

Report

“Dry stone in the landscape: ancestral and innovative for sustainable territories”

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Vineyards in Burgundy

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Introduction

Although originally people learnt to tame their natural environment, with the advent of machinery and industrial goods (mainly owing to oil) they were thrust into an unbridled pursuit of development that swept away inventive time-honoured practices. This overconsumption is now being questioned. A growing awareness of limits is allowing an innovative approach with the reclaiming of forgotten skills. Dry stone walling has benefited from this awakening: the trend towards producing and building in a different way by making better use of local resources is of the utmost relevance to the dry stone walling community.

For several decades now on several continents – Europe, Australia, (North) Africa and North America – trailblazers in a number of disciplines have been meeting every two years to swap methods, knowledge and inventories for the purpose of preserving this intangible vernacular landscape heritage. This joint action brings together practitioners, researchers, institutions and local authorities. In France, with the revival of the dry stone walling technique, a Code of Good Practice has been drawn up,¹ endorsed by several doctoral dissertations in the field of engineering, and a well-reasoned manifesto has been jointly approved. The trade has also been revitalised through the introduction of certification and official registration of the skill at national level. Ordering dry stone work means taking a stand against standardised techniques and reflects an alternative choice endorsed by centuries of practice across the globe. Familiarising policy-makers, insurance companies, technical inspection offices and also teachers with this tradition is essential, since it is only by providing such knowledge to the building industry, the highways sector, farming, and catchment water management that it will be possible to validate and build confidence in this system of construction.

The members of the International Scientific Society for Dry Stone Interdisciplinary Study (SPS) believe that methods of building with materials other than cement blocks and concrete (natural stone, for example) should be brought back into favour or even invented. Ignorance of stone and the techniques for its use is a substantial obstacle to its usage. It is therefore imperative for natural stone applications to be taught again in engineering colleges, schools of architecture and construction-industry apprentice training centres to make it the material of the future for the building industry. In addition, the merits of dry stone structures should be studied in the farming, forestry, water, landscape and environment sectors, and such instruction should be provided at all levels, as in the building industry.

“Art of dry stone walling, knowledge and techniques” was inscribed on 28 November 2018 on the Representative List of the Intangible Cultural Heritage of Humanity.²

1. The Code of Good Practice (“*Règles de l’Art*”) was developed by three wallers’ associations at the end of 2007 and follows on from two doctoral engineering dissertations. Its full title is *Guide de bonnes pratiques de construction de murs de soutènement en pierre sèche* (“Guide to good practice for building dry stone retaining walls”) and it was published by the École Nationale des Travaux Publics de l’État in 2008.

2. Unesco, 13.COM, November 2018 (File reference: 1393). <https://ich.unesco.org/en/10b-representative-list-01013>

1. Dry stone: timeless and universal

1.1. Definition

According to Éric Vincens, a lecturer at the École Centrale de Lyon and researcher at its Tribology and System Dynamics Laboratory (LTDS-G8), “a dry stone structure, because of the special way in which the stones are arranged and the friction between them, does not require any binding to make it stable”. Similarly, Denis Garnier, a researcher at the Navier Clinical Laboratory and teacher at the École des Ponts Paris Tech, emphasises that a dry stone wall is made from only one material, stone, and the rest is just empty space.

Dry stone walling consists in piecing together stones to form a structure without mortar or binding. It is a system of construction that cannot be mechanised and which uses local stone – a natural, healthy material – from previous structures or nearby quarries. The stone can also be obtained by collecting it or clearing it from fields. Depending on the geology of the land, it may be possible to gather weathered surface stones, known as “overburden”.

The term “dry stone” is often unwittingly misused: a distinction must be drawn between dry stone and dry-jointed dressed stone (or discreetly pointed stone).

1.2. An age-old system of construction



Fig. 1. Traditional crops in Syria (2009).



Fig. 2. Building with available materials: stone, wood, thatch. Reconstruction at Machu Picchu, Peru (2007).



Fig. 3. *Nuraghe* in Sardinia (Bronze Age), Italy.



Fig. 4. Megalithic chamber tomb in Minorca (*Naveta d'Es Tudons*, Bronze Age), Spain.

From time immemorial wherever there has been stone there have been dry stone structures. Human beings have sought to meet their needs by making do with whatever natural materials they found to hand: wood, straw, earth or stone. Thus, depending on geography, they have levelled hills to make their homes and farm the slopes, building fences and walls to mark ownership as well as to protect their crops and keep their animals in. They have also made paved pathways to drain the ground and prevent mud from accumulating around the village fountain and in their farmyards, along mule tracks and in street gutters. They have collected water to channel to their crops and distribute fairly to everyone; they have battled erosion by building drainage barriers across valleys to slow the destructive run-off from the melting of the snow or from heavy rainfall. These barrier systems for controlling soil erosion caused by hillside run-off act as detention basins and are therefore particularly fertile places

for farming and are absolutely essential in stony arid areas. In 2004, Urs Lippert, a Swiss waller, went to East Africa with Caritas to teach the younger generation of war survivors how to build these barriers again, in order to manage the water shortage.

1.3. A disappearing skill

People cleared their fields of stones to be able to work them and collected these stones in heaps in order to use them again afterwards. The distinctive skill of dry stone walling developed among craftsmen from a stoneworking background and from the peasantry. Whatever the type of stone – limestone, granite, schist, gneiss, sandstone, basalt, etc. – the walling was built on the same basic principles, and models differed more in the shape of the stone available than the structures to be constructed. The technique was refined by trial and error.

However, a sudden change in knowledge has gradually taken place in all sectors of took place in all branches of the building industry, agronomy and agriculture. In some countries, men were carried off by war, and industry met the huge reconstruction needs of the time by providing different systems of construction and sweeping away those already in existence. In the building trade, for example, workers became fitters and applicers of industrial products. Industry's phenomenal discoveries radically changed the structure of the construction industry. Steel and concrete came to spell modernity, speed through standardisation, and, by extension, lower production and roll-out costs. The building industry gradually lost the concept of collective work achieved through dialogue and the pooling of the knowledge and skills of each trade and profession, including architects. The Second World War marked a final clean break. In France, only the historical monuments sector has been able to preserve skills and the tradition of collaboration.

At the same time, depopulation of the countryside left the hills and mountains uninhabited; the technological exploits of agricultural and earthmoving machinery revolutionised attitudes, with the cost-effectiveness of monoculture and chemical fertilisers being lauded. Dry stone walling became an antiquated technique, abandoned beyond recall. Just as they had torn out hedges to make room for bigger and bigger farm machinery, so farmers got rid of their stone enclosures, whose stones were usually crushed and buried into the earth. Farmers neglected their terraces, allowing trees to invade them and close up the landscape.

1.4. A specific skill

Dry stone walling is a universal, timeless technique that requires real skill in selecting and arranging stones, upon which the structure's performance and stability over time depend.

All the stones must be sorted before beginning work. Each stone, depending on its size and shape, has its place and function in the walling. Each course will be stable because the stones are wedged against each other laterally, vertically and internally: it must be possible to walk over each course to check that the stones remain in place. They are tightly locked, being wedged in three dimensions. Precise technical tricks, recognised by scientists, have been developed by wallers to achieve this.³ A stone is trimmed either to pin another stone in the wall or to be dressed for the facing. Once placed in the wall, the stone should not be trimmed to avoid destabilising the stonework. The condition of the collected stone should be checked by listening to the sound that it makes when tapped with a walling hammer. If

2. *Op. cit.*

it sounds wrong, this suggests that it is weak and may therefore split in freezing conditions. In this case it will not form part of the wall's structure but be used for the rubble drain behind the wall if the latter is a retaining structure. On the outer side of the wall, small pinning stones must be avoided for the facing as they could also split in freezing conditions, leading a section of the wall to collapse because other stones have slipped. The way the wall is put together meets the usual requirements for masonry. It is coped with handsome stones to weight it.

A dry stone wall is a gravity wall, with the weight helping to stabilise the structure. The coping stones can be placed either flat or on edge. An upright stone coping means that more stones can be used to provide this weight. This method deters animals (mainly goats) from jumping or climbing the wall. In Minorca (Spain) the lack of large stones has been solved by a coping roughly 30 cm high consisting of small stones coated with lime mortar and then whitewashed. Similar practices are found in Kyoto and Nara in Japan. A coping dislodged by the passage of animals may well collapse, with wild boars often being to blame. Care is therefore needed when replacing a coping stone. This knowledge and wallers' ability to remember the characteristics of the stones that they have sorted previously, together with their skill – sharp eyes and sure hands – in finding the right place for each stone, mature with practice over the years. Wallers' fingers and forearms, used to carry the stones and turn them round and over when choosing the shape that will best fit the spaces to be filled and the stones to be pinned, are very muscular.



Fig. 5. Private garden in Toulon (Var), France.



Fig. 6. Gordes, Luberon (Vaucluse), France.



Fig. 7. Nara (Kansai region), Japan.



Fig. 8. Bottom of a communal garden, acting as a barrier across a small valley leading to the sea, Ciutadella de Menorca (Minorca), Spain.

Building a dry stone wall requires patient, precise work. Contemporary wallers, many of whom resist standardisation, are artists who leave their mark on their stonework: not only are their joints different, but their work also includes an original compositional detail based on the colour or shape of the stones. The international land artist Andy Goldsworthy works with the best British wallers when creating his works all over the globe.



Fig. 9. Polychromatic stonework in walls, Minorca, Spain.



Fig. 10. Polychromatic stonework in walls, near Midelt, Middle Atlas, Morocco.



Fig. 11. Restoration of a retaining wall in Oppède-le-Vieux, Luberon (Vaucluse), Maison des Métiers du Patrimoine work experience project.



Fig. 12. Mediterranean high-speed line (TGV Méditerranée) embankment slope, Tavel (Gard), France. Built by Opus Patrimonio.



Fig. 13. Wall by Urs Lippert, Switzerland.



Fig. 14. Wall by Laviers et Murailleurs de Bourgogne (Burgundy Stone Roofers and Wallers), France.



Fig. 15. Wall by Marc Dombre, Saint-Germain-de-Calberte (Lozère), France.



Fig. 16. Wall by Roland Mousquès, Vialas (Lozère), France.

The work requires a high degree of precision. This precision ensures that the structure will last. Wallers must know what they are doing. Paul Arnault, a craftsman and founding chairman of the French Federation of Dry stone Professionals (Fédération française des professionnels de la pierre sèche, FFPPS) explains:

The stones are not simply added to make the wall; they are wedged. It must be possible to walk on each course without any stone moving, since the stones are wedged by at least three points of contact and the joints are crossed in three dimensions: laterally, vertically and internally... For a retaining wall there are two faces plus the drainage behind, since it is not the slope that holds the wall but the wall that supports the slope.

2. Dry stone influences the three pillars of sustainability

The time is ripe for active involvement in sustainable development. Every sector of the economy must endeavour to show how its performance and output, and the use made of them, will contribute to the

well-being of future generations. From this point of view, dry stone walls are usually held in high regard by the public: they blend in with the environment and have both natural and cultural advantages.

Talk of dry stone shelters previously met with a warm welcome, but there was no appreciation of the walls themselves. Any mention of maintaining road retaining structures with just dry stone walling sparked a protest that “it won’t hold up; it’s technically impossible”. This distrust of dry stone walling was quite simply the consequence of the entire sector having lost its knowledge and expertise, whether those concerned were engineers, craftsmen or architects.⁴ Starting in the 1950s, industry lobbying succeeded in getting rid of dry stone walling. Only shuttered concrete, cement blocks and perhaps clay bricks were allowed onto the construction syllabus. For earthworks, roads or formation levels for houses, rockfill with large blocks of stone laid by mechanical diggers, or else gabions (iron cages filled with smaller rocks), was the only answer on offer. Decades of silence caused the loss of an unrecorded technique handed down orally from generation to generation. Without a written record it could not exist or be certain of enduring. Fortunately, the shelters – and the dry stone walling knowledge with them – were saved through the commitment of heritage and landscape associations, usually by means of work sites for young international volunteers and work experience projects.

2.1. A revitalised skill

Outside these associations, and despite the unfavourable environment, some professionals have taken action locally. Braving the mockery of the unquestioning supporters of cement blocks and concrete, they have gained knowledge through their families or asked old hands for advice and have thus been able to perpetuate the tradition. Volunteers have worked to catalogue and preserve dry stone shelters. Researchers, craftsmen and technical supervisors of work experience projects have pooled their skills, energy and enthusiasm to put together a career path. The preoccupation with sustainable development has been growing since 2003, and this approach has become the model to follow. Further, it has been scientifically proven how far dry stone walling is germane to the future.

Knowledge-sharing and transdisciplinarity have helped to improve dry stone walling.⁵ In France, for example, there has been trialling of test walls made from Vaucluse limestone in 2002, followed by Cevennes schist in 2003 and Cevennes granite in 2007. This collective progress resulted in the *Guide de bonnes pratiques de construction de murs de soutènement en pierre sèche* (“Guide to good practice for building dry stone retaining walls”), which came out in 2008. By making it possible to plan structures with adequate and confidence-inspiring dimensions, the sizing charts developed by researchers in this guide have been essential for easier preparation of estimates. Before this, the

4. Until the 2000s, dry stone walling was not taught in vocational colleges.

5. A number of doctoral dissertations in the field of engineering have been submitted on dry stone walling: Boris Villemus, “Étude des murs de soutènement en maçonnerie de pierre sèche” (“Study of dry stone retaining walls”), 2004; Anne-Sophie Colas, “Mécanique des murs de soutènement en pierre sèche : modélisation par le calcul à la rupture et expérimentation à l’échelle 1” (“Mechanics of dry stone retaining walls: yield design modelling and full-scale field trials”), 2009; Hong Hanh Le, “Stabilité des murs de soutènement routiers en pierre sèche : modélisation en trois dimensions par le calcul à la rupture et expérimentation à l’échelle 1” (“Stability of dry stone road retaining walls: three-dimensional yield design modelling and full-scale field trials”), 2013; James Oetomo, “Comportement des murs de soutènement en pierre sèche : une modélisation par approche discrète” (“Behaviour of dry stone retaining walls: a discrete approach to modelling”), 2014; Benjamin Terrade, “Évaluation structurale des murs de soutènement en maçonnerie” (“Structural assessment of stone retaining walls”), 2017; Nathanaël Savalle, “Comportement hydraulique et sismique des murs de soutènement en pierre sèche” (“Seismic and hydraulic behaviour of dry stone retaining walls”), 2018.

precautionary principle led craftsmen to oversize their structures; more stones and working time were needed, making it a costly option and hindering access to the market.

Another step was taken with the introduction of a national vocational qualification: the “dry stone craftsman” certificate (*certificat de qualification professionnelle*, CQP), approved by France’s Joint National Employment Commission in the BIP (teaching information bulletin) of 4 March 2010. Approval of a higher level, “dry stone journeyman”, followed in 2014.

Certification of the technique and skill has provided the credibility that was lacking to reassure influencers and business insurance companies and to encourage some elected officials to promote the return of the art of dry stone walling in their areas. Building trade professionals have now become interested in green building and are taking the CQP examination. While some are seeking recognition of an existing skill, others are adding this skill to their businesses or even setting up as self-employed. Co-contracting (through a *groupement momentané d’entreprises*, GME) is used to bid for public contracts requiring large volumes of stones.

Networking has provided leverage for reaching contractors, developing dry stone walling as a trade and generating a market.

2.2. Environmental benefits

Dry stone walling has benefited from changes in the perception of the building industry, town and country planning and agriculture. Everyone’s right to live in an unspoilt environment with balanced development is being recognised as a key step and asserted. Industrialisation and the unbridled growth attendant on it have resulted in the loss of whole areas of expertise. Nowadays, the need for traceability and authenticity, and a growing concern for sustainability, are encouraging the examination of old techniques that have been sidelined a little too quickly. Upon closer study, professionals in the field – engineers, architects and craftsmen – are discovering that these techniques offer a number of benefits. Together they are improving and adapting them to meet today’s needs. Bio-based and geo materials such as straw, hemp, earth, stone, etc. are being studied, tested and tapped as green supply chains for the building industry.

Dry stone structures are consonant with the 2015 United Nations action plan “Transforming our World: the 2030 Agenda for Sustainable Development”. Since social and economic development depends on sustainable management of our planet, this plan lays down sustainable consumption and production patterns, sustainable management of natural resources and action to combat climate change.

In France, dry stone structures are also consonant with the 2015 Energy Transition and Green Growth Act. With this law, France has shown its determination to make energy a key issue of the future. The goals are to: consume more efficiently by saving energy (fewer fossil fuels, less transport); produce in a different way while preserving the environment (more local resources, less waste); move society forward by means of projects that will engage the public (co-operative projects), and create jobs in the new occupations of the future and the building industry. Dry stone structures are faithful to the spirit of France’s 2005 Charter for the Environment – which enshrines as a fundamental principle the right to a balanced environment conducive to a humanist ecology that does not set man against nature – and also to the spirit of landscape legislation, which anchors local projects and their management to specific features of the landscape.

2.2.1. Local materials

People's ingenuity and adaptability have produced skills tailored to their needs and developed with local resources. The structures they have built thus blend into the landscape, reflecting the principles of the circular economy.

According to Paul Arnault, a craftsman and founding chairman of the FFPPS:

We shouldn't count on manufacturers to fix everything any longer; we should instead resist and fight to give skills the status they used to have, placing the emphasis on local people and their resources. For what did our elders do to meet their needs? They adapted to their environment and made do with the materials they found around them, simply because travel was costly and time-consuming. We need to get back to this common sense, adaptability, a common language and interdependence between trades as the key to success. The act of building is a collective effort.

2.2.2. Reused materials

It is worth noting that all the stones from decaying structures can be reused and the structures themselves can be repaired. To repair a gap in a wall, for example, all the loose stones must be removed in order to start with a stable area on which to rebuild. Paul Arnault again: "Gapping is like darning a sock: you look for the sound and secure part of the wall to attach the rest." The stones are then tested (by the sound they make when the waller strikes them with his or her hammer) and sorted for reuse. Approximately 30% of the structure's stones will usually have to be imported if the wall is to be strong enough. The new stones are generally taken from the nearest quarries, thus allowing the quarriers to recycle their "waste". Unfortunately, the recent fashion for gabions (cages filled with stone) in architecture and road-building has forced up the tonne price of ungraded stone. The extra stone can also be obtained from a stone picker who collects stones from fields with the landowner's permission. Mention must also be made of vandalism in the shape of theft of stone from old walls, often with four-wheel drive vehicles to reach out-of-the-way sites. In France some mayors have resorted to by-laws to prohibit use of four-wheel drive vehicles for off-road purposes.

2.2.3. Creviced structures, biodiversity refuges, ecological corridors for the green and blue belt, beneficial for organic farming

There was a time when, particularly in the canton of Valais (Switzerland), gaps created by the collapse of vineyard terraces resulted in the dry stone walls being replaced by shuttered concrete walls. A few years later it had to be acknowledged that the vines were more prone to disease on concrete terraces, requiring phytosanitary treatment to remedy the situation. The concrete also changed the nature of the vineyard landscape. Furthermore, this option often required the concrete mixer to be helicoptered in, because the sites were inaccessible. A comparison between concrete and dry stone vineyard terraces was presented in a report on preserving dry stone walls and terraced vineyards in the canton of Valais (*Sauvegarde des murs en pierres sèches et du vignoble en terrasses valaisan*) written by the Agricultural Office of the Canton of Valais.⁶ This conclusion has been drawn and taught time and again.⁷

6. PARVEX François and TURIÉL Antonio, 2001.

7. LIPPERT Urs, STOLL Gerhart and the Fondation Actions en faveur de l'environnement (FAFE).

These dry stone walls are rampant with life (*Murs secs pleins de vie*⁸) and are thus good for ecosystems.

In an expertly built wall, with good cohesion between each stone in all three dimensions (laterally, vertically and internally), no more than 16% will be empty space. For walls in general, this figure tends to be 25%. Consequently, because of the many crevices that it contains, it provides a strategic habitat for plant and animal species.

To begin with, dust and bacteria accumulate on and between the stones. This deposit very quickly turns into moss, lichen and fungus, which grow and then decay to create organic matter. This humus brings plants and therefore insects and other animals. The plants carry seeds and thus add to the variety of species harboured by the walls.

Ants are the first to arrive in a new wall, together with spiders. They are soon joined by small animals looking for shelter. In cold climates or at high altitudes they like the warmth inside the walls at night. Butterflies, bees, reptiles, scorpions, hedgehogs, voles, bats, and sometimes birds as well, all come to nest and find their food there, breed and even settle in some cases. Conversely, in hot climates they seek the coolness of the walls in the daytime. Hedgehogs find hiding places there, while amphibians like to stay in the damp, dark cracks to shelter during the day. Bees and wasps make clay nests on the surface of the stones to reproduce. Some butterflies undergo their metamorphosis there. Mice go there for warmth. These walls are thus a source of food and a hunting ground for a number of predators such as spiders and lizards.

The type of vegetation depends on the wall's aspect, since a north-facing side will optimise the water retention effect. The stone's porosity and pH value also make the wall able to retain both moisture and heat. The species nesting in the wall benefit from these conditions, as do those living nearby. The base of the wall, being thicker and closer to the dampness of the soil, is thus cooler. In contrast, the top of the wall is narrower and more vulnerable to dryness.

Plants and animals take into account these differences and also, depending on their requirements, the different pH values of stones: for instance, it seems that snails prefer limestone.

In a Mediterranean climate these walls are an oasis in the open, unshaded high-grassland, crop and field landscapes oppressed by the summer heat. However, whatever the climate, a straight double-skinned wall, snaking over an open landscape, provides a hidden corridor allowing movement without the risk of being spotted by birds of prey which perch on the walls on the lookout for their victims or other predators. It is a migration corridor for snakes, lizards, salamanders and other cold-blooded animals that especially appreciate this temperate abode: warm in winter and cool in summer. The stone's ability to slowly accumulate the heat of the day and then to release it during the night means that the wall acts as a temperature regulator and creates a microclimate in its immediate vicinity. The stone has high thermal mass and thus a long thermal lag. This is a great asset for farming, and particularly for so-called "heroic" cultivation, carried out on plots where the land is particularly steep.

Over large areas, the landscape created by monoculture is not only monotonous but also devoid of any possible shelter for flora and fauna, which then shun these unsafe and lifeless zones.

8. *Murs secs pleins de vie*, Cahier Musée d'histoire naturelle de la Chaux-de-Fonds No. 10, 2009, in association with the Swiss Association for the Preservation of Dry Stone Walls (ASMPS) in the Swiss Jura.

Animals prefer the centre of the wall, while plants occupy its surface or immediate vicinity. A wall acts as a staging post for animals such as bees and migratory birds. It is eminently suitable for hibernation. The walls thus act as a semi-natural habitat in the same way that hedges, ponds and wells do.

Frédérique Mahieu, a waller in Minorca (Balearics) observes, for her part:

Iris rhizomes keep in place the stones, some of which tend to crumble with age... In the walls that I dismantle I often find a graveyard of snail shells at the bottom: perhaps these shells help to increase the walls' humidifying capacity by collecting the dew gathered by the stones during the night.

Depending on its nature, stone can act as a sponge. As with moss, lichens and fungi concentrate radioactivity and thus, by extension, pollution. Since stone is used to balance the pH value of water in natural swimming pool systems, do stones not have a filtering function too? Bearing in mind the issues raised by climate change, thermal cameras measuring urban heat islands have shown that a single tree is able on its own to lower the temperature in its shade by at least 3°C. The benefit of building dry stone walls should also be considered from this angle.



Fig. 17. Lizard in Molompize (Cantal), France.



Fig. 18. Sedum flowers on a south-facing wall in Saint-Trinit, Plateau d'Albion (Vaucluse), France.



Fig. 19. Moss on a north-facing wall in Molompize (Cantal), France.

Dry stone walls thus play a part in the functioning of ecological corridors and they must be considered when addressing the issues raised by green and blue belts and planning tools.

2.2.4. Free-draining walls: erosion control system and silt trap

Since 25% is empty space, these stone walls are therefore entirely free-draining. This is a valuable quality in a retaining wall, since a waterproof retaining wall has to have a number of weepholes, correctly distributed to release any surplus water building up behind. In limestone areas particularly, and depending on the pH value, weepholes in a waterproof wall eventually become choked. The retaining wall is consequently weakened, with a risk of sudden collapse under the weight of the waterlogged earth. This can be dangerous when the structure is in a public area, such as a road. Since

the road-mender units who used to inspect the roads have been disbanded for economic reasons, the safety of using concrete for road networks may legitimately be questioned. Concrete, even when cast properly, does not last forever. Some types of concrete develop weakness due to human negligence. For instance, failure to position reinforcement bars correctly means that they will not be fully protected by the concrete and will oxidise and rupture the concrete. The advantage of a dry stone retaining wall with multiple weepholes spread over the whole of the structure is therefore undeniable, especially as a dry stone wall gives advance visual warning of collapse: a swelling appears.

This free-draining capability has been used for centuries in various ways:

- In dams across thalwegs. In high mountain areas they can help prevent soil erosion during the snow melt. They have everywhere proved their efficacy in slowing rapid run-off by acting as detention basins and facilitating infiltration and deposition of materials that enrich crops – a sort of silt trap. They are also very useful for preserving the soil in hilly terrain, reducing the formation of torrents and limiting devastation. In arid and semi-desert zones the cropland made possible by these thalweg terraces is often the only fertile area.



Fig. 20. Chorges (Hautes-Alpes), France.

Fig. 21. Vilafranca (Castellón), Spain.



Fig. 22. Near Imilchil, High Atlas, Morocco.

Fig. 23. Limestone plateau, north-west of Aleppo, Syria (2009).



- In February 2003, after several years of drought, the Cyclades suffered torrential rain for three days. Having flown over the area in a helicopter and thus seen for himself the deposits surrounding each island, a representative of the Greek Government deplored the situation, speaking at the start of a seminar on “stone skills” in Tinos:⁹ “Your islands’ soil has disappeared into the sea. What are you going to do once your islands are just rock? The tourists will go elsewhere and you will be left to weep!” Since the land was no longer being worked, the multitude of derelict dry stone terraces was no longer helping to prevent erosion. Shortly afterwards, a grant was voted to encourage the rebuilding of dry stone walls.

9. EuroMed Heritage programme on local skills.



Fig. 24. Dovecotes, Tinos, Greece.

- The Terrisc¹⁰ project for terraced landscape restoration and natural hazard prevention studied the benefits of dry stone walling. A joint experimental design was adopted with a view to evaluating water regulation and risk prevention on terraced sites. In France the findings of the National Centre for Scientific Research (CNRS) were based on the conclusions of the “Water Resources” project of the Gardons Joint Planning and Water Management Public Consortium (*Syndicat mixte d’aménagement et de gestion des eaux, SMAGE*) in Peyrolles in the department of Gard. Jean-François Didon-Lescot comments as follows:

The restoration of old hydraulic structures – the *tancats* – has allowed an alternative method of sustainable water-resource management, while promoting social management of water through a work experience project, providing training and jobs. Monitoring of a terraced site given different top dressings has shown the extent to which soil characteristics assist deep water penetration. Limited run-off was found only on the worked terrace without any vegetation. The terracing of the slopes acts like a system: all the walls and drainage systems are connected, forming a whole. If part of the system suffers damage, this ends up affecting the rest.

Figs. 25-26. Walls after a storm in Majorca. Photo: Philippe Alvaro-Frotté (for Terrisc).



The concern is to forestall deterioration of terraces, prevent their abandonment and encourage their restoration. In Majorca, where violent storms occur, but only occasionally, the terraces – to play their retention role – sometimes have double-skinned retaining walls constituting a particularly thick structure (approximately 80 centimetres broad at the top) and contain ingenious drainage systems to remove surplus water, guiding it towards small, very carefully-built irrigation channels.

10. Interreg IIIB South West Europe programme (2000-2006). Lead partner: Majorca Council (Consell Insular de Mallorca); four demonstration sites: Douro Valley, Porto, Portugal; Serra da Estrela, Coimbra, Portugal; Serra de Tramuntana, Majorca, Spain; Vallée Obscure, Cevennes (Gard), France. Claude MARTIN, Jean-François DIDON-LESCOT and Joël JOLIVET, UMR 6012 Espace GEMS, CNRS Montpellier and Université Nice-Sophia-Antipolis.

- In France, in the department of Bouches-du-Rhône, the Alpilles and Montagnette Flood Prevention Action Programme (PAPI) considers these time-honoured systems to be effective. Laurent Reynaud, in a paper entitled *De l'intérêt des techniques ancestrales pour gérer les débits* (“Benefits of time-honoured techniques for managing flows”), states:

The properties of the subsoil and the action of the water eroding the massifs over millennia have created small valleys. Whether gently sloping or more in the nature of a ravine, during heavy rainfall they tend to drain very quickly. Their upstream position means that the principles of limiting production and slowing run-off must be applied ... All the activities in a catchment area (building, soil sealing, ploughing, channel-cleaning, etc.) automatically lead to faster run-off and shorter concentration times... This is a harmful tendency, since it exacerbates the adverse effects of storm events...

In the past, pastoralism and wood-gathering kept plant cover low. Depopulation of the countryside has allowed pines to take over, which are then burnt down by summer wildfires; the autumn rains disturb and gully the soil. However, small valleys with collinear dams (free-draining dry stone barriers roughly every hundred metres) can still bring an improvement even today.

In the above paper, Laurent Reynaud explains:

Over time, the sediment load carried by the run-off (stones mixed with earth and organic matter) builds up behind the structure to form a sloping bench covered with vegetation. This vegetation, which anchors small particles and creates organic matter, gradually produces deep soil (thus increasing the useful water reserve). Depending on the type of bedrock, this water either seeps down to the water table or resurfaces further on. In any event, run-off is slowed down. When there is a heavy thunderstorm, the volume of water generated by the catchment area is greater than the infiltration capacity of the benches. Yet the structure is still perfectly functional, since the water flows perpendicular to it, over the coping stones, and then falls vertically. This fall dissipates a certain amount of energy on the spot. The water gradually resumes its journey down the valley. Its erosive power is thus reduced and the concentration time again extended.

Conversely, valleys that have lost their collinear dams have been utterly leached, and vegetation will struggle to recolonise them; this phenomenon may be expected to worsen.

2.3. Social and cultural benefits

2.3.1. Local economy: local resources (people and materials)

In terms of life-cycle analysis (LCA) and overall cost, there is a genuine economic case for dry stone retaining walls. Moreover, building and maintaining existing structures helps develop a local market offering jobs that cannot be mechanised or relocated. Replacing a dry stone road retaining wall with a concrete retaining wall means using a civil engineering firm that is a studded-concrete specialist, which will not be local and will leave again once the work is finished. Repair of the same sustaining wall by a craftsman waller from the village will, on the contrary, help keep the village alive: the craftsman's children will enable a class – or even the village school – to continue, and the family will make their purchases in the village, buying their bread and fuel there, having their car repaired, and so on.

When a mayor does the calculations and opts to keep a family that is living and buying locally, this is not without significance. Local crafts and small businesses indisputably create social bonds, and in France this is reflected by the slogan of the Provence-Alpes-Côte d'Azur Chamber of Trades and Crafts: "Buy local, shop small!" This makes sense in local neighbourhoods and the countryside. It is up to elected representatives to calculate the long-term benefit for their communities, since nothing comes free of cost. As Jamal Moussali says, lamenting the derelict terraces around his family's fortified village (ksar) in Morocco: "What isn't paid for now must be paid for later. Farmers prefer to get their wheat from the government because it's cheaper for them than growing it on their own land." The heart of the Moroccan Anti-Atlas Mountains between Tafraout and Ait Baha is a mountain landscape striated with dense terraces running as high as possible and as far as the rock will permit, where every piece of ground used to be worked; only almond and argan trees remain.

Using the services of a waller (local labour) also means restoring their dignity to skilled crafts people and acting sustainably at the local level.

2.3.2. Promoting skills and putting people at the heart of the building process

The waller's craft has meaning: wallers use a noble, natural material and repair what our ancestors left, without changing the nature of the landscape and without risk to their health or the environment. For decades they have been building useful structures that command respect and are full of poetry, resonance, light and shadow. They leave their mark on their walls by the way in which they put them together. Sometimes defiant, sometimes mischievous, wallers are proud people. In France, any craftsman who can lay claim to this skill can have it recorded in the trades register of the Chamber of Trades and Crafts of the *département* where his or her business has its registered office.

Furthermore, France's Law No. 2005-882 of 2 August 2005 promoting small and medium-sized businesses,¹¹ (and consolidated in 2006) allows a waller to apply for the Living Heritage Business label (*Entreprise du patrimoine vivant*). This is a mark of government recognition awarded to French businesses with first-class manufacturing or craft skills.

An Order of 24 December 2015 describes the occupation of "waller" as a heritage mason specialism in the national list of crafts and in the trades register.¹² This list was drawn up jointly by the Minister for the Economy, Industry and Digital Affairs, the Minister for Culture and Communication, and the Minister of State with responsibility for Commerce, Craft Industries and Trades, Consumer Affairs and the Social and Solidarity-based Economy. It was then published and promoted by the National Institute of Arts and Crafts (INMA), a body under the authority of these ministers. There are a lot of people and organisations that want a high-quality, environment-friendly dry stone economy generating business and jobs, creating social bonds and producing handsome structures.

Paul Arnault has noted the importance of developing "a community of interests between practitioners, researchers, influencers, elected representatives, institutions and local areas to carry on the work and do their utmost to ensure that dry stone walling is recognised not only as rural and landscape heritage but also as a locally based green industry and an eco-efficient system of construction".

11. *Journal officiel de la République française*, No. 179, 3 August 2005.

12. *Journal officiel de la République française*, No. 26, 31 January 2016 (Text No. 48).

2.3.3. Jobs that cannot be relocated: families who live and buy locally

Dry stone construction will never be mechanised. Only the waller's expert eye and hand can properly piece together the stones to make a sturdy, lasting structure. Wall building and maintenance is the province of serious professionals and mainly local ones. When choosing between a firm from outside the area, which will just do the work for a short time and then head off to other projects, and a local professional, a mayor would be well advised to measure the impact of his or her decision. Maintaining walls locally and rebuilding them exactly as they were is a civic act supporting the municipality's economy: local jobs and local consumers. Whether as a farmer, a craftsman or the municipality's countryside maintenance officer, a waller will live locally since he or she will opt to maintain the terraces and enclosures situated nearby.

In the past, the state road services had roadmen's houses. These houses, built along major and minor roads, were used as official accommodation for the employees who were responsible for maintaining and inspecting the road system. Their job consisted in checking not only the serviceability of structures but also the condition of safety barriers; they pruned trees, weeded and kept the gutters clean, checked that water would flow freely if there were storms, filled potholes, etc. This local service has been abolished; current practice is to send maintenance staff occasionally (every four years) to inspect a stretch of road and raise the alarm if there are safety issues. The system for calculating the cost-effectiveness of government departments was changed in the 1970s. Rather than relying on regular inspection and maintenance, since both items come under the operating budget, the method is to prioritise major repairs, which come under the capital investment budget.

2.3.4. Protecting an environment's identity for its inhabitants

The quality of an environment depends on the harmony of the landscape, the sign that an area is well-governed. Landscapes evoke the history of the people who shaped them, reflecting society and how it is organised. A community's identity thus merges with the identity of the landscape in which it lives. The latter provides people with the calm and stability they require, which contributes to their well-being. They need to know and understand their roots, and this need grows as globalisation continues to homogenise the landscape. Uniform international architecture (with the same shops, homes and signs) erases difference and contributes to standardisation of the landscape.

2.4. Economic benefits

2.4.1. An enabler of local quality growth

The European ProTerra programme¹³ was the first to work in the field of "re-evaluating cropped terraces". Eventually, fifteen or so local areas were involved. In a paper called "*Les terrasses de cultures, lieu de l'innovation obligatoire*" ("Cropped terraces, a necessary site of innovation") in *Aménagement et nature* (2001, No. 141), Sébastien Giorgis made the following comments:

Once again in the history of the farming landscape, terraces, which were anything but "economically correct" in the 1980s, are a site for testing new ways of viewing the relationship between "quality of life, product quality and landscape quality". This slogan brought together

13. European programme from 1982 to 1989, revived from 1996 to 2001, between France, Greece, Italy and Spain. Lead partners: Mediterranean Centre for the Environment, L'Isle-sur-la-Sorgue (Vaucluse) and Les Baronnies Joint Public Planning Consortium (Drôme).

fringe stakeholders (associations, new farmers and inquiring, non-typical researchers) in these fringe areas, supported by a fringe authority (the humble Landscape Task Force). The “terraces” programme made it possible to conceive and test new answers to questions of mechanisation, agricultural diversification, irrigation, retaining techniques and specific equipment such as the solar tunnels (greenhouses) developed in the Cevennes. It was these fringes that produced the new ideas that were later fleshed out in sustainable development plans and have now been generalised through land use contracts. The European ProTerra programme has taken this work a stage further and shows how this return to terraces in the landscape is a shared vision.

A few examples from the programme may be mentioned by way of illustration:

Didier Lecuyer from the Cevennes National Park in France has been working with the Lozère Chamber of Agriculture to rehabilitate derelict terrace landscapes. New farmers have been won over to growing Spanish onions on terraces once again, like their predecessors. This rehabilitation has been rewarded with a protected designation of origin (PDO). The Spanish-onion festival has been revived in Saint-Martial and is celebrated annually on 15 August. The current website of the Spanish-onion growers’ co-operative describes their many efforts to rebuild the terraces and restore this landscape that has made their reputation and prosperity. Nowadays their potatoes are also showcased through the landscape, with the slogan “From terrace to table: the belle of the bancels [terraces]” displayed on their net packaging.



Fig. 27. Surroundings of Saint-Martial (Gard), France.



Fig. 28. www.oignon-doux-des-cevennes.fr



Fig. 29. Surroundings of Saint-Martial (Gard), France.

The ProTerra programme also helped to defend the farming community by getting the designation of farmer (*agriculteur*) extended to cover smallholders, a status previously denied them because their holdings were thought too small to live off:

“Small organic and hill farms growing aromatic and medicinal plants have come down in size from 5 hectares to 1 hectare in the plains and 5,000 m² on irrigated farmland for growers wishing to work the Cevennes terraces. The human scale of these smallholdings allows the plants to be tended very carefully. Moreover, [...] growers pick some 80% of plants in the wild (bilberry, heather, lavender, rosemary, thyme, yarrow, etc.).”

The programme has led to an improved perception of peri-urban agriculture, since peri-urban ground is deemed to be local food-producing land. The resulting landscape creates a green strip marking the city’s boundaries, and this “green lung” benefits both its inhabitants and the flora and fauna (ecological corridor). A farming charter and support from the agricultural technical studies centre (CETA) can help protect land in urban planning documents. In some areas of the Aubagne municipality, the Jardins du Pays collective local brand is promoting its market gardening crops grown

on walled plots and small terraces. This concern for local vegetable crops to supply city-dwellers' plates is enormously significant. In many countries, the urban periphery has been sacrificed to opportunistic urban planning on an ad hoc basis, conceived in terms of zoning, whereas it would have been wiser to come up with an overall planning project for each of the cities concerned, anticipating the structure of the needs created by urban development and the facilities required. The population would have gained in terms of food security and its living environment. The landscape of many approaches to cities has now become repellent: extremely poor architecture, a complex, over-dominant road system, appalling traffic conditions that are dangerous to any pedestrians and cyclists venturing into the area, and so on.

2.4.2. Tourism economy: landscape's identity value, rural heritage, hiking

Landscape contributes to the economy, and tourism is a windfall to be considered from two angles: foreign tourists looking for new things to see and try, and tourists from local towns or cities wanting to enjoy unspoilt areas and breathing spaces for their outdoor and recreational activities at the weekend. Such trips bring both first-time and return visitors.

For instance, the steep terraced vineyards of Cinque Terre in Italy offer a unique landscape with their villages perched on sheer cliffs plunging into the sea. Cars belonging to non-residents are prohibited. Visitors therefore have to take the train or walk. The vineyards' success is such that bottles of wine are often sold before the grapes are even harvested.



Fig. 30 and Fig. 31. Cinque Terre (Liguria), Italy.
Photos: Jules Respaud-Bouny.



Ecomuseums constitute another approach and type of history site. Not only are they particularly attractive and very typical, but they also constitute an ultimate solution. Mention can be made of the Swiss open-air museum of Ballenberg, east of Interlaken. This is a large park bringing together both tangible and intangible Swiss rural heritage. A hundred or so buildings representing different cantons have been dismantled (each piece being numbered) and then rebuilt exactly like the originals. The park includes country gardens with farm animals and showcases traditional crafts. The museum is a charitable foundation and 80% self-financing; its maintenance depends on donations and bequests. One of the chalets has been renovated; the resulting contemporary architectural work, heedful of its heritage character and careful to use traditional materials, demonstrates that it is possible to preserve heritage without forgoing modern-day amenities. Throughout the park the enclosures, terraces and building surroundings are all demarcated by dry stone walls or wooden fences.

2.4.3. Home-grown produce: local marketing

An attractive farming landscape is undeniably a sign that good farming practice has been followed and high-quality local produce is being grown; it thus helps to give people pride and reflects the quality of work that preserves the ecosystem balance and is consistent with the rhythm of the seasons, crops, soil, trees, etc.



Fig. 32. Sheep sorting pens for the end of mountain pasturing in Belalp, Aletsch Glacier above Brig, Switzerland. Restored by Stoneworks Lippert. Photo: Urs Lippert.



Fig. 33. Moselle Valley at the confluence with the Rhine, Germany.

In Germany, the vineyards of the Moselle Valley up to its confluence with the Rhine are set out in narrow terraces on the south-facing slope, the slope with the most exposure to the sun. It is climbed by a system of little monorail trains, borrowed from the Swiss, enabling the vines and walls to be looked after, and it also facilitates the harvest. Some tourists take the river boats for excursions, while other sportier ones follow the cycle path along the river. Tours of the Moselle Valley are very popular. Each village is a gourmet stopping place, where cafés and restaurants offer Moselle wine tastings on their terraces, accompanied by charcuterie and grilled sausages with potatoes (*Bratwurst und Kartoffeln*).

Sébastien Giorgis noted:

What is new, perhaps as a reaction to the impossible choice today between overexploited landscapes on the one hand and derelict ones on the other, is this desire to be somewhere, to live in a landscape to which you can relate and to consume products whose link to a local area guarantees a degree of quality.¹⁴

2.4.4. Appeal of local areas to image-conscious businesses

Appealing landscapes are an important factor in attracting businesses. These businesses endeavour to retain their managerial staff by offering them a pleasant living environment. Some areas, with “landscape quality” labels (such as parks) are particularly sought after, and this image is often used to promote products made there.

3. A range of uses for this building method

3.1. Dry stone landscape structures

The examples below illustrate the landscape value of various dry stone structures.

14. Op. cit.

3.1.1. Terraces



Fig. 34. Castagniccia Valley, Corsica, France.



Fig. 35. Amalfi coast, Italy.



Fig. 36. Galicia, Spain.



Fig. 37. Province of Castellón, Spain.



Fig. 38. Majorca, Spain.



Fig. 39. Between Aït Baha and Tafraout, Anti-Atlas Mountains, Morocco.

3.1.2. Stone enclosures



Fig. 40. Punta Nati near Ciutadella (Minorca), Spain.



Fig. 41. England, United Kingdom



Fig. 42. Paz Valley (Asturias), Spain.



Fig. 43. Island of Gotland, Sweden.

3.1.3. Gardens



Fig. 44. Gordes, Luberon (Vaucluse), France.



Fig. 45. Nara (Kansai), Japan.



Fig. 46. Tavel (Gard), France.



Fig. 47. First prize in the 2014 Victoires du Paysage landscape competition in the “Urban Garden” category: Jardin des Migrations, Fort Saint-Jean, Marseille, France. Design: APS, Valence. Construction: Les Murailleurs de Provence, trainers for the Acta Vista work experience scheme.



Fig. 48. Haute-Marne, France.



Fig. 49. Côte-d’Or, France.

3.2. Buildings and their surroundings

3.2.1. Free-standing walls



Fig. 50. Aveyron, France.



Fig. 51. Castellón, Spain.



Fig. 52. Minorca, Spain.



Fig. 53. Priory at Ganagobie (Alpes-de-Haute-Provence), France.



Fig. 54. Payzac (Dordogne), France.

Fig. 55. Gateway of a farm in Minorca, Spain.



3.2.2. Retaining walls



Fig. 56. Valldemossa (Majorca), Spain.

Fig. 57. Kyoto, Japan.



Fig. 58. Gargas, Luberon (Vaucluse), France. Construction: Maison des Métiers du Patrimoine. Technical supervisor: Matthieu Collot, waller.

Fig. 59. Toulon (Var), France. Retaining wall built by Albert Porri, waller.



Fig. 60. Moselle Valley, Germany.

Fig. 61. Blauzac (Gard), France. Built by Vincent Mougel, waller.



3.2.3. Paved pathways and areas



Fig. 62. Majorca (Balearics), Spain.

Fig. 63. Salagon Priory, Mane (Alpes-de-Haute-Provence), France





Fig. 64. Fountain, Aveyron, France.

Fig. 65. Farm near L'Étivaz, Pays d'Enhaut (Vaud), Switzerland.



3.2.4. Foundations and bases



Fig. 66. Base of a chalet, Island of Gotland, Sweden.

Fig. 67. Base of a vineyard hut, France. Built by Laviors et Murailleurs de Bourgogne (Burgundy Stone Roofers and Wallers). Photo: Johan Mari.



Fig. 68. Foundations and base of a new mud-brick house, Chinguetti, Mauritania.



3.2.5. Avalanche breakers for mountain chalets



Fig. 69. Near L'Étivaz, Pays d'Enhaut (Vaud), Switzerland

3.2.6. Houses



Fig. 69. Farm near Alberobello (Apulia), Italy.

Fig. 70. Farm near Noci (Apulia), Italy.





Fig. 71. Earth-bermed house with broom thatched roof, Lozère, France.



3.2.7. Shelters



Fig. 72. Dry stone wind shelter (*barraca*), Minorca, Spain.



Fig. 73. Shelter for livestock (*pont de bestiar*), Minorca, Spain.



Fig. 74. Shelter in a vineyard wall, Saint-Chinian (Hérault), France.



Fig. 75. Former mountain shepherd's huts (*orri*) above the Videssos Valley (Ariège), France.

3.2.8. Granaries



Fig. 76. Galicia, Spain.



Fig. 77. Amtoudi oasis, Anti-Atlas Mountains, Morocco.

3.3. Roads and their surroundings

3.3.1. Retaining walls



Fig. 78. Aurel, Mont Ventoux (Vaucluse), France.

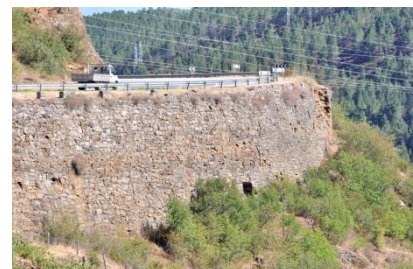


Fig. 79. Galicia, Spain.



Fig. 80. Eastern Pyrenees, France.

Fig. 81. Near Midelt, Atlas Mountains, Morocco.



Fig. 82. Mont Faron, Toulon (Var), France.

Fig. 83. Cap Corse, France.



3.3.2. Bridges



Fig. 84. Epirus, Greece.

Fig. 85. Navarre, Spain.



3.4. Paths and their surroundings



Fig. 86. Catalonia, Spain.

Fig. 87. Apulia, Italy.



Fig. 88. Near Sóller (Majorca), Spain.

Fig. 89. Muddy sunken road to drain rainwater and protect grazing for Limousin cattle, Masgot (Creuse), France.





Fig. 90. Ascent to castle, Saint-Saturnin-lès-Apt, Luberon (Vaucluse), France.



Fig. 91. Ascent to chapel, Moustiers-Sainte-Marie (Alpes-de-Haute-Provence), France.

3.5. Hydraulic structures



Fig. 92. Payzac (Ardèche), France.



Fig. 93. Var, France.

3.6. Other structures



Fig. 94. Fishery (fish trap), El Jadida, Morocco.

Fig. 95. Subsistence plots beside a wadi, liable to flooding, Amtoudi oasis, Anti-Atlas Mountains, Morocco.



Fig. 96. Family allotments on a floodplain, River Lot, Saint-Julien-du-Tournel (Lozère), France.



3.7. Protection systems

3.7.1. Flood prevention and run-off control

Being flexible and free-draining, dry stone walling helps control erosion and run-off. By retaining a slope's earth to allow cultivation, terraces promote a controlled flow of water from catchment areas (in times of both water surplus and water shortage) and protect the land. Building stepped terraces is a

radical means of breaking the slope and at the same time limiting the force of the water. Rivers also have dams – or crests – barring the valley.



Fig. 97. Double-skinned dam (*restanque*) barring a valley, Switzerland. The waller is pointing to his work.



Fig. 98. Farming landscape formed by double-skinned dams (*restanques*), Venasque, Monts de Vaucluse, France.



Fig. 99. Building across the valley to the south of Tiznit, Anti-Atlas Mountains, Morocco.



Fig. 100. Detail of structure, south of Tiznit, Anti-Atlas Mountains, Morocco.

3.7.1.1. River banks



Fig. 101. Galicia, Spain.



Fig. 102. River Nile, Egypt.



Fig. 103. North of Dijon (Côte-d'Or), France.



Fig. 104. River Lot, Saint-Julien-du-Tournel (Lozère), France.

3.7.1.2. Irrigation channels



Fig. 105. Combe des Bourguignons, Marguerittes (Gard), France.



Fig. 106. Majorca (Balearics), Spain.

3.7.2. Drought and desertification control



Fig. 107. Aswan, Egypt.

Fig. 108. Chinguetti, Mauritania.



3.7.3. Wind control

Round gardens enclosed by high openwork dry stone walls, for example, are used to break the force of the wind and protect citrus trees on the island of Pantelleria in Sicily.

3.8. Rockfall and avalanche barriers, military defences, etc.



Fig. 109. Peaks of Europe (*Picos de Europa*), Asturias, Spain.

Fig. 110. Zakopane, Tatra National Park, Carpathian Mountains, Poland.



Fig. 111. Austro-Hungarian military trenches, Val Venosta, Italy.

Fig. 112. Moat of a former outlook over the Toulon roadstead, Mont Faron, Toulon (Var), France.



Conclusions

Every time a landscape is lost, when the roadside walls crumble, collapse and are replaced by concrete, rockfill or gabions (iron cages filled with stone), this change is noticeable, and we feel a mixture of nostalgia and futility. Yet these dry stone landscapes merely have to be farmed and properly maintained throughout the year to reflect the overall quality of the area, the work done by those living there and the crops produced.

Wherever dry stone heritage occurs, it is wise to consider its purpose and contemporary relevance.

Dry stone walling, a valuable mainstay that should be listed with the landscape

Some landscapes have a particular understated beauty, such as the low dry stone walls snaking across the Jura in France and Switzerland, the perfectly straight lines of the livestock pens criss-crossing Punta Nati on the island of Minorca in the Balearics, the vineyard terraces climbing the hilly slopes

above the confluence of the Rhine and the Moselle in Germany or those of the Valais in Switzerland. Only a few of these landscapes have been recognised by UNESCO: Cinque Terre and the Amalfi coast in Italy, the Alto Douro in Portugal, Lavaux in Switzerland and the Serra de Tramuntana on the island of Majorca. Yet, while they have obtained their listing because of the authenticity of their terraces, underscored by the dry stone walling, oddly enough nothing requires these walls to be maintained or restored to their original condition. When we travel across these unique sites and look more closely, it becomes apparent, sadly, that the failure to include these structures in the site specifications is sometimes a factor in their replacement by other methods of building, thus leading purely and simply to their disappearance and hence diminishing the beauty of the landscape.



Fig. 113. Alto Douro, Portugal.

Fig. 114. Promoting the landscape in a glazed tile in Pinhão Station, Alto Douro, Portugal.



Fig. 115. Jura, France.

Fig. 116. Amalfi coast, Italy.



Lack of knowledge is often the cause of damage to landscape, as it is to architecture. Good intentions, or, more venally, a purported (short-term) profit, can irremediably sacrifice the richness and diversity of landscape composition, shaped over centuries of toil. These age-old methods of construction are fascinating for their adaptability to the climate, relief and local resources.

We can see that dry stone heritage is still under threat of destruction, not only through lack of maintenance but also in the name of economic constraints considered purely in terms of capital cost rather than a structure's overall lifespan or working life. The disappearance of this intangible know-how and these free-draining structures represents an impoverishment of knowledge and is not consistent with the call for sustainable practices on a human scale with due regard for the planet's resources. Protection of this heritage in each individual country could draw on knowledge, experience and input from a broad range of stakeholders. We must recognise the importance of preserving these irreplaceable structures whichever the nation to which they belong.

Dry stone structures, knowledge and skills as local resources to be promoted

It is necessary to promote knowledge and use of dry stone walling (publicising skills and structures) as a local resource in both environmental and farming policy. Stone is a natural, healthy material that can be quarried locally and re-used. Dry stone structures are free-draining and help prevent erosion, they are tailored to the terrain and follow the contours to fit into the surrounding countryside, and they act as detention basins for run-off. In addition, the crevices of dry stone structures are biodiversity niches,

which maintain the ecosystem and promote healthy soil conducive to organic farming and biodynamic agriculture.

We should also take account of the need to preserve and promote dry stone walling in the terms of reference for maintenance of major landscapes and listed sites as an example of good practice for gardens, hiking trails, scenic routes, river banks, walls, soil permeability, erosion control, hydrology, etc. It is essential for wallers' skills to be recognised as intangible cultural heritage.

Publicising, teaching and putting across the merits of dry stone walling

The merits of dry stone walling ought to be publicised, taught and put across to influencers and practitioners, policy-makers and the public.

Training

Some old structures collapse owing to lack of maintenance and replaced by imitations because the knowledge is lacking. In this particular case, leaving aside the rigidity of this new masonry, the benefits of dry stone walling are no longer guaranteed. To ensure that structures are properly maintained and built the right way in accordance with standards of good workmanship, dry stone walling training modules ought to be added to the syllabus for basic and further training when they fit in. In particular, this type of teaching should be included in training for:

- practitioners: builders, stonemasons, gardeners, foresters, countryside maintenance staff, local-authority maintenance staff, farmers, olive-growers, winegrowers, breeders, etc.;
- designers/influencers: architects, landscape designers, technicians, urban planners, design and inspection offices, construction engineers, civil engineers, geotechnical engineers, agronomists, etc.

To provide this training the standard of teaching must be guaranteed, and the vocational training schools' technical supervisors must move away from the predefined curriculum. Scientific testing carried out for doctoral engineering dissertations has shown that the precision with which walls are built is the guarantee of their reliability. Any poorly built stonework that collapses helps to make the case for critics of dry stone walling. If the knowledge is to be handed down properly, teachers' and trainers' know-how and skills have to be validated.

Raising awareness among local-authority officials, the general public and other stakeholders

It is crucial to raise awareness of the merits of dry stone walling among local-government officials (who are responsible for managing municipalities, natural areas (in both town and country), paths, roads, forests and rivers), the general public and other stakeholders. Although it is the technical staff who come up with the ideas, the decisions lie with local elected representatives. The capital cost is sometimes enough to sway their decision; yet appropriate stonework would last longer and fit in with its surroundings. It is important for elected representatives to be properly informed about the benefits of dry stone walling in a landscape.

Time and again we find that the elements of our everyday surroundings are becoming undervalued. It sometimes takes a delighted pair of fresh eyes to recall the beauty of the landscape; and it is only when it no longer exists that regrets are voiced. The wisest course is to preserve history by keeping sites

unaltered in order to set an example. The public can be attracted by educational and recreational amenities and hence won over.

A few examples of good practice that are simple to follow:

- The heritage trails set up by the Corsica Environment Office, in France. Any village can apply by submitting a plan to restore old paths in its surroundings, in order to receive funding for their rehabilitation. The application must contain a technical project stating the reasons for the choice, with a substantial historical background. If selected, it will then be promoted at regional level. As a result, tourists will have an alternative to the famous GR 20 long-distance path, which is not within everyone's capabilities, as it is so strenuous. They will also have a chance to see villages that they would never have thought of visiting before. A heritage trail is thus an opportunity for relaxed discovery and a family stroll. This is why the programme is so successful. It appeals equally to tourists and residents. These paths had long been neglected. Young people were not aware of them because they had disappeared beneath the undergrowth. Today the paths spark curiosity as soon as work begins. The oldest members of the village explain how the paths were used and tell their stories to the younger generation. The delight in rediscovering a threshing ground, a spring or a gravity irrigation channel carrying water to former fields means that even the gardens get a new lease of life, there is room for a donkey, an old tree is cherished, etc. These heritage trails are now the villagers' pride and joy. Their coverage in regional tourism advertising brings visitors to the very heart of Corsica and permits a form of calm ethnocultural tourism with a longer season. With changes in society, these remnants of village life take on full meaning, and often plots are reclaimed by families which pride themselves on looking after the plantations and work of their elders.
- The Dry Stone Route (*Ruta Piedra Seca*), or GR 221, in Majorca (Spain) runs along the Serra de Tramuntana. The idea was floated by a chairman of Majorca Council's economic development agency (FODESMA) and, in the late 1980s, probably looked somewhat reckless because the project seemed so unworkable. The old mule tracks had sunk into oblivion, having been invaded by undergrowth or annexed as private property. The traces of these old tracks had to be found in old land registers, and repurchase or long lease of the land had to be negotiated. In the 1990s a national programme was developed, grants provided by the Ministry of Employment and workshop schools (*escuela tallers*) set up. Young architecture, geography and agronomy graduates were recruited to supervise unskilled jobless young people in work experience schemes for restoring public heritage. These young people were thus able to devote their energies to restoring an 18th century house and park, a tower, a mill and a dry stone landscape. This organisation made it possible to raise public awareness and attract some new people to this field. The Wallers Association of Majorca *Gremi de Margers* (a "murger" being a thick wall or dressed cairn – consists of older members, trained in the university of life and now proud craftsmen, who act as envoys to inform the public and persuade their village councillors to carry on the dry stone walling tradition for the benefit of all. All these efforts were rewarded with the UNESCO "Cultural Landscape" label in 2011, the application for which was supported by one of the island's most fervent admirers, the US actor Michael Douglas. At present, Majorca Council's Department of the Environment (Departament de Medi Ambient) is involved in an international programme for cultural dry stone routes in the Mediterranean with a shared commitment to developing proposals for dry stone trails.

Preserving and maintaining old infrastructure

Decision-makers should also establish or re-establish repair and maintenance departments. The occupation of road menders, which has disappeared in some countries, includes managing road assets. The idea is to ensure regular inspection of structures, ditches and drains and maintenance of infrastructure to avoid the need for emergency work. Since the disappearance of road menders in some countries, the best scenic routes, crossing typical local landscapes, have been undergoing modernisation. While this may be considered effective in functional terms, it inexorably leads to a drastic deterioration in the distinctive nature of these roads. Consideration should be given to the landscape benefits of narrow winding mountain roads with dry stone retaining walls.

A number of examples of these winding roads and their landscape benefits may be cited.

- The Sa Calobra road in Majorca has wisely been kept as it is. Tourist buses are allowed to use it at specific times (either in the uphill or the downhill direction to avoid their routes intersecting, which is impassable because of the narrowness of the road at the point where there is an exceptional old dry stone retaining wall (17 metres high and 140 metres long)).
- Switzerland protects its twisting roads over mountain passes by registering them as historical monuments. The layout of the Gotthard Pass has been preserved: dry stone retaining walls, cobbled surfaces, kerbstones marking the edge of the road, etc. The old road is still preferred by walkers, cyclists and motorcyclists, and the new road, which takes a direct route through a tunnel lower down, is used by a constant stream of cars and coaches.
- The old Collias road in Nîmes (Gard) has been restored for use as an access road for prevention of forest fires. It also serves as a much-appreciated footpath in the Gorges du Gardon, which have obtained the official “Grand Site de France” label and became a UNESCO biosphere reserve in 2015.

Using inventories for better knowledge and the right conservation decisions

If landscape protection, management and planning is to be promoted, it is essential to be familiar with the landscapes in order to take appropriate action. This entails making inventories of significant dry stone walling structures.

A few examples of this are given below:

- In the Balearics (Spain), Majorca Council’s Department of the Environment has catalogued miles of terrace walls and recorded dry stone walling sites. Any gaps or deformations in these structures, together with any gullies and channels hollowed out by run-off, have been studied to understand their origin and adapt site restoration accordingly.
- In the early 2000s, the village council of Limogne-en-Quercy in the Lot *département* (France) passed a by-law prohibiting destruction of low dry stone walls. This by-law also requires storage of stones, where available, so that they can be re-used at a later date to restore other walls visible from public areas and for public benefit. These low walls are a characteristic feature of the approach to the village and are part of the landscape’s identity value. As a signature feature of the village, they must be respected. Other councils, such as Felletin in the department of the Creuse, have organised village stockpiles.
- The work of the Association de Sauvegarde d’Entretien de Restauration du Patrimoine urbain et rural (ASERPUR, Association for Protecting, Maintaining and Restoring Urban and Rural Heritage), founded by Maurice Roustan in the Gard (France), has been included in the

computerised land register of the city of Nîmes. All the walls and *capitelles* (dry stone shelters) in the garrigue have been catalogued and are protected under the rules of the local development plan (PLU). The flash flood disaster of 1988 brought realisation of the drainage efficiency of the dry stone walls on the hills overlooking the city. A municipal grant was voted to help owners maintain these structures. It is important for council employees to be educated about dry stone walling in order to validate good practice.

- The work of the Pierre Sèche en Vaucluse association (Vaucluse Dry Stone Walling), founded by Danièle Larsen, in the Monts de Vaucluse in France has been used to make changes to the latest version of the local development plans (PLUs) for several municipalities with the help of inventories made by volunteers.

Human relations are underpinned by respect. Identifying heritage in local areas enables policy-makers, practitioners and the public to understand its purpose. It is necessary to respect the choices made by the builders of this heritage and the ingenuity with which they designed these structures.

The next step must be to include this concern in planning documents, with the aim of ensuring that dry stone walling's role in the landscape is properly recognised.

Fig. 117. Paz Valley, Asturias, Spain.



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