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A relative study of microclimate responsive design approaches to buildings in Cypriot settlements

Timothy O. IYENDO[1], Ebunoluwa Y. AKINGBASO[2], Halil Z. ALİBABA[3], Mesut B. ÖZDENİZ[4]

[1] tidosmart@yahoo.com • Department of Architecture, Faculty of Architecture, Eastern Mediterranean University, Famagusta, North Cyprus, Turkey

[2] ebunoluwaakingbaso@ymail.com • Department of Architecture, Faculty of Architecture, Eastern Mediterranean University, Famagusta, North Cyprus, Turkey

[3] halil.alibaba@emu.edu.tr • Department of Architecture, Faculty of Architecture, Eastern Mediterranean University, Famagusta, North Cyprus, Turkey

[4] mesut.ozdeniz@emu.edu.tr • Department of Architecture, Faculty of Architecture, European University of Lefke, Lefke, North Cyprus, Turkey

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Abstract

This study describe the microclimates, its effects on building design, and how it depends on the specific climate of a place. The aim of this study is to examine the microclimate responsive design approaches to buildings in the Cypriot settlement through different basic elements of bioclimatic design for human comfort. The study focuses on selected buildings in Famagusta and Lefkosa district of North Cyprus, to understand the effect of microclimate design approaches on the vernacular and contemporary edifices. In line with climate characteristics; site planning, building form and orientation, vegetation, indoor ventilation, and building material was considered in this study. The research techniques applied, includes related frameworks, on-site observation, and interview with building dwellers. The findings suggested that the vernacular buildings and its environment are more sustainable when matched to contemporary buildings. Moreover, the study inference suggests that contemporary buildings should incorporate vernacular buildings responsive design approaches to maximise human comfort. The implication of the study serves as a guide for further investigation on designing microclimate responsive buildings.

Keywords

Microclimate, Bioclimatic design, Vernacular housing, Cypriot settlements, Human comfort.

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1. Introduction

Designing buildings to conform to the local climate is not a new concept as such. Tracing back from history, beside food, shelter is one of the essentials of human life on earth. The first humans built shelters and lived in caves to protect themselves from harsh climatic conditions, such as rain, precipitation, storm, and cold weather (Ozay, 2005). From the beginning of time, around the fourth century BC, the Greeks knew the importance of incorporating buildings with climatic conditions. Likewise, they are knowledgeable about the sun's path and the need of placing windows on the southern orientation to capture adequate needed heat for thermal comfort. Much progress was made in the fourth century (110 BC), when interest in architectural design with climate was first documented by one of the great philosopher, Vitruvius. Vitruvius argued that we must take note at the outset of the countries and climate in which buildings are built (Oktay, 2001).

For instance, in the old capital city of Italy in Rome, builders were aware of the importance of mitigating temperature (bright sun) by creating massive walls with stone and their shadows. These walls were made of stucco bricks and were typically twelve to twenty feet wide, which allowed an extended area to be captured in the shadows of the walls keeping the city cool during the midday hours. The stuccoed walls serve as climate-responsive architecture or constructed to make use of the surrounding climate and its natural effects. In support of this, one study has shown that in most ancient Roman cities colonnades were built along both sides of their major streets to hinder climatic elements on pedestrians (Oktay, 2002). In the Middle East, for example, windows are kept to a minimum to prevent the sun from entering the building in hot dry (arid) climates. As indicated in Figure 1, bright stucco finishes are used to reflect light to keep the bright environment.

From this context, it is obvious that local climate varies significantly within a small area due to changes in altitude and rainfall. Building techniques of local climatic have been developed over a long history of construction, and these have advanced to promote passive climatic conditioning to protect inhabitants from their harsh environments. Those ideas and techniques of city planning, building form, and construction methods offer great insight to contemporary Architecture. Indeed, climate simulates needs for shelter and influence local culture, including local building materials. Similarly, studies have studied demonstrated climatic issues, which include both vernacular and modern buildings. This can be seen in Vitruvius, Koppen Geiger, Dollfuse, and Olgyay's study, which provides useful data about climates and each of these studies unfolds the classification of selected climatic zone or area (Szokolay, 1980). Indeed, when individuals design with a specific local environmental characteristics in mind. This creates an avenue to manipulate the relationship between the climates,

(a) *(b)*

Figure 1. *(a) Archetypal surviving (1st century A.D.) exterior stucco rendering on stone-faced concrete walls at Ercolano; (b) an exterior stucco rendering in the Middle East (Bronski, 2010).*

the site, and the building, which in turn generates a local environment or microclimate around the building. The "mini climate" that is created around the building can decrease the apparent severity of the climate, that is, the work the building must do to make for a comfortable interior and exterior environment around the building. There is that tendency, if badly handled or designed can increase the severity of the local climate of the building (Moore, 1993).

2. Links between the microclimate, site and buildings

Designing with the climate, micro, or macroclimate of a particular geographical location, the design should take into account the relationship between the climate, site, and occupants, as well as the building itself in order to have a building base on the local microclimate of the environment under consideration. This supports the notion that human thermal comfort in building design is achieved by understating the basic principles of bioclimatic design, which deals with maintaining of thermal comfort within the building. Thus, thermal comfort is achieved when there is a heat balance between human beings and the surrounding in which they live (Moore, 1993). Similarly, Susie (2011) remarked that designing a climate responsive building require proficiency in the aspect of the climatic analysis of the area under consideration as whole, thereby providing design strategies which favour the use of renewable energy, effective site analysis, proper choice of building materials, construction techniques, building forms, orientations, as well as effective use of vegetation. However, these design strategies depend on the microclimate of an area, that is to say that bioclimatic architecture happens to be a concept of architecture which design helps conserve resources while facilitating the use of the local climate around a dwelling to construct a green home or building that is passively sustainable (Taleb & Sharples, 2011).

2.1. Major factors manipulating human comfort

An investigation by Gut and Ackerknecht (1993) classified the major factors affecting human comfort as, temperature, humidity, in the form of vapour and precipitation, wind and air movement (breeze or draught), exposure to radiant heat sources (solar radiation), and cool surfaces to radiate for cooling. Additionally, it is worthwhile to mention that the air temperature and mean radiant temperature of a homogeneous environment affect the "dry" heat exchange of the body by convection and radiation. However, the rate of this heat exchange depends on the air velocity and on the clothing. Under constant conditions of air velocity and vapour pressure, a rise in the air temperature is responded to by an increase of skin temperature and sweat rate. Moreover, this rate also depends on the air velocity and humidity levels (Gut & Ackerknecht, 1993). Similarly, humidity of the air on the other hand, indirectly affects the thermal comfort of the body and determines the evaporative capacity of the air and hence the cooling efficiency of sweating.

It is generally accepted that the internal temperature of the human body should for all time be reserved contained by the narrow limits at around 37°C, any variation of this value is an indication of sickness, and an increase of 5°C or a fall of 2°C from this value may lead to serious health problem or even death. Likewise, air movement is another factor that affects the thermal comfort by both the evaporative capacity of the air and the convective heat exchange of the body. The effect of air velocity on the evaporative capacity is interrelated with the effect of humidity, as well as the effect of air velocity and air temperature and the collective heat exchange are interrelated (Gut & Ackerknecht, 1993). A study has indicated that when the air temperature is below skin temperature these two effects work in the same direction. While on the other hand, if the air temperature is above the skin temperature these two effects operate opposite way (Oktay, 1998). Therefore, to achieve a comfortable environment for occupants or intended users, significant aspect needed to be considered which includes site condition and orientation, plan configuration, construction

methods and materials, ventilation and shading properties, thermal mass, and landscape of the building surroundings. Furthermore, when all these elements combine, indeed, relaxed temperatures and high indoor air quality are attained. However, other personal variables that add to the human comfort ability includes activity, clothing, sweat, dieting habit (et cetera). The major factors needed to be considered when designing a climate responsive building includes the following:

2.1.1. Building orientation and form

It is important to consider the local climate during the first stage of building design. That is, an energy conscious design, which results in an energy efficient building, has to be based on the local climate. Susie (2011) supported that in any building, the shape and the orientation of the building should be first defined considering the climate of the area, the wind, the temperature and the solar radiation. On the other hand, Oral and Yilmaz (2002) advocated that the most important design parameters affecting indoor thermal comfort and energy conservation on the building scale are orientation, building form, optical and thermo physical properties of the building envelope. These factors are of major concern in order to achieve the reduction and control of solar radiation as well as provision of natural ventilation and natural cooling of the external building surfaces by evaporative cooling (Susie, 2011).

2.1.2. Building envelope and materials

Building as a whole need to provide comfort for the occupant keeping the internal environment thermally balanced so that the occupants can perform their duties and the structures serve its function as a shelter (İpekoğlu, Böke, & Ozlem, 2007). However, to construct a building that is thermally balanced, heat gain from outside of the building should be controlled and heat loss from the internal environment should be minimised via the building envelop. Contemporary methods of controlling heat loss and heat gain from a building suggests double skin facade as an effective means to balance the interior and exterior part of the building (Indraganti, 2010). Similarly, choice of reliable material has an impact on the occupant depending on the climate, properties of materials such as ease of cleaning, roughness, emission of heat absorption of heat as well as its environmental adaptability (Susie, 2011).

2.1.3. Integration of renewable energies

The global world today faces the challenge of averting the excess carbon dioxide (CO2) produce globally. It could be argued that over half of emitted energy lead to the accumulation of greenhouse gasses and ozone depleting gasses. Indeed, the overuse of the available resources has reached unacceptable limits, for example, regions like Europe has come up with measures of producing low energy consumption buildings with the aid of the European Union (EU) programs (Susie, 2011). Across studies, it has been demonstrated that renewable energy tends to have a high initial cost, but yields a prudent result at a later stage. Interestingly, the Eco friendly alternative has yielded subsentail benefit that promotes sustainable environments (Indraganti, 2010; Taleb & Sharples, 2011).

2.1.4. Water bodies

Water bodies are useful elements in a particular building environment which provides an alternative in designing a climate responsive building or environmentally conscious architecture through an intelligent use of water that proves to be effective in the enhancement of occupant comfort (Chmutina, 2010). As this is a significant aspect to promote human comfort, Architects and urban designers should work collectively toward implementation of this useful strategy, however, this need initial design consideration of individual buildings or units of the building. This strategy can be feasible when rain or storm water are collected and used in different ways in building surroundings, such as creating fountains, pools as well as pond, especially in summer times to enhance thermal comfort balance (Indraganti, 2010).

2.1.5. Daylight Strategies

Indeed, daylight has a positive and negative effect on the activities of buildings and their occupants, despite this, climate responsive buildings, energy conscious design, explore the potentials of natural ventilation, natural lighting and passive design to provide a comfortable environment (Susie, 2011). The major concept behind the provision of day lighting strategy in buildings is to provide adequate illumination for the interior using the environment and architectural elements so that energy consumption can be reduced and visual comfort enhanced. It is of significance to note that daylight strategy is considered at the initial design stage in order to minimise the over reliance on electricity through transparent insulation, roof light, atriums, light duct and proper shading to avoid visibility glare from direct sunlight (Oral & Yilmaz, 2002).

2.1.6. Site vegetation/landscape

Vegetation or landscape is an important aspect of design with climate and environmental conscious design. For example, vegetation such as trees can be used to protect the building from unwanted wind. It also provides a favourable atmosphere to buildings in sunny days, especially during summer as well as outdoor seating with some design architectural elements of outdoor spaces. In some places like India, they use deciduous trees on the south and eastern sides for shading, the occupied space during the summer and allowing solar penetration during the winter season (Kanagaraj & Mahalingam, 2011).

2.1.7. System participation in building design

There are general system parameters to be considered when designing and building an ecological building or a climate responsive building, these include influencing parameters, design interface, and efficient mechanism. The Influencing parameters take into consideration factors that will an have effect on the proposed building and occupants upon completion, such as macro parameters, outdoor parameters, desired indoor parameters and human comfort parameters. In the design interface, this deal with factors that can be incorporated at the design stage to provide the desired comfort and function through analysis and effective use of macro climate, microclimate of the site, building design as well as human body and both factors work together to provide intelligent building. Similarly, the aspect of the efficient mechanism devoted to the macro and microclimate modification by addition or reduction of climatic factors using architectural elements and much more. Integration of passive and mechanical systems in building to work together in order to conserve energy as well as human regulatory and behavioural adaptation, which have a direct effect on human behaviour and their activities within the building (Kanagaraj & Mahalingam, 2011).

3. Microclimatic factors and human comfort in North Cyprus settlements

From architecturally point of view, there are three focal considerations guiding tropical design, which includes the people and their needs, climate and its attendant ills and the materials and the means of building. This implies that, climate, sun, and humidity act as the main liabilities, whereas wind is an asset. In this view, Tzikopoulos, Karatza, and Paravantis, (2005) suggests that, to attain comfort in hot and humid regions, bioclimatic factors must be taken into account in building construction, which includes topography, (e.g. Slope, site orientation, site views), and movement of the sun and its impact during the year (i.e. Solar altitude and azimuth). This same study also suggests other climatic conditions such as prevailing wind patterns, incoming solar radiation, temperature, air moisture; environmental conditions such as daylight and shading of the construction site; mass, volume and size of building; local architectural standards, and availability of local building materials. In addition, the utilisation of vegetative cover or non-reflective flooring materials also helps in preventing reflected radiation and glare, as well as flattening day and night temperature swings within the interiors. Moreover, it has also been suggested that the cre-

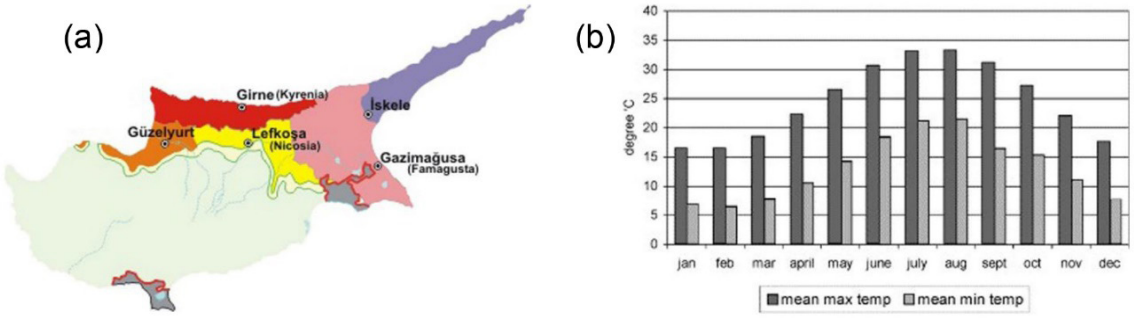


Figure 2. *(a) Location of the three basic cities in North Cyprus map (Modified by author); (b) temperature data for Northern Cyprus (Dinçyürek, Mallick, & Numan, 2003).*

ation of the open arcaded hall situated on the south and proportioned in such a way to keep away the high summer sun, while letting in the low winter can increase comfort in hot humid regions (Dinçyürek, Mallick, & Numan, 2003).

In line with the Mediterranean climate, North Cyprus is the third largest island situated in the north – eastern part of the Mediterranean Sea (34.5N latitudes and 32.5E longitude) (Aksugur, 1996). It is 65 km away from Turkey, 95 km from Syria, 350km from Egypt and 750 km from Greece (Palmer, 1990). As portrayed in Figure 2a, North Cyprus climatic features can be scrutinised from four main regions; Lefkosa (Nicosia) island, Gazimağusa (Famagusta), located on the eastern coast, Girne (Kyrenia), situated on the northern coast, and Guzelyurt on the western coast. However, these regions are characterized in the same climatic zone called the semi-arid Mediterranean climatic zone and are in close proximity to each other. These regions can be categorised under three distinct climatic conditions, such as hot–arid, hot–humid, and composite climates. This is due to the geographical qualities such as topographical values and proximity to the sea (Oktay, 2002).

Climatically, North Cyprus Island has an intense Mediterranean climate that comprises of typical seasons, long hot dry summer from (June – September), moderately cold winters with little cloud cover or changeable rainy days (November – March), which is separated by a short autumn and spring season of rapid change in (October, April – May) (Price, Michaelides, Pashiardis, & Alpert, 1999). As presented in Figure 2b, the average coldest daytime temperature in winter (January – February) ranges from 12–15 oC. In summer, the average maximum temperature in coastal regions is 32 oC. The maximum temperature often reaches 40 oC – 47 oC in July and August. The wet season extends from November to March, with most (approx. 60%) of the rain falling between December and February (Giannakopoulos et al., 2010).

4. North Cyprus climate responsive design approaches

In hot and cold climate, climate responsive architecture uses special techniques and designs to help get the most benefit out of the natural environment. This is done by taking advantage of the surrounding environment and the average climate conditions of the region. Around the globe, there are well-known examples of buildings and settlements that employ such designs. To overcome variations in climatic conditions, North Cyprus buildings, implements several aspects of climate responsive design. However, the impact of climate on the architectural designs in rural areas can be seen more often in crowded villages.

4.1. Compacted settlements/housing

In the Vernacular Cypriot settlements, houses in towns and villages are characterized by optimal protection against solar radiation by mutual shading, which leads to compact settlements, narrow streets and small squares. The discerning factors of these buildings lie in the array of the dwellings, around social centre and especially in the narrow streets. These narrow streets that meet at the centre leave space open for westerly and more infrequently easterly winds and are designed in a way to shed shad-

Figure 3. *(a) Map portrays a traditional quarter in Famagusta (Oktay, 2002); (b) a narrow Street in the traditional quarter of Arabahmet, Lefkosa (Authors archives, 2013).*

ows to lessen the impact of acute heat felt in the streets during summers. As demonstrated in Figure 3a & b, the narrow streets permit breeze flows and which, also facilitate passive cooling. Buildings are closely joined (Oktay, 2002; Günçe, Ertürk, & Ertürk, 2008). For example, Dechra settlements in Italy cluster their houses close together facing the south in order to minimize heat loss (Bensalem, 1995). Likewise, in North Cyprus settlement, compacted streets make it walking easier, due to the shade it casts on the streets and allows the occupants, particularly the women to sit in the street (Oktay, 2002).

4.2. The use of vegetation

Designs using vegetation in the urban environment are of functional, in landscaping and aesthetic as well as the climatic importance of its radiation absorbent surface and its evaporative and shade-giving properties. The vegetation in and around houses also has definite effects on air movement. Landscaping or vegetation around buildings improves the microclimate outdoors and indoors. It checks hot and dusty winds. Planting trees around building help in leaves transpiration and reduces temperature around the surrounding. Shade of plants or trees lowers daytime temperatures and heat emission at night, thus resulting in appropriate balanced temperatures for the occupant comfort. It balances the humidity in the building environment as well. During precipitation, much of the free water is absorbed and during dry periods, water is evaporated through vegetation. Figure 4 shows a typical example of how vegetation is used in Cypriot houses.

4.3. Utilisation of the cooling effect of water

As indicated in Figure 5, in some region within North Cyprus, for example, in the Kyrenia area, water bodies are integrated close to buildings, which evaporate and therefore reduces the surrounding temperature, as well as for thermal balance of the building occupants in most cases.

4.4. Usage of arcades, bay windows (cumba) cantilevered roofs

As illustrated in Figure 6, the bay windows (cumba), thick adobe walls, pitch roof structures and their overhangs are all the expression of the climatic responsive design (Ozay, 2005).

Figure 4. *Describes the use of vegetation in Boyunca Street in Lefkosa (Authors archives, 2013).*

Figure 5. *A typical building in the Kyrenia area, portraying water boding around the building for cooling effect (Source: Authors archives, 2013).*

Figure 6. *Portraying bay windows (Cumba) in a street- walled city of Lefkosa (Authors archives, 2013).*

In Cypriot settlements, arcades, porches, colonnades, cantilevered roof or components, and membranes serve as traditional responses to the climate in the villages and urban settings; this gives an inward looking and provides a transition from indoor to outdoor light. The most prominent climate-modifying element in some of these houses is the arcaded hall, which is located on the south without exception. The porch, which is positioned in the southern part of the dwelling, is of great worth to Cyprus traditional dwelling and consists of a semi-open and arcaded space. It is more conducive in winter period due to the passage area, which is located in between the closed and open areas. It allows penetration of sunrays in winter and keeps out cool flow of air. During the summer period, it provides an ideal space and allows for the cool flow of air (Dinçyürek, Mallick, Numan, 2003; Günçe, Ertürk, & Ertürk, 2008). As represented in Figure 7, it also serves as shading elements for most of the day's especial sunny periods, and for heavy rainfall

4.5. Using of small enclosed courtyards in Cypriot houses

Most of the Cypriot houses have courtyards due to the weather in the summer period, and are almost similar in shape, which is either rectangular or square in nature. The courtyard is where most of the daily activities are carried out and is used for various activities, which includes social gathering and entertainment (such as playing local cheese), preparation of food and eating of food, domestic works are done there during spring and summer periods, washed cloths are dried in the courtyard likewise (Oktay, 2002). As depicted in Figure 8a & b, vegetables, flowers and trees are grown to provide a fascinating eye-bird appearance of nature. In addition, vegetation in the courtyard act as evaporative agent and coolants in the courtyard. They also serve the purpose of air filters; such as dust in the atmosphere within the courtyard. Furthermore, the courtyards also serve as accommodation for the household pets, and traditional oven is used for baking bread for the household or visitor in the courtyard (Günçe, Ertürk, & Ertürk, 2008).

Figure 7. *Cases of porch in a single storey Cyprus traditional dwelling (Günçe, Ertürk, & Ertürk, 2008).*

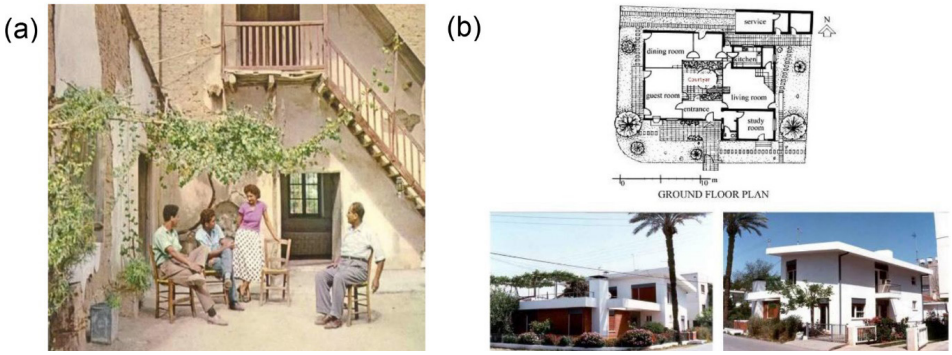


Figure 8. *(a) A typical old traditional village Cypriot courtyard (Pulhan, 2008); (b) an archetypal courtyard Cypriot dwelling from the 1960s (Ozay, 2005).*

Moreover, the courtyards serve as wind protected exterior spaces in winter and cooling effect or cool air pools that occur in courtyards in summer to satisfy effective comfort of the occupants. It minimises the solar radiation impact on the outside walls and provides a cool area within the building, which is surrounded by rooms. Other requirements such as safety defence, privacy, and lifestyle are also attained in the Cypriot rural traditional dwelling courtyard. However, a centrally situated courtyard may not be suitable for houses in North Cyprus, due to the severe summer heat and sometimes compromises this intended purpose, because of inadequate cross ventilation within the courtyard (Pulhan & Numan, 2006).

4.6. Using balconies, terrace and canopies

As one of the primordial forms of architecture, "courtyard styles" may be relevant for any type of building, be it residential, commercial, institutional or industrial. "Special places that are outside yet almost inside, open to the sky, usually in contact with the earth, but surrounded by rooms" (Blaser, 2010). In some cases, canopies are introduced over their building windows to direct the airflow upwards and to serve as shading elements as well. Balconies above the ground floor are usually used as outdoor sitting area during the summer time when the sun intensity is much in order to have comfortable living spaces. The canopies also provide a sitting environment with a nourishing vista usually around pools, cafes and many more. As described in Figure 9, the terraces of the traditional Cypriot dwellings or houses serve the purpose of food drying and clothes drying in some occasions. Construction provision of the balconies must ensure discontinuity of their extended, exposed structure to the air, which is liable to act as a thermal bridge to the internal slab. Unfortunately, most houses in North Cyprus are poorly designed in terms of balconies. The balcony is always narrowly constructed, especially in apartment buildings, and this undermines the intended purpose.

Figure 9. *A dwelling with an effective terrace along salamis road in Famagusta (Authors archives, 2013).*

4.7. The use of shading devices

In Cyprus, shading devices are used in both residential and public buildings, but feature prominently in some public buildings. The need arises because of radiation experienced in the form of increased air temperature, radiant heat and glare mostly in the summer time, when there is much intense heating and need to keep the internal environment cool to control warm air or direct sunlight effect on the occupant. As shown in Figure 10a & b, adequate shading reduces these effects considerably, and which call for both vertical and horizontal shading used in North Cyprus buildings.

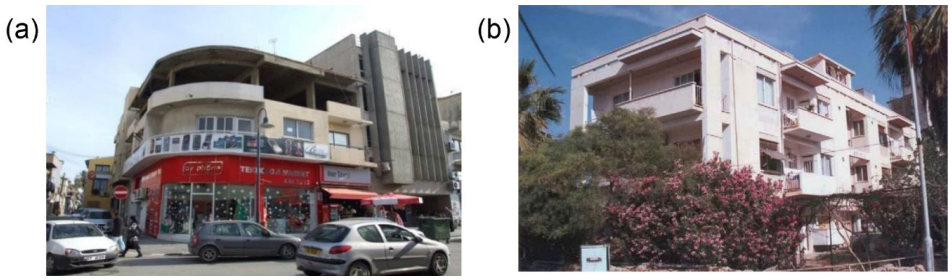


Figure 10. *(a) A mix-use apartment block with combined shading devices - horizontal shading devices (Authors archives, 2013); (b) apartment block with horizontal shading devices (Ozay, 2005).*

4.8. The use of bright colours

As depicted in Figure 11, most buildings in Cypriot settlements are carefully painted with bright colours, this is due to the climatic condition of the area, and most of the colours that are used in their buildings are light or bright colours. Bright colours are applied in Cypriot building facades to reduce reflection of sun into buildings, since the reflection of sunlight increases heat penetration to the interior. Application of bright colours in Cypriot building immensely facilitates in the reduction of heat penetration to the indoor environment, thereby providing a conducive surroundings for occupants, as well as reducing the defects of sunlight on the exterior walls.

4.9. The use of building materials

In line with climatic characteristics, building material was carefully selected in the rural areas of Cypriot settlements. For example, in the Traditional building material like 'adobe' is commonly used in the village settings, as it is locally available materials, which provides Its energy efficiency and can be recycled. As shown in Figure 12, stone infill structures were mostly used instead of wood. Marble is used as flooring covering materials with respect to the climatic conditions. In some cases, yellow limestone and adobe are also used. However, in the rural area building materials and techniques are chosen based on topography and resources of the local environment. For example, in Mesaorian regions, adobe is the most substantial building materials in use. Stone is commonly used in the mountainous region, with respect to climatic and topographic conditions. Consequently, to attain climatic comfort for dwellers using the natural sources available (Oktay, 2002).

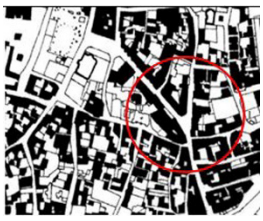
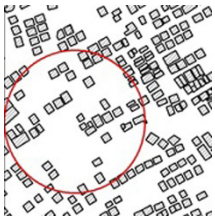
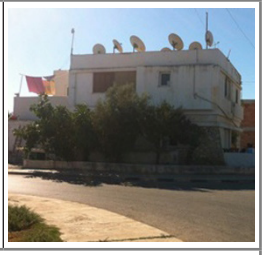
5. Conclusion

The study indicates that designing with climate in North Cyprus is of two fold, the vernacular and contemporary buildings. The vernacular buildings and its environment are more sustainable compare to the modern ones. The organisation in the city and villages differs from each other, this account for more appropriate in the climate accommodation. Climatic condition and social aspect differences have driven specific acclimatization of the people through the buildings. In Famagusta

Figure 11. *Portraying the use of bright colour in Cypriot vernacular dwellings (Authors archives, 2013).*

Figure 12. *A building depicting availability of local building material (stone and adobe), in Arabahmet, Lefkosa (Authors archives, 2013).*

Table 1. *Classification of the vernacular and contemporary settlements in terms of sustainable and non-sustainable.*

Sustainable	Unsustainable	Sustainable	Unsustainable
			
1 **Figure ground**		2 **Use of water bodies**	
The narrowness of the streets and arrangement of buildings simply defines the surrounding space for alternate uses and users. Compacted streets and buildings makes walking easier.	While on the other hand, scattered buildings create irrelevant space and disqualifies the orientation and use of spaces created within.	Delibrate design of some forms of water bodies (such as pond, wtaer fall) or adoption of existing lakes, wetland, stream e.t.c as a cooling device makes living comfortable for both human and animal species within immediate environment.	On the other hand, absence of any water body and at the same time, absence of vegetation around buildings may insure more ventilation cost on the inhabitation.
			
3 **Street layout**		4 **Use of windows**	
Narrowed street pattern was a delibrate climate adaptive mechanism that enables shadow casting which cools the frontages for sitting and walking comfortability	Some newly developed parcel area divisioning does nt give cognisance to this potential and therefore creates some wider streets along parcel blocks.	Large or small size of window frame also has respective roles in creation of comfort in a house. Likewise, the wooden or aluminium frame materials utilized determines the degree of heat absorption or air penetration into the building.	Recent designed buildings are with larger window sizes in smaller numbers, which makes the assumed volume of air not to be properly cross ventilated.
			
5 **Use of Vegetation**		6 **Roof utilisation**	
To provide favourable atmosphere in sunny days, certain species or combination of many plant are used to support outdoor sitting elements. While same tree is use as wind blockage in the cold winter wind.	A lack of such a conducive environment increases the tendency of adverse discomfort, increase spread of diseases, high cost of housing renovation resulting from harshness of the heating and cooling of building walls.	Another sustainable way of obtaining comfort in a house is through the adoption of cantilevered roofs and porches to help maximize the air and solar energy in either season which is used in the vernacular settings.	While inexistence of alternate energy control methods would result in the adoption of mechanism that are more cost consuming.
			
7 **Use of Courtyard**		8 **Building material**	
Beyond a space, the courtyard was for building and streets linkages, social, domestic and ventilation derivation	Contemporary building designs assumes the role of courtyard as waste and irrelevant thereby deprived of such connections.	Vernacular use of adobe (clay), timber and yellow stone materials were practically meant to moderate climatic temperatures.	Metal, concrete, cement is most unique to the unsustainable contemporary houses.

and Lefkosa regions, several aspects of design with climate and sustainable architecture can be found easily, especially in term of acclimatization to the nature. However, this is a great improvement. As indicated in Table 1, in some buildings, the concept of climate design and sustainability are totally neglected, especially in the apartment buildings within these regions. The newer developments, just similar to other cities in the world are neglecting the natural-local aspect, culture, and tradition of the users. The older material such as stone and earth has higher thermal lag than new constructed contemporary buildings. Wooden opening materials were effectively used-no glass house effect in the older houses. In addition, the new housing developments undermine the used of balconies, which is one of the ways to respond to the climatic condition for human comfort.

When a building is designed with energy maximisation in mind, comfortable environment is achieved at a lesser cost. Resources used efficiently to judiciously manage waste and recycle as much as possible makes a living more sustainable. In the vernacular buildings, many of these features are considered greatly, while construction process is carried out, whereas, many of the contemporary buildings neglect the simple and basic facts that one can benefit from nature. Building in the newly developed quarters of Famagusta is seen to lack many of these basic natural mechanisms for a more conducive habitation, which does not only have an effect on man but also on the biological species available to the ecosystem. Just as a bird would inhabit on the trees that provides shade for man during a hot weather, the chances for such species of plant is likewise narrowed. Responding to climate through many of the above listed techniques creates a symbiotic relationship between man and nature through building design and construction. In this view, this study suggests incorporating the vernacular buildings responsive design approaches and its physical, environmental characteristic into the contemporary edifices for adequate habitants' comfort.

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