

Architectural Building Treatments in the Mediterranean Climate from an environmental perspective; Case study of Amman City – Jordan

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Abstract

The paper will provide the most important architecture treatments which were adopted and applied in the Mediterranean region buildings, the paper provides an analysis of the architecture elements that have contributed to reduce the consumption of energy and a positive interaction with the environment and region climate based, a case study in Amman city – Jordan was chosen to come out of conclusions and recommendations which can help in the design process in Mediterranean region architecture.

Keywords: Architectural Building Treatments, the Mediterranean Climate, environmental perspective.

1. Introduction

The protection from unfavourable, harsh climatic conditions and achieving comfortable microclimate are the primal objectives of architecture. The Mediterranean traditional architecture evolved to produce buildings that would be in harmony with the harsh climates of its various regions (Serghides, 2010). In the traditional architecture the mechanism of indoor thermal regulation was incorporated in the building. The topography, the construction, the morphology even the layout and use of internal spaces participated in the operation and function of the thermal regulating mechanism. Characteristic examples of this phase in the various regions of Mediterranean give the anonymous architecture and the planning of traditional settlements.

1.1 Research problem

With the different climate the architecture solutions vary in the building design and that depends on the surrounded environment, the main research problem could be defined as the need of studying the surrounded environment with its climate before starting the designing process in order to select the appropriate design solutions.

1.2 Methodology

What the paper seeks to do is to illustrate the architecture design treatments which has been adopted in the building that is located in the Mediterrean climate, descriptive analytical method will be adopted to analyze the building techniques in this region and types of material which had been used there, and how it was interactive in a sustainable way with the surrounding environment, case study method was adopted by passing in a case study of Amman city architecture which is introduce the most important architectural design treatments in addition to analyze the construction materials that have the appropriate properties with the climate and the environment for the city.

2. World Climate Regions

Climate is more than "the average state of the atmosphere" because a complete climate description should also include variations and extremes to accurately portray the total character of an area. The most important elements in climate descriptions are temperature and precipitation inasmuch as they have the greatest influence on people and their activities and also have as important impact on the distribution of vegetation and the development of soils. (Serghides, 2010)

Perhaps the first attempt at climate classification was made by the ancient Greeks, who divided each hemisphere into three zones: torrid, temperate, and frigid. Since the beginning of the twentieth century, many climate-classification schemes has been devised. The classification of climates is the product of human ingenuity and its value is determined largely by its intended use. (Glossary of Meteorology)

2.1 Köppen Classification of Climate

For decades, a climate classification devised by Wladimir Köppen (1846–1940) has been the best-known and most used tool for presenting the world pattern of climates. The Köppen classification uses easily obtained data:

mean monthly and annual values of temperature and precipitation. Furthermore, the criteria are unambiguous, simple to apply, and divide the world into climate regions in a realistic way. Köppen believed that the distribution of natural vegetation was the best expression of an overall climate. Consequently, the boundaries he chose were largely based on the limits of certain plant associations.

Climate Controls: The major controls of climate are:(1) latitude(variations in the receipt of solar energy and temperature differences are largely a function of latitude), (2) land/water influence (marine climates are generally mild, while continental climates are typically much more extreme), (3) geographic position and prevailing winds(the moderating effect of water is more pronounced along the windward side of a continent), (4) mountains and highlands(mountain barriers prevent maritime air masses from reaching far inland, trigger orographic rainfall, and where they are extensive, create their own climatic regions), (5) ocean currents(pole ward-moving currents cause air temperatures to be warmer than would be expected), and (6) pressure and wind systems(the world distribution of precipitation is closely related to the distribution of Earth's major pressure and wind systems).(Köppen,1913).

Köppen recognized five principal climate groups,Each designated with a capital letter: A (humid tropical), B (dry C (humid middle-latitude, mild winters), D (humid middle-latitude, severe winters), and E (polar).Four groups (A, C, D, E) are defined by temperature. The fifth, the B group, has precipitation as its primary criterion.(Gebrüder and Borntreager 2006).

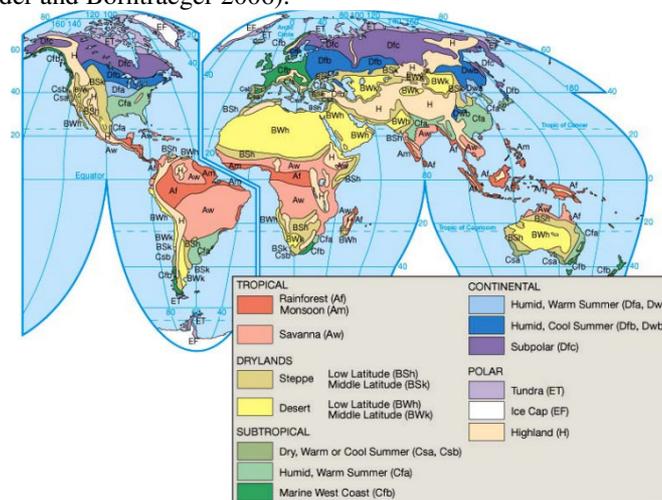


Figure 1. world map of the koppen-Geiger climate classification

2.2 .Cs – Mediterranean climate

A Mediterranean climate is the climate typical of the Mediterranean Basin, and is a particular variety of subtropical climate. The lands around the Mediterranean Sea form the largest area where this climate type is found, but it also prevails in much of California, in parts of Western and South Australia, in south western South Africa, sections of Central Asia, and in central Chile.

Most of the Mediterranean population lives in grouped housing Mediterranean inhabitants favor partnership, community life and helping one another. No doubt Qreek1 Woman and Arab-Muslim heritage have contributed to this form of community. Mediterranean cities and villages are places of vicinity1 friendliness and hospitality. once again the Mediterranean develops numerous and various possibilities. the spirit evoked above is common to all. However, two general cases can be found first, compact more or less dense villages with different morphological solutions, and second, dispersed villages with seemingly random scattered houses. these to layouts are linked to different models of social organization. this second model very frequent in North Ffrical1 corresponds to tribal communities and societies ,whereas the first model corresponds to more organised1 complex urban societies (Peel, 2007).

Considering the Mediterranean area is so significant in size - and if we reason, as is our case, in terms of action and effectiveness and not embalming preservation - the extent of traditional construction is extraordinary. indeed, if we want to avoid the error of extracting an object from its context, by considering heritage as a series of lifeless objects, without culture or time, in stone, brick or wood, then we should accept this traditional architecture taking into account its material and immaterial context.

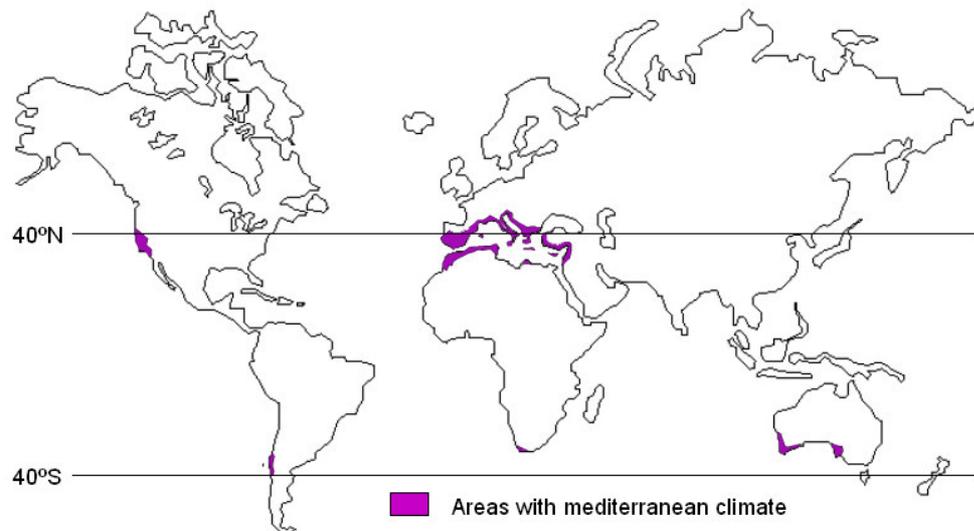


Figure 2. Area with Mediterranean climate

3. Mediterranean house

The Mediterranean has a large range of solutions to incorporate the idea of defence in construction, A grouping can be made according to three criteria the house is itself a defensive element the tower house, the house incorporates this defensive element House with a tower, the house incorporates morphological strategies of defence, without their strictly corresponding to elements of defence, Volumes and materials can sometimes provide a perfect camouflage for a house or an entire village.

If we mentioned the patio, courtyard or garden, it is because they are three rich, formal and locally varied expressions of a Mediterranean facts life is lived as much in the open air as under a roof, an architecture of earth, stone or wood as much as light, shade or aromas< While the house is the area especially for women, the street is the area especially for men. (Vavili at el. 2012).

3.1 Traditional Building Elements – Indoor Climatic Modifiers

3.1.1 The Solarium and Courtyard - Fundamental Bioclimatic Elements

The solarium and the courtyard constitute fundamental traditional building structures of thermal control, which reflect the wisdom of traditional Mediterranean architecture.

In the countries of Mediterranean and the regions with hot climates, in which the sun is desirable in the winter while in the summertime the cooling and ventilation is necessary, the solarium and the courtyard are indispensable solar features of houses, unique elements of local architecture.

Both components, although outdoor, open spaces of building, they are focal elements around which the various activities of all other spaces, are composed and synthesized whether the house is found in the plains or in the mountains, in the village or in the city. They form the heart of the dwelling spatially, socially and environmentally.

They are important architectural characteristics and they show the instinctive approach of passive solar design and planning that contributed in the climatic configuration of the Mediterranean house. Their form evolved naturally from the climatic conditions, the needs of the family and the social structure of community. Their form and function varies from region to region, even from locality as expression of their sensitive response to the various influencing parameters. The solarium and courtyards have multiple uses in the local architecture that vary depending on the region, even the locality, the climatic conditions and the social structure.(Sinis, 1988).

.Winter:

Both components are two fundamental means used in traditional building design to temper extreme weather conditions. Combined with their other uses they always create microclimate that moderates the climate surrounding the building. The planning of courtyards and solariums varies depending on the degree, the frequency and pattern of solar radiation, winds, rain and snow fall. a. Access to the Sun In the old houses the main concern of the design of the courtyard and the solarium was to ensure privacy while also providing the benefit of good conditions for solar access to the southern elevation. The configuration of the house with courtyard and solarium is a key device for the achievement of this aim by providing enclosed private spaces. Also this geometry of houses makes explicit the intention to provide insulation to different rooms at times when sunshine may be most beneficial. Nevertheless the proportions of both components can play a critical role in

solar access.

When the courtyard is directed to the south it acts as sun space that accepts the desirable solar radiation of winter. This is an aspect our predecessors judged empirically and intuitively. However, today the evaluation of their performance is possible with the aid of modern technology. (Anderson et al, 2009)

The extent of solarium cover admits the rays of the winter sun to penetrate and so solar radiation can be utilized. For this reason the solariums in the mountainous regions are moved in the upper levels for better wintry exploitation of the sun. In vernacular architecture the width of projection of the cover varies and it was intuitively sized by the indigenous builders.

Buffers to the Cold Winds :When the courtyard and the solarium are facing towards exposed, vulnerable in winter sides to the prevailing cold winds, they act upon as buffers protecting the main building with the creation of calm pockets protected from cold winds and low temperatures.

- **Surrounding Buildings:** The buildings that surround the courtyard protect it from cold winds; their height nevertheless determines the creation or not of wind whirls in the courtyard.
- **Vegetation:** The vegetation and the protective hedges in form of wind breakers impede the cold winds of winter or at least they lower their velocity and consequently the heat losses from the building. The planting in the exposed aspects blunts the influences of unfavourable climatic changes.

Summer

Besides their importance as climatic modifiers, the courtyard and solarium form a key issue in building design for summer conditions. In multiple thermal modes, varied design and careful construction combined with the surrounding landscape they moderate temperatures round the building. The most frequently found ways are:

a. **Evaporation**

In the hot arid regions of Mediterranean, such as the island of Cyprus, evaporation for air humidification is necessary for the creation of comfortable conditions. This could be achieved with water sprays over the solarium and courtyard walls as well as the vegetation that surrounds them.

- **Ground Surfaces:** Natural coverings of courtyard as grass and other plants moderate high summer temperatures and promote cool atmosphere with the evaporation.
- **Fountains, Pools and Sprinklers:** The configuration of courtyards with fountains, pools and sprinklers offer pleasant cool exterior spaces and with the evaporation of water benefit adjacent indoor spaces. In old mansions in the courtyard a fountain is incorporated which offers additional evaporation and increases the levels of humidity and therefore creates a pleasant environment.
- **Spraying:** Moreover the local habit of residents to sprinkle water or to wash with water the floor of courtyard and the vegetation in this it evaporates water and refreshes the atmosphere, creates cool currents and it increases the humidity.

b. **Temperature and Radiation**

The temperatures in and around the building can also be tempered by the design and nature of the surrounding surfaces combined with the night sky radiation. The surfaces exposed to the clear sky cool down by radiation and the air immediately in contact with them also become cooler. In the summer the courtyard building configuration is of particular significance for the Mediterranean hot arid regions such as the island of Cyprus characterized by large diurnal fluctuations (15 to 25 degrees centigrade) and its potential inherent in the courtyard to act as cold sink by radiating heat during the night to the cold sky. Furthermore, the additional mass of the courtyard and the solarium absorbs the heat during the day and release it during the night to the cooler exterior ambient air.

c. **Ventilation, Winds and Breezes**

In the Mediterranean region, ventilation is necessary for comfort and hygiene; even on hot summer days when the outdoor is warmer than the building interior. In traditional buildings a great deal of attention was given to ventilation especially to the pre-treatment of air. The courtyard and solarium design and landscaping regulate the flow of air by transporting inside fresh, clean air from outside, when this is cooler than the interior. The influencing parameters are:

- The Form and the Layout of the solarium and the courtyard.
- The Region where the residences are found (Coastal, mountainous or urban regions)
- **Elements as Wind Towers:** above the roofs of adjacent buildings (7m-8m) with the orifice towards the prevailing breezes. The placement of a fountain in their base cleans and refreshes the air that is channeled in the courtyard.
- **Arches, Overhangs and Porches** that direct summer breezes when on the windward sides maximize and distribute the flow of air.
- **Vegetation and planting of trees** channel summer breezes in the building.

d. **Shading**

The treatment of courtyard and solariums offers important techniques in providing shading and extend thermal building control. The main elements of courtyard and solarium for shading are:

- **Enclosing Elements.**

- Arches, and Overhangs that intercept the sun in the summer and leave it unhindered to the winter.
- Vegetation: Climbing deciduous plants, such as traditional grape-vines, in horizontal pergolas that offer shade in the summer and admit the sun in the winter. Dense compact vegetation in the east and west for protection by the low sun of summer in the morning and afternoon.

3.2 Mediterranean Architecture and Building Materials

The Mediterranean area is a distinct geographical entity, since the origins of the human history, with particular geomorphologic and climatic features. From antiquity to the present cultural trends of East and West intersect and influence each other and in combination with the natural environment, the climate, the light and the sea, they have defined a very special way of life and consequently, a unique architectural style. It is noticed that the architectural elements are tied together with nature and form a functional and aesthetic whole. The great diversity of nature, the beautiful beaches, the harmonic curves of the hills, the countless islands, the bright sun and the clear atmosphere, create a measure, intimate and human. Furthermore, we easily discern the relationship of Mediterranean architecture with the place and thus the materials it produces (earth, mud, stone, wood, glass). The concept of the "spirit of place" (genius loci) was adopted for the first time by the ancient Mediterranean, for whom "place" made reference to the immutable qualities and senses of a site that, was associated with a local spirit or deity.

The relationship between indoor and outdoor environment is an important qualitative feature of Greek architecture and one notices that this communication can be achieved in various ways. Examples include galleries, roofed verandas, the semi-open spaces, large windows and of course, the most representative element, the atrium. From the formal structure of ancient houses around the courtyard until present times the atrium was a special feature of Mediterranean architecture.

4. Case study of Amman – Jordan

The city is located in central-north Jordan and is governed by Greater Amman Municipality, headed by its mayor Aqel Biltaji. It has a total of 27 districts. East Amman is predominantly filled with historical sites that host frequent cultural activities, while the West Amman area is more modern, stylish, and holds the economic center of the city.

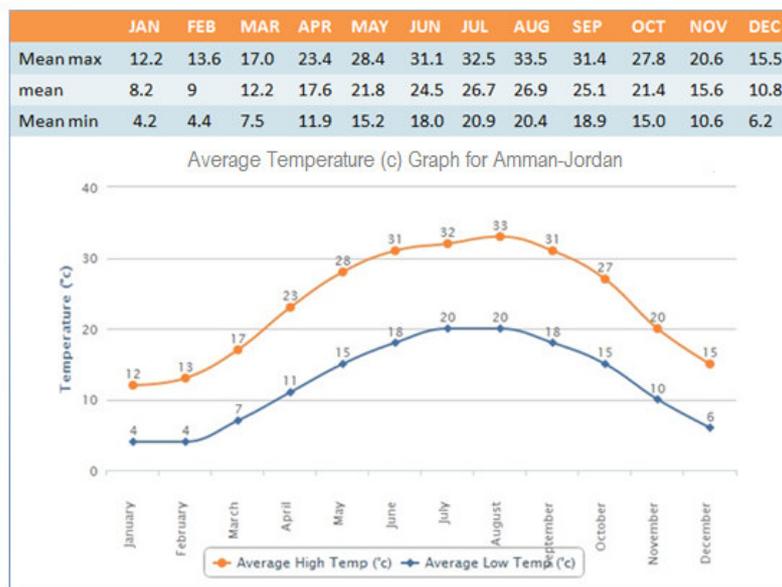


Figure3, Average temperature Amman

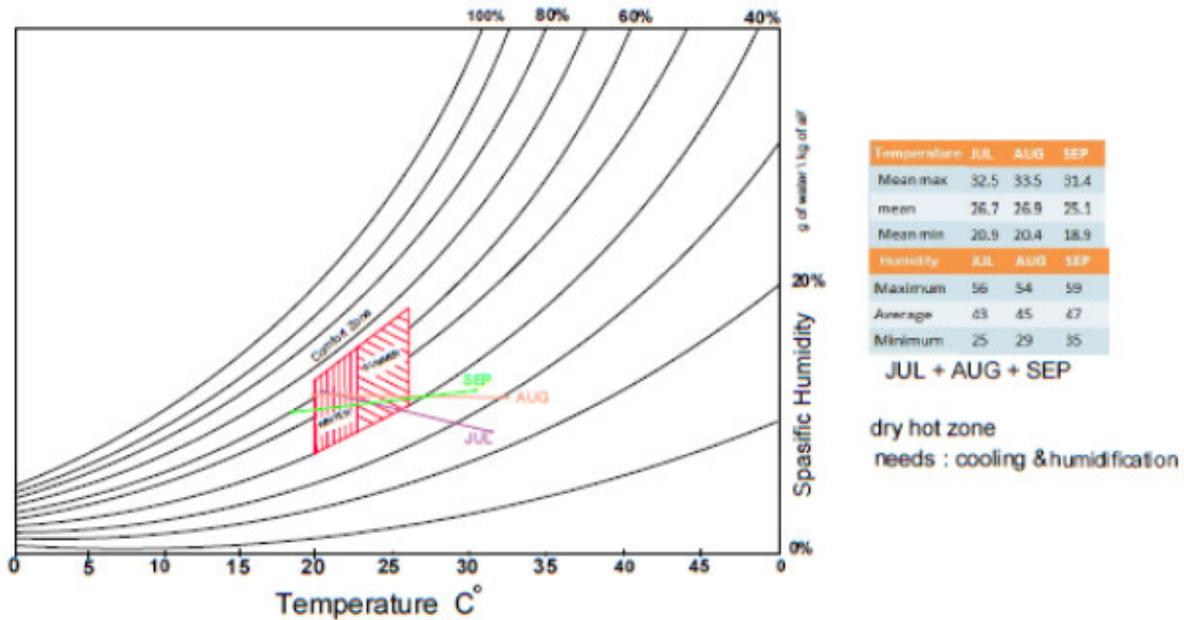


Figure4, the psychrometric chart describes the venous mixtures of air and water vapour of different temperatures

We conclude from above that the main callange in thermal and heating exist in july month , that why I picked this month to study the solar radiation in it and it is effect on the building by its colours.

Io for Amman city in July from 11 – 12 am = 982.

Direct component = 738 watt\m2.

Coefficient Albedo= Ireflected \ direct solar radiation.

Global= direct + defused.

Diffused= 0.33 direct.

Absorbance = 100% - reflectance.

Radiation Emitted = Absorbance * Emittance.

Netgain = Absorbance – Emitted.

Aluminum foil, bright:

Solar reflected= 798 * 0.95 = 701 watt.

Absorbed = 798 * 0.05 = 39.9 watt.

Emitted = 399 * 0.5 = 19.9 watt.

White plaster,

Solar reflected= 798 * 0.93 = 742.14 watt.

Absorbed = 798 * 0.07 = 55.86 watt.

Emitted = 55.86 * 0.91 = 50.83 watt.

Fresh snow,

Solar reflected= 798 * 0.87 = 694.26 watt.

Absorbed = 798 * 0.13 = 103.74 watt.

Emitted = 103.54 * 0.82 = 85.06 watt.

White wash, mew:

Solar reflected= 798 * 0.80 = 638.4 watt.

Absorbed = 798 * 0.20 = 159.6 watt.

Emitted = 159.6 * 0.9 = 143.6 watt.

Light gray paint,

Solar reflected= 798 * 0.6= 478.8 watt.

Absorbed = 798 * 0.4 = 319.2 watt.

Emitted = 319.2 * .93 = 296.85 watt.

White powdered sand,

Solar reflected= $798 * 0.6 = 478.8$ watt.
Absorbed = $798 * 0.4 = 319.2$ watt.
Emitted = $319.2 * .93 = 296.85$ watt.

Brick (light-dark):

Solar reflected= $798 * 0.36 = 287.28$ watt.
Absorbed = $798 * 0.64 = 510.72$ watt.
Emitted = $510.72 * .95 = 485.18$ watt.

Dark gray paint:

Solar reflected= $798 * 0.3 = 239.4$ watt.
Absorbed = $798 * 0.7 = 558.6$ watt.
Emitted = $558.6 * .95 = 530.6$ watt.

Asbestos, slate:

Solar reflected= $798 * 0.19 = 151.62$ watt.
Absorbed = $798 * 0.81 = 646.38$ watt.
Emitted = $646.38 * .96 = 620.52$ watt.

White paint:

Solar reflected= $798 * 0.73 = 582.54$ watt.
Absorbed = $798 * 0.27 = 215.46$ watt.
Emitted = $215.46 * .93 = 200.37$ watt.

Concrete:

Solar reflected= $798 * 0.40 = 319.2$ watt.
Absorbed = $798 * 0.60 = 478.8$ watt.
Emitted = $478.8 * .88 = 421.34$ watt.

Indians limestone:

Solar reflected= $798 * 0.43 = 343.14$ watt.
Absorbed = $798 * 0.57 = 454.86$ watt.
Emitted = $454.14 * 0.95 = 432.117$ watt.

Amman city climate: sun-scorched, wind-swept, dry land much sun, little rain sea mass brings high humidity, mild winters & summer exposed to strong [north] winds

The urban fabric: The fear of pirates relocated villages far from the shore on steep cliffs or hidden valleys where they were harder to spot or to reach from the sea.

The urban fabric: High density, narrow streets, small buildings due to:

- shortage of safe land
- mutual protection from sun & wind
- security
- family growth
- construction economy
- the highly communal spirit of the old societies.

Major building features: Solid volumes, thick walls, small openings, unifying plaster fused into neighbourhoods' via flexible repetition. (Bretz, and Akbari,1997).

Major building features:•organic forms, responding to environmental constraints using local resources, imprinting social evolution ergonomic scale similar to ships material & space minimalism vital for sustainability products of necessity rather than choice.

Shelters topography and construction economy led to vaulted caves of various sizes & uses, excavated into soft but coherent volcanic ash. Their masonry fronts may well support a terrace or a footpath above.

5. Conclusion

The architecture we cherish nowadays as 'picturesque' is in fact the outcome of a long struggle for survival in an

adverse setting by many generations that have squeezed their means out of the available resources in a truly sustainable manner. The locals adapted their comfort & needs to the given conditions, merging the Four Elements into an honest & minimalist architectural brilliant example of vernacular environmental sustainability.

Through the example that mentioned above we understand that using the Mediterranean materials and their mutations, we can achieve both contemporary forms in structures and a harmonization with the environment. In the context of the new technologies, these materials, can broaden the creative artistic expression and claim a major role in the re-birth of architectural ideas, where light and heavy material, the transparent and the solid, traditional design and modern technology, initially contradictory, coexist and interact.

Of course, not just the materials but the whole architectural approach should be reviewed. Perhaps it is time to recall those architectural elements that characterize our place, re-think and re-use them, not simply by imitating traditional forms, but by exploiting the strengths of the Mediterranean archetypes and, as a result, developing solutions that preserve the original spirit. The question is if meetings like this one can be creative enough to discuss and introduce an architectural vocabulary that will take into consideration the unique Mediterranean world.

Besides these two main elements of traditional architecture which mitigate the extreme climatic conditions, the well developed spatial organization in which the insulation criteria are obvious in orientation, other architectural solutions and components are identified which reflect the traditional wisdom and which are used in modern passive solar architecture. Such components are the varied designs of windows and their shading devices such as shutters, screens, pergolas and overhangs..

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