The Vernacular Dwellings of Mount Pelion in Greece:
A migratory living pattern

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ABSTRACT: This paper investigates the spatial and environmental performance of the Greek vernacular Architecture of Mount Pelion. The main body of the work focuses on a well-preserved mansion in the Vysitsa village, which contains the typical architectural features of the Mount Pelion traditional architecture. What characterizes these traditional dwellings is the seasonal migratory living pattern in response to the external environmental conditions. This study investigated the luminous and thermal environments in the chosen building, which was designed and constructed, based on accumulated knowledge and past experiences to provide environmental delight to the occupants. The conclusions derived from this study establish an appreciation and understanding of the occupants' past living habits and seasonal needs. The findings from this research will be useful references for the architectural designers and environmental engineers working in the field of sustainable design. The migratory living pattern evident in the vernacular dwellings at Mount Pelion is a living pattern that we should learn from and potentially re-apply in modern design.
Keywords: migratory living patterns, environmental delights, occupants' seasonal comfort

INTRODUCTION

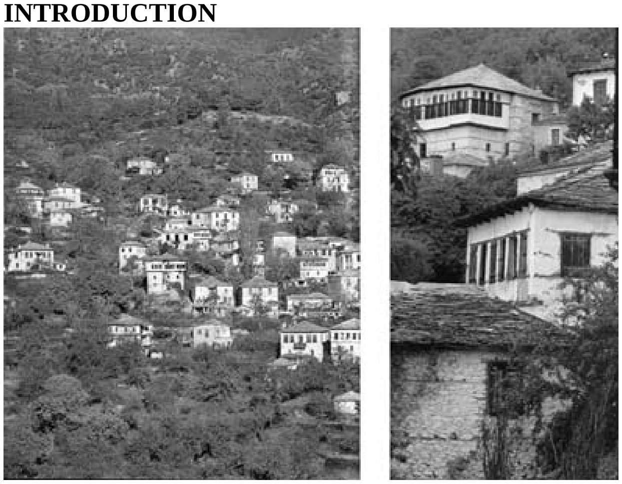

Fig.1: Mount Pelion Architecture

The Pelion traditional architecture is a remarkable phenomenon because apart from the historical context in which it developed, it is an appropriate architectural and environmental response to the local context and climatic conditions. These responses are largely direct reaction to the desirable environmental comfort and delight for their daily domestic and social activities (Fig.1).

Many architects have shown interests in the architecture of the Pelion region [1,2,3]. Le Corbusier was interested in the elegant architectural style of the Balkans and Istanbul that influenced the Pelion traditional architecture. During his trips to these regions, he studied the architectural features, which contributed to the architectural delight and environmental performance of the buildings. In some ways, these trips were later seen to have inspired some of Le Corbusier's future design projects [4].

In this paper, the aim is to fill the knowledge gap in the research of the Mount Pelion architecture. The environmental performance of the traditional Pelion mansions is investigated qualitatively and quantitatively. On-site monitoring and interviews, computer simulations, physical model testing, were conducted to draw meaningful conclusions, which can be used as references for architectural designers.

PELION ARCHITECTURE

History The vernacular architecture on Mount Pelion did not develop as an autonomous cultural phenomenon, but rather, it was an architectural expression that evolved in the period of Acme (18th-19th centuries) under the late rule of the Ottoman Empire. The Turkish arrival led to the expansion of the population in these villages, as people from the lowlands fled to the mountains for protecting themselves from piracy, predatory raids, and the frequent conflicts that accompanied the establishment of Ottoman rule, creating a distinctive type of defensive domestic architecture. The Greek residents, immigrating to the Mount Pelion, created a network of closed farming, shepherding, and other family-based economic units. The newcomers through their commercial dealings with wealthy cities abroad, developed the twenty-four villages of Mount Pelion into vital economic centres, characterized nowadays by local legislation as "traditional settlements required absolute protection" [1,2,3].

Climate The Mount Pelion belongs to Thessaly Region in Greece. The western side, where the chosen traditional mansion (Karagiannopoulos Mansion in Vysitsa village) is located, drops smoothly toward the Pagasic Gulf. This region is characterized by calm streams and rich vegetation, which modifies the local microclimate.

In general, the climate of the mountain is moderate during the summer and cold during the winter. Snowfalls are usually observed till early spring. The winter months are cold and humid; the average temperature is 4°C and can be lower than -5°C. The summer months are warm and humid; the average temperature is 27°C and can reach 33°C. The annual average temperature is 14°C and the relative humidity varies from 52% to 75%. The cold prevailing winds in winter come from the west (5.5°C), whereas in summer, the hot prevailing wind come from the east (25.8°C) [5,6].

CASE STUDY

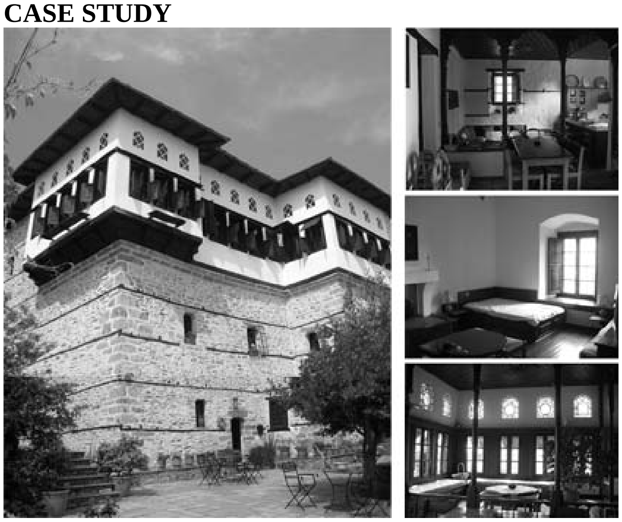

Fig. 2: Karagiannopoulos mansion external view, ground floor kitchen and dining room, first floor bedroom, second floor living room.

The Karagiannopoulos Mansion is located in Vysitsa village, 28km from Volos City at an altitude of 450m. The orientation of the L-shaped mansion is a deviation of 27° from due north to east, having a view to the Pagasic Gulf. The old house, built in 1791, used as a guesthouse today, still retains all the typical characteristics of Pelion vernacular architecture (Fig.2). These include not only the materials used, but also the internal distribution of the living environments, all keeping a humble, almost monastic simplicity.

The building has three floors with two upper storeys connected by a narrow wooden staircase, which enables the vertical circulation of the occupants.

All storeys have the same layout and each floor is separated into two zones: the public and the private (Fig.3). The public zone, which is in the southwest, has the advantage of a good view and orientation, and consists of the living and sitting rooms, and the kitchen. The private zone contains only bedrooms and bathrooms. The building envelope is exposed to the elements and the NW façade is shielded by the steep mountain slope.

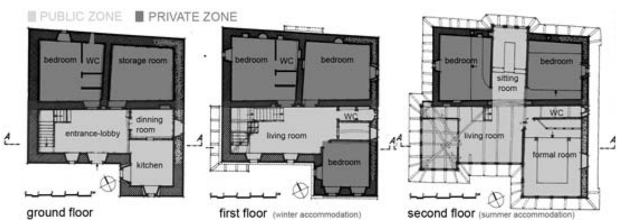

Fig. 3: Public and private zone in the three floors of Karagiannopoulos mansion

The ground and first floors have very thick external stonewalls (0.9m-1m) and internal stonewalls (0.5m-0.7m), which play a self-supporting role with very few windows. The first floor is called "winter accommodation". In stark contrast to the thick wall construction of the ground and first floor, the second floor is a combination of lightweight and heavyweight construction and is normally used as the "summer accommodation".

The private zone here is a heavyweight construction and the public zone is a lightweight construction (wall thickness of 0.15m), pierced by many windows. The lightweight enclosure is projected from the main masonry core by 0.5m, and is covered by a slate pitch roof which projects 0.7m from the light weight external walls, protecting the vulnerable envelope from excessive sun gain, rainfall, and snowfall [2].

INTERNAL MIGRATION LIVING PATTERN

The most interesting phenomenon in this type of architecture is the seasonal migration of the occupants in response to the climatic conditions. The internal migration happens horizontally and vertically depending on the activities of the occupants, the time of the day and the season (Fig.4).

As for the horizontal migration by activities (communal and individual), the relation between the luminous environment, the social activities of the occupants, and the design of the mansion's building envelope is closely related. According to different functional spaces (e.g., bedroom or living room), different quantities and qualities of natural light are required. For resting, where the occupants sleep or get dressed, higher thermal protection and relatively low light level is required. The external walls of the bedrooms, therefore, have only one window, providing little light in to the interior. On the other hand, the living rooms, in which people gather and spend time together, require lower thermal protection and are well illuminated by daylight. Thus, the social needs and the daily and seasonal activities dictate the envelope design and the use of building materials.

For the vertical migration, in the past, the family would move from one floor to the other, depending on the season (i.e. in summer, residents used the “summer accommodation,” and in winter, the “winter accommodation”). This living pattern, worked seamlessly with the lightweight and heavyweight structures within one building. It enabled the family to live without the need for heating or cooling systems, instead contriving an internal migration pattern that responded to their need for comfort.

Focusing on the seasonal need for comfort, a comparative study of the winter and summer accommodation in terms of daylight and thermal performance was conducted.

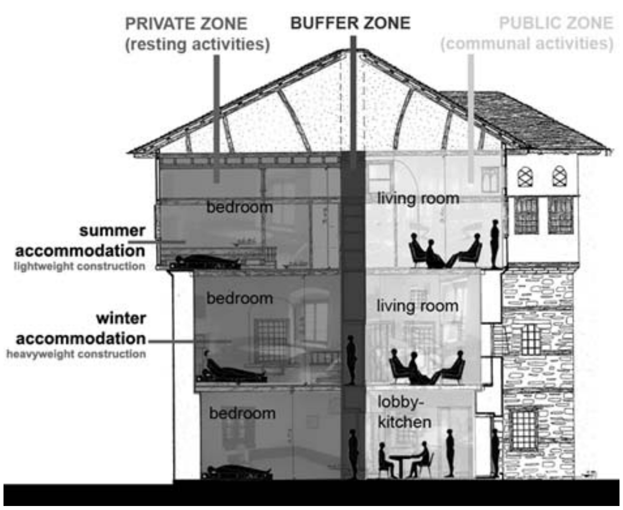

Fig. 4: Internal migratory living pattern: vertical migration by season (winter-summer) and horizontal migration by activity (communal-resting)

The Winter Accommodation The comfort issues that arise in wintertime are the reduction of heat losses and the maximization of the solar gains while providing a secured, well daylit environment. The builders and the occupants in the past, based on their experiences, managed to strike the right balance between these conflicting comfort requirements in designing their winter accommodation (Fig.5).

During the cold seasons, the second floor with lightweight construction was not used by the occupants, except for silk production. The trapdoor on the second floor would be closed, thus the winter accommodation (the ground floor and first floor) were isolated from the second storey. These two floors with heavy weight construction enhance the introvert characteristics of winter activities in the mansion. Its facade treatment, window location and internal layout clearly show the desire for protection against the low temperature, cold western prevailing winds, and snow. As winter accommodation, the occupants selected the least exposed lower floors, which are thermally protected by the second floor, the thick external envelope, and the ground.

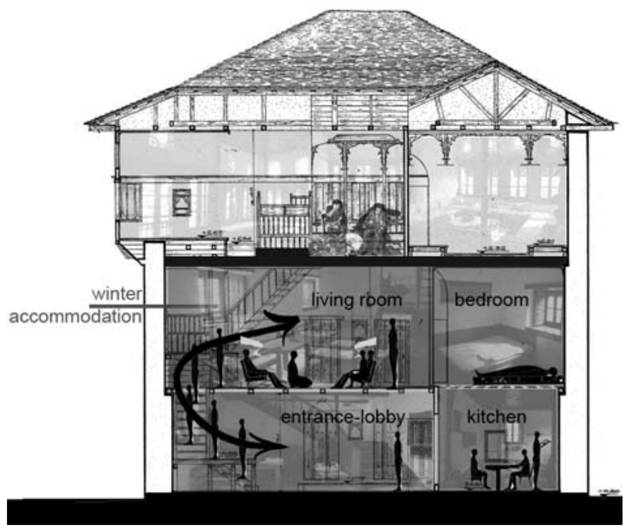

Fig.5: Wintertime internal migration in section

What contribute to the winter accommodation’s thermal performance is the thick stonewalls, which stabilise the internal temperature, playing the role of an effective thermal barrier between the external and internal environment.

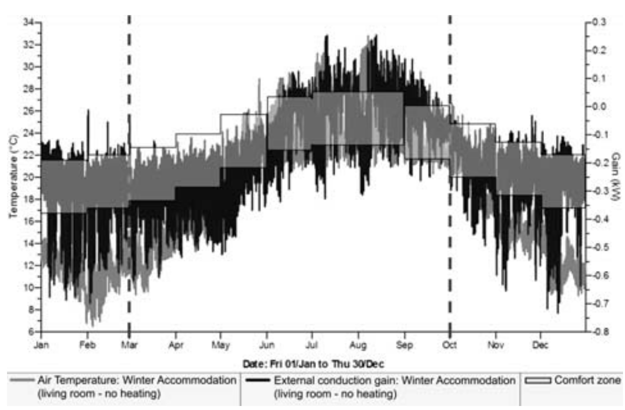

Fig.6: Annual thermal performance of the winter accommodation derived from thermal analysis by using IES programme.

The thick walls also reduce temperature swings inside the mansion because of their high thermal mass. The dynamic thermal simulation revealed that the effect of the heavyweight construction on the internal thermal environment is significant during the winter months. Without heating, the average internal temperature is 15.4°C, while the external temperature is 7.3°C. Additionally, the average annual conduction of the external envelope is low (-0.2kW). The dynamic simulation conducted takes into account the local climatic data, the internal gains (seasonal occupancy), the thermal conductivity of the stone walls and the infiltration of the building envelope (Fig.6).

For heating required in cold winter nights, occupants used the fireplaces in the private zone and cordwood stoves in the centre of the room in the public zone to provide warmth. Besides, the occupants, in the past, wore thick woollen clothing indoor. Therefore, the heating needs were reduced considerably. In the period between April and late September, the internal temperatures of the winter accommodation are mostly within the comfort zone.

The small number and size of the window apertures in the winter accommodation can be explained as the result of the historical defensive purpose and the desire to minimize heat losses in winter [2]. However, this may also reduce the solar ingress in winter making the rooms look dark and gloomy at the back. In order to rectify these problems, the window's reveal is made splayed, providing graded contrast between the bright windows and the internal walls. Also better daylighting performance at the back of the room is achieved (Fig.7).

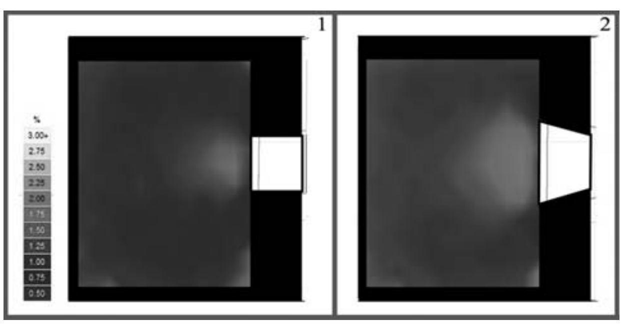

Fig. 7: 1. Room without splayed reveal window in plan (Av.DF: 1.10%), 2. Room with splayed reveal window in plan (Av.DF: 1.30%). Daylight simulation by using Ecotect software.

Although the splayed reveals reduce the brightness contrast and enhance the daylight performance of the winter accommodation, the bedrooms in general are dimly lit. The daylighting performance analysis indicated that the average daylight factor is 0.37% in bedrooms and 0.60% in the living room, while the SW bedroom has an average value of 1.44%. In addition, the incoming light is not well distributed inside the winter accommodation and only the areas which located close to the windows are adequately lit (Fig.8). To improve the existing situation, occupants used oil lamps or candles to improve the luminous environment in the winter accommodation.

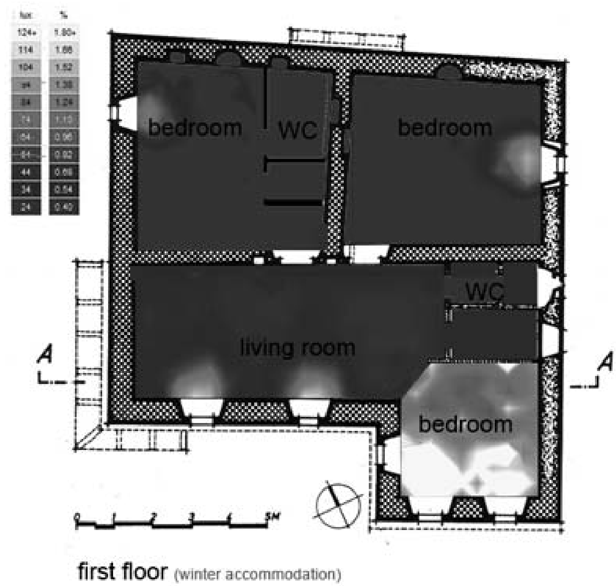

Fig 8: Winter accommodation daylight analysis by using Ecotect software

The Summer Accommodation The most important issue that arises in summer is to reduce overheating and solar gains, while providing a well-illuminated luminous and airy internal environment. The vernacular builders and the occupants developed appropriate solutions for these conflicting needs by trial and error.

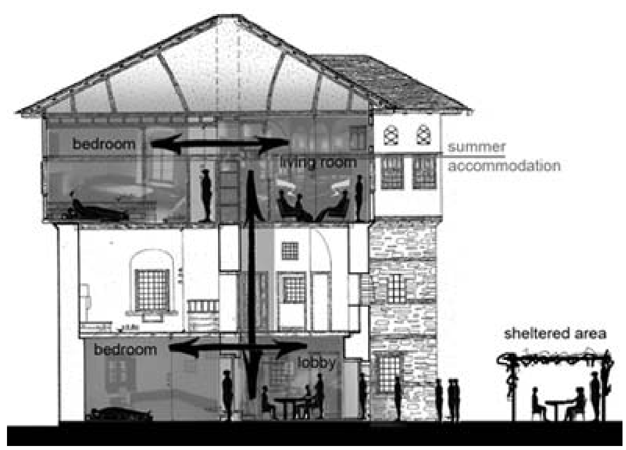

Fig.9: Summertime internal migration in section

During summer, all the activities are concentrated on the second floor (the summer accommodation), the ground floor, and the sheltered outdoor areas (fig.9). The extroverted character of the summer accommodation is

clearly recognizable by its generous open plan living room, the numerous large window apertures and the exposed lightweight construction (15cm thick walls).
The building envelope, which is pierced by many apertures and multi-coloured clerestory windows, reflects the need of the occupants to live in a brightly lit but controllable space. Because of the high solar altitude of Greece during the summer (79° at noon in summer solstice), the windows with 3-part wooden shutters, adjustable by the occupants, effectively protect the internal environment from excessive solar radiation [5]. Their role is to prevent the public zone from overheating and glare. In addition they enable the family to be connected to the external environment and the surrounding views, converting the room from a dark enclosed space into a semi-outdoor one. In addition, the roof eave plays the role of an overhang, which further protects the upper storey from the direct sun in summer.
The daylighting performance analysis indicates the internal daylight levels of the summer accommodation in the public zone are adequate (formal room: Av.DF 1.97%, living room: Av.DF 1.84%). On the other hand, the bedrooms of the private zone with thick stone walls and small openings, are still dark, as in the winter accommodation (Av.DF 0.35%-0.65%). The following diagram illustrates the daylight distribution throughout the summer accommodation:

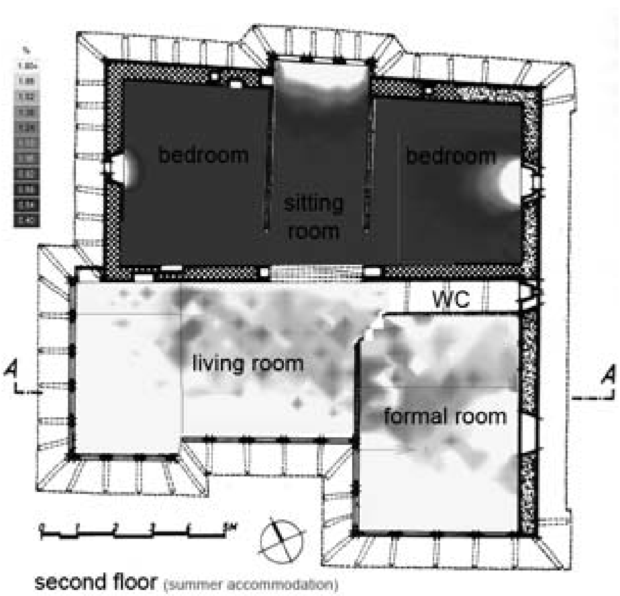

Fig.10: Summer accommodation daylight analysis by using Ecotect

In the southwest communal spaces (Fig.10), apart from the numerous windows, the fixed multi-colour clerestory windows play a significant role in enhancing the luminous environment in the summer accommodation. The comparative study highlights their role to illuminate the upper part of the walls (the ceiling height in the living room varies from2.70m-6.30m) and the back of the rooms, improving the overall internal daylight level and distribution (Fig.11).

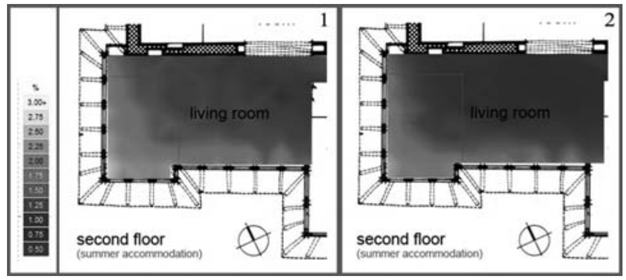

Fig.11: 1. Living room with fixed clerestory windows (existing condition) in plan (Av.DF: 1.84%), 2. Living room without fixed clerestory windows in plan (Av.DF: 1.35 %)

The summer accommodation is the floor that is the most exposed to solar gain. Its envelope does not have high thermal performance (low thermal capacity and high thermal conductivity) to reduce the temperature swings. Thermal bridges can be found in the windows with single glazing and old metal or timber frames. The lightweight walls which surround the public zone of the second floor are made of local oak or chestnut, with the voids filled with the following layers: a mixture of clay and local sheep's wool, a dense net made by thin fibre, wattles, straw, clay-rich soil, mud, and another layer of the clay and sheep's wool mixture (*tsatmas*). This is an inexpensive structure that would incur no transportation cost, and it is non-toxic, low-impact, and user-friendly. On the other hand, it's poor in thermal mass, contributes to occasional overheating in summer.

To reduce this risk, the occupants tend to leave the shutters half open and the windows fully open to provide adequate airflow throughout the rooms for passive cooling and solar control (cross and single-side ventilation). The windows on the northeast facade are placed only on the northeast sitting room wall to assist cross-ventilation. In addition, the deviation of the mansion 27° from due north, optimizes the natural ventilation by capturing the prevailing wind in summer.
Due to the high solar altitude, the roof is one of the most vulnerable parts of the mansion and it should be protected to prevent the building from overheating [5]. In the Pelion mountain mansions, the roofs have a small inclination of about 30°, which is designed to protect it from sinking under heavy snow loads. Traditional slates (which are quite reflective) clad the roof construction, diminishing the excessive solar radiation and reducing the solar gains. A wooden structure is covered and insulated by a mixture of clay and mud, accomplishing the objective of insulation effectively. In case the hot air enters the building through the roof, it affects mainly the upper parts of the rooms, which are not in the living

zone. For more effective control of the heat influx, false ceilings are placed in all the communal spaces of the summer accommodation. The attic space between the roof and the suspended horizontal ceiling plays the role of an air buffer providing the interior of the room with thermal stability. In the past, small holes in the wooden ceilings extracted the accumulated hot air out of the rooms and into the roof voids, where it was trapped and did not considerably affect the occupants' thermal comfort.

Another architectural element that prevents the summer accommodation from overheating is the horizontal trapdoor, which stops the hot air from the ground and first floor to flow into the upper floor.

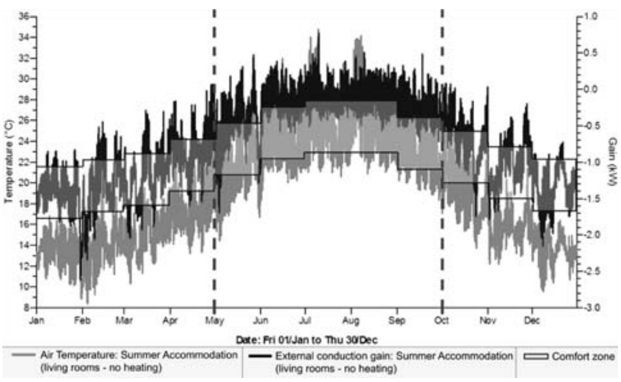

Fig.12: Annual thermal performance of the summer accommodation derived from thermal analysis by using IES programme.

The thermal performance analysis indicated that the lightweight walls in the summer accommodation perform less satisfactory than the thick stone walls in the winter accommodation. This can be proved by the fact that the average external temperature of 22.7°C in summertime is almost the same as the internal temperature of 21.17°C and the annual conduction gains in the summer accommodation (-0.68kW) are three times higher than the winter accommodation (-0.2kW). However, because of the adjustable shutters and the single sided and cross ventilation made possible by the strategically positioned windows, the internal environment in the summer accommodation falls within the comfort zone (Fig.12).

CONCLUSION

By analysing the overall environmental performance of the Mount Pelion traditional mansions in relation to the occupants' living patterns, it can be concluded that, in the past, the local masons and the occupants with the basic knowledge, accumulated experiences and limited resources, built their dwellings to perform naturally and effectively throughout the year. What principally improved their comfort conditions was the division of their house into two distinctive seasonal accommodations.

In the winter accommodation, the occupants' priority was to keep the internal temperature constant and the internal spaces warm, along with their need to feel safe from the invaders. To achieve these, the design of the external envelope of the first floor had compromised the luminous environment. Additional lighting means was needed in winter, but minimum heating means was required. In the summer months, the occupants' priority was to enjoy bright and airy living spaces, where they could practice their communal semi-outdoors activities. Therefore, migrating to the summer accommodation is a direct response to this need. Although the thermal performance of the lightweight summer accommodation is relatively poor, the vernacular designers employed architectural elements like the movable wood shutters, roof overhang, double height spaces, suspended ceilings with ventilation inlets, ceiling voids and trapdoors to prevent the building from overheating in summer.

Nowadays, contemporary and renovated buildings no longer use the concept of internal seasonal migration as a response to the quest for comfort by the occupants. In general, the design of the dwellings is no longer divided into seasonal accommodations, but they are built in a way that the entire structure can be used throughout the year.

Through the investigation of the vernacular architecture of Mount Pelion, it is evident that some of the characteristics of the vernacular dwellings can be selectively re-used in architectural design and the ingenious seasonal migration living patterns can be learnt by the architectural designers and re-introduced to modern living to reduce global energy consumption in the domestic sector.

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REFERENCES

1. Moutsopoulos N., Anguelova R., Pavlovic D., Riza E., Sezgin H., Stoica G. and Thomo P., (1993). Balkan Vernacular Architecture, *Melissa*, p.1-48.
2. Kizis, Y., (1994). Mount Pelion Constructions (in Greek Language), *Cultural Technological Institute*, p.101-136,145-179, 191-218, 437-439.
3. Leonidopoulou-Stilianou R., (1992). Greek Vernacular Architecture, Pelion, *Melissa*, p.9-23, 57-62.
4. Brooks Allen H., (1997). Le Corbusier's Formative Years, Charles-Edouard Jeanneret at La Chaux-de-Fond, *The University of Chicago Press/Chicago and London,* p.33-45.
5. Tsipiras T., Tsipiras K., (2005). Ecological Architecture, *Kedros*,p.126,152-162, 192-194,232,353.
6. Climate Data of Mount Pelion, [Online], Available: http://www.hnms.gr. [5 September 2008]