



The Impact of Urban microclimates on Environmental Comfort in Public open spaces (case study: Fields at the end of Vakilabad, Mashhad)

Farnosh Vazin¹, Sanaz Saedi Monfared², Toktam Hanaei³

1. MA in Urban Design, Urbanism Department, Mashhad Branch, Islamic Azad University, Mashhad, Iran.

2.3. Assistant Professor, Urbanism Department, Mashhad Branch, Islamic Azad University, Mashhad, Iran.

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Abstract

The quality of designing public open spaces as a resort for leisure has an important role in the satisfaction of individuals. Feelings of pleasure and satisfaction will occur when a person has reached a relative level of physical and mental (environmental comfort) and is free from constraints. Also, one of the factors of satisfaction is environmental comfort due to climatic hierarchy. However, urban microclimate is one of the factors that is needed to design urban spaces and public open spaces in order to achieve environmental comfort and satisfaction. Therefore, according to the above, the purpose of this study is to investigate the effects of microclimates on environmental comfort in a space with tourism potential in the fields at the end of Vakilabad in Mashhad. In this regard, the research methodology is based on the analytical method with the help of inferential statistics and analysis with Autodesk Revit software. Also, to achieve this goal, understanding, and recognition the factors of environmental comfort of tourists and the microclimates affecting it can be considered as a way to solve many obstacles in attracting tourists to this area, which will be addressed in this study.

Keyword: *Microclimate, climate comfort, tourist, Fields at the end of Vakilabad*

Introduction

Essentially, economic development in any country requires investment in various sectors and economic activities of that country, and without investing in infrastructure and superstructure project cannot expect the expansion of employment, production, and economic well-being. To achieve this, today many countries around the world have a strong desire to attract foreign investment. Investing in tourism infrastructure and using the potential of regional regions to attract tourists is one of the appropriate ways to do this [1]. In fact, travel and tourism have become one of the largest areas of business in the world. With tourism-related industries, it has accounted for about 10.4% of gross domestic product and 10% of total world employment in 2018. The direct share of travel and tourism in world gross domestic product is 3% and the direct share of employment is 3.8% of total employment. But despite the rapid growth of tourism in today's world and the favorable luck of developing countries to use the potential of this sector, tourism in Iran still faces serious challenges and has not reached a good position even among the region of countries. It seems that Iran's improper use of high tourism potentials has empty the other regions of countries. And countries such as the UAE, Turkey, and Georgia made good use of the

Georgia made good use of the opportunity and while capturing the regional and world markets, they also attract Iranian tourists [2]. In such conditions, one of the factors that should be considered in the discussion of tourism is the climatic conditions because the climate of a region is one of the most important factors in attracting tourists or, conversely, weakening it. Therefore, tourism is clearly dependent on climate and plays a major role in tourist demand. However, the climate is not only a thermal and physical factor but also an aesthetic factor that affects the shape of the plant and environmental society, and so on. In fact, a suitable climate can lead to positive responses from tourists, and tourists plan their programs according to the climatic conditions and atmosphere of the destination [3]. Therefore, tourists are usually looking for the desired climate or climate comfort in which the person does not feel any dissatisfaction and lack of thermal and climatic discomfort, and this factor plays an important role in deciding on a tourist destination [4]. Climate comfort of tourism is usually stated by a set of meteorological, human and environmental elements and the indicators used in this field will show the reaction of people to climatic conditions, which, using numbers and figures in a numerical classification, includes degrees from very appropriate to very inappropriate [3]. Therefore, from the point of view of climate comfort, in addition to geographical location, topography, landscape, vegetation, and animals, climate plays a role as one of

*Corresponding author.
farvazin@gmail.com

the most important local resources in the development of the tourism industry. Thus, it can be said that the climate is characterized by a huge natural wealth that influencing the environmental resources, duration and the quality of tourism, controls the health of tourists, and even the personal experiences of tourists [5]. These changes in experiences can be observed not only in the field of tourism but also in other areas so that in some studies, differences in behavioral patterns of people have been attributed to climatic conditions ([6], [7], [8]). Therefore, the feeling of comfort in the human environment undoubtedly affects the quality of his behavior and activities; therefore, paying attention to the logic of comfort of people in designing different urban spaces has a great impact on the health of their body and soul. The highest degree of flexibility of the interior spaces of the building is provided when the environmental conditions can be naturally adjusted in terms of ventilation and light. On the other hand, the range of activities and the extent of its flexibility in an outdoor location depends to some extent on the microclimate of its climate, especially the state of sunlight and wind speed [9]. Iran is one of the rich countries in the field of tourism in terms of natural and historical beauty, which receives a large number of tourists every year. However, due to economic, political, cultural, and social problems in the field of tourism, it faces many problems in this field. In recent years, with the increase in the number of tourists to meet their needs has faced many problems. Among these problems is the lack of recreation and accommodation centers. Also, according to official statistics announced by the Climatological Research Institute, Iran has a temperature between 17 and 25 degrees centigrade only 35 days a year as an ambient comfort temperature. The sum of these factors has led to tourists being less willing to use urban spaces and tourism. Therefore, in this study, the existing literature in the field of microclimatic effects on environmental comfort in tourism spaces with tourism potential such as fields at the end of Vakilabad in the cultural capital of Iran, Mashhad, is studied to get familiar with research in this area to express the structural problems and existing obstacles to providing appropriate solutions in this area. Table 1 provides a brief history of the studies. Regarding the literature review on the issues of tourism, environmental comfort, and urban microclimate, it should be acknowledged that Mohammadi et al. (2005) in his article the needs and sensitivities of tourists that should be considered in the design, including the needs of physiology, the need for change activities in the environment, the need for peace, health and social communication and cultural interactions [10]. Khanzadeh Natanzi (2010) in his article on sustainable tourism and microclimate and green roof stated that the benefits of small-scale roof greenery in improving the thermal comfort of the outdoor environment is limited to the area around the planted roof and the effects of greenery roofs on the

microclimate in dense mobile areas are more noticeable than others [11]. Martin et al (2016) in their paper presented new validation protocols for an urban microclimatic model based on city temperature measurement as well as a new model for estimating man-made heat caused by traffic in urban spaces [12]. Pijpers and Esch (2015) in their book examines the effects of urban microclimate on physical well-being and health, the influence of urban environment on its micro-climate such as the effects of building height on shading, etc. and finally provides a framework to support knowledge dissemination the knowledge of urban microclimate reached the process of urban design [13]. Vanus (2014) in his article examines the vulnerability and mental health of children due to microclimate in public and outdoor open spaces, the relationship between mental health, behavior and, physiology of children with weather conditions and offers policies to control children's climatic health [14]. In his book, Erell et al. (2011) examined the impact and application of climate in urban planning and design and the application of linear spaces and vegetation on urban microclimates and urban design strategies based on urban microclimates [15]. Finally, Brown (2010) in his book examines the conflicting cases and situations related to microclimates and examines the basic mechanisms in micro-climates and offers design solutions [16].

2. Literature Review

2.1. Tourism

The word tourism is derived from the word tour meaning to travel which the root of the Latin word turns means to go around, back and forth between the origin and the destination, which has spread from Greek to Spanish and French and finally to English [17]. Yasuri considers tourism as a factor for social, cultural, and economic development. Culturally, tourism promotes society and strengthens national beliefs and social capital and finally, from the perspective of economic development, tourism has a key role in poverty alleviation and improving the quality of life and livelihood of local people and job creation, which is a sustainable economy and job opportunities for various groups, including women, youth and even the disabled. In areas with high unemployment where relatively unskilled labor and alternative sources of employment are very limited, the formation of tourism activities may be the most appropriate action [18]. Also, tourism can be studied from a systemic perspective. From this perspective, tourism, like any other system, is composed of components that interact with each other to achieve specific goals. In fact, in this industry, inputs enter the system and are in the conversion process, and after performing a certain operation, it leaves the system as an output. It is natural that the output of this system, according to the type of inputs and the type of operations that are performed in the conversion process; it can be

different desirable or undesirable. As a result, the tourism system is exposed to a variety of effects from the changes in society [19].

2.2. Concepts of environmental comfort

Environmental comfort is one of the most important and basic components of man-made environments, because the city is a big home for living and just as the house must have the attributes and benefits to make the living and resident desirable and comfortable, so must the city have the qualities and characteristics for a field of comfort, convenience and security. Also, the city like home should have a warm, intimate and pleasant environment to provide the possibility of a desirable life, urban designs determine the quality of urban life which is related to physical and climatic environments. Of course, it is also related to other social aspects; cities are social products that are not made up of unrelated events, Moore believes that cities are a reflection of the communities that have shaped them, and that they have actively collaborated with communities in shaping human behavior and character. Urban populations are exposed to various pressures from the urban environment; Such as noise, fatigue, wear and tear, all kinds of industrial pollution and finally heat stress. Public spaces such as squares, pier promenades and parks provide places for relaxation, entertainment and a variety of informal social activities [20]. Also, environmental comfort, feeling of satisfaction and comfort is the result of coordination of physiological, psychological and physical aspects of human beings and their environment which includes a wide range of thermal, acoustic, visual, smell and air quality conditions to beauty [21]. Each of these environmental factors affects the senses through variables such as cold, heat, sound and light and it is the response to environmental stimuli that determines the level of comfort on a case and general basis. In fact, environmental conditions determine the initial value of comfort indicators. Findings from environmental comfort studies show that although the factors affecting comfort are not the same weight, but most of them emphasize the importance of thermal conditions as the most influential issue on space satisfaction and the most important criterion of public comfort [22].

2.3. Environmental comfort and the place of microclimate in it

Research focused on creating the comfort, convenience and health of open urban spaces and the global quality of urban life is growing and evolving. The growing urban population indicates that more people are turning to public open spaces, which is causing some changes in the characteristics of urban planning [20]. Careful design of urban environments can significantly improve the physical health of people in cities. The World Health Organization says a healthier environment can prevent many of the world's disease problems [23]. They also

state that urban design is an important factor for urban health [24]. Micro-urban climate is one of the biological factors affecting physical health, so it should be considered by urban designers. Environmental comfort is the feeling of satisfaction and comfort resulting from the coordination of physiological, psychological and physical aspects of human beings and their environment, which includes a wide range of thermal, acoustic, visual, olfactory and air quality conditions to beauty [21]. In addition to the natural landscape and local climate, another type of climate that is mostly influenced by constructions and designers' decisions is the micro-climate, in which there is a close relationship between buildings and their external environment. Each building changes the climate around it. The geometry and cross-section of the city, the shape, the height, the size of the building, the direction of the streets and buildings, and the level of the open spaces are all factors that determine the microclimate of the city. Therefore, every man-made element of the city, such as buildings, streets, parking spaces, airports, factories, etc., creates a special artificial climate around and above itself, which is interacted always with it. It is sometimes observed that certain details in the exterior architecture of the building have a decisive effect on the surrounding environmental conditions, especially on pedestrians, such as: protection from rain, sun or strong light by installing prominence on the upper levels of the building and dominates the passage, roofed corridors and canopies. Not only the shape of the city and its components and elements can affect the quality of the city and its spaces, but also the air quality of the city can change [25]. Man-made environments can make a significant difference in micro-climate. In general, wind speed is 25% lower in areas with construction than in areas without construction [26].

2.4. Climate and the place of microclimate in it

Climate from the Greek word *climate*, in the Oxford dictionary, means logics with specific conditions of temperature, dryness, wind and light, and so on. The general and scientific definition of climate can be said as: the temporal composition of the physical state of the atmospheric environment that is characteristic of a specific geographical location [27]. Working with the climate and conserving it will focus on three levels of climate: macro, local and micro. Macro climate is global climate. The local climate is the local climate of cities and the environment has been built which is adjusted by topography, landscape and building. Microclimate is a local climate and can be as small as a street, a corner, and around the bench in the urban space. Good weather, or at least the best climate, depending on the location, place, and the most important criteria to ensure the ease of people's movement in the cities [28]. According to the Environmental Encyclopedia, climatic factors are called macro - climatic features of a geographic region, while the microclimate is defined as the weather features

of a certain area or a specified area. The characteristics of the microclimate, depending on the amount of solar energy absorption and the amount of solar energy absorption and the degree of retention of solar energy, may be significantly different from the climatic characteristics (and the amount of wind conductivity within the atmosphere). Considering each urban space as a microclimate, urban designers try to modify the climate in the microclimate in such a way that the characteristics of the microclimate (urban space) located in the area of human comfort. With the location of urban space in the comfort zone, the desire of people to attend and perform behavior in this urban space increases [29].

2.5. The importance of microclimate in urban design of spaces and effective factors in it

Attention to microclimate is generally forgotten in urban design. Designers have little role to play in macro level climate change and have a very limited effect on meso-scale natural features, except on very large sites or the design of new collections. These features include the nature around the site and topographic elements such as hills and plains that affect how the site is exposed to wind. Design decisions have an important effect on changing the effects of microclimate on the environment and can help make the environment easier. Related factors in this scale are:

- Formation of the proposed development plan and its effect on the relationship between buildings and other impacts within the site.
- Location of access network and sidewalks, trees and other vegetation, walls, fences and barriers.
- Orientation of indoor, outdoor spaces and facades according to the direction of sunlight and shadow.
- Full and empty volumes, how volumes accumulate and the formation of space between buildings.
- Wind in the environment
- How to place the main entrances and other openings that act as intermediate spaces between inside and outside.
- Outdoor landscaping, arboriculture, fountains that enhance the cooling of spaces naturally.
- Air pollution, noise pollution in the environment [30].

In order to respond to climate issues at the local level and beyond, design must be tailored to climate issues. In addition to what has been said about climate design factors, it should be borne in mind that the micro-climate effects are exacerbated by topography. For example, the shape of the ground is effective in assessing the area. Walking or cycling on a steep upward path and towards a strong wind current can be especially tiring for the elderly and children. Paying attention to the alignment lines of a place and their connection points and differentiating them from each other in a natural and residential landscape, creates an important part of the site evaluation. Tall buildings can often affect the

microclimate of their surroundings and create unfavorable wind tunnels. In contrast, some open spaces can be sunny spots are very good in winter. Paying attention to the existing characteristics of microclimate can be key points in how to develop in the future [31].

3. Methodology

The present research is of descriptive-analytical type, based on which the methods of data collection are based on field studies, review of library documents and books and articles related to the research topic. Data analysis methods are descriptive analysis based on climate studies in Mashhad and the 12th district of Mashhad and graphic analysis with the help of Autodesk Revit software has also been used to analyze shading and radiation levels.

3.1. Introducing the study area

The study area, according to the stages of historical development of Mashhad, has been in the direction of development with a higher speed than before since 1986 and this intensified between 1975 and 1985 and is now declining rapidly due to the decline of arid fields. However, it can be said that until 1989, the area had a relative development. This area is surrounded from the south to Vakil Abad Boulevard and from the north and northwest by Chehel Bazeh channel and from the east by Vakil Abad Castle. In terms of recreational tourism potentials, according to Figure 1, this area is located close to Mashhad International Exhibition, Ershad Cultural and Sports Complex, Vakilabad Forest Park and finally Shadi Park Mountain, and in terms of access to the main second-class arterial thoroughfare and the main highway of Mashhad.

4. Results and Discussion

4.1. Investigate the tourism potentials of the area

As stated in the introduction of the area, the field at the end of Vakilabad, according to Figure 2, have a strategic position in the field of connecting recreational and tourism zones in Mashhad which has necessitated micro-climatic studies on the comfort zone in this site with tourism potential. In order to design this area in the future development of the city as a field with recreational tourism potential for the metropolis of Mashhad, the location of attractive tourist elements around this area should be identified and in this regard a proposal for the role of tourism and type of tourism services in this site should be considered. As shown in Figure 2, this area is from the north adjacent to the International Exhibition, from the west adjacent to the Ershad Cultural and Sports Complex, from the south to the mountain heights and the Shadi Park Amusement Complex and the Vakilabad Forest Complex. It can also be said that the area is in a good condition in terms of access to public transport network due to its proximity to city train and bus terminals, it should be noted that the beginning and end of urban rail transit line 1 is from

Hasheminejad Airport to the end of Vakilabad, also, one of the important stations is Basij Square, which leads to the shrine. Therefore, this makes the area accessible for tourism and accommodation development in terms of access, and enables tourists that can be use the recreation and summer centers of the west of the city, and also provides them with the possibility of pilgrimage at the lowest cost and time and this is strengthened by the presence of BRT lines.

4.2. Investigating the environmental comfort in the range

In short, it has been acknowledged that environmental comfort, feeling of satisfaction and comfort is the result of the coordination of physiological, psychological and physical aspects of man and his environment which includes a wide range of conditions of thermal comfort, sound, visual, olfactory and air quality to beauty. In fact, environmental conditions determine the initial value of comfort indicators. In this regard, due to the emptiness of the study tissue in order to understand the presence or absence of environmental comfort in the area can only suffice to examine the level of shading to understand the relative thermal comfort and extract a solution based on it. Figure 3 shows the level of shading in different seasons in October, April, January and July at the same time. As can be seen, only in summer, due to the topography of the area and the angle of radiation of the shadow surface in the center of the site, it has caused climatic and thermal adjustments and, consequently, thermal comfort. In other seasons, due to the angle of the sun and the topographic height of the site, the shadow surface is more at the edge of the range and the desired shadow is not observed in the center.

4.3. Investigation of micro-climatic factors in the area

Climatic conditions play an important role in the natural landscapes of the regions. Geographical position, altitude and topographic position, distance and position in relation to water zones determine climatic conditions and any planning must be done according to the climatic conditions of the region, otherwise the proper result will not be achieved. In the intervention area, in the two parts of east and northwest, there is topography and height difference, which in the eastern part is a hill and along the north and northwest to the southwest is a valley, in other words, the general slope of the field in the intervention area according to Figure 4 is from east and southeast to north, northwest and west, which can be said that the slope of the field is about forty intervals. In general, seasonal winds have been observed in the study area, so that in summer months, the wind is from the east and at an angle of 90 degrees for 3 months, in the winter months from the southeast and northwest,

with angles of 135 for 1 month and 315 degrees for 2 months and in spring and autumn from the south at an angle of 180 degrees for 6 months and the movement of the sun is in the range from east to southeast, southwest and west, respectively. According to Figure 5, the area is surrounded by Vakilabad Boulevard from the south, which has high motor traffic at certain times of the week, this causes air and noise pollution in the area that should be considered in the design. Considering the favorable and unfavorable winds that blow from the east in summer and from the northwest in winter and the radiation situation in the desired direction of the buildings and passages on the site is as follows. As can be seen in Figure 6, the proper orientation of buildings based on radiation in the study area is south and to a lesser extent southwest and southeast. Also, the optimal orientation of the buildings in the direction of the area winds is in the north direction and to some extent northwest and northeast, as well as south to some extent to the southwest and southeast. In order to design and consider the network of passages based on the angle of radiation and wind in the area, according to Figure 7, the appropriate direction of the passage is based on radiation, north-south and based on east-west wind.

Therefore, it is expected that in the development of tourism space design, the required buildings and passages will be in the right orientation with the direction of wind and radiation to bring maximum adaptation to the micro-climate in order to create environmental comfort for tourists.

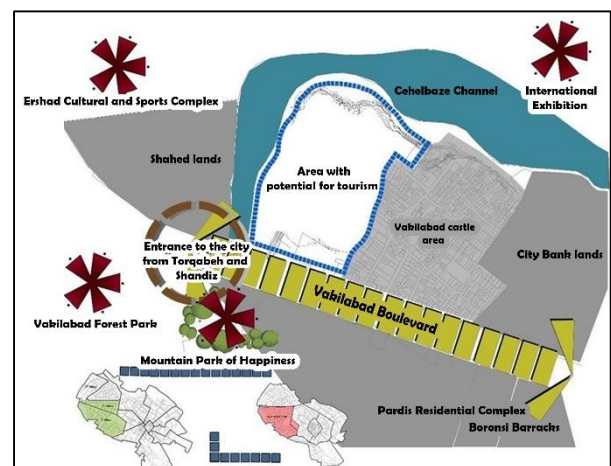


Figure 1- Location of the study area about the elements of tourism index and city access

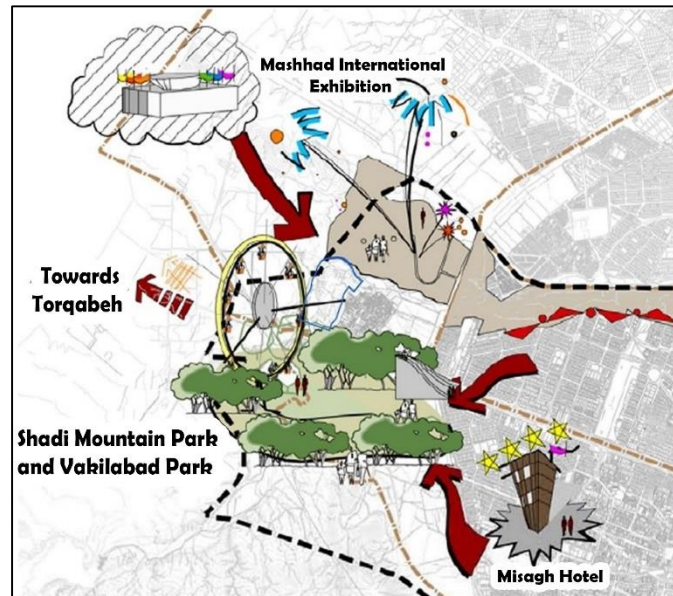


Figure 2 - Tourism potentials in the study area

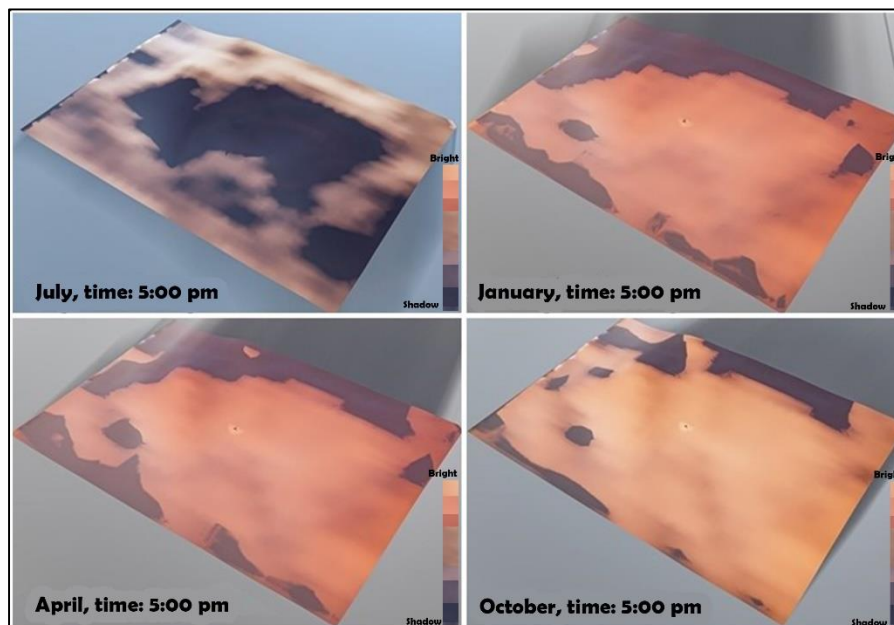


Figure 3- Comfort zone in January, July, October and April in the study area

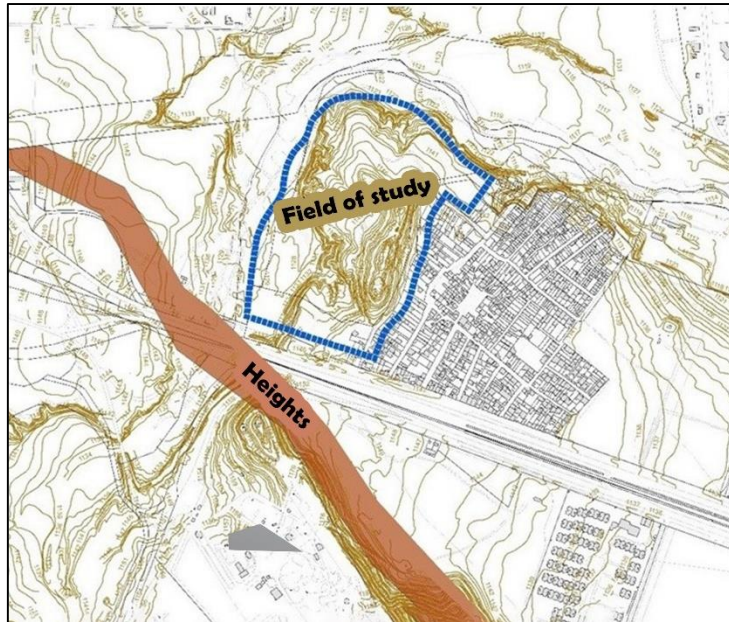


Figure 4- Status of topography and internal and external heights of the study area

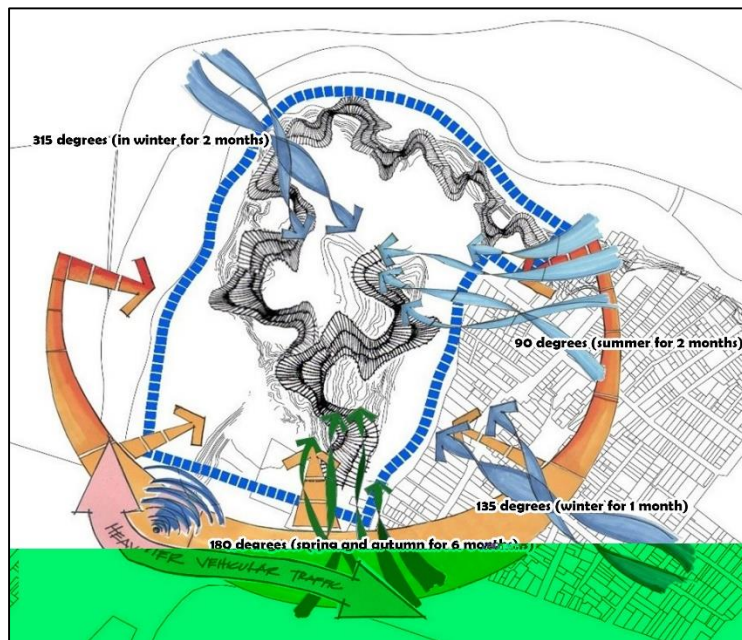


Figure 5- Status of winds and their orientation in the study area

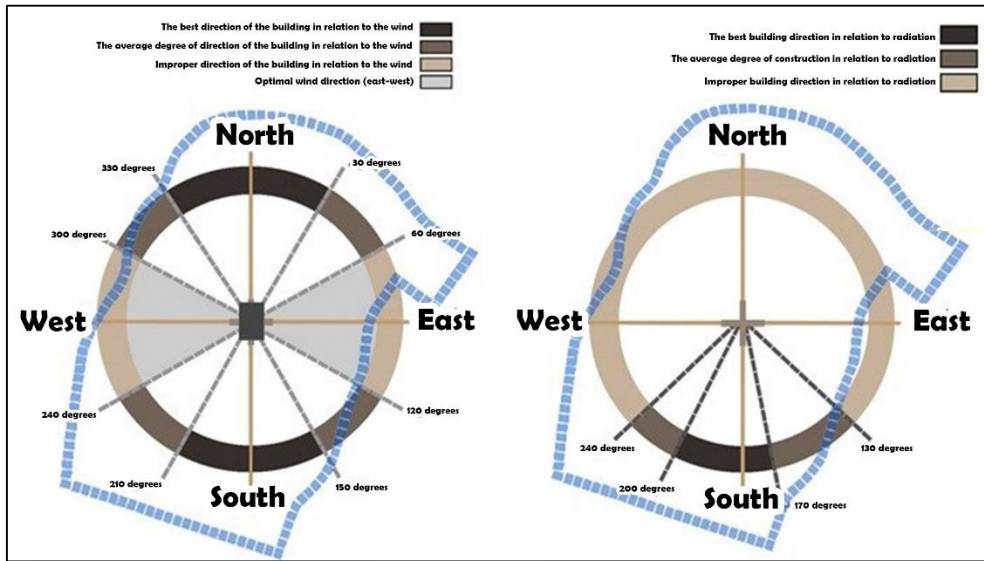


Figure 6- Appropriate orientation of buildings based on radiation (right image) and wind (left image) in the study area

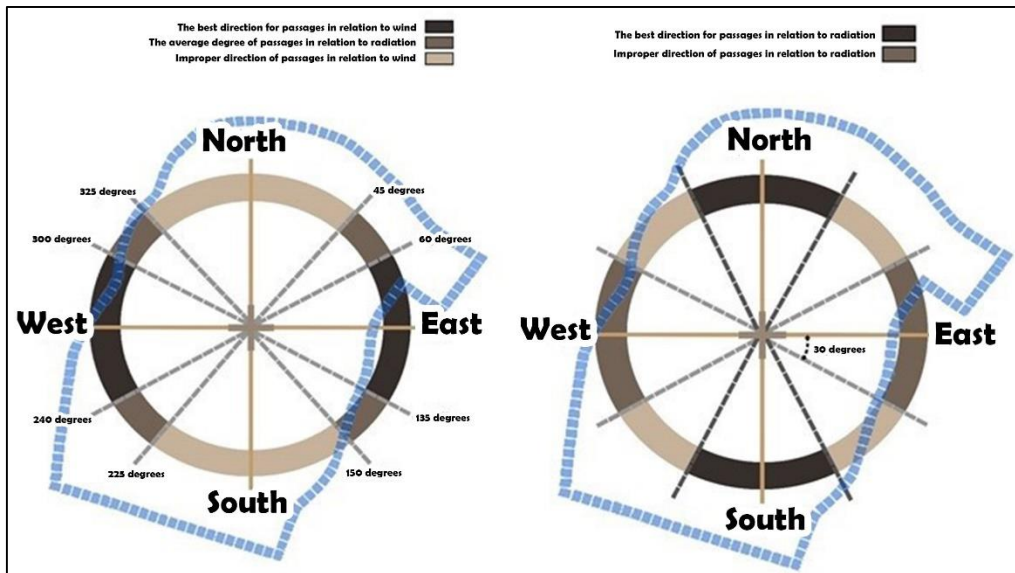


Figure 7- Appropriate orientation of passages based on radiation (right image) and wind (left image) in the study area

5. Conclusions

According to the mentioned studies and analyzes reported from the study area as a site with tourism potential in terms of micro-urban climate and environmental comfort can be acknowledged which this area from one hand, due to its location next to the elements of tourism in Mashhad, including Kuhistan Park, Vakilabad Garden, Ershad Complex, etc., as well as excellent access to the access network and the main foundation of the city (Vakilabad Boulevard) can become one of the best tourism and recreation areas of the city in the future development of the city and on the other hand, the existence of natural topography in these fields, as well as the natural slope and the resulting shading situation can become a potential for the microclimate-based design for the environmental comfort of citizens. Therefore, the result indicates that by knowing the appropriate orientation of buildings and passages based on the radiation and wind of Mashhad and its compliance with the site can be obtained that to design this area as a tourism zone based on climate comfort, the internal networking of this area should be considered as east-west as possible and extended the networks from the side texture of this site in the range and also based on this, designed buildings with complementary tourism uses for maximum lighting in the north-south direction. Also, despite knowing the level of shading in the operational area, in the center of the site in open spaces and spatial openings, light shades and suitable urban furniture should be used so that in winter, autumn and spring, radiation can be used to heat urban spaces and relative comfort. In the middle and peripheral spaces of the site, shaded green complementary spaces can be used to moderate the air and prevent visual and noise pollution, as well as enhance environmental comfort. The proposed solutions can be a specific policy for designing a tourist zone for the environmental comfort of tourists and coordination with the micro-climate of the region.

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