Int. J. Urban Manage Energy Sustainability, 2(2): 80-90 Spring 2021

DOI: 10.22034/JUMES.2020.242519

ORIGINAL RESERCH PAPER

Evaluation Outdoor Thermal Comfort of Urban Square with PET Index

O. Jeddi Farzaneh[1]*

1--Department of Urban Planning, Faculty of Architecture and Urban Planning, Tabriz Islamic Art University, Tabriz, Iran

Received 10 Jan 2020 revised 11 Feb 2021 accepted 19 Jul 2021 available online 25 Aug 2021

ABSTRACT: The most important public urban spaces are squares, which have been called by various titles such as the beating heart of urban activities, open spaces called urban lungs and the main centers of social interactions, and the main signs of identity and civic and historical character of cities. The constituent structures of the squares enclosing the field are important both in terms of their impact on the field space and the role they play in urban cells. The most important thing about buildings, regardless of their role in the body of the field, is the energy consumed by them and the microclimate created by the arrangement of the masses. Preventing the creation of heat islands and consequently creating thermal comfort as well as optimizing energy consumption in buildings are among the main and most important agendas in the field of cities today. Microclimate assessment is done by ENVI-Met4 software on modeling this case (assumed future situation). In the next step, in order to achieve the desired micro-climate, the criteria required for the texture will be simulated and evaluated and presented in two groups of scenarios, based on which a three-dimensional simulation of the urban fabric of the design site will be performed. The second evaluation in the software will be for this case, and if the micro-climate situation improves due to the applied changes, the desired texture for the design site and the body enclosing the field will be suggested.

Keywords: Outdoor Thermal comfort, Urban Square, RayMan, PET Index

RUNNING TITLE: Outdoor Thermal Comfort of Urban Squares

INTRODUCTION

Preventing the creation of heat islands and consequently creating thermal comfort as well as optimizing energy consumption in buildings are among the main and most important agendas in the field of cities today. In energy efficiency in the city, radiant energy, heat demand and the use of renewable energy of wind and solar are the most important issues discussed. The energy consumption of buildings can be significantly reduced by making changes in the density and shape of buildings as well as the way they are positioned relative to each other. On the other hand, in the impact of these buildings on their intermediate space, which is the space of the square, it should be noted that each building changes the climate around it. The effects of man-made elements on climatic factors create an artificial climate that these elements and the resulting climate always have interactions with each other. According to the mentioned cases, by studying the structures that form the texture surrounding a field, and

Corresponding Author Email:** o.jeddifarzaneh@Tabriziau.ac.ia **Tel. +98 9369667157

achieving the most suitable morphology by considering the climate and all the effective cases, it means that the field design with the desired climatic comfort was achieved. Both drastically reduced the amount of energy consumed in the tissue and by controlling the morphological criteria mentioned above, which are effective in energy consumption and create the qualities of field space, a space with high energy efficiency (pollution production and energy consumption by field body buildings) At the same time, it has the desired qualities (climatic comfort created by the design of the field body and the shape and form of the field itself, and in addition to observing the beautiful cognitive and perceptual principles in the design), created an urban space (both quantitatively and qualitatively). Therefore, in discussing the design of the square with regard to the above, given the structure of today's cities and the vital importance of the energy issue, it is not possible to be satisfied only with its aesthetic, geometric and perceptual aspects and consider the square only as a public space in terms of its function. . Rather, before reaching these aspects, the issue of the effect of texture as well as the functional characteristics of the urban space that emerges as a field on the amount of energy consumption and the micro-climate of that area as the main factors and aesthetic and social issues after it should be discussed. Due to its principles and criteria, it entered the design stage. The vitality of the field, its sociability and presence are influenced by various variables, including climatic comfort, which emphasizes the importance of paying attention to this category to ensure more and more continuous presence of users in the space.

Since today, the issue of energy and environment is the most important focus on urban issues, which is discussed at the macro level, in terms of type and production of energy consumption, and at the intermediate and micro level, the amount and method of consumption. Fields are often designed with functionalist or one-dimensional aesthetic and social approaches, and less attention has been paid to the design of fields in terms of impact on climate comfort or environmental sustainability. In designing the square as the main urban space and the basis for meeting social and cultural needs, attention to the dimensions of urban environmental sustainability should be considered as the main approach governing the design process to achieve the desired end result. In this case, although the social and aesthetic dimensions of the field are meant, in this regard, the response of the environment from an environmental and energy perspective will also be provided. Observance of these principles in the country and also in a metropolis such as Tabriz is essential. Khavaran town of Tabriz, as the newest town and at the same time the most modern residential town in the country, is a suitable platform for this design and meeting the needs of the people for urban space. This town is designed for 150,000 people, and if the project is completed and this population lives, their various needs must be met through planning and design. Designing residential buildings in order to optimize energy consumption and improve the micro-climate of the city and prevent the formation of heat islands on the one hand and respond to the social needs of residents by creating public spaces for interaction and socialization in the town on the other hand, requires a residential texture with High energy efficiency as well as a local square are at the town site. The present study is completely important in terms of all three dimensions of sustainability (economic, social and environmental). Energy efficient design reduces the need for heating energy consumption in buildings, and since the city of Tabriz is located in a cold and mountainous climate, this can be very economically effective. Also, less energy consumption reduces pollutants, which is significant from an environmental point of view, and finally, the design of the field, with favorable climatic comfort, increases interactions and strengthens vitality in the settlement area and strengthens the social dimension. Therefore, creating an urban space with favorable climatic comfort and urban texture with low and sustainable energy consumption in terms of environment in the area of Khavaran town, is very important and necessary. The purpose of this dissertation is to design a square with an environmental sustainability approach, to provide a model as a model for other squares and communal

spaces of the town in order to lead to more environmental sustainability of the town and more vibrant neighborhoods. Since today, the issue of energy and environment is the most important focus on urban issues, which is discussed at the macro level, in terms of type and production of energy consumption, and at the intermediate and micro level, the amount and method of consumption. Fields are often designed with functionalist or one-dimensional aesthetic and social approaches, and less attention has been paid to the design of fields in terms of impact on climate comfort or environmental sustainability. In designing the square as the main urban space and the platform for meeting social and cultural needs, attention to the dimensions of urban environmental sustainability should be considered as the main approach governing the stages of the design process to achieve the desired final result. In this case, although the social and aesthetic dimensions of the field are meant, in this regard, the response of the environment from an environmental and energy perspective will also be provided. Observance of these principles in the country and also in a metropolis such as Tabriz is essential. Khavaran town of Tabriz, as the newest town and at the same time the most modern residential town in the country, is a suitable platform for this design and meeting the needs of the people for urban space. This town is designed for 150,000 people, and if the project is completed and this population lives, their various needs must be met through planning and design. Designing residential buildings in order to optimize energy consumption and improve the micro-climate of the city and prevent the formation of heat islands on the one hand and respond to the social needs of residents by creating public spaces for interaction and socialization in the town on the other hand, requires a residential texture with High energy efficiency as well as a local square are at the town site. The present study is completely important in terms of all three dimensions of sustainability (economic, social and environmental). Energy efficient design reduces the need for heating energy consumption in buildings, and since the city of Tabriz is located in a cold and mountainous climate, this can be very economically effective. Also, less energy consumption reduces pollutants, which is significant from an environmental point of view, and finally, the design of the field, with favorable climatic comfort, increases interactions and strengthens vitality in the settlement area and strengthens the social dimension. Therefore, creating an urban space with favorable climatic comfort and urban texture with low and sustainable energy consumption in terms of environment in the area of Khavaran town, is very important and necessary. The purpose of this dissertation is to design a square with an environmental sustainability approach, to provide an example as a model for other squares and communal spaces of the town in order to lead to more environmental sustainability of the town and more vibrant neighborhoods.

METHODOLOGY

The present study is structural-analytical-descriptive and in terms of the main purpose, is a type of development-applied research. The method of data collection is in the form of libraries (documents), databases, field navigation and extraction from the map. For climate information, two softwares, Climate Consultant and Meteonorm, are used, and in necessary cases, data is simulated by Google Sketchup software. First, by reviewing the literature on the subject and reviewing the research background, and in relation to the research path, the effective criteria and indicators required for the study are explained from theoretical foundations in the form of a conceptual framework. In the next stage, first by examining the existing criteria of the detailed plan and construction regulations provided by the Municipality of Tabriz Region 9, the hypothetical situation for the future of the town is predicted and this hypothetical situation is evaluated in ENVI-Met4 software. In the following, to optimize the microclimate formed in the design site, two sets of scenarios for the proposed texture (the first group with constant building density and the second group with constant occupancy level) are presented. The proposed scenarios are also adjusted based on density, occupancy level and number of classes extracted from the existing criteria so

that the options are not far from reality. Then, by evaluating the presented scenarios (six scenarios in total) and analyzing the results obtained from the evaluation (temperature, wind speed, humidity, direct radiation and average radiation temperature), a scenario as the optimal scenario for the tissue with the occupied area and number Specific categories are selected that will be generalized to the site context. After concluding the texture, the field space is evaluated for three models of thermal comfort, new effective standard temperature (STE), physiological equivalent temperature (PET) and estimated mean temperature (PMV) by RayMan software. In this evaluation, three height modes for the field body are evaluated in the form of three options and the result of the thermal comfort evaluation will indicate the best position for the field body in order to provide thermal comfort. After achieving the optimal state of the texture and body of the square, by observing the massification instructions obtained from the evaluations, the initial plan of the site is obtained and the urban design process for the design of the local square begins. The goals, strategies and policies presented in the design process are also within the framework of the mentioned guidelines and in line with the main design approach as well as the qualities expected from the local field and will result in the final design of the local field with the environmental sustainability approach.

METHODS OF DATA ANALYSIS

In the first scenario group, three scenarios with constant building density percentage and in the second scenario group, three scenarios with fixed occupancy level are considered, six scenarios are modeled in ENVI-Met environment and the microclimate obtained from each of them on the coldest and warmest day of this year It becomes pseudo. Temperature, wind speed, humidity, direct radiation and the average temperature of the radiation resulting from the simulation for the scenarios are compared, the ranking and the superior scenario are determined. In the field evaluation, three options with different number of floors were modeled in ReyMan environment and the thermal comfort SET, PET and PMV were simulated for all three modes in the coldest and hottest days of the year and by evaluating the results and determining the best value for each model of Thermal comfort, the ideal state for the body of the field is determined by the best thermal comfort. Eventually, the top texture scenario and the best state of the field body are combined to achieve the original plan

Fabric evaluation and analysis

The current situation of Khavaran town has no urban context and only office and municipal buildings and the center of international conferences and the number of residential license plate areas have been scattered. No construction has been done on the site to design the square and it has been abandoned in the preparatory stage.

Texture evaluation and analysis (simulated based on existing detailed design and municipal criteria)

Therefore, in order to create a better understanding of the future situation of this part of the town, in case of construction with existing criteria and documents, based on the detailed plan map of Khavaran town and the criteria proposed by the municipality of Tabriz 9th district for construction in this town, the situation Assuming the future of the site is simulated design.(Fig 1).

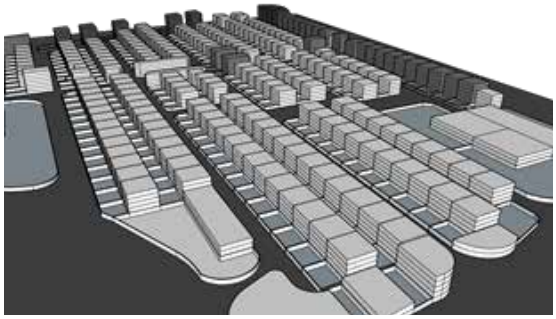


Fig 1: 3D simulation of the assumed situation of the design site in the future

Segmentation of the design site in the detailed plan, except for six parts, five of which are over 1000 meters and one is over 600 meters, and are allocated for office uses and urban

facilities and equipment, and their occupancy and density based on the type of use or The use is defined, the rest are residential use and are less than 500 square meters. According to the specifications of different residential patterns in the criteria announced by the Municipality of Tabriz Region 9 for construction in Khavaran town, parts with a quorum of 350 square meters, which includes the majority of site plates, occupancy level of 55% (192 square meters) and Number of floors 5 and number of 9 residential units, plots with a quorum of 390 square meters, 55% occupancy level (214) meters and 5 floors, plots with a quorum of 525 square meters, 50% occupancy area and 8 floors and a limited number of plots with The quorum is 720 square meters, with 50% occupancy and 8 floors. The maximum permissible building density for the first and second categories is 275%, the third category is 350% and the fourth category is 400%. The area of open space for each unit is between 17.5 - 20 square meters. With the mentioned specifications, three types of patterns available on the site have been simulated. In addition to the 3D simulation used as the current situation, this mode is modeled in ENVI-MetV4 software and its micro-climatic conditions in the desired geographical coordinates and in the coldest (winter revolution 21 Dec) and warmest (summer revolution 21 June) Has been evaluated

Based on the specifications mentioned in the previous section and also the general principles and criteria of massing, the parts available on the site in the Space environment of ENVI-Met4 software are assumed to simulate the texture and a three-dimensional model of the design site is prepared in the space of this software. With the climatic parameters of both time periods (summer and winter revolutions), in each case, climatic simulations were performed for 48 hours, the results of which are as follows. (Fig. 2)..

ENVI-Met4 assessment results

The results obtained from the first part of the evaluation of the hottest day of the year (June 22) in two time periods of 15:00 (warmest hour)

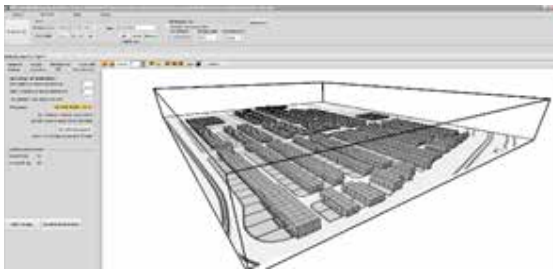
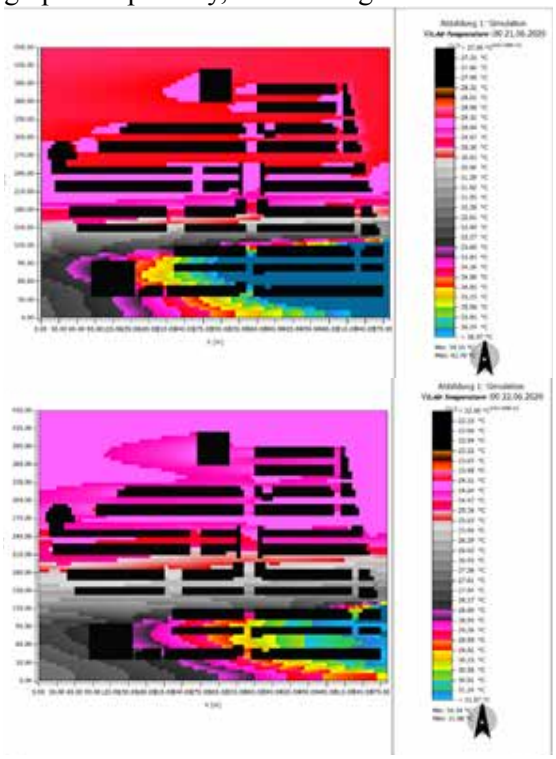


Fig 2: 3D modeling of the hypothetical situation for climate simulation in Space ENVI-Met4 software

and 5:00 (coldest hour) are as follows in the form of temperature map and separate diagrams from The average of 24 hours of simulation is temperature, wind speed, humidity, direct radiation and average radiation temperature. (Fig. 3).

And the results obtained from the second part of the evaluation of the coldest day of the year (December 21) in two time periods of 15:00 (warmest hour) and 5:00 (coldest hour) also as follows in the form of temperature maps and graphs Separately, the average of 24 hours



of simulation of temperature, wind speed, humidity, direct radiation and average radiation

temperature are given.(Fig. 4).

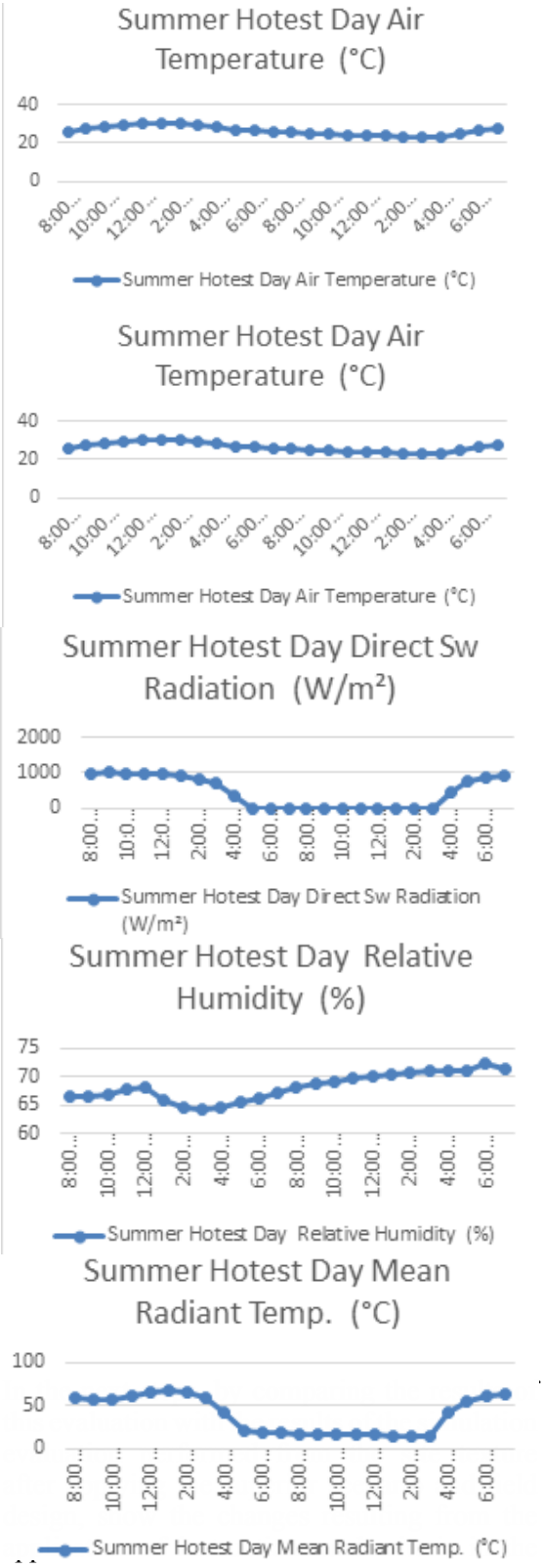
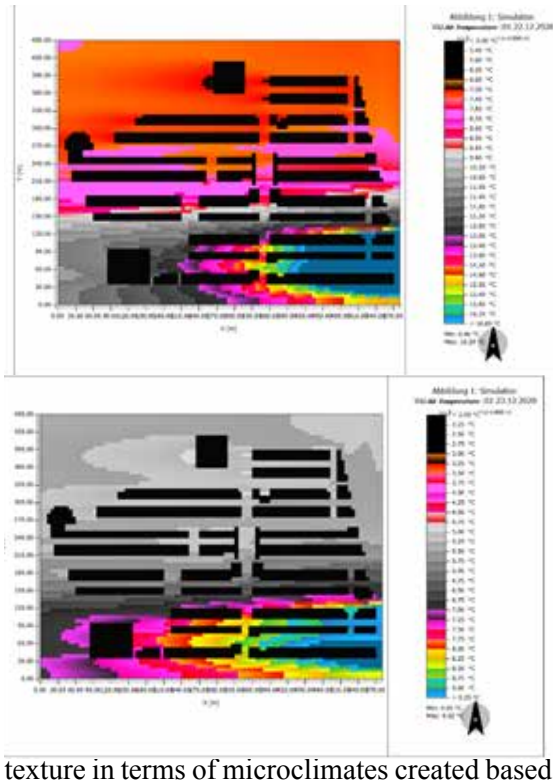
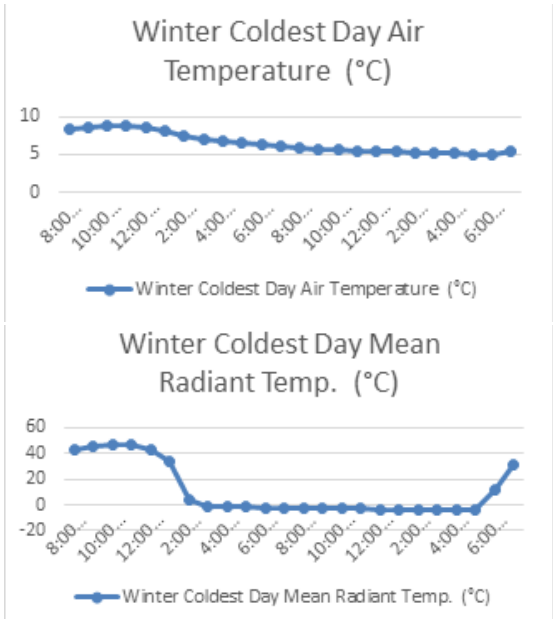


Fig 3: Design site temperature map in the assumed future condition, on the hottest day. Right at 5:00 and left at 15:00



texture in terms of microclimates created based on these parameters. It will be given that these changes will result in less energy consumption in buildings as well as climatic comfort in the field space.



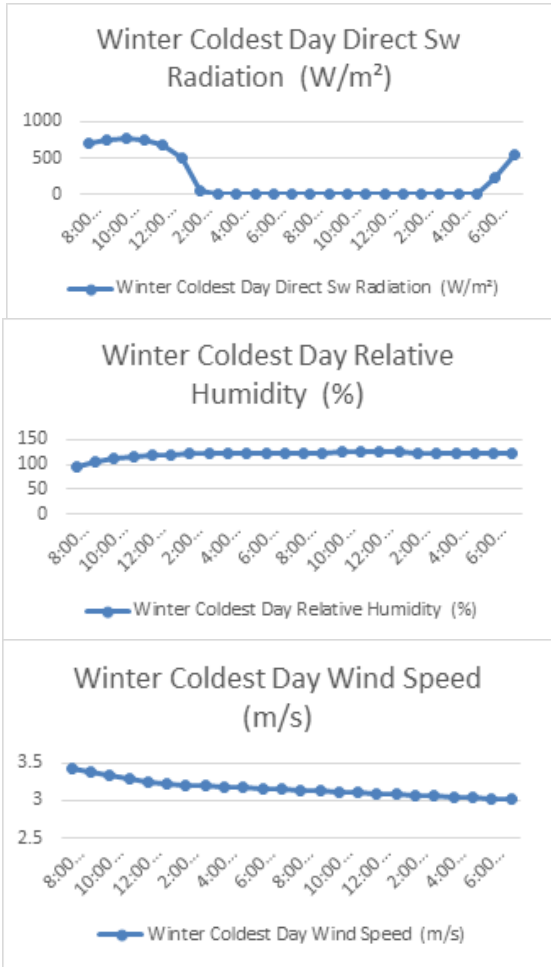


Fig 4: Design site temperature map in the assumed future state, on the coldest day. Right at 5:00 and left at 15:00

Fabric massing scenarios

In order to achieve the intended goal, which is to select and present the type and type of mass in the residential context of the design site, in this step, two groups of scenarios are defined and their examples in ENVI-MetV4 modeling software and microclimatic conditions of each We simulate. The results of this simulation determine the best possible case for us, which we extend to the whole site. The two sets of scenarios defined in this section are one based on fixed employment level and the other based on fixed building density percentage. In the first scenario group, the relationship between the level of occupancy and the microclimate created in a situation where the level of building occupancy is constant and the building density and the number of floors are variable is evaluated. In the second scenario group, the relationship between building density and micro-urban climate created in a situation where the number of floors and the level of occupancy of parts is variable is evaluated

To achieve the desired level of occupancy and density in a fixed amount of scenarios, by referring to the table .... and using the criteria of the municipality of District 9 for construction in the town of Khavaran, Tabriz, and also examining the part of the texture that is used for scenario writing It can be explained that the main parts of the design site are 397, 420 and 442 square meters. Therefore, these size limits form the main basis of scenario work. According to rows 3 to 7 of the above table, the occupancy level of 50% and 55% is allowed for parts with the mentioned sizes, and considering that the occupancy level is 50% for the majority of parts, so the occupancy level is 50% for the fixed occupancy level. In the first scenario group is selected. Also, the allowable density for residential parts of the design site varies from 275% to 400%. We choose a density of 350%, which includes the majority of site components, as a constant density in the second scenario group. In the first scenario group, taking into account the occupancy level (50%), and based on the 3 allowable building densities in the criteria for parts (275%, 350% and 400%), this scenario group with three modes in the number of floors 5, 7 and 9 are presented. The first case is classified as 50% occupancy level, 275% density and 5 floors, the second case occupancy level is 50%, the occupancy rate is 350% and 7 floors and the third case is 50% occupancy level, 400% density and 9 floors. .

Modeling in ENVI-MetV4

As in the simulation of the previous part, in the simulation of the presented scenarios, the hottest and coldest day is used as a criterion and in each of them, after 24 hours of simulation, the results of critical hours (hottest and coldest hours) are evaluated. Finally, by examining the average of each parameter for each scenario on the desired day and comparatively comparing

the results with each other (according to the optimal amount of each parameter in relation to its impact on the microclimate of the season), and assigning a ranking weight to each scenario for each parameter The weighted average of each scenario, which includes all 5 parameters mentioned in the previous section, indicates the best scenario for use in the context of Khavaran town. The results of the average of each parameter in the hottest and coldest day of the year for each scenario are given in the table below. (Tab.1)

Fig 4: Results The average of each parameter on the hottest and coldest day of the year for each scenario

	A1	A2	A3	B1	B2	B3
Hotest Day of Summer Air Temperature Average	24.35	24.22	24.23	24.31	24.35	24.34
Coldest Day of Winter Air Temperature Average	5.81	6.05	6.17	6.08	6.09	5.98
Hotest Day of Summer Wind Speed Average	2.54	2.46	2.54	2.56	2.53	2.48
Coldest Day of Winter Wind Speed Average	3.98	3.86	3.99	4.10	4.05	3.97
Hotest Day of Summer Relative Humidity Average	64.10	64.27	64.08	63.73	63.44	63.77
Coldest Day of Winter Relative Humidity Average	116.25	116.47	116.76	116.85	116.98	117.20
Hotest Day of Summer Direct Sw Radiation Average	468.96	469.98	470.00	469.79	469.86	469.85
Coldest Day of Winter Direct Sw Radiation Average	0.00	96.22	212.09	199.41	208.71	0.00
Hotest Day of Summer Mean Radiation Temp Average	36.53	36.55	36.32	36.69	36.78	36.59
Coldest Day of Winter Mean Radiation Temp Average	0.63	5.04	10.94	11.02	10.94	2.02

In Leonardo environment, from ENVI-Met4 software platform, for each of the mentioned critical hours, a thermal map output scenario is taken from each scenario, which can be seen in Figures. But as it was said, the criterion for choosing the option was not the map but the numbers and figures obtained from the simulations and the objective reasons for the selection are given in 4-4. The data are also displayed in the form of diagrams for better understanding. The diagrams are divided and presented for 5 parameters and two time periods.(Fig.6)

Evaluate the results of ENVI-MetV4

As can be seen in the diagrams, each parameter has a different status in each of the scenarios at each time point, and by summarizing these results and comparatively comparing and ranking weights for each scenario for each parameter separately, to As shown in the following tables, the final result is obtained and the superior scenario is selected. (Fig.7)

For ranking in each parameter, according to the effect of the amount and amount of that parameter in the climatic situation of the region, the lowest, highest and optimal range has been the ranking criterion

CONCLUSION

Finally, by comparing the average rank weight of each scenario, the result of scenario A3 is introduced as the best of the six scenarios presented in the form of two scenarios with constant occupancy level and constant density. This scenario provides 65% of the occupancy level and 5 construction floors in the best case for the formation of micro-climate on the site. In this scenario, the building density is 350% and it should be noted that as in the three-dimensional simulation of the scenarios in Figure .., the placement of the masses is in the middle of the parts and each piece has two yards north and south. Of course, mathematically, the displacement of the masses along the parts, provided that this displacement is applied equally to all parts, will not affect the proportions of the corridors, and therefore the simulation will have the same result in any of these types. If these criteria are observed and they are fully applied to the constructions, the following situation can be imagined in the future of Khavaran town in this part and design site, which has a fundamental difference in the micro-climate in the region

compared to the current situation. , Its heat islands and consequently the amount of energy needed to meet the heating and cooling needs of the building. The evaluations performed in this chapter were performed in two main parts of the texture and space of the field and by evaluating the results of both parts, the optimal massification for the texture and body of the field was obtained. In the first stage, the assumed condition of the texture in the future was evaluated by considering the municipal criteria and the detailed simulated plan and the resulting climate wisdom in Envy Matt software. At this stage, based on the criteria and size of the parts available on the design site, the number of floors, occupancy level and density were determined. Then, two proposed scenarios for the texture were proposed. In the first scenario group, the building density was considered constant and the occupancy level and number of floors were variable, and in the second scenario group with a fixed occupancy level and the number of floors and building density were variable. Each group was evaluated with three scenarios and the result was made by evaluating five variables of air temperature, velocity, humidity, direct radiation and average radiation temperature, scenario A3 with an occupancy level of 65%, a density of 350% and 5 floors. Selected as best mode. In the second part, the field space was modeled in two modes, north-south and east-west, and in Envy Matt software, climate simulation was performed on both models, and based on the output obtained from the simulation, based on five air temperature variables. , Speed with, humidity, direct radiation and average radiation temperature, the north-south option with better conditions than the other option was selected and placed in the plan. In selecting the best height of the field body from the point of view of thermal comfort, the field body in three heights of 3, 5 and 7 floors at six different points of the field surface is simsulated in Rayman software environment and based on physiological equivalent temperature and standard temperature, the best Thermal comfort mode was approved for the field body with 5 floors height. Therefore, in this part, the final plan of massing the site based on the results obtained from this chapter is presented as follows with 65% construction and 5 floors and the body of the square with the same number of floors.

REFERENCES

A Gulyas, J., & Unger, A. (2006). Matzarakis: Assessment of the microclimatic and human comfort conditions in a complex urban Matzarakis: Assessment of the microclimatic and human comfort conditions in a complex urban. Build Environment, 41(12), 1713-1722.

Abreu-Harbich, L. (2014). Thermal bioclimate in idealized urban street canyons in Campinas, Brazil. Theoretical and applied climatology, 115(1-2), 333-340.

Acero, J., & Herranz-Pascual, K. (2015). A comparison of thermal comfort conditions in four urban spaces by means of measurements and. Building and Environment, 93, 245-257.

Adolphe, L. (2001). Modelling the Link between Built Environment and Urban Climate: Towards Simplified Indicators of the City Environment. Seventh International IBPSA Conference, (pp. 679-684). Rio de Janeiro.

Aguiar, A. (2012). Urban Heat Islands: Differentiating Between the International Workshop on Geoscience and Remote Sensing. International Journal of Climatology, 1-17.

Aguiar, A. (n.d.). Urban Heat Islands: Differentiating Between the International Workshop on Geoscience and Remote Sensing. 316-319.

Ahmad, K., Khare, M., & Chaudhry, K. (2005). Wind tunnel simulation studies on dispersion at urban street canyons and intersections—a review. Journal of Wind Engineering and Industrial Aerodynamics, 93(9), 697-717.

Ahmad, K., Khare, M., & K. K. (2005). Chaudhry, Wind tunnel simulation studies on dispersion at urban street canyons and intersections—a review. Journal of Wind Engineering and Industrial Aerodynamics, 93, 697–717.

Ahmed, K. (2003). Comfort in urban spaces: defining the boundaries of outdoor thermal comfort for the tropical urban environments. Energ Buildings, 35(1), 103-110.

Akbari, H., Pomerantz, M., & Taha, H. (2001). Cool surfaces and shade trees to reduce energy use and improve air quality in urban areas. Urban Environment, 70(3), 295–310.

Algeciras, J., Consuegra, L., & Matzarakis, A. (2016). Spatial-temporal study on the effects of urban street

configurations on human thermal comfort in the. Building and Environment, 101, 85-101.

Ali-Toudert, F., & Mayer, H. (2006). Numerical study on the effects of aspect ratio and orientation of an urban street canyon on outdoor thermal comfort in hot and dry climate. Build Environment, 41(2), 94-10.

Ali-Toudert, F., & Mayer, H. (2006). Numerical study on the effects of aspect ratio and orientation of an urban street canyon on outdoor thermal comfort in hot and dry climate. Building and environment, 41(2), 94-108.

Ali-Toudert, F., & Mayer, H. (2007). Thermal comfort in an east–west oriented street canyon in Freiburg (Germany) under hot summer conditions. Theoretical and applied climatology, 87(1), 223-237.

Ali-Toudert, F., & Mayer, M. (2006). Numerical study on the effects of aspect ratio and orientation of an urban street canyon on outdoor thermal comfort in hot and dry climate. Building and environment, 41(2), 94-108.

Alznafer, B. (2014). The impact of neighbourhood geometries on outdoor thermal comfort and energy consumption from. Cardiff University.

Arboit, M., Diblasi, A., Fernandezllano, J., & Derosa, C. (2008). Assessing the Solar Potential of Low-Density Urban Environments in Andean Cities with Desert Climates. Renewable Energy, 33(8), 1733-1748.

Arens, E., Zhang , H., & Huizenga , C. (2006). Partial- and whole-body thermal sensation and comfort, part I: uniform environmental conditions. Journal of Thermal Biology, 9, 31-53.

Arens, E., Zhang, H., & Huizenga, C. (2006). Partial- and whole-body thermal sensation and comfort, part II: non- uniform environmental conditions. Journal of Thermal Biology, 31, 60-66.

Arnfield, A. (2003). Two Decades of Urban Climate Research. Int. J. Climatol, 50-68.

Arnfield, A. (2008). Canyon geometry, the urban fabric and nocturnal cooling: a simulation approach. Phys Geography, 11, 220-239.

Arnfield, A., Herbert, J., & Johnson, G. (1998). Coupling of a scalar dispersion and an urban canyon energy budget model. Mathematics and Computers in Simulation, 43, 277-283.

Aroztegui, J., & Miguel, Í. (1995). Temperatura Neutra Exterior. In: Encontro Nacional Sobre Conforto No Ambiente Construído (ENCAC. Gramado: Anais.

Ashrae. (2001). Advanced Ventilation Technologies in the 21st Century. Crete island.

Ashrea. (2004). Thermal environmental conditions for human occupancy. GA: American Society of Heating, Refrigerating and AirConditioning Engineers (ANSI/ ASHRAE). Atlanta: Ashrea.

Asimakopoulos, D., Peppes, A., & Santamouris, M. (2002). Experimental and numerical study of buoyancy-driven stairwell flow in a three storey building. Building and environment, 37(5), 497-506.

Azer, N., & Hsu, S. (1977). The prediction of thermal sensation from a simple thermoregulatory model. ASHRAE Transactions, 83, Part 1.

Bauer, M., & Yuan, F. (2007). Comparison of impervious surface area and normalized difference vegetation index as indicators of. Remote Sensing of environment, 106(3), 375-386.

Bauman, F., Baughman, A., Carter, G., & Arens, E. (1998). A field study of PEM (personal environmental module) performance in bank of American's San Francisco office buildings. Berkeley: Berkeley: Center for the Built Environment.

Belding, H., & Hatch, T. (1965). Heating, Piping and Air Conditioning. 27(8), 129-36.

Benz, A., Winkelman, N., Porter, J., & Nimphius, S. (2016). Coaching Instructions and Cues for Enhancing Sprint Performance. Strength and Conditioning Journal, 38(1), 1-11. doi:10.1519/SSC.0000000000000185

Bhiwapurkar, P. (2007). Urban heat island phenomenon, Urban morphology. Sustainable Cities and Society, 19.

Biddulph, M. (2007). Introduction to Residential layout Architectural Press. Oxford: Elsivier.

Biddulph, M. (2007). introduction to residential layout. oxford: architectural press.

Biddulph, M. (2007). Introduction to Residential Layout. Oxford: Elsevier.

Blake, C., Kazin, E., Beutler, F., Davis, T., Parkinson, D., Brough, S., & Croton, D. (2011). The WiggleZ Dark Energy Survey: mapping the distance–redshift relation with baryon acoustic. Monthly Notices of the Royal Astronomical Society, 418(3), 1707-1724.

Bluestein, M., & Osczevski, R. (2002). Wind chill and the development of frostbite in the face. Preprints, 15th Conference on Biometeorology and Aerobiology, Kansas City, 168-171.

Bourbia, F., & Awbi, H. (2004). Building cluster and shading in urban canyon for hot-dry climate. Renewable Energy, 29, 291-301.

Bourbia, F., & Bourcheriba, F. (2010). Impact of street design on urban microclimate forsemi arid climate (Constantine). Renewable Energy, 35, 343-347.

Brode, P., Fiala, D., Blazejczyk, K., Holmer, H., Jendrizky, G., Kampmann, B., . . . Havenith, G. (2012). Deriving the operational procedure for the Universal Thermal Climate Index (UTCI). International Journal of Biometrology, 56(3), 481-494.

Brown, R., & Gillespie, T. (1995). Microclimatic landscape design: creating thermal comfort and energy

efficiency. New York: John Wiley & Sons.

Brown, R., Krys, S., & Gillespie, T. (1990). A model for estimating radiation received by a person in the landscape. Landscape Research, 15(3), 33–36.

Brown, R., Vanos, J., Kenny, N., & Lenzholzer, S. (2015). Designing urban parks that ameliorate the effects of climate change. Landscape and Urban Planning, 118-131, 118-131.

Cambridge Systematic. (2005). Climate change and its effects on urban spaces in Chile: A Cambridge Systematics, Inc. Heat Island Reduction Initiative.

Canniffe, E. (2011). review of Urban Space by Rob Krier. Manchester : Manchester School of Architecture.

Carmona, M. (1996). sustainable urban design: the local plan agenda, urban design. London: E&FN Spon.

Carmona, M. (2003). Public space , Urban spaces: the dimensions of urban design. Illustrated, 117.

Carmona, M. (2006). Designing Mega-projects in Hong Kong: Reflections from an Academic Accomplice: Practice Note. Journal of Urban Design, 11(1), 105-124.

Carmona, M., & de Magalhaes, C. (2006). Public space management – Present and Potential. Journal of Environmental Planning & Management, 49(1), 75-99.

Carmona, M., Tiesdell, S., Heath, T., & Oc, T. (2003). Public Places Urban Spaces-The Dimension of Urban Design. Oxford, UK: Architectural Press.

Cheng, M., Shu, Y., Guo, Z., & Wang, S. (2006). University of Wageningen, Netherland.