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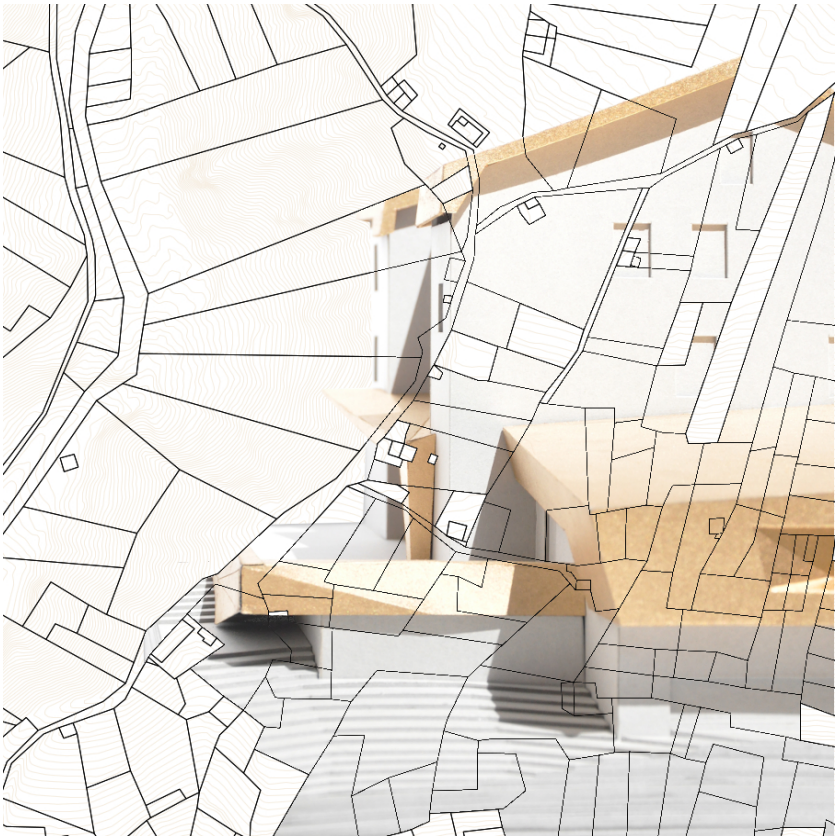
Riccardo Giacomelli

DESIGN HIGH | HERITAGE IN TRANSITION

Classification and design tools for alpine isolated building systems



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Classification and design tools for alpine isolated building systems

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INTRODUCTION

The Alps consist in a geographical and morphological complex system, with which man interfaced for thousands of years. The relationship between man and the Alps is complex, and constantly evolving, becoming a space for conquest and comparison under different profiles of human action.
Each phase of confrontation leaves signs that as architects we must contextualize and understand within a stratification process that defines the landscape palimpsest.
This thesis aims to treat a coherent family of these signs: isolated alpine buildings, as significant elements built by man to anthropize the mountain and make it capable of responding to specific needs in precise time spans.
Among all the buildings built by man in the alpine context, the thesis aims to deepen those artefacts that present a scattered settlement dynamic, where the sign of man finds himself in direct dialogue with the environment, without the filter of the building curtain, those artefacts that dialoguing with the slope find their own identity.
They are rare buildings, far from inhabited centres, often connected to specific and seasonal uses of the mountain, uses linked to professions and human passions that translated technical needs into landscape figures.

In the first chapter of this thesis will be given a theoretical point of view on the historical development of mountain perception passing through the evolution in human possible relations with high lands.
Change always has been influenced both by inside and outside factors, building a domestication of lands in connection to alpine tourist locations and the increasement of mountaineering activities.
Mountain communication is helped by the continuous innovation in the forms of representation directly or indirectly influencing the construction of a stereotyped image of alpine architectures.
The section ends with an interpretation of echoes from the “Alpine Architecture” by Bruno Taut edited at the beginning of XX century, describing his utopic vision of mountain architecture. Building a

relation with alpine refuges' actual development, it represents a way to interprete heritage conservation and proposals for the future.

In the second chapter the theoretical language gives space to a scientific approach on the research in order to build a series of tools for the quantitative and qualitative data analysis, helping the choice of the alpine architectures' evolution dynamic.
The distribution of high mountain buildings in national context has been at first examined, georeferencing the mountain heritage of the Italian Alpine Club and building a central database for the same institution.
This action gives place to the analysis of geographic data, developing digital GIS maps presenting environmental, cultural, infrastructural information focused on each refuge in the Province of Trento (Italy). Furthermore, specific case studies will be presented that have seen the experimental use of the built GIS system of analysis.
The research continued studying the theme of seasonability, applying GRASS analysis on the refuges located in the defined area of the Brenta Dolomites (Trentino – Italy). Conseguences of climate change and different ways of mountain fruition lead in fact to think to the possibility of extending the opening periods for those refuges located in high alpine territory.

The thesis deals with the outcomes of two different activities generating isolated alpine buildings: alpicolture and mountaineering. In both these anthropic practices, buildings become technical devices for dealing with ascension.
Altimetry and access times guide the choice of the location of isolated alpine buildings, both to satisfy the seasonality of mountain animal husbandry and to allow the achievement of the peaks.
Refuges, bivouacs and cabins are three building typologies linked by the definition of isolated alpine buildings; three different logics of landscape infrastructure deepened in the last two chapters of this doctoral thesis.
These buildings will be analysed, through the lens of the image, as a narrative analysis, and the design, capable of linking the general dimension to the singular one, moving from network analysis to the project for the single artefact.
The built research methodology is based on single case studies referring to each of the three mountain building typologies. Working on a single

building gives the opportunity to underline the variations within the considered distinguishing strategic values and their territorial networks, considering them on various scales - regional, interregional, national, transnational - getting closer to similar landscape systems.

Qualitative and quantitative analysis results assume a central role in the construction of a digital landscape, creating a space where the single data can be questioned and it's the user that can select the character to be focused on. It is important to consider the maps as subjective representations, in awareness that is just one of the possible outputs for the results of the research. Building a digital landscape is a strategic element in the replicability of the methodology of this research, facilitating the visualization and consultation of georeferenced data and system values. Within the limit given by the availability and updating of the chosen data, applying this research methodology gives the possibility to elaborate a complex system of analysis that favour the choice of project solutions able to interact with their landscape context, involving antropic, environmental, economic, management features in a scenary of contemporary sustainable development.

1. THEORETICAL FRAMEWORK

Introducing the argument of alpine isolated buildings actual development, a theoretical framework is first presented, concerning an historical analysis on the representation and perception of mountain anthropized landscape and, more specifically, the context of european alpine chain.

Starting from the definition of the subject of the research – isolated alpine buildings – will be defined the distintion into agricultural and alpinistic structures, and deepened the historical evolution of this mountains' perception passing through diverse epochs, meanings and designs that influenced and generated actual projects throughout the Alps.

This first chapter assume the role of theoretical reference for the research methodology, evolving in the next chapters to the main adoption of digital tools. Both theoretical and digital systems of analysis are involved as references in the on-site research application, helping the construction of different scenaries for the evolution of mountain buildings, presented in the last chapters of the thesis.

Theoretical analysis played an important role in the choice of the building typologies to be included in the research, involving not only alpinistic buildings but also agricultural ones, according to the evolution in the economic alpine system and the necessity of a reorganisation of building heritage for actual uses.

The impact of mountain imaginary attracting external interest since the beginning of mountain excursion activities is main subject of this framework, and alpine architecture – between functionalism and utopia - becomes central in the social idea of alpine landscape. In the evolution that is expected, aiming at sustainability of mountain fruition, is it possible to find a balance between historic, architectural, economic, environmental and cultural values?

1.1. Defining Isolated Alpine Buildings

In the Alpine architectural landscape three main building categories are considered: rural cabins, bivouacs, refuges.
These subjects are very close together representing the image of the Alps, the idea of rurality, difficult climbings and sublime landscapes. The case studies follow presented in the thesis will define the categories in two groups of buildings: linked with agricolture activity (chapter 3) and with alpinism (chapter 4). The focus on marginal building heritage possibly includes examples with easier access or strenght relation with main urbanized areas, but the differences between anthropization and tourism evolution all along the alpine chain can sometimes centralize some of the buildings included in the analysed categories.

The presence of men in this mountain chain, now very vocated to the tourism sector, take its roots in agricolture and forestry. The choice to include the architectures of cabins, actually redirecting their existence to minor tourist sector, is important in the recognition of a relation between landscape and building methods.
In a situation of lower altitude respect to other Isolated Alpine Buildings, we find the alpine cabins that can be considered point of support consisting in permanent buildings, generally generated with restoration or recovery interventions on existing buildings typical of mountain pasture landscape, such as unused stables, cabins, huts. This interventions help to save a traditional mountain landscape, where this buildings represent a landmark for historical agricultural activities.

Recognition of an alpine agricoltural landscape with specific characters and ideal images, underlines the architectural and hystorical difference with higher buildings linked to rock and elevation (subchapter 2.2.1), opening to possible diverse building solutions.
Refuges and bivouacs, the other building categories that will be central in this research, can be considered part of the common heritage and, in the higher altitudes of the Alps, are generally owned by non-profit private collectivities like the Alpine Clubs.
The heritage represented by mountain refuges can be considered just one part of the heritage of mountain fruition infrastructure, but the most known. A refuge is a building finalized to the activities of alpinism, mountaneering, climbing, hiking, organized to offer ospitality,

considering it just a stop for eating or a stay for night with the connected services.

An alpine refuge is a self-sufficient technical solution able to protect mountaineers against atmospheric agents and an isolated building characterized by important consistency, mostly located in remote and weakly connected high mountain areas.

The Italian Alpine Club (CAI) owns an heritage of 363 refuges with 21.000 beds, refuges represent two thirds of the total amount of CAI buildings and nine tenth of CAI beds. Generally are opened and managed during summer months and, if the location is accessible in winter months, a part of the building or a separate smaller building can be organized as emergency winter bivouac.

The permanent bivouac is a technical manufact realized to help alpinistic activities and protect mountaineers against atmospheric agents. It has small dimensions with the possibility to host from 6 to 12 fruitors. It's generally located in highest lands of mountain chains, fruited for classic alpinism, used as base for longest climbs or high altitude long hikes. It's shape has been generally characterized by a prototype easy transportable and assemblable at high altitude by the same mountaineers. Nowadays technology permit different forms and possibilities thanks to the use of flying transports.

But the nature of bivouac is not changed, this building can bee free used without booking and are always open to the visitor. Looking to CAI heritage, the numer of bivouacs is 229 with 2.080 beds. They represent one third of CAI buildings and one tenth of CAI beds.

1.2. Alps and architecture

Evolution of Alpine space is guided by transformations due to endogenous and exogenous factors. Climate changes and the human forms of colonization in their ongoing dialogue with nature produce a complex palimpsest that we call landscape.
Significant interactions between environment and anthropization processes characterize the Alps. It is a major mountain chain for environmental, historical, cultural and relational values [W. Bätzing, 2003]. Their barycentric position has governed for centuries the systems of connection between northern and southern Europe. The ambivalent reality of this territory, among connective natural fabric and interspace of marginality, generated over the centuries an alternating flow of communication between the intra and extra Alpine spaces and economies, transmitting different forms of representation and interpretation of the same territory.
From outsiders the Alpine chain can be recognized as a unique landscape, acting a synthesis of complex and contradictory factors. In this delicate system of interactions, the urban transformations play an important role because of the amplified three-dimensional perception of space and for the conflicts they generate in relation to other forms of land use. Such conflicts are amplified in Alpine mountain regions by the general lack of soils presenting easy accessibility and profitability conditions. Urban transformations are charged with a number of meanings that grow with the history of the places and the rarefaction of settlement systems [E. Ferrari, G. Moretti, 2003], in which prevails the direct relationship between artefact and natural environment.
Within a global debate on the weight of human community action on the earth, it is relevant to open a reflection on the role of architectural project, even if it's limited to the context of the Alpine region.
Architecture is conveyed to meet the defined need to complete a general view of the landscape, it cannot escape from being an action causing physical and cultural transformation, weakly reversible, of the territorial palimpsest. Furthermore, the architectural design becomes an actor of a continuous process of innovation, dealing with both its own technical and disciplinary tools [C. Lamanna, 2008] together with the collective imaginary and the expectations generated by them. These general considerations assume different levels of intensity in time and

Figure 1. Piedmont village of Paraloup

Figure 2. Voralberg promotion: holiday + architecture

space, depending on the specific socio-cultural, historical and environmental conditions of the territory.

Current generations inherit a large building heritage widely under-utilised, descendent from the super-construction processes of certain locations and, on the other side, from mass depopulation of many Alpine communities. Today this heritage is characterized by a low degree of specificity and by a high linguistic and technological homogenization rate, rooted in the success and good fortune of the picturesque image of the Alps in the first XIX century. This building stock has effectively legitimized, through a delicate relationship between tradition and innovation, the crystallization of some formal aspects of the spontaneous alpine agricultural architecture. This led to a gradual loss in the relationships type-figure and type-scale, accompanied by the progressive abandonment of mountainside agriculture and forestry practices.

Figure 3. Agricultural alpine landscape, Canzolino – Pergine Valsugana (6 march 2016), [Giacomelli, R.].

Today the issue of sustainability, as ability to find a balance between environmental, economic and social dimensions in the anthropic processes aimed to ensure the longevity of the systems of life and opportunities to future generations, is taking a central role also in relation to the growing population the globe and the unequal division of resources.

This scenario requires more consideration when using available resources and the planner needs to reconsider the significance of existing building heritage. The restoration of historical heritage can have an end in itself or open to the opportunity of creating a new

semantic, capable of holding together past testimonies and innovative technical regulation instances. In Alpine region different, sometimes contradictory, attitudes for renewal operate on the building stock taking as examples the restore of the ruins of the towns of Ostana and Paraloup in Piedmont, or the widespread proposals of renovated semantics in the Swiss confederation, Voralberg and Italian South Tyrol. The architectural project becomes the intermediary to show different technological and technical solutions, in a continuous dialectical confrontation between the different attitudes towards change, continuing the paradigm of building process established in the Alps since the beginning of XX century.

Some categories of artifacts assume a relevant value in building local identities, and involve in direct and indirect forms a large number of stakeholders, as it happens for the common goods. From this point of view are emblematic, among others, the debates following the publication, in 2012, of the results of the design competition for the renovation of the three South Tyrolean refuges: Ponte di Ghiaccio, Pio XI and Vittorio Veneto al Sasso Nero.

Figure 4. Refuge Ponte di Ghiaccio, South Tyrol (Italy)

Figure 5. Refuge PioXI, South Tyrol (Italy)

Figure 6. Refuge Vittorio Veneto al Sasso Nero, South Tyrol (Italy)

The South Tyrolean community, who sees in architecture a strong element of identity [V. Curzel, 2013], and that historically has expressed a high level in architectural production, highly questioned himself on what should be the limit between the material preservation of an identified heritage in high altitude and a new semantic of it which takes account of the technical instances, regulations and procedural guidelines of a new building. The case of South Tyrolean refuges underlines that the value of public art architecture [L. Valeriani, 2004], could assume multiple meanings that transcend the boundaries of the discipline, making it difficult to control with the only instruments of design and planning. In this sense, the communication of the image of architecture as a characterized element of the landscape, is an important decoder and interpretation key [A. Cecchetto, 1998] related to the contemporary trend moving towards the definition of an architecture for the Alps. It is in fact in place a relevant phenomenon of self-identification of a large number of geographically-based architects and designers, recognized both in terms of scientific production [A. De Rossi, R. Dini, 2012] as well as in the new government and development of planning tools for the Alpine landscape [D. Donegani, G. Lauda, 2015], also named the *Contemporary Alpine Architecture*. Important initiatives, such as seminars, international conferences, forms

of free association, awards and publications, recognize in the territorial architectural significance a potential self-centred resource for development [G. A. Caminada, 2006].

It is therefore important to investigate the historical role of architecture in the composition of the image of the Alps [A. De Rossi, 2014], in order to understand their meanings, influences and processes that underline the rules for implementation and transformation of the mountain building heritage [M.C. Giuliani, 2002].
The collective imaginary transferred to intra and extra-alpine populations through various forms of romantic representations is still latent in the evaluation of proposals that aims to transform the landscape palimpsest [J.A. Garcia-Esparza, 2013]. In this scenario, the architectural design, from the modern period onwards, held a dialogue with the tradition, without finding a morphological and figurative unanimous approach, but generating a wide variety of solutions [A. De Rossi, R. Dini, 2012] resulting from the same ambiguity in the discipline. Following the growing interest towards the alpine territory, research and architectural production in the Alps mainly focused in the analysis and development of building types oriented to tourism, favouring a widespread perception of the Alps as "the playground of Europe" [L. Stephen, 1878].
Alpine space and its architectural production, have had a general progression from an introspective and exclusive pre-romantic dimension, to the contemporary dimension, inclusive and mainly oriented to increase tourism intensity and attractiveness [L. Bolzoni, 2000-2001]. This development has had a stronger dimension into large tourist winter resorts, while the crisis of the Alps as a place for living is still distinguishing in many mountain areas, indicating a substantial fragility of the system muted in facing climate changes.

On the other hand, the development of rural architecture was linked to the evolution of the socio-economic forms of each community and Alpine enclave, without impositions or pre-coded linguistic forms. The shapes of the landscape were physical expressions of the forms of self-sufficiency and general lack of arable land, that pushed also to the use of soils with reduced profitability in order to ensure land provision.
The seasonal use of isolated alpine buildings becomes a central subject in the codified communication of the Alps started in XIX century but,

at the same time, it began to suffer from economic changes and new opportunities related to the growing tourism demand.
The loss of resilience in mountain farming, that faced during XIX migration and depopulation phenomena where climate problems and the availability of agricultural soils played a relevant role, led to a gradual abandonment of fields and of many rural buildings, as well as to the strong contraction of the forestry sector and of the craft forms related to them, limiting local centuries-old capacity for technical-linguistic innovation of rural buildings.
The lack of economic opportunities related to mountain farming, and the growing need to intercept tourist demand in order to satisfy outsiders expectations, has led to an osmotic exchange between the aprioristic image transmitted to the observers and the cultural identities of the local communities, activating an irreversible homogenization of multiple and kaleidoscopic spontaneous local morpheme [M. Clemente, 2005]. The contemporary stereotype of the Swiss chalet is perhaps the maximum expression of this process of regional image standardisation and interpretation of a chrystallized tradition [J.M. Leniaud, 2005].

The disconnection that has been generated between the capacity of self-determination of many alpine communities and the convey of the bucolic stereotype, has changed the paradigm of inhabiting the Alps. Research and construction activity regarding this territory faced in the past century a restriction of interest [L. Bolzoni, 2009] introducing a strong breaking element with tradition, with respect to which the recognition of a contemporary alpine architecture category stands as a mean for redefining a new vision of inhabiting the Alps, potentially capable of generating a new transnational regional identity. The elements defining contemporary architecture are now capable of communicating through the technological, figurative and typological research, the great opportunity to redefine the limits of their own disciplinary field, stimulating the construction of new scenarios and consciousness for the Alpine region. In this way, processing operations on the isolated Alpine buildings are crucial to lead peoples' imagination towards a new way of thinking Alpine scenery, which could find, in its internal resources and in the natural evolution, a new dimension of resilient and innovative landscape, as a sustainable solution to the permanent environmental complexities.

1.3. Thinking mountain: the pre-romantic relation with high lands

The image of the mountain comes from the filtered vision of an outside observer, contributing to the construction of a collective imaginary only partially representative of the landscape complexity. The picturesque view of the alpine architecture and environment diffused during romanticism, has been able to facilitate the cultural relocation of the mountain, moving from an inhospitable to a sublime space.
The alpine region has not been always considered a valuable landscape as it is now, and the appreciation of the particular presence of morphological, environmental and anthropic-cultural aspects is relatively recent [R. Bodei, 2008]. The same thing happens in general debate about canons of beauty, which shows an evolution considering or breaking from previous beauty perception.
Connecting this to the actual valuable characters that are considered for the recognition of a UNESCO World Heritage, it was natural or cultural or mixed property, the presence of past testimonies that express a value judgement, have a significant weight in its evaluation. In this way, the historical permanence of a property in the category of excellence for societies, leads to ratify an exceptional value. The protection of the site/property/immaterial good leads to its permanence and transfer to the future generations.
An example of judgement emerged after the scientific discovery of the Alpine Mountain Heritage, when the romanic travellers started to directly visit and experience this landscapes in order to write and paint it. The created images were like ideal landscapes, a referral for the theory of the aestestic of Sublime. The mountain picks are the sublime place to which every one rises [R. Bodei, 2008]. The Alps became a significant model for literary men in the romantic age and for this reason they contributed to the modern concept of natural beauty.

But the idea of mountain hasn't always had a positive acceptation. For long time the mountain has been considered as an inhospitable space and there was no interest in exploring it, even if stable permanence of man in the Alps began in the Ice Age (about 13500BC). The pre-romantic man opposed a sense of fear to the actual sense of beauty thinking about mountain peaks. The sense of fear and respect concerning high lands was spread and reaches us through the most relevant media of that time: the holy scriptures. "I lift my eyes to the

mountain – where does my help come from? My help comes from the Lord, the maker of heaven and hearth" [Psalm 121:1-2].
Likewise, difficulties on crossing mountains when speaking about mobility and transports seem to confirm the innate low permeability of this high landscape. Mountain, now close to be domesticated through technological capacity, for long time worked like a safe natural barrier against invasion attempts. To report some of this times: the battle of Thermophylae in 480 BC, the crossing of the Alps by Hannibal and his army with elephants in Colle Clapier in 218 BC [Mahaney et al., 2016]. Long connections imperial transalpine routes were considered dangerous by many medieval travellers describing a widespread sense of fear crossing alpine passes and valleys, usually following existent ancient Roman imperial routes. The difficulty was given possibly by limited seasonal use and conseguent abandonment of the network of Roman routes [C. Marchesoni, 2012].

The image of a mountain territory declined in a culturally inaccessible space was common in the pre-romantic and extra-alpine communities. Even in the pre-Christian cultures, mountain was a space rich in religious concepts, inaccessible and for this reason safe place for gods, like the hellenic Olympus. For many pagan populations living in the Dolomites the effort in climbing a mountain was a synonym of the difficulty of reaching the divine. Highest lands were precluded to human activity and were space for the supernatural dimension.
It is possible to find this theme in many monotheistic religions, such as Judaism with the delivery of the Tables of the Law on Mount Sinai, Christianity with the Transfiguration of Christ on Mount Tabor and Islam with the miracles of Mohammed. Numerous written and archaeological proofs also report the diffusion of sacrificial practices in the high mountains to avoid the ill will from the gods, both in South America, with human sacrifices of the Inca [M.C. Ceruti, 2015], and in the Middle-East, with the sacrifice on Mount Moriah in the Book of Genesis.
The action of the ascension occurs repeatedly in Renaissance literature, as the narrative device in the Divine Comedy by Dante Alighieri and as allegory in the epistolary tale of Francesco Petrarca of 23 April 1336, in which he describes his "ascent to the Mont Ventoux". In both texts the objective ascending difficulties become metaphors of the obstacles found by man during the process of purification and approach to the

supernatural. Petrarca, through the conversational level of narration, introduces for the first time the subject of the conquest of the mountaintop not as a divine place but just useful for his pleasure as a privileged space for the observation of the landscape.

The reinforcement of the concept of Alps as terribly beautiful place, instead of terrible place, comes during the Renaissance (Josias Simler, Conrad Gesner) and Enlightenment (Johann Jakob Schreuchzer, Albrecht von Haller) to be confirmed in Europe between 1760 and 1780 with the La Nouvelle Heloise by Jean-Jacques Rousseau [W. Bätzing, 2003]. This letter contains brief meditations on the pleasure delivered from spectacles both peaceful and terrifying – respectively, the cultivated land of Vaud as viewed from the boat, and the horrible but awesome tableau of the mountains above Meillerie [N. Paige, 2008].
To validate this change in mountain perception also in architecture in 1765 in the periphery of Geneva was built the first hotel with a panoramic view looking to the Alps [W. Bätzing, 2003].
The critical judgement on the mountain introduced during Renaissance is an experiential character, ennobling the effort and the difficulties of climbing a mountain, meaning now a way to self-consciousness and not more a moral and ethical metaphor of a cultural character.
The transition from the cultural *a priori* vision of the mountain to the experiential vision, however, fails to be completed during the Renaissance. In the treaty "Telluris Theoria Sacra" written by Thomas Burnet in 1681 reinterpreting the Bible, the divine punishment identified in the Great Flood that would make inhospitable the perfect and primitive terrestrial globe is an image close to the mountains [H.V.S. Ogden, 1947], as the "most terrifying spectacle offered by nature" [R. Bodei, 2008].

1.4. The romantic idea of mountain experience

In the end of the XVII century, at the same time of the "Telluris Theoria Sacra", many British travellers making the Grand Tour begin to ennoble the sublime of Nature. Practicing climbing and alpine excursions they transform the emotion of making mountain closer in aesthetic admiration and simultaneously fear.
Theoretical thinking of Romanticism is well described in the emotional contrast, that brings a revolution in the judgement of natural and mountain landscapes. The horrid and the enchanting are brought systematically closer, building an oxymoron in mountain description.
Another antechamber of Romanticism could be recognized in XVIII century in the spreading taste of travellers, moving preference to sublime of Nature transmitted through many forms of artistic communication such as carving, painting and narration.
In the late eighteenth century the artistic and literary research, that finds valid exponents in the english Byron and Shelley, finally frees the mountain from the divine, surpassing the augustan dualism soul-landscape [R. Bodei, 2008]. The emotional and experiential components of the panic contrast between man and nature are now legitimized as bases for human reflextion approaching mountain.
Industrial revolution of European cities causing many changes in urban ladscape moves the intellectual perspective of man towards the appreciation of unspoiled natural landscapes. The relationship between man and mountain changes, and mountain becomes an interesting destination instead of a closed and marginal space.
The success of the communication of the Alpine space to the great European public has to be largely attributed to its opposition to the model of industrial development of the european metropolis. However, the socio-economic reasons that have led to the existing forms of rural architecture and to the particularly remarkable morphological components of landscape, such as pastures and hay meadows, resulted largely unknown to the outside observer. It was difficult to grasp the technical and economic values of a cultural landscape model, the "Kulturlandschaft" [B.M. Anderson, 2012]. The morphological-figurative aspects conveying to the observer through the forms of representation were ideal-typified [A. Salsa, 2014] in a comprehensive continuous development.

Toghether with mountain, other unnoticeable and uncontaminated landscapes became interesting for human eye, such as marginal natural reserves or exotic places. The image of the Alps was filtered and promoted through panorama views up to 360° or large format representations, which were able to reach mass public of European cities increasing interest in a closer view of this natural landscapes.
The choice of subjects, themes and perspectives was appropriately targeted to intercept and satisfy the changing taste of the common user of the image. The subjects were capable of transmitting to the observer the themes of purity, originality and picturesque and were amplified in the composition of the image to balance the sublime component of the Alpine landscape, which still causes on the ordinary observer the weight of an aprioristic and negative consideration of the mountain.
The rule of the "image of the Alps" is structured around what recent literature defines with oxymoron as "complementary contrast" [A. De Rossi, 2014], in which the sublime elements of the Alpine landscape (glaciers, gorges, geomorphologic fractures, precipices, etc.), are represented by defined signs, cool colours and perceptual distortions [F. Torchio, R. De Carli, 2013] that enhance the sublime character of the morphological and environmental framework. This representation reveals the new taste and new artistic Romantic research, but at the same time is placed on the background of the image, counterposing them in the foreground with refined subjects, closer to the taste of a common user. Forms of rural architecture, tempting mountain pastures and improbable scenes of bucolic life are main actors. The same technique of their represetation, such as warm colours, soft shapes and the ultra-definition of the picturesque aspects, reveals the soothing role they assume in the pictorial composition and thus, in communication and diffusion of the image of the Alps.

The new interest for mountain experience brought a change in Alpine territories starting to activate communication oriented to large public of extra-alpine European cities. On site many changes occur organizing new physical devices and people's competences, in order to facilitate a multi-scale fruition of the mountain.
European mankind started to get involved in that morphological and complex inter-space that divides Northern Europe from Southern Lands, where you can experience the sublime and where man is still

able to live in harmony with nature, in analogy to the myth of the *bon sauvage* [A. De Rossi, 2014].
The weak alpine economy, based on agriculture, grazing and forestry, from a limiting factor for inhabitants and an effective expression of the general economic and cultural backwardness of the Alps [W. Bätzing, 2003], becomes one of the main conditions for the success of the Alpine region during Romanticism and even later. The cultural and economic delay of Alpine Territories in XVIII century, increased by a low connection in sense of communication and physical connection of high altitude places with respect to the rest of European continent, makes this region even more fascinating for the new bourgeoisie class which shows an interest in exploring it.
In this contest grow up mountaineering as a discipline to explore the mountain territory, in order to achieve the main priviledge points of view in the Alps. The birth of the discipline can be attributed to Horace-Bénédict de Saussure, who climbed to Cràmont in 1779, reaching a place where he could look at the full extension of the Mont Blanc chain [L.M. Gibello, 2011].
In XIX century the possibility to directly explore the Alps is limited to few people, but the activity of mountaineering has had a crucial role in communicating the Alps. The publication of many articles and travel narrations contributed to the identification and promotion of many strategic alpine villages that later grow in a touristic and infrastructure development [W. Bätzing, 2003]. The relevance of alpine tourist regions as favourite destinations for European citizens brought an increasment of social and environmental costs, still not enought considered in actual tourist promotion even if sustainable tourism actions are always more present.

1.5. Bruno Taut and "Die Alpine Architektur"

As a significant historically consequent vision of the Alps, we will now explore the vision of Bruno Taut, giving form to a new alpine architecture.
"Die Alpine Architektur" (1919) is a collection of suggestions still relevant for Architectural and Landscape design. After a century from its publication we still should feel a strong drive to improve our work in order to recognize mountain values; in its forms and relationship with open space and light. So, what are the values that could communicate to us and that we should try to develop?
The Alpine architecture, and in particular isolated alpine buildings, thanks to their unique relationship with the mountain landscape should tend to rise high and be qualified to become lighthouses for the construction of the lower valley. The mountain, seen as a field of experimentation for beauty and technique from a theoretical point of view, becomes a space for achieving the greatest results we can. This theme leads to an evolution of architectural research concerning mountains, with particular reference to the design of its most representative buildings, the alpine refuges.

Can refuges, among beauty and sobriety; heritage conservation and proposal for the future, become lighthouses for Architectural design and ambassadors of Taut's message?
This questions introduces a reflection on alpine architecture, starting from a synthesis of Taut ideal mountain architectures and connecting them with actual refuges' needs and architectures. This first analysis will then move to a short history of alpine refuges birth and development, trying to introduce the needs of actual alpine fruitors relocating the role of the refuge as a place where to find the highest ideal structural solutions, that could also influence urban architecture.
"Die Alpine Architektur" can represent the revealing of a deep research work generated during the Frist World War. In a period when it wasn't possible to build in the Germany, Taut and others with him, took time to think which could be the bases for future architecture, letting their mind go to quite idealised shapes. In the present moment we can read and learn from the utopia of this creations, and also take out time to let the mind open to new possibilities.

In the creative sequence of drawings of Taut's work, we find some elements that break away from the materialism of the period, like the use of glass and steel, composing pure and clean architectures, as an activism against the limitations of rationalism. Taut seems to suggest to look to the top of the mountains, and even on the other side of them, in order to take inspiration from shining high chrystal cathedrals. Glass was a synonym of purity and the paradigm of innocence, an interior dream world that, instead of facing the ideological and social problems of the historical period, he enclosed in a chrystal bubble.

Taut's most important heritage that we can nowadays directy apply in the Design of the Alps, is to recognize those superior values of which Mountain is guardian, even overcoming the magnificent shape we can see in his publication. From Taut expressions we find elements that recall mountain, considering it as a priviledge space to practice openness when architecture changes technology, using glass as a tool that helps internal and external vision as well as passing of light. Mountain is also a unique space where through difficult hikes, a community can strengthen relations and reciprocal knowledge. In natural environment, peoples' eyes get in touch with monumental landscapes feeling part of them and strengthening a personal relationship with them. In this way it's clear that a change in material can bring a change in society, and Taut's expected architecture could have been able to do that. Glasarchitektur means a change in materials, going from heavy bricks houses to light crystal alpine buildings. But it also means a change in society, with more collective thinking and solidarity in order to propose new social settings instead of old middle class government. Architecture is not just a building, but also an immaterial architecture to experience a new space, open to universe and possibilities.

During 1919-1920 Taut established an exchange of letters with other intellectuals – in particular Walter Gropius and Hans Sharoun – while waiting the time for a change in architecture and society. The name of the group was Glaeserne Kette/ Glass chain, and his symbol was crystal, as a metaphor of purity lighting a renewed common society [P. Ardizzola, 2017]. The renovation could be recognized in the Volkshouse/ House of the people, as the central building of a new civic society with strengthen relations.

In the letters Taut also expressed the importance of waiting, in order to recognize and reinforce the objectives of the transformation.
"As a matter of fact, it is a good thing that nothing is being built today. Things will have time to ripen, […] and when buildings begin again we shall know our objectives and be strong enough to protect our movement against botching and degeneration" [B. Taut, 24 november 1919, in The Crystal Chain Letters].
It was relevant for him to give form to their architectural revolutionary needs as imaginary architects, while waiting the right time, when the society would have been ready for a new architecture. During our work of architects, we never know if it's the right moment to propose a change, but is a help for us to know and imagine the main elements of this change.
Going to the years after this period of Tauts' utopian design and thoughts, we meet a different vision in his works, expressing function and material in form of collective housing, giving people a practic response to their needs. Doing this he proposes a different concept of space, always meeting themes of community, high, colour and technology. In some way high storage capacity buildings like mountain refuges.
The idea of Taut has to be considered a revolution in architectural canons, giving birth to a new concept of architecture, inclusive of a social transformation. With the utopia of crystal architecture, he seems to invite society to a new spirit of collectivity, which can be expressed through pureness, lightness, research of high represented by crystal and mountain [P. Ardizzola, 2017].

The proposed new architecture follows certain main concepts that I will try to compare to actual mountain refuges architecture, outlining a connection between an ideal and a significant visible alpine architecture.
The first topic is the community, where the new architecture doesn't mean to think to a single architectural unit, but to a complex of spaces and functions where the single part represents a cell in a bigger architectural community. Moreover, an architectural community constitute a living organism in the big cell system of the city. This new architecture should be oriented towards needs of common people.
Moving to alpine environment, we try to consider a refuge as a small architectural community, with not only a single building but a complex

of spaces and functions based on visitors needs. A mountain refuge, as it is mostly disconnected from urban areas, is a living body, where every part has to be correctly balanced in comparison to others, or it will collapse. The refuge is a community hub creator, because it forces different people to cohabitation a neighbourhood. A character of mountain fruition is collective thinking, where all humans have to take care of shared spaces.

Another theme of new architecture is light. "Glass architecture is just apparently a material concept. Architecture means to build, and it means to bring light. Glass is light, wood and rock architecture always wanted to bring light. So history of glas architecture is history of architecture in general" [B. Taut, 1920]. Architecture is made of light, to be intended as materia in form of energy. Light is transparent, immaterial, visible and it can be able to hidden architectural sign, design, code [M. Nardini].

Every architecture, including mountain buildings, are made of light and it's always important to maximize the influence of natural light in one body, also establishing new connections with the landscape. A mountain refuge offers a vision to surroundings territory, and his design serves not to hide, but to give an open view and be recognized.

New architecture is not only a research of new forms, but also a renewed concept about entire world. Architecture should become 'art' in and of itself, coming to signify the unity of all the art forms in one body. In Taut's thoughts, art should be considered a space for utopy. To develop efficent technologies shold be a strategy to reach high results.

Working on urban or mountain building design, functions should be content of aesthetic. Taut writes: "To wish for just the useful and the comfortable without any higher ideas is boredom", or also "similar to all […] vehicles the appearance of the buildings should not be in conflict with their function, on the other hand […] mere functions do not lead to a pleasant appearance" [B. Taut, 1925].

Refuges standards are expressed in maximum volume and surfaces for user, so we begin with a limited space in high land that has to be functional, and of course, content of aesthetic. It could be possible to develop in the building the binomio beauty and technique in order to achieve the greatest results we can, that means not only the research of new forms but a complete vision of the system development.

At last it has been examined the topic of need of resources for new architecture, considering existing architecture as not necessary in the

same form. As Taut writes: “Abundance can be achieved by the decomposition of the old”. We deduce that existing architectural culture is considered as a completely different resource for the new.
The theme of using resources, both by recomposition of the old and also research of new resources from the mountain environment, can be declined for alpine refuges. It could bring to the definition of a new shape, that goes from the steretyped idea of an alpine refuge, to a new inclusive architecture, that cares of history, natural resources, landscape, technology, beauty, management, fruitor needs…

At the end of the third chapter of “Die Alpine Architektur” we find lighthouses in the action of giving importance and shape to mountain architecture (Figure 7).
Lighthouses made me think to the mountain values that isolated alpine buildings, with their unique relationship with high land landscape, could rise, and now these could become examples for the construction in the lower valleys. Up to now mountain architecture seems to give a late responce to the architectural actual changes happened in urban areas, and the need to study conscious renovation is a duty for qualified professionals. This could reach the goal of revaluating mountain values as an answer to peoples needs, including social and comfort elements.
Working between architectural design and architectural composition, we find new scenarios to propose projects for high land infrastructures, giving new life and actual validity to the utopian designs for mountain environment.

Figure 7. “DIE BERGNACHT. Scheinwerfer und leuchtende Bauten | SCHLUSS DES 3. TEILS! Aber das Hoehere wissen! Das gewaltigste Werk ist nichts ohne das Hoehre. Wir muessen immer das Unerreichbare kennen und wollen, wenn das Erreichbare gelingen soll. Nur Gaeste sind wir auf dieser Erde, und eine Heimat haben wir nur im Hoeheren, im Aufgehen darin und im Unterordnen. [B. Taut, 1919]
Translation: THE MOUNTAIN NIGHT. Lighthouses and lighted buildings | END OF THIRD CHAPTER! Know high things! The most important job is nothing without high. We should know and need what is difficult to achieve, when what is alreadu achieved gives success. We are guests in this world and we find out Heimat in high, even if as surrender and staying in the lowland.”

2. REFERENCES AND SYSTEM ANALYSIS

The action of looking at the mountain gave inspiration to many valuable architects, planner and designer in history up to the present moment. Passing through different approches from the wide open look of the panorama to the geometric vision of Eugène Viollet-le-Duc, from the metaphor of an utopian anthropization of high peaks given by Bruno Taut we make a leap in the actual digital environment represented in this thesis by diverse tools, able to help the development of analysis through the attribution to mountain morphology of much more element for an aware reading and contextualization.

Using actualized systems of analysis the mountain view aims at recognizing distinctive marks of nobility in order to support the passage from theory and hypothesis to project.

New forms of knowledge for new forms of operativity, is the purpose that brough to the adoption of three different digital approaches with the result of three references for the mountain enhancing process.

For supporting the management of buildings in high mountain environment, has been build a national database collecting general and specific informations on bivouacs and refuges property of the Italian Alpine Club.

To renegotiate the objectives of development for alpine refuges, has been created a Geographical Information System (GIS) environment where to introduce the case study on this buildings in the territory of Autonomous Province of Trento, integrating valences and languages of their own landscape.

Moreover, the assessment of de-seasonalisation of refuges activity passed through the multi-criteria analysis applied to the case study on the alpinistic refuges located in the Brenta UNESCO Dolomites.

2.1. Database of Italian Alpine Club (CAI) refuges

The Italian Alpine Club (CAI) is a national association born in 1863 that aims at "the alpinism enhancement in all its representations, from knowledge to research, expecially on italian mountains, and for the protection of their natural environment" (art.1 of CAI Status).
It counts more than 300.000 associates and is present with 511 local sections and 310 subsections in all the 21 italian regions, including the two provincial groups of Trentino and Alto Adige/Südtirol.
During its existence in order to help and promote a comprehensive mountain fruition, including lower and higher destinations, popular or marginal locations, a great heritage of mountain buildings has been built. This, in addition to other mountain infrastructures of other proprietors, creates the skeleton of italian mountain chains.
The created physical infrastructure is in continuous evolution, modifying or implementing the existent. Relating to the Charta of Verona of 1990, the CAI is engaged in the objective of regeneration of existent buildings supporting italian mountain crossing, with no possibilities of creating new buildings in a vision of continuous positive protection of this delicate environment.

Building a database represented a first step that could make possible planning the development and direct resources with a specific strategic vision. This database has been named UNICO-CAI-Rifugi and is the only official archive of all the structures owned by the Italian Alpine Club. It comprises different categories of reception: refuges, bivouacs and social capanna. It's a database in continuous evolution, annually updated directly from the local sections. The database is composed by a privat basement accessible from central CAI management, and a public section which can be consulted on the web-site infoMONT from all the associates for the organization of alpinistic and excursion activities.
The recognized CAI building heritage is composed by 709 structures divided in 363 refuges, 229 bivouacs, 72 social capanna, 28 points of support and 17 shelters.
The main category is represented by the 363 refuges that are owned by 163 local sections. It's an important information showing that 68% of the CAI local sections have no properties of refuges, while of this 163: 103 have one refuge, 30 have two refuges, 12 have three refuges, 13

have from four to nine refuges, one has 10 refuges, one has 15 refuges, one has 20 refuges and one has 35 refuges.
It's relevant to notice that 42 of the total amount of refuges are not located in the administrative territory of the owner section. This derives from the historic interest of some sections towards the most important destinations in order to get closer to the best alpinistic hikes situated in the higher alpine mountain chain.

Figure 8. Map of italian distribution of refuges owned by the CAI.

The collected data on the mountain building heritage helps to compose a database that could represent a way to manage the refuges as a resource.
Before the composition of this digital infrastructure, the central organizational intitutions of the Italian Alpine Club could not have a complete vision of the alpine building heritage, because most of it is owned and managed directly by local CAI sections that now are in charge of the annual compilation of the database with respect to their individual properties, passing informations to central commissions.

The survey structure composing the database UNICO-CAI-Rifugi is detailed in the sequent items: general informations, history, position, contacts, management, CAI section, relevance, opening periods, dimensions, services, categories of users, accessibility, crossing, synergies, conformity on regulations, certifications, power supply, water supply, waste management, profitability, promotional initiatives.

\ rev1 \ rg

Nome campo	Informazione	Descrizione	Tipo	Azione	Osservazioni
	Data inserimento	la data del primo inserimento	data	inserita dal sistema	
	Data aggiornamento	la data dell'ultimo aggiornamento	data	inserita dal sistema	
	GPS	coordinate GPS UTM WGS84	num	inserita da operatore administrator	da UNICO_CAI
info generali	CURIF	codice rifugio	num	inserita da operatore administrator	Diventare univoco per il CAI
	TIPO RIFUGIO	Custodito , bivacco, ecc	char	compilato da dizionario	
	NOME RIFUGIO	nome del rifugio	char	compilato	Controllarlo
	TIPO RIFUGIO REG	tipo di rifugio escursionistico/alpinistico da legge regionale	char	compilato da dizionario	
	CATEGORIA	categoria CAI	char	compilato da dizionario	da inserire ex novo
	FOTO	immagine	file.gif	upload	più immagini categorizzate max 5
info storiche	ANNO DI COSTRUZIONE		num	compilato	
	FOTO PRIMO RIFUGIO	immagine	file.gif	upload	
	ANNO PRINCIPALI INTERVENTI		num	compilato	Possibilità 2/3 numeri
	FOTO PRINCIPALI INTERVENTI	immagine	file.gif	upload	
	COERENZA TIPOLOGICA	PIENA coerenza tipologica dello stato dell'arte con il nucleo originario	booleano si/no	compilato	
	COERENZA TIPOLOGICA 2	coerenza tipologica PARZIALE/RECUPERAILE dello stato dell'arte con il nucleo originario	booleano si/no	compilato	
	COERENZA MATERICA	coerenza materica dello stato dell'arte con il nucleo originario	booleano si/no	compilato	
localizzazione	SITO	breve descrizione sulla collocazione	char	compilato	
	p.ed.	particella edificiale	num	compilato	
	p.f.	particella fondiaria	num	compilato	
	COMUNE	nome del comune	char	compilato da dizionario	
	COMUNE CATASTALE	nome del comune	char	compilato da dizionario	
	PROVINCIA	nome della provincia	char	compilato da dizionario	
	REGIONE	nome della regione	char	compilato da dizionario	
	LOCALITA	località	char	compilato	
	VALLE	nome della valle	char	compilato	
	COMUNITA MONTANA	nome della comunità montana	char	compilato da dizionario	
	GRUPPO MONTUOSO	nome gruppo montuoso da guida monti CAI	char	compilato da dizionario	
	QUOTA	quota in metri	num	inserita da operatore administrator	

Figure 9. Detail of the management chart organizing the informations included in the database UNICO-CAI.

The knowledge of the heritage represents the first step in the enhancement of the management and planning of its future developments, in awareness of its positive potential features.
Following this scenerio, knowledge could play an essential role when organizing the mainteinance and future development of the existing refuges or other alpine buildings. The ongoing research for financial resources could be directed to the promotion of projects in order to compete for institutional or privat calls at different levels, from local to european.

2.2. Geographic data for high altitude building heritage

Analyse geographic data through a Geographic Information System (GIS) is an important phase in the committment for developing an organized framework of qualitative and quantitative findings concerning a territory, in the case of the research it goes to improve the knowledge of an environment of difficult access at high altitude, not always included in the strategic development plans of low altitude urban areas.

A GIS consists in a system of maps and databases including geo-referenced data, meaning the linkage of objects and their attributes to a determined geographic place, providing location measures referred to a set of geographical coordinates.

Due to the character of data to be constantly elaborated, it's possible to produce upgradeable thematic maps when changing existent data or adding new informations. Datas that can be managed using a GIS have a numerical nature, consisting in matrix (called raster), vector or tables. A raster represent a continuous group of data, in form of an homogeneous layer. Main raster layer used for the research consist in the Digital Terrain Model (DTM), that provides a connection base for the numerous vectorial data analyzed and gives a elevation dimension for a bi- or threedimensional interpretation of the same data. Vectoral data can are visible on the map in the form of points, lines or polygons and represent punctual characters of human settlements, infrastructures, morphological and hydrographic features, or an undefined number of qualitative and quantitative informations.

Created GIS maps contain a sum of the different data layers uploaded for reproducing a complex database, which works as a digitalized accurate virtual reality where is possible to produce data interactions in order to analyse and anticipate a complex real environment. This gives fundamentals to the management of a specific area, to verify interventions on a territory or to the analysis of projects impacts.

The origin of data reached now a situation of facilitated access in most countries, and in our digital environment a great amount of opendata results available for privat, professional or institutional use. The possibility to reproduce a precise documental data through various forms of restitution (geographical coordinates, relational databases, three-dimensional models, ...), has led to the construction of many

digital archives, available on demand, at relatively accessible costs or many times with open access to many public asseverated data.
The digital environment of a created GIS map offers a multi-scale vision and interrogation of chosen data, building an analytic-scientific framework for inquiring complex systems. Since the outcome is not a statical, only analysable, representation, but a searchable carthography, actions like editing or querying given dataset are encouraged.
Moreover, a result in form of a digital map can be combined with other data analysis methods, such as graphs, diagrams, temporal trends, schemes, helping the communication of the information data. This action is able to reveal the spatio-cultural context generated in a defined landscape, giving a complex vision on past and present characters.
A digital superstructure can be easily upgradable and becomes interactive with the user, even if not an insider.
The promotion and communication of territitories using a strategic synergy between physical reality and digital superstructures offer a double result for insider and outsider. Local communities increase their awareness on existent and possible heritage, users or external managers find information on opportunities and give to their wishes a direction.
In this way, the action of building a digital carthography is not limited to the development of a positive management, but also fundamental for the communication of cultural and environmental values giving an answer to the fruition request of a territory.

The environment investigated through the research are the high lands, a morphologically complex space, mainly carachterized by limited possibilities to establish connections. Is a territory where crossing of man dates back to the Ice Age, about 13500 BC, since when human activity produced various tangible signs like cave paintings, melting furnaces, alpine necropolis, prehistoric settlements of great historic relevance. More recently events such as the World War One left fortifications and trenches outlining boundaries to be conquered or defended. Historic signs, together with the same environmental values, in form of geological signs or natural preminences like historic heritage trees, become very meaning in the definition of a unique cultural and environmental palimpsest for the tourist promotion of these territories, to which have to be added recent artifacts of artistic and cultural relevance.

The enhancement of mountain landscape heritage, comes through the definition of access tracks which is not easy to solve because of the large dispersion of buildings meeting morphological distributive problems of creating crossing paths.
Hiking or climbing represent the majour mobility practices to achieve high altitude destinations, and the development of access facilities become primary in the optimization of mountain fruition and in the interrelation of strategic values. Despite this, the existing network of paths constitute a physical invariant of high altitude territories, that is difficult to extend for both morphological and economical points of view, not forgetting the environmental costs of increasing infrastructures throughout non-urbanised areas.
Building a digital network that supports physical network can help in increasing attractiveness of marginal high lands. Even more efficient could be the specialization of existing buildings and infrastructures that could be helped in the recognition of cultural and environmental values more related to their location in a movement of sustainable development. This role of communicators should be undertaken by refuges, as devices for a conscious development of high lands.

2.2.1. Applied GIS analysis on alpinistic and excursion refuges in the Autonomous Province of Trento

As we delined in the previous paragraph, with the aim of building a network of references for programming the development of refuges, the construction of a GIS environment on the landscape referred to the refuges located in the Autonomous Province of Trento sets a scientific basis for the analysis of the various features to be possibly enhanced.
Management of refuges tend to be mainly oriented to consider factors like accessibility or the location along an esistent mountain route, but the exploitable characters present in high mountain alpine context are much more than just positional physical data. Environmental and cultural values have to be considered in the process of analysis for the valorisation of structures and landscape connected to alpinistic and excursion refuges.
The research “Architecture for the mountain of tomorrow – potencial resources for trentino refuges” comes from a collaboration between

Academy for Mountain of Trentino Province (Accademia della Montagna) and the working group rifugioPLUS of DICAM Department of Civil, Environmental and Mechanical Engineering of the University of Trento.
Concerning the 156 refuges, excursion or alpinistic, classified as Refuges by the Provincial Law n.8 of 1993/03/15 "Ordinamento dei rifugi alpini, bivacchi, sentieri e vie ferrate" in the Autonomous Province of Trento, the study starts from the geo-referentiaton of these structures, mostly located in areas far from main urbanized valleys but in strict relation with many tourist destinations of this alpine region, protected natural spaces or recognized valuable landscapes, as it's the case of the Dolomiti UNESCO site.

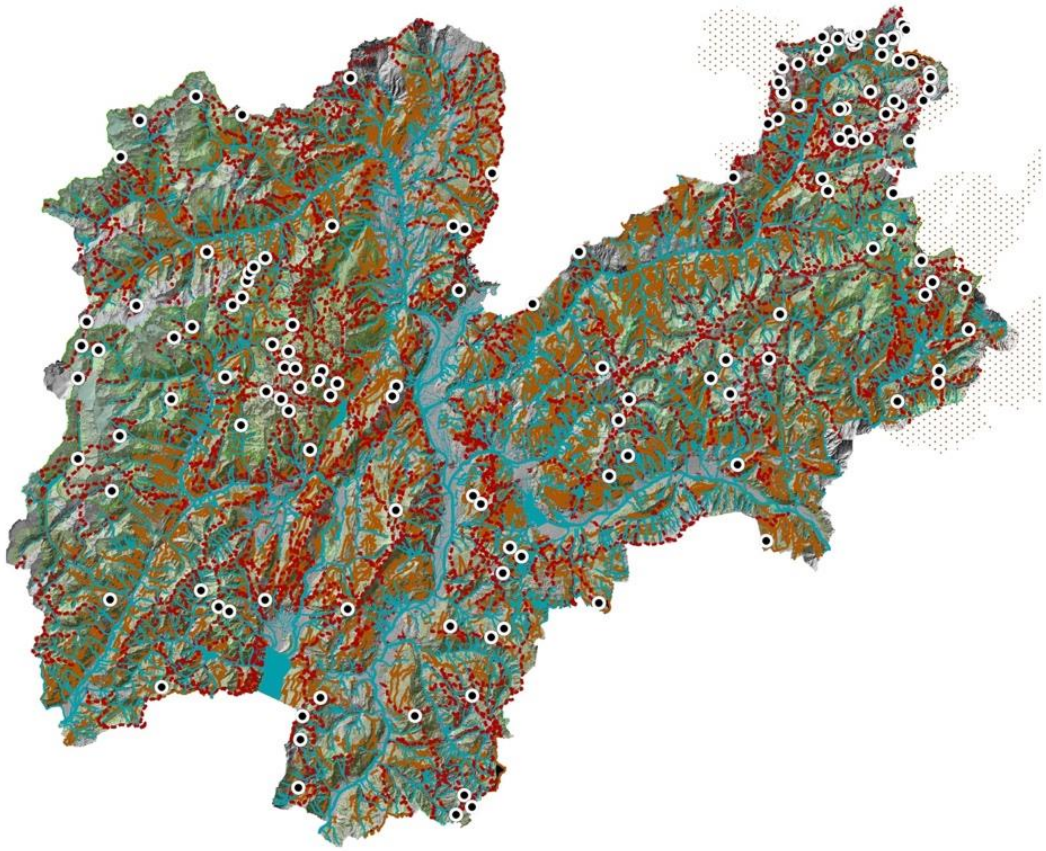


Figure 10. Georeferencing trentino refuges. Position data can be faced to regional elevation model, hydrography, urban areas, trail infrastructure.

Geo-referenced refuges are reinterpreted as added value in the relation with the territory where they play a role of custodians, releasing him from the contingency of the only building connecting them with the contextual peculiarities.
The developed individual GIS maps of each refuge show in detail the values with a close location to the alpine buildings, visually underlining those in a radium of one kilometre.

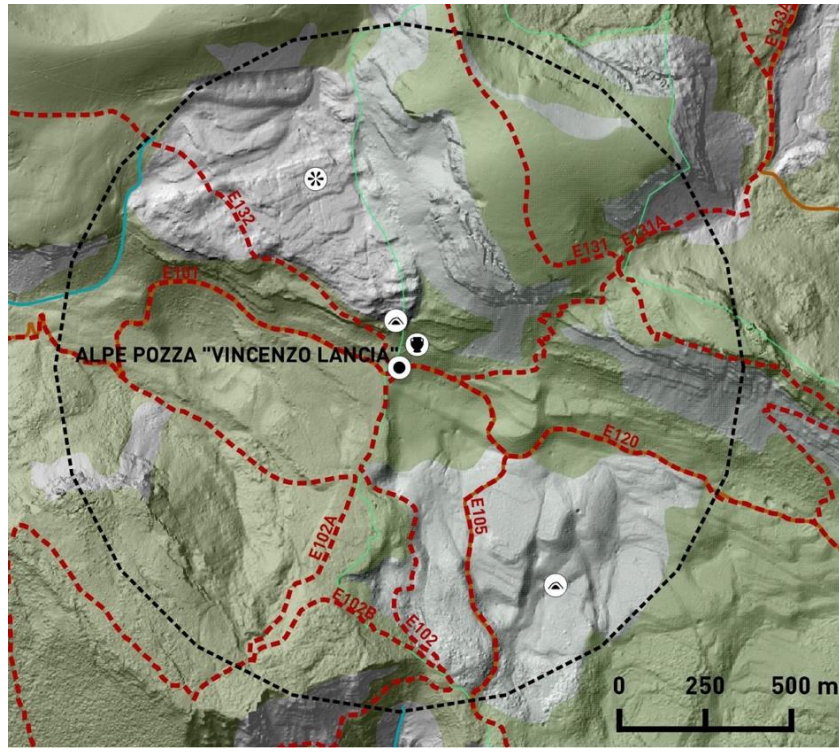


Figure 11. Example of individual map defining the pertinencial area of interest for the refuge, matching geo-refeferentiation of the building with cultural, environmental, infrastructural datasets.

The important step concerning the identification of local characters to be considered for the construction of the system of analysis, will lead to the constitution of omogenous clusters of the relationship landscape-refuge. These are presented in form of Abacus of Languages, when representing the relation refuge – general landscape, and in form of Abacus of Actions when connecting each refuge to single determining cultural, environmental or infrastructural elements.

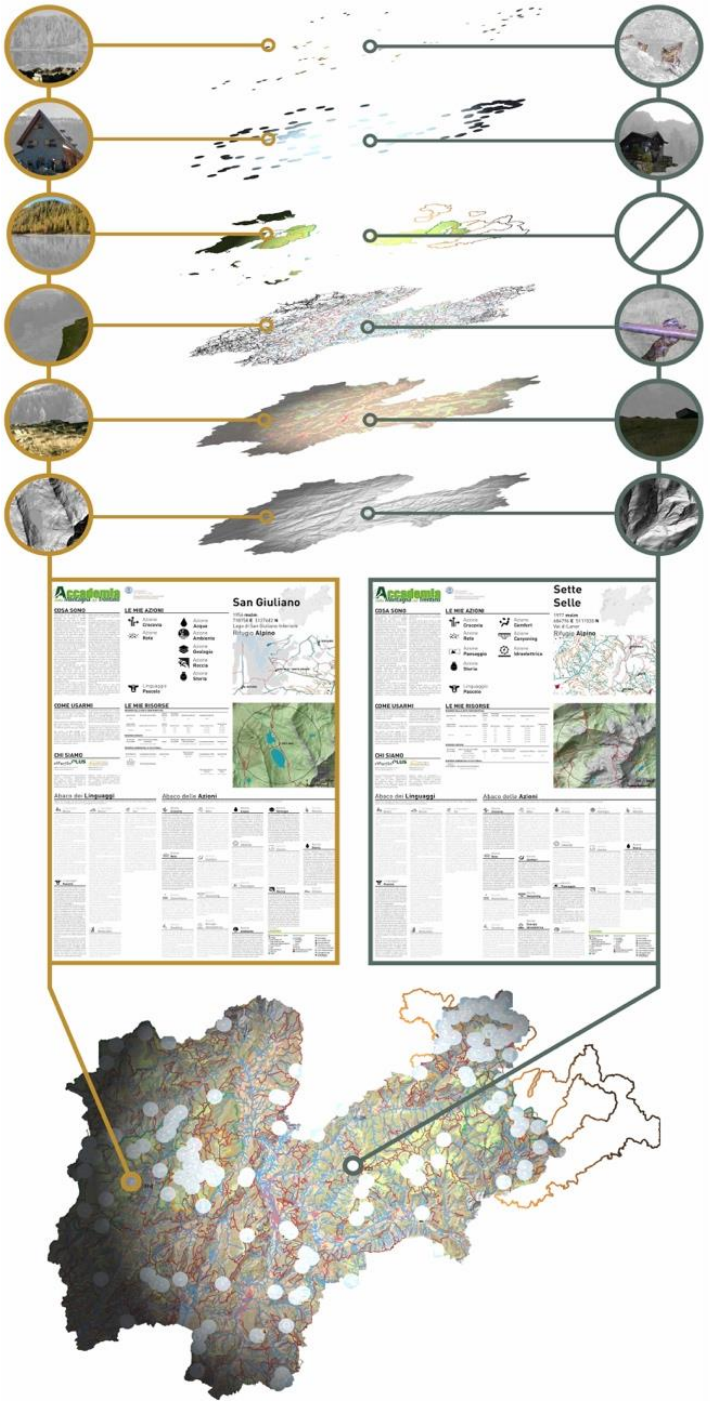


Figure 12. Different layers underlying the attribution of cultural and environmental valences to the refuges of Trentino Province.

In the research outputs the relationships between refuge and landscape is firstly presented in an organic form, referring to each refuge a landscape framework, and the connection to a landscape language and to the single actions to be possibly considered in its development strategy.

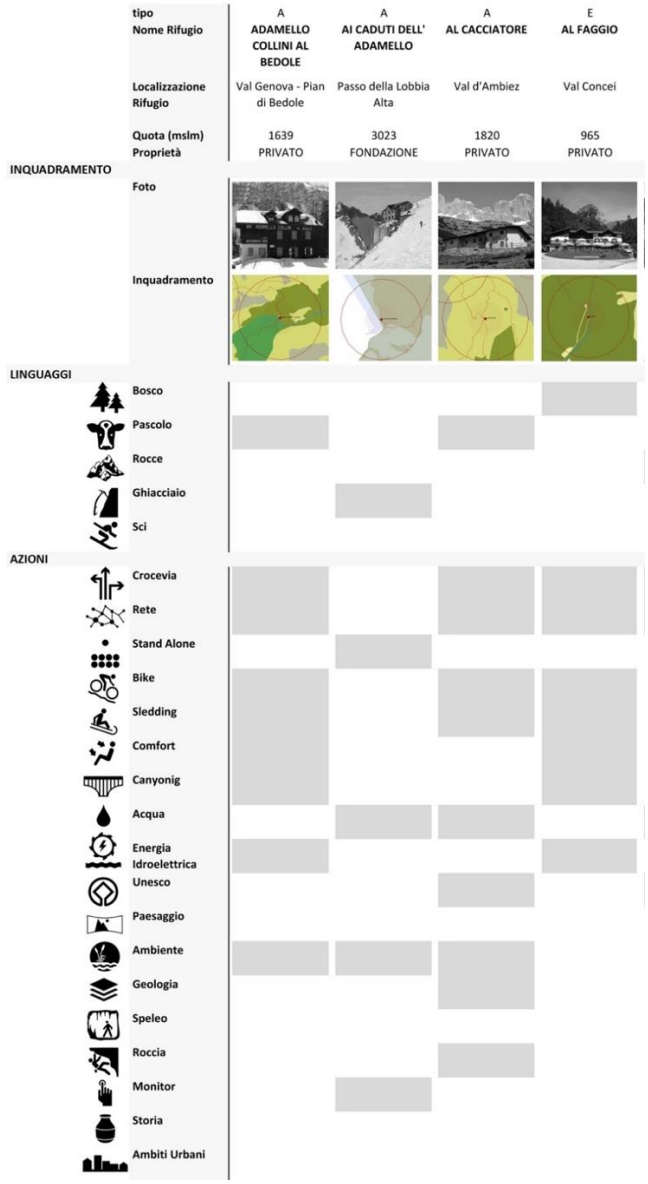


Figure 13. Example of restitution of valences attribution in form of abacus for each Refuge in Trentino Province.

The second step that helps to reach each Refuge interest has been to development individual Action boards, presenting the referred Languages for the relationship with the landscape, the development Actions and the resources from which these are derived. Resources are reported in both written and visual ways, presenting a specific landscape carthography and in form of chart named “my resources”.

Figure 14. Example of an individual action board distributed to the Trentino refuge managers.

Abacus of Languages

The first investigated form of interaction between refuges and landscape find his roots in the connection of the same landscape character with the architectural features that a refuge could have in order to limit his impact. The idea is to recognize the material and shapes of the environment that surrounds each refuge and repropose them in the composition of refuges' architecture.

Identified languages follow an altitudinal and environmental division, as it's the case of woodland, rock and glacier landscapes, but also recognize the land use considering the activities carried up by men, such as pasture and ski slope landscape.

Language Woodland

Refuges located in woodlands could give a preminent role to the use of wood in their expressive potencial, using wood as a building material in the dialogue with users and environment visible in the construction of external facades, interior furniture or outside terraces.

Traditional building systems should give space to contemporary expressive forms of design, reflecting on the value of using a local material and the capability to apply technological innovations for an efficient result of development strategies.

The external shape of a refuge should take inspiration from surrounding forest environment, characterized by trees with their linear, vertical, segmented composition of single elements. Buildings' structure activates forms of interaction with the landscape not only using its prevalent material but also composing interactions through openings and relational structures, or scomposing itself in smaller elements representing the right scale of the relationship.

Most of all the wooden finishes speak the same language of surrounding woodland, and imposes a detailled work while projecting the relation between façade and roof. The use of wood instead of other building materials don't undermine efficiency and durability of the entire building, but reflects on the renovation and application expert skills.

Language Pasture

Features present in the historical matrix composing alpine huts and stables could give inspiration to the construction or enlargement of those refuge located in pasture landscape. Internal and external spaces

should build a relationship with the surrounding landscape, adopting alpine gable roofs or using traditional pasture materials and shapes.
The project for pasture refuges should repropose the bipartition between rock basement, protecting the bottom part of the building from moisture infiltrations and giving solidity to the entire structure, and wooden elevation, applying *blockbau* building technique or other forms of wooden structures, bringing lightness to the entire building and consolidating the value of local alpine identities.
Due to the facilitated access to this structures, mostly connected with carriable gravel road, external spaces play a relevant role in predisposing refuges' offer to be oriented to open air summer seats on external terraces instead of a big amount of internal seats or bed accomodations. Instead of quantity of accommodation, result to be more relevant to improve the quality of them, offering more comfortable rooms with privat services.
For those refuges still included in pasture landscape but connected to higher summer alpinistic fruition, is valid the suggestion to remind architectural values linked to pasture and agricultural landscape but the composition of internal and external spaces should be related to an alpinistic fruition.

Language Rocks
Rocky landscape is located in higher lands, where human activity did not exist until the second half of XIX century. That time represents the beginning of alpinism, intended as climbing or hiking with the aim of reaching and discovering most sublime alpine summits. Existing refuges are witnesses of the necessity of fix supports to the mountain ascensions. As an example in the research on Trentino territory we find the Refuge Tosa (1872 m a.s.l.), the first refuge built by the local Alpine Club (CAI-SAT) in order to have a stop between the lower village of Molveno and the higher peaks of Brenta Dolomites.
Their original significance of being founded to help alpinistic ascension shoul be reminded to actual fruitors, that now, helped by a developed mountain infrastructure, easly reach these high buildings. The connection to past values could be trasfered through the remind to mountain attitude of frugality, or through an introspective nature communicating the aim of protecting all fruitors.
Technology helps the management of structural problems deriving from climate conditions in high mountain locations. Refuges in rocky

landscape should take inspiration from actual available technology regarding structural and cover materials, in order to protect the building from leakages during long thawing period and avoid erosive phenomenon. Should be priviledged water resistant sheet metal or stones, with chromatic characters that builds a relation with the context, avoiding reflectance events. Native structures using local stone are functional in being resistant to climate conditions in granitic environments, but in dolomitic environment, where the stone is permeable, the problem of bottom-up leakage in load-bearing walls is still common.
In architectural composition the referral to the archetype of the mountain hut, in the structural morphology and material choise, results to be inadequate, most of all in dolomitic environment and higher locations. Weather and morphological factors causing specific environmental circumnstances such as wind, snow accumulation, shading, can be studied in advance and solutions can be specifically projected. Undertake to analyse rocky landscape in order to recognize specific shapes and preminences to be reproposed in the refuge architecture should be relevant and have to be added to climate solutions in the aim to build a dialogue between man work and environment.

Language Glacier
Similarly to the buildings in rocky environment, refuges located in glacial landscape don't impose an historical precedent related to mountain man-intrusion to the architecture of the building. The guiding factors for the projects should be defined on environmental and technological reasons, responding to climate and landscape conditions. Structural materials that avoid water leakage and waterproof cover are essentials, and in this case covers could adopt photovoltaic installations or reflecting solutions, likewise glaciers' aspect.

Language Ski
Refuges directly located on ski areas show the necessity of a relevant amount of internal and external seats, and the relation of the compositive spaces with landscape should be amplified in order to respond to fruitor needs. With the aim accomodations need higher level of comfort and, differently from alpinistic refuges, to propose smaller

rooms with 4-6 beds, sometimes privats and furnished with privat bathroom.
Summer opening and accommodation offer are distinguishing elements from other ski-area structures. Summer opening should intercept mountain hikers, enhance environmental and cultural values, or propose sport activities on ski-slopes like downhill or grass skiing, taking positive advantage from the presence of existent cable way infrastructure.
Refuges' architecture should be presented as a distinguishing factor from other ski structures, using materials coherent with the landscape composition.

Abacus of actions

In the second part of the document are presented various suggestions to be possibly applied as integration in the development strategy of each refuge, they are described in form of actions connected to individual specific characters, including infrastructural, cultural, environmental, sportive features.
Infrastructural, such as forest tracks, gravel paths, water network, build the potential of actions named: crossroad, network, stand alone, water, hydroelectric energy, comfort and mixed sportive actions that take advantage from infrastructural presence like: bike, sledding, canyoning.
Cultural and environmental features influence the inclusion in developing actions called: Unesco, history, landscape, environment, geology, speleology, rock, monitor, urban areas.
Landscape, in its digital representation on GIS, in analysed in order to select punctual elements or areas of interest to be interrelated with geo-referenced refuges' location and recognize the potential enhancing elements.
Geographic dataset processed in the digital carthography created project, utilising punctual, linear or areal vectors, are entrusted to the public database 'Opendata Trentino' developed by the Autonomous Province of Trento. Each selected dataset, in form of *shapefile* – partly original partly elaborated, is connected to one or more actions.
In the following part of the paragraph we will define the actions taking their roots in this digital analysis of the landscape.

Crossroad

Action applicable to refuges that show a natural predisposition to act as crossroads, developing routes and improving connections between the different branches of the trail network. In this sense they could reactivate unconnected trails in their area of competence, favor access to the refuge and an hiking proposal extended throughout to all seasons and aimed at different categories of users. A better marking and subdivision of the paths will lead to greater safety both by avoiding the collision between different users like bikers with walkers, and in awareness of the risk in relation to the season.

In addition to this, there is the possibility of connecting new destinations rather than other refuges and of specializing the trails indicating the categories of use.

This possibility is extendable to the winter season, allowing the identification and communication of the trail with the least degree of avalanche danger for the access to the refuge.

Network

This action encourage joint promotion and connection with hiking trails between refuges belonging to the same mountain group, in order to intercept a broad range of users and territorial values.

Refuges located along the main crossroads of the Alpine crossing networks have the opportunity to specialize according to common projects that have as their objective the added value of networking. The goal should be to move from competitive logics to shared projects of promotion of the Alpine context. For doing it's needed to define and promote hiking circuits weighed on different difficulties in order to intercept a wider spectrum of users and to connect different values in the alpine landscape.

Stand Alone

This action is considered in case of a structure able to function independently from other Refuges. If the refuge is located along obligatory trails it could become part of networks of mountain wide crossings. In this case the refuge should aim to specialize the offer, developing the potential of the territory they preside, rather than seeking alternative economies like pastoralism, become centres of alpine or slowfood taste or similar initiatives.

Bike

The refuges which are directly connected, rather than inserted, in areas with a consolidated network of forest roads or gravel trails, have the important opportunity to specialize in order to intercept different kind of users. Bikers' sector is recently facing in an important way the Alpine context and to avoid the promisuous use of the trail network will preserve from deriving safety problems.

In addition to that has to be considered the development of e-bike access and infrastructures. Structural intervention in cycling accessible refuges shoul meet bikers needs, offering deposits, recharging points, organized repair centres not forgetting to activate promoting initiatives for a safety access to mountain trails.

Sledding

The presence of a network of forest trails favors access to refuges at lower altitudes even in winter months and the practice of various sports such as snowshoeing, skiing, sledding, fat-bike.

This network ensure access with moderate slopes which can be safer during winter period and appropriate to be crossed with snowshoes and skis at the service of refuge able to guarantee winter opening.

In presence of medium slopes it could be organized for the sledding discipline during winter season, as it's the case of many South Tyrolean mountain structures, as well as the promotion of fat-bike planning dedicated events.

Comfort

The availability of surface water at short distance from the refuge suggests a verification of the possibility of developing energy supply for the structure. It could allow an increasement of toilets amount in the alpinistic refuges, or the possibility to equipe some rooms with privat toilets in case of excursion refuges. These services should be provided with flow reducers capable of sensitizing guests to the lack of water but at the same time offer a higher level of comfort in the most reachable structures.

Canyoning

The proximity of the refuges to surface watercourses could activate the practice of water sports such as canyoning and kayaking in an alpine environment. This action need to evaluate the opportunity of providing

guided courses or improve the structure with specific services for these activities such as hot showers or duly sized drying rooms/*trockenraum* for wet clothes and equipment.

Water

The water resource need greater attention and the provision of saving and reuse initiatives during ordinary management of the refuge.

Refuges that are not located in close proximity to water courses with constant flow rates should be provided with water collection tanks, in order to be able of covering water demand during high season peaks of presence.

Moreover it's important to raise awareness of mountain users to the topic of water scarcity and safeguard. On the other hand resource consumption must also be limited by containing the number of sanitary facilities or applying water flow reducers, and it can be helped by introducing gray and rainwater storage systems.

Hydroelectric

Supply of sustainable energy to the refuge can also be generated searching for renewable energy sources, which could use reduce generator pollition using local the water resources.

The presence of superficial hidrography within a radius of 1km invites to verify the possibility of installing small turbines in order to supply refuges with clean and renewable energy. In this way refuge could increase their energy self-sufficiency and reducing the use of fuel generators, which inflict high management costs and noise pollution. The refuge can therefore offer itself in a more coherent and balanced way compared to the fragile context in which it is located.

UNESCO

Refuges included in the UNESCO Heritage Core Zone could improve their organization in order to become information and training centers for landscape and characters enhancements. Their reliability is determined by the research for management sustainability in high lands. Develop the refuge as an outpost to promote the UNESCO heritage, in a hybrid form between refuge and visitor centre, where to organise educational activities to raise awareness of mountain fruitor towards water scarcity problems, safety and prevention of risks, environmental protection. It's relevant to improve the sustainable image of dolomite

refuges to an exemplary level to promote the UNESCO world heritage brand involving all 9 protected Dolomite areas pertaining to different administrative regions.

Landscape

This action aims at improving a relationship with the landscape both in morphological and in the perceptive ways. Reorganization and orientation of internal and external space, as well as the design of external shapes seems to be relevant in this objective.

The goal is to amplify the emotional contact between man and landscape, through the use of devices that enhance valuable monitoring elements, such as larger openings and privileged observation points.

The same configuration of the expansion rather than demolition-reconstruction interventions in these contexts, requires linguistic and relational research considering connected landscape values.

Environment

The centrality with respect to a protected area or park transform the refuge in a point of contact with flora, fauna, environmental protection initiatives, in order to become a central element for raising awareness of environmental issues.

Refuges included in protected areas could become icons of sustainable and balanced relationship with the environment, sensitizing guest to the issue of resource deficiency and better management. At the same time, close collaborative relationships must be established with the park institutions in order to build or reorganise environmental education spaces and promotional points within the protected areas. These are places where to organise specialised activities for guests, training of the refuges' staff and exhibiting sections dedicated to flora and fauna characters.

Geology

The transmission of scientific, morphological and cultural values concerning the environment passes through staff training initiatives.

The attention should consider the geological history capable of telling the evolution of the landscape and its link with human activities.

To transmit the scientific, morphological and cultural values linked to the formation of the Alpine context, it is necessary to train the staff of the refuges on the geological specificities of the environment in which

they are inserted in addition to establishing thematic sections in the common spaces of the refuge, with museum exhibits of rocks and fossils. The relationship between man and the high lands started since prehistoric times on the basis of the presence of minerals at high altitude and continued until today with the most recent logics of mining industry and settlement identities related to the use of local Trentino stone.

Speleo

This proposed action aims to the diffusion of knowledge regarding underground structures, through training and exploration activities that facilitate understanding external environment.

Speleology is a niche practice linked to hard-outdoor that could find an important support in the refuges for the exploration of the karst cavities present in the Dolomite areas, rather than in abandoned mines. The refuge could become the link between speleologists and hikers for the diffusion and enhancement of the underground world, with specific sections inside the structure and training-guided tours. Enhancing this discipline means bringing the hiker to enter the structure that generates the passage in which the refuge is inserted to understand its meaning as well as appreciating its surface.

Rock

The morphosculptures of absolute value for the scenic values of geological aspects have always attracted the attention of mountaineers becoming classic climbs, which despite global reduction of hard-mountaineering practices maintain a constant relevance over time.

The refuge plays a very important role in territory protection and monitor, so it would be a good practice to entrust the structures to alpine guides who well know the area and possesse skills to advise mountaineers to safer excursions. In the refuge it is advisable the presence of accurate documentation on climbs and the maintenance of a sober profile of hospitality that refers to the values of classic mountaineering.

Monitor

Refuges located in glacial environment can become central points for an important monitoring activity of glacial evolution through a commitment that could involve specialists of different sectors in order to activate mechanisms of knowledge transfer to the refuges' guests.

The aim is to communicate scientific information and to directly involve hikers in understanding the effects of the climate change dynamics.
Monitoring activity can also be enlarged to other disciplines such as the historical or environmental sectors, observing environmental factors and elements or preserving remains of historical struggles in high lands.

History
The refuges, through staff training, the organization of activities and specific dedicated sections within the common areas, can make an important contribution to the diffusion of knowledges of phases and methods of human settlements in high lands.
Remains involve different ages: from prehistoric ovens to historical artifacts of the classical period, up to the remains of struggle events such as the World War One. At the same time, refuges could spread knowledge of landscape evolution and land use expressions built in the different historical phases. These elements clarify the evolution of the relationship between man and high lands, of which the refuges are today the only managed elements.

Urban
Refuges located in peri-urban areas or with easiest access should activate mechanisms for approaching and promoting the mountains through dedicated events, courses for school groups and cultural events throughout the year, becoming ambassadors of mountain culture for the urban area.

2.2.2. Applied GIS analysis on two case studies: *Refuge Alpenrose* and *Refuge Velo della Madonna*

Starting from the indentification, in the first part of the research on Trentino refuges, of an Abacus of Languages and Abacus of Actions for improving the organization, management and promotion of the 156 refuges included in the territory of the province, a second stage followed, in order to verify at local dimension the validity of the proposal.
The verification involved Refuge Alpenrose, an excursion refuge constituying an acces to the Brenta Dolomites in the western part of the province, and Refuge Velo della Madonna, an alpinistic refuge located in the eastern Dolomites of Trentino. The two refuges present relevant differences, from accessibility to typology of fruitors, and a personal on-site investigation helped in declining appropriate development suggestions adding to the study the relief of personal skills and vocations of managers looking to the proposed clusters.

Refuge Alpenrose
Excursion refuge
La Rì, 1084 m a.s.l.

Case study: Refuge Alpenrose

Excursion Refuge Alpenrose is located in the Giudicarie valleys, in the western part of the Province of Trento, starting point to reach protected areas such as Dolomiti Unesco core-zone and adjacent to the Natural Park Adamello-Brenta.
The refuge is accessible through a forest road in all seasons, and close to famous tourist destinations such as San Lorenzo in Banale, Andalo and Molveno. From here is possible to start hikes following well marked trails going to discover many interesting environmental characters, including flora, fauna, rocks, glaciers.
A network can be build connecting the numerous mountain huts, tourist centres, alpine refuges at low distance from the studied refuge Alpenrose.
The refuge, owned by privat managers, offers accomodation with 20 beds divided in 8 rooms, and a typical restaurant.
The facade of the building is in plastered masonry, with external and internal wooden elements recalling the typology of hut in the alpine agricoltural semi-natural landscape.

Figure 15. External appurtenances

Figure 16. Dining room

Figure 17. Terrace

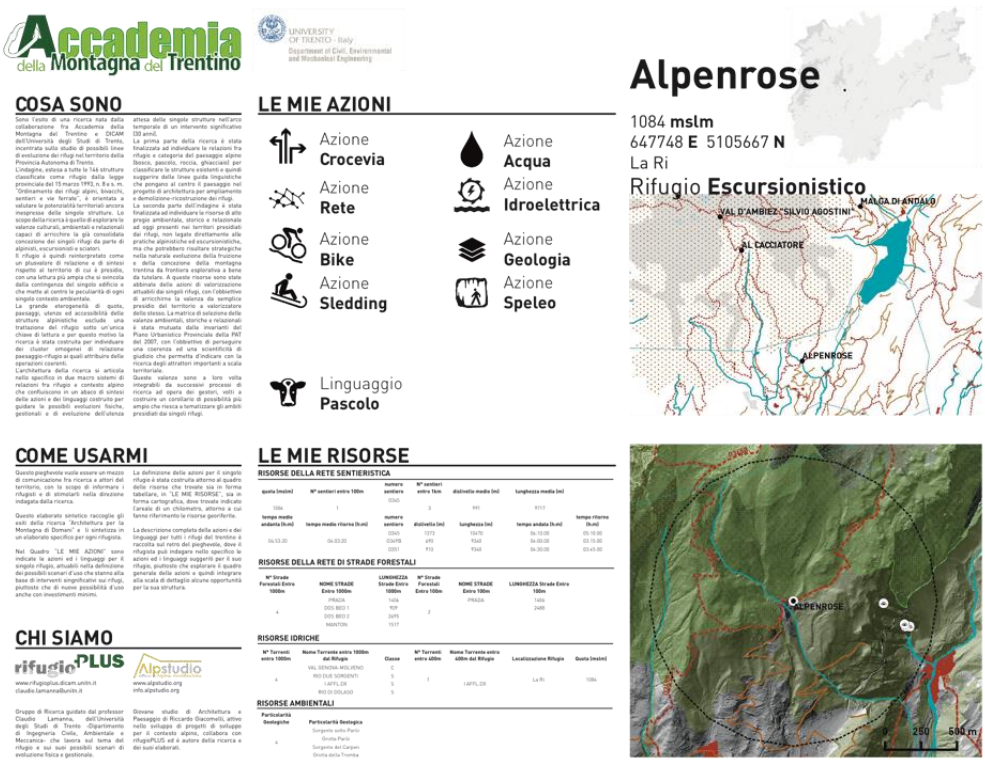


Figure 18. Action board Refuge Alpenrose, Trentino

The reported action board attributes to the refuge a localization comprised in pasture landscape, adjacent to the starting woodland, confirming the relation to past and present agricoltural practices in the surroundings.
Possible action for development and strenghtening of the management opportunities have been analysed and some of them have been complitely verified, some others have been partially verified, suggesting a research of additional information in order to solve them positively. Verified actions include: Crossroad, Network, Bike, Geology, Speleo.
Partially verified action, needing a deepening of legislative and technological nature, are the following: Sledding, Water, Hydroelectric.

Stating the outcomes from the digital and personal analysis, have been defined some suggestions for the enhancement of the refuge, in order to meet local socio-economic development scenery. Actions include strenghtening the relationship with orher refuges, institutions and become an access point to the Brenta Dolomites and opening to new type of tourism fruition, as follows:

- Enhancement of the external appurtenances of the refuge, focusing on the panoramic value and the sun exposure;
- Renovation of the interior spaces of the restaurant by interpreting the historical materials of the construction tradition of spontaneous rural architecture in a contemporary key;
- Redefine the level of comfort of the rooms recognizing the proximity of the structure to permanent settlement contexts;
- Organization of activities to promote mountain values, mainly directed to tourists but also to experts capable of involving local associations aimed at increasing awareness of sustainability and safety in the mountain context;
- Recovery of a relationship with tourism promotion institutions, for a greater presence within the initiatives promoted at the local level by building relationships for the enhancement of the internal tourism environment;
- Enhancement of the culinary skills of the management also through the proposal of Alpinist / Bikers' snack or breakfast menu, to intercept cyclers and hikers reaching other refuges located at higher altitude in the Brenta group;

- Improvement of the connection service with Refuge al Cacciatore, as shuttle departure / arrival station for the transport of hikers to and from the Val d'Ambiez;
- Promotion in synergy with closest refuge of a connection path between the two refuges open to bike or e-bike, marking it correctly to avoid interference with walkers;
- Promotion of the geological and karst dimension of the territory, first through cultural events in collaboration with external speakers, then with the strengthening of a district system in collaboration with the Tourism Promotion Institution, aiming the definition of a thematic path;
- Recovery of the possibility of using and promoting the crag located near the refuge, as an added value for those staying overnight in the structure but also an attraction for daily excursions for expert users and courses for those who intend to approach the climbing discipline;
- Strengthen the presence of the structure on the web, digitizing the promotion of the structure also as regards the accomodation service, with the possibility of online direct booking.

Case study: Refuge Velo della Madonna

Located on the Pale di San Martino, in one of the nine mountain groups composing the italian UNESCO Dolomites, the Refuge Velo della Madonna is an alpinistic refuge surrounded by a lunar rocky landscape as it was noted through the digital GIS analysis.
The refuge is also included in the protected area of the Natural Park Paneveggio and Pale di San Martino, where at lower altitude the landscape is characterized by valuable woodlands. The area is touristically suited, attracting visitors during the all year, even if particularly during summer and winter seasons.
In the high mountain plateau exist different organized and marked trails, and three high Dolomiti trails with different levels of difficulty connecting the the five refuges located in this alpine space.
Refuge Velo della Madonna was built in 1980 and is property of the CAI-SAT, the local section of Italian Alpine Club, that rent the management of the structure.

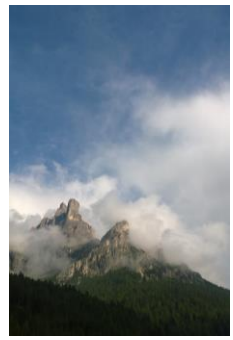
Figure 19. Action board Refuge Velo della Madonna, Trentino

The refuge opening time is from half june to half september, in order to make safer the access to the location in high lands. It can give accomodation to 68 guests and during winter months is freely open the bivouac with 10 beds.
To have access to the refuge different trails, partly fix rope routes, depart from all the surrounding tourist locations and the refuge is a stop included in the Palaronda Treck, in both hard and soft trecks. Thanks to the high touristic value of the area the refuge is very known destination in the dolomitic space, thanks to the wide diffusion of alpinistic sport activities.

Refuge Velo della Madonna
Alpinistic refuge
Peak of the Madonna, 2334 m a.s.l.

Figure 20. Access to the refuge

Figure 21. Landscape looking to the dolomite peaks Pale di San Martino



The actual management of the refuge results well in-line with the proposed Rocky Language from the research outputs.
Selected Actions result all verified with positive result, and concern the actions: Crossroad, Network, UNESCO, Environment. In this respect some other suggestions have been defined as follows:

- Qualify the geological dimension that gives reason for the election of this Dolomite group as a UNESCO World Heritage Site. The enhancement can take place through training initiatives on this topic, but also by encouraging attention to the geological context during individual excursions thanks to a brief introduction offered by the same staff operating in the refuge increasing curiosity, however attention to safety and respect for the mountains;
- Become an active part of a pilot project for the enhancement of the UNESCO Dolomites Refuges, which includes training initiatives on all aspects concerning the relationship between man and environmental context. The obtained central role of the refuge in the valuable site should the guide the fruitors in the exploration of its unique environmental, geological and cultural characteristics;
- Strengthen the positive dimension given by the connection through a network of hiking routes of the refuges in the same mountain context. The validity in the construction of this relationship is evident in the good results of the Palaronda Treck, in terms of promotion and participation in the mountaineering offer suitable for hikers with different abilities;
- Build relationships with the Paneveggio - Pale di San Martino natural park in order to improve the role of the refuge as an

information point on the naturalistic features and raise the awareness on the conservation and protection of the environments and the alpine biodiversity present within this protected area.

2.3. Applied multi-cryteria analysis on alpine refuges in the Brenta group (UNESCO Dolomites, Trentino, Italy)

In the Alps exist more than 1500 alpine refuges built for a limited summer use. The sport fruition of the mountain during winter season is quickly developing, strongly increasing the number of ski-mountaineers asking for services. The majority of alpine refuges were built before 1950 and, for this reason, they can be considered cultural heritage to be preserved but, at the same time, old buildings that are too complex for a winter opening suitability. Through an SMCA approach has been investigated the existing refuge networks, evaluating both user attractiveness and management issues. In this way, we defined the Season Extension Suitability of Alpine Refuges (A.R.S.E. Suitability), considering different case studies throughout the Brenta Dolomites Group. The definition of the most suitable existing alpine refuge is aimed to the proposal of re-design to ensure small forms of winter receptivity, in mountain areas without ski-areas-infrastructures.

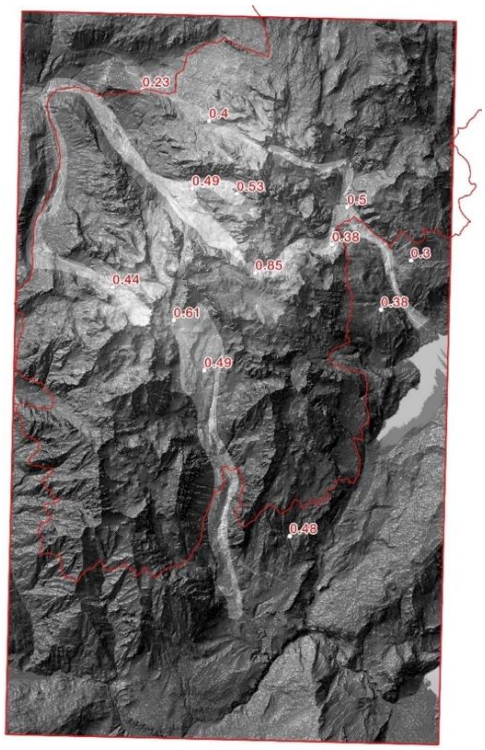


Figure 22. Map of the Brenta Dolomites Group, summarizing indication of level of suitability A.R.S.E. and boundaries of the UNESCO Dolomite core zone (QGis)

2.3.1. Definition of the study area and subjects of the research

The Alps are one of the most important mountain chains in the world, where, since the birth of the alpinism (XIX century) and the foundation of the Alpine Clubs (1861), has been explored in various forms of leasure.
If the sublime of the unpublished panoramas enjoyable from the peaks have quickly developed an exploring process of the Alps during summer season in the first years of the XX century, the higher average level of the mountain chain compared to the most populated European plains, have led to the actual development of the opportunity to enhance the Alps through the diffusion of disciplines like cross country and downhill skiing.
The first approach to the Alps is founded on some pillars of the alpinism thought, as the importance of freedom, the personal risk assumption, the explorative value and the respect to the mountain, expressed through the peak conquest only by its own efforts.
The cross country and downhill skiing approach is more oriented in customer satisfaction, that leads to an increasing level of services and security offer.
The two divergent approaches to the Alpine environment fruition have led to different forms of facilities and territorial structures. If alpine refuges are generally projected for a summer season opening, with weak connections to the urbanized areas (as pedestrian paths, service cableway, without any acqueducts or energetic networks), on the other hand skiing facilities are part of large scale territorial transformation since birth of ski-areas, generally connected to urban areas with networks, and cable car stations. In the last years we can observe how some characters of large scale impact are redefining the historic way to practise sport in the Alps. Climate changes and general global warming are generating a problem of lack of snow to the lower altitude ski areas and they are anticipating from early summer to early spring the safe attendance of many ice-climbing and dry-tooling historic ways.
The technological advances into the winter sports fields (both in the technical material and in personal protective equipment) are quikly increasing the number of people asking for discipline as ski mountaineering and snowshoeing, which are more appealing in the less anthropized areas

The Brenta Dolomites, are one of the most iconic alpine groups of the Eastern Alps, situated in the western part of the Italian Autonomous Province of Trento.

Discovered by the great european XIX century public through the romantic paintings of Gottfried Hoffer (1852-1932), have been explored for the first time from the alpinistic point of view in 1864 by the english John Ball (1818-1889). After Ball's famous Brenta crossing through "Bocca di Brenta", the Brenta beauty has been brought to the public through the pages of the Alpine Club review, encouraging a challenge among all the world mountaneers for the conquest of the Brenta Dolomite peaks.

If the conquest of the "Campanil Basso-Brenta Spitze" by Otto Ampferer and Karl Berger (18th August 1899) represent one of the most important steps in the history of Modern climbing, the iconic value of the Brenta chain became, to the turn of XIX century, the land of affirmation of the nationalist waves who wanted to physically assert the cultural and natural belonging respectively to the Kingdom of Italy and the Austro-Hungarian Empire. For this reason the local Alpine Club SAT (Società degli Alpinisti Tridentini, 1872) and the DOAV (Deutsche und Oesterraiche Alpen Verein, 1873) began a real race in the construction of alpine refuges in the heart of the Brenta.

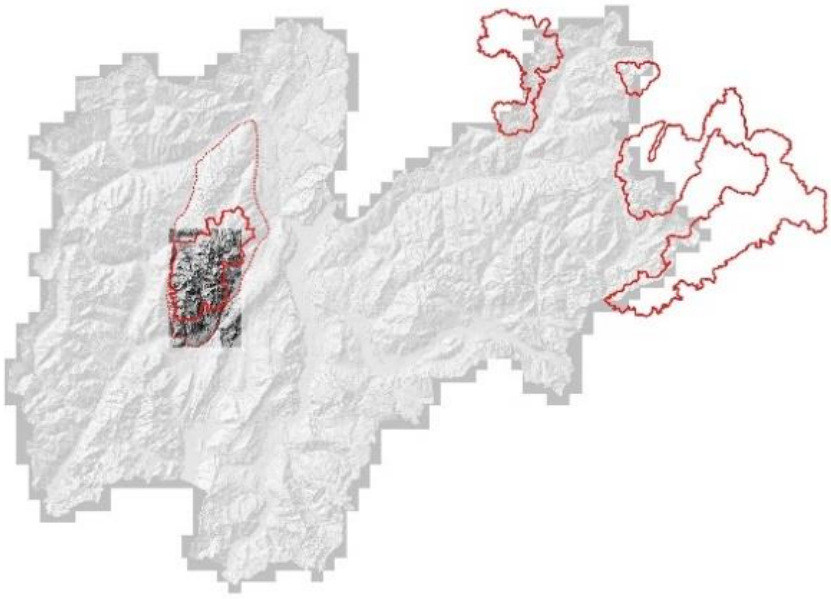


Figure 23. The study area in the South Brenta Dolomites and evidence of the others UNESCO Dolomites (QGis)

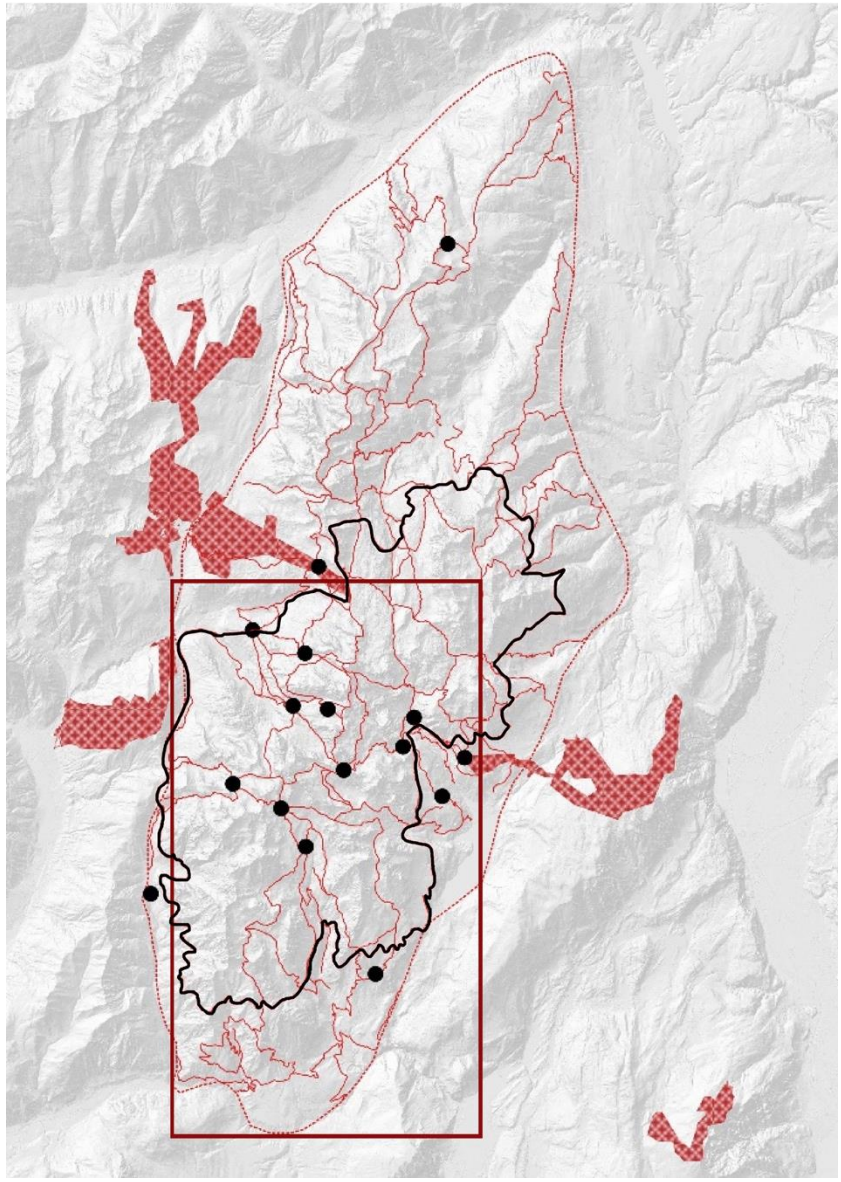


Figure 24. The Brenta Group – Trentino (Italy): ski areas (red areas), pedestrian paths (red lines), core area UNESCO (black boundary), alpine refuges (black dots), study area (dark red frame)

The Brenta ski development began in the 50s with the Monza's entrepreneur Alberto Fossati Bellani, and actually Madonna di Campiglio is one of the most important tourist destinations among the Alps, both in summer and winter seasons.

If all the main ski-areas are placed in the norhern district of Brenta, the area of study is recognized in the southern part of the Brenta Dolomites, the less infrastructured, characterized by the most scenic rock wall in the area and valid geologic features, very appreciated by the increasing number of people practicing ski mountaneering and snowshoeing in winter or climbing during summer. Actual development of mountain fruition both by expert or amateur, moves to a change in the high altitude buildings increasing the accomodation capacity adopting enlargement or restorations.

Since 2009 the southern part of Brenta Chain is recognized as UNESCOs World Natural Heritage for the sublime landscapes and the geological features with other eight serial dolomitic mountain systems. Some of the studied refuges are included in the core area UNESCO, becoming part of the recognized site, with a potential development in the sustainable evaluation of environmental values, aspect that could help in the proposal of opening extention.

In the area of study we can find 13 existing alpine refuges, with different proprietors, altitudes and localizations (Figure 25), which allows the fruition of different districts of the southern Brenta chain.

Cod	Name	Property	Location	Altitude (m a.s.l.)
1	**AL CACCIATORE**	Private	Val d'ambiez	1850
2	**ALIMONTA**	Private	Vedretta degli sfulmini	2588
3	**ALPENROSE**	Private	La Rì	1084
4	**CASINEI**	Private	Poggio dei Casinei	1825
5	**CROZ DELL'ALTISSIMO**	Private	Valle delle Seghe	1441
6	**DODICI APOSTOLI "F.LLI GARBARI"**	S.A.T.	Alta Val di Nardis	2488
7	**F.F. TUCKETT E QUINTINO SELLA**	S.A.T.	Vedretta di Brenta Inferiore	2269
8	**LA MONTANARA**	Private	Malga Tovre	1512
9	**MALGA DI ANDALO**	Municip.	Casinati	1365
10	**MARIA E ALBERTO BELLANI AI BRENTEI**	C.A.I.	Brentei	2179
11	**SELVATA**	Private	Pian della Selvata	1656
12	**TOSA "TOMMASO PEDROTTI"**	S.A.T.	Sella del Rifugio	2500
13	**VAL D'AMBIEZ "SILVIO AGOSTINI"**	S.A.T.	Alta Val d'Ambiez	2405

Figure 25. Names, property, location and altitude of the research alternatives' Refuges

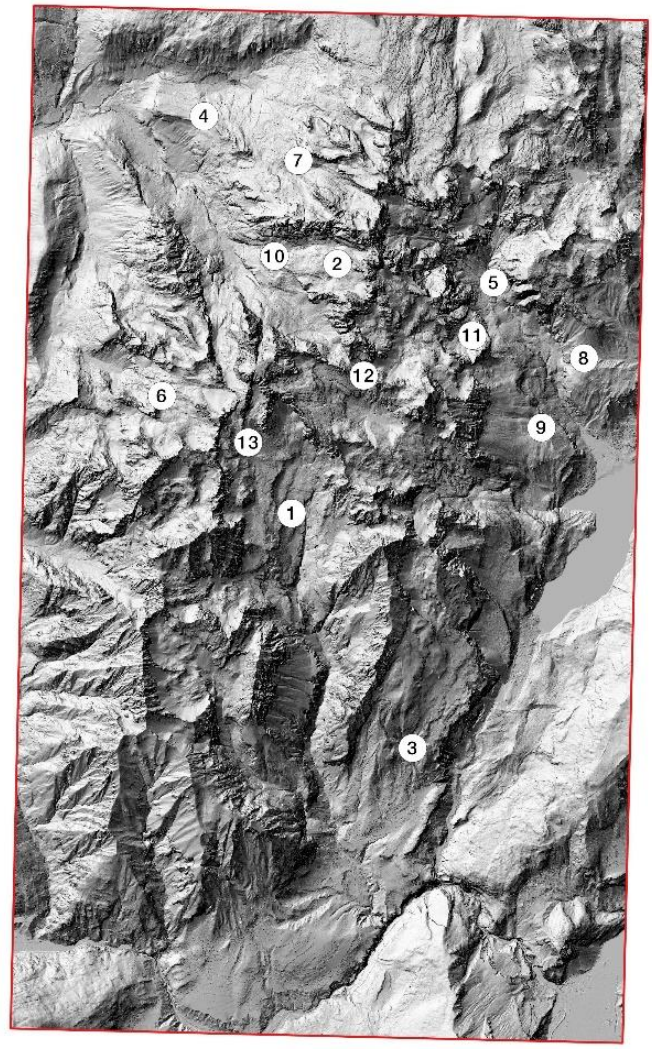


Figure 26. The 13 Alternatives Alpine Refuges of the Study Area in the Brenta Dolomites – Trentino (Italy)

Alpine Refuges are generally designed both in construction packages and technology systems, as well as in the distribution and management like structures for a limited summer season use, even if all of them have a legal obligation to guarantee the free access to a "winter room" as emergency shelter also in the commercial closing period.
Apart of the private refuge "Alimonta", the other refuges with higher elevation and localized closer to the climbing wall, are properties of the Italian Alpine Club, through their sections of Trentino (SAT) and Monza (CAI Monza). This buildings are the oldest of the Brenta chain,

but the Alpine Club could be the most interested stakeholder in the seasonal extension, even without great economic revenue, according to his statute and mandate, most centred on support to mountain alpinistic practices.
Private refuges are situated at the lower altitudes, along the access paths to the higher refuges and climbing wall.
They are part of an efficient network of facilities, with newer buildings of small dimension, that could be easily renovated for winter season use, as shown by the ones which are closer to the town of Molveno (Malga di Andalo, La Montanara and Alpenrose), that favored by particular condition of low altitude, accessibility and tourist flow, are historically opened during the winter period.
The possibility to search a generic suitable location for a new building, far from the existing refuge is excluded by law constraint and environmental respect.

The results of the GRASS analysis in the A.R.S.E. research are presented in form of maps of reference, that georeference and summarize the concentration value of the analysed dataset. Even there is no fixed scale of representation in the reported maps as they only pretend to visualise the data concentration, it is important to notice that the scale of definition of each data is 1:1 meters as a consequence of the adoption of the Digital Terrain Model (DTM).
In the next subchapter will be first presented the criteria and subcriteria considered in the research and some maps show few of the subcriteria. The following action has been the normalization of the subcriteria, redefining the features' values within an homogeneous spatial organization composing the normalized subcriteria maps. Recomposition of the criteria maps has been sequently developed assigning a weight to each subcriteria, in order of relevance for the research topic.
A.R.S.E. suitability has been finally verified including all the created normalized criteria values, obtaining for each refuge a summarizing value underlining the most suitable refuges for a possible extension of opening season.

2.3.2. ARSEs criteria and subcriteria definition

In the definition of the ARSEs (Alpine Refuge Seasonability Extension suitability), it has been considered 4 criteria (Attractivness, Accessibility, Dangerousness, Managment), each one described by 3 sub-criteria according to the following definitions.

Attractivness: defines the position value of the alpine refuges compared to mountain attractors, described through:

- *Geologic Attractors Distance* which recognize the importance of geology, even as punctual singularity in the specific offer of Brenta chain (spatialized by a proximity map derived from PUPs punctual thematism of geologic features);
- *Alpinistic Attractors Distance* which recognize the importance of the refuge proximity to winter mountaineering objectives, derived from comparison with mountain guides, as Canalone Neri, Tosa top, Bocca di Tuckett, Bocca di Brenta… (spatialized by a proximity map derived from a personal digitalization based on alpine guide comparison);
- *Scenic Wall Distance* which recognize the sublime features of some dolomites rock walls as an added value to the attractivness of a place (spatialized by a proximity map derived by personal digitalization based on landscape analysis);

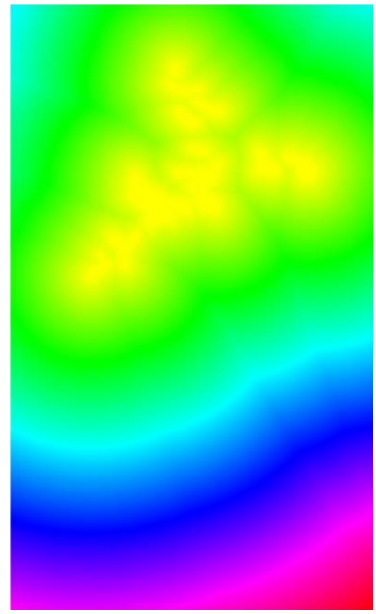


Figure 27. Map of attractiveness / Scenic wall distance
(wall_scenic_dist proximity map, GRASS Gis)
Color yellow marks the highest proximity to the most scenic rock walls.

Accessibility: defines the accessibility value of the alpine refuges as a relevant factor for the customers of winter-open refuges described through:

- *Access Time* which recognize, the importance of the winter access time from the winter car parks to the refuges (spatialized by a buffer map on access paths, that spatially attribute time features to spaces – like refuges – derived by the SAT Alpine Club paths cadastre);
- *Connection Time* which recognize, the importance of the winter connection time among the refuges as a network property suitable for the costumers (spatialized by a buffer map on connection paths, that spatially attribute time features to spaces derived by the SAT Alpine Club paths cadastre – like refuges where the increasing numer of connections are linearly added by raster operations, increasing the role of refuges with a larger number of connection to other structures);
- *Slope* which recognize the access and descendent path costs that become extremely relevant in the snow progession (spatialized by a slope map derived by GRASS GIS raster operation on the Digital Elevation Model_hillshade 135°, 1 meter resolution, of the study area available on the autonomous Trentino province public webGIS SIAT);

Figure 28. Map of accessibility / Slope (dtm_slope slope map, GRASS Gis) Color black marks the highest gradient of slope.

Dangerousness: defines the risk of avalanche connected to the winter paths fruition, based on historical events, in order to express an avarage value of risk, that can't express the daily/hourly and punctual condition of risk (dependent on instant temperature, solar exposition, slope, vegetation, altitude, oldness of the snow, soil temperature) but which is relevant in the risk attitude of different districts and paths and therefore in the choice of the most suitable refuge for winter seasonability extension, described through:

- *Access Risk* which recognize the importance of the winter access risk from the winter car parks to the refuges (spatialized by a buffer map on access paths, that spatially attribute time features to spaces derived by the SAT Alpine Club paths cadastre, featured by a risk value of the path derived by a weighted average between buffer's area that intercept the Avalache Risk Map of PGUAP, available on the webpage of "Servizio Geologico" of the autonomus province of Trentino);
- *Connection Risk* which recognize the importance of the winter connection risk among the refuges (spatialized by a buffer map featured with an averege risk value derived from the same procedure for the Access Risk);
- *Descent Risk* which recognize the importance of the risk among the ski descent from refuges to the car park (spatialized by a raster map, based on personal digitalization of the safest ski descendent routes by bibliography and alpine guide comparison, featured with an averege risk value derived from the same procedure of weighted average used in the Access Risk);

Management: defines the suitability in the winter management of the alpine refuges by external and environmental factor, described through:

- *Solar Insolation Time* which recognize the importance of the solar gains to the alpine refuges, for active and passive energy production and accumulation (spatialized by a time insolation map generated by the r.sun GRASS GIS application, as result of the combination of the Digital Elevation Model of the study area, with environemental fatures of the site – lat, long, horizontal hight…);
- *Glaciers Distance* which recognize the importance of the proximity to permanent glaciers, as potential reserve of water in the winter drought periods (spatialized by a proximity map from PUPs areal thematism of glaciers);

- *Supplies Risk* which recognize the risk of loosing the supplies connection between the refuge and the urbanized area by avalanche as an important economic factor in the refuge management (spatialized by buffer map, of the supplies track previously featured by weighted average only on the ground track as explained for the Access Risk);

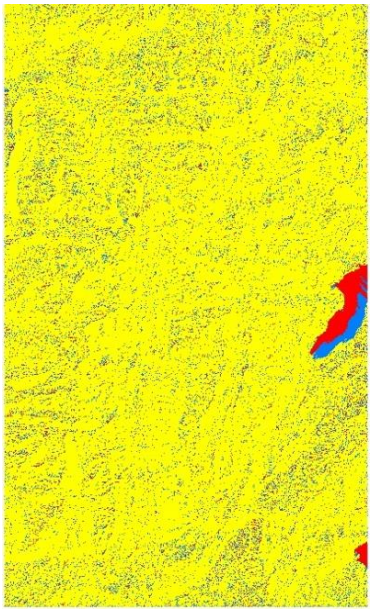


Figure 29. Map of management / Solar insoltaion time
(insol_time insolation time map, GRASS Gis)
Color yellow marks highest insolation time.

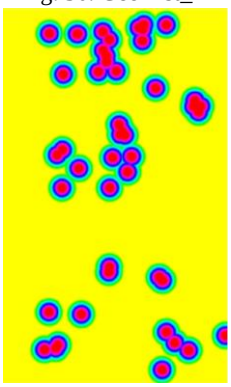
SUBCRITERIA MAPS NORMALIZATION

Each subcriteria map must be normalized to obtain homogenous spatial distribution in each map, from a minimum value "0" that identify the less suitable spatial condition for each criterion, to the most suitable "1", in order to allow a correct subsequent normalized comparison for each criterion and a final weighted normalized subcriteria maps addition that generates the normalized criteria maps.
For each subcriteria has been written a normalization function through the GRASS GIS application r.mapcalc, that consider the specific features and thresholds.

Map normalization:

Distance from Geologic attractors (GeoDist_NN)

Fig. 30. GeoDist_NN

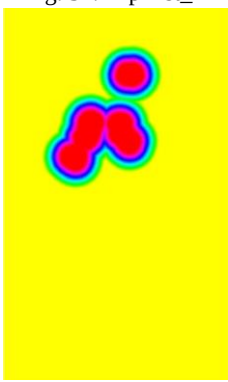


GeoDist values (0-5252 m)
COST, we accept with 1 values every place within 200 m by the geologic site, and we don't accept places 800 m farer from the site, for the punctual definition of the sites.
Among 200 and 800 m we have a linear cost distribution, as put in evidence by the subsequent GRASS GIS command:

```
GeoDist_n=
r.mapcalc((if(pupgeo07f_dist@riccardo<200,1,((600-(pupgeo07f_dist@riccardo-
GeoDist_NN=
r.mapcalc(if(GeoDist_n@riccardo>0,GeoDist_n@riccardo,0))
```

Distance from Alpinistic attractors (AlpDist_NN)

Fig. 31. AlpDist_NN

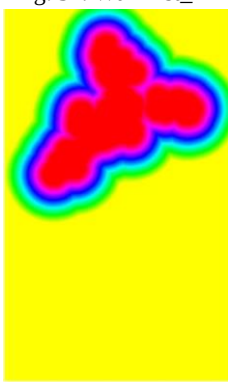


AlpDist values (0-13777 m)
COST, we accept with 1 values every place within 500 m by the alpinistic attractors, and we don't accept places over 1500 m far from the site, for definition of the attractors.
Among 500 and 1500 m we have a linear cost distribution, as put in evidence by the subsequent GRASS GIS command:

```
AlpDist_n=
r.mapcalc(if(Alpinistic_Attractors_dist@riccardo<500,1,(1000-
(Alpinistic_Attractors_dist@riccardo-500))/1000)
AlpDist_NN=
r.mapcalc(if(AlpDist_n@riccardo>0,AlpDist_n@riccardo,0))
```

Distance from Scenic walls (WallDist_NN)

Fig. 32. WallDist_NN



WallDist values (0-14032 m)
COST, we accept with 1 values every place within 500 m by the scenic walls, and we don't accept places over 2500 m far from the scenic walls,
Among 500 and 2500 m we have a linear cost distribution, as put in evidence by the subsequent GRASS GIS command:

```
WallDist_n=
 r.mapcalc(if(wall_scenic_dist@riccardo<500,1,(2000-(wall_scenic_dist@ricc.-
500))/2000))
WallDist_NN=
r.mapcalc(if(WallDist_n@riccardo>0,WallDist_n@riccardo,0))
```

Access time (AccTime_NN)

AccTime values (0,5-5,5 hrs)

COST, we don't accept access time within 1,5 hrs and over 5,5 hrs, among 1,5 and 3 hrs we have the best suitability "1".

Among 3 hrs and 5,5 hrs we have a linear cost distribution, as put in evidence by the subsequent GRASS GIS command:

```
AccTime_n=
r.mapcalc(if(accbuf_time@riccardo <0.5,0,(2.5-(accbuf_time@riccardo-3))/2.5))
AccTime_NN=
r.mapcalc(if(AccTime_n@riccardo>1,1,AccTime_n@riccardo ))
```

Connection Time (ConnTime_NN)

ConnTime values (0,5-5,5 hrs)

COST, we accept with 1 values every connection time path within 2 hrs, and we don't accept time over 5 hrs.

Among 2 hrs and 5 hrs we have a linear cost distribution, as put in evidence by the subsequent GRASS GIS command:

```
ConTime_NN=
r.mapcalc(if(connbuf_time@riccardo<2,1,(3-(connbuf_time@riccardo-2))/3))
```

Presence of Slopes (Slope_NN)

Slope values (0-90 dgr)

BENEFIT/COST, we don't accept slope values over 45° we consider with a linear benefit function the slope value within 28°, which is the first slope where avalanche risk becomes relevant, and we consider with a linear cost function the slope values among 28 anf 45°, as put in evidence by the subsequent GRASS GIS command:

```
Slope_n=
r.mapcalc(if(dtm_slope@riccardo<28,dtm_slope@riccardo/45,(17-
(dtm_slope@riccardo-28)/17)
Slope_NN=
r.mapcalc(if(Slope_n@riccardo>0,Slope_n@riccardo,0)
```

Map normalization:

Fig. 33. AccTime_NN

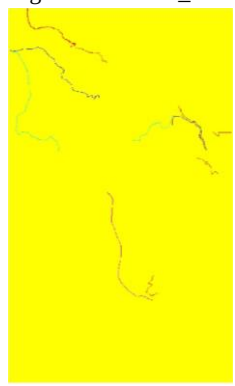


Fig. 34. ConnTime_NN

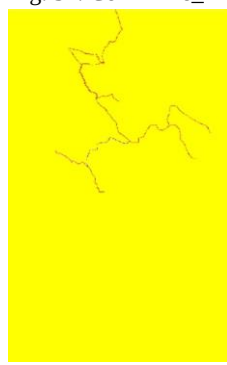
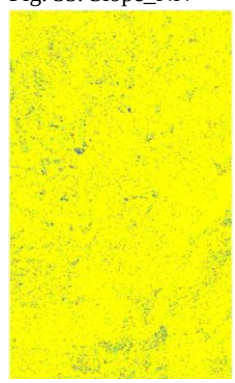
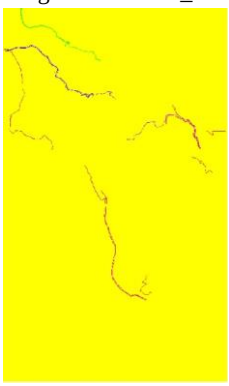


Fig. 35. Slope_NN



Map normalization:

Fig. 36. AccRisk_NN



Risk of access (AccRisk_NN)

AccRisk (0-0.22)

COST, we consider with a linear cost function between 0 and 0,22, as put in evidence by the subsequent GRASS GIS command:

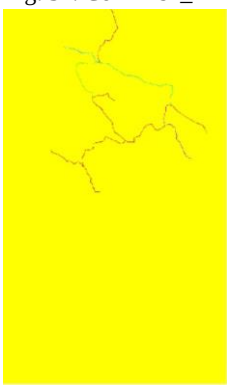
AccRisk_NN=
r.mapcalc(0.22-accbuf_risk@riccardo)/0.22)

Connection risk (ConnRisk_NN)

ConnRisk (0-0.22)

COST, we consider with a linear cost function between 0 and 0,22, as put in evidence by the subsequent GRASS GIS command:

Fig. 37. ConnRisk_NN



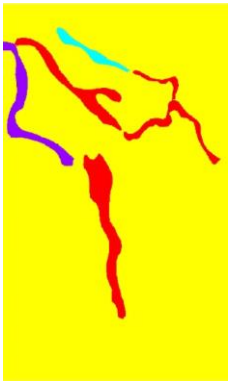
ConnRisk_NN=
r.mapcalc((0.22-connbuf_risk@riccardo)/0.22)

Descent risk (DesRisk_NN)

DesRisk (0.3-0.8)

COST, we accept with 1 values every descendent risk value within 0,3. Among 0,3 and 0,8 we have a linear cost distribution, as put in evidence by the subsequent GRASS GIS command:

Fig. 38. DesRisk_NN



DesRisk_NN=
r.mapcalc(if(desk_risk@riccardo<0.3,1,(0.5-(desk_risk@riccardo-0.3))/0.5))

Solar insolation time (InsolTime_NN)

InsolTime (0-12 hrs)

BENEFIT, we accept with 1 values every place with a solar insolation time over 6 hrs, we don't accept places within 2 hrs of insolation.

Among 2 and 6 hrs we have a linear benefit distribution, as put in evidence by the subsequent GRASS GIS command:

```
InsolTime_n=
r.mapcalc(if(insol_time@riccardo<2,0,(insol_time@riccardo-2)/4))
InsolTime_NN=
r.mapcalc(if(InsolTime_n@riccardo<6,InsolTime_n@riccardo,1))
```

Distance from Glaciers (SnowDist_NN)

SnowDist values (0-14272 m)

COST, we accept with 1 values every place within 1000 m by the glaciers, and we don't accept places over 5000 m. Among 1000 and 5000 m we have a linear cost distribution:

```
SnowDist_n=
r.mapcalc(if(pupghi07f_dist@riccardo<1000,1,(4000-(pupghi07f_dist@riccardo
-1000))/4000))
SnowDist_NN=
r.mapcalc(if(SnowDist_n@riccardo>0,SnowDist_n@riccardo,0))
```

Map normalization: IceDist_NN (GRASS Gis)

Supplies Risk (SupplRisk_NN)

SupplRisk (0-1.0)

BENEFIT, the function is naturally normalized:

```
SupplRisk_NN= r.mapcalc(supplbu_risk)
```

SUBCRITERIA WEIGHT ATTRIBUTION

The four principal criteria maps that follow, are derived by a weighted sum of the normalized subcriteria maps.

In order to generate a homogeneus set of normalized criteria map, it's important to maintain an unitarian value of the summed map. For this reason the sum of the weights, given by direct assignment to every criterion's subcriteria, have to be 1.

Map normalization:

Fig. 39. InsolTime_NN

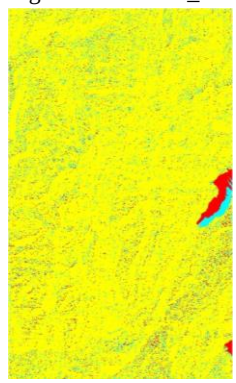


Fig. 40. SnowDist_NN

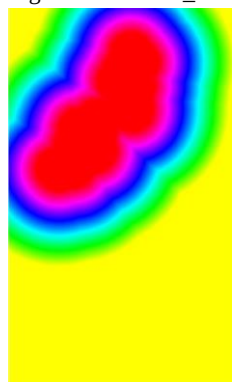


Fig. 41. SupplRisk_NN

Attractiveness_NN

The Attractiveness normalized maps is generated by the weighted sum of the normal maps GeoDist_NN, AlpDist_NN and WallDist_NN.

As we consider as most the impotant subcriterion the Alpinistic Attractors Distance, cause of mountaneerings are the main costumers for refuge winter opening, we attribute to AlpDist_NN a weight of 0,5. Among GeoDist_NN and WallDist_NN which are quite similar, we give a small advantage to the environmental dimension of WallDist_NN with a weight attribution of 0,3 instead of 0,2 as put in evidence by the subsequent GRASS GIS command:

Attractiveness_NN=
r.mapcalc(0.2*GeoDist_NN@riccardo+0.5*AlpDist_NN@riccardo+0.3*WallDist_NN@riccardo)

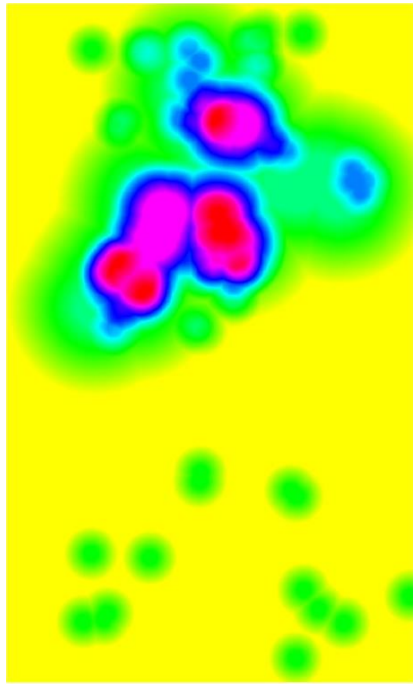


Figure 42. Subcriteria weight attribution: Attractiveness_NN (GRASS Gis)

Accessibility_NN

The Accessibility normalized map is generated by the weighted sum of the normal maps AccTime_NN, ConnTime_NN, Slope_NN.

As we consider as the most and equivalent impotant subcriteria the Access Time and the Slope, we attribute to this two normalized map the weight 0,4.

The Connection Time is weighted as 0,2 because it's a second order level of access, while the other two subcriteria are fundamental to guarantee the accessibility to the most suitable refuge as put in evidence by the subsequent GRASS GIS command:

```
Accessibility_NN=
r.mapcalc(0.4*AccTime_NN@riccardo+0.2*ConTime_NN@riccardo+0.4*Slope
_NN@riccardo)
```

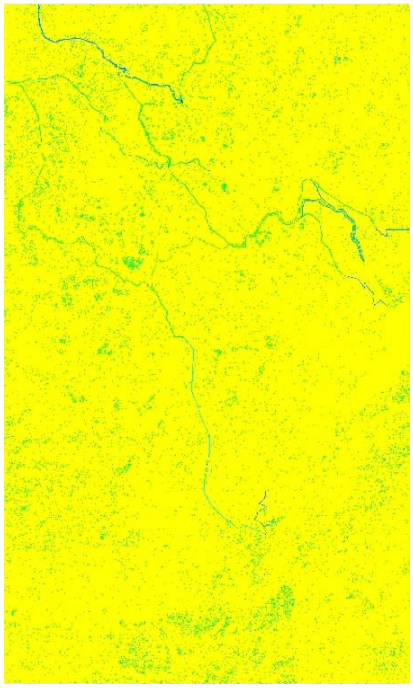


Figure 43. Subcriteria weight attribution: Accessibility_NN (GRASS Gis)

Dangerousness_NN

The Dangerousness normalized map is generated by the weighted sum of the normal maps AccRisk_NN, ConnRisk_NN, DesRisk_NN.

As we consider as the most important subcriteria Risk the ski Downhill, we attribute to this subcriteria a weight of 0,5.

Among the Connection and Access Risk, which are quite equivalent, we attribute a small advantage to the direct access to the refuge, weight 0,3, instead of the connection risk, weighted 0,2 as put in evidence by the subsequent GRASS GIS command:

Dangerousness_NN=
r.mapcalc(0.3*AccRisk_NN@riccardo +0.2*ConnRisk_NN@riccardo+0.5*
DesRisk_NN@riccardo)

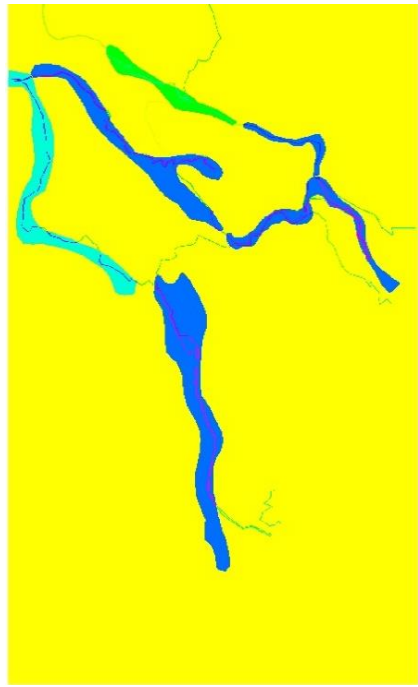


Figure 44. Subcriteria weight attribution: Dangerousness_NN (GRASS Gis)

Managment_NN

The Managment normalized map is generated by the weighted sum of the normal maps InsolTime_NN, SnowDist_NN and SupplRisk_NN.
As we consider as the most and equivalent important subcriteria the Insolation Time and the Supplies Risk, we attribute to this two normalized maps the weight 0,4.
The Glaciers Distance is weighted as 0,2 because it's a second order level of characteristic, while the other two subcriteria are fundamental to guarantee a suitable management to the refuge as put in evidence by the subsequent GRASS GIS command:

Management_NN=
r.mapcalc(0.4*InsolTime_NN@riccardo +0.2*SnowDist_NN@riccardo+0.4* Suppl Rik_NN@riccardo)

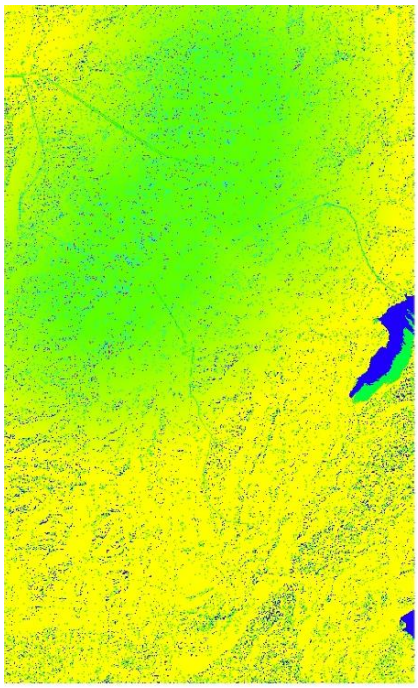


Figure 45. Subcriteria weight attribution: Management_NN (GRASS Gis)

CRITERIA WEIGHT ATTRIBUTION

The presented 4 principal criteria maps are now ready to be combined in order to define the "Alpine Refuge Seasonability Extension suitability" normalized map through the weighted sum of the criteria.
As in the previous processes, the whole sum of the weights have to be equal to 1, and the weight attribution is on direct assignment.
We consider as the most important criterion the Dangerousness normalized map, with a weight of 0,35, followed by the Management normalized map 0,3, the Attractiveness normalized map 0,2 and finally the Accessibility normalized map 0,15.
The GRASS GIS command that is used for generating the "Alpine Refuge Seasonability Extension" normalized map is:

```
ARSE_NN=
r.mapcalc(0.2*Attractiveness_NN@riccardo +0.15*Accessibility_NN@riccardo +
0.35*Dangerousness_NN@riccardo +0.3*Management_NN@riccardo)
```

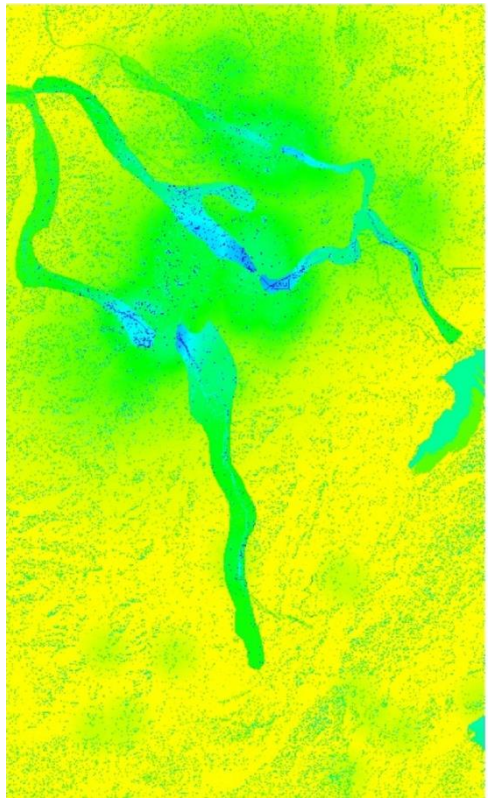


Figure 46. Alpine Refuge Seasonability Extension suitability normalized map, ARSE_NN (GRASS Gis)

Verifying punctually the "Alpine Refuge Seasonability Extension suitability" normalized map values of our 13 alpine refuge alternatives, we can observe (Figure 48) that there are 5 refuges with a ARSEs value <= 0.40, other 5 alpine refuges, with ARSEs value <=0.50 and only 3 refuges with higher value, the "Tommaso Pedrotti" alla Tosa, the Val d'Ambiez "Silvio Agostini" and "Alimonta".
If the Alimonta refuge is a private property and have an ARSEs value similar to other refuges, the best 2 refuges in the ARSEs rank are both property of the local Alpine Club (SAT) and, in this suitability model, show very high values of the indicator, very far from the others refuges.
The most significat and curios result is the best suitability among the 13 alternatives of the SATs refuge "Tommaso Pedrotti" alla Tosa, the nearly older refuge of the chain, that can be interpreted as an evidence of the localization value of this first refuge.

Cod	Name	Suitability
4	**CASINEI**	0,23
8	**LA MONTANARA**	0,30
9	**MALGA DI ANDALO**	0,38
11	**SELVATA**	0,38
7	**F.F. TUCKETT E QUINTINO SELLA**	0,40
6	**DODICI APOSTOLI "F.LLI GARBARI"**	0,44
3	**ALPENROSE**	0,48
10	**MARIA E ALBERTO BELLANI AI BRENTEI**	0,49
1	**AL CACCIATORE**	0,49
5	**CROZ DELL'ALTISSIMO**	0,50
2	**ALIMONTA**	0,53
13	**VAL D'AMBIEZ "SILVIO AGOSTINI"**	0,61
12	**TOSA "TOMMASO PEDROTTI"**	0,85

Figure 47. The ARSEs values applied to the Alpine Refuges in Brenta Dolomites Group

3. MOUNTAIN BUILDING HERITAGE FOR AGRICULTURE

The chosen building typology to represent agricultural building heritage are *cabins* - translating the italian word *maso* or the german *hof*, even if the same words can have different significant when speaking about latin or german alpine settlements (subchapter 3.1). In actual rural mountain landscape they represent a specific mark, representing in some ways a stereotyped ideal place for quiet holidays strictly linked to the natural environment.
Presently this building type is aware of a detouchment from agricultural activities, and is going to change the concept of his existence, finding a new development potential.
The building type of alpine cabins, differently from other farmer building typologies, is not connected to an urban or semi-urban space. It is in fact in strict relation with the alpicoltural landscape, but stays generally in an isolated or rur-urban situation.
This specific agricoltural condition is normally located on an intermediate elevation range, limited to pasture or forest space, not above the natural upper timberline. The altimetric limit is determined by the historic functional character of the building type, connected to the need of pasture for breeding and construction- or firewood to bring down to the lower family house.
Comparing to the two other building categories threated in the thesis – bivouacs and refuges – the cabins seem to be present in the Alps with a larger density. This is determined by various reasons, mainly connected to the small dimension referred to a single family use.
Moreover, cabins have mostly been taken into account related to mountain huts or farmhouses, which differently are directly managed by a farmer, representing an important tourist destination all along the alpine region, where it's possible to buy fresh dairy products or to stay for a rural holiday. Cabins surely represent rural settlement, but not strictly connected with stable and barns, like the farmhouses. They can well remind the past condition of self-sufficiency of a family needing a place for summer pasture for goats or few cows, often just few animals.

Future development scenarios for cabins consider a change of shape and fruitors, going to represent a stage for a sustainable tourist infrastracture to be connected not only with rural/agricultural tasks but also with alpinist or climbing activities.
Even in this case, like in the past where they had no principal role but only a seasonal single-family use, the function of cabins in actual mountain tourist offer is secondary and directed to niche market.
Actual restoration processes are also characterized by technological upgrade, improving potential services that can be offered and sustainability.
Alpine tourist development invite to a restoration of the cabins, giving them new significance. It is even possible to change their first identity becoming part of other alpine building categories, like bivouacs or refuges. In other cases, transformation needs can just regard modest enlargements prevalently when keeping a privat use of the properties.
Observing the general situation at large alpine scale, the building typology of cabins can be referred to limited areas, similar in a general view but very specific of each valley, touching traditions and local skills.
The research aims at giving a key for understanding past composition principles in order to reinterpret them within contemporary language of mountain architecture.

This chapter offers a view on historical development in the perception and academic debate on alpine rural settlements and presents the results of the research on Alpine cabins in the Stelvio/Stilfser Joch National Park, concerning the sector of the Autonomous Province of Trento with the Valleys of Peio and Rabbi.
Within the framework of the Plan for the National Park the research deepened the individual characters of the rural buildings composing summary tools that can be used in the interpretation of the logics of their birth and development.
The hystoric dynamic of the evolution followed a natural development mainly based on functional needs of the buildings, and the created imperfection has to be read as a value for the whole structure.
The governance of development of rural mountain buildings, concerning restoration or enlargements, should better be based on the identification of specific local features of architectural composition.

3.1. Fragments of history on Alpine rural settlements

The XIX century brought a debate at European level for the theoretical distinction between Latino and Germanic settlement. In the following century this differentiation lost his stategic value leaving space to a more detailed analysis favouring the singolar evolution of each traditional settlement, considered to have a proper development caused by various cultural, environmental, economical factors.
Despite this, the recall of the protagonists of the first debate seems to bring an additional benefit to the research. August Meitzen (1895) traces the origin of each rural settlement to the different cultural models, in opposition to that Friedrich Ratzel (1882-1891) considered the different cultural forms as determined by natural conditions.
Previously, the Swiss Jakob Hunziker (1865) developed the opinion that the shape of alpine rural settlements could be divided according to the distiction caused by German and Latin ethnic influences. Scattered villages were attributables to German culture and to the preference in the use of wood as building material, on the other hand, close centralised villages had Latin origins preferring stones for the construction. “Latin and German concepts […] are historic-geographical concepts exclusively applicable to the interaction between Alpine environment and history of man” [W. Bätzing, 2005].

In the following image (Figure 49) is described a limit in altitude for traditional agricultural activities regarding Latin Alpine ethnicity, related to the possibilities of pasture in the Alps during different seasons. Generally there is a four step movement that starts from the villages in the lowest land of the valleys where families stay during winter months, from october/november to april. Here families own their private houses, and sometimes there’s the possibility to have a stable with superimposed hay loft. This buildings used to recover animals during winter can also be not directly attached to the privat house, but located in rural reachable areas. In this case they could be located between 1000-1300m asl and be used also for temporary animal lodgement and pasture during spring and autumn. This second step is represented by the private summer rural house for families, where haymaking is possible sometimes also with two forage harvests, depending on weather conditions, and where is possible to produce vegetables and fruits harvested between august and september.

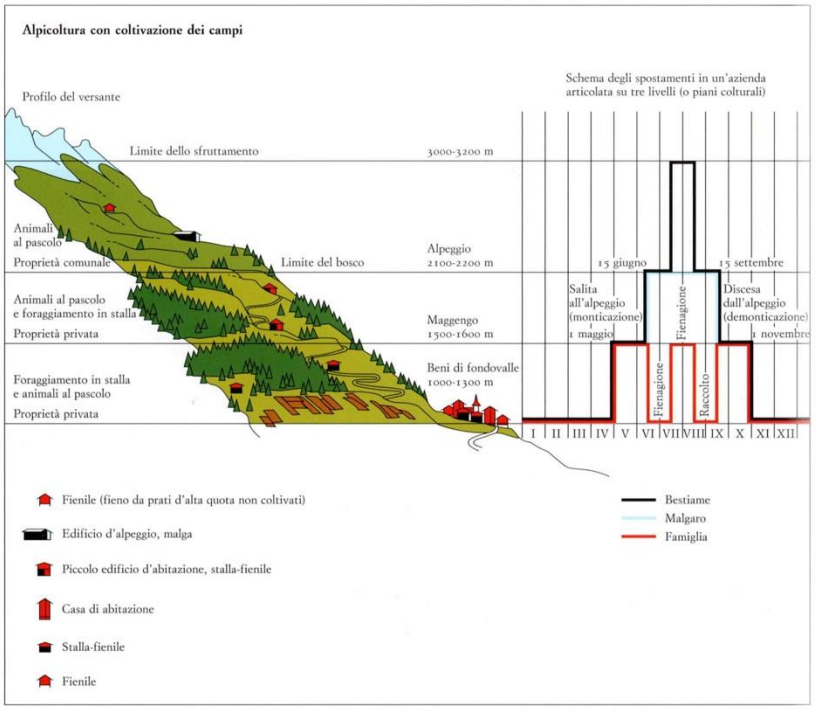


Figure 48. Scheme of traditional system of mountain use in Latin agricultural model.

In may begins the third step, the ascent to highest lands located from 1500 to 1600 m asl. Here we find private huts or cabins, smaller than the previous ones and generally divided into two small room, one for people – normally just one person: the shepherd/dairy farmer - and one for animals and/or hay storage. Close to the building there's also the possibitity for hay and firewood making, and the collected hay or firewood is then transported to the low valley. The fourth step, possible just between july and August interests the rural areas between 1700-2200 m asl which are not divided into privat properties and where the range management and mountain pasture is organized in community huts, where a shepherd/dairy farmer takes care of the animals.

This reading represents a detailed interpretation of a single Latin case study, located in the Swiss Valais, that we will now compare with the features of a general German Alpine settlement. This second model is characterized by the prevalence of agricultural activities related to animal husbandry instead of farming, as it happens in Latin ethnicity. The attachment to zootechny makes settlement less dependent to

altitudinal limit of grain cultuvation, while the required lands for animal husbandry have to be wider than those needed from farming activities.
The traditional German agricultural landscape is distinguishible from hills and mountain sides with fertilized lawns (previously farmed with grains, alternated to the pasture use in order to be fertilized) plus scattered cultivated fields of reduced dimensions. Woodland is the prevailing mark in the lanscape, resulting in forestry as a major activity integrative of locals income [W. Bätzing, 2005; C. Marchesoni and L. Toller, 2015].
Privat property is wider that in the Latin areas, with the aim of self-sufficiency for each farm/*hoff* or group of farmhouses. The single family farmhouse, including related field, pastures and woodlands, is integrally inherited by the first descendent as it happens in Italian South Tyrol (*maso chiuso*) [V. Curzel, 2013].
As it happens in the history of Bersntòl, or Valley of Fersina (Trento, Italy), an example of ethic-linguistic minority island in Italian territory, the concept of the farm means a group of buildings (dwelling, stables, barns) to which cultivated fields, mowing meadows, woodlands and a summer stable on the edge of high pastures (over 1500m) that are owned by the single *hoff* or shared with a group of families. The farmhouse is composed on the ground floor by the stable, the residential part in masonry and other various service areas and on the upper floor the wooden hayloft set in place with the blockbau system and the gable roof covering in larch wood tiles.
Each farm is designated by a toponym that reflects the particular morphological and environmental conditions or the name of the family that first settled there. Toponyms still today identify the resident group and are used as synonyms of lineage. The economy was centered, above all, on animal breeding and the sale of calves. Grain cultivation (oats, barley, rye) aimed at self-consumption and limited to more flat areas or fields obtained with terracing system [P. Scheumeier, 1995; C. Marchesoni and L. Toller, 2018].

3.2. The case study of *Stelvio/Stilfser Joch National Park*

The *Stelvio/Stilfser Joch National Park* can be considered one and triune, bringing together three different governative and management institutions: the Autonomous Province of Bolzano, the Autonomous Province of Trento and the Lombardia Region.

The Park was founded in 1935 with the National Law 740 of 24/04/1935 and became the fourth Italian National Park. For his extension measuring 1350 km^2 it becomes the first Italian Alpine Park and the second Alpine Park in Europe.

The territory of the National Park includes an inhabited area with 64.821 resident inhabitants (2018) divided in 23 municipalities: 10 in the Province of Bolzano, 10 in Lombardia Region, 3 in the Province of Trento. In this chapter will be presented a study on the rural building heritage in the Valleys of Peio and Rabbi, referring to part of the territory pertaining to the Autonomous Province of Trento.

The natural character of the Park is featured by an high altitude alpine environment, with the presence of 129 glaciers, 37 habitats and 9 priority habitats Natura 2000 (a network of priority natural protection areas including Special Areas of Conservation and Special Protection Areas in the territory of the European Union)

The Plan of the National Park, adopted in June 2019, aims a continuity of environmental values for the management of the protected area, in a unitary vision of territorial preservation, and at the same time the recognition of punctual notations for each administrative territory, underlining social and structural peculiarities for a complex view of a continuous landscape.

The characters composing the landscape of the Park, as we can notice in the following diagrams, have a prevalence in rocks with glaciers, coniferous forests and pasture landscapes. A minority part is occupied by agrarian and urban settlements, even so, this minor portion results to be the doors of the park with various access points for discovering the natural areas. The main visitor centres are located in the towns of Bormio (Lombardia), Cogolo (Trentino), Rabbi Fonti (Trentino), Glorenza/Glurns (Bolzano).

As regards agricultural sector, considered as an activity strictly connected with the landscape for the direct and significant conseguences on it, farms have generally medium-small dimensions

Figure 49. Location of the Stelvio/Stilfser National Park within the Italian territory.

Figure 50. Institutional division between three administrative regions.

Figure 51. Plan and anthropocene: the sector of the Park pertaining to the Autonomous Province of Trento and the uban areas included in the protected territory (in black).

and are often connected with other economy activities mainly directed to touristic industry.

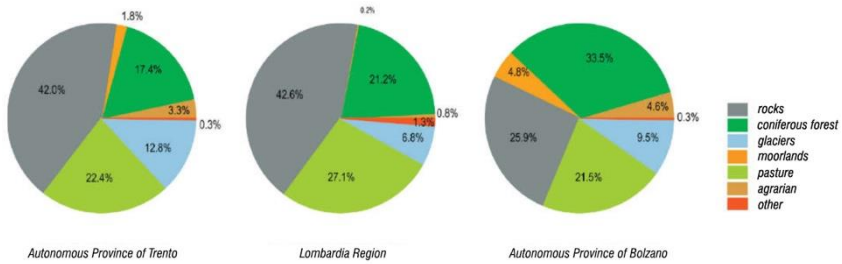


Figure 52. Landscape partition of the Stelvio/Stilfser Joch National Park

Exists many structures working in primary sector proposing accomodations as an additional and complementary business, called *agriturismi* or *masi/hof*. Other economic sectors are related to tourism like services and construction industry, looking to the remarcable presence of tourist infrastractures. This last is also partly connected with forestry sector.
Tourist offer covers a great variety of outdoor activities, such as skiing, natural guided walks in all season, other sport activities, and is also characterized by the presence of therme and a rich gastronomic proposal with local products.
Presence of tourists, measuring 5.812.244 presences, can be divided in two main seasons: summer, with 2.545.092 presences, and winter, with 3.267.152 presences. For tourists are provided 1.163 structures offering 37.646 beds, the majority is located in Province of Bolzano (47%) and Lombardia Region (47%). [Plan of the Stelvio/Stilfser Joch National Park, 2019]

The main goal of the National Park is the protection of environments, and on the basis of specific and contingent needs of tranquillity and protection of fauna or of preservation and restoration of habitats and flora, the Plan of the Park identifies specific areas for which can establish additional temporary limitations to use and fruition, having heard the Provincial/Regional Committee for coordination and address. This represents an important step in the governance of the fruition of the protected area, giving remark to a low impact of tourist activity but

recognizing the important role of inhabited areas to address visitors to a sustainable access in the Park.

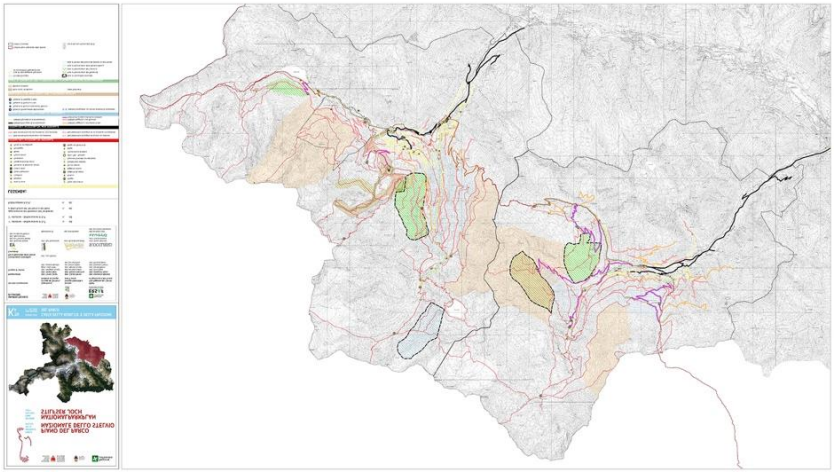


Figure 53. Map of mobility and fruition of the Stelvio/Stilfser Joch National Park, section Autonomous Province of Trento

3.2.1. Alpine cabins in the *Stelvio/Stilfser Joch National Park*

An important task of analysis and classification of the existing rural artifacts has been realized within the works for the Stelvio/Stilfser Joch National Park Plan in the sector of the Autonomous Province of Trento. The research activity aimed at giving references for the governance of the restoration and enhancement of isolated alpine buildings, in both theoretical and carthografical ways.
Realized products are the Maps of Artifacts in scale of 1:5000 for the areas of Peio, high Val del Monte, high Val de la Mare, Rabbi, Còler.
In the following map example, presenting the artifacts in one of this territories, is possible to observe both the geo-referencing and the classification of all the recorded rural artifacts.

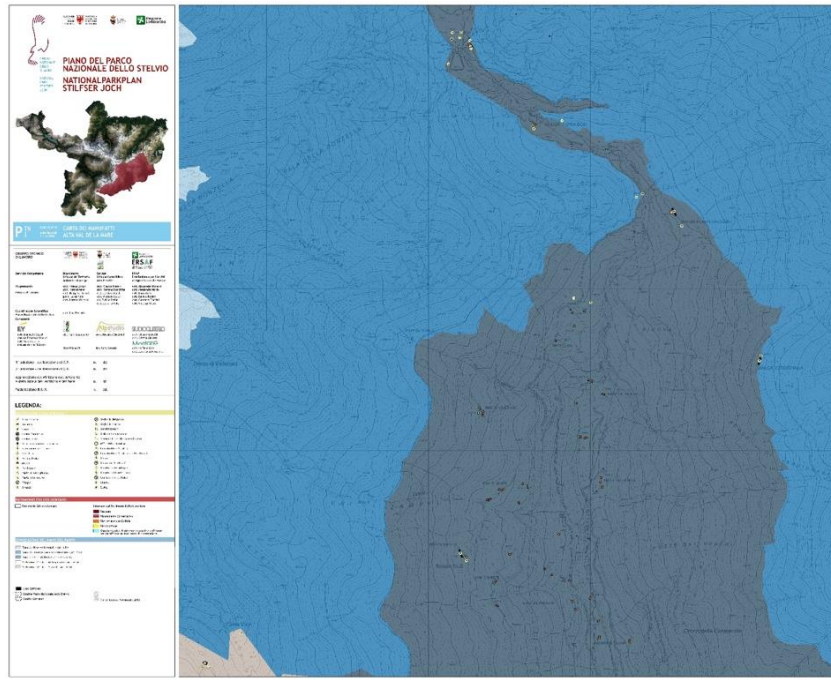
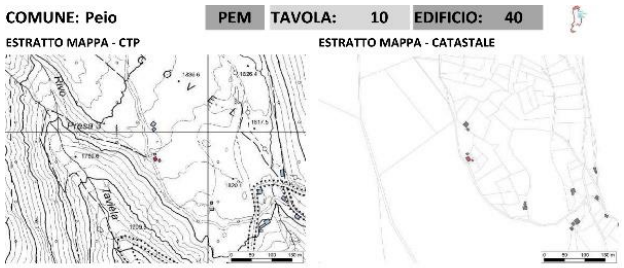


Figure 54. Example of punctual map of artifacts, Alta Val de la Mare, section Autonomous Province of Trento

Added to this the Plan contains a systesis of the isolated scattered building heritage of the same territories, in form of a detailed filing of each single building.
Given information regard the analysis of state of affairs, reporting: the

localization through cadastrian and Provincial Technical Maps, typological-functional classification, period of construction, actual use, degree of use, building characters, architectural typology, state of conservation, added or connected buildings, technical networks, access infrastructure, legislative restictions. Other informations are given reporting the previsional possible development, specifying: types of intervention, general legislative addresses, designated use, destination for a volumetric increasement, legislative restrictions, specific normative guidelines.



ANALISI		
1. Tipologia Funzionale	Baita di Alpeggio/ MAlga/ MUlino/ FUcina/ SEgheria	FBA
2. Epoca di costruzione	data (aaaa)/anteriore 1860 (EA)/1860-1945 (EB)/dopo 1945 (EC)	EEB
3. Uso attuale	AGricolo/ ARtigianale/ ABitativo/ Turistico-Ricettivo/ di SErvizio	UAG UAB
4. Grado di utilizzo	in uso TEmporaneo/ in uso PErmanente/ in ABbandono	GTE
5. Caratteristiche edificio	tipo Costruttivo (Pietra/ legno a Blockbau/ legno a Telaio/ legno in Assito/ Misto pietra/legno)	CCM
	Volume (Ampliamenti/ Superfetazioni)	
	Elementi in aggetto (Poggioli, Ballatoi, Scale, Camino, Forno)	
	Tetto (a Capriate/ con Trave di colmo/ a Volta)	CTT
	Manto di copertura (Scandole/ Pietra/ Lamiera/ Cemento/ COtto/ plAstica)	CMS
	Accessori tetto (Comignoli/ Parabolica/ PaNnelli/ Abbaini/ Velux)	CAC
	Serramenti fori (Legno/ Alluminio/ Pvc/ Ferro)	CSL
	Finiture intonaco (a raso Sasso, Civile) e legno (Tinteggiatura)	CFS
	Particolari di pregio (Fori, Travi, Affresco, fOcolare aperto, Intagli)	
6. Tipologia architettonica	- ORiginale - MOdificata (grado leggero): interventi su finiture facciate, materiali serramenti, manto di copertura - TRasformata (grado medio): interventi su elementi parziali quali tetto, facciate, fori - ALterata (grado notevole): interventi su struttura originaria quali tipo costruttivo, volume, tipo facciate, tipo fori, tipo tetto	TTR
7. Stato conservazione	- BUono (necessita solo interventi di manutenzione) - DIscreto (necessita interventi su parti di edificio) - CAttivo (necessita interventi su intera struttura)	SBU
8. Pertinenze	a Verde Aperto/ a Verde Recintato	PVA
	Posto Auto/ AUtorimessa	
	Manufatto di Servizio/ Deposito Attrezzi / LEgnaia	
9. Reti tecnologiche	Acqua (Rete potabile/ Vasca accumulo/ Sorgente/ Assente)	RAR
	Acque Reflue (Rete fognaria/ Vasca Imhoff/ a Dispersione/ Assente)	RRD
10. Viabilità	accesso Area (Comunale/ Forestale/ Sentiero/ Pista/ Assente)	VAF
	accesso Edificio (Comunale/ Forestale/ Sentiero/ Pista/ Assente)	VEF
11. Legislazione (vincoli)	Individuazione Bene Ambientale	No
PREVISIONE		
1. Tipologie di Intervento Indirizzi normativi di carattere generale	Manutenzione Ordinaria/ Manutenzione Straordinaria/ ReStauro	
	Ristrutturazione Edilizia/ Risanamento Conservativo	IRE
	Demolizione e Ricostruzione – Ripristino edilizio e adeguamento tipol.	
2. Destinazione d'uso	AGricolo/ ARtigianale/ ABitativo/ Turistico-Ricettivo/ di Servizio	DAB
3. Ampliamento volume	Malga/ AgriTur / Segheria/ FUcina	
4. Legislazione (vincoli)	Individuazione Bene ambientale	
5. Indirizzi normativi di carattere specifico	Revisione delle modalità d'inserimento delle finestre nell'elevazione lignea.	

Figure 55. Example of filing of scattered building heritage, section Autonomous Province of Trento

Moreover, for each of the analysed buildings, the filing report a photographic document referred to actual and past reliefs, offering a vision of temporal development relevant to check the past authorized

interventions and to recommend improving developments aligned with a defined rural landscape.

Figure 56. Example of filing of scattered building heritage, section Autonomous Province of Trento

Alpine landscape is deeply characterized by manufacts that reflect the agricoltural practices of the local population. During centuries of activities, people developed a complex building heritage where emerges a rich planning attitude that consolidate material and figurative relations visibles in the construction of the anthropic landscape of many alpine valleys. As a case study for this mountain building activity will be proposed the analysis of this heritage in the valleys of Peio and Rabbi (Autonomous Province of Trento, Stelvio National Park), recognizing some elements of value and construction identity that characterize this spontaneous architecture. Recognizing the characters of the existing heritage could make possibile to guide a simplification of landscape planning. In this sense it's important to notice the precice proportions

even if normally built without a design and the continuous variations even if using the same local materials.
Each isolated Alpine artifact finds a unique form of relationship with the place where it's located, descending from economic and development logics, sizing the building unit as much is considered useful for the existence of a family unit, responding to given functional characters such as altitude, quality of pasture, number of animals and hay consequently needed. Now the same building is mainly evaluated for the perceptive relationship that is able to establish with the given context. In this logic, cabins become starting points for managing meadows and preserve environmental and cultural framework.
The connection generated from the relationship between building and semi-natural context is visible through the greening of soil directly touching the building sediment. The construction of this buildings didn't permanently effect the land on which is based without downstream works of earth-moving but with precise works of connection to the land's natural profile.

Figure 57. Relation between manufact and context

The created continuity of landscape is characterized by the absence of privat property boundaries, descending from the memory of a community dimension still present in the Valleys of Peio and Rabbi in the legal forms of local association aimed at managing civic uses and

the *consortela*. This is considered an important value in the relation between artifact and context that is important to preserve and reiterate.

Figure 58. Relation between manufact and soil

The features and the logics of distribution of alpine cabins are determined by morphological and infrastructural elements and characters. It is the context that makes the decision for an aggregation or rarefaction of manufacts and determines buildings' volumetric proportions. In presence of major slopes, roof cover results to be perpendicular to contour lines in case of a central compact building or parallel to them in case of a linear developed building.
Building orientation appears to be mostly influence by morphology instead of solar exposure, hinging the building activity to the choice of the pasture localization that sometimes, without being a rule, coicides with a most efficient southern exposure.

Figure 59. Logics of settlement

Muris muratam et lignaminibus edificatam et scandolis copertam. Since late Renaissance there are evidences of the tripartite division of rural buildings: a ground floor using local stone, preventing from humidity leakage possible during snowy or unfreezing periods; a wooden building elevation using natural larch wood; and generally, a gable roof cover using larch shingles with reduced roof projection beyond the building facade and without gutter.

Figure 60. Tripartition in rural buildings

The compositional tripartition between basement, elevation and roof assumes value in relation to the different expressive densities of its composing materials. The basement becomes a massive element, founder of the architecture itself, presenting a limited number of small openings that increase the perception of the wall thickness in the part that finds a continuous dialogue with the ground. When rising in elevation it decomposes, opening to different insertion modules for the wooden elevation in walls and corners which keep the exposed wall surface free of holes. It looks like a rough massive body, covered with lime-based plaster, without high edges that clearly define the wall surfaces.

Figure 61. Density of the composing materials

The wooden elevation presents the characteristics of a light volume where the disjunction between structural and infill elements leads to the perception of a full-bodied but light volume, which is opposed to the density of the ground floor due to spatial articulation and surface vibration. Historically, the theme of the openings in the wooden surface was limited to elements of modest size, without frames but characterized by the defined incision of the surface, or to the disjunction

of infill elements in a continuous variation in the perceptual density of the elevation.
The roof appears as a planar and non-volumetric element in contrast to the stone base and the wooden elevation. The proportions of the roof let appreciate the only two-dimensional component, because of the relationship between extension and thickness of cantilevers in coherence with a progressive ascensional lightening of the components that configure the spontaneous rural architecture in theValleys of Peio and Rabbi. The same layout is characterized by the ability to manage changes in the volumetric composition of the building and for the texture of the draining surface producing continuous vibrations of light that amplify the perception of a light and floating surface.

The necessity of enlargements in responce to the increasement of the number of animals afferent to the single building unity brought two different approaches in the valleys of Peio and Rabbi, caused by the absence of a building regulation outside urban areas. In the first one prevails the answer in the form of a shelter for the shepherd, called *bait*, made in stone in addition to the stone basement of the building, constituting a smaller element respect to the size of the principal building. In the valley of Rabbi prevails the necessity to have more hay for animal feeding, causing a responce in the enlargement of wooden elevations with open or closed volumetric additions like galleries or lattice, assuming a great element of identity in the traditional anthropized landscape.

The dimension of identity in the alpine rural artefacts, as well as the univocal relationship determined with respect to a specific geographical and cultural context, are visible through the care and the proposal of minimal linguistic elements that are met in the rural building context as a technological expression of a specific material culture.
The building composition is typified with different design variations that borrow from environmental, social and functional conditions, elements that are generated according to a precise construction code made of technological solutions such as nodes, connections, textures, holes and frames representing the minimal and irreducible elements of the architectural language, the morphemes.

Figure 62. Representation of building enlargements

The natural evolution of the morphemes of spontaneous alpine rural architecture collide today with two limits compared to the iterative approach of past solutions. The first limit is rooted in the weakening of the traditional local forestry and in the interrupted relationship between forestry and construction practices, once intimately connected for the governance of alpine landscape. This distance leads the sector to be less inclined to the custody of interdisciplinary knowledge and equally less inclined to develop the process of slow and continuous innovation of punctual technological solutions or morphemes. The second limit arises as a general reading of the artefact and its components which can lead to the simplification of identity characters towards forms of picturesque and alpine rustic. With regard to this theme, the need to overcome the risk of design standardization guided by technological standardization, forgetting complexity and identity features, appears to be central. It can be achieved starting from a new centrality of linguistic morphemes and from the innovation of those distinctive of mountain contexts, through contemporary construction techniques aimed at a site-specific linguistic research.

It is necessary to start from the choice of the wooden essences of traditional architecture, from the characters and the ability to maintain the geometric and chromatic-change conditions of larch and fir. Larch

wood is used in structural solutions, roofing (shingles and gutters) and facade composition because of its greater resistance to atmospheric agents. Fir wood is lightest, geometrically stable and modelable, used for floors and interior finishes. This approach leads to a double-sided perception of architecture, which presents a mono-material character for all the external wooden elements in larch (facade and roof), as opposed to internal fir wood core. The only exception for internal spaces occurred in rooms directly touching ground and in the stables where the floor structure was made of larch responding to the particular thermo-hydrometric conditions.

Figure 63. Linguistic morphems of rural buildings

The aging characteristics of the larch wood do not allow to create perfectly flat surfaces, but lead to continuous surface changes giving vibrations to the facade through a chiaroscuro which takes root in the continuous offsets between the planks that guaranteed the passage of air between internal and external space necessary for hay drying. The disjunction of the construction elements and the infill elements is a compositional theme of great interest in the enhancement of mountain building heritage and allows a functional transition towards seasonal residential and tourist use, updating a rural morpheme in a contemporary concept of skin of architecture.
Within the extensive theme of the display of wooden structural element

and its disjunction from the infill elements, many identifying morphemes of the rural architecture of the Peio and Rabbi valleys can be highlighted, including: roof beams with wooden joint interlocking between stone base and wooden elevation; the heads of beams protruding from the structural joints; the main upright at the roof ridge; the uprights at the corners of the wooden elevation and against walls; the roof strut outside the frame for the frames' resistance; the wooden junction to avoid the mutual sliding of the structural components. Similarly, the precise solutions to protect the heads of the protruding beams against weather actions, as well as the fixing solutions for the rafters and the trellis to guarantee ventilation of the upper part of the barns, are of great identity. It's not common the presence of balconies, *solàri* in Rabbi valley and *pontìvi* in Peio valley, however it was historically present and aimed at drying hay. The balcony was normally located on the ground floor, also integrated in a system of overlapping balconies, as an additive element of the wooden elevation. This composition enhanced the spaciouness and lightness of the facade thanks to the use of small diametred horizontal and vertical wooden components, sometimes recognizable with its own volumetric size due to the presence of modest single-pitched roofs.

The theme of openings is revealed in different forms within the same building unit, assuming strong symbolic value and great interest in the functional transition of the existing rural heritage towards a housing and accommodation dimension. Following a methological and conceptual dimension, it is appropriate to differentiate the wooden elevation openings from those characterizing the inferior stone base.

The openings in the wooden elevation were designed for the management of the ripening and conservation cycle of haymaking, they were characterized by two functional levels: continuous ventilation throughout the seasoning period and hay loading and unloading devices. The ventilation holes are made in the larch cover, without frame or closing devices, presenting simple geometric shapes or icons of symbolic value for local communities. The ventilation slots are regular sized vertical notches that modulate the ventilation by interpreting the texture of covering boards and locally expanding the air passage section.

The openings for hay loading consist of sections larger than the ventilation holes, which have a double nature of full when closed, of empty when open, determined by the flap mechanism on the vertical or

horizontal axis of the closing portal. In traditional rural architecture they are configured with similar languages to the wooden elevation of the farmhouse, through a cover of larch boards more or less permeable to air, sometimes underlined by the definition of a modest volume slightly projecting with respect to the plane defined by the covering tables in larch of the main structure of the building.
In the stone basement there are openings in the wall facades aimed at creating access doors and windows that had to guarantee access to the lower floors of the building, aimed at guaranteeing the minimum aero-lighting ratios to meet the needs of the functional program. The ground floor was generally suitable for the shelter of animals and for this reason it was characterized by modest openings. On the other side, upper floors could coincide with housing functions, especially in urban aggregates, and therefore presenting larger openings, helping to transmit a reading of progressive lightening of the architecture in its reading from basement to roof cover.

Figure 64. The theme of openings in rural buildings

The proportions of the openings of the stone base are guided by the structural matrix of the walls and by the nature of local stone. They are characterized by a modest width, reproposed in height through the proportion of the square in the windows of the ground floor. It is multiplied in the height of the elongated elements by a factor of up to 3 widths, which is useful for guaranteeing greater lighting and internal ventilation. In both the opening solutions in the stone base the solutions

for the redistribution of the higher loads than the opening itself are attributable to the static solution of the stone arch and the wooden architrave embedded in the wall facade and exhibited as element well above the clear opening of doors and windows.
The solution given by a wooden lintel is more widespread and often presents an aggregate solution for several openings, such as windows and doors, joined by the same upper wooden lintel, often stylistically repeated at the lower edge of the opening in order to create a balcony. All the openings within the stone facade underline the thickness of the masonry itself through the setback on the internal edge of the wall of the elements defining the internal space with respect to the external space. This elements can be represented by double cross-laminated doors in larch and railings or windows that regulate the air-lighting towards the internal space, always in the absence of frames.

The analysis of the openings reveals a coherence with respect to the concept of drilling the distinction between internal and external space limited to those existing in the stone base, while a reduced dimension of the openings emerges in the wooden elevation, where the continuity of the wooden skin is preserved and conveyed upon reaching certain aero-illuminating levels through the disjunction of facade elements. These are conveyed using carved ornaments and modulation devices assuring the passage of air which allow the temporary exhibition of the hole and the compensation in the continuity of the cover in the wooden elevation.

The rural architecture of the Trentino valleys of the Stelvio National Park has sometimes taken on a monolithic figurative dimension that differs from the tripartition previously described for the characterization of the wooden elevation using the *blockbau* technology.
This technology involves the construction of wooden structures carrying continuity through the overlapping of rough-hewn trunks of three possible typologies – Fiume, Trieste or squared - joined at an angular joint. This solution is less widespread than that which displays the structural frame in the wooden elevation, due to the considerable use of construction wood and the morphological and distributive limits associated with this structural choice.

Figure 65. Monolitic dimension of rural buildings

The *blockbau* influences in a very rigid way the dimensional structure of the rural building which becomes a function of the linear module, or of the double linear module, of the construction wood available in the area. Likewise, the modifications to the functional and distributive structure, such as elevations, growths and addition, increase with complexity because put in crisis the organization of the wooden structure itself.

Rural architecture assumes a very important material and apparent density over the entire altimetric development of the building, also for the strong thickness of the wooden trunks and for the substantial absence of openings in the wooden elevation; the aeration of the hay was guaranteed by modest ventilation holes with simplified shapes, compared to the other rural artefacts of the Peio and Rabbi Valleys, and by the physical disjunction between the different structural elements. [P.A.T., 2019]

4. MOUNTAIN BUILDING HERITAGE FOR ALPINISM

Leaving the environment where agricultural practices represent the central engine for daily life and connected infrastructures, we will now focus on the landscape characters of mountain alpinistic space.
Facing a rapid increasement and diversification in mountain fruition, alpinism infrastructures should undertake a subsequent change in their offer. Some suggestions have been analysed with the studies presented in the previous chapters, expecially speaking about seasonal extension, recognition of values and restoration of existent heritage. The developed references, added to a site specific feature recognition, will design the future development strategies.
In contrast to mountain building heritage for agriculture, that is now changing their primitive identity to meet other forms of existence, buildings for alpinism are always more essential. Volumetric ratio present an increasement of internal and external areas, underlining the necessity of extensions' management in terms of division of spaces, organisation and organicity.

As a starting point of this chapter, giving relevance to teaching activities for a sustainable development, we refer on some contemporary experiences of academic studies and connections within the alpine context.
The following sub-chapters first define historical roots and then decline evolution scenarios for two main typologies of Isolated Alpine Buildings: Refuges and Bivouacs.
Presenting for each of the category an applied case study, this work represent the incentive for the validation of both the theoretical and referencial frameworks presented in the previous chapters of this thesis, reaching important positive results for the research work.

4.1. Isolated Alpine Buildings in academic teaching

Social and cultural transformations brought by this century can be translated in a visible change in land use, where rural economies give way to secondary and tertiary sectors, and now we have smart cities and surrounding territories. The fluid dimension of our territory is possible through the transformation of individual mobility, which helps to reach and inhabit marginal and mountain places and connect them with digital nets and other infrastructures to the rest of the world. Environmental sensitivity and lower market values attract people to satellite territories, building connections with the main urban areas through work and social relations. In this context the space of living is characterized by a continuum between the different polarities of the territory. All the people can experience in an indistinct way spaces of tourism, living, producion, community. All the components of the territory find a significance in their relation values and in the ability to create a sinergy between the inhabitants needs and expectations and the outsider users.
Cultural landscapes are a complex synthesis of physical and cultural networks that giving sense to territorial elements, they define forms of government and decide for transformation actions. Many actors are able to influence and activate decisions for cultual and physical transformaitons: stakeholders, institutions, single or associated citizens. Through a process of innovation Universities and Research centers have the difficult role to anticipate scenarios for future development. Starting from the analysis of the unexpressed potential Universities could be able to give scientific support in order to reactivate critical contexts. Exchanges of information and experiences are provided in academic communities and able to connect local and internationals interlocutors. The networks built toghether with other institutions, administrations or privat stakeholders can be the cultural contexts for social renovation of the territories in which universities are located. Specifically, the technical departments and degree courses, dedicated to the training of designers in the broadest sense of the term, should propose as a central matter the study of their own landscape transformation.
The synergies between territory-cities and universities can materialize into stable themes of research and teaching finalized to the formation and the awareness on specific key issues in those cultural contexts.

Figure 66. Students at refuge Tommaso Pedrotti alla Tosa, 2491 m a.s.l., 2014

The alpine space, with its morphology and societies, constitute an interesting framework to build a connection that trascend national or regional borders in order to build a European dimension of investigation on mountain characters and development strategies. The alpine landscape, considered as a macro-system, is a framework for different cultures that express their needs that sometimes are in conflict with the others, such as living and infrastructuring territories, rather than defending and developing specific areas. Because it's a sensitive landscape, divided into finding opportunities for development and guarantee protection for a sensitive environment, is relevant to build an interdisciplinary approach to investigate the complex context. Activating specific courses or research projects on defined issues could be possible to give a response to the territory needs of interventions.

Within the alpine space, some Universities, Research Centers and Institutes that investigate the mountain area as a potential self-centered development resource for local communities have therefore specialized, with the aim of innovating the culture and development scenarios for the Alpine Space. Moving on the alpine chain there are some examples of academic/private institutions dedicated in various fields to Alpine development research.

Starting from the eastern part of the chain, we find the Institute for Mountain Architecture taken up by the Politecnico of Torino as a

review of the first conferences on alpine architecture at the Sestriere of Carlo Mollino. Then, at the Ecole Nationale Superieure d'Architecture at the University of Grenoble there is the laboratory on Architecture, Paysage, Montagne led by Jean-François Lyon-Caen. At the University of italian Switzerland we find the LabiSAlp at the Academy of Architecture in Mendrisio coordinated by Luigi Lorenzetti, and still in Switzerland at the University of Applied Sciences in the Graubünden is present the Institute for Construction in Alpine Regions (IBAR). Going back to Italy we meet the University of the Mountain of Edolo, a branch of the University of Milan. Then, the Province of Trento where, at the University of Trento, started in 2013 and continued up to the 2019, the alpine architecture laboratory rifugioPLUS, directed by Claudio Lamanna.

Figure 67. Moments of the laboratory RifugioPLUS, 2016

As a device to open debate on the scenarios of possible development for architecture in the Alps, the multi-year course for the students in the course of Architecture and building engeneering of DICAM, led to the investigation of different building typologies, including bivouacs, refuges with different altitude, accessibility and fruition, huts and mountain cabins. With the aim to investigate and experiment new forms of high altitude infrastructuring, it always has been open to propose innovation also through the reinterpretation of construction traditions. The laboratory could also be a device to open a debate on the possible development scenarios' in the Alps, proposing to local communities new researched possibilities with respect to the cultural landscapes. The activity saw a continuous integration between research process and public sharing of the results, taking part with an exhibition and final presentation of the students' projects and laboratory activity to the

yearly Trento Mountain Film Festival.
This process is connected with the opportunity to underline the very role of architectural discipline, as an instrument of investigation and design of the alpine landscape in its broadest sense, from the economic to the identitary, like the processes already happened in regions with similar characteristics such as the Voralberg, the Italian South Tyrol and the cantons of the Swiss Confederation. Through specific research, communication devices have been found, that are able to raise awareness and activate the operators of the sector towards an attitude capable of recalling their perception and planning of the development of alpine buildings, re-focusing the position value of the structures with respect to a wide range of values, such as sustainable tourism, and equipping them with a greater awareness of the importance of an architectural project for the subsequent restructuring activities.
At this stage it's relevant to find significant case studies in order to present the change through the obtained research result, that don't want to disfigure or stereotype the alpine landscape but to study a site-specific development solution. It's like a cultural acupuncture process aiming to clarify the role of the architectural researched project. In the next chapters I will present some of the doctoral research results referred to different scale of isolated alpine buildings.

4.2. Refuges

The Alpine refuge is a building type that gives a technical solution to the previous mobile camps that were used by alpine explorers of the origins. We can see in the following representation of the first ascension to the Aiguille du Midi (Chamonix – Mont Blanc, France) of Lord Fernand de Boillè a good example of a climb at the end of the XIX century, when groups of explorers guided by local alpinists moved step by step the necessary tends and equipment. This same location represents now a definite change in mountain fruition compared to the dawn of mountaineering, with high tecnological equipments to easly reach spectacular views on Mount Blanc and italian, swiss, french Alps.

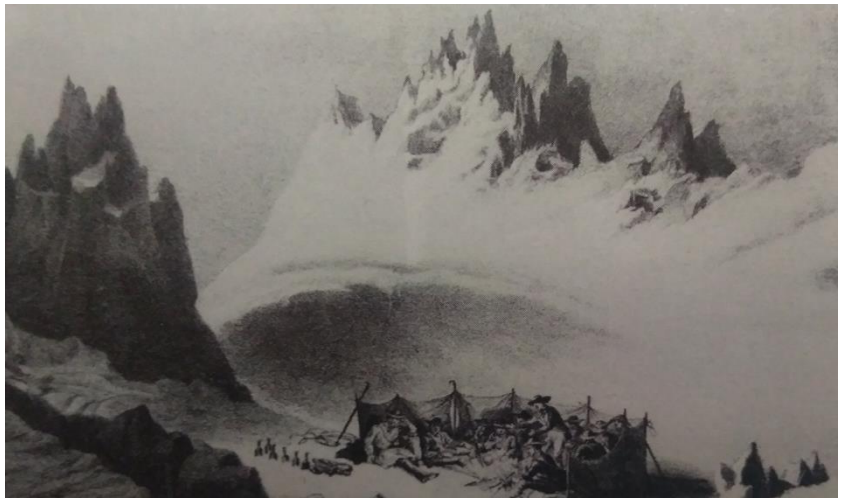


Figure 68. First climb to the Aiguille du Midi of Lord Fernard de Boillè (4/5 August 1856, 3500m a.s.l., -10°C)

Looking to this kind of past experiences in alpine exploration, started during the XIX century, the need of shelters to use during climbs brought to the construction of the first shelter-refuges that were built in strategic locations. So, at first they had no aesthetic but practical principles, because also just to get close to high lands was much harder than now.

The father of the refuges, recalling the idea of Crystal Temple by Bruno Taut, is the Sublime Observatory of Montenvers (France) with a priviledged view on the famous glacier Mer de Glace and facing Mont Blanc, the top of Europe. This kind of buildings, located out of the

Fig. 69. Mountain buildings as observatories of the sublime of Nature. The “temple of nature” of Burrit in Mentenvers, 1795.

Fig. 70. The “hotel” of Charles in Montenvers, 1779.

alpicoltural functional vision typical of the Alps, have been born to give an answer to a new need of european bourgeois.
Predicting a change in fruition and consequently shape, technology and capacity, the first built refuges in the Alps were the Refuge Aiguille du Goûter and Refuge des Grands Mulets both by the Guides San Gervais in 1853. The subsequent renewals to respond to user needs reveal the validity of their first location.

Figures 71, 72. 1853 – Guides San Gervais, Refuge Aguille du Goûter

Figures 73,74. 1853 – Guides San Gervais, Refuge des Grands Mulets (CAF)

Fig. 75. Refuge au Col du Midi, Guides Courmayer, 1863. In the picture restructuring of 1895.

Fig. 76. Example of internal furniture of the first refuges. Konkordiahütte, Bern Oberland, 1877

The first italian Refuge in the Alps is recognized in the Refuge au Col du Midi in 1863 constructed by the Guides of Courmayer, an essential building attached on the rocks of the mountain at more than 3500 m a.s.l.. It gived place to the Refuge des Cosmique, built in 1991 at 3613 m a.s.l. on the same Col du Midi and now, together with the Refuge Torino, it's one of the starting points for the climbings to the Monte Bianco, Mont Maudit and the Mont Blanc du Tacul.
The first refuge built by the newborn Italian Alpine Club (CAI) has been the Alpetto Refuge on mount Monviso in 1866, that was constructed on initiative of the lawyer ad alpinist Tommaso Simondi di Barge, who climbed with the local alpine guide Michele Re to the top of Monviso in 1864 and publishes the book "Dall'Alpe Alpetto al

Monviso" describing the way to reach it. The building aimed at helping mountain fruition, now gives place to the Alpetto Museum to promote the history of italian alpinism.
Regarding the Alpine Society of Trentino (SAT) the first refuge was built in 1881 on Brenta Dolomites and it's the Tosa Refuge by the Bocca di Brenta. This refuge was born as a refuge-hotel, with large spaces to host guests. The internal environment characterized by a high quality of the internal boiserie is divided between a unique dining room where now we can observe a low density of tables for guests, a large dorm and a kitchen.

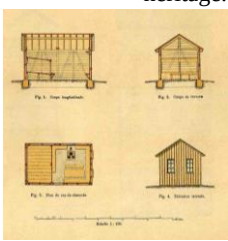
Fig. 77. Refuge Tosa, Bocca di Brenta, 1881. First Refuge of CAI-SAT in Trentino.

Refuges are building highly rooted in the history of all the Alpine Clubs. The birth of the Alpine Clubs in Europe begins with the English Alpine Club in 1957, the Oesterreichischer Alpenverein in 1863, the Club Alpino Italiano and the Club Alpin Suisse in 1863. Then, in 1869, was instituted the Deutscher Alpenverein, in 1872 the Società Alpina of Trentino region (Austria), in 1874 the Club Alpine de France and in 1893 the Alpine Association of Slovenia. Except from the English Alpine Club, that is not located in the Alps, the main activities of the other associations include building and maintaining the refuges in their national territory. As regards some ordinary and extraordinary management activities, both for refuges but above all for open and unmanaged structures such as bivouacs, the important role of the local sections of the Alpine Clubs is made through the voluntary intervention of the members, operating in various activities of management, maintenance, control and restoration of access routes, and many other activities which from time to time are necessary to guarantee all mountain users access and hospitality in isolated high altitude buildings.

In their beginnig, refuges, could show many structural problems and the main reason was that they were built in the same way as people could build in the valleys, using material that could be hand-carried by the same alpinists. They were the expression of the diffused participated self-building processes that characterized building activity in the alpine valleys, such as happened for schools or aqueducts. There were no site specific project and technology or a knowledge of how to solve the specific problems consequential to building at high altitude. In this context a help from the alpine organisations comes through the

development and introduction of prototypes thought to responce to mountain environment characters.
In this way building activities and results could have been better programmed, trying to simplify some of the realized building in new building typologies for refuges.
In this way goes the study work published at the end of XIX century, in 1892, called *Les cabanes du Club alpin suisse* written by Julius Becker-Becker. It consists in the collection of the detailled design projects of the mountain building heritage property of the Suisse Alpine Club, consisting in 40 refuges, bringing them to be models for future construictions.

Fig. 78. An example of the work of Julius Becker-Becker dated 1892, callecting surveys on Swiss Alpine Club building heritage.



Some years later, in 1907, architect Umberto Martini designs the first project for Refuges of the Alpine Society of Trentino, defining the prototype named Cubo/Cube because of it's shape.
The project, situated between prefabrication and self-contruction, had to be realized on the module of the lenght of the wooden beams that supported the first floor slab that functionally divided the day and night spaces. The first floor is divided in tree different rooms, one dedicated to alpine guides, one is a bigger common sleeping room and the third is the room for ladies, underlining an openness of mountain fruition even if still minority respect to male users.

Fig. 79. Refuge Ottone Brentari, Cima d'Asta, 1908, an example of Cubo SAT building type.

This building type aticipate the character of plan rooftop building present in the Modern Movement of architecture. There are 12 realized Refuges based on the project, many of them still existing even if modified with additions. The introduction of a prototype brings a distance with other building from the same age, heirs of a pictoresque view of the alpine buildings. What is considered *traditional* refuge is the product of a collective stereotype, that comes from the formal reinterpretation af an archetype of the valley. A de-contextualized figure that sometimes prevales on the principles of localization and affordability of the building.
The prototype begins to be applied, but the time was running and the refuge increase their original role to mark the national borders. Building in the Alpine high lands is connected to the difficulty of the definition of country borderlines, with many changes throughout history caused by the two World Wars and property quarrels.

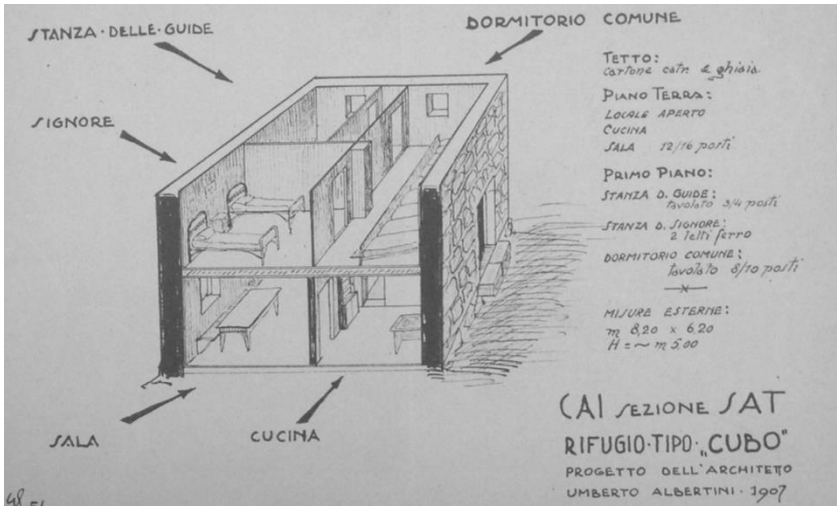
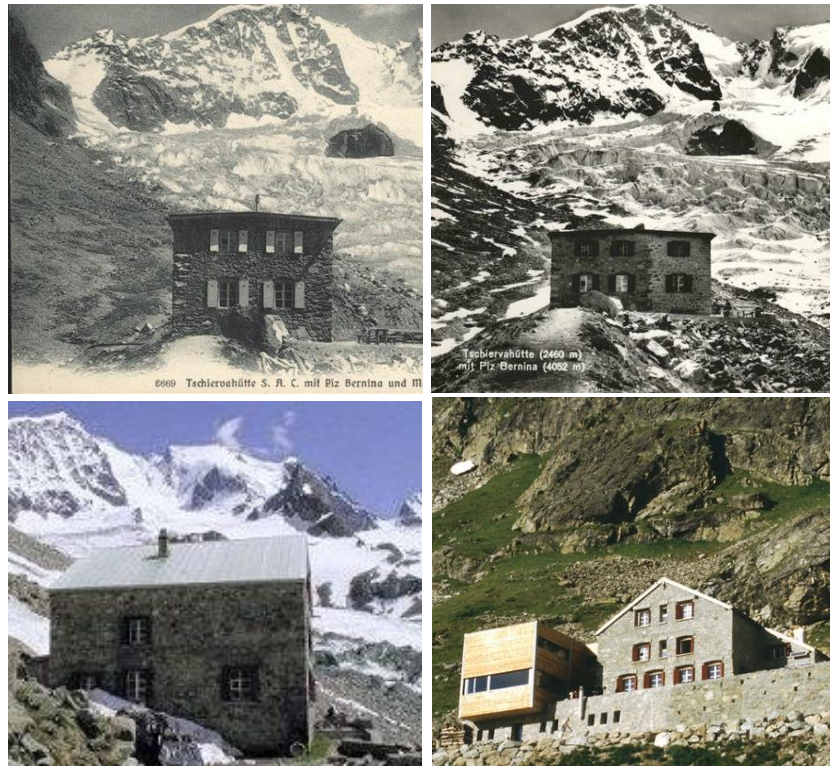


Figure 80. An internal prospectus of the composition of the prototype "Cubo" CAI-SAT, 1907

Society need of territory and traditional characters definition causes reflexes also on the top of the mountains, where the construcion of new Refuges becomes a pretext for marking national borders. This is clearly visible in the buildings of Refuge Quintino Sella, property of the Italian Alpine Society of Trentino and Refuge Francis Ford Tuckett, Berliner DuOe AV, both built in 1906 at few meters one to the other in the middle of the Italian Brenta Dolomites. In this buildings were reflected the respective local ways to build in the lower valley, representing two social realities in few square meters.


Figure 81. Opening of Refuge Q. Sella and behind the Berliner Hutte (actual Refuge F.F. Tuckett), 12 august 1906

In 1905 the Heimatschutz, a swiss organisation operating in the field of architectural culture, recognized a style characterised by traditional and regional building structural shaped. The style is visible in many examples in urban contexts, but also produced some prescriptions reserved for Refuges. Their front composition had to recall the ideals of solidity and solemnity, with sober elements of plastic modelling; the building technics expects the use of stones and the roofs have to be built with two sided layers made in eternit or sheet. In the buildings influenced by the movement we see a stereotyping process, that will later not help in the need of expansion or side extension of the buildings. This process is visible in the example of the Tschiervahütte at Piz Bernina (CAS Switzerland, 2583 m a.s.l.), built at first on the moraine of the Tschierva glacier in 1899 and expanded some years later, then rebuilt in the actual site in 1951 with a shape recalling Heimatschutz style characterized by a gable roof. In 2003 has been expanded through the addition of a different autonomous building.



Figures 82,83,84,85. Stereotyping processes: the case of Tschiervahütte at Piz Bernina (Switzerland)

The change proposed by the Heimatschutz movement is opposed to the proposal given by the italian architect Giò Ponti in the ’30, when he has written a leaflet for a new architectural type of refuge-hotel. The general principles are: the precise architectonic character; the stylistic unity of the whole building; the necessity of a maximum front exposition to the sun; the exposition to the best surrounding panorama; and the possibility of extension. Proposing the abandonment of the scheme previously used, specified not to be an italian architecture typology, with a two sided gable roof and an external coating in natural wood, he suggests the adoption of a one-side roof and a coating in wood treated with varnish, possibly colored. In this new type of building there is the possibility of expantion through a continuous side extention, rooms and halls have a maximum exposition to the sun and the best panoramic view, the building is characterized by a limited depth and a maximum extension of terraces protected from direct wind, stairs have a minimum development in order not to lose useful space. Examples for this architectural proposal are the SportHotel at Mount Pana by Franz Bauman and the SportHotel in Martello Valley by Giò Ponti (Alto Adige/Südtirol – Italy).

Figure 86. Leaflet of the manifesto by Giò Ponti, 1930

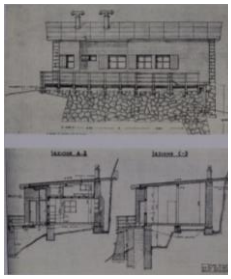
Figure 87. Sporthotel in Val Martello, Giò Ponti, 1936

Between the two World Wars on 14th February 1921 the Italian Ministry of Defence states that all refuges property of German and Austrian Alpenverein (DOAV) or owned by other foreign Alpine Clubs have to be assigned to Italian Alpine Club (CAI). With this action the

DOAV gives to Italy and Jugoslavia an amount of 95 refuges. [L. Gibello,].

The "Four-year Plan of works in the Western Alps" (1937-1941) was a responce to the problem of lack of offer in respect to possible fruitors and the mountain development and was aimed at improving the accommodation offer which included the construction or reconstruction of 44 refuges, the extension of 12 refuges and the renovation of 26 refuges located between the Colle di Tenda (Italy-France) and San Giacomo Pass (Italy-Switzerland). The beginning of the Second World War stopped the proceeding renovation works, but after the end of it some works have been later concluded and contemporary local Alpine Club sections have been entrusted of the management of some of this rebuilt refuges.

Figure 88. Project for rebuilding of Boccalatte Refuge Giulio Apollonio, 1938



In this context we recall the role of the engeneer Giulio Apollonio, president of the Società degli Alpinisti Tridentini (SAT) in 1942-44 and 1949-50, who took part to the techical commission of the referred plan, giving the criteria for the refuges' projects development. He was also the designer of the "Cubo-SAT", previously presented, and he dedicated in his professional activity to design projects and renewals for alpine refuges. In 1958 he presented his research "How to build our refuges". He said "it's necessary to consider today's accentuated hiking movement in the mountains, because the masses and their needs must not be ignored for a false concept of mountaineering aristocracy".

After the end of the Second World War there has been a relevant work for rebuilding damaged refuges, most of all in the western Alps where they were used during struggles of Resistence movement.

The increasing interest towards the mountain brought to the birth of the movement that we call social alpinism, with the need of more points of support on the ways to the tops of the Alps.

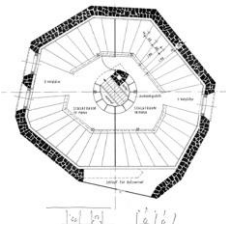
The opening to new and more refuge users gave more success to the idea of refuge-hotel developed in the '30es but, througout the alpine region, there are different responces to the new need of increasement the accomodation capacity of tourist infrastructures.

Making a comparison between the swiss and the italian approaches we find two different ways to give a solution to the need of refuge development and increasement.

The swiss approach proposed systematic interventions of demolition and rebuilding, with the conseguence of a proportional increasement of

the touristic accomodation capacity of the structure. The intervention included all the components of the refuge system through a strategic approach, concerning rooms, kitchen, dining room, toilets, deposits.
To explain the swiss approach we present the case of the Domhütte in Vallese (Switzerland), 2940 m a.s.l.. The history of the refuge begins in 1890 with the first building, renovated using the Heimatschutz approach by Heinrich Bram in 1919 (fig. 90). The second renovation dates 1957 (fig. 91), built with rocks and designed by Jakob Eschenmoser, with a complete change in the refuge shape. The polygonal layout distibution in the form of a Bergkristal, follows an anthropometric ideal solution and recalls the designs of Bruno Taut (subchapter 1.5). The need of another extension brings a lateral increasement in 1978 (fig. 92), then recently renovated in 2012 (fig. 93).

Figure 89. Dormitory plan with anthropometric sketches of the bunks, at the Domhütte by J. Eschenmoser, 1957



Figures 90,91,92,93. Development process: the case of the Domhütte in Vallese (Switzerland)

Responding to the enlargements needs introduced by social alpinism the italian approach give a different answer compared to the swiss approach, proposing lateral enlargements, extensions in high and

Figure 94. Italian approach: additions to the original "cubo" building in the Refuge Ottone Brentari at Cima d'Asta

renovations. It was usually oriented to increase the number of beds, without an organic vision for the whole building. We can have an example in the Refuge Ottone Brentari at Cima d'Asta (Trentino – Italy), 2473 m a.s.l., that presents an attributional and consequential modelling approach. After the renovation of 1952 that aims to solve damages caused during the second world war, there is a radical rebuilding in 1982-85 in order to increase the accomodation capacity adding new parts to the original "cubo" building of 1908.

The initiatives of building new refuges within the Italian Alps ends in 1990, when the Italian Alpine Club signs the "Charta of Verona". Referring to the owned mountain buildings the CAI undertakes to rethink the role and function of refuges, with particular reference to the redevelopment or redefinition of the existing buildings. Stating to this document the last refuge realized from scratch has been the Velo della Madonna on the Pale of San Martino in the Trentino Dolomites, built in 1980.

The importance of taking care of existing refuges is one of the main assets of the CAI, together with the diffusion of principles to increase sustainability and inclusion of young generations in mountain fruition.

Referring to refuge heritage the CAI makes a classification dividing them in two groups: excursion and alpinistic refuges, underlying a different accessibility and consequently possibility of supply. The first group, comprising excursion refuges, has two categories (A – B): the first includes the ones accessibles through a drive way or close to it; the second concernes refuges reachable or approachable using mechanical devices of open to the public, like cable ways or funicular.

The second group concernes the alpinistic refuges, divided in three categories (C – D – E) considering local situation, specifically altitude, lenght and difficulties in accessing, supply system adopted.

Italian Alpine Club actual regulation [CAI Regulation on Refuges] on refuges stricly defends existing building heritage, and impose the necessity to obtain approval from the Central Commitee when is proposed a relevant extension of the building, a new building, an increasement of the accomodation capacity most of all when seats exceed number of beds. It represents a way to confirm actual heritage, excuding a dangerous increasement for mountain sustainability.

Many technical solution have to be considered when speaking about mountain refuges. We are speaking of an heritage in high altitude where food/material supply is made many times by cable way or just

helicopter; resources procurement like water and electricity or activities like waste management need site specific solutions.

4.2.1. The case study of Refuge *Maria ed Alberto Bellani ai Brentei*

Summarizing the elements that connect Taut's Utopia and the proposed concept of mountain building as a light house for lower valley development, the positive examples are really few: the research on new technologies, the analysis of preexistence, the research of new collective spaces that educate the small community of refuges to a forced peace condition, together with the typological proposals by Giò Ponti, Jacob Eschenmoser and Umberto Albertini. What is possible to highlight by contrapposition is that the worst and inappropriate high land building production, including huts and refuges, is connected to an imposition of a model that is not used to listen to the values of the Mountain.

The importance of a deep thinking before building was also for Bruno Taut a good practice. In the research has been developed a case study on the refuge Maria ed Alberto Bellani ai Brentei. Starting from the analysis of resources and social needs, will be given a proposal of renewal to be placed between decomposition of the old, refuncionalisation and aesthetic/beauty.

The refuge Maria ed Alberto Bellani ai Brentei, 2182 m a.s.l., is located in the Brenta Dolomites, one of the nine groups forming the Dolomites UNESCO World Heritage since 2009, mixing natural and cultural values of this mountains. The UNESCO Dolomites are situated in the north of Italy, distribute in five provinces: Trento, Bolzano, Pordenone, Belluno and Udine. The orogenesis that started about 230 million years ago has raised these rocks that were under water level, modeling them slowly to reach their present morphology, loved both by scientists and alpinists.

The refuge is reachable from Madonna di Campiglio, a famous tourist destination, and from the Brentei valley that offers a great panorama on the Brenta rock walls. Its location has good connections with the other important refuges in the mountain group and points of acces to famous climbs.

Starting from a little mountain cabin owned by family Gigioti Bolza from Ragoli in the 30's in few years hosted many apinists discovering

Refuge Maria and Albero Bellani ai Brentei, 2182 m a.s.l.

Figure 95. 50s

Figure 96. 70s

Figure 97. 90s

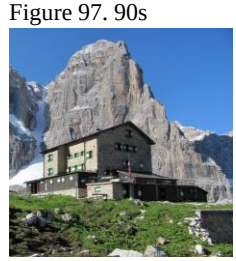
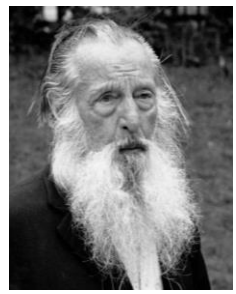


Figure 98. Alpine Guide Bruno Detassis



Brenta excursions and climbs. In the 50's the president of the cable way of Madonna di Campiglio was the textile entrepreneur Gian Vittorio Fossati Bellani from Monza (Milan - Italy), that bought the little hut building the actual refuge giving the name of his parents Maria and Alberto Bellani. Later he donated the refuge to the CAI section of Monza, that give it in management to the famous alpinist Bruno Detassis. From 1949 to 2008 the family Detassis managed the refuge making of it an important stage exploring the area. From 2008 is the alpine guide Luca Leonardi and his family that manage the refuge.
The actual building doesn't have a great quality, with a scarce disposal between bed capacity and services. Many technical problems affect the structure and the opening possiblity.
Looking now at the mountain values in order to assume principles for the project, means also change our point of view and the design tools. In particular we ask to the structure of the mountain several informations through GIS system, defining for each of the 156 refuges of Trentino action sheets about guide lines for the language and sustainable actions to be managed in order to tend to high value. This research has been carried out for our case study, highlighting actions to recognize landscape specificities as potentialities and landscape languages as form of architecture (subchapter 2.2.).

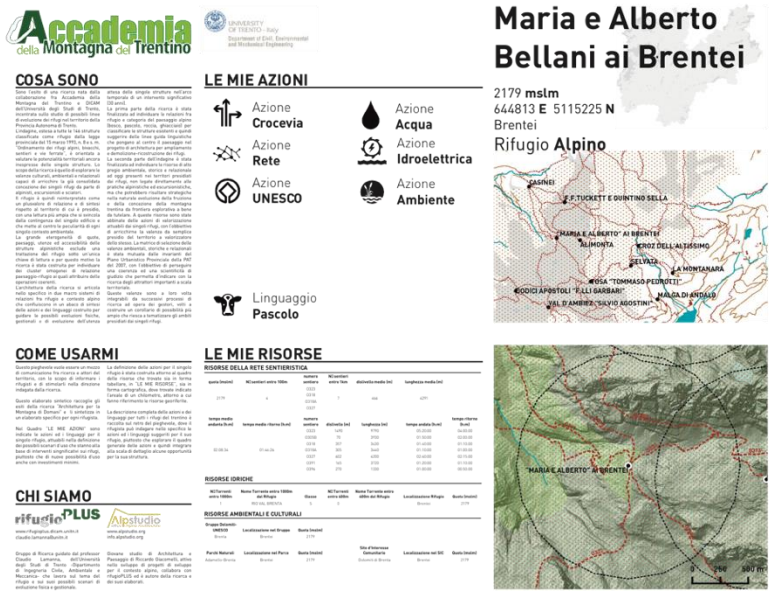


Figure 99. Action board Refuge Maria e Alberto Bellani ai Brentei, Trentino

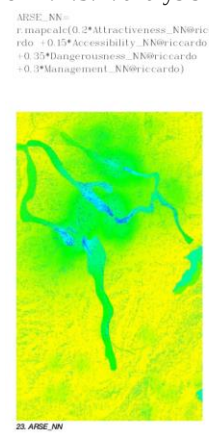
Through the geo-localization of the Refuge we observe that it's located in an area still connected with Pasture landscapes, but in strict contact with a Rock landscape. In the architecture of the Refuge should be underlined this location, building a double-sided architecture facing pasture on the front side and rocks in the back side.

The identified Actions are the following:

- Crossroad, Web: underlining the potential in connecting localities and other refuges in the Brenta Dolomites through the building of a network including infrastuctures, points of interest and touristic/climbing routes. In the architecture in relevant to enhance dining facilities and improve resting conditions for users, users with animals and workers;
- Water, Hydroelectric energy: recognizing the value in the possibility of a continuous water supply in high lands, taking care of the resource, carefully draw without waste in order to maintain the spring. The refuge system should be able to improve water storage and evaluate the construction of a mini-hydroelectric power station;
- UNESCO, Landscape, Environment: give value to the location, recognizing and teaching to the visitors the natural and historical characters. Focus on the sustainability of the refuge management, facilitating the training on it of owners, managers and tourists/alpinists. It's relavant for the architecture to enhance the panoramic percepions from the refuge and identify in the refuge a space dedicated to environmental education.

More over has been defined through the A.R.S.E. research verification an analysis model in GRASS environment, in order to test the suitability in terms of de-seasonalization for the recognition of the capacity of the Refuge to give an answer to possible user request out of actual seasonal activity (subchapter 2.3.). Thanks to this analysis the seasonability value relevated for the Brentei Refuge is 0,49/1, underlining the necessity of a functional bipartition of the refuge to facilitate not only summer but also autumn and spring managed use.
The multispacial criteria analysis concerns the values of attractiveness, accessibility, dangerousness and management. Applied on the case study of Brentei Refuge the values are 0,89/1 concerning attractiveness, 0,42/1 concerning accessibility, 0,39/1 concerning dangerousness,

Fig. 100. GRASS map of A.R.S.E. analysis



0,39/1 concerning management. Attractiveness during winter months is clearly relevant and the propose to enhance the presence of an emergency shelter building for winter free or managed use is an important verified necessity.

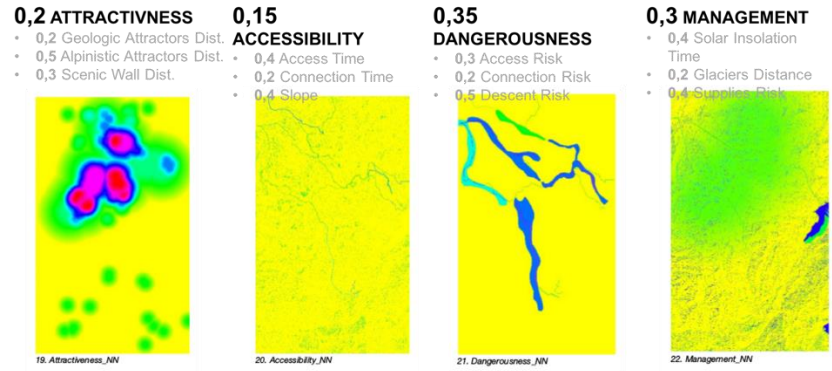


Figure 101. Subcriteria map normalized to show spatial distribution and weight of the criteria: attractiveness, accessibility, dangerousness, management. A.R.S.E. research

Consequently to the reading of the references suggested by the mountain context and following the advices given by proposals of actions and languages, can be defined the functional layout of the building.

In particular the hypotesis consist in developing a two sided architecture, with a traditional image, obtained by the increasement of the access path side, connected to the pasture language, in contrapposition to the new extension hanged on Brenta Valley. The extension enhance a great panoramic view building a dialogue with the rocks on the back side.

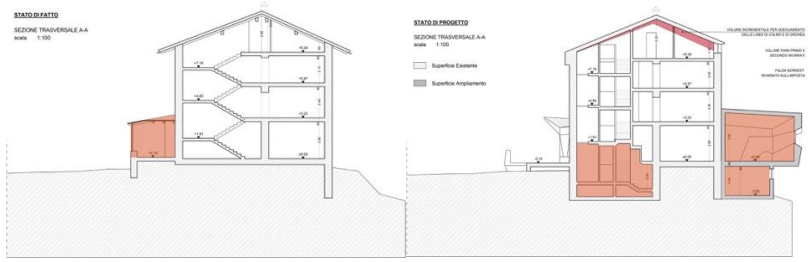


Figure 102. Prospects: status quo (left) and project (right)

The building will work with more spaces, making the refuge more approachable with an incoming space and increasing the dining room ensuring a bigger numer of seats.

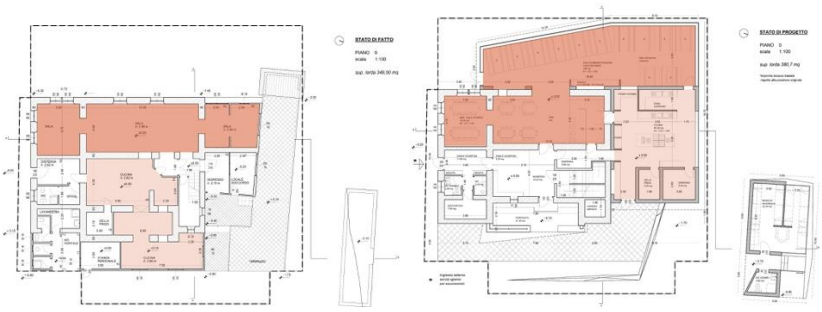


Figure 103. Ground floor with dining rooms: status quo (left) and project (right)

The funcional bipartition of the refuge for the seasonal extension in autumn and spring, makes possible a complete fruition of the building during summer months and a partial fruition of it in order to assure the control of the building with a factual reduction of the resources use.
The existing open space for beds at third floor is divided in more smaller rooms, in order to improve resting conditions and differentiation of the users, based on the activity they are going to do in the area or the presence of pet animals.

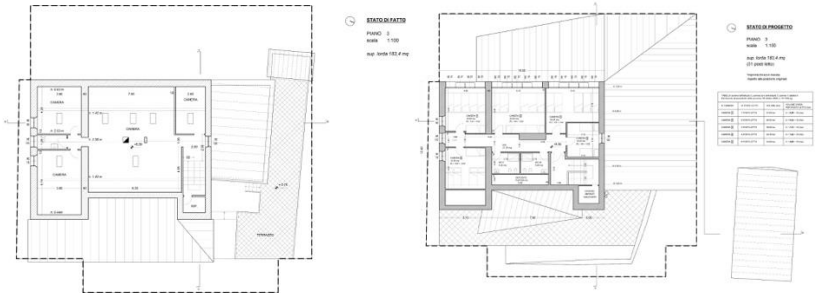


Figure 104. Third floor, division of the openspace in smaller rooms: status quo (left) and project (right)

The improvement of comfort conditions of the users is a priority, but also the identification and distincion of spaces, as it concerns the creation of rooms and spaces dedicated to workers and managers. Moreover, the identification of a space dedicated to environmental

education during summer months can give space to the necessary emergency shelter building realised to assure safe rest for winter users.

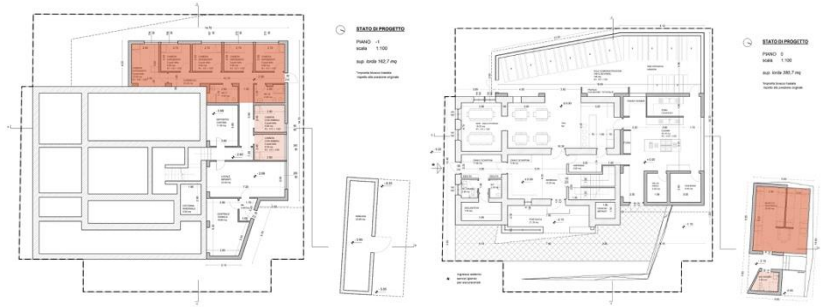


Figure 105. Identification of spaces: worker rooms project (left) and winter shelter/educational room project (right)

Then we can find a general new concepion of the area that will decrease the number of buildings, concentrating in a principal refuge building system with a significant recognized position. Out of this will remain two small separate building for the arrival of the cableway from valley and the one for the departure of a higher cableway reaching Alimonta refuge.

Figure 106. Existing condition of Brentei refuge location

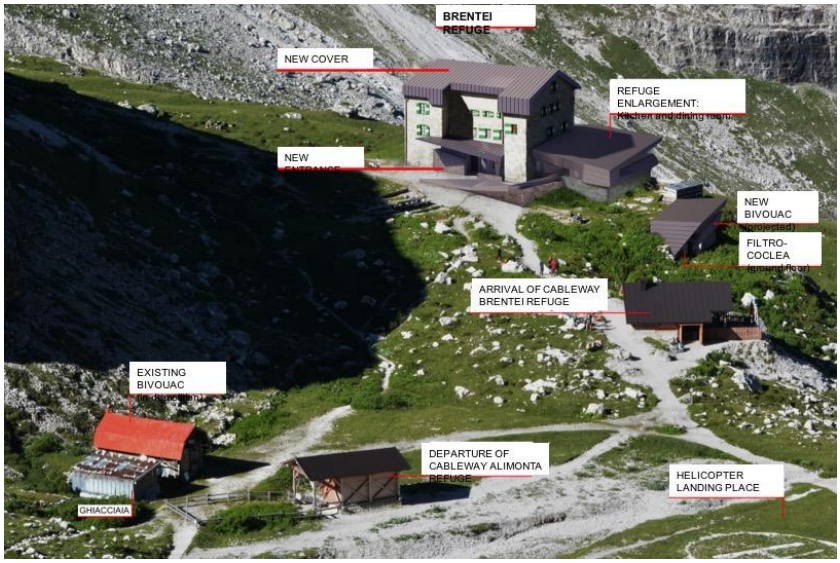


Figure 107. Brentei refuge location in project proposal

If the landscape language of pasture is maintained through the restoration of the stone wall that characterizes the original refuge building, the language of rocks dialoguing with it is definitly present in the extension of the building. For the design of the new extension are recalled the "cenge", a particular geomorphological condition that was transferred by the alpinist Bruno Detassis into the most spectacular path of the area, a circular path called "Bocchette di Brenta" that allows a panoramic alpinistic visit to the Brenta Dolomites.


Figure 108. The geomorphology of the "cenge" of Dolomites in the Bocchette path

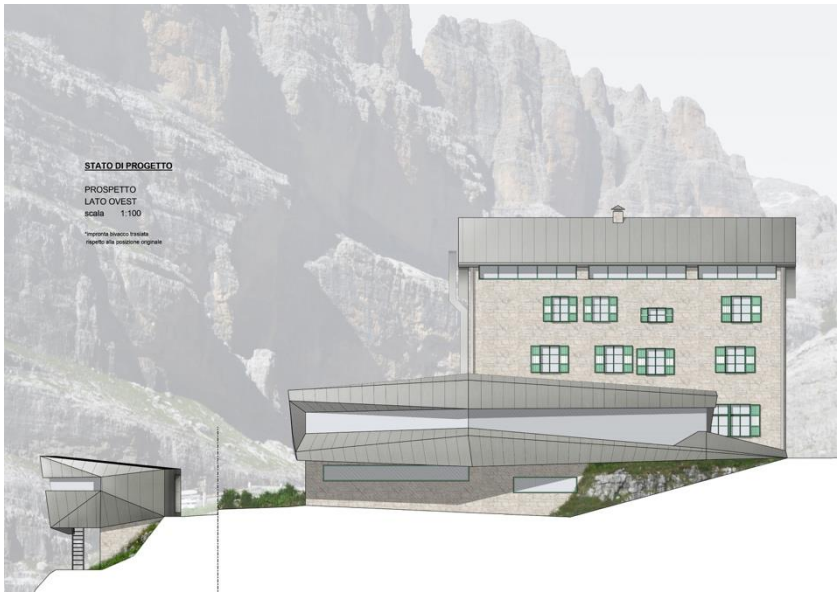


Figure 109. Project of Brenta refuge, prospectus of western side

Figure 110. Project of Brenta refuge, prospectus of eastern side

4.3. Bivouacs

The paradigm of the small scale is an historical expression of living in the Alps, moreover represents an answer to a systemic deficiency of resources for alpine communities. Smallness helps an attidute of living with less and share with the community, attitude that we can find when we get closer to high mountain or rural realities.
Starting from the ancestral refuge then transformed in an alpine rural spontaneaous and seasonal architecture, for centuries smallness represents a form of resilience of alpine population.
History of architectural thinking gives many examples on the theme of *existenz minimum*, starting from the project of Ville Radieuse by Le Corbusier in 1930, to the 15th International Architecture Exhibition *Reporting from the front* by Alejandro Aravena at the Biennale of Architecture in Venice in 2016. The concept of satisfying all the primary needs related to the habitation brought to the obtimization of available resources reducing wastes, safeguarding a condition of social and energetic sustainability as a form of protection for communities.
During XX century in the Alps acupunctural processes brought to the definition of a new type of mountain building: the bivouac. Their primar intention is to be a technical response in the form of a shelter to the need of assuring points of support along climbing routes, when the access takes long time or is considered particularly difficult.
They can be considered an expression of freedom but also an architercture of limit thinking to the difficulties in building them, and represent a distinct mark in the symbiotic dialogue between man and mountain.
Outlining the history of bivouacs architecture in Italian alpine context we introduce the concept of temporal families of building typologies, starting from bivouac model Ravelli in the 20s, meating the bivouac model Apollonio after the Second World War, up to now with a prevalence of site specific projects for bivouacs.

The birth of the icon represented by the bivouac prototype proposed by the Ravelli brothers in 1923, just after the First World War, comes from an idea of the Academic Italian Alpine Club that instituted a technic commission composed by Lorenzo Borelli, Francesco Ravelli and Adolfo Hess. The success of this building typology and of the officinal metallurgica of the Ravelli Brothers based in Turin has been relevant

Fig. 111. Bivouac Col d'Estellette Adolfo Hess, Valturnanche (Valle d'Aosta), 2958 m a.s.l., 1925, the first example of Ravelli bivouac

Fig. 112. Bivouac Duccio Manenti on the shore of Balanselmo Lake (Valle d'Aosta), 2790 m a.s.l., 1955, an example of the Ravelli Brothers bivouac typology

Fig. 113. Bivouac Slataper on the Sorapìss (BL-Veneto), 2650 m s.l.m., 1965, an example of the bivouac prototype proposed by eng. Giulio Apollonio

until the 70s. Despite the opportunities given by this typology only few examples have been built in the Alps, probably because of the age of elitist alpinism in which it was born, when no large number of building heritage were needed to support climbings.
The building was defined on some basic principles: it needed a wooden internal cover and a galvanized sheet metal external cover, a wooden floor covered with tar paper, a door and a small window, a hole for kitchen tube, a lightning conductor to protect from damaging atmospheric factors, heavy blankets, a can for water, a pot, a broom, an axe, a shovel, a bucket, a lantern and a small cleaning equipment.
The pre fabricated building had limited dimension and could be handly-brought from volunteers dividing it in about 20 packages of 25 kg, with a total weight of 500kg. It could host 4 people in a unique low building which measured 2*2,25*1,25 m. The total amount of the structure was 6000 Lire.

After the Second World War, engeneer Giulio Apollonio that we named in relation to the histoy of alpine refuges (subchapter 4.2.), patented a new model of refuge-bivouac. Mostly keeping the same building technology of the previous Ravelli model typology using a wooden pre fabricated structure covered with galvanized sheet metal, the proposed building is extended in high using a curved roof with variable radius that makes possible to stand upright inside the building and host 9 beds. The bivouac measured 2,1*2,63*2,29 m and the weight increases a lot compared to the Ravelli model, going to weigh 2060 kg. Despite this transport innovation helped in bringing material up on the mountain offering the possibility to use the helicopter instead of a heavy and dangerous hand-carriage.
In the alpine buildings minimum comfort has to be given, in order to decrease discomfort after or before facing difficult climbs. The concept of an essential bivuac "made with four walls and a roof" is declined and a minimum comfort will not upset the character of integral purity of a small high altitude building.
The prototype represents a design of minimum spaces with integrated internal design, dividing the dining area placed just after the entrance from the sleeping area on the bottom of the building. But the possible configurations were still flexibles, based on a sectional layout and not on a central layout.

In a period of increasing social alpinism, bivouacs, as much as mountain refuges, had to be able to give an answer to the number of excursionists, mountaneers and climbers that were diffusely facing the alpine context.

The Apollonio model was not the only existing model at disposal, and many times alpine building reconstruction brought to the reuse of military or work infrastructures, like the model of Capanna Nissen. Another example are the structures used by English army and ANAS (Italian street management institution) as deposits along way infrastructures. This type consists in a modular building wich measures 3,80 wide, 3,30 high and 1,06 depth*number of module, using a simple sheet metal cover which represents a weak technology interacting with mountain environmental conditions. The dimension of this model could also be very important, as we can see in the following example of refuge Panepucci, and they had to be adapted to be used as a bivouac.

Fig. 114. Refuge Savona, Tanaro Valley (Cuneo), 1600 m a.s.l., model of capanna Nissen

Fig. 115. Bivouac Valerio Festa, Val Camonica (Lombardia), 2320 m a.s.l., 1966, modular building

Fig. 116. Ex Bivouac Pelino, Monte Amaro (Sulmona), 2795 m a.s.l., 1966-1974, modular building

Fig. 117. Model of Capanna Nissen for military use, 1948

Fig. 118. Refuge Alessandra Panepucci, Gran Sasso (Abruzzo), 1700 m a.s.l., 1979, modular building

Fig. 119. Bivouac G.B. Giacomelli, Vigolana (Trentino), 2030 m a.s.l., 1966-2016, internal spaces of the modular building

Other contemporary examples go back to an elementary shape, proposing simple structures with few beds and essential spaces, adapting to smallness using asymmetric entrances or covers with low gradient. The archetype of traditional low valley gable roof huts is otherwise revised aiming to achieve a more rigid unitary monolithic shape.

Fig. 120. Bivouac Colombo, Cevedale (Lombardia), 3486 m a.s.l., 1959, 6 beds, elementary shape

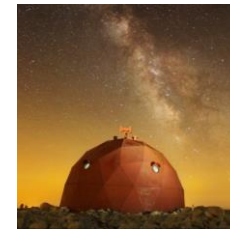
Fig. 121. Bivouac Suretta, San Giacomo Valley (Lombardia), 2798 m a.s.l., 1983, 9 beds, monolitic shape

Helped by the rapid growth of alpinism in the 60s takes also place the suggestion of interpreting the limit and the unknown as an epic technological and figurative conquest of space. As a metaphor of otherness in relation to the context, this building touches mountain soil like if being on a planet that needs to be explored. Following I propose some examples of buildings characterized by central layout.

Fig. 122. Bivouac Bruno Ferrario, Grignetta (Lecco), 2178 m a.s.l., 1968, central layout, top porthole, geodetic volume

Fig. 123. Bivouac Dolent – Le Maye, Mount Blanc (CAS Switzerland), 2667 m a.s.l.

Fig. 124. Bivouac Pelino, Monte Amaro (Sulmona), 2795 m a.s.l., 1979-1982



The identity of bivouacs developed in an hybrid identity touching industrial design but with a stong referral to building tradition, riproposing wooden gable roof structures recalling alpicoltural building shapes.

Fig. 125. Bivouac De la Sassa, Ceresa Valpelline, 2973 m a.s.l., 1988

Fig. 126. Bivouac Malvezzi- Antoldi, Gran Paradiso national park, 2920 m a.s.l., 2003

Past models, prototypes and proposals for bivouacs imprinted in mountain environment a large historical heritage that has been analyzed in order to lead to the definition of actual development concerning alpine buivouacs.

We will define four main strategies to project and build bivouacs: the restyling of the preexistent prototype; the adoption of green technology; the reproposition of the hybrid identity between modernity and tradition; the conceptual site-specific identity.

The first strategy concerns the restyling of past bivouacs prototypes aimed at keeping the existent building through maintenance, reactivating the structure characters. When, because of deep structural problems, a changeover is needed it doesn't propose a detachment from the past, but a reproposal of previous features.

Figs. 127, 128. Bivouac Brenva, Veny valley, 3060 m a.s.l. 1929

2016

Figs. 129,130. Bivouac Ettore Canzio, Grand Jorasses, 3818 m a.s.l. 1961

2016

Figs. 131,132. Bivouac Lampugnani – Grassi, Colle Ecoles, 3580 m a.s.l., 1939 1958

2011

Figs. 133,134. Bivouac Città di Clusone, Presolana, 2050 m a.s.l. 1968

2015

Figs. 135,136. Bivouac II Na Jazerih, Triglav national park (Slovenia), 2118 m a.s.l., 2016

Internal space

Figs. 137,138. Bivouac Città di Cantù, Ortles Gran Zebrù, 3535 m a.s.l., 1971

2016

The second development strategy concerns the high contamination of exasperated shapes recalling ideals of modern green technologies and sustainability. The shape of the building works as an intermediary for the communication of the high technological features composing the functional life of the structure. The structures corresponds to a response to the contextual exposition to local renewable resources, giving the possibility of a better comfort.

Figs. 139,140. Bivouac Alessandra Boarelli, Monviso, 2820 m a.s.l., 2004

Figs. 141,142. Bivouac Giusto Gervasutti, Grand-Jorasse, 2835 m a.s.l., 1948-2012

A third group of refuges identifies with the hybrid identity, recalling features of the first building types and other characters referred to alpicoltural buildings, in particular the materials used in the construction or the gable roof. Despite this, those bivouacs includes a relation with industrial design and materials.

Figs. 143,144.
Bivouac Luca Vuerich, Sella Nevea, 2530 m a.s.l.
2012

Figs. 145,146.
Bivouac Colle Clapier, Susa valley, 2447 m a.s.l.,
2014

Figs. 147,148.
Bivouac Kobariški Stol (Slovenia), 1673 m a.s.l.,
2003

The last identified variance in actual bivouac development is the possibility to build an identity strictly in touch with the single environmental features. Contextualizing the concept of site-specific development gives birth to interesting and important shapes in contemporary works, able to build a relation with the existent.
Many building types in a short period of time, with a small number of realizations, express a great diversity of approaches and visual experiments, able to innovate but also keep their primitive reason of being. These manufacts are the expression of an opportunity given by the creation of new marks in the landscape, that transform a natural heritage giving new significants connected with cultural needs of belonging to a territory.

Fig. 149.
Bivouac Kotovem (Slovenia), 2005

Fig. 150.
Bivouac Legarji (Slovenia), 2009

Fig. 151.
Bivouac Skuta (Slovenia), 2015

Fig. 152.
Bivouac Kanin
(Slovenia), 2016

Fig. 153.
Bivouac f.lli Fanton
(Italy), to be realized

Concluding this introduction on this small alpine buildings we assume that the bivouac tells us about the intimate relationship with a place, a temporary occupancy of the soil and for this reason its approach with the landscape tend to respect the environmental condition. The building is a project of minimum meeting human needs, trying to be fully reversible in its existence. It is a metaphor of projecting a minimum that meets human needs, which tries to limit soil use, building materials, and identifies the right volume within which the only free contributions and the heat given from the humans ensure the well-being of guests.

4.3.1. Bivouacs development: the site specific project of Bivouac *Gianbatta Giacomelli alla Vigolana*

Starting from posing ourselves some questions we will try to evaluate the sustainability of the bivouacs building production development in the Alps. How can we manage the sense of belonging that an alpine community attribute to a building, when its intrinsic nature leads us to investigate the limit of the meaning of material tracks conservation? Is it possible to find some tools for designing a landscape for the future that resets all the references to the cultural landscape that we were used to? The possible solution is to involve the community as participant in the renovation process. The aim is to offer the opportunity to renegotiate the definition and the sense of belonging to a landscape, also through the investigation of the relational surplus features that some isolated buildings show towards sublime landscapes, with whom they can establish unique dialog forms.

The case study concerns the replacement of a bivouac in the eastern Alps, an experience of democratic process of reactivation of a landscape with a strong identity: Vigolana mountain group. It's a territory with many natural interests in the geomorphology, speleology and wildlife fused with anthropic characters emerging in villages, mountain buildings connected with alpinism and religious marks. The latter are well represented in the toponomy of the two spires surmounting the bivouac Gianbatta Giacomelli, named Friar and Virgin Mary.

Stating many structural problems, in occasion of the 50th anniversary from its first construction dated 1966, the CAI-SAT section of Caldonazzo together with the competent municipalities of Caldonazzo, Vigolo Vattaro and Bosentino close to this landscape element for institutional but most of all for cultural reasons supported with financial and technical interventions the reconstruction of the bivouac.

As we can read in the previous paragraph, the construction or replacement of bivouacs normally consisted for long time in the use of a hand-carriable technical element at high altitude, modular and replicable in different landscapes as a prototype.

This building renovation is more complex and democratic in some ways, as it opened to the redefinition of the Vigolana landscape starting from the potential value of a relational architecture, designed for a specific place. The process of renovation focused on sharing with local communities even the cultural significance of the new dimension of the project, leading to a great awareness about the landscape transformations.

The new construction of Gianbatta Giacomelli bivouac offers a change compared to the previous structure in terms of insertion into the landscape and service offered. It proposes itself as an architecture integrated in the shape and morphology of the prominences constituted by the spiers of the Friar and the Virgin Mary, highlight this unique profile and placing itself as an ideal connection point between the slopes and the summit, as a completion of this natural line that makes this place an icon of the Vigolana mountain group.

The bivouac, first of all, plays the role of support point for the mountaineering ascents on the spiers and on the routes of the north face of the Vigolana. It is therefore identified with the moments of sharing offered by the practice of climbing and mountaineering excursions.

Figure 154. Morphology of the Giacomelli bivouacs' location, descending from the spire Friar (left), the spire Madonnina (central) to the bivouac.

The CAI-SAT section of Caldonazzo has taken care of and maintained the structure since its construction (1963-1966) and still continues this activity by checking the presence of emergency tools and ensuring the use in all seasons of the climbers without any form of income.
The public nature of this type of Alpine buildings has suggested the opportunity to present the project in a public and shared way to the population, receiving great support and enthusiasm for the initiative since the first meetings, which we consider an added value for this structure. in terms of belonging to a common good.
The design and construction activities (2011-2016), carried on by volunteers of the University, of the Alpine Club, local craftsmen and CAI-SAT members, has become an opportunity for discussion between the climbers and the local communities, taking them towards a greater sense of inclusion for the same process of transformation of a common good and of a landscape with strong identity characteristics.
If its construction in the 60s required 3 years of work and 92 people, the current construction lasted 14 working days in altitude and at least 24 people on the field. The spirit that accompanied the process of replacing the old bivouac is a distinctive sign with respect to the community which in different ways has given wide availability, starting from the positive reception of the project, up to the sharing of the results in

moments of public celebration both at altitude and downstream, organized by the municipalities, bodies and associations involved.
The initiative had generated strong enthusiasm in the institutions and in the local population of both the village of Caldonazzo and the Altipiano della Vigolana which framed it as a great opportunity for the territory to in order to relocate it within a panorama of alpine locations enriched by alpine architectures of strong value and meaning.

The process started with a call for project, after the last mainteinance operation in 2011 that showed the bed conditions and technical problems which needed a radical solution. Fifty years after the first building, despite different mainteinance actions, a replacement of the bivouac was needed. The structure was in obsolete and structural decay conditions, most of all caused by thermal and hygrometric stress of the location with high exposure class referring to weather events.
Consequently, the geometric relief and the first draft version of the project have been the bases for the change. Many internal and external discussions added to collection of opinions and an important initiative of crowd-funding followed at local and national scale. The final project approved in 2016 gived space to the factual realization, first in the valley to prove the integrity of the project, prefabricate and put in place the internal furniture and most of all to involve the part of the community and association members that could not reach the location in high altitude. Finally, in july 2016, the works brought to the realization of the new bivouac in the mountain expressing himself through co-working, volunteering, inspections and measurement of the whole climber community.
The construction phases carried out on-site started from the demolition of the existing bivouac and continued with the excavation of the concrete base which, in addition to the work of the volunteers in the field, made use of the help of helicopters for upstream transport and for laying of the various subsequent structural elements through hangover. After the structure was completed, the activities of the volunteers in the field followed with the laying of the roof and the internal wooden furnishings. The structure is characterized in the materials by the use of Xlam panels and an aluminum roof covering, chosen to counteract the durability problems highlighted in the previous bivouac. The structure has been elevated from the ground with a concrete casting foundation anchored to the limestone outcrops of the spur, in order to make the use

Figure 155. Leaflet promoting crowd-funding for bivouacs' rebuilding, 2015

of tie rods superfluous and, at the same time, to arrange a access to the natural panoramic balcony facing the valley.

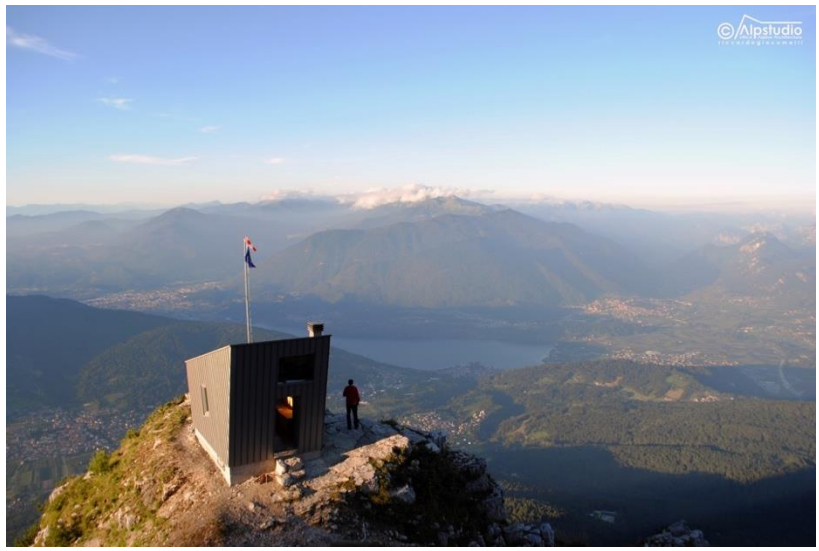


Figure 156. View from the Giacomelli bivouacs' promontory, looking down to the lake of Caldonazzo and up to the Brenta Dolomites.

The prevalence of the material is found in wood, recognized as a material of tradition and innovation in the alpine environment, it is resistant to environmental stress, can be used as a structural material without expansion, insulating and finishing, going to build a pleasant and welcoming environment as well as strong resistance.
The project includes structural technical solutions to permit the use of the limited external spaces at disposal, shrinking, moving and rotating the basement of the old building. An internal distribution between day and night spaces in length and in high permit a confortable living space for at least six people.
An element of connection between the interior and exterior of the structure are the openings, which allow to enjoy the landscape offered by the position even in windy or precipitating situations, as often happens in this high altitude position; as well as defining the character of openness to passing mountaineers.
The roof and side slopes are designed so that they never have mutually draining surfaces and avoid any form of water stagnation with the related problems of freezing and thawing.

No facilities have been set up inside the structure, with the exception of the wood-burning stove with the task of making the environment more welcoming and allowing cooking. The choice to maintain the simplicity of the services is made in order not to invade the primary purpose of the bivouac, recognized as temporary and emergency shelter, and not to make difficult the management carried out by volunteers in a situation of access with high alpine routes.
Finally, it's relevant to observe that the participation process permitted to extend to a larger number of subjects the sense of belonging to the same bivouac, increasing the utilization care and improving a shared management of a common good normally difficult to reach. Moreover, the new bivouac has led to a significant increasement in the number of visitors of this mountain environment, publishing the building as a recognizing mountain symbol of inclusion and beauty.

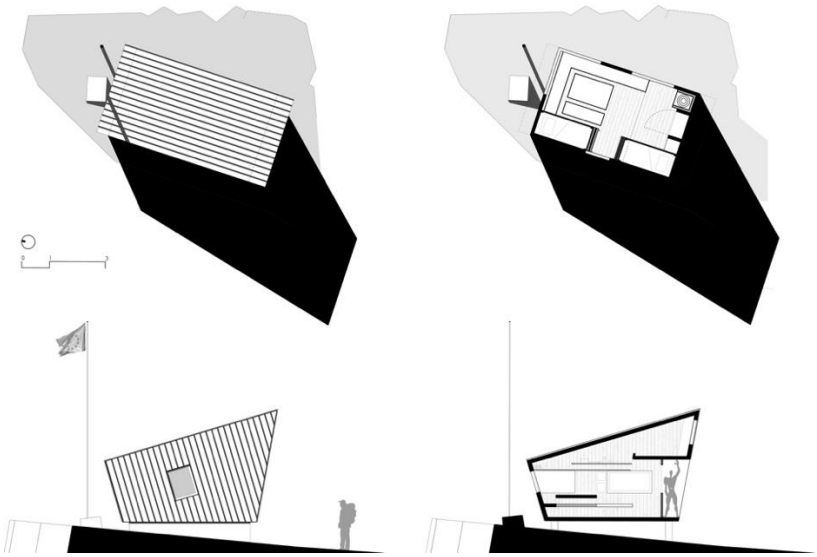


Figure 157. Bivouac G.B. Giacomelli alla Vigolana, prospectus and building plans

Figure 158. Bivouac G.B. Giacomelli alla Vigolana internal design

CONCLUSIONS

The doctoral thesis, following a consequential line of development from the study of references to the applied case study, produced and evaluated the validity of a visible change of paradigm in the design of Alpine Isolated Buildings in all its representative forms.
The building becomes a sign and a landmark of its own landscape, interpreting the shapes and knowledges that is capable to intercept from both its profound and aesthetic vision.
Modern development has not homogeneously effected the alpine chain, it results more concentrated in the western part of the Eastern Alps, creating attractive tourist destinations where economy and population are increasing through the development of tourism and multifunctionalism of agricultural activities. The relevance of Isolated Alpine Buildings is many times connected to main destinations, but for reasons like being located out of urbanized areas, building high altitude tracks connections, being characterized by interesting morphological, environmental, cultural factors, they increase popularity thanks to the possibilities of experience they can offer to visitors.
Stating new ways and times of fruition of mountain environment, at lower or higher altitude all around the alpine chain, technological and infrastructural changes to support the evolution of mountain access are required.
To reach the better result responding to the new needs, the development of a project have to be solidly based on a punctual analysis. And the digital technologies at disposal added to valid investigation methods facing academic research, allow to build systems of analysis for a detailed interpretation of complex mountain spaces.
The outcomes of the research on the specific features referred to a sigle building creates motivations and interests for the project design, in a scenario of interchanges and relationships between the various characterizing elements of the landscape.

The proposed methodology begins with the classification of the object of the study and the theoretical deepening of cultural and architectural

context referred to the main subject: mountain and Alpine chain. Questioning different forms of art and utopian views helps in building the framework for the subsequent analysis of the complex reality. The objects retained interesting for the research, starting from local scale, are not ready quantitative data, but most of all qualitative features – historic, cultural, perceptive elements - transformed in gereferenced data to be examined through the digital analysis. Different can be the solutions for the digital research and cataloguing, involving also open source tools and public data, and the choise of them ones more begins with the definition of the primary objects. The study of local resources support planning decisions, base for subsequent individual projects.
The adoption of digital research tools on different case studies related to the Alpine mountain, from the agricultural to the alpinistic environment, evidences the application of a non-standardised process of analysis to respond to the necessity of a shared result.
The complex vision for the building development including historic and cultural values, sustainability of the project and its evolution, is moved by specific needs of functional change coexisting with sensitivity environmental problems linked to mountain space.

The project, verified both by digital and on-site research, results to be closer to the context, observed as a complex system of relations between single combined elements.
The project has to be open to important variations of meaning, in the agricultural buildings leaving the traditional practic uses, but also in the alpinistic building heritage that has the hard role of promoting a mountain fruition sensitive to environmental and functional problems, and at the same time increase its offer for a better management of the requests coming from users.
Aesthetics of the project has to reproduce the change of significances, representing possible and desiderable positive shapes opening to contemporary architecture, most of all when the past identity moves to new objectives and landscapes.
For all these reasons a site-specific project is suggested, keeping a deep contact with local community that in many ways can be responsible of the undertaken development direction.

In particular, we can outline some final considerations on the three building typologies attributable to the definition of Isolated Alpine

Buildings with respect to the evolution of the dynamics of use, the constructive consistency and the need for building interventions (Figure 159).

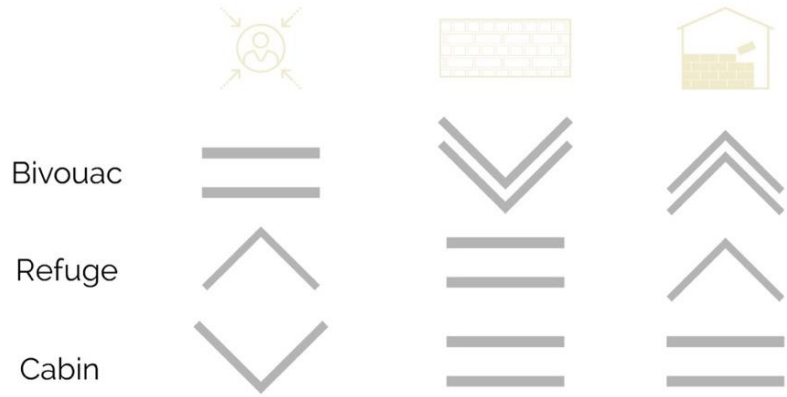


Figure 159. Graph on the possible development for alpine isolated buildings involving dynamics of fruition, constructive consistency, need for building interventions

The bivouacs, oriented towards specialist and mountaineering use, maintain their role and traditional use over time. Their weak structural consistency, prevents from interventions that exceed the category of extraordinary maintenance; therefore, the integration of new elements and functions, as well as technological and structural adaptation passes through the complete replacement of the building.
Refuges developed starting from where mountain agricolture could not be sustainable, keeping constructive techniques in higher altitudes. Their evolution presents changes in the initial volume ratio, building partition for specific needs (kitchen, room, storage…) or unmanaged enlargement and extentions. They have expanded in the course of time in capacity, offer and function, increasing integrated and specialized facilities and spaces in order to accommodate an ever wider and more heterogeneous user platform. Most refuges are built with specific durable and conservable techniques, therefore they can be developed through systemic approaches that preserve the value of being testimonies of the historical nucleus of settlement, integrated by contemporary elements that allow further usage patterns.
Finally, the cabins, which indicate a substantial defunctionalization, connected to the important changes in mountain agricultural

management and adoption of modern agricultural techniques. The concept of Alps as a rural region, still relevant in the construction of the ideal image of the region, faces the major role of tourism.
According to a general need of rethinking the conditions of use of cabins, the development has to be declined within a preservation perspective of the compositional principles of self-building tradition, and the opening to contemporary contaminations in architectural languages capable of reactivating pre-existence towards different purposes. The process begins with the recognition of specificities and, helped by the introduction of region-specific policies, can be possible to build the development strategies and site-specific projects. In this way could be an advantage to take in account possible interactions with higher altitude buildings related to alpinism fruition, building a structural connection for better accessibility.

Mountain tourism is highly sensitive and dependent to future changes in the climate. We face a situation of significant rise of global temperatures since pre-industrial era, presenting in the latest five-year the highest temperature on record, no cleare trend in annual precipitation for Europe and a downward trend in soil moisture. In 2019 precipitations in the Alps was above average, and combined with a larger number of cold days and night they fell as snow, leading to many disruptions, fatalities, warnings for avalanches. Global and European glaciers are seeing a substancial loss of ice mass, and since 1997 has been monitored in the Alps a loss of 29 m of ice, even presenting intermittent periods of mass gain in the 20th century [Copernicus, 2020]. Alpine Tundra, rich in biodiversity an providing key ecosystem services, will be more effected from warming and climate changes due to the tight ecological-climate bands in mountain, with a shrinkage of actual presence and the loss of Natura 2000 sites. Moreover, natural climatic treeline is also projected to move upwards, with effects in ecosystem services, habitat for biodiversity, recreational services [L. Feyen et al., 2020].
Building in high altitude presents direct consequences to the delicate Alpine environment. The proposal to develop site-specific projects within a vision of building system, is directed to ensure sustainability in fruition development.
Many refuges in the Alps face problems connected to climate changes, a relevant one concerns the static conditions of the buildings situated at

high altitudes. Buildings in contact to rock glaciers or permafrost soil are visibly effected from rising temperature and ice melting, reflecting in the necessity of urgent stability interventions on unstable slopes.
Moreover, the difficulty of water supply is becoming more relevant in a scenario of increasing mountain fruition. The evolution of the buildings has to measure the sustainability of more comfort and capacity in comparison to water supply and waste water management, being able to make the choice of less number of services added to a work of information and environmental education. Isolated Alpine Buildings, icons of mountain and achievement, become ones more places for change suggestions, driven by the openness derived from their visible uniqueness and sensitivity.

The role of refuges as lighthouses suggesting ideas for architecture in the lower valley, derived from the reading of "Die Alpine Architektur" by Bruno Taut, summarize the idea of project proposal for high altitude buildings. It begins with the recognition of mountain values and the design as a tool for reinterpreting the building.
The changes introduced in mountain building development could inspire urban architercture, in contrast to the past and usual urban-mountain direction of the project and the administrative policies.
Think to the building, not like a single building, but like a complex system of spaces and functions, as well as work to build connections with other systems and to involve community in the decisions are good practices. Aesthestic is another priority of the project, leaving previous lines related to different context - like agricultural shapes on high altitude refuges - and underlining the relations with local landscape, inspiration, sustainability, beauty. Interrelation with the landscape are helped by structural tools like buildings shape, accessibility, dialogue with light and high. Technological opportunities for management or construction help to balance larger mountain fruition with the sustainability of the impact on environment and to select the strategic resources for the development of each building system through on-site visits added to digital research tools.
Conseguence of the adoption of research, functional and aesthetic strategies is the definition of an inclusive architecture, that works between design and composition, redefining stereotyped ideas of mountain buildings.

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The research program deepened the role of architecture in the constitution of the alpine landscape and generated instruments for the development of builfings located in mountain areas. Thanks to their unique relationship with the mountain landscape isolated alpine buildings become lighthouses for the construction of the lower valley.

The thesis investigates the development potentialities for isolated alpine building systems through the analysis of the location and connection values related to the environmental context and landscape (geomorphological and anthropic features) as well as to the presence of recognized latent resources. In the system of isolated alpine buildings are included bivoucs and refuges, referring to alpinism activities, and cabins concerning an agricultural use of mountain areas.

Bivouacs means temporary camp, and in the studied form consist in a permanently open emergency shelter in remote mountain areas. A refuge is a place where you go for safety and protection, a temporary condition for mountain fruition. As high density accomodations they are built as site specific projects, with high variability in dimension and provided services. Cabins consist in small shelter or houses situated in pastures or wild remote areas. They were an answer to needs of alpine farming, now facing changes in mountain economic development mainly redirecting to tourism activities.

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My research objectives concern: the study of the forms and interventions whithin the refuges and bivouacs present in the Alps; the anlysis of the historical evolution of isolated alpine buildings (bivouacs, refuges, mountain hutes); geospatial analysis in the Alpine region.