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FLAT DRYSTONE ARCHITECTURE IN THE ADRIATIC BASIN

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ABSTRACT

This article examines flat drystone architecture in the Adriatic basin, focusing on low constructions and spatial shelters as former elements of pastoral economy. It describes shelter construction through the false dome and corbelling, using unshaped, found, broken, or rarely dressed stone. The study analyses how stone type affects architectural form, comparing regular structures such as the Istrian kažun with underground casitas of the Trieste Karst. It identifies walls, wells, ice huts, threshing floors, and sheep-fold systems as key forms, interpreting their roles in ownership division, animal movement, grazing protection, water access, cereal threshing, ice storage, and cultural landscape formation.

Keywords: stone, drystone, corbelling, wall, well, ice hut, threshing floor, pastoral architecture, Adriatic basin, cultural heritage

ARCHITETTURA PIANA IN PIETRA A SECCO NEL BACINO ADRIATICO

SINTESI

Il presente articolo esamina l'architettura piana in pietra a secco nel bacino adriatico, concentrandosi sulle costruzioni basse e sui rifugi spaziali come antichi elementi dell'economia pastorale. Descrive la costruzione dei rifugi mediante la falsa cupola e la tecnica dell'aggetto, utilizzando pietra non lavorata, raccolta sul posto, spezzata o raramente squadrata. Lo studio analizza il modo in cui il tipo di pietra influisce sulla forma architettonica, confrontando strutture regolari come il kažun istriano con le casite sotterranee del Carso triestino. Identifica muri, pozzi, ghiacciaie, aie e sistemi di ovili come forme principali, interpretandone le funzioni nella divisione della proprietà, nel movimento degli animali, nella protezione del pascolo, nell'accesso all'acqua, nella trebbiatura dei cereali, nella conservazione del ghiaccio e nella formazione del paesaggio culturale.

Parole chiave: pietra, pietra a secco, aggetto, muro, pozzo, ghiacciaia, aia, architettura pastorale, bacino adriatico, patrimonio culturale

INTRODUCTION: ADRIATIC BASIN

The Adriatic Sea, as part of the Mediterranean, seems to be a closed area, because all other regions lie beside it or in it – the various neighbouring countries of Europe, Middle East and Africa encircle this sea, islands are located in the middle, with strong connections between them (Balearic islands for instance) or to the continent (Greek islands), some are isolated, with their typical ancient culture (Corse/Corsica, Sardegna/Sardinia, Sicilia/Sicily, Malta). The Adriatic Sea is divided into two halves: the left side is entirely Italian, with only a few islands, from Otranto in the south to the Gulf of Trieste in the north. The right half belongs to Slovenia, Croatia, Bosnia & Herzegovina, Montenegro, Albania and Greece, the last two being near the Ionic Sea (Juvanec, 2009b). The two sides have different cultures, nations, political systems and stage of development – with an important influence of classical Rome and Venice, partially even Eastern cultures, including in the architecture of stone. Some modest economic objects are the same (threshing floor), while an extreme range of both shape and use can be found there in stone shelters.

Scientific elaboration is in this field of built art inadequate. Especially Italian side of Adriatic is professionally connected to the whole Italy, connections to the Eastern part are more or less neglected and unknown. The Adriatic basin encompasses all the countries along the coast of the Adriatic, and examples from Puglia in southern Italy and Abruzzo to the Karst on both sides of the border with Slovenia have been studied. The Slovene part encompasses the Karst and Slovene Istria and the eastern coast of the Adriatic continues with Croatia, Herzegovina and Montenegro, where the Adriatic basin ends, but similar stone structures continue on the islands of Greece.

Vernacular architecture is the fruit of unlearned, unschooled craftsmen without knowledge of theory, which is of course the foundation of science. It is about experience, which can be explained and understood today with the help of simple mathematics and geometry. Simple constructions, a drystone wall, for example, cannot be calculated, either because of the internal structure of the stone (in which completely unexpected tensions can occur and thus cause a collapse) or because of non-compact assemblies, whereby the stones are only laid together and not bound. The characteristic of vernacular drystone architecture is primarily the diversity and, in some cases, the composition of the stone, which act as demanding complexities, for example as a siphon (Juvanec, 2023). The planned scientific contribution of the article is the review, explanation and comparison of the functioning of drystone, the

effects on human work and the environment, not least on the appearance of the cultural landscape, which changes with human intervention.

Literature overview

A major problem with flat constructions in drystone is their insufficient scientific treatment. Drystone itself, and especially simple flat objects, both vertically and horizontally, are technically very modest and simple elements – except constructions of a room made in corbelling. “Elaboration of documents also shows the identification, characterisation, geo-location and dissemination of the objects of study, considered as an asset for this theme. It is important to alert and counter the tendency to abandon this type of heritage, valuing it and making it known” (Feroldi et al., 2021, 143) not only in practice, also in the theory. Such objects are even only discussed by a few scientists, starting with Rudofsky, who mentions a view of Yemen’s city as a vertical ‘cross section’, some aerial views of villages as ground plans and horizontal sketches of ‘totenhaeuser’ (houses for the dead) (Rudofsky, 1993).

Excavations of Sardinian architecture are presented by Giovanni Lilliu with a grid of the village of Serra Orios. Other architecture is shown as three-dimensional cross sections – but they are mostly corbelled constructions with inner rooms in a vertical view, for instance Sa Sedda ‘e sos Carros in Oliena (Lilliu, 2006) and – of course – some horizontal patterns on the pavements. Professor Oliver enumerates a number of types of drystone walls with vertical patterns, connecting ground level with topstones (local Italian ‘pinacollo’). In the Encyclopaedia of Vernacular Architecture, there is a special section on ‘drystone architecture’ (Oliver, 1997). In the new version of the Encyclopaedia, edited by Marcel Vellinga, this technical term is defined by the author of this book under the title ‘Drystone’.

A lot of technical details of drystone constructions in Spain (mostly in the Valenciana region) can be found in the books of Arturo Zaragoza Catalan. His drawings show stone walls, as well as wooden details for field gates (Zaragoza, 2000), walls and even a bridge. In relation to the anthropological concept of material culture, Amerlinck derives hypothetical sources in plane groundplans for the spatial organization of settlements, nest-building behaviour, semantic architecture, domestic (vernacular) architecture, up to systems with controlled fire – from the Miocene to the Bronze Age – but only as a schematic grid (Amerlinck, 2001).

The most interesting constructions can be found in Koprivec’s work about walls and pavements on the island of Korčula. She mentions Roman influences in the composition of the walls as real ornamentation

in the wider rural environment – also as vernacular architecture. The variety of both shapeless and hewn stones in controlled compositions is amazing, on the vertical walls and horizontal pavement. This decoration can be also understood as both construction and artistic work, with the use of a necessary order of proportion, a grid (Koprivec, 2006).

The main problem of this insufficient scientific elaboration of these modest realizations and their simplicity is contained in a simple statement: the simplest realizations are the most useful, effective and also the most beautiful compositions in both senses: constructional and artistic. The simplicity of existing flat constructions (still in use after some thousand years), has to be documented and scientifically elaborated for future generations.

Methodology

Drystone seems to be a very simple and modest architectural construction but is not. There are numerous static problems, the use of natural materials with their characteristics, the composition of detail, the object and placing the object in the environment, as well as heritage with its own demands within the framework of culture. The multidisciplinary nature of the problem has to be considered, with diverse objectives and outcomes, needing a range of research methods. Several methods were used in the investigation of this important heritage, mostly historical, comparative and, finally, analytical. Geometrical and symmetrical theory is also very important, because of its order, which must be used when building in drystone, without any cement or mortar (Juvanec, 2009a).

An explanatory approach was used, rooted in prior research of the field. The article investigates an interesting amalgamation of the selected scientific fields, explaining significant and valuable technical data, especially in comparisons between materials, their use, shape and results in architecture (Benko & Benko, 2023). Only a single method could not be successful.

CONSTRUCTIONS: A WALL AND CORBELLING

Drystone allows only two construction principles, in a flat surface as a plane and in composing a usable space, a room. A wall can be composed of stones in the width of a single stone element or can be several metres wide, with two vertical constructions, filled with rubble in between. A single wall needs to be constructed very carefully, bigger walls allow the builders more simplicity but the stones must be bigger, heavier and need much more strength from the workers, it is really heavy work. The basic principle of a wall is composing elements next to each other,

with all vertical connections covering the lower layer. A wall needs a good base, body and covering. This covering can be appropriate for walking on (people or insects, lizards) or for preventing passage over it, with vertical plates or pointed stones, which obstruct crossing visually and practically.

Corbelling is more demanding but allows more: while a wall divides, corbelling composes a room, usable for sheltering (Rovero & Toniatti, 2014). Corbelling requires horizontal layers of stones, which overlap each other right to the top of the construction. In groundplan, corners and the problems associated with them are avoided with a circle but, on the outside, the composition can be completely unique: semicircular, pointed, stepped, with a pronounced roof, with stresses or without them. Only one topmost shape is possible in the construction: corbelling creates a false cupola. Such objects can be found on both sides of the Adriatic, from north (Guacci, 1982) to south.

Corbelling is gradual overlapping that is repeated from layer to layer, in height all the way to the capstone. Experience suggests that the ideal internal height of a construction is $\sqrt{3}/2$ of the diameter of the base plus the thickness of the wall (Juvanec, 2013). The composition of a shelter has three elements: corbelling as the supporting construction, an external frame, which leads off water, and weighting elements of the corbelling as a counterweight. In between is a filler, which fills and with volume gives weight to the composition itself.

Objects thus occur in which the corbelling and frame are almost combined, as well as those in which they are completely separate. In ground plan, corbelling is a construction of horizontal circles, and in cross section of overlapping layers. This construction does not affect the shape (Juvanec, 2008). However, three constructional elements can be observed: corbelling – the construction itself, the frame and the filling (gravel) between them.

The square root of three is the height of an equilateral triangle, if the baseline is equal to two. The diagonal of a square with baseline of one is equal to the square root of two. The mathematical order, or rule, of such rectangles (one to the square root) is that the diagonal of a rectangle is one number higher than the number under the square root of the baseline. So: a rectangle with baseline (square root of two) and height (one) has a diagonal equal to $\sqrt{2} + \sqrt{1}$. This is $\sqrt{3}$ (Juvanec, 2024).

The external shapes of objects can be completely different; in the case of the Adriatic basin they can be seen as a simple underground shelter in Carso Triestino (Juvanec, 2024), without any outer shape (only a heap of soil is visible), while trullos in Puglia/Apulia compose complete homesteads and even towns (Alberobello, Locorotondo and Martina Franca).

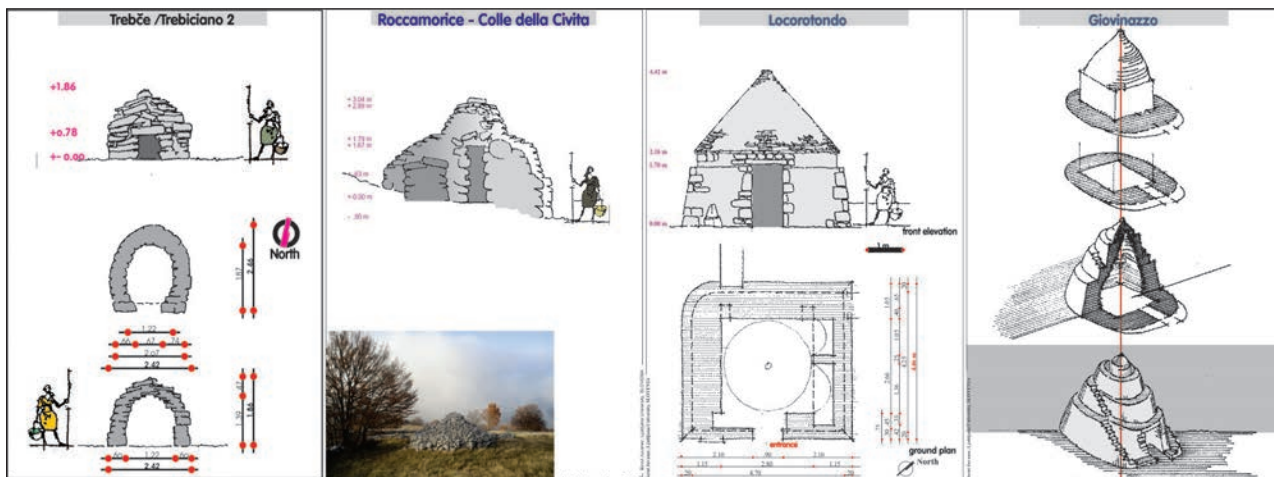


Figure 1: Italian side of the Adriatic: corbelled constructions casita, capanna and trullo (Source: B. Juvanec).

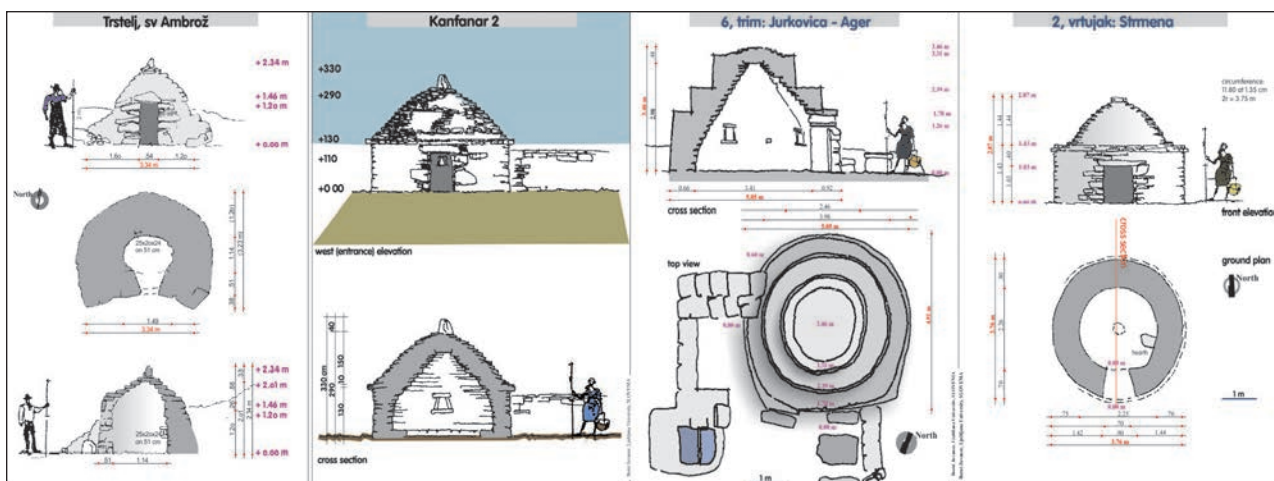


Figure 2: Shelters in corbelling, eastern side: hiška (Slovenia), kažun, trim, vrtujak (Croatia) (Source: B. Juvanec).

A wall as a basic element of vertical construction

Technically, a wall can separate different types of pastures, places of different ownership, one flock from other, safe and dangerous areas, important places in the environment. A wall can connect two separate economies, different flocks to a water source or several ownerships into organizational clusters. Walls are extremely important for small animals such as insects and lizards, because they connect their living spaces. A wall can direct people and livestock from one point to another, it can keep together groups of walkers or animals on a track or direct individuals to a desired object (water source, home). Some ‘roads’ can be of an enormous width, up to fifty metres. A wall can protect one part from another, such as dangerous slopes or abysses, in limited circumstances also against wild animals. It can

mark, organize or emphasize important items in nature. For all these various purposes, a wall must be of various constructions, heights or widths, special constructions are needed for particularly threatened animals, such as holes for rabbits, passages for boars; even for people there may have to be stairs, narrow passages or other special features. A wall can capture water, redirect it or facilitate its use for irrigation. All the purposes of walls form them, as well as depending on their origin, properties and shape. It is very simple to construct a wall with flat stones of the same width; difficulties start when stones found on a pasture are used.

Walls are a very important part of the built environment, changing it, but with important reasons: they are needed and are useful. The most interesting are walls in Dalmatia, where they can be seen on the slopes, separating and organizing the agricultural economy. A wall on sloping terrain is especially important, where

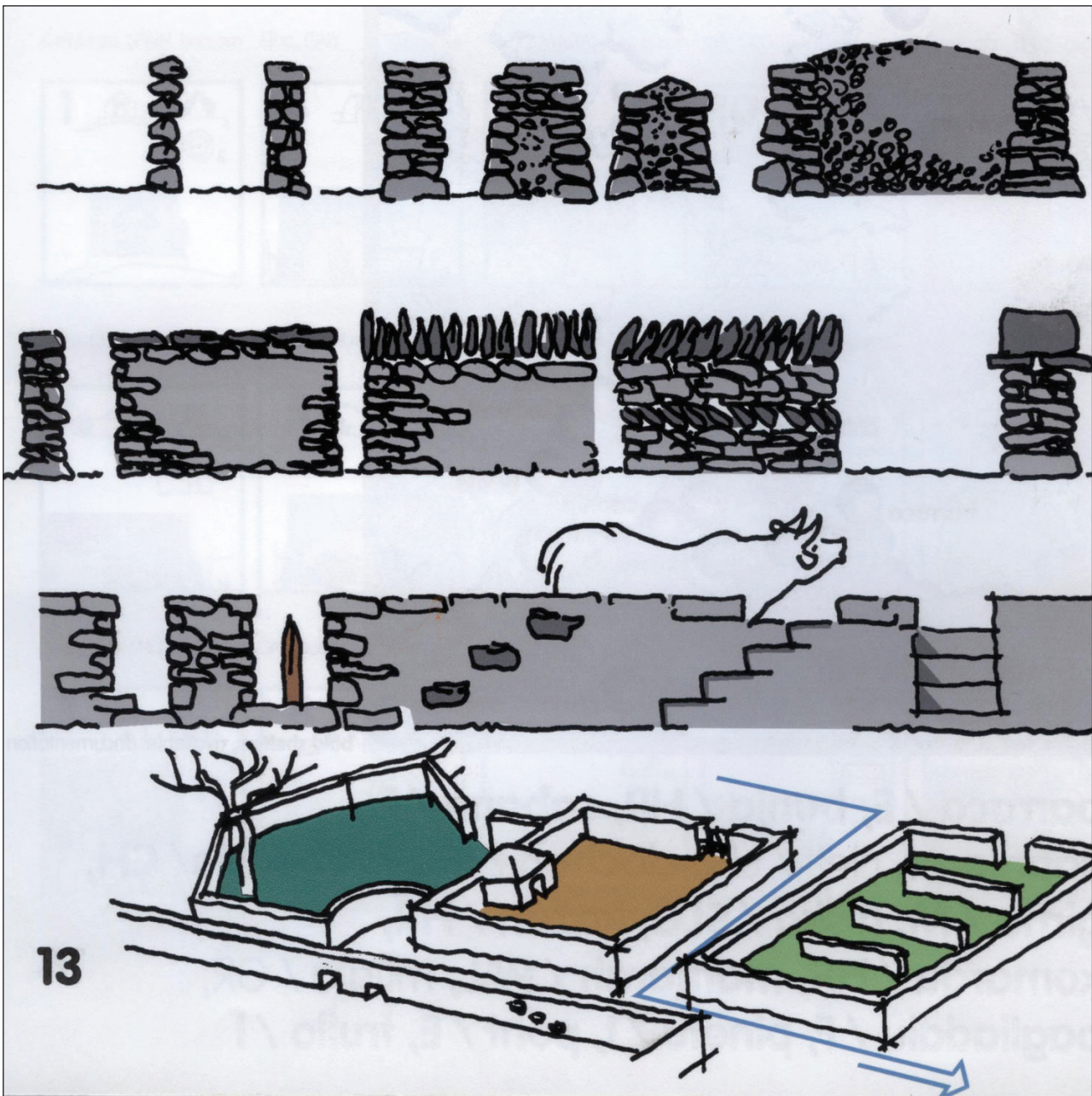


Figure 3: Different types of wall: a/ different widths are needed; b/ coverings serve different purposes – just for protection of the construction or also for using the wall as seats etc., preventing passage over it etc. (Source: B. Juvanec).

it levels the terrain and retains water for watering trees and other cultivated plants. The permeability of the wall is of great importance: dense walls are unstable because of the extremely large stresses of retaining water. Drystone, with openings between the elements, is a perfect solution. Stone can also be useful in producing energy, where the walls direct or retain water for driving waterwheels, which are connected to mills, as well as to power stations (Juvanec, 2023) and for irrigation (Juvanec, 2016b).

Stone – as an ‘eternal’ material is also used also for religious purposes. Niches and complete objects can be built in stone, with a construction covered by a simple lintel or with corbelling (Juvanec, 2017a), but statues or pills are more common. well-known from history. In contrast to classical buildings, palaces, manors and castles (Benko & Benko, 2023), such monuments are simply built, although located in important places. Where water is rare and is a matter of survival, a well can be an object of



Figure 4: This incredible type of wall in single construction, called a 'unjulica' (single wall), on the island of Cres separates flocks and protects them from unsafe areas. It is permeable but also resistant against strong winds. It doesn't use a lot of material for a massive construction, which cannot be found there (Photo: B. Juvanec).

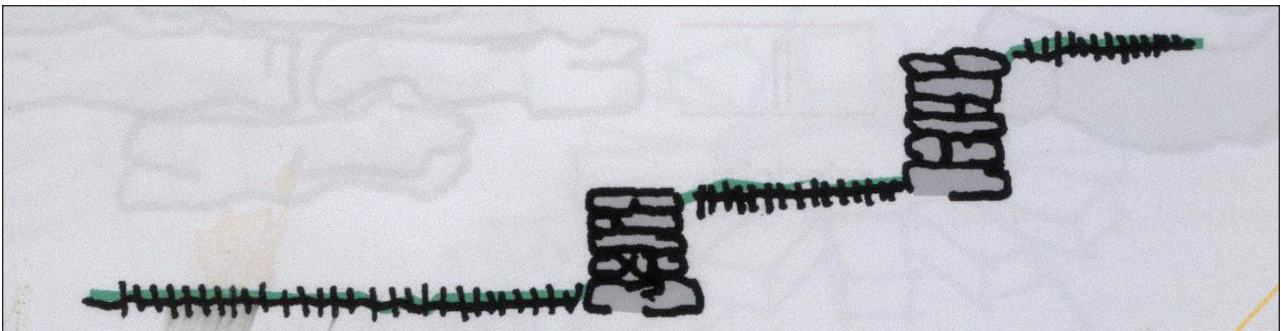


Figure 5: A 'škarpa' is a retaining wall in Slovenia, which holds water for better cultivation (Source: B. Juvanec).



Figure 6: The shade of a wall offers good shelter, but at noon there is too little for herdsmen. The combination of a niche and the wall's shade is good as a modest shelter (Source: B. Juvanec).

vention – such as in Sardegna/Sardinia (Sardara, Sant’Anastasia’sacred well’; Juvanec, 2015). Such objects cannot be found on this side of Italy.

A niche is also an element of a wall: primarily used as a storage place for food and drink, needed while watching grazing animals. It is cold, a perfect place for storage, but in bigger dimensions can also be used for sheltering from the sun. This is the first step of composing a shelter.

Depository constructions

The basic structure for a stone depository is a wall. Stone is unsuitable on the pasture: it heats up in the sun and radiates warmth a long time after the sun is gone, this is bad for vegetation, which leads to miserable fodder, the pasture is less effective. It is also dangerous for the animals’ feet, which can be injured there (Juvanec, 2013). A pasture full of stones is unusable. Stones have to be cleared from green areas and deposited. This depositing can be done by discarding the stones, by making a heap, but uncontrolled stone returns in time to the surrounding terrain. For the effective clearing of grazing place, all heaps must be constructed into a wall or into freestanding constructions, with all the necessary principles of composition, with a foundation, body and cover. Such compositions in Slovenia are called ‘griža’ or ‘grublja’, like ‘le clapas’ in France. They can also be found in Herzegovina near ‘poljarice’.

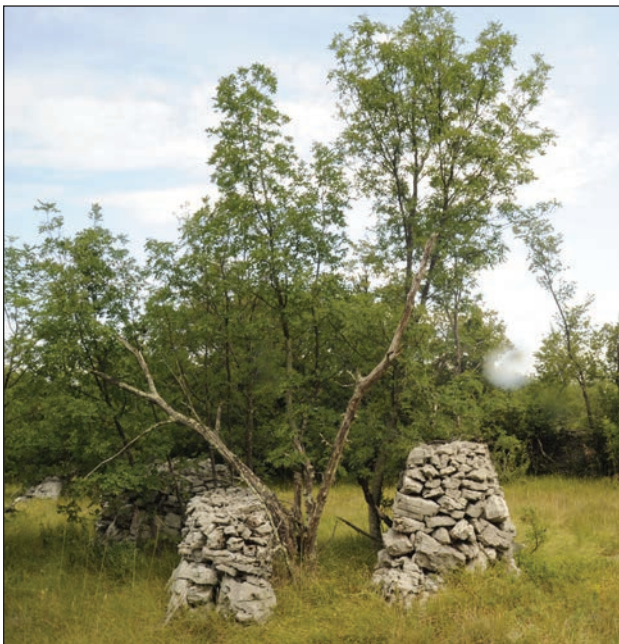


Figure 7: ‘Griža’ or ‘grublja’ on the Slovene Karst (Photo: B. Juvanec).

Threshing floor

A crop of cereals has to be threshed for use: the chaff must be separated from the grain. This can be done by humans with a ‘cepec’ (a flail, two connected sticks for beating by hand) in Slovenia or with the help of animals (cows, oxen or donkeys), which are connected by a rope to a central pole. The cereals are threshed by the animal walking round. The threshing floor is made of a paved circular floor with an outlet for water, which also serves for self-cleaning by rain.

The most important thing is the location: after threshing, the chaff must be separated from the grain. The wind is used for this purpose: men raise both chaff and grain up into the air, the wind pushes the chaff (which is lighter than the grain) off the floor – and pure grain remains on the ground. Not only a location with wind is important; this can also be achieved by raising the entire construction, for catching the stream of wind that can normally be found some metres above the ground.

Pond and well

A well is a device for catching underground water or collecting rain. A natural karst pond is great for thirsty animals. The funnel collects water from an extended area and the water stays there until the rainy season. Artificial ponds, encircled by drystone walls, are needed for wider use. It has a natural,



Figure 8: Freestanding constructions for depositing stones from a pasture can be seen in a wall in Herzegovina near a ‘poljarica’ (Freudenreich) (Photo: B. Juvanec).



Figure 9: An 'aia' in Puglia is normally located near to the homestead (Photo: B. Juvanec).

circular shape and the narrow access is designed for control of drinking.

The simplest system is a vertical wall around a shaft, some metres in diameter and a staircase to the bottom. The basin collects underground water as well as water from the environment: the stones in the wall are inclined towards the inner part and water can flow into it (Juvanec, 2017b). Wells with groundwater have no need to be covered; where water is scarce, a cover is good, is valuable and is needed as protection against evaporation.

In sloping terrain, a basin can be built in corbelling, with access by stairs from ground level. Where there are no natural water sources but water is needed for animals and the herdsmen, the only solution is rain. On the island of Krk, on the mountains above Baška, there is a series of self-sufficient wells. They have a basin and a drystone construction as the roof. The entrance is narrow and only allows use by people – uncontrolled use by animals could affect it for years. The most important part is the roof: it is made of stone plates and water can enter the basin at its edge. The water is retained from one rainy season to another, because of the massive construction, and

the basin, deep in the ground, keeps the water cold and healthy. The same system, but bigger in both construction and use, can be found on the slopes of Lovćen mountain.

The most suitable system, with easy use where water is needed, is the underground system in Puglia. The trullo construction, as a homestead, has a kitchen, living room and sleeping room. The reservoir is under the kitchen, with a direct vertical connection. Water can be obtained by a bucket on a wire or chain close to the fireplace. Water is very important for our lives and drystone constructions allow a series of different solutions to collect, obtain and use it.

Watermill

A watermill is connected to the active use of water, with movement. The building of a watermill is normally stone, because of its higher bearing capacity and especially because of the vibration during work. The waterwheel, normally constructed in wood, is turned by a water current, which is led by a stone or wooden channel. Horizontal turning has to be converted into vertical

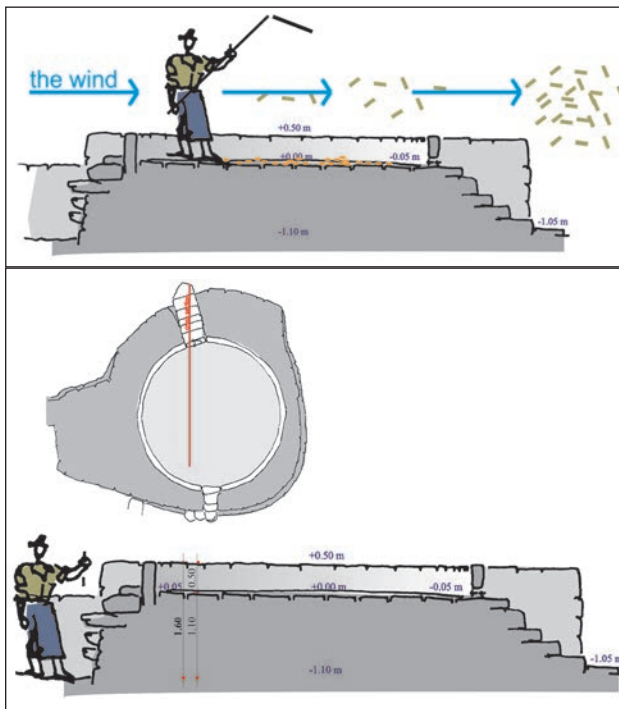


Figure 10: On the island of Krk (Croatia), all threshing floors are at least one metre above the ground, catching stronger wind (Source: B. Juvanec).

with wooden cogwheels, because the millstones turn horizontally, with a vertical axis.

Small watermills are driven by fast streams with a smaller amount of water, with an overshot system, where the current jet comes to the upper side of the wheel. An undershot system can be used on the bigger stream of a river, which flows more lazily but has more power, turning several wheels. A waterwheel with a vertical axis is used with an extremely powerful jet, by which the waterwheel becomes almost a turbine – as in bigger power stations. This type of watermill can be found in Bosnia and Herzegovina and in southern Croatia.

A very special, exceptional system was used in the Popovo Polje area, where the river Trebišnjica only flows through the valley twice a year. Normal systems cannot be used, because of the extremely different water levels. ‘Mlinice’ are built as vertical stone cylinders, located far from the riverbed. At high water flow, the water comes above the entrance to the mill, which is built inside (Juvanec, 2016b). The most important thing is the location of the mill: it stands above a karstic sinkhole, where the water disappears into the earth. The oldest, still existing have a wooden waterwheel.

In an extreme situation, when from time to time the water outflow becomes an ‘estavelle’ (outflow that changes its direction and – after a time - throws

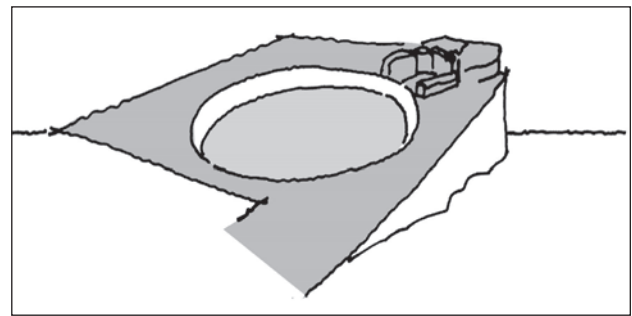


Figure 11: On sloping terrain the threshing floor can be raised above the ground – for catching the wind (Gornja Lastva, Montenegro) (Source: B. Juvanec).

water out of it), the mechanism uses both directions of drive. Only a few of these unusual mills can be found there today, but some decades ago they were in use, with mechanisms in cast iron, made in Vienna or in Ganz factories in Budapest.

Ice hut

An ice hut is an architectural solution for storing ice, which was already used in Mesopotamia and Greece in the classical period and was particularly widely appreciated in the Middle Ages for both comfort and health (Acovitsioti Hameau, 1996). The first possibility is an ice cave, generally an excavated chamber, since this provides the best insulation from the heat. The walls are covered with stones, with openings used for placing the ice in and taking it out. The roof was initially made in corbelling, later an arched frame construction, a dome and, finally, a classic wooden carpentry roof thatched with straw. Horizontal caves used as ice caves can be found in Slovenia only in its north-eastern part (Benko & Benko, 2023). The large population of the historical city of Trieste/Trst needed a lot of ice for comfort, health and keeping fish fresh. Its surrounding, the Karst plateau, some hundred metres higher, with harsh weather conditions, was perfect for this economic activity.

An ice hut is in principle a vertical cylinder with walls sloping towards the bottom, with a staircase and a roof. The staircase can be made in stone or wood. A corbelled construction in stone such as those in both Spain (Boira i Muñoz, 2012) and France was unknown in Slovenia (Juvanec, 2018).

In France, ice production was a very successful economic activity from the 16th century (Acovitsioti Hameau, 1996) near Pivaut, Mazaugues in Provence, later also in Spain (Boira i Muñoz, 2012) in Pou del Surdo. This economic activity was alive in Slovenia until 1962. Export from Trieste/Trst to Egypt stopped after the First World War (Juvanec, 2018).



Figure 12: Karst pond in stone, Basovizza/Bazovica, Italy (Photo: B. Juvanec).



Figure 13: Lokvica in the Slovene language means ‘a small pond’: the well is about five metres deep, but in 2012 was without any water (Photo: B. Juvanec).

‘Naplov’: collection area for water

‘Naplov’ is the local name for a stone platform that collects water in dry regions of the island of Hvar, Croatia (Bodrožić et al., 2016). Technically, this device is very simple: dry soil absorbs water immediately, but water is of crucial interest for living people, animals and plants. The paved area

is not only horizontal, it consists of a flat surface, in one corner it is shaped as a funnel – for water to flow into an underground cistern, on the other it also collects water with sloping surfaces high above the basic surface – for catching water when it is raining with a strong wind, when the rain is almost horizontal. This is oriented toward the most frequent wind. Every drop of water is of great importance for life.

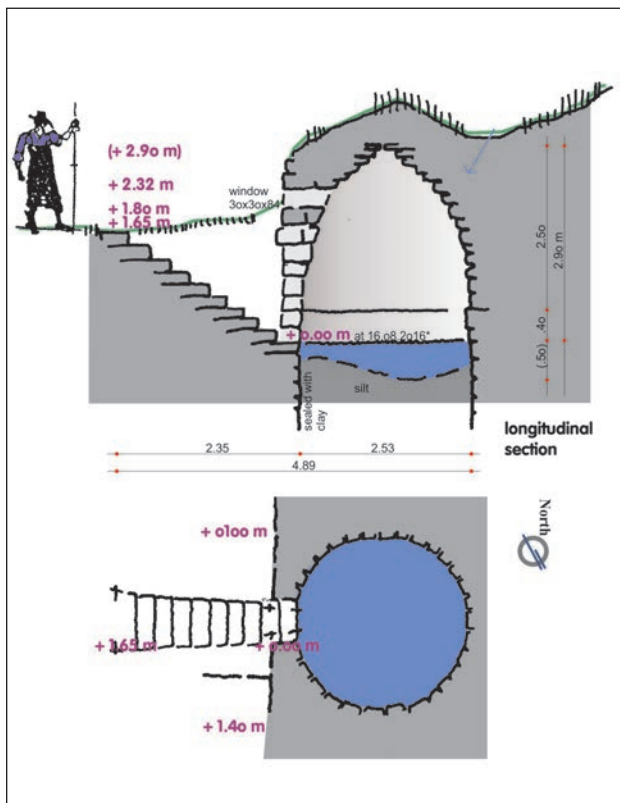


Figure 14: ‘Škedenc’ in Zabavlje, Slovene Istra/Istria is a well with underground water on sloping terrain (Source: B. Juvanec).

‘Mošuna’: sheep pen

With natural breeding, sheep live free in the open air, but if they have young or a hut is needed, a ‘mošuna’ on the island of Krk is a really perfect solution. The stall is built in drystone with a wooden construction of the roof, which has two central posts. The roof is thatched with dry ‘travina’, a sort of local grass. Weather conditions are harsh: in summer it is hot, in spring and autumn it can be extremely cold, because of the wind. The sun shines all day and shade is needed. The roof’s cross section is the most important aspect. The two parts of the roof can be seen, with no ridge, with a width of about half a metre. The sun’s rays are welcome but in limited amounts only. The gap between the roofs allows only limited sunbeams, enough for the first hours in the morning, while all day it is in shade. The roof is the most important, its inclination allows hot air to exit from the interior. This is a sort of natural air conditioning: the sheep have insulation, shade and a bearable climate.

‘Mrgari’: sheepfold, organization walls

Transhumance was an economic activity of great importance years ago, from daily grazing, seasonal transhumance to nomadic moving of whole



Figure 15: The reservoir is cut into the ground under the kitchen. Water is collected from the roof of the living and auxiliary parts of the homestead in Puglia (Masseria Maccherone near Alberobello) (Photo: B. Juvanec).

tribes. The most important object for transhumance activity is a stone shelter, a well-known building in drystone, constructed in corbelling as a false dome (Juvanec, 2016a). Such shelters can be found all over the world, including on both sides of the Adriatic. On the Italian side, it is a casita in Carso Tiestino, a capana in Abruzzo and a trullo in Puglia/Apulia. On the eastern side, there are several objects, called hiška in Slovenia, kažun, komarda, bunja, trim, vrtujak and kućarica in Croatia and poljarica in Herzegovina. 'Mrgari' is an object for sorting the flocks after grazing. It is composed of a funnel for directing the animals into the great hall, where the owners select the sheep and direct them

to individual cells. After selecting and control, the sheep are free to go back to the pastures or – after the final control – home.

The local transhumance economy is still alive, but in negligible quantity. Local ethnic festivals are organized each year when the flocks return from the high pastures, such as 'faericha' in Belalp in the Bern Alps, Switzerland. In Slovenia, such festivals are numerous, for flocks of sheep and herds of cattle in Jezersko and Bohinj, such as the 'Cow Ball' (Juvanec, 2022). Mrgari are not the only existing system, similar objects can be found in Wales GB, 'rettir' in Iceland (Juvanec, 2024) and 'schaeful', 'faericha' in Belalp, Switzerland.



Figure 16: The construction of the milling system is all in wood, while the building construction is all in drystone (Mazurin's watermill in Slovene Istra) (Photo: B. Juvanec).



Figure 17: Wooden propeller used as a turbine for a mill in Konavle, Croatia, still in use. The same can be seen in Popovo Polje in Herzegovina, BiH (Photo: B. Juvanec).

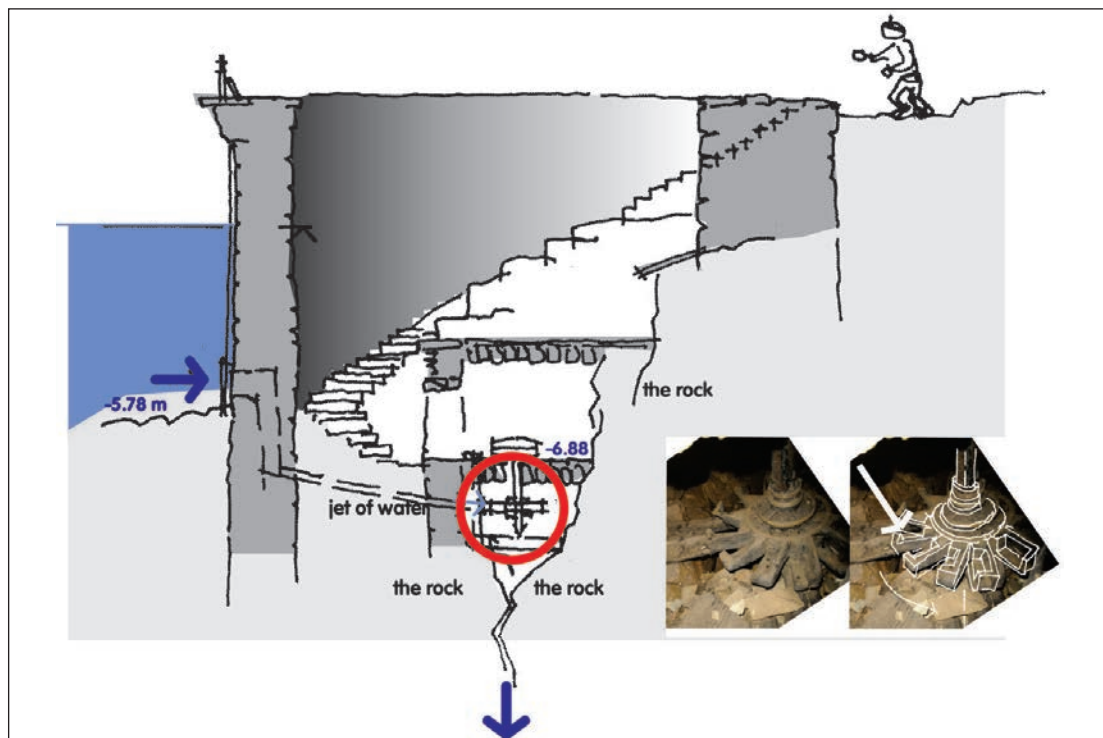


Figure 18: Cross section of watermill in Popovo Polje, BiH. At high flow of the Trebišnjica twice a year, the water comes very high, which can drive the turbine (Source: B. Juvanec).

CONSIDERATIONS

Scientific excellence in vernacular architecture is manifested in the diversity and comparisons of construction designs that enable the widespread use of simple principles, even for the most demanding constructions. These need to be seen, recognized and understood. The scientific contribution of the article is thus confirmation of a review of the diversity of stone constructions in the wider area of the Adriatic basin, an explanation of their functioning and the impact of stone constructions on the environment, and especially on human survival since prehistoric times, which historical solutions confirm by both their existence and their functioning. In the past, people understood only the functioning and results, an example of which is the use of sunlight for religious purposes to create a miracle (Pozzo Sacro di Santa Cristina in Sardinia). Today we can recognize the functioning, analyse it and understand it not just as a result, but also as a complex composition.

There are interesting other examples from history: the Treasury of Atreus, for example, is built in corbeling – unbound horizontal layers of stone and forming a space with a height of just under 15 meters. The structure was built in 1500 BC and is still standing after more than three and a half millennia

(Oliver, 1997). Today, despite all the digitalization and theories of construction and the scientific excellence of some sciences, buildings collapse much earlier. In this case, theory and practice do not understand each other very well.



Figure 19: Kačiče icehouse has a magnificent column in the middle, as a support for the cone-shaped carpentry roof, covered with clay tiles. The icehouse was in use in the sixties of the last century, today it exists only as a relic of the former successful economic activity (Slovenia) (Photo: B. Juvanec).

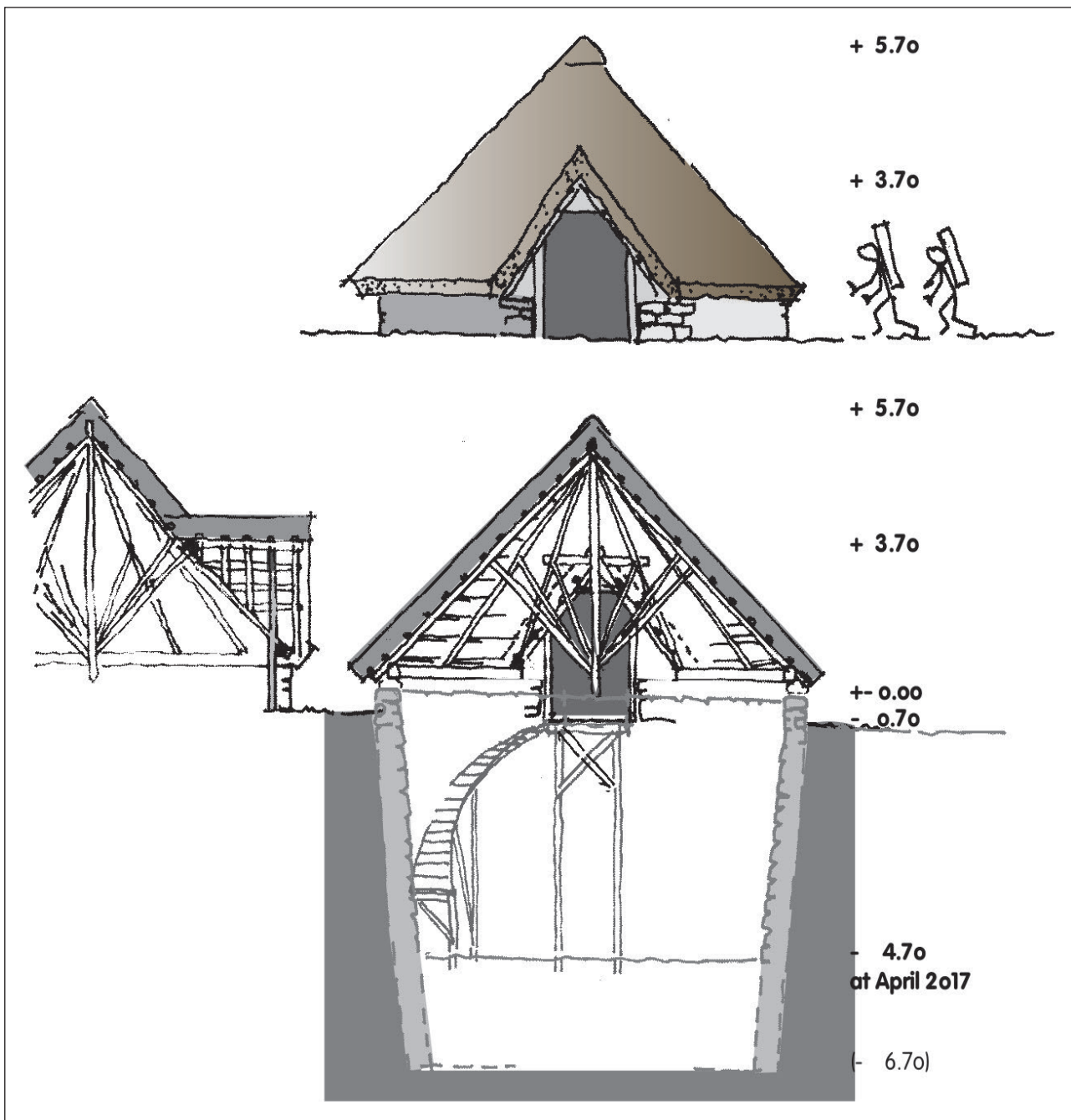


Figure 20: Reconstruction of an ice hut in Vrhovlje, Slovenia. The reconstruction was done by a local lady as a memorial to this economic activity of her father (Source: B. Juvanec).

Architecture is a technical science and uses technical language with short sentences, as concisely and simplified as possible, in contrast to the language of the sociological sciences or even philosophy, for which the language must be particularly rich in vocabulary. In the technical sciences, action is more important than theoretical description. In order to understand even the simplest solutions,

scientific processing is necessary, since stone structures appear in the construction of buildings, in the organization of operations (transhumance), in enabling agriculture and fruit growing (scarps) by increasing cultural areas, in arranging and protecting the environment even in the most problematic cases and, in the design sense, these are artistic changes to the environment that prove man's contribution to



Figure 21: A 'naplov' can be several metres high; its surface can be some hundred square metres, island of Hvar, Croatia (Photo: B. Juvanec).

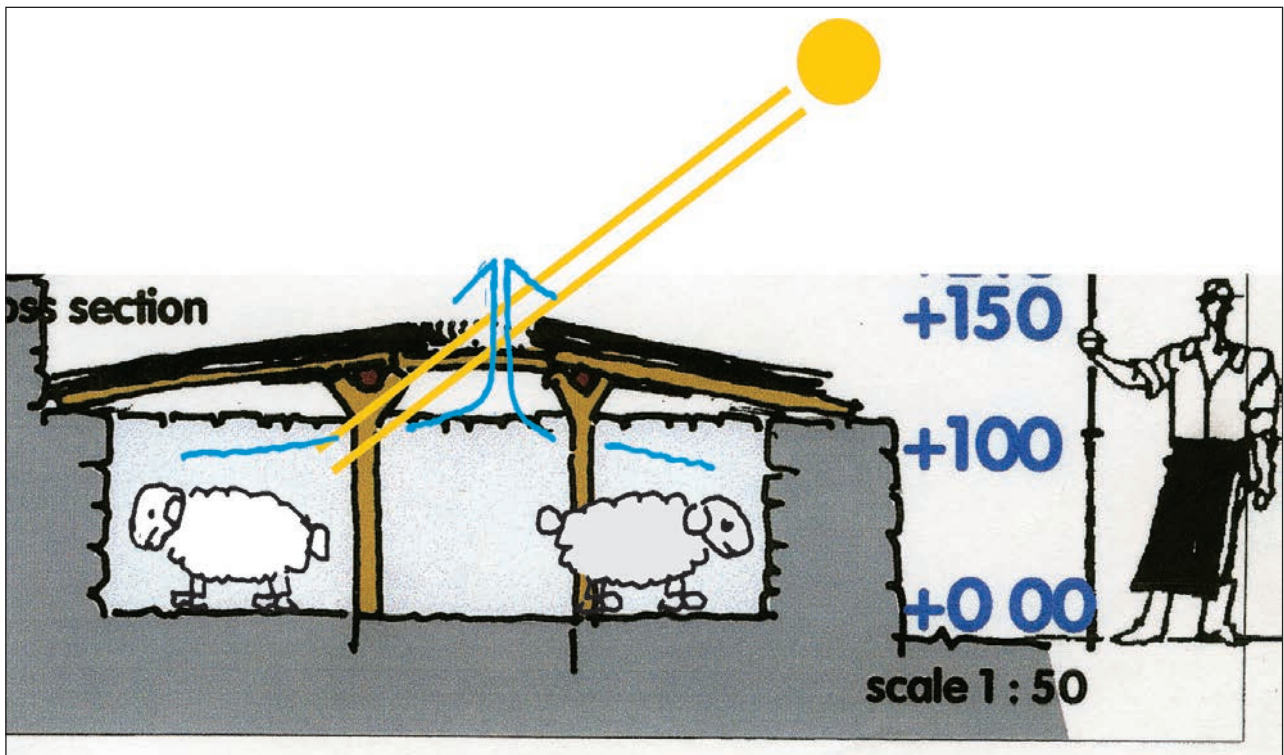


Figure 22: 'Mošuna', the cross section shows the construction and its use – sheep need shade, limited sunbeams and more or less cold air. The slopes of the roof lead warm air upwards until the missing ridge, where it exits (Source: B. Juvanec).

arranging it in ways that are crucial, even for the survival of both humans and animals. The contribution of science in this is the recognition of both the static and dynamic functioning of elements whose components are stone.

CONCLUSIONS

The main contribution of this article is a review of numerous objects, closely connected to old economies, which are today mostly abandoned, forgotten and neglected. These are mainly (in both number and type) walls that separate and connect different areas, lead or block, indicate ownership or danger, serving as paths (people) or places for biotopes (insects, lizards, rodents). The construction follows the type of material, stone: the simplest (loose stones found on grazing places) need a higher level of skill and knowledge, broken strata of stone enable complex compositions. One aspect should be mentioned: the builders of drystone objects were all simple herdsmen and shepherds without schooling and without special tools. It is important to note that many drystone constructions still exist after centuries of use. Knowledge of this type of vernacular architecture is today of great importance for both laic and professional audience.

The explanation of the stone's origin, its construction, use and the role of stone in our history as an important part of the cultural environment is important for our heritage, both the history of architecture and new building techniques today. All new materials: concrete, steel, glass and plastic materials have been developed from natural sources, but with the highest knowledge, techniques and technologies. A comparison between some identical objects shows the skills and intelligence of builders, who found natural material, stone, understood the possibilities and built functional compositions with an important role for their survival. Something else must be mentioned: all the stone constructions in the natural environment are the artificial work of men but are built in such a way that the changes brought by human intervention are smart and have become part of nature itself.

The most important and most numerous objects for transhumance are drystone shelters with a false dome construction, designed for herdsmen, but other elements in stone, composed as flat constructions, both vertically and horizontally, are interesting. Some of them are an aid during work, others provide possibilities for living – for instance, to name only a few of them: water collectors, wells, watermills, irrigation systems. Some of them are common throughout the stony world, others are local, because of individual use or natural opportunities of materials and weather

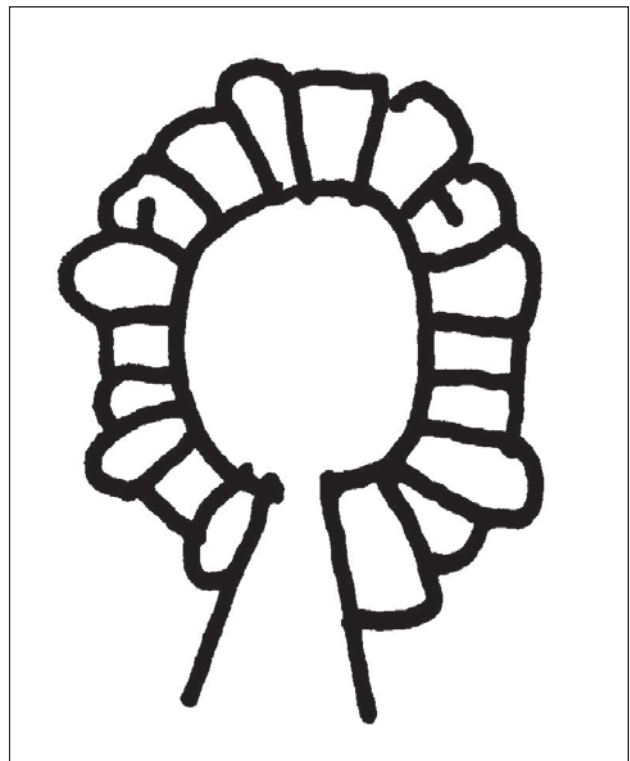


Figure 23: The principles of a 'mrgari': the funnel, great hall and individual cells. The totality seems to be a real flower (by Horvatić, 2000, 82: B. Juvanec).

conditions (Oliver, 1997). 'Priority the actions of ordinary maintenance, reconstruction of damaged portions of the walls and cleaning are considered' (Agnoletti et al., 2015).

Nature offers numerous possibilities; with some examples it also teaches how to build, to use or compose objects that are needed for everyday living and working. Stone, as a natural material, is found and used in its own environment, it is a part of it and changes made by the users are not disturbing. Its technical characteristics help a lot in obtaining it, elaborating, building and use. It is a heavy material and objects are built near to its source. This is very important because of a modest carbon footprint and the use of simple tools by local masters. The biggest problem is quarries: they wound nature both during operation and after use.

The Adriatic, on both sides of the sea, seems to be a small appendage to the Mediterranean but is not, because of its history and preserved elements of human culture, especially in stone. It is an important part of Mediterranean culture, also in drystone. It is not unimportant that UNESCO recognized drystone as important world heritage (UNESCO, 2018) by entering it into the List of the Worlds Heritage. 'The abandonment of drystone constructions is placing rural zones at risk, as they assume a strategic role in environmental conservation



Figure 24: 'Mrgari' on the mountains above Baška on the island of Krk, Croatia (Photo: B. Juvanec).

efforts – as highlighting importance of safeguarding this cultural heritage' (Jimenez de Madariaga, 2021, 270). The same is important for the professional scientific work of specialists in this field. Some of those objects can be understood as real technical innovations, which could also be used today.

The culture of the Adriatic countries is very seldom elaborated in common, because of the history,

geographical differences, political systems and unpleasant schism between 'West' and 'East', which also splits its culture. Concerning this problem it is very clear: the Adriatic basin has a rich culture, especially in its differences, mostly because of the stone, in classical, artistic and vernacular architecture, but needs more scientific elaboration and coordination between professionals of the kind.

PLOSKA ARHITEKTURA SUHOZIDA V JADRANSKEM BAZENU

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POVZETEK

Prispevek obravnava plosko arhitekturo suhozida v Jadranskem bazenu, pri čemer se osredotoča na nizke oziroma talne konstrukcije in prostorska zatočišča kot pomembne sestavine nekdanjega pašniškega gospodarstva. Namen prispevka je opredeliti glavne oblike suhozidne gradnje, pojasniti njihove konstrukcijske značilnosti ter interpretirati njihovo vlogo v kulturni krajini. Posebna pozornost je namenjena zatočiščem, ki so bila zaradi potrebe po zaščiti pred dežjem, snegom, mrazom, vetrom in pogledi oblikovana kot prostorski objekti. Njihova gradnja temelji na nepravi kupoli oziroma korbelingu, pri katerem se vodoravne plasti kamna postopno prekrivajo. Tak način gradnje omogoča izvedbo brez podpor in gradbenih odrov ter uporabo neoblikovanega, najdenega, lomljenega ali redkeje klesanega kamna. Analiza kaže, da vrsta in oblika kamna pomembno vplivata na arhitekturno zasnovo, kar je razvidno iz primerjave med pravilneje oblikovanimi kažuni v Istri in podzemnimi casitami na Tržaškem krasu. Prispevek obravnava tudi zidove, vodnjake, ledenice, gumna in mrgare kot značilne oblike ploske suhozidne arhitekture. Njihove funkcije so povezane z razmejevanjem lastništva, usmerjanjem živali, varovanjem čred, dostopom do vode, mlačvijo žita, shranjevanjem ledu in organizacijo pašniškega prostora. Obravnavani objekti so interpretirani kot materialni izraz nekdanjih gospodarskih praks ter kot pomemben del kamnite kulturne krajine Jadranskega bazena.

Ključne besede: kamen, suhozid, korbeling, zid, vodnjak, ledenica, gumno, pašniška arhitektura, Jadranski bazen, kulturna dediščina

SOURCES AND BIBLIOGRAPHY

- Acovitsioti Hameau, Ada (1996):** De neiges en glaces. Brignoles, Cahier de l'ASER.
- Agnoletti, Mauro, Conti, Leonardo, Frezza, Lorenza, Monti, Massimo & Antonio Santoro (2015):** Features Analysis of Dry Stone Walls of Tuscany (Italy). *Sustainability*, 7, 10, 13887–13903.
- Amerlinck, Mari-Jose (ed.) (2001):** Architectural Anthropology. Westport, Praeger.
- Benko, Andreja & Tajda Benko (2023):** Rakičan Manor as a Monument of Prominence in Time and Space. *Podravina: časopis za multidisciplinarna istraživanja*, 22, 44, 33–51.
- Benko, Andreja & Borut Juvanec (2020):** Ledenice Lendave – Lendva Jegvermei. Lendava – Lendva, Občina Lendava – Lendva Község.
- Boira i Muñoz, Pascual (2012):** Les neveres de la provincia de Castelló. L'ús i el comerç de la neu a les comarques castellonenques. Ares del Maestrat, Ajuntament.
- Bodrožić, Siniša, Bubalo, Filip, Frangeš, Grga, Renić, Miše & Filip Šrajter (2016):** Gradimo u kamenu. Split, Slobodna Dalmacija.
- Feroldi, Ada, da Silva, Elisa & Marta Marçal Gonçalves (2021):** Drystone Walls in the Algarve, Portugal. Characterization and Interconnection with the Geology and Lithology. *IOP Conference Series: Materials Science and Engineering*, 1203, 2, 022129.
- Guacci, Adriana (1982):** Un esempio di architettura spontanea, le dimore temporanee del carso triestino. Udine, Del Bianco, 303–341.
- Horvatić, Berislav (2000):** Mrgari – suhozidne ovčare u obliku cvijeta na otoku Krku na sjevernom Jadranu, 10. Konferenca o vernakularni arhitekturi ALPE ADRIA, 82–83.
- Jiménez de Madariaga, Celeste (2021):** Dry stone constructions – intangible cultural heritage and sustainable environment. *Journal of Cultural Heritage Management and Sustainable Development*, 11, 4, 614–626.
- Juvanec, Borut (2008):** Chozo de Extremadura, Joya en Piedra. Cáceres, ARTE.
- Juvanec, Borut (2009a):** Basics of Proportion Systems in Architecture. *Prostor*, 17, 1, 192–199.
- Juvanec, Borut (2009b):** Corbelling of the Mediterranean. In: Mecca, Saverio & Letizia Dipasquale (eds.): *Earthen Domes and Habitats. Villages of Northern Syria. An Architectural Tradition Shared by East and West*. Pisa, ETS, 65–80.
- Juvanec, Borut (2013):** Arhitektura Slovenije 5: Vernakularna arhitektura, kraški svet. Ljubljana, i2, Fakulteta za arhitekturo.
- Juvanec, Borut (2015):** Sacred Well Sant'Anastasia, Sardinia. *Restauro Archeologico*, 1/2014.
- Juvanec, Borut (2016a):** Hiška: pastirsko zatočišče na Krasu. Ljubljana, i2.
- Juvanec, Borut (2016b):** Popovo Polje, a Different View. *Acta Carsologica*, 45, 3, 275–283.
- Juvanec, Borut (2017a):** Najstarejši sakralni objekti v korbelingu vse do krščanstva. *Bogoslovni vestnik*, 77, 17, 201–219.
- Juvanec, Borut (2017b):** Vodnjak. Ljubljana, i2.
- Juvanec, Borut (2018):** Ledenica. Ljubljana, i2, Slovenska akademija znanosti in umetnosti.
- Juvanec, Borut (2022):** Pastirska arhitektura Slovenije in Evrope / Transhumance Architecture of Slovenia and Europe. Ljubljana, i2, Slovenska akademija znanosti in umetnosti.
- Juvanec, Borut (2023):** Theory of Using Energy in Vernacular Architecture. *Symmetry: Art and Science*. *Veszprém*, 114–117.
- Juvanec, Borut (2024):** Iceland Drystone Constructions from under Glaciers. *Jökull*, 74, 1, 2–17.
- Koprivec, Ljudmila (2006):** Kamen u zidovima otoka Korčule. *Luško libro*, 14, 11–25.
- Lilliu, Giovanni (2006):** Sardegna nuragica. Cagliari, Il Maestrale.
- Oliver, Paul (ed.) (1997):** Encyclopedia of Vernacular Architecture of the World. Cambridge, Cambridge University Press.
- Rovero, Luisa & Ugo Tonietti (2014):** A Modified Corbelling Theory for Domes with Horizontal Layers. *Construction and Building Materials*, 50, 1, 50–61.
- Rudofsky, Bernard (1993):** Architektur ohne Architekten. Wien, Residenz Verlag.
- UNESCO (2018):** Art of Dry Stone Walling, Knowledge and Techniques. <https://ich.unesco.org/en/RL/art-of-dry-stone-walling-knowledge-and-techniques-01393> (last access: 2022-03-06).
- Zaragoza, Arturo (2000):** Arquitectura rural primitiva en seca. Valencia, Col·lecció Politècnica.