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The conservation of traditional olive oil mills in Cyprus

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ABSTRACT

Naturally grown and still present in the rural areas of Cyprus, olives and the oil they produce have had a significant place for Cypriots. Since olive oil has been used widely for culinary, religious, and medical purposes throughout history, the methods of oil extraction have developed from being very basic in ancient times to the machinery production of today. Olive mills that house this activity became integral parts of villages where olive groves were dense. More recently the establishment of large factories rendered traditional olive mills redundant and the lack of maintenance of these has resulted in serious deterioration. This paper presents olive oil mills as witnesses of a traditional way of life and a significant feature of the rural landscapes of Cyprus, and aims to develop conservation proposals. It focuses on the olive oil mills in the villages of the Karpas region, which has largely maintained its rural character and houses dense olive groves. The architectural and structural characteristics of 18 olive oil mills with traditional machinery that are located in 14 villages are documented and analysed. The study identifies major building defects and presents conservation strategies to address 12 olive oil mills.

KEYWORDS

Architectural conservation; traditional buildings; olive oil mill; rural heritage; rural tourism; Cyprus

1. Introduction

Most communities in rural areas have been built around agricultural production and traditional industries. The disruption of these has led to the migration to urban centres and the dereliction of rural areas. As in many other places, this has had a domino effect in Cyprus with the disruption of traditional industries in the mid-twentieth century. The long-term dereliction of traditional industrial buildings presents a conservation problem, and the solution to this has the potential to benefit rural communities. This dereliction is very visible when travelling through rural Cyprus, and inspired the work presented in this paper. These observations emphasized the urgency of the need to protect these olive oil mills and the lack of information from which to develop conservation strategies. The preliminary literature survey showed that there are few studies on olive oil mills in Cyprus and elsewhere.[1] The book on olive oil processing in Cyprus is mainly an archaeological study and outlines the historical development of olive oil production starting from very early ancient tools up to the Byzantine period.[2]

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This study, however, aims to provide detailed data about the olive oil mills built between the late nineteenth and mid-twentieth centuries, and proposed a holistic approach to their conservation. While some of the suggestions are specifically tailored to specific building types, and the conservation approach is developed according to the needs of a specific community; they can also serve as models for other buildings and communities facing similar situations. Thus, the research intends to contribute to both studies on traditional industrial buildings and to help communities to expand local economies through heritage conservation.

Cyprus is located in the eastern part of the Mediterranean Sea. Its climatic properties allow natural growth of plants such as carob and olive trees, fruits that have always had an important place in the daily life of local communities. As a perennial crop that does not require irrigation, olive trees are often found in hilly locations. Wild olive groves grow throughout the northeast and southwest parts of the island. They are dense at the foot of mountains; mainly the southern Troodos and eastern Kyrenia range. The cultivation of olive trees dates back to the ancient period by rooting wild trees and later officially spread on the island from two natural nurseries located close to the Limassol and Karpas regions.[3] Olives are generally harvested from October to December. While a minor part of the harvest is used as table olives edible after the salting process, the major part of the crops goes through the oil extraction process. In both forms, olives have a wide range of uses in traditional and contemporary life. As table olives, they are still an essential ingredient of breakfast and are consumed as a mezze in its green and black form and often eaten with bread. Olive oil, on the other hand, serves various culinary, medical, and religious purposes. The widespread use of olive oil has led to more sophisticated oil extraction tools to be developed and these were housed inside individual buildings known as olive oil mills.

Cyprus olive oil mills constitute an important part of the existing traditional building stock and represent its agriculture industry. Although their conservation is important in conveying information about this traditional industry to future generations, most of them have already been destroyed. The remaining mills are in poor condition, and very few have been preserved. It is therefore important to form a database that includes the architectural features, machinery, alterations, structural damage, and material deterioration as an initial step, in order to develop conservation proposals. The study is primarily based on the data collected in site surveys and is confined to the Karpas region in the northern part of Cyprus. Geographically referred to as the Karpas Peninsula, the study area is within the boundaries of İskele County, as defined in the administrative divisions of northern Cyprus illustrated in Figure 1, which provides both Turkish and former Greek names of the counties in parentheses. Yet, the geographical name will be used throughout the text.

The main criteria in selecting the Karpas region in İskele County as the study area are the density of the olive groves and the preserved rural character. Figure 2 illustrates the latest available statistics about the distribution of olive groves in northern Cyprus. Further criteria about the limitations of the study are provided in the methodology.

Among 35 villages situated in the region, 20 olive oil mills were found in 14 villages (Figure 3). However, two buildings in Kaplıca and Dipkarpaz were not measured and analysed since they were inaccessible. Although site preferences, some architectural features and type of machinery may change, they are all single-storey masonry buildings, which were constructed for the purpose of being olive oil mills and marked in British period

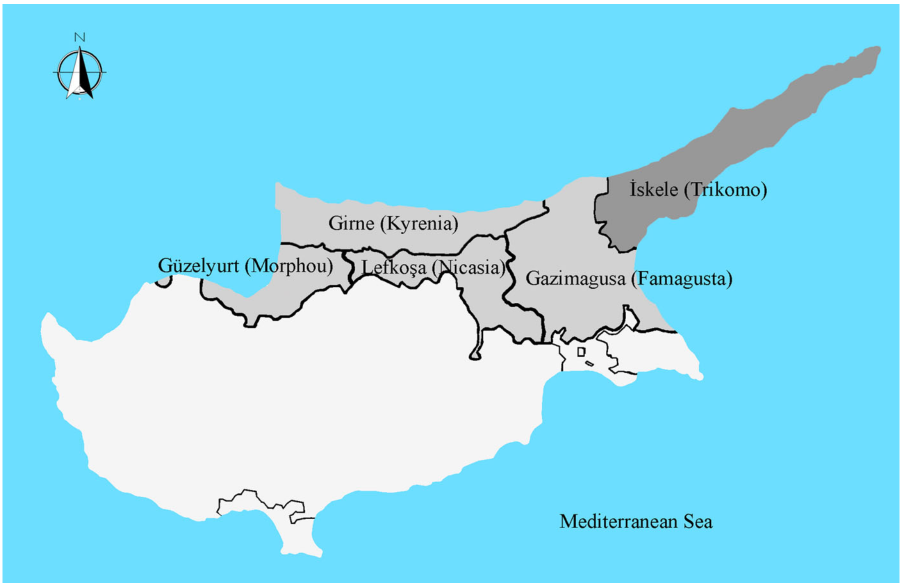

Figure 1. Map of Cyprus indicating the study area.

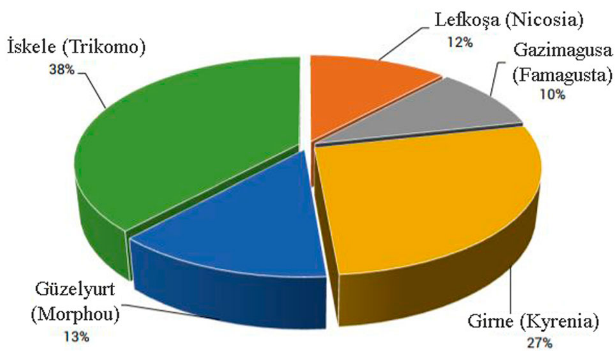

Figure 2. Distribution of the number of olive trees by region in 2016 (Agricultural Master Plan, 2017).

maps as such. Two of them have already been restored to serve as museums, 18 buildings are in poor condition and require urgent work. Among 18 measured olive oil mills, 6 buildings are excluded from the further study since they have either been restored or lost their authenticity. The following headings explain the detailed examination of the 12 mills and provide suggestions for their restoration together with a holistic conservation approach including reuse suggestions that are provided prior to the conclusion.

2. Limitations and methodology of the study

The buildings in the study were mostly built during the British rule of the island. Soon after the establishment of the Republic of Cyprus in 1960, the island was divided into two sectors in 1974. As a result, two major ethnic communities, who were previously living together, were displaced. While the Greek community settled in the southern

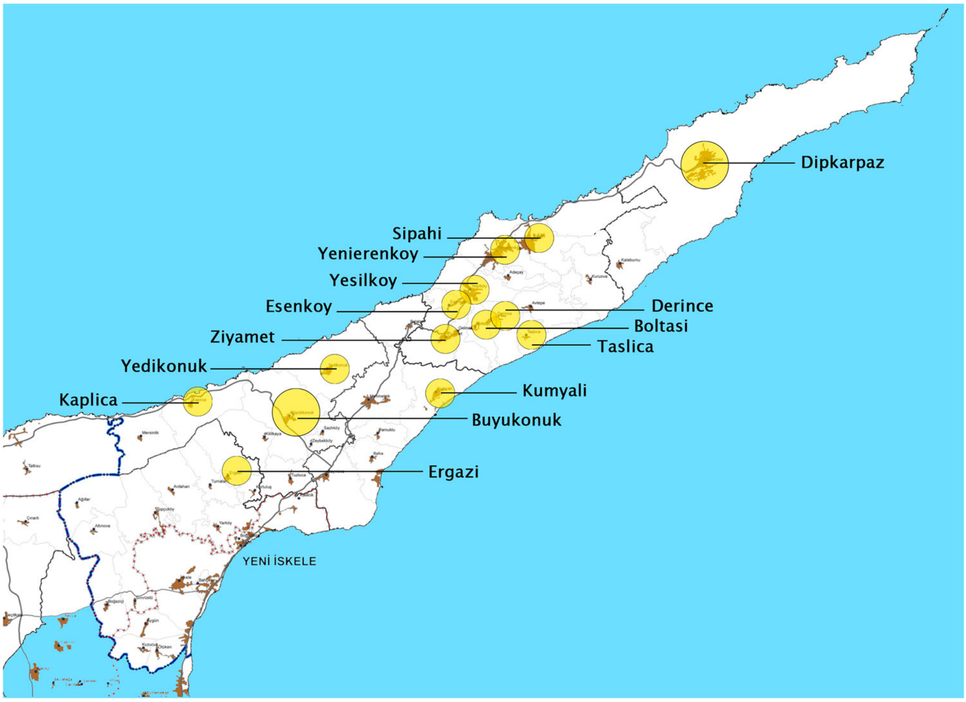

Figure 3. Locations of studied olive oil mills.

sector, the northern part was inhabited by the Turkish Cypriot community. Later in 1983, a politically unrecognized state was established in the north under the name of Turkish Republic of Northern Cyprus (TRNC). Since this situation still continues, most conservation studies cannot offer an island-wide perspective. Some other consequences of the division are the lack of accurate information about cultural heritage sites and their conservation status, a lack of policy consistency on similar type of buildings within the two sectors, and limited opportunities for the protection of heritage sites due to economic inefficiency on the northern part currently under embargo. The political dynamics of the island together with the amount of fieldwork required led to a geographical focus in the Karpas region towards the northeast of the Island. Although the selected area is set within an island-wide context, the rural character together with the urgent need for the protection of the buildings provided a suitable setting for the study.

The study has five main constituents; literature review, examination of archival documents, fieldwork, data analysis and an evaluation of conservation and local community needs:

- Literature review: The literature review is carried out parallel to the field survey. It is limited to written and electronic sources in both English and Turkish, and includes olive processing, olive oil presses and mills in Cyprus and elsewhere. Although information on more recent mills is lacking, there are some individual conservation studies from Turkey, Greece, Italy and Spain.
- Archive research: In order to check the legal protection status of the buildings, archives from the Department of Antiquities were reviewed. This showed that from 18 buildings

observed only 3 are listed and have already been restored. These have been examined with permission from the legal owners and responsible institutions.

- Fieldwork: Three architects specializing in architectural conservation, structural analysis and restoration carried out this between June and August 2017 with some extra visits later in September and November. It was carried out in the following stages:
  - Determining the locations of olive oil mills in the study area and preparing location maps.
  - Recording observations in inventory charts including photographs, sketches and notes on the physical properties of the buildings.
  - Measuring the buildings and preparing plans, sections and elevations at 1/100 scales.
  - Interviewing the relevant local authorities, owners and/or locals who have knowledge about the buildings.
- Data analysis: The data collected from fieldwork were analysed by considering architectural features (including the site, setting, plan layout, architectural elements, structural system, and construction techniques), machinery, alterations to buildings, material decay and structural damage.
- Local community needs: Restoration and rehabilitation proposals including the re-functioning of olive oil mills were developed during the final stage. National conservation policies together with local community needs played a significant role in the determination of reuse opportunities.

3. Fieldwork and research results

The fieldwork located the olive oil mills in their setting, produced plans, sections and elevations, defined architectural elements and alterations, and listed structural deformations.

3.1. Ownership and legal status

Ownership of the olive oil mills were identified as either private, the church/Evkaf, village cooperatives or municipalities. The rich and diverse cultural buildings of Cyprus were built during the Greek, Roman, Byzantine, Lusignian, Venetian, Ottoman and British periods prior to the establishment of the Cyprus Republic in 1960. The properties inherited were managed by Evkaf – the plural of Vakif or Vaqf – during the Ottoman period of the island.[4] Established by the Ottoman Empire and still active in Turkey and northern Cyprus, Evkaf are religious endowments or foundations serving to maintain religious, cultural and social activities. After the division in 1974, the responsibility for the care of most of the churches and monasteries, which belong to Church of Cyprus, fell to the Cyprus Evkaf Foundation. Any property that belonged to the churches, such as the olive mills have been under the responsibility of Evkaf.

The ownership of cooperatives, on the other hand, has remained from the British period. The first agricultural cooperative in Cyprus was established in 1909, as a credit cooperative by the villagers.[5] In 1914, the 'Law on Cooperatives' was enacted. According to the current legislation in northern Cyprus, cooperatives operate in areas such as agricultural production, industrial production, retail marketing, wholesale marketing, import/

export, housing, finance, credit, and banking. Since most of the industrialized mills were built during the British period, the villages, which need financial aid in buying machines, set up cooperatives in order to meet the expenses.

The legal conservation status of olive oil mills within the boundaries of church plots are listed by the Department of Antiquities and are therefore registered as cultural property, whilst the others are not listed. Table 1 provides the ownership status of the mills in relation to their setting.

3.2. Environment and setting

Village settlements in northern Cyprus exhibit different distribution patterns. In the plains, they form a compact pattern due to limited water resources and defence concerns.[6] Since topography, climate, and water resources differ on mountain slopes, the settlement pattern becomes more fragmented on the northern slopes and more compact on the southern slopes of the Kyrenia Mountains, which lie parallel to the north-east coast and covers a wide area of the TRNC in terms of land use.[7] Having more than half of this mountain range in the study area, the villages visited in the fieldwork present various patterns within the topography. The villages that have olive oil mills are generally close to the mountain range where the olive groves are dense and the mills are easily accessible in the centres.

It was observed that the mills are constructed as individual buildings in three different settings:

- In the courtyard of a house: In some villages wealthy residents who can afford to buy olive presses, constructed buildings for the purpose of olive oil extraction in their large courtyards and these mills also served other residents.
- As a part of a church complex: The relationship between olive oil extraction and the church has been noted from the literature. Hadjisavvas states in his archaeological survey of southern Cyprus that some olive presses and mills are found in the gardens of early Christian and Byzantine churches.[8] Our field survey suggests that

Table 1. Ownership status and location of studied olive oil mills.

Village	Ownership	Location
Taşlıca	Cyprus Evkaf Foundation (3)	Church (3)
Esenköy		
Kumyalı		
Ziyamet	Village cooperative (9)	Village centre (11)
Sipahi		
Yenierenköy		
Yedikonuk		
Büyükkonuk 2,3,4		
Dipkarpaz 1		
Boltaşlı		
Derince		
Büyükkonuk 1	Private (2)	
Büyükkonuk 5	Private (4)	House garden (4)
Yeşilköy		
Ergazi 1,2		
		Total 18

this had been going on until the recent past and some of the expenses of the church were generated by income from the sale of olive oil.

- In the village centre: Olive growing, harvesting, and processing are significant features of the socio-cultural life in the case study villages, as they require collective work. The olive oil mills are thus constructed as individual buildings close to the centre in the majority of the villages, where there is sufficient land to collect the harvested olives.

The olive oil mills were founded either by private owners, churches or cooperatives. As mentioned earlier the ones within the boundaries of church plots are listed by Department of Antiquities whilst the others are not listed. Table 1 provides the location and ownership status of studied olive mills.

3.3. Buildings

The buildings have evolved through time parallel with the evolution of oil extraction methods and technology. Following the harvest, olives are separated into those for eating and those for oil production. The ones that are chosen for the oil are transferred to the mill. Before industrialization, the mills comprised of a millstone, a pressure stone and stone bowls for oil collection. The mill operates by the rotation of a stone placed vertically on another round stone, which are tied by timber levers. It is turned by the help of either the villagers or donkeys (Figure 4(a,b)). As the stone turns the olives are crushed and then collected into in woven bags. Five or six bags are put on top of each other and are squeezed with a lever weighted with stones, or via a twisting rivet (Figure 4(c)). The extracted oil is collected in clay pots. Sometimes the bags are squeezed a few more times with hot water in order to extract more oil.

Although this was initially an outdoor activity, later housing the tools and machinery inside a building became more common, which gave way to the construction of olive oil

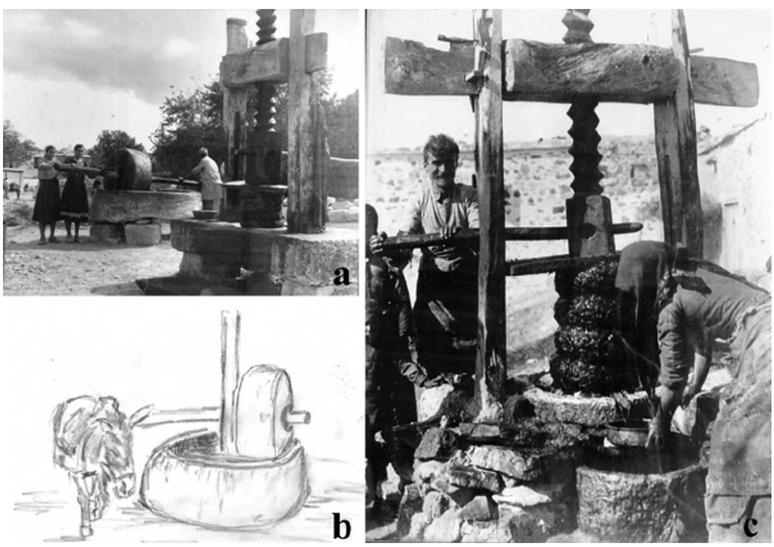

Figure 4. (a) Photo of villagers grinding olives in stone mill, (b) illustration of a mule rotating the millstone, and (c) photo of villagers pressing bags filled with crushed olives (Photos a and c are taken at Diner Olive Oil Factory).

mills. Small rectangular units for the mill and press were enough prior to the advent of industrial machinery. Later, these units grew larger but maintained their simplicity. All the buildings were single-storey masonry constructions of either stone or less commonly mud brick and were covered by slightly inclined gable roofs. Reinforced concrete columns, beams and flat roof slabs were employed for later additions. Details about the buildings are provided under following headings.

3.3.1. Space characteristics and plan layout

The olive oil mills generally comprise of one single space, the size of which varies depending upon the machinery it houses, and fall into three categories:

- TYPE A: These smallest sized mills constitute the first stage of olive oil mills that evolve through time. They house pre-industrial machinery; only a press in this type. The millstones for olive crushing are placed outside, generally in front of the building. They comprise of single space with a nearly square form measuring approximately 5.5 m × 6 m or 6 m × 7 m (Figure 5). Although their plan layouts are similar, the upper structure can be either a pitched roof or flat. The pitched roof can be carried either by an arch or a log acting as a ridge member. The masonry walls are stone, mud brick or sea-sand brick (Table 2).
- TYPE B: Different than Type A, these larger sized mills accommodate both the crushing millstone and press. They are single space buildings with a rectangular form measuring approximately 6 m × 10 m (Figure 6). The mills that fall into this type have flat roofs with traditional timber construction.
- TYPE C: Single space with a rectangular form measuring approximately 8 m × 16 m (Figure 7). These largest sized mills house industrial machinery working with diesel or later electrical engines. Although their plan layouts are similar, the roofs can be

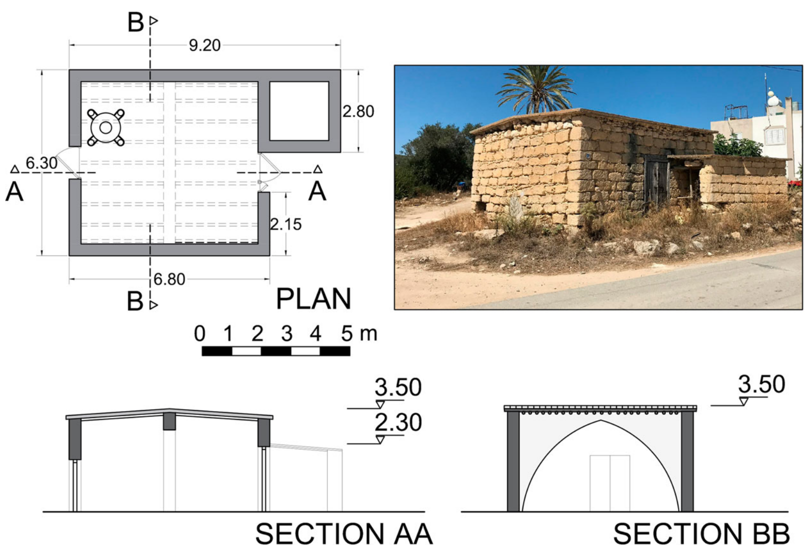

Figure 5. Type A olive oil mill in Boltaşlı (Litrangomi).

Table 2. Two different roof systems of the olive oil mills.

Village	Roof type	
	Originally traditional timber roof with timber beam and post, timber truss, pointed arches	RC slab over the traditional roof and RC slab only
Taşlıca	X	
Esenköy	X	
Kumyalı		X
Ziyamet		X
Sipahi	X	
Yenierenköy	X	
Yedikonuk		X
Büyükkonuk 1,2,3		X
Büyükkonuk 4,5	X	
Dipkarpaz	X	
Boltaşlı	X	
Derince		X
Yeşilköy	X	
Ergazi 1,2	X	

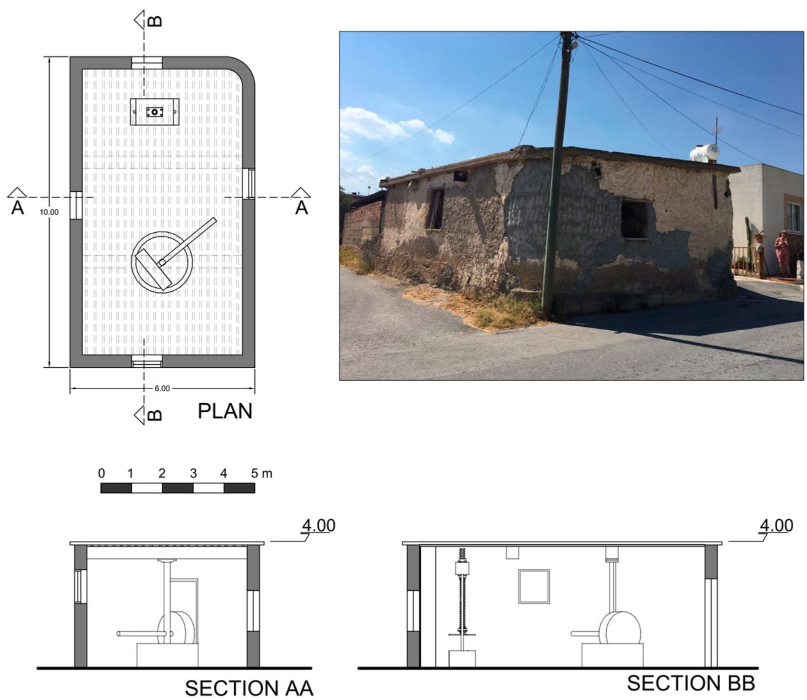

Figure 6. Type B olive oil mill in Ergazi (Ovgoros).

either pitched or flat. The structure of the pitched roof can sometimes be a timber truss (Table 2).

It is observed through the field surveys that additional spaces were constructed as needed so some comprise multiple units, which include additions to these basic two types.

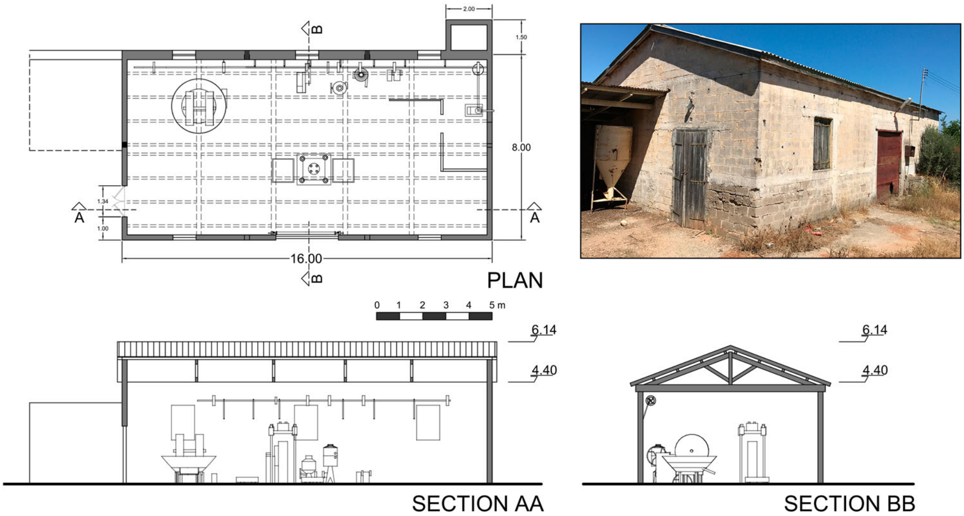

Figure 7. Type C olive oil mill in Sipahi (Aytrias).

3.3.2. Building elements

These include walls, roof structures, doors and windows, and floor surfaces under the following headings.

3.3.2.1. Walls. The walls are loadbearing and are constructed of either local yellow stone, adobe masonry or sea-sand brick. The earlier Type A and Type B mills have stonewalls of 40–50 cm thick. Nine buildings are constructed from yellow sand stone. The size and construction technique may vary mainly due to later interventions. The walls are originally plastered with traditional gypsum plaster, with some later additions being finished in cement render.

Adobe walls are in four olive oil mills where the stone foundations rise 40 cm above the ground. The adobe walls are around 50 cm thick and plastered with a mud-based mixture but much of this has been eroded due to weather conditions over the years. Owner of the two adobe masonry mills put the cement and gypsum plastering over the walls (Ergazi 1 and 2) and they claim that they prevent the collapse of their building.

Sea-sand brick walls are detected mostly in Type C olive oil mills, which were constructed during later periods. These walls are 25 cm thick and covered with cement plaster. The inner walls are covered with 10 cm × 10 cm white glazed ceramics up to 150 cm above the ground for reasons of hygiene and in order to prevent damage to the wall material from olive processing. Above this, there is gypsum plaster on the internal wall surfaces.

3.3.2.2. Roof structures. Most of the mills are covered with timber pitched roofs but there are few examples with flat roofs as later interventions (Table 2). The ridges of the pitched roofs in Type A mills are either timber logs of around 30 cm diameters or a pointed stone arch which acts as a ridge. If the ridge is a timber log, it is generally supported by a timber post in the middle of the space that also serves as a spinning centre post for the olive crushing stone as in the Esenköy and Ergazi 1 examples. In six mills, there are pointed arches instead of ridges and depending on the length of the space, there are two or more pointed arches in a mill. The roof structure over the arch or log has timber beams, wicker and mud at the top. In Type C mills the roof structures are timber trusses with a metal sheet as a top cover.

In four examples (Buyukkonuk1, Yedikonuk, Ziyamet, Kumyalı) RC slabs are constructed over the traditional timber roofs or arches. It is clear that these buildings had rainwater problem and faced with this wrong intervention in different time periods.

3.3.2.3. Doors and windows. Timber is the original material for the windows, doors and lintels for stone and adobe masonry mills that mostly fall to Type A and B. Those that have lost the timber elements have been replaced with metal.

3.3.2.4. Floor surfaces. The floors are finished with natural compacted soil for most of the mills. Cement floors are found in Type C mills or as later additions.

3.3.3. Machinery

The olive harvest has been handpicked or ‘shrugged’ for centuries, and this has remained virtually unchanged for thousands of years. Another tradition from ancient times in olive oil culture is oil extraction from its fruit without being treated with heat, otherwise known as cold pressed. Cold pressing is the earliest and healthiest method, as it does not require any chemical processing. The steps in olive oil production methods are the same, although different machines can be used:

Storage: Olives are removed for food and crushing after harvesting. There should not be much time between the olive harvest and the olive oil process.

Washing: The olives are washed to remove any waste.

Crushing: The olives are crushed to extract the olive oil. Stone mills are used for this.

Pressing: The crushed olives are placed in circular baskets on top of each other. Sometimes hot water is used during this process to extract more oil.

Decomposition: The mixed oil with prestrained water is left to rest. At this stage, the oil decomposes.

Olives are crushed and turned into paste, which is then squeezed or pressed. Finally, the oil is separated from the extracted water of the olive fruit (black water). At the beginning of the nineteenth century, hydraulic presses have been developed and today centrifugal forces are used to extract the oil without applying any presses.[9] The most common of these is the ‘continuity system’.

The machinery in Type A mills are the simplest stone mills with only press, while Type B mills house both olive crushing stone and press. Type C buildings accommodate early twentieth century machinery (Table 3). Figure 8 represents the machinery inside a Type B-Ergazi and Figure 9 Type C olive oil mill in Sipahi.

3.4. Structural damage types

Damages in the olive mills can be categorized according to the structural material of the mills. Among six adobe olive mills one has already collapsed and four have high structural damage, because they have collapsed parts and/or large (more than 1 cm) cracks. Three of these buildings have additional concrete or reinforced concrete roofs on their walls, whilst three of them have metal roofs. This means that none of these buildings have their original

Table 3. Mills and their machine types.

Village	Machinery type	
	Stone and press working with human and animal power	Hydraulic presses machinery
Taşlıca	X	
Esenköy	X	
Kumyalı		X
Ziyamet		X
Sipahi		X
Yenierenköy		X
Yedikonuk		X
Büyükkonuk 1	X	X
Büyükkonuk 2,3		X
Büyükkonuk 4,5	X	
Dipkarpaz		X
Boltaşlı	X	
Derince	X	
Yeşilköy	X	
Ergazi 1	X	
Ergazi 2		X

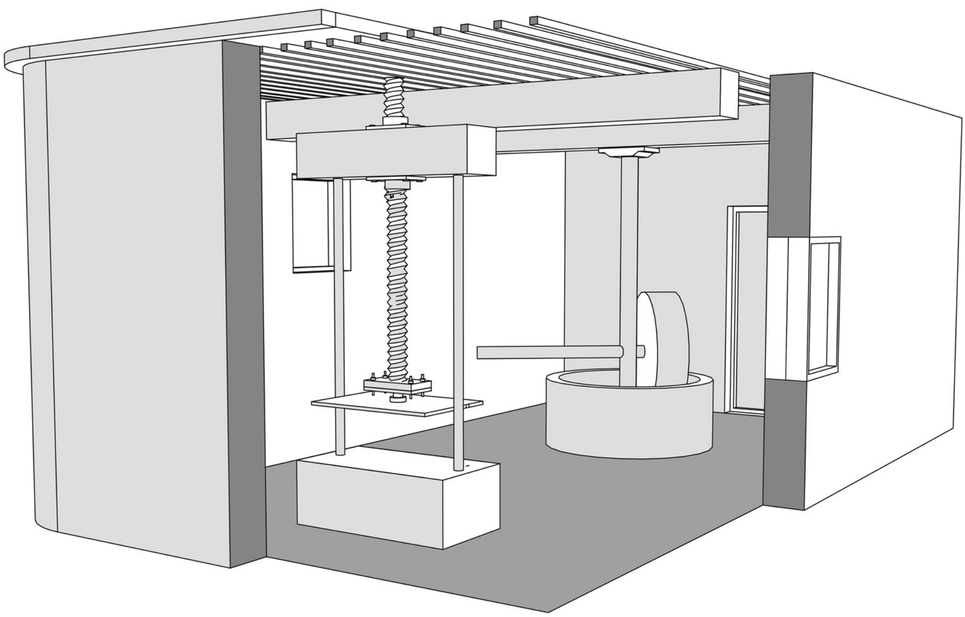

Figure 8. Machinery types in Type B mills – Ergazi (Ovgoros)

roofs. Metal roofs give harm to the originality of these structures, however the concrete roofs are heavy and they cause the collapse of these buildings in long term.

Four of these adobe buildings have large vertical cracks on their walls, whilst three of them have diagonal cracks. Figure 10 shows a large vertical crack and a large diagonal crack in Büyükkonuk 1 olive mill. There are thin vertical and diagonal cracks in all adobe olive mills. Holes are opened in the walls of Yenierenköy olive mill for the purpose of putting mechanical equipment pipes into the building. However, these holes did not affect the structure.

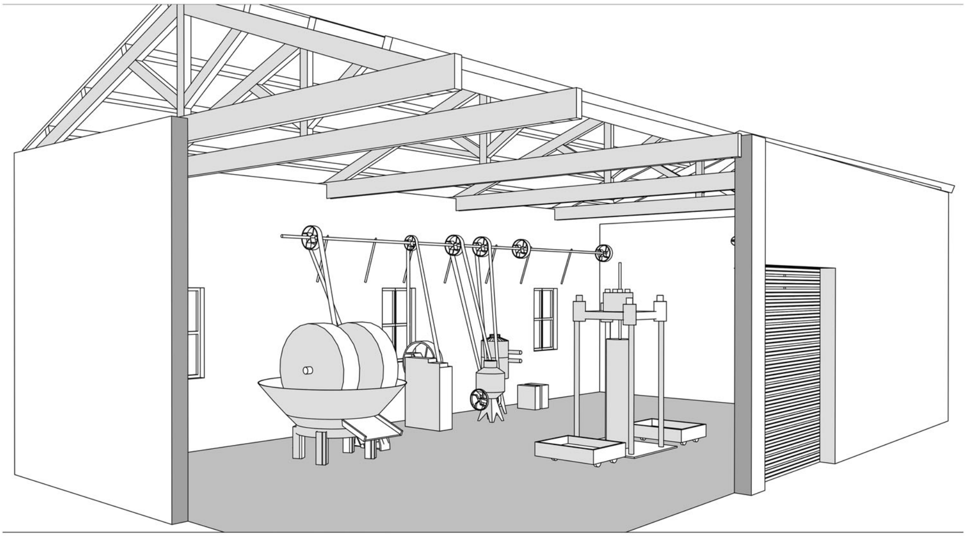

Figure 9. Machinery types in Type C mills – Sipahi (Aytrias)

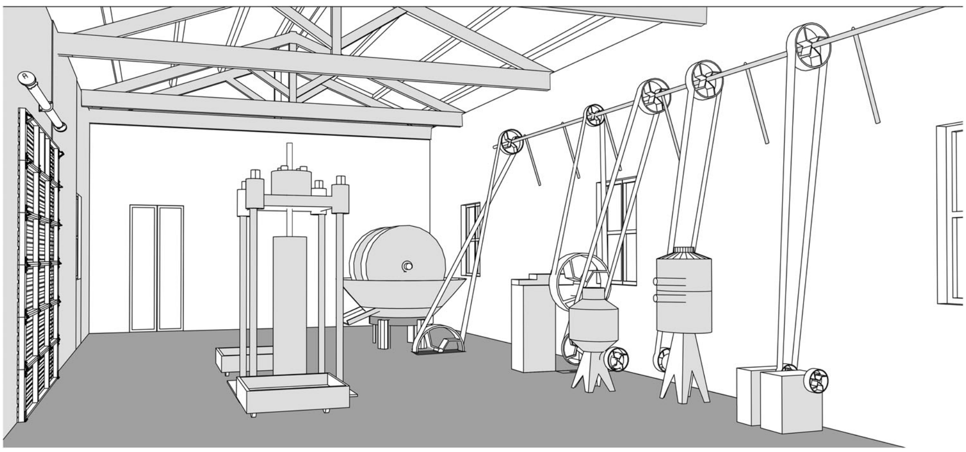

Figure 9. Continued

Some damages in the adobe buildings are at the places where adobe meets with stone. Stone is usually used at the corners and around the openings. Since locations of the stone parts are not evenly distributed on the plan of the building, this damage might be due to earthquakes during the past years. This might have caused twisting around these stone parts because mass of stone is larger than adobe. Three of the adobe buildings have been damaged because of the effect of slope and one of them have been damaged due to a tree which is growing inside the building.

There is considerable damage in the stone olive mills too. Four of the mills have lost their architectural character, one has been restored successfully, 5 of these 12 mills have high structural damage and 2 have medium damage depending on the collapsed parts

Figure 10. A vertical and a diagonal crack in the walls of Büyükkonuk1 olive mill.

and size of cracks in their walls. If there were collapsed parts and/or cracks larger than 1 cm, the damage has been classified as high damage.

Roof materials of 6 buildings out of 12 have been changed by adding reinforced concrete or concrete over the existing structure. One of the buildings currently has metal sheet roof cover. Figure 11 shows concrete slab on the roof of Esenköy and Buyukkonuk1 olive mills. As it is seen from the figure the concrete roof has already been separated from the walls.

There are collapsed parts in 5 out of 12 stone olive mills. There are large vertical cracks in the walls of 3/12 of the stone mills. There are large diagonal cracks in the walls of 2/12 of the mills. Holes have been opened in the walls of 2/12 of the mills. There are also thin vertical and diagonal cracks in all mills. Figure 12 shows a collapsed part in the walls of the Büyükkonuk 1 mill, a large vertical crack in a wall of the Boltaşlı mill and a large diagonal crack in a wall of the Taşlıca mill. 2/13 of the damage in the stone olive mills was due to slope.

3.5. Material deterioration

The visual assessment of the olive oil mills in the Karpas Peninsula showed that the most of the decay is caused by natural factors as well as human factors, namely neglect through abandonment. Poor quality later interventions (additional spaces, cement slabs, and plasters) have also led to major structural problems. The disappearance or loss of some parts of the windows, doors and roofs, and the deterioration of the bonding of the stone masonry

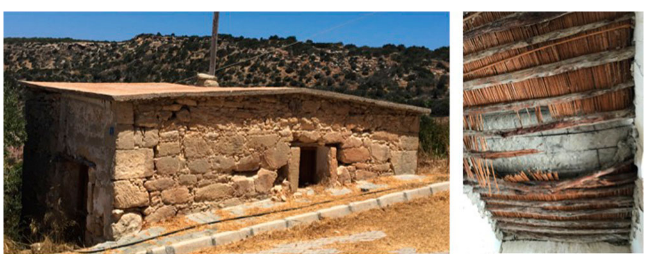

Figure 11. Concrete roof over Esenköy and Büyükkonuk 1 olive mills.

Figure 12. (a) A collapsed part in the walls of the Büyükkonuk 1 mill, (b) a large vertical crack in a wall of the Boltaşlı mill, and (c) a large diagonal crack in a wall of the Taşlıca mill.

has led to water penetration, plant growth, animal attacks, and corrosion of steel equipment.

There are incompatible interventions such as cement mortar and plastering the cracks repair, which did not stop them from widening. The buildings have also been plastered in some parts, and most of the plaster has vertical cracks in it. In some adobe buildings, wrong plaster material was used (Ergazi 1 and 2), which might cause deterioration of adobe as an organic material in long term. Adobe walls should have earth-based plaster. However, there were cement or gypsum-based plaster in some adobe olive mills. Climatic factors such as wind, sun and rain have led to severe damage to the adobe, stone and brick materials and jointing. These unwanted openings allowed rain water to enter, which has caused further damage.

After a preliminary analysis of the damage, signs of moisture penetration and mould were easily identifiable, especially on the north elevations. The internal walls of the buildings were also damaged by moisture as a result of the collapsed roof.

3.5.1. Ineffective roofing system

There are seven types of roof systems for the olive oil mills. Timber beam and post, timber truss, pointed arches, and timber beam roofs are the traditional roof systems with wicker mesh and soil on top. This traditional system was mostly inefficient and in a deteriorated condition in three mill buildings (Büyükkonuk 1, Boltaslı, Yesilkoy). Since most of the sample buildings have been abandoned, their roofs have collapsed as a result of the climatic factors and the lack of regular maintenance.

The disappearance of the roof structure have led to internal plant growth and moisture and staining on the wall surfaces. Since the traditional roof was not strong enough to withstand the weather conditions, incompatible interventions such as RC slabs collapsed the traditional roof and also brought major structural problems. This problem also accelerated the corrosion of the iron window bars and other steel elements in most of the buildings.

3.5.2. Timber decay

Timber that had been used for these buildings were obtained from Juniper trees that are mostly found in Cyprus. The timber was used as a post and beam system in all of the mills during their original construction. The durability of this wood is very high (against water and termites) and they remained in fair condition until the roofs (partial roof in some buildings) became damaged. The timber lintels, windows, door frames and shutters were in poor condition and some had disappeared altogether. This resulted in water ingress (roofs, walls, windows and doors) which caused the timber to become unstable and susceptible to fungal attack. It was noticed that some of the timbers were collapsed which may have been due to the later addition of RC slabs over the traditional roof construction.

3.5.3. Damage caused by animals

Pigeon damage was present in most of the mills due to openings and collapsed roofs.

3.5.4. Human factors

Numerous defective repairs were noticed including: inadequate new roofs, RC buttresses, steel I beams, cement plaster, and the closing/opening some openings (Figure 13). Inappropriate repairs like the extensive application of incompatible, impermeable materials, especially cement and RC buttresses and concrete post and beam and slab additions, over the years have significantly and irreversibly damaged the historic fabric both structurally and aesthetically (Figure 14). As a result, the decay of these structures increased and this requires major repairs (consolidation of stone, replacement of adobe and mortar and reintegration of missing elements-doors-windows, etc.).

To summarize, human neglect and the lack of proper maintenance or inadequate restoration has led to a negative impact on the historical, architectural, cultural and technical value of these buildings. Table 4 lists the major material damages, and provides an overview of the observed phenomena. Based on these findings, the following recommendations are set out for preserving and integrating this architectural heritage into the contemporary life.

Figure 13. A new door opened on the front façade of Yenierenköy.

Figure 14. (a) Inappropriate interventions – cement plastering, (b) additional spaces next to the mill, and (c) addition of RC buttresses.

Table 4. Major damages in building materials of the olive oil mills.

Effect of the environment	Damage in masonry	Damage in timber	Damage in sea-sand brick	Damage in Adobe	Damage in steel (press machines and iron bars)
Weathering	Cracking	Decay, Fragile, Broken		Deterioration of roofing material	
Erosion	Mortar fragmentation			Adobe fragmentation	
Dampness	Detachment of mortar covering	Fungal attacks Corrosion of metal connectors		Adobe crumbling	Corrosion of steel machines and irons bars
Vegetation	Mortar crumbling, crack formation on load bearing wall		Existence of trees nearby buildings causes crack on the walls	Mortar crumbling, crack formation on load bearing wall and inner spaces	
Animal effects	Corrosion of the steel, erosion on the stone and adobe surfaces.				
Human effects					
Inappropriate interventions	Inserting new roof, RC buttresses, Steel I beams, space, cement plaster, closing some of the openings – windows and doors and storing many items				
Storing many items in					
Incompatible materials					
Neglect					

4. Suggestions for holistic conservation

Underpinning this research, the conservation of olive oil mills is seen as part of the sustainable development of rural areas and ensures the physical maintenance of the structures. This should entail social and economic benefits for the local residents by integrating them into the related projects at several stages. The conservation, then, should follow two main interrelated paths: architectural restoration of olive oil mills and their reuse.

4.1. Restoration of olive oil mills

Suggestions for the restoration of the buildings are provided as follows.

4.1.1. Interventions to solve structural problems

Tables 5–8 address the conservation solutions and interventions to solve structural problems according to construction materials of olive oil mills. Figure 15(a,b) illustrates details for implementations.

Table 5. Structural restoration attempts for structural problems in stone walls.

Structural damage		Solution
Damage to roof structure	Damage to roof cover and beams	Design and reconstruction using the original system
	Damage to timber posts or stone arches	Design and reconstruction of a reversible frame structure which can carry the roof and also provide additional support to stone walls. E.g. There can be steel vertical elements, which are connected to walls with the help of metal tendons inserted into the walls.
Damage to walls	Collapsed minor parts	Partial reconstruction
	Cracks in buttresses	Partial reconstruction
	Presence of major vertical or horizontal cracks (larger than 1 cm)	Use of anchors containing steel bars and tendons (Figure 17(a)), injection of puzolanic lime-based grout into the cracks, wire-mesh and plaster application to the internal walls (Figure 17(b)).
	Presence of medium/minor vertical or horizontal cracks	Injection of puzolanic lime-based grout wherever necessary, wire-mesh and plaster application from inside of the problematic walls
	Use of earth mortar in the walls	Partial replacement

Note: If there is severe damage in stone structures, an additional steel frame can be added to carry the roof and support the walls.

Table 6. Structural restoration attempts for structural problems in adobe walls.

Structural damage		Solution
Damage to roof structure	Damage to roof cover and beams	Design and reconstruction using the original system
	Damage to timber posts or stone arches	Design and reconstruction of a reversible frame structure which can carry the roof and also provide additional support to adobe walls. There can be timber vertical and horizontal elements, which are connected to walls with the help of timber pieces locally inserted into the walls.
Damage to walls	Severe collapse	Reconstruction
	Collapse of small parts	Partial reconstruction
	Presence of major vertical or horizontal cracks (larger than 1 cm)	Design and reconstruction of a partial reversible frame structure which can support the cracked wall. There can be timber vertical and horizontal elements, which are connected to the wall with the help of timber pieces locally inserted into the wall. Wire-mesh and earth-based plaster application can be added to provide additional strength.
	Presence of medium/minor vertical or horizontal cracks	Wire-mesh and earth-based plaster application can provide additional strength (similar to Figure 15).
	Compost formation due to the use of incorrect plaster material	Removal of the existing plaster and application of earth-based plaster.

Note: If there is severe damage in adobe structures, an additional timber frame can be added to carry the roof and support the walls.

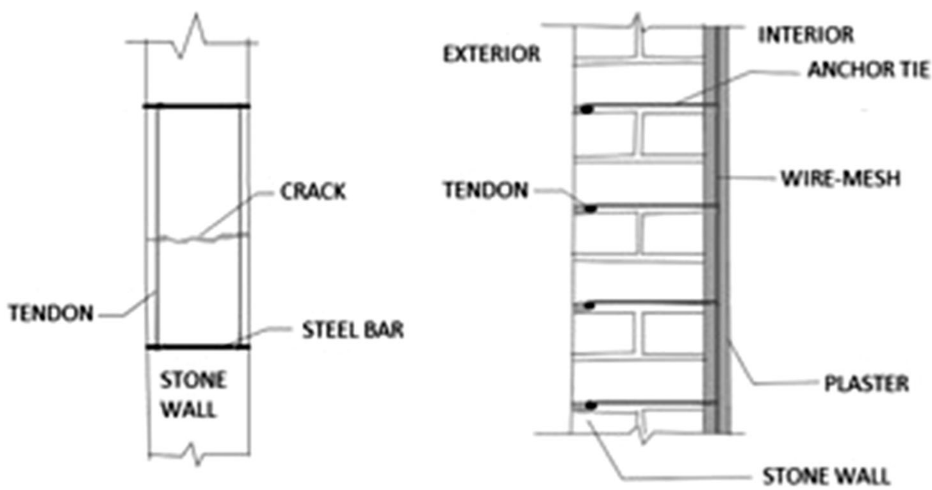

Figure 15. (a) Use of anchors containing steel bars and tendons and (b) wire-mesh and plaster application to the internal walls.

Table 7. Structure and structural damage in adobe masonry buildings and adobe or sea-sand brick or adobe + stone or sea-sand brick + stone masonry buildings with conservation proposals.

Building name	Wall and slab structure	Alterations	Wrong decisions	Damage in structure	Level of damage	Conservation proposal
Ergazi1 	Wall: Adobe masonry Slab: Timber and steel beams, metal sheet, concrete roof	Metal sheet, concrete roof Bad plastering	Concrete roof	• 2.5 cm vertical crack at the corner • 45 degree thin crack at the other corner	High damage	• Removal of plaster. • Wire-mesh and earth-based plaster application to all walls. • Addition of a timber frame should be considered to carry the roof and support the walls. • Design and reconstruction of the original roof cover.
Ergazi2 	Wall: Adobe masonry + buttresses outside + buttresses added inside Slab: Steel beam + RC slab	• Buttresses added inside • Plastering -RC slab	RC slab	• 1 cm vertical crack at corner • 2 cm vertical crack at the other corner due to slope	High damage	• Slope should be considered to eliminate future damage. • Removal of plaster. • Application of wire-mesh and earth-based plaster application to all walls. • Addition of a timber frame should be considered to carry the roof and support the walls. • Design and reconstruction of the original roof cover.

(*Continued*)

Table 7. Continued.

Building name	Wall and slab structure	Alterations	Wrong decisions	Damage in structure	Level of damage	Conservation proposal
Sipahi 	Wall: Back wall is rubble stone, other walls are sea-sand brick, no interlocking at corner cut stones, RC vertical and horizontal tie-beams (not at corners) Slab: Timber truss + metal sheet	Metal sheet	• No interlocking at corners • No vertical tie-beams at corners	• 2 cm vertical crack at the corner • Diagonal crack at the same corner because of slope, incorrect structure and addition of water storage	High damage	• Slope and water storage should be considered to eliminate future damage. • Plaster should be removed. • Wire-mesh and cement-based plaster application to interior walls. • Addition of a steel frame should be considered to carry the roof and support the walls. • Stone parts should be balanced to avoid twisting. • Design and reconstruction of the original roof cover.
Yenierenkoy 	Wall: Rubble stone back wall, sea-sand brick at other walls, RC vertical and horizontal tie-beams Slab: Timber truss + metal sheet	Added parts are connected with metal hooks. Metal sheet	-	• Holes opened for pipes • New large door opened • Vertical thin crack beside the vertical tie-beam • 45 degree crack because of slope	Medium damage	• Slope should be considered to eliminate future damage. • Added parts should be removed. • Holes should be closed. • Plaster should be removed. • Wire-mesh and cement-based plaster application to interior walls. • The new door should be replaced with the original. • Stone parts should be balanced to avoid twisting. • Design and reconstruction of the original roof cover.

Table 8. Structure and structural damage in stone masonry buildings with conservation proposals.

Building name	Wall and Slab structure	Alterations	Wrong decisions	Damage in structure	Level of damage	Conservation proposal
Boltaşlı 	Wall: Stone masonry Slab: 1 pointed stone arch + RC slab	RC slab	RC slab	• Collapsed part • 8 cm vertical crack at one corner • 1 cm vertical crack at another corner	High damage	• Partial reconstruction of the collapsed part. • Use of anchors containing steel bars and tendons. • Injection of puzolanic lime-based grout into the cracks, wire-mesh and plaster. application to the internal walls. • Addition of a steel frame should be considered to carry the roof and support the walls. • Design and reconstruction of the original roof cover.
Buyukkonuk1 	Wall: Stone masonry Slab: Pointed stone arches	• Roof system changed • Internal plastering	–	• 2 cm crack between wall and arch • 45 degree 4 cm crack at the corner • 45 degree 2 cm crack at other corner • Collapsed parts	High damage	• Partial reconstruction of the collapsed parts. • Anchors + steel bars + tendons for the vertical and diagonal cracks. • Injection of puzolanic lime-based grout into the cracks, wire-mesh and plaster application to the internal walls. • Addition of a steel frame should be considered to carry the roof and support the walls. • Design and reconstruction of the original roof cover.

(*Continued*)

Table 8. Continued.

Building name	Wall and Slab structure	Alterations	Wrong decisions	Damage in structure	Level of damage	Conservation proposal
Esenköy 	Wall: Stone masonry Slab: Timber beams	–	–	• Roof has a belly • 5 cm vertical crack at the corner due to slope • Collapsed parts	High damage	• Slope should be considered to eliminate future damage. • Reconstruction of the collapsed parts. • Use of anchors containing steel bars and tendons. • Injection of puzolanic lime-based grout into the cracks, wire-mesh and plaster application to the internal walls. • Addition of a steel frame should be considered to carry the roof and support the walls. • Design and reconstruction of the original roof cover
Kumyalı 	Wall: Stone masonry Slab: Timber beam + metal sheet	Plastered Metal sheet	–	No damage	• No damage • Lost character	Not suggested

Taşlıca 	Wall: Stone masonry Slab: Multiple arches Concrete on wicker + mud	Badly plastered Concrete roof	Concrete roof	• Hole which caused 45 degree major crack • Vertical cracks on plaster close to arches • Corner is damaged • 45 degree major crack at corner	High damage	• Plaster should be removed. • Anchors + steel bars + tendons for vertical and diagonal cracks. • Injection of puzolanic lime-based grout into the cracks, wire-mesh and plaster application to the internal walls. • Reconstruction of the damaged part. • Addition of a steel frame should be considered to carry the roof and support the walls. • Design and reconstruction of the original roof cover.
Yedikonuk 	Wall: Stone masonry Slab: RC slab + RC beam + vertical element	Plastering RC slab	RC slab	Holes opened for electricity	Medium damage	• Holes should be closed. • Plaster should be removed. • Design and reconstruction of the original roof cover.
Yeşilköy 	Wall: Stone masonry Slab: Timber beams	Partial plastering inside	–	No roof	Medium Damaged	• Holes should be closed. • Plaster should be removed. • Design and reconstruction of the original roof cover.

(*Continued*)

Table 8. Continued.

Building name	Wall and Slab structure	Alterations	Wrong decisions	Damage in structure	Level of damage	Conservation proposal
Ziyamet 	Wall: Stone masonry + RC columns + stone buttresses at front Slab: RC slab added	• RC system added • Plastered	RC system –	• Column has damages • Corner collapsed • 45 degree thin crack at corner	High damage	• Removal of the damaged RC column. • Plaster should be removed. • Partial reconstruction of the collapsed part. • Injection of puzolanic lime-based grout into the cracks, wire-mesh and plaster application to the internal walls. • Addition of a steel frame should be considered to carry the roof and support the walls. • Design and reconstruction of the original roof and its cover.

4.1.2. Interventions to solve material problems

The structure and fabric of most of the case study buildings were in varying states of decay caused by weather conditions, lack of maintenance and long-term neglect. This has affected walls and render, windows, doors, and roofs. The most extensive damage was to the masonry, staining of the stone blocks adjacent to the missing windows, decay to timber lintels, doors and windows due to moisture, damage to roofs, vegetation growth, and severe cracking due to weather and inappropriate interventions.

The following remedial measures are recommended:

- Most of the timber lintels, windows, and door elements are in poor condition and require repair. Measures should be taken to protect all of the timber elements from fungal decay, and those beyond repair should be replaced.
- The roofs should be reconstructed using the traditional Cypriot roof system (juniper tree, wicker and mud), to ensure rainwater and other environmental agents do not enter and harm the structure.
- The cracks on the stone and mud brick walls should be repaired by the injection of impermeable fillers.
- All cement mortar joints between the stone and cement plastering should be replaced with a lime-based mortar for stone buildings and mud-brick plastering for adobe to ensure compatibility of the materials while maintaining the historic fabric of the buildings.
- The intervention for the stone buildings should be also non-aggressive and restoration works should respect the chemical and mineralogical properties and surface characteristics of the stone already existing in the monument. Cleaning is often one of the first steps to remove staining from the stone surface. Consolidation is necessary to restore and make the stone at least as strong as it was originally, so it can prevent further decay.
- Corrosion of the steel beams and the mechanical equipment should be cleaned and lubricated as required.

4.2. Adaptive reuse of olive oil mills

The evaluation of research data demonstrates that the current situations of olive oil mills show differences with respect to their conservation status, ownership pattern, physical state and the machinery they contain. One common feature is that all but two are currently obsolete. As already stated in the related literature, obsolescence is a common cause of decay and in the long-term leads to their destruction.[10] In order to sustain the conservation of the olive oil mills, their utilization is crucial. Re-use opportunities should be evaluated in terms of sustainability, which respects the rural character of the region, considers the benefits of the rural population and encourages rural development. Among several factors acting as a catalyst, tourism has the biggest share in the economic growth of northern Cyprus according to latest statistics of the State Planning Organization.[11] This share is mostly generated in the major urban centres on the Mediterranean coast where the tourism model is characterized by summer time accommodation in massive hotel chains. More recently, however, there has been an increased interest in cultural diversification, where tourism has played a significant role in rural development.[12] Some Mediterranean countries, such as Spain and Italy, are known to attract tourism by establishing cultural travel routes including agricultural activities. This helps to increase the production of olives and olive oil and thus the sustainability of local culture which includes the growing of trees, harvesting, oil production, and the promotion of Mediterranean cuisine where olive oil is the primary ingredient.[13] Olive-olive oil tourism, which has many activities such as the presentation of olive oil in traditional bazaars, museums, fairs and festivals, is becoming more prevalent in most Mediterranean countries.[14]

The contribution of olive mills to the European Route of Industrial Heritage (ERIH) can also be considered. The report on *Industrial Heritage and Agri/Rural Tourism in Europe* prepared by the European Parliament's Committee on Transport and Tourism underlines the importance of the interrelation and importance of rural tourism and industrial heritage tourism.[15] As stated in the report, they both are helpful in keeping features of heritage landscapes. While their aid can be directly processed through the conservation and re-use of heritage buildings for tourism purposes, valorization of the work of conservation agencies in financial terms through visitor income can indirectly helpful. Both rural tourism and industrial heritage tourism have potential for job-creating opportunities and job training impacts.

The economic contribution of olive and olive oil tourism can be provided through the following activities:

- The introduction of olive, olive oil, and soap products obtained from olive farming,
- Demonstrations of the production processes of these products in the form of training and marketing to tourists,
- The expansion of gastronomic tourism by olive oil tasting and advocacy of Mediterranean style nutrition.
- The new tourism model can be implemented by museology (monitoring production processes in olive oil workshops), agricultural tourism (olive picking tours), rural tourism (visiting olive production areas), and gourmet tourism (extra virgin olive oil tasting and culinary arts tourism).

Set within a wider context there are opportunities for extending tourism opportunities beyond olive oil products such as black and green olives, soap, oil and its related activities. Other examples include grapes and its products such as wine, grape molasses, grape juice; carobs and its products such as the juice of the carob pod referred to as 'carob honey' and their warehouses can also create tourism opportunities within the cultural heritage of the Karpas area. All of these products and their buildings-olive oil mills, vineyards, and carob warehouses in the Karpas area can be promoted through thematic heritage routes that will bring together a variety of activities and attractions under a unified theme, and thus motivate micro-entrepreneurial opportunities through the development of additional products and services.[16] This type of tourism will bring more positive impacts in terms of sustainable economies, mitigate the migration from rural area, and regenerate rural micro-economies in Cyprus.

Similarly, as it is stated in National Physical Plan (NPP, 2012, 2015) and Agricultural Master Plan, 2017 in North Cyprus, tourism-related activities help to reactivate social and economic condition for local communities and villages.[17] The olive agriculture and olive oil production, grapes and its products, and carob (carob juice-black gold) are important elements of cultural heritage that can be integrated into heritage routes in the Karpas Peninsula. The beauty of the location and the spatial character of the olive oil mills make a convincing case for an alternative tourism in the area. In this way the 18 inactive olive oil mills could be conserved through a comprehensive conservation approach except the totally destroyed (Buyukkonuk 5), already restored (Buyukkonuk 4 and Dipkarpaz) and Derince, Kumyalı mills that already lost their character. The first step is enough investment to restore the basic building envelopes and consider re-use opportunities (although in some cases this may be the retention of olive oil production but within an agri-tourism context). New functions may include space for tasting, marketing, sales, cooking, workspaces, education spaces, etc. New compatible annexes may be added or already existing annexes could be re-functioned with respect to the existing character of the mills.

5. Conclusion

Olives, olive oil, and its production are not only part of a country, but have also been an integral part of life for thousands of years as a common cultural heritage of Mediterranean geography. The island of Cyprus had been a special settlement for people of different religions and ethnicity, who have always been connected with olive and olive oil production in their daily lives. The traditional olive oil mills are worthy of interest and protection as significant witnesses that shed light on agricultural production, and the social, commercial and cultural life of rural Cyprus. Their conservation and maintenance therefore becomes important in terms of the sustainability of agro-industries and rural development. However, their conservation is often hampered by the fact that mills are largely obsolete with newly established factories serving the region and resulting in the depopulation of rural areas. With these problems in mind, the conservation of olive oil mills in the Karpas region, which still maintains its rural character, have been addressed within the scope of the study. The results of the research showed that only 2 of them were already restored and reused as museums, while 18 are derelict and in poor condition. The study provides principals for architectural restoration of the olive mills and suggests their adaptive reuse in a holistic way in order to guarantee their long-term wellbeing. The reuse options are built around cultural and rural tourism that is characterized mainly with natural, cultural and social characteristics of the area can be appreciated with the thematic cultural routes – olive route in this case. Along this route, the villages need to provide commercial and cultural facilities and accommodation for tourists. This type of tourism also brings participation of different stakeholders such as farmers, villagers, village cooperatives and small businesses.

Notes

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No potential conflict of interest was reported by the authors.

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