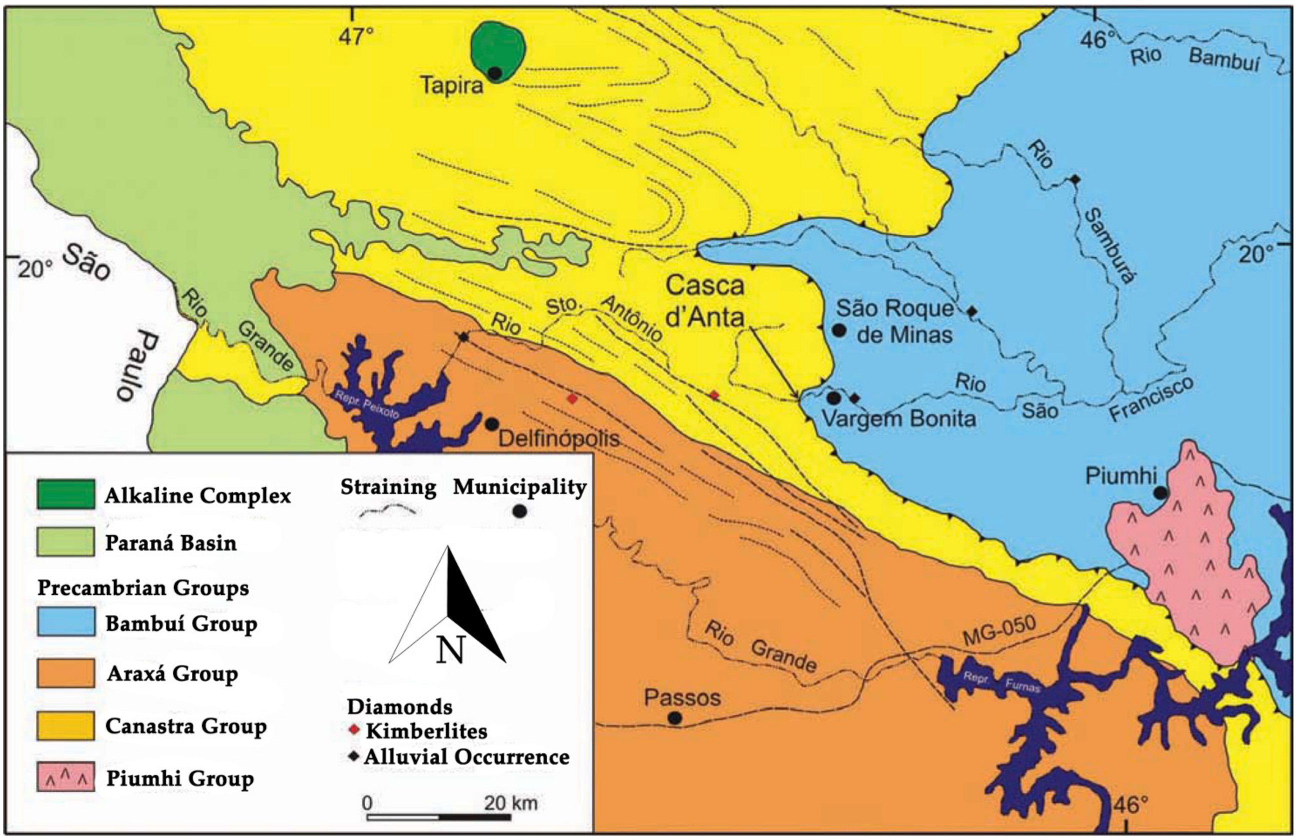


Figure 4. Geological map of the Canastra region in Minas Gerais State (modified from [51]).

Nowadays, under the federal administration of the ICMBio, the region is subject to many controversial management actions—intensified by the current federal government—causing several landowner conflicts and no investment in public policies for the locals whatsoever. The region also faces problems such as the consequences of years of deforestation, wildfires, erosion, intensive mining operations, livestock production, and sugarcane agriculture.

3.3. Coromandel-Vazante Region

Coromandel and Vazante are two municipalities located in the Triângulo Mineiro region in western Minas Gerais, based on the Bambuí speleological province, a complex karst system that encompasses several features, including endokarst (caves) and exokarst (sinks, sinkholes, and karst springs) (Figure 5) [53]. The region was named after its triangle-shaped territory and is one of the most important in terms of economy for the state. Historically, the exploitation and settlement of the area was mostly done by the slaving and extermination of indigenous populations and maroon communities (*quilombolas*) as it was in the entire Brazilian colony [53,54]. Additionally, the area is known for its impressive geological features, such as waterfalls, lakes, mountains, and caves, along with geotourism activities related to leisure and contemplation of those features. At the same time, mining is one of the main economic activities developed in the area, followed by agriculture-related industries and business [54].

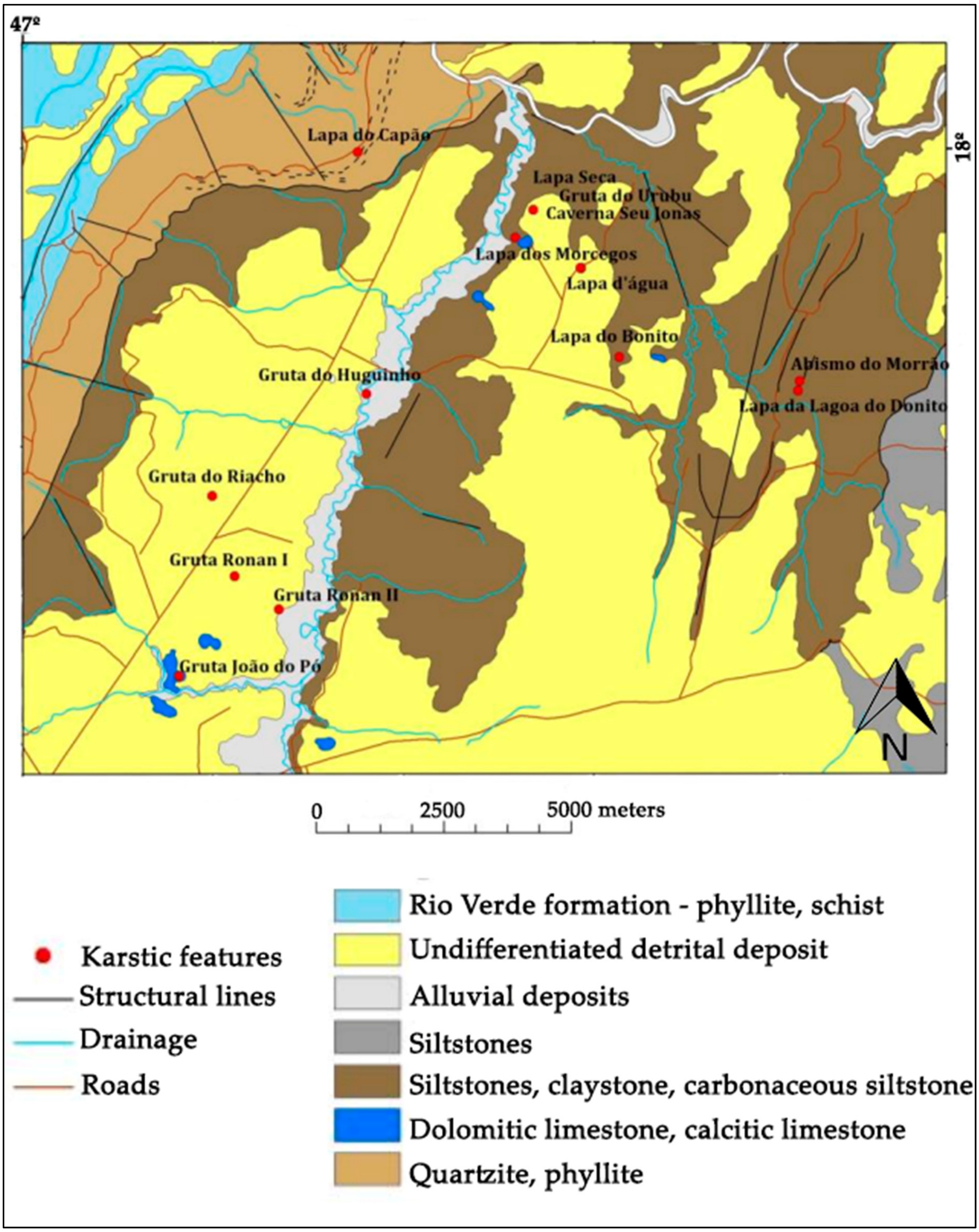


Figure 5. Geological and hydrological map of the Coromandel region in the Minas Gerais State (modified from [55]).

Coromandel has an approximate area of 3313 square kilometers and an estimated population of 28,398 inhabitants. In 1997, the municipality was certified by the Brazilian Institute of Tourism (EMBRATUR) due to its ecotourism potential and included in the tourist route of the Triângulo Mineiro region [54].

Meanwhile, according to the Brazilian Institute of Geography and Statistics (IBGE), Vazante has an approximate area of 1913 square kilometers and an estimated population of

20,506 inhabitants. The municipality is known for its various different-sized underground chambers, where cultural and religious festivities are held.

3.4. Quadrilátero Ferrífero Geopark Project (QF)

The Quadrilátero Ferrífero (or the Iron Quadrangle), is a ferruginous geosystem in the central-southeastern part of the Minas Gerais state with approximately 7000 square kilometers, composed of tonalitic-granitic gneisses of Archean age (Figure 6) [56,57]. The area has fundamental importance for the state's economic development, and it is composed of the following municipalities: Alvinópolis, Barão de Cocais, Belo Horizonte, Belo Vale, Bom Jesus do Amparo, Brumadinho, Caeté, Catas Altas, Congonhas, Conselheiro Lafaiete, Ibirité, Itabirito, Jeceaba, Mariana, Mário Campos, Moeda, Nova Lima, Ouro Branco, Ouro Preto, and Raposos.

Recently, the area was one of the four Brazilian sites included in the The First 100 Geoheritage Sites by the International Commission on Geoheritage (IUGS) as one of the most important records of the Paleoproterozoic banded iron formation on earth [58]. The capstone deposits (in Portuguese "cangas") are formations that originated due to the concentration of ferruginous compounds welding different materials because of the intense action of climatic factors on the geological material [56,57]. The region has been a landmark for European and African populations in the region since the 17th century. These deposits have been the subject of geochemical and tectonic investigations and studies on the genesis of duricrusts and related cave formations [57–59].

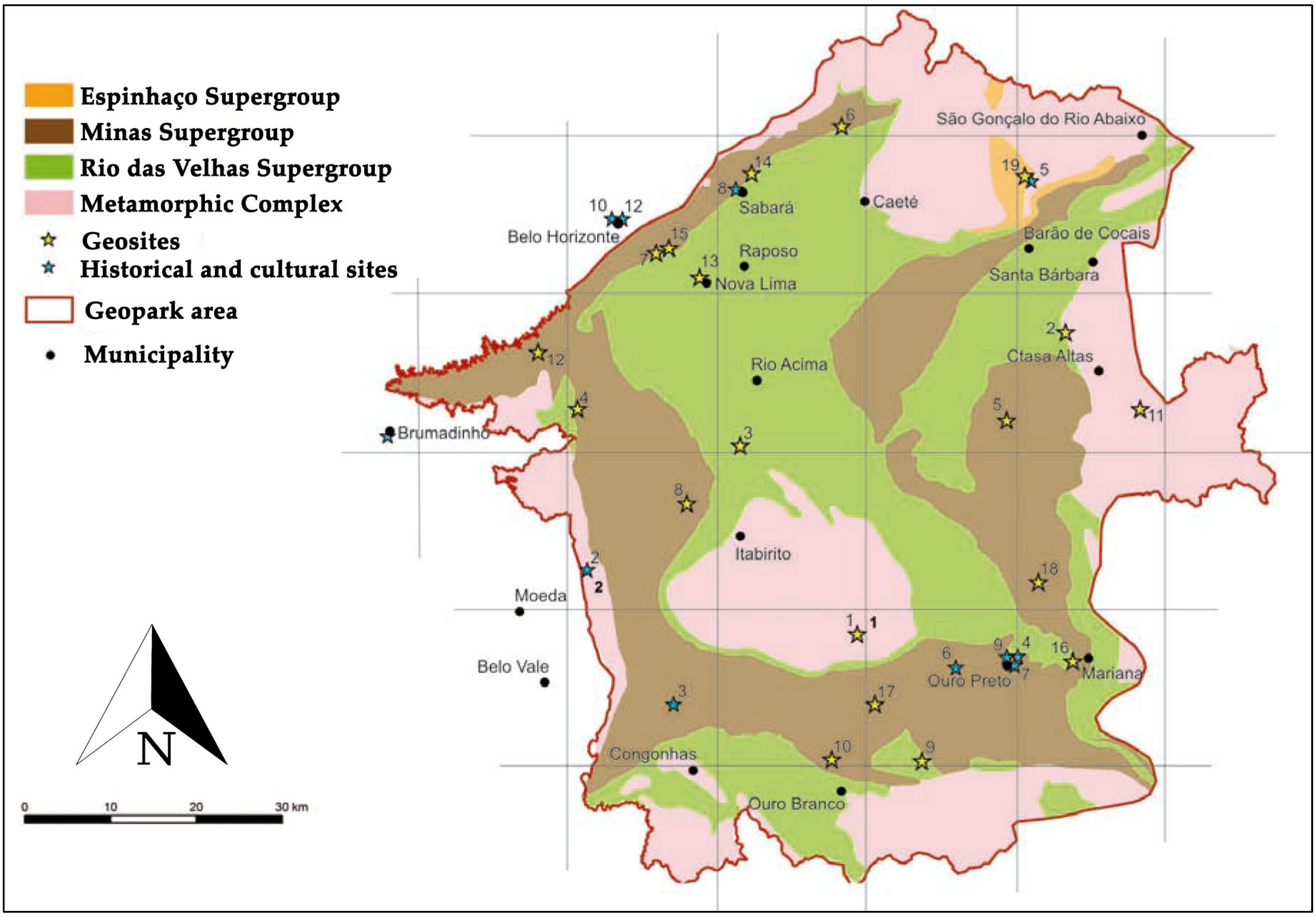


Figure 6. Geological map of the Quadrilátero Ferrífero Geopark project area (modified from [56,57,59]).

Well known for its mineral richness, as well as gold and ore deposits that historically led to the creation and development of several important mining towns and roads, such as the Rota do Ouro (Gold Route), Ouro Preto, and Mariana [55,56], the Gold Route is full of trails, waterfalls, valleys, caves, and historic buildings that range from mansions to churches built during the Brazilian Gold Cycle (18th century) [59]. The municipalities in the area are all connected by the Estrada Real (Royal Road), whose more than 1600 km in length make it the largest tourist route in Brazil passing through three states: Minas Gerais, Rio de Janeiro, and São Paulo.

The region has the highest urban concentration in the state, and the intense exploitation of these resources by the industrial sector without proper environmental monitoring has triggered a series of impacts [56]. In addition to the large iron and gold mines, the region also has several mining businesses that exploit deposits of several rocks and minerals (e.g., topaz and bauxite) [55]. Among the problems detected are groundwater and soil pollution, loss of biodiversity, improper disposal of hazardous waste, and erosion [56,59].

3.5. Morada Nova de Minas Geopark Project (MN)

The Morada Nova de Minas geopark project is located in the central region of MG, belonging to the Três Marias micro-region (Figure 7). With an area of 1735 square kilometers, the project is coordinated by Gasbras-MG, the Federal University of Minas Gerais, the Nuclear Technology Development Center, the International Institute of Ecology and Environmental Management Association of São Paulo, the Federal University of Ouro Preto, and the National University of Comahue (in Argentina) [60]. The group has been working with geopark actions in the area since 2017. It encompasses three municipalities: Morada Nova de Minas (the main center with 8910 inhabitants), Biquinhas (with 2498 inhabitants), and São Gonçalo do Abaeté (with 8459 inhabitants) [60].

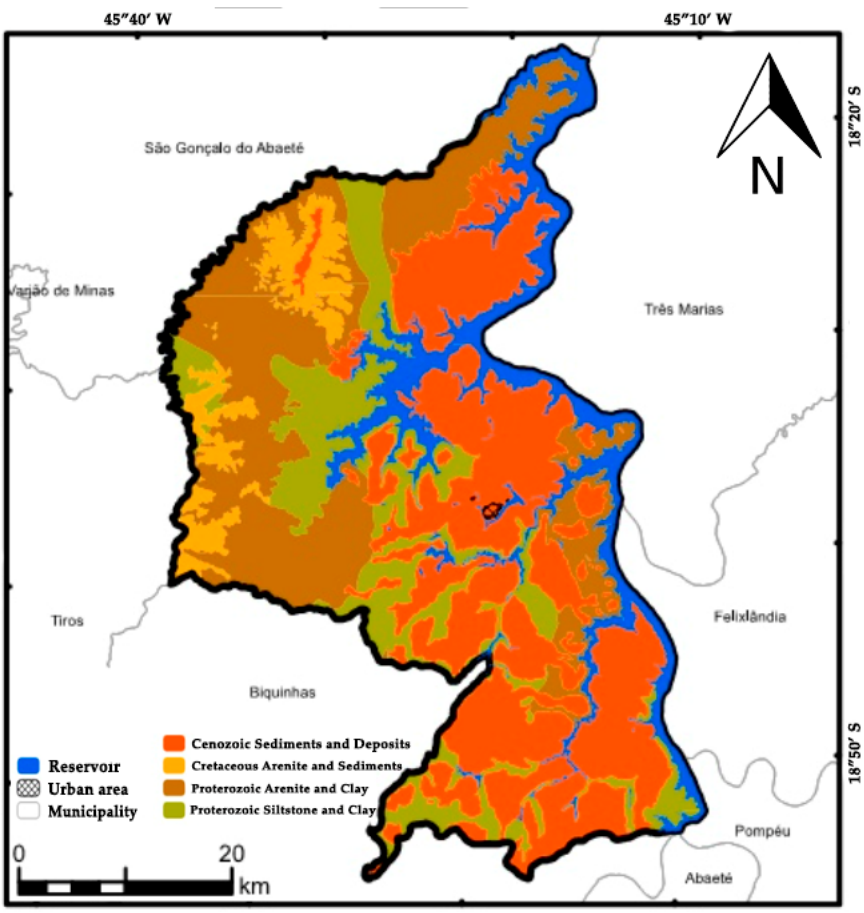


Figure 7. Geological map of Morada Nova de Minas in the Minas Gerais State (modified from [60]).

Situated in the São Francisco basin, one of the largest terrestrial sedimentary provinces in Brazil, MN holds large reserves of natural gasses deposited thousands of kilometers deep that can be commonly observed in the surrounding rural areas, where they emanate from the ground or waters and can naturally catch fire [60]. The gas in the area is a fossil fuel generated from the maturation of organic matter deposited over millions of years of geological events. In the São Francisco basin, the gas is estimated to have formed between 740 and 550 million years ago in a marine environment of sedimentation [60]. It is known as unconventional (or shale gas), as it is deposited in very deep and little porous rocks, which are difficult to access. In 2011, MG's government announced the existence of a volume between 176.6 billion and 194.6 billion cubic meters of natural gas, which would guarantee a production capacity of 25 years [60].

During the 1960s, the Três Marias hydroelectric plant was built in the region and flooded part of its land, harming the farmers and locals and consequently the economy, population growth, and natural resources [61]. At the same time, the reservoir, along with the lakes and rivers of the region, brought a new economic aspect to the area based on fish farming and touristic and cultural attractions because of its aesthetic values and hospitable people. Today, agriculture, aquaculture, livestock, and forestry are strong practices as well.

3.6. Uberaba—Terra de Gigantes Geopark Project (UB)

Situated in the same region as Coromandel and Vazante in western MG, the area of the Uberaba Terra de Gigantes (Land of Giants in English) encompasses the municipality of Uberaba and is approximately 454,051 square kilometers with 340,277 inhabitants, according to the IBGE in 2020 (Figure 8). The project is a partnership between the Uberaba City Hall, the Brazilian Association of Zebu Cattle, the Federal University of Triângulo Mineiro (UFTM), and the Brazilian Support Service to Micro and Small Companies (SEBRAE).

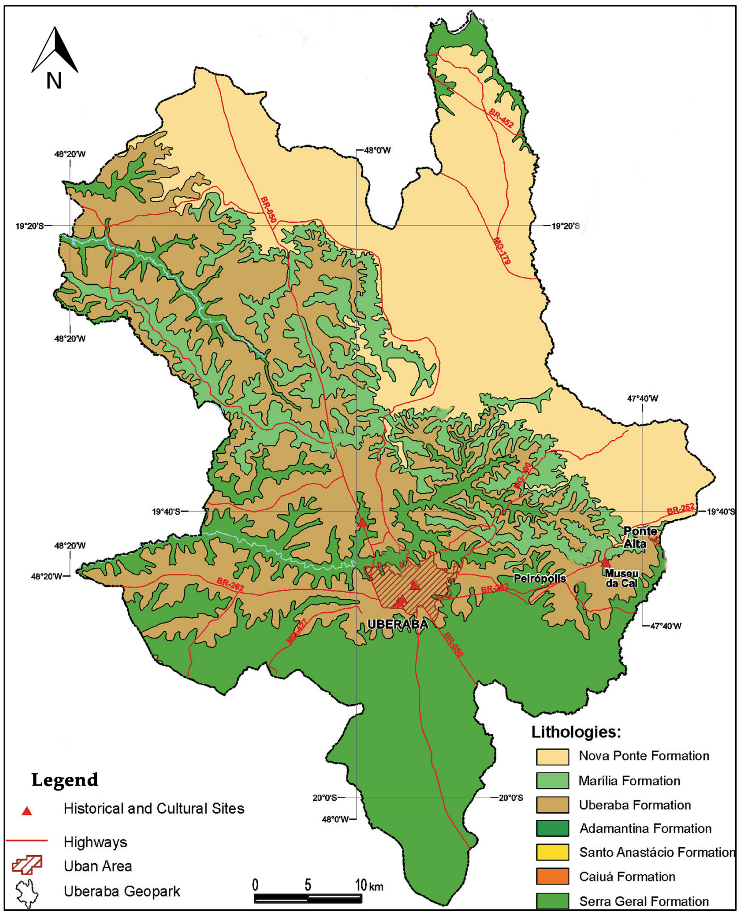


Figure 8. Geological map of the Uberaba territory (modified from [62]).

Situated in the Bauru basin, which constitutes effusive rocks with an alkaline character [63], the topography of the area is primarily smooth, composed of monotonous undulations, broad hills, dominated by watercourses with an area greater than 4 square kilometers, extensive and flat tops, slopes, and unique geological units [62,63].

In the late 19th and throughout the 20th century, the growth of many activities related to mining, agriculture, livestock, and industries, with the participation of European immigrants, made the municipality a solid and diversified industrial park and a dynamic and productive commercial center, being included in the Royal Road of the state [64]. In the 1940s, workers discovered traces of fossils, unfolding a series of intense paleontological investigations that started due to mining and industrial operations that found the first evidence. The reason is that the entire municipality comprises one of the largest and most important paleontological sites of the Brazilian continental Cretaceous—with fossil records dating from 80 to 65 million years old—and is home to the Titanosaurus (*Uberabatiban riberoi*), the largest known dinosaur in Brazil [62].

In addition to the remarkable geosites scattered throughout the city, historical, artistic, and sociocultural landmarks are also significant, such as the several paleoarts created by Rodolfo Nogueira. Moreover, the zebu cattle have important economic and cultural values to the region due to its world-famous festivals, fairs, and technological advances. Moreover, the strength and significance of the municipality's religious values are mostly based on the philanthropist and spiritist Chico Xavier, known as the greatest spiritist leader in Brazil's history, attracting approximately 250 thousand visitors throughout the year [62,64].

4. Results and Discussion

4.1. Geopark and GEOfood Implementation and Management Analysis

Some of the cases included in this work have areas or are already under the SNUC as protected areas, for example, CA, QF, and MN, which have different areas designated as conservation units (i.e., national and state parks). It is important to highlight that being included under the SNUC is not mandatory for the implementation of geopark areas, but it can help in determining a well-defined territorial extent and designing an action plan for conservation and management for UGGp application since most of the SNUC areas have defined a management plan, some infrastructure, and necessary equipment [65]. Nonetheless, UNESCO requires that the overlap of different protected areas must be clearly justified, showing evidence of increased values. Integrated management based on different heritage efforts can be successful global conservation instruments, provided that there are human and financial resources to sustain the actions and strategies over time and that they are supported by public policies [65–67].

Moreover, local communities are an essential component of a geopark. Their support and involvement are mandatory for the implementation and development of the geopark initiative. The geopark projects or suggestions discussed here can only move forward with their actions along with their respective communities' participation. Giving locals the responsibility of applicants and managers is a fundamental cooperation instrument for the development of actions at the local level, promoting the exchange of information, additional partnerships, voluntary rules, and experiences that contribute to building capacities related to sustainable planning and the strengthening of decision-making approaches [68–70]. All three recognized Brazilian UGGps have created their own respective multimunicipality consortiums/associations, established through partnerships and cooperation between different bodies, entities, and communities (each project in MG is discussed in detail in the subsections below), with the aim of sharing knowledge, ideas, and practices to reach the full potential of geopark actions as well as the development of local communities.

Finally, most of the mining landscapes in this study are in rural areas, presenting several new possibilities for linking mining and rural development, whether economic, social, or environmental. Assessing the values related to the mining landscape for communities can provide essential information to raise awareness of the importance of geoheritage and the management of these areas, particularly if the area in question presents some essential value for the communities [30,31]. Despite the reluctance of companies in Brazil to recognize geopark-related initiatives as a strategic ally to demonstrate the importance and necessity of mining activities for rural communities, the idea is not new; successful examples can be drawn from globally recognized geoparks in both Europe and Asia, bringing benefits to all sectors involved and, especially, future generations [71–73]. Additionally, once an UGGp and GEOfood, enterprises and producers inserted in the territories can make use of them as a "status", creating new frontiers for marketing and promotional tools. Branding is an essential component of the implementation stage; it represents the image of the program, how the public recognizes and identifies themselves as actors, and the actions related to geoparks. For locals and tourists, the strength of a brand can further assist in attracting new visitors, engaging emotions, evoking personal beliefs, and prompting ecological and geological friendly stewardship when the brand's core values are appropriately expressed [22,74].

4.1.1. Quadrilátero Ferrífero

From the analyzed cases (Table 2), the project QF is the biggest one, comprising a bold number of 28 municipalities. The project started in 2011 with the partnership of the Public Consortium for the Development of Alto Paraopeba (CODAP), and it was expanded in 2014 with the Strategic Economic Development Council (CEDECAP) and the Quadrilátero Institute, originating an effective cooperation network supporting and promoting programmatic, organizational, and statutory conditions related to sustainable practices. Since January 2018, the project is also a member of the Sustainable Development Solutions Network (SDSN) enhancing actions and partnerships with UNO towards Agenda 2030 and the Sala Verde from the Brazilian Ministry of Environment, encouraging educational spaces to act as training and environmental information centers.

Table 2. Status of the selected case studies regarding their administrative actions.

Name	Type	GEOfood IGCP	Number of Municipalities	Association	Websiate	Logo
Canastra	Project	Included	9	N/A	N/A	N/A
Quadrilátero Ferrífero	Project	Not included	26	Yes	https://www.geoparkquadrilatero.org (accessed on 1 October 2022)	Yes
Morada Nova de Minas	Project	Not included	3	N/A	https://www.geoparque.gasbrasmg.com.br (accessed on 1 October 2022)	Yes
Uberaba Terra de Gigantes	Project	Not included	1	N/A	N/A	Yes
Coromandel-Vazante	N/A	Not included	2	N/A	N/A	N/A
Arcos-Pains	N/A	Not included	5	N/A	N/A	N/A

The project has an official logo, and they supplemented their actions by creating a dossier to officially become an aspiring UGGp in 2011, but it was not completely successful [75,76]. During one of our interviews, the managers explained that during the initial phase, some mining companies inserted in the territory presented resistance against the geopark idea. However, the initiative is positive about integrating them again due to the fact that a lot has changed since the start of the project in the last decade, meaning that new national mining policies and political scenarios require new and urgent actions/demands from the sector. The project is starting a new phase in 2023, focusing on rescuing processes left behind and investing in new approaches such as delimiting a new area of influence for the geopark, highlighting the necessity of involving locals (communities and the private sector), investing in short- to long-term social, educational and geoconservation actions enabling greater management viability, and better preparation/integration in order for all of them combined to make profits from the socioeconomic benefits based on this big project. The managers stated that the new phase, along with the upcoming new federal government, shows a possible path and solution for the problems found in an extremely large geopark area.

Its official website is the most complete one, with plenty of information regarding the project, their activities, partnerships, official logo (Figure 9), and their last UNESCO dossier submitted; however, its last update is from early 2022. Websites and social media are considered highly effective educational tools, used worldwide (i.e., rural and urban areas) for indoor and outdoor activities, and the case of geoeducation is no different [77,78].

Figure 9. Official logos of the projects in the state of Minas Gerais. It is possible to find in each logo unique characteristics representative of its geoparks, such as: flowers (*Actinocephalus polyanthus)* and the iron banded formation from Quadrilátero Ferrífero; different species from freshwater to land ecosystems (i.e., *Oreochromis* sp. and *Ara ararauna*) from Morada Nova de Minas; fossils, cattle, and Chico Xavier from Uberaba—Terra de Gigantes.

Moreover, the IGCP 726 is in contact with them for a possible future addition to the list of members by implementing GEOfood's initiatives in the region. One major strategy is the involvement of the famous craftsmen and enterprises working with ornamental stones. The aesthetic values associated with the stones are present in many aspects of the Quadrilátero Ferrífero, such as churches, museums, mansions, souvenirs, and heritage sites [79]. They can be used in different UGGp and heritage initiatives, such as the experiences shared by Sesia Val Grande UGGp with heritage stones [80,81]. Furthermore, the addition of the area to the First 100 IUGS Geoheritage Sites, combined with the already famous trails and routes established, could be promoted through GEOfood Food Trails, boosting interest in the geological peculiarity of the area, and attracting thousands of tourists. Several GEOfood partners (e.g., Burren and Cliffs of Moher UGGp; Cliffs of Fundy UGGp) have established food trail networks crossing their territories, connecting geotourism, local enterprises, and outdoor activities [82,83].

4.1.2. Canastra

The project was recently introduced to UNESCO (in 2020) at the "1st International Digital Course on UGGp: territories of resilience", and it is in the process of creating its dossier for submission, along with an official website and logo.

Beyond the six main municipalities that are part of the CA region and have some level of consortium created—meaning that they have included multimunicipality management and actions with more diplomatic settings based on previous agreements of the Serra da Canastra National Park—the new project also has a strong motivation for the inclusion of the municipalities part of the Canastra *terroir*, as they present the same characteristics as the others included and new geosites that are being assessed by local institutions. The mountainous region is well known worldwide for its *terroir*, in which climate, native pastures, and the artisanal process confer unique characteristics to the locals' products, which are derived from traditional agriculture and livestock activities [84,85]. The *terroir* encompasses the municipalities of Bambuí, Medeiros, Piumhi, and Tapiraí, as well as totaling 10 municipalities and requiring new forms of association.

Furthermore, future GEOfood initiatives mainly revolve around livestock and dairy products, especially in the *Canastra* cheese, with the partnership of the Association of Canastra Cheese Producers (APROCAN). The association created its own label to recognize, certify, and control the cheese origin. Meanwhile, the product is safeguarded as a Brazilian intangible cultural heritage under the National Historical and Artistic Heritage Institute (IPHAN) [84]. It is important to highlight that even if a product is already part of a label or protected by public policies, it can also be included as GEOfood if it is in accordance with the criteria and the values expressed in the brand's manifesto. In addition, many other foods and general products made in the region through artisanal processes and traditional communities (e.g., *cachaça*, *dulce de leche*, tapioca flour, and jam) can be included as GEOfood as well since the raw materials are derived from the geopark area. French and Portuguese UGGps have developed successful examples with similar products [86,87]. By now, it is the only project in MG that is a member of the IGCP 726 project, developing actions towards awareness, networking, assessments, and strategies for GEOfood development in partnership with the Federal Institute of Minas Gerais—Campus Bambuí.

4.1.3. Uberaba—Terra de Gigantes

In regard to the project UB, since it is composed of one municipality only, the responsibility falls under the City Hall administration and the institutions listed in the description of the site, based on an institutional nonprofit association model. Currently, it is the most advanced geopark project in the state in terms of implementation. They have a strong presence on social media (i.e., Instagram and Facebook) and plenty of information spread across different tourist and media sites in Uberaba. According to the managers, the official website should be out in the upcoming weeks, and the application and letter of intention were submitted to the Brazilian Ministry of External Affairs in November 2022 [88], which has the responsibility to handle them for the UNESCO committee to become an aspiring geopark. The results should be out by 2023.

The focus of the activities is surrounding the creation of local policies to protect geoheritage and strengthen geoconservation. The municipality is carrying out paleontological mapping to identify areas where it is easier to find fossils. In this way, future enterprises will know where to develop their initiatives without compromising geoheritage elements. Furthermore, there is a deployed quarry (a geosite open to visitors) and an active quarry located in the geopark territory that is not open to visitors now, although the geopark administration is working to open it soon.

In terms of geoproducts, the project has been investing in a vast catalog, including several actions focused on local symbols (i.e., dinosaurs, fossils, Chico Xavier, zebu cattle), as well as crafts made with sustainable materials. More than 1000 different items are included, mainly Christmas items but also crochet items, accessories, biscuits, MDF crafts, wooden and rock art, cloth dolls, rugs, etc. They are curated by the administration and sold in different stores under the geopark label across the area. In addition, the GEOfood network is in contact with them about a possible future addition to the list of members as well. One big strategy for GEOfood in the location is that the geopark's symbols (i.e., paleontological and spiritual values) can be used as authentic and unique ways to explore storytelling and intangible heritage, supporting local communities' engagement in the valorization of traditions and commitment to sustainable development.

4.1.4. Morada Nova de Minas

According to the managers, the project was developed as a compensatory measure for the company Gasbras-MG, which intends to make use of the natural gas present in the region. Many of the elements required for an aspiring geopark application were suggested and initially developed in the dossier; however, it needs to focus on regional and local development, involving education, heritage conservation, improvements in the tourism sector, and initiatives that encourage community empowerment and local government actions. Despite the good development in terms of partners and surveys, no association was created between the municipalities involved. Knowing that hydroelectric activity and the future installation of a natural gas industry can cause impacts of various types, the Gasbras-MG project can be one of the most interesting geological features supporting this UGGp project. Beyond their commitment to protect the region from the negative effects of gas extraction, their processes can be the basis for some of the geotourism resources and economic activities that can be major components when integrated into the project. Projects in Europe and Africa are making use of gas, reservoirs, and hydroelectric power to support their implementation and activities [89–91].

From a GEOfood perspective, sugarcane and fish production should be considered the main assets. The region is known for being an important pole in the Brazilian fish market, and the geopark is expected to partner with COOPEIXE (a local fishers association) to strengthen initiatives related to public policies licensing their processes. Many local producers are unaware of their cost structure and how to become more efficient. In addition, there is a shortage of adequate labor, inputs and technologies are expensive, and there are no credit lines available for aquaculture farmers [60]. As part of the GEOfood network, the area could rely on their knowledge sharing for the promotion and structure of capacity building and the logistical chain, based on local markets, profitability, and sustainable practices. As a result, under the brand label, their products could become even stronger and more competitive in the market, and they could even ignite or support discussions on public policies for fishers. Increasing the fish productivity can contribute to value-derived products as well (e.g, meat processing and the reuse of tilapia skin in the textile and medicinal markets), and some examples can be drawn from different enterprises in UGGps such as the ones in Magma, Qeshm Island, and Burren and Cliffs of Moher [92,93]. Nevertheless, GEOfood is currently in contact with managers, trying to establish partnerships.

4.1.5. Arcos-Pains and Coromandel-Vazante

Despite having several national and international studies in different areas such as geodiversity, geology, geoheritage, and geoconservation, administrators in both AP and CV have not yet proven any interest in geopark development. However, Oliveira [94] comprehensively conceptualizes the geomorphological heritage potential of the two municipalities involved in the CV region, while Timo [95,96] does the same for AP. Based on their reports and our analysis, we proposed, in Section 3, viable municipalities that could be included in case of association. Currently, the knowledge and actions taking place in those regions can tremendously benefit from UGGp, as studies have shown in similar areas [43,97]. If combined with prominent help from the local administration, the private sector, or institutions—including support from renowned research centers (but not limited to); for CV: Federal University of Uberlândia—UFU and Federal University of Minas Gerais—UFMG; for AP: Federal Institute of Minas Gerais—Arcos, Bambuí and Formiga—can foster geoparks' initiatives and strengthen the existing system of self-regulatory instruments for geoconservation in the region.

The presence of many mining operations in the AP region and the Mining Association of Pains-Arcos (AMPAR) can be seen as important assets if well explored. Together, they can promote pioneering joint actions for the mining workers and companies, as well as seek support from local and state governments and other segments of organized civil society for regional development based on geopark strategies, respecting the environment/mineral resources, and advocating for social justice and sustainability.

Surely researchers and other big players we have discussed can ignite conversations and propose options, but locals and stakeholders should always participate as well.

The need for information/clarity about geodiversity values and the public entities and mechanisms involved, along with low heritage education, can present obstacles for the communities' members of the projects analyzed. In this case, policies, investment, and motivation for geopark implementations are low, and the same is true for budgets/funds and activities. Understanding and elevating the UGGp and GEOfood concept, keeping in mind the balance between protected areas-land-use, is a big step for sustainable development in MG, primarily including different sectors such as private and public.

4.2. Geosites and Geoheritage Aspects

All geosites were analyzed and classified according to the aforementioned criteria (Section 2). Among the contrasted data (Table 3), the UB stands out, with 12 of its geosites present in the national registry. In our interviews, one of the managers mentioned the intensive work of the prominent scientist Luiz Carlos Borges Ribeiro in assessing and maintaining the local sites over the last few years. In addition, QF has six of its geosites present in the national registry and four in analysis, followed by CA with four present and one in analysis (geosite examples can be found in Figures 10–14). Despite having some good initiatives being led by a few institutions and state agencies, such as geosites assessed in previous works, monitoring and practicing geoconservation, AP, CV, and MN did not have any geosites included in the national registry of GEOSSIT. This is probably due to the following factors: lack of knowledge about the national platform, the UGGp label and GEOfood brand, human resources, or special funds. Mostly, they are focused on measures to address major issues, such as irregular activities in the extraction and processing of minerals, environmental crimes, and vandalism in geosites. Successful geoconservation efforts require access to funds, manpower, capacitated personnel, monitoring, assessments, partnerships, and interdisciplinary approaches [98]. Additionally, investments in public educational policies strengthen the teaching of geosciences from elementary school to higher education, encourage environmental education practices, while fostering the training of stakeholders and guides, the creation of protected areas, and promote appreciation of geotourism [99].

One incoherence found in the analysis was that multiple geosites were included in the platform as only one, which can be explained by bundle characteristics in certain geosites (e.g., geographically adjacent geosites can collectively tell a story) or by different people adding information on the online platform [100]. Moreover, it is also important to state that some regions (i.e, QF) had geosites included in the platform that were not in their official reports. For QF, some studies include inventories of 55 sites of natural and cultural interest, representative of the geological and mining history in that territory, even though they did not make it to the final dossier.

Furthermore, the karst geosystems home of the geosites in AP and CV present outstanding examples with caves and grottos, with several archaeological and historical records and sites representing the long history of mining and quarrying in the region. Those features have been used in different UGGps with significant results for geopark-based geotourism, where visitors can discover and learn about the mining grounds and their activities, geological heritage, historical landscape aspects, and the identity of the area [101,102]. For MN, beyond the analyzed geosites, the presence of natural gasses can present new opportunities for geosite development [103].

In general, sites must increase their staff in the field to be able to cover the whole area for their monitoring activities. Beyond that, the staff must be properly trained to be able to conduct evaluations of different resources and even economic activities. In addition, as there are regions where there is a high concentration of attractions and geological diversity, access to geotourism activities should not be allowed only to contemplate different aspects of geomorphology but should favor and promote the awareness and importance of the local resources. The existence of guides, panels, educational programs, and preventive activities can arouse interest by emphasizing the sustainability and legality of the use of resources related to mineral production due to the maximized demand for the high productive potential of the municipalities.

Table 3. Geosites and their respective interests in each site. Interest abbreviations: aesthetic (AE), educational (ED), scientific (SC), economic (EC), cultural (CL), touristic (TO), religious (RE), and historical (HI).

Name	Geosites	Interest	GEOSSIT Status
Arcos-Pains	1. Loca da Mureta 2. Zezinho Beraldo Grotto 3. Monkfish Sink 4. Retiro Lagoon 5. Loca do Retiro 6. Cave X001 7. Casca Fina Grotto 8. Duca's Grotto 9. Dry Valley 10. Uvalas 11. Chalice 12. Nymphet Cave 13. Mastodon Grotto 14. Ice Cream Grotto 15. João Lemos Grotto 16. Mandembo Grotto 17. Rala Coco Grotto 18. Zé da Fazenda Grotto 19. Uncle Rafa's Grotto 20. Low Ceiling Grotto (Q135) 21. Cave U274 22. Sink Cave (N064) 23. Tilted Tower 24. Paranoá Grotto 25. Martins' Lagoon 26. Cazanga Grotto 27. Posse Grande Outcrops 28. Asparagus Grotto 29. Indigenous Hut II 30. Little church hut 31. Stone Bridge Grotto 32. San Francisco River Canyon 33. Sanctuary Grotto 34. Brega Grotto 35. Eyeglasses Grotto	1. AE, ED 2. AE, TO 3. AE, SC, ED 4. AE, TO 5. SC, ED, AE 6. AE, SC, ED, TO 7. AE, SC, ED, TO 8. SC, ED, RE 9. SC, ED 10. AE, ED 11. SC, ED, TO 12. SC, ED, AE, TO 13. SC, ED, HI 14. SC, ED, AE, TO 15. AE, ED 16. AE, SC, ED 17. AE, SC, ED 18. AE, SC, ED, TO 19. AE, SC, ED, TO 20. SC, ED 21. SC, ED 22. AE, SC, ED, TO 23. AE, TO 24. SC, AE, ED, TO 25. SC, ED, TO, RE, CL 26. SC, ED, RE, CL, TO 27. AE, SC, CL, ED, TO 28. AE, SC, ED 29. AE 30. AE, CL 31. AE, SC, ED, TO 32. AE, SC, ED, TO 33. SC, ED, TO 34. SC, ED, TO 35. AE, SC, ED	N/A
Canastra	1. Casca d'Anta waterfall (lower part) 2. Casca d'Anta waterfall (upper part) 3. Chinela waterfall 4. Recanto da Canastra waterfall 5. Stone Stockyard 6. Station for local products 7. Canastra cheese farm 8. Levadas in old farm 9. Chapadão da Canastra observatory	1. SC, AE, ED, HI 2. SC, AE, ED, HI 3. SC, CL, TO 4. SC, CL, TO 5. SC, ED, HI, CL 6. TO, CL 7. TO, CL 8. SC, ED, CL 9. SC, AE, ED, HI	1. Consisted 2. Consisted 3. N/A 4. N/A 5. N/A 6. N/A 7. N/A 8. N/A 9. Consisted

Table 3. *Cont.*

Name	Geosites	Interest	GEOSSIT Status
	10. San Francisco River historical site	10. SC, ED, HI, CL	10. Consisted
	11. Pato-Mergulhão observatory	11. SC, TO	11. N/A
	12. Chapadão da Canastra observatory 1 (or Diamante)	12. SC, ED, HI	12. N/A
	13. Chapadão da Canastra observatory 2 (or Diamante)	13. SC, ED, HI	13. N/A
	14. Mirante para a Cachoeira Casca d'Anta	14. SC, AE, ED, HI	15. N/A
	15. Chapadão da Canastra observatory 3	15. SC, ED, HI	16. N/A
	16. Chapadão da Canastra observatory 4 (São José do Barreiro disctrict)	16. SC, ED, HI	17. N/A
	17. Cachoeira Casca d'Anta sightsee	17. SC, ED, AE, HI	18. In analysis
	18. Casca d'Anta hike trail	18. SC, ED, AE, TO	
Coromandel-Vazante	1. Lapa Velha grotto 2. Lapa Nova grotto 3. Lapa Deuza grotto 4. Gameleira cave 5. Lapa Nova grotto 2 6. Backpack abyss 7. Cave of Guardian Severino 8. Deputy's grotto 9. Barreiro waterfall 10. Andorinha waterfall 11. Mascate waterfall 12. Green well 13. CPA rapids 14. Bride's veil waterfall	1. TO, CL, RE 2. SC, CL 3. SC 4. SC 5. SC 6. SC 7. SC 8. SC 9. SC 10. SC, AE 11. SC, AE 12. SC, AE, TO 13. SC, AE, TO 14. SC, AE	N/A
Morada Nova de Minas	1. Black stone 2. Lower Indaiá exudation 3. Cisalhamento do Traçadal zone 4. Lapa ribeirão do inferno 5. Mato seco archaeological site 6. Black Stone waterfall 7. Seco Waterfall 8. Lake Três Marias 9. Pontal do Guarda Beach 10. Nossa Senhora de Loreto Church 11. Saint Joseph Chapel 12. Artisan House and Museum 13. Manuelzão Museum	1. SC 2. SC 3. SC 4. SC 5. SC, ED, HI 6. SC, AE 7. SC, AE 8. SC, ED, AE, TO 9. AE, TO 10. CL, RE, HI, TO 11. CL, RE, HI, TO 12. CL, HI, TO 13. SC, CL, HI, TO	N/A
Quadrilátero Ferrífero	1. Campo waterfall (Bação Complex Gneiss)	1. SC, ED	1. N/A
	2. Metavolcanics from rio das velhas and bicame de pedra supergroups (high catas)	2. SC, ED	2. N/A
	3. Metarenites from Serra do Andaime	3. SC, ED	3. N/A

Table 3. *Cont.*

Name	Geosites	Interest	GEOSSIT Status
	4. Quartzite and basal conglomerate of the coin formation	4. SC, ED, AE, CL, TO	4. Consisted
	5. Serra do Caraça and Caraça Sanctuary (high catas)	5. SC, ED, AE, CL, TO, HI, RE	5. Consisted
	6. Itabiritos from Serra da Piedade	6. SC, ED, AE, CL, TO, HI, RE	6. In analysis
	7. Serra do Curral	7. SC, ED, AE, CL, TO, HI	7. Consisted
	8. Itabira Peak	8. SC, EC, ED, AE, CL, TO, RE	8. In analysis
	9. Itacolomi Peak	9. SC, ED, AE, CL, RE, HI, TO	9. Consisted
	10. Serra de Ouro Branco	10. SC, ED, AE, CL, HI, TO	10. N/A
	11. Fonseca	11. SC	11. Consisted
	12. Serra do Rola Moça	12. SC, ED, AE, CL, HI, TO	12. In analysis
	13. Morro Velho Mine	13. SC, ED, AE, CL, HI, TO	13. N/A
	14. Córrego do Meio Mine	14. SC, ED, AE, CL, HI, TO	14. N/A
	15. Águas Claras Mine	15. SC, ED	15. N/A
	16. Vila da Passagem	16. SC, ED, TO, HI	16. In analysis
	17. Capão do Lana	17. SC, TO, HI	17. N/A
	18. Nossa Senhora da Lapa Grotto	18. CL, HI, RE, TO	18. N/A
	19. Serra das Cambotas	19. SC, TO, AE, HI, ED	19. N/A
	20. Mangabeiras Park	20. SC, ED, AE, CL, HI, TO	20. N/A
	21. Ruins of the Clandestine Gold Foundry House (Coin)	21.HI, ED, CL	21. Consisted
	22. Patriotic Factory	22. HI, SC, ED	22. N/A
	23. Morro da Queimada	23. HI, SC, TO	23. N/A
	24. Pedra Pintada archaeological site	24. SC, CL, HI	24. N/A
	25. Tripuí ecological station	25. SC, AE, CL, HI	25. Consisted
	26. Museum and School of Science and Technique of Minas/UFOP	26. HI, SC, ED, CL, TO, EC	26. N/A
	27. Gold Museum	27. HI, SC, ED, CL, TO, EC	27. N/A
	28. House of Tales	28. HI, SC, ED, CL, TO, EC	28. N/A
	29. Mines and Metal Museum	29. HI, SC, ED, CL, TO, EC	29. N/A
	30. Inhotim Museum	30. HI, SC, ED, CL, TO, EC.	30. N/A
	31. CRPG Geological Heritage Reference Center—MHNJB/UFMG	31. HI, SC, ED, CL, TO, EC	31. N/A
Uberaba Terra de Gigantes	1. Caieira	1. SC, ED, TO,	1. In analysis
	2. Galga Mountains	2. SC, ED, CL, TO,	2. In analysis
	3. Saint Rita	3. SC, ED, TO	3. In analysis
	4. High Bridge Quarry	4. SC, ED	4. Consisted
	5. Triangle Quarry and Partezan	5. SC, ED	5. In analysis
	6. Mangabeira	6. SC, ED, TO	6. In analysis
	7. High Bridge Waterfall	7. ED, TO	7. Consisted
	8. Smoke Waterfall and Canyon	8. AE, ED, TO	8. Consisted
	9. Rio Claro Bridge Waterfall and Rapids	9. ED, TO	9. Consisted
	10. Pontilhão Waterfall	10. AE, ED, TO	10. Consisted
	11. Clemente Waterfall	11. AE, ED, TO	11. Consisted
	12. Blue Waterfall	12. AE, ED,	12. In analysis
	13. Córrego das Lajes Section	13. ED, TO	13. Consisted
	14. Univerdecidade	14. SC, ED, TO	14. Consisted

Table 3. *Cont.*

Name	Geosites	Interest	GEOSSIT Status
	15. Enchanted Valley 16. Eldorado Waterfall 17. Café Park Waterfall 18. Bela Vista Viewpoint 19. Galga Mountains Viewpoint 20. Agronelli Farm 21. Lapa do Giovane 22. Quartéis Waterfall 23. Boscobel Farm Paleoflood 24. Marzola Waterfall 25. Emendado Waters 26. Vereda do Córrego Emendado 27. Source of the Uberaba River 28. Caieira do Meio 29. Caieira do Barreiro 30. Church of Saint Domingue 31. Peirópolis	15. AE, ED, TO 16. AE, ED, TO 17. ED, TO 18. AE, ED, TO 19. AE, ED, TO 20. AE, ED, TO, HI, CL 21. ED, TO 22. AE, ED, TO 23. ED, TO 24. AE, ED, TO 25. ED, TO 26. ED, TO 27. ED, TO 28. ED, TO 29. ED 30. ED, TO, HI, CL, RE 31. SC, ED, TO	15. In analysis 16. In analysis 17. In analysis 18. In analysis 19. Consisted 20. Consisted 21. In analysis 22. In analysis 23. In analysis 24. In analysis 25. Consisted 26. Consisted 27. In analysis 28. In analysis 29. In analysis 30. In analysis 31. In analysis

(**a**) (**b**)

Figure 10. Geosites located in Uberaba: (**a**) Dinosaur's Museum and (**b**) Saint Rita (Source: UFTM/Uberaba City Hall).

However, for the establishment of a UGGp, additional actions are necessary, as only the presence of important geological sites is not enough. Regarding geotourism, many of the municipalities have remarkable attractions, infrastructure (e.g., hotels, restaurants, etc.), and tourist demand (whether during local festivals or randomly). Nevertheless, adequate planning is also needed if recreational and educational activities want to be developed in a sustainable way and become viable both for those who make use of them and for the ones that manage them [104]. According to the different managers contacted, there are some further actions that are being developed to subsidize the consolidation of geotourism in the areas: interpretive signalization and panels, developing of a geotourism plan and map, assessment of geosites, training, more effective community participation, and the inclusion of geoeducational programs in local schools.

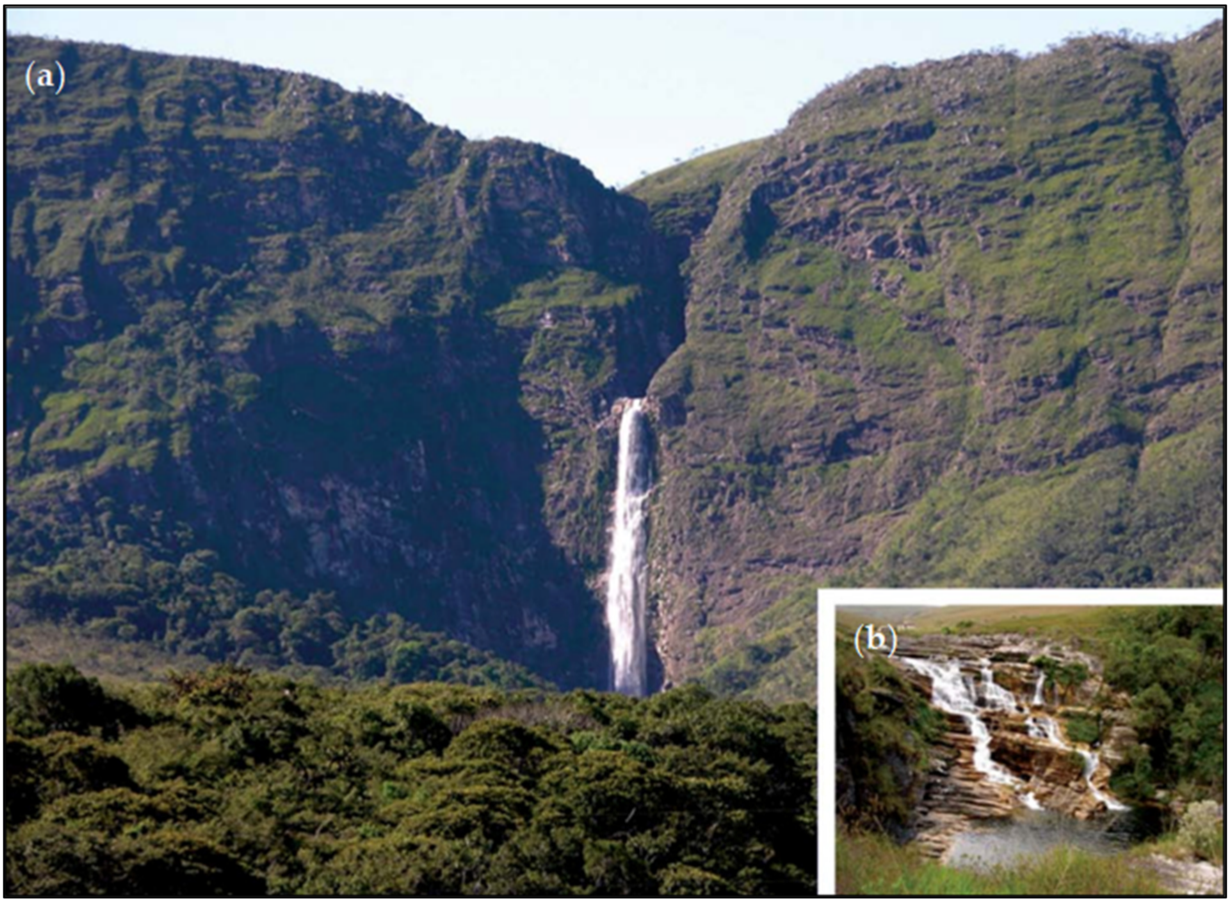
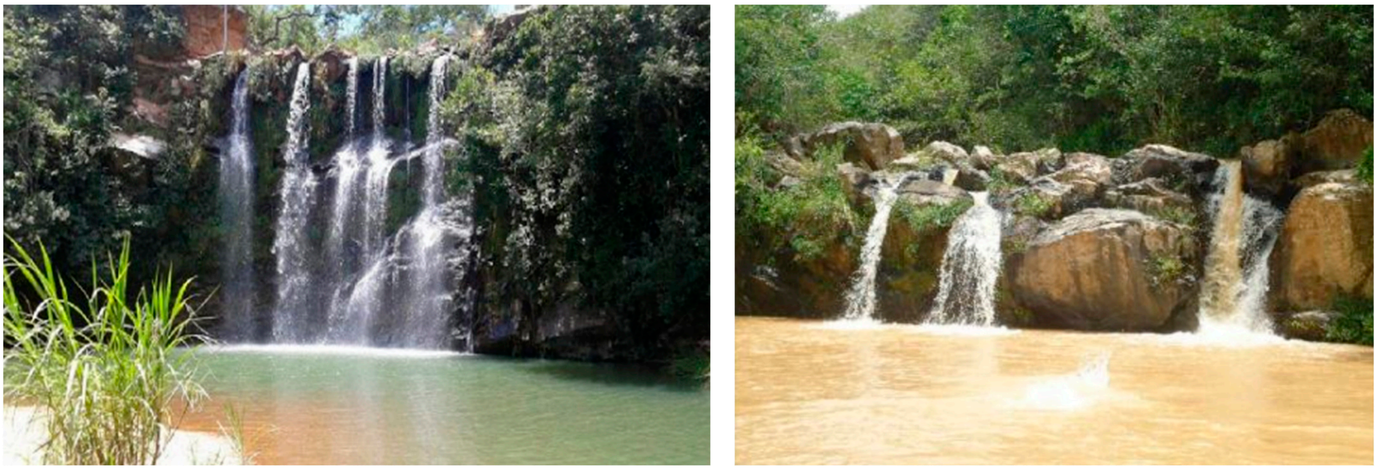


Figure 11. Geosites in the southern slope of the Canastra Range: (**a**) Casca d'Anta Waterfall (Source: A. C. Girodo) and (**b**) view of the upper part of the waterfall (Source: L. Benitez).

(**a**) (**b**)

Figure 12. Geosites from the Arcos-Pains region: (**a**) Karst Archeological Museum (Source: M. B. Timo) and (**b**) carbonate wall with its spitzkarren (Source: L. E. P. Travassos).

It is understood that the strategies promoting geoheritage are important tools for understanding and disseminating the concept of geodiversity, however, they need to be improved so that their objectives are widely achieved. It is not mandatory to protect all areas, as society needs to make use of resources for its subsistence. However, it is necessary to inventory and protect the most relevant elements. Limiting access to some geosites can also become an important strategy. For example, for geosites with an expressive amount of eccentric and fragile speleothems or species such as the ones in AP, overcrowding can damage, breaking or even trampling them. In this case, it is suggested that the visitation is carried out only by coordinated small groups.



(**a**) (**b**)

Figure 13. Geosites from the Coromandel-Vazante region: (**a**) Mascate waterfall and (**b**) Barreiro waterfall with its muddy waters after raining (Source: P. C. A. de Oliveira).

(**a**) (**b**)

Figure 14. Geosites from the Quadrilátero Ferrífero: (**a**) Piedade cave (Source: L. E. Faria) and (**b**) Itacolomi mountain peak (Source: L. G. Godoy).

5. Conclusions

Regardless of the absence of specific legislation and relatively new initiatives in geoconservation, Brazil is brilliantly tracing its way as a reference for the world of geodiversity. Considering the characterization and consolidation of UGGp and GEOfood initiatives and how they promote adaptive management, providing achievements in geoconservation and sustainable development, it is correct to affirm that the initiatives linked to the creation of geoparks in the state of Minas Gerais have shown an expressive expansion in the last decade. This fact can be understood by the number of existing publications and projects analyzed here. In this way, the initiatives discussed must be sought as a real possibility for sustainable management practices in mining landscapes and for the maintenance of these municipalities even after the end of the mining activity. In addition, the managers we contacted have shown interest in developing cooperative actions/strategies and partnerships with different projects in the state. With several state projects working together and supporting each other, that could potentially lead to the creation of a solid network of UGGps for MG.

In general, countries or regions whose economies are subordinated to mining activities face challenges imposed by market dynamics, risks and scarcity related to natural and mineral resources in the medium- to long-term (with the need to develop sustainable activities that replace the post-mining era), and greater responsibility to the environment and local communities. Minas Gerais will be no different. Ultimately, the expansion of the UGGp label and geoconservation could secure financial resources at a global and national level to carry out projects, programs, and adapt infrastructure. Thus, the catalog, assessment, and discussion in this study about the potentials of the areas indicate a path for the next actions, which include: political support and financial resources for the development and execution of an action plan/geoconservation plan and more educational actions, as well as the identification and maintenance of geosites and geoheritage. The expansion of protected areas and geoconservation initiatives, such as the ones we have shown, should be considered priorities if we want to guarantee the preservation of remarkable world resources.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/resources12020020/s1, The complete geodiversity map of the State of Minas Gerais developed by the Brazilian Geological Survey is available as supplementary material S1.

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