



INTERNATIONAL CONGRESS ON LANDSCAPE ARCHITECTURE

"City and Human"

November 28-29, 2024 Ege University, Izmır, TURKIYE


PROCEEDINGS BOOK




Editors: Prof. Dr. Emine MALKOÇ TRUE
Assist. Prof. Dr. Merve ÖZEREN ALKAN

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HEALTHCARE CENTERS LOCATED IN URBAN HEAT HOTSPOTS IN BORNOVA, İZMİR

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ABSTRACT

Cities experience the impacts of high temperatures that influence the health and welfare of urban residents. Mean temperatures have been continuously exceeded in the world, especially in Europe. The year 2024 has been recorded as the world's hottest on record. Scientific evidence shows that the frequency and intensity of extreme heat and heat waves will continue to rise in the future because of human induced climate change. This puts the urban citizens at great risk of extreme heat globally. The impact of extreme heat will not be evenly shared within cities. Understanding the heat hotspots in cities and addressing thermal inequality is an urgent challenge. This study focuses on the urban heat hotspots and geographic locations of the healthcare facilities in the Bornova district of Izmir. Therefore, the research question of this study has been defined as "what is the percentage of the healthcare facilities that are located in the urban hotspots in Bornova?" For this purpose, the urban heat hotspots were defined using two parameters: aland surface temperature map between 2000-2023 and a healthcare facility map. The results show that all healthcare facilities are in the extreme hotspots in the study area. That means that these facilities are already exposed to the hot temperatures and in order to mitigate these effects, urgent action is needed. The findings were discussed to mitigate the severe consequences of extreme heat for healthcare facilities, healthcare professions and citizens in Bornova. The conclusion is that local adaptation options should be taken into consideration in Bornova to help reduce these effects and guide local adaptation efforts.

Keywords: heat exposure, health clinics, hospital, Bornova

Introduction

Europe is warming faster than the global average and heat records have been broken constantly over the years (EEA, 2021a). The negative effects of excess heat on human health is high. Unfortunately, the most vulnerable, such as elderly people, young children, outdoor workers, people who live in formal settlements and people with pre-existing health conditions are hit hardest. Therefore, the locations and distribution of health facilities are important in cities. This is vital because the health and well-being of our people in cities are essential and these facilities should be easily accessible to all citizens.

The United Nations is also underlining the importance and urge action for the extreme heat conditions (United Nations, 2024). In the last 20 years, heat-related mortality has increased by around 30% (Copernicus Climate Change Service. 2004). It is estimated that between 2019 and 2000 annually, approximately 489,000 heat-related deaths occurred and 36 per cent of those were in Europe (Zhao et al., 2021). Excessive heat affects 70% of the global workforce of 3.4 billion people (ILO, 2024). According to the World Meteorological Organization (2024), extreme heat will be more intense in the future. Therefore, a wider set of populations will be affected. This will intensify global health risks, causing higher morbidity and mortality (WEF, 2024). According to WEF (2024), it has been estimated by 2050 there will be 14.5 million additional deaths from climate related risks worldwide. Reports show that Mediterranean countries have the highest risk of heat-related mortality (Ballester et al., 2022). The European Statistical Office reported unusually high excess mortality rates for the summer of 2022 (Eurostat, 2022).

For this reason research focused on the relationship of extreme heat and human health has recently increased. There are some studies focused on heat exposure and vulnerability of healthcare facilities and healthcare professions in European cities. On the other hand, the effect of extreme heat on health facilities is a relatively new subject and has not been studied in Türkiye. One of the metropolitan districts of the city of İzmir, Bornova, has experienced extreme summer heat and heatwaves, lately. Therefore, this study has been designed to fill this gap. It aims to define healthcare facilities located in heat hotspots in the city of Bornova. The research question is defined as “what is the percentage of the health facilities that are located in urban heat hotspots in Bornova?”.

Materials and Methods

Study area

This study was conducted in Bornova in the district of İzmir (38º33′30″- 38º21′30″ N and 27º9′0″-27º21′0″ E). The district is located in the heart of the city (Figure 1) with 447,553 inhabitants (TurkStats, 2024). The city has experienced increasingly hot summers. The annual mean temperature is 18.0℃. The Maximum temperatures and Mean summer temperatures are 43.2℃ and 32.3℃, respectively. (MGM, 2024).

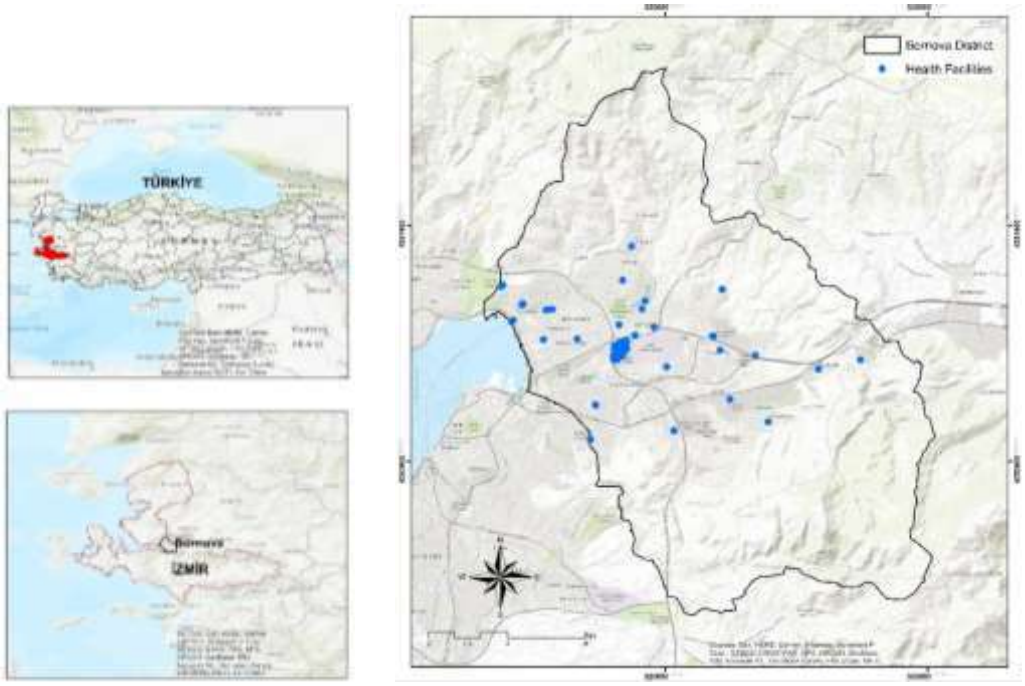

Figure 1. The location of the study area

Methodology

The health care facilities located in different surface temperature zones are defined based on two parameters: land surface temperature (LST) and health care facility map. LST was calculated using Landsat-8 OLI/TIRS satellite images from the average of June, July, August months between 2000 and 2023 based on the steps given in Table 1 (Sobrino et al., 2004; Akyürek 2020; Mercan 2020). LST is classified into 5 levels as low (25ºC-28ºC), moderate (28ºC-32ºC), high (32ºC-34ºC), very high (34ºC-35ºC) and extremely high (over 35ºC) to determine the level of heat islands. In order to define the intensity of LST, low and moderate classes are defined as hotspot, high, very high and extremely high classes are defined as extreme hotspots.

The vectoral health care facility map that includes public hospitals and healthcare centers (such as health centers, dispensaries, clinics) is derived from data from the Ministry of Health and Directorate General for Mapping. The health care facility map is classified into two classes: hospital, and healthcare center (dispensary, health center). The LST map is intersected with the health care facility map in ArcGIS 8 to assign the health care facility exposed to high surface temperatures.

Table 1. LST calculation steps (Sobrino et al., 2004; Akyürek 2020; Mercan 2020).

Steps	Equations
Conversion to Top of Atmosphere (TOA) Radiance	$L\lambda = ML \times Qcal + AL$ L: TOA spectral radiance (watts / (m2*sr*µm)) ML: Radiance multiplicative Band 10 AL: Radiance Add Band 10 Qcal: Quantized and calibrated standard product pixel values (DN)
Conversion to Top of Atmosphere (TOA) Brightness Temperature (BT)	$BT = \frac{K_2}{\ln\left(\frac{K_1}{L}+1\right)} - 273{,}15$

	BT: Top of atmosphere brightness temperature (°C) L: TOA spectral radiance (watts / (m2*sr*µm) K1, K2: Thermal conversion constant for Band 10
Normalized Difference Vegetation Index (NDVI)	$NDVI = \frac{NIR - RED}{NIR + RED}$ NIR: DN values from Near Infrared (Band 5) RED: DN values from the RED (Band 4)
Land Surface Emissivity (LSE)	$\varepsilon = 0{,}004 \times P_v + 0{,}986$ Ɛ: Land Surface Emissivity (LSE) P_v: Proportion of Vegetation $P_v = \left(\frac{NDVI - NDVI_{min}}{NDVI_{max} - NDVI_{min}}\right)^2$ $NDVI_{min}$: Minimum DN values from NDVI Image $NDVI_{max}$: Maximum DN values from NDVI Image
Land Surface Temperature (LST)	$LST = \frac{BT}{\left(1 + \left(10{,}8 \times \frac{BT}{P}\right) \times \ln(\varepsilon)\right)}$ P= $1.438*10^{-2}$ mK

Findings and Discussion

The results showed that 80 healthcare facilities (50 hospitals and 30 healthcare centers) are located in Bornova and they are mostly clustered in the city center. All of the healthcare facilities in the district are located in extreme hotspots where the surface temperature is over 32 degrees (Figure 2) (Table 2). That means, compared to European countries the heat exposure of hospitals in Bornova are almost two times higher. Moreover, during possible heatwaves, this would create devastating impacts. According to European Environment Agency, 46% of hospitals are in areas at least 2°C warmer than the regional average in Europe (EEA, 2022). That means the healthcare facilities in Bornova are in extreme hotspots and their conditions are worse than European cities. Moreover, the majority of the healthcare professions and patients are exposed to medium and high surface temperatures.

Table 2. Number of healthcare facilities located in heat hotspot

Health Facilities	LST zones				
	Hotspot		Extreme hotspot		
	<28	28-32	32-34	34-35	>35
Hospital	0	1	22	19	9
Health center	0	0	20	2	8

As healthcare facilities provide rapid response to heat-related health problems, it is crucial to access these facilities during extreme hot weather and heatwave conditions. Therefore, close proximity of the

healthcare facilities to urban heat hotspots is an advantage for the people who seek help. On the other hand, hospitals should be located in urban cool islands in order to mitigate the the heat-related risk and vulnerabilities.

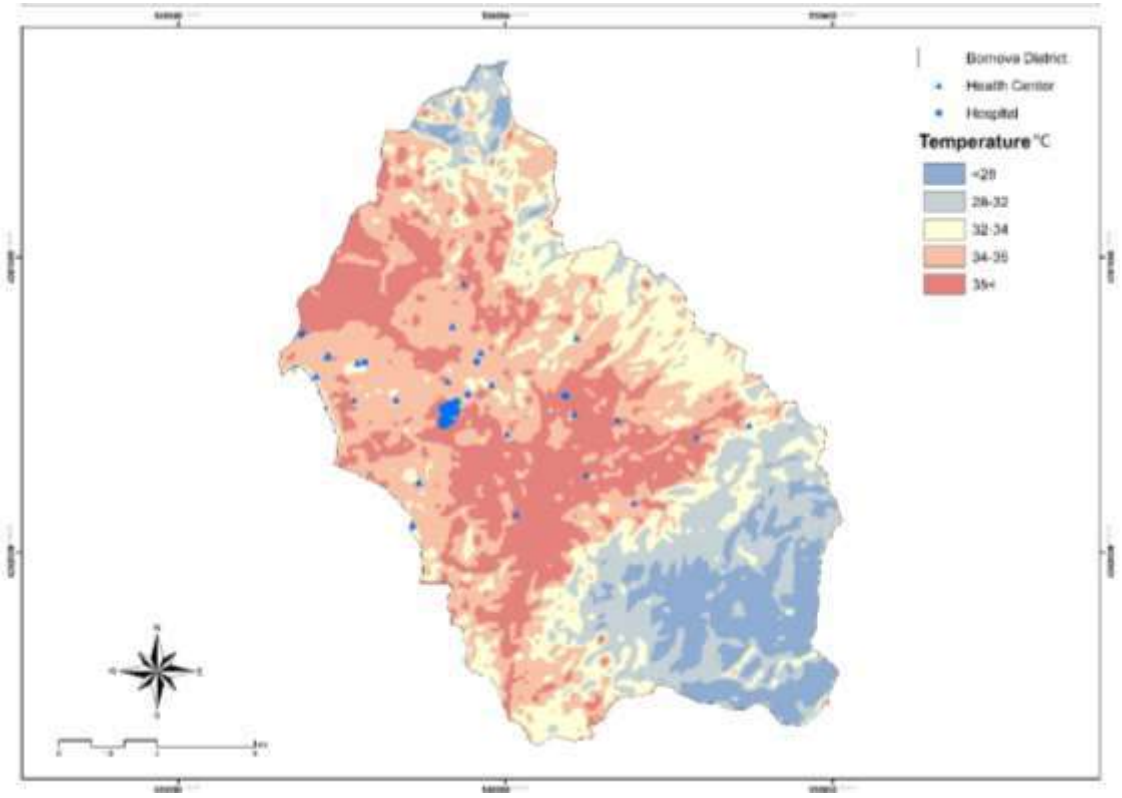

Figure 2. Healthcare centers located in the urban heat hotspots in Bornova

This research has some limitations worth acknowledging. This research focused on the high temperature exposure of healthcare facilities by using two parameters: LST and vectoral healthcare facility data. Heatwaves, population, patient capacity and the number of healthcare staff at each facility were not taking into account. The next step of this research is designed to combine these parameters together with some socio-economic parameters into this research.

Extreme heat and heatwaves result in overloading the healthcare facilities. The outputs of this research should provide valuable data for the health sector as an indicator where to reduce exposure and increase resiliency to the effects of climate change.

Conclusion and Recommendations

This paper aims to define the percentage of the health facilities located in urban heat hotspots in Bornova. All the healthcare facilities are located in hotspots. This is clear evidence of the necessity of urgent actions in order to protect healthcare facilities from the harmful effects of extreme heat in their environments. This should help them to prepare these facilities for future crises.

In order to address this problem, the heat intensity in the city as well as healthcare facility zone urgently needs to be reduced by integrated nature-based solutions (Coskun Hepcan, 2022a-2022b). As the healthcare facilities are mainly clustered in the city center, focusing on the city center to increase tree cover and blue-green infrastructure would be a positive step.

Research shows that some of the deaths could be prevented if the appropriate adaptation actions are taken. Therefore, these adaptation actions and preparedness interventions to focus on improvement of the physical environment of healthcare facilities in the study area will address the heat exposure of healthcare professionals and patients and reduce the healthcare expenses and health insurance expenses.

The healthcare centers with gardens or yards in the study region have the potential to mitigate the effect of high temperatures. The gardens of healthcare facilities with pockets of heat residency could be

converted to cooler spaces. Moreover, these areas could be designed as cooling stations/centers that serve not only the vulnerable groups but also the city residents in the case of a heatwave. That will not only improve the physical conditions of the gardens and reduce the heat effect but also improve the resiliency of these facilities in the district. These actions should be integrated with the measures to keep healthcare facilities resilient to the effects of high temperature

In conclusion, successfully implementing measures to create cool islands in Bornova and the neighborhoods of healthcare facilities will lead to many benefits, including improved health and well-being of citizens and healthcare professionals. These actions will help to reach Sustainable Development Goals such as SDG 3 Good Health and Well-being, SDG 11 Sustainable Cities and Communities, and SDG 13 Climate Action.

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