

Thermal Comfort in the Vernacular Structures of the Traditional Settlements of Pelion-Greece

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Abstract

The traditional settlements in Pelion have been studied many times through the years due to the rich architectural and cultural heritage that sustains through the centuries in a beautiful and diverse natural environment. Most of these studies focused on the form and the structure of the buildings in the context of tradition, socio-political and economic and historic conditions as well as the prevailing building techniques in the time they developed. The major findings of my previous research at UCLA in 1997 on “The revitalization of the traditional settlements in Pelion, Greece. Strategies for economic and tourism development in the context of preservation of the natural and human environment”, indicated that the villages possess a great diversity of cultural and natural resources and potential that will help them revitalize culturally, socially and economically without compromising future changes. My conclusions of this study led me to continue further my research and examine the issue of thermal comfort, in the traditional houses of the classical era (1750-1850) which represent the prevailing and most recognizable architectural form of the houses in Pelion that derive from the model houses of the broad Balkan area during the Ottoman occupancy. Special attributes of these structures are the climatic elements of these that make them viable even after the centuries that passed. My research included on site temperature measurements on specific buildings for 3 full years.

During the recent years the great area of Pelion experienced fervent construction activity which focused mainly in restoring and remodelling the old building fabric. For that reason I strongly believe that knowing the bioclimatic elements and attributes that the buildings possess is critical for the preservation of the existing as well as the new buildings of the area.

Keywords: *Sustainability, Thermal comfort, vernacular architecture,*

1 The settlements at Pelion

The traditional settlements in the mountain of Pelion in Greece have been admired through the centuries for their impressive setting and architecture. They developed and flourished economically and culturally under the Ottoman Empire during the “Greek Enlightenment”. With the advent of the industrial revolution the villages failed to compete with the fast developing urban centers. Therefore their economies started to decline. Economic depression and depopulation were the main characteristics of the region for a long period of time. Dereliction has led to the degradation and partly the distraction of the rich architectural heritage.



Figure 1: Map of the area

However the villages possessed a great diversity of cultural and natural resources and potential that helped them sustain and revitalize in the recent years. This is probably due to the fact that the traditional settlements of Pelion were initially formed and evolved with many sustainable attributes. The settlers chose wisely the location based on good orientation, protection from the weather and enemies and availability of natural resources such as water and prosperous land for family production. Self sufficiency and local autonomy were the most important factors that led to a strong economy which grew beyond family production. The respect for the environment is among the many important attributes that the villages had to show. The settlers understood the importance and their dependence on it and therefore, tried to protect and nourish it. The

villages were established in a beautiful and rich landscape and yet did not harm it. On the contrary they enhanced it with harmonious structures built with indigenous materials.

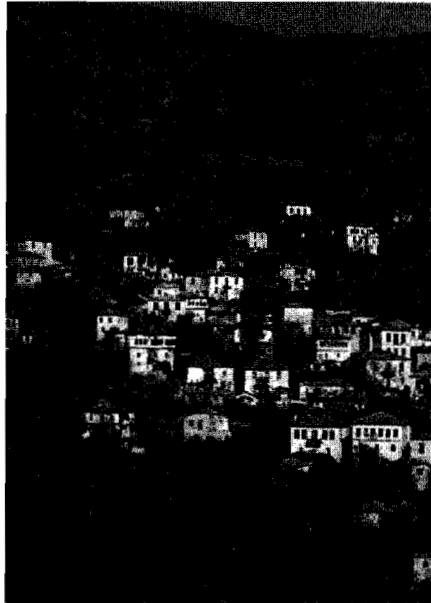


Image 1: The village of Pinakates

My research focuses on the way the traditional settlements developed with consideration and sensitivity to the climate and the natural environment. Furthermore, the effort of the local builders and the inhabitants to comprehend and respond to the local weather conditions, in order to protect or benefit from them and create an agreeable microclimate inside and around the house.

The climatic elements in the vernacular buildings can be enlightening since these structures yield valuable lessons to the designer and builder, on how one can design with and not against the forces of nature focusing on the thermal comfort of the inhabitants.

The settlements of Pelion were formed dynamically with the successive migrations that occurred in the period between the 17th and 19th century. The buildings under study belong to the middle period (1750-1850) and they comprise the classical Pelion architecture (Kizis 1994). This is the period of the socioeconomic flourish and prosperity and these structures that constitute the known Architecture of Pelion have many similarities with the architecture of the broader region of the Balkans and Asia Minor under the Ottoman Empire. (Stylianou, 1987, Kizis, 1994).

2 Climatic Elements of the Vernacular Buildings at Pelion

2.1 Climate analysis

The region of Pelion generally belongs to the ‘Mediterranean mountainous’ climate, which is characterized by fairly cold winters with strong NE winds, rains and rainstorms, and very often snow. The temperature is often around or below the freezing point (0° C). The summers are hot with temperatures around 30°C (86° F) and in hot spells can rise above 35°C (95°F).

The significance of micro-climate should always be taken under consideration. In the specific area, climatic conditions differentiate slightly between the East and the West sides. The East side faces immediately the sea and thus is more vulnerable to cold winds and air. Some villages (facing south east) benefit less from the low western sun in winter time because of the slope of the mountain. Humidity is much higher than from the West side and the breezes in the summer are cooler. In the West side the climate follows the same patterns but it is more temperate and humidity is much lower.

2.1.1 Community planning and outdoor comfort

Even though the form and structure of the vernacular dwellings in Pelion was determined by many factors, (cultural, topography, socioeconomic, functional, tradition, availability of materials etc.) climate was not disregarded. Many climatic characteristics can be distinguished in community scale as well as in the individual houses.

The planning articulation of the communities was not the outcome of any specific plan. However its structure is not coincidental. It is evident that circulation, orientation, adjacency to the cultivable and grazing land and distribution of natural elements (air, water and light) were taken under consideration. (Makris, 1976)

Usually the setting of the villages is oriented towards the south, southwest on slopes. The morphology of the landscape is a defining factor in the configuration of the villages. The steep slopes in most of them result in an amphitheatrical arrangement that allows for views in most of the structures. The dwellings are not clustered due to an “unwritten” law that required that all structures should be separated by approximately 1m to allow the rain-water to pass. This configuration enhances ventilation, and better solar access in all the facades, during the different times of the day throughout the year. The rich vegetation provided satisfactory shading in the outdoors spaces (yards, plazas, roads). (F. 2)

The deviations of the landscape presented different problems that depended on the intuition and invention of the residents for solutions. These peculiarities of the settlements led to a great variety and diversity among the villages and even though they all followed common guidelines, each and every one of them appear unique in its own interesting features and environment.

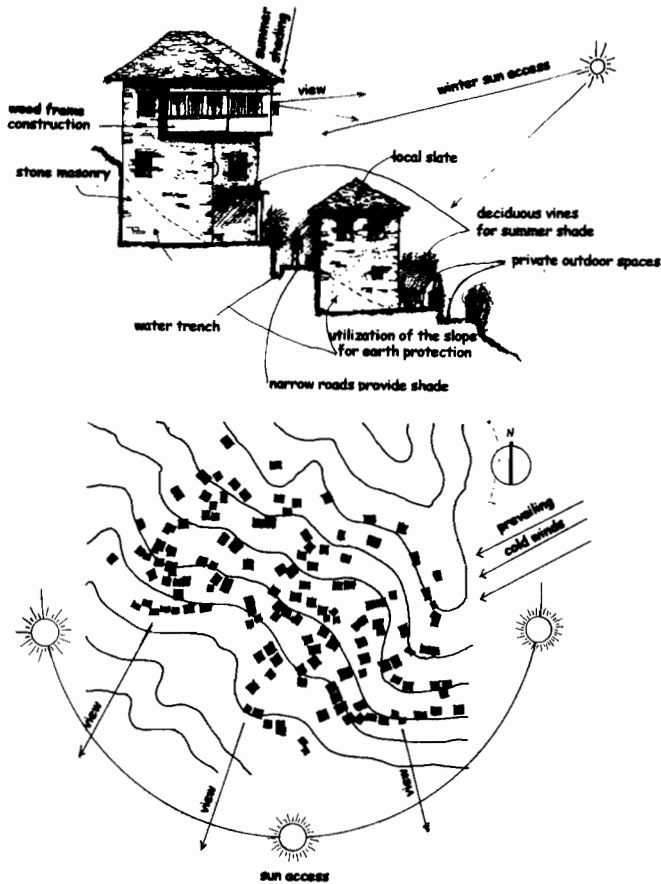


Figure 2: Climatic elements of the community

Outdoor activities are a very important part of the life in the villages, especially during the warm months of the year. Therefore, outdoor comfort becomes very essential for the life and well being of inhabitants. Careful landscaping with trees and many plants can modify dramatically the micro-climate and create agreeable conditions around the house.

In community scale, the narrow winding flagstone trails can be pleasant when adequately shaded by either the surrounding structures, or vegetation and trees. The shade, in combination with running waters in the ditch at the side of the road, enhances the moisture of the air and the cooling effect. The plazas accommodate many people throughout the day, all year round, especially in the high tourist seasons. The huge old plane - tree shades most of the area of the plaza providing great comfort even in the hottest days while it loses all its leaves in the winter when sun is needed.

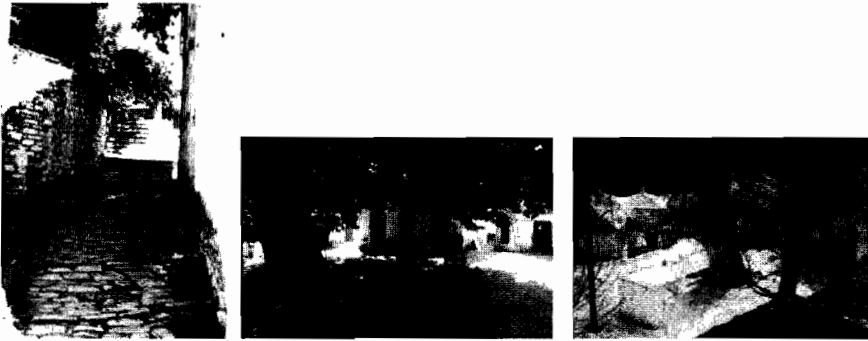


Image 2: Outdoor spaces and the plaza

2.1.2 The house

The houses were fortified, tower like buildings, concentrated on safety. They usually consisted of three floors made of stone and were characterized by the daring wooden cantilevered projections of the last floor. All the levels were divided in two zones the front and the back by a thick structural wall. This division helped accommodate the different functions of the household. The back zone or the inner house (Kizis, 1994) was used for the storage of the goods on the ground floor and for the private rooms on the rest. The front zone or the outer house accommodated the social and join activities of the family as well as domestic and manufacturing activities.

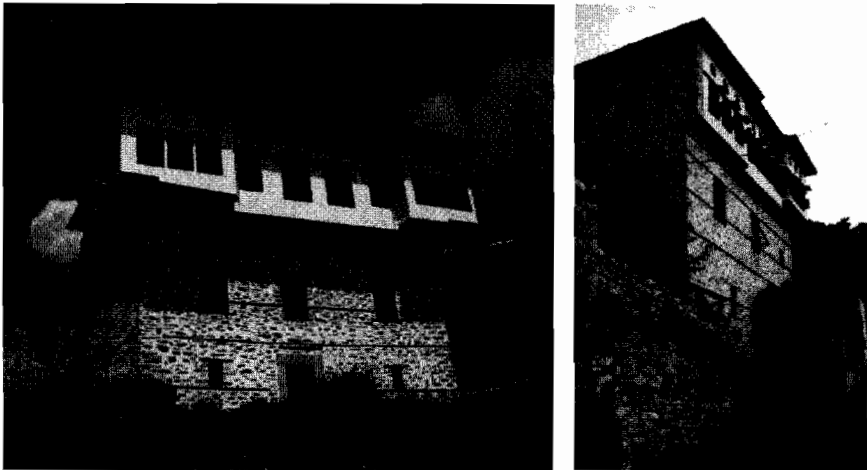


Image 3: Houses of the classical period

The first two floors were made of stone and had only very few openings (for safety reasons). The last floor appears much different with a projecting wooden structure perforated by many openings. In earlier examples these projections included open spaces where the family production took place during the hot

months of the summer.

The inhabitants of the villages in Pelion migrated seasonally either between villages (from the highest elevations in the summer to the lower in the winter) or between the different parts of the house.

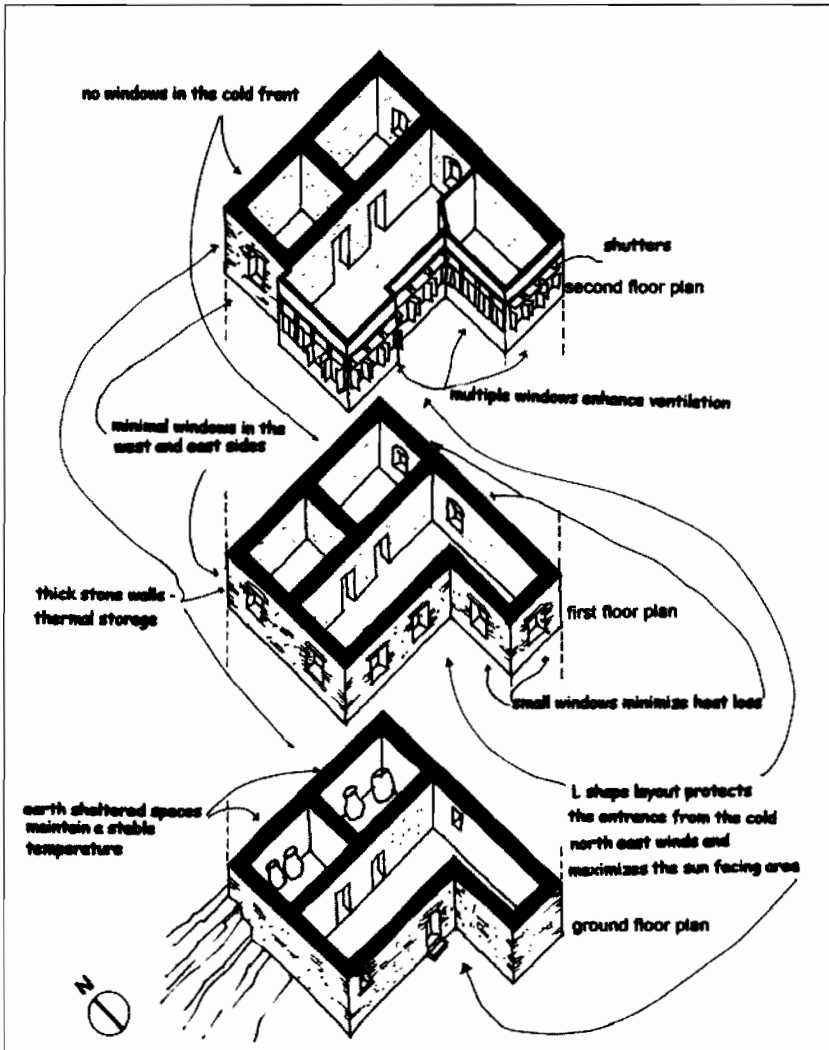


Figure 3: Climatic elements of the structures

The winter house was usually in the middle or lower level with very small height and had the bedrooms in the back zone (which was usually facing the north). The north wall had no windows to minimize the impact of the cold front and the only window in the room was usually facing east or west. In most of the examples these rooms were heated from the fireplace, usually located in the

middle of the back wall. The front zone accommodated the family and also had minimal windows facing south, east and west in order to take advantage of the sun. The small number of windows as well as the small height and the floor above minimized the heat losses in this floor, assured more comfortable temperatures and protected the residents from the extreme weather.

The summer house was always located in the top floor and followed the same pattern. The main difference here was the gallery in the front zone with the wood structure projecting in the south, southwest and southeast. This wall was penetrated by an array of openings. These windows helped a lot in the ventilation, especially cross ventilation and had always shutters on the outside. In the north side the thick masonry walls continued all the way to the roof, with only a few openings, and the great mass helped minimize heat gain. During the summer these rooms maintained a fairly cool temperature that made them ideal for sleeping.

The ground floor and especially the back zone usually penetrated the slope of the mountain and took benefit of the insulating characteristics of the earth. In addition the levels above helped this zone maintain a permanent temperature and thus be ideal for food storage. (Fig. 3)

The outdoor activities constituted an important part in the life of the inhabitants. For this reason, the yard was an indispensable piece of every household. During the warm months the local inhabitants spent most of the time outside, protected from direct sun by trellises, covered with the foliage of the deciduous vines. The shading devices also shaded the building itself and helped minimize overheating. In many houses the yards were surrounding the building and were therefore used in different time of the day. Vegetation and planting of the surrounding area provide significant shade to the outside walls. Deciduous trees are preferable since they lose their leaves in the winter when shade is not desired.

2.1.3 The materials

The main materials used in construction in the area of Pelion were stone and wood which the rich mountain possessed in abundance. The stone walls were constructed very thick (usually 80cm or more), mainly for structural reasons. The stones were laid on earth mortar with timber ties at intervals of approximately 1-1.5m to reinforce the structure. The stone walls had no insulation except from the lime mortar and the first layer of the exterior plaster (where applicable) that consisted of tiny bits of flax. This great mass constitutes an important thermal element that could store the heat from the sun and dissipate it in the interior of the house in the later hours of the day when temperature drops. In hot summer days the mass of the walls prevents the penetration of the heat in the interior. At night when the ambient temperature is cooler the retained heat could be flushed out by conduction with ventilation.

At the southern sides of the structures the masonry stopped before the last floor where wooden jetties were constructed. These cantilevered structures sometimes projected as much as 2m especially in the early examples in order to

maximize the floor area. (Kizis, 1994) The jetties were constructed by either corbelled timber beams or oblique braces and sometimes by a combination of these techniques. (Kizis, 1994) The wooden walls of the last floor consisted of a system of horizontal and vertical members that formed a frame which was then filled with wattle and daub. Rubble was also used as infill and occasionally brick or lath and plaster.

The roof was wooden and 4-hipped, and the eaves which provided shade to the upper floor, were wooden and often decorated. Wood was also used in the construction of the upper floors (the ground floor was usually mud or slates), ceilings, the window casements, the shutters and the doors. Many architectural elements were standardized in size dimensions and proportion as a result of the long experience of the builders and craftsmen that moved in the area from the northern parts of Greece.



Image 4: The structure: Stone walls and the wooden jetties

The shutter was an important and versatile element in the building tradition of the area. It could be manipulated to provide shade, night insulation and even promote ventilation. The design of the shutters has evolved in different forms during the long architectural history of the area. Most of these types have been salvaged. There are two component and three component shutters. (Image 5) The one with the three pieces allows for greater flexibility since it can work as both an overhang and fin. In the late 19th century the German shutters were

Introduced, which consisted of two louvered pieces. The louvers were operable and could be manipulated to allow the air to penetrate the building or be completely shut.

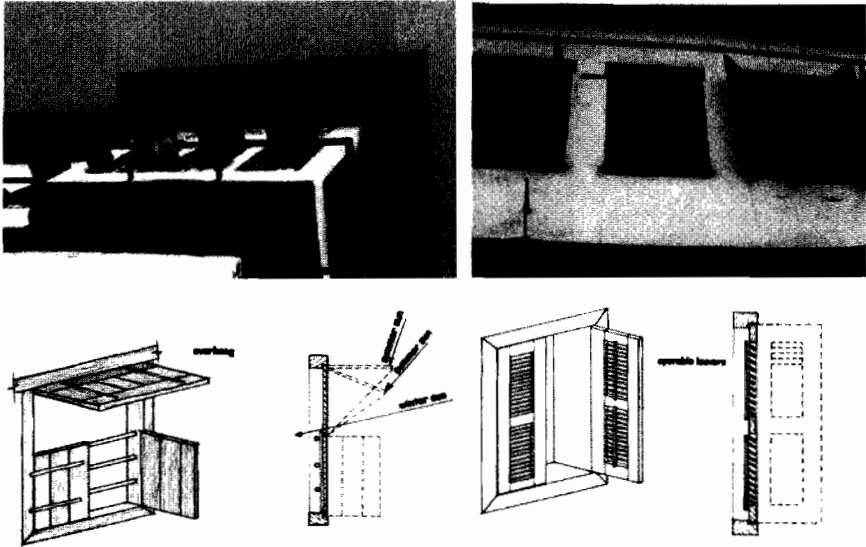


Image 5: The wooden shutters

2.1.4 Design guidelines

All of the above concerning the response of the buildings to the climate were further researched with the temperature measurements on two houses in different villages. I will present part of the results on one of them. The house was built in the early 19th century. It sustains its original form, space articulation and elements despite the restoration and rehabilitation that took place in the early 1990's. The window panes are still single and no insulation was added to the exterior walls. The house is heated by the fireplaces (one on the first and one on the second floor) and a small heater on the ground floor.

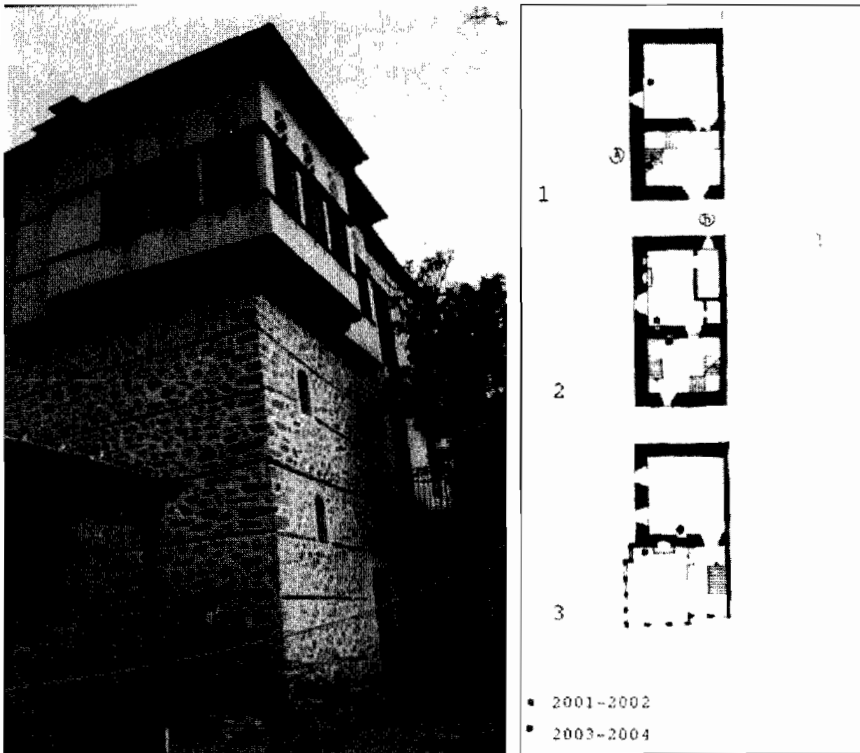


Figure 6: The house under study. The red and blue spots on the floor plan indicate the placement of the data loggers.

The tables show that the building's response to the climate is most satisfactory in the summer. The temperatures were taken with DATA LOGGERS and their position in the house is stated with the red and blue dots. The red dot represents the position the 1st year and the blue the second and third. In all the positions the ground floor retains a stable temperature which is very comfortable in the summer and cold in the winter but much higher than the exterior. The 1st floor follows the same pattern more or less. The 2nd floor demonstrates clearly the effect of the thermal mass of the thick stone walls in comparison with the wooden light structure. When the data logger is on the front room the temperature follows the deviations of the exterior. Conversely when it is positioned in the back zone its pattern is similar to that in the lower levels.

Table 1: Winter 2001. The data loggers on the red spots.

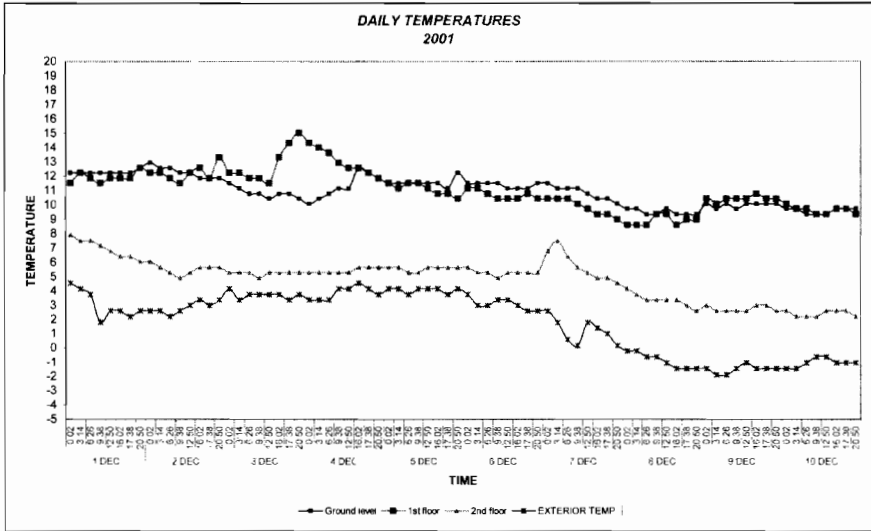


Table 2: Summer 2002. The data loggers on the red spots.

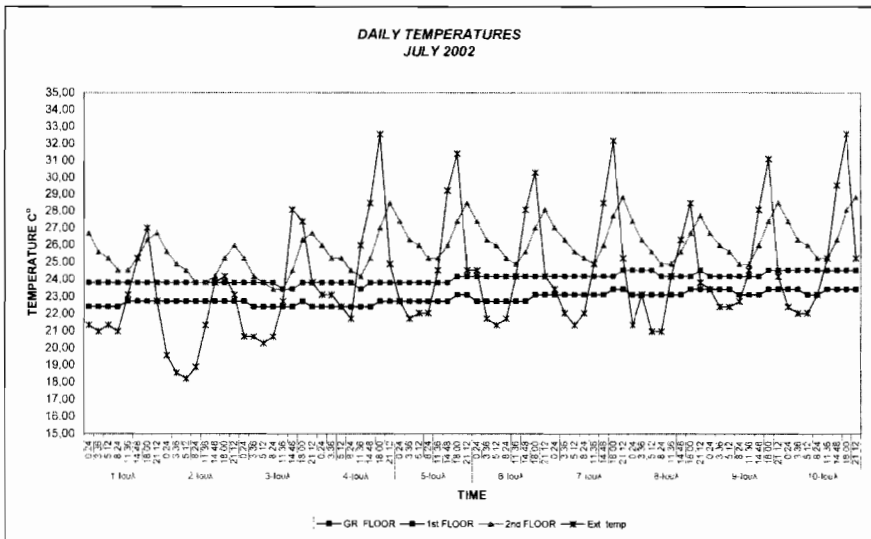


Table 3: Winter 2003. The data loggers on the blue spots.

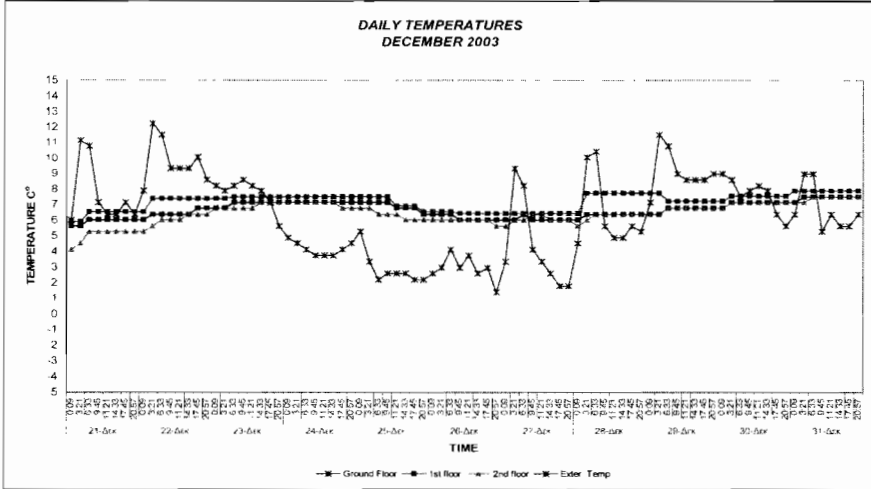
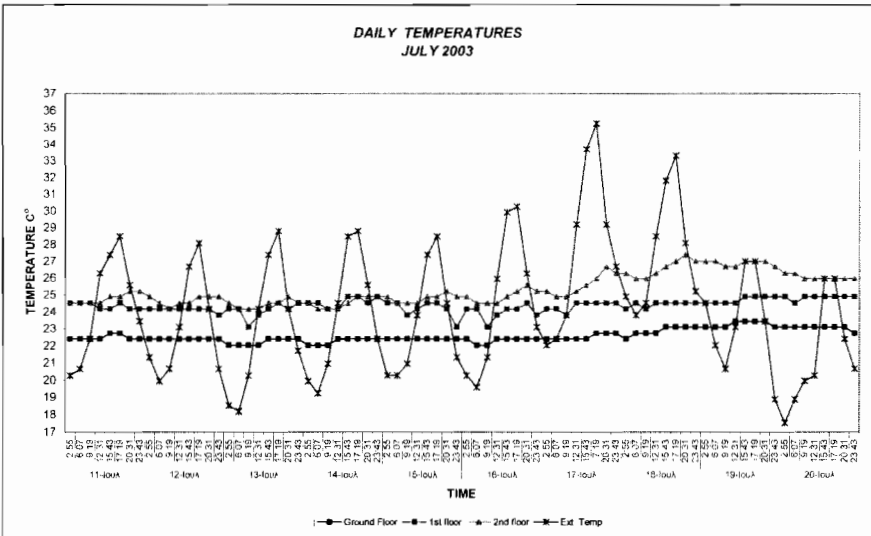


Table 4: Summer 2003. The data loggers on the red spots



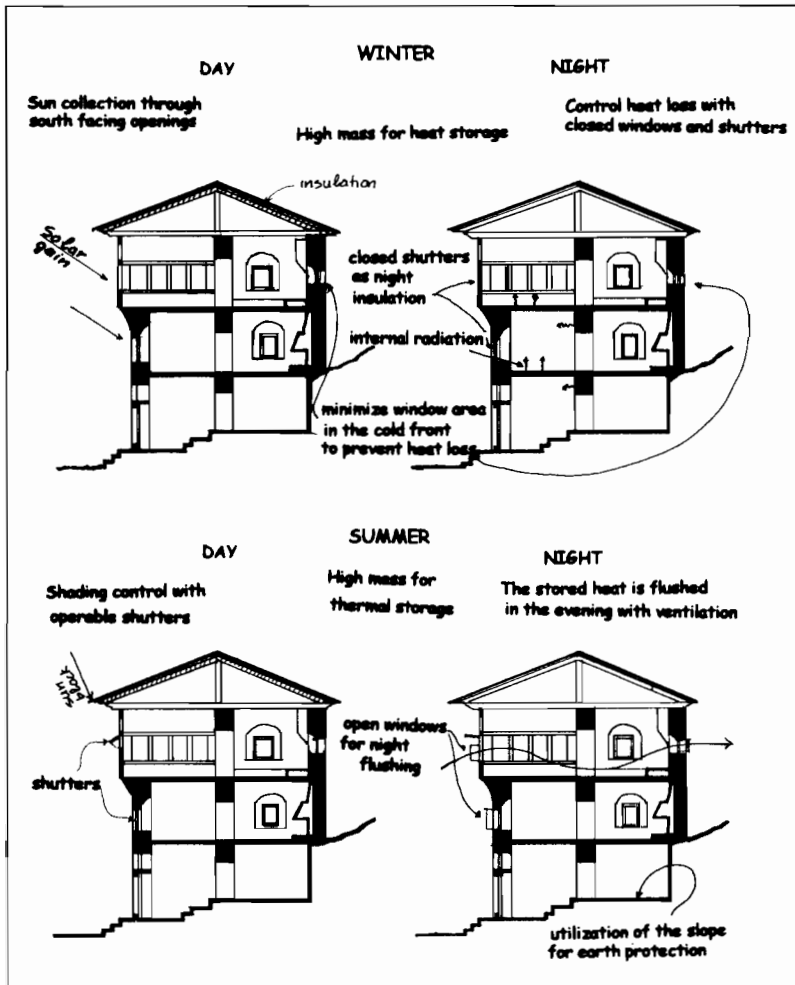


Figure 7: Design Guidelines

3 Conclusion

Winter: The climate analysis designates that the winter aspect becomes the most challenging in this specific area. Protection from the cold winds, solar gain and food insulation of the envelope are the more important guidelines.

Summer: Summer conditions and the configuration of the buildings make the indoor comfort easier to achieve. Shading and natural ventilation (cross ventilation and night flushing induced by the diurnal temperature range) can reduce significantly the indoor temperature and thermal comfort conditions.

The setting of the villages on the slopes is ideal for earth protection.

Advantages of building in the slope include the insulation value of the earth and the lack of diurnal swing. This factor eliminates the heat gain and loss into and out of the building.

Outdoor and indoor comfort is a very important element for the well being of the inhabitants of a place. Furthermore, for a place where the economy relies mostly on tourism, comfort becomes very essential and can enhance dramatically the tourist qualities of the place. Taking climate into account is a very important step towards the sustainable development in the level of both the community and tourism. Minimizing the use of non-renewable resources, while at the same time succeeding in creating comfortable conditions year round, is a very essential factor, for the well being of inhabitants, tourists and the surrounding magnificent natural environment.

In spite of the many qualities the vernacular structures appear to have, living conditions have become much more demanding. It is evident that new techniques and appropriate technologies should be incorporated to these structures to help them adapt to the new way of life.

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