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Heritage at Risk: Documenting and Valorising Ice-Houses in Mountain Territories

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Throughout history, people have always faced challenges in the collection and distribution of water in its various forms. The collection and transportation of ice, in particular, posed significant difficulties. Since antiquity ice storage and distribution systems, such as ice-houses, have been employed worldwide. Mediterranean countries have, over time, developed extensive ice storage and distribution networks. Snow was collected at high altitudes and stored in mountain ice-houses, while artificial lakes were constructed specially for ice production. Ice-houses belonged to two main categories: those strategically located near production areas, serving as summer storage facilities, and those situated in villages on the plains, where ice was stored after purchase. Today, ice-houses risk being forgotten. While a few of them are still used, for example for aging wine, most have long been abandoned, lost to memory, or fallen into disrepair. Only a very small number of ice-houses, such as the Madonnina ice-house in the Ecomuseum of the Pistoia Mountain, are currently being protected and enhanced as part of the local built heritage. This contribution aims to raise awareness of the heritage value of ice-houses to foster their preservation and promote their enhancement. This can be achieved through the systematic documentation of ice-houses and of the systems historically employed for ice preservation, thereby ensuring the long-term conservation and effective appreciation of these structures.

Key Words: ice-houses, built heritage, heritage conservation, construction materials

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INTRODUCTION

Ice has been utilized since antiquity as a remedy for migraines (as early as the 2nd century AD, Galen recommended the use of 'snow water' to alleviate headache), to lower body temperature, to stop haemorrhages,
[404] and to alleviate pain (Rozier 1785). The Mediterranean region, characterised by its mountain ranges close to major port cities, provided a particularly conducive environment for the development of snow and ice production and trade (De Planhol 1973). Throughout the Medieval and Renaissance periods, snow from Brussels was transported to Constantinople in special insulated barrels, and knights in Malta often reported the use of snow traded from Naples for medical purposes. Although the ability to buy and preserve ice close to home was primarily a prerogative of the nobility, ice also served public and common uses. In the south-eastern Mediterranean, for example, the use of ice to refreshen drinks in the scorching summer months was a matter of public comfort. In Egypt, for example, 'in the 16th century, snow had become a relatively common commodity, sold in abundance in the city's shops' (De Planhol 1973, 326, translated by the author), while in Italy and Spain, in the same period, 'snow water seems to be quite widespread. In Italy, it explains the early art of sorbets and ice creams' (Braudel 1986, 12–13, translated by the authors).

The use of ice to preserve food in domestic ice-houses is documented throughout Europe from at least the 17th century, particularly in the British Isles and in mountainous regions: '[t]he cooling function of domestic or communal icehouses prevailed from the 17th century onwards, both in Great Britain and in the Alpine regions. Meat, dairy products and even fruit were stored in compartments inside the tanks, airlocks or access corridors and hung above the ice or simply placed on top of it. This function became increasingly widespread from the 19th century onwards' (Acovitsióti-Hameau 1999, 135, translated by the author). In the Alps and the Appennines, too, ice derived from the storage of snow was used for the preservation of food: 'until the early 20th century [...] the storage of perishable foods such as fish were linked to the use of natural ice [...] obtained by collecting snow in special structures' (Beltrametti and Stagno, 2019, 102). In Genoa, 'until the end of the 18th century, ice was produced exclusively through the use of snow collected in snow houses' (p. 103) and in Turin 'as early as the mid-17th century, ice customers used the product stored in icehouses to preserve (*rinfrescar*) perishable items' (p. 119).

The increasing demand for ice among nobles and the aristocracy between the 16th and the 18th century was driven by a shift from a 'culture of honour' to the *civilitas* of conviviality and good manners (Raggio 2023), which characterised the aristocratic classes of this period This cultural shift brought significant changes to the system of [405]
production and distribution of food and related products, including ice, leading to a progressive expansion of production activities and the development of dedicated infrastructures. One such infrastructure involved *pelagi* (freezing basins), where water was channelled during the winter period, so that it would freeze due to the drop in temperature between day and night. At the same time, specific architectural structures, such as *neviere* (literally, snow-houses) and *ghiacciaie* (ice-houses), were developed for the storage and preservation of ice. The use of compressed snow is documented, for instance in the Genovesato area, as the main source of ice until the second half of the 19th century, when the use of ice produced from artificial lakes and basins became predominant (Stagno 2018). The snow-houses were modest structures, typically excavated into the ground and used for the collection of snow, which, once compacted, transformed into ice. In contrast, ice-houses were more complex and elaborate constructions. Typicallycylindrical or truncated-conical in shape, these structures could be either partially or completely underground. They were lined with square stone blocks and surrounded by thick walls, sometimes measuring up to a couple of metres, to ensure adequate thermal insulation to the storage space. In some cases, these structures were built entirely above ground, requiring additional measures to protect the ice from external heat.

Ice-houses had coverings made of wood and straw or masonry, while the number and size of the openings were minimised to limit air exchange with the outside. These openings facilitated the loading and unloading of ice, as well as providing ventilation and internal lighting. The floor of the ice-house was designed to be insulated from the ground, sometimes resting on small vaults, above which a wooden slatted grid was placed to enhance insulation and prevent direct contact between the ice and the meltwater. The meltwater was typically drained outside through a specially designed channel. Alternatively, the vaults could be replaced with a wooden grid elevated at least thirty centimetres above the ground, upon which an insulating layer of brushwood or straw was placed, topped by an additional wooden slatted grid.

Ice-houses were rapidly replaced with the invention of the electric

refrigerator in the mid-20th century, and today they represent a fragile and endangered heritage. They provide tangible evidence of how people skilfully used natural resources to improve their living conditions, developing tools and methods for ice production and storage. Despite
[406] this, many ice-houses have been completely destroyed, while others have significantly deteriorated as a consequence of abandonment. A lack of acknowledgment of their historical significance, coupled with the challenge of repurposing them for functions beyond their original use, has resulted in the gradual loss of buildings that possess historical, technological, social, architectural, and scientific value, and that once served as key representations of the socio-cultural life of their time. This heritage remains accessible today only where ice-houses have been repurposed for the aging of wine, or in the rare cases where they have been preserved and enhanced, such as the *Ghiacciaia della Madonnina* at the Ecomuseum of the Pistoia Mountain or the *Ghiacciaia di Sala Monferrato* (Alessandria), located beneath the municipal building and recently restored (Frixia et al. 2020).

In light of these considerations, it was deemed appropriate to undertake the study and analysis of several ice-houses located in Piedmont and Tuscany, with the following aims: (1) to promote their recognition as valuable heritage, an essential prerequisite for initiating active preservation measures; (2) to deepen knowledge of these structures through investigations analysing their constituent materials and identifying the relationship between those materials and the geomorphological characteristics of the territories in which they were built; (3) to examine the conservation challenges they face. The case studies analysed in this work were selected from among ice-houses used for the collection of ice at high altitudes. They either stored snow during the winter months or gathered water in specially constructed basins. From these structures, the ice was subsequently transported to lowland centres, such as Biella and Turin in Piedmont, and Florence in Tuscany. An exception is represented by the *Ghiacciaia della Madonnina,* built in proximity to the monastery and producing ice exclusively for monastic use.

The following observations were made by the authors during a series of on-site visits carried out between September 2023 and July 2024. In the Tuscany case studies, the site visits were followed by laboratory analyses aimed at assessing the material composition and geological characteristics of the construction, thereby linking the ice-houses to

locally-sourced stone and typical building materials. The observations of the Piedmont case studies relied primarily on direct inspection, with particular attention devoted to construction techniques and the state of conservation of the ice-houses.

[407] The selection of case studies, despite the widespread presence of ice-harvesting and transportation systems throughout much of the Alps and the Apennines, was guided by the geographical proximity of the authors to the two areas under consideration. For the Piedmont case, an initial survey of the structures was carried out based on a number of graduate theses supervised in the 1990s at the Polytechnic University of Turin by prof. Giovanni Brino (D'Angelo 1992; Maccagno 1994; Fasolis 1998) that aimed to map the remaining ice-houses in different areas of the region. Building upon this documentation, further field research was conducted to determine which of the structures identified in the theses were still standing and, where possible, accessible. This process led to the identification of the Cervo Valley as the area of investigation.

As for the Tuscany case studies, research began with the 1987 publication *Archeologia industriale* (Cinotti et al. 1987), commissioned by the Acquedotto Consorziale Alto Reno at the time of the construction of the Pontepetri dam. The book examines the Pistoia Apennines – particularly the Reno Valley – within the context of ice production, reconstructing its rise from the late 18th century and its decline with the end of production in the early 20th century. The analysis draws on oral testimonies from those directly involved in the activity, archival photographs, the remains of ice-houses and the associated hydraulic system, and the archives of families who produced natural ice. The analysis indicates the presence of over 70 ice-houses in what is defined as a 'working district' (Cinotti et al. 1987, 13). The great importance of this phenomenon, not only in geographical but also in socio-economic terms 'given that there is no family that has not participated in some way in the production or trade of natural ice' (p. 15, translated by the authors), led to a census of ice-houses. Their cataloguing also made it possible to obtain data concerning the quality and quantity of the industrial process. Actions and initiatives have since been implemented to recognise the value of these artefacts, such as the inclusion of a dedicated itinerary in the Ecomuseo della Montagna Pistoiese (Pistoia Mountain Ecomuseum) and various restoration and reuse projects.

The Monte Senario ice-house, located in the Florentine territory,

was built in 1844 and remained active until the late 19th century. The ice-house has been the subject of several studies by Barbara Aterini (1988; 1989a; 1989b; 1991a; 1991b; 1991c; 2006; 2007; 2011; 2014). These include a restoration project (Aterini 2006) that was never carried out
[408] and, although the ice-house has been included in an itinerary dedicated to historic butter factories, it currently stands in a state of desolate abandonment.

THE *GHIACCIAIA DELLA MADONNINA*

The practice of ice preservation in Tuscany can be traced back to antiquity, with evidence of it dating to prehistoric times, as shown by discoveries in certain caves of the Apuan Alps. This tradition continued throughout the medieval period and into the era of the Grand Duchy of Tuscany, when masonry ice-houses were constructed, and persisted until the establishment of ice factories in the post-war years. In the upper Reno Valley, from the late 18th century to the early 20th century, significant quantities of ice were produced, thanks to the combination the river's abundant water, the area's harsh climate, and an ingenious system of canals and artificial lakes. The village of Le Piastre grew in importance, becoming a pivotal relay station for the transportation and trade of ice.

The *Ghiacciaia della Madonnina* is one of the few remaining intact ice-houses, in active use from the 18th century until after the Second World War. Its most important period was during the 19th century, facilitated by the Modenese road, begun in 1766, and by the Porrettana railway,

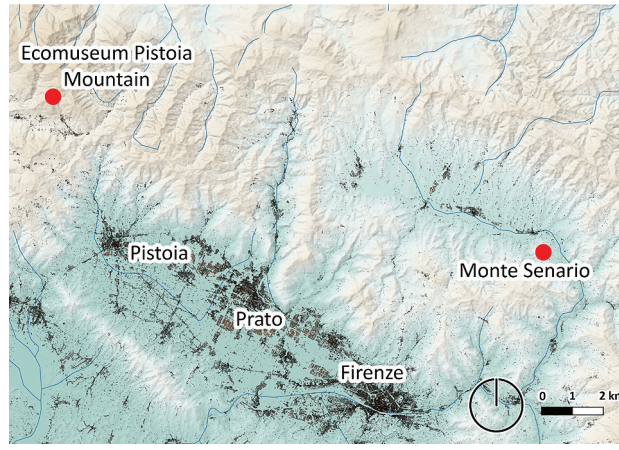


FIGURE 1

The Location of the Ghiacciaia della Madonnina and the Ice-House Located near the Monastery of Monte Senario in the Tuscan Appennines, Italy

constructed between 1858 and 1864. The development of these infrastructures enabled efficient ice trading, particularly between Florence and Bologna (Cinotti et al. 1987; Nesti 1998) In its early years, ice was primarily sold to butchers and hospitals (Cinotti et al. 1987). Over time, wealthy families began purchasing ice for their private villas, which often featured small ice-houses. By the 19th century, ice was supplied to the general population, as many Tuscan cities had ice-houses known as *conserve,* which were used to store ice brought from mountain areas before its retail distribution. After purchase, ice was stored within households in specially designed cabinets divided into two compartments: one for the ice and one for keeping perishable goods (Cinotti et al. 1987). Starting in the 19th century, with the construction of many new roads and the development of tourismhotels and guesthouses also began to be equipped with ice-houses. [409]

The Ghiacciaia della Madonnina underwent restoration and is now part of an itinerary created by the Ecomuseo della Montagna Pistoiese association. The Sentiero della Ghiacciaia (Ice-House Trail) allows visitors to explore the site 's history and function and is complemented by an audio guide accessible via QR code. The trail offers a privileged vantage point from which to observe the Reno River damming system, the sluices that regulate water flow, the ice-formation basin, and the stone-and-wood ice-house itself. In 2012, restoration work was carried out to repair the thatched roof, which had developed numerous holes, and to stabilise the masonry crown, weakened by erosion of the mortar joints. These efforts enabled the Ecomuseo della Montagna Pistoiese to open the ice-house to the public and to establish an educational ice centre in the town of Pracchia. The centre houses a curated collection of materials and tools used in the Fabbrica del Ghiaccio (Ice Factory), as well as documentation, publications, and iconographic archives offering a comprehensive overview of the historical development of ice production and storage in the area (more info can be found at https://www.ecomuseopt.it/itinerari/il-ghiaccio/).

During the ice-production process, the *calle* (inlet and outlet gates) were left open to allow the water to flow freely and thereby promote the formation of ice on the surface. Once the ice had reached a thickness of 20–30 cm, it was broken using a wooden *palamina* (a tool with a short handle and a triangular point), which was used to create holes spaced 50 cm apart. The ice was then cracked from one hole to the next with a second *palamina* made entirely from iron. The resulting sheets of ice,

known as *barconi,* were then conveyed into the ice-house via the *porto,* a ramp designed to reduce the height difference.

Inside the ice-house, the ice was meticulously arranged in layers, with chestnut leaves placed between them to ensure complete separa-
[410] tion. Once filled, the ice-house was sealed until the ice was sold, typically in June. The ice was then extracted from the ice-house and transported to cities and lowland centres by ox-drawn carts. The ice was wrapped in wet jute and placed inside special barrels insulated with cork to prevent melting when exposed to external temperatures. Ice production was influenced by several variables related to climate and seasonal conditions. High-quality ice needed to be compact, not fragile, and clear rather than opaque. The quality of the water was crucial, as impurities had to be filtered out. Equally important was the freezing process itself, which progressed from the surface inwards. A gradual decrease in temperature was essential, as was effective drainage, which removed air – the main cause of opacity in the ice.

Description of the Structure, Materials and State of Preservation

The Ghiacciaia della Madonnina is 15.60 meters high and has a volume of 760 cubic metres. The base is made of loose stone and is equipped with a drainage system to prevent the accumulation of meltwater, which could accelerate the liquefaction process. The structure features three doors, strategically positioned at different heights, allowing access to the ice-house depending on the amount of ice stored inside. The above-ground part is made of coarsely hewn sandstone ashlars, laid in irregular courses and bonded with lime mortar. The roof is made of rye

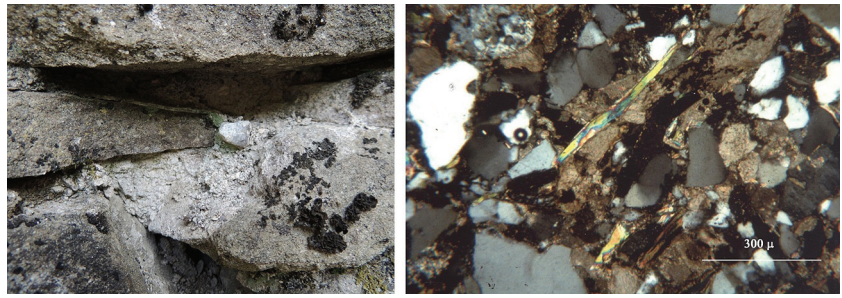


FIGURE 2 Well-Preserved Pietra Serena Sandstone (left, only biological growth (mosses and lichens) is visible); Thin Section under Polarised Light (right)

straw. The sandstone in question belongs to the Macigno Formation of the Falda Toscana (Fratini and Rescic 2014), a turbiditic sandstone dating to the Oligocene. This sandstone contains a clastic fraction consisting of quartz, feldspars, fragments of magmatic and metamorphic rocks, muscovite, and biotite, all set within a clay matrix. It can be [411] classified as lithic arcose (QFR diagram for Folk's sandstone classification) (Folk 1980). Its resistance to weathering is generally low due to the presence of clay minerals in the matrix. However, the presence of precipitated calcitic cement within the pores may increase its weathering resistance; the good condition of the stone ashlars in the ice-house suggests that such calcitic cement is indeed present.

THE ICE-HOUSE IN MONTE SENARIO

Monte Senario, ancient Asinarius or Sinarius, is located, as the historian Repetti wrote, 'between the river Sieve and the river Mugnone, 4 Tuscan miles south-east of Vagliara and 10 Tuscan miles south of Florence' (Repetti 1835, 130, translated by the authors). The Monte Senario ice-house is part of an itinerary created by the Vaglia Pro Loco in collaboration with the Circolo Arci 'Chiari di luna.' Sponsored by the municipal administration, the route offers visitors the opportunity to explore ancient rural structures: the large ice-house and the *burraie* (butter factories). The ice-house, one of the largest in Europe, has lost all architectural embellishments that once made it elegant and valuable, yet it still impresses visitors with its monumental scale.

This impressive structure was built by the monks from the nearby monastery around 1840. Its original dimensions were recorded as 14 metres in diameter and 15 metres in height, with a partially underground chamber descending 12 metres below ground level. The structure was crowned with a lantern, which facilitated ventilation. The dome, built with a double brick layer separated by an air space, was decorated externally with *embrici* and curved tiles (Aterini 2018). The base of the cylinder was lined with stones and bricks, also curved, producing a beautiful two-tone effect. The ice that formed during the winter in twelve small artificial lakes, specially constructed in the area, was collected at night and transported to the ice-house, where it was stored until the summer months, protected from heat by the thick walls. In the summer, the ice was cut into blocks to be sold and, again during the night, transported by carts to Florence. No trace of the twelve ponds survives today.



FIGURE 3 The Ice-House in Monte Senario

NOTES Remains of the stone and brick cladding (top left); detail of the base and core of the masonry in split stone elements (top right); interior details of the icehouse: the impressive depth (bottom left); the access opening (bottom right).

Description of the Structure, Materials and State of Conservation

Production of ice in the area of Monte Senario was abandoned at the end of the 19th century. Subsequently, around 1950, the Prior of the Monte Senario monastery decided to use the ice-house as a quarry for building materials. The lantern and all external cladding were removed so that the stones and tiles – already shaped – could be reused for the restoration of farmhouses. Despite the removal of the roof covering and the abandonment of the activity since the late 19th century, the structure remains largely intact. For safety reasons, however, it is now surrounded by a protective net that prevents access and obstructs even a partial view of the shaft where the ice was historically stored. The inner chamber, formerly used to hold ice and snow, has a truncated-cone profile. The walls are constructed of square stone blocks. The bottom of the chamber slopes gently towards the meltwater drainage shaft, which ended up in an underground conduit and emerged at the bottom of the slope.

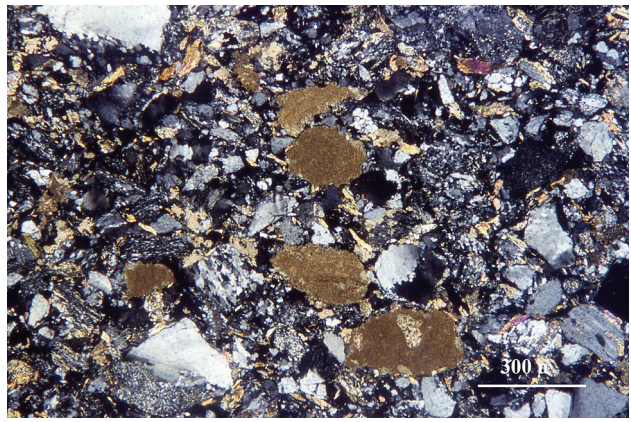


FIGURE 4

Montesenario Sandstone

NOTES Thin section under polarised light microscope, crossed nicols, bioclasts are visible.

Sandstone is the main material used, in the form of squared ashlars for the deep inner chamber and for the original two-coloured outer facing, and as split stone for the masonry core. The sandstone used in this construction comes from the local outcrops of the Montesenario Sandstone Formation, a turbiditic sandstone of Oligocene age belonging to the Subligure Unit known as the Canetolo Complex, which is tectonically located above the Tuscan stratum (Cipriani et al. 2005). It can be classified as a sandstone between lithic and feldspathic (QFR diagram for Folk's sandstone classification) (Folk 1980). The presence of bioclasts is a distinctive characteristic of this type of sandstone. The sandstone ashlars are in good condition, likely due to a high proportion of calcitic cement in the stone (Chiocchini et al. 1996). Bricks formed the two-toned exterior decoration, and flat tiles were used in the construction of the double dome. According to oral sources, these materials were produced at the nearby site known as *La Fornace* (the furnace), where the monastery operated a kiln using clay from the Chaotic Complex; this clay is still used for the production of the renowned *Cotto Impruneta* in the Chianti area. The bricks and tiles of the ice-house are well preserved.

ICE-HOUSES IN THE PROVINCE OF BIELLA

In Piedmont, particularly in the province of Biella, the collection and transport of ice were practised for several centuries, as evidenced by archival records which document the presence of ice-houses in the area since at least the 17th century (Oddone 2004). Ice production continued in the area until the 1930s, when the construction of industrial ice fac-

tories in lowland towns, especially Biella, led to the decline of the practice of the collection and storage of natural ice in mountain centres. Nevertheless, small depots for local consumption continued to operate until the 1950s. At Oropa, snow was loaded onto large wagons and
[414] transported downhill, mainly to the city of Biella. In other locations, ice was obtained by channelling water into specially constructed basins or by enlarging natural pools. Some of the ice-houses in the Cervo Valley are still standing, albeit in varying states of preservation. The ice, formed in the (then) perennial snowfield located on the slopes of Monte Bo, was harvested at night after being broken up with axes and hatchets and then transported to the depots. This work was primarily carried out by women, who thus supplemented the meagre household income by selling ice to lowland centres, particularly to butchers' shops and hospitals.

The village of Candelo, located at the mouth of the valley, had two ice-houses. The first was located in the *ricetto* (the fortified part of the town where inhabitants sought refuge in times of danger), while the second – still visible today, though in poor condition – lay just outside the modern town. The latter was probably modified after its initial construction for a different use. Openings were added and the structure was heightened to resemble a tower; however, the original stone structure with its low opening located on the northern façade (designed to limit the entry of heat during the summer ice harvests) remains visible. The structure is currently neglected, and the roof and part of the upper masonry have collapsed.

The village of Ronco Biellese also has two ice-houses that have been well preserved. The public ice-house, built in the 19th century inside what was once the Town Hall, is now incorporated into the Ecomuseo della Terracotta, where it is used as a storage area. Its original function is recognizable only by the characteristic opening in the roof, once used for storing ice. Although its almost continuous use as a storage space and its inclusion into the Ecomuseum ensure the maintenance of the space, the public ice-house in Ronco Biellese is not sufficiently valued as historical evidence, and knowledge of it is largely confined to local historians and enthusiasts.

A second ice-house in Ronco Biellese stands outside the town and is accessible only via a woodland path. It is situated a few steps from the Rio Pelle, the stream that was once dammed (the stone slab used for this purpose is still visible) to create a small basin used for ice pro-

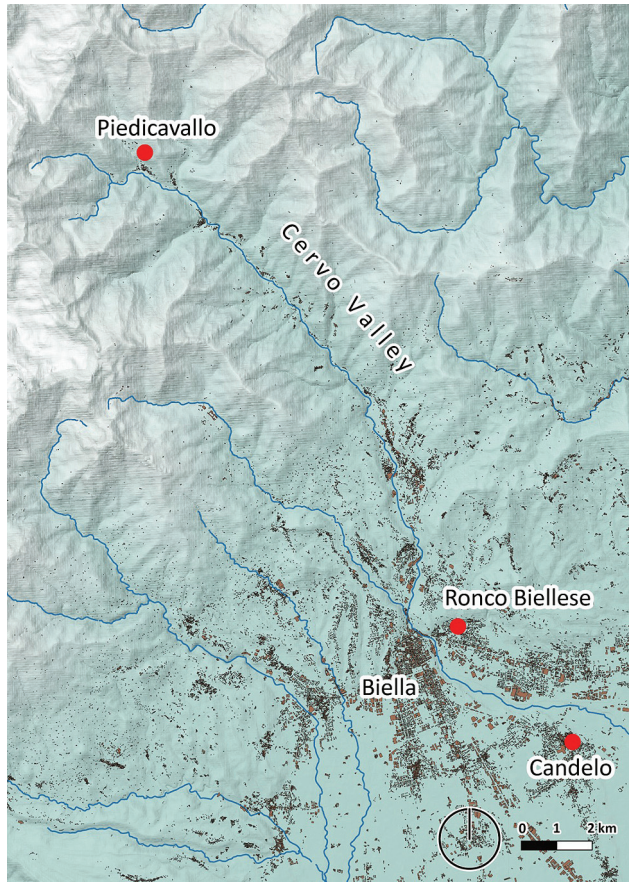


FIGURE 5

The Location of the Existing Ice-Houses in the Cervo Valley, in the Province of Biella in Piedmont (Italy)

duction during the winter months. The ice-house has a circular base with an internal diameter of approximately five metres, and the date of construction, 1886, is clearly visible on the interior surface. Despite its secluded location and the lack of signage, the ice-house is included in guided tours organised by the Pro Loco of Ronco Biellese during spring and summer. The structure is in a good state of preservation and an information near the entrance provides a brief historical account of of local ice production and trade.

The small ice-houses located outside the mountain settlements are those that have suffered the most from neglect and abandonment. The village of Piedicavallo, located at the head of the valley, contains an ice-house that appears well preserved, but is inaccessible for safety reasons due to the lack of maintenance. The ice-house, which has a hemispheri-



FIGURE 6 Ice-House in the Woods near Ronco Biellese (left); Opening in the Ice-House Ceiling (right, used to draw ice during the summer)



FIGURE 7 The Ice-House in Piedicavallo (left); A Detail of the Stone Masonry (right)

cal dome, has been informally referred to as the *panettone;* a sign identifies the structure as a *giasera* (ice-house in the local dialect). It is located in an area currently used as a car park. Its state of abandonment is particularly striking given its strategic location along the major paths ascending to the surrounding peaks. A café now stands just within the perimeter of the former ice-making basin, traces of which remain visible.

CONCLUSION

The production of natural ice during the 18th–19th centuries in the mountains of the Mediterranean region constituted a form of a genuine proto-industry that was accompanied by a vibrant trade and represented a significant source of income for mountain communities. The production and trade of ice existed in the Mediterranean region from antiquity, made possible by ingenuity and expertise that are difficult to imagine today. These activities required a profound knowledge of the

territory, as well as of the materials with which ice-houses and ice production basins were built.

Ice-houses are not only part of our tangible heritage but also embody the intangible heritage of skills, know-how, and practices that belong to the historical legacy of mountain communities. The conservation, [417]
restoration and valorisation of historical ice-houses are of the utmost importance in order to preserve the memory of production activities that, if not actively transmitted, could disappear within a few years. The most pressing issue in the conserving the memory of ice production and the ice trade is the loss of the material fabric of the ice-houses: once industrial ice production rendered traditional techniques obsolete, these structures were rapidly abandoned, leading to their existence being erased from local memory in a lot of cases.

As previously noted only a limited number of the ice-houses originally built in Piedmont and documented during the 1990's still exist. Within the area around Turin, for instance, only the Salbertrand ice-house and the two royal ice-houses in Turin, located in Porta Palazzo and beneath the Emanuele Filiberto square (Pejrani Baricco and Gatti 2004), are preserved. The rapid loss experienced over barely thirty years casts a troubling shadow over the future of these structures. This case study highlights the preservation of ice-houses located within urban centres and of larger structures dedicated to ice production for public and royal use, often aided by their reuse. A notable example is the town ice-house of Ronco Biellese which, despite its limited historical significance, has been well preserved due to its continuous use, initially as a storage facility and subsequently as a warehouse for the Terracotta Ecomuseum.

There are also numerous examples of ice-houses located in town centres, often subterranean structures built beneath noble palaces or the Town Hall, being reused as wine cellars for ageing. This process generally involves restoration and maintenance work to ensure their preservation. However, this situation is far from ideal, as the safeguarding and communication of the historical value of ice-houses rely solely on the initiative of the individual proprietors.

The structures most vulnerable to destruction are the small ice-houses intended for local consumption, situated outside inhabited areas in the high and mid-mountains. These structures are typically small, often little more than snow wells dug into the ground, with ashlar roofs rarely made to last; their transitory nature contributing to

their disappearance. Located in places that are often inaccessible and difficult to reach without knowing their exact location, these ice-houses were abandoned and frequently forgotten once artisanal ice production ceased, surviving only in local memory. Nevertheless, these structures
[418] are a precious resource for recalling the local proto-industry, still standing, in woods and forests close to inhabited centres.

Consequently, it is imperative to undertake careful documentation campaigns to preserve remaining evidence from oblivion. Georeferencing ice-houses and disseminating the resulting data would represent a fundamental step in preserving the memory of what constitutes a true ancient water infrastructure, including production sites, storage facilities, and trade routes. Guided visits that combine history and nature, such as those offered in Ronco Biellese, and itineraries like the one in the Ecomuseum of the Pistoia Mountain are effective tools for preserving the history of this craft and communicating its significance within local history. For the most forgotten ice-houses (those small structures still standing in secluded woodlands, far from the most well-trodden paths), it is particularly important to provide systematic documentation so that they may be preserved within the collective memory.

The establishment of a shared database encompassing the location and documentation of ice-houses at a national or regional level has the potential to facilitate knowledge exchange and promote community involvement. Locally-driven initiatives could successfully integrate local memory, territorial valorization, and the preservation of these structures. A deeper understanding of the history of ice-houses would allow us to rediscover an ancient means of economic subsistence for mountain communities and to preserve a craft which, although now extinct, haped the everyday lives of many generations.

DISCLAIMER

The article is the result of joint work of the four authors. In particular, Manuela Mattone is the author of the section 'Introduction,' Silvia Rescic is the author of the section 'The Ghiacciaia della Madonnina,' Fabio Fratini is the author of the section 'The ice-house in Monte Scenario,' and Giulia Formato is the author of the section 'Ice-houses in the Province of Biella.' The conclusion was written jointly.

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