Atiyat, J Archit Eng Tech 2015, 4:3
http://dx.doi.org/10.4172/2168-9717.1000151

Architectural Engineering Technology

Case Report Open Access

Architecture Building Treatments in the Mediterranean Climate From an Environmental Perspective: Case Study of Amman – Jordan

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Abstract

This research will provide the most important architecture treatments which were adopted by Mediterranean region, the research will provide 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 had adopted to came out of conclusions and recommendations which can help in the design process.

Keywords: Environment; Architecture; Climates; Vegetation

Introduction

The protection from unfavorable, 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 [1]. 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.

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.

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.

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 in flounce on people and their activities and also have as important impact on the distribution of vegetation and the development of soils.

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 [2].

The climate of a location is affected by its latitude, terrain, and altitude, as well as nearby water bodies and their currents. Climates can be classified according to the average and the typical ranges of different variables, most commonly temperature and precipitation. The most commonly used classification scheme was originally developed by Wladimir Köppen.

Koppen classification of climate

For decades, a climate classification devised by Wladimir Köppen 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 or graphic 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

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Received July 22, 2015; **Accepted** September 07, 2015; **Published** September 17, 2015

Citation: Atiyat D (2015) Architecture Building Treatments in the Mediterranean Climate From an Environmental Perspective: Case Study of Amman – Jordan. J Archit Eng Tech 4: 151. doi:10.4172/2168-9717.1000151

and wind systems (the world distribution of precipitation is closely related to the distribution of Earth's major pressure and wind systems).

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 [3] (Figure 1).

A quick brief for each climate type

Type A climate: Tropical Situated along the equator, the wet tropics(Af, Am) constant high temperatures and year-round rainfall combine to produce the most luxuriant vegetation in climatic realm—the tropical rain forest. Temperatures in these regions usually average 25°C (77°F) or more each month and the daily temperature variations characteristically greatly exceed seasonal differences.

Type B climate: Dry regions of the world cover about 30 percent of Earth's land area. Other than their meager yearly rainfall, the most characteristic feature of dry climates is that precipitation is very unreliable. Climatologists define a "dry climate "as one in which the yearly precipitation is less than the potential water loss by evaporation. To define the boundary between dry and humid climates, the Köppen classification uses formulas that involve three variables: (1) average annual precipitation, (2) average annual temperature, and (3) seasonal distribution of precipitation.

Type C climate: Temperate humid middle-latitude climates with mild winters (C climates) occur where the average temperature of the coldest month is less than 18°C (64°F) but above -3°C (27°F). Several C climate subgroups exist.

Type D climate: Cold humid continental climates with severe winters (D climates) experience severe winters. The average temperature of the coldest month is -3°C (27°F) or below and the average temperature of the warmest month exceeds 10°C (50°F). The greatest annual temperature ranges on Earth occur here.

Type E climate: Polar climates (ET, EF) are those in which the mean temperature of the warmest month is below 10°C (50°F). Annual temperature ranges are extreme, with he lowest annual means on the planet. Although polar climates are classified as humid, precipitation is generally meager, with many no marine stations receiving less than 25 centimeters (10 inches) annually.

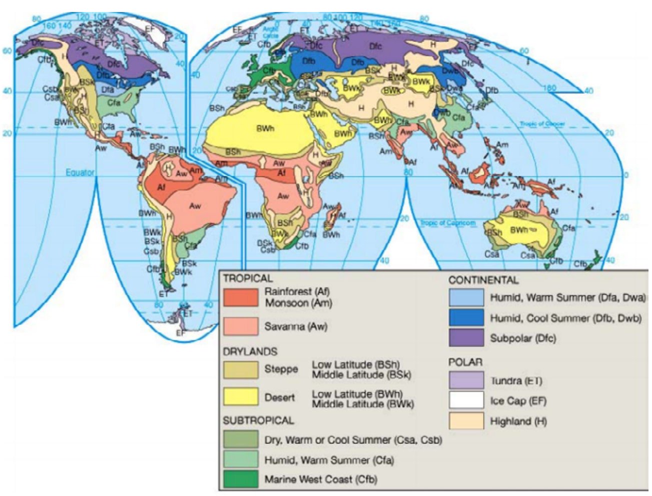

Figure 1: World Map of the Koppen-Geiger climate classification.

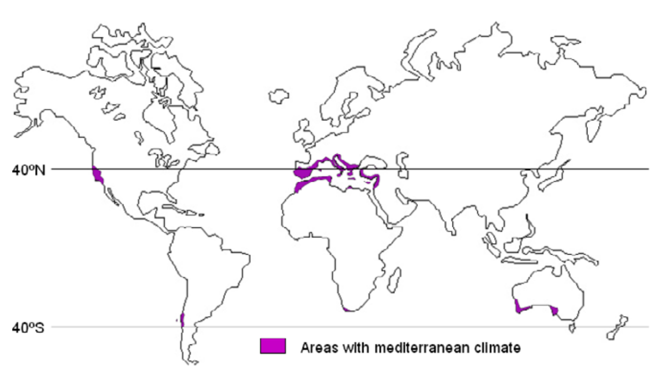

Figure 2: Mediterranean.

Type C looks interesting!

Moist subtropical mid-latitude climates (c): This climate generally has warm and humid summers with mild winters. Its extent is from 30 to 50 degrees of latitude mainly on the eastern and western borders of most continents. During the winter the main weather feature is the mid-latitude cyclone. Convective thunderstorms dominate summer months. Three minor types exist: Cfa - humid subtropical; Cs - Mediterranean; and Cfb - marine. The humid subtropical climate (Cfa) has hot muggy summers and mainly thunderstorms. Winters are mild and precipitation during this season comes from mid-latitude cyclones. A good example of a Cfa climate is the southeastern USA. Cfb, marine, climates are found on the western coasts of continents. They have a humid climate with short dry summer. Heavy precipitation occurs during the mild winters because of continuous presence of mid-latitude cyclones. Mediterranean climates (Cs) receive rain primarily during winter season from the mid-latitude cyclone. Extreme summer aridity is caused by the sinking air of the subtropical highs and may exist for up to 5 months. Locations in North America are from Portland, Oregon to all of California [4].

Cs – Mediterranean: 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 southwestern South Africa, sections of Central Asia, and in central Chile (Figure 2).

Most of the Mediterranean population lives in grouped housing Mediterranean inhabitants favour 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 Africa corresponds to tribal communities and societies, whereas the first model corresponds to more organised complex urban societies.

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.

Mediterranean House

One way of life, many ways for dwelling. Scattered houses, grouped houses, neighbors are always present. Three solutions for a style of housing the basic house; the compact house; the multiple structure houses. Patio; courtyard; garden; trellis from domestication to an expressed household area.

The Mediterranean has a large range of solutions to incorporate the idea of defense 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 defense, without their strictly corresponding to elements of defense, 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.

Traditional building elements – indoor climatic modifiers

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 [1].

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 [5].

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 snowfall. 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.

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 unfavorable climatic changes [6].

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 [7].

• 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°C) 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 (7 m-8 m) 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 grapevines, 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 [6].

Other climatic building elements

Besides the solarium and the courtyard, the two fundamental means that were used in the traditional planning of buildings for the mitigation of extreme climatic conditions, there a lot of other architectural aspects and structural elements which exist in the old houses that reflects the traditional wisdom [6] such as:

a) The Layout and the Orientation of the Building with big glass surfaces aspecting south for solar access in the winter when the sun path is low in the sky and with calculated shading devices that admit the solar radiation of winter and provides solar protection in the summer [8-10].

b) Openings.

• Small openings in the east and the west to avoid the summer sun in the morning and the afternoon.

• Small openings and in the north to avoid cold winter winds but also for achievement of cross-ventilation in the summer.

• Small windows placed mainly above the staircase for ventilation.

• Shutters, Screens and Pergolas that allow ventilation, lighting and view but simultaneously control the penetration of the sun in the summer.

c) Light wells evolved to ventilate and light the interior of dwellings in densely built urban environments.

d) Materials and Methods of Construction. These vary depending on the region and locality [6].

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 [11].

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 [12]. 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.

Use of local, Mediterranean materials

Stone, bricks, wood, straw, marble, ceramics, lime, glass, reeds, sand, and clay are the materials found mostly in Mediterranean architecture. Nowadays, not just the use but also the development of these materials is the gamble of every restless composer and creator [13,14]. An attempt to combine them with the use of new tools, combinatorial methods and industrial-type processes, produces a new, interesting architectural style. The gabion stone, the wood paneling, the apparent brickwork, the translucent marble, the alabaster, the bearing glass and

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the glass bricks, copper, carbon fibers, sensors, the standardized and industrialized production, even the technique of reusing - recycling materials, are some examples that try not only to adopt the traditional Mediterranean style (Tables 1 and 2) but to evolve it and integrate it smoothly and seamlessly into the contemporary architectural industry (Figures 3 and 4).

CDD and HDD for Amman city

- Heating start (1\1- 1\5) (20\9 – 31\12)
- Cooling start (1\5 – 20\9)

$$HDD=\left(\int_{1}^{5} 20\,dx-\int_{1}^{5} 0.010x^4-0.316x^3+2.768x^2-5.319x+10.48\,dx\right)+\left(\int_{9.8}^{12} 20\,dx-\int_{9.8}^{12} 0.010x^4-0.316x^3+2.768x^2-5.319x+10.48\,dx\right)$$

$$HDD=\left(20X+C\,\Big]_{1}^{5}-0.010\frac{X^5}{5}-0.316\frac{X^4}{4}+2.768\frac{X^3}{3}-5.319\frac{X^2}{2}+10.48X+C\,\Big]_{1}^{5}\right)+\left(20X+C\,\Big]_{9.8}^{12}-0.010\frac{X^5}{5}-0.316\frac{X^4}{4}+2.768\frac{X^3}{3}-5.319\frac{X^2}{2}+10.48X+C\,\Big]_{9.8}^{12}\right)$$

Io for Amman city in July from 11-12 am = 982. Direct component = 738 watt\m². Coefficient Albedo= I reflected \ direct solar radiation. Global= direct+ defused. Diffused= 0.33 direct. Absorbance = 100% - reflectance. Radiation Emitted = Absorbance * Emittance. Net gain = Absorbance – Emitted.			
	Solar Reflectance (%)	Thermal Reflectance (%)	Thermal emittance
Aluminum foil, bright	95		0.5
White plaster	93		0.91
Fresh snow	87		0.82
Aluminum foil, oxidized	85		0.12
Aluminum sheet, polished	85		0.08
White wash, new	80		0.9
White painted aluminum	80		
White paint	70-75		0.91
Chromium plate	72		0.9-0.95
Polished copper	75	85	0.15
Snow, re granules	67		0.89
Light gray paint	60	5	0.90-0.95
White powdered sand	55	45	0.9
Aluminum, paint	45-50		0.33-0.73

Table 1: Temperature reflexences.

$$HDD=\left\{\left[(20\times5)-(20\times1)\right]-\left[\left(0.010\frac{5^5}{5}-0.316\frac{5^4}{4}+2.768\frac{5^3}{3}-5.319\frac{5^2}{2}+10.48\times5\right)-\left(0.010\frac{1^5}{5}-0.316\frac{1^4}{4}+2.768\frac{1^3}{3}-5.319\frac{1^2}{2}+10.48\times1\right)\right]\right\}$$
$$+\left\{\left[(20\times12)-(20\times9.8)\right]-\left[\left(\left(0.010\frac{12^5}{5}-0.316\frac{12^4}{4}+2.768\frac{12^3}{3}-5.319\frac{12^2}{2}+10.48\times12\right)-\left(0.010\frac{9.8^5}{5}-0.316\frac{9.8^4}{4}+2.768\frac{9.8^3}{3}-5.319\frac{9.8^2}{2}+10.48\times9.8\right)\right)\right]\right\}$$

$$HDD=([100-20]-[58.12-8.66])+([240-196]-[196.68-167.80])=(30.54)+(28.88)=59.42℃$$

$$HDD=59.42\times30 = 1782.6℃$$

$$CDD=\int_{5}^{9.8} 0.010x^4-0.316x^3+2.768x^2-5.319x+10.48\,dx-\int_{5}^{9.8} 20\,dx$$

$$CDD=0.010\frac{X^5}{5}-0.316\frac{X^4}{4}+2.768\frac{X^3}{3}-5.319\frac{X^2}{2}+10.48X+C\,\Big]_{5}^{9.8}-20X+C\,\Big]_{5}^{9.8}$$

$$CDD=\left\{\left[\left(0.010\frac{9.8^5}{5}-0.316\frac{9.8^4}{4}+2.768\frac{9.8^3}{3}-5.319\frac{9.8^2}{2}+10.48\times9.8\right)-\left(0.010\frac{5^5}{5}-0.316\frac{5^4}{4}+2.768\frac{5^3}{3}-5.319\frac{5^2}{2}+10.48\times5\right)\right]-\left[(20\times9.8)-(20\times5)\right]\right\}$$

$$CDD=\left[(176.80-58.12)-(196-100)\right]=118.68-96=22.68\ ℃$$

$$CDD=22.68\times30=680.4℃$$

Amman city climate: sun-scorched, wind-swept, dry land much sun, little rain sea mass brings high humidity, mild winters and summers 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 [15].

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

- Shortage of safe land
- Mutual protection from sun and 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 neighborhoods' via flexible repetition.

Major building features: organic forms, responding to environmental constraints using local resources, imprinting social evolution ergonomic scale similar to ships, ships material and space minimalism

	Solar reflected	Absorbed	Emitted
Aluminum foil, bright	798 * 0.95=701 watt	798 * 0.05=39.9 watt	399 * 0.5=19.9 watt
White plaster	798 * 0.93=742.14 watt	798 * 0.07=55.86 watt	55.86 * 0.91=50.83 watt
Fresh snow	798 * 0.87=694.26 watt	798 * 0.13=103.74 watt	103.54 * 0.82=85.06 watt
Aluminum foil, oxidized	798 * 0.85= 678.3 watt	798 * 0.15=119.7 watt	119.7* .12=14.36 watt
Aluminum, sheet. Polished	798 * 0.85= 678.3 watt	798 * 0.15=119.7 watt	119.7* .08=09.57 watt
White wash, mew	798 * 0.80=638.4 watt	798 * 0.20=159.6 watt	159.6 * 0.9=143.6 watt
Light gray paint	798 * 0.6= 478.8 watt	798 * 0.4=319.2 watt	319.2 * .93=296.85 watt
White powdered sand	798 * 0.6= 478.8 watt	798 * 0.4=319.2 watt	319.2 * .93=296.85 watt
Aluminum paint	798 * 0.48= 383.04 watt	798 * 0.52= 414.96 watt	414.96 * .53=219.92 watt
Brick (light-dark)	798 * 0.36= 287.28 watt	798 * 0.64=510.72watt	510.72 * .95=485.18 watt
Dark gray paint	798 * 0.3= 239.4 watt	798 * 0.7=558.6watt	558.6 * .95=530.6 watt
Asbestos, slate	798 * 0.19= 151.62 watt	798 * 0.81=646.38 watt	646.38 * .96=620.52 watt
Galvanized iron, aged	798 * 0.15= 119.7 watt	798 * 0.85=678.3 watt	678.3 * .28 189.9 watt
Granite	798 * 0.45= 359.1 watt	798 * 0.55=438.9 watt	438.9 * .44=193.116 watt
White paint	798 * 0.73= 582.54 watt	798 * 0.27=215.46 watt	215.46 * .93=200.37 watt
Concrete	798 * 0.40=319.2 watt	798 * 0.60=478.8 watt	478.8 * .88=421.34 watt
Indians limestone	798 * 0.43=343.14 watt	798 * 0.57=454.86 watt	454.14 * 0.95=432.117 watt

Table 2: Climatic changes.

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	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Mean max	12.2	13.6	17.0	23.4	28.4	31.1	32.5	33.5	31.4	27.8	20.6	15.5
mean	8.2	9	12.2	17.6	21.8	24.5	26.7	26.9	25.1	21.4	15.6	10.8
Mean min	4.2	4.4	7.5	11.9	15.2	18.0	20.9	20.4	18.9	15.0	10.6	6.2

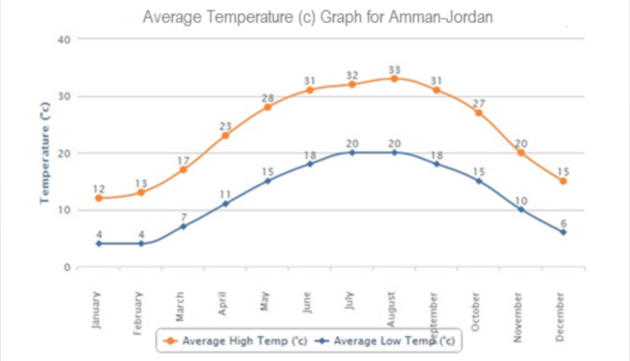

Figure 3: Average temperature Amman-source: the researcher, 2014.

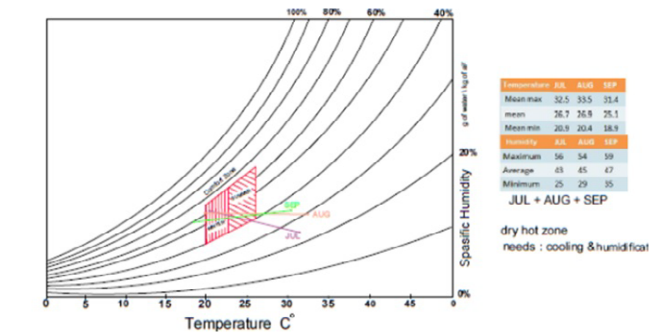

Figure 4: The psychometric chart describes the various mixtures of air and watervapour of different temperatures.

vital for sustainability, sustainability products of necessity rather than choice [16].

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

Material recycling

A major construction difficulty: Transport of materials

- The only available means: donkeys and mules
- Rule 1: respect ground stability
- Rule 2: embed or recycle to lessen transportation burden.

Cooling

- Very sunny place
- Excessive isolation creates discomfort by reflections, glare, heat-emitting mass
- Shading devices were too costly or flimsy
- Climbers require precious water and cannot endure winds
- Solar protection is provided by adjacent buildings or free-standing walls
- 'meltemi' offers relief when not too strong
- Only caves comfort in daytime, thanks to low radiant temperature.

Heating

- Winter is humid and windy
- Fireplaces did not exist, just small portable stoves –'mangali'
- Bush branches were the main fuel
- Heavy clothes, metabolic heat, or patience were the alternatives
- Radiant heat from cave walls improved comfort for most of winter
- Small openings reduce heat losses
- But at the same time they decrease daylight to the interior
- Artificial light only from oil lamps and candles.

Rainwater collection

- Rainwater collection was absolutely vital, affecting building layout and form
- The precious liquid was directed from roofs and terraces to cisterns via well-laid routes
- Limestone was used for disinfecting the cistern and the water route-that had to remain free of droppings [17].

Domestic hygiene: Washrooms were away from the main quarters, over a collection tank; its contents were periodically transported to the fields as man-made fertilizer. Today tankers bring water to the arid island, supplementing the desalination plant. Thus many old cisterns are converted to septic tanks and swimming pools emerge everywhere.

Ventilation

- Ventilation and daylight provided into caves only through their façade.
- Top clerestory lets warm air to escape; brings daylight deeply.
- Vertical ducts through the ground admit extra air and light.
- Lack of heating plus limited ventilation trigger condensation and mould growth, assisted by soil moisture.
- Bad indoor air, chronic water shortages, co-existence with numerous animals: a smelly rather than idyllic picture of everyday life in the past [18].

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 and needs to the given conditions, merging the Four Elements into an honest and 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 [19].

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 [20,21].

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Citation: Atiyat D (2015) Architecture Building Treatments in the Mediterranean Climate From an Environmental Perspective: Case Study of Amman – Jordan. J Archit Eng Tech 4: 151. doi:10.4172/2168-9717.1000151