MOUAIAD ALMASRI THE DIFFRENCE BETWEEN TRADISHIONAL HOUSE AND MODERN HOUSE IN DAMASCUS, SYRIA NEU 2021

THE DIFFRENCE BETWEEN TRADISHIONAL HOUSE AND MODERN HOUSE IN DAMASCUS, SYRIA

A THESIS SUBMITTEDTO THE GRADUATE SCHOOL OF APPLIED SCIENCES OF NEAR EAST UNIVERSITY

BY
MOUAIAD ALMASRI

In Partial Fulfilment of the Requirements For the Degree of Master of Science in Architecture

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Approval of Director of School of Graduate Studies

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We certify this thesis is satisfactory for the award of the degree of Master of Science in Architecture

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To my parents…

ABSTRACT

Air temperature (*Ta*) of inter-house is changed from a house to another in a dry and warm area, like Damascus, and during the long hot summer periods, the UHI force is fundamentally influenced by the uncommon direct sun-situated radiation and lead to an expansion in the energy utilization and air contamination as well as outdoor thermal discomfort.

Many researchers have reported that most of the current patterns that existed in Damascus City did not take into consideration the extreme external microclimate conditions when they were designed. That is greatly affected the thermal discomfort in the outdoor spaces. The residential is the largest use in the city of Damascus as well as the highest energy consuming. Accordingly, the problem of this study was determined by: "There is a need to investigate the impact of different residential patterns and Microclimate Improvement Strategies on the local and micro climate condition as well as thermal comfort of Damascus City".

Study focusses on effect of metropolitan examples in Damascus City, which are contrast in their calculation, on the microclimate conditions and human warm solace. In addition, the study tries to evaluate the effects of microclimate improvement strategies on micro-climatic conditions and thermal comfort in these houses.

Within this research three Microclimate Improvement Strategies were used which were:

- Exterior view of the rooms.
- size of rooms.
- material of surface.

Simulation tool Envi-met was used to evaluate and assess the selected study areas and how Microclimate Improvement Strategies effect on them. The period of this study was one year from 01/06/2019 until 31/05/2020 one parameter was measured in this study which was Indoor air temperature (Ta). All measurements are taken automatically by two data loggers (temtop temlog st5) were installed to save temperature at the same time two time a day at (02:00) and (14:00). This study has given a superior comprehension of the job of microclimate improvement strategies on thermal comfort and interior spaces quality of Damascus's residential neighborhoods. This study will present the difference between two

types of houses which from different age and different building material with the goal that it assists with producing the rules of the plan and build houses in hot and dry urban areas.

Keywords: Traditional & modern difference; Thermal comfort; Microclimate Improvement Strategies, architecture.

ÖZET

Bina iç hava sıcaklığı (Ta), Şam gibi kuru ve ılık bir bölgede, uzun sıcak yaz dönemlerinde konuttan konuta değişmektedir., KSE kuvveti temelde yaygın olmayan doğrudan güneşte bulunan radyasyondan etkilenmektedir ayrıca enerji kullanımında genişleme ve hava kirliliğinin yanı sıra dışarıda termal rahatsızlık verebilmektedir.

Pek çok araştırmacı, Şam Şehrindeki mevcut modellerin çoğunun tasarlanırken aşırı dış mikro iklim koşullarını dikkate almadığını belirtmektedir. Bu da dış mekandaki termal rahatsızlığı büyük ölçüde etkilemektedir. Konut, Şam kentindeki en büyük kullanımın yanı sıra en yüksek enerji tüketen yerdir. Buna göre, bu çalışmanın sorunu şu şekilde belirlendi: "Farklı yerleşim düzenlerinin ve Mikroklim İyileştirme Stratejilerinin Şam Şehrinin yerel ve mikro iklim koşulları ve termal konforu üzerindeki etkisinin araştırılmasına ihtiyaç vardır". Şam Şehri'ndeki büyükşehir örneklerinin hesaplamalarında zıt olan mikroklima koşulları ve insanın bireysel sıcaklığı üzerindeki etkisine odaklanmaktadır. Ayrıca çalışma, mikro iklim iyileştirme stratejilerinin mikro iklim koşulları ve bu modellerde termal konfor üzerindeki etkilerini değerlendirmeye çalışmaktadır. Buna göre Araştırma Hipotezi.

Bu çalışmada iki Mikroklima İyileştirme Stratejisi kullanılmıştır:

• mekanların dış görünümü,

• mekan büyüklüğü,

• Yüzey malzemesi,

Simülasyon aracı Envi-met, seçilen çalışma alanlarını ve Mikroklima İyileştirme Stratejilerinin bunları nasıl etkilediğini değerlendirmek ve değerlendirmek için kullanılmıştır Bu çalışmanın periyodu 01/06/2019 ile 31/05/2020 arasında bir yıl olup, bu çalışmada İç hava sıcaklığı (Ta) olan bir parametre ölçülmüştür. Tüm ölçümler, günde iki kez (02:00) ve (14:00) sıcaklıkları aynı anda kaydetmek için iki veri kaydedici (temtop temlog st5) ile otomatik olarak alınmıştır. Bu çalışma, Şam'ın yerleşim bölgelerinin termal konforu ve iç mekan kalitesi üzerine mikroklima iyileştirme stratejileri işinin daha iyi anlaşılmasını sağlamıştır. Bu çalışma, planın kurallarını oluşturmaya ve sıcak ve kuru kentsel alanlarda evler inşa etmeye yardımcı olması amacıyla farklı yaş ve farklı yapı malzemelerine sahip iki tip konut arasındaki farkı ortaya koyacaktır.

Anahtar Kelimeler: *Geleneksel ve modern farklılıklar; Termal rahatlık; Mikroklima İyileştirme Stratejileri**,** mimarlık.*

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CHAPTER 1: INTRODUCTION

Damascus City is an example of cities with an extreme hot dry climate (Syria Agrometeorological Network 2017; World Meteorological Organization 2017; Syria Meteorological Organization 2015). This climate is causing discomfort in urban spaces as well as increase energy demand for cooling and air conditioning in indoor spaces which lead to increase air pollution in outdoor spaces. In addition, the city suffered from an increase in the ambient air temperature (*Ta*) of open areas compared to the near rural areas creating Urban Heat. This phenomenon is crocuses increasing energy consumption and air pollution as well as increasing human thermal discomfort in outdoor spaces.

A number of previous studies have mentioned that the current urban patterns in Damascus City (except traditional compact pattern) have been created based on present day arranging rehearses. These practices were imported from western settings, where cold and moderate atmospheres are pervasive without thought to extraordinary neighborhood atmospheres in hot-bone-dry districts.
This study will look better of thermal comfort indoor spaces between the study houses. In addition, this study will focus on residential neighborhoods as it is the most land use and the most energy consuming use in the city of Damascus (Mayoralty of Syria 2000; Ministry of Electricity 2015).

Accordingly, there is a need for investigation the effect of different residential houses in the city of Damascus on the quality of the urban environment and on the indoor thermal comfort at the room's level, and how microclimate improvement strategies can contribute to improve microclimatic conditions and thermal comfort in these houses.

To investigate the effect of urban patterns in Damascus City, which are differ in their geometry and vegetation covered, on the microclimate conditions and human thermal comfort. In addition, the study tries to evaluate the effects of microclimate improvement strategies on micro-climatic conditions and thermal comfort in these patterns at the scale of denizen level.

The methodology of this study was depended on the study investigated the selected areas effect on microclimate conditions and human thermal comfort and how microclimate improvement strategies can impact on these areas by using simulation**.** Three strategies were used in these studies which were urban geometry, indoor properties and surface material**.**

Research framework

The study consists of three parts as follows:

a) The study begins with the theoretical part, where the scientific background and the general problem of the study were reviewed in order to arrive at the study problem which was determined by: " There is a need to investigate the impact of different residential patterns and Microclimate Improvement Strategies on the local and micro climate condition as well as thermal comfort of Damascus City". On the basis of that, the aim and hypothesis of the study will be placed in (Chapter One). The study then reviews the previous literature that related to its problem in (Chapter Two). This chapter was divided into five sections which were urban microclimate, urban geometry and microclimate improvement strategies.

b) The practical part of the study will contain two stages. The first one in (Chapter Three), a review of Damascus City and its characteristics which included the use of thermal maps of the satellites for comprehensive study on the Land Surface Temperature (LST) variations in Damascus City. It is performed in order to map thermal distribution pattern of the existing urban areas in Damascus City and its relation to the existing urban characteristics,
including form and density. Based on LST reseals, areas for investigation were identified. At the second stage, the numerical modeling which simulates the external microclimate conditions of a number of proposed different scenarios where the methodology, measurement and evaluation tools that adopted in this study will be covered. This part also presented and discussed the results of the microclimate modelling simulation of the different scenarios and then compare the results using Predicted Mean Vote, *PMV* (Chapter Four).

c) Conclusions and recommendations of the study were presented in (Chapter Five).

1.1 General Information

This chapter deals with the theoretical backgrounds of the study and reached to specific study problem, aims and hypothesis. The first section contains introduction of this chapter. Section 1.2 focuses on Global Context of study's background. Secondly, section 1.3 deals with study's problem. Thirdly, section 1.4 deals with study's aims and hypothesis. Fourthly, section 1.5 contained the scope and limitations of this study. Finally, section 1.6 contained the summary of this chapter.

1.2 Research's Background: The Global Context

Since the Industrial Revolution that occurred during the eighteenth and nineteenth centuries, and the onset of Globalization, the world has experienced numerous significant changes and major turning points that were fundamental in shaping the contemporary built environment and which have contributed to creating the environmental and energy challenges that we are facing today.

The rapid world urbanization and vast migration from rural to urban areas that were driven by the economic growth during the last centuries, as well as the changes in development trends, have produced variation in the urban tissue. With that development, the temperatures inside the metropolitan centers are relied upon to be higher than that in their encompassing open country, making metropolitan warmth island (UHI) marvel (Oke 1997).

This can be clearly observed in today's mega cities where the large surface area of urban structure compared to rural, display a high thermal mass in their surrounding environments (Oke 1997).

In 2014, in their Fifth United Nation Report surface-air temperatures have been risen by 0.85°C from 1880 until 2012. The same report expected increase in it by 0.3 or 4.3 from 2012 until 2100. The increase will depend on emissions scenarios, Figure 1.1 The report of the Intergovernmental Panel on Climate Change (IPCC) was concluded that the impact of atmospheric warming will leads to change in the overall water cycle, decreased snow and

ice intensity and rise sea level. The goal is to make rise temperature less than two degree compared to pre-industrial epoch (Inter-governmental Panel on Climate Change 2014).

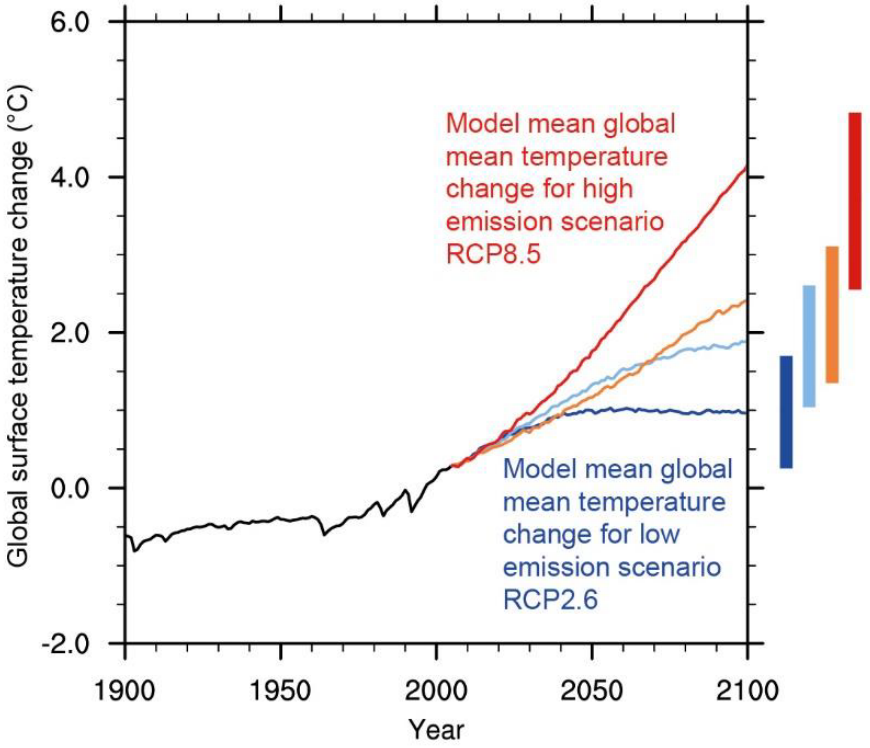

Figure 1.1: The observed and expected changes in average global surface temperature under four emission paths. The color bands on the right show four possible scenarios for temperature rise depending on emissions. (climate.nasa.gov 2020).

In addition to the adverse impact caused by warming on the well-being of inhabitants, these rises in urban air temperature can be associated with increasing energy demands in urban buildings and inside building. The International Energy Agency (IEA) indicates in their energy report that the percentage of the total energy use in non-industrial buildings, i.e. residential, schools, hospitals and offices, ranges between 30% and 50% (IEA 2008). While, the same report states that the potential energy saving of 20 - 60% in residential space heating and air conditioning could be achieved with the adoption of sustainable strategies.

Scientists are zeroing in on the potential methodologies for relieving UHI. Huge numbers of them are keen on exploring at the size of neighbors (Alshammary 2013; O'Malley et al. 2015; Wang & Akbari 2015; Wang etal. 2015).

Most of the dedicated literature to the investigate the urban microclimate has concluded that the alteration in urban microclimate and the elevated air temperature in urban areas, or the so called UHI, are to a large extent formed by a number of man-made causative factors, including (a) the urban forms, (b) the thermal properties of urban surfaces, and (c) the heat released from anthropogenic sources (Oke 1987; Gartland 2008; Rizwan et al. 2008). As there is an increasing belief in the importance of the role of external microclimate conditions in promoting sustainable built environment, the evaluation of the environmental quality and comfort in outdoor spaces has become the central issue in most of the recent scientific conferences that have been dedicated to urban climate studies, e.g. The International Conference on Urban Climate (ICUC), The Inter-governmental Panel on Climate Changes, (IPCC). Indeed, the great attention that is given to the external environmental quality was in fact driven by the concept of promoting a comfortable indoor environment from outdoors, since it is found that the connection between outside and inside living spaces affect, to varying degrees, the way the occupants perceive the indoor environment. A number of studies that focused on evaluating the influence of external environmental conditions on the indoor microclimate have found a strong inverse correlation between the energy consumption in urban buildings and the thermal satisfaction of occupants with outdoor thermal conditions (Thomas 2006; Rijal et al. 2007). In other words, this finding indicates that the greater the satisfaction of people with the external thermal environment the less to become dependent on active cooling systems, more to use outdoor living spaces and, consequently, less energy consumed by cooling or heating loads in indoor spaces.

The notion of comfort through a climate responsive design that ensures both the psychological and physiological well-beings of inhabitants, of which 'thermal comfort' is a key factor, becomes necessary in the design of the contemporary built environment. Thus, the design of the outdoor spaces should be made in response to the local climate conditions in order to increase the use of outdoor spaces and provide outdoor thermal comfort while reducing energy loads in buildings. For this reason, there has been a significant number of

explores that intend to recognize the practical fabricated climate, and which metropolitan structures may most influence maintainability (Jenks and Burgess 2000). The discoveries from such examinations recommend that not one, but rather various metropolitan structures might be economical (Williams 2001). Ordinarily, the discussion about the practical assembled climate, and metropolitan structure specifically, centered around expanding the thickness of built-up area, ensuring a mix of uses, and achieving economic diversity, while meeting the social, cultural, and ethical norms of the communities involved (Kennedy 2007). With respect to that, some believe that a sustainable built environment could be achieved by applying the principles of the bioclimatic design to the design of outdoor spaces (Mills 2006). Thus, in recent years, there have been an increasing number of applied urban climate studies which take into consideration the climate dimension in designing the urban street canyon (Barring 1985; Oke 1988; Pearlmutter et al. 1999; Mat Santamouris, N. Papanikolaou 1999; F. Mayer and Ali Toudert 2006; Krüger et al. 2010). However, the quantitative technique and the relationships of the available theoretical knowledge in the outdoor spaces in hot-dry climate regains, such us Damascus, is still required (Erik Johansson 2006; Elnahas 2011; Robinson 2006; Alznafer 2014) and in Syria, which is characterized by extreme hot-dry climate, the urban design practice are still lacking including standardization and lack of guidelines for those wishing to use the climatological principles in urban design and planning (Alobaydi et al. 2016).

1.3 Statement of the Problem and the Research Justifications

In numerous pieces of the world, metropolitan advancement happens over an extensive stretch, along these lines permitting metropolitan approach producers time to react to any further changes that could actuate antagonistic effects on the climate and the prosperity of occupants. In certain nations, in any case, urbanization is exceptionally quick and happens inside a generally brief timeframe, making a scope of ecological and energy challenges. One such nation is Syria. Driven by the high rate of population growth and vast migration from rural to urban areas, urban density increased rapidly during the last century in Syria. Damascus is currently the most densely populated cities in Damascus where it has about 4.4 million people. This is nearly one quarter of the Syria's population (The National Committee for Population Policies 2011), see Table 1.1

Table 1.1: The approximate population of Syria from 16th century to 2010 (The National Committee for Population Policies 2011).

YEAR	POPULATION	YEAR	POPULATION
16th century	58.000	1913	300.000
17th century	80.000	1976	1.000.000
18th century	90.000	2004	4.000.000
1816	100.000	2007	4.150.268
1878	142.000	2010	4.400.000
1884	160.000		

Damascus has a subtropical desert atmosphere and is probably the sultriest city on the planet. Summer periods are a large portion of the year. From June to August, the normal most extreme temperature is as high as 44°C (111°F) joined by bursting daylight: precipitation has indeed been recorded on less than about six events during this season and has never surpassed 1 millimeter (0.04 in). Indeed, even around evening time temperatures in summer are only from time to time beneath 24°Celsius (75°Fahrenheit). Because the humidity is moderate due to Damascus's distance from the Arab Gulf and Syria, dust storms from the deserts are some days during summer (World Meteorological Organization 2017; Syria Meteorological Organization 2015). The UHI force is essentially affected by the outrageous direct sun-based radiation and prompts open air warm inconvenience during the whole day.

Likewise, it causes an expansion in the energy utilization and air contamination. As a result of this issue, the interest in understanding the UHI impact at microclimate scales around structures, metropolitan gullies, and surfaces has expanded (Erik Johansson 2006; Ratti et al. 2005; Bourbia and Awbi 2004).

On an associated setting, the city has various examples of metropolitan structures; including noteworthy cores that have been created based on present day arranging rehearses. These practices were imported from western settings in which moderate and cold atmospheres are predominant without thought to the outrageous neighborhood atmospheres in hot-parched districts (Alobaydi et al. 2016).

When studying cities that have similar climatic conditions of the city of Damascus, such as the city of Amman in Jordan, it was discovered that UHI wonder exists in the city and is more obvious during the evening time**.** This condition increases the energy demands for cooling during the summer time from the urban dwellers by 7**.**7% compared to that consumed in buildings located in the surrounding rural areas**.** Such an increase in the energy demands for cooling costs the city over US$30 million annum (Al-Saud 2006)**.** Likewise a similar report was presumed that more consideration should be given to limit the seriousness of metropolitan microclimate conditions in the Amman City by proposing different metropolitan plan procedures including (a) keeping up low structure thickness to decrease heat emanations that are normally connected with profoundly populated metropolitan zones, (b) expanding the distance between elevated structures to quicken the cycle of warmth misfortune, , it was found that UHI wonder exists in the city and is more clear during the night time (Mayoralty of Syria 2000)**.** In addition, the residential use consumes the highest ratio of electrical energy which is 44**.**7% of the total energy use while the industrial sector consumes 15% and agricultural 1**.**5% as the Figure 1.2 indicates (Syrian Ministry of Electricity 2015)**.**

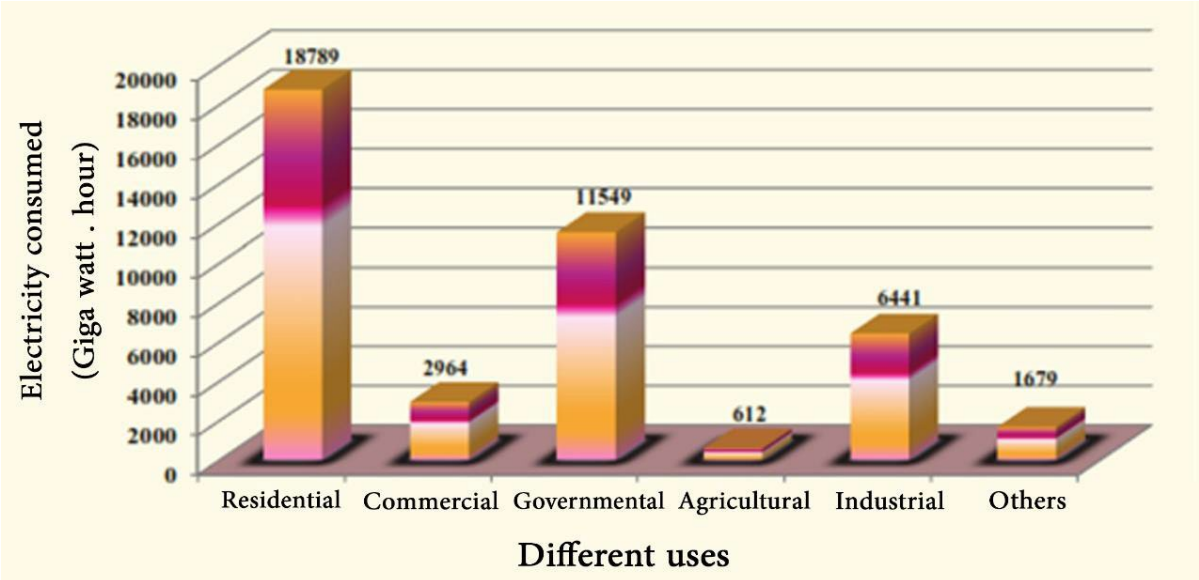

Figure 1.2: Distribution of electricity consumed in different uses in Syria (Ministry of Electricity 2015)**.**

In Damascus city, most of the electrical energy of residential buildings is consumed in air conditioning for the purpose of providing thermal comfort, where about 60% of electricity is consumed (Hussein 2008; Economic and Social Commission for Western Asia 2002).

On the basis of the previous discussion, it appears that the massive demand for energy in Damascus city, which is consumed mainly in cooling loads and particularly in residential buildings, can be decisively linked with the severe hot microclimate conditions in the city during the summer time where the average external air temperature could reach 44°C (Syrian Meteorological Organization 2015). The lack of taking into account the bioclimatic design principles in the adopted urban strategies in Damascus, and the dramatic growth of urbanization and population, have contributed in increased air temperature in the city, which is anticipated to continue to rise in the decades to come (Jentsch et al. 2010).

Accordingly, the research problem was determined by:

"There is a need to investigate the impact of different residential patterns and Microclimate Improvement Strategies on the local and micro climate condition as well as thermal comfort of Damascus City".

1.4 Research's Objective and Hypothesis:

This aims to realization the impact of urban patterns on inside microclimate in Damascus City, which are differ in their geometry and vegetation covered, on the microclimate conditions and human thermal comfort. In addition, the study tries to evaluate the effects of microclimate improvement strategies on micro-climatic conditions and thermal comfort in these patterns at the scale of pedestrian level. The study aims to achieve more suitable outdoor spaces for thermal comfort and increase social interaction opportunities, as well as reducing pollution and energy consumption.

Accordingly, Research Hypothesis:

- Various patterns in the city of Damascus have different influence on the quality of the urban environment and on human thermal comfort. This depends mainly on their geometries and vegetation covered.
- Microclimate Improvement Strategies can contribute to improve micro-climatic conditions and thermal comfort in the patterns.

- The effectiveness of Microclimate Improvement Strategies can depend on the geometry of urban patterns.
-

1.5 Research Scope and limitations

This study focuses on investigate the effect of urban geometry and green area on human thermal comfort and quality of indoor spaces under hot and cold condition Damascus. Also, evaluate the effects of microclimate improvement strategies on two different residential urban forms in Damascus City. Urban form was defined in this study as density and orientation of buildings as well as the height to width aspect ratio (H/W), where H represents the height of elevations or buildings while W represents the width of street or the open space between the buildings. Thermal map of the satellites was used for comprehensive study on the surface temperature variations in Damascus City to assess the effect of existing urban forms on the local microclimate condition. The two different residential forms and the effect of microclimate improvement strategies on them were simulated in different scenarios model. The date of simulation would be from 01/06/2019 until 31/05/2020. The result from different scenarios were compared based on their effect on human thermal comfort and quality of indoor spaces.

1.6 Summary

This chapter presented the theoretical backgrounds of general problems that research has begun with it and reached to research problem, aims and hypothesis. Firstly, Global Context of research's background will be shown in section 1.2. Secondly, research problem was reached in section 1.3. Thirdly, research objective and hypothesis were reached in section 1.4. Fourthly, section 1.5 contained research scope and limitations. Finally, section 1.6 contained the summary of this chapter.

CHAPTER 2: URBAN MICROCLIMATE AND THERMAL COMFORT

2.1 Introduction

This chapter presents the theoretical backgrounds of the subject of urban microclimate and design, and how urban patterns can and microclimate improvement strategies affect the quality of the urban environment of residential neighborhoods, particularly on thermal comfort. This chapter consists of five main sections:

- Urban microclimate: this section presents the classifications of urban microclimate, factors influencing it.
- Urban Heat Island (UHI: this section presents the UHI phenomenon and its type in urban areas as well as its effect on Damascus City.
- Outdoor thermal comfort: this section presents literature review about thermal comfort in outdoor spaces as well as the conditions a parameter influence on it. In addition, it presents thermal comfort measuring tools in outdoor spaces.
- Urban geometry: this section presents a literature review about urban geometry and how it effects on the microclimate condition at pedestrian level of residential neighborhoods and its relation to human thermal comfort.
- Microclimate improvement strategies: this section presents literatures review about the strategies that will be applied in this study including Urban geometry, Vegetation and Material of surfaces.

2.2 Urban Microclimate

2.2.1 Urban climate on different scales

Different horizontal layers of air are formed, when rural area air flows over a city. These layers develop their own climate. There are three scales of climate stratify in urban areas which are meso, local and the micro scales (Oke 2004). The meso-scale represents an entire city and the local scale represents urban neighborhoods, whereas the micro-scale includes streets, squares, buildings, trees, gardens, etc. see Figure 2.1

When we are looking at a vertical section of the city, as shown in Figure 2.1), it can be seen that the micro-scale locates within the roughness sub layer. After this height, the effects of

the microclimate coming from the buildings and objects below are eliminated. The Metropolitan shelter layer (UCL) is required the region between the ground and the housetops and this layer speak to the lower cut of the harshness sub-layer. UCL layer contains structures and the spaces among them, for example, roads, gardens, and squares. In the UCL layer, the variety of microclimate is incredibly inside short distances (Oke 1988).

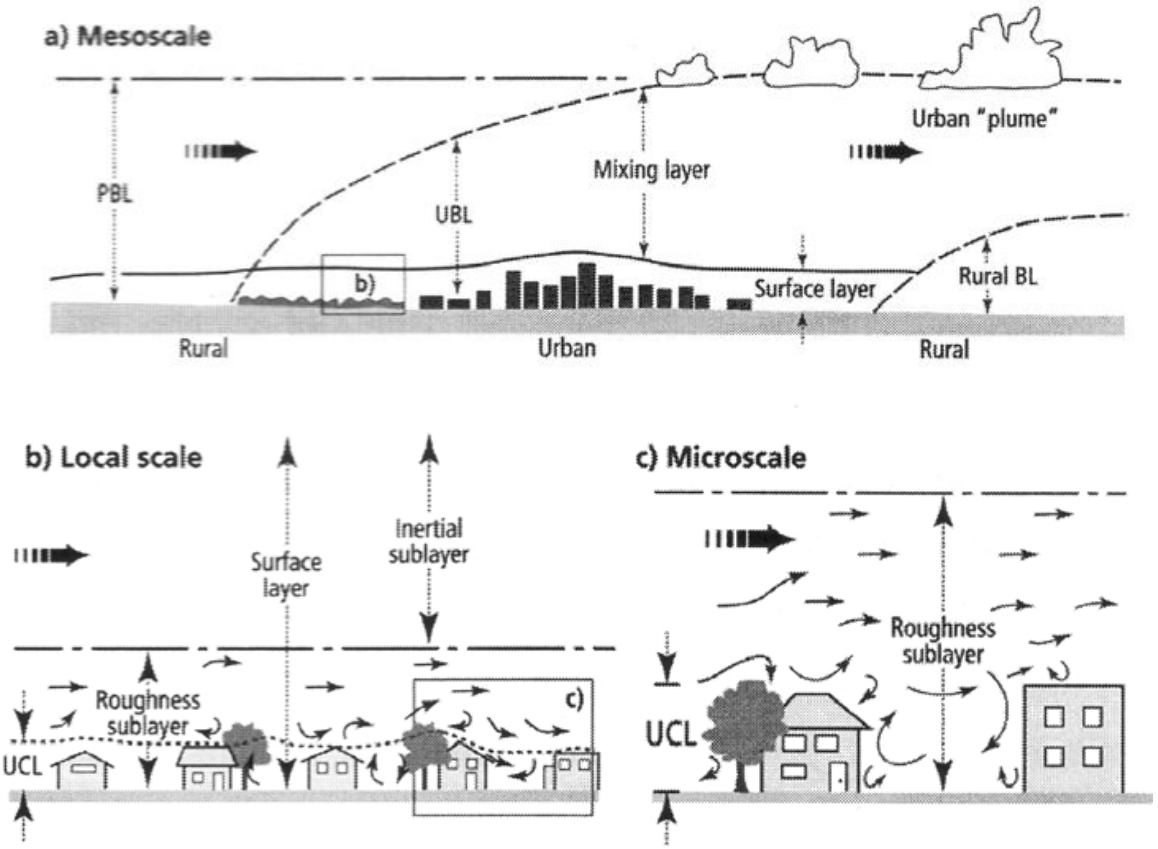

Figure 2.1: Urban areas climatic scales which are meso, local and microscale (Oke 2004; Eirk Johansson 2006).

So, the turbulence processes inside UCL could be increased by complex urban geometry and leads to a mosaic of microclimate conditions. These turbulences are usually taking place in a quite limited area and produces radical changes in atmospheric properties and the nature of the surface in an urban location (Oke 2002). Among the above urban atmosphere classifications (Figure 2.1), the microclimate condition within the UCL has received the largest amount of research efforts since it is found to have a great impact on the well-being of inhabitants, e.g. (Oke 1988; Shen & Leclerc 1997; Pearlmutter et al. 2006; Marciotto et al. 2010; Pichierri et al.2012).

2.2.2 Factors impact on the urban climate

1) Anthropogenic heat

Warmth delivered to the climate because of human exercises. It is including modern plants, space warming and cooling, human digestion, and vehicle debilitates. Be that as it may, this warmth is low contrasted with the radiation energy transition in metropolitan zones (Al-Asir et al. ,2009).

2) Air pollution

Air pollution from mechanical exercises, engine vehicles, and residue particles can decrease approaching sunlight-based radiation and causing an expansion in its diffuse constituent. Worldwide sun-based radiation decrease may contrast somewhere in the range of 10% and 20%. Along these lines, contaminated air is diminished ground warmed on the off chance that it is contrasting with clear air. Oppositely, the net active long-wave radiation (ground cooling), is likewise less for a contaminated contrast with clear climate. Therefore, the net impacts of air contamination on the temperature are little (Oke 1987; Arnfield 2003).

3) Vegetation and green areas

With the growth of cities, the urban environment is increasing where buildings and built-up surfaces replace green and soil surfaces. These new surfaces are often waterproof surfaces. Thus, the capacity of the ground to deliver energy through dissipation and happening was diminished essentially. In any case, the temperature of the green regions inside the city can be near the provincial regions and are typically cooler than developed zones, particularly around evening time. During the daytime, especially in hot-arid areas, trees can play an important role in providing shade. Shading can contribute to reduce the solar radiation reaching the surfaces and lead to cooler surfaces, thus decreasing air temperature (Shooshtarian 2014).

2.2.3 Impact of building on open climate

1) Sun radiation on open area

In urban area, the total solar radiation take in walls depends mainly on reflectivity of the urban surfaces and on the canyon geometry. Sun azimuth and altitude angles, as well as the orientation of a surface, determine the direct-beam irradiation on the surface. At street level,

the total of diffuse irradiation received to be determined by the sky view factor (SVF), which represent the sky portion that seen from the street, as shown in Figure 2.2 Decreasing sky view factor led to a decrease in the diffuse radiation (Alznafer 2014).

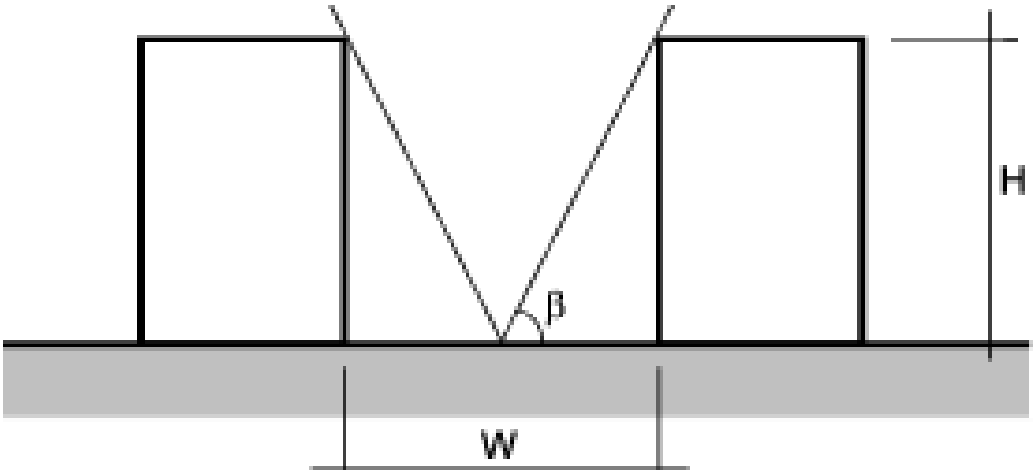

Figure 2.2: The relationship of the building height with the sun narrator.

The reflectivity of the provincial surfaces is by and large higher than in general reflectivity of metropolitan texture. The purpose behind this is uneven metropolitan surface lean towards hinder sunlight-based radiation. Limited quantity reflected back to the air because of various reflections inside the ravines. Approaching sun based (short-wave) radiation during the day

2) Air temperature

The air temperatures of courtyard are required to be warmer than that in their provincial environmental factors, making metropolitan warmth island (UHI) marvel. This marvel is clearer at evening periods. In daytime periods the contrast among metropolitan and provincial zones is little, see Figure 2.3 In numerous urban areas, the field considers have indicated that the volume of metropolitan warmth islands at evening time increments with expanding H/W proportion (decreased SVF) of road ravines (Oke 1997; Erik Johansson 2006; Shooshtarian 2014; Alshammary 2013). During daytime, the metropolitan ravine is a decent safeguard of sun-oriented energy in light of the generally high warm limit of metropolitan surface materials. Texture put away this energy and isn't delivered it until after

dusk. The biggest distinction of temperatures among metropolitan and rustic regions were happens on cloudless and quiet evenings (Al-Asir et al. 2009).

During daytime, cool and warmth islands can be found. It's regularly accepted that daytime heat islands brought about by anthropogenic warmth, while cool islands are ascribed to the shade cast by structures or through components, for example, trees. Anthropogenic warmth has frequently little consequences for air temperature and occasional a significant reason for metropolitan warming. Air contamination lessens both net active long-wave radiation and net approaching short-wave radiation, so the absolute net impact on the radiation spending plan is little (Oke 1987; Arnfield 2003), see Figure 2.3.

Air temperature can essentially influence by green zones and vegetation. Park and enormous green regions recorded lower air temperature than developed territories. The basic temperature distinction is from 1 to 2°C yet it can arrive at 5°C. Flooded green regions in hot and dry districts might be significantly cooler than developed territories because of the supposed desert spring impact (Oke 1987). The air can be cooler if there is a large abundance of water, and the waste from vegetation and wet soil becomes so solid that energy is taken from it. Notwithstanding, if the water system stops, the impact will in the long run vanish. It should be noticed here that the impact of vanishing on air temperature for single trees and little groups of trees is little (Al-Asir et al. 2009). During the daytime, cool and heat islands can be found.

Air temperature can significantly affect by green areas and vegetation. Park and large green areas recorded lower air temperature than built-up areas. The common temperature difference is from 1 to 2°C but it can reach 5°C. Inundated green territories in hot and dry districts might be significantly cooler than developed zones because of the purported desert garden impact (Oke 1987). The air can be cooler if there is an abundance of water, and it fades from the vegetation and it turns out that the moist soil is so solid that energy is taken from it. In any case, if the water system stops, the impact will in the end vanish. It should be noticed here that the impact of vanishing on air temperature for single trees and little bunches of trees is minuscule (Al-Asir et al. 2009).

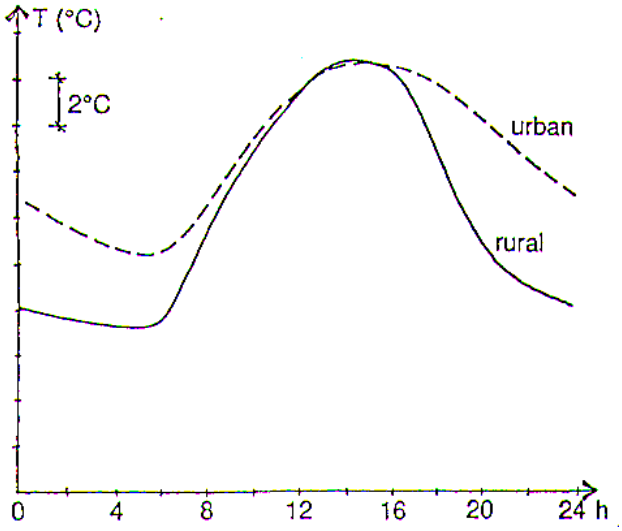

Figure 2.3: Air temperature temporal variations in an open area (Oke 1987).

3) Humidity

Humidity differences between rural and urban areas in general are small. In the cities, the highest humidity values are recorded during the nighttime period while the lowest humidity values are recorded during the daytime period (Oke 1987).

2.3 Urban Heat Island

Air temperature near the ground in urban area, especially in big cities, is higher compared to rural or non-urbanized areas for that named Urban Heat Island (UHI) phenomenon has been widely investigated e.g. (Oke 1973; Yamashita et al. 1986; Cenedese & Monti 2003; Peng et al. 2012). The interest in studying urban heat island phenomenon is increasing and this was driven by the fact that this phenomenon has been found adverse impacts on the well-being of inhabitants in the built environments. It is reducing the habitability of suburban and urban space, including human discomfort in outdoor urban spaces, increased air pollution, health problems, higher energy consumption in urban dwellings, and even an increase in mortality rates (Rosenfeld et al. 1998; Akbari & Konopacki 2005).

Urban heat island (UHI) phenomenon is generally defined as: raised air temperatures dome which located above the city or urban area. It is produced by the absorbed heat by urban structures and buildings (Park 2007). The creation of this phenomenon is exceedingly connected with the extent of mass and thermal exchanges between the external surfaces of the urban constituents and the surrounding environment. In addition, the geographical

locations of the urban areas impact on the size of the UHI**.** Number of causative variables can make UHI age some of them can be controlled including fake city structures and air contamination brought about by anthropogenic exercises in the city, while the others can't be controlled, for example, from common parts including sun, wind, and overcast cover (Rizwan et al**.** 2008), see Figure 2.5

In the constructed climate, it has been discovered four primary controllable components that decide the force and the size of the UHI which are**:** (a) the metropolitan calculations effects on the energy equilibrium of metropolitan features including the sky see elements of metropolitan territories, angle proportion of metropolitan ravine, road direction regarding sun, (b) the effects of metropolitan materials warm properties on warmth stockpiling including; emissivity for long-wave radiation and reflectivity for sun based radiation (albedo), (c) the green regions and vegetation inside urban communities whether as discrete components like trees or in assembled structure like stops and gardens, and (d) the measure of warmth and air contamination delivered from anthropogenic warmth sources and exercises, for example, from power generators, metropolitan structures and transportations (Oke 1987; Dimoudi and Nikolopoulou 2003; Taha et al**.** 1997; Sailor 2011; Pereira et al**.** 1999; Epa 2008)**.** Surely, it has been discovered that the recently referenced controllable variables are impact on other potential metropolitan factors that may expand UHI force**.** These elements including vanishing surfaces decrease in view of the expansion in the waterproof surfaces in metropolitan segments, decrease in tempestuous exchange brought about by the metropolitan calculations, and metropolitan nursery because of the anthropogenic exercises (Oke 2002)**.**

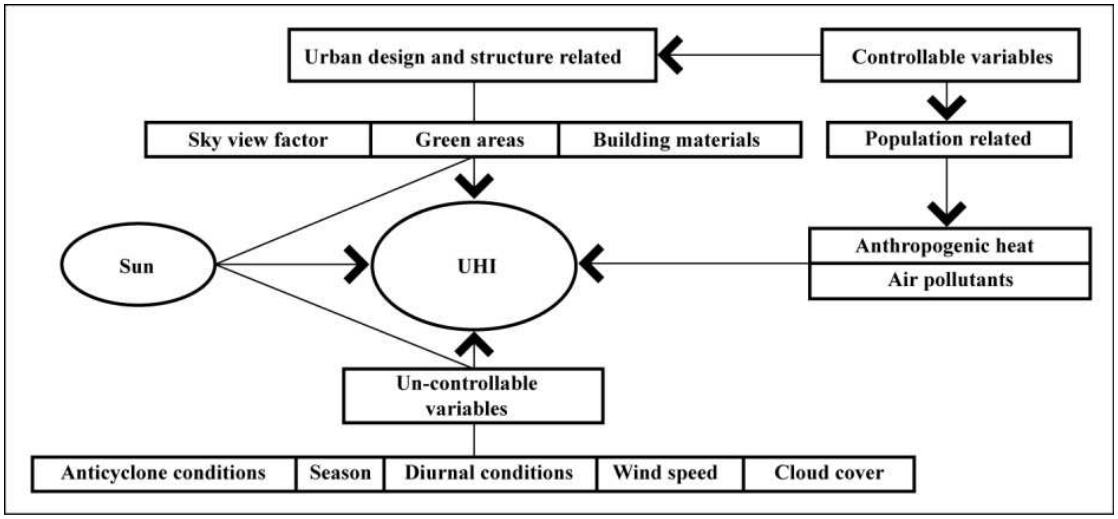

Figure 2.4: Urban Heat Island (UHI) generation, source**:**) Rizwan et al**.,**2008)**.**

Geometries characteristics, urban materials and the anthropogenic activities that happen inside the city are closely linked with the formation of the UHI**.** Higher air temperature is usually observed in areas which have low sky view factors and high building density (Yamashita et al**.** 1986) and highly populated (Oke 1973), such as business districts and city centers**.** In contrast, lower air temperatures – the so-called Urban Cool Islands UCI (Rizwan et al**.** 2008) - are usually observed over and in the vicinity of green parks**.** so, urban area, specifically mega cities, the warmth island profile over it can contain a few 'Levels' as indicated by exercises of individual metropolitan area and the basic metropolitan attributes, where a precarious temperature dropdown 'Bluff' is usually seen at metropolitan limits as appeared in Figure 2.4

Illustration of the normal diurnal variety of country and metropolitan air temperature (top) and the nighttime force of UHI can be seen in Figure 2.4 These phenomena become more obvious and reaches its maximum at night under clear sky with low wind speed in the urban location (Emmanuel & Fernando2007; Alznafer 2014)**.**

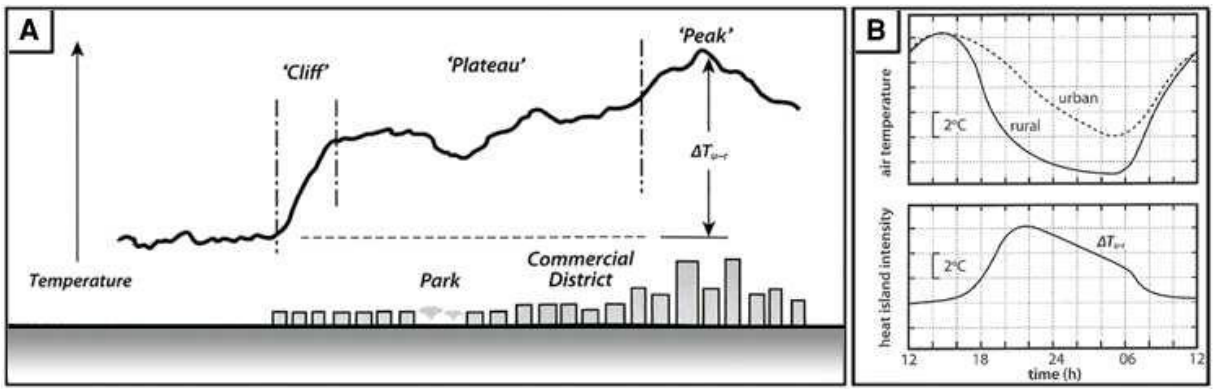

Figure 2.5: Urban heat islands schematic profile, A) section of a city that show UHI difference, B) UHI difference between urban and rural areas, source**:** (Erell et al**.**,2011)**.**

2.4 Outdoor Thermal Comfort

Warm solace has a few definitions**.** (ASHRAE 2004) offers noticeable quality to its mental and abstract measurement by portraying solace as a state of psyche, which communicates fulfillment with the warm climate**.** (Fanger 1970) has more sound meaning of warm solace, where he relates solace to energy gains and misfortunes**.**

He depicts the condition of solace as fulfilled when the warmth streams from and to the human body are in balance**.** This is accomplished when the body information, which are sweat rate and additionally center temperature and skin temperature, are inside a scope of solace**.** The thermo-physiological guidelines of an individual are halfway represented this information**.**

Contrasted with the inward climate, the outside climate conditions show huge transient and spatial contrasts and the body warm equilibrium is only here and there in a steady state**.** It is perceived that physical and mental execution are separate when the human body is exceptionally warm**.** Furthermore, at high temperatures, heat pressure may cause heat-related sickness (Alznafer 2014). Figure 2.7 shows the components influencing warm solace in outside spaces**.**

What's more, outside action level will in general differ more than inside, regularly from quick strolling to sitting. Occasional atmosphere varieties additionally profoundly decide individuals dress in open air spaces

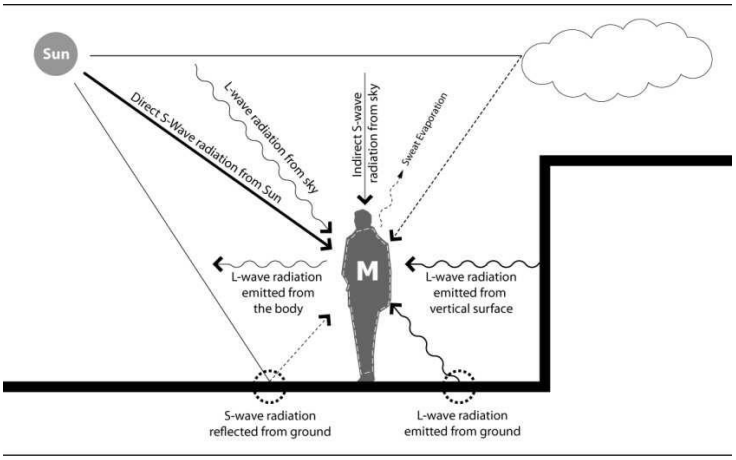

Figure 2.6: Factors affecting the energy balance of human being in outdoor spaces. (Havenith 1999; Alznafer 2014).

In outside, the climate is considerably more unique and complex so the mental elements are probably going to be more prominent. Number of studies have indicated that the outside spaces have more extensive safe place than inside (Nikolopoulou and Steemers 2003). One of the explanations for that is the notion of individuals are diverse in outside in light of the fact that the warm climate shifts substantially more in reality and it wild.

2.4.1 Type of thermal comfort

Human warm solace surveying is certainly not a new issue. Individuals' prosperity was constantly given consideration and they searched for techniques to measure their vibe of warmth or cold (ASHRAE 2004). A component of one single factor can't portrayed the warm climate and its effect on a human body (for example T) on the grounds that the body doesn't have singular sensors for each factor and thus feels the warm climate overall. a similar thought applies to the warm record which is joins a few factors, for example, Ta, RH, v and radiation transitions into a solitary variable which summarizes their synchronous effects on the tangible and physiological body reactions (Givoni 1976, ASHRAE 2004).

There are enormous number of warm lists exist and the greater part of them share numerous regular highlights. They can be sorted into two kinds: sound and observational. These lists

are all around archived (Al-Asir et al. 2009; Alznafer 2014). Former group indices, which developed earlier, are depends on simplified relationships or measurements with subjects which do not necessarily follow theory (ASHRAE 2004). These are often limited to the assessment of the combined effect of air speed, air humidity and air temperature on people in sedentary activity.

2.5 Urban geometry effect on microclimate conditions and outdoor thermal comfort

It is by and large concurred that metropolitan calculation assumes a significant part in deciding the natural condition inside the lower layer of metropolitan air – the purported UCL (Oke 1988; Arnfield 2003). Consequently, any modification in the state of this lower layer of metropolitan air brought about by the changing in metropolitan math can have direct effects on the human prosperity and solace, regardless of whether inside or outside. Along these lines, impressive measure of exploration exertion has been devoted to evaluate the ecological conduct of metropolitan calculations over various metropolitan settings for example (Erik Johansson 2006; Targhi and Van Dessel 2015; Perini and Magliocco 2014). By and by, a delegate metropolitan calculation is very difficult to discover if all adjusting boundaries must be considered including, model structure, metropolitan level of conservativeness, road viewpoint proportion, and direction.

Besides, the interest in evaluating human warm solace in metropolitan spaces has gotten a lot of consideration in the greater part of the new metropolitan atmosphere examines. A portion of these were completed to evaluate, by methods for survey, the effect of metropolitan microclimate condition and micrometeorological factors on the human warm fulfillment in outside spaces for example (Tseliou et al. 2010; Alznafer 2014). Other outside solace examines, notwithstanding, were more toward exploring the concealing and mathematical impacts of different metropolitan parts, for example, metropolitan road gullies and trees, on the indoor degree conditions at person on foot level and therefore on the human warm solace in open air.

Also, a few investigations were completed utilizing a blend of field perception and warm demonstrating ways to deal with foresee the mathematical effect of different road gorge on the microclimate conditions at person on foot level and subsequently on the human warm

solace in open air spaces for example (Toudert 2005; Alznafer 2014). Given that the current examination considers the human warm solace in hot atmosphere area of Damascus City, the accompanying material will introduce contemplates that committed to the examination of the mathematical effect of metropolitan segments on the human warm solace in hot parched atmosphere districts.

Bourbia and Awbi (Bourbia and Awbi 2004) discussed the structure gathering and hiding in a metropolitan ravine in the dry and hot environment of al Oued Algeria. It is an open climate which was finished by an assessment examination of air and object temperatures similarly as a hiding multiplication concentrate by using the Shadow pack code variation. Concerning propagation study, the makers derived that different significant associations can be made between the computation and the microclimate of metropolitan street gorges and these associations are helpful for specialists making metropolitan arrangement rules for the street estimations and bearings. Regardless, the assessment just investigated the air temperature and surface temperature and no other climatic limits were assessed, for instance, sun fueled radiation, wind speed, and relative tenacity. In this manner, warm comfort was barred from the assessment.

Johansson (Erik Johansson 2006) contemplated the impact of metropolitan math on outside warm solace in the dry and hot of atmosphere city Fez in Morocco. The investigation depended on estimations throughout the late spring and winter. The investigation looked at a profound gully and shallow road gulch with respect to microclimate and warm solace by methods for disagreeable estimations over 1.5 years during the sweltering summer and cool winter seasons, in which the mean limit of Ta under such condition could arrive at 34°C. The meteorological information got from both examined ravines were contrasted with the comparing information acquired from country climate station. The examination contended that in the mid years, the profound ravine is genuinely agreeable while the shallow is incredibly awkward. Nonetheless, the Ta inside the profound gulch gets hotter than the relating one in shallow gorge around evening time, inferable from productive radiative cooling in the shallow gully in view of a lot higher SVF.

As indicated by the creator (Johansson), there is an enormous contrast in the PET qualities estimated inside the examined gullies and this can be fundamentally clarified by the

consolidated impact of air temperatures which were primarily influenced by Sun radiometer arrives at the road level. Subsequently, the worldly development of PET qualities inside the profound gully was truly steady somewhere in the range of 23°C and 28°C PET, though the PET qualities inside the shallow gully were amazingly high surpassing 40°C, inferable from the joined impact of high Ta and high Tmrt somewhere in the range of 11:00 and 17:00, in which the shallow gully during such time of times is completely presented to sunlight-based radiations. Then again. The investigation presumed that for the dry and hot atmosphere, reduced metropolitan plan with profound gulches is best however for the colder time of year in Fez, the metropolitan plan ought to remember some more extensive roads or open spaces for request to give sun-based admittance. Be that as it may, the investigation was just founded on estimations and did exclude a poll learn about the abstract warm insights. Additionally, the Physiological Equivalent Temperature record (PET) was the solitary determined file to break down the outcomes and no other files have been researched to test the legitimacy of these outcomes.

From the previously mentioned examines, the connection between gullies calculations, evaluated by viewpoint proportions specifically, and the microclimate conditions can see unmistakably at road level. To be sure, all investigations have recognized the incredible impact of sun-based radiation in sweltering dry atmosphere areas on the warm climate inside road gorge and, therefore, on solace. Accordingly, expanding the measures of concealing through the plan of road gorge, including perspective proportions and ravine's exhibitions, alongside other metropolitan concealing components, for example, trees and fake concealing gadgets, must be considered as a critical system for advancing solace in open air spaces under sweltering summer condition.

2.6 Microclimate Improvement Procedures

With the negative effects of the metropolitan warmth island (UHI) effect, numerous analysts are zeroing in on the potential procedures for development microclimate at the size of neighbors (Alshammary 2013; O'Malley and Akbari 2015; Makropoulou 2017). There are a few improvement systems, for example, metropolitan calculation, vegetation, utilization of

water and materials of surface (O'Malley et al. 2015; Santamouris 2013; Rosenfeld et al. 1998; Mobaraki 2012).

The objective of this methodologies is limit the natural effect, to update the metropolitan scene and the occupants' personal satisfaction (Makropoulou 2017). There are a few improvement methodologies however the best and normal techniques just as reasonable with the scene of private neighborhoods in the city of Damascus were metropolitan calculation, vegetation and materials of surface.

2.6.1 Metropolitan calculation methodology

Metropolitan calculation is described by Sky View Factor (SVF), tallness to width proportion (H/W) of metropolitan ravines, building thickness and direction of roads. Metropolitan calculation technique means changing in one or these boundaries like change in tallness to width proportion (H/W) or building thickness (Mobaraki 2012; Alznafer 2014; Erik Johansson 2006; Perini and Magliocco 2014).

This technique has been utilized in many related setting studies, for example, (Perini and Magliocco 2014; Alznafer 2014; Ali-Toudert, F. what's more, Mayer 2006) and numerous scientists have highlighted the significance of utilization this methodology to giving shadows in hot-dry urban areas by various ways, for example, expanding the proportion of (H/W) and thickness of building (Alznafer 2014; Ali-Toudert, F. also, Mayer 2006). Notwithstanding, the utilization of this system relies upon a few elements, for example, the sort of example utilized and area of the region in the city. More Detailed can be found in Section 2.5.

2.6.2 Vegetation technique

The vegetation is a changing component of the nearby atmosphere. The utilization of the green as a technique to relieve the metropolitan warmth island (UHI) and improve the microclimate has been generally accentuated for example (Epa 2008; Mobaraki 2012; O'Malley et al. 2015). A quantitative assessment of the climatic part of the metropolitan vegetation is needed since this is likewise made arrangements for different undertakings, for example caustics, decrease of contamination, style, and social issues, and so forth.

Vegetation can add to stop cool island (PCI) impact and subsequently can diminish air temperature up to 3 to 4°C in summer (Targhi and Van Dessel 2015; Dimoudi and

Nikolopoulou 2003). Vegetation makes this warmth decrease conceivable through four instruments: 1-with a higher albedo contrasted and development materials like cement or black-top, 2-through vanishing and happening (the amount of these two cycles together called evapotranspiration), with lower explicit warmth limit greeneries ingest less warmth, and 4-with concealing, leaves and branches diminish the measure of sunlight based radiation that arrives at the metropolitan surfaces underneath covering layer (Oke 1987; Dimoudi and Nikolopoulou 2003; Taha et al. 1997; Sailor 2011; Pereira et al. 1999; Epa 2008).

The impacts of vegetation on microclimate and solace can be assessed by utilizing ecological displaying. This was considered with the intend to comprehend a large number of the current ecological issues; it permits to evaluate the impacts because of zone changes (land inclusion) on meteorological boundary and on personal satisfaction outcomes, through microclimate models as Envi-met (Perini and Magliocco 2014; O'Malley et al. 2015).

2.6.3 Materials of surface technique

Cool asphalts are additionally pertinent as compelling warmth decrease procedures. Advancements in asphalt and rooftop materials bring about less warmth aggregation and therefore lower surface temperatures in contrast with regular materials. Cool materials' exhibition is related with properties, for example, sun-based reflectance, heat limit, penetrability, surface unpleasantness, heat move rates, and warm settlement. For instance, specialists in Lawrence Berkeley National Laboratory have assessed that each 10% expansion in albedo of surfaces could diminish surface temperatures up to 4°C (Pomerantz et al. 2000).

In subsequently methodology, a few procedures could be embraced to improve the nearby microclimate. Some of them can be handily applied and could likewise be savvy. The most widely recognized strategies include:

The albedo increments of rooftops and clearing surfaces. The term albedo is characterized as the hemispherical and frequency coordinated reflectance of a material or surface (Bretz et al. 1998; Taha 1997). A few examinations demonstrated that the albedo increment on a city scale adds to bringing metropolitan temperatures and, in this manner, down to diminishing the structures' cooling interest and the energy utilization individually (Santamouris 2013; Gaitani et al. 2014).

The utilization of cool materials at the clearing surfaces, i.e., materials with high sun-based reflectance and high infrared settlement esteems (Bretz et al. 1998). Subsequently, cool materials assimilate less sun-oriented radiation and simultaneously discharge the retained warmth all the more without any problem. As an outcome, these materials create lower surface temperatures, decreasing warmth convection from the surfaces to the surrounding air, thus prompting lower air temperatures and a cooler climate (Santamouris 2013). Various examinations have zeroed in on the positive impact of cool materials on surface and encompassing temperatures (Fanchiotti et al. 2012; Synnefa et al. 2008; Zhou and Shepherd 2010; Santamaria 2014; Zinzi et al. 2012; Doulos et al. 2004). like, (Synnefa et al. 2008) was a most extreme sunlight-based reflectance distinction of 22 between a norm and a cool material, there was a surface temperature contrast of 10.2°C throughout the mid-year. A few analysts considered cool materials' application on metropolitan open spaces and their constructive outcome on the human warm. In every one of those refered to considers, the commitment of cool materials to encompassing temperature decrease was affirmed. Santamaria et al. (Santamaria et al. 2012) recognized a decrease of the pinnacle surrounding temperature down to 1.9°C during an ordinary summer day. Likewise, Gaitani et al. (Gaitani et al. 2011) likewise assessed an encompassing temperature decrease down to 1.6°C because of the utilization of cool materials.

Nonetheless, a few specialists have said that expanding the estimation of albedo materials can prompt negative impacts, as the surrounding air temperatures may ascend during daytime periods, the explanation behinds that might be to build the measure of sun-oriented radiation reflected from surfaces of structures and roads, such us (O'Malley et al. 2015). Malley proposed that it very well might be a result of the expanded light reflection from building veneer surfaces with a high albedo rating onto solid zones among structures and bringing temperatures past those up in other reproduction information. Also, another possible purpose behind this is the structure design which is with the end goal that takes into consideration different impressions of light and warmth all through metropolitan ravine.

2.6.4 Effect of microclimate improvement strategies on microclimate conditions and thermal comfort

These strategies have been widely used in recent studies in temperate and cold climates, but such studies are still needed in dry hot areas such as Damascus City**.** In addition, the effectiveness and efficiency of these strategies vary according to the different urban configurations and the possibilities available for their use as well as microclimate conditions**.** The difference in effect may be caused by the shadows of adjacent buildings or the change in wind speed in different urban formations or the amount of vegetation used**.** The following examples will review a number of studies that have used these strategies**,** (Magliocco and Perini,2014).

Figure 2.7: Pictures of the three chose regions (from left to right**:** Detached house zone, Middle ascent region, and High-ascent zone**.** (Magliocco and Perini,2014).

Considered impacts of vegetation, metropolitan thickness, building stature, and environmental conditions on nearby temperatures and warm solace in three urban communities of Italy**.** The specialists received one of the basic examples in Italy and in what capacity can expand vegetation cover, tallness and thickness of structures impact on the

states of the miniature atmosphere and outside warm solace (by utilizing the Predicted Mean Vote, PMV). The examination was led by methods for a three-dimensional microclimate model, ENVI-met 3.1, which conjectures the microclimatic changes inside metropolitan conditions. The impacts of building thickness (% of constructed region) and ravine impact (building tallness) on expected temperature mean brilliant temperature, and Predicted Mean Vote conveyance are evaluated. The impact of a few sorts of green regions (vegetation on the ground and on rooftops) on temperature alleviation and on solace enhancements is researched for various air conditions and scopes in a Mediterranean atmosphere.

The aftereffects of the examination show that thickness and stature of structures in a city zone impact likely temperature, mean brilliant temperature, and Predicted Mean Vote dissemination; for a large portion of the cases inspected higher thickness causes higher temperatures and with taller structures vegetation has higher cooling impacts. Considering the cooling impact of vegetation, a distinction can be seen relying upon the measure of green zones and vegetation type. The aftereffects of this investigation show likewise that vegetation is more successful with higher temperatures and lower relative stickiness esteems in alleviating expected temperatures, mean brilliant temperatures, and PMV and in diminishing the cooling load interest.

This research also found that using cold asphalt methodologies may provide some advantages during scorching summers, for example, improving warm human consolation. Whatever the case, it may also cause some negative effects during the cold winter periods. For some areas, for example, Sacramento, California, where it is hot in the summer and cold in the winter, some cold asphalt methodologies (for example, fade or mask asphalt) used to improve warm conditions in late spring may make winters colder to Somewhat. However, some cold asphalt measures, for example, smart asphalt can improve warm human consolation in viral winters while reducing warm human consolation in hot summer periods. Accordingly, the methodology, for example, improved fading in summer only and hiding of trees in summer only, which can help reduce scorching temperatures in the middle of the year but will not reduce cooler year temperatures, are attractive. However, this test has just been based on a computerized PET list that doesn't consider clothing and exercise a factor. Since PET is devoid of clothing and movement, it is only an express percentage of warm

stress or consolation, yet it is a device for surveying warm climates (Höppe 1999). Likewise, the model created in this paper needs full approval with field analyzes and estimated information.

2.7 Conclusion

This part introduced a review on the accessible information because of metropolitan math, green regions and microclimate improvement methodologies on nature of the climate and warm solace in outside spaces, with an exceptional consideration given to those did in hot and parched atmosphere districts. Investigations of groupings of metropolitan microclimate and Urban Heat Island (UHI) marvel were likewise featured.

This investigation demonstrated that the connection between ravines calculations, evaluated by angle proportions specifically, and the microclimate conditions can be seen plainly at road level. In reality, all examinations have recognized the incredible impact of sun based radiation in blistering dry atmosphere districts on the warm climate inside road ravines and, thusly, on solace. In this manner, expanding the measures of concealing through the plan of road ravines, including perspective proportions and gully's displays, alongside other metropolitan concealing components, for example, trees and fake concealing gadgets, must be considered as key methodologies for advancing solace in open air spaces under sweltering summer condition. Furthermore, past investigations indicated that green territory and vegetation land canvassed in Damascus city can diminish the land surface temperature (LST) while uncovered (soil) lands record most elevated LST values at daytime period. Nonetheless, there is as yet a need to examine the connections between the LST of metropolitan zones with metropolitan calculations, land covered.

CHAPTER3: DAMASCUS CITY CHARACTERISTIC AND EXPERIMENTAL WORK.

3.1. Introduction

This chapter covers the review of specific study areas and their characteristics**.** In addition to the study variables, measurement and evaluation tools that adopted**.** At the beginning of this chapter, a general view of the geographical location, physical environment, and climate condition in Damascus City, as well as the urban characteristic and population density is presented as a basis for understanding the need in this thesis (section 3**.**1)**.** Following that, an empirical study which is including Land Surface Temperature study (LST) to identify the temperature distribution patterns of urban surfaces in Damascus's metropolitan and its relation to the existing urban form and density (section 3**.**2) which is going to be acquired from the LST study, aims to answer one of the research questions that related to the influence of the existing urban form on the microclimate condition in Damascus City which stated previously in the research questions (see chapter one)**.**

Based on the results and conclusions of (section 3**.**2), a study site location was selected which has contain different LST values and different residential units' patterns to investigation in the microclimate conditions and human thermal comfort of these patterns at the scale of pedestrian and how microclimate improvement strategies effect on the human thermal comfort and quality of outdoor spaces under summer condition in Damascus City (section 3**.**3)**.**

(Section 3**.**4) contains the methodology of investigation including a review of study variables and parameters, in addition to the methods used, measuring and evaluation tools to achieve the objectives of research and answer its questions**.**

3.2 Damascus City, Syria

Damascus is the biggest city and the capital of Republic of Syria**.** The city is arranged in the southwest of Syria, 80 kilometers from the Mediterranean Sea at a level of 680 meters above sea level**.** Residents drink from the Barada River**.**, Which starts from mountain streams that

are looked after on a relaxing holiday**.** Surrounding Damascus is Ghouta, an irrigated agricultural land where many vegetables, oats and natural materials have been developed since outdated events**.** Aides to Roman Syria show that the stream of Barada has been exhausted in a pond the size of a pond east of Damascus**.** Today it is called Zarzar Lake, given its absence in long periods of a true dry season**.**

Figure 3.1: Images for Damascus City, (Ahmad Mansour photographer**,**2019)

Figure 3.2: Syria's map (left) and Damascus's map (right)**.** (nationsonline.org,2005)

3.2.1. urban climate of Damascus

Urban microclimate and outdoor thermal comfort are generally given little importance in the urban design and planning processes (Eliasson 2000; Johansson 2006b). Moreover, few studies have dealt with the relationship between urban planning regulations and the local microclimate. Several studies, however, indicate that the existing planning regulations in hot dry climates are not adapted to the climate. In the city of Fez, Johansson (2006b) found that the intention of the current regulations is to guarantee daylight for buildings. This may be relevant for the winter period when solar elevations are low and passive heating of buildings is desired. However, during the long, warm summer, when there is a need for solar protection, this results in a very poor microclimate at street level. The worst conditions are found in areas designated for low-rise houses where plots are very large and plot coverage low. The current urban design in the modern parts of Fez stands in stark contrast to the old city where narrow alleyways and projected upper floors create adequate shade at pedestrian level.

3.2.2. The climate of Damascus

Damascus has hot dry cities in the world and it has a subtropical desert climate**.** Hot dry periods are most of the year and from April to September, the normal greatest temperature is as high as 44°C joined by outrageous daylight**.** Indeed, even around evening time temperatures in summer are only from time-to-time underneath 24°Celsius**.** The stickiness

is medium. Winters are cool and to some degree blustery; snowfall is inconsistent. Yearly precipitation is around 130 mm, happening from October to May.

Figure 3.3 shows the climate's classifications of the word and where is Damascus located. It can be observed clearly that it is classified in the climate region of [BSH] as Hot-arid. Countries that are located within the climate zone [BSH] have a desert atmosphere, having a very high temperature, extraordinary diurnal temperature contrasts, medium mugginess, high dissipation, and scant precipitation (Peel et al. 2007). However, the Tigris and Euphrates rivers provide most of the water needs for agriculture, drinking and other uses.

However, the air temperature in the city could reach 50°C and fall below zero as reported in July 2015 and January 2008, respectively (Syria Meteorological Organization 2015). The relative humidity in general is medium in the city with maximum mean of 90% as reported in January, and the lowest in July with less than 30%. The mean surface-wind speed ranges between 3.6 and 2.4 ms-1, and prevailing wind directions from North-West significantly and to a lesser extent from South- East (Al-Noori & Al-Sakini 2014). Since the climate in the city is characterized by mostly clear sky with high solar radiation intensities during daytime, extreme diurnal temperature differences are usually observed in the city which can reach over 15°C in summer time, especially in the month of July when the night-day variations in air temperature reaches its maximum (Syria Meteorological Organization 2015).

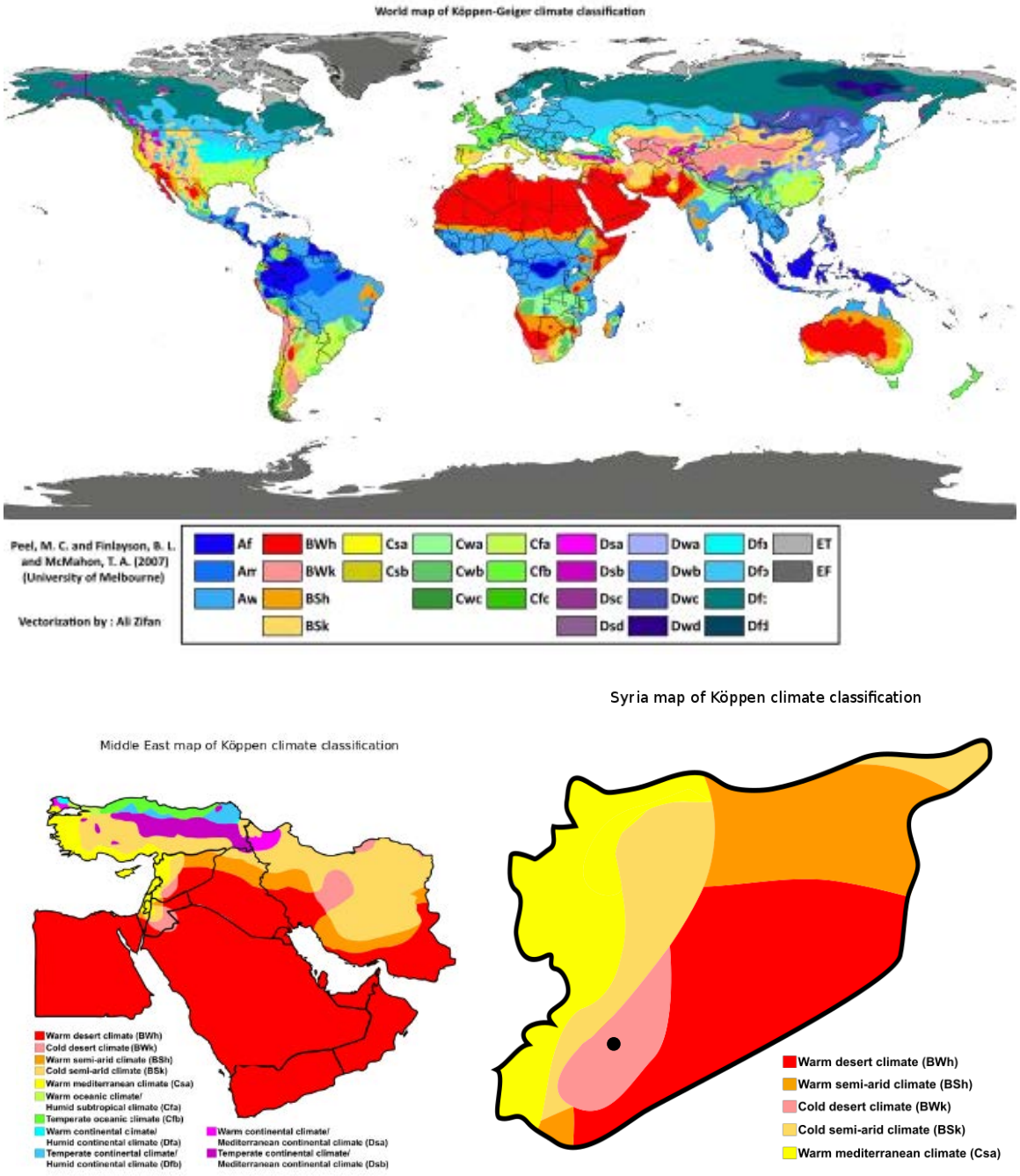

Figure 3.3: Climate classification**:** a) World map of the climate classification, b) Middle-East map of climate classification, c) Damascus location**.** (Ghaleb Faour,2010)

TABLE 3.1: Climate information on monthly averages for period 1976-2008, source**:** (Syria Meteorological Organization 2015; World Meteorological Organization 2017)**.**

Month	Mean daily minimum temperature(°c)	Mean daily maximum temperature(°c)
January	0.4	12.6
February	1.3	14.8
March	3.7	18.9
April	7.0	24.5
May	10.5	29.7
June	14.2	34.2
July	16.9	36.5
August	16.5	36.2
September	13.0	33.4
October	8.9	28.0
November	4.0	20.3
December	1.3	14.2

3.2.2 The Population characteristics of Damascus city

Damascus is currently the most densely populated cities in Syria where it has about 4**.**4 million people**.** This is nearly one quarter of Syria's population (The National Committee for Population Policies 2011)**.** Driven by the high rate of population growth and vast migration from rural to urban areas, urban density increased rapidly during the last century in Syria (The National Committee for Population Policies 2011), (Figure 3.4 and Table 1.1).

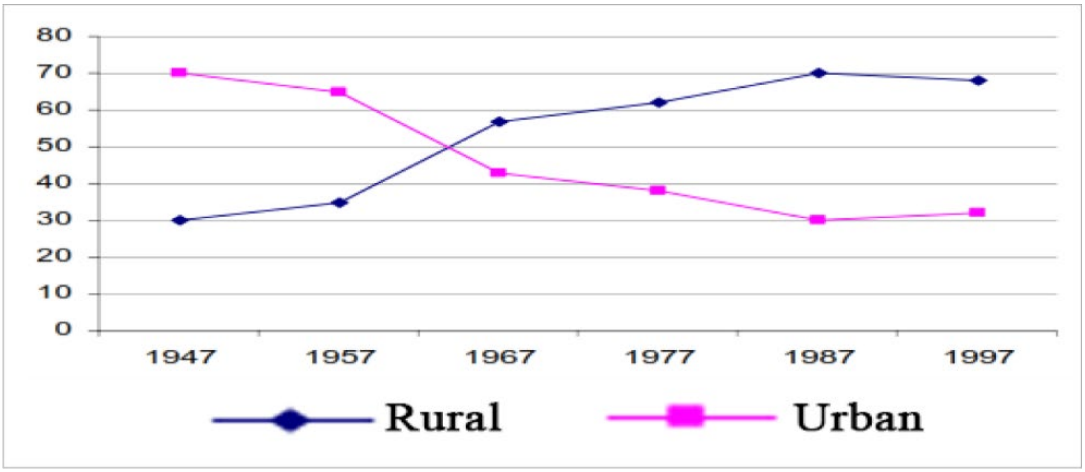

Figure 3.4: Migration trends between rural and urban in Syria at the period from 1947 to 1997 (The National Committee for Population Policies 2011)**.**

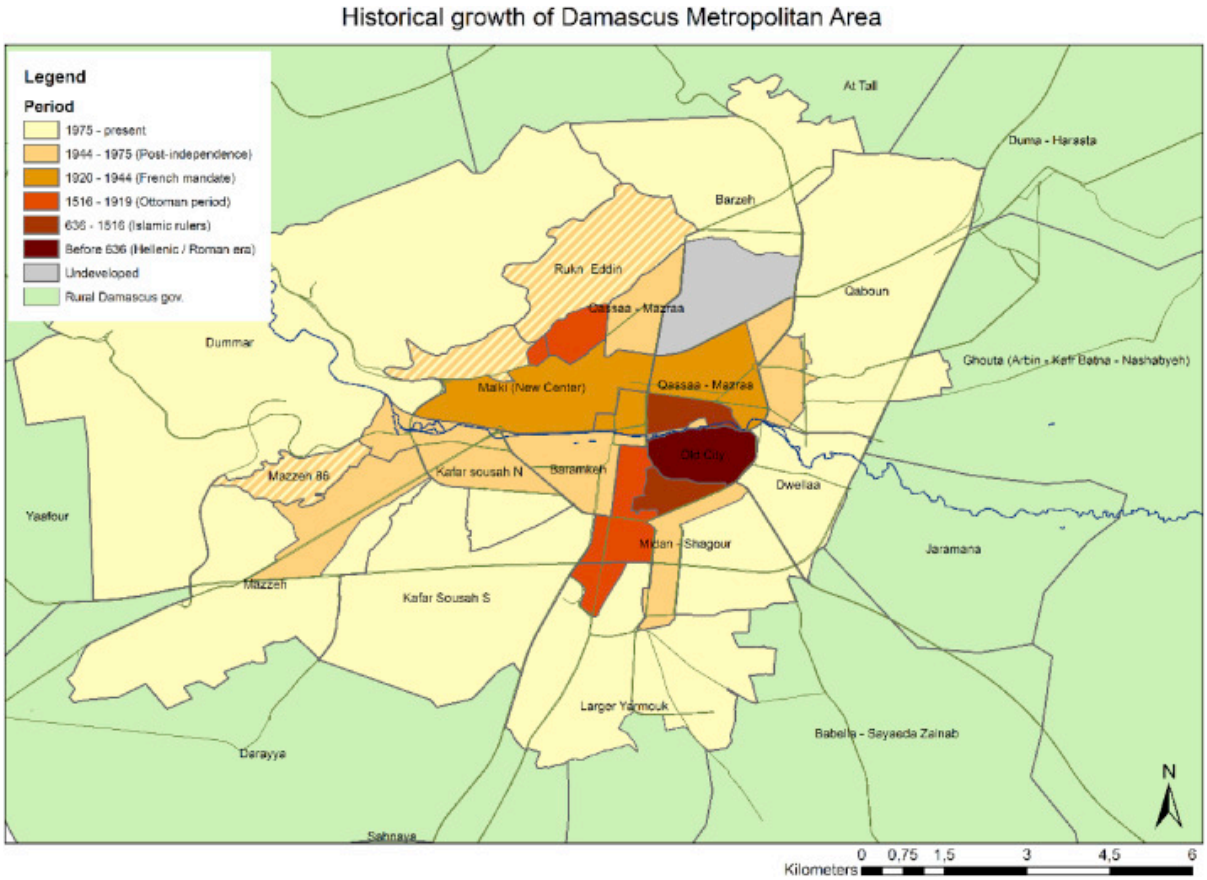

Figure 3.5: Distribution of population densities within the urban areas of Damascus, Naito,1988; AlQattan, 2002; Lababedi,2008; Verdeil,2012 Stockhammer &Wild, 2009)**.**

3.3 Residential Typology of Damascus

Residential use represents the largest proportion of about 62.6% of the total use (Mayoralty of Damascus 2000). The city contains several types of vertical and horizontal housing. Horizontal housing has two types indoor view(courtyard) and outdoor view. The indoor type is traditional type that was formed primarily in the 17th century, it was registered on the world heritage List by UNESCO. The outdoor type is the modern type were start build under the French Mandate.

3.3.1 Indoor view (the courtyard houses).

1) Introduction

The courtyard house is one of the most struggling engineering structures, rising above local, verifiable and social boundaries. Its balance of appropriate direct development, natural control and social and family structures continues to attract engineers and synthetic archaeologists. The accentuation of the square in Islamic architecture gave it the name "envelope design", because it centers around interior spaces (courtyards and rooms) that cannot be observed from an outside perspective. The yard housing is a structural tool with a long history that first appeared in the structures of Syria and Iraq three centuries ago. The nomadic migrants initially used the idea of the yard as they moved and remained in the desert. They set up their tents around a focal area, which gave their cows refuge and security. With the advancement of Arab-Islamic design, the courtyard became a stylistic primary element. It is almost certain that the way of life of Arabs in the desert in the past affected their permanent homes. The patio then meets a deep drawdown need for an open living area. This article depicts the style of the Syrian courtyard, and presents various models (Figure 3.6) of courtyard houses in Damascus.

Figure 3.6) The Al-Azem Palace in Damascus. google.com (2012).

The residence in the courtyard dates back to the beginning of the thousand years BC, when it appeared in the structures of the Levant and the area between the Tigris and Euphrates. Migrants from the Middle East used the notion of perishability during their movements and survival in the desert. They set up their tents around a focal area, providing a safe and secure home for their cows. With the advancement of Arab-Islamic design, the courtyard became a stylistic primary element. It is almost certain that the immigrant desert lifestyle of the Arabs has affected their permanent homes. (Mahmoud Zein,2010).

The houses are generally gotten to through a humble space driving into a roomy and wonderfully finished courtyard. The passage entryway comprises of a couple of wooden entryway leaves, strengthened with lead plates fixed with steel nails. The little size of the outer entryways speaks to humility, which is likewise exhibited in the absence of designs of the outside windows. It is troublesome, consequently, to pass judgment fair and square of riches or neediness of the houses from their outer appearance. The passage entryway generally prompts a restricted path toward the finish of which another entryway or drapery channels the passageway to the courtyard, permitting this last to be absolutely private and outwardly blocked off from an external perspective. (Mahmoud Zein,2010).

The progress from an external perspective to within is set apart by a differentiation in spatial experience, from an unobtrusive and once in a while severe access to a profoundly enhanced inner open courtyard with a focal wellspring (and in some cases a well) and wonderful exteriors.

Finishing likewise assumes an important function in a typical Syrian home yard. They consist of two main classifications: agricultural enrichment, for example, climbing jasmine and flower hedges, which add tone and scent to the climate of the courtyard, and citrus trees. The exterior of the inner courtyard is exceptionally designed with unexpectedly woven mathematical examples. (Mahmoud Zein,2010).

2) The building components of the Damascus courtyard house

the typology of the Damascus courtyard house made out of three sections:

- cellar floor.
- Living room at ground floor called Al Salamlek;
- private rooms on first floor named Al Haramlek.

Basement reliably recognizes the degree of equal temperature. In this way, it becomes a living space attractive amid temperatures unprecedented in the winter or summer. The tornado shelter will likely be warm during the warm dry season, allowing the accumulated hot air to be cooled by trapping and moistening the breeze before being transported to the patio area. It is also used to reduce the annual food supply as is the case in different areas of Aleppo squares, a city made in different wars. (Mahmoud Zein,2010).

Iwan is a critical open courtyard covered with which to obtain high-yard qualities. It gives a high stage (in several ways), used as a staging and sitting external tricky, fun and nightlife scene of events, for example, the usual music playing. It is arranged iwan mostly on the northern facade of the courtyard to find the cold breeze throughout the period before the summer. Iwan contains two rooms Zojitin stand next to each other and has a stone in front of me a detailed curve facing the yard. The progress of the yard space to separate different iwan striped marble floor resembling the eastern carpet.

The Iwan Challenge is the main guest banquet room - used for new stings and good times, for example, Eid. This section is the most decorated place in the house and contains the best things of furniture. In specific houses, for example, the homes of al-Wakeel, al-Basil, and al-Ghazali in Damascus, see Figure 3.16, the important guest hall is covered with a curve.

Figure 3.7: Iwan of Ghazali house in Damascus, google.com (2014)

The ground floor contains iwan, guest rooms, kitchen and toilets**.** The main floor is known as Haramlek**.** This is an expression of the importance of the Turkish start of the women's segment at home**.** The living and rest areas are completely isolated**.**

The haramlek contain bed rooms, this rooms space for guardians, one for young ladies and space for single young men, and each kid when he wedded, he takes one space for him, spouse and his kids**.**

The entrance from the beginning to the principal floor is through a flight of stairs situated in the yard**.** Little condos can now and then be found on the primary floor, especially on account of more distant families**.** The primary floor can likewise contain a few porches, permitting the sun's beams to enter the yard**.** These give valuable open spaces to resting during hot night**.** The rooftop area are normally all around ensured by high railing dividers, giving sufficient security**.** (Dana Amro,2015).

3) Yard association and climatic elements

The patio joint is suitable for hot dry climates because it enhances concealment and takes into account the formation of a wonderful microclimate**.**

Access to bright plants and water inside the patio helps to cool and hydrate the indoor environment**.** The development procedure, which relies on heavy stone bearing workmanship, gives a satisfying warm mass**.**

Cooling towers pump air into the basement, where it is cooled and left in the patio space as a great summer ventilation**.** The delicacy of the exterior and the roads that push the houses also help create a cool, hidden outdoor climate**.** (Dana Amro,2015)

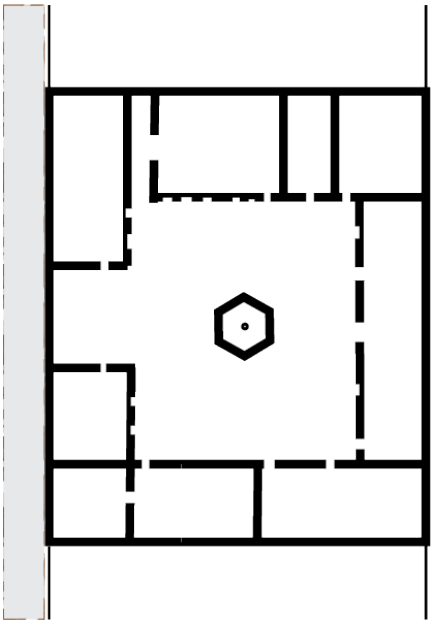

Figure 3.8: Indoor courtyard of traditional Damascus house (Alhamoi's house) (2019)**.**

4) Different variables

a. Economic factors

As recently examined, all Damascus patio houses share an unassuming outer appearance**.** Be that as it may, their size and level of inner design relies upon the abundance of the involving families**.**

b. Building materials and development methods

Locally available structural materials have completely affected the course of events and the condition of the Syrian home. The stone wealth in the region made it the standard building

material in advancing parts of Damascus. The dividers are identified periodically by layers of white and dark stones called ablaq, which constitute a specific type of balcony patch in Syria. Such as Figure 3.9).

Figure 3.9: The Al-Azem plalace Damascus**.** Source**:** google**.**com (2005)**.**

3.3.2 Outdoor view (modern houses).

1) Introduction

The French mandate established a network of roads linking Damascus to each other to facilitate the movement of military vehicles (Figure 3.10), and then they needed the headquarters of the officers, so they built their buildings in a modern style on both sides of the road**.**

Some intellectuals and educated people who lived in this expatriate house and transferred western culture to the Arab community, as it was open and developed**.**

There was a lot of opposition to this new style because it embodied a new style that is contrary to the moral and religious beliefs of the Damascene in this period**.**

Modern houses built of concrete and concrete blocks, the buildings coating according to the importance of building some of them coating with white stone either building are covered with Cement slurry, inside the houses were paint**.**

Figure 3.10: Abu rommaneh street**.** (1959), Syria historical (2015)**.**

2) The architectural elements of the Damascus courtyard house

Damascus Modern House classification consists of four components**:**

- Residential area
- Night area
- External garden
- parking

The living area contains (living room - kitchen - guest room), the relationship between the living area and the outdoor garden with wind and doors, knowing when you come from outside must walk through outdoor garden**.**

Night area contain three bedrooms for (parents - boys - girls), knowing boys when married must live in new house**.**

outdoor garden look like courtyard but from outside the house, the privacy of outdoor garden is semipublic**.** Every house has parking at least for one car; parking has relation with outdoor garden and can walk through to house**.**

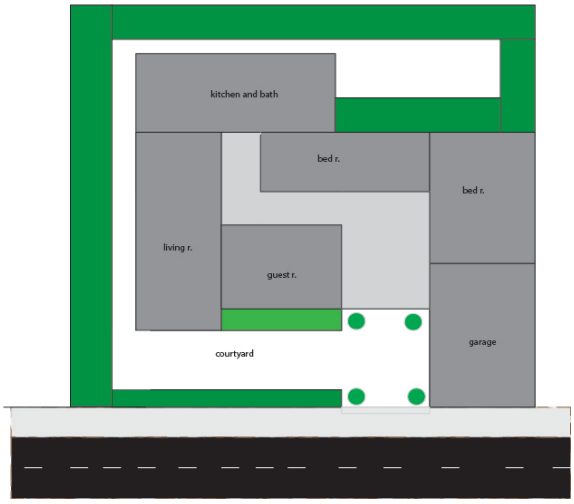

Figure 3.11: Outdoor courtyard for modern house

3) Outdoor garden organization and climatic factors

Medium shading from trees and building and some area has full shades from building opposite side of sun, this area is good for hot days**.** The availability of plants in outdoor garden helps to size humidity**.** The construction technique, which is based on concrete which is bad for outdoor environment**.** Outdoor garden is surrounded by buildings, which form air corridors that resemble the currents that form in the alleys**.**

4) Various other factors

a. Economic factors

As discussed earlier, the share of modern houses in the modest exterior**.** However, the size and the level of interior decoration depend on the job title or social level**.** When the home owner is the president, the level differs from that of an educated and educated doctor in Western culture**.** The material was coated from the outside, either with white stone or rough concrete clay, as for the interior cladding, the sinking was clad with soft mud and paint

b. Building material and construction techniques

The building materials by concrete so that this material were submitted with the French mandate to use faster materials in implementation to build the new community for the leaders and embassies**.**

c. social factors

Social, social and strict variables have assumed a significant part in the advancement of the cutting-edge house Damascus**.** Metropolitan advancement and impersonation of Western development are among the main highlights that affected the cutting-edge home**.**

CHAPTER 4

MATERIAL AND METHODS

4.1 Introduction

In this research, the results of the microclimate modelling simulation of the different scenarios. presented and discussed. Assessment of external conditions of the microclimate was based on their impact on the quality of the environment and human thermal comfort in indoor spaces at the scale of resident's level and relationship between indoor and outdoor.

At first, the results of the microclimate conditions will be shown and discussed based on their impact on the quality of the environment at the scale of resident's level (Section 1). Second, the results of the effect of different scenarios on the human thermal comfort of indoor environment at the scale of pedestrian level (Section 2). The assessment of outdoor thermal comfort in different scenarios will be according by using the Predicted Mean Vote, *PMV* (UNI EN ISO7730 2006). Finally, the end of this chapter, will contain its summary (Section 3).

In this study, the selected areas described in section 3.4 were divided into three types as shown in Figure 3.15). Each area was represented by four images. They are: Aerial Satellite View, CAD Map, Canopy image and Input file. First, Aerial Satellite View contain High resolution satellite images are directly obtained by using the program SAS. Planet (SAS.Planet. Release.141212, 2015). Second, CAD Map contains images drown by the author using AutoCAD program (AutoCAD, 2015). Third, Canopy image contains images of the selected area taken by the author. Finally, Input file contains drawing area snapshot images from space program in ENVI-Met 4.1. The red point in the last type (Input File) represented the selected point of measurement that have been depended on their results in analysis and evaluation of the following sections.

4.2 Characteristics of the experience

The Characteristics of the experience depends on four factors (installation-period- timing - location –properties of room).

4.2.1 Installation

use two same data loggers for this experiment (TEMPTOP Temlog s150) formatting to measure temperature at (02:00) and (14:00) everyday, installing at 31/05/2019 and stop the devise at 02/06/2020.

4.2.2 Period

This experiment needs a long time, at least for a year, so that we need to operate the thermal recorder for a year in order to discover the thermal differences between the two studied sites in all seasons or on hot and cold days in order to be able to obtain a full study of the differences between the two study sites. For this experiment, the device was installed on the date 31/05/2019 and the results were obtained on 02/06/2020. Thus, we obtained the results for a period of 368 days to help us compare and produce the results.

4.2.3 Location

The damascene house (alhamoi's house) located in bab Touma street old Damascus /Syria

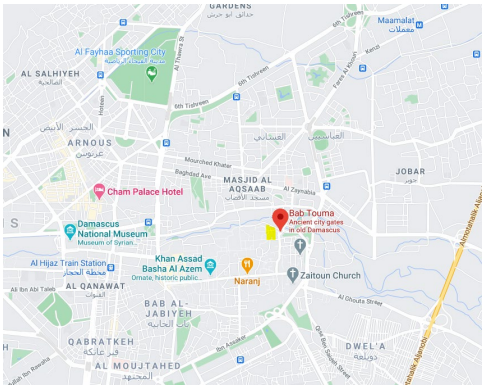

Figure 4.1: Location of damascene house (Alhamoi's house)

The modern houses (Mahmalji's house) located near Abo Jafer Almansour street Adnan Almalki square in Almalki area Damascus/ Syria Figure 4.2

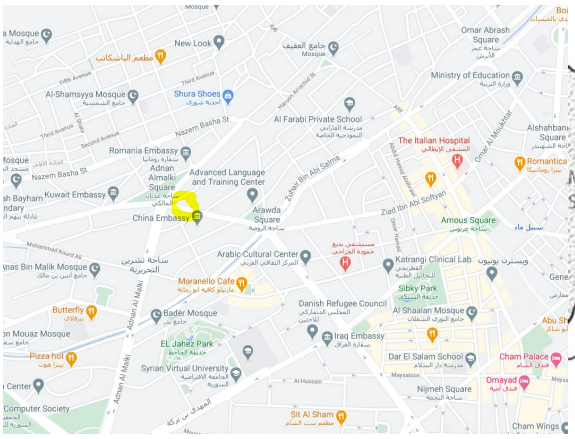

Figure 4.2: Location of modern house (Mahmalji's house)

Figure 4.3: Location of Damascus

4.2.4. Climate of Damascus

Damascus has hot dry cities in the world and it has a subtropical desert climate. Hot dry periods are most of the year and from April to September, the normal greatest temperature is as high as 44°C joined by outrageous daylight. Indeed, even around evening time temperatures in summer are only from time-to-time underneath 24°Celsius. The stickiness is medium. Winters are cool and to some degree blustery; snowfall is inconsistent. Yearly precipitation is around 130 mm, happening from October to May.

Figure 3.3 shows the climate's classifications of the word and where is Damascus located. It can be observed clearly that it is classified in the climate region of [BSH] as Hot-arid. Countries that are located within the climate zone [BSH] have a desert atmosphere, having a very high temperature, extraordinary diurnal temperature contrasts, medium mugginess, high dissipation, and scant precipitation (Peel et al. 2007). However, the Tigris and Euphrates rivers provide most of the water needs for agriculture, drinking and other uses.

However, the air temperature in the city could reach 50°C and fall below zero as reported in July 2015 and January 2008, respectively (Syria Meteorological Organization 2015). The relative humidity in general is medium in the city with maximum mean of 90% as reported in January, and the lowest in July with less than 30%. The mean surface-wind speed ranges between 3.6 and 2.4 ms-1, and prevailing wind directions from North-West significantly and to a lesser extent from South- East (Al-Noori & Al-Sakini 2014). Since the climate in the

city is characterized by mostly clear sky with high solar radiation intensities during daytime, extreme diurnal temperature differences are usually observed in the city which can reach over 15°C in summer time, especially in the month of July when the night-day variations in air temperature reaches its maximum (Syria Meteorological Organization 2015).

4.2.5. Altitude of Damascus and study houses

The altitude of center Damascus is about 702m above sea level which amount of Damascus elevation between 699m until 725m above sea level. We have two study houses one in the old Damascus and the second in modern area.

The altitude of traditional damascene house is 704m above sea level, the altitude of modern house is 711m above sea level.

4.3. Discussions of Microclimate Conditions

This section presented and discussed the results of the different scenarios on the quality of outdoor environment at the scale of pedestrian level. two microclimate conditions have been measured air temperature (*Ta*), the measurements will be taken in residents' room and the result of different scenarios will compare based on their effect on quality of outdoor spaces. The specified measurement points of location of measure device.

the aim of this study is taking about two different types of residential houses in Damascus, Syria.

The first house is the traditional Damascus house, which is characterized by a unique character, which is characterized by several differences:

- The house is overlooking an internal courtyard
- The size of the internal rooms is relatively large
- It is built of stone and clay with straw

The second house is the modern house build in the second half of the 20th century and features a number of properties:

- Exterior view of the rooms
- Average size of rooms

- It is built of cement and cement blocks

for that there are several different between traditional house and modern houses,The most important of these differences, which remained a place of controversy among the Damascene, is the thermal comfort.

4.4. The Experimental Houses

The utilization of characteristic to acquire cooling inside residences has been known since early occasions. There are numerous customary methods for aloof cooling in houses, yet they are very simple and their effectiveness is moderately low.

Models incorporate high-mass dividers and rooftops (which store night coolness), unearthed underground rooms and houses that have interior nurseries. As of late, with the development of innovation in material science and engineering plans have arisen in current uninvolved cooling frameworks. In hot–bone-dry districts of the Middle East, the utilization of these frameworks has been propelled by the longing to monitor energy as well as, to keep up warm solace inside structures.

4.4.1. The traditional damascene house (Alhamoi's house)

A single-family house, built by stone and mud for walls and wood and mud for the ceiling, the ground is paved with stones with different types and colors with a great variety of building typologies. The house contains five rooms, was chosen for the experiment. It has an indoor courtyard surrounded by rooms. It has an indoor courtyard surrounded by rooms. The courtyard contains trees and flour, the courtyard like garden.

The house has square plan and has an internal courtyard in the central area of the house. An octagon pool with a fountain in the middle is in the courtyard. The house located inside old Damascus in Alqaymarieh street. Figure 4.4

Figure 4.4: Place of a traditional damascene house in Damascus**.** (Alhamoi's house)

The houses are assembled near one another, alongside restricted, winding roads Figure 4.4 This gives an unmistakable building style to the territory. An examination between this city and the urban areas of the antiquated period reveals an incredible arrangement about the personal relationship found between them. An enormous piece of this relationship can be ascribed to climatic requests.

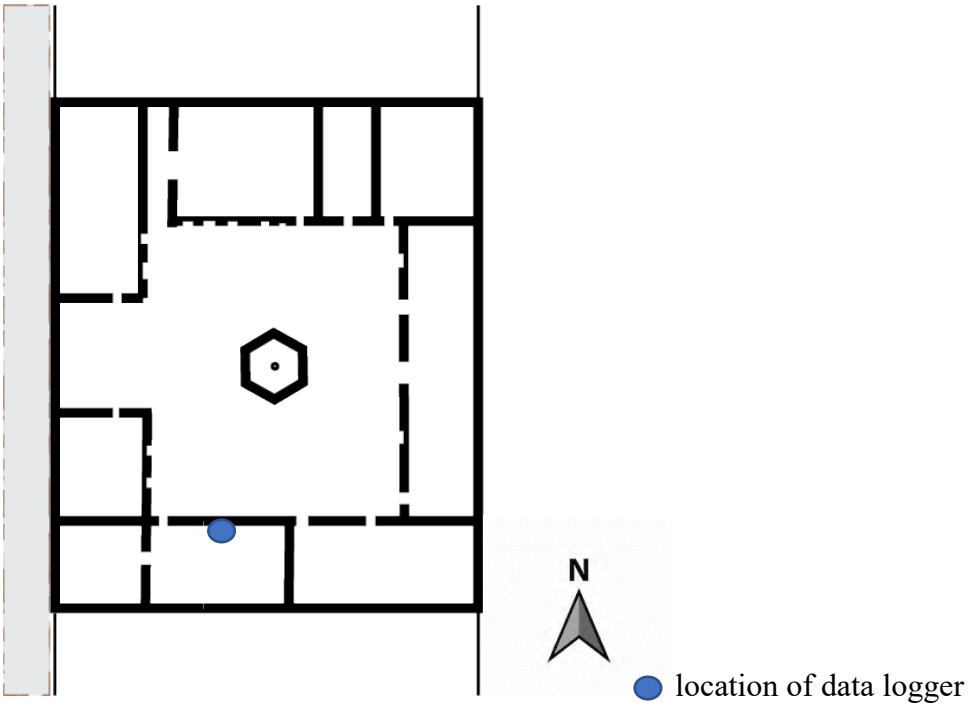

Figure 4.5: The plan of a traditional damascene house in Damascus**.** (alhamoi's house)

Figure 4.6: Courtyard of a traditional damascene house in Damascus**.** (alhamoi's house)

Figure 4.7: Temperature data logger device in damascene house in Damascus**.** (Alhamoi's house)

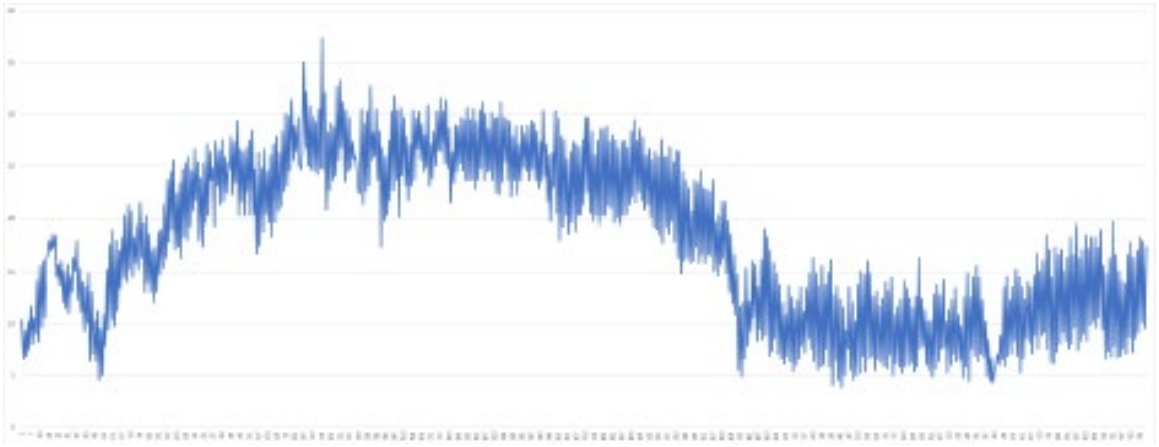

Figure 4.8: Temperature chart of the traditional damascene house in Damascus**,**(Alhamoi's house).

The flow chart shows the recommended temperature range and the few temperature differences the highest temperature saved 37.4°C at 05/07/2019 at 14:00 o'clock and lowest temperature was 3.9 °C at24/12/2019 @02:00 o'clock

4.4.2 The modern house (Mahmalji's house).

A single-family house builds by concrete, it contains five rooms and an outer courtyard, rooms overlook on courtyard, the courtyard surround the house from three sides. The house located near Almalki square in Damascus, this type of construction was adopted in the 1970s.

Figure 4.9: Location of the modern house

Figure 4.10: Plane of the modern house

Location of data logger

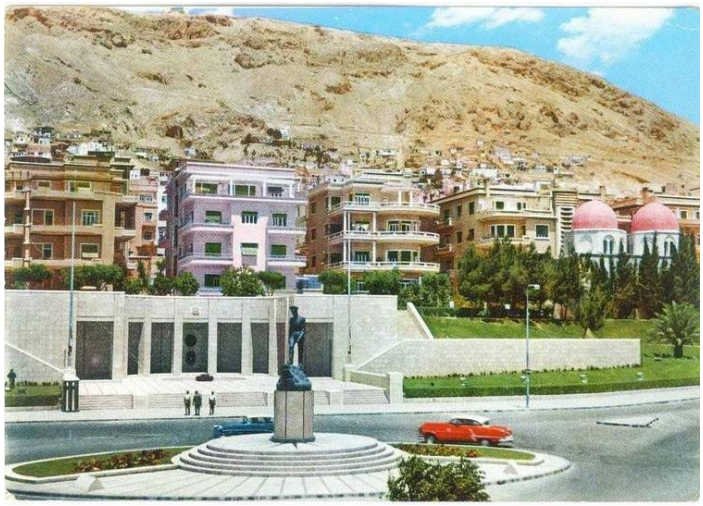

Figure 4.11: Adnan Almalki square (1955) (Emad Al Armashi and colored by Nevien Allhaam ,2018)

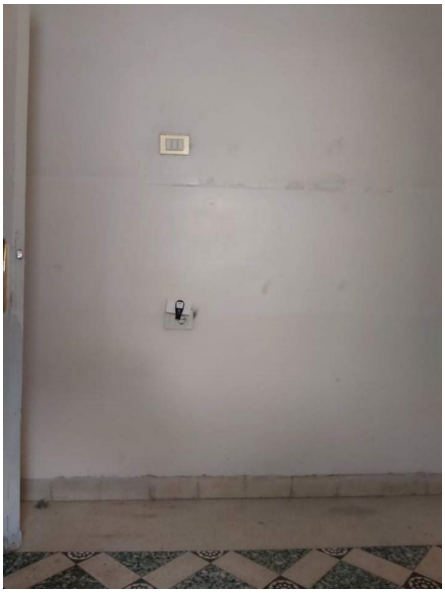

Figure 4.12: Temperature data logger device in modern house in Damascus**.** (Mahmalji's house).

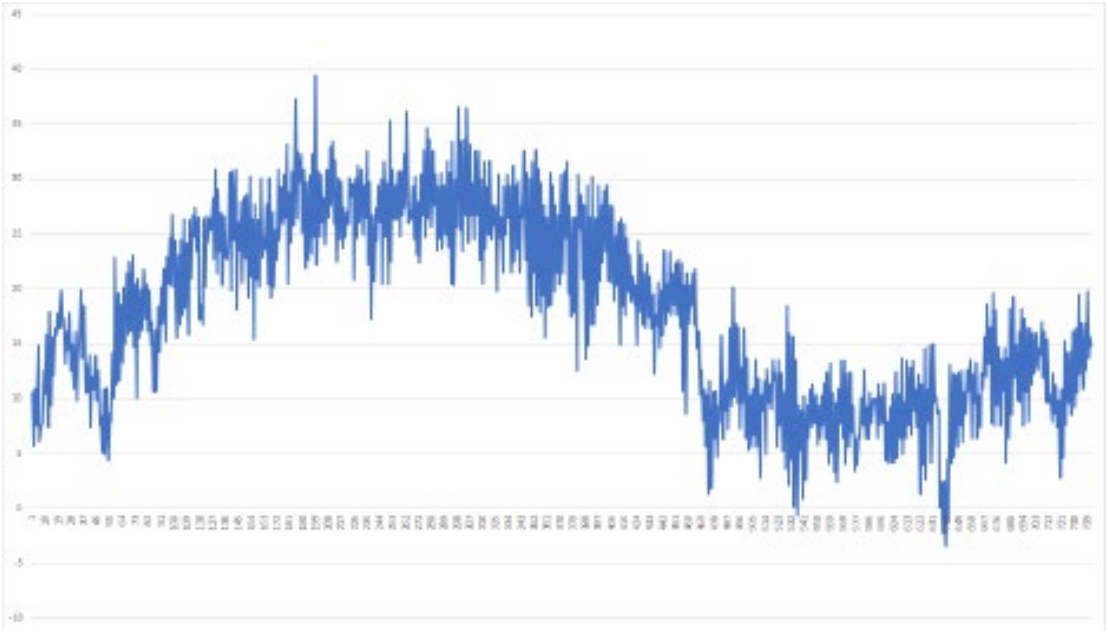

Figure 4.13: Temperature chart of the modern damascene house in Damascus**.** (Mahmalji's house).

The flow chart shows the medium temperature range and the medium temperature differences the highest temperature saved 40**.**6°C at 05/07/2019 at 14**:**00 o'clock and lowest temperature was -3**.**4 °C at11/02/2020 @02**:**00 o'clock

4.5 Aim

• Papers aim to compare the traditional Damascene House with the 1970s house by:

1) courtyard shape, size, contents, relation with rooms, determinants.

2) house inner or outer overlook.

3) compare temperature in open spaces.

4) Discussion

This paper aims are comparing two residential houses, the first house is a traditional damascene house for single-family, located in old Damascus in Alqymaria, the second house is modern house build in 1975 located in Almalki near Adnan Almalki square.

Comparing these points:

1) the difference between the typology of open space in the houses.

2) visual relation between rooms and courtyard.

3) research about a comfortable climate in open space by measuring the temperature and humidity and comparing the result with an official temperature of Damascus.

4.5.1 Courtyard shape

the traditional damascene house (Alhamoi's house) has in the middle rectangle courtyard, rooms surround the courtyard from all sides, the walls are thick build by stone and mud and paved by brownstone from courtyard side, the courtyard open to sky and ground paved by white and black stone. The dimension of the courtyard about are (530*780) cm, the walls high surround the courtyards are about 400cm in three sides and about 500cm in one side, the courtyard contains a lot of trees more than ten trees it makes courtyard shaded most of the time.

The relation between rooms and courtyard are too strong, the courtyard is the only outlet for the rooms and any connection between rooms must be through the courtyard. Figure 4.14

The courtyard has a connection between inside and outside the house. The courtyard is bounded by brownstone walls with windows and doors.

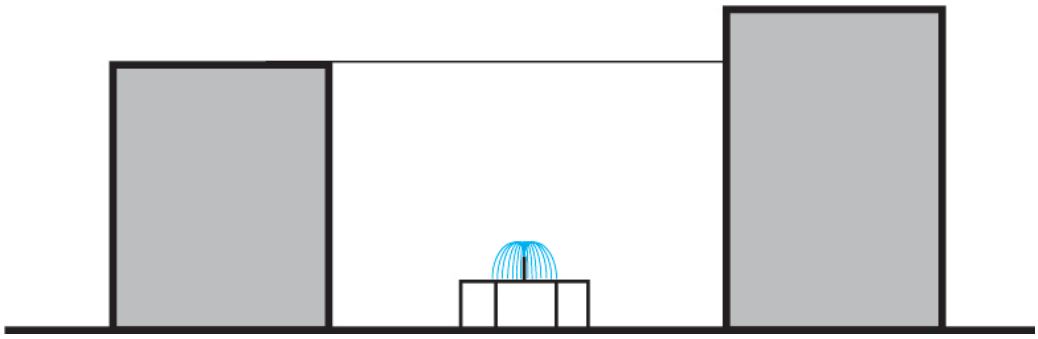

Figure 4.14: Section in a traditional damascene house in Damascus. (Alhamoi's house).

The modern house (Mahmalji's house) has open space on the corner of the house north side of open space is linked with the house, the east side linked with closed garage, the south side linked with fancy overlooked on the street and the west side close with the wall. The courtyard is open to sky and ground paved by white stone. the dimensions of the courtyard are bout (800*400) cm, the wall high from east and west side about 300cm, northern wall high is about 420 cm, and southern wall side about 90cm.

The courtyard contains three trees Jasmin, citrus and Ficus elastic and a lot of flowers.

The between house and courtyard is simple to make the connection between inside and outside, the connection between house and street cross through the courtyard. Figure 4.15

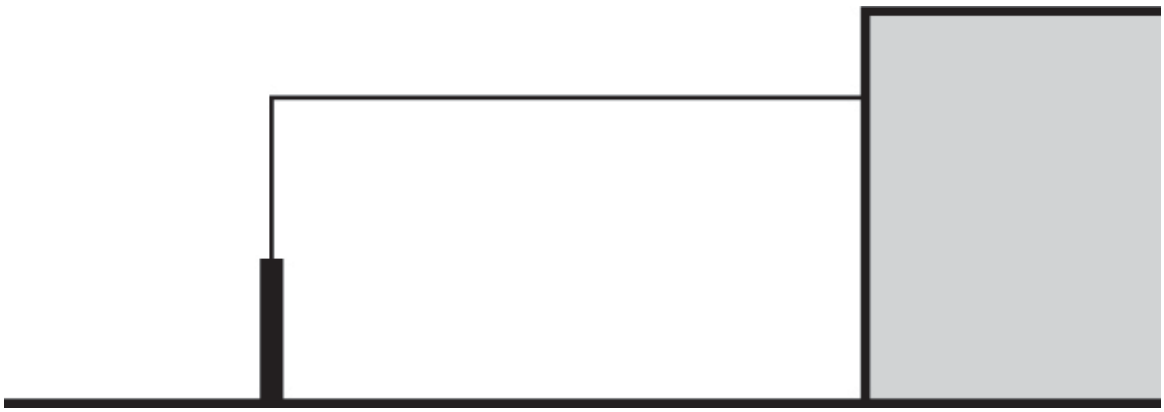

Figure 4.15: Section in courtyard of the modern house (Mahmalji's house)

4.5.2 Visual relation between rooms and courtyard

The traditional damascene house (Alhamoi's house) has an inner overlook, all rooms are overlooking the courtyard to make more privacy to the house.

All rooms take sunlight and ventilation from the courtyard.

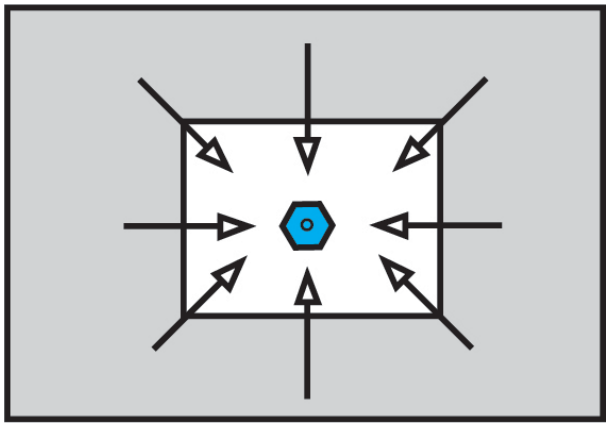

Figure 4.16: Overlook rooms of a traditional damascene house in Damascus. (Alhamoi's house).

The modern house (Mahmalji's house) has outer overlook all room, the room overlook to outside life through outer courtyard, in this case, courtyard can't give privacy like the traditional damascene house, everybody in street overlook courtyard, the room can see the street through the courtyard. Rooms take sunlight and ventilation from outside through the windows.

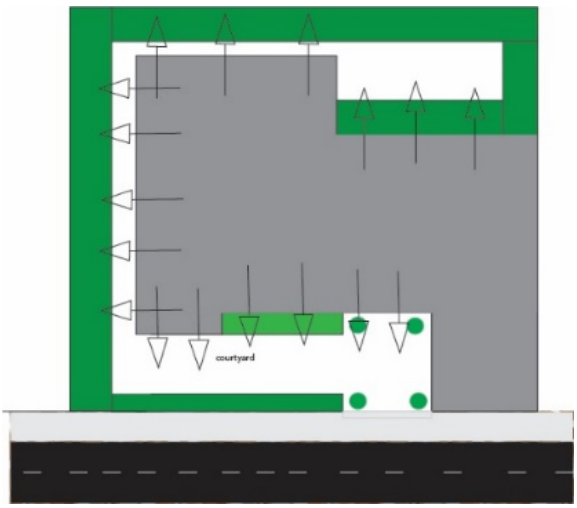

Figure 4.17: Overlook rooms of the modern house (Mahmalji's house).

4.5.3 Research about a comfortable climate in open space by measuring the temperature and humidity and comparing the result with an official temperature of Damascus

This study focused on the warmest and coldest conditions in the hot and dry region**,** The main objective of this examination was to assess the performance of the various warm lists of mourning by searching for the characteristic warm conditions and surveying the sense of warmth among individuals in Damascus throughout the mid-year and winter seasons**.**

This includes finding the lower and lower limitations of the warm range consolation just as the nonpartisan temperatures of a portion of these records in the Damascus atmosphere**.** These warm stopping points will help urban planners and architects make recommendations for plan as outlined in Climate Imperatives**.** Additionally, the strangeness of this investigation is to analyze the effect of cooling devices on the external warm compatibility of individuals**.**

This examination likewise means to research social variation to the neighborhood atmosphere conditions**.** The investigation depends on thorough micrometeorological estimations joined with a poll study during summer and winter**.** This examination is one of few investigations which manage microclimate and emotional warm solace in the Middle East**.**

4.6 Materials and Methods

A mix of estimations and organized meetings was utilized for surveying distinctive warm conditions to all the while decide clients' warm sensation through exploring diverse warm files**.**

Damascus climate

Climate information relative to the temperature and adhesion in Damascus**.** Damascus is characterized by a bright summer and winter cute**.** It can be in the summer 35 degrees Celsius temperatures exceed during the day, but the nights are often cold**.**

Spring and harvest time is generally suitable with the normal temperature range is from 16 to 20 degrees Celsius**.** Winter is really cool and can reach temperatures to 0 ° C in the evening**.**

Determination of estimation areas and time spans

The areas chose were two sorts of neighborhood. Speak to the most well-known conditions in Damascus.

The principal neighborhoods in present day Damascus contained three estimation areas: Almallki region the subsequent zone is Old Damascus—contained a profound gorge: Alqaymarieh Street.

Check in in the coldest season. During the months of August and September 2020 mid-year, and during January and February 2020, the cooler time of the year. Northwest - Southeast (NW - SE), Upper Southwest (NE - SW), East and West (E - W). We will put two temperature data loggers one in the courtyard old damascene house and the second in modern house.

and set the data logger to take the temperature and humidity automatically in same time, two time in the day one at 05:00 and other at 14:00 o'clock.

Micrometeorological measurements

The measurement device was placed at internal room, the measured microclimatic variables, measurement instruments, the measurements in the traditional damascene house or the modern house must be shaded from sun direct light and must be at height of one meter above the ground.

Chapter 5: RESULT AND CONCLUSION

5.1 Introduction

This section make conclusion depends on the past section, and their effects for climatic in warm weather regions, exemplified by the city of Damascus**.** It shows the compression outside climate its effect on micro climate between two type of damascene houses

5.2 Compression Between Energy Need in Summer and Winter in Two Houses

From a recent review of the table of temperatures we conclude**:**

The old house has a greater flattening of the temperature table, and it gives this house more insulation and more thermal efficiency, and in return for less energy need for heating in winter, less need for cooling in summer.the climate in Damascus shows four seasons for that we take chart for every season and study it.

5.2.1 deference temperature between houses in summer

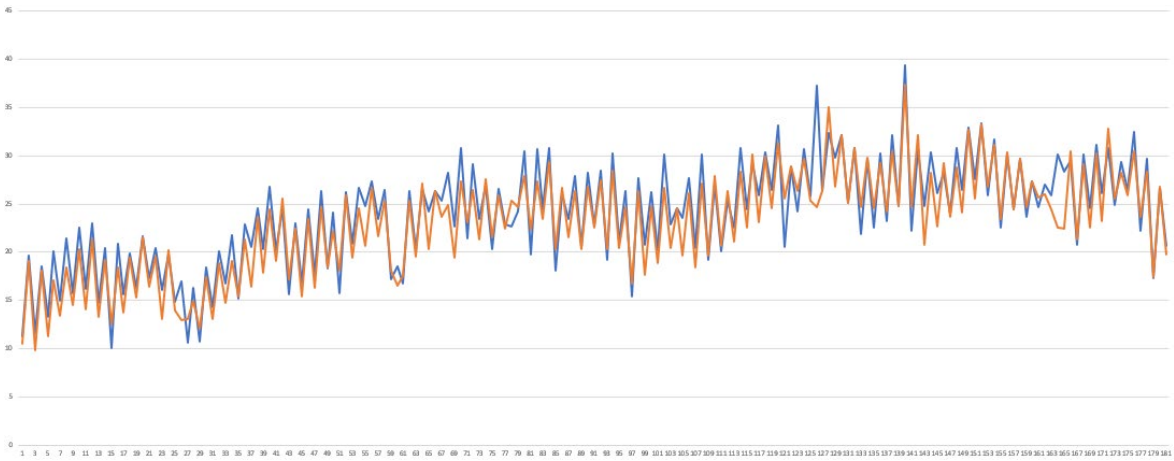

figure 5.1: comparison between houses temperature in summer (vertical for temperature, horizontal for date)

- Charts of traditional house (Alhamoi's house)
- Charts of modern house (Mahmalji's house)

This chart led to modern house storage more heat from sun in summer, the modern house recorded higher temperature from traditional house, that's mean the traditional house more isolate from the modern house

5.2.2. deference temperature between houses in autumn

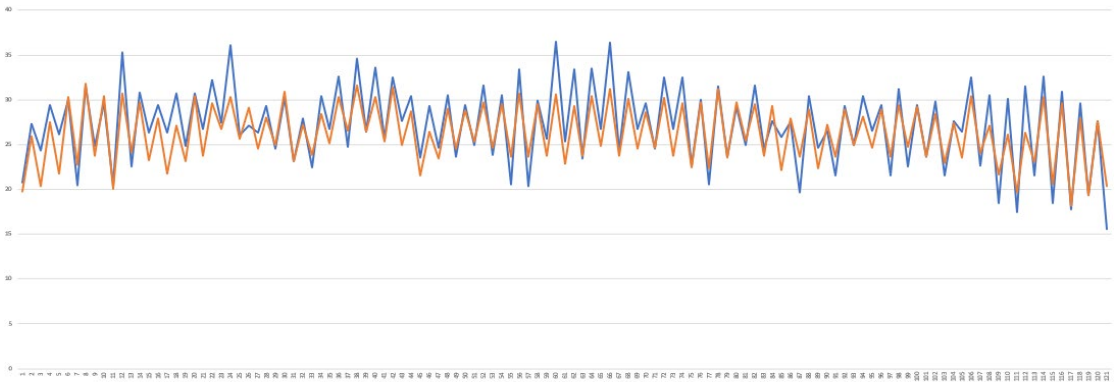

figure 5.2: comparison between houses temperature in autumn (vertical for temperature, horizontal for date)

- Charts of traditional house (Alhamoi's house)
- Charts of modern house (Mahmalji's house)

The chart shows more fluctuating in the modern house because direct relation with outside climate, show us the modern house is less isolate.

5.2.3. deference temperature between houses in winter

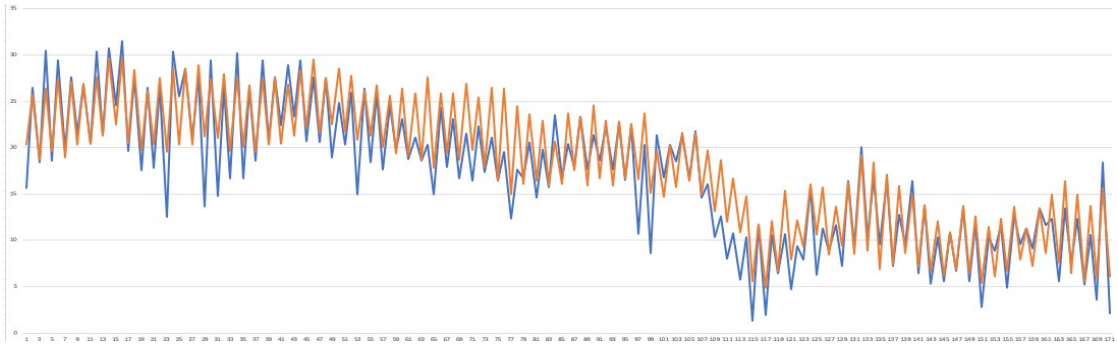

figure 5.3: comparison between houses temperature in winter (vertical for temperature, horizontal for date)

- Charts of traditional house (Alhamoi's house)
- Charts of modern house (Mahmalji's house)

In winter the modern house recorded lowest temperature than the traditional house, and the traditional house recorded higher temperature because storage heat from autumn.

5.2.4. deference temperature between houses in spring

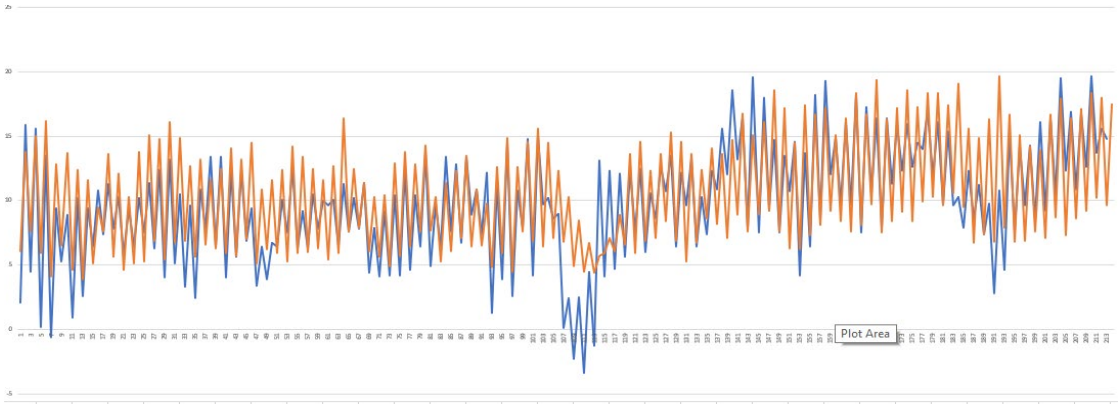

figure 5.4: comparison between houses temperature in spring (vertical for temperature, horizontal for date)

- Charts of traditional house (Alhamoi's house)
- Charts of modern house (Mahmalji's house)

The chart shows more fluctuating in the modern house because direct relation with outside climate, show us the modern house is less isolate.

5.3 Deference Between Highest and the Lowest Temperature Between Two Houses

The greater the temperature difference between summer and winter, the less effective the house with thermal insulation**.**

Table 5.1: Highest and lowest temperature of houses

	maximum temperature(°c)	**minimum temperature(°c)**
Traditional house (Alhamoi's house)	37.4°C	3.9°C
Modern house (Mahmalji's house)	40.6°C	-3.4°C

5.4 Conclusion

According to the Syrian classification of antiquities, Damascus contains two types of archaeological houses, the first type is the old typology called the traditional Damascene houses. As for the second type, it is the modern house. They are very close to the architectural style. The home is inward and this courtyard becomes an indoor distributor for the home. As for the modern house, it has a courtyard that resembles a perimeter of the house, but is fenced by a wall so that the courtyard separates the house from the neighbors' courtyard through a concrete wall.

In this style, the courtyard in the modern style became like a heavenly space belonging to the house. The aim of this study is to conclude the best architectural style for the suitable internal climate for the house. Inside the two houses, two temperature registers and calibers were installed to record the temperature twice during the day for a whole year in order to know the number of thermal differences that occurred during a whole year and from it we can reduce the amount of insulation occurring Inside the room and this leads to knowing which house is better with respect to thermal comfort.

Based on Figure 5.1, so that the temperature chart for the traditional Damascene house is placed above the temperature chart of the modern house, and from it we conclude that differences between the two plans appear so that the modern house plan has more ramifications and contains greater differences between temperatures, and this leads to the modern house being more lost. From it we can say that the old Damascene house is better in terms of thermal comfort, but the modern house needs insulation.

According to table (5.1), the maximum change in temperature between the highest recorded temperature minus the lowest temperature is recorded in the traditional Damascene house (33.5°C). As for the maximum change in the modern house (44°C), from which we conclude that the amount of heat loss in the modern house increases by about (10.5°C).

In addition, the results of this study confirmed to add more isolate to modern house to make it more compatible with the surrounding environment and how this can lead to a significant contribution to the improvement of micro-climatic conditions at the indoor level and lead to outdoor spaces more suitable for human thermal comfort.

Although Damascus is in a hot, dry environment that needs energy in order to ensure thermal comfort inside homes, it is possible to infer through this study and the like to reduce the use of energy and may lead to stopping the use of energy in order to obtain thermal comfort inside homes. From the results, we can conclude the necessity of having a courtyard inside homes with an increase in the thermal insulation of rooms, and from it leads to a higher thermal comfort and a reduction in energy use.

5.5 Suggestion for Future Studies

This study investigated the effect of the residential interior in the city of Damascus on the quality of the internal environment and thermal comfort at the room level. These rooms differ in their internal form. In addition, study will inquiry the effect of microclimate improvement planning on the thermal comfort of two types of houses. However, this study was limited to the following points:

a. two types of Damascus houses.

b. Two common residential types.

c. internal spaces only.

d. Only one-year time included.

e. Use one index to evaluate the thermal comfort.

Accordingly, there is a need to study the following points in future studies:

1) All internal typology residential in the city of Damascus.
2) Include both internal and external spaces.
3) Studying other indexes to evaluate thermal comfort such as humidity degree.

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Appendices

Appendix 1: User manual of data logger

Temtop®

User Manual

⚠ Caution

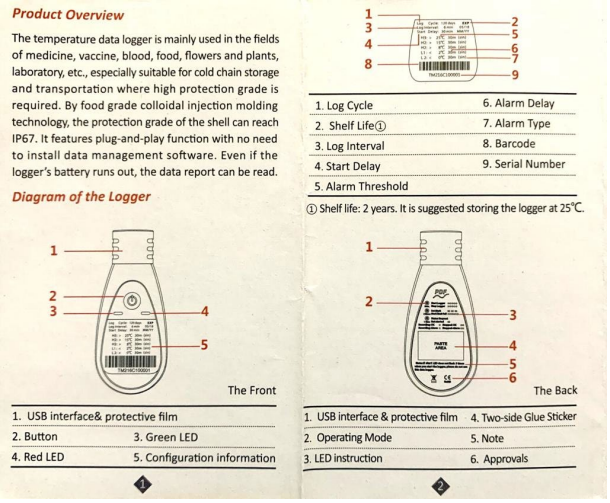
Please read the manual carefully before using the logger.
Please do not use screws to fix the logger.
Please do not put the logger in alcohol, gasoline and other organic solvents.
Please store the logger at room temperature (25℃).
Please use a marker pen to take notes on the card.

Temtop®

Disposable Temperature Data Logger

CE

TemLog ST5



Product Overview

The temperature data logger is mainly used in the fields of medicine, vaccine, blood, food, flowers and plants, laboratory, etc., especially suitable for cold chain storage and transportation where high protection grade is required. By food grade colloidal injection molding technology, the protection grade of the shell can reach IP67. It features plug-and-play function with no need to install data management software. Even if the logger's battery runs out, the data report can be read.

Diagram of the Logger

The Front

1. USB interface& protective film
2. Button
3. Green LED
4. Red LED
5. Configuration information

◆1

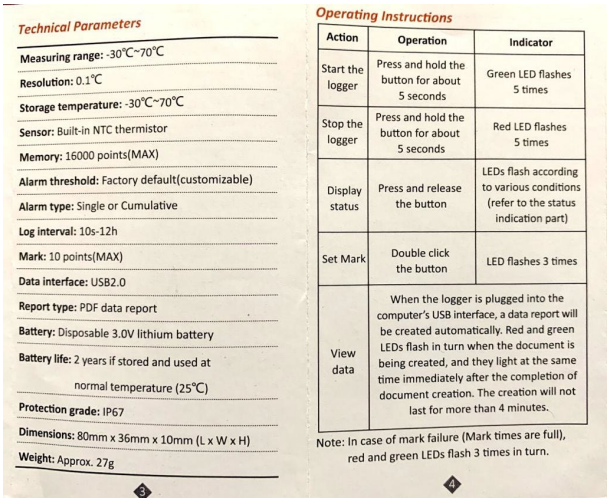
1. Log Cycle
2. Shelf Life①
3. Log Interval
4. Start Delay
5. Alarm Threshold
6. Alarm Delay
7. Alarm Type
8. Barcode
9. Serial Number

① Shelf life: 2 years. It is suggested storing the logger at 25℃.

The Back

1. USB interface & protective film
2. Operating Mode
3. LED instruction
4. Two-side Glue Sticker
5. Note
6. Approvals

◆2



Technical Parameters

Measuring range: -30℃~70℃
Resolution: 0.1℃
Storage temperature: -30℃~70℃
Sensor: Built-in NTC thermistor
Memory: 16000 points(MAX)
Alarm threshold: Factory default(customizable)
Alarm type: Single or Cumulative
Log interval: 10s-12h
Mark: 10 points(MAX)
Data interface: USB2.0
Report type: PDF data report
Battery: Disposable 3.0V lithium battery
Battery life: 2 years if stored and used at normal temperature (25℃)
Protection grade: IP67
Dimensions: 80mm x 36mm x 10mm (L x W x H)
Weight: Approx. 27g

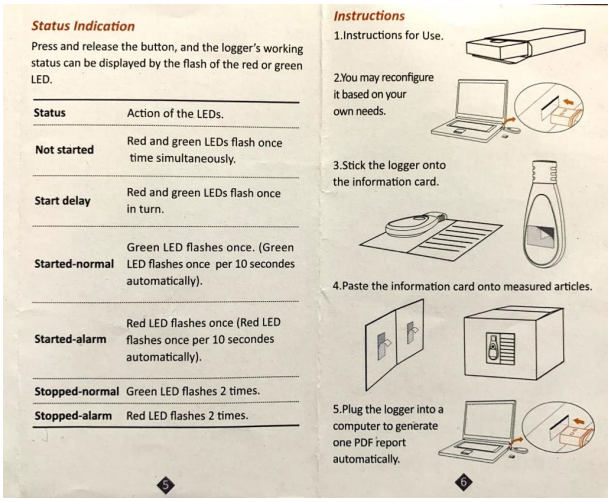
◆3

Operating Instructions

Action	Operation	Indicator
Start the logger	Press and hold the button for about 5 seconds	Green LED flashes 5 times
Stop the logger	Press and hold the button for about 5 seconds	Red LED flashes 5 times
Display status	Press and release the button	LEDs flash according to various conditions (refer to the status indication part)
Set Mark	Double click the button	LED flashes 3 times
View data	When the logger is plugged into the computer's USB interface, a data report will be created automatically. Red and green LEDs flash in turn when the document is being created, and they light at the same time immediately after the completion of document creation. The creation will not last for more than 4 minutes.	

Note: In case of mark failure (Mark times are full), red and green LEDs flash 3 times in turn.

◆4



Status Indication

Press and release the button, and the logger's working status can be displayed by the flash of the red or green LED.

Status	Action of the LEDs.
Not started	Red and green LEDs flash once time simultaneously.
Start delay	Red and green LEDs flash once in turn.
Started-normal	Green LED flashes once. (Green LED flashes once per 10 secondes automatically).
Started-alarm	Red LED flashes once (Red LED flashes once per 10 secondes automatically).
Stopped-normal	Green LED flashes 2 times.
Stopped-alarm	Red LED flashes 2 times.

◆5

Instructions

1.Instructions for Use.

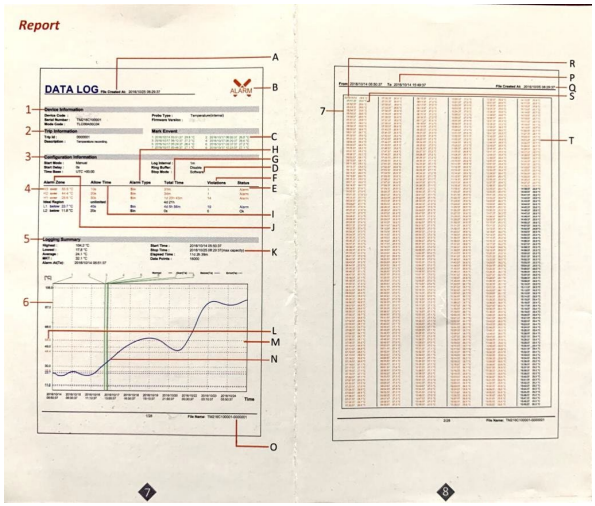
2.You may reconfigure it based on your own needs.

3.Stick the logger onto the information card.

4.Paste the information card onto measured articles.

5.Plug the logger into a computer to generate one PDF report automatically.

◆6


Report
DATA LOG
ALARM
A
B
C
H
G
D
F
E
I
J
K
L
M
N
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R
P
Q
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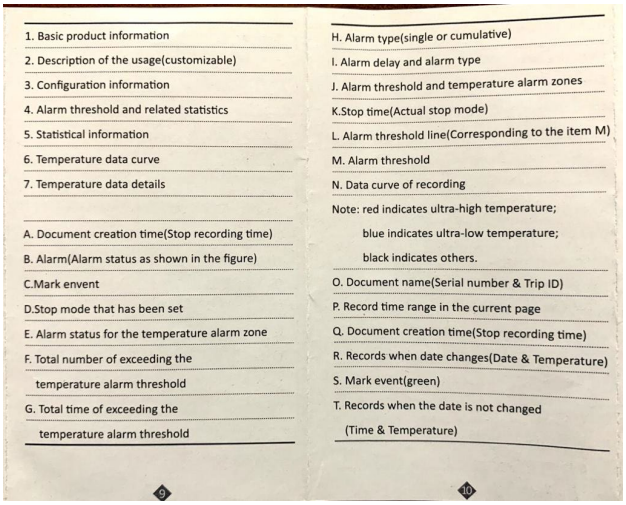
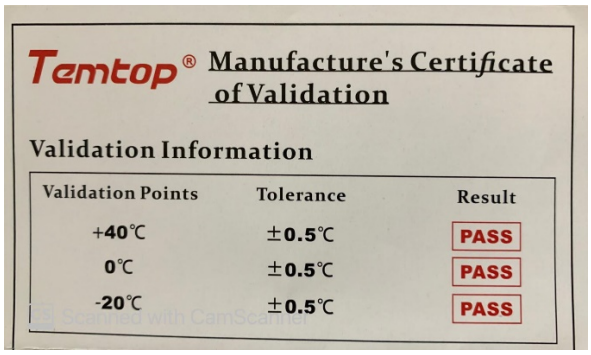
T
7
8


1. Basic product information
2. Description of the usage(customizable)
3. Configuration information
4. Alarm threshold and related statistics
5. Statistical information
6. Temperature data curve
7. Temperature data details
A. Document creation time(Stop recording time)
B. Alarm(Alarm status as shown in the figure)
C.Mark envent
D.Stop mode that has been set
E. Alarm status for the temperature alarm zone
F. Total number of exceeding the temperature alarm threshold
G. Total time of exceeding the temperature alarm threshold
H. Alarm type(single or cumulative)
I. Alarm delay and alarm type
J. Alarm threshold and temperature alarm zones
K.Stop time(Actual stop mode)
L. Alarm threshold line(Corresponding to the item M)
M. Alarm threshold
N. Data curve of recording
Note: red indicates ultra-high temperature;
blue indicates ultra-low temperature;
black indicates others.
O. Document name(Serial number & Trip ID)
P. Record time range in the current page
Q. Document creation time(Stop recording time)
R. Records when date changes(Date & Temperature)
S. Mark event(green)
T. Records when the date is not changed (Time & Temperature)
9
10


Temtop®
Manufacture's Certificate of Validation
Validation Information
Validation Points
Tolerance
Result
+40℃
±0.5℃
PASS
0℃
±0.5℃
PASS
-20℃
±0.5℃
PASS
Scanned with CamScanner

Appendix 2: The traditional house (Alhamoi's house) temperature data logger result

Data Report File created on:2020-06-03 16:32:16

Device Information

Device Model:	ST5	Sensor Type:	Temperature(Internal)
Serial Number:	TM2184D01507	Firmware Version:	V1.3

Trip Description

Trip Number: 0000001

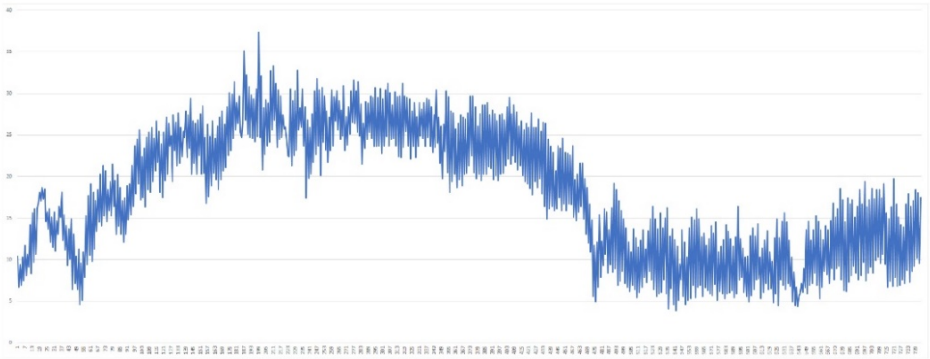
Trip Description: Temperature recording.

Config. info

Start Mode:	Press Button	Logging Interval:	0H 03M 0S
Start Delay:	12H00M	Repeat Start:	Disable
Time Zone:	UTC +03:00	Stop Mode:	Use Software
unit:	celsius degree	Logging interval shortened in alarm:	Disable
Light:	Disable		

Summary

Maximum:	37.4°C	First Reading:	2019-05-28 14:00:00
Minimum:	3.9°C	cycle Reading:	0D 12H 0M 0S
Average:	18.0°C	Last Reading:	2020-06-02 14:00:00(Use Software)
Mean Kinetic Temperature (MKT):	19.6°C	Recorded Period:	371D 4H 28M 17S
		Current Readings:	743



From 2019-05-28 12:04:29 to 2020-06-02 16:32:46 File created on: 2020-06-03 16:32:16

Time	°C	Time	°C	Time	°C	Time	°C	Time	°C	Time	°C
2019-05-28		2020-05-06		14:00:00	24.7	02:00:00	25.6	2019-08-30		14:00:00	28.9
14:00:00	17.4	02:00:00	15.3	2019-06-14		14:00:00	28.3	02:00:00	24.6	2019-10-08	
2019-05-29		14:00:00	21.5	02:00:00	16.8	2019-07-23		14:00:00	30.2	02:00:00	21.2
02:00:00	14.7	2020-05-07		14:00:00	26.3	02:00:00	25.9	2019-08-31		14:00:00	27.4
14:00:00	19.4	02:00:00	16.4	2019-06-15		14:00:00	30.5	02:00:00	23.7	2019-10-09	
2019-05-30		14:00:00	19.5	02:00:00	17.6	2019-07-24		14:00:00	29.6	02:00:00	21.0
02:00:00	13.9	2020-05-08		14:00:00	24.8	02:00:00	23.7	2019-09-01		14:00:00	28.0
14:00:00	20.3	02:00:00	13.1	2019-06-16		14:00:00	28.4	02:00:00	22.4	2019-10-10	
2019-05-31		14:00:00	20.2	02:00:00	18.9	2019-07-25		14:00:00	29.7	02:00:00	19.6
02:00:00	15.5	2020-05-09		14:00:00	26.7	02:00:00	17.4	2019-09-02		14:00:00	27.5
14:00:00	21.7	02:00:00	14.0	2019-06-17		14:00:00	26.8	02:00:00	22.3	2019-10-11	
2020-04-01		14:00:00	18.7	02:00:00	20.4	2019-07-26		14:00:00	31.2	02:00:00	20.1
02:00:00	8.1	2020-05-10		14:00:00	24.6	02:00:00	19.8	2019-09-03		14:00:00	26.7
14:00:00	10.6	02:00:00	13.1	2019-06-18		14:00:00	25.9	02:00:00	23.5	2019-10-12	
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2/3 File Name: TM2184D01507_0000001

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14:00:00	13.7	02:00:00	5.9	2020-02-22		14:00:00	18.4				
2019-12-07		14:00:00	13.4	02:00:00	6.7	2020-06-01					
02:00:00	6.4	2020-01-15		14:00:00	12.4	02:00:00	15.2				
14:00:00	12.6	02:00:00	6.0	2020-02-23		14:00:00	22.0				
2019-12-08		14:00:00	12.5	02:00:00	8.6	2020-06-02					
02:00:00	5.4	2020-01-16		14:00:00	14.1	02:00:00	14.6				
14:00:00	11.5	02:00:00	6.3	2020-02-24		14:00:00	25.5				
2019-12-09		14:00:00	11.6	02:00:00	8.2						
02:00:00	6.1	2020-01-17		14:00:00	13.6						
14:00:00	12.3	02:00:00	5.4	2020-02-25							
2019-12-10		14:00:00	12.7	02:00:00	7.1						
02:00:00	6.7	2020-01-18		14:00:00	14.7						
14:00:00	13.6	02:00:00	5.9	2020-02-26							
2019-12-11		14:00:00	16.4	02:00:00	8.9						
02:00:00	7.9	2020-01-19		14:00:00	16.8						
14:00:00	11.3	02:00:00	7.6	2020-02-27							
2019-12-12		14:00:00	12.5	02:00:00	7.6						
02:00:00	7.2	2020-01-20		14:00:00	15.1						
14:00:00	13.5	02:00:00	7.9	2020-02-28							
2019-12-13		14:00:00	11.4	02:00:00	8.9						
02:00:00	8.6	2020-01-21		14:00:00	16.1						
14:00:00	14.9	02:00:00	6.1	2020-02-29							
2019-12-14		14:00:00	10.3	02:00:00	9.2						
02:00:00	7.6	2020-01-22		14:00:00	18.6						
14:00:00	16.4	02:00:00	5.6	2020-03-01							
2019-12-15		14:00:00	10.4	02:00:00	7.6						
02:00:00	6.4	2020-01-23		14:00:00	17.2						
14:00:00	14.9	02:00:00	4.9	2020-03-02							
2019-12-16		14:00:00	12.9	02:00:00	6.3						
02:00:00	5.6	2020-01-24		14:00:00	14.5						
14:00:00	13.7	02:00:00	5.7	2020-03-03							
2019-12-17		14:00:00	13.8	02:00:00	6.2						
02:00:00	5.9	2020-01-25		14:00:00	17.4						
14:00:00	15.6	02:00:00	6.4	2020-03-04							
2019-12-18		14:00:00	12.8	02:00:00	7.3						
02:00:00	6.1	2020-01-26		14:00:00	16.7						
14:00:00	13.8	02:00:00	7.6	2020-03-05							
2019-12-19		14:00:00	14.3	02:00:00	8.1						
02:00:00	7.6	2020-01-27		14:00:00	17.2						
14:00:00	15.0	02:00:00	7.7	2020-03-06							
2019-12-20		14:00:00	10.3	02:00:00	9.2						
02:00:00	5.9	2020-01-28		14:00:00	15.1						
14:00:00	16.2	02:00:00	5.3	2020-03-07							
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02:00:00	4.1	2020-01-29		14:00:00	16.4						
14:00:00	12.8	02:00:00	6.1	2020-03-08							
2019-12-22		14:00:00	12.3	02:00:00	7.6						
02:00:00	6.5	2020-01-30		14:00:00	18.4						
14:00:00	13.7	02:00:00	7.1	2020-03-09							
2019-12-23		14:00:00	13.5	02:00:00	8.1						
02:00:00	4.6	2020-01-31		14:00:00	16.7						
14:00:00	12.4	02:00:00	6.4	2020-03-10							

Appendix 3: The modern house (mahmalji's house) temperature data logger result

Data Report File created on:2020-06-03 16:05:25

Device Information

Device Model:	ST5	Sensor Type:	Temperature(Internal)
Serial Number:	TM2184D00853	Firmware Version:	V1.3

Trip Description

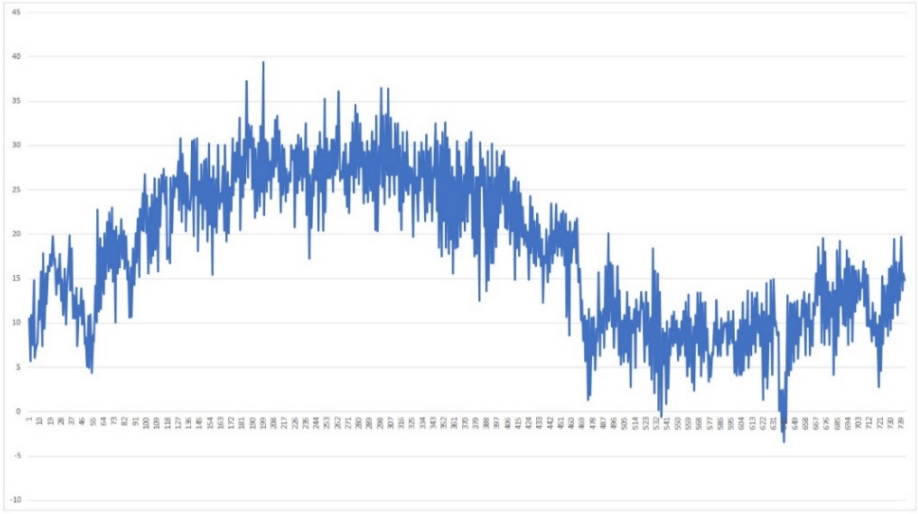
Trip Number: 0000001
Trip Description: Temperature recording.

Config. info

Start Mode:	Press Button	Logging Interval:	0H 14M 0S
Start Delay:	12H00M	Repeat Start:	Disable
Time Zone:	UTC +03:00	Stop Mode:	Use Software
unit:	celsius degree	Logging interval shortened in alarm:	Disable
Light:	Disable		

Summary

Maximum:	40.6°C	First Reading:	2019-05-28 14:00:00
Minimum:	-3.4°C	cycle Reading:	0D 12H 0M 0S
Average:	18.2°C	Last Reading:	2020-06-02 02:00:00(Use Software)
Mean Kinetic Temperature (MKT):	19.7°C	Recorded Period:	371D 0H 7M 21S
		Current Readings:	742



Time	°C
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2019-05-29 02:00:00	10.7
14:00:00	15.9
2019-05-30 02:00:00	14.5
14:00:00	24.8
2019-05-31 02:00:00	12.1
14:00:00	15.3
2019-06-01 02:00:00	21.4
14:00:00	29.1
2019-06-02 02:00:00	23.4
14:00:00	26.9
2019-06-03 02:00:00	20.3
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2019-06-04 02:00:00	22.9
14:00:00	22.7
2019-06-05 02:00:00	24.2
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2019-06-06 02:00:00	19.8
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2019-06-07 02:00:00	24.4
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14:00:00	27.7
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2019-06-16 02:00:00	20.2
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14:00:00	24.6
2019-06-18 02:00:00	23.6
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2019-06-19 02:00:00	20.4
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2019-06-20 02:00:00	19.2
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2019-06-29 02:00:00	26.4
14:00:00	32.4
2019-06-30 02:00:00	29.8
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14:00:00	30.8
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2019-07-03 02:00:00	22.6
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2019-07-04 02:00:00	23.2
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2019-07-05 02:00:00	24.8
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2020-01-12 02:00:00	6.4
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2020-01-13 02:00:00	7.5
14:00:00	12.6
2020-01-14 02:00:00	6.3
14:00:00	9.2
2020-01-15	

Time	°C	Time	°C	Time	°C	Time	°C	Time	°C	Time	°C
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2020-01-16		14:00:00	12.3	02:00:00	10.4	2020-05-11					
02:00:00	7.8	2020-02-24		14:00:00	15.8	02:00:00	10.7				
14:00:00	10.0	02:00:00	10.9	2020-04-03		14:00:00	18.4				
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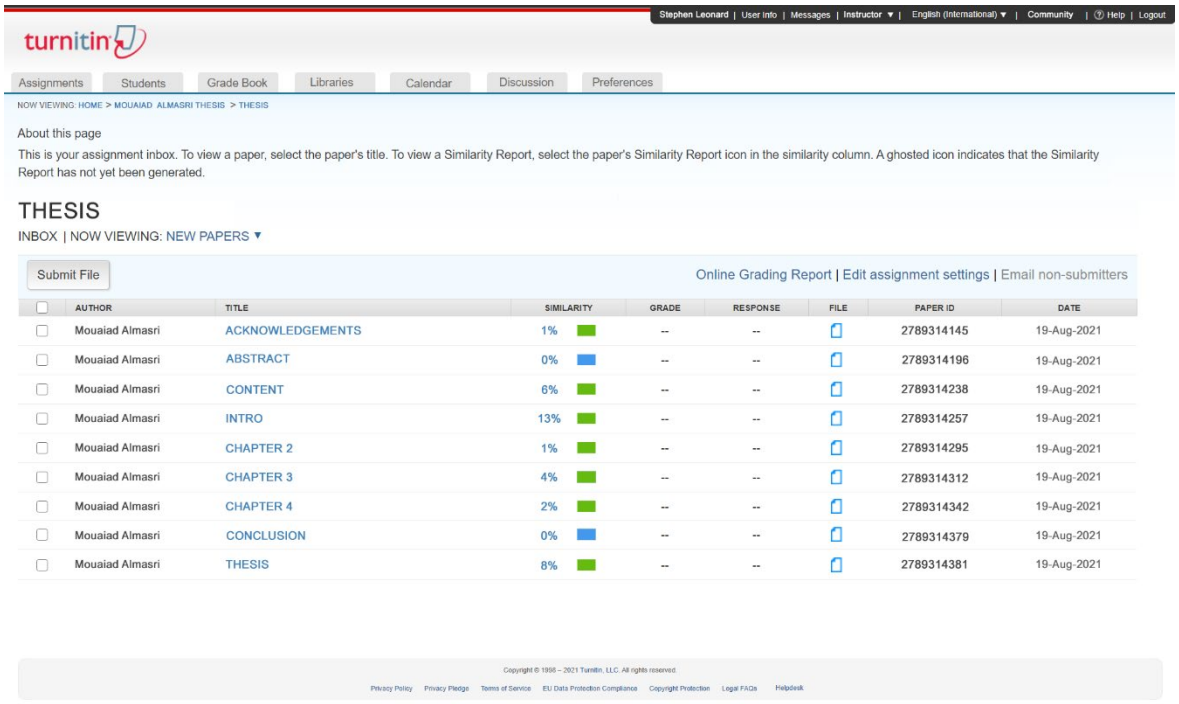
Appendix 4: Similarity report



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