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A Framework Proposal for the Developing Climate Sensitive Spatial Design Strategies: The Case of Kırklareli City Center*

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Abstract
Climate change has emerged as a major challenge affecting urban sustainability. Increased population mobility due to social and economic factors has led to an expansion in urban density. This growth in urban space has resulted in the transformation of physical spaces into built environments lacking green areas. In the microclimate zones formed in dense urban areas, temperatures different from the current situation and thermal values that prevent the comfort level are observed. One of the most basic solutions that can prevent this temperature stress is the creation of recreational areas. In this study, the regulating effect of urban green spaces on microclimate is evaluated as a design element in urban planning. In this context, a study approach is proposed to develop climate-sensitive spatial design strategies. Micro-regions in the city center of Kırklareli are identified and comparative evaluations are made with recreation areas. The study aims to make two main contributions: (1) basic climatic conditions and problems are identified at the city and neighborhood scale, and (2) climate-sensitive spatial design strategies and recommendations are developed in urban and recreational themes.

Keywords: *Climatic Sensitivity, Urban Heat Island, Spatial Design Strategies, Climatic Micro-Regions, Kırklareli*

*This study is not included in the study group that requires TR Index Ethics Committee Approval.

1. Introduction

Green spaces in urban areas that are used for recreational activities are defined as parks of all scales, urban groves, forest areas, picnic areas and playgrounds, and other similar spaces designed with vegetative material. These spaces provide opportunities for children and young people to engage in safe play and sports activities (Müftüoğlu, 2008; Önen, 2015). The contemporary urban environment is beset by a multitude of challenges. Urban green spaces that provide recreation opportunities fulfill a multitude of functions that support sustainability in the city and provide resilience against urban challenges. The establishment of urban green spaces within buffer zones and building islands serves to restrict the physical expansion of cities due to population growth. This is achieved by reducing building and population density between these zones. These gaps have a crucial role to play in saving lives in the event of a major disaster, such as an earthquake. A considerable body of research indicates that urban green spaces exert a beneficial influence on the physical environment, social sustainability, and economic resilience of cities (Wu et al., 2015; Sturiale & Scuderi, 2018; Du & Zhang, 2020). In terms of access to nature, it also fulfills the need of all levels of society to come together, which is a need for access and social communication. The configuration of urban green spaces directs and restricts the movement of pedestrians and vehicles within the physical environment of the city. It is an irrefutable fact that urban traffic is of paramount importance for the safety of life and property (Givoni, 1991; Newman & Kenworthy, 1999; Parizi & Kazeminiya, 2015; Verani et al., 2015; Ronchi et al., 2020; Lin et al., 2021) as well as its deleterious effects on urban dwellers, including exhaust emissions from transportation, noise, and the phenomenon of heat islands (Ülger & Önder, 2006).

Another a priori advantage of green spaces is the physical perception of the city. Cities that have incorporated vegetated areas and landscape designs have also benefited from features such as character, legibility, continuity, and closure, which distinguish the city from others and give it a unique character. The aesthetic effect created by vegetated landscape areas in different seasons allows the city to be transformed into a place with aesthetic value beyond the utilitarian value of concrete blocks. Because of population growth, our living spaces, cities, are being constructed from multi-storey houses. The presence of green areas containing vegetal areas serves to create a proportion between the high-rise structural areas. This helps eliminate negative feelings and anxiety such as feeling compressed and dimensionless (Ülger & Önder, 2006). In addition, green spaces allow people of all ages to relax passively through observation or actively through various sports and games. In addition to their aesthetic value, green spaces perform important functions in urban environments. They serve to prevent and screen out undesirable images, limit undesirable sprawl, and protect tissues that are undesirable to deteriorate (Sinemillioglu et al., 2010). Furthermore, they act as windbreaks, blocking the prevailing wind. Furthermore, green spaces provide shelter for biodiversity, which is in decline as a consequence of urbanization and the destruction of the built environment (Sandström et al., 2006; Kabisch et al., 2016; Kruize et al., 2019). As is well known, numerous international conventions and protocols are dedicated to the maintenance of species diversity on land and in the seas around the globe.

Another crucial function is the creation of infiltration areas within urban environments, particularly in response to irregular and unpredictable rainfall patterns, which are a direct consequence of climate change. This not only addresses the issue of urban runoff, which can potentially lead to significant environmental and societal challenges, but also facilitates the replenishment of groundwater resources. This cycle is of great importance in terms of the release of water vapor into the atmosphere.

Furthermore, green spaces facilitate the formation of microclimatic zones within urban areas. The heat island phenomenon, which is characterized by elevated temperatures in urban environments, is particularly prevalent in areas with dense development and continuous vehicle traffic. Green spaces play a role in reducing the urban heat island effect and regulating the microclimate in terms of heat/humidity balance (Alexandri & Jones, 2008; Bowler et al., 2010; Li et al., 2011; Chen et al., 2014; Yao et al., 2020; Lin et al., 2021). The perception of the urban climate is influenced by climatic conditions, including average temperature, relative humidity, and average wind speed (Çetin et al., 2019).

The main objective of this study is to develop an analytical strategy to address the issues discussed in the spatial design literature in the context of "climate-sensitive planning" approaches, which are particularly prominent today. In this context, climatic micro-regions were identified in the city center of Kırklareli according to the steps described in the methodology section. Findings in urban and landscape themes were identified and recommendations were developed. The recommendations developed in this context are presented under two main headings: "urban" and "recreational". It is anticipated that the study will contribute to the existing body of literature and urban analysis methods by providing a micro-zoning approach and evaluations.

2. Method and Material

This research focuses on the municipal administrative boundaries of the Central District of Kırklareli Province, examining the current situation within the urban fabric and macroform boundaries. The basic flow of the study is illustrated in Figure 1. The study methodology includes basic psychometric climate analysis for Kırklareli Province. This is followed by problem definition and design strategies for summer and winter periods. Urban heat island and air circulation analyses, as well as micro-zoning syntheses, have been carried out in the study. Based on these analyses, reliable assessments of thermal comfort and recreational use were made, reliable neighborhood-level problems were identified, and the strategies and recommendations were developed. The sub-sections present the detailed methods and data used at each stage.

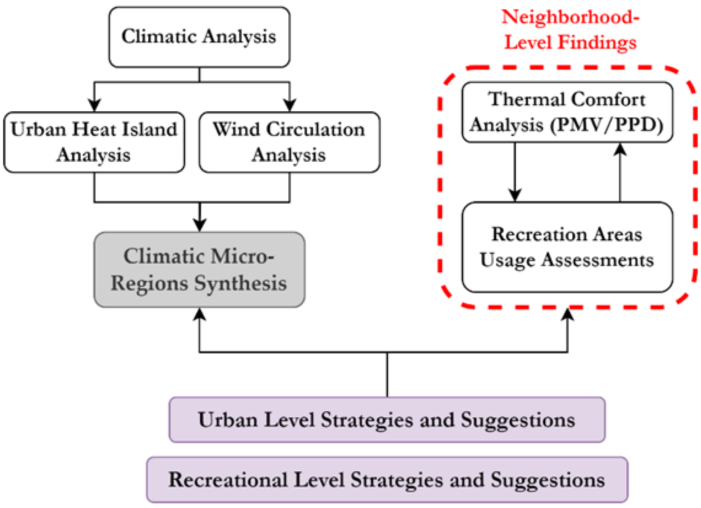

Figure 1. Methodological Flowchart of the Study

2.1. Climatic Analysis Workflow

Kırklareli province is classified as "semi-arid-humid" according to various climate classification standards (MGM, 2016a, 2016b, 2016c, 2016d). On the other hand, it is in a region of "very severe drought" according to the current standard precipitation index (MGM, 2021). EPW data, which provides meteorological information such as wind, humidity, temperature, and precipitation on a global scale for the past 15 years, were obtained for the province of Kırklareli (ClimateOneBuilding, 2023). The data were analyzed using the open-source software Climate Consultant 6.0, and climate structure evaluations were made based on psychometric graphs. Psychometric graphs summarize the thermodynamic properties of moist air and were developed by Richard Mollier in 1923. This technique is significant because it can display fundamental properties of the climatic structure, such as thermometer temperature, relative humidity, specific humidity, specific volume, and enthalpy, in a single graph. The graphs can be used to identify basic comfort levels and climatic problems (Kirkby, 2011).

Climatic comfort is an issue that increases the quality of life of people with balanced heating and cooling loads. In this sense, climatic comfort is the ability of the individuals to adapt to their environment at an optimum level by spending a minimum level of energy (Mirza & Topay, 2018). Olgyay, defines bioclimatic comfort as a combination of outdoor temperature of 21-27.5 °C, relative humidity of 30%-65% and wind speeds up to 5 m/s (Olgyay, 2015). Bioclimatic comfort values vary according to geographical regions, with 14.4-20.6 °C in the UK and 20.2-26.7 °C in the USA (Teodoreanu, 2016). According to (Escourrou, 1989), the climatic comfort zone includes a range of 20-26.5 °C and semi-humid weather conditions. One of the most important indices for revealing the bioclimatic comfort structure of a region is the Physiological Equivalent Temperature (PET). This index considers both the physiological characteristics of people and climate parameters and reflects these characteristics in the results. PET gives results in 0 °C, which is why many professional disciplines utilize this method in their studies (Matzarakis et al.,1999). Over the past few years, several bioclimatic comfort zone indices have been developed using different methodologies and literature (Yan, 2005). The most prominent index among these is the Comfort Zone Determination Index, prepared by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) (ASHRAE, 2004). Recent studies show that the ASHRAE-55 index can be used for many countries and cities (Brager & de Dear, 2001; Dear, 2011; Vecchi et al., 2015). The data obtained for Kırklareli were analyzed with the program Climate Consultant 6.0 based on ASHRAE-55 index values and the climatic comfort conditions were analyzed. In addition, the main types of structural/urban interventions that should be implemented according to the psychometric graphs defined in (Corp, 1980) and (Watson & Labs, 1983) were compiled.

2.1.1. Urban Heat Island (UHI) Analysis Workflow

Recent studies have focused on computing land surface temperature and identifying urban heat island regions in the built environment using satellite imagery and related algorithms (Saaroni et al., 2000; Kafy et al., 2021; Kim & Brown, 2021; Kuru, 2024). Landsat TM satellite images are mostly used in the literature (Deilami et al., 2018). The UHI calculation was based on the method used in (Rahman et al., 2022). To measure the heat island effect, Landsat-8 satellite images (Level 2-1) from July 2023 were used for Kırklareli province (USGS, 2023). To ensure accurate observations, the images were collected when cloud cover was between 0% and 5%. For UHI calculation in Landsat-8 satellite imagery, Band 10 was utilized, while Band 4 and 5 were used for NDVI calculations (He et al., 2019). UHI values were calculated in ArcGIS 10.8 software. The calculation steps are summarized in Table 1.

Table 1. UHI Calculation Steps (Rahman et al., 2022)

Step	Step Title	Formula	Comments
Step 1	Top of Atmosphere Radiance (TOA)	$L_y = ML\ x\ Q_{cal} + AL - O_i$	Ly: TOA value, ML: Radiance multiplicative Band number, AL: Radiance Add Band 10, Qcal: Quantized and calibrated standard product pixel values, Oi: Correction value (0.29)
Step 2	Temperature Brightness (TB)	$TB = \frac{K2}{\ln(\frac{K1}{L_y + 1})} - 273.15$	TB: Temperature Brightnesss value (°C), K1 and K2: Band-specific thermal conversion constant value, (-273.15 stage for Kelvin to Celsius)
Step 3	Normalized Difference Vegetation Index (NDVI)	$NDVI = \frac{Band\ 5 - Band\ 4}{Band\ 5 + Band\ 4}$	Band 5: Near Infra-Red Band, Band 4: Red Band (Landsat-8)
Step 4	Land Surface Emissivity (LSE)	$PV = \left(\frac{NDVI - NDVI_{min}}{NDVI_{max} - NDVI_{min}}\right)^2$ $LSE = 0.004\ x\ PV + 0.986$	PV: proportion of vegetation, NDVI min-max: minimum and maximum value
Step **5**	Land Surface Temperature (LST)	$LST = \frac{TB}{\left[1 + \left(\gamma\ x\ \frac{TB}{c2}\right)\ln(LSE)\right]}$	γ: the wavelength of emitted radiance, c2: 14,388 μmK
Step **6**	Urban Heat Island (UHI)	$UHI = \frac{LST - LST_m}{SD}$	LSTm: The mean temperature of LST, SD: Standard deviation

2.1.2. Wind Circulation (WiC) Analysis Workflow

Various techniques are currently being used to model 3D wind circulation in the terrain. It is crucial to determine wind speed levels at different elevations, including valleys and ridges. In the built environment, it is essential to consider factors such as floor height, floor area surface, and the level of air abrasion created by buildings. WindNinja is one of the open-source applications used for this analysis today (Forthofer & Butler, 2007; Forthofer et al., 2014a; Forthofer et al., 2014b; Wagenbrenner et al., 2016). The WindNinja algorithm utilizes a technique to simulate wind changes based on topography while minimizing the margin of error. To obtain the numerical solution on a terrain-following mesh, the finite element method (FEM) is employed. The mesh is composed of layers of hexahedral cells that increase in size vertically with height (Wagenbrenner et al., 2016). To use WindNinja software, a mesh file that includes natural and built environment information as well as elevation differences must be created. As a result, wind speed and direction values changing with the effect of built environment were determined. The process and data used to create this file are outlined in Table 2.

Table 2. WiC Calculation Steps

Step	Step Title	Comments
Step 1	Natural Terrain Mesh (NT)	NT raster was produced in ArcGIS 10.8 software with a resolution of 30x30 meters using 1-meter elevation curves.
Step 2	Built Environment Mesh (BE)	"Average of the Gross Building Height" raster data prepared by (Pesaresi & Politis, 2022) using Sentinel2 images was used
Step 3	Total Terrain Mesh (NT+BE)	In ArcGIS 10.8 software, two raster files were merged using the Plus toolset in the Spatial Analyst Toolbox. → $OutRas = Plus\ ([NT_{value}, BE_{value}])$

2.2. Climatic Micro-Regions (CMR) Synthesis Workflow

Micro-climate refers to regions of climatic change that are shaped by the built environment and can be monitored at the micro-scale (Toparlar et al., 2017; Yang et al., 2023) state that the literature generally addresses micro-climate zones formed by temperature and urban heat island effect, while excluding other components such as wind and humidity. (Antonioue et al., 2019), on the other hand, argue that components such as wind aerodynamics, wind thermal comfort, energy demand, pollutant dispersion, and wind-induced rainfall should also be considered in micro-climate zones. When examining post-2000 studies, it is evident that urban micro-climate zones are characterized by changes in surface temperature, humidity, wind speed, and wind direction (Javanroodi & Nik, 2019; Li et al., 2022). Table 3 summarizes the components used in determining micro-climate zones based on a compilation of literature.

Table 3. Summary of Relevant Literature Review

Source	Components used to identify micro-climate zones
(Alonso & Renard, 2020)	Temperature, Humidity
(Antoniou et al., 2019)	Air temperature, Surface temperature, Wind speed
(Burdett, 2020)	Temperature, Wind speed and direction, Humidity
(Cao et al., 2022)	Air temperature, Relative humidity, Wind speed and direction, Albedo of buildings
(CG, 2013)	Urban heat islands, air pressure and wind speed
(Kousis et al., 2021)	Air temperature, Relative humidity, Wind speed and direction, Barometric pressure, CO2 concentration, PM10
(Larsen & Heiselberg, 2008)	Air temperature, Wind speed
(Lin et al., 2020)	Air temperature, Wind speed
(Mangiameli et al., 2022)	Temperature, NDVI
(Uehara et al., 2000)	Air temperature, Wind speed, Turbulence intensity
(Zhang et al., 2015)	Air temperature, Wind speed

The study's components align with the general literature. Humidity was excluded due to the lack of an available and open-source dataset on settlements. As a result, UHI and WiC analyses were reclassified into five classes (1: lowest, 5: highest). The Combine toolset in the Spatial Analyst Toolbox of ArcGIS 10.8 software was used to merge two raster files. The synthesis presents a binary classification of UHI and WiC levels at the urban micro scale.

2.3. Thermal Comfort Analysis (PMV/PPD) Workflow

Thermal comfort is the level of suitability of the temperature in the living environment for human metabolism. It is defined by the components of personal and environmental effects. Today, thermal comfort is universally standardized by ASHRAE 55 and ISO 7730. It can also be described as a 'state of mind expressing satisfaction with the thermal environment'. The Predicted Mean Vote (PMV) and Predicted Percentage of Dissatisfied (PPD) indices were developed to assess the level of thermal comfort (de Dear & Brager, 1998; Dyvia & Arif, 2021). PMV and PPD values were calculated using the calculator provided by (Gao, 2008). Average values within neighborhood boundaries were used in the calculation phase. This led to the identification of neighborhoods with a negative thermal comfort level for July, which is the hottest month. Table 4 describes the components used in the calculation phase and the reference values adopted.

Table 4. Components and Reference Values for PMV/PPD Calculation Phase

Step	Step Title	Comments	Scale
Step 1	PMV Calculation	• **Personal Factors** ***MRM (W/m2): Metabolic energy production,*** Reference value: Moderate Metabolic Rate (165) see (Fanger, 2024) ***Icl (clo): Basic clothing insulation,*** Reference value: 0.5 for summer, see (Fanger, 2024) • **Environmental Factors** ***Ta* (°C)*: Ambient air temperature,*** Reference value: Average temperature in July (24.48 °C) ***Tr* (°C)*, Mean radiant temperature,*** Reference value: The mean LST value (see step 5 in Table 1) within the neighborhood boundaries used. (Li, et al.,2023) found correlation and correspondence between LST and Mean radiant temperature values. ***v (m/s): Relative air velocity,*** Reference value: The mean WiC value within the neighborhood boundaries used. For conversion from km/h to m/s see (GSG, 2023). ***rh (%): Relative humidity,*** Reference value: Average humidity in July (%47.92)	See (Fanger, 2024) +3: very warm +2: warm +1: slightly warm 0: neutral -1: slightly cool -2: cool -3: very cold
Step 2	PPD (%) Calculation	Based on formula $PPD = 100 - 95\ x\ e^{-0.03353\ x\ PMV^4\ -\ 0.2179\ x\ PMV^2}$	See (Gao, 2008; Fanger, 2024)

2.4. Assessments on Recreation Areas Usage Workflow

For the city center of Kırklareli, the location of recreational areas and the level of their use were assessed by using Google Maps location data with web-scarping method through Apify web platform (Özkök, 2023). In addition, overall interpretations were made with Urban Atlas Street Tree Layer data obtained from (Land Copernicus, 2023). Within the data, the effects of recreational areas and green texture on CMR zones at the neighborhood level were examined.

The following section presents the findings obtained within the scope of the presented methodology.

3. Findings and Discussion

The study's findings are presented below in the same order as the Methodology section.

3.1.Findings and Evaluations

3.1.1.Climatic Analysis Findings

The study evaluated climatic EPW data for Kırklareli province between 2007-2021 according to the ASHRAE-55 comfort model and generated psychometric graphs. Only 13.8% (1207 hours) of the total 8760 hours in the year were found to be suitable for comfort level. The main climatic issues are as follows: (1) Sun shading of windows (%11.1), (2) High thermal mass night flushed (for short Night-Purge Ventilation (DB, 2021)) (%4.8), (3) Internal heat gain (%27.2), (4) Passive solar direct gain low mass (%12.9), (5) Dehumidification (%4.9), Heating and humidification (%37.3). When analyzing the entire year, the main issues are shading, heat accumulation, humidity balance, and air circulation. The types and levels of these issues vary between summer and winter periods (see Figure 2). During the summer period (June-August), 29.5% (651 hours) of the total 2208 hours are at comfort level. The most significant climatic problems, to varying degrees, are natural ventilation (9%), dehumidification (30.5%), and active/passive heat gain (46.2%). The UHI and WiC analyses considered in the overall study are consistent with the problems observed in the summer period. During the winter period (December-February), it is not possible to observe climatic values that are suitable for a comfort level. The main issue identified is the lack of proper heating and humidification, which accounts for 85% of the problem.

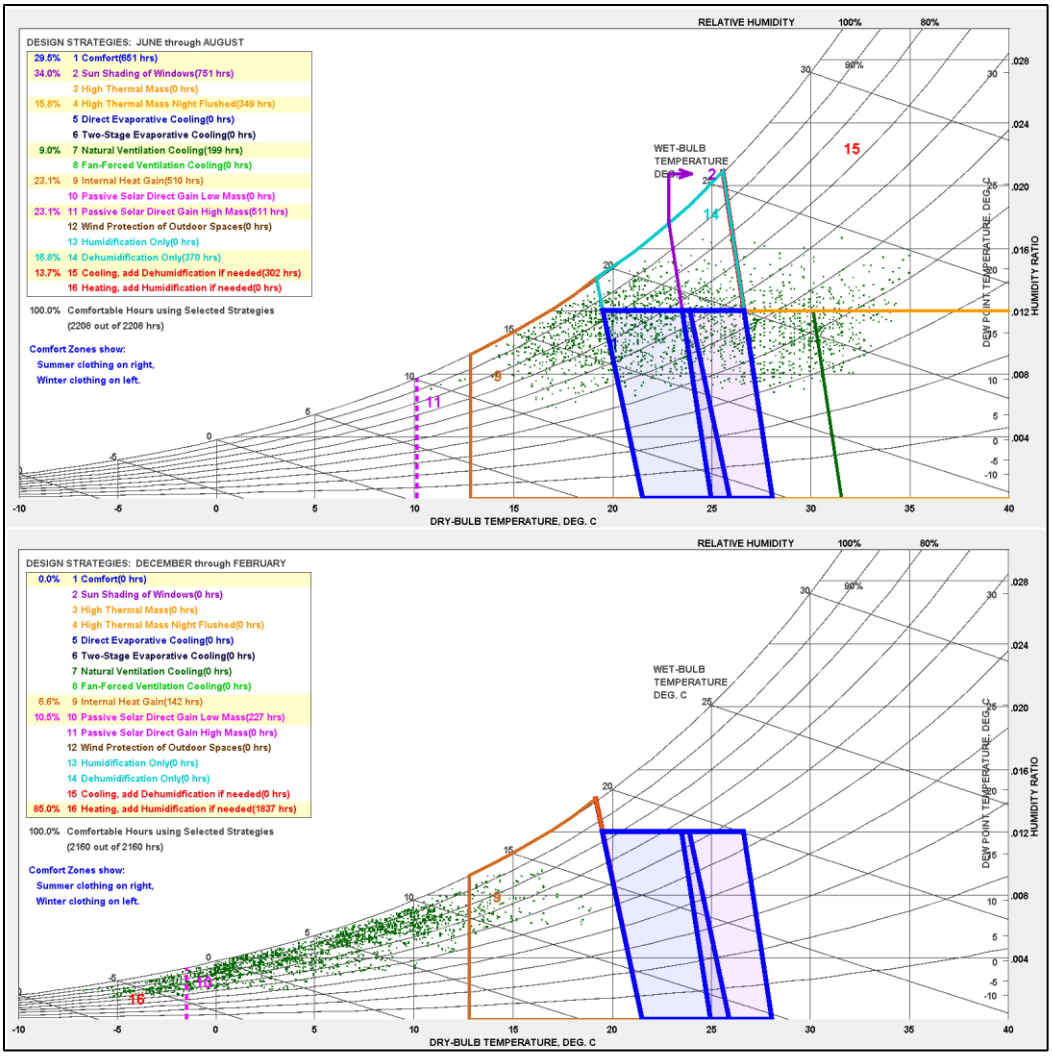

Figure 2. Psychometric Graphs for (top) Summer and (bottom) Winter.

3.1.2.UHI and WiC Analysis Findings

When analyzing the UHI (Urban Heat Island) data (see Appx-1), low heat values are observed in the southern part of the municipality boundaries, while heat values increase in the north and northeast directions. Although the dominant wind direction in Kırklareli province is north and northeast, the cooling effect of the wind is not observed in these regions. Instead, heat accumulation is observed at very high levels, especially due to the very low NDVI, which refers to plant density values in the region. Regarding topography, the macroform is located among the heat accumulation foci with its rising structure in the northern directions. Low values are typically found in valleys, bodies of water, and areas with relatively low slopes. Upon closer examination of the macroform, high and very high levels can be observed. The highest value area in the center is where the existing building stock is 5 or more storeys high and has a contiguous layout, and where there are small industrial sites, workshops, and trade sectors. This area also experiences high vehicle traffic and exhaust gas accumulation due to the nearby bus terminal, which increases heat accumulation in the area. In the TOKİ mass housing area located in the northern part of the city, there are mostly 4-storey houses with gardens. However, unlike the structure described in the center, this area experiences intense heat accumulation due to the low plant density and lack of shading elements.

When analyzing the WiC analysis (see Appx-2), the reasons for the heat island effect can be understood. As mentioned in the UHI analysis, the speed drops to the average value and below (4.5 km/h) in the topography rising in the northern directions. Based on municipal boundaries, the wind speed increases from east to west, and the macroform is in this transition area. The UHI analysis shows that the wind speed is low to medium in the region with high heat accumulation. Despite the heat accumulation, there is a low level of air circulation in the center, while the low air circulation around the mass housing area in the north affects the cumulative heat accumulation.

Regarding UHI and WiC values, the macroform shows a high and very high level of heat accumulation. The presence of green tissue and/or plants to absorb this heat accumulation, as well as the air circulation effect to cool this heat effect cannot be observed. Furthermore, the urban fabric shaped by the built environment poses additional risks to climatic comfort due to low and medium levels of air circulation, particularly in the eastern region.

3.1.3.CMR Synthesis Findings

These micro-regions were identified by combining the reclassified versions of the UHI and WiC analyses (Appx-3), and their distribution is summarized in Table 5. The municipality boundaries contain 10 micro-regions and there are 8 micro-regions at the macroform level. Regions with high heat accumulation in July and low to medium wind circulation are concentrated at the macroform level. Areas with low to medium heat accumulation but observable cooling effects from wind, such as zones 6-8, are limited in availability. The urban fabric in these areas is generally 1 or 2 stories with low floor area utilization. When comparing neighborhood populations and the most intense CMR level within the neighborhood boundaries, it is evident that climatic problems persist in densely populated and/or above-average population neighborhoods (Özkök, 2016; Gündoğdu et al., 2019). However, the built environment can make these problems more complex (Table 6).

Table 5. Summary of Micro-Region Characteristics

#	UHI-WiC Levels of Regions	Area (ha)	Percentage (%)
1	**UHI, WiC Medium**	**253.42**	**21.46**
2	**UHI: High, WiC: Low**	**207.56**	**17.58**
3	UHI: High, WiC: High	9.30	0.79
4	**UHI: High, WiC: Medium**	**538.42**	**45.60**
5	UHI: Low, WiC: Low	18.02	1.53
6	UHI: Low, WiC: High	11.28	0.96
7	UHI: Medium, WiC: Low	135.13	11.44
8	UHI: Medium, WiC: High	7.63	0.65
	Total	1180.75	100.00

Table 6. Summary of Neighborhood-Level Micro-Region and Population

Neighborhood Name	UHI-WiC Levels of regions	Population (2023) (TURKSTAT, 2022)	Number of Buildings /Average Storeys
Akalar	UHI: High, WiC: Low	4156	980/3
Atatürk	UHI: High, WiC: Medium	3456	154/5
Bademlik	UHI, WiC Medium	7842	773/5
Cumhuriyet	UHI: High, WiC: High	3899	267/4
Demirtaş	UHI: High, WiC: Medium	4068	623/3
Doğu	UHI: High, WiC: Medium	1280	236/4
İstasyon	UHI, WiC Medium	12927	720/6
Karacaibrahim	UHI: High, WiC: Low	12958	1325/6
Karahıdır	UHI, WiC Medium	1818	811/2
Karakaş	UHI, WiC Medium	19306	1585/5
Kocahıdır	UHI: Medium, WiC: Low	4358	824/4
Pınar	UHI: Medium, WiC: Low	7632	821/4
Yayla	UHI: High, WiC: Medium	4448	1349/3

3.1.4. Thermal Comfort Analysis Findings

PMV values are scaled between -3 and +3. Upon examining the PMV values calculated on a neighborhood level in Table 7, it is evident that the Akalar, Atatürk, Doğu, Karacaibrahim, and Yayla neighborhoods have values close to 2, which is considered 'warm' on this scale. These neighborhoods should therefore be the focus of priority interventions and solutions. Based on ISO 15265 standards; PMV values ranging from 0.5 to 2 are classified as 'warm discomfort' and can lead to discomfort and heat-related metabolic stress over extended periods (D'Ambrosio Alfano et al., 2013). In these neighborhoods, the average wind speed (in meters per second) is very low, while the land surface temperature is very high. Among these neighborhoods, Karahıdır and Pınar are relatively the best regarding PMV values, and the level of disturbance (PPD) is the lowest with an average of 67%.

Table 7. Thermal Comfort (PMV-PPD) Analysis Results

Neighborhood	MRM	Ta	Tr	V	rh	Clo	PMV	PPD (%)
Akalar	165	24.48	36.61	1.31	47.92	0.5	1.98	76
Atatürk			36.07	1.34			1.94	74.1
Bademlik			34.47	1.38			1.84	68.9
Cumhuriyet			35.13	1.45			1.86	69.9
Demirtaş			35.03	1.38			1.87	70.5
Doğu			35.39	1.29			1.91	72.8
İstasyon			34.28	1.36			1.83	68.6
Karacaibrahim			35.56	1.33			1.91	72.8
Karahıdır			33.68	1.38			1.79	66.5
Karakaş			34.29	1.36			1.83	68.6
Kocahıdır			34.37	1.30			1.85	69.6
Pınar			33.83	1.31			1.82	67.9
Yayla			36.52	1.35			1.97	75.2

3.1.5.Recreation Areas Usage Findings

This section compiles the findings of the study (Özkök, 2023). Based on the usage statistics presented on Google Maps (Table 8), it was determined that the 11 parks (small-scale children's playgrounds or pocket parks were excluded) have varying levels of usage on weekdays and weekends. The parks within the city are primarily used on weekdays, while the larger parks on the periphery and outside the city are mostly used on weekends. During weekdays, park usage is limited, with the main intensity occurring only during the day and afternoon. Upon examining the service buffer zones within 500 meters of the parks (see Appx-4), it is evident that the neighborhoods of Bademlik, Karahıdır, Pınar, Kocahıdır, Doğu, and Atatürk are located outside of the service access zones. However, when considering the urban street tree layer obtained from Land Copernicus (2023), the urban heat island effect becomes more apparent. Although the existing recreation areas have few trees, the proportion of broad-leaved trees in the city is also very low. When evaluated in conjunction with the urban heat island analysis (see Appx-5), it is evident that areas with large groups of broad-leaved trees have a moderate to low level of heat island effect. Conversely, areas with smaller groups of trees are unable to provide the shade and humidity level effect that reduces the heat effect. The neighborhoods with the lowest number of trees are Cumhuriyet, Atatürk, Bademlik, Karacaibrahim, and Pınar.

In this respect, the negative situation determined by UHI, WiC effects and the high level of uncomfortable micro-climate effect supported by PMV/PPD values are due to the lack of recreation areas and large tree groups.

Table 8. Recreational Areas Usage Analysis Results

#	Title	Google Maps Score	Usage					
			Daytime	Noon	Evening	Night	Weekday	Weekend
1	İstasyon Street	4.5	27	773	2176	0	1813	1163
4	Yayla Park	4.5	148	1096	2270	0	2248	1266
2	Walldorf Grove	3	6	517	589	0	432	680
3	Kırklareli Millet Bahçesi	3.8	448	1218	2294	130	3135	955
5	Ahmet Cevdet Paşa Park	4.2	292	813	1921	211	1978	1259
6	Karagöz Park	4.5	*no data*					
7	Kırklareli Urban Forest	4.4	205	782	991	135	974	1139
8	Kırklareli Valiliği Cumhuriyet Grove	3.9	190	231	713	124	412	846
9	DSİ Picnic Area	4	156	950	1145	3	1074	1180
10	Karahıdır Grove	4	85	575	928	19	689	918
11	Saatli Park	3.7	*no data*					
13	Şht. Göktan Özüpek Park	4.5	26	876	1756	6	1745	919
14	Temel Reis Park	4	192	1560	1545	88	2019	1366
15	Şevket Dingiloğlu Park	4	488	1841	1310	44	2538	1145

3.2.Discussions

Upon analysis of the primary findings of the study, it becomes evident that the Kırklareli province necessitates the implementation of distinctive solutions in consideration of its intrinsic climatic characteristics. In a city where the comfort level is only 13.8% and problems such as natural ventilation and temperature accumulation are intense, it is essential to design the texture according to this structure. This interpretation is supported by the results of UHI and WiC analyses. The zones identified as a result of CMR and Thermal Comfort analyses offer specific decision-making areas for planning and design (Oke, 1982;Emmanuel & Krüger, 2012) states that local governments should develop climate change policies and plans, identify urban sprawl zones, and estimate the potential heat impacts of new urban tissue typologies. Despite a relatively low population growth rate in the city center of Kırklareli, as evidenced in Table 6, the urban built environment is characterized by a high degree of density. Even if policies are produced, the urban climate anomaly is likely to persist unless the fundamental characteristics of the built environment are modified. (Santamouris, 2015) expands on this point, noting that the formation of heat islands may vary depending on the mobility effects, even during diurnal periods. Consequently, the policies and interventions to be developed should be diversified at the neighborhood or sub-textural scale, even within the city.

In addition to spatial texture design, an analysis of the usage of recreation areas also reveals the importance of green infrastructure planning at the city scale. As (Ramyar et al., 2021) asserts, green infrastructure planning will bestow a multitude of benefits, both ecological and otherwise. These include improvements to human health, the urban economy, social psychology, and the sense of urban belonging.

In broader terms, projects and policies developed between the "human-nature-built environment" under the headings of (1) multifunctionality, (2) connectivity, (3) protection, and (4) self-organization will enable resilient cities against climatic threats. Such examples can serve as a foundation for the formulation of current design policies. As stated by (Ramyar et al., 2019), the implementation of green belts has been shown to result in enhanced wind speed and flow patterns. (Connors et al., 2013) outlines the primary strategies for transforming gray infrastructure and the built environment into green and ecological resources. (Cheng, 2013) conducted an evaluation of watershed planning, recreation areas, and disaster risk reduction within the context of holistic green infrastructure planning. Consequently, priority policy and design development zones for the city center of Kırklareli can be defined from this perspective. The implementation of integrative green infrastructure planning and recreational area designs between **CMR zones coded 2, 4, and 7** is recommended.

4. Conclusion and Strategy Suggestions

The phenomenon of the heat island effect, where cities experience higher temperatures than surrounding areas, has been shown to result in noticeable differences in thermal comfort at the micro scale. In addition to the impact of designed areas on the built, socio-cultural and economic environment, it is important to consider the climatic effects that will occur in the post-design process. As the case of Kırklareli city center shows, the construction of small-scale or low-quality recreational areas in the context of a high-density urban environment can lead to imbalances in perceived heat levels. In summary, while there is a high level of heat accumulation at the city scale, the air circulation effect, which is one of the natural solutions to heat accumulation, cannot be observed throughout the city. In addition, the availability of recreational areas and landscaping, another solution to heat accumulation, is limited in the city. The access capacity of recreational areas is low, and daytime use (usually in the evening) is limited in terms of spatial qualities. The neighborhoods with the highest UHI-WiC levels and thermal comfort (PMV/PPD) values are Akalar, Atatürk, Karacaibrahim, and Yayla. Among them, Karacaibrahim neighborhood is the main intervention area in terms of population and building density, and the main heat island has also been identified in this neighborhood. Therefore, it is important to produce qualified solutions instead of dense construction and small green areas in urban centers. The implementation of green space solutions that evaluate the city as a system and include open green spaces with different plant groups, such as trees, shrubs and grasses, can ensure the right to live in accordance with the climate at the social level.

In this context, the study proposes basic strategies at the "urban" and "recreational" levels. All the assessments and recommendations made in the study are based on general climate data and components that can be calculated from satellite images, including temperature and wind. It is possible to develop more precise recommendations in future studies by evaluating other climatic components, such as humidity, particulate matter accumulation, and permeable surface data in a spatial dimension. The main strategies proposed by the study are as follows *(For further readings and detailed information see: (Corp, 1980; Watson & Labs, 1983; Boduch & Fincher, 2010; Gupta et al., 2012; Du et.al., 2019; Lee et al., 2021; Lee & Han, 2021; Smith, 2021)*:

Principal Urban-Level Strategies

- In areas with high UHI levels, (1) Shaded spaces should be created every 60-100 meters on average by using appropriate urban furniture (awnings, etc.). (2) Arrangements should be made with large park solutions containing dense vegetative areas consisting of grass, ground cover, shrubs, trees and trees at the neighborhood and city scale, green roofs, green walls at the building scale, mobile green areas at the street scale, trees with large crown diameters. (3) Reflective flooring materials should not be used. (4) Existing rivers and stream bed surfaces in cities should be opened up and their surroundings should be transformed into recreational areas to ensure flood disaster and climate resilience.

- In areas with low WiC values, (1) Obstructive urban furniture, signboards, large surfaces should not be used (2) Workplaces such as bakeries, bakery restaurants, etc. should be regularly inspected to ensure that they have appropriate fuel, chimney, and filter systems.
- To increase passive heating in winter, most glass surfaces should be oriented to the south, but in summer, these surfaces should have protrusions to provide shading.
- Double-glazed high-performance glass (Low-E) should be used on the west, north and east for maximum passive solar gain.
- The buildings (especially in UHI low or cool zones) should be oriented on an east-west axis to provide passive heat gain in winter and reduce heat accumulation in summer.
- Instead of contiguous, split or block layout types that can provide sunny, wind-protected exterior spaces should be preferred. In cases where split or block layouts cannot be formed, garden distances should be expanded in adjacent layouts to create spaces that will allow air flows.
- Building floor areas should be reduced. In this way, energy efficiency should be increased.
- Windows in buildings should be designed to allow the prevailing wind to flow indoors. In addition, buildings within the urban fabric should be designed with floor heights and floor sizes that do not interrupt each other's air flow.
- Low pitched roofs with large overhangs can be used.
- Mobile disassembled vehicles can be used to address the problem of shading on streets with dense residential and commercial functions.
- Trees (neither conifer nor deciduous) should not be planted in front of passive solar windows but are OK beyond 45 degrees from each corner.

Principal Recreational-Level Strategies

- In selecting plant species for urban environments, it is advisable to prioritize those that are naturally or endemically adapted to urban conditions, exhibit low water and maintenance requirements, and are compatible with the local ecological context.
- Planting in shelter designs should include plants that provide orientation, trap dust and gases, and rain gardens should be included in the system.
- In areas with heavy traffic, such as Karacaibrahim and Karakaş neighborhoods, green buffers should be used on vehicular roads to limit access and prevent parking along the road.
- In recreational areas such as parks and children's playgrounds, no more than 30% of the area should be covered, and the remaining area should be left to form natural ground.
- Materials with glossy surfaces that cause heat accumulation and light diffusion should not be used.
- In the design, it is essential to address both the dimensions that restrict wind corridors and those that provide urban ventilation. To mitigate the adverse effects of cold and polluted air in the green belt configuration, wind curtains are planned in a perpendicular orientation to the prevailing wind direction, utilizing plants that are resistant to wind and tipping (evergreen plants). If the area is insufficient, the arrangement can be implemented as single rows or dense rows of trees and shrubs. Nevertheless, obstacles such as contiguous buildings and high vegetative screening that will impede air circulation, particularly during the summer months, should also be removed.
- When selecting locations for urban green spaces and recreation areas, it is recommended that priority be given to the following areas, in addition to those with climate-related problems: (a) within the optimal accessibility radius of areas ((Sınmaz & Özkök, 2022) *have determind the optimum accesibility distance as 330 meters in Kırklareli city center*) with high populations of children, the elderly, and persons with disabilities (who are particularly vulnerable to the effects of climate change); (b) in areas with high concentrations of greenhouse gas emissions (such as transfer hubs, manufacturing zones, and intersections with high traffic volumes); and (c) in areas at risk of natural disasters.

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References

Alexandri, E., & Jones, P. (2008). Temperature decreases in an urban canyon due to green walls and green roofs in diverse climates, *Building and Environment,* 43(4), 480-493, https://doi.org/ 10.1016 /j.buildenv.2006.10.055.

Alonso, L., & Renard, F. (2020). A New approach for understanding urban microclimate by ıntegrating complementary predictors at different scales in regression and machine learning models. *Remote Sensing*, 12(15), Article 15. https://doi.org/10.3390/rs12152434

Antoniou, N., Montazeri, H., Neophytou, M., & Blocken, B. (2019). CFD simulation of urban microclimate: Validation using high-resolution field measurements. *Science of The Total Environment*, 695, 133743. https://doi.org/10.1016/j.scitotenv.2019.133743

Boduch, M., & Fincher, W. (2010). *Standards of human comfort: relative and absolute*. Austin: The University of Texas.

Brager, G. S., & de Dear, R. (2001). Climate, comfort, natural ventilation: A new adaptive comfort standard for ASHRAE standard 55. *UC Berkeley: Center for the Built Environment*, 2–18.

Bowler, D. E., Buyung-Ali, L., Knight, T. M., & Pullin, A. S. (2010). Urban greening to cool towns and cities: A systematic review of the empirical evidence. *Landscape and urban planning*, 97(3), 147-155.

Burdett, M. (2020). *Urban microclimates: Causes.* GeographyCaseStudy.Com. https://geographycase study. com/urban-microclimates-causes/

Cao, S., Wang, Y., Ni, Z., & Xia, B. (2022). Effects of blue-green ınfrastructures on the microclimate in an urban residential area under hot weather. *Frontiers in Sustainable Cities*, 4. https://doi.org/10. 3389/frsc.2022.824779.

CG. (2013). *Urban Microclimates.* Retrieved April 13, 2024, from https://www.coolgeography.co.uk/A-level/AQA/Year%2013/Weather%20and%20climate/Microclimates/Urban_climates.htm

Çetin, M., Adiguzel, F., Gungor, S. , Kaya, E., Sancar, M.C., (2019). Evaluation of thermal climatic region areas in terms of building density in urban management and planning for Burdur, Turkey. *Air Qual Atmos Health 12*, 1103–1112 https://doi.org/10.1007/s11869-019-00727-3

Chen, A., Yao, X. A., Sun, R., & Chen, L. (2014). Effect of urban green patterns on surface urban cool islands and its seasonal variations. *Urban Forestry & Urban Greening,* 13(4), 646-654. https://doi.org /10.1016/j.ufug.2014.07.006

Cheng, C. (2013). *Social vulnerability, green infrastructure, urbanization and climate change-induced flooding: A risk assessment for the Charles River watershed, Massachusetts, USA* [Doctoral Thesis]. University of Massachusetts.

ClimateOneBuilding. (2023). *Turkey-EPW Database*. https://climate.onebuilding.org/WMO_Region_6_Europe/TUR_Turkey/index.html

Connors, J. P., Galletti, C. S., & Chow, W. T. L. (2013). Landscape configuration and urban heat island effects: Assessing the relationship between landscape characteristics and land surface temperature in Phoenix, Arizona. *Landscape Ecology*, *28*(2), 271–283. https://doi.org/10.1007/s10980-012-9833-1

Corp, T. A. R. (1980). *Regional Guidelines for Building Passive Energy Conserving Homes*. US Dept.of Housing and Urban Development.

D'Ambrosio Alfano, F. R., Palella, B. I., & Riccio, G. (2013). On the transition thermal discomfort to heat stress as a function of the PMV value. *Industrial Health*, 51(3), 285–296. https://doi.org/10.2486/indhealth.2012-0163

DB. (2021). *Night-time purging*. Designing Buildings: The Construction Wiki; https://www.designingbuildings.co.uk/wiki/Night-time_purging

De Dear, R., & Brager, G. S. (1998). Developing an adaptive model of thermal comfort and preference. *ASHRAE Transactions*, 104(1), 145–167.

Dear, R. (2011). *Recent enhancements to the adaptive comfort standard in ASHRAE*. 55-2010, 2–8.

Deilami, K., Kamruzzaman, Md., & Liu, Y. (2018). Urban heat island effect: A systematic review of spatio-temporal factors, data, methods, and mitigation measures. *International Journal of Applied Earth Observation and Geoinformation*, 67, 30–42. https://doi.org/10.1016/j.jag.2017.12.009

Du, M., & Zhang, X. (2020). Urban greening: A new paradox of economic or social sustainability? *Land Use Policy*, 92, 104487. https://doi.org/10.1016/j.landusepol.2020.104487

Du, X., Bokel, R., & van den Dobbelsteen, A. (2019). Spatial configuration, building microclimate and thermal comfort: A modern house case. *Energy and Buildings*, 193, 185–200. doi: 10.1016/j.enbuild.2019.03.038

Dyvia, H. A., & Arif, C. (2021). *Analysis of thermal comfort with predicted mean vote (PMV) index using artificial neural network*. IOP Conference Series: Earth and Environmental Science, 622(1), 012019. https://doi.org/10.1088/1755-1315/622/1/012019

Emmanuel, R., & Krüger, E. (2012). Urban heat island and its impact on climate change resilience in a shrinking city: The case of Glasgow, UK. *Building and Environment*, *53*, 137–149. https://doi.org/10.1016/j.buildenv.2012.01.020

Escourrou, P. (1989). Les critères d'étude de biométéorologie humaine. *Les Critères d'étude de Biométéorologie Humaine*. 14, 21–30.

Fanger. (2024). *The fanger method: Estimation of thermal comfor*t. https://www.ergonautas.upv.es/ergoniza/app_en/land/index.html?method=fanger

Forthofer, J. M., & Butler, B. (2007). *Differences in simulated fire spread over Askervein Hill using two advanced wind models and a traditional uniform wind field*. 046, 123–127.

Forthofer, J. M., Butler, B. W., McHugh, C. W., Finney, M. A., Bradshaw, L. S., Stratton, R. D., Shannon, K. S., & Wagenbrenner, N. S. (2014a). A comparison of three approaches for simulating fine-scale surface winds in support of wildland fire management. Part II. An exploratory study of the effect of simulated winds on fire growth simulations. *International Journal of Wildland Fire*, 23, 982–994. https://doi.org/10.1071/WF12090

Forthofer, J. M., Butler, B. W., & Wagenbrenner, N. S. (2014b). A comparison of three approaches for simulating fine-scale surface winds in support of wildland fire management: Part I. Model formulation and comparison against measurements. *International Journal of Wildland Fire*, 23. https://doi.org/10.1071/WF12089

Gao, C. (2008). *Calucation of Predicted mean Vote (PMV), and Predicted Percentage Dissatisfied (PPD).* https://www.eat.lth.se/fileadmin/eat/Termisk_miljoe/PMV-PPD.html

Givoni, B. (1991). *Impact of planted areas on urban environmental quality: A review, Atmospheric Environment*. Part B. Urban Atmosphere, Volume 25, Issue 3, Pages 289-299, ISSN 0957-1272, https://doi.org/10.1016/0957-1272(91)90001-U

GSG. (2023). Wind—Air Flow. https://lufft-messtechnik.com/en/principles-of-measurement/wind-air flow.

Gupta, K., Kumar, P., Pathan, S. K., & Sharma, K. P. (2012). Urban neighborhood green ındex–a measure of green spaces in urban areas. *Landscape and Urban Planning*, 105(3), 325-335. https://doi.org/10. 1016/j.landurbplan.2012.01.003

Gündoğdu, H. M., Tok, E., & Özkök, M. K. (2019). Planlama *sisteminde iklim değişikliği duyarlı stratejilerin kademeli olarak değerlendirilmesi*. In Y. Aksoy (Ed.), İklim Değişikliği ve Kentler—Yapısal Çevre ve Yeşil Alanlar (pp. 324–347). DAKAM.

He, B.J., Zhao, Z.Q., Shen, L.D., Wang, H.B., & Li, L.G. (2019). An approach to examining performances of cool/hot sources in mitigating/enhancing land surface temperature under different temperature backgrounds based on landsat 8 image. *Sustainable Cities and Society*, 44, 416–427. https://doi.org/10. 1016/j.scs.2018.10.049

Javanroodi, K., & Nik, V. M. (2019). Impacts of microclimate conditions on the energy performance of buildings in urban areas. *Buildings*, 9(8), Article 8. https://doi.org/10.3390/buildings9080189

Kabisch, N., Strohbach, M., Haase, D., & Kronenberg, J. (2016). Urban green space availability in European cities. *Ecological Indicators*, 70, 586-596.

Kafy, A.A., Abdullah-Al-Faisal, Rahman, Md. S., Islam, M., Al Rakib, A., Islam, Md. A., Khan, Md. H. H., Sikdar, Md. S., Sarker, Md. H. S., Mawa, J., & Sattar, G. S. (2021). Prediction of seasonal urban thermal field variance index using machine learning algorithms in Cumilla, Bangladesh. *Sustainable Cities and Society*, 64, 102542. https://doi.org/10.1016/j.scs.2020.102542

Kim, S. W., & Brown, R. D. (2021). Urban heat island (UHI) intensity and magnitude estimations: A systematic literature review. *Science of The Total Environment*, 779, 146389. https://doi.org/10. 1016/j.scitotenv.2021.146389

Kirkby, N. F. (2011). Mollier diagram. In thermopedia. *Begel House Inc*. https://dx.doi.org/10. 1615/AtoZ.m.mollier_diagram

Kousis, I., Pigliautile, I., & Pisello, A. L. (2021). Intra-urban microclimate investigation in urban heat island through a novel mobile monitoring system. *Scientific Reports*, 11(1), 9732. https://doi.org/10. 1038/s41598-021-88344-y

Kruize, H., van Der Vliet, N., Staatsen, B., Bell, R., Chiabai, A., Muiños, G., ... & Stegeman, I. (2019). Urban green space: creating a triple win for environmental sustainability, health, and health equity through behavior change. *International Journal of Environmental Research and Public Health*, 16(22), 4403 https://doi.org/10.3390/ijerph16224403

Kuru, A. (2024) Investigating the neighborhood effect of urban morphological metrics on summertime land surface temperature variations in Istanbul, Turkey. *Int. J. Environ. Sci. Technol*. https://doi.org/10.1007/s13762-024-05553-4

Land Copernicus. (2023). Urban Atlas Street Tree Layer 2018 (vector), Europe, 6-yearly. https://land. copernicus.eu/en/products/urban-atlas/street-tree-layer-stl-2018

Larsen, T. S., & Heiselberg, P. (2008). Single-sided natural ventilation driven by wind pressure and temperature difference. *Energy and Buildings*, 40(6), 1031–1040. https://doi.org/10.1016/j.enbuild.2006.07.012

Lee, B., Lee, M., Zhang, P., Tessier, A., Saakes, D., & Khan, A. (2021). *Socio-spatial comfort: using vision-based analysis to ınform user-centred human-building ınteractions*. Proceedings of the ACM on Human-Computer Interaction, 4(CSCW3), 238:1-238:33. doi: 10.1145/3432937

Lee, M.H., & Han, S.H. (2021). Utilization of the evaluation system for spatial comfort toward multi-layered public hanok facilities. *Designs*, 5(4), 79. doi: 10.3390/designs5040079

Li, J., Mao, Y., Ouyang, J., & Zheng, S. (2022). A Review of urban microclimate research based on citespace and vosviewer analysis. *International Journal of Environmental Research and Public Health*, 19(8), 4741. https://doi.org/10.3390/ijerph19084741

Li, J., Song, C., Cao, L., Zhu, F., Meng, X., & Wu, J. (2011). Impacts of landscape structure on surface urban heat islands: A case study of Shanghai, China. *Remote Sensing of Environment*, 115(12), 3249-3263. https://doi.org/10.1016/j.rse.2011.07.008

Li, X., Chakraborty, T., & Wang, G. (2023). Comparing land surface temperature and mean radiant temperature for urban heat mapping in Philadelphia. *Urban Climat*e, 51, 101615. https://doi.org/10.1016/j.uclim.2023.101615.

Lin, B. S., Cho, Y. H., & Hsieh, C. I. (2021). Study of the thermal environment of sidewalks within varied urban road structures. *Urban Forestry & Urban Greening*, 62, 127137.

Lin, Y., Ichinose, T., Yamao, Y., & Mouri, H. (2020). Wind velocity and temperature fields under different surface heating conditions in a street canyon in wind tunnel experiments. *Building and Environment*, 168, 106500. https://doi.org/10.1016/j.buildenv.2019.106500

Mangiameli, M., Mussumeci, G., & Gagliano, A. (2022). Evaluation of the urban microclimate in catania using multispectral remote sensing and GIS Technology. *Climate*, 10(2), Article 2. https://doi.org/10.3390/cli10020018

Matzarakis, A., Mayer, H., & Iziomon, M. G. (1999). Applications of a universal thermal index: Physiological equivalent temperature. *International Journal of Biometeorology*, 43(2), 76–84. https://doi.org/10. 1007/s004840050119

MGM. (2016a). Aydeniz İklim Sınıflandırmasına Göre Türkiye İklimi. T.C. Meteoroloji Genel Müdürlüğü.

MGM. (2016b). De Martone Kuraklık İndeksine Göre Türkiye İklimi. T.C. Meteoroloji Genel Müdürlüğü.

MGM. (2016c). Erinç İklim Sınıflandırmasına Göre Türkiye İklimi. T.C. Meteoroloji Genel Müdürlüğü.

MGM. (2016d). Thorntwaite İklim Sınıflandırmasına Göre Türkiye İklimi. T.C. Meteoroloji Genel Müdürlüğü.

MGM. (2021). Standart Yağış İndeksi Metoduna Göre 2021 Yılı Meteorolojik Kuraklık Durumu [Map]. T.C. Meteoroloji Genel Müdürlüğü. https://www.mgm.gov.tr/veridegerlendirme/kuraklik-analizi.aspx

Mirza, E., & Topay, M. (2018). *İklimsel konfor ve planlama*. In H. Babacan (Ed.), Mimarlık Bilimlerinde Güncel Akademik Çalışmalar (pp. 281–291). Gece Kitaplığı.

Müftüoğlu, V. (2008). *Kentsel açık-yeşil alan karar ve uygulamalarının imar mevzuatı kapsamında Ankara kenti örneğinde irdelenmesi* [Msc Thesis]. Ankara University.

Newman, P., & Kenworthy, J. (1999). *Sustainability and cities: overcoming automobile dependence*. Island Press.

Oke, T. R. (1982). The energetic basis of the urban heat island. *Quarterly Journal of the Royal Meteorological Society*, *108*(455), 1–24. https://doi.org/10.1002/qj.49710845502

Olgyay, V. (2015). *Design with climate: bioclimatic approach to architectural regionalism*. Priceton University Press.

Önen, E. (2015). *Kentsel açık-yeşil alan stratejilerinin belirlenmesi: Güzelbahçe (İzmir) ilçesi örneği* [Doctoral Thesis]. Ege University.

Özkök, M. K. (2016). *Kentsel yerleşimin, kentsel politikalar ve sürdürülebilir planlama yaklaşımı kapsamında değerlendirilmesi: kırklareli örneği*, [Msc Thesis]. Yıldız Technical University.

Özkök, M. K. (2023). *Büyük veri tabanlı planlama anlayışı: kentteki kullanıcı örüntülerini çözümlemede yeni teknikler ve tartışmalar*. Dünya Şehircilik Günü 47. Kolokyumu, Ankara.

Parizi, S. M., & Kazeminiya, A. (2015). Evaluation of human-oriented transport in city hall transportation projects approach to sustainable case study of the Kerman City Hall. *Journal of Building Construction and Planning Research*, 3(3), 149-161.

Pesaresi, M., & Politis, P. (2022). GHS-BUILT-H R2022A - GHS building height, derived from AW3D30, SRTM30, and Sentinel2 composite (2018)—OBSOLETE RELEASE (OBSOLETE RELEASE. European Commission, Joint Research Centre (JRC) [Dataset]) [dataset]. *European Commission, Joint Research Centre (JRC)*. https://doi.org/10.2905/CE7C0310-9D5E-4AEB-B99E-4755F6062557

Rahman, M. N., Rony, M. R. H., Jannat, F. A., Chandra Pal, S., Islam, M. S., Alam, E., & Islam, A. R. M. T. (2022). Impact of urbanization on urban heat ısland ıntensity in major districts of Bangladesh using remote sensing and geo-spatial tools. *Climate*, 10(1), Article 1. https://doi.org/10.3390/cli10010003

Ramyar, R., Ackerman, A., & Johnston, D. M. (2021). Adapting cities for climate change through urban green infrastructure planning. *Cities*, *117*, 103316. https://doi.org/10.1016/j.cities.2021.103316

Ramyar, R., Ramyar, A., Kialashaki, Y., Bryant, M., & Ramyar, H. (2019). Exploring reconfiguration scenarios of high-density urban neighborhoods on urban temperature–The case of Tehran (Iran). *Urban Forestry & Urban Greening*, *44*, 126398. https://doi.org/10.1016/j.ufug.2019.126398

Ronchi, S., Salata, S., & Arcidiacono, A. (2020). Which urban design parameters provide climate-proof cities? An application of the Urban Cooling InVEST Model in the city of Milan comparing historical planning morphologies. *Sustainable Cities and Society*, 63, 102459. https://doi.org/10.1016/j.scs.2020.102459

Saaroni, H., Ben-Dor, E., Bitan, A., & Potchter, O. (2000). Spatial distribution and microscale characteristics of the urban heat island in Tel-Aviv, Israel. *Landscape and Urban Planning*, 48(1), 1–18. https://doi.org/10.1016/S0169-2046(99)00075-4

Sandström, U. G., Angelstam, P., & Khakee, A. (2006). Urban comprehensive planning–identifying barriers for the maintenance of functional habitat networks. *Landscape and Urban Planning*, 75(1-2), 43-57.

Santamouris, M. (2015). Analyzing the heat island magnitude and characteristics in one hundred Asian and Australian cities and regions. *Science of The Total Environment*, *512–513*, 582–598. https://doi.org/10.1016/j.scitotenv.2015.01.060

Sınmaz, S., & Özkök, M. K. (2022*). Yaya erişilebilirliği çerçevesinde kentlerin mekânsal engellilik düzeyini ölçme ve değerlendirme sisteminin geliştirilmesi: Kırklareli Merkez İlçe Örneği* (No. KLÜBAP-216). Kırklareli: Kirklareli University.

Sinemillioglu, M. O., Akin, C. T., & Karacay, N. (2010). Relationship between green areas and urban conservation in historical areas and its reflections: case of Diyarbakir City, Turkey. *European Planning Studies*, 18(5), 775-789.

Smith, Z. (2021). *Spatial Comfort and Stress.* Retrieved September 1, 2022, from https://www.cuanschutz.edu/centers/national-mental-health-innovation/news-media/nmhic-blog/nmhic-blog/spatial-comfort-and-stress

Sturiale, L., & Scuderi, A. (2018) The evaluation of green ınvestments in urban areas: a proposal of an eco-social-green model of the city. *Sustainability*. 10(12):4541. https://doi.org/10.3390/su10124541

Teodoreanu, E. (2016). Thermal comfort ındex. *Present Environment and Sustainable Development*, 10(2). https://doi.org/10.1515/pesd-2016-0029

Toparlar, Y., Blocken, B., Maiheu, B., & van Heijst, G. J. F. (2017). A review on the CFD analysis of urban microclimate. *Renewable and Sustainable Energy Reviews,* 80, 1613–1640. https://doi.org/10.1016/j.rser.2017.05.248

TURKSTAT. (2022). Address Based Population Registration System Database. http://www.tuik.gov. tr/PreTabloArama.do?metod=search&araType=vt

Uehara, K., Murakami, S., Oikawa, S., & Wakamatsu, S. (2000). Wind tunnel experiments on how thermal stratification affects flow in and above urban street canyons. *Atmospheric Environment*, 34(10), 1553–1562. https://doi.org/10.1016/S1352-2310(99)00410-0

USGS. (2023). EarthExplorer. https://earthexplorer.usgs.gov/

Ülger, F.N., & Önder, S. (2006) Kayseri kenti açık-yeşil alanlarının nitelik ve nicelik açısından irdelenmesi, *Selçuk Ü. Ziraat Fakültesi Dergisi*, 20 (38): 108-118.

Vecchi, R. D., Sorgato, M. J., Pacheco, M., Cândido, C., & Lamberts, R. (2015). ASHRAE 55 adaptive model application in hot and humid climates: The Brazilian case. *Architectural Science Review*, 58(1), 93–101. https://doi.org/10.1080/00038628.2014.981145

Verani, E., Pozoukidou, G., & Sdoukopoulos, A. (2015). The effect of urban density, green spaces and mobility patterns in cities' environmental quality: An empirical study of the metropolitan area of Thessaloniki. *Spatium*, 8-17. DOI: 10.2298/SPAT1533008V

Wagenbrenner, N. S., Forthofer, J. M., Lamb, B. K., Shannon, K. S., & Butler, B. W. (2016). Downscaling surface wind predictions from numerical weather prediction models in complex terrain with WindNinja. *Atmospheric Chemistry and Physics*, 16(8), 5229–5241. https://doi.org/10.5194/acp-16-5229-2016

Watson, D., & Labs, K. (1983). *Climatic Design: Energy-Efficient Building Principles and Practices*. McGraw-Hill.

Wu, J., Wang, M., Li, W., Peng, J., & Huang, L. (2015). Impact of urban green space on residential housing prices: Case study in Shenzhen. *Journal of Urban Planning and Development*, 141(4), 05014023. https://doi.org/10.1061/(ASCE)UP.1943-5444.00002

Yan, Y. Y. (2005). Climate comfort indices. *Encyclopedia of World Climatology*, 227–231. https://doi.org/10.1007/1-4020-3266-8_44

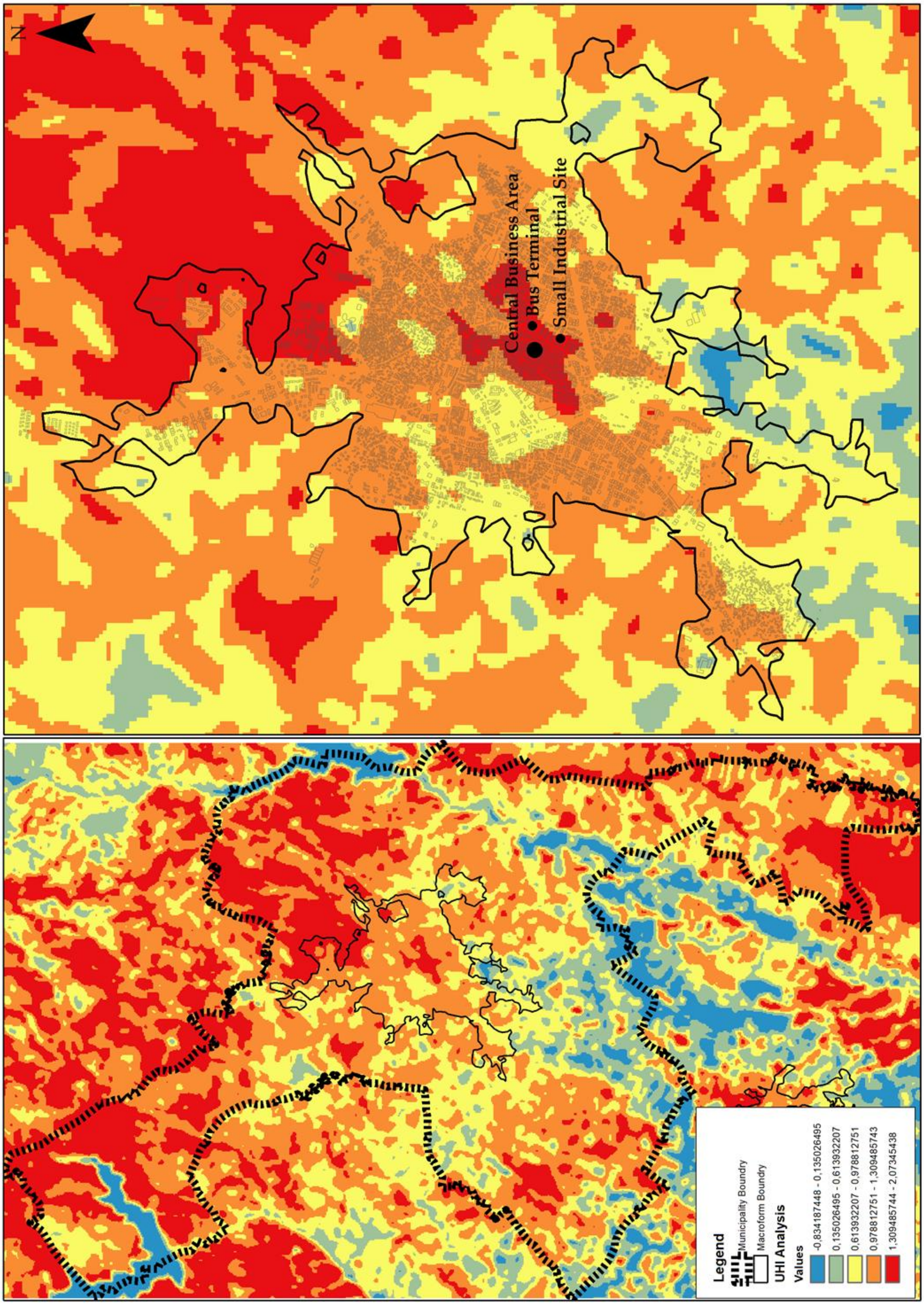
Yang, S., Wang, L., Stathopoulos, T., & Marey, A. M. (2023). Urban microclimate and its impact on built environment – A review. *Building and Environment*, 238, 110334. https://doi.org/10.1016/j.buildenv.2023.110334

Yao, L., Li, T., Xu, M., & Xu, Y. (2020). How the landscape features of urban green space impact seasonal land surface temperatures at a city-block-scale: An urban heat island study in Beijing, China. *Urban Forestry & Urban Greening*, 52, 126704. https://doi.org/10.1016/j.ufug.2020.126704

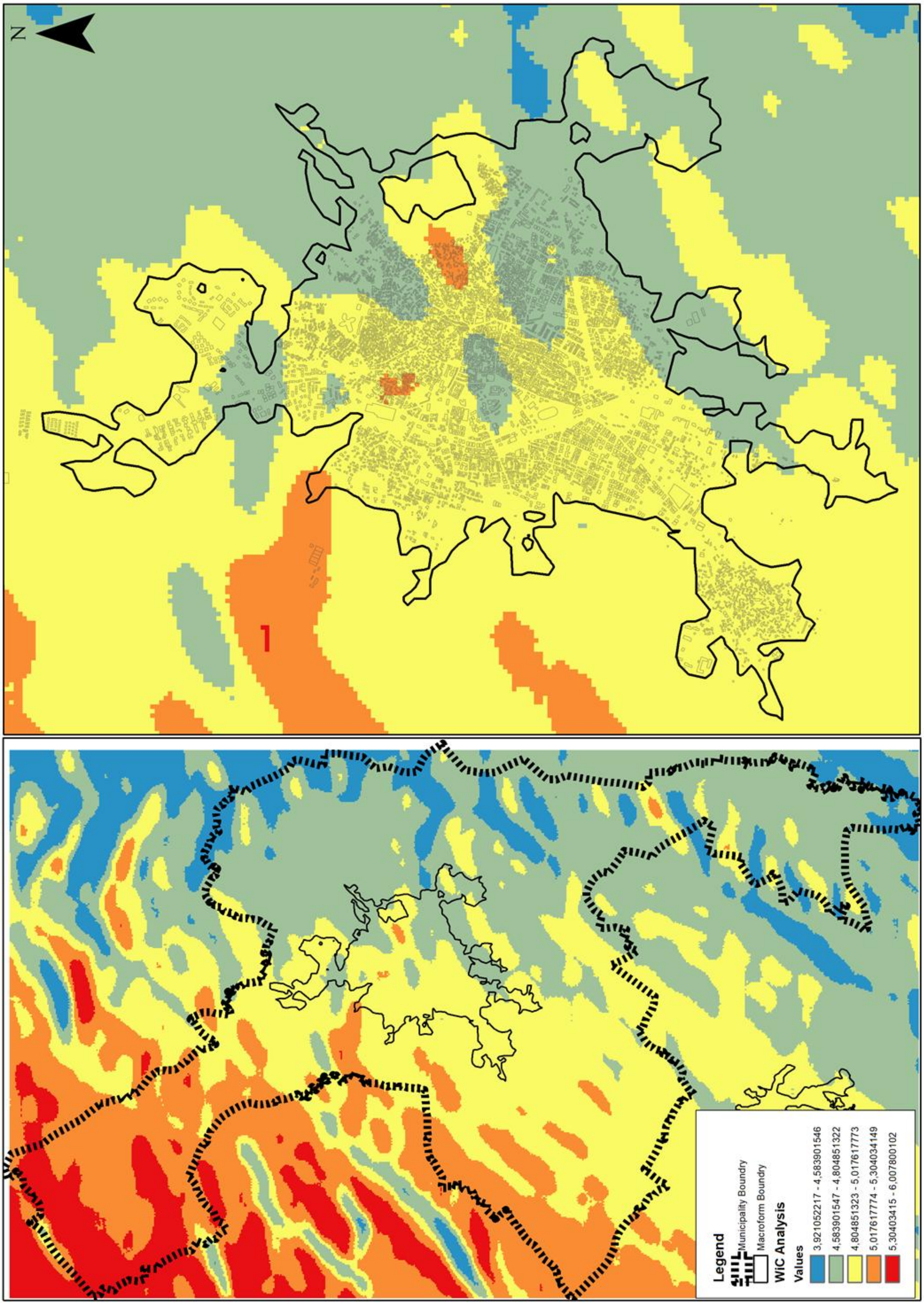
Zhang, L., Feng, Y., Meng, Q., & Zhang, Y. (2015). Experimental study on the building evaporative cooling by using the Climatic Wind Tunnel. *Energy and Buildings*, 104, 360–368. https://doi.org/10.1016/j.enbuild.2015.07.038

Appendix

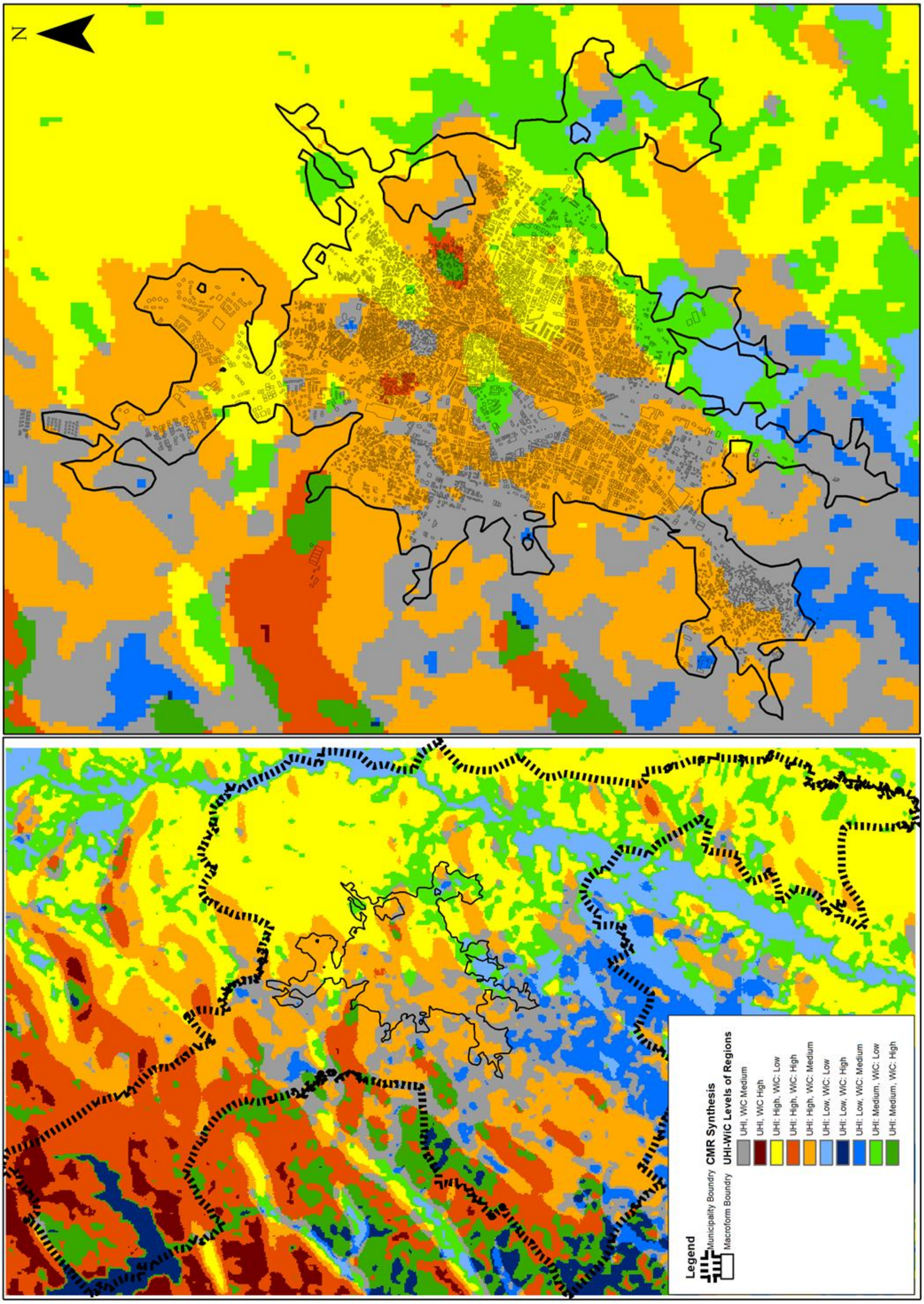
Appx-1: UHI Analysis Results



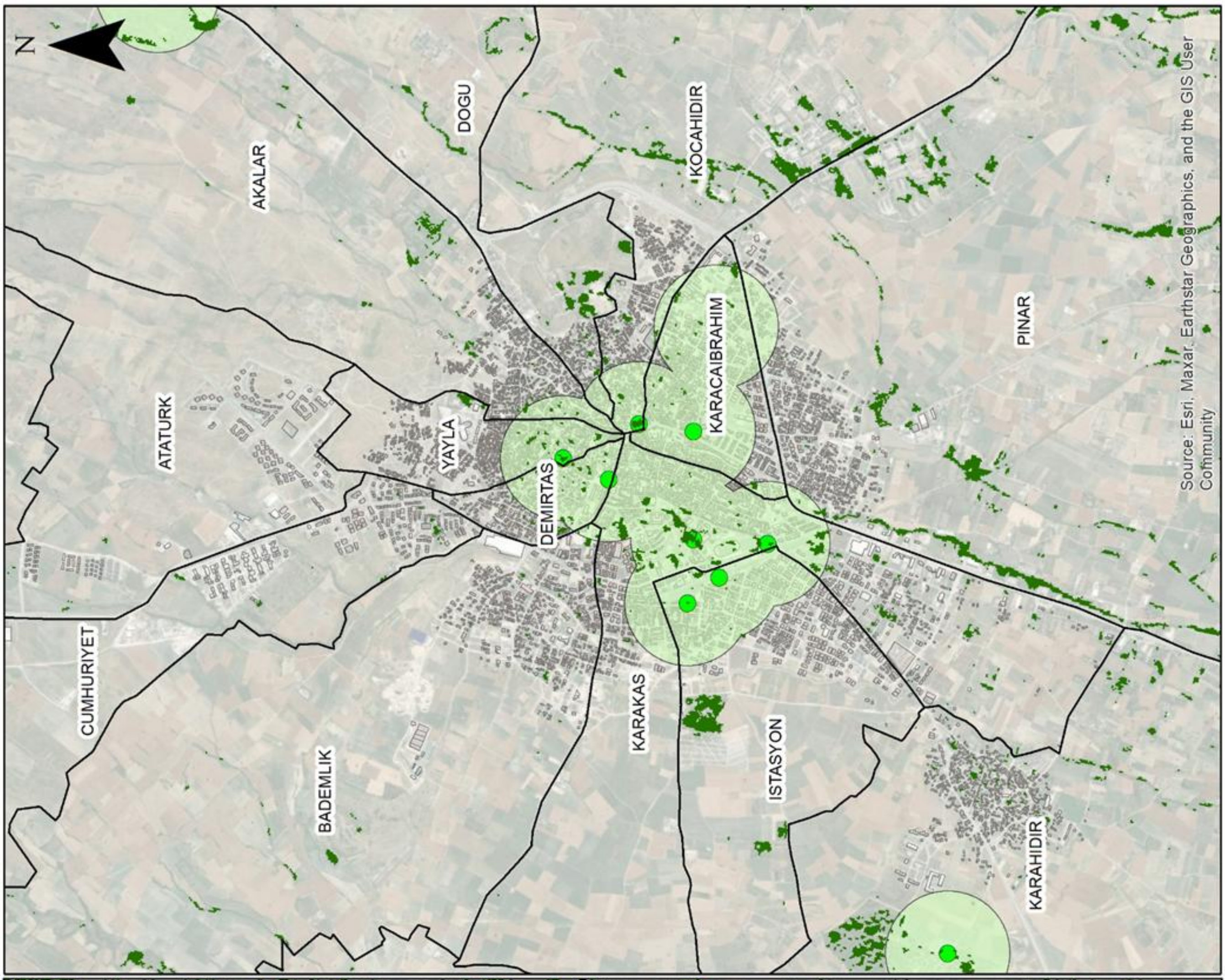
Appx-2: WiC Analysis Results

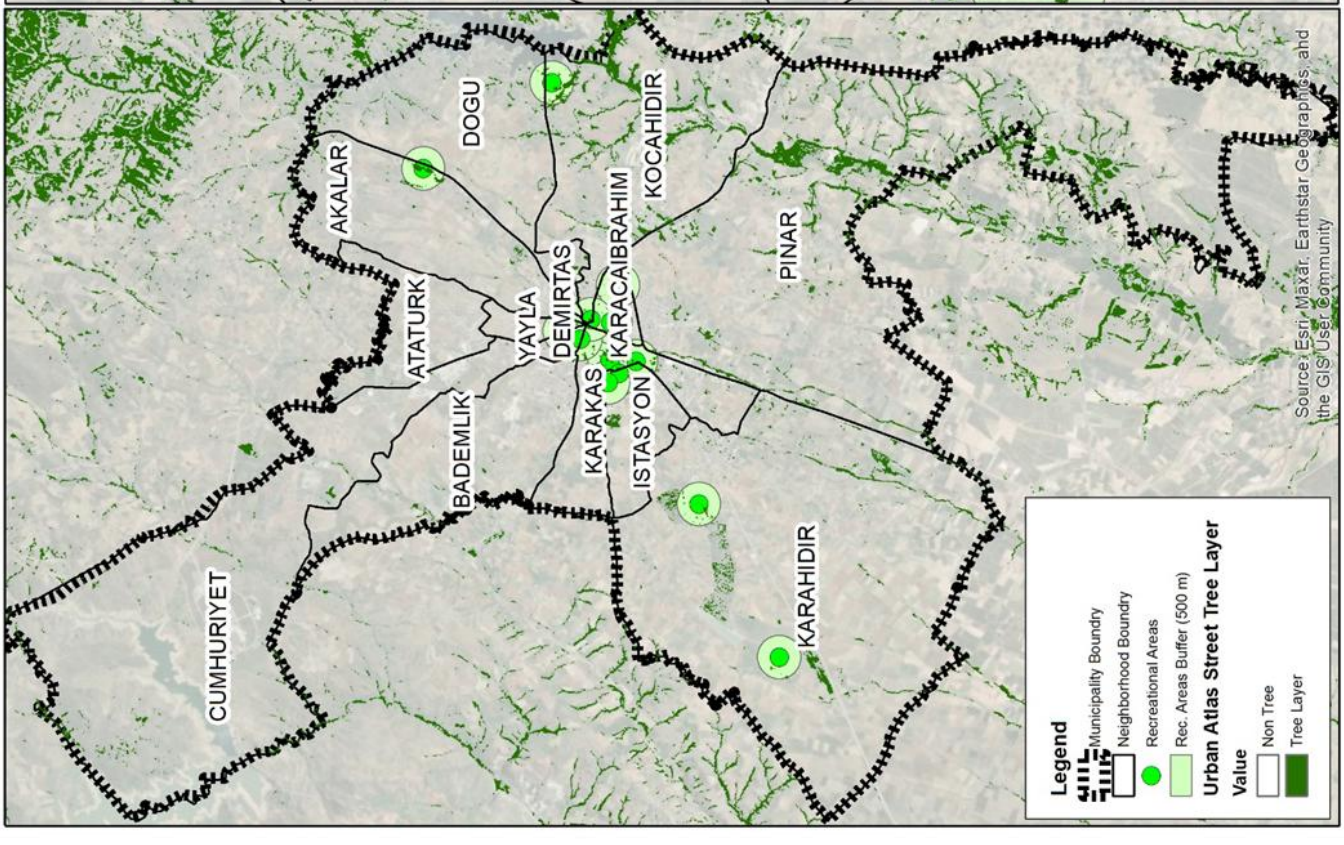


Appx-3: CMR Synthesis Results



Appx-4: Recreational Usage Analysis Results





Appx-5: Urban Street Tree Layers and UHI Analysis Comparison Results