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*Published in:*  
[Host publication title missing]

2012

[Link to publication](#)

*Citation for published version (APA):*  
Yahia, M. W., & Johansson, E. (2012). Thermal perception and physical characteristics of urban spaces in Damascus, Syria. In G. Mills (Ed.), [Host publication title missing] University College Dublin.

*Total number of authors:*  
2

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## 389: Thermal perception and physical characteristics of urban spaces in Damascus, Syria

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### Abstract

In recent years, the quality of outdoor urban spaces has received a lot of attention. There is a broad recognition that microclimatic conditions contribute to the quality of life in cities, both from the economic as well as from the social viewpoint. The purpose of this study is to investigate the relationship between microclimate and thermal comfort in different urban design patterns during the summer and winter in the hot dry city of Damascus, Syria. The study examines the influence of microclimate on people's thermal perception, physical properties of the place (beautiffulness and pleasantness). The study is based on questionnaire surveys during the summer and winter in six locations with different microclimates. It is shown that the urban design plays a significant role in mitigating the negative aspects of microclimate, especially during the summer time. The study also illustrates that when people's thermal perception is within the thermally acceptable range (i.e. slightly cool, comfortable and slightly warm) they experience the urban design as significantly more beautiful and more pleasant than during thermally unacceptable conditions. Our findings suggest that a new perspective is needed for determining urban microclimate requirements and incorporating them into the urban design process to enhance the thermal environment in outdoor urban spaces in Damascus.

Keywords: Damascus, Hot dry climate, Outdoor urban spaces, Thermal perception, Urban design

### 1. Introduction

In the city development, the importance of creating successful urban spaces has become the fundamental demand for architects, designers and planners. Thus, the quality of the urban spaces has received a great attention not only from social and economical perspectives, but also from an environmental point of view. In addition, the role of microclimate and thermal comfort is an essential dimension to assess the quality of outdoor urban spaces. The combination of urban design, urban microclimate and thermal comfort is useful to enhance the attractiveness of the urban spaces and to develop the built environment in the city. Recently, the concept of thermal comfort can be noticed in the latest related scientific researches. Some studies have focused on the influence of urban design and urban geometry on outdoor thermal comfort, e.g. [1]. Some others have focused on Influences of culture and environmental attitude on thermal, emotional and perceptual evaluations of the urban public places, e.g. [2]. Others have studied the influence of environment on outdoor thermal comfort, e.g. [3]. Others have investigated the thermal perception, adaption and attendance in urban public spaces, e.g. [4]. Although these and other studies provided useful insights in the field of microclimate and thermal comfort, there is still a need to examine the relationship between people's thermal comfort, perception and physical

characteristics of urban spaces in all types of thermal environments especially in regions with warm climates where both global and urban warming have a negative impact on the physical environment, people's thermal sensation, physical and mental performance as well as health problems [5]. The purpose of this study was to investigate the relationship between microclimate and thermal acceptability for different urban design patterns during the summer and winter in the hot dry city of Damascus.

### 2. Materials and methods

#### 2.1 The location and climate of Damascus

Damascus city (Elevation: 620 meters, Latitude: 33.5° N, Longitude: 36.5° E) is located in the south-west of the Syrian Arab Republic in the Middle East (see Fig.1) and It has two main parts: 1. The old part: It has a regular planning in general, with N-S and E-W street orientation. Most streets are narrow in the form of deep canyons and the buildings have inward orientation to the courtyards.

2. The modern part: The approach to urban design changed radically during the French colonial period (1920–45). New areas were built up with wide streets in a grid pattern and buildings were outwardly oriented [5]. Damascus is surrounded by an oasis – the Ghouta region –

watered by the Barada River that used to provide the city with drinking water.



Fig 1. The location of the city of Damascus in Syria

Damascus has sunny summers (June to August) and fairly cold winters (December to February). Summer temperatures can reach in excess of 35°C during the day, but evenings are generally cool. In winter, minimum temperatures can reach 0°C. Snowfall is common in winter on the mountains surrounding the city. Spring and autumn have the most comfortable climate with average temperatures in the range of 16 to 20°C (see Fig. 2).

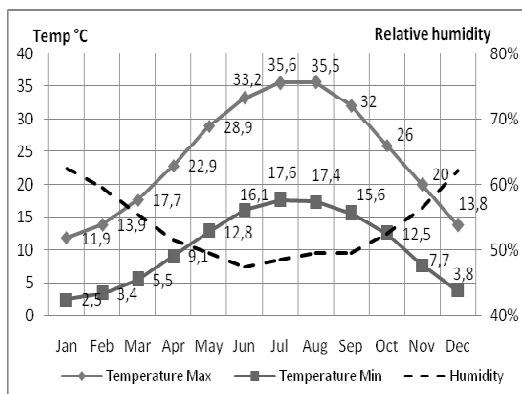


Fig 2. The average values of temperature and relative humidity in Damascus city for the period 1961-90. Source: Damascus airport meteorological station

## 2.2 Measurements and structured interviews

Field measurements and structured interviews were conducted during the summer and winter in Damascus to describe different thermal environments as well as to determine the outdoor thermal comfort. However, this paper discusses only the survey study. The study was conducted during August and September 2009 for the summer, and during January and February 2010 for the winter. The sample of this study contained 720 participants of which 360 in the winter season and 360 in the summer season. Six locations were selected for case studies and 60 interviews were conducted in each location. The interviewees were between 20 and 65 years of age of which 78% were males and 22% were females. These six locations were divided into

three categories that represent the most common urban environments in Damascus. The first category – outdoor spaces in modern Damascus – contained three studied areas: Al Gassany area which is located in the east of Damascus (see Picture b in Fig. 3), New Dummar area which is located in the west of Damascus, see picture c in Fig. 3, and Barzza area which is located in north east of Damascus (see picture d in Fig. 3). The second category – outdoor spaces in Old Damascus – contained only deep canyons and narrow streets and Al Qaymarieh Street was selected to represent Old Damascus (see picture f in Fig. 3). The third category – parks in modern Damascus – contained two areas: Al Tigara Park which is located in the east of Damascus (see picture a in Fig. 3), and Al Mazza Park which is located in the west of Damascus (see picture e in Fig. 3). The field study took place between 12:00 and 15:00 in both weekdays and weekends. At this time of the day, both the air temperature (Ta) and solar radiation reach their daily maximum, and all places have the most visitors. The questionnaire was designed to assess the people's thermal perception, climatic and aesthetic preferences in Damascus, and it covered questions about gender and age, clothing, living or working in the city, the reason for being in the places, time spent outdoors and in the places, the assessment of the microclimate, the aesthetic qualities of the place, emotional state, and assessing the attitude to urban outdoor exposure. This paper however, only discusses the results of thermal comfort and urban design, aesthetic quality of the place and thermal perception, and the results of the use of urban spaces. SPSS 18 (Statistical Package for the Social Sciences Software for Windows) was used to analyze the answers by calculating frequencies and Pearson Chi-Square test.



Fig 3. studied locations in the city of Damascus, where (a) is Al Tigara park, (b) is Al Gassany area, (c) is New Dummar area, (d) is Barzza area, (e) is Al Mazza park, and (f) is Old Damascus [6]

### 3. Results

#### 3.1 Microclimate and urban design

Fig. 4 shows the frequency distribution of how people experience the place when their thermal sensation is within the thermal acceptable range (i.e. slightly cool, comfortable and slightly warm) during the summer and winter. In summer – although the weather conditions were similar in all studied locations – Fig. 4a illustrates that people thermally accept the microclimate in Old Damascus more than the microclimate in parks, whereas they thermally accept the microclimate in parks slightly more than the microclimate in modern Damascus (Chi-square = 11.27, P = .004, df = 2). In contrast to the summer results, Fig. 4b reveals that people in winter thermally accept the microclimate in modern Damascus more than the microclimate in parks, whereas they thermally accept the microclimate in parks more than the microclimate in Old Damascus (Chi-square = 24.09, P = .000, df = 2). It should be noted that the studied day in Old Damascus was very cold, which at least may partly explain the results.

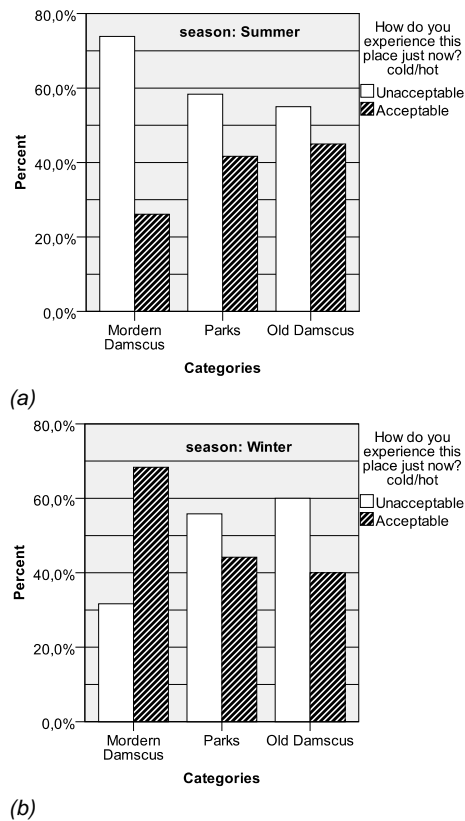


Fig 4. The frequency distribution of how people thermally experience the place in modern Damascus, parks and Old Damascus during (a) summer and (b) winter.

The results reflect the strong influence of the urban geometry and urban design on microclimate and thermal comfort. Old Damascus has deep canyons with high aspect ratios, which creates a positive effect on microclimate and thermal comfort in summer. This is because the direct short wave radiation from the sun, and consequently the mean radiant temperature,

decrease with the increase of the aspect ratio. In contrast, the outdoor spaces in modern Damascus have a low aspect ratio and therefore these spaces are more exposed to solar radiation, and thus the mean radiant temperature increases, which is positive in the winter. In the parks, the open space can be similar to modern Damascus but the trees and vegetation help to create some shade that mitigate the thermal stress. The results illustrate that the urban design plays a significant role in creating different microclimates. This agrees well with other studies, e.g. [1].

#### 3.2 Aesthetical quality and thermal perception

Fig. 5 shows the frequency distribution of how people experience the place in terms of beautifulness and ugliness. Fig. 5a illustrates that when people's thermal sensation is within the thermal acceptable range; people perceive the urban design as more pleasant than when their thermal sensation is out of the thermally acceptable range. (Chi-square = 13.68, P = .001, df = 2). In addition, Fig. 5b shows that when people's thermal sensation is within the thermally acceptable range, they perceive the urban design as more beautiful than when their thermal sensation is out of the thermally acceptable range. (Chi-square = 17.26, P = .000, df = 2). Fig. 5 reveals that people's perception of aesthetical quality of the urban design is affected by the weather and climate. The results agree well with other studies in the same climate [3].

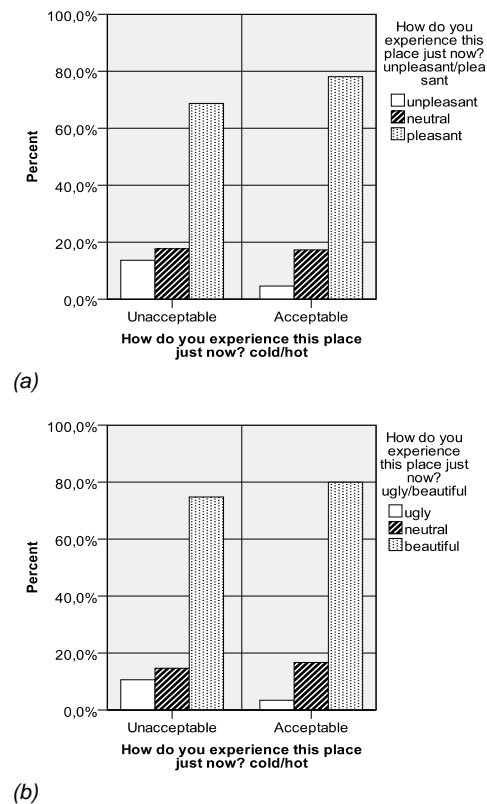


Fig 5. The frequency distribution of how people who feel either thermally acceptable or unacceptable and how they experience the aesthetical quality of the place in terms of (a) pleasantness and (b) beautifulness

### 3.3 Enhancing the use of urban spaces

Fig. 6 shows the frequency distribution of the most important reason for people to be outdoors in modern Damascus (residential areas), parks and Old Damascus. The result illustrates that the main reason for being in modern Damascus – for about 75% of the users – is to go to work, home, or school, whereas about 20% of users were there to meet other people, relax and get some fresh air. Regarding the public parks, about 64% of the users go to the parks to meet other people, relax and get some fresh air, whereas about 30% were there for going to work, home, or school. In Old Damascus, about 48% of the users passed by in order to meet other people, relax and get some fresh air, whereas about 48% were there for going to work, home, or school. Fig. 6 reveals that people tend to go to the park mainly to have some fresh air, meet other people and relax, whereas only 20% of the users in modern Damascus use the urban spaces for recreational reasons (Chi-square = 127.07,  $P = .000$ ,  $df = 4$ ). Another study in different climate found that the most important reason for being in the square is for going to work, home, or school, whereas the reason for being in the park was to get fresh air, to exercise, etc [7]. These results show that the difference between the studied areas in terms of urban design has an impact on the chosen activity by people. Thus, the results highlight the importance of improving the urban spaces in residential areas in modern Damascus so as to encourage people to spend time outdoors for recreational reasons and not only for passing by on the way to work, school or home.

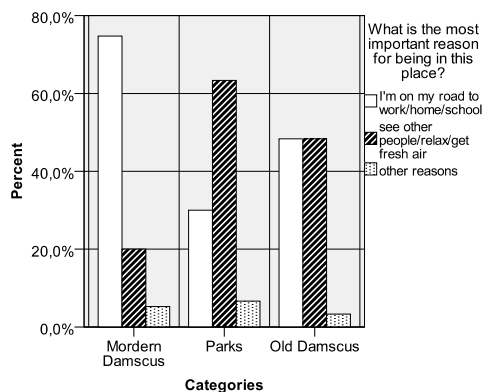


Fig 6. The frequency distribution of how people use the outdoor urban spaces in Modern Damascus, parks and Old Damascus

### 4. Discussion and conclusions

This study highlights the relationship between urban design, microclimate and thermal comfort in outdoor urban spaces. In addition, the study illustrates that the urban design plays a significant role in mitigating the negative aspects of microclimate, especially during the summer. Moreover, the study reveals that people's perception of the aesthetical quality of the urban design is affected by the weather and climate. Furthermore, the study shows that the people in Damascus tend to go to parks mainly to have

some fresh air, meet other people and relax, whereas only 20% of the users in modern Damascus use the urban spaces for recreational reasons.

One of the aspects that can help to enhance the urban design is to improve the microclimate in residential areas in modern Damascus and to increase the thermal comfort in outdoor urban spaces, especially during summer which is the most problematic season. These improvements can help to encourage people to spend more time outdoors than indoors.

The findings suggest that a new perspective is needed for determining urban microclimate requirements and incorporating them into the urban design process. This can be done by considering microclimate and thermal comfort in urban planning regulations, to develop outdoor urban spaces and to enhance the quality of life.

### 5. Future studies

More studies will be performed including statistical analysis of the emotional states, preferable weather conditions, and evaluating the outdoor activities for the people who live in Damascus. In addition, simulation studies will be conducted in order to enhance the thermal environment in Damascus' urban spaces.

### 6. Acknowledgements

This study was financially supported by Erasmus Mundus External Cooperation Window Lot 3 and Lund University, Sweden.

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