270: Water conservation in the traditional environment of the island of Sifnos, Greece

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Abstract

The vernacular architecture of every area is based on the accumulated experience and practice of many centuries and can constitute a continuous source of knowledge. The paper focuses on the island of Sifnos, which forms part of the Cyclades islands complex, in order to present and analyse the various features of its vernacular architecture, which are related to water conservation. These do not only involve morphological elements such as, flat roofs, gutters and cisterns (water reservoirs) in almost every building, but also large-scale interventions to the natural environment, with the creation of terraces (*pezoules*) on many hillsides. The aim of this analysis is to record these elements and investigate ways to integrate them in contemporary buildings, structures and landscaping.

Keywords: Sifnos, water storage, water preservation, cisterns, terraces

1. Introduction

Water is one of the most important and necessary elements for life on the planet. The development of human civilisation in most parts of the globe is and always has been closely linked to the presence of water elements (rivers, lakes, etc.). All human activities, ranging from biological needs and personal hygiene to economic activities, such as agriculture and industry, are dependent on this valuable resource. Today, water is treated as an important and valuable resource that must be preserved. UNEP stresses that *the equitable and sustainable management of water resources is a major global challenge.* [1] Greece is among those areas of the planet that suffer from drought and is cited on the high-risk list of international organisations.

The issue of collecting, managing and distributing drinkable water has always been of capital importance for human societies from early on. [2] In countries with low water availability, like Greece, the practice of collecting rainwater is reflected not only in large, historical structures, but also in the vernacular architecture. The importance attached to collecting and managing the biggest possible amount of rainwater is easily discerned in the vernacular architecture of the Aegean islands, an area of Greece with relatively low water availability.

The study, which is presented in this paper, is a first attempt to address the issue of water conservation through the investigation of the different ways in which this was promoted and accomplished in both the built and the natural traditional environment of the island of Sifnos. The main part of the study includes the identification, the presentation and the analysis of a series of functional and/or morphological elements, which are incorporated in almost every building, as well as of large-scale interventions to the natural environment, all of which aim at the exploitation of rainwater.

The aim of this analysis is to reach conclusions concerning the importance of these elements and the easiness and/or difficulties of architecturally integrating them in existing (refurbished) and contemporary buildings, structures and landscaping. For this reason, a preliminary attempt is made to depict the relationship and the integration of water-conservation equipment and spaces in a series of draft, typological drawings.

2. The use of water in Greece

2.1 Historical data

Throughout the history of Greece, there are many important architectural monuments of the Roman and Byzantine period, such as aqueducts and cisterns, which are closely related to the collection and distribution of drinkable water, especially in dry areas. Such historical structures can be found in most large, greek cities (e.g. Athens, Halkida, Kavala, etc.).

Furthermore, the need for water conservation is evident in the anonymous, vernacular architecture of smaller towns and villages, both in the greek mainland and on the islands. There, the low availability of groundwater and the scarcity of rainfall lead to a series of features, which were related to water-conservation. The close relationship of vernacular architecture with the climate and the available natural resources resulted in the construction of cisterns and water reservoirs in almost every building.

2.2 Present situation

In Greece, water consumption is mostly connected with agriculture (85-87%). [3] This is immediately related to the large increase in irrigated surfaces during the past 70 years [3], the

cultivated crops [4], and the irrational and inefficient means of irrigation, like surface irrigation and artificial rain [2]. In the industrial sector, the conservation and/or the recycling of water is not possible, because in most cases no water processing systems are used.
While water consumption is continuously increasing due to the rise of population, the improvement of living standards, and the constant growth of economic activities, water resources remain the same or decrease. With rainfall gradually reducing, drought and quality degradation problems become, day-by-day, more intense [2].

3. Presentation of the study

3.1 Methodology

This study attempts to document and analyse the various water-related features, which are integrated to the design of buildings and open spaces in vernacular settlements. The Cyclades region in Greece is an area, which has suffered from limited water-availability and drought from very early on. For this reason, both the production of the built environment and the shaping of the landscape, aimed at preserving this important natural resource. From the islands of the Cyclades complex, the Sifnos is chosen as a case study.
First of all, basic data concerning the climate and particularly rainfall are given for the wider Cyclades area, as well as for Sifnos. The main part of the study includes the recording and the presentation of the various aspects of the traditional environment, which contribute to the conservation of water and the exploitation of rainwater. These interventions are divided into two distinct parts, the first, and most extensive one, involving buildings and their immediate surroundings and the second, the landscape and the open countryside.
The analysis is primarily based on a bibliographic research concerning the traditional, built environment of the island. It should be noted, though, that in most references, links between the relationship of water and the various built elements are scarce. For this reason, the main part of the analysis is based on a series of in-situ visits and field trips, around the main traditional settlements of the island and across various traditional paths, during which different interventions were detected and photographed.

3.2 Geographic and climatic data

Sifnos is situated at the south-western end of the Cyclades complex, at 37°N latitude and 24.7°E longitude. (Fig.1)
The traditional settlements of the island are situated in the mainland (Apollonia, Artemonas, Katavati, Exambela, Ano and Kato Petali), as well as on the coast (Kastro, Faros, Heronissos). (Fig.2)

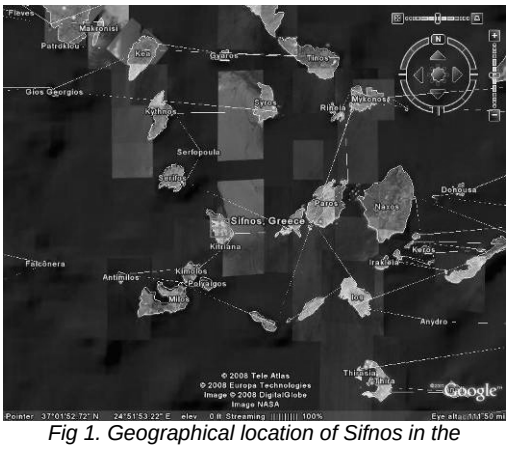

Fig 1. Geographical location of Sifnos in the Cyclades complex.
Source: Google Earth

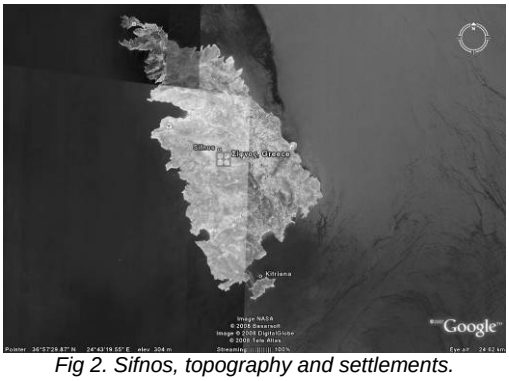

Fig 2. Sifnos, topography and settlements.
Source: Google Earth

The climate can be characterised as Mediterranean, with mild, short winters and warm, dry summers. (Figs.3 and 4) Rainfall is scarce and is restricted to the period from October to March. (Fig.5) The total, annual amount of rainfall is 385 mm.

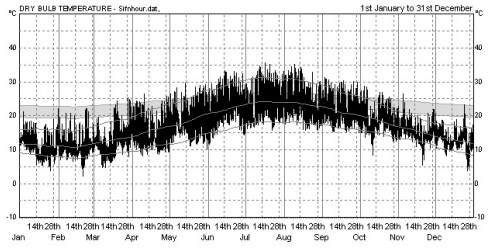

Fig 3. Hourly dry bulb temperature values for Sifnos.
Source: [7], with climatic data from [6].

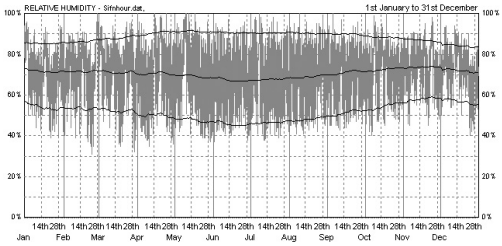

Fig 4. Hourly relative humidity values for Sifnos.
Source: [7], with climatic data from [6].

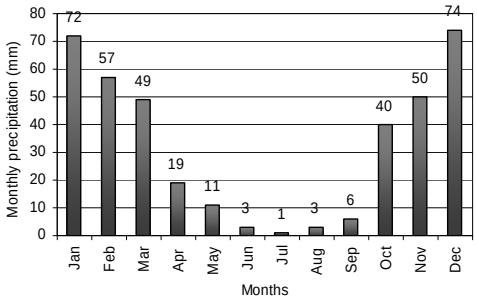

Fig 5. Monthly rainfall for Sifnos.
Source: Adapted from [6].

3.3 Water conservation in buildings

Water conservation in traditional buildings in Sifnos, and all around the Cyclades complex, involves different elements of the house: the roof where the rain falls and the cistern, where the water is collected, as well as the ways in which it is conducted from the place of incidence (the roof) to the space of storage (the cistern).

In order to collect the largest possible amount of rainwater, traditional buildings in Sifnos have flat roofs. The typical, vernacular flat roof construction involved multiple layers of natural and local materials, each of which fulfils a different function. (Fig.6) The final, external layer, which was a mixture of lime and oil, was renewed every autumn and acted as water-proofing, preventing water from penetrating the structure of the roof, while at the same time, keeping the surface of the roof and, consequently the rainwater falling on it, clean. [8]

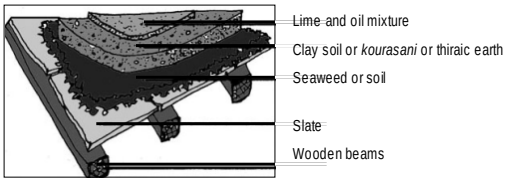

Fig 6. Typical flat roof construction in Sifnos.
Source: Drawn after the description given in [8].

During the rainfall, the water, which was accumulated on the surface of the roof, was conducted to the water reservoir (cistern or *sterna*). This was achieved with a variety of morphological elements, which ranged from simple to more complex ones. A simple way of leading the water towards the cistern was the moulding of the external rendering of the house in such a way as to create a channel (*kanalos*). (Figs.7 to 9) Another way was the creation of gutters (*ydroroes, aykles* or *kiougkia*), which "ran" parallel to one or more building facades and were plastered in order to protrude from them and stand out as decorative elements of the simple, white, cubist architecture. [8] These were usually made of fired clay -the island has a long and continuing tradition in pottery-, which were incorporated to the facades and then plastered.

A more sophisticated and, probably, more recent way of collecting and storing rainwater from the flat roof involved the use of tin "boxes", which were introduced in the beginning or at the end of the gutter. (Figs.10 to 12) These rectangular "boxes" lead the water from the roof to the gutter or from the gutter to the cistern, but also had a hole in one of their sides. Their function was quite simple: at the beginning of the first rainfall of the season, the hole that lead to the cistern was blocked and water was forced to exit from the side hole. In this way, the flat roof surface was cleaned in a natural way and the "first" water, which carried dirt, was rejected. After that, the side hole is blocked and clean rainwater was collected in the cistern.

Fig 7. Façade of abandoned traditional house with channel for rainwater.

Fig 8. Façade of traditional house with two channels for rainwater.

Fig 9. Façade of traditional house with three channels for rainwater.

Fig 10. Detail of gutter in combination with tin box.

Fig 11. Detail of gutter in combination with tin box.

Fig 12. Detail of gutter in combination with tin box.

The cistern is an enclosed space/room, usually underground, where the rainwater is stored during the winter period and used throughout the year. Its size varies depending on the position of the house in the settlement, the type of settlement, and in some cases, the composition of the ground.

In the medieval, fortified settlement of Kastro, cisterns have a small size. On the other hand, houses that are situated in less densely built settlements (Fig.13) or in the countryside, have more spacious cisterns, which are usually situated beneath the yard (*avli*) (Fig.14). The same applies to the many country churches and monasteries, which are situated along the various paths of the island. In some cases, as in the village of Faros, where the ground consists mainly of granite-type rocks that cannot be easily extracted, cisterns are constructed over the ground, forming small rooms. In all the afore-mentioned cases, the cistern is also employed as a volumetric/ morphological element, adding to the complexity and the combination of volumes that characterise the architecture of the Cyclades' islands. The opening of the cistern usually forms a protrusion, which usually has a well-like opening (Figs.13 and 15).

Fig 13. Cistern below the front yard of a house in Artemonas, with gutter with the tin box and well-like opening.

Fig 14. Cistern in the centre of the yard of a country-house (Mousia) on the south of the island.

Fig 15. Detail of the opening of the cistern of Fig. 14.

Fig 16. Country house with open cistern.

The use of the collected rainwater varies according to the house (country or urban) and, consequently, to its needs. It also depended on the maintenance of the cistern. Frequently cleaned cisterns provide water not only for secondary activities, but also for drinking and cooking. In country houses, water from the cistern could also be used to water the plants or the animals. There were also country-houses where the cisterns were open and were used for other activities. (Fig.16)

Finally, in the case of country churches and monasteries, which are still active, rainwater is accumulated throughout the year in order to provide drinking water for the occasional visitors, but, most important, to be used on the day of the feast of the protecting saint (*panigiri*). On that day, water from the cistern is used in order to clean the church and the surrounding buildings, to cook, etc.

3.4 Water conservation in landscaping

The limited water availability not only affected traditional architecture, but also led to a series of interventions to the landscape. These involved the creation of terraces (*pezoules*) on many hillsides with the building of dry-stone walls. (Figs.17 and 18) In this way, people aimed at increasing water absorption, while at the same time, controlling soil erosion. The terraces are usually planted with olive trees, which are indigenous to the Mediterranean, are able to withstand heat and drought, and provide the people with the most valuable ingredient of their diet: olive oil.

Fig 17. Terraces with olive trees on a hillside of the island.

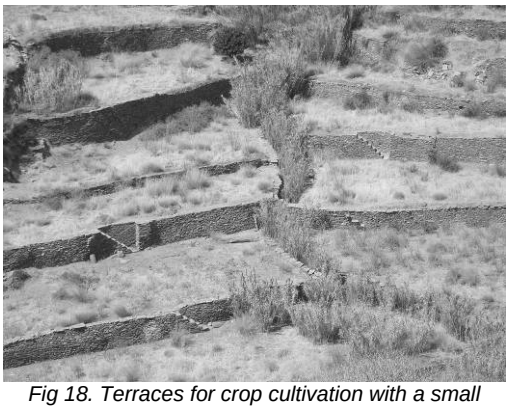

Fig 18. Terraces for crop cultivation with a small stream in between.

4. Proposals – Learning from the past

4.1 Existing buildings - refurbishment

In existing / refurbished buildings, where the cistern and the ducts already exist, it is relatively easy to maintain, restore and continue to use them. The main problem, which arises in refurbishments, is the replacement of the old ducts (ceramic or tin) with new ones made of PVC, which has become a common practice during the last decade. Unfortunately, this is also the case in new buildings. This option is not viewed as an environmentally friendly one due to the important environmental impact of this material in terms of embodied energy, gaseous (CO_2, SO_2 and NOx) and toxic emissions during the production, etc. [9]. Furthermore, the gutters are usually left exposed to solar radiation, which causes their rapid degradation and need for replacement.

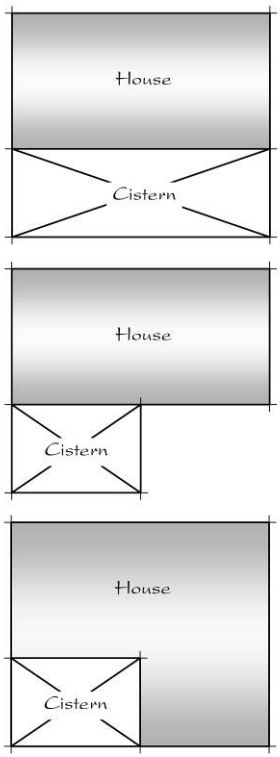

Fig 19. Draft, typological drawings depicting the relationship between the house and the cistern.

4.2 Contemporary buildings

In contemporary buildings, the integration of the cistern can follow the traditional principles and be constructed below the yard of the house (Fig.19). In areas without granite rock formations, the cistern can also be incorporated to the volume of the house, as part of the basement. In every case, the accumulated water can be used, apart from cleaning and watering the plants, in the house toilets (flushing). This requires a carefully designed plumbing network, which cannot easily be integrated in existing structures.

The choice of the morphology of the channels or gutters can be decided according to the settlement where the house is situated. The same applies to the choice of materials, which should not include the use of PVC (see 4.1).

4.3 Landscaping

Contemporary solutions for landscaping usually involve the rebuilding of the existing dry-stone walls or the creation of new ones with the use of prefabricated steel frames filled with slate rocks. (Fig.20)

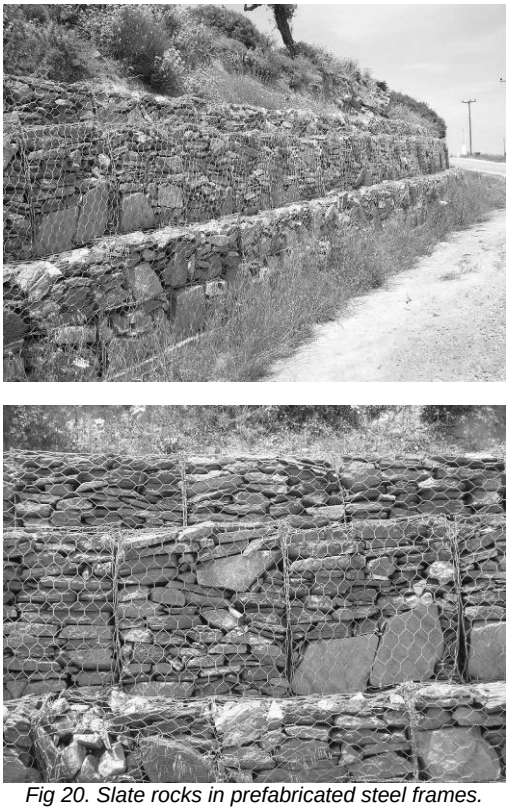

Fig 20. Slate rocks in prefabricated steel frames.

5. Conclusion

Nowadays, in many greek islands most water-conservation strategies have been forgotten and abandoned, mainly due to the development of tourism and the drastic modification of the way of life and activities that it caused. This fact, combined with all the afore-mentioned data render the need to look into the past for solutions very important. The interventions, which were described in this paper, can be viewed as a first step towards this direction. Furthermore, given the fact that in many Greek islands, presidential decrees make the construction of a cistern in every new building obligatory, the integration of such morphological elements in contemporary structures can constitute an interesting challenge for architects and designers.

Apart from the traditional elements presented in this paper, contemporary techniques for water conservation have been developed and must be applied to areas with limited water-availability. These include various water treatment and purification systems, [2] among which those that employ plants can be viewed as the most suitable for the traditional environment.

Finally, concerning the landscape, contemporary interventions may involve the construction of small dams along the path of streams. In this way, during the winter period, when the streams are active, the quantity of water absorbed by the ground is maximised, while soil erosion is largely reduced. This was applied successfully in the area of Aperathos, at the island of Naxos. [10]

6. Acknowledgement

This paper is dedicated to the memory of Nikolaos Kalamaris, who taught us to observe and to love both the natural and the built environment of Sifnos.

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