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Interpretation of Heritage in Mountain Areas (Leitariegos and Cueto Arbás (Asturias, Spain)) Through Experience Based on Virtual Reality

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Abstract: Virtual Reality (VR) has emerged as an effective technology for the dissemination of geographical knowledge due to its visual, interactive, and dynamic nature. This technology allows for adequate valorization of the territorial attributes of marginal mountain areas undergoing tertiarization processes, as it provides suggestive experiences of approach, discovery, and interpretation. All of this should result in the fortification of the conservation process against the expansion of new uses that impact the inherited landscape. In this work, the aim was to design a VR experience for the interpretation of mountains that can be used by public and private entities as a strategy for differentiation in the context of positioning for territorial development. The study area covers the mountain pass of Leitariegos and the Cueto Arbás massif (a mountain in the west of Asturias and León, Northwestern Spain), which make up a geographical unit with ecological, aesthetic, ethnographic, and historical importance. Using a VR tool, we sought to enhance the identification and interpretation of the keys that lead to the initiation and consolidation of the patrimonialization process, uncovering the processes and agents through their practices, the vectors around which the process pivots, and the conflicts in the competition for land use.

Keywords: patrimonialization; deagrarianization; tertiarization; Virtual Reality; Leitariegos mountain pass (NW Spain)

Academic Editors: Carmen Delgado-Viñas, María L. Gómez-Moreno and Hannes Palang

Received: 14 November 2024
Revised: 25 December 2024
Accepted: 6 January 2025
Published: 30 January 2025

Citation: Herrera, D.; Rodríguez, C.; Sevilla, J. Interpretation of Heritage in Mountain Areas (Leitariegos and Cueto Arbás (Asturias, Spain)) Through Experience Based on Virtual Reality. *Land* **2025**, *14*, 292. https://doi.org/10.3390/land14020292

1. Introduction

The idea of "heritage" has evolved during the past century and now encompasses all types of material and immaterial realities associated with collective practices. The heritage issue appears in the scientific literature and institutional language linked to concerns relating to the desire to protect, preserve, and transmit every valuable expression of memory or collective practices [1,2]. Indeed, heritage, which is socially constructed, entails feelings and values relevant to a community [3]. In this context, a new contemporary reaction of society regarding nature [4] and the dissemination of environmental awareness [5] has contributed to the evolution of this concept and, thus, given rise to a territorial and scenic dimension of heritage [6,7]. The question 'What is heritage?' also applies to territories characterized by several features (representativeness, singularity, rarity, conservation, etc.). Certain places thus gain the characteristic of heritage as a result of the recognition, study, or enjoyment of their practices by social, scientific, and institutional agents who prioritize ecological, aesthetic, pedagogic, and symbolic value, among others [8].

This type of process has been intense in mountainous areas since the late nineteenth century. The intellectual interest developed during the Enlightenment had already given

rise to a change in attitudes toward mountains [9]. Afterwards, the Romantic Movement consolidated aesthetic categories that created a new sensibility regarding nature and reinforced the evaluation of mountainous landscapes: the emotions and incentives generated by the bucolic vision of the "picturesque" or the majesty of the "sublime" had started to strengthen. Simultaneously, topographic, geologic, botanic, and ethnographic campaigns, among others, were developed, accentuating intellectual attention as well as stimulating the diffusion of hiking and sports practices at places then conceived as sources of physical and moral regeneration [10–12].

This interaction between concern and knowledge provided benefits and inspiration besides the implementation of the first official state action for natural protection at the end of the 19th century and in the early 20th century. Indeed, this consideration of heritage has been perceived as widespread since UNESCO's "World Heritage Convention" held in 1972 in Paris. All this led to the valuation of nature as being universally conceived of as outstanding based on scientific and aesthetic judgements [13,14]. In this period, partly due to its conceptualization by this international body, the use of the term "heritage" also applied to the aims of geographic science (previously, many proposals and practices totally related to heritage in character did not make use of the term itself) [15]. The existence of this process was confirmed by the incorporation of the "cultural landscape" category into the guidelines of the World Heritage Convention in 1992 [16]; this term originated from the creation of the European Landscape Convention, signed in Florence in 2000 (ratified in Spain in 2008), which conceived landscape as a component contributing to human well-being.

In attempts to continue the dissemination of heritage knowledge and reinforce its importance as a source of learning as well as a factor for development, emergent technological tools that transform the way of approaching territorial resources play a relevant role. In this regard, the development of mobile devices gave rise to benefits such as the ability to employ advanced tools with processors, displays, and sensors that transcend interpersonal communication. In the context of globalization and the increasing attention paid to innovations in information and communications technologies (ICTs), the use of such smartphones and tablets has modified our society habits [17]. These mobile devices constitute polyvalent tools that transform daily experiences when accessing information or creating and exchanging online content.

Among these newer technological advantages, the development of Virtual Reality (VR)—which allows images of a real environment to be reproduced in an interactive way through virtual elements accessed via a device—is of particular interest [18–22]. This technology, whose origin dates back half a century, has evolved thanks to a wide variety of potential apps, including those related to education, tourism, and management [23,24]. Given the importance of the sensory dimension in the interpretation and assessment of landscapes, which constitute a public good and a source of well-being improvement and learning in accordance with the European Landscape Convention, the interest in tools equipped with suggestive dynamic and interactive components that renew the way in which the notion of territory is approached is understandable with respect to raising awareness about heritage. Additionally, this territorial heritage perceived in and through landscapes constitutes a potential component of the reaffirmation of regions (social, cultural, and economic) in the context of globalization. VR apps oriented toward heritage are incredibly advantageous as they can enhance the user's experience of territorial attributes, providing them with new experiences of approaching, discovering, and interpreting [25]. They revitalize views in open or enclosed spaces by engaging the viewer in the recognition of points of interest (POIs) in an interactive and automatically guided way, as shown via the activation of tridimensional and interactive elements with types of materials and

information that do not have the same rich combination in classic. Furthermore, these apps can integrate elements that reinforce the acquisition of users via gamification or interaction in social networks [26–28].

VR apps can also be used to address some sustainable development objectives [25,29,30]. When transforming the way of approaching a destination, they help regularize access and redistribute flow [31], slowing down touristic pressure, and thereby protecting ecological processes and cultural manifestations [32] and, in turn, preserving the integrity of the attracting factors [33].

Of the two basic stages in the production of VR apps (technical development and content production), we focus on the second one, related to the methodological approach to the creation and design of content. Specifically, our study addresses VR applications that renew the ways in which territorial and scenic resources with a heritage interest are visited and recognized [29,32]. In any case, this is a task that had to be coordinated with the strictest technological approach, given that we sought to prepare dynamic audiovisual and textual materials for assembling visual elements adapted to heritage valuation, including panoramic views, virtual tours, animations, slides, 3D blocks, and so on, in which the technical characteristics of the app have to be adapted, taking into account aspects such as usability.

Here, the VR results help to improve the experience of interpreting the patrimonialization process as a complete experience that benefits from the use of interactive, adapted, dynamic, and attractive materials. VR will likely be exploited by public and private organizations as a tool that could be used for management, touristic promotion, and formal and non-formal education [34–37]. The content is assembled around an itinerary that emphasizes environmental, aesthetic, ethnographic, and historical values, among others. It shows how the patrimonialization of the Leitariegos pass and Cueto Arbas Massif is configured through practices, discourses, and representations of the actors that have promoted the study and preservation of this mountainous area, as well as the dissemination of information about it.

The aim of this study is to highlight a marginal area within the Cantabrian Mountains that is immersed in a process of tertiarization, placing emphasis on the recent dynamics of the landscape and, more specifically, the incompatibility of uses resulting from policies in the field of the protection (concerning use as natural parks or biosphere reserves) and exploitation of natural resources in recent decades (e.g., regarding open-pit mines, ski resorts, etc.).

2. Study Area

The Leitariegos pass and the Cueto Arbas Massif constitute a natural mountainous area that has extensively been used for traditional farming, a key aspect of a historic itinerary (*Camín Real de Leitariegos*). Outstanding ecological, aesthetic, ethnographic, and historic value has been attributed to it, and this value has been institutionally recognized in protection and conservation actions (via its classification as a natural park and a nature reserve and through recognition via SCI, SPA, Global Geosites, etc.) but also promoted through the development of snow sports oriented toward the tourism industry (e.g., Leitariego's winter resort).

The study area constitutes a medium-high Atlantic mountain region located in the western sector of the Cantabrian Mountains (Northwest Spain) on the border of the Atlantic Ocean and the Cantabrian watershed (Figure 1). It is small (measuring about 3 km in length by 5 km in width) but contains great complexity due to the interaction of natural factors and the human footprint in the area (regarding farming companies, mining, hospitality, tourism, etc.).

In this area, one can see the superposition of forms corresponding to diverse morphogenetic periods, a fact that allows the planning of an evolutionary reconstruction of reliefs, according to the rest of the Cantabrian Mountains. From a biogeographic point of view, it represents a diverse mosaic of vegetation, which is a result of the distribution of vegetation

on bioclimatic land and is determined, to a greater or lesser extent, by traditional farming use (Figure 2).

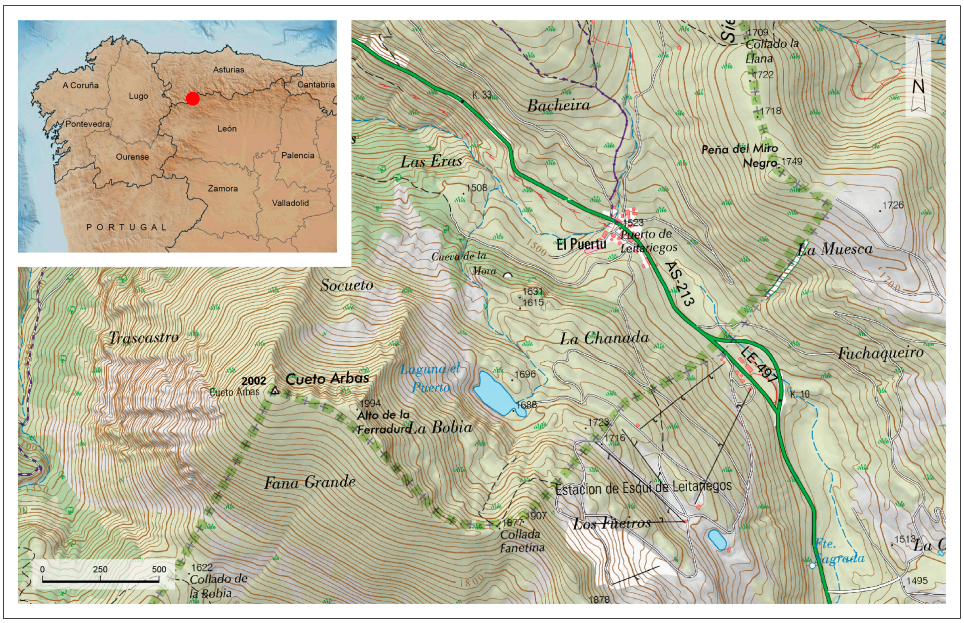

Figure 1. Map of the study area. The figure is the authors' own creation and was developed using IGN official series and Observatorio del Territorio cartographic bases.

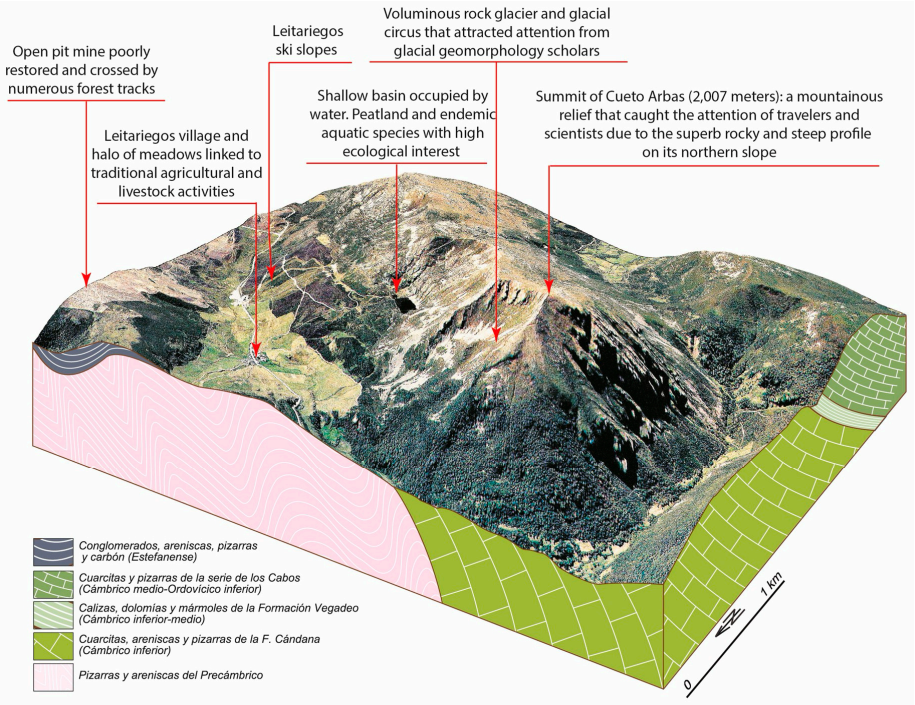

Figure 2. Block diagram (interactive digital model) with labels explaining the main elements of the landscape. This figure was developed by the authors using MDT02 by IGN. It is an orthophoto adapted from imagery from a US Army B Series Flight (1958), Vuelo de la Diputación (1970), Vuelo General de España (1983), and Vuelo del Principado de Asturias (1994).

The importance of natural components should not cause us to forget the influence of farming activities, which contribute to the valuation of this landscape as a heritage site. It can thus be considered a natural landscape with rural uses and cultural content uncovered by erudite travelers and scientists (botanists, ethnographers, geologists, etc.). Such individuals

have been traversing these places and reporting their observations since the end of the 18th century, creating texts that have left a highly lauded argument regarding its heritage valuation. We cannot omit the relevance of this place as a distinguished pass in the communications and mercantile trade of the western regions of Asturias and León since the Middle Ages; this is also a reason why carrying out activities developed over centuries by their neighbors (for which they were even rewarded with real privileges) acquires a special meaning.

Another aspect that cannot go unnoticed is the recent transformation of the landscape through the implementation of new uses that are inconsistent with the traditional landscape features and constitute a cause of significant trivialization and deterioration.

3. Materials and Methods

When elaborating the proposal of a Virtual Reality (VR) application for the Leitariegos pass and the Cueto Arbas Massif, a working procedure in which office and field tasks were alternated was used. Our work began with a bibliographic review of the advancements in information and communications technologies and the use of VR as a tool with advantageous features for reinforcing heritage locations and goods. In addition, bibliographical and documental sources in the fields of analysis of landscape and the valuation of heritage were reviewed.

Also, systematic bibliographical revision about this sector of Cantabrian range resulted in being essential for the identification and organization of all the information with which we could settle the heritage keys. The use of previous works, including landscape analyses and a systematic review of this territory's heritage values, was also very useful [15]. A hundred studies from diverse fields of study (geology, botany, ethnography, anthropology, sociology, history, art history, geography, tourism, and sport) were read, excluding news and local or regional columns. Then, the principal actors, their activities, the spatial milestones, and the most outstanding observed attributes in these studies were codified (being placed inside parentheses and abbreviated with the first 3–4 letters/characters) in order to identify patterns in the practices that have constructed a heritage image of the locations in the area. All of them are presented in the first section of the Results (Section 4.1), which explains the key steps that needed to be taken prior to the preparation of the itinerary (Table 1). At the end of that section, Table 2 synthesizes the correspondence between actors, locations, and outstanding attributes.

Table 1. Coding keys in the patrimonialization process.

Agent (Agen)	Practice (Prac)	Location (Loc)	Attribute (Attr)
enl: enlightened intellectual bot: botanist geol: geologist jur: jurist ethn: ethnographer hist: historian alp: mountain club ski: ski club yout: youth association cult: cultural association adm: public administration	tour: tour, travel fiel: field work ess: essay publ: scientific publication divu: divulgation spor: promotion of sport infr: building of infrastructures prot: protection and management priv: grant of privilege	vill: villages slop: massif slopes road pass: mountain pass path: historical path mass: mountain massif lag: lagoon glac: glacier summ: summit	mag: magnitude and/or intensity of components and phenomena div: diversity repr: representativeness rar: rarity and/or residuality aest: aesthetic and scenic quality, i.e., chromaticism, textures, volumes, and visual angles ad: adaptation of communities to the environment and sustainable use anc: effective maintenance of ancestral activity, i.e., knowledge, traditions, language, spirit and feeling, techniques, and management systems mem: memory space cons: conservation without major alterations, i.e., components, materials, forms, locations, uses, phenomena, and linked processes sci: scientific interest use: resources for non-agricultural land use

Source: The authors' elaboration based on [8,38].

Table 2. Territorial values and qualities according to types of actors and practices in the referenced places.

	Villages	Slopes	Road	Pass	Path	Massif	Lagoon	Glacier	Summit
enlightened intellectual						mag, sci	ad, sci		
botanist						mag, aest, sci			
geologist	aest			sci		mag, aest	sci	sci	aest
jurist	rar, aest, ad, anc, cons	mag, aest, sci	aest, ad	aest		use			
ethnographer	rar, aest, ad, anc, cons				ad				
historian	mag, rar, aest, ad, anc, cons			aest, sci, mem	aest	mag, aest, sci	mag		mag, mem
mountain club				aest	aest	mag, aest, use	aest		mag, aest
ski club						use			
youth association						use			
cultural association					anc, mem	aest, use			
public administration	ad, mem			ad, mem, use	ad, anc, mem	div, repr, aest, ad, cons, sci, use		sci	

Source: authors' creation based on reference studies on Leitariegos.

Afterwards, profiting from 3 days of field work, the points of interest on which the VR application could be based were selected according to the key aspects of the patrimonialization process. As a result of this task, the suggested itinerary combines a stretch amounting to 4 km by vehicle, following road AS-213 via the Asturian route to the Leitariegos pass, and an 8 km stretch on foot, continuing through the path that leads to the Arbas lagoon and Cuetos' peak from the base of the ski station. In the first part, which begins just before Brañas de Arriba village, several points were selected, considering both the availability of secure places to park and the excellent observational locations. For the second stretch, the one that is covered on foot, the app proposes a calm observation of reliefs and vegetation, as well as the land uses on higher ground, which are essential, in fact, for understanding the complex landscape dynamic. It is in this second section of the itinerary where we can better experience the impression that travelers and scientists had for the first time, as the itinerary is carried out in reference to the milestones marked by those who ascended to the summit of Cueto Arbás.

Particular emphasis has been placed on explaining the incentives that provoked the relevant actors' interest in this mountainous stretch. In this way, the importance of several natural and cultural characteristics and the way these are integrated in the patrimonialization process has been underlined in the itinerary design. At this point, a distinguished aspect is the valuation of actions taken during the last few decades, linked to the development of both sport and mining activities, which have precipitated relevant conflicts due to overlapping plans for the use of ground, especially in old mining operations, which are inefficiently restored, and the skiing station.

Therefore, in the itinerary section, each of the POIs is presented with coded agents, practices, and associated values, and the corresponding graphic display illustrates representative audiovisual components. Each POI is paired with a 360-degree photograph (taken using a professional camera) on which additional components are inserted. Synthetic texts were made, consisting of audiovisual materials taken from previous sources (aerial photography from historical flights, photographic records, and cartographic images and files) and made by the authors (with specific software), in order to grab the attention of the user through visual effects with aesthetic or documental value. By making use of these materials, animations with text, audio, and immersive and interactive images were created to enhance the elements and processes at every moment of the virtual visit. These graphic resources are useful in reconnaissance and approach flights as well as for the superposition of coverage with thematic information that allows one to understand processes and dynamics (even from a diachronic perspective). Other dynamic figures include slides with buttons that swap the current picture of overlapped images with identical angles acquired

at different dates, serving as useful comparatives for recognizing the transformation of the landscape, as well as 3D interactive blocks showing totally and partially and from different angles the form and structure of the area, taking advantage of a three-dimensional viewpoint. Superposition with thematic information is also possible on these blocks.

When activating VR elements by clicking markers on each POI 360° image, the user is redirected to the storage system of the Observatorio del Territorio de la Universidad e Oviedo (where graphic elements are contained). It can be accessed through the following link in a non-immersive external way, but it is also designed to be observed in an immersive experience with VR glasses: https://www.observatoriodelterritorio.es/rarv/Leitariegos/ (accessed on 23 December 2024).

4. Results

4.1. Verification of Heritage Keys

The conception of the Leitariegos pass and the Cueto Arbás massif as a heritage site is the result of a complex and lengthy process involving multiple actors (scientists, hikers, administrations of different levels, the local population, etc.). The vectors that have been identified are also of a different nature (the condition of the historical itinerary, the lagoon and the Arbas Peak, and the exceptional nature of snow in the geographical context).

4.1.1. Determination of Processes and Actors

This section identifies and characterizes the activities of the individual and collective initiatives that have contributed to our knowledge of the Leitariegos pass and the Cueto Arbás massif and are responsible for its valorization. Discourses and representations of different agents are analyzed, mainly scientific and intellectual figures, hikers, and travelers who discovered, explored, and enjoyed the area and disseminated information about it. These actors contributed to the consolidation of a new way of perceiving the mountains at the end of the Modern Age and as the Contemporary Age progressed, a perspective that took the form of valuable writings and graphic materials that underline the qualities and value of natural and rural mountain space. It is precisely the characterizations and images included in these works that later directly stimulated or indirectly inspired some institutional efforts to enhance the value of mountain areas.

The Intellectual Sphere in the Dissemination of Value

At the end of the 17th century, we find a significant mention of Cueto Arbás in the work *Antigüedades y cosas memorables del Principado de Asturias* by the Asturian historian, religious scholar, teacher, and university lecturer Luis Alfonso de Carvallo (agen: hist; prac: ess), who was a native of the Narcea region. In Title Six, referring to the terrain on which the clashes between the Vandals and the Suevi took place, Carvallo briefly describes the mountainous area of Cueto Arbás as follows:

> *"[. . .] Y aviendo venido a las manos, fueron vencidos los Suebos, y se acogieron desvaratados a la cumbre del collado, que llaman el Cueto de Arbas, que es el más soberbio, y levantado de todas aquellas montañas, y de todas partes se sube a la cumbre con gran dificultad, y en lo alto es muy espacioso y llano, con una laguna grande, y muchos guijarros redondos [. . .]".* [39]

Like many authors we will see below, he refers to the location of the massif on the watershed and administrative boundary. Apart from this, an appreciation of the majesty of the Cueto (loc: lag [attr: mag], mass [attr: mag, aest, sci], summ [attr: mag, mem]), which stands out from the surrounding mountains and is striking due to the marked break in the slope between the walls and the summit, is already present in Carvallo's work.

In the following century, the *Descripción de la Real Jurisdicción de Leitariegos o Lazariegos* (Description of the Royal Jurisdiction of Leitariegos or Lazariegos), a work by the famous Spanish intellectual Gaspar Melchor de Jovellanos (agen: enl), stands out. As an intellectual and politician concerned with development, he took great care to recognize and analyze the territorial resources of Asturias, with the aim of identifying opportunities for its modernization [40]. It was in this context that he made a trip to the Narcea region, which is recounted in the sixth notebook of his diary (written in 1795 and 1796). Jovellanos then included a note about the Leitariegos pass and its surroundings that seems to correspond to the observations made by the scribe Manuel Folgueras (prac: tour, ess).

The description contains a certain idealization: he not only praises the elevation of the massif—a constant in his characterizations of the Cueto—but also considers it to be one of the most important massifs in Europe (loc: mass [attr: mag, sci]). In addition, he describes the characteristic topography of the pass, a singular vertex on the border between León and Asturias and the watershed between the Narcea and Sil basins. He also looks at the land surrounding Lake Arbás (loc: lag [attr: ad, sci]), where he observes a hollow with a water reservoir characterized by a certain extension and depth, which is beneficial for pastures, as follows:

> "*[. . .] Se encuentra cerca de la cumbre de aquella montaña eminente llamada el Pico de Arbas un poco de término a manera de cárcaba o cuna, en donde se registra un piélago de agua, que titulan la Laguna de Arbás, con bastante extensión y profundidad, que de invierno la rebosa y aprovechan su agua para riego de prados con vertiente al Narcea [. . .]*". [41]

Scientific progress, favored by the technical advances resulting from industrialization, was the motivation behind the most outstanding visits known in the Contemporary Age. Numerous campaigns arose to deepen scientific knowledge of the Cantabrian mountains, such as that of Michel Charles Durieu de Maisonneuve, a French infantry officer and botanist, in 1835, who was encouraged by his compatriot Jean-Baptiste Bory de Saint-Vincent, an army captain and renowned naturalist [42]; this was a recommendation that also reached the naturalist Jacques Gay (agen: bot), who was commissioned to study many of the plant specimens collected in Asturias.

Part of Durieu's Asturian campaign took place in the southwest (prac: fiel, publ). From the town of Cangas, he traveled to the headwaters of the Naviego and the Cueto Arbás massif to study the vegetation there and complete his *exsiccata* of Asturian plants [43,44]. And to these experiences correspond the texts by Jacques Gay in "Viaje botánico de Durieu por Asturias emprendido en el año 1835", written based on the correspondence between the two.

Like Carvallo, Gay's text emphasizes the shape of the Cueto (loc: mass [attr: mag, aest]), with its flattened summit and steep, inaccessible walls. Durieu would also have noticed the rocky outcrops on several flanks and the occasional snowdrift still visible in late summer. The permanence of the snow attracts the attention of those who stop and get to know this mountain range in Southwest Asturias, as seen in the following:

> "*[. . .] separado completamente de las cumbres próximas, semeja una pirámide truncada cuyas caras se alzan escarpadísimas por todas partes. Es difícil, sobre todo, la mitad superior, ceñida por incómodos pedregales movedizos y en absoluto inaccesible por el este y norte, con lo que ha de atacársela por el duro repecho del sudeste. [. . .] En esta ladera oriental, un poco por debajo de la cumbre, todavía quedaban restos de un nevero el 17 de julio de 1835, que habían desaparecido una semana después [. . .]*". [45]

Subsequent explorations by other prominent scientists are known, such as the one carried out in August 1914 by the geologist and paleontologist Eduardo Hernández-Pacheco, the Nobel Prize winner for Medicine Santiago Ramón y Cajal, the botanist Blas Lázaro

Ibiza, and the physicist Ignacio González Martí (agen: geol), all linked to the university of Madrid and the *Institución Libre de Enseñanza* [46]. Eduardo Hernández Pacheco took the opportunity to make notes about the natural environment, as reflected in the *Boletín de la Real Sociedad de Historia Natural* (prac: fiel, publ; loc: pass, lag [attr: sci]), where he writes that he "[. . .] has recognized signs of glaciers in the region of the Leitariegos pass and lagoon [. . .]" [47].

Later, in 1929, it was Francisco Hernández-Pacheco (agen: geol)—Eduardo's son—who traveled the slopes of this mountain massif, writing a note entitled "Datos de Geología Asturiana (Leitariegos y Somiedo)" for the periodical publication of the Natural History Society, in which he refers to its geological structure and lithological composition (prac: fiel, pub; loc: lag [attr: sci]). He mentions the glacial origin of Lake Arbás [48].

In the same issue of the *Boletín*, R. Stickel (agen: geol), an assistant professor at the University of Bonn, published "Observaciones de morfología glaciar en el NO. de España", which resulted in a trip embarked on in August and September 1928 (prac: fiel, publ). One of the headings is devoted entirely to "Pico Cueto de Arbas: -Puerto y valle del arroyo de Leitariegos". It is headed by a description of the silhouette of the Cueto (loc: mass [attr: aest], glac [attr: sci], summ [attr: aest]), in which the perception of the contrast between the slope of the "abrupt wall" and the culmination "finished by the flat summit" appears once again. Regarding glacial morphology, he makes the following remark:

> "*[. . .] En la pared que mira a NE. se han labrado dos circos, de los cuales el más al N. bajo la cumbre del Cueto, es el mayor. En el fondo de este circo se ve un número grande de montones de bloques erráticos, que muestran el extremo inferior del glaciar de circo que allí existió, situado de unos 1.600 a 1.640 m, de altitud. El otro circo está a unos 100 m. más arriba de un lago pequeño, bastante enrunado, de 1.755 m. de altitud [. . .]*". [49]

His work gives an account of the extent of the Quaternary glacier and reflects the shape of the landform that "cradles" the lagoon (loc: lag [attr: sci]):

> "*[. . .] Este lago llena una hoya situada entre el muro de arenisca y el reborde de pizarras que está delante. El glaciar salía del circo y ha excavado la hoya del lago actual. Sus morrenas laterales están sobre la vertiente del reborde de la hoya lacustre que mira al puerto de Leitariegos, al cual no alcanza, sino que queda a una altitud de unos 1.600 m. [. . .]*". [49]

We thus note some characteristic elements of the heritage value of this European mountain: the striking concavity of the relief forms resulting from glacial action and, as a witness to this, the presence of a lagoon.

The interest aroused by this type of manifestation of scientific progress, together with a new ideal of recognizing little-visited areas, stimulated the creation of mountain clubs and hiking associations in the second half of the 19th century. The members of these groups became involved in completing and enriching the information on the mountain systems explored [50]. They also published magazines and bulletins with excellent accounts of excursions containing orographic, geological, toponymic, and ethnographic information and varied graphic representations [51,52].

Teichman set off for the Leitariegos pass on the 8th of January. Without losing details of the slope and the sinuosity of the path (loc: path [attr: aest]), or the inhabited places, he quickly set his sights on the Cueto de Arbas (loc: mass [attr: mag]), "which seems to close the valley". Then, once the pass was reached (loc: pass, mass [attr: aest]), the effects of light on the voluminous peak surprise the hiker: "the majestic Cueto de Arbas [. . .]" with "icy snowdrifts shone in the morning sun" [53].

In his ascent to the summit, he switches between walking and contemplative rest, feeding his descriptions: "I found the lake in front of me [. . .] it was completely frozen" (loc:

lag [attr: aesc]). The observations regarding the water in different states are common in the valorization of mountain areas; and here they are related to the possibilities they offer for engagement in snow sports, whose acceptance was rapidly growing in Spain at that time (loc: mass [attr: use]): "it would have been an incomparable slope for sports [. . .]" [53].

The effort of the ascent is compensated by the panorama at the top of the mountain (loc: summ [attr: mag, aest]): "it is to be seen and not described", says the author. Emotion permeates the story, and, indeed, a certain romantic heritage is evident. The clarity of the sky ("the atmosphere was so transparent that you could see far away"), the snow "on [all] sides mountains with their snow-capped peaks", and the rock ("an incomparable circus") stand out [53].

The *Revista Ilustrada de Alpinismo Peñalara*, which included an edited version of Arno Teichman's account, was published four years after the aforementioned experience of the naturalist Francisco Hernández-Pacheco (agen: geol), also a prominent member of the hiking society. His observations and those of Teichman have common features, as the imposing figure of the Cueto (loc: mass [attr: mag, aest]) already appears in the first impression. Moreover, like other visitors in previous centuries, Hernández-Pacheco associates the image of the mountainous mass with, at its base, the inhabited site of the pass as a basic representation.

Hernández-Pacheco, accompanied by his wife, ascended the lagoon and the Cueto and enjoyed the view (prac: tour), pointing out the main mountains and valleys in the four cardinal directions (loc: summ [attr: aest], vill [attr: aest]). Cueto Arbás is a special natural viewpoint from which one can see the leafy forest, the cleft and shade in the valley, the serenity of the lagoon, and the inhabited village on the pass.

Later, when leaving the area and starting out on the road to Somiedo, the author explicitly takes up the metaphor that had been announced in the representations of previous intellectuals: the Cueto is the sentinel of the pass; it watches over the historic pass from the highest heights of this part of the mountain range (loc: mass [attr: mag, aest], lag [attr: sci], glac [attr: sci]). Aside from this, the atmospheric state and light effects continue to be of interest, underlining the traces of Quaternary glaciers, as seen in the following:

> "*[. . .] A nuestra espalda y tras el grupito de casas, se levanta majestuoso el Cueto de Arbas, el guardián del puerto que, curioso, se asoma por encima de las montañas astures, hacia las vallonadas leonesas. El sol, iluminándole lateralmente, deja ver en sus ásperas laderas la acción de los hielos cuaternarios, destacando netamente los lomos morrénicos al pie del pequeño circo que enmarca la laguna [. . .]*". [54]

Finally, we must point out that Leitariegos has also received notable attention with respect to the study of social aspects, as they gain importance with the development of the official scientific and statistical bodies and the proliferation of university faculties. Furthermore, the creation of private societies concerned with the dissemination of social and humanistic knowledge, as well as the editorial initiative for the dissemination of regional culture and heritage, contributed to the emergence of new contributions regarding the western mountain. Among them, we must analyze that of Luis Bello (jurist, essayist, and politician and member of the Generation of 1898), from a campaign that sought to discover the schools in Northwestern Spain [55].

Bello's story about Leitariegos (agen: jur) appears in the chapter "Journey through Asturias" in the article titled "Leitariegos-Brañas de Arriba", which includes his experience after ascending the Leonese slope (prac: tour, ess; loc: slop [attr: aest], pass [attr: aest]). The contrast between the types of weather on both sides (loc: slop [attr: aest, sci]), very striking in any pass of the mountain range, introduces a story rich in nuance. About the countryside, it curiously points out a poor image, different from those previous ones that highlighted the richness of the pastures. He does mention the abundance of snow after

winter. Then, Bello writes about the breadth and depth of the precipice that opens the upper part of the valley (loc: slop [attr: mag, aest]) as well as the villages hanging on the steep slopes over which the road winds (loc: vill [attr: rar, aest, ad, anc, cons], road [attr: aest, ad]). Furthermore, the picturesqueness of the conical roofs of homes in Brañas de Arriba stands out. The materials they are composed of and the shapes of the homes recall African constructions, as follows:

> "*[. . .] Entrar en Asturias por Leitariegos es asomarse a uno de los grandes y magníficos espectáculos que puede ofrecer al hombre la montaña. [. . .] Solamente unas cuantas casas de camino real. Y, sobre todo, el camino, el puerto, que ya basta, pues sólo con un kilómetro empezamos el descenso por la vertiente de las Brañas, y éste es el lugar más hermoso que he visto y pienso ver en mi vida. Será porque la niebla suaviza un poco el tono sombrío de los montes que le sirven de fondo. Será porque todo el primer término está iluminado por una luz intensa, cálida; y en este inmenso derrumbadero, que la carretera baja en zig-zag, pueblos, bosques, prados y ganados que en ellos pastan, aparecen como en tangente, sostenidos por arte mágico. [. . .] El primer pueblo que ha logrado trepar hasta aquí se llama Brañas de Arriba, y se afirma como puede, agarrándose al suelo con los machones de sus hórreos y ofreciendo a la nieve unos extraños techos cónicos, africanos, de bálago o de paja hábilmente trabada por unas varas que sirven de flejes [. . .]*". [56]

Fritz Krüger, a German linguist and ethnographer at the University of Hamburg (agen; ethn; prac: faithful, pub), also took note shortly afterwards, in the autumn of 1927, of the plan, materials, and layout of the buildings as well as, in general, its settlement and traditional ways of life. In his work, he alludes to the inaccessibility of Southwest Asturias, which explains the maintenance of ways of life that draw his attraction (loc: path [attr: ad], vill [attr: rar, aest, ad, anc, cons]), as seen in the following:

> "*[. . .] Esta parte de Asturias está unida al mundo exterior por una carretera que desde Oviedo conduce a la provincia de León [. . .]. La economía y la vida de esta región han permanecido completamente arcaicas, lo que es perfectamente comprensible dado el carácter grandemente quebrado y montañoso de la región, dadas sus escarpadas vertientes, en las que están situados los pequeños poblados de pastores y campesinos, y el débil nudo de comunicaciones (pues, aparte de la citada carretera, solamente existen caminos para carros y peatones) [. . .]*". [57]

Krüger is satisfied with his approach to a fascinating medium that contrasts with other areas previously explored. As in the writings of Jacques Gay, Francisco Hernández-Pacheco, and Luis Bello, the relationship of the settlement with its natural environment defines the aesthetic value of the region—something that a historian from the University of Oviedo Juan Ignacio Ruiz de la Peña (agen: hist) also perceived decades later in a study that, according to the author's note, was partly the result of an excursion taken in the company of Arturo Rodríguez Álvarez-Buylla and another historian, Eloy Benito Ruano, in the fall of 1972. They considered the area especially attractive due to the impression of isolation and the archaism in the ways of life (prac: tour, ess). The text draws attention to the sensation produced by the undulating path (loc: pass: [attr: aest], path [attr: aest]). As we perceive in the works of Krüger and other authors, he resorts to the exaltation of the unusual when he looks at the hamlets and relates an impression of the stillness and almost timelessness of these places (loc: vill [attr: rar, aest, ad, anc, cons]), as follows:

> "*[. . .] Un silencio profundo flota en el ambiente; apenas dos hogares humean: aquí se ha detenido el tiempo. Recorremos las angostas callejuelas de Las Brañas, con sus casas elementalísimas de planta circular o elíptica y recias paredes de mampostería sobre las que descansa una empinada techumbre cónica de paja. Nos encontramos ante una de las escasas supervivencias que quedan de un sencillo y primitivo tipo de construcción*

circular –el de la pallaza- que tuvo amplia difusión desde tiempos remotos por el Noroeste de la Península [. . .]". [58]

Ruiz de la Peña's text highlights other key features in the construction of the heritage image of Leitariegos: the altitude of its villages, the highest among those inhabited in Asturias (loc: vill [attr: mag]); exposure to snowfall for much of the year; and two vocations of his neighbors, caregiving and mule driving, to which we refer later (loc: pass [attr: sci, mem]).

Approach to Institutional Contemporary Attention

The accumulated characterizations made by numerous agents constitute an image recognized as heritage. But not all influence the first official contemporary action taken for this area. It is the perception of snow as an inherent element in this region that gives it a new dimension in the central decades of the 20th century: the abundance of snow, which covers the area for a good part of the year, begins to be conceived as a source of leisure and, over time, a source of wealth, as it is seen to be very suitable for mountain recreation and snow sports.

Teichman already referred to Leitariegos' aptitude for sports practice in the journal *Peñalara*, but he was not the first to make a consideration of this type: shortly before, a chronicle by Ramón García Redruello (agen: jur; prac: ess), a first-instance judge in Cangas del Narcea in 1924 and 1925, was published in the Madrid newspaper *La Voz*, in which he precisely recommended that the Peñalara Society, among other groups, visit Leitariegos. García Redruello saw the Cueto Arbás massif as a "suitable place for mountaineering;" at the same time, he was surprised at the lack of knowledge that winter sports fans had about it (loc: mass [attr: mag, use]). Furthermore, there is parallelism with the Madrid mountains already evoked by Rivas Goday and Rivas Martínez. The author himself refers to another article that appeared in the journal *Vida Leonesa*, published by the Sports Cultural Society of León, where he encourages taking advantage of the areas of Pajares and Leitariegos as alpine centers [59,60].

In the following years, the popularity of hiking continued to spread, often with recreational and contemplative intentions, driven by local or foreign initiatives (agen: cult; prac: divu; loc: mass [attr: aest, use]) reported in the chronicle (*Boletín del Tous pa Tous La Maniega*, *Boletín de la Sociedad Canguesa de Amigos del País* and *Revista Narcea Órgano del Club Narcea*, with an Asturian atmosphere, published in Madrid). By the 1950s, skiing was already noticeable, or at least that is what the Leonese press reported [61,62]. The courses and some championships were promoted more generally from the province of León in the nineteen-sixties with the collaboration of the León Mountain and the Ski Groups of the Frente de Juventudes, the León Provincial Council, the Spanish Ski Federation, the Hispanic Sports Society, and the Villablino City Council, among other institutions (agen: yout, ski, adm; prac: spor; loc: mass [attr: use]).

In this context, the house dedicated to the collection of old provincial fees, which was the property of the Oviedo Provincial Council and disused, was transferred, leading to its transformation into a youth hostel for the O.J.E., following the request of the Local Youth Delegation and the City Council of Cangas del Narcea. This made it easier to organize activities and increased the love of skiing, which was initially scarce on the Narcea slope. However, there was no means of towing, which forced people to carry skis on their shoulders when ascending the slope of the massif [63]. Hence, the Peña Rubia society, created on the Leonese side, was concerned with raising funds to pay for a tele-trawl at the beginning of the following decade. The construction of an adequate shelter was requested at the same time [63,64].

Once an Asturian-Leonese Federation was established and due to the growing number of fans, with a very significant influx from Villablino and Ponferrada, launching a ski resort and promoting the mountain pass became a clear objective from the perspective of the tourism industry [63,65,66].

The works corresponding to the tele-tow project began in 1972, when a Management Board headed from Bierzo and promoted by Peña Rubia obtained the necessary credit (agen: ski; prac: spor, infr; loc: mass [attr: use]). In addition, a hostel promoted by the Villablino City Council, with the support of other corporations, such as Palacios del Sil, the National Delegation of Physical Education and Sports, and the Provincial Council of León (agen: adm; prac: spor, infr; loc: pass [attr: use]), was inaugurated in October 1973 after being transferred to the León Provincial Council [67,68].

Therefore, in Leitariegos, the patrimonialization process is nuanced, with the first official action directed towards the exploitation of the mountain for sports. The Spanish political and economic context of the time can explain this turn of events. This area had not previously received significant attention from the official organizations that promoted the first conservation movements in Spain.

Subsequently, this space has been the object of different institutional attention, being widely recognized for the values revealed above, which have motivated its official protection. The landscape led to the declaration of protection of these spaces, although attention is primarily focused on environmental and ecological value (natural habitats, the presence of unique animal species, relevant biogeographic aspects, etc.).

The southern sector of this mountain massif, administratively belonging to the province of León, is in turn part of the Laciana valley, a space that is included within the Alto Sil Site of Community Interest (SCI), part of the Special Protection Zone for Birds (SPA) Alto Sil and the Sierra de Ancares Natural Area. Since 2003, the Laciana Valley has also been a biosphere reserve (agen: adm; prac: prot; loc: mass [attr: div, repr, aest/sce, ad, cons, sci]).

The northern sector, part of Asturias, is an area also protected under different protection measures, being defined as the Partial Nature Reserve of Cueto de Arbas (included in the Natural Resources Management Plan of Asturias -PORNA-); Site of Community Importance of Fuentes del Narcea and Ibias; SPA of Fuentes del Narcea, Degaña, and Ibias; and Fuentes del Narcea, Degaña, and Ibias Natural Park and Biosphere Reserve (agen: adm; prac: prot; loc: mass [attr: div, repr, aest/sce, ad, cons, sci]).

Additionally, the Leitariegos glacier complex was designated as a Site of Geological Interest (LIG 0-95) in the Geological Heritage Catalog prepared by the Geological and Mining Institute of Spain (agen: adm; prac: prot; loc: glac [attr:sci]). Furthermore, the Camín Real de Leitariegos, included for two decades in the Natural Paths Program of the Ministry of the Environment and Rural and Marine Environment, was incorporated into the Cultural Heritage Inventory of Asturias in 2011 due to its status as a historic road (agen: adm; prac: prot; loc: path [attr: ad, anc, mem]).

Regarding the assessment of the natural elements and landscape in the different categories of protection in this area, aspects that relate to the importance of natural habitats also stand out, for example, the peat bog formations associated with the lagoon or the high mountain vegetation made up of juniper, heather, and blueberry bushes that grow above an altitude of 1800 m in the Cueto Arbás. The presence of highly relevant fauna species is also highlighted, such as the Cantabrian brown bear, the capercaillie, wolves, and otters. Thus, the recognition of this area is reflected in the implementation of specific regulations guaranteeing the conservation of some of the most threatened elements, highlighting the recovery plans for the brown bear and the consideration of its biological corridor.

In this same sense, the declaration of the Fuentes del Narcea, Degaña, and Ibias Biosphere Reserve indicates that the area fully meets the conditions for compliance with the three basic objectives of this protection measure, as follows:

> "*[. . .] posee un medio natural caracterizado por su gran diversidad y elevado grado de conservación y en su territorio se asientan comunidades locales cuyo desarrollo socioeconómico se está llevando a cabo de un modo compatible con la conservación de dichos valores, por lo que se constituye como un lugar privilegiado para el ensayo y demostración de modelos de desarrollo sostenible [. . .]*". [69]

In the case of the Laciana Biosphere Reserve, the landscape qualities are also highlighted, as follows:

> "*[. . .] Los prados, huertos y pueblos del fondo de valle, los bosques mezclados con brezales y brañas en las laderas y las zonas de cumbres, frecuentemente cubiertas de nieve, con arandaneras, pastizales y roquedos, crean un mosaico de gran contraste cromático. Los matices del verde en verano, el contraste del blanco de las cumbres con los marrones del bosque en invierno y los tonos amarillentos y rojizos del otoño, espectacular aquí por la gran variedad de árboles, generan sensaciones inolvidables* [. . .]". [70]

4.1.2. Synthesis of Patrimonialization Vectors

The process of patrimonalizating the Leitariegos pass and the Cueto Arbas massif was carried out by considering three principal aspects: the presence of snow as an element constantly associated with this region (and the ski station); the lagoon and Cueto Arbas; and its role as a distinguished path for a historical itinerary (the Real Path of Leitariegos) between the Cantabrian coast and the peninsular inland.

Some of these referents have already been widely covered in the previous parts of this study, especially when referring to the importance of snow as an inseparable element of Leitariegos' landscape and the fact that, over time, snow led to the first institutional designation: the ski station.

We have also referred to the importance of the lagoon and Cueto Arbas in the valuation of this space. The unique elements of the relief and the hydrography have been underlined and described by intellectuals who have traveled to this area, comparing it with the famous lagoon of Madrid and the Peñalara massif, with which they certainly share some similarities.

Further details are needed when discussing the relevance of the Leitariegos pass as a historical path in the occidental sector of the Cantabrian division, a function that seems to date back to the past times. In Roman times, it served as a channel for the transport of goods between the sector, with aquifer exploitation, from Western Asturias and the valleys that contain the Leonese regions of Laciana and El Bierzo [58,71,72].

However, it is in this medieval period that the pass simultaneously acquires recognition and becomes subject to intensified transit. Proof of this is provided by the existence of documented shelters and hospitals since the middle of the 12th century. These areas provided assistance, accompaniment, and protection to travelers on foot; they also provided a bed for resting, food, and sanitary care, constituting good aid if the roughness of the weather conditions is taken into account [58,73]. This was essential care work given the growth in Astur-Leonese trade in the Middle Ages. This is why official recognition through the bestowal of a royal privilege was given to the populations of Leitariegos, Brañas, Trascastro, and the rest of the villages in the mountain pass by Alfonso XI on 14 April 1326 (agen: adm; prac: priv; loc: pass, vill [attr: ad, mem]).

The residents benefited from this legal statement, which provided exemption from imposing responsibilities (fiscal, stately, and military ones), ensuring the continuance of their dedication to the refurbishment of the paths and the guidance and assistance of

travelers. This was the main purpose of the pass apart from hunting, farming, and *arriería*, the last of which benefited from the mentioned tributary advantages.

The privilege was ratified by the monarchy for more than five centuries until it was abolished in 1879, when, over the already recognized Royal Path from Madrid to Asturias, a road between Cangas and Villablino was opened. This infrastructure negated the risks and difficulties that had once supported the special dedications made to the pass' population, so the main reason for the maintenance of this legal distinction was no longer valid [44,58].

However, in those times, stagecoaches and carts began to be used, generating activity, with the foremost example being the stagecoach line to Leon that Cándido Cosmen, from the *Casa Provisor,* established. The Ponferrada–Cangas line was also opened; it was looked after by *Casa la Fuente*, also from the Cosmens, previously related to the *arriería*. Some of these people became involved in the launch of transport services with motorized vehicles in Asturias. The occupation of cart driver opened the way for truck and bus drivers, with the first line cars that went through the pass entering circulation in 1913 [44,73].

In this secular process, the inhabitants become aware of a territorial identity settled by the ways of life and work conditioned by the ground conditions [5], in this case, derived from the corresponding orographic and meteorological difficulties. And this identity is also found at the base of the construction of a heritage image of Leitariegos and its surroundings, as pointed out by Fernández Salinas [74] in his classification of the cultural landscapes of Asturias (in the category "noted geographical referents" and in the type of transit zone).

In relation to this vector of patrimonialization, the Grupo Ecologista Cangués Azor (GECA), founded in Cangas de Narcea in May of 1985, published some didactic guides about the Narcea river and the *Camín Real* through their voluntary work on rivers. In this context, in the last seven years, this association has carried out important field and documental work (cartography, photography, etc.) with the aim of documenting the original route, which is still recognizable, taking into account the invaluable assistance of the elder population that accompanied them while identifying some of the stretches (agen: cult; prac: fiel, divu, prot; loc: path [attr: anc, mem]). Through this type of initiative, the paths, which once had a significant historic role, recover part of their former prominence via a different use, now related to the sustainable development and enjoyment of the landscape.

4.1.3. Identification of Conflicts Caused by the Patrimonialization Process

The patrimonialization process has not been conflict-free. Above all, the first thing that should be pointed out is related to the fact that this area is owned by two regional administrations that have defended two different development models that, in some respects, are incompatible.

In this way, Asturias is bent on the preservation of the natural environment (through creating natural parks, nature reserves, partial nature reserves, etc.). In the neighboring province of León, while inclusion in the ecological and valuing the landscape have been promoted (Natura 2000 and Nature reserve), other types of uses far less respectful of the environment (surface mining and the development of a ski station) have also been promoted. A faithful reflection of this diversity of perspectives and the corresponding conflict consists of the jurisdictional disputes between the councils of Cangas del Narcea (Asturias) and Villablino (León) over the lands where the enlargement of the Leitariegos winter resort has occurred. The ministry finally resolved in favor of the city council of Laciana, thus giving free rein to the developers of the construction projects.

Furthermore, in each of the provinces, other problems have been noted. In relation to the Natural Park of Narcea, Degaña e Ibias, in Asturias, the inclusion of a high percentage of private property land has caused disagreement between a significant number of neighbors. Some of them have brought forth contentious administrative remedies that have reached the

Supreme Court in Spain, with the result being the nullification of the Use and Management plan for the Sustainable Development of the Natural Park of Narcea, Degaña e Ibias. The Supreme Court found that evidence in the applicants' hearing was omitted and that the lands were not marked with coordinates or other ways of allowing their identification. Also the memory or economic-financial study suffers the lack of precision as it contains only generic records with no reference to the compensations for the established restrictions.

The new document that regulates the management of this natural area (Order 10/2015, 11th of February, establishing the Special Preservation Zones of Fuentes del Narcea, Degaña e Ibias and Muniellos) and approves the first Tool of Integrated Management of diverse protected places in the councils of Cangas del Narcea, Degaña e Ibias, does not seem to have permanently addressed the demands of the local population.

For its part, in the Leonese area of Leitariegos, in spite of its inclusion in different preservation nets (Natura 2000, Natural Spaces Net of Castile and Leon), the conflict also serves as evidence of incompatible uses, manifested by the new Ski Station at Leitariegos.

The increase in this type of action seems difficult to understand in the context of a nature reserve and brings to light a lack of definitions. This is even more evident from the existence of several open-cast mining operations, some of which are illegal, whose environmental and landscape-related impacts are inconsistent with a sustainable development model (Figure 3). It is worth noting the outright opposition of several local (Filón Verde and Asociación en defensa de la Naturaleza de Laciana) and regional (Plataforma en defensa de la Cordillera Cantábrica) environmental associations, which, together with other groups (the Laciana Greens, the 15-M "Toma la Montaña" movement, and members of the European Parliament linked to the Green Group), have expressed their total rejection of this type of initiative, considering it to represent an irreversible loss of the natural value and therefore heritage of the area.

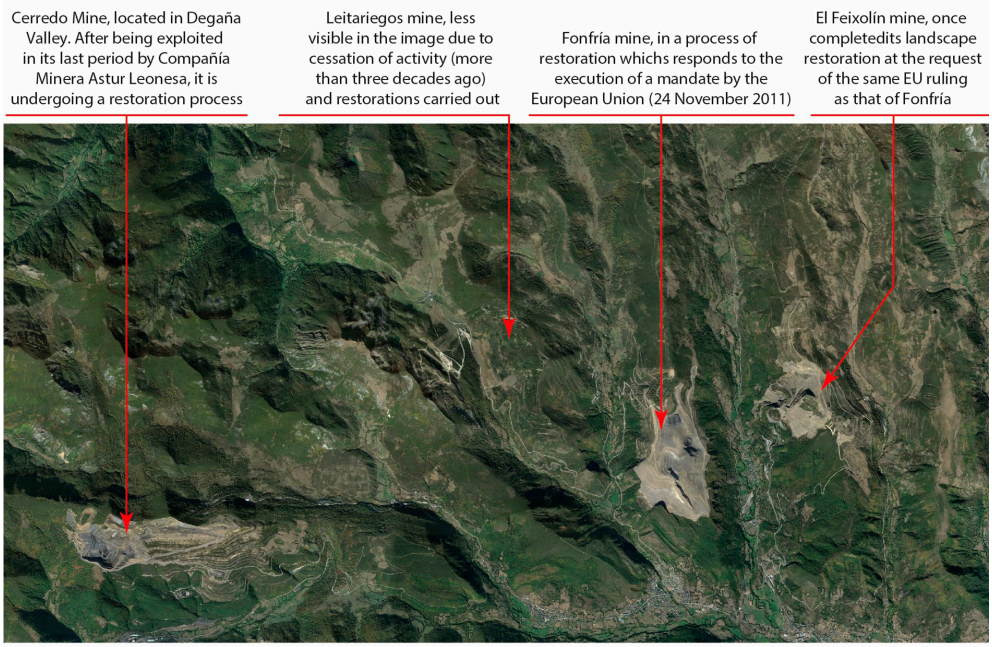

Figure 3. A general overview of Degaña, Leitariegos, and Laciana (Google Earth image from 2014), highlighting the enormous impact of open-cast mining operations on the landscape.

4.2. Conception of the Itinerary with Virtual Reality

In this section, we present an itinerary in which dynamic images are displayed to highlight the key aspects of the heritage process (Figure 4). It is designed to allow users to autonomously activate and manipulate graphic resources (Figures 5–13) to attain an

enriched interpretation of the processes that have occurred, the practices engaged in by the fundamental actors, the vectors around which the process pivots, and the conflicts in competition for land uses. At each point of interest, the codes corresponding to the types of agents and practices that have contributed to the dissemination of knowledge, as well as the highlighted territorial attributes, are indicated (Tables 1 and 2).

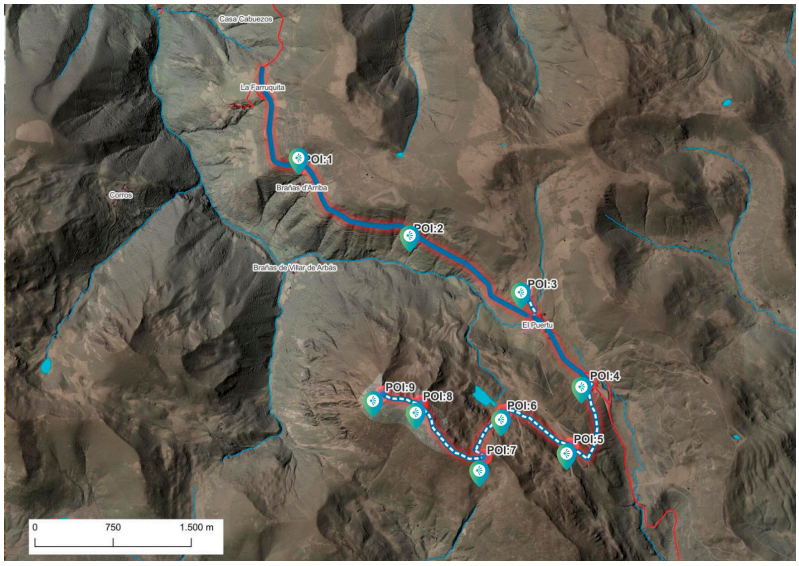

Figure 4. Itinerary map showing points of interest (created by the authors using MDT02 by IGN). The solid line corresponds to stages by motor vehicle and the dotted one refers to those on foot. It is included in the general virtual tour accessible at https://www.observatoriodelterritorio.es/rarv/Leitariegos/ (accessed on 23 December 2024).

Figure 5. Image captured from POI 1 (360° view). An audio file with a description of Brañas made by the historian Juan Ignacio Ruiz de la Peña is included. Together with the contemplation of the 360° photograph, listening to it allows a more immersive experience of the territory and, therefore, a better understanding of the heritage value of this humanized landscape. As a complement, a rotating three-dimensional block has been inserted. Five aerial photographs corresponding to different years are superimposed on it, enabling diachronic analysis from the middle of the last century to the present. Along with changes in scale, this resource is versatile as it allows the modification of the viewing plane or the orientation of the images with respect to magnetic north. The user can search for the most appropriate perspective from which to observe the transformation of the landscape. VR components: virtual tour with a 3D model and an audio fragment. Source: authors' creation.

Figure 6. Image captured from POI 2 (360° view). A rotating three-dimensional block is inserted with a superimposed geomorphological map. Together with the three-dimensional feature, it provides the possibility of adopting different perspectives and making changes in scale to understand the importance of relief in the configuration of the landscape—the significance referred to in regard to glacial modeling repeatedly highlighted by scientists. As a complement, an audio file with a text by the geologist Stickel referring to the forms of modeling used is inserted. VR components: virtual tour with a 3D model and an audio fragment. This includes a text call. Source: authors' creation based on aerial photographs taken in 1958 (US Army B Series), 1970 (Diputación), 1983 (Vuelo General de España), 1994 (Principado de Asturias), and 2023 (PNOA).

Figure 7. Image captured from POI 3 (360° view). Two complementary resources are inserted, one of which is an audio file with a description of the town of Leitariegos by the historian Juan Ignacio Ruiz de la Peña. Together with the contemplation of the 360° photograph, listening to this file allows a more immersive experience in the territory and, therefore, a better understanding of its heritage value. As a complement, a rotating three-dimensional block is inserted. Five aerial photographs corresponding to different dates are superimposed (dating from the middle of the last century to the present), enabling diachronic analysis. This resource is especially versatile as it allows, along with changes in scale, users to modify the viewing plane or the orientation of images with respect to magnetic north. It thus allows the most appropriate perspective to be found to observe the fact being analyzed. VR components: virtual tour with a 3D model showing the evolution of land use over time. This is complemented by an audio fragment. Source: authors' creation based on aerial photographs taken in 1958 (US Army B Series), 1970 (Diputación), 1983 (Vuelo General de España), 1994 (Principado de Asturias), and 2023 (PNOA).

Figure 8. Image captured from the POI 4 360° view. A date comparator is inserted to create simultaneous viewing by moving the curtain. It is useful to appreciate the significant and irreversible transformation of the landscape due to the installation of the ski resort. VR components: virtual tour with a photo comparator. Source: authors' creation based on a Vuelo de la Diputación extract and an actual PNOA image.

Figure 9. Image captured from P0I 5 360° view. The rotating three-dimensional block illustrates the main conflict in the patrimonialization process: it shows the transformation begun by the installation of the ski resort in the 1950s. The succession of photographs on the three-dimensional block allows a more dynamic and interactive reading of the transformation process. VR components: virtual tour with a 3D model showing the evolution of land use over time. Source: authors' creation based on aerial photographs taken in 1958 (US Army B Series), 1970 (Diputación), 1983 (Vuelo General de España), 1994 (Principado de Asturias), and 2023 (PNOA).

By vehicle:

- POI 1: Brañas de Arriba viewpoint (43°00′43.90″ N–6°26′48.18″ O).

The following corresponds to decisive agents, practices, and associated values:

- agen: adm; prac: priv; loc: pass, vill [attr: ad, mem].
- agen: jurist; prac: tour, ess; loc: vill [attr: rar, aest, ad, anc, cons], road [attr: aest, ad].
- agen: ethn; prac: tour, fiel, publ; loc: path [attr: ad], vill [attr: rar, aest, ad, anc, cons].
- agen: hist; prac: tour, fiel, publ, divu; loc: path [attr: aest]; vill [attr: rar, aest, ad, anc, cons].
- agen: cult; prac: fiel, divu, prot; loc: path [attr: anc, mem].

Figure 10. Image captured from POI 6 (360° view). The selected audio files (with text by Gay and Jovellanos) serve to highlight the importance of two elements that are frequently mentioned in the assessment of the Leitariegos landscape, namely, the snow and the Cueto Arbás lagoon (milestones in institutional and public recognition), along with the summit of Cueto Arbás. Listening to the audio while observing the 360° photograph allows the user to understand these features' prominent roles in institutional and public assessments of the region. VR components: a virtual tour with audio complements. Source: authors' creation.

Figure 11. In POI 7, an audio file with a description by Gaspar Melchor de Jovellanos is included. Listening to this audio while observing the 360° photograph allows a better perception of the feeling that travelers must have experienced. VR components: a virtual tour with audio complements. Source: authors' creation.

The first POI on this itinerary constitutes a special observation point for understanding the admiration that the pyramidal silhouette of Cueto Arbás aroused in hikers and scientists who approached the Leitariegos mountain pass from the northern slope. Indeed, references to the majesty and beauty of the summit of Cueto Arbás have been a constant in the historical texts that describe this area since the mention in Carvallo's work at the end of the 17th century.

This admiration comes in response to the superb rocky and steep profile of the northern slope, a result of the presence of a well-defined glacial cirque. It is crossed by numerous avalanche channels that are still partially functional.

Figure 12. In POI 8, a rotating three-dimensional block, along with the geomorphological map already included in PO2, is included. The map's reuse is justified as its content shows a complementary view to that of PO2 on modeling forms that organize the landscape. An audio file is also included to provide the user with geologist Hernandez Pacheco's impression when glimpsing Leitariegos valley during his ascent to the summit of Cueto Arbas. VR components: a virtual tour with audio complements and a 3D model showing geomorphic configuration. Source: authors' creation.

Figure 13. POI 9 contains an audio file with Carvallo's text highlighting the attraction provoked by the pyramidal summit of Cueto Arbas over the mountain pass, which has become the most prominent landmark in the Western Asturian mountains. Listening to this description while contemplating the 360° photo helps the user understand the impression that Leitariegos had on ancient travelers. VR components: a virtual tour with an audio complement. Source: authors' creation.

There is also a view of Brañas de Arriba, a place that drew special attention to the picturesqueness of the conical plant roofs on houses with a circular or elliptical plan. Currently, this small mountain village provides an attractive vista, as the buildings are quite well preserved. They have not been transformed radically beyond the replacement of thatched roofs with slate ones.

It is also possible to verify the maintenance of deciduous tree formations that serve as a refuge for the varied fauna inhabiting this space, among which the Cantabrian brown bear (*Ursus arctos arctos*) stands out. The habitual presence of this animal species is one

of the main arguments used for the conservation and institutional enhancement of this region's territorial features.

- POI 2: northern access to the Leitariegos pass, next to the rocky threshold (43°00′10.08″ N–6°25′30.59″O).

The following corresponds to decisive agents, practices, and associated values:

- agen: hist; prac: ess; loc: mass [attr: mag, aest, sci], summ [attr: mag, mem].
- agen: bot; prac: fiel, publ; loc: mass [attr: mag, aest].
- agen: geol; prac: fiel, publ; loc: mass [attr: aest], glac [attr: sci], summ [attr: aest].
- agen: alp; prac: tour, publ; loc: path [attr: aest], mass [attr: mag], pass, mass [attr: aest].
- agen: geol; prac: tour; loc: summ [attr: aest], mass [attr: mag, aest], glac [attr: sci].
- agen: jur; prac: tout, ess; loc: slop [attr: mag, aest, sci], pass [attr: aest].
- agen: adm; prac: prot; loc: mass [attr: div, repr, aest/sce, ad, cons, sci].
- agen: adm; prac: prot; loc: glac [attr: sci].

The concentration of significant volumes of snow over millennia in the highest-altitude areas led to the formation of well-defined glacial cirques and, fed by these, small ice tongues.

At this point, there is a break at the visible rocky threshold in a cascade of seracs. This is also an appropriate place to recognize the voluminous rock glacier that houses the interior of the Cueto Arbás glacial cirque. It has already attracted the attention of glacial geomorphology scholars.

From this watchtower, we can also enjoy a privileged view of the head of the Naviego valley, also highlighted by several of the scientists and hikers who entered Asturias from Leitariegos. What drew attention, in addition to the broken relief, was the change in the landscape precipitated by the frequent presence of fog on the Asturian slope, contrasting with the characteristic luminosity of the Leonese slope.

- POI 3: Village of Leitariegos and Camín Real (42°59′57.35″ N–6°25′08.55″ O).

The following corresponds to decisive agents, practices, and associated values:

- agen: adm; prac: priv; loc: pass [attr: ad, mem], vill [attr: ad, mem].
- agen: geol; prac: fiel, publ; loc: pass [attr: sci].
- agen: alp; prac: tour, publ; loc: pass [attr: aest].
- agen: geol; prac: tour; loc: vill [attr: aest].
- agen: jur; prac: tout, ess; loc: pass [attr: aest].
- agen: hist; prac: tour, ess; loc: pass: [attr: aest, sci, mem], vill [attr: mag].

The village of Leitariegos, located at 1525 m above sea level, and the Camín Real, which, in this section, coincides with the road, have since ancient times been fundamental elements in the patrimonialization process of this territory. Their historical relevance as prominent and assistive steps in the communication of this sector of the Cantabrian Mountains dates back to ancient times.

From a landscape perspective, the halo of harvested meadows surrounded by stone walls that are still in excellent condition stands out. They are witnesses to the maintenance of traditional livestock exploitation in this rural landscape of the Atlantic mountains.

There has also been a change in the composition of livestock as well as its management. Thus, while cattle populations have remained the same or even experienced a slight increase in numbers (as has happened with horses), sheep and goats have practically disappeared, so the most productive pastures tend to be used to a greater extent (meadows located around the village or areas with open scrubland). Additionally, more remote or topographically less suitable areas have been abandoned and invaded by shrub species. In any case, this trend seems to affect the more remote, privately owned plots, while the communal pasture

areas are kept in a quite acceptable condition thanks to the clearing work carried out by neighbors.

- POI 4. Leitariegos ski resort base (42°59′35.96″ N–6°24′44.30″ O).

The following corresponds to decisive agents, practices, and associated values:

- agen: alp; prac: tour, publ; loc: mass [attr: use].
- agen: jur; prac: ess; loc: mass [attr: mag, use].
- agen: yout; prac: spor; loc: mass [attr: use].
- agen: ski; prac: spor, infr; loc: mass [attr: use].
- agen: adm; prac: spor, infr; loc: pass [attr: use].

The aim is to highlight how the decline of old land use is accompanied by the implementation throughout the 20th century of new ones associated with inhabitants of urban areas' demand for mineral resources and leisure spaces. New elements do not always integrate harmoniously into the landscape. This is the case of the Leitariegos ski resort, created in the 1970s to satisfy the demand for an activity that began in the middle decades of the century and expanded in 2007 to reach a higher altitude, or extractive activities, which have left visible traces in the last quarter of a century.

On foot:

- POI 5: Leitariegos ski slopes.

The following corresponds to decisive agents, practices, and associated values:

- agen: alp; prac: tour, publ; loc: mass [attr: use].
- agen: jur; prac: ess; loc: mass [attr: mag, use].
- agen: yout; prac: spor; loc: mass [attr: use].
- agen: ski; prac: spor, infr; loc: mass [attr: use].
- agen: adm; prac: spor, infr; loc: pass [attr: use].
- agen: adm; prac: prot; loc: mass [attr: div, repr, aest/sce, ad, cons, sci].

It is in this POI where the transformation of the natural landscape by human action is most notable. It represents one of the conflicts caused in the process of the patrimonialization of this mountain space. It constitutes an appropriate place to refer to the incompatibility of uses that is evident in the policies promoted by the different regional administrations that manage this territory. The regional government of the Principality of Asturias has opted for more protection, while the Provincial Council of León has further promoted the exploitation of its natural resources (via open pit mines and a ski resort).

On the opposite slope, one can see how open pit mining has led to an important and irreversible transformation of the landscape since the combination of harsh climatic conditions, together with poor soils, prevent or hinder the recovery of vegetation cover. This can be seen in the area affected by coal extraction in the Leitariegos pass.

In 1984, the company Minero Siderúrgica de Ponferrada decided to begin exploiting the coal deposit located in Leitariegos. The extraction of minerals through the transfer of waste material was considered inevitable. Thus, in mid-1985, subcontractors began clearing the area. Once coal mining ceased, the affected area was poorly restored, and active erosion processes can still be observed on the slopes that have not yet been completely colonized by vegetation. This situation is aggravated by forest tracks, which represent a negative factor for landscape recovery.

- POI 6: Cueto Arbás lagoon.

The following corresponds to decisive agents, practices, and associated values:

- agen: hist; prac: ess; loc: lag [attr: mag].

- agen: enl; prac: tour, ess; loc: lag [attr: ad, sci].
- agen: geol; prac: fiel, publ; loc: lag [attr: sci].
- agen: geol; prac: fiel, pub; loc: lag [attr: sci].
- agen: geol; prac: fiel, publ; loc: lag [attr: sci].
- agen: alp; prac: tour, publ; loc: lag [attr: aesc].
- agen: geol; prac: tour; loc: lag [attr: sci].
- agen: bot; prac: fiel, publ; loc: mass [attr: mag, aest, sci].

Among the different glacial relief forms that can be recognized in the area, the lagoon, together with the summit of Cueto Arbás, represents the main element in heritage recognition. The repeated references by hikers and scientists show the interest and admiration that this unique element aroused, something that is also common in assessments of other mountainous spaces, wherein the mention of water in its different states is common.

Another heritage element of the Cueto Arbás massif can be seen in detail, one especially valued by the botanists who came to this space and highlighted the vegetal richness of the subalpine juniper forests covering the highest-altitude areas, namely, juniper (Juniperus communis Subsp. alpina), heather (Calluna vulgaris), blueberry (Vaccinium uliginosum and Vaccinium myrtillus), and dense grasslands (cervunales), the last one occupying the culminating flat areas rich in water due to their favorable disposition for moisture retention. Finally, peat bogs and endemic aquatic plant species with undoubted ecological interest are preserved in the glacial over-excavation basins and in the lagoons. These have been taken into account in the institutional patrimonialization of this space.

- POI 7, 8, and 9. Cueto Arbás summit alignment.

The following corresponds to decisive agents, practices, and associated values:

- agen: hist; prac: ess; loc: summ [attr: mag, mem].
- agen: geol; prac: fiel, publ; loc: summ [attr: aest].
- agen: alp; prac: tour, publ; loc: summ [attr: mag, aest].
- agen: geol; prac: tour; loc: summ [attr: aest].

The last POIs on this tour are on the summit alignment of Cueto Arbás (up to 2007 m). They constitute a special balcony from which to value the pass of Leitariegos and the different heritage elements that have been recognized over time. The summit itself is the first resource to consider. Its pyramidal and prominent profile within the siliceous alignment of which it is part has been a repeated quality mentioned in different texts about this area.

The intramountain valley constitutes an excellent example of the interrelation between nature and human actions in the construction of a landscape as well as the conflicts generated by the disparity in the criteria used by the regional administrations involved in this region's management.

5. Discussion and Conclusions

Virtual Reality (VR) appears to be useful for improving users' experience in their autonomous approach to resources that have a striking landscape imprint and relevant heritage value, but whose full interpretation requires adapted, dynamic, and attractive interactive materials [30]. In short, implementing the proposed VR application can strengthen sensitivity to and interest in territorial resources that, despite their relevance, still have room for improvement with respect to knowledge, interpretation, and dissemination [75–77], thus contributing to preserving these resources' value in the face of certain threats arising from the tertiarization that threaten mountain areas. Moreover, this is a proposal that is unique in the study area and promotes this area's perception as a reference space in

the western sector of the Cantabrian Mountains. In general, there have not been many such approaches applied in the southwestern European mountains to date, probably due to their technological nature and the complexity of their preparation; however, there are some projects whose development has been shown to bolster the development of activities wherein field observation is of fundamental importance, such as geomorphology [78] or landscape analysis [24,79–82].

The above characteristics show the interest that VR can generate in the study of spaces and heritage assets, as well as in the understanding of the complexity of processes, taking into account their importance in the development of the territorial culture of citizens and institutions [22,31,83]. Learning to observe and interpret is a basic issue given that a territory is a key object in the construction of solid citizenship in regard to social, cultural, and environmental knowledge; this idea even reaches the foundations of new conceptions of heritage resource management [14,84].

This approach can be adapted to the changing needs of society (concerning institutional, scientific, educational, and citizen actors) as well as advances in technology, with digital competence and familiarization with ICT being among the determining aspects in this regard in recent decades. This state of affairs is related to postulates of an important institutional consensus at different scales, such as those contained in the European Landscape Convention (European Union) or the Manifesto for a New Territorial Culture (College of Geographers and Spanish Association of Geography). Furthermore, along with others, this idea is consistent with the following directives and framework agreements (among others):

Principle 1 of the London Charter for the computer-based visualization of cultural heritage (Unesco) (2009): "computer based visualization is applied to the research or dissemination of cultural heritage" [85].

The EU Framework Programme for Research and Innovation Horizon 2021–2027; Pillar II Global Challenges and European Industry Competitiveness: Cluster 4 (digital world, industry and space); and Pillar III Innovative Europe: Knowledge and Innovation Communities [86].

Recommendation CM/Rec(2008)3 of the Committee of Ministers for member states on the guidelines for the implementation of the European Landscape Convention II.2.3: Participation, awareness raising, training, and education. B. Awareness-raising: "Landscape simulation or representation tools employing 3-D methods or block diagrams lead to better understanding and discussion between all involved" [87].

Recommendation (EU) 2021/1970 of 10 November 2021 on a common European data space for cultural heritage, Principle 11: "In addition to serving preservation and restoration purposes, 3D technologies may also provide increased opportunities for cultural heritage institutions to reach wider audiences with more immersive experiences that include virtual access to places which are normally inaccessible (e.g., underwater) or temporarily closed, or to reach persons with visual impairments by offering [. . .]" [88].

Spanish Science, Technology and Innovation Strategy 2021–2027: Axis 10 "Multidisciplinarity. Encourage inter- and multidisciplinarity, fostering and supporting the cross-cutting use of essential enabling technologies, disruptive digital technologies or deep technologies that enable business and social progress"; Axis 14 "Social. Promote the commitment of Spanish society to R&D&I, fostering scientific dissemination and culture, reflection on the role of science and technology in today's society, and promoting open and inclusive science and innovation"; Objective 4 "To generate knowledge and scientific leadership, optimising the position of research personnel and institutions, as well as the quality of their infrastructures and equipment. To foster quality and scientific excellence, favouring a systemic effect that reaches and benefits a larger number of groups. To apply scientific knowledge to the development of new technologies that can be used by companies

and to intensify the capacity to communicate with our society and to influence the public and private sector".

According to this proposal, the development of VR applications facilitates a new way of knowing, valuing, raising awareness of, and disseminating knowledge in conjunction with traditional methods, including field trips and geographical itineraries, which, in any case, do not cease being valid; on the contrary, they acquire new nuances through the technological proposals explained above [24,89]. Indeed, the incorporation of VR represents a new stage in the process of continuous adaptation between forms of representation and assessment and technical advances. Original combinations of classic graphic resources with reinforced utility are provided through different methods of integration into new combined tools that have not been previously tested by other geographical university teams in Spain. These are thought to be enjoyable in immersive and non-immersive contexts with new approaches to territorial processes, forms, and structures. We have taken new steps in the continuous process of adapting applied geography and its forms of representation to technological advances. In this work, we seek to provide more intuitive and efficient visualizations in which the expectations of 21st-century users are taken into account (interactive, dynamic, self-guided, and multitemporal representation).

Our proposal benefits from the incorporation of highly effective graphic resources such as the three-dimensional component and interactivity, which are very useful for highlighting territorial features in a temporal perspective [90]. The ability to insert complementary virtual elements is a decisive factor in enriching the content of activities aimed at helping users to comprehend elements of high environmental, socio-cultural, and economic interest. In any case, it is necessary to carefully plan the content and materials such that, when implemented through new technologies and modes of communication, they function as a solid tool in the transmission of knowledge. In this sense, and to spread the use of these tools, it would be interesting to hold contact sessions between creators of digital geographic content (e.g., universities and companies aware of the needs, values, and qualities of a territory) and local public and private actors to learn about the advantages of these new graphic approaches and arrive at collaboration and contracting agreements for the design and development of specific applications (for management, educational, or touristic purposes). The creation of content must be carried out from a shared perspective that integrates the points of view of local institutions and populations together with intellectual/academic-scientific contributions.

In short, in the context of this work, we have proposed to use sources and materials that are well known in our scientific area, integrated with new representation techniques that, until recently, have not been widely used in the classic channels of scientific dissemination. This innovative aspect of graphic representation opens up new possibilities for approaching the processes that condition territorial evolution or conflicts and are of interest to researchers, teaching staff, technical management teams, tourism agents, and so on. However, this line of research must be investigated in the immediate future, due to the challenges posed by newer and more advanced Virtual Reality techniques, in order to integrate more realistic three-dimensional and interactive components in an environment that simulates direct contact with a territory [91–93].

Author Contributions: Conceptualization, J.S., C.R. and D.H.; methodology, J.S., D.H. and C.R.; software, C.R. and D.H.; validation, C.R., J.S. and D.H.; formal analysis, C.R., D.H. and J.S.; investigation, C.R. and J.S.; resources, D.H., C.R. and J.S.; data curation, D.H.; writing—original draft preparation, J.S. and C.R.; writing—review and editing, J.S., C.R. and D.H.; visualization, D.H., C.R. and J.S.; supervision, J.S., C.R. and D.H.; project administration, D.H., J.S. and C.R.; funding acquisition, D.H. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Ayudas para Grupos de Investigación de Organismos del Principado de Asturias 2021–2023 (GRUPIN-2021) under the code AYUD/2021/52140. The final steps of this research were funded by Agencia Estatal de Investigación: Proyectos de Generación de Conocimiento, Programa Estatal de Investigación Científica, Técnica y de Innovación 2021–2023. Project: Paisajes de Interés Cultural en riesgo de desaparición (NO de España): su documentación y digitalización (PID2023-147884NB-I00).

Data Availability Statement: The authors confirm that the data presented in this study are available within the article. The virtual components are contained in the storage system of Observatorio del Territorio (University of Oviedo). They can be accessed at https://www.observatoriodelterritorio.es/rarv/Leitariegos/ (accessed on 23 December 2024).

Conflicts of Interest: The authors declare there are no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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