



ÇANKAYA UNIVERSITY

**ANALYZING THE PRINCIPLES OF SUSTAINABLE ARCHITECTURE IN
VERNACULAR KARAMAN HOUSES OF NORTHERN CYPRUS**

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ANALYZING THE PRINCIPLES OF SUSTAINABLE ARCHITECTURE IN
VERNACULAR KARAMAN HOUSES OF NORTHERN CYPRUS

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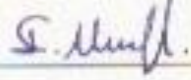
Title of the Thesis: **ANALYZING THE PRINCIPLES OF SUSTAINABLE ARCHITECTURE IN VERNACULAR KARAMAN HOUSES OF NORTHERN CYPRUS**

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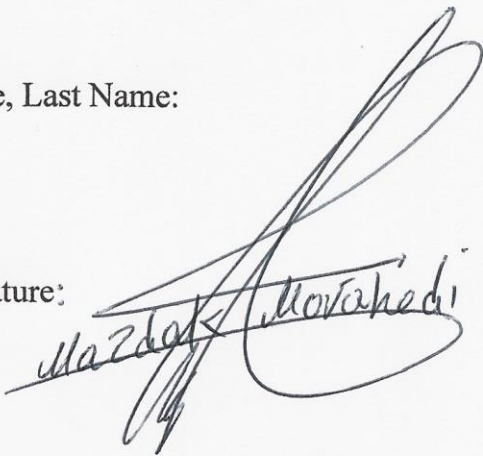
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ABSTRACT

ANALYZING THE PRINCIPLES OF SUSTAINABLE ARCHITECTURE IN VERNACULAR KARAMAN HOUSES OF NORTHERN CYPRUS

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It became evident through the study of vernacular structures in the Turkish Republic of Northern Cyprus's (TRNC) Karaman Village, that these structures can serve as a basis for future developments in sustainable architecture, beyond helping to define the general principles of the sustainability in architecture. In a time when the island is looking to expand more structurally, a framework and set of criteria is needed to preserve the vernacular structures already found, but to also improve on the sustainable aspects of these houses. Therefore, the research presented here, through a literature review and in-depth analysis of three different cases studies, outlines the significant qualities of vernacular architecture and shows that these principles can and should be used in today's architectural toolkit in order to create contemporary yet sustainable designs for future buildings and houses in Cyprus.

Therefore, this study has assessed the roots of sustainable architecture by analyzing three examples of vernacular structures of the Karaman Village in the TRNC. This is done in order to create a set of principles that will further define sustainable architecture to create a basis for which future designs can be based on

and be improved on in this region. How vernacular architecture fits into the greater understanding of sustainability is also a byproduct of this study, especially in a way that will assist future designers and builders in understanding the most efficient and sustainable way to transition from traditional housing and building to structures that can be used and improved on in the modern era.

Keywords: North Cyprus, Sustainable Architecture, Vernacular Houses

ÖZ

KUZEY KIBRIS'TA VERNACULAR KARAMAN EVLERİNDE SÜRDÜRÜLEBİLİR MİMARİ İLKELERİNİN ANALİZİ

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Kuzey Kıbrıs Türk Cumhuriyeti (KKTC) Karaman köyünde bulunan yerel mimari örnekleri üzerinde yapılan bu çalışma ile, söz konusu yapıların, sürdürülebilir mimarlığın genel prensiplerinin tanımlanmasında yardımcı olmaktan öte, bu konudaki gelecek gelişmeler için bir temel teşkil edebilecekleri anlaşılmıştır. Adanın yapısal olarak gelişmekte olduğu bu zamanda, varolan yerel mimari eserlerinin korunması ve bu yapıların sürdürülebilir niteliklerinin artırılması için bir çerçeve ve kriterler seti oluşturulması gerekmektedir. Sunulan bu tez çalışmasında; gerçekleştirilen literatür araştırması ve üç örnek analizi ile, yerel mimarinin öne çıkan özelliklerinin altı çizilmiş ve bu prensiplerin, Kıbrıs'ta yer alan konutların ve gelecek yapıların modern ve sürdürülebilir bir nitelikte yaratılabilmesi için günümüzün mimari araçları olarak kullanılması gerektiği görülmüştür.

Bu çalışma sürdürülebilir mimarinin kökenine, KKTC Karaman köyünde yer alan üç yerel mimari örneğini analiz ederek değinmiştir. Bahsi geçen analiz, bu bölgede gerçekleştirilecek yapılarda, oluşturulan prensipler setinin temel alınması ve bu sayede geliştirilebilmesi amacıyla yapılmıştır. Bu çalışmanın bir yan ürünü olan, yerel mimarinin, daha geniş bir perspektifte anlayışa sahip olan sürdürülebilirlik

kavramının içerisinde nasıl bir yer edindiğini görmek; gelecek tasarımcı ve yapı endüstrisi sorumlularına, geleneksel konut yapılarından, modern çağ yapılarına mümkün olan en verimli ve sürdürülebilir şekilde geçiş yapabilmek konusunda ışık tutacaktır.

Anahtar Kelimeler: Kuzey Kıbrıs, Sürdürülebilir Mimarlık, Yerel Mimari Evleri



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I. INTRODUCTION

From the outset of ancient times, even before our modern conceptualization of architecture was solidified, the idea of using and harnessing natural resources to make houses and buildings more live-able, sustainable, and cheaper were being developed throughout the Mediterranean region. Characteristics including wind direction, amount and angle of sun radiation, and availability of organic and unrefined material all have been studied in order to create houses and buildings that provide solutions to specific and demanding environmental needs. While the Mediterranean region is not alone in this research, the concept of sustainability here has developed into a vital concept in construction and design in order to create structures that provide bearable living conditions without the high financial cost or the environmental degradation of using artificial cooling and heating systems or imported construction materials. Building plans in which incorporate, respond to, or harness the different climate conditions of each season have increased in use throughout the region.

Other than individual preferences for living standards, Global Warming and Climate Change have also led to a renewed interest in these topics, as the use of non-renewable energy and materials has led to threatening levels of environmental degradation. Throughout the world in all climates and geographic locations, architects have increasingly turned to green architecture, or eco-friendly buildings, in order to create these more sustainable structures and reduce the negative impact of these edifices on the environment.

The personal and worldly demands for these types of developments in architecture have yielded numerous studies into this subject. However, further research is needed in order to train both the architect and the policy maker in order to efficiently implement these concepts of sustainability into current and future building projects.

The research conducted in this thesis centers on vernacular houses in Cyprus, and demonstrates that they have been designed already by some degree in the concept of sustainability, and therefore can assist in creating a framework that can create more sustainable houses for the future. As will be discussed, the island of Cyprus is located in the Mediterranean region, a region that is notorious for its excessively hot temperatures and high levels of humidity in the summer but with winters that see mild temperatures, strong winds, and a high percentage of rain. This climatic makeup alone leads to very specific needs for the buildings in this region. While these seasons and weather patterns have affected the island for centuries, it is important to note that it is not sufficient to solely look at the houses of the past if the aim is to show both their importance for the modern times, and the possible considerable improvements for the future. And while the principles of sustainable architecture have been researched and developed, it is also true to note that the technology has yet to match these advances; which denies the present designs the characterization of truly sustainable architecture. This thesis shows how the vernacular architecture of Cyprus contributes to its sustainable lifestyle and culture.

The approach to this thesis combines the use of a literature review with an analysis and perceptive study of three house-types that have been built in the Northern Cyprus area. The following study consists of five chapters. The first chapter introduces the central aims and objectives that this thesis is focused on, while

posing additional problems and questions to be considered and presenting the methodology of research used. The second chapter outlines key definitions and terms that are critical in understanding the theoretical framework surrounding past and current research of both sustainable architecture and vernacular structures by defining overarching concepts, terms and definitions. The third chapter takes a more direct look at the Turkish Republic of North Cyprus by discussing the history, economic concerns, social aspects and available materials that all impact the issue of housing design and building on the island. In chapter four, the discussion of sustainable and vernacular architecture are brought together with the overview of North Cyprus in order to analyze whether or not the application of the concepts is apparent throughout the region. Finally, in chapter five, three different case studies are presented in order to have an in-depth analysis of the use of sustainable principles on houses and buildings on the island.

1.1 Aims and Objectives

The main aim of this research is to present an overview of existing and potential future perspectives of sustainable architecture through the analysis of the main characteristics of vernacular architecture, particularly in Cyprus. In order to achieve this, The Turkish Republic of Northern Cyprus has been taken as a case study, an island with a long history of traditional houses. These houses and structures are analyzed as to their advantages and disadvantages and as a pathway for the transition into today's broader concept of sustainability in architecture. The objectives of this study are further categorized into two separate types of aims: General Aims and Practical Aims.

At the General level, this research aspires to develop a methodological work that will determine the characteristics of vernacular architecture in an overarching

understanding of the general area of study. These characteristics can then be fashioned into a criterion, of sorts, that will provide insight for developing future houses either like the current vernacular structures, or improved from these basis conditions. These structures will further be studied in order to find a way to efficiently and effectively use the naturally found resources and the provided space to make the transition as smooth as possible from using non-renewable materials to renewable and more environmentally friendly resources. The data found from these houses will construct a template in order to generalize to a greater scale, and provide some ideas for creating sustainable structures in differing climates.

At the practical level, the conclusions found through the general aims level will be used in order to find a method of implementation in specific circumstances and geographical locations. The study of these structures is one look into using materials that are naturally found on the island instead of the non-sustainable alternative of imported or inorganic manufactured material, but also to continually expand the ideas of an efficient use of space and climatic conditions. While the artistic and creative sides of the sustainable architecture found on the Cypriot island are not analyzed here, it is important to note these aspects do and should continue to play a significant part in the design of these structures in order to aesthetically fit into their surroundings. With this in mind, a primary practical aim is to use the building orientation and sun shadings of different seasons in order to deal with everyday issues of adjusting to the climate and at the same time ensuring privacy to the inhabitants. A secondary practical aim is to creatively use the spaces of the area, both the indoor and the outdoor to adjust for these environment demands while at the same time minimizing the actual built area. Then finally, we aim to develop the country's areas by incorporating the design of the geographical location and organic

materials in the buildings. Both aims described above are more clearly visualized in the following graph:

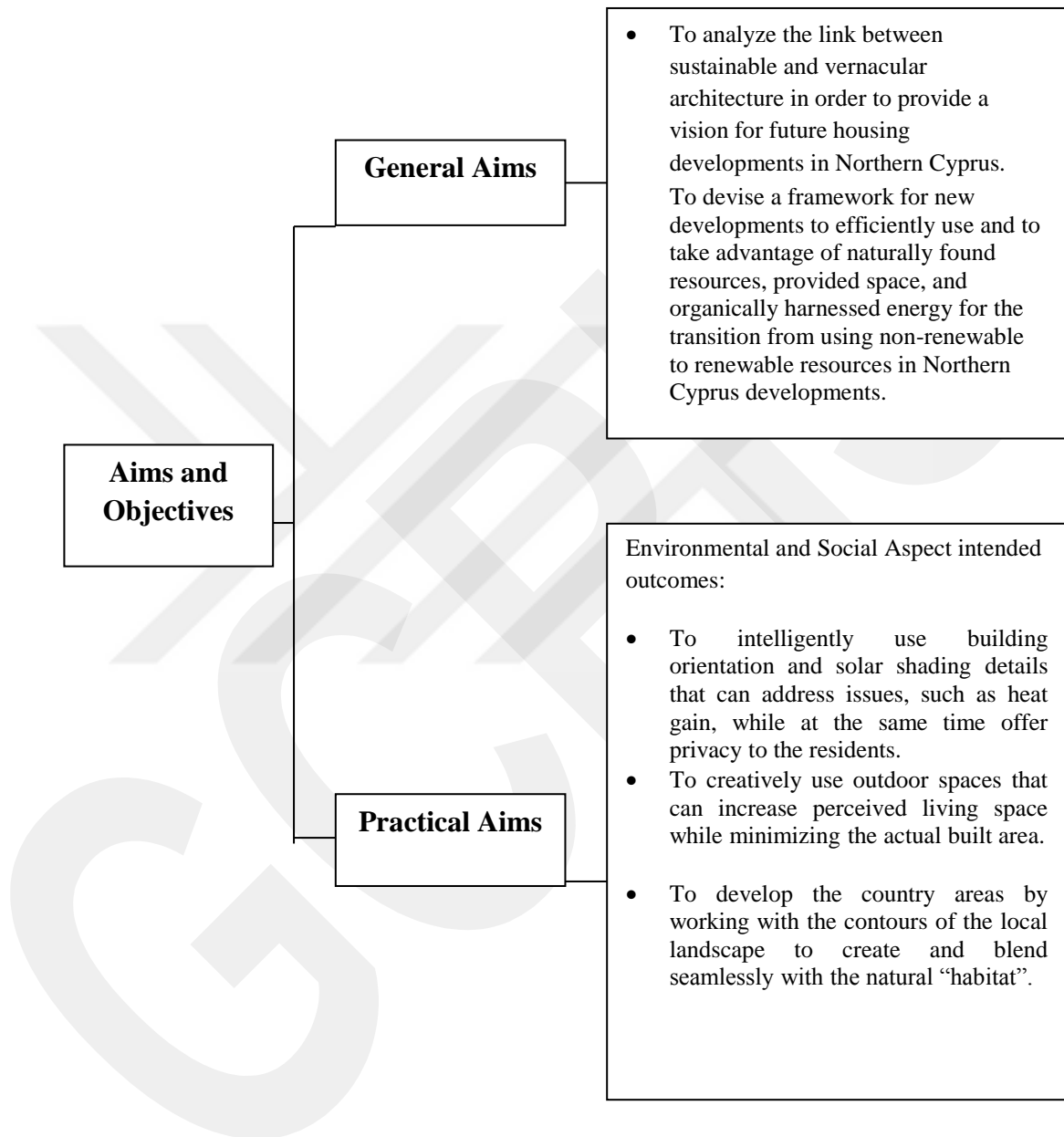


Figure 1. 1 Visual representation of aims and objectives focused on in this thesis

The research questions of the study are as follows:

- What are the principles of vernacular architecture?
- What are the parameters of sustainable architecture?

- What are the characteristics of Cypriot vernacular architecture?
- What are the principles of sustainable architecture in examples of Cypriot Vernacular Architecture?

1.2 Research Methodology

As to the research methodology, firstly, all related issues pertaining to both sustainable and vernacular architecture were pinpointed and identified. Depending on the identified factors of the associated subjects, the selected viewpoints and approaches on the topic were further studied and analyzed. After selecting the related parameters concerning the research subject, these factors were evaluated regarding the main goal of the research. . Questions were then introduced to help clarify the issue being analyzed.

The method of this research is based on two resources: a literature review of the relevant terms and definitions that provide the basis of the known aspects of sustainability as it pertains to vernacular structures and observations of three case study houses in the Karaman village in the TRNC. The latter resource has allowed, as will be shown, how vernacular architecture was developed throughout the island harmoniously with the ecosystem and can actually act as an indicator of sustainability. Inquiries and conversations with the house owner of the three case studies provided general information about the use and efficiency of the three particular structures. After such conversations, the research questions were reassessed and answered in accordance with the information provided by the house owner.

II. BASIC CONCEPTS AND DEFINITIONS

The following section will discuss more general terms and definitions of vernacular architecture. After such terms and aspects are defined, examples found in Iran are used to further cement the understanding of each definition. These examples are intended to give an overview of what can and cannot be characterized as vernacular architecture in a more regional geographic sense, before looking at more specific examples in Northern Cyprus.

2.1 Vernacular Architecture

Derived from the Latin root “*vernaculus*”, the term Vernacular became a household word by the 1950s, even though it was first noted to be used in England in 1839 (Oliver, 2003). When applied to architecture, vernacular architecture may be considered as “the common speech of building” (Oliver 2003). While the term has been around for over half a century, it has still proven to be difficult to perfectly define, and to see what is and what is not considered vernacular. The difference between vernacular architecture, and the more common everyday architecture is not a difference of economic means, or even of a level of quality in design. Some studies, such as Bernard Rudofsky’s “*Architecture without Architects*”, show that we can consider even monumental and religious structures of many cultures exactly as the works that define a particular vernacular (Oliver, 2003).

Other than solely using the term ‘Vernacular Architecture’, over the years alternative phrases have been produced to mean generally the same concept. These have ranged from: ‘indigenous’ architecture, ‘anonymous’ architecture,

‘spontaneous’ architecture, and ‘folk’ architecture to ‘traditional’ architecture. All of these alternative phrases profess a part of the larger whole on what makes up vernacular forms, however not one of these has given a true and total definition of what it means to qualify as one of these terms. For example, the term ‘indigenous’ architecture does not show the differences between the vernacular of a colonial structure or an immigrant society structure. Moreover, the term ‘anonymous’ architecture does not actually show the divergence of a design by an undistinguished attitude versus towards the preference of architecture by famous architects. Therefore, it may be understood that vernacular architecture is a subject that has no concise definition. Making matters even harder to define, is that what may be considered vernacular of one generation, does not automatically state the same for another generation. It must be accepted that these types of structures go through a continual change.

A single solid definition of what can and cannot be classified as sustainable architecture has yet to be seen as required, let alone desired. Looking for a single interpretation may in fact be detrimental and be a huge disservice to the whole study by ignoring potentially vital aspects of the design. That being said, it is possible, however, to use some general descriptions that are considered the most common found characteristics and features of what most scholars define as vernacular architecture. These are:

- The structure was built either by the owner or the community, not a trained architect.
- Traditional technologies were utilized in the construction of the buildings.

- There was a strong relation to and respect for the local environmental context of the building.
- Only material found indigenously to the area were used for the buildings and structures (Japan & Gyōsei, 1990).



Figure 2. 1 Examples of materials in vernacular structures of Iran: Clay and wood found indigenously in Kashan, Iran (Mocahedi, 2014)

The two photographs above show an example of naturally found resources used in vernacular architecture. In this example, wood and local clay are commonly found in structures in Kashan, Iran. As stated above in order for structures to be classified as vernacular, even in the most general sense, the structures must be fully comprised of materials that can be found organically in the environment and that don't require further refinement, such as those seen above.

Another critical aspect of vernacular architecture is that the culture of all community values including traditions and myths are embodied in the very architecture that they create. Interestingly, the beliefs of the cosmos are reflected in these designs and are another stimulating feature of vernacular architecture.

Comparable to the Chinese concept of Tao, vernacular architecture is actually a unique concept based on the balance found in everyday life. "The direct relation to human need and accommodation of economy, beliefs, and cultural values yields a phenomenological sense of place that is therefore of important value to the study of architectural design- and the future of the built environment" (Japan & Gyōsei, 1990).

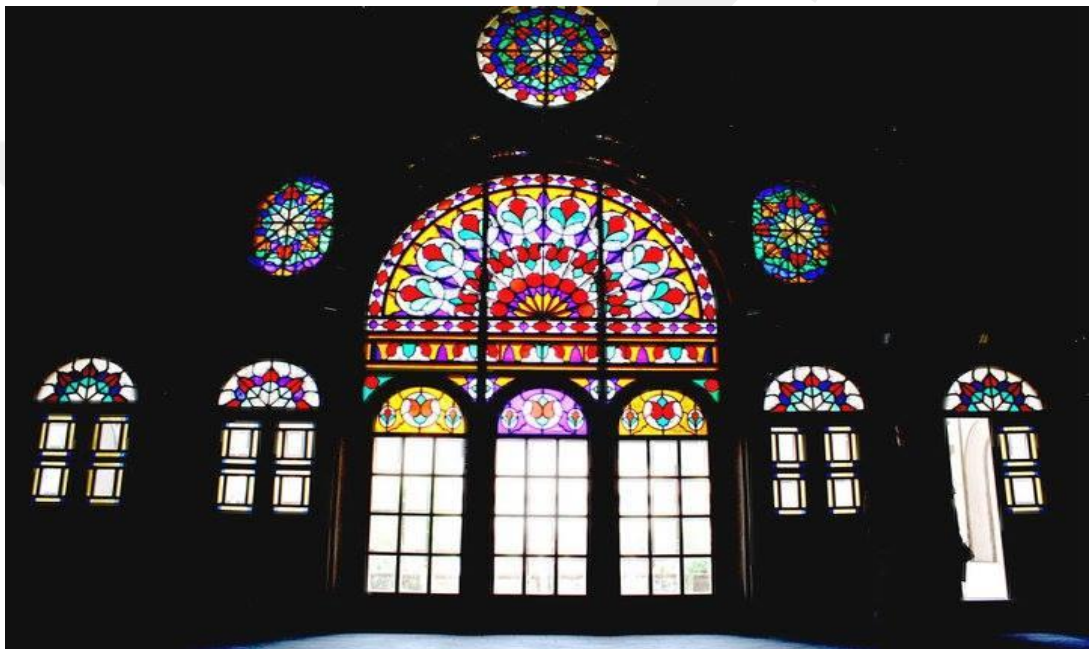


Figure 2. 2 Example of architecture influenced by local culture and beliefs (Movahedi, 2014)

The inclusion of arches and stained glass must be included along with other prerequisites of vernacular architecture as discussed previously. These elements add an artistic feel that expresses the societies' culture along with adding calming and enjoyment elements to everyday structures. Figure 2.2, in particular, shows an example of this in Kashan, Iran.

The approaches to studying vernacular architecture have proven to be as varying as the definitions. Originally, analysis of vernacular architecture was generally used as an instrument of studying archeology, not as the roots of

sustainable architecture as it is now. These found artifacts were useful in identifying, dating, and understanding the behavior and living habits of early humans found in these uncovered sites. Today some significant points such as the conservation and preservation of structures are the most common reasons why to study vernacular structures further (Oliver, 2003). However, a dependence on only one field, or approach to study, has drawbacks. As John Linam (1999) writes, by only portraying these discoveries in a “museum-like setting” the viewer is unable to understand the reality of the characteristics found in these structures, and often imagine these structures in a vacuum, away from the overall community from which they were extracted. Therefore, it becomes necessary to not only view the structures but to also have a first-hand experience in their uses to understand the motives behind specific designs.

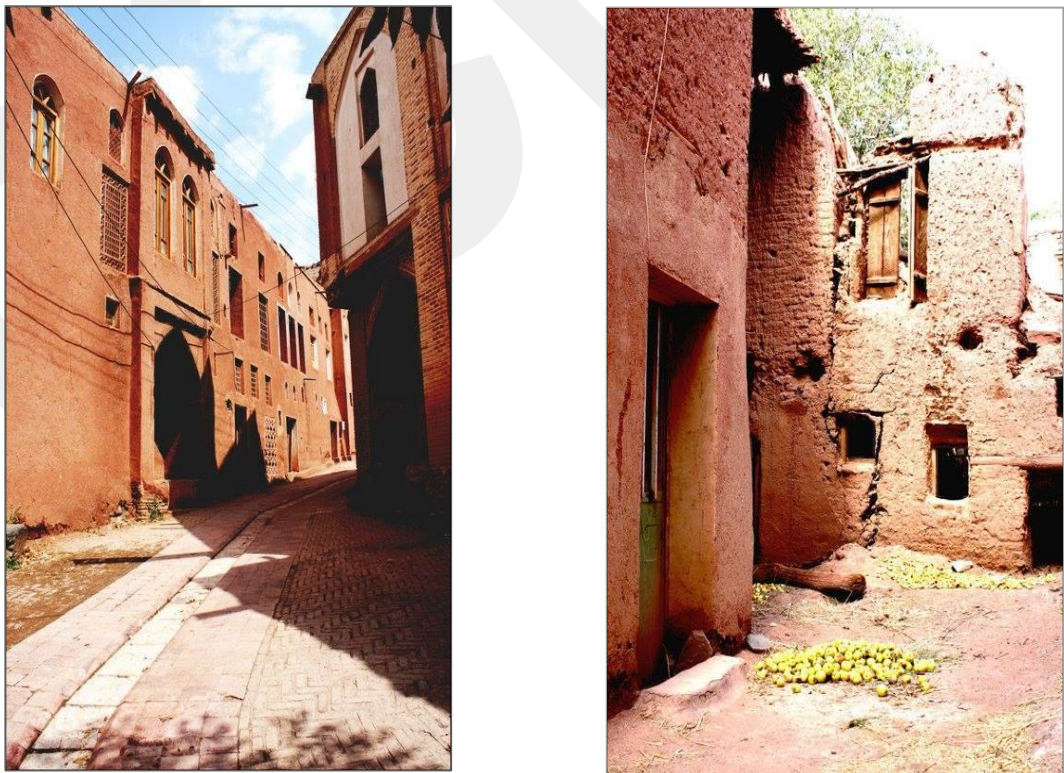


Figure 2. 3 A side street view of the exterior of vernacular houses (Movahedi, 2014)

The two photos shown above are vernacular structures constructed with locally found clay and wood, and assist archeologists in understanding the people, social aspects and general community lifestyles that inhabited in these structures of Kashan, Iran.

Once the architectural community is able to understand the motives and process underlying vernacular type architecture, the present built environment can be better understood. Both the motivations behind building, and the perceptions of the use and functions of the buildings are necessary when understanding the impact of and utility of our built environment on our everyday lives (Oliver, 2003).

When viewing vernacular forms, aesthetics are an important aspect in which the architect is able to portray the social customs and traditions of the applicable society. They act as symbols, which can be translated to define community identity and social patterns of the society. The difficulty here then evolves from the observer's ability to overcome preconceived ideas of the structure being viewed, as well as setting aside understandings of his or her own culture as separate (Linam 1999). Figure 2.4 shows the use of naturally found clay and wood in a vernacular structure in Kashan, Iran, which incorporates aesthetics into its design. It can be inferred that the structures found in vernacular architecture, therefore, are not only based on the inhabitants needs due to climatic conditions and structures that are harmonious with the surrounding environment, but they also draw on the social needs of the population to portray customs, beliefs, and creative outlets of individuals.



Figure 2. 4 Incorporating aesthetics into vernacular structures (Movahedi, 2014).

The aspects as just discussed sometimes have proven to be even more powerful than just aesthetics when creating these historical vernacular structures. The basic needs of societies and the societal order, which are more important aspects of a community, are also represented in these structures through different ways. This leads to an even larger understanding of not only the architect, but the circumstances in which had the biggest impact on the designs (Linam, 1999). Other needs of the community include security, communal areas, and places for economic enterprises. While these may not require aesthetically pleasing structures, they are required in all built societies. As will be discussed, overall needs of a society are also incorporated into the design and build of these structures.

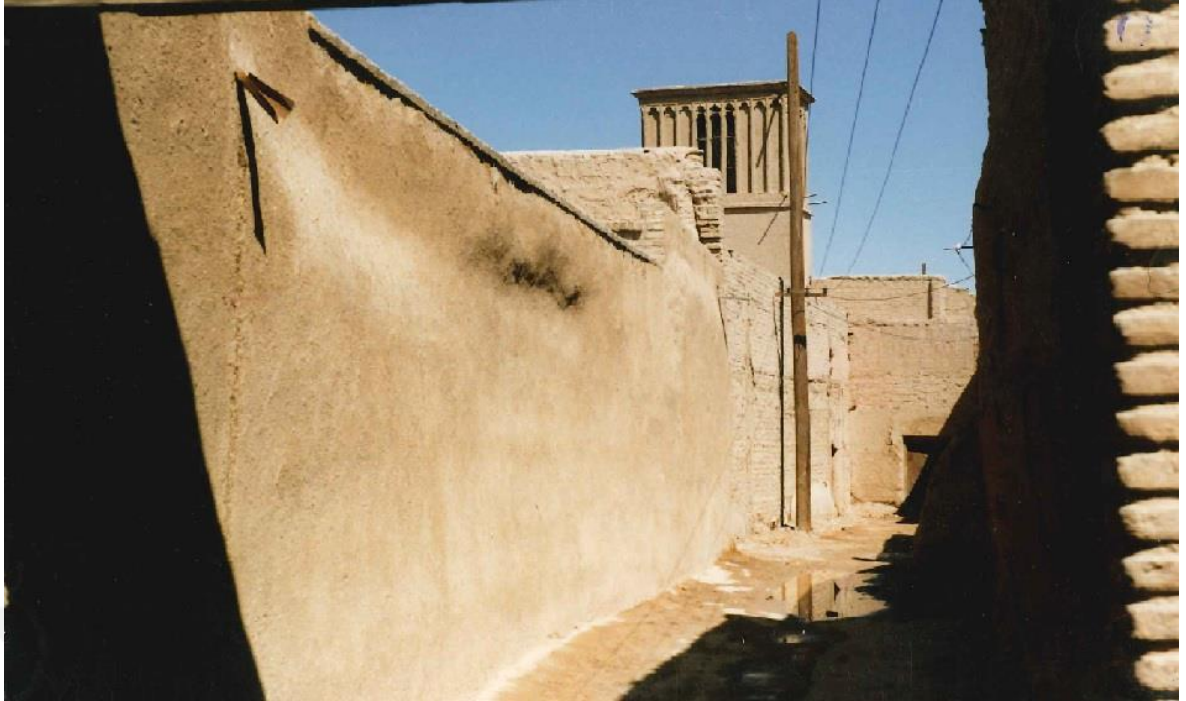


Figure 2. 5 Example of structures demonstrating security needs of community in Yazd, Iran (Movahedi, 2004).

As it has been already stated, it may be unwise to have one singular and unique definition for vernacular architecture, mainly due to its versatility and evolution over time. However, in the Encyclopedia of Vernacular Architecture of the World, Oliver defines this term as buildings created by the people of the community, in which environmental contexts, community relations, organic materials, and traditional technologies are all taken into account (Oliver, 1997). Besides, he continues, “the forms of this architecture are built to meet particular needs. They include the values, economies and ways of living of their cultures” (Oliver, 1997).

Furthermore, according to Philokyrou (2011) vernacular architecture of each area reflects the local traditional needs and materials of that area. This type of architecture can be seen

in relation to "polite architecture, which is caring not only about a building's functional needs:

“Vernacular architecture is a category of architecture based on localized needs and construction materials, and reflecting local traditions. Vernacular architecture tends to evolve over time to reflect the environmental, cultural, technological, and historical context in which it exists. It has often been dismissed as crude and unrefined, but also has proponents who highlight its importance in current design. It can be contrasted against polite architecture which is characterized by stylistic elements of design intentionally incorporated for aesthetic purposes which go beyond a building's functional requirements”. (Philokyprou, 2011 p.27)

In other words, this type of architecture is efficiently employed in order to meet the needs of the society in which it shelters (Oliver 2003). This concept of sheltering the society shows that the concept of “sustainable architecture” is not a new concept in the sense that it shows similar aims and factors with vernacular architecture as seen in this section.

Beginning at the end of the 20th century, there has been an expansion within the study of vernacular architecture that focuses on developmental aspects. It has commonly been viewed as a new classification, and therefore can be considered as a new approach altogether. The following section will outline the evolution of this aspect of vernacular architecture through the work of international organizations working to define precisely what development vernacular architecture might be.

Taking into careful consideration the term “development” makes it debatable that this is merely a feature of vernacular architecture, and not an entirely separate form of it. It seems to bring to mind an entirely new way of thinking that while may have sprung from the original idea of vernacular architecture, has many unique

aspects and ideas of its own. In this context, the term “development” is a means to describe the human act for improving, or attempting to improve, the quality of life through the creation of better living standards and conditions. In reality this different approach boldly “views vernacular architecture (and architecture in general) as part of one aspect of development”, as opposed to seeing developmental architecture as an aspect of vernacular architecture

Unfortunately, this concept does not enjoy “a highly articulated set of principles, theories, or even dialogue”, due to its sometimes very abstract ideas that surround it (Joseph & Booth 2013). Without a completely agreed on definition of what developmental vernacular architecture actually is, the ability to create such principles and theories is stunted.

More recently, however, there has been some research and built works that may help to elaborate more on the subject. The work done by Hasan Fathy (1973) on the New Gurna Village of Egypt may be one of the most recognizable examples. This work focuses on a self-reliant system of building that is based on local material, process, and community participation, with the main goal of creating a pleasing architectural form. To some, however, his work is believed to focus more on the aesthetic aspects of architecture, while sometimes losing sight of the value of using community participation. Nonetheless, it can be seen as a valuable step toward the raising and awakening of this new concept of developmental vernacular architecture.

Another example of these first pioneers of developmental vernacular architecture is that of the Indian architect Charles Correa. His work aims at finding an “elegant symmetry” of past and present concepts by manipulation symbols of Hindu beliefs. Correa’s work leads the architectural community to see the possibility

of such methods of development being utilized in ways other than solely projects for the poor (Correa 1989 p 12-13). As Correa notes that developmental vernacular architecture:

“Expresses the values and the needs of the local, especially poorer communities, and not least to survive, it demonstrates continuity with change: remaining rooted in the past and the local, while incorporating the new and the external to meet contemporary needs”. (Correa, 1989)

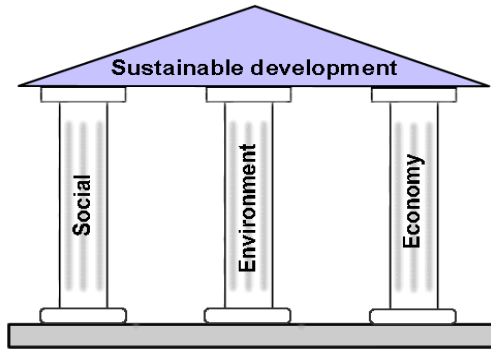
2.2 Sustainable Development

The terms of sustainability and development became key phrases and issues to be discussed among world leaders, not only in individual countries, but also in larger organizations such as the United Nations. The idea of this form of sustainability as stated previously is not a new subject. These ideas and demands are an adaptation of the International Union for Conservation of Nature (IUCN), which produced similar ideas beginning in 1969. Then following up with these initial proclamations, the United Nations Environment Programme met in Stockholm in 1972 as to look for common principles in which all countries and individuals can preserve and protect the environment (Adams 2006).

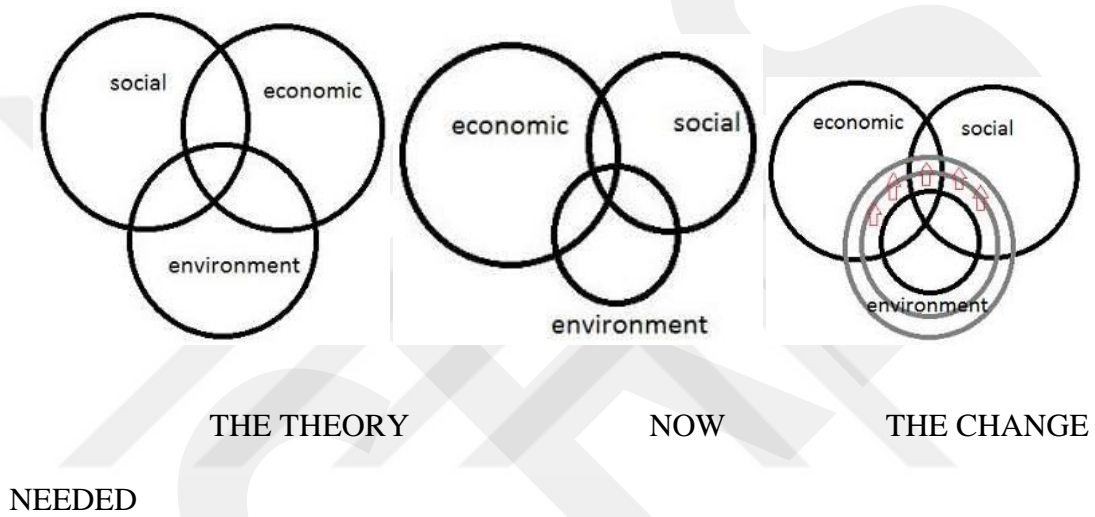
The first publication that used the “sustainability” concept in connection with contemporary environmental analysis was *The World Conservation Strategy*, published in 1980. While the use of vernacular architecture had been an interesting and valuable concept for several hundred years already, a few years after this publication, the ideas began to develop at a much more rapid pace in growing areas of Saudi Arabia, Egypt and Yemen- and even adapted to industrial buildings in the United States. Then in 1987, the United Nations defined the overarching general

principles of sustainability in their publication *The World Commission on Environment and Development* (Brundtland, 1987). The United Nations showed in this report their beliefs that using natural resources would guarantee an improved life quality for the future generations.

In 1987 the Brundtland Report, or more formally known as the World Commission on Environment and Development (WCED) was published in order to unite countries in the name of pursuing sustainable development together and for the entirety of the globe. Furthermore, the Brundtland Report provided an early (and still much-used) authoritative definition of what constitutes sustainable development. They defined sustainability as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland, 1987). In other words, further showing that sustainable development is about how to invest money on resources and technology to meet the present and future needs. (Adams 2006). This definition was not clear enough but it explained two major issues with economic growth: environmental degradation and decreasing poverty. The core of mainstream sustainability thinking has become the idea of three dimensions, environmental, social and economic sustainability (Adams 2006). These have been drawn in a variety of ways: as “pillars”, as “interlocking circles” or as “concentric circles” which can be seen in Figure 2.6 below.



1) Pillars



2) Interlocking Circles



3) Concentric Circles

Figure 2. 6 Three visual representations of sustainable development: Pillars, Circles, and Interlocking Circles (W.A. Adams, 2006)

Following this report, work began to take place which all culminated in 1992 in the form of the first comprehensive plan for sustainable development laid out in the United Nations- sponsored Earth Summit in Rio de Janeiro (Strong, 1997). This two-week conference produced a blueprint of action on how to achieve sustainable development across the globe. According to this, sustainable development includes protection of the global commons like air, sea and rain forests (Paschich & Zimmerman 2001). Following this conference in Rio de Janeiro, an issue that was widely recognized by world leaders was global sustainability. At the turn of the 21st century, ten years after the Rio conference, in 2002 The World Summit on Sustainable Development (WSSD) took place in Johannesburg, South Africa. They discussed the demands placed by humankind on the earth in the first decade of the new century.

The project to consider sustainability as an integral aspect of all development following the lead of the Brundtland Commission has been enshrined in international declarations, conventions and other plans for action. The Earth Summit in Rio de Janeiro, Brazil was a defining event in the sustainable development movement. Not only did it bring together an unprecedented number of countries, organizations and citizens from throughout the world, it represented the first time that developed and developing nations reached consensus on some difficult issues related to the environment and development (Williamson 2003).

While a majority of this section outlined the development of the concept of sustainability and development in general terms, and in regards to global initiatives, it is important to note this evolution of thought in order to understand the development aspects of vernacular architecture, and as to why they are so important. It also underlines the ability of this form of vernacular architecture to be seen as

either a basic founding principle of vernacular architecture, but also its ability to stand-alone as its own form of architectural ideas.

2.3 Sustainable Architecture

It should not be forgotten that when looking at how sustainable structures impact the environment in which we live, words such as “Green” and “Ecological” are also used to reference the same practices that “minimize our impact on the environment and generate a healthy place of living” (Ghani, 2012). While these terms are mainly used by environmentalists to spread awareness and research pertaining to the importance of such practices, they are gradually gaining more attention in other realms, like that of architecture. While these terms will not be dealt with in this research, it is important to keep these in mind in order to keep a clear distinction between the terms of “Green” or “ecological” and what is discussed here of vernacular architecture.

As stated, when sustainability is applied to a field such as architecture, it becomes more than just design. The term then turns to encompass other values, and even a combination of values. These are, but are not limited to: “aesthetic, environmental, social, political, and moral” principles (Walker 2006). It incorporates not only these values but has to link “sustainability, durability, longevity, appropriate materials” with the technical skill and ability to design (Walker 2006). Because of these circumstances and combinations of such multitudes of values and factor; “The definition of architectural sustainability has since become as varied as the architects, ecologist developers, and environmentalists who practice it” (Paschich & Zimmermen, 2001).

The following authors have thus elaborated on the definition of sustainable architecture and what it encompasses in different circumstances.

Thomas Fisher's 1993 editorial in *Progressive Architecture*, described sustainable architecture more specifically as that which "conserves energy, uses renewable or recyclable materials, reduce our dependence on fossil fuels, and attempts to create more intimately scaled buildings and communities".

Bill Mollison elaborated on the U. N's long-range criteria in his 1994 book *Introduction to Permaculture*, saying "the aim (of sustainable architecture) is to create systems that are ecologically-sound and economically viable, which provide for their own needs, do not exploit or pollute and are therefore sustainable in the long term." (Mollison, 1994).

Finally, and most recently, various "green builder" programs around the country have formalized more specific criteria to give to developers and architects. These criteria that have been presented act also in the likes of a checklist. These tasks include: avoiding the use of material that could be harmful to human and animal health, avoiding building in ecologically fragile areas, maximizing the use of recycled material, reducing all types of waste pollution, and reducing all types of waste. These different points brought up by these "green builder" programs are all in the hopes of creating structures which will provide for generations to come, and that will be able to be molded easily into the needs of every generation after (Paschich and Zimmermen, 2001).

The terms that have been defined by the "green builder" programs and the previous authors listed above all recognize the benefit sustainable practices can achieve for the community, environment, and the future of our societies.

Contemporary and modern architecture has been strongly influenced by the ideas and values presented by the field of Sustainable architecture. Previously, the image of vernacular architecture was loosely based on a building or structure that was suitable for its environmental context. This would be one that would adequately protect the inhabitants from the climate. This previous idea was centered on protection of the inhabitant from the environment. However, in more recent times, this idea of sustainability must incorporate focusing on the inhabitant together with the protection of the environment.

The concept of good architecture therefore has shifted to encompass the notion of a building that is sensitive to its environment – one that will adequately protect the environment from the potential pollution and degradation caused by human habitation. This marks the transition from the predominance of external risk to that of manufactured risk (Giddens 1999).



Figure 2. 7 Examples of early- vernacular buildings that were designed to protect the inhabitants, all while being sustainable and environmentally friendly (Movahedi, 2004)

These ideas of environmentally friendly buildings are further emphasized through the writing of Maria Philokyprou. Interest in sustainable architecture grew in the early 21st century in response to growing concerns about the environment, but in fact people have been building sustainably for thousands of years as examples of vernacular architecture, because sustainable projects are often practical in nature (Philokyprou, 2011).

Philokyprou further assesses that most of sustainable architecture focuses on building intelligently. For example, if a building is located towards the southern region of the Northern Hemisphere, the building will receive adequate heating during the day by the sun. In order to utilize this to its maximum, the heat needs to be stored as to not lose it for passive heating during the cool nights (Philokyprou, 2011). These practical structures address issues such as natural sources of cooling and heating, water and energy usage, and the protection of the materials used to construct the building. Figure 2.8 shows the famous wind catchers of Yazd, Iran. This system was developed in order to harness the winds during the day and night in order to provide cooling to the inside of the building that the wind catchers are attached to. They are able to cool the houses in two ways, the first being a simple redirection of the wind into the building, while the other requires the suction of air below the surface in order to cool it before it is redirected into the building. Both ways are used in sustainable architecture throughout Yazd, Iran as a way to cool buildings without relying on modern technology such as air conditioners, which could be harmful to the environment if used in excess.



Figure 2. 8 Examples of structures that harness wind in order to decrease the use of nonrenewable energies and regular street pattern. Yazd, Iran (Movahedi, 2004)

Some of the important sustainable standards for development are:

- Minimization of energy usage through natural ventilation, rainwater harvesting, solar energy, and processing of wastewater.
- Intelligent use of building orientation and solar shading details serves to solve heat gain issues while offering privacy to the estate residents.
- The creative use of outdoor spaces increases perceived living space while

minimizing actual built area.

- The development blends seamlessly into the local environment while reducing cut and fill, or taking material from one area and depositing it in an area nearby (Philokyprou, 2011).

This literature review has created the foundation in which the three major definitions for this research have been defined, and how different authors through the years have come to define these terms depending on the different circumstances and situations. The three major terms found in this chapter, and that will be used throughout this research are: sustainable development, vernacular architecture and sustainable architecture.

III. BACKGROUND STUDY ON CYPRUS AND CYPRIOT VERNACULAR ARCHITECTURE

3.1. Regional Characteristics of Cyprus

According to the updated Köppen-Geiger climate classification, the climate on the island of Cyprus is located in the Warm Mediterranean Climate (Csa), which is described most generally as having hot, dry and long lasting summers and short but rainy winters (Peel, Finlayson, & McMahon, 2007). The region observes summers with little cloud coverage; very high aridity and extremely low yearly rain fall. During the winter months (December through February), the temperature can vary from fifteen to five degrees Celsius. November through February months see the most days of precipitation with averages reaching 100mm per month of rain. From June until September, the summer months see average temperatures ranging from thirty-three to forty degrees Celsius. The Spring and Autumn months are much milder in contrast to the Winter and Summer highs and lows, and see an average of twenty-eight degrees Celsius (Kyrenia Monthly, n.d.). From this short explanation of average Cypriot temperature, it can be easily seen that the climatic conditions is an important key feature in the design of houses and buildings on the island, in order to create the most livable spaces (Hill, 1972).

3.2. Historical Background of Cyprus

The history of the colonizers, geographical location and modern political disputes have all had an influence on the distinctive architecture found in Northern Cyprus. While small in size, around 9, 251 square kilometers, it has been a principal

target of the rich and powerful ethnic groups starting as early as 325 BC in the time of the Hellenes. Beginning with the Romans in 50 BC, Cyprus has seen a vast amount of occupying powers throughout the centuries, such as: the Byzantines, the Ottomans, and then finally ending with the British in 1878 (Hill 1972).



Figure 3. 1 Aerial Map of Cyprus Island (Carney, 2012).

The current structures found in Cyprus actually only date back to the time of the Ottoman occupation which remained an important influence from 1571- 1878 (Hill 1972). The Ottomans left the largest impact on the island all of which can still be seen today. The system of administration, economic structures, and social organizations brought by the Ottomans laid the foundation for the architecture throughout the urban areas of the island (Numan, Dincyurek, and Pullhan, 2001). The Ottomans left their legacy through their symbolic architecture as well as

structures that were adaptable and harmonious for the surrounding environment found on the island (Dastjerdi & Sani, 2015).

Starting in 1878, the British began to interrupt the architectural domain of the Ottoman Empire, when the Empire leased the island to Great Britain. Then in 1914 the island was officially annexed by Great Britain, thus halting any further Ottoman influence on building structures. While continued political strife throughout the island destroyed parts of the built environment constructed by the Ottomans, the legacy of their architects and builders can still be seen in the Turkish Republic of Northern Cyprus today (Mallinson, 2005).

It is important to note here, that even though the current structures were constructed during Ottoman times, based on the history of occupational powers within Cyprus it is impossible not to recognize the distinct characteristics that they have all brought through a culture and specific uses of built and non-built areas throughout the island. It is impossible to find a group of people, or even a structure built that can easily be divided into distinct characteristics of just one culture or ethnicity. In a type of 'vernacular cosmopolitanism' as suggested by Stuart Hall, mixes the limitations of each culture into the use and functioning of built and non-built structures. These limitations and cultural identities will play into how the specific houses studied in this thesis are used (Yilmaz, 2004).

3.3. Economic Characteristics

The main parts of the economy of the island are from agriculture and tourism, which further divides the functions of the buildings in rural and urban settings. The rural structures must adjust to the agrarian lifestyle of its inhabitants while the urban

centers must be designed in ways to attract tourist and also keep them comfortable in the drastically hot Cypriot summer (Numan, et al. 2001).

The challenge to keeping sustainable architecture is mostly in these urban structures where the design must adjust to the tourist industry, as it is a major part of the island's economy. While it is possible, it further erases the availability of sustainable structures in cities as well as further distances itself from rural sustainable designs (Numan, et al. 2001).



Figure 3. 2 Example of a Vernacular Cypriot House (Dincyurek, 2002)

3.4. Ethnic Groups

As mentioned already, Cyprus is in the center of trade between Europe, Asia, and Africa. This strategic geographical location has attracted a highly diverse

amount of occupying forces throughout its history, each of which has brought its own cultural influences to the island (Numan, et al. 2001).

Currently there have been five main ethnic groups that make up the island: Greek Cypriot, Turkish Cypriot, Maronites, Armenians and Latins. Greek Cypriots make up the majority, while the Turkish Cypriot population makes up the second largest ethnic group. Prior to the independence of Cyprus from Britain, these two groups lived in separate enclaves spread throughout the island, however today they are strictly divided into different communities by a border keeping them apart (Numan, et al. 2001).



Figure 3. 3 Example of a vernacular church (Movahedi, 2013)

3.5. Available Natural Materials

The most used and available materials for Cypriot buildings are stone and Kerpich (adobe). Stone and adobe have a long history as a building material in

Cyprus as well as in many other countries. Stone and Kerpich are both natural materials allowing for them to be recycled and obtained locally. Furthermore because of their natural characteristic they are healthier than synthetic and fabricated materials found elsewhere. Problems such as environmental pollution and economic restraints would increase, if the buildings were made from non-recycled or imported synthetic materials. Lastly, wood is also an important material in Cypriot vernacular architecture, usually used in the structural aspects of the building, such as for the columns and beams (Miller and Hajek 1981).

3.6. Overview of Cypriot Vernacular Architecture

Inside the eastern mediterranean basin, The Cyprus island is house to one of the oldest settlements in the region. Throughout its history, Cyprus has found itself on the many different occupying powers due to its strategic geographic location. This power ranging from Gothic and Ottoman influences to the British culture, have all had a lasting impact on the inhabitants and culture, which has also been reflected in the architecture of the island. While these forces left their mark the main characteristic of the vernacular architecture of the island developed originally from the people, material, and needs of the island itself (Ker-Lindsay 2011). Some of the important factors that have led to the distinct development of Cypriot vernacular architecture are: the abundance or lack of material, the climate, and the agrarian way of life. The history of occupying powers has also brought different ethnicities to the island and therefore these ethnic cultures, has divided the island into different groups. This social cultural structure of the island has also had an impact on the needs of the architecture on the island (Dincyurek and Turker, 2007).

Mesoria, the central lowlands of Cyprus, is house to a unique adobe architecture which is usually categorized as the traditional structure in the vernacular

architectural world. According to the needs, availability of materials, and environmental conditions of the island, these structures have been further developed and advanced. However, the slow yet inevitable effects of globalization, such as the construction materials and technologies coming to the islands are threatening the core features of Cypriot vernacular architecture (Dincyurek, 1998).



Figure 3. 4 Example of a vernacular courtyard of a house in Cyprus (Movahedi, 2013)

In their comprehensive research, Numan, Dincyurek, and Pulhan discuss the challenges that the environment, differing cultural identities, and unique history all together bring the effective use of vernacular architecture in Cyprus. They further explain that there is a possibility of the “deterioration of the unique identity” of these structures if those designing and building in Cyprus are not aware of such important factors and challenges (Numan, et al., 2001).

The researchers look to the architecture found in Mesoria as a successful example of maintenance, yet evolution of vernacular structures have adjusted to the local changing needs over the past thousands of years. This gradual change has been made mostly by the inhabitants of Mesoria. This constant and gradual evolution of the design and function of these structures, is an important aspect of sustainability by

allowing for self-regulation and maintenance. Unfortunately the evolution and amendments found in the Mesorian vernacular architecture have ended by the beginning of the last century as a direct result of the introduction of the new construction materials, techniques and technologies, and above all the increasing impacts of globalization to the island (Numan et al., 2001). Not surprisingly, while under threat by the globalized materials and design, the structures found in this region have an important place in the world of vernacular heritage.



Figure 3. 5 View of vernacular houses' roofing (Numan, et al., 2001)

3.7. Evolution of Vernacular Architecture

As Oliver writes in the Encyclopedia of Vernacular Architecture of the World, there are many classifications that can be applied in order to understand fully the weight of vernacular architecture in the world. While geography, population density and cultural landscape are all parts of the classifications, it is no doubt that the climatic conditions is one of the most important (Oliver, 1997).

The traditional style of the Cypriot built environment has made the Cypriot Vernacular architecture unique in regards of sustainable structures around the world. Thus, the island's vernacular architecture can be further categorized into rural and urban vernacular. While both the urban and rural structures have many similar restraints such as climatic conditions and availability of materials, numerous differences exist creating clearly observed differences in the two categories (Numan, et al., 2001).

Rural vernacular architecture owes a majority of its design to the factors of agrarian lifestyles, availability of building materials and climatic conditions (Dincyurek 1998). For hundreds of years houses and structures in the rural areas of the island have remained consistent due to the permanent environmental conditions. In contrast, urban houses have had a variety of cultural influences impacting their designs and functions due to the high volume and long history of diverse immigrants to the island. For this reason, the urban buildings have changed conditionally and drastically throughout the past centuries. In some respects, the only real changes found in rural vernacular houses are based on the differentiation of the environment of the island.

IV. ANALYZING THE PRINCIPLES OF SUSTAINBLE DESIGN IN VERNACULAR ARCHITECTURE OF CYPRUS



Figure 4. 1 Example of a vernacular house in Northern Cyprus (Movahedi, 2012).

When discussing architecture in Cyprus, one of the most important concepts is the sustainability of the designs and materials used in both urban and rural settings. The ability of vernacular architecture to be able to respond to the demands and needs of the inhabitants as well as the island's environment will be analyzed and discussed here. This analysis will further lead to the evaluation of how the designs and materials used in North Cyprus effectively use the overall principles of sustainable and vernacular architecture.

There are two factors that must be considered in the architecture of Cyprus. First is the weather condition and second is the use of natural resources. Vernacular houses

on the island must incorporate both of these factors into their designs, and create solutions to potential problems that may be caused. In order to create the harmony between the environment and the houses, the designers and architects must use the correct amount of natural resources needed and be aware of the inevitability of environmental degradation. While implementing the usage of natural resources and planning for minimal environmental degradation, it should be noted that there are some drawbacks of this type of architecture. One of these disadvantages is the inability to incorporate inventions such as wood burning fireplaces or the use of wood within the structure. These two examples, while valuable and useful cannot be classified as sustainable. Furthermore, there is a growing generation gap between when these houses were first built and designed, and the present use of them. This gap can be identified by the over growing list of the different every day needs, values and functions. One example would be the modern need for motorized vehicles, which lead to the need to have parking areas or garages in or next to the house (Despina, 1992).

As has been mentioned, the island of Cyprus is located in the Mediterranean region. A region characterized most notably by its hot temperatures. Due to this, the solarium and the courtyards become the most important aspects of the Cypriot vernacular houses in order to adjust for the hot summer and cool winters. These two features are what make Cypriot vernacular architecture so unique. These features are also focal points of the exterior and interior and then are adjusted based on their locations, altitude and population density of the area. The courtyard and the solarium become the hearth of the Cypriot design as both part of their architectural functions and their ways to modify the amount of sunlight in order to adjust the exterior and interior areas (Dincyurek and Turker, 2006).

The characteristics of vernacular houses of Cyprus, ranging from their form and layout energy conservation, and provided thermal conditions, through design will be analyzed in this chapter. This chapter will focus on the balancing and utilization of natural light and wind, in the summer and winter. Along with this analysis, these elements of vernacular houses will be compared to main overarching principles of sustainable architecture, and how it all fits together.

4.1. Thermal Conditions of Northern Cyprus

Climate in Northern Cyprus is most severe during two seasons in particular, the Winter and the Summer. Each of these seasons has distinct weather conditions that must be either protected from, or harnessed in order to reduce the use of non-renewable energy resources. Due to the extreme weather conditions of summer, the priority is to provide thermal comfort mostly inside the building, with the benefit of also cooling the surrounding area. This is done in vernacular architecture through the shape of the courtyard, use of plants and vegetation, and finally the process of ventilation, or the control of winds and breezes (Despina, 1992). In contrast, the high winds in the Winter must be harnessed in order to protect the inhabitant, but also in order to prevent the interior of the house from becoming too cool. This is done mostly through the strategic placing of neighboring buildings and efficient use of vegetation in the courtyard.

4.1.1. Sun Admittance

One of the challenges for vernacular house in Cyprus is creating a design in which takes into the consideration the sun altitudes in Winter as to allow maximum admittance of sunlight into the courtyard and the sunrooms. This allowance of sun is important to maximize in the Winter months to provide insulation to different rooms at the most efficient times.

4.1.2. Summer Use of Gardens and Courtyards

The Mediterranean region, in which Cyprus is situated, experiences huge fluctuation in temperature, ranging from 5 to 40 degrees Celsius (Kyrenia Monthly, n.d.). Based on this reality, the shape and the design of the surrounding areas of the building, such as the courtyard and the garden, have fundamental importance in maintaining a comfortable and livable area. The shapes for the courtyards mostly utilized are rectangle or square. The reason for this is because the 90-degree angles of the corners are the most useful and easiest angles to modify in the plan if the owner or builder wishes to add additional structures, such as a depot or barn after the building has been finished. The primary goal when creating the shape of the courtyard or garden is to adjust for potential extreme temperatures and fluctuations of climate in the Summer. The rectangle and square shapes can create an artificial sink for cold air, which cools the area during the day but then radiates the heat at night. The heat is replaced by the cold air at the ground, which lingers into the morning of the following day making a comfortable air inside (Glassie, 2000).

4.1.3. Protection Against Winter Winds

The Winter months come with sometimes damaging amounts of wind that must be either harnessed or redirected. Protecting the buildings from those potential damages in vernacular houses were neighboring buildings. (Atesin, 2005)

In vernacular architecture encompassing the courtyard is a system of exterior aspects of these clusters of houses; it provides an additional layer of protection to the outdoor courtyard from Cypriot Winter winds. After these structures have been built if more protection is needed, the building of additional smaller houses (for example: outhouse of small barn) can be constructed within the courtyard along its premiers.

Furthermore, the buildings of a simple wall to encompass the courtyard will also create more protection from these winds and breezes (Despina, 1992).

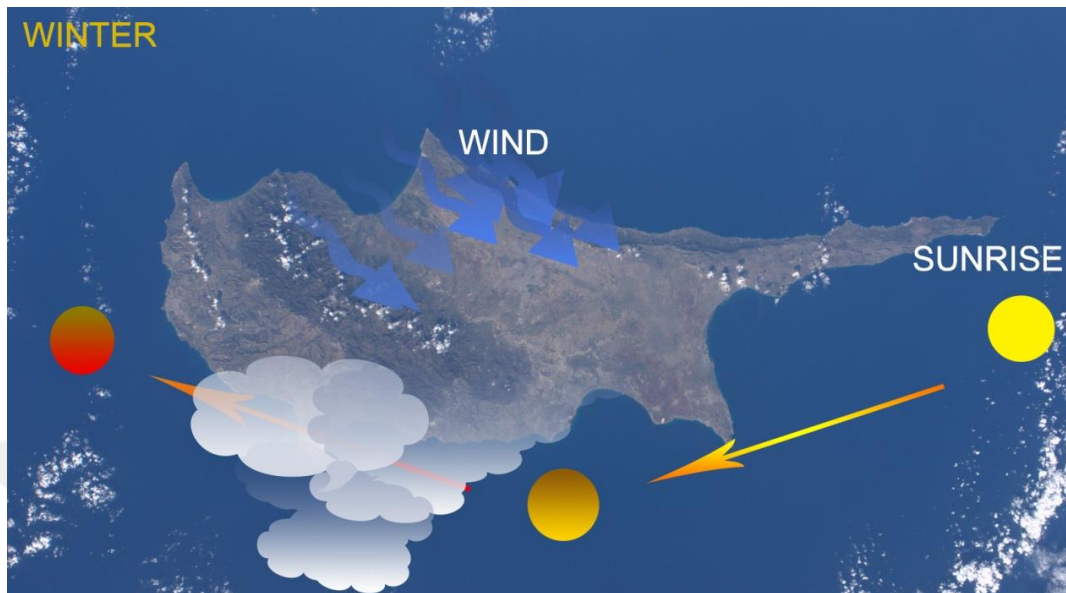


Figure 4. 2 Sky position in winters (Movahedi, 2012).

During the winter months the placement and degree of the sun, winds, rain, and snow all have an impact on the way the courtyard and indoor spaces must be designed to allow for the most appropriate living condition.

4.1.4. Coastal locations

The location of the coastal areas allows for the courtyards to be situated at a higher level and look toward the coming sea breezes. During the day the flow of these breezes comes from the water inland. This air coming from the sea is cooler and replaces the warmer land air temperatures. Then the process is reversed at night it brings the warmer breezes and sends out the cooler air, acting as a constant cycle as seen in the graphic below.

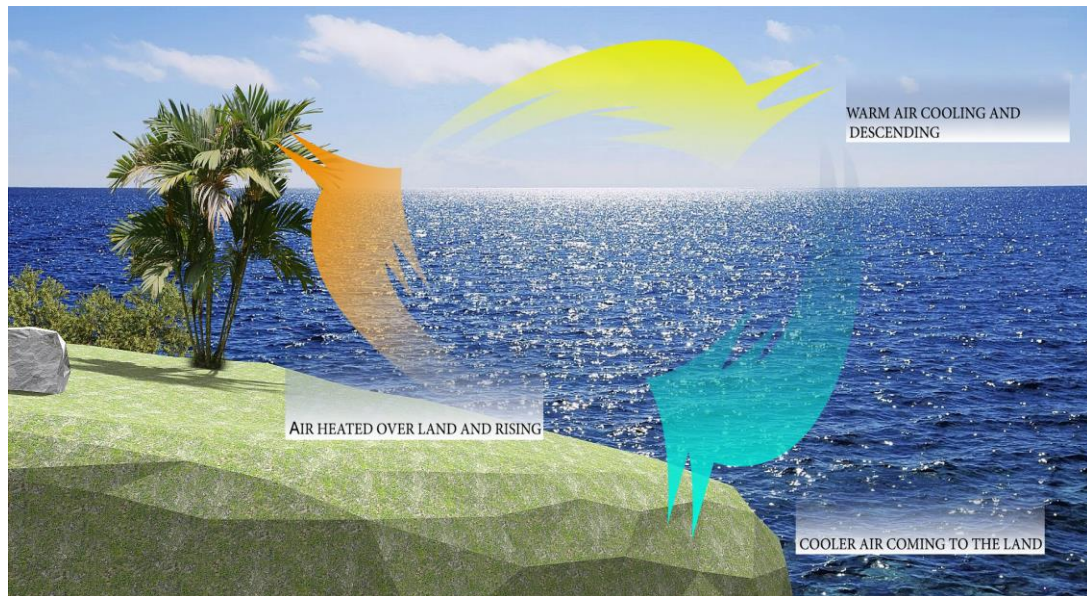


Figure 4. 3 Wind circulation in coastal areas (Movahedi, 2016).

4.2. Form and Layout of Vernacular Cypriot Houses

The two main parts of the vernacular house, in Cyprus, are the sunrooms or solarium and the courtyards or exterior space. The design and utilization of these two aspects vary depending on factors such as: region, climate, and social structures. Depending on the season, most notably the Winter or the Summer, these two designed spaces are utilized for either protection from the climatic conditions, or are able to capture the excess of the natural found energy, such as sun and wind, to create not only a more livable and comfortable environment in and around the structure, but to also decrease the dependence on non-renewable energy sources. Socially, these two compartments are major places for gathering of either the family or the greater community. As mentioned above, vernacular houses incorporate not only environmentally harmonious designs, but also exhibit characteristics that are congruent to the social makeup of the community in which it shelters.

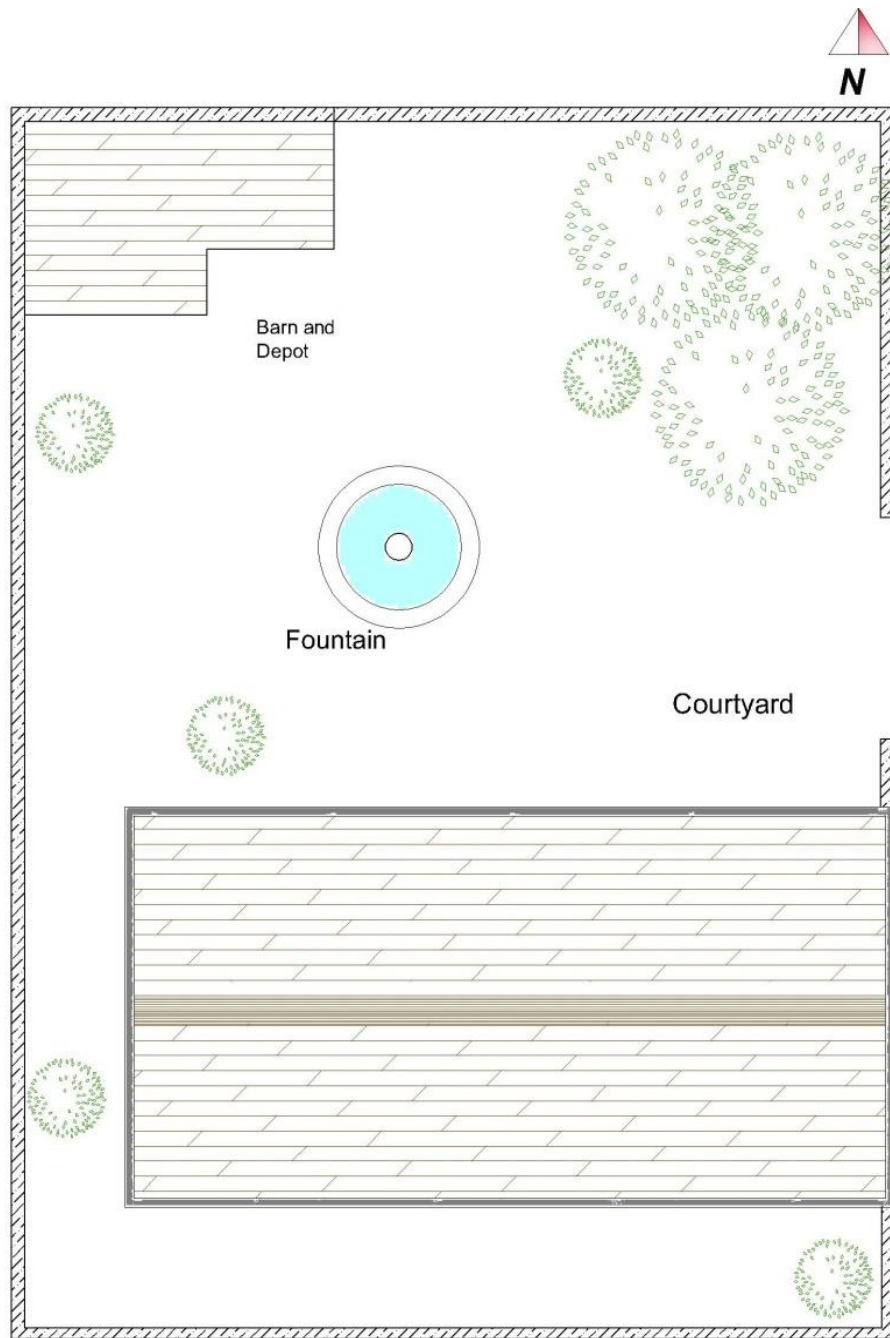


Figure 4. 4 Courtyard layout of a typical Northern Cypriot vernacular house (Movahedi, 2012)

4.2.1. Usage of Interior Spaces

The inhabitants of these houses primarily conduct their daily activities or routines in the rooms located toward the middle of the house's plan. These rooms receive a limited amount of light during the Summer and Winter months. The two rooms most utilized are as follows:

Social and private living space is an area that is occupied for a majority of resting or socializing time.

Kitchen and its surrounding rooms are used for cooking, washing, and eating. This area also benefits the most from the resources of water at house (Despina, 1992).



Figure 4. 5 Example of the use of interior spaces of a vernacular house (Movahedi, 2012)

In the same time there are many examples in vernacular architecture of this region that in which the kitchen and similar spaces are converted into the courtyards in other words bringing the interior to exterior (Despina, 1992).

4.2.2. Usage of the Exterior Spaces

When the weather is not permitting or it is uncomfortable, such as during the winter months, the activities usually reserved for the outside courtyards are moved indoors. However, activities such as preparing the agricultural products (such as for farmers or agricultural workers) or feeding the animals are done outside, in the courtyard (Glassie, 2000).



Figure 4. 6 Example of a courtyard of a vernacular house in use (Movahedi, 2012).

Both the sunroom and the courtyard must be designed in a way that will balance the amount of sunlight received in order to create a livable climate both for the surrounding and inside of the building. Those designs are of most importance during the Winter and Summer months, which have extreme weather conditions (Despina, 1992).

4.2.3. Built-in structures

The sunroom, or solarium, is located on the South side of the building in order to take the most amount of sunlight during the day. The design of the windows incorporates the most efficient amount of sun and these vary depending on the placement of the house itself whether in the mountainous or valley region (Despina, 1992).

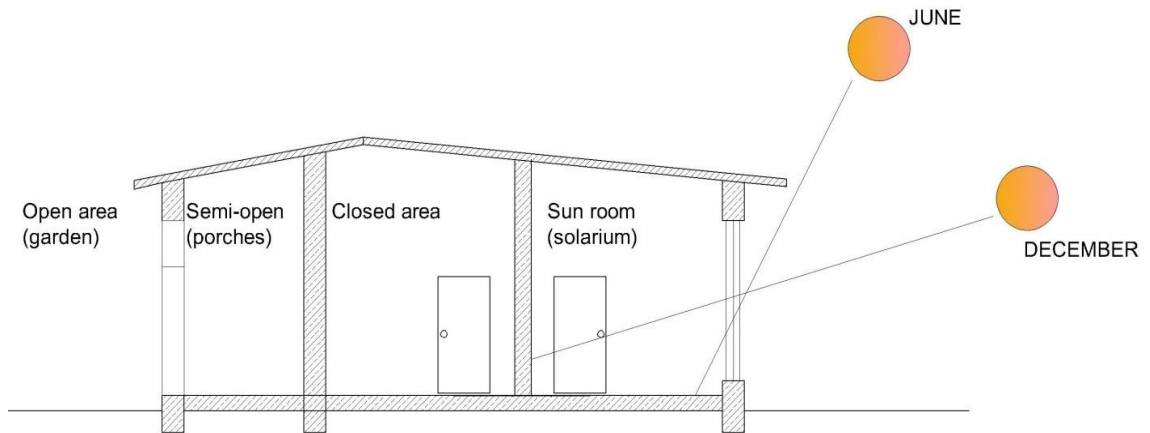


Figure 4. 7 Impacts of sun radiation in the summer and winter of different sections of a vernacular house (Movahedi, 2012)

The location of the courtyards is also important, in Winter there are three main aspects in which the location depends on, including: the width of the courtyard, the sun position at its lowest sun-path, and the height of the courtyard. If the courtyard is facing to the South it will receive the most sun light which during the Winter months is the most advantageous (Glassie, 2000). These aspects are incredibly important during the winter months. Even though these months are significantly shorter than the summer season, they are drastically different from the summer weather that their change in climate must be adjusted too in order to create a livable living situation. As will be seen later in the individual case studies, each house has its advantages and disadvantages based on how the individual designs account for these changes in weather, and the strategies used to adjust. They will be outlined and shown in a visual representation following each of the case studies, and then a summary at the end of the chapter.

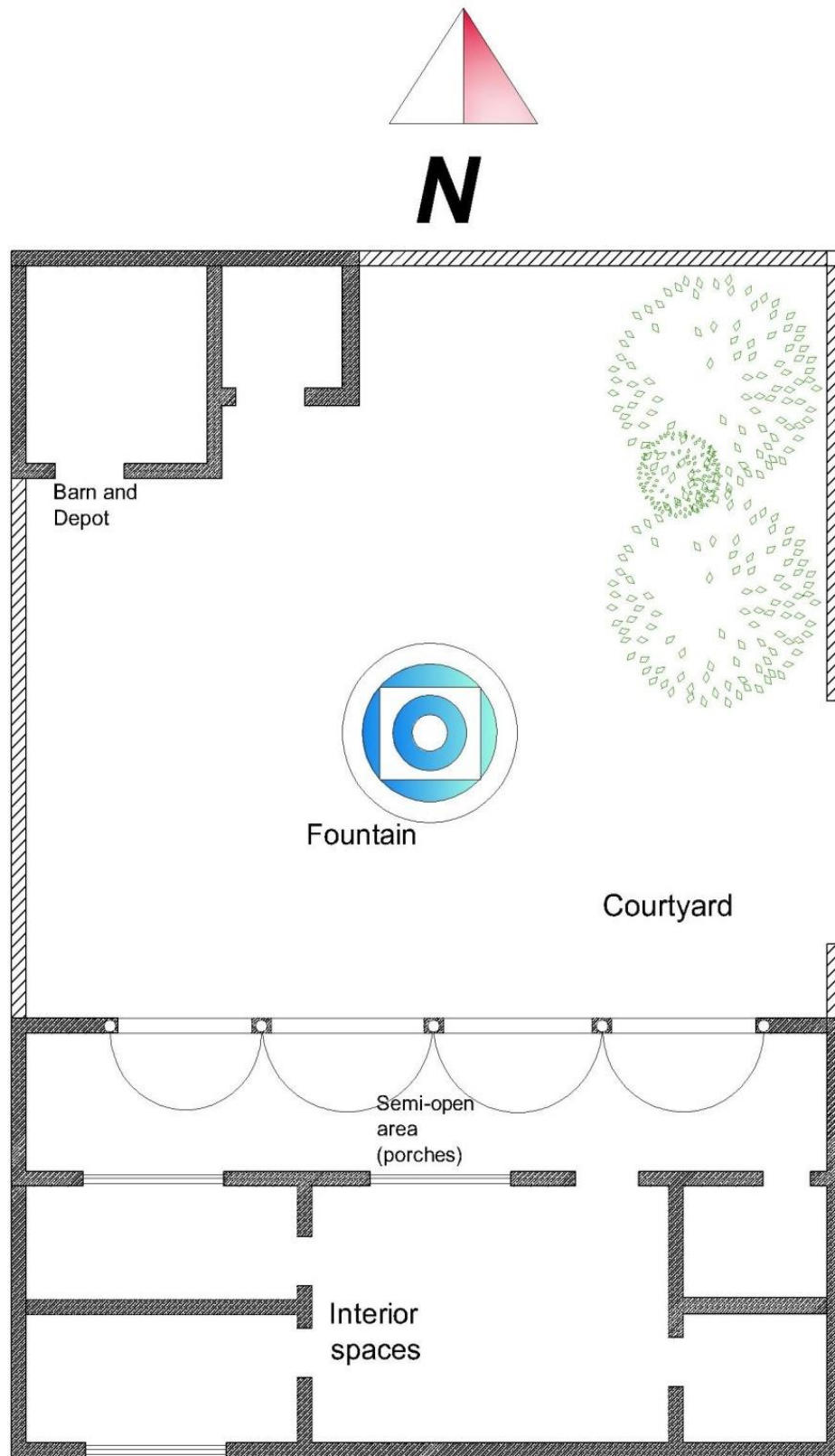


Figure 4. 8 Plan of a typical vernacular house (Movahedi, 2012)

4.2.4. Breaking Down Design Strategies

If designed correctly, the solarium or sunrooms only receive sunlight in the winter months creating a different function of these sunrooms for the Summer months. The designs of the horizontal or central corridors are expected to be at the sides of room, which has the ability of acting as a breezeway, taking in the passing winds. The horizontal and central corridors should be long in order to take in the maximum amount of these cooling breezes to naturally cool the inside of the buildings. This also allows the heat that has built up in the walls transfer to the exterior spaces at night to warm the exterior during the cool Summer night. In order to efficiently and accurately use these winds, wind speeds and directions of the winds must be considered and calculated into the interior design and formation of the sunrooms and buildings (Despina, 1992).

4.2.5. Enclosing Structures

Any structure or element surrounding the building like fences walls, when they are higher than the width of the building, adds shade during the day, even during the most extreme days of Summer (Glassie, 2000). While initially these may be seen as a disadvantage of the community as a whole, such as the narrow streets and lack of parking area, they are actually an advantage, creating the most shade as possible for the inhabitants of not only the individual houses but also those visiting the area (Oliver, 1997).

4.2.6. Arches and Overhangs

Arches and overhangs are good examples in vernacular architecture for strategically using shade, in order to provide an effective way to control the amount of solar radiation admitted (Glassie, 2000).



Figure 4. 9 Open space and semi-open spaces in vernacular housing (Movahedi, 2012)

4.2.7. Walls and Fins

The sun altitude during the early Summer mornings and late afternoons is very low, meaning that the horizontal overhangs being used are only enough to provide full coverage and shade to porches and arches with South facades. Vertical fins are used in order to protect the porches and arches from the solar radiation coming from the East and West. The length and size of the vertical fins is therefore important. The size of these fins should be between 1 meter and 1.2 meters to be useful in creating sufficient shade. (Glassie, 2000)

4.3. Energy Conservation

4.3.1. Shading

Outside of the structures, the uses of strong trees, such as olive trees are a technique to provide shade in Summers, used by community vernacular designers. However, this creates small complication in regards to the creation of un-wanted or unneeded winds. Since sunlight is of paramount importance in the Winter months, the planting of these trees and other vegetation should be restricted from being planted in the South side of the garden or courtyard.



Figure 4. 10 Use of olive tree in a garden of vernacular house for shade (Movahedi, 2012)

At the Mediterranean region, with abundance of sun in summer, the shading is one of the most important elements of vernacular architecture in order to get rid of, or moderate, the excess sunlight that would increase the temperature of the structure inside and out to an uncomfortable degree. There are four main elements included in the aspect of shading in vernacular architecture: Enclosing elements arches and

overhangs, vertical side-walls and fins, and vegetation. All of these elements will be discussed here (Dincyurek and Turker, 2007).

4.3.2. Passive Cooling Strategies

In vernacular buildings in Cyprus as was seen in the construction and design for the winter months the courtyard and sun rooms of these structures must be balanced. However unlike in the winter months, the temperature of interior and exterior of the building should be lower by modifying the impact of sun's radiation (Dincyurek, 1998). These strategies are important not only based on the length of the summer season, but also the ability to live in the built and non-built areas of each individual house and the community as a whole.

4.3.3. Summer-Time Ventilation: Control of Wind and Breezes

One of the most important elements to deal with in the summer months is the natural ventilation through the capture and utilization of winds and breezes. When the exterior temperature is warmer than the interior, the ventilation aspect is of paramount importance when trying to create a comfortable area to live in. In these traditional, vernacular buildings, Ventilation is given special attention as to how they can be directed and used naturally (Glassie, 2000).

On the days when the winds and breezes are too much the additions of overhangs act as modifier and deflector. They balance the incoming winds by adding additional pressure to the opening areas, thus creating suitable ventilation for the indoor areas by replacing the hot air. (Despina, 1992)



Figure 4. 11 Porches of a vernacular public building (Movahedi, 2012)

4.3.4. Utilization of Evaporative Cooling

There is a necessity to utilize the natural process of evaporative cooling in order to create a comfortable climate in the courtyard of the house. One of the possibilities of doing this is through the creation of a sprinkler system or fountain to spray water over the courtyard on a suitable ground cover, such as grass (Despina, 1992).

Existing fountains and sprinklers near the courtyard or building will provide redirected cooler winds from the exterior of the structure and create breezeways to be effective in the interior spaces (Despina, 1992).



Figure 4. 12 Fountain in a vernacular house (Movahedi, 2012)

4.3.5. Water - Producing Fixtures

In the wealthier regions of the city, houses that use water-producing fixtures such as fountains, pools and sprinklers can be seen. These fixtures function simultaneously as reservoirs of water in which evaporative cooling will be used by covering the level of humidity and by cooling the air when assisted by the presence of a breeze (Despina, 1992). This is yet another traditional method used in vernacular architecture to benefit from natural resources and to reduce the need for extra energy supplies or materials.



Figure 4. 13 Water source in yard of a vernacular public building (Movahedi, 2012)

4.4. Eco-friendly Material Usage

The structural systems of the vernacular houses were made out of wood, while the walls and the rest of the building are made of brick, handmade clay, and local stone of Cyprus, named Kirpich. As seen in Figure 4.13., some structures were made out of stone, as an accent to the surrounding structures, however this was a rare case. Those materials are all natural and easily available around the island. The stones are functioning to saving the heat during the day to release it during the night time. The bricks are functioning by reflecting the heat by taking the help from their bright yellow color (Dincyurek, 1998). The emphasis of using these indigenously found materials is a main aspect of creating a sustainable structure, which is one of the main principles outlined in earlier chapters. The use of these materials makes the structures more financially friendly, but also decreases the amount of environmental degradation.



Figure 4. 14 Exterior walls of a vernacular house (Movahedi, 2012)

4.4.1. Vegetation

Along with the shape of the garden or courtyard, the ground coverings further absorb and store heat during the day, which can be released outside during the night. Furthermore, planting the vegetation must be done in the correct location as not to interrupt the wind corridors during the Summer. Also, the correct location is important for the potential shadow that can be created to cover and protect the exterior areas of the buildings from Summer heat (Glassie, 2000).

Other than the built structure, natural vegetation and trees can also provide a vast amount of shade. The use of certain types of plants, like fig trees, pomegranates, grape, etc. simultaneously provides sun in the Winter and appropriate shade in the Summer.



Figure 4. 15 Garden of a vernacular house (Movahedi, 2012)

- Trellises or pergolas and climbing vegetation are used to reduce reflecting sunlight when used as shade walls.
- Tall trees should be used in the Southern side of the courtyard to cover roofs and walls with shade.
- Climbers, shrubs, dense trees and hedges in the East and West of courtyards act as interceptors during the early mornings and late afternoons of Summer (Despina, 1992).



Figure 4. 16 Garden of a vernacular house (Movahedi, 2012)

An aspect of vernacular structures is the preference of natural cover as opposed to man-made covers of the outside ground. Natural ground covering, such as grass allow for a reduction of summer temperatures in the courtyard, as it gives opportunity for the evaporative cooling process. In contrast the man-made impermeable coverings increase the air temperature by absorbing the sun's heat and not reducing the temperature through evaporation process (Despina, 1992).



Figure 4. 17 Example of a shading wall (Movahedi, 2012)

V. CASE STUDY ANALYSIS OF KARAMAN VILLAGE

In order to analyze the principles examined regarding sustainable architecture, three case studies of vernacular houses were chosen in the Turkish Republic of Northern Cyprus. The Karaman Village (locally known as Karmi Village), located in Kyrenia, proved to be the most accessible for this study of North Cypriot houses mostly due to its active use and the demonstrated use of traditional techniques incorporated into its renovation. This village is an important example of vernacular architecture of previous generations. The following chapter will discuss the extent to which these houses were initially considered vernacular, and how these were later developed further into examples of sustainable architecture years later.



Figure 5. 1 Girne Map and location of Karaman Village (Carney, 2012)

5.1. General Information about Karaman Village

The town is overlooked by two main landmarks, one man-made the other natural. The Gothic St. Hilarion Castle and the Beş Kardeş Mountains both encompass the village allowing for soft winds in the summer, which in turn cool the village, a trait quite unique to this village.

On July 15th, 1974 the National Guard, which was under the control of the Greek Cypriots, staged a coup d'état against the Cypriot government, which would leave the island split between its Greek and Turkish ethnicities even until now. This split between the two sides, while still a somewhat hot conflict was pacified, to a certain extent, by the United Nations Peacekeeping Force in Cyprus, which designated a green zone through the capital city of Lefkoşa. To the North of this zone, the Turkish Cypriots were to reside, while the southern side was thus reserved for the Greek Cypriots (United Nations Peacekeeping Force in Cyprus, 1974). Originally, Karaman Village was mostly made up of Greek Cypriots. Due to the 1974 hostilities, the Greek Cypriots were forced to move southward and leave the village behind, damaged by fighting and utter abandonment, the village turned to destitution (Foster, 2000).

It was not until 1989 when the Turkish Republic of Northern Cyprus (TRNC) Ministry of Tourism took over the village in order to begin restorations. They were mostly concerned with the restoration of all roads and infrastructures, but then developed a system of leasing out houses to only foreigners, in order to spread the total cost of restoration (Foster, 2000). Major projects began populating throughout the village to renovate and develop resident tourism (North Cyprus Council of Ministers, 1989). Today German and British expatriates are the main inhabitants of the village. Over the past few decades Cyprus, on both sides of the green zone, has

developed as a major tourist destination, allowing for an increase in revenue and flow of international visitors.



Figure 5. 2 Rooftop view of Karaman Village (Movahedi, 2014)

Fortunately, the Council of Tourism and those expatriates who have moved in took caution and care in their renovation efforts for Karaman Village. Their main goal was to keep the character of the village but at the same time build structures that could withstand the needs of the presently thriving tourism industry. Therefore, solar heaters were not permitted and wooden rafters and rush mats were used for ceilings in all buildings and structures (North Cyprus Council of Ministers, 1989).

5.2. Solar Radiation in Karaman Village

Based on its location, unfortunately Karaman Village in the Winter months does not receive ample amounts of sun. Since Karaman is located in the foothills and based on the angles of the sun in the Winter month, most parts of the day the mountains directly block the majority of the Winter sun rays which is another unique

trait to this tiny village. Furthermore, a typical Cypriot Winter entails an increase in number of windy days and cloudy nights. Wind directions are from the Northwest and North direction in the Winter, and both are coming from the ocean. Winter in Karaman Village receives only a small percentage of sunlight, which is usually during the middle of the season, in comparison to the Summer months.

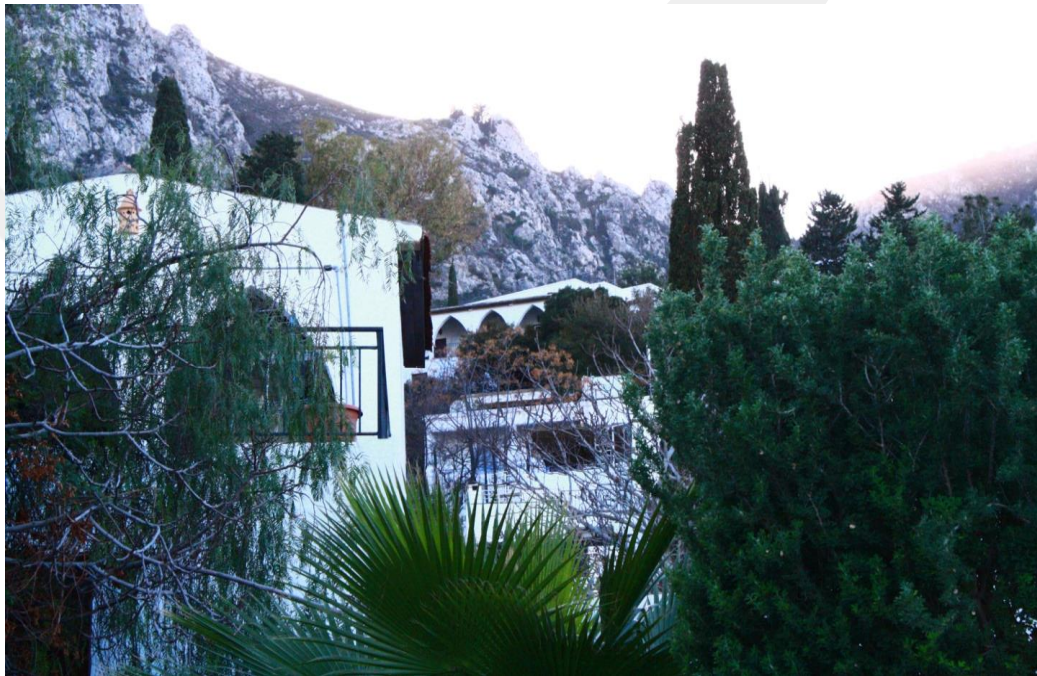


Figure 5. 3 Karaman Village (Movahedi, 2014)

It can be seen that during the summer months, the sun mostly passes from the top of Karaman village. Quite unlike the winter months, because of the angles of sun during the summer months, Karaman Village sees an average of 14 hours of sunlight each day. This drastic change in amount of sun is not unique to the village- it is experienced by the whole island.

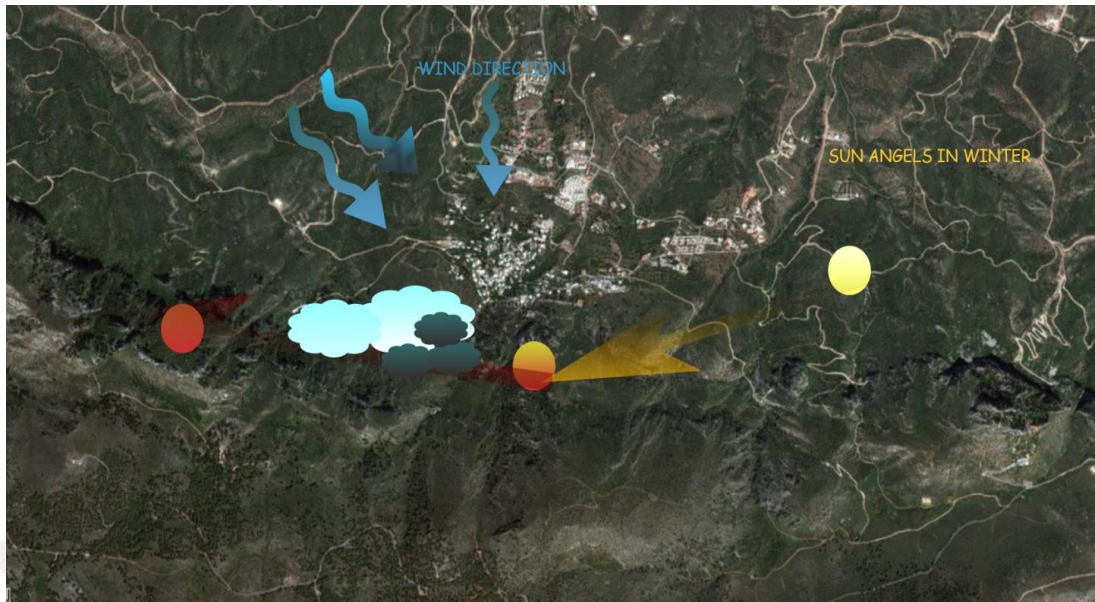


Figure 5. 4 Winter sun received in Karaman Village (Movahedi, 2014)

The dichotomy of the availability of sun in Karaman Village in the Winter and the Summer months is due mostly to the location of the village. While the placement of the small town in the foothills of the Beş Kardeş Mountains blocks the sun in the Winter afternoons, it does not give Karaman Village protection from the Summer sunrays. This phenomenon therefore is not preferable regarding the principles of sustainable architecture, since the needed passive heat does not occur sufficiently in colder months.

5.3. Infrastructure

While the Council of Tourism and the Council of Ministry of Northern Cyprus paid a lot of attention to the infrastructure of the village during its reconstruction phase, one design was out of their hands- the roads of the village including their shape, size, and capacity. Due to its historical origins in ancient times in the island, the roads and streets were not constructed with the use by automobiles

in mind. This not only makes mobility throughout the village difficult but also creates a deficit in suitable parking spaces for both tourists and inhabitants. However, these more modern concerns, which would change the current structure of the roads and/or parking areas, would not positively impact the sustainability of the village, therefore are not a priority. As has been mentioned before, the structure of these roads and pathways are narrow as a technique of providing as much shade as possible to the inhabitants- changing this, therefore, would decrease the shaded areas outside of the houses.



Figure 5. 5 A street of Karaman Village (Movahedi, 2014)

Thankfully, the councils in charge of the restoration were highly concerned with the maintenance of the original aesthetics of the village; therefore, no changes were made to the streets. Inadvertently, this wish to not change the aesthetics of the village allowed for the maintenance of this shade throughout the village. The roads, streets, and parking spaces of Karaman Village may not be up to the standard of

today's needs regarding the tourism industry, let alone the ability to expand for mass tourism projections of the future, but this is not a priority for the sustainability and livelihood of those living in the village.



Figure 5. 6 A main road of Karaman Village (Movahedi, 2013)

Based on the original design of Karaman Village, the condition of driving through the village and parking spaces available all create a disadvantage to the town's capacity for tourism. In the Northern Cypriot region, tourism is one of the main sources of generated revenue for the island, which mandates tourism as a modern necessity. Even though on the exterior these look as disadvantages for the community in terms of economic development, it is not a concern for the sustainability of the village. The creation of parking spaces outside of the village is one option for alleviating the parking problem without interrupting the structure of the village. While it may be a small inconvenience to visitors, it would allow for the village to continue to survive and be sustainable.

5.4. Analysis of Vernacular Houses of Karaman Village as Case Studies

In Karaman Village, the houses and structures can be labeled as vernacular structures based on two characteristics: their age and their builder. To be a truly vernacular structure, the building must have been designed and built by a local person, usually without the assistance of architectural training. Furthermore, these houses are ranging in age from 70 to 100 years old, which makes up another criterion to be classified as Vernacular Architecture. In this section, three different cases will be presented and analyzed in terms of the principles of sustainability.

Along with their vernacular/ sustainable characteristics, three cases will be analyzed referring to their floor plans, all in which are showcasing and exemplifying a different style of house found in the original Karaman Village. The exterior of the houses may have changed in order to cope with modern ways of life, but the floor plans remain fully intact with its original form, allowing for an analysis of their configuration compared with the specific values of sustainability.

5.4.1 House 1

The first case to be analyzed is a house owned by an elderly couple originally from the United Kingdom. From the onset a note of culture is needed to be mentioned. While the inhabitants of the country are from the UK, a Western European culture, the designer and builder of the house was of the Mediterranean region. Coming from the UK, the needs and requirements of the inhabitants differ from those of the original builders of the house in which they live. As will be seen throughout the analysis, the difference in culture around cooking, such as how to use a fireplace, and entertaining, will put additional stress on the ability to keep these vernacular houses sustainable. Figure 5.10 below shows the exterior of the walls surrounding the courtyard. Note that the house takes in the contours of the

mountainside in which it rests and is molded to it. This is just one of the examples of its type throughout the village. Also, it is important to note the specific materials used. In this example adobe and stone are blended together with the wooden doors, showing a practical use of the island's organic and natural resources to create a sustainable and fitting structure to the surrounding area.



Figure 5. 7 Relative location of House 1 (Movahedi, 2014)



Figure 5. 8 Courtyard view of House 1 (Movhedi, 2014)

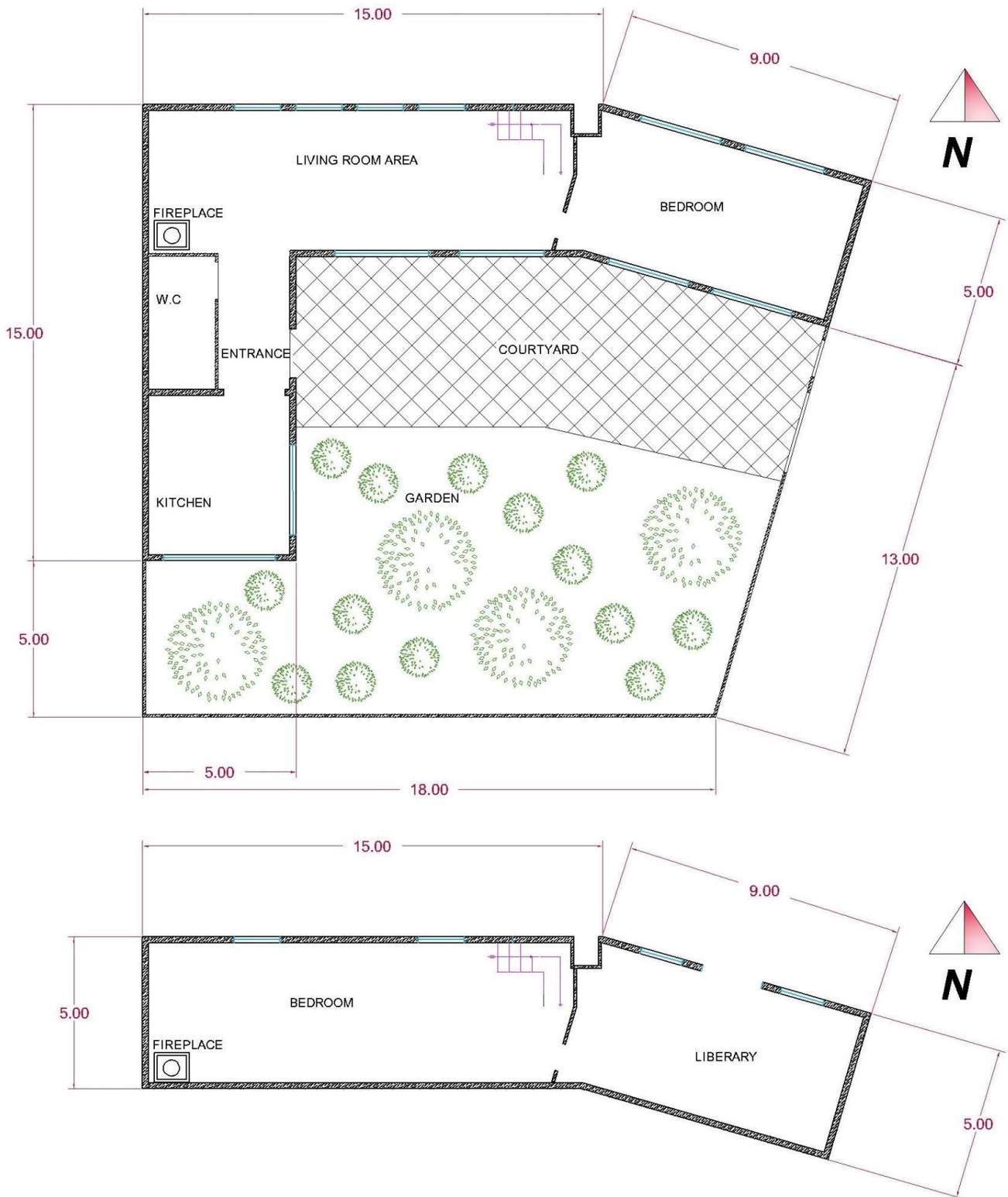


Figure 5. 9 Ground floor and basement floor plan of House 1 (Movahedi, 2014)



Figure 5. 10 North-side elevation of House One (Movahedi 2016)

As demonstrated by the given floor plan, House 1 includes a bedroom, a living room, a bathroom, a kitchen and a fireplace. At the basement floor there is an additional bedroom accompanied by a library.



Figure 5. 11 Northside facade view of House One (Movahedi 2014).

On the South side of the building (determined during construction and final planning stages) there are five windows, allowing the kitchen, living room and the bedroom on the ground floor to receive maximum amount of sunlight during the

Winter and Summer months. Because of its rarity, this is valuable in the cool winter months, however in the long summer months this can prove to be uncomfortable if not compensated for by other means. Therefore, there are three windows that are located in the North side of the building on the ground floor. This placement of windows on opposite ends allows for the maximum wind circulation during those long hot and humid Summer days, fully exploiting the winds coming in from the ocean.

The basement floor, which houses the additional bedroom and the library, receives no direct sunlight during any season. Such underground rooms remain cool all year round, and in the Summer months still remain the coolest place of buildings.

As mentioned above, during the Summer months if other measures are not taken, five windows on the South facade can bring in a large amount of solar radiation to the rooms on the ground floor, which can lead to an uncomfortable environment to live in. Therefore, plants and other vegetation in the courtyard provide effective shading for the house, most notably for these rooms Tall trees are utilized in the yard to cover the building from direct sunlight, adding a protective barrier to the houses from the sun, especially in the Summer days.

The last element to mention is the fireplace, located on the ground floor of the house. It is located within the living room with the exclusive function of burning wood for space heating in the Winter. Unfortunately, due to its design and location, it lacks the capacity and capability to function simultaneously for cooking. This element of the house, therefore, is solely there for the purpose of providing heat and creating comfort for the inhabitants during the winter months.

As to an overall evaluation, House 1 can be defined as a sustainable vernacular house. The environmental characteristics and demands have been kept in mind during the design and building of the structures. Due to the location of these houses, in the foothills of the overshadowing Beş Kardeş Mountains, there is (and was) a need to extract the maximum amount of sunlight during the Winter months. Simultaneously, there is the need to provide protection from the harmful Summer sun, which rotates at different angles during the Summer season, and is not hidden behind the Beş Kardeş Mountains during these months. Furthermore, wind patterns for both the Winter and summer seasons were also taken into consideration during the planning and implementation of these houses.

While all of these elements of the surrounding environment were taken into consideration and adjusted for accordingly, there were some disadvantages to creating this sustainable vernacular structure. During the Summer months the priority is to protect the houses from the overbearing sun radiation, using wind circulation from window placement and plants and vegetation in the courtyard and yards. However, when these adjustments are made, it creates an obstacle for taking in the most amount of sun as possible in the Winter months. This leads to additional heating within the walls to create a comfortable and livable space during the Winter season. This was the main reason for the addition of the fireplace into the living room. However, this addition of the fireplace cannot be seen as a sustainable supplement due to its design, materials used to create the heat, and its singular use. The burning of biomass, such as the wood used in this case, creates an unhealthy environment to live in because of the suspended particulate matter. This phenomenon leads to poor indoor air quality.

Furthermore, outside of the floor plan of the house, due to the time period when these were designed and constructed, the inhabitants had no need to create streets that were large or wide. Leading to a plan of tight, winding, narrow streets that circulate throughout the village. The area lacks room for driving as well as parking- leading to a drawback in living in this village, and hampering the ability to visit the entirety of the village for touristic reasons. However, as has been mentioned already, these drawbacks are not a priority for the sustainability of Karaman village. While economic income is a concern, it should not come at the price of the destruction of comfortable shade in the pathways and narrow walkways throughout the village.



Figure 5. 12 South side wall and entrance of House 1 (Movahedi, 2014).

The following diagram summarizes the specific techniques used in the structuring of House One in order to adjust to the extreme weather of both the Summer and the Winter months. As can be seen in the figure, this house is most sufficiently built for the summer months, and lacks efficient capabilities of dealing

with the cold and rainy winter months. While the winter is significantly shorter than the summer, it is still quite important for the inhabitants.

Climatic Adjustment Strategies for: House One	
Winter	Summer
1-Use indoor spaces	1-Use outdoor spaces
2-Built area is two times smaller than the courtyard	2-Courtyard is twice the size of the built area
-----	3-80% of the house is in non-direct receiving sun areas
-----	4-Using windows in the North facade of the building to receive wind in order to cool the house
-----	5-Using vegetation for making shadow for both interior and exterior areas
3-Using the fireplace for creating warmth within the house	-----

Table 5. 1 Summary of House 1 climatic adjustment strategies

5.4.2 House 2

As in the first house, an English family who has lived in this house for the past 40 years and owns this particular structure also inhabits this second house. Similarly, the inhabitants have had to adjust the living standards from which they were raised to those standards that the builder designed the house for. This cultural difference can be seen in the cooking styles, and in the way of entertaining in the built and non-built structures. While most buildings are concentrated in the center of Karaman Village, this structure, as an example of its type, is located in the Southern side of the village. The house itself is accompanied by a small garden to the North and then a larger garden just behind the building, on the Southern side.



Figure 5. 13 Relative location of House 2 (Movahedi 2014)



Figure 5. 15 Exterior Walls of House 2 (Movahedi, 2014)

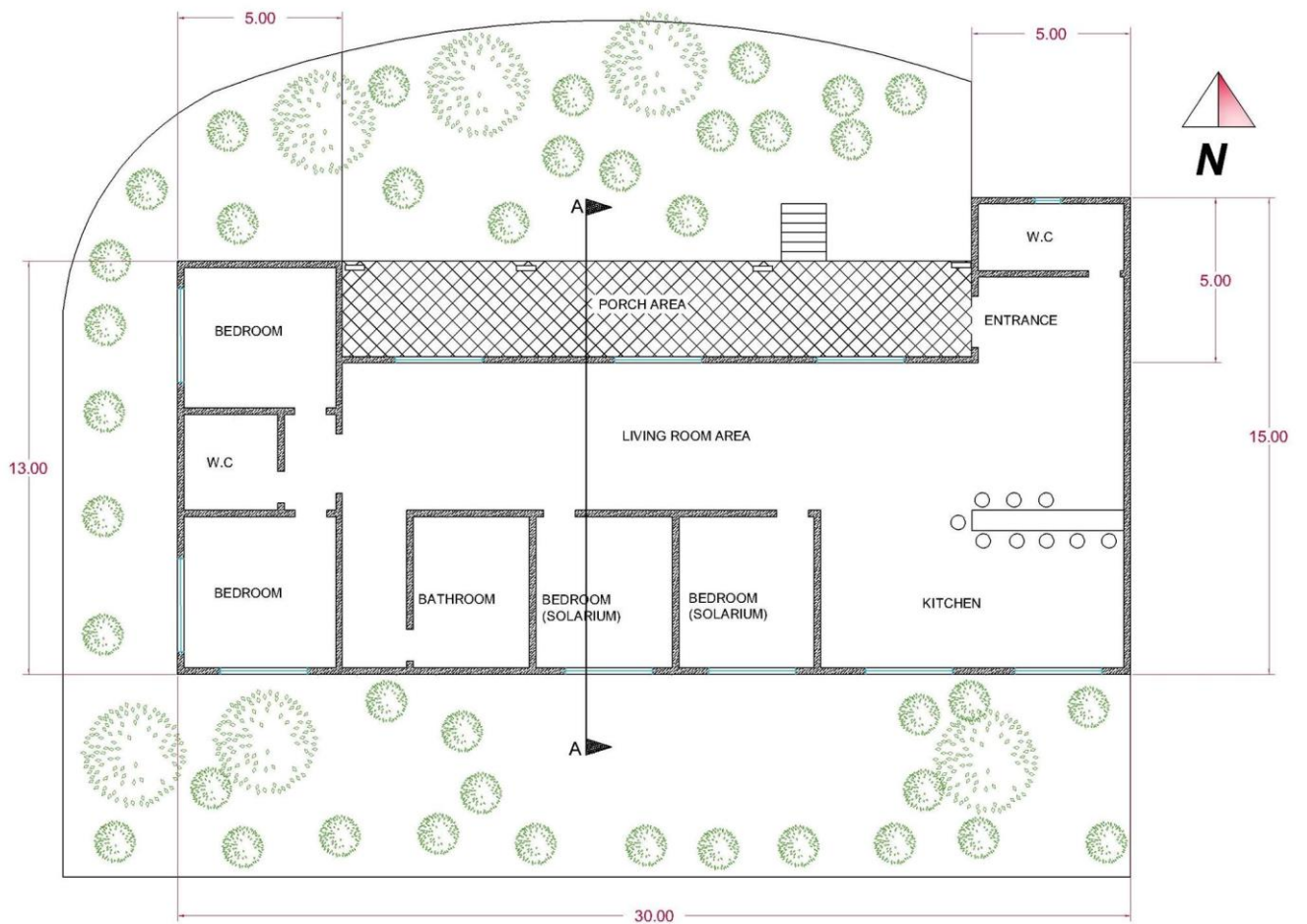


Figure 5. 14 Ground Floor plan of House 2 (Movahedi, 2014)

Similar to House 1, this structure harnesses the wind coming from the ocean and utilizes the circulation through the strategic placement of windows. Here it can be seen that there are three windows located on the North end of the building and an identical four windows to the South end of the building. As can be expected, if the windows are open during the hot and humid summer months then wind circulation can cool the house effectively and sufficiently. Again, the windows of the South side bring in the maximum amount of sunlight available, regardless of the season. While this is of course beneficial in the Winter months when there is enough sun to prove useful, in order to reduce the effect of the sun in the Summer season, plant must be cultivated in the courtyard and surrounding streets to provide effective natural shadowing protection to the house from unwanted and harmful solar radiation.

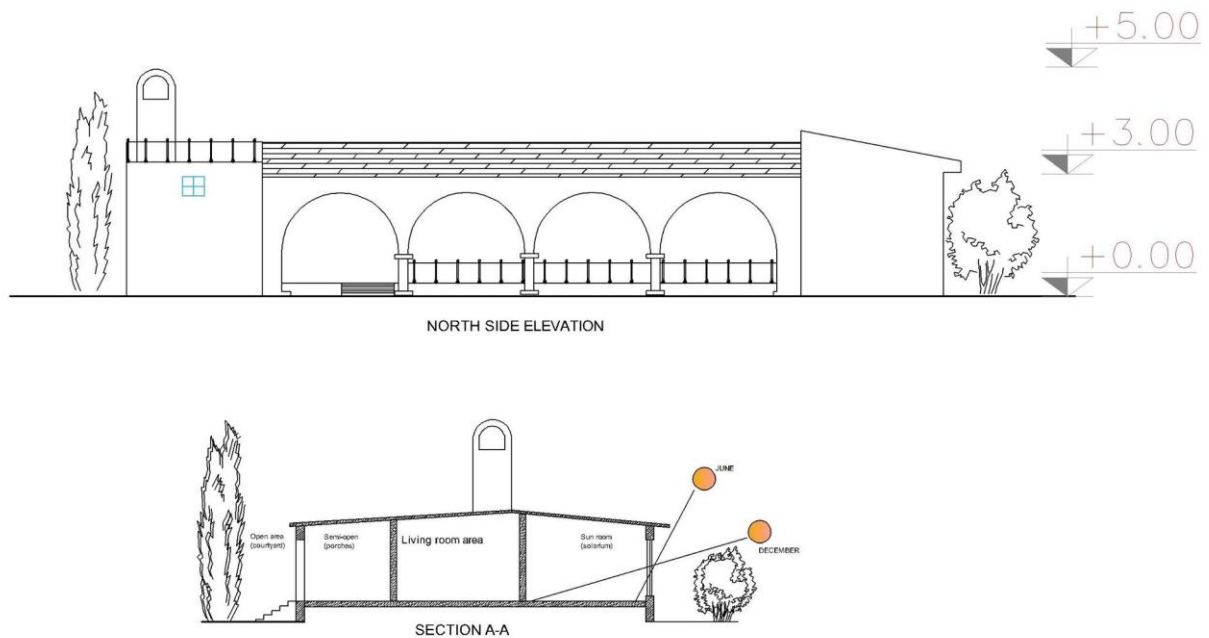


Figure 5. 16 North side elevation and Section A.A (Position of Solarium Room)
of House 2 (Movahedi, 2016)

A major difference between House 1 and House 2 is that, in House 1 rooms which do not receive any natural light are located at the basement floor, however in this House the two rooms that do not benefit from the sun are on the West side of the building. These rooms receive minimal sunlight, but only during the afternoon which is a period of the day in which the sun rays are not as strong as they are in other periods of the day. Even though they do receive bits of sun throughout the day, unlike the first case, they still remain the coolest rooms of the house.

In this case, vegetation and gardens are situated on the South side of the house. They include rich trees and plants in order to fully engross the area in shade and keep the area cool throughout the summer months.

As mentioned for House 1, additional heat is needed for this structure due to the shading effect that lasts throughout each season. The method used in this example again is the fireplace. Even though this does have a benefit for the user and creates a thermally comfortable living space during the cooler Winter months when heating is needed, it cannot be classified as purely sustainable. As was the phenomenon in House 1, the use of indoor heating through a fireplace reduces the quality of indoor air, creating an undesirable living condition.



Figure 5. 17 North side-walls second example (Movahedi, 2014)

Like the first house, this structure can be regarded as a sustainable vernacular design, even with the addition of the fireplace in the living rooms. Sunlight penetration is maximized through the strategic placement of windows on the opposing North and South walls of the houses, while plants and common trees provide a protective layer of covering to assist in cooling the house, and reducing the amount of harmful rays to the inhabitants. These opposing windows also allow for effective cross ventilation through wind circulation from the winds coming from the ocean, which can cool the house without the use of modern active air conditioning units. The Western rooms remain the coolest during the Summer months, and it is important to note that the sunlight penetration causes not only harm to those living in the structure, but also causes damage to the building themselves and must be protected.



Figure 5. 18 Porches of House 2 (Movahedi, 2014)

The following diagram in Figure 5.20 summarizes the strategies used by House Two when adjusting for the extreme weather conditions brought by either the Winter or the Summer months. This house, including its built and non-built elements, is well designed for both seasons. The design of the indoor area of the house allows for a large portion of the house (the two bedrooms) to act as a solarium during winter months, which bring in natural sunlight, therefore natural heat. However, when this heat is not enough, the additional use of a fireplace also is used to further heat the inside built area. Also noteworthy from the design of this house is the clever use of vegetation in both seasons to block direct sunlight in the summer months, but also block the strong cold winds for the winter months assisting in cooling and heating respectively.

Climatic Adjustment Strategies for: House Two	
Winter	Summer
1-Use indoor spaces	1-Use outdoor spaces
2-Built area is two times smaller than the courtyard	2-Courtyard is twice the size of the built area
3-Uses two bedrooms as solarium rooms to adjust to comfortable air conditions	3-Living Room which is 40% of the house, is the only non-receiving direct sunlight room
-----	4-Using windows in the North facade of the building to receive wind in order to cool the house
4-In North side courtyard the use of vegetation for directing the wind, (blocking and cutting techniques)	5-Using vegetation for making shadow for both interior and exterior areas
5-Using the fireplace for creating warmth within the house	-----

Table 5. 2 Climatic Adjustment strategies for House 2

5.4.3 House 3

The third design to be analyzed is an exception to the normal designs of its area. It is a 72-year old building situated in the Northern area of the village. However, this model incorporates the design of the Southern area. The differences can be seen in the location of the entrance, which opens directly from the building to the street. This is much different than its neighbors in the Northern part of the area, in which the entrance opens directly from the building to the courtyard. These differences can be seen in Figure 5.22. and 5.23. given below.



Figure 5. 19 Relative location of House 3 (Movahedi, 2014)

Unlike the previous cases, this house has fewer windows incorporated into its design. As evident in the plan given above, there are two windows on the North side of the building, and two more on the South side, opposed to the four and five windows used in the first and second plans. To the North of the building the two windows open to the kitchen and the library. An entrance further accompanies these two Northern windows to the house. There is also a depot located on the Southwest

of the building, which opens directly to the street, instead of opening into the courtyard, which is more common in these Northern village type houses.

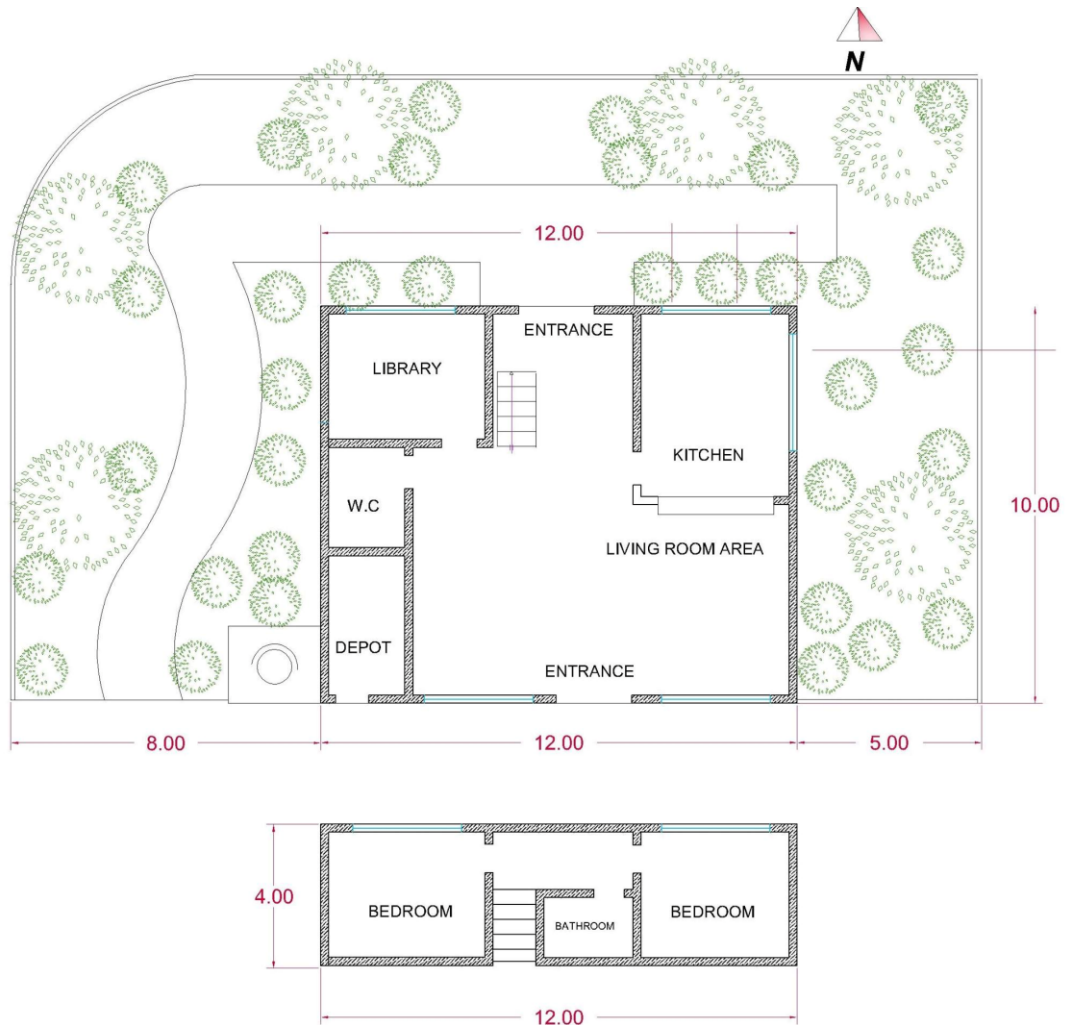


Figure 5. 20 Ground floor and basement plan of House 3 (Movahedi, 2014)

This case does not utilize the available wind circulation in its interior design. The windows on the North side do in fact receive wind coming from the north, the northwest and from the ocean- however due to the walls of the kitchen and the library, the southern two windows cannot be reached in order to create the needed wind circulation. This design uses the basement feature, as introduced by the first case. This house also cannot benefit from any wind circulation either. However, it

still allows for a very comfortable living space during the summer since it receives no direct sunlight.

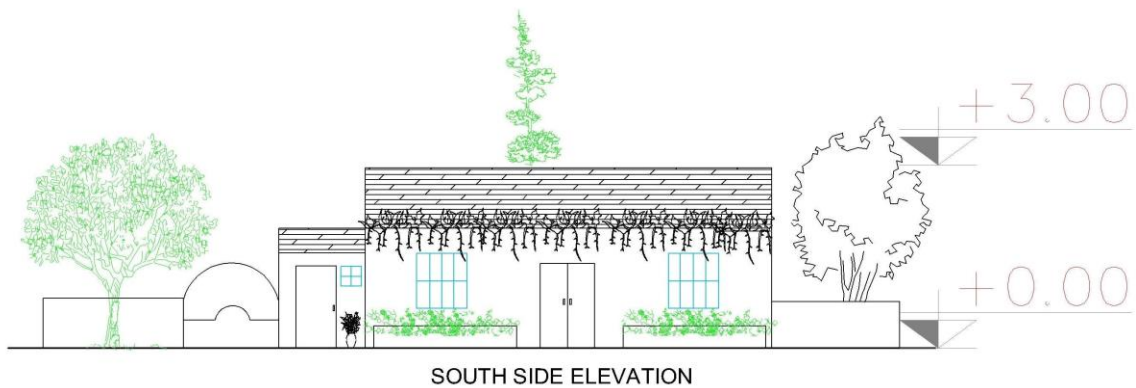


Figure 5. 21 South side elevation of House 3 (Movahedi, 2016)

The two windows located on the south of the building bring in the most amount of sunlight. This shows that the living room benefits the most from solar radiation both in the Winter and Summer. If no shading elements are introduced to the southern side, or the street side, then it will lead to very uncomfortable living conditions for the largest room of the structure. The library and the kitchen do not receive any direct sunlight during any season.

When these vernacular houses were designed and built, the inhabitants added an additional oven to the Southwest wall of the buildings. While beneficial at the time that it was added, it is not as necessary in the modern times, as it was 72 years ago.

At the exterior, in the garden and on the streets surrounding the house, the same types of trees that were introduced in the second case are used. In this

particular example, one old and tall Pine tree is included in this garden. This vegetation of the garden is mostly located in the north side of the building. However, when it is positioned to the north side, it does not add to the shading components for cooling the houses during the summer months, and also blocks the view of the ocean from these houses. These houses actually provide a lot of cooling elements for the sake of the whole village. While the shadowing effects of the trees and other vegetation have no effect on the houses themselves in the northern part of the village, they help the cooling of the surrounding village.



Figure 5. 22 South side walls of House 3 (Movahedi, 2014)

Unfortunately, even though this case provides more shading and cooling effects for the village as a whole, this design has many disadvantages. One of the disadvantages is in the utilization of available wind for circulation. As mentioned above, the design of the interior walls blocks the ability for natural cooling, even though there is an abundance of wind coming in from the north and from the ocean. This is further compounded by the problem that there are only two windows on each

side, unlike the four or five windows to each side found in the first and the second plan.

Another disadvantage comes from its shading elements. The elements used for this case do not provide enough shade or protect the house from the hot and humid summer days to produce a livable and comfortable space. The plants and vegetation are located in the courtyards of the buildings, but it is to the north. Which add no additional shading to the house. Therefore, the houses receive an abundance of sun in the summer. It can be argued that this is beneficial for the winter months, and in reality it is, but the seasons are mostly warm anyway, and it is only a small marginal benefit that does not outweigh the overall cost of this type of shading. However, one interesting thing to note here is that in the gardens, other than the shading factors of these plants, the inhabitants are able to grow food for themselves and for the community. This is an advantage both for the house owner in feeding their own family, but also creates a possibility for selling and creating a sustainable economy within the village.

The final disadvantage is shared by all of the presented cases, which is constituted by the fireplace. However, one element that this house has that the others do not incorporate as well are the exterior ovens, used for baking bread and cooking meals. These ovens, unlike the fireplaces, do add an advantage and a component of sustainability to these houses in which the fireplaces cannot.

Like the other cases, and the village as a whole, this area of the village also shares in the seemingly disadvantage of the shape and design of the roadways, pathways and parking areas. But as noted previously, while these elements were not considered during the time that the houses were first built, and by today's standards

cannot be classified as sustainable due to the reliance of cars and transportation vehicles in modern times, it should not affect the reconstruction or remodeling of the village.



Figure 5. 23 Entrance of House 3 (Movahedi, 2014)

Figure 5.26 again summarizes the techniques and strategies used by House Three. This house is set apart from the other two with more unique techniques used, mostly in the design of the outdoor spaces almost completely surrounding the built area- and how much smaller the built area is as compared to the non-built outdoor area. For these reasons, this third house, while comfortable, lacks the common techniques used in House One and House Two.

Climatic Adjustment Strategies for: House Three	
Winter	Summer
1-Use indoor spaces	1-Use outdoor spaces
2-Built area is three times smaller than the courtyard	2-Courtyard is three times bigger than the built area and surrounds built area almost entirely
3-70% of house (the living room) is working as a solarium to capture the most available sun	3-Basement is the only room not receiving direct sunlight
4-Interior walls are blocking wind circulation allowing for containment of warmth indoors	-----
-----	4-Using vegetation for making shadow for both interior and exterior areas
-----	-----

Table 5. 3 Summary of House 3 Climatic adjustment strategies

5.5. Overall Evaluation of the Three Cases

All three examples case studies have similarities and differences regarding their design, function and use. The first and second cases' plans are the closest in design to each other, but they do all share some commonalities. The only real difference between Houses 1 and 2 is that House 1's living room receives sunlight and the House 2 does not. In all three houses, the bedrooms are the coolest areas in the structures. In all four seasons on the Cypriot island, these rooms remain cool as to the amount of sunlight that is allowed in.

Each of the three plans incorporates a fireplace. In the first and second case, the fireplace is placed on the inside and for the sole purpose of warming the house. However, in the third case it is situated on the exterior of the house, and can be used for other than just heating functions. The third case allows for the fireplace/oven to be also used for cooking.

The overall size and area of these houses are also similar. While they cannot be built or designed as a large-scale house, they should not be considered small or inadequate in size for a family to live in. They are built very closely together, which incorporates them within the village atmosphere, and promotes strong neighborly relationships.

All three cases also use the slope of the hill to their advantage, by either placing their bedrooms on the basement floor, or in a position, which allows for these rooms to be the coolest.

Additionally, the materials used in the houses are made up of adobe, which can be naturally found on the Cypriot island. This alone allows them to have a sustainable characteristic, due to the ability to continually find and use without the

need for importing from other countries. However, caution is needed when renovating these houses. In order to keep the commonality and the village aesthetics, sometimes there is a tendency to blend this adobe with white plaster, however this white plaster must be imported, which degrades the level of sustainability of the house. The first and the second houses have accurately planned for wind circulation in their design. They efficiently use this wind to provide cooling throughout the house during the summer months. This creates a type of natural ventilation for these houses. This natural ventilation provides a more relaxed and reasonable living area by reducing the temperatures of the house during these long hot summers. In Cyprus, the summer season is longer, due to its Mediterranean climate, which creates a longer need for cooling within the houses. These plans also incorporate the use of vegetation in the courtyards to further assist in cooling through shading. However, the shade provided by these plants and vegetation are only evident in the first and the second cases, while the third case adds cooling effects for the village as a whole, and not for its own house.

Another major difference is that the third house discussed does incorporate the wind circulation factor into the house plan. While this may provide an easy living space during the winter months, as in Cyprus the Winter season is quite short when compared to the Summer season, so this cannot be seen as an overall benefit for any house on the island. The courtyard of this plan is located in the north end of the house, which is unlike the other two plans. This does not provide any protection from the sun for this house. Therefore, any window that opens to direct sunlight cannot be a barrier or hindrance from this penetrating heat. This, as mentioned above, is beneficial for the Winter months, but is of no use for the longer summer season.

The following diagram is a summation of all the techniques used by the three case studies when adjusting for specific climate conditions. While each house has its specific positives and negatives, when put together, the techniques can be used to build the ultimate vernacular structure that can withstand the extreme weather conditions brought on by summer and winter. This blueprint, therefore, should be utilized in the reconstruction, building, or redesigning of houses in the Karaman village. These techniques can also be used as a more general guideline that could extend to houses with similar climatic conditions on the Cypriot island.

General Techniques and Strategies to Adjust the Relative Temperature During Times of Extreme Weather	
Winter	Summer
1-Use indoor spaces	1-Use outdoor spaces
2-Built areas are mostly three times smaller than the courtyards of the houses reflecting the shorter winter months	2-Courtyards are mostly three times bigger than the built areas reflecting the longer summer months
3-Using Solarium rooms for creating the comfortable air condition within the house	3-Using the non-receiving sun rooms as a means of staying cool while still inside the house
4-Blocking the amount of received wind by covering windows, barns, and additional buildings	4-Using arches and windows located in North side elevation as wind corridors and wind absorbing tool
5-Using vegetation for directing the wind, (blocking and cutting techniques)	5-Using vegetation for making shadow for both interior and exterior areas
6-Using the fireplace for creating warmth within the house	6-Using the fountain in courtyards to cool the surrounding air

Table 5. 4 Summary of all case study houses' climatic adjustment strategies

VI. CONCLUSION

In order for an architectural structure to be considered sustainable, there are certain qualities that the building must possess. One of which is being harmonious with the nature of the surrounding area. Most of the vernacular houses built in Cyprus were built with the principles of sustainability without any knowledge that they were using these principles. This tendency to design buildings by using naturally available resources to the fullest is what makes them vernacular and somewhat sustainable.

Other criteria are the use of environmental characteristics and materials as well as keeping the cultural attributes of the area in which the buildings are designed and built. The houses and settlements found across the island of Cyprus meet all of these aspects of vernacular sustainable architecture. They have been structured in a way that meets the basic needs of the builder and consumer while adjusting for the environmental demands.

Some of the main issues that impact the ability to live comfortably in a house include: orientation of the house, openness of the courtyards, openness of the hallway, types of building material, availability of natural ventilation, and the type of roof. All of these issues then must be taken into consideration in a way that will not only help the inhabitant live in the most efficient way, as in using the smallest amount of resources as possible, but also that the look of the house must fit into the natural characteristics of the landscape. In Cyprus, the vernacular architecture examples provide these aspects. The structures protect the houses and its inhabitants

from damaging amounts of solar radiation in the summer, but simultaneously let in the desired winter sun rays. The designs allow for winds to ventilate the houses by creating wind circulation inside the buildings. And lastly the houses incorporate different techniques of cooling and heating based on the naturally found materials of the island.

Each house is unique due to its location. Some of the houses, such as the case studies analyzed, are located at a higher elevation and built on a slope. Each of these houses is developed in such a way that allows them to adapt to these physical constraints. Furthermore, the naturally available resources such as adobe, local marble, gypsum, timber, etc. are all incorporated into these houses in a way that rejects the need for importing materials, or using unsustainable synthetic building material.

As can be expected of a vernacular architectural design, these houses and buildings were designed with the basis of the needs, desires, and lifestyles of the locals from older generations. In other words, those who developed these houses had unique set of demands of a house, and usually this was done without the thought of future generations to come, and their evolving lifestyle necessities. These ideas and needs of a house form a type of ‘vernacular cosmopolitanism’, or a blending of different cultures in a way that makes it impossible to easily separate or categorize what influenced each part of the designs (Yilmaz 2004).

Those ideas, however, which in some way are regarded as the sustainability indicators of vernacular settlements of the island, cannot be the criteria for explaining the recently built houses and settlements of the island. These newer more modern structures do not give any attention or importance to the existing nature and

local culture of the island- and are more focused on making their house the most cost-efficient. The types of houses that these newer generations are creating can easily be seen in any other country, and when viewed in Cyprus are easily identified as a foreign importation of ideas of what should and should not be included in the design of housing or buildings.

The theories and ideas about sustainability in architecture are not new, nor are they modern. Needless to say, the principles of sustainability in Cypriot vernacular houses date back to ancient times, however they have lasted through to present times. Most of these houses have been created solely with respect to adjusting the living conditions in accordance with the Mediterranean climate. Keeping interiors cool in the long hot summer months, together with using methods to keep the heat during the short winter months are provided in these vernacular examples of architecture. In the research of this thesis, it was found that the suitable built vernacular houses in Cyprus have in fact benefited from most of the principles of sustainability in their designs.

While it has been noted that the principles of sustainability are indeed from earlier times, and are not modern, there are some technologies that make these projects easier to achieve. One of these is the incorporation of solar panels or systems to be used for cooling, heating, and energy use within the house. Therefore, modifications are needed, by the use of developing technologies, which can help achieve the level of sustainability needed for these houses. These houses have valuable features that should continue to be used, but now can be developed further.

The case studies of Karaman Village, with three vernacular houses allows additional conclusions to be made about the advantages and the disadvantages of

sustainable architecture, not only on the island but in general terms as well. The village itself, located within the Turkish Republic of Northern Cyprus, is in a fortunate geographical location. The village is encompassed by the Beş Kardeş Mountains, which partially block the village from continual year-round sunlight. However, most of the cases did take into account the use of the winds coming in from the ocean in order to provide natural cooling through wind circulation. While the mountain blocks some of the sun, additional protection is still needed which can be found in the use of this wind circulation within the household. Along with wind circulation for this in-house cooling system, strategic placements of vegetation also allow for shading to be effective to protect the house materials and inhabitants as well.

While these are the most important advantages of these designs, there are also some disadvantages. The third case incorporated an indoor fireplace and an outdoor oven, allowing for heating and cooking to be done through the design of the house. However, in the other two cases the only heating device built in was the fireplace, which does not allow for simultaneous use, creating an unsustainable mode of living. The fireplace, as mentioned, is also a difficult aspect of the house depending on the individual using it. Mediterranean culture has a very different view of how a fireplace is to be used than the British culture, which are inhabiting the houses currently. This divide between the cultures of the inhabitants and the designer makes the houses not as comfortable for one culture, while perfectly reasonable for the other.

From a modernist viewpoint, another disadvantage of the structures when put altogether, is the space between the buildings, or the pathways. It would appear to the visitor of the village that when they were designed, they had no idea of the

emergence and demand of the use of automobiles. However, the smaller the space between the buildings and the narrower the streets, the more shade available (Oliver 1997). Even though these roadways and pathways are narrow with many tight corners and lack any real parking spaces for cars or trucks, it preserves the cool temperatures afforded by high fence walls and narrow pathways. While this creates a problem for those living in the village and for those wishing to visit the village for touristic purposes, it would be wise to keep these pathways and spaces the same, and add additional parking outside of the village. A potential for economic income may be hindered by the seemingly inconvenience of parking outside of the village, however, the integrity of the village is preserved which suffice is to say is the greater advantage.

Overall, the example of Karaman Village allows an overview of the real vernacular houses of the Turkish Republic of Northern Cyprus. They have been found as useful for studying mostly based on their originality of design. A further study of these structures can lead to a better understanding of building techniques and the incorporation of evolving technology that can better utilize natural resources to make these houses more harmonious with the environment which they are located in.

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