This Project is funded by
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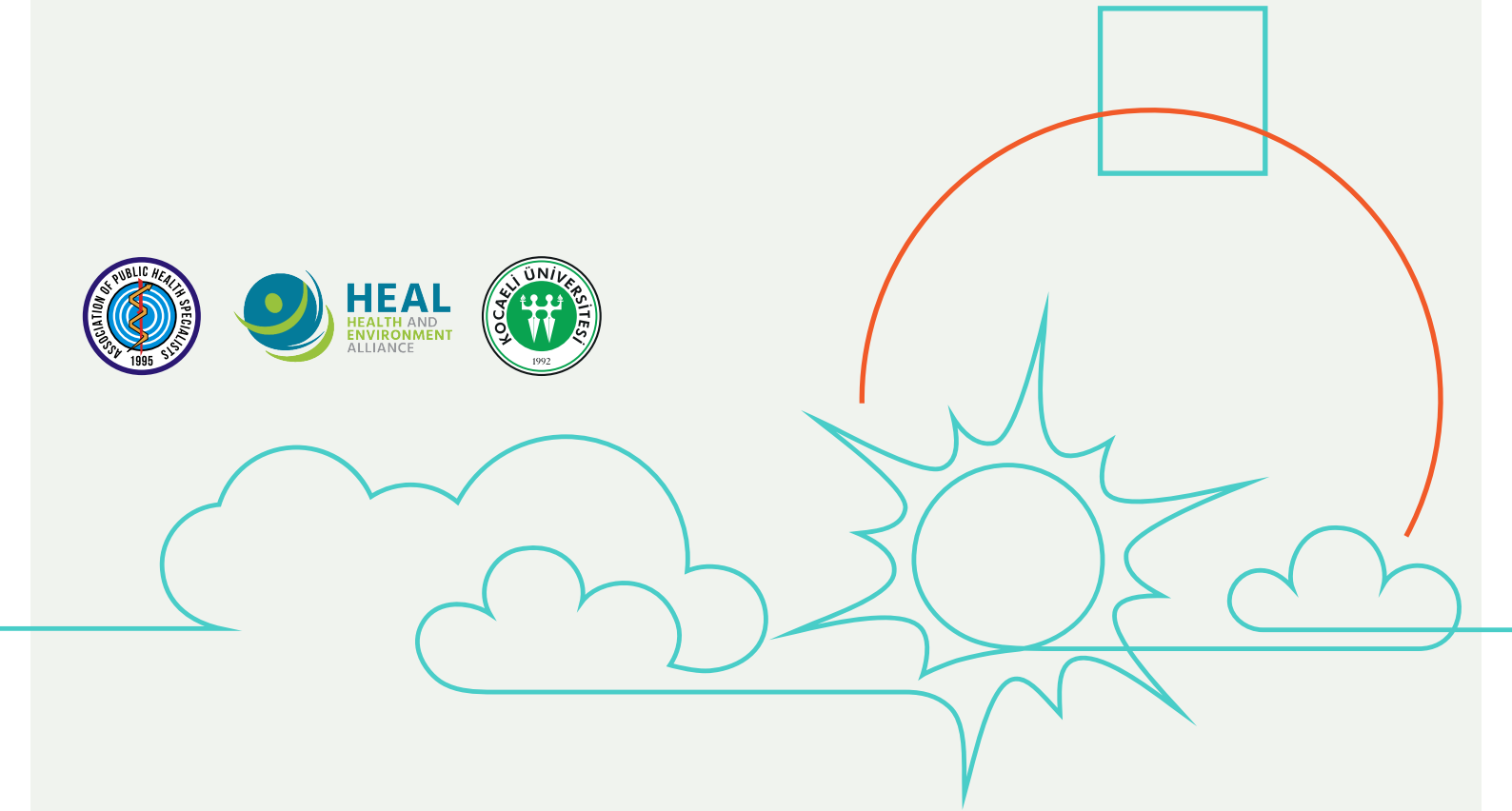
HEALTH
ENVIRONMENT
AND CLIMATE
TURKEY

BRIEFING:

Heatwaves and Public Health



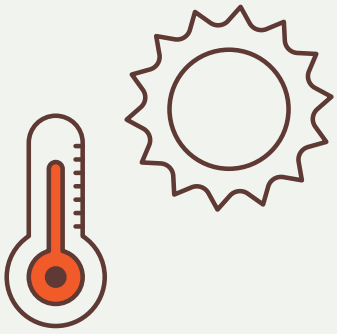
1- The increase in heatwaves in Turkey and Europe

What is a heatwave?

High temperatures are a well established public health threat.[1] When exposed to heat, human thermoregulation, that is, the body temperature regulation mechanism, reacts to balance the effect of heat. However, when the temperature is too high to maintain equilibrium, the risk of illness and death increases significantly during or within days of exposure.[2]

The US EPA defines a heatwave as "a prolonged period of excessive heat".[3] These periods can last from a few days to several weeks. Heatwaves are the leading cause of climate change-related deaths. For this reason, heatwaves, which are meteorological events, should be assessed for their impacts on human health.[4]

The climatic conditions in different regions and the local population's adaptation to the climatic conditions can influence the impact of extreme heat. Consequently, there is no global definition of a heatwave. There can be multiple heatwave definitions even at local level, based on varying temperature levels or time periods.[5]



The World Meteorological Organization defines a heatwave as **"five or more consecutive days during which the daily maximum temperature surpasses the average maximum temperature by 5°C (9°F) or more".[6]**

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1 Basu, R. (2009). High ambient temperature and mortality: a review of epidemiologic studies from 2001 to 2008. Environ Health, 8, 40. https://doi.org/10.1186/1476-069X-8-40
Basu, R., & Samet, J. M. (2002). Relation between elevated ambient temperature and mortality: a review of the epidemiologic evidence. Epidemiol Rev, 24(2), 190-202. https://doi.org/10.1093/epirev/mxf007
Ye, X., Wolff, R., Yu, W., Vaneckova, P., Pan, X., & Tong, S. (2012). Ambient temperature and morbidity: a review of epidemiological evidence. Environ Health Perspect, 120(1), 19-28. https://doi.org/10.1289/ehp.1003198
2 Xu, Z., FitzGerald, G., Guo, Y., Jalaludin, B., & Tong, S. (2016). Impact of heatwave on mortality under different heatwave definitions: A systematic review and meta-analysis. Environ Int, 89-90, 193-203. https://doi.org/10.1016/j.envint.2016.02.007
3 EPA, U. S. (2021). Terms & Acronyms. erişim tarihi 11.05 from https://sor.epa.gov/sor_internet/registry/termreg/searchandretrieve/termsandacronyms/search.do?search=&term=heat%20wave&matchCriteria=Contains&checkedAcronym=true&checkedTerm=true&hasDefinitions=false
4 Robinson, P. J. (2001). On the Definition of a Heat Wave. Journal of Applied Meteorology and Climatology, 40(4), 762- 775.
5 Tong, S., Wang, X. Y., & Barnett, A. G. (2010). Assessment of heat-related health impacts in Brisbane, Australia: comparison of different heatwave definitions. PLoS One, 5(8), e12155. https://doi.org/10.1371/journal.pone.0012155
6 Rafferty, J. P. (2018). Heat wave. In Encyclopedia Britannica. erişim tarihi 10.05.2021, from https://www.britannica.com/science/heat-wave-meteorology

Some countries have set different standards according to their own climatic conditions. For example, in India the Meteorological Department defines heatwaves as temperatures increasing 5–6 °C (9–10.8 °F) or more above normal temperature, whereas the US National Weather Service defines it as **“abnormally and uncomfortably hot and unusually humid weather spanning two days or more”**.[7]

The Turkish State Meteorological Service (TSMS) defines a heatwave as high temperatures and high humidity spanning a long time period. As for the standard set for Turkey, it is defined as “an extended period during which temperatures exceed the highest average temperature by 10 °C or more, and are accompanied by extreme humidity”.[8] When taking into consideration the probable health effects of heatwaves, the TSMS refers to another concept called the “heat index”. The heat index is an indicator of what the actual temperature feels like when the relative humidity is combined with air temperature. The Turkish State Meteorological Service has developed early public warning procedures based on the estimated heat index.

Exposure to extreme heat has a wide range of physiological impacts for all humans and can result in premature death and disability.
Although heatwaves are the most dangerous natural threats, they rarely receive attention because their death toll and destruction is often not immediately visible.

7 Rafferty, J. P. (2018). Heat wave. In Encyclopedia Britannica. erişim tarihi 10.05.2021, from https://www.britannica.com/science/heat-wave-meteorology
8 Özalp, Y. (2021). Isı Dalgası - Isı Endeksi. Meteroloji Genel Müdürlüğü erişim tarihi 11.05.2021 from https://www.mgm.gov.tr/genel/saglik.aspx?s=113

According to the estimates of the World Health Organization (WHO), more than 166,000 people died between 1998 and 2017 because of heatwaves.[9] In 2003, more than 70,000 people died as a result of the heatwaves that took place in Europe from June to August,[10] and more than 56,000 people died during the 44-day heatwave in the Russian Federation in 2010.[11]

Furthermore, since 1990, populations in European and Eastern Mediterranean regions have been the most vulnerable to extreme heat among all WHO regions due to ageing populations, the high prevalence of chronic diseases and rising levels of urbanization.[12]

The frequency, duration and intensity of extreme weather events are increasing on a global scale. The rise in global temperatures is an important indicator of the magnitude of climate change and its possible impacts. Global temperatures have been rising steadily since the end of the 19th century. The rate of increase has been particularly high since the 1970s at around 0.2 °C per decade.[13] Between 2000 and 2016, the number of people exposed to heatwaves increased by around 125 million.[14] 2020 was the warmest year on record for Europe[15], and 19 of the 20 warmest years have occurred since 2000.[16]

9 WHO. (2018a). Heatwaves. erişim tarihi 13.05.2021 from https://www.who.int/health-topics/heatwaves#tab=tab_1
10 WHO, https://www.who.int/health-topics/heatwaves#tab=tab_1
11 WHO. (2018b). Information and public health advice: heat and health. erişim tarihi 14.05.2021 from https://www.who.int/globalchange/publications/heat-and-health/en/
12 Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Beagley, J., Belesova, K., ... & Costello, A. (2020). The 2020 report of The Lancet Countdown on health and climate change: responding to converging crises. The Lancet.
13 EEA. (2021). Global and European temperatures. erişim tarihi 14.05.2021 from https://www.eea.europa.eu/data-and-maps/indicators/global-and-european-temperature-10/assessment
14 WHO. (2018a). Heatwaves. erişim tarihi 13.05.2021 from https://www.who.int/health-topics/heatwaves#tab=tab_1
15 WMO. (2019). The Global Climate in 2015–2019. erişim tarihi 14.05.2021 from https://library.wmo.int/index.php?lvl=notice_display&id=21522#.YJ4-IGYzbPB
16 NASA, Global Climate Change: Vital Signs of the Planet, https://climate.nasa.gov/vital-signs/global-temperature/

The world is warming, and Europe in particular is warming faster than the global average. The annual European land average temperatures over the past decade have been 1.7 to 1.9 °C warmer than in the pre-industrial period (Figure 1).[17] Many parts of Europe experienced an extraordinary heatwave in June and July 2019, which set all-time high national temperature records multiple times.[18]

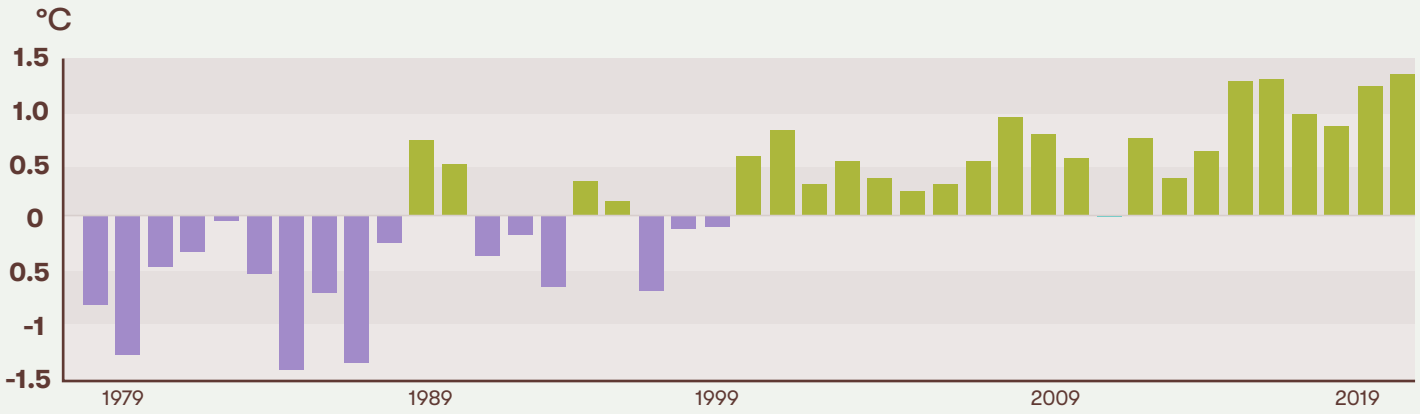


Figure 1. Europe Annual Temperature Anomalies, 1979-2019 (C3S, 2020)

Like for Europe, temperatures in Turkey have increased since the intensification of industrialization. 2020 was recorded as the third warmest year post-1970s.[19] 2020's annual mean temperature of 13.5 °C is 1.4 °C above 1981-2010 normal temperatures (Figure 2).[20] Temperature increases have been particularly more pronounced since the 2000s.

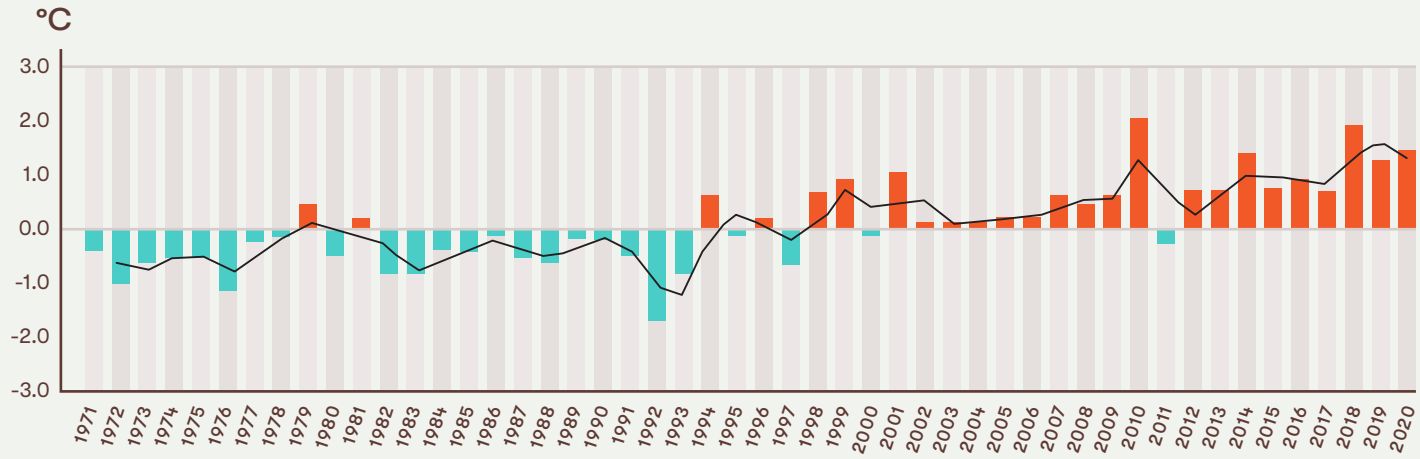


Figure 2. Turkey Mean Temperature Anomalies, 1971-2020 (TSMS, 2021)

Human activities, and greenhouse gas emissions in particular, are largely responsible for the warming.

17 C3S. (2020). European State of the Climate 2019. Copernicus Climate Change Service, European Commision. erişim tarihi 14.05.2021 from https://climate.copernicus.eu/ESOTC/2019
18 C3S. (2020). European State of the Climate 2019. Copernicus Climate Change Service, European Commision. erişim tarihi 14.05.2021 from https://climate.copernicus.eu/ESOTC/2019
18 MGM, T. C. (2021). Türkiye 2020 Yılı İklim Değerlendirmesi. T.C. Meteoroloji Genel Müdürlüğü, İklim ve Zirai Meteoroloji Dairesi Başkanlığı, Araştırma Dairesi Başkanlığı erişim tarihi 14.05.2021 from https://mgm.gov.tr/FILES/iklim/yillikiklim/2020-iklim-raporu.pdf
20 MGM, T. C. (2021). Türkiye 2020 Yılı İklim Değerlendirmesi. T.C. Meteoroloji Genel Müdürlüğü, İklim ve Zirai Meteoroloji Dairesi Başkanlığı, Araştırma Dairesi Başkanlığı erişim tarihi 14.05.2021 from https://mgm.gov.tr/FILES/iklim/yillikiklim/2020-iklim-raporu.pdf

It is estimated that the intensity, frequency, duration and geographical extent of heatwaves will increase as climate change progresses.[21]

What is an Urban Heat Island?

An urban heat island (UHI) occurs when city temperatures are higher than in surrounding rural and natural areas. In big cities such as New York and London, the difference in temperature is 3-4 °C and can exceed 11 °C in extreme cases.[22]

Although the urban heat island effect has been known since the beginning of the 19th century, it has been occurring in more cities over the last century as a consequence of the urbanization dynamics and the loss of urban green spaces.[23] **In Istanbul, Bursa, Trabzon and Erzurum urban heat islands became more frequent between 1984 and 2011 as a result of urbanization, industrialization and land changes.[24]**

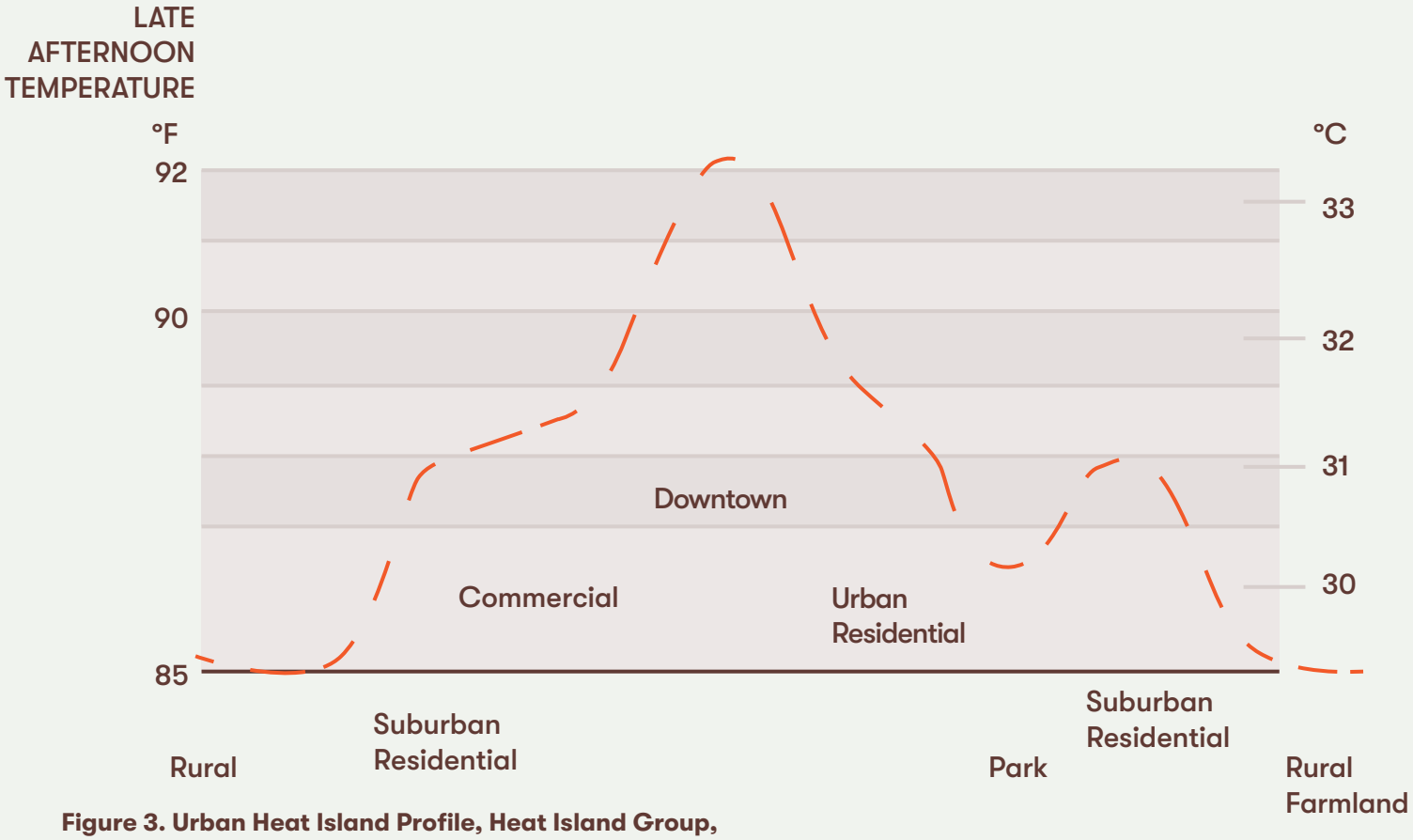


Figure 3. Urban Heat Island Profile, Heat Island Group, Lawrence Berkeley National Laboratory, 2019

21 Meehl, G. A., & Tebaldi, C. (2004). More intense, more frequent, and longer lasting heat waves in the 21st century. Science, 305(5686), 994-997. https://doi.org/10.1126/science.1098704
22 Gedzelman, S. D., Austin, S., Cermak, R., Stefano, N., Partridge, S., Quesenberry, S., & Robinson, D. A. (2003). Mesoscale aspects of the urban heat island around New York City. Theoretical and Applied Climatology, 75(1), 29-42. Nickson, A., Woolston, H., Daniels, J., Dedring, I., Reid, K., Ranger, K., ... & Reeder, T. (2011). Managing risks and increasing resilience: the Mayor's climate change adaptation strategy. Greater London Authority, London.
23 NASA - Global Climate Change: Vital Signs of the Planet. (2021, Nisan 29). Can you explain the urban heat island effect?. https://climate.nasa.gov/faq/44/can-you-explain-the-urban-heat-island-effect/
24 Dihkan, M., Karsli, F., Guneroglu, N., & Guneroglu, A. (2018). Evaluation of urban heat island effect in Turkey. Arabian Journal of Geosciences, 11(8), 1-20.

The intensity of urban heat islands are directly related to the following:[25]

Land-use change

Shade from vegetation and water evaporation reduce air temperature. The loss of natural green areas through urbanization weaken the cooling effects whereas trees and green spaces in cities can have a local cooling effect.

Urban materials

Concrete and asphalt surfaces of buildings, roads and infrastructures in cities have low solar reflectance properties. These materials retain the sun's heat more than green spaces and water areas. Since the heat that is stored in the urban fabric during daytime is released to the atmosphere after sunset, the effect of an urban heat island is felt more prominently at night time in dense urban surroundings.

Urban settings

Building layouts, dimension and densities in cities affect the winds as well as the heat retained by materials. Narrow streets and tall buildings prevent air circulation in the city and slows down the cooling effect of the winds. In dense urban surroundings, not only do buildings retain more heat but the release of this heat is also more difficult.

25 Ramamurthy, P., & Bou-Zeid, E. (2016). Heatwaves and urban heat islands: a comparative analysis of multiple cities. Journal of Geophysical Research: Atmospheres, 122(1), 168-178.

Anthropogenic heat

In cities, many human activities - from fossil fuel-based energy production and industrial activities to vehicle exhausts - contribute to the urban heat island effect by releasing waste heat into the atmosphere. Waste heat can raise temperatures by 1-3 °C, locally. In addition, rising temperatures in urban areas increase the demand for space cooling (air conditioning) and the waste heat from cooling activities is released into the atmosphere, thus creating a vicious cycle that reinforces the urban heat island effect.

Geographic features and microclimate

The layout of the city affects microclimatic features such as winds, and therefore the urban heat island. For example, in coastal cities, sea breezes can alleviate the heat island effect.

Weather

Daily weather also affects the daily urban heat island as it affects the exposure to the sun. For example, the effect weakens with cloud coverage.

Urban heat islands can vary on a daily basis, across seasons, regions and different cities as well as within the same city, depending on the interaction of these features.[26] The aforementioned urban heat islands of Istanbul, Bursa, Trabzon and Erzurum have different intensities.[27] A study conducted in İzmir revealed that the urban heat island effect is more severe during daytime and during summer and spring.[28]

26 NASA - Global Climate Change: Vital Signs of the Planet. (2021, Nisan 29). Can you explain the urban heat island effect?. https://climate.nasa.gov/faq/44/can-you-explain-the-urban-heat-island-effect/
27 Dihkan, M., Karsli, F., Guneroglu, N., & Guneroglu, A. (2018). Evaluation of urban heat island effect in Turkey. Arabian Journal of Geosciences, 11(8), 1-20.
28 Yavaşlı, D. D. (2017). Spatio-temporal trends of urban heat island and surface temperature in Izmir, Turkey. American Journal of Remote Sensing, 5(3), 24-29.

Urban heat islands have negative impacts on the ecosystem and human health. The heat that accumulates on urban surfaces is carried to aquatic ecosystems through stormwater drainage and degrades these ecosystems.[29] If the increase in cooling demand during summertime is met with fossil fuels, there is an increase in pollutant emissions, which poses a threat to public health.[30] The most important impact of urban heat islands is that they expose the vulnerable groups, such as the elderly and people with preexisting cardiovascular diseases, to greater heat stress.[31]

Urban heat islands intensify the health risks of heatwaves. In August 2003, during the European heatwave that led to the death of more than 70,000 people, temperatures in France rose by 3.7 °C above the 1950-2006 average and 15,000 people lost their lives.[32] The analysis of satellite imagery for a study on the heatwave's impacts in France revealed that urban heat islands were one the main factors that increased the mortality risk because they caused high night time temperatures.[33]

Climate change will increase average temperatures and cause longer and more intense heatwaves.[34] Urban heat islands will trigger urban temperature increases in both cases. For example, according to the worst case scenario, climate change is expected to increase Istanbul's average temperature by 4.5 °C and urban heat islands are expected to add another 1-2 °C.[35] This requires that public health measures take into account the urban heat island effect.

29 U.S. Environmental Protection Agency (EPA). (2020b, Temmuz 29). Heat Island Impacts. https://www.epa.gov/heatislands/heat-island-impacts
30 U.S. Environmental Protection Agency (EPA). (2020b, Temmuz 29). Heat Island Impacts. https://www.epa.gov/heatislands/heat-island-impacts
31 Heaviside, C., Macintyre, H., & Vardoulakis, S. (2017). The urban heat island: implications for health in a changing environment. Current environmental health reports, 4(3), 296-305.
32 Brücker, G. (2005). Vulnerable populations: lessons learnt from the summer 2003 heat waves in Europe. Eurosurveillance, 10(7), 1-2.
Laaidi, K., Zeghnoun, A., Dousset, B., Bretin, P., Vandentorren, S., Giraudet, E., & Beaudeau, P. (2012). The impact of heat islands on mortality in Paris during the August 2003 heat wave. Environmental health perspectives, 120(2), 254-259.
33 Laaidi, K., Zeghnoun, A., Dousset, B., Bretin, P., Vandentorren, S., Giraudet, E., & Beaudeau, P. (2012). The impact of heat islands on mortality in Paris during the August 2003 heat wave. Environmental health perspectives, 120(2), 254-259.
34 Revi, A., D.E. Satterthwaite, F. Aragón-Durand, J. Corfee-Morlot, R.B.R. Kiunsi, M. Pelling, D.C. Roberts, and W. Solecki. (2014). Urban areas. İçinde: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T. E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 535-612.
35 Istanbul Büyükşehir Belediyesi (İBB). (2018). İstanbul İklim Değişikliği Eylem Planı: İklim Senaryoları Raporu.

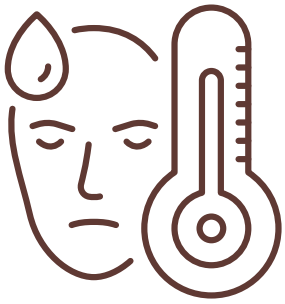
2- Consequences of Heatwaves

Health Impacts

Climate change is expected to increase the average summer temperatures, frequency and intensity of hot days. The heatwaves that arise as a result of these increases negatively affect human health by causing heat-related diseases and deaths. Human sensitivity to ambient temperature changes defines the relationship between exposure to heat and cold waves and their corresponding impacts. Both high and low temperatures, indoors and outdoors, pose significant risks to human health, including increases in mortality, morbidity and healthcare use.

During a heatwave, the body tries to lower its temperature through the widening of blood vessels and sweating. If the temperature continues to increase, this leads to an increase in some hormones (antidiuretic hormone and aldosterone), and respiratory rate and heart rate, and has an adverse effect on the body's thermoregulation mechanisms.[36] Heat stroke is associated with a systemic inflammatory response that leads to life-threatening, multi-organ dysfunction when basal body temperature exceeds 40 °C.[37]

Heatwaves have direct and indirect health impacts.



Direct health impacts include heat-related illnesses such as heat stroke, heat cramps, heat exhaustion, heat syncope, rhabdomyolysis (muscle injury that can lead to kidney failure), heat rash as well as cardiovascular, respiratory, renal and nervous system diseases, and sleep disorders and deaths. Heatwaves can impact mental health, too.

Indirect impacts include exacerbating pre-existing mental and physical conditions, increasing healthcare service demand as well as the workload of health workers and slowing down ambulance response time.

36 Koppe, C., Sari Kovats, R., Menne, B., Jendritzky, G., Wetterdienst, D., & World Health Organization. (2004). Heat-waves: risks and responses. Gösterimi (Koppe ve ark;2004)
37 van Steen, Y., Ntarladima, A. M., Grobbee, R., Karssenberg, D., & Vaartjes, I. (2019). Sex differences in mortality after heat waves: are elderly women at higher risk?. International archives of occupational and environmental health, 92(1), 37-48.

Heatwaves can also have impacts on wider infrastructure that is essential for health, such as power, water and transportation. **Extreme temperatures also impact air quality. Hot and sunny days can increase ozone (O_3) levels, which in turn impact nitrogen oxide (NO_x) levels.**

Furthermore, increased need for air-conditioning leads to higher electricity consumption, which can increase air pollutant emissions including particulates, depending on the energy source. Increased ozone and particulate matter emissions can pose serious threats to human health.v

Heatwaves can also increase the risk of occupational injuries, as heat may result in sweaty palms, fogged-up safety glasses, dizziness, difficulty concentrating, or burns from accidental contact with hot surfaces.[38]

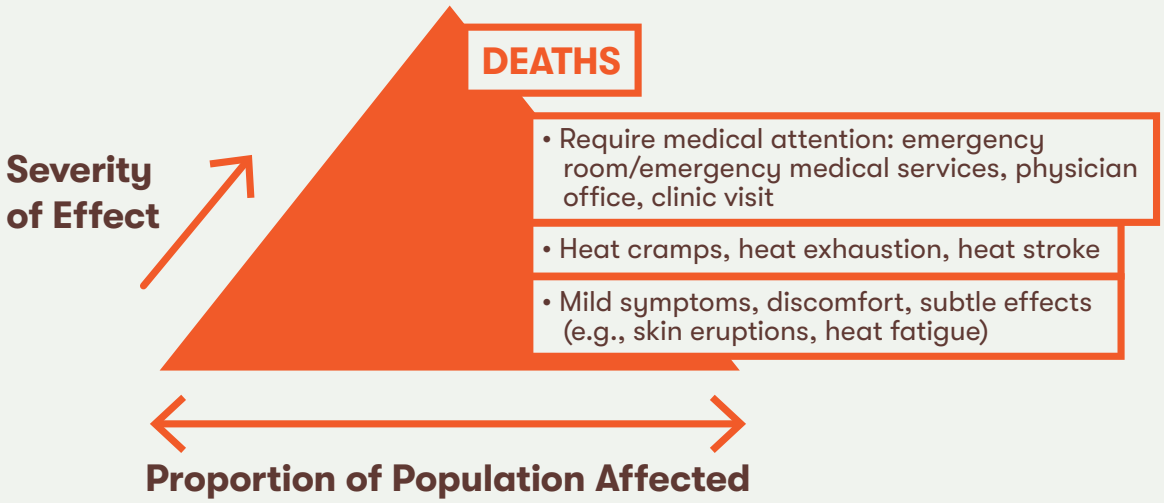


Figure 4: Extreme Heat Events Cause a Range of Health Problems (based on US CDC).[39]

Extreme heat events cause health problems and can make other health problems worse. Mild effects are more common, but in extreme cases, people can die.

38 Feyen, L., Russo, S., Naumann, G., Formetta, G., Forzieri, G., & Girardello, M. (2020). Global warming and human impacts of heat and cold extremes in the EU. Publications Office of the European Union. https://doi.org/10.2760/47878
Koppe, C., Sari Kovats, R., Menne, B., Jendritzky, G., Wetterdienst, D., & World Health Organization. (2004). Heat-waves: risks and responses. Gösterimi (Koppe ve ark;2004)
Heat Waves and Climate Change | Center for Climate and Energy Solutions. (2021). Erişim Tarihi May 5, 2021, from https://www.c2es.org/content/heat-waves-and-climate-change/
The U.S. Environmental Protection Agency, & CDC. (2016). CLIMATE CHANGE and EXTREME HEAT What You Can Do to Prepare. October. https://www.cdc.gov/climateandhealth/pubs/extreme-heat-guidebook.pdf
39 Center for Disease Control and Prevention, from: https://www.cdc.gov/climateandhealth/pubs/climatechangeandextremeheatevents.pdf

Heatwaves and Mortality

Between 1980 and 2017, heatwaves accounted for 68 percent of natural hazard-related fatalities and 5 percent of economic losses among the European Economic Area countries.[40] In 2003, the devastating heatwaves in southern Europe led to around 15,000 additional deaths in France alone[41] and to an estimated 70,000 deaths across Europe.[42] Heatwaves are the leading cause of weather-related deaths in Australia and the United States. Heatwaves cause more than 600 deaths per year in the United States, more than all other impacts.[43]

A study conducted in Turkey revealed that three heatwaves that lasted a total of 14 days in the summer of 2015, 2016 and 2017 significantly increased the mortality rate and caused 419 additional deaths during 23 days of exposure.[44]

40 World Bank. 2020. Analysis of Heat Waves and Urban Heat Island Effects in Central European Cities and Implications for Urban Planning. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/34335 License: CC BY 3.0 IGO.
41 WHO Europe, Health and Global Environmental Change Series No:2 https://www.who.int/publications/i/item/heat-waves-risks-and-responses
42 Zuo, J., Pullen, S., Palmer, J., Bennetts, H., Chileshe, N., & Ma, T. (2015). Impacts of heat waves and corresponding measures: a review. Journal of Cleaner Production, 92, 1-12.
43 Heat Waves and Climate Change | Center for Climate and Energy Solutions. (2021). Erişim Tarihi May 5, 2021, from https://www.c2es.org/content/heat-waves-and-climate-change/
44 Can, G., Şahin, Ü., Sayılı, U., Dubé, M., Kara, B., Acar, H. C., ... & Gosselin, P. (2019). Excess mortality in Istanbul during extreme heat waves between 2013 and 2017. International journal of environmental research and public health, 16(22), 4348.

In the past 20 years, heat-related mortality in people older than 65 years increased by 53.7 percent and in 2018 it reached 296,000 deaths, globally.[45] A recent study showed that heat-related deaths in Europe could increase 50-fold, compared to 1981-2010, and reach 151,500 deaths between 2071 and 2100.

It is estimated that heatwaves will account for 99 percent of climate-related disaster fatalities by the end of the twenty-first century.[46]

Vulnerable Groups and Heatwaves

While heatwaves can affect anyone, some people are more vulnerable than others. Those with chronic illnesses, young children, people aged 65 and over, people with disabilities, those who live in poverty or social isolation, those who work outdoors for long hours and the homeless are at much higher risk of developing heat-related health problems. Three key factors put some people at higher risk than others. These are:

- **Exposure**

Some people are more exposed to high temperatures than others, such as those who spend long hours working or exercising outside, the homeless, or those living in uninsulated/non air-conditioned buildings.

- **Sensitivity**

Infants, young children, pregnant women, the elderly, and those with pre-existing chronic diseases made worse by exposure to heat are less tolerant of heat than others. Furthermore, certain medications can affect the body's ability to regulate temperature. People may be more sensitive to heat if they are under the influence of alcohol or drugs that affect thirst. Elderly individuals are less likely to perceive being overheated, even though they are physiologically at greater risk. According to various studies, the elderly who have more than one risk factor constitute a significant risk group for heat-related deaths.

45 Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Beagley, J., Belesova, K., ... & Costello, A. (2020). The 2020 report of The Lancet Countdown on health and climate change: responding to converging crises. The Lancet.
46 Forzieri G, Cescatti A, e Silva FB, Feyen L (2017) Increasing risk over time of weather-related hazards to the European population: a data-driven prognostic study. Lancet Planet Health 1:e200–e208

• **Ability to respond and prepare**
People with limited incomes who cannot afford air conditioning or the electricity to use it, those who have mobility issues that prevent them from receiving healthcare or changing locations and outdoor workers are less able to avoid heat than others.

Socio economic and behavioral factors that increase the mortality risk during a heatwave include living alone, inability to self-care, lack of mobility, living on the top floor, living in an uninsulated/non air-conditioned building and unwillingness to change their behavior during a heatwave.[47]

3- Ecological Consequences

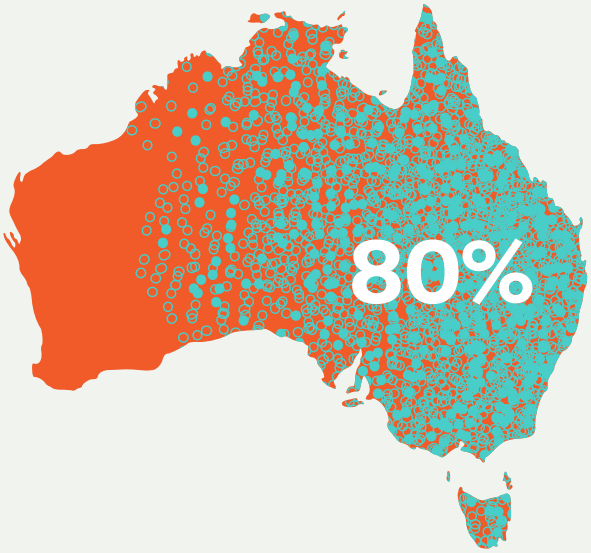
Forest Fires

Oxygen, temperature and fuel are referred to as the "fire triangle".[48] When heatwaves and drought occur simultaneously, forest biomass -dry tree branches and leaves on the forest floor- can ignite with extreme heat and turn into forest fires. As the frequency of heatwaves increases, the intensity and frequency of forest fires will also increase.[49] In the Mediterranean Basin where Turkey is located, the heatwaves that are expected in June and September can trigger forest fires.[50]

47 The U.S. Environmental Protection Agency, & CDC. (2016). CLIMATE CHANGE and EXTREME HEAT What You Can Do to Prepare. October. https://www.cdc.gov/climateandhealth/pubs/extreme-heat-guidebook.pdf
48 Boğaziçi Üniversitesi. Orman Yangınları Sebepleri Ve Sonuçları http://climatechange.boun.edu.tr/orman-yanginlari-sebepleri-ve-sonuclari/
49 Ege Orman Vakfı, erişim tarihi from https://www.egeorman.org.tr/iklim-degisikligi-ve-ormanlar.aspx on 03.06.2021
50 Daily Sabah. September 2020. Minister warns of forest fire risk amid heat wave across Turkey. https://www.dailysabah.com/turkey/minister-warns-of-forest-fire-risk-amid-heat-wave-across-turkey/news

Fire risk is predicted using various different forest fire indices around the world, including Turkey.[51]

The 2020 fires in California or the 2019-2020 fires in Australia constitute examples of fires caused by heatwaves. In August-September 2020, temperatures rose to 50 °C with concurrent heatwaves and dry winds in many cities in California and resulted in the largest wildfire in the state's history.[52] 2015 was Australia's hottest and driest year on record, with temperatures exceeding 45 °C in some regions[53] and multiple bushfires throughout the year. Even though the Australian government had predicted a long and severe bushfire season, heatwaves were considered to be one of the contributing factors. Forest fires are climate change or global warming-induced and cause extremely poor air quality that can affect large populations.



In the fires of 2019-20, 80 percent of Australians were affected by smoke pollution. Forest fire smoke contains a number of pollutants, including particulate matter, carbon dioxide, nitrogen oxides and volatile organic compounds.[54]

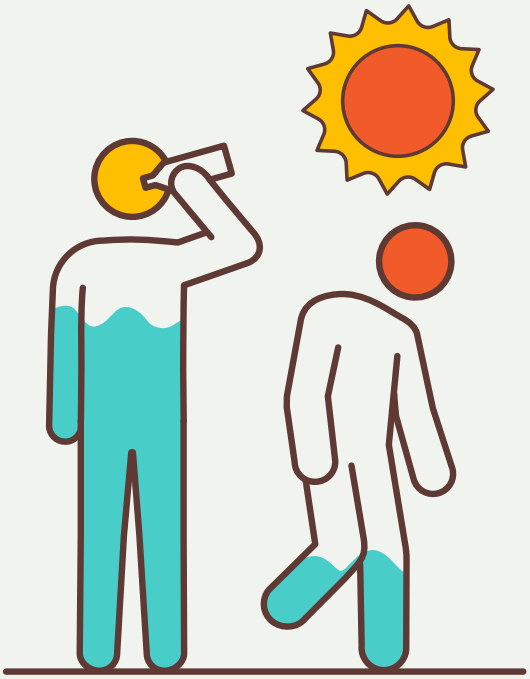
51 Boğaziçi Üniversitesi. Orman Yangınları Sebepleri Ve Sonuçları http://climatechange.boun.edu.tr/orman-yanginlari-sebepleri-ve-sonuclari/
52 Earth Observatory NASA, September 2020 https://earthobservatory.nasa.gov/images/147256/california-heatwave-fits-a-trend
53 Australian Government Bureau of Meteorology. "State of the Climate 2020".
http://www.bom.gov.au/state-of-the-climate/documents/State-of-the-Climate-2020.pdf
54 The Limits of Livability, The Global Climate and Health Alliance (GCHA), from:
https://climateandhealthalliance.org/wp-content/uploads/2021/06/016062021_GCHA_bushfire_report_limits_livability_health.pdf

Forest fire smoke can lead to serious health issues, especially in vulnerable groups. People aged 65 and over, people with asthma, chronic obstructive pulmonary disease (COPD) and cardiovascular disease, and those who spend more time outdoors are relatively more vulnerable. Cough and shortness of breath are short-term effects of fire smoke.[55]

Water scarcity and water pollution

Heatwaves do not only impact public health, they also have a number of adverse impacts on many other components of nature, and water resources in particular. Since heatwaves bear negative impacts both on water quantity and water quality, discussions about heatwaves need to address the issues of water scarcity and water pollution as a whole.

The first impact of heatwaves on water resources is the loss of water as a result of excessive evaporation of surface waters such as streams and lakes. This can lead to water scarcity in residential and rural areas that meet their water needs from surface waters (streams, lakes and dam reservoirs, etc.). Moreover, heatwaves occur in many parts of the world during the warmer months when rainfall is at its lowest least and water demand is at its highest, magnifying the existing water supply-demand imbalance.

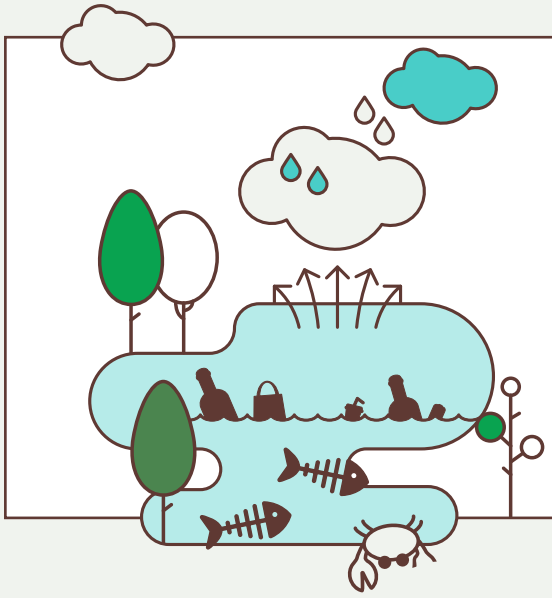


Water use lies at the intersection of key measures that need to be taken to cool off the human body during a heatwave. In addition to individual measures[56] such as drinking plenty of water to cool off the body, taking cold showers and using water-filled containers for indoor evaporative cooling, there are public measures -such as increasing green spaces to prevent urban heat islands and installing water dispensers in common areas- that need to be taken.

55 The Limits of Livability, The Global Climate and Health Alliance (GCHA), from: https://climateandhealthalliance.org/wp-content/uploads/2021/06/016062021_GCHA_bushfire_report_limits_livability_health.pdf
56 Şahin, Ü. (2019). Sıcak Dalgaları: İklim Değişikliğiyle Artan Tehdit ve Sıcak-Sağlık Eylem Planları, İPM-Mercator Politika Notu. İstanbul Politikalar Merkezi, Sabancı Üniversitesi.

Therefore, more water is needed during a heatwave and water use increases. Hence, heatwaves constitute a serious public health threat, particularly in urban areas that are already experiencing water issues -that is, water scarcity and/or pollution- as a result of population growth and water-intensive activities.

However, water loss by evaporation during a heatwave has negative impacts not only on humans, but also on species living in aquatic ecosystems and on all species whose lives depend on these water resources. Aquatic ecosystems such rivers, lakes and wetlands need to maintain a certain level of water and environmental flow in order to sustain their functions. If not, substantial population declines and even extinction of some species as well as migration may occur and, together with other uncertainties, they can trigger unpredictable and uncontrollable changes in the ecosystem.



Water loss by evaporation also leads to an increase in the concentration of pollutants.

These pollutants, which are not harmful at normal water level, can be toxic to aquatic species and other organisms when the water level drops.

Heatwaves have also a direct negative impact on water quality. **Studies reveal that heatwaves bear an impact on the thermal and oxygen dynamics of lakes, alter phytoplankton populations and lead to cyanobacteria blooms.**[57] The most recent and well known example is **the mass die-offs of many aquatic organisms, and particularly mass fish deaths, when surface water temperature rose during the 2018 heatwaves in Europe and reduced the level of dissolved oxygen in the water.**

Furthermore, drought and heatwaves reduce surface water and cause water scarcity, which leads to excessive groundwater use.

The excessive extraction of groundwater, especially in coastal areas, results in seawater intrusion into empty aquifers, which are underground stores of freshwater. The irreversible aquifer salinization and pollution makes the groundwater unusable. Excessive water extraction from aquifers can also put pressure on groundwater-dependent ecosystems, causing wetlands to dry up.[58] Groundwater is a strategic resource and its depletion increases our vulnerability to extreme climatic events, and heatwaves in particular.

57 Woolway, R.I, Jennings, E ve Carrea, L. (2020) "Impact of the 2018 European heatwave on lake surface water temperature", Inland Waters 10:3, 322-332, DOI: 10.1080/20442041.2020.1712180
58 Gökkür S. (2016). "İklim Değişikliğinin Su Kaynaklarına Etkisi", Apelasyon: 34, http://www.apelasyon.com/Yazi/506-iklim-degisikliginin-su-kaynaklarina-etkisi

Worse still, **there is a substantial increase in concurrent heatwaves and drought.** Concurrent heatwaves and droughts occurred in many parts of the world in the summers of 2003, 2010 and 2015; in Europe and Western Russia in the summer of 2018; in the USA in 2012-2014; in Australia in 2013; and Southwest and North China together in 2006, 2009-2010 and 2014. Even though research on these compound extreme climate events are still at early stages, we already can see that there is a rise in the frequency and that the impact of compound drought and heatwave events are greater compared to their individual impacts.[59]

The frequency, duration and magnitude of extreme climatic events such as heatwaves and droughts are expected to increase with the rise of global average temperatures. Creating cities and rural areas that are more resilient to heatwaves requires taking measures to reduce the negative impacts of this climatic event on water resources. If we neglect to take these measures, water scarcity and water pollution will escalate into a series of inevitable issues in many parts of the world.

4- Recommendations

Recommendations to Decision Makers

Climate change leads to changes in weather patterns and a significant increase in extreme weather events, including heatwaves. Recent heatwaves in Europe have led to an increase in related death rates, but the adverse health effects of heat and heatwaves are mostly preventable. Prevention requires an action portfolio that includes meteorological early warning systems, timely public and medical advice, improvements to housing and urban planning, and health and social system preparedness.[60]

59 Mukherjee, S., & Mishra, A. K. (2021). "Increase in compound drought and heatwaves in a warming world", Geophysical Research Letters, 48, e2020GL090617. https://doi.org/10.1029/2020GL090617
60 Heat-Health Action Plan, WHO Europe, https://www.euro.who.int/__data/assets/pdf_file/0006/95919/E91347.pdf

The main elements of a Heat-Health Action Portfolio

The World Health Organization recommends that countries and cities develop and implement thermal health action plans to prevent, respond and control heat-related health risks.

The eight main elements for a successful action plan are:

- Agreement on a lead body,
- Acurate and timely warning systems,
- Heat-related health information plan,
- Reduction in indoor heat exposure,
- Special care for vulnerable groups,
- Preparedness of health and social care systems,
- Long-term urban planning,
- Real-time surveillance and evaluation.[61]

Furthermore, keeping to the Paris Agreement[62], which entered into force in 2016 and aims at limiting global warming to well below 2, and preferably to 1.5 degrees Celsius, is also key. This treaty is that it is the first-ever universal, legally binding climate change agreement. Parties to the Paris Agreement agreed on the following:

- Limiting the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels,
- Reporting the climate actions they have taken to the public and to other Parties and meeting every five years to monitor long-term targets and nationally determined contributions (NDC),
- Empowering communities to cope with the impacts of climate change.

61 Heat-Health Action Plan, WHO Europe, https://www.euro.who.int/__data/assets/pdf_file/0006/95919/E91347.pdf
62 United Nations Framework Convention on Climate Change, from: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement
European Union, from: https://ec.europa.eu/clima/policies/international/negotiations/paris_en

Recommendations to Healthcare Professionals

- There should be awareness raising and capacity building for family physicians or general practitioners, emergency doctors and other healthcare professionals on heatwaves and their impacts. It is important that the health system is prepared for a severe heatwave.
- Provincial Health Directorates, and Public Health Directorates in particular, should develop and implement programs to prevent and protect the public from the health effects of heatwaves as they will continue to increase.
- Provincial Health Directorates should work together with Provincial Meteorology Directorates, local governments and other related institutions to develop and implement heatwave response plans.
- The public should be informed about the health effects of heatwaves through public messaging, media and communication strategies.
- Data regarding heatwaves should be regularly collected and evaluated by surveillance systems in order to develop relevant strategies.[63]

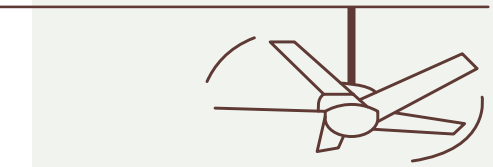
Recommendations to Individuals

Extreme heat has adverse public health impacts and the elderly, infants, outdoor workers and people with chronic illnesses are particularly vulnerable. **Heat can trigger exhaustion and heatstroke and can worsen existing medical conditions such as cardiovascular, respiratory and renal diseases and mental disorders.** The adverse health effects of hot weather can be largely avoided with good public health practices.

63 Şahin, Ü. (2019). Sıcak Dalgaları: İklim Değişikliğiyle Artan Tehdit ve Sıcak-Sağlık Eylem Planları, İPM-Mercator Politika Notu. İstanbul Politikalar Merkezi, Sabancı Üniversitesi.

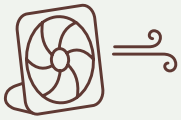
Stay away from the heat

- Avoid going out and doing strenuous activities during the hottest hours of the day.
- If possible, do your shopping during early morning and evening hours.
- Stay in the shade and do not leave children or animals in parked vehicles. If possible, spend a few hours a day in a cool place.



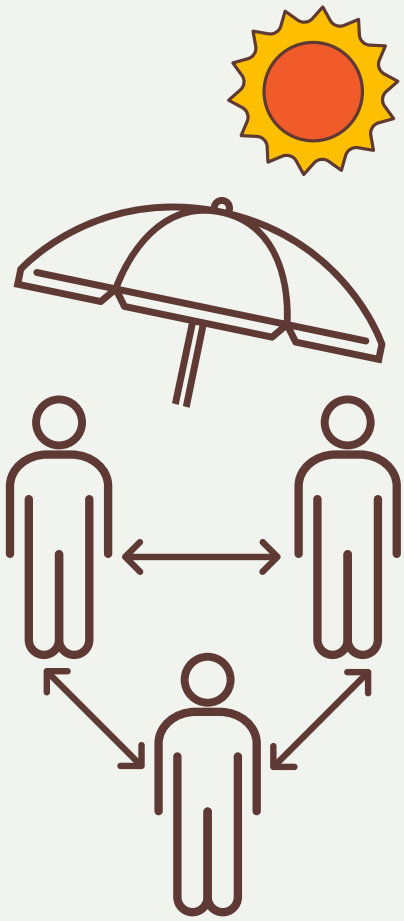
Keep Your Home Cool

- Use night air to cool your home.
- Reduce the heat load inside your home during the day by using blinds or shutters and turning off as many electrical appliances as possible.



Keep Your Body Cool and Drink Plenty of Fluids

- Use light and loose clothing and bedding.
- Take a cold shower or bath.
- Drink water regularly, avoid sugary, alcoholic or caffeinated beverages.



Stay Cool During the COVID-19 Pandemic

- Avoid sun exposure.
- You can catch COVID-19 regardless of air temperature. So protect yourself and others by washing your hands regularly, coughing into your elbow or a tissue, and avoid touching your face.
- Check on family, friends and neighbors who spend most of their time alone. People in vulnerable groups may need help on hot days, so if someone you know is at risk, help them get advice and support.
- Do not forget that it is crucial to follow physical distancing recommendations during the COVID-19 pandemic.[64]

Heatwaves and Health

The World Health Organization provides various materials on heatwaves and health including a **summary of evidences for effective protection**[65], **videos**[66] and **library**[67] of public health advice, and **heat-health action planning.**[68]

64 WHO, from: https://who.canto.global/pdfviewer/viewer/viewer.html?v=coronavirus&portalType=v%2Fcoronavirus&column=document&id=lne2ss259d5f1fsn35eislc52d&su%17x=pdf
65 WHO Europe, from: https://www.euro.who.int/en/health-topics/environment-and-health/Climate-change/publications
66 WHO Europe, https://www.youtube.com/playlist?list=PLL4_zLP7J_mjqWnqvlUSnQ13NcSuSDgU3
67 WHO, from: https://who.canto.global/v/coronavirus/library?keyword=COVID-19_HealthAdviceHotWeather&viewIndex=1
68 WHO Europe, from: https://www.euro.who.int/en/health-topics/environment-and-health/Climate-change/activities/public-health-responses-to-weather-extremes/heat-and-health/heathealth-action-planning

5- Further Reading and Useful Resources

- World Health Organization (WHO) Europe, “Heat–health action planning”

- Dr. Ümit Şahin, 2019, Sıcak Dalgaları: İklim Değişikliğiyle Artan Tehdit ve Sıcak-Sağlık Eylem Planları (Turkish)

- The U.S. Environmental Protection Agency (EPA) and the Centers for Disease Control and Prevention (CDC), 2016, Climate Change and Extreme Heat: What You Can Do To Prepare

- Centers for Disease Control and Prevention (CDC), Climate Change and Extreme Heat Events

- WHO Europe, 2004, “Heat-waves: risks and responses”

- Heat-Shield Research Program, 2016

- Red Cross Red Crescent Climate Centre, “Heatwave Guide for Cities”

About the project

The Environment, Climate and Health Cooperation Project (ÇİSİP in Turkish) was launched by the Health and Environment Alliance (HEAL), HASUDER (Association of Public Health Professionals-Turkey) and Kocaeli University Department of Public Health in April 2020. Funded by the European Union, CISIP's aim is to bring together all environmental health actors in Turkey and to support health professionals in the fields of environmental and climate policies.

The Environment, Climate and Health Cooperation Project will continue until April 2023 and aims to:

- Establish a collaborative platform on the environment and climate change for all health professionals.
- Organize online trainings, provide mobile training seminars and courses for medical students on the environment and climate change with a public health perspective.
- Create a dialogue between health professionals in Turkey, professional organizations, non-governmental organizations and think tanks in Europe.
- Produce environmental, climate change and health content, briefs and training materials directed to health professionals.

This Project is funded by the European Union

Disclaimer

HEAL gratefully acknowledges the financial support of the European Union for the production of this publication. The responsibility for the content lies with the authors and the views expressed in this publication do not necessarily reflect the views of the EU. HEAL's EU Transparency Register Number: 00723343929-96

This briefing is part of the Environment, Climate and Health Cooperation Project (ÇİSİP in Turkish) lead by the Health and Environment Alliance (HEAL), HASUDER (Association of Public Health Professionals-Turkey) and Kocaeli University Department of Public Health. The project was launched in April 2020 and will end in March 2023.

Date of Publication
September 2021

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HEALTH ENVIRONMENT AND CLIMATE TURKEY

ASSOCIATION OF PUBLIC HEALTH SPECIALISTS 1995

HEAL HEALTH AND ENVIRONMENT ALLIANCE

KOCAELİ ÜNİVERSİTESİ 1992