# How to integrate cultural and geological heritage? The case of the Comuniterrae project (Sesia Val Grande UNESCO Global Geopark, northern Italy)

Irene Maria Bollati[1,*], Valeria Caironi[1], Alessio Gallo[1], Eliana Muccignato[1], Manuela Pelfini[1], Tullio Bagnati[2]

[1] University of Milan, Earth Science Department "A. Desio", Italy
[2] Sesia Val Grande UNESCO Global Geopark, Italy
* Corresponding author: irene.bollati@unimi.it

**ABSTRACT**

Geoheritage is recognized as a component of the cultural heritage, especially in areas like UNESCO Global Geoparks. In the Sesia Val Grande UNESCO Global Geopark (northern Italy), the "Comuniterrae project" is a participated project focusing on the elaboration of Community Maps of the Middle Lands and including 10 municipalities located in a "mid" territory between the valley bottom and the highlands. Local communities have inventoried 270 elements, both immaterial and material, as components of their cultural heritage. These sites show a strong link with the geological and geomorphological background. We aimed at enlightening this link by selecting the most iconic geo-cultural sites. An original procedure of classification based on 3 main criteria was set on 70 selected sites: i) the kind of geofeatures; ii) the spatial relation between geofeatures and cultural sites, and the reciprocal conditioning; iii) the relation between humans and geofeatures. The results highlight that heritage stones and natural landforms, especially if conditioning the cultural site location, are the most recurrent categories. The use of geofeatures by humans is the most common kind of relation. These results invite to organize meetings with local populations to discuss these outcomes, and to enrich the touristic offer with multidisciplinary approaches.

**KEYWORDS**

geocultural sites; geoheritage; landscape; UNESCO Global Geoparks; Comuniterrae project

Received: 3 January 2023
Accepted: 10 May 2023
Published online: 21 June 2023

Bollati, I. M., Caironi, V., Gallo, A., Muccignato, E., Pelfini, M., Bagnati, T. (2023): How to integrate cultural and geological heritage? The case of the Comuniterrae project (Sesia Val Grande UNESCO Global Geopark, northern Italy). AUC Geographica 58(1), 129–145
https://doi.org/10.14712/23361980.2023.10

## 1. Introduction

Since the beginning of the XXI century the concept of geological heritage as component of cultural heritage has been boosted by many geoscientists (e.g., Gordon et al. 2021). Anyway, as remarked by Pijet-Migoń and Migoń (2022), many UNESCO World Heritage Sites, the most emblematic examples of cultural heritage, despite being characterized by mixed geological and cultural features, are not recognized for their intrinsic geological value. In 2018 Brilha (2018), reviewing a large amount of literature, codified clearly what geoheritage means. In particular, if we consider the diversity of geological elements of a region (i.e., *geodiversity*, sensu Gray 2004), some sites could be selected to depict this diversity: these are the *geodiversity sites* (Table 1). When these sites are recognized as having a relevant scientific value, they become, according to Brilha (2018), *geoheritage sites*. Within this term is inherent the concept of heritage, something to be protected and transmitted to future generations.

In order to select sites that can be considered elements of the geoheritage deserving conservation, several methodologies have been applied, again reviewed by Brilha (2018). These methodologies were mainly tested to evaluate sites of geomorphological interest (i.e., *geomorphosites*; Panizza 2001; Table 1), but may be applied to all the geoheritage sites. In general, at this scope, according to Panizza and Piacente (2003) two classes of values can be distinguished: the scientific value (proper and intrinsic of the geoheritage sites s.s.) and additional values (cultural, socio-economic, aesthetic and ecological). The cultural, aesthetic and socio-economic values, in particular, represent the starting point to raise awareness in the society, and even more in local populations, of this kind of heritage (Lahmidi et al. 2022). The single sites, indeed, are part of a complex cultural landscape that should be valued. According to the European Landscape Convention, signed in 2000, local population living in a territory, then, should be aware of this heritage and of its resources.

In this research the focus has been put in particular onto the cultural value: this is also one of the geosystem services provided by geodiversity to society, as described by Gray et al. (2013). The cultural value of a geodiversity or geoheritage site could, indeed, be related to both material and immaterial cultural features connected with it. The cultural features could depend strictly on the geo-features (e.g., the influence of the geomorphological setting on human settlements), making the site acquire an even higher cultural value, or could be not related at all (e.g., a geo-feature of interest located nearby a cultural asset) (e.g., Forno et al. 2022). Moreover, the reciprocal importance could be variable: the cultural aspect may prevail on the geological one, as for cultural sites having an additional geological value, or vice versa (Pijet-Migoń and Migoń 2022). When one feature prevails over the other, the challenge consists in giving value to both the components of the heritage. Indeed, as mentioned before, one of the main obstacles to the recognition of the geoheritage value associated with sites representing cultural heritage s.s. is the scarce awareness of society about the role of geofeatures and their importance in underpinning the cultural heritage. Local populations in particular, as underlined by Reynard and Giusti (2018), are more open to protect their cultural heritage than the natural abiotic heritage, thus negatively affecting the implementation of protection policies at the local level. This is a relevant aspect if we consider the potential change that natural resources experience in relation to ongoing climate change, undermining the integrity of sites and provoking a loss of their value (Prosser et al. 2010; Pelfini and Bollati 2014). For this reason, it could be really important to investigate the potential interconnections to boost conservation of both features (Lahmidi et al. 2022).

In literature the potential connection between cultural and geological values has been only recently investigated, and mainly in relation to archaeological heritage, one of the categories of cultural heritage (Moroni et al. 2015; Melelli et al. 2016; Melis and Mariani 2022). Considering the definition of archeological site as that by Watkinson and Corfield (2008; Table 1), in this specific case, new terms were recently introduced in the literature to indicate sites where both interests are found (Tab. 1): *cultural geomorphosites* (Niculiță and Mărgărint 2018), *geoarcheoheritage sites* (Taha and El-Asmar 2018), *geoarcheosite* and *archeogeomorphosite* (Fouache and Rasse 2009; Fouache et al. 2012), *archeo-geosites* (Melelli et al. 2016); *geoarcheomorphosite* (Brandolini et al. 2019).

In particular, *archeo-geosites* are "archeological sites where the geological substratum and/or the geomorphological evolutionary conditions are determinant for the knowledge and correct interpretation of the site itself" (Melelli et al. 2016). Instead, in the case of *geoarcheomorphosite* (Brandolini et al. 2019) the emphasis is strongly put on the impact and changes produced by human activities on sites of archeological and geomorphological interest. These last definitions open the great issue of human impact on cultural sites, leading in some cases to the geomorphosites being totally dismantled or, at least, hidden and not visible anymore (Prosser et al. 2010; Pelfini and Bollati 2014; Niculiță and Mărgărint 2018; Clivaz and Reynard 2018). Moreover, for Brandolini et al. (2019), archeological information at *geoarcheomorphosite*s is very important to understand the evolution of the geomorphosite, and not only additional as stressed by previous authors (Fouache and Rasse 2009; Fouache 2012). Another interesting term proposed for complex situations at the landscape scale is *archaeo-cityscape* which considers the geological and

**Tab. 1** List of definitions applied to sites of interest from an archaeological and geological point of view, and for sites where the combination of interests is clear. In bold the term selected for the present study.

| Category | Name | Reference | Definition |
|---|---|---|---|
| *Archeological* | Archeological site | Watkinson and Corfield (2008) | Archaeological sites are locations where former human activity is manifested. Any concentration of artifacts, ecofacts, features, and structures manufactured or modified by humans. |
| *Geological* | Geodiversity site | Brilha (2018) | Geodiversity elements that do not have a particular scientific value but which are still important resources for education, tourism, or cultural identity of communities (in situ and ex situ). |
| | Geological site heritage, or geoheritage | | (i) in situ occurrences of geodiversity elements with high scientific value – geosites<br>(ii) ex situ geodiversity elements that, in spite of being displaced from their natural location of occurrence, maintain a high scientific value (for instance, minerals, fossils, and rocks available for research in museum collections) – geoheritage elements. |
| | Geomorphosite | Panizza (2001) | A landform to which a value can be attributed |
| *Combined* | Archeo-geosite | Melelli et al. (2016) and reference therein | An archaeological site where the geological substratum and/or the geomorphological evolutionary conditions are determinant for the knowledge and correct interpretation of the site itself. |
| | Archaeo-cityscape | Mariani and Melis 2022) and reference therein | An existing or past urban-related landscape (a cityscape) where the geological (e.g., structural and lithological setting, potential hazards and catastrophic events, mineral resources, ores, and quarry materials) and geomorphological (e.g., morphodynamics in time, response to climate change) history play a part in its heritage value from before its inception to its decline, abandonment, or transformation. |
| | Geoarcheosite | Fouache and Rasse (2009) | An archaeological site located on a geomorphosite. |
| | Archeo-geomorphosite | Fouache et al. (2012) | A geomorphosite with archaeological interest and in which the geomorphological study has been prompted by historical and archeological questions. |
| | Geoarcheoheritage site | Taha and El-Asmar (2018) | Not provided. |
| | Cultural geomorphosite | Niculiță and Mărgărint (2018) and reference therein | Landforms which have an intrinsic cultural value or which favored human activities (archaeological sites, historical monuments or construction of settlements) and gain a cultural value. |
| | Geoarchaeomorphosites | Brandolini et al. (2019) | Any geomorphosite derived by the dynamic interaction between natural (mainly fluvial) and human events (es. Protohistoric TC settlements, Roman regular field system, Medieval canals and artificial river diversions) and for which the archaeo-historical data are crucial to assess its genesis and development during different historical times, and to enhance the geomorphosites' scientific and cultural/ historical values. |
| | **Geocultural site** | Reynard and Giusti (2018) | Sites where "the geological features interact with cultural elements (historical or archaeological vestiges, cultural or religious monuments, etc.), and the geoheritage value joins the cultural value". |

geomorphological variables in the assessment of the evolution of urban landscapes, underlining how the connection between cultural and geological features may empower dissemination of knowledge since general public is more familiar to cultural heritage (Mariani and Melis 2022).

Recently, Reynard and Giusti (2018) introduced a further definition, that of *geocultural sites* (Table 1), to indicate more broadly all the sites where "the geological features interact with cultural elements (historical or archaeological vestiges, cultural or religious monuments, etc.), and the geoheritage value joins the cultural value".

All these proposals and related investigations contribute to the discipline named *cultural geomorphology* (Panizza and Piacente 2003), reflecting the important role of geomorphological features in the cultural heritage assessment.

As depicted in a recent review (Pijet-Migoń and Migoń 2022), there are several kinds of interrelations (spatial, conceptual, causal, and thematic) between geoheritage and cultural heritage, that could be translated into topics of research. In figure 1 some practical examples of these interconnections are depicted, referring to the cases listed as follows, modified from (Pijet-Migoń and Migoń 2022). Please, consider that sites may belong to more than 1 category.

a) The use of rocks in buildings (De Wever et al. 2017) and the urban geoheritage in general, including landforms in urban environments (Bizzarri et al.

2018; Thornbush and Allen 2018; Pelfini et al. 2021) (Fig. 1a);
b) Cultural landscape i.e., landscapes deeply influenced by human action (e.g., mining and quarrying sites, terraces) (e.g., Gordon 2018a) (Fig. 1b, c);
c) History of Sciences as cultural, but mainly scientific, value of the site (e.g., Gordon 2018b) (Fig. 1d).
d) How natural processes, especially catastrophic ones, affect cultural heritage and human settlements (e.g., Canuti et al. 2009; Bollati et al. 2012; 2018; Taha and El-Asmar 2018; Migoń and Pijet-Migoń 2019; Forno et al. 2022; Mariani and Melis 2022) (Fig. 1e);
e) Intangible values like art (among which rock art sites), literature, religion and traditions (e.g., Nesci and Borchia 2017; Gordon 2018b; *Geomithology*, Vitaliano 2017; Variale et al. 2022) (Fig. 1f).

Again concerning the potential threat to cultural heritage from natural and anthropic processes (point d), the importance of considering geoheritage


**Fig. 1** Some examples of interconnections between geological and cultural features in potential geocultural sites. a) Montorfano church of the Romanesque period built mainly with the local granites and gneiss of the Ossola Valley (Northern Italy); b) the Cava Madre of Candoglia where the beautiful marble for the Milan Cathedral has been quarried since the XIV century (Ossola Valley, Northern Italy); c) Wine terraces of Lavaux, UNESCO World Heritage sites along the shore of Lake Léman (Vaud Canton, Switzerland); d) Erratic boulder used by Guglielmo Marconi for the first attempt of phone communication (Valais Canton, Switzerland); e) Example of Alpine rural heritage completely isolated by a landslide of geological interest; the yellow dotted line represents, according to an oral communication by local people, the previous path to reach the Alpine hut and the red cross indicates the interruption of the path due to the landslide on the right, blocking the access to the valley and obstructing the stream; f) the iconic landscape drawn by Piero della Francesca in the Italian Renaissance in the Italian Apennines. Source https://www.marinadeicesari.it/montefeltro-paesaggi-invisibili.

as a cultural element deserving attention has been recently analyzed. Indeed, not only cultural assets of anthropic origin may be damaged by geomorphic processes like the climate-related ones, but also geoheritage sites themselves (Prosser et al. 2010; Bollati et al. 2012; Pelfini and Bollati 2014; Gordon et al. 2021; Migoń and Pijet-Migoń 2019). If this kind of processes modifies features of geoheritage and geodiversity sites, and, where applicable, of geocultural sites, modifications could be irreversible, potentially causing a relevant loss of value (Pelfini and Bollati 2014; Migoń and Pijet-Migoń 2019).

In this research the main objects of interest are potential geocultural sites (Reynard and Giusti 2018), where several diversified cultural and geofeatures could be found, offering visitors a broader experience. Even if for Reynard and Giusti (2018) geocultural sites are more connected to the concept of geoheritage sites, rather than geodiversity sites (*sensu* Brilha 2018), in this research the concept includes both geoheritage and geodiversity sites, having scientific value but indeed featured by a relevant cultural value.

The aim of the research is, hence, to investigate the possibility of integrating cultural and geological heritage at specific geocultural sites, selecting an area where this link is particularly strong.

### 1.1 The case study: the Comuniterrae project

Specific areas where cultural and geological heritage may be intimately related are the UNESCO Global Geoparks (UGGPs). They are officially defined as "single, unified geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, education and sustainable development" (source: https://www.unesco.org/en/iggp/geoparks/about). A bottom-up approach, combining conservation with sustainable development and aimed at actively involving local communities, characterizes these regions. UNESCO ratified the interest towards the Global Geoparks Network in 2015 with the birth of the UNESCO program named "International Geoscience and Geoparks Programme". At present (2022), there are 177 UGGPs in 46 countries. Hence, in such areas, the mixture between social and scientific values is often very strong and the possibility of investigating their potential integration is relevant.

For this reason, we selected a case study in the territory of a UGGP, the Sesia Val Grande (SVGP, Piedmont Region, Northern Italy) (Fig. 2) which in 2013 officially became a member of the UGGP Network (http://www.sesiavalgrandegeopark.it/index.php/en/). It is a wide territory spanning from the Eastern Ossola Valley, bonding the Val Grande National Park, to the Sesia Valley, and occupying about 2202 km sq, including 106 municipalities. Its geological heritage is rich and diversified (Perotti et al. 2020): 68 geosites, 18 geotrails and 13 thematic museums, these latter representing offsite geoheritage sites (Brilha 2018), were inventoried. This broad offer to tourists and school students, founded on *place-based learning* (Gordon et al. 2021), can promote the value of potential geocultural sites, underlining the need to preserve them for both their scientific value and importance for the society.

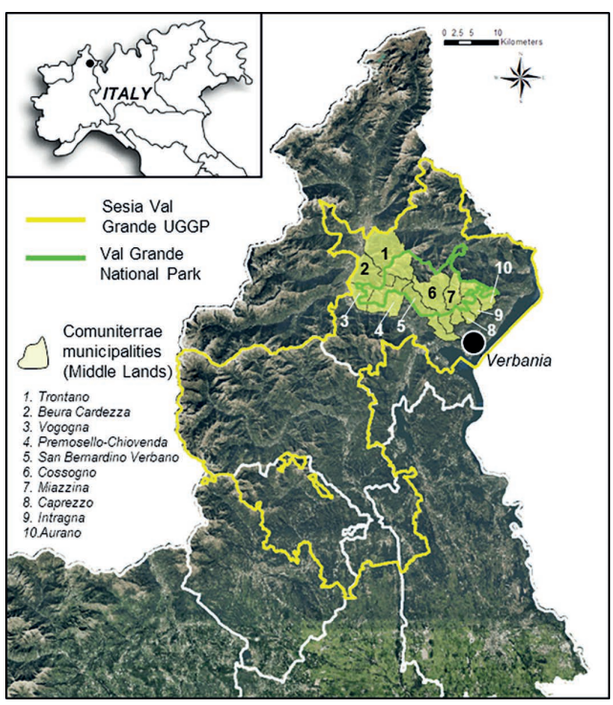


**Fig. 2** Location of the Sesia Val Grande UGGP (yellow line) in northern Piedmont, in the Italian Alps, with the areas of the 10 municipalities of the Comuniterrae project (in light brown), represented in relation to the borders of the Val Grande National Park (green line).

Then, the choice fell specifically on the easternmost portion of the SVGP, where an interesting project has recently started: the *Comuniterrae Project* (http://www.comuniterrae.it/) (Cerutti 2019; Bagnati and Perlo 2020; Cerutti 2020), started in November 2016 and launched in January 2017. The project was awarded with the European Heritage Award / Europa Nostra Award 2019 for the actions in the frame of "Education, training and awareness raising". It is a cultural participated project involving 10 municipalities, spread in 2 valleys, in a "mid" territory (i.e., Middle Lands; Fig. 2) located between 300 and 900 m (a.s.l.), the valley bottom and the high lands (Bagnati and Perlo 2020), across the borders of the Val Grande National Park, featured by unique and identity-making features (Cerutti 2019). The area can be considered a marginal or peripheral region where, despite the abandonment and depopulation (Bagnati and Perlo 2020), a rich cultural heritage, representing a socio-economic and touristic asset, is preserved (Cerutti 2019). The municipalities, in which about 9.6 thousand people still live (Cerutti 2019), are: Aurano, Beura-Cardezza, Caprezzo, Cossogno, Intragna, Miazzina, Premosello-Chiovenda,

San Bernardino, Trontano and Vogogna. The 10 communities are involved in the production of Community Maps of the Middle Lands through the institution of "focus groups" (Fig. 3a, b). One of the main results of the project is the weakening of the borders among municipalities, strengthening the idea of a unique "Middle lands" territory (Cerutti 2019; Bagnati and Perlo 2020). The next planned step will be the foundation of an Ecomuseum that will be managed by local populations with the support of the Val Grande National Park (Cerutti 2019).

In particular, the community or participatory maps derive from the evolution of the concept of the Parish maps born in the XX century from an idea of Clifford and King (1996). The maps are aimed at drawing cultural landscapes tying together the interconnections between physical places, with hidden or forgotten stories and with the capacity of representing and narrating them. As demonstrated in the framework of several analogous national and international projects (Summa 2009), they are a strong communicative tool in collecting and sharing the knowledge with different spheres of inhabitants, landscape users and tourists, practicing a process of heritage valorization. In the Comuniterrae case local inhabitants are involved as both "shareholders", since sharing the territory and its heritage, and "stakeholders", since they use the territory and are interested, as a person or community, in a good management of its heritage (Cerutti 2019). Community maps favor the identification of a community through a cartographic representation, and increase the perception and consequent representation of the territory and its cultural heritage, being it material or immaterial. Moreover, they represent an opportunity for local development and heritage conservation, actively involving local communities in the management of territories (Cerutti 2019). Within the Comuniterrae project, 250 have been the participants (e.g., entities, associations, municipalities administrators, inhabitants), 270 sites and common goods have been selected by local communities, according to specific criteria (see details on the procedure in Cerutti 2019), and marked on site with plates with a QR Code (Fig. 3c). Many other sites are still under evaluation. Among the activities of the participants are: organization of meetings in each municipality involving the inhabitants in selecting the heritage sites (Fig. 3d), inventory of the heritage sites, preparation of the Community maps of


**Fig. 3** The identifying traits of the Comuniterrae Project. (a) The Community map of the entire Middle Lands; (b) Example of a Community map of a municipality (Premosello- Chiovenda); (c) Plate with the QR Code placed at one of the Comuniterrae site; (d) One of the meetings involving local communities to work on the inventory of sites; (e) Leaflet of a Comunitour organized in one of the municipalities. Source of images a, b, d, e: www.comuniterrae.it).

the Middle Lands (1 global map, Fig. 3a, and 1 for each municipality, Fig. 3b) and organization of Comunitours (Fig. 3e), tours guided by the local population to accompany visitors to discover and become aware of the local cultural heritage. Indeed, people living in the territory are "insiders", reading their own identity in the cultural landscape, offering it to people visiting the territory, that are instead "outsiders" (Cerutti 2019). The final Community Maps were released in November 2018, and several were the realized Comunitours (4 editions from 2019 till 2022), considering also the Covid-19 forced pause.

Our research was stimulated by the fact that some of the 270 Comuniterrae sites preserve and show a strong link with the geological and geomorphological background. Being the Comuniterrae territory part of the SVGP, geoheritage has been already inventoried. There are 3 sites included in the national Geosites Inventory (http://sgi.isprambiente.it/GeositiWeb/ricerca_geositi.aspx), 5 sites listed in the Piedmont Regional Inventory of sites of interest (https://www.geoportale.piemonte.it/cms/), and 6 included in the SVGP geosite list (Perotti et al. 2020). Moreover 5 geotrails connecting some of these localities are also present (Perotti et al. 2020).

Finally, this research is aimed at enlightening those tight links proposing a classification of potential geocultural sites among those inventoried within the Comuniterrae project.

## 2. Material and methods

The method consists in a preliminary selection of the most suitable sites that can be considered geocultural sites among those inventoried in the Comuniterrae project. After that, a method for classification and categorization of such sites has been applied and proposed as original and never tested before.

First of all, a preliminary survey using the Google © platforms was distributed to one representative selected by the Comuniterrae project managers for each one of the 10 municipalities. The aim was investigating the effective interest towards geofeatures, and collecting more inputs about them in their own territory. The survey (in Italian language), is closed but it can be viewed at this link: https://docs.google.com/forms/d/e/1FAIpQLSdPs3w7NMArGXeZKyLYHZKla4tUq4-jFzVaIA5dfcslxmA5OA/viewform?usp=sharing.

Then, according to the workflow in figure 4, a preliminary analysis of the existing data about the sites was followed by direct observations in the field, that allowed one to collect and confirm in situ geological and geomorphological data, pictures and information. Rocks cropping out at or related to the geocultural sites were sampled and identified through petrographic study in thin section, forming a database which may be used in the future for further themes of divulgation. The geological and geomorphological results were integrated and compared with the available maps and literature concerning the study area.

Then, we removed from the preliminary list those sites that, according to our judgment, do not show evident geofeatures (e.g., Middle-Land festivities, bakery ovens, dairies, schools). The classification of the remaining geocultural sites was performed according to 3 main steps or criteria (Fig. 5). The method of classification is completely original, but it considers the main outcome of the researches available in literature (see Section 1). The steps or criteria are listed as follows:

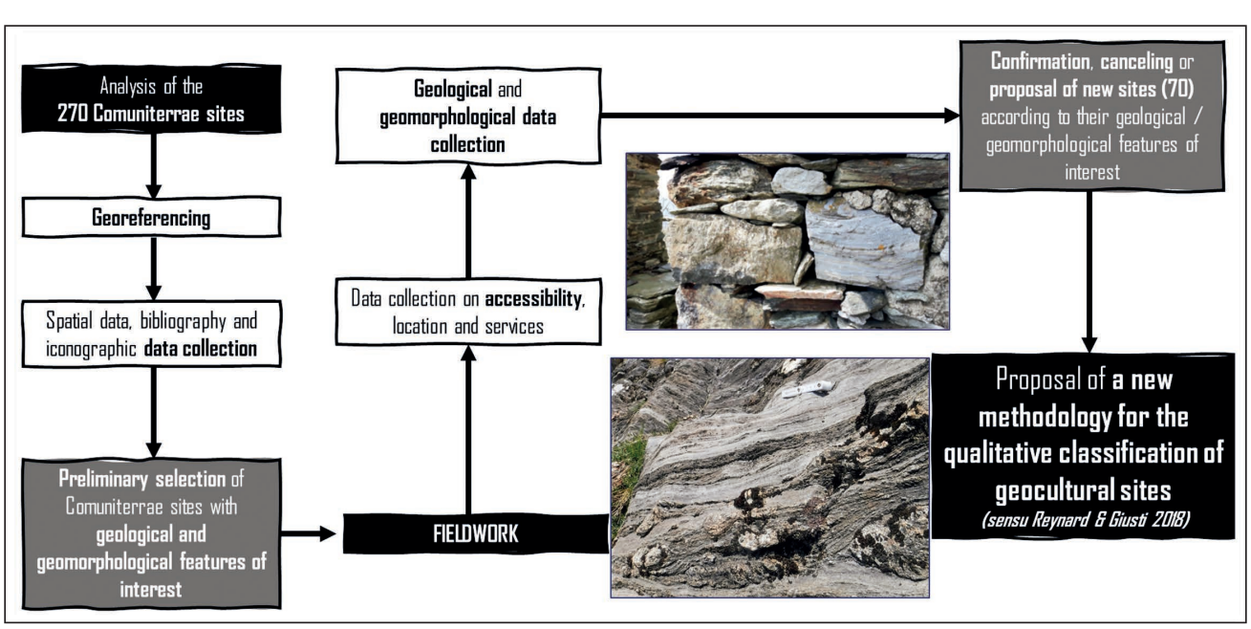


**Fig. 4** Workflow of the research from the preliminary data collection, to fieldwork activities as far as the final selection of the potential geocultural sites among the 270 sites inventoried by the Comuniterrae Project participants.

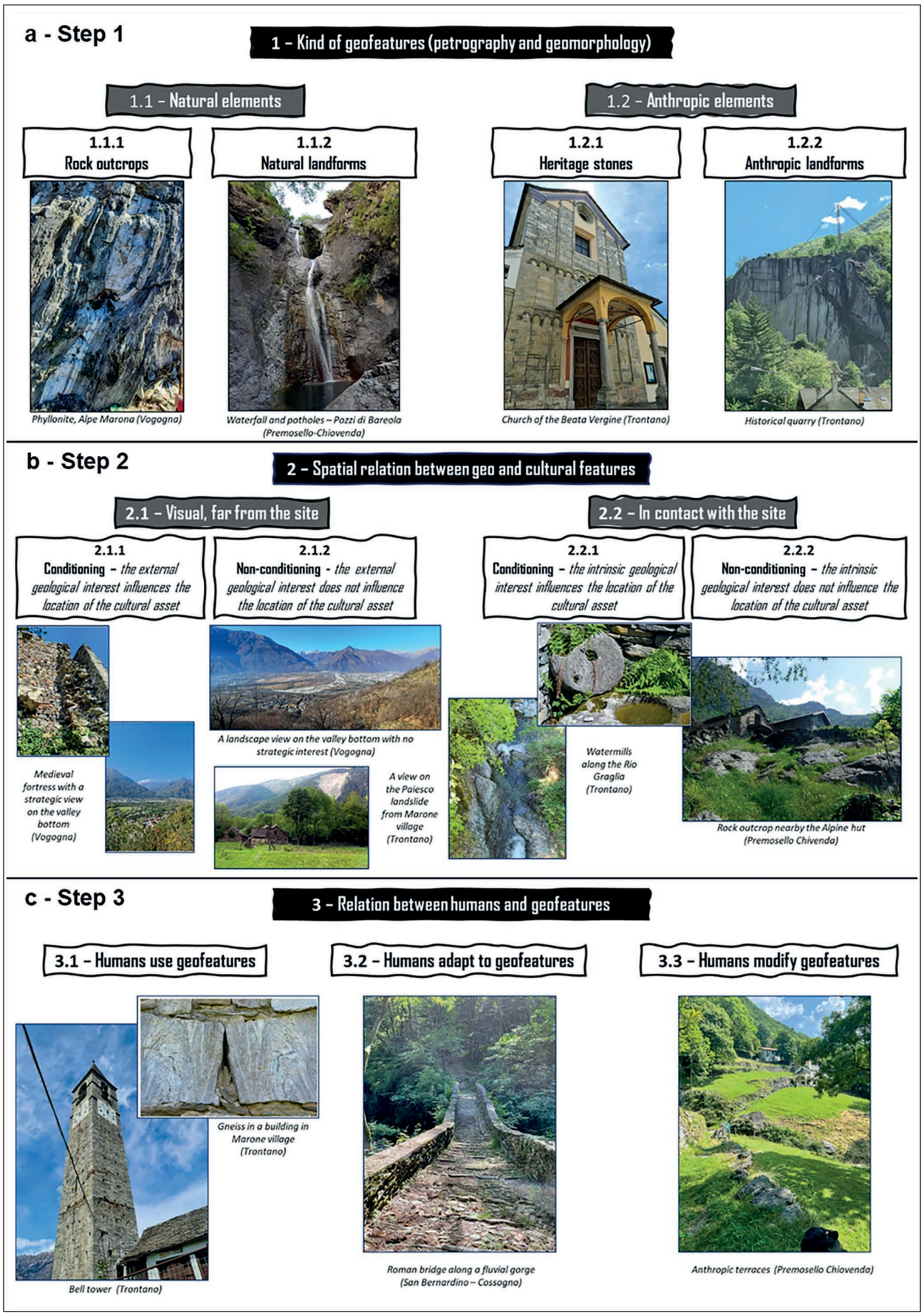


**Fig. 5** Classification of the geocultural sites according to 3 main steps or criteria.

1) *Kind of geofeatures* and distinction between *natural* and *anthropic geofeatures*: the question is if the geological and geomorphological features of interest are of natural (rock outcrops, natural landforms) or anthropic origin (heritage stones, anthropic landforms);
2) *Spatial relation between geo- and cultural features* that is the relation of *distance* (i.e., visual) or *proximity* (i.e., in contact), *and degree of conditioning of the interesting geofeatures on the site's location* (i.e., conditioning or non-conditioning). In the case of visual geofeatures, the concept of *viewpoint geosite* proposed by Migoń and Pijet-Migoń (2017) was considered. They are "locations which allow for unobstructed observation of the surrounding landscape and comprehension of Earth history recorded in rocks, structures and landforms visible from this locality";
3) *Relation between humans and geofeatures* (i.e., usage, adaptation, modification). The question is if humans were able to use local georesources or needed to adapt to the local conditions, in some cases modifying the georesources.

According to the results, finally, a discussion on the potential outcomes of the methodology will be proposed.

## 3. Results and discussion

The preliminary survey was completed by 9 over 10 representatives (90%). They all demonstrated to be aware of the meaning of geological elements, and almost always indicated appropriate examples of geofeatures in their own municipalities (e.g., rock outcrops, tectonic lines, rocks shaped by glaciers, and "fertility rocks", rocks traditionally believed to be talismans for female fertility). Also concerning landforms, they brought both natural and anthropic examples (e.g., alluvial fans, landslides, terraces, mountains, hills and plains). Finally, they proved to understand the importance of such elements as resources for the territory and as cultural elements, useful for building the collective memory. They believe that such elements are worth to be included and promoted within the Comuniterrae Project. These results stimulated the continuation of our research.

Hence, the preliminary phase and the fieldwork led to the selection of 70 sites from the 270 Comuniterrae sites (Fig. 6). These sites are featured by 151 geocultural characteristics, as a single site may show more than one kind of interest. All the data on the 70 sites and the related classification according to the 3 criteria are included in the Supplementary File A.

Among the categories used in the Comuniterrae project, recently slightly modified, there was one named Nature/Landscape (Cerutti 2019): among its sub-categories (i.e., trails and mule tracks, water, woods, panoramic viewpoints, fauna) only indirect indications to Geosciences can be retrieved (i.e., water, panoramic viewpoints). It is then interesting that only 3 sites were evidently included in the Comuniterrae list for their prominent geological or geomorphological interest (Fig. 7): the Vogogna-Premosello geological trail (Vogogna) (Fig. 7a); the Brigalun landslide (Aurano) (Fig. 7b); the Bareola waterfalls and potholes (Premosello-Chiovenda) (Fig. 7c). We assume that these sites were indicated since they are well known by the local population. The last two show very evident geomorphological characteristics, that are easily perceived by the public (Fig. 7b and c), and in particular one of them was considered for the inherent local legend (see more information in Section 3.1.2). The geological trail, instead, even if the topic is more difficult, is close to the Vogogna village, with some illustrative panels within the town itself.

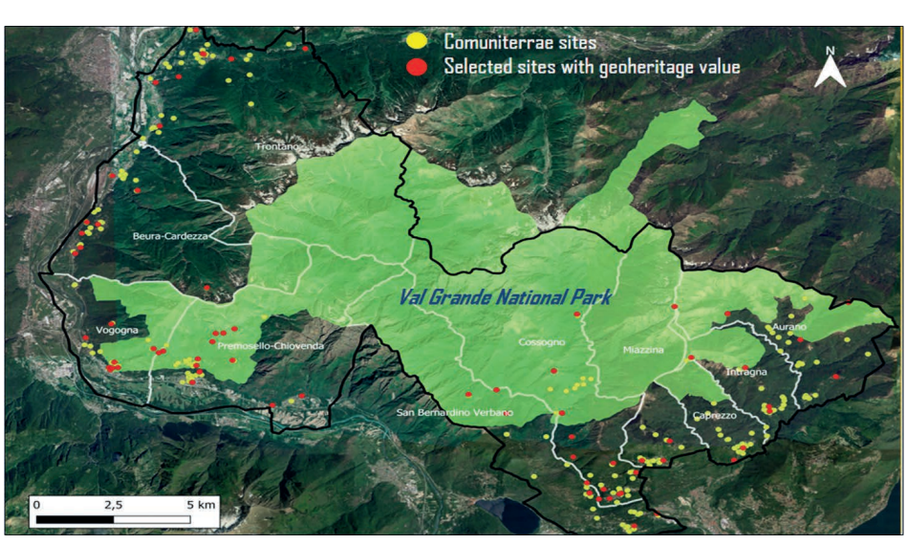


**Fig. 6** Spatial distribution of the 270 Comuniterrae sites (yellow dots) and of the 70 sites selected for the analysis (red dots). The sites are depicted with respect to the borders of each municipality (in white) and of the Val Grande National Park (in black) (Background: Google Earth ©).

It is also very publicized and used by local schools, so the inhabitants are really aware of its importance.

The graphs in Fig. 8 summarize the final results of the classification (Fig. 8a), as well as the results of the 3 steps of the procedure (Fig. 8b, c, d and e). The classification demonstrated to be very hard to perform, due to the possible occurrence of geofeatures in different categories of the same step, especially in step 3 (*Kind of relation between humans and geofeatures*). In doubtful cases, we selected the prevalent one according to our judgment.

In general, the great majority of sites (40%) shows 1 geofeature of interest, while the maximum value is 7 geofeatures characterizing only 1% of the sites (Fig. 8a) (see an example in Section 3.1.1). The subdivision of the sites among the categories for each of the 3 steps revealed no great difference between anthropic (85; 56%) and natural (66; 44%,) elements, a prevalence of sites in contact with the geofeatures of interest (126 over 151; 83%), and finally, a dominance of the use of geofeatures (70; 66%) by humans over adaptation (22; 21%) or modification (14; 13%) (Fig. 8b).

More in detail, concerning the *kind of geofeatures and distinction between natural and anthropic geofeatures* (Fig. 8c), natural landforms and heritage stones (anthropic elements) reached respectively 36% (55 elements) and 33% (49 elements) of abundance, while rock outcrops and anthropic landforms of interest are less common (20%; 30 elements and 11%; 17 elements respectively). Whereas rock outcrops have been deeply studied in the region, heritage stones of monuments still need to be specifically investigated in the municipalities using the great amount of material collected during the fieldwork for the present project. Natural landforms, the dominating category, represent the first elements to be enhanced and promoted and also need to be investigated in detail. Concerning the *spatial relation between site and geofeatures*, the elements in contact with the sites represent the majority of cases (84%; 126 elements), and non-conditioning are the most abundant (52%; 78 elements). Again, the geofeatures in contact with the sites also represent a future object of attention.

Concerning *the kind of relation between humans and geofeatures*, the results show a majority of sites characterized by the use by humans (66%; 70 elements). Some examples are reported in figure 9: the


**Fig. 7** The 3 sites of geological or geomorphological interest included in the Comuniterrae list. (a) The Vogogna-Premosello geological trail (Vogogna; source: www.parcovalgrande.it); (b) The Brigalun landslide (Aurano); (c) The Bareola waterfalls and potholes (Premosello-Chiovenda).

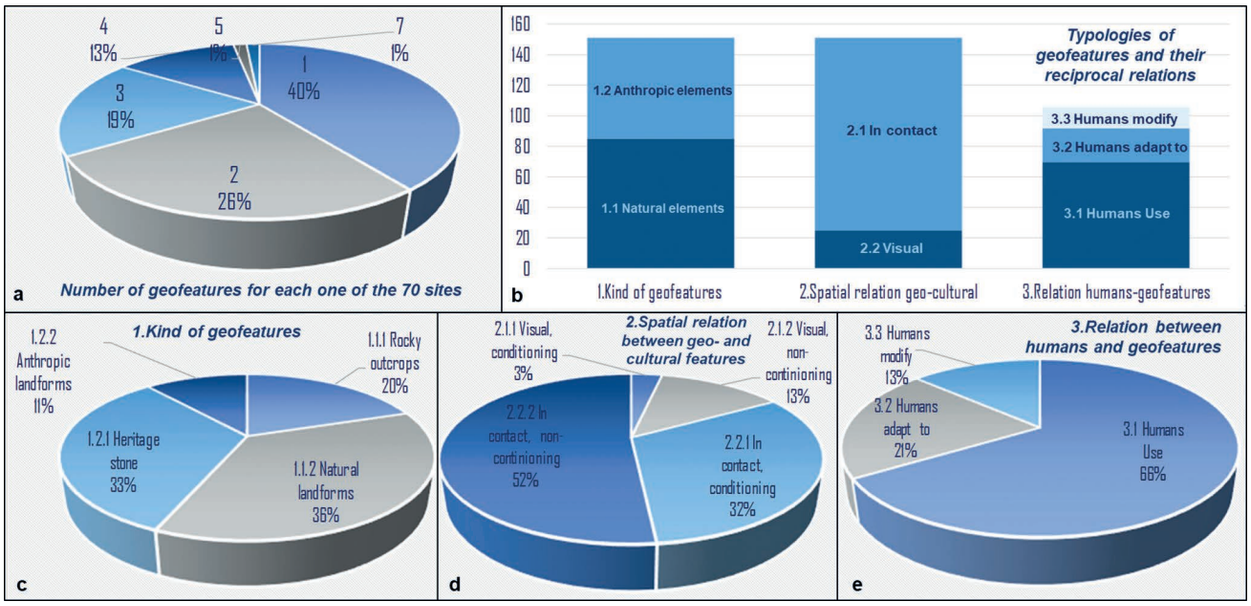


**Fig. 8** Graph summarizing the result of the classification of the 70 sites according to the criteria in figure 5. (a) Number of geofeatures for each site; (b) Distribution of geofeatures among the 3 steps of the classification; (c) Kind of geofeatures (petrography or geomorphology; natural or anthropic); (d) Spatial relation between geo- and cultural features; (e) Relation between humans and geofeatures.

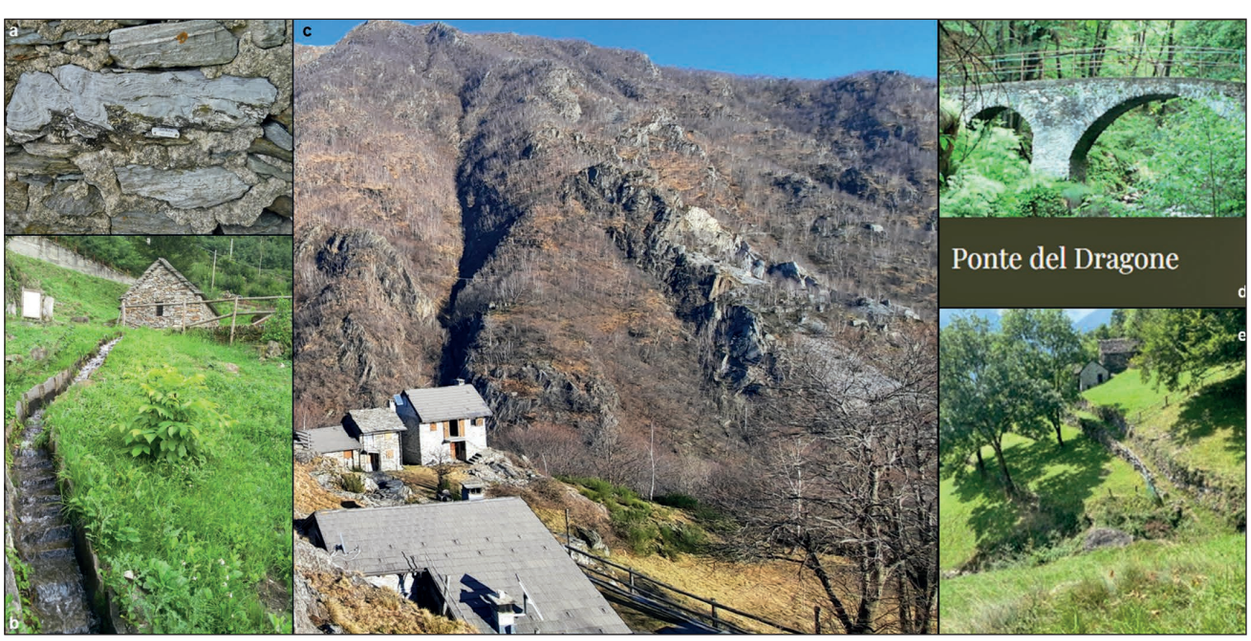


**Fig. 9** Examples of sites where the relationship between humans and geofeatures is evident – (a) Rocks from local outcrops used in building of mountain huts; (b) The use of water at the Rio Graglia watermill in the Trontano municipality; (c) The quarries in front of Alpe Marona in the Vogogna municipality; d) The Dragone bridge in the Aurano municipality; (e) Anthropic terraces at Colloro village in the Premosello Chiovenda municipality.

use of rocks as heritage stones for buildings (Fig. 9a), the use of water at water mills (Fig. 9b), and again the use of rocks in local quarries (Fig. 9c). They are hence georesources. The sites characterized by adaptation (e.g., bridges over a river Fig. 9d) and modification (e.g., terraces) are less abundant (21%; 22 elements; 13%; 14 elements respectively), but also significant.

Summarizing, the results obtained in this research suggest to plan, in the future, activities more specifically addressed to some categories of sites: heritage stones, natural landforms and sites in contact, as well as sites where people use geofeatures. These initiatives still regard the scientific research, but other suggestions emerge for an effective use of these data in the framework of the Comuniterrae project. What is really important is to calibrate the proposal to the end-user (Gordon et al. 2021).

Concerning local populations, the first step could be the organization of dedicated meetings to share the outcome of this research, discussing the

parameters considered for the classification and the possible integration of the geofeatures characterizing the assets inventoried within the community maps of each municipality. Maybe, after these meetings new ideas could also arise from the local population indicating other potential geocultural sites. Moreover, local people could also contribute to the monitoring of geocultural sites for detecting potential threats by natural and anthropic processes inducing damages (point c; Section 1), in the view of participatory approaches. These latter could be intended not only for allowing more punctual data collection about the site conditions (e.g., as for glaciers Pelfini and Leonelli 2014), but also for suggesting proper management strategies in the view of conservation (Kaur 2022). An interesting example is represented by the projects sponsored by Vegas et al. (2018): "Watch over a rock" or "Adopt a geosite". The project invites volunteers to take care of a geosite that could be a special place for them, in order to inform about any threat to the site. This kind of dialogue could be intended as a form of 'heritage revelation', namely the identification by geologists of the heritage value of geosites and sharing of information with an audience outside the geo-heritage specialists (Reynard and Giusti 2018): Comuniterrae participants, as in this case, or external visitors of the area (i.e., tourists). Also for this category, proposals could be done. The most immediate and potentially successful one could be the promotion within the Comunitours of the topic of geofeatures linked to the visited sites, as suggested for cultural tours at archaeo-cityscapes by Mariani and Melis (2022). This could increase the attractiveness of the area offering multidisciplinary thematic trails (Moroni et al. 2015; Melelli et al. 2016; Pijet-Migoń and Migoń 2022), as highlighted in the specific case of archeo-geosites (Moroni et al. 2015; Melelli et al. 2016; Taha and El-Asmar 2018). In addition to mutual enrichment, there could be an impulse towards the conservation and protection of both elements, overcoming the problem reported in the literature (Reynard and Giusti 2018; Taha and El-Asmar 2018), of comparatively minor interest of local populations towards the protection of natural heritage with respect to cultural heritage. The idea that a loss of cultural sites is a loss of the related geological site too, and vice versa, could be really strengthened in this way. Finally, since the survey also revealed that people are not really aware of the role of a UGGP for a territory, we think that the promotion of projects of this kind can help to clarify what the institution of a UGGP can do for the development of a territory like that of the Middle Lands.

## 3.1 Examples of application to selected geocultural sites

In the next sections two practical and different examples will be illustrated: the first one (3.1.1) aims at integrating geological and geomorphological features within a Comunitour offered by the Premosello-Chiovenda municipality; the second one (3.1.2) is a single site in the Aurano municipality, particularly meaningful for the link between natural hazards and immaterial goods (i.e., legends).

### 3.1.1 The "Alpeggi di Premosello" trail (Premosello-Chiovenda)

One of the sites selected to study the potential for mixing cultural, geological and geomorphological aspects is a path connecting some mountain pastures (Alpeggi "I Curt", "Curpic", "La Colla") scattered on the slope behind the Premosello-Chiovenda village (Fig. 3b). This trail was proposed as a Comunitour within the Comuniterrae Project in 2019. The Comunitour was essentially focused on presenting local traditions and ancient activities, since the pastures were used until the 1950s by local inhabitants. The "*Premosellese Mountain Consortium*" still takes care to clean the path as well as other agro-silvo-pastoral trails.

From our fieldwork during 2019 and 2021, accompanied by the study of rock samples and by geomorphological observations, we concluded that this trail offers numerous examples of interaction between geological and cultural elements. The main themes suitable for promotion are:

i) *The scientific value of the area to show the effects of geological and geomorphological processes (point e; Section 1)* – The selected path runs along the Insubric Line, a major fault which constitutes the contact between the Austroalpine Domain (to the NW), involved in the Alpine metamorphism, and the South Alpine Domain (to the SE), which preserves much older structures (Steck 2008, Steck et al. 2013) (Fig. 10a, b).
The first outcrops encountered along the path are granulites (metapelites and metabasites, Fig. 10c, d) and mantle peridotites (ultramafic rocks; Fig. 10e), belonging to the lower crustal Southalpine Ivrea Verbano Zone. They are followed by outcrops of phyllonites (Fig. 10f) mainly derived from Austroalpine gneisses, and metacarbonates (Fig. 10f), among which calcschists (Fig. 10g), derived from Permo-Triassic cover rocks interposed between the two main domains. This 'geodiversity' also gives the opportunity to show in more detail how the different lithotypes were differently affected by low temperature deformation related to the Line, according to their structural characters.
Furthermore, the proposed trail offers good examples of lithological and structural control on landscape evolution. Two litho-structurally-controlled saddles, one along the trail ("La Colla", the endpoint of this trail; Fig. 10a), and one visible from the trail itself ("La Colma di Premosello"), may be easily recognized in correspondence with the band of rocks more affected by the movements of the

Insubric Line. Moreover, they are both aligned with the glacio-structural saddle of the "Scaredi Hut", visible at some distance and linked too with the Insubric Line, and which is the arrival point of the *Loana Geotouristic Trail* (see below). Finally, the presence of carbonate rocks, more sensitive to erosion, allowed for the development of small, deeply incised valleys and karst features (i.e., local sinkholes; Fig. 10i). Similar bedrock and geomorphic features are visible along the *Loana Geotouristic Trail* located at the opposite side of the Val Grande National Park, in the Malesco municipality, outside the Comuniterrae area (https://ecomuseomalesco.it/anello-geoturistico-della-valle-loana/). The trail was equipped with panels in 2019 (Bollati et al. 2018; 2019; 2020). This similarity may offer insights on the spatial scale of geological processes and the potential common traits existing also among distant municipalities.

ii) *The influence of geomorphology on human settlements (point b; Section 1)* – The mountain pastures of "I Curt" and "Curpic" are located on morphological terraces (Fig. 10h), probably the remnants of ancient glacial terraces of Pleistocene glacier stages (Sacco, 1930), whereas the hut of "La Colla" lies within the above-mentioned litho-structural saddle. The panoramic viewpoints along the path (Fig.10a, b) are also suitable for discussing the evolution of local relief in relation to the general context of the Toce valley landscape.

iii) *The use of local geofeatures as georesources (point a, b; Section 1)* – The mountain huts are mostly built with rocks cropping out 'in situ' or in the immediate vicinity (Fig. 10j, k). These rocks were mainly used according to their characteristics: the phyllonites, which are schistose rocks easily splitting along flat surfaces, for roofing and other planar elements (e.g., seats or shelves protruding from the walls; Fig. 10k), and the very compact granulites and ultramafic rocks, in natural or just roughly squared blocks, for wall building (Fig. 10j). In addition, we also recognized blocks of orthogneiss, a lithology cropping out some tens of km upstream in the Ossola valley and exploited for centuries in numerous quarries. The blocks may represent quarry waste brought here specifically for construction purposes by the stonecutters residing in this area, or alternatively materials of the upper Ossola Valley, transported to this area by the Toce glacier. Following the indications of local inhabitants, we also discovered a possible lime kiln, probably located in correspondence of a natural sinkhole (Fig. 10i) developed in limestone cropping out near one of the pastures. A similar kiln, more developed and better preserved, recently refurbished and used for demonstration of lime production for schools and tourists, is located along the above-mentioned *Loana Geotouristic Trail* (Bollati et al. 2018; 2020).

As already discussed, the width of a geocultural site (in this case an area clustering several mountain pastures) determines the variety of geological and geomorphological features (i.e., local geodiversity). In this specific case the guideline is represented by the Insubric Line, the consequent geomorphological modelling and the cultural use of georesources, be they rocks or landforms, for specific uses. These types of topics are listed by Pijet-Migoń and Migoń (2022) among the potential link between geoheritage and cultural heritage (see Section 1).

### 3.1.2 The Brigalun landslide (Aurano)

This is one of the only 3 sites of geological type selected by the Comuniterrae participants (Fig. 7b), probably because this natural landform is linked to a legend told from generation to generation (point c, d; Section 1). It is a landslide located in the Aurano municipality (http://www.comuniterrae.it/luogo/frana-brigalun/) and classified in the Italian Landslide Inventory (IFFI) as quiescent, with a last reactivation in 2014 (ID 1035003300; https://idrogeo.isprambiente.it/app/iffi/f/1035003300), but with no data about its first occurrence. The date of 19 October 1863 indicated in the Comuniterrae website, is recorded in a memorial preserved in the Parish Archives of Aurano. The movement is of rockfall / toppling type and the crown is located along a ridge where micaschists and paragneisses are in contact with amphibolites, near a N-S oriented fault (Boriani et al., 1975). The detachment area is indicated with the names of Monte Brugherato (from 'brughiera', a kind of low and stunted vegetation like moor or heath) and Monte Nudo (naked), both recalling the idea of a surface not occupied by vegetation due to instability (source Catasto Teresiano, 1722; Sommarione, ACA, Catasto b.95). The name of the landslide (Brigalun) derives from *brigaà*, a local term meaning "big landslide" (Gagliardi 2016). A watermill was active at the foot of the slope, but it was damaged by the landslide and then abandoned (Gagliardi 2016). This site can be considered an active geomorphosite (Prosser et al. 2010; Pelfini and Bollati 2014), where geomorphic processes responsible for the site genesis are ongoing, potentially affecting cultural heritage (point c; Section 1).

The legend linked to this site is well rooted in the community culture (point d; Section 1). It attributes the landslide to the ghost of a priest that haunted the Scareno village. During the second half of the 16th century, padre Bartolomeo Caneva, a Jesuit, was asked to drive away the spirit. During its escape, the ghost hit the mountain slope provoking the landslide. The legend also says that the evil is still hidden inside the landslide body, and for this reason the movement is still active. Other similar legends are still alive in the area, to the point that even in recent times priests

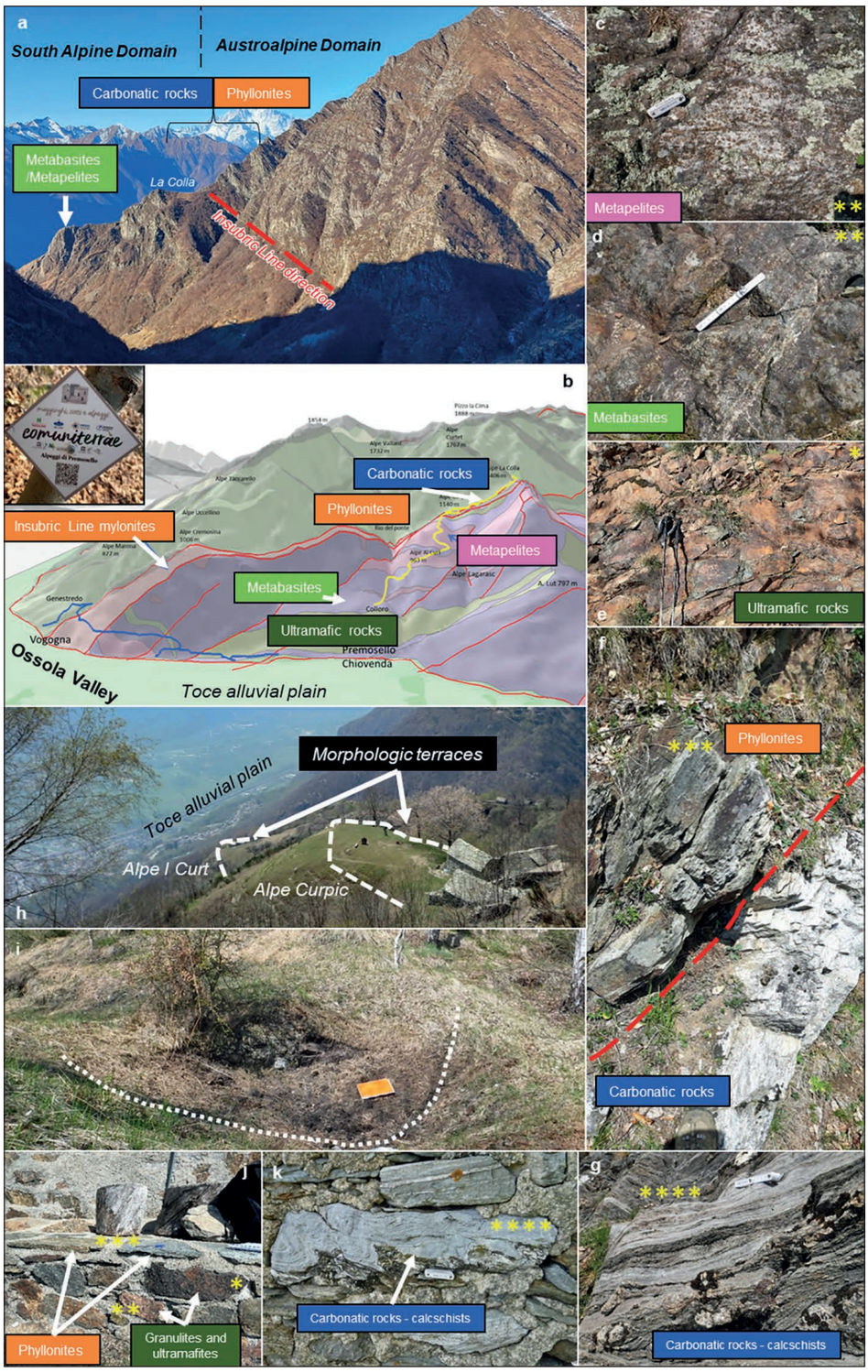


**Fig. 10** The Comuniterrae geocultural site "Alpeggi di Premosello"– a) Panoramic view on the structural saddle where the mountain hut "La Colla" is located, viewed from "La Colma di Premosello"; b) The 3D model with the geological map of the Val Grande National Park (source: shapefile courtesy of the Val Grande National Park) depicted on the Digital Elevation Model (5 m resolution, source: Geoportale Regione Piemonte) using the ArcScene software and the QR Code of the Comunitour; c, d) Metapelites and metabasites of the Ivrea-Verbano Zone near "I Curt" and "Curpic"; e) Ultramafic rocks cropping out in the Colloro village; f) Tectonic contact between phyllonites, testifying for deformation along the Insubric Line, and carbonatic rocks at "Curpic"; g) Calcschists near "La Colla"; h) Morphological terraces where the pastures of "I Curt" and "Curpic" are settled; i) Sinkholes used as lime kilns by mountain inhabitants; j, k) The use of local rocks (phyllonites and ultramafic rocks, j; calcschists, k) as architectural elements in Alpine huts at "I Curt". The yellow stars and the respective numbers link the rocks used in the buildings to their outcrops in the surrounding area.

have blessed the mountain to avoid further disasters (Chiaberta 2000; Gagliardi 2016).

The connection between the physical conditions predisposing the slope to landsliding and the legend passed down, could be an interesting starting point for the institution of a geocultural site. As demonstrated in many other situations (Coratza and De Waele 2012; Migoń and Pijet-Migoń 2019; Forno et al. 2022), a geocultural site like this could be a useful tool for raising awareness of local inhabitants in the hazardous dynamics deriving from natural processes, taking care of preserving the traditional believing.

## 4. Concluding remarks

Geoheritage, as other types of natural heritage, can be considered as part of the cultural heritage, in a broad sense, of a society, a nation or humankind (Panizza and Piacente 2003). According to Pijet-Migoń and Migoń (2022), geoheritage sites may "show an additional value associated with cultural heritage. However, the relationship can be also in reverse, in that cultural values are considered as superior, but this should not lead to the neglect of geodiversity and geoheritage aspects at these sites." This concluding message is strongly sustained by the results of the present research, depicting very relevant geocultural sites where the geological and geomorphological features deeply influenced the settlements of cultural sites. The Comuniterrae project, initially born to highlight the cultural heritage of a territory, the Middle Lands, and its change through time (Bagnati and Perlo 2020), could hence widen the view to the concept of geocultural site, thus increasing awareness in both local populations or external visitors towards geocultural heritage and natural and human dynamics mining its preservation. As highlighted by Gordon et al. (2021), if people understand different values that geodiversity and geoheritage may have, they could feel a deeper connection with them, more likely viewing them as assets to be managed sustainably (see also Reynard and Giusti 2018). Moreover, sustainable promotion and conservation of geocultural sites may be favored through participatory approaches, involving local populations in data collection and proposing management strategies, allowing a constant monitoring of the cultural heritage in a territory by local inhabitants, aware of its value and of the threats potentially damaging it (Pelfini and Bollati 2014). The link between geodiversity and cultural landscape, especially people's cultural roots and sense of place (Variale et al. 2022), can help in boosting a holistic approach to Nature, including geoheritage among the cultural assets s.s. (Gordon et al. 2021). Concluding, the *place-base aesthetic* and *emotional experiences*, as those offered in the case studies described in this text, are key elements, prerogative of geocultural sites.

## Appendix

See Supplementary Material A (available online) including the list of the 70 sites selected for this research with the classification according to the 3 criteria.

## Acknowledgements

The Authors are particularly grateful to the people and the Authorities of the municipalities involved in the Comuniterrae project.

This work was supported by the University of Milan [grant number RV_TAR16VCAIR_M] and by a liberal donation [grant number LIB_VT20IBOLL].

## References

Bagnati, T., Perlo, F. (2020): ComuniTerrae. Dai Luoghi alla Comunità. In: Gisotti M.R. Rossi, M., Territori e comunità. Le sfide dell'autogoverno comunitario, Atti VI° Convegno della Società dei Territorialisti Castel del Monte (BA), 15–17 Novembre 2018, 26–36, Collana Ricerche e studi territorialisti. Available online: https://www.societadeiterritorialisti.it.

Bizzarri, R., Melelli, L., Cencetti, C. (2018): Archaeo-geosites in urban areas: A case study of the etruscan Palazzone Necropolis (Perugia central Italy). Alpine Mediterranean Quaternary 31, 1–12, https://doi.org/10.26382/AMQ.2018.15.

Bollati, I. M., Della Seta, M., Pelfini, M., Del Monte, M., Fredi, P., Palmieri, E. L. (2012): Dendrochronological and geomorphological investigations to assess water erosion and mass wasting processes in the Apennines of Southern Tuscany (Italy). Catena 90, 1–17, https://doi.org/10.1016/j.catena.2011.11.005.

Bollati, I. M., Smiraglia, C., Pelfini, M. (2013): Assessment and selection of geomorphosites and trails in the Miage Glacier Area (Western Italian Alps). Environmental Management 51(4), 951–967, https://doi.org/10.1007/s00267-012-9995-2.

Bollati, I. M., Crosa Lenz, B., Zanoletti, E., Pelfini, M. (2017): Geomorphological mapping for the valorization of the Alpine environment. The case study of the Loana Valley (Western Italian Alps). Journal of Mountain Science 14(6), 1023–1038, https://doi.org/10.1007/s11629-017-4427-7.

Bollati, I. M., Reynard, E., Cagnin, D., Pelfini, M. (2018): The enhancement of cultural landscapes in mountain environments: An artificial channel history (Torrent-Neuf, Canton Valais, Switzerland) and the role of trees as natural archives of water flow changes. Acta Geographica Slovenica 58(2), 87–100, https://doi.org/10.3986/AGS.4137.

Bollati, I. M., Crosa Lenz, B., Zanoletti, E. (2019): A procedure to structure multidisciplinary educational fieldworks for understanding spatio-temporal evolution of the Alpine landscape. Rendiconti On-Line della Società Geologica Italiana 49, 10–18, https://doi.org/10.3301/ROL.2019.46.

Bollati, I. M., Crosa Lenz, B., Caironi, V. (2020): A multidisciplinary approach for geomorphological landscape analysis: scientific value and risk of degradation of outstanding landforms in the glacial plateau of the Loana Valley (Central-Western Italian Alps). Italian Journal of Geosciences 139(2), 233–251, https://doi.org/10.3301/IJG.2020.01.

Boriani, A., Bigioggero, A., Origoni Giobbi, E. (1975): Carta geologica della zona di Verbania (Lago Maggiore, provincia di Novara). Memorie di Scienze geologiche XXXII, 1 map, 1 : 50,000.

Brandolini, F., Cremaschi, M., Pelfini, M. (2019): Estimating the potential of archaeo-historical data in the definition of geomorphosites and geo-educational itineraries in the central Po plain (N Italy). Geoheritage 11(4), 1371–1396, https://doi.org/10.1007/s12371-019-00370-5.

Brilha, J. (2018): Geoheritage: Inventories and Evaluation. In: Reynard E., Brilha J. (Eds.), Geoheritage, Elsevier, Amsterdam, 69-85, https://doi.org/10.1016/B978-0-12-809531-7.00004-6

Canuti, P., Margottini, C., Fanti, R., Bromhead, E. N. (2009): Cultural heritage and landslides: research for risk prevention and conservation. In: Canuti P., Sassa K., Landslides–disaster risk reduction, Springer, Berlin, 401–433, https://doi.org/10.1007/978-3-540-69970-5_22.

Cerutti, S. (2019): Geografie perdute, storie ritrovate: percorsi di partecipazione e sviluppo locale nelle Terre di Mezzo. Rivista geografica Italiana, CXXVI, 57–80, https://doi.org/10.3280/RGI2019-003003.

Cerutti, S. (2020), Narrare, mappare, partecipare: esperienze di confine tra emozione, arte e scienza. In: Zilli S., Modaffari G. (Eds), Confin(at)i/Bound(aries). Società di Studi Geografici. Memorie geografiche NS 18, 63–73.

Chiaberta, P. (2000): Non è vera ma è così. Tararà Ed., Verbania, 97–98.

Clifford, S., King, A. (1996): From Place to Place: Maps and Parish Maps. London: Common Ground.

Clivaz, M., Reynard, E. (2018): How to integrate invisible geomorphosites in an inventory: A case study in the Rhone River valley (Switzerland). Geoheritage 10(4), 527–541, https://doi.org/10.1007/s12371-017-0222-7.

Coratza, P., De Waele, J. (2012): Geomorphosites and natural hazards: teaching the importance of geomorphology in society. Geoheritage 4(3), 195–203, https://doi.org/10.1007/s12371-012-0058-0.

De Wever, P., Baudin, F., Pereira, D., Cornée, A., Egoroff, G., Page, K. (2017): The importance of geosites and heritage stones in cities – a Review. Geoheritage 9, 561–575, https://doi.org/10.1007/s12371-016-0210-3.

Forno, M. G., Gianotti, F., Gattiglio, M., Pelfini, M., Sartori, G., Bollati, I. M. (2022): How Can a Complex Geosite Be Enhanced? A Landscape-Scale Approach to the Deep-Seated Gravitational Slope Deformation of Pointe Leysser (Aosta Valley, NW Italy). Geoheritage 14(3), 1–33, https://doi.org/10.1007/s12371-022-00730-8.

Fouache, E., Ecochard, E., Kuzucuoğlu, C., Carcaud, N., Ekmemekçi, M., Ulusoy, I., Cinener, A., Des Courtils, J. (2012): Palaeogeographical reconstruction and management challenges of an archaeological site listed by UNESCO: the case of the Letoon shrine in the Xanthos Plain (Turkey). Quaestiones geographicae 31(1), 37–49, https://doi.org/10.2478/v10117-012-0002-z.

Fouache, E., Rasse, M. (2009): Archaeology, geoarchaeology and geomorphosite management: towards a typology of geoarchaeosites. In: Reynard E., Coratza P., Regolini-Bissig G. (Eds.) Geomorphosites, Pfeil, München, 213–223.

Gagliardi, M. (2016): La frana del Brigalun. Enchiridi della Valle Intrasca, Puntolinea Ed., Verbania.

Gordon, J. E. (2018a): Geoheritage, geotourism and the cultural landscape: Enhancing the visitor experience and promoting geoconservation. Geosciences 8(4), 136, https://doi.org/10.3390/geosciences8040136.

Gordon, J. E. (2018b): Geotourism and cultural heritage. In: Dowling R., Newsome D. (Eds.), Handbook of geotourism, Edward Elgar Publishing, Cheltenam, 61–75, https://doi.org/10.4337/9781785368868.00013.

Gordon, J. E., Crofts, R., Gray, M., Tormey, D. (2021): Including geoconservation in the management of protected and conserved areas matters for all of nature and people. International Journal of Geoheritage and Parks 9(3), 323–334, https://doi.org/10.1016/j.ijgeop.2021.05.003.

Gray, M. (2004): Geodiversity: valuing and conserving abiotic nature. John Wiley, Sons, Chichester.

Gray, M., Gordon, J. E., Brown, E. J. (2013): Geodiversity and the ecosystem approach: the contribution of geoscience in delivering integrated environmental management. Proceedings of the Geologists' Association 124(4), 659–673, https://doi.org/10.1016/j.pgeola.2013.01.003.

Kaur, G. (2022): Geodiversity, Geoheritage and Geoconservation: A Global Perspective. Journal of the Geological Society of India 98(9), 1221–1228, https://doi.org/10.1007/s12594-022-2156-1.

Lahmidi, S., Lagnaoui, A., Adnani, A.E., Berrada, I., Saadi, M., Bahaj, T. (2022): Integrating Geological and Archaeological Heritage for Conservation and Promotion of Foum Larjamme Geosite from Bani Geopark Project South-Eastern Morocco. Geoheritage 14(3), 1–20, https://doi.org/10.1007/s12371-022-00718-4.

Mariani, G. S., Melis, R. T. (2022): The Potential for Valorisation of Archaeo-geosites Through Climate Change: Exploratory Study of the Nora Site (Sardinia, Italy). Geoheritage 14(4), 1–15, https://doi.org/10.1007/s12371-022-00759-9.

Melelli, L., Bizzarri, R., Baldanza, A., Gregori, L. (2016): The Etruscan "Volumni Hypogeum" archeo-geosite: New sedimentological and geomorphological insights on the tombal complex. Geoheritage 8(4), 301–314, https://doi.org/10.1007/s12371-015-0162-z.

Migoń, P., Pijet-Migoń, E. (2017): Viewpoint geosites – Values, conservation and management issues. Proceedings of the Geologists' Association 128(4), 511–522, https://doi.org/10.1016/j.pgeola.2017.05.007.

Migoń, P., Pijet-Migoń, E. (2019): Natural disasters, geotourism, and geo-interpretation. Geoheritage 11(2), 629–640, https://doi.org/10.1007/s12371-018-0316-x.

Moroni, A., Gnezdilova, V. V., Ruban, D. A. (2015): Geological heritage in archaeological sites: case examples from Italy and Russia. Proceedings of the Geologists' Association 126(2), 244–251, https://doi.org/10.1016/j.pgeola.2015.01.005.

Nesci, O., Borchia, R. (2017): Landscapes and landforms of the Duchy of Urbino in Italian renaissance paintings. In: Soldati M., Marchetti M. (Eds.), Landscapes and

Landforms of Italy, Springer, Cambridge, 257–269, https://doi.org/10.1007/978-3-319-26194-2_22.

Niculiță, M., Mărgărint, M. C. (2018): Landslides and fortified settlements as valuable cultural geomorphosites and geoheritage sites in the Moldavian Plateau, North-Eastern Romania. Geoheritage 10(4), 613–634, https://doi.org/10.1007/s12371-017-0261-0.

Panizza, M. (2001): Geomorphosites: concepts, methods and examples of geomorphological survey. Chinese Science Bulletin 46(1), 4–5, https://doi.org/10.1007/s12371-017-0261-0.

Panizza, M., Piacente, S. (2003): Geomorfologia culturale, Pitagora Ed., Bologna.

Pelfini, M., Bollati, I. M. (2014): Landforms and geomorphosites ongoing changes: Concepts and implications for geoheritage promotion. Quaestiones geographicae 33(1), 131–143, https://doi.org/10.2478/quageo-2014-0009.

Pelfini, M., Leonelli, G. (2014): First results of the participatory approach for monitoring supraglacial vegetation in Italy. Geografia Fisica e Dinamica Quaternaria 37(1), 23–27, https://doi.org/10.4461/GFDQ.2014.37.3.

Pelfini, M., Brandolini, F., D'Archi, S., Pellegrini, L., Bollati, I. M. (2021): Papia civitas gloriosa: urban geomorphology for a thematic itinerary on geocultural heritage in Pavia (Central Po Plain, N Italy). Journal of Maps 17(4), 42–50, https://doi.org/10.1080/17445647.2020.1736198.

Perotti, L., Bollati, I. M., Viani, C., Zanoletti, E., Caironi, V., Pelfini, M., Giardino, M. (2020): Fieldtrips and virtual tours as geotourism resources: examples from the Sesia Val Grande UNESCO Global Geopark (NW Italy). Resources 9(6), 63, https://doi.org/10.3390/resources9060063.

Pijet-Migoń, E., Migoń, P. (2022): Geoheritage and cultural heritage – a review of recurrent and interlinked themes. Geosciences 12(2), 98, https://doi.org/10.3390/geosciences12020098.

Prosser, C. D., Burek, C. V., Evans, D. H., Gordon, J. E., Kirkbride, V. B., Rennie, A. F., Walmsley, C. S. (2010): Conserving geodiversity sites in a changing climate: management challenges and responses. Geoheritage 2(3), 123–136, https://doi.org/10.1007/s12371-010-0016-7.

Reynard, E., Giusti, C. (2018): The landscape and the cultural value of geoheritage. In: Reynard, E., Brilha, J. (Eds.), Geoheritage, Elsevier, Amsterdam, 147–166, https://doi.org/10.1016/B978-0-12-809531-7.00008-3.

Sacco, F. (1930): Il glacialismo nelle valli Sesia, Strona, Anza e nell'Ossola. Memoria. Provveditorato generale dello Stato.

Steck, A. (2008): Tectonics of the Simplon massif and Lepontine gneiss dome: deformation structures due to collision between the underthrusting European plate and the Adriatic indenter. Swiss Journal of Geosciences 101(2), 515–546, https://doi.org/10.1007/s00015-008-1283-z.

Steck, A., Della Torre, F., Keller, F., Pfeifer, H. R., Hunziker, J., Masson, H. (2013): Tectonics of the Lepontine Alps: ductile thrusting and folding in the deepest tectonic levels of the Central Alps. Swiss Journal of Geosciences 106(3), 427–450, https://doi.org/10.1007/s00015-013-0135-7.

Summa, A. (2009): La percezione sociale del paesaggio: le Mappe di Comunità, Il progetto dell'urbanistica per il paesaggio. Atti della XII Conferenza Nazionale della Società Italiana degli Urbanisti, Bari, 19-20 Febbraio 2009, 1–5. Available online: http://www.diss.uniroma1.it/moodle2/pluginfile.php/6832/mod_resource/content/1/5%20Summa%20Mappe%20di%20comunit%C3%A0.pdf.

Taha, M. M., El-Asmar, H. M. (2018): Geo-archeoheritage sites are at risk, the Manzala Lagoon, NE Nile Delta Coast, Egypt. Geoheritage 11, 441–457, https://doi.org/10.1007/s12371-018-0297-9.

Thornbush, M. J., Allen, C. D. (2018): Urban geomorphology: Landforms and processes in cities. Elsevier, Amsterdam.

Varriale, R., Genovese, L., Aldighieri, B. (2022): "Diffused Geoparks": Territorial Integration as Solution for a Shared Sustainable Growth Based on Geotourism in Italy, Japan and Tunisia. Heritage 5(3), 2083–2105, https://doi.org/10.3390/heritage5030109.

Vegas, J., Cabrera, A., Prieto, A., Díez-Herrero, A., García-Cortés, A., Díaz-Martínez, E., Salazar, A. (2018): 'Watch over a rock', a Spanish programme towards geosite stewardship. In: Głowniak, E., Leonowicz, P., Wasiłowska, A., Geologii, W., IX ProGEO Symposium: Geoheritage and Conservation: Modern Approaches and Applications Towards the 2030 Agenda, Chęciny, Poland, 25–28 June, 2018, Programme and Abstract Book, 141.

Vitaliano, D. B. (2017): Geomythology: geological origins of myths and legends. Geological Society, London, Special Publications 273(1), 1–7, https://doi.org/10.1144/GSL.SP.2007.273.01.01.

Watkinson, D., Corfield, M. (2008): SITES | Conservation and Stabilization. In: Pearsall D.M., Encyclopedia of Archaeology, Academic Press, Elsevier, Amsterdam, 2004–2013.