MUNICIPAL MANAGEMENT OF EXTREME HEAT

33

MUNICIPAL IMPLEMENTATION TOOL #33

MAY 2021

DELAWARE VALLEY
dvrpc
REGIONAL PLANNING COMMISSION

This brochure is one in a series of Municipal Implementation Tools (MITs) available to local governments and planning partners to assist in implementing the region's long-range plan, *Connections 2045*. Prepared and adopted by the Delaware Valley Regional Planning Commission (DVRPC), the long-range plan provides a sustainable land use and transportation vision for the region's growth and development through the year 2045. *Connections 2045* establishes five key principles that are essential to realizing a sustainable future:

- Sustain the environment.
- Develop livable communities.
- Expand the economy.
- Create an integrated, multimodal transportation network.
- Advance equity and foster diversity.

Municipal governments have the primary authority and responsibility to implement these policies. The series is designed to introduce local officials and citizens to planning techniques that may be useful in their communities. Each covers a different topic and provides an overview of the use of the tool, the benefits, and best practices from within the Greater Philadelphia region. For additional information about *Connections 2045,* please visit www.dvrpc.org/Connections2045. To download additional brochures, visit www.dvrpc.org/MIT.

"Yet the heat extremes forecast … are so frequent and widespread that it is possible they will affect daily life for the average US resident more than any other facet of climate change."[1]

According to the National Aeronautics and Space Administration (NASA), 19 of the 20 warmest years on record for global temperatures have occurred since 2001, with the exception being 1998.[2] Greater Philadelphia has seen 8 of its 10 hottest years on record in just the past 15 years. Warming temperatures combined with increased urban development have resulted in unbearable heat for many of the region's residents. Vulnerable populations—including persons with disabilities, the elderly, racial and ethnic minorities, and the poor—bear the brunt of the ill effects. The National Oceanic and Atmospheric Administration (NOAA) lists extreme heat as the most deadly of all climate-related events in the United States over the past 30 years, including floods and hurricanes.[3] As noted in DVRPC's Municipal Implementation Tool #31, *Municipal Management in a Changing Climate*, municipalities can take action to keep their neighborhoods cool and their residents safe.[4]

This brochure is focused on extreme heat, and how your municipality can mitigate, prepare for, and respond to it.

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[1] Dahl, Kristina, Erika Spanger-Siegfried, Rachel Licker, Astrid Caldas, John Abatzoglou, Nicholas Mailloux, Rachel Cleetus, Shana Udvardy, Juan Declet-Barreto, and Pamela Worth. 2019. *Killer Heat in the United States: Climate Choices and the Future of Dangerously Hot Days "Killer Heat."* Cambridge, MA: Union of Concerned Scientists. www.ucsusa.org/resources/killer-heat-united-states-0.

[2] "Global Surface Temperature." NASA. January 22, 2021. climate.nasa.gov/vital-signs/global-temperature/.

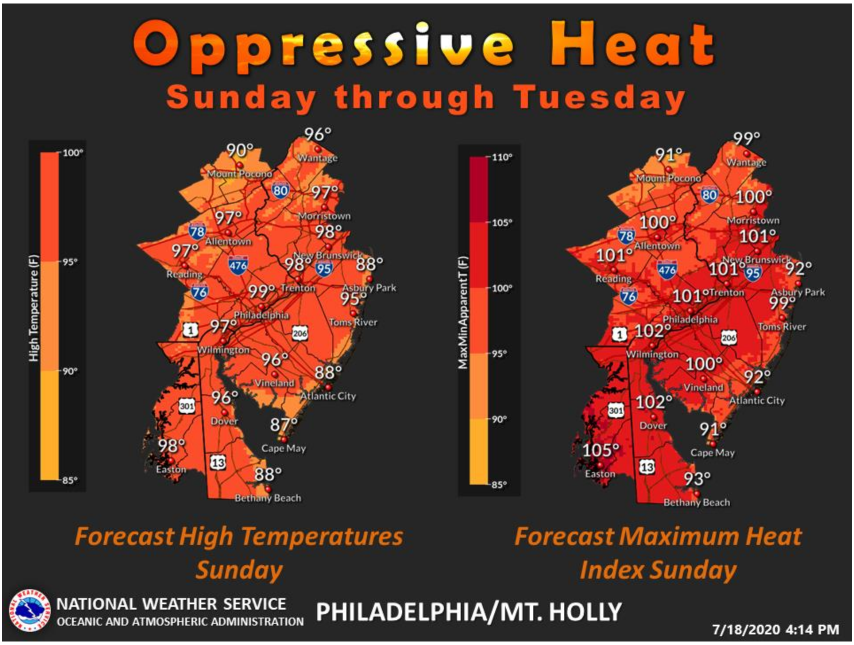
[3] US Department of Commerce, NOAA. "Weather Related Fatality and Injury Statistics." National Weather Service. NOAA's National Weather Service. Accessed February 12, 2021. www.weather.gov/hazstat/.

[4] www.dvrpc.org/Products/MIT031/

This document is organized as follows:

- An overview of extreme heat: what it is and why it happens.
- Expected impacts of extreme heat on populations and infrastructure.
- Recommendations for mitigating extreme heat and reducing local temperatures.
- Recommendations for preparing for and responding to extreme heat events.

What is Extreme Heat?

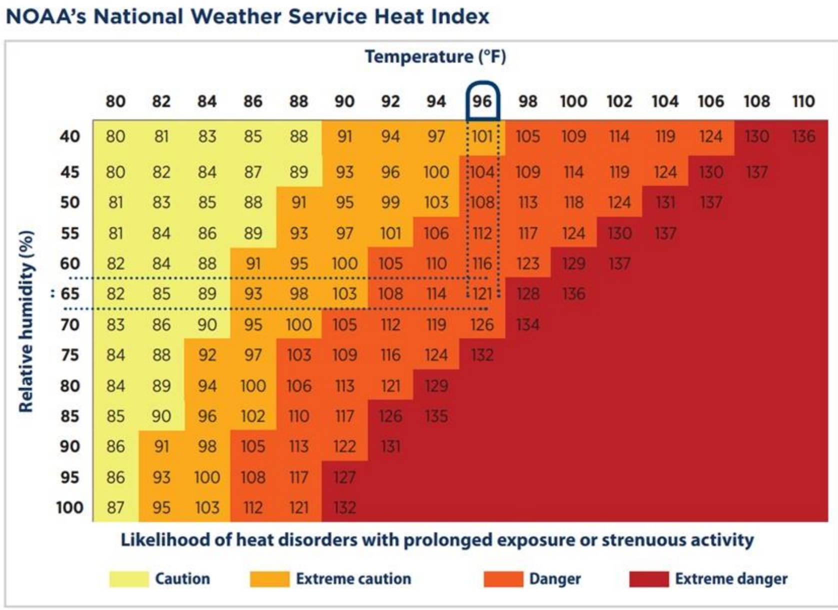


Screenshot showing an extreme heat warning for July 18, 2020.

According to the Centers for Disease Control and Prevention (CDC), extreme heat is defined as weather that is much hotter and/or more humid than average for a particular time and place. Extreme heat is not just a nuisance; it kills hundreds of Americans every year and causes many more to become seriously ill.

Temperature alone is not a good measure of deadly heat. Humidity also has a strong part to play. High humidity reduces the body’s ability to cool itself through sweat evaporation. The National Weather Service (NWS) combines temperature and relative humidity to produce what it terms the “heat index.” The heat index can be considered the “feels like” temperature. The Heat Index chart in Figure 1 shows how high humidity can make even a relatively mild temperature dangerous.

Figure 1: NOAA's National Weather Service Heat Index



NOAA's National Weather Service Heat Index

Temperature (°F)

Relative humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of heat disorders with prolonged exposure or strenuous activity

Caution · Extreme caution · Danger · Extreme danger

This chart shows that as the temperature (horizontal axis) and relative humidity (vertical axis) each increase, they combine to create a heat index (colored values) that feels hotter than the actual temperature. For example, when the temperature is 96°F, with 65 percent humidity, it actually feels like 121°F (indicated by the blue lines in the chart above). Source: NOAA National Weather Service, 2016.[1]

Local heat advisories are issued at the county level. The National Weather Service (NWS) advises that a *local heat advisory* be issued when the heat index in a region is expected to reach or exceed 100°F for 48 hours and that an *excessive heat warning* be issued when the heat index reaches or exceeds 105°F for 48 hours.

This MIT focuses on extreme heat because it is the deadliest of all weather-related disasters and because there are steps municipalities can take to mitigate it. Extreme heat is projected to continue to grow in importance in Greater Philadelphia as climate change progresses, with multiple and interconnected impacts on life and the economy throughout the region.

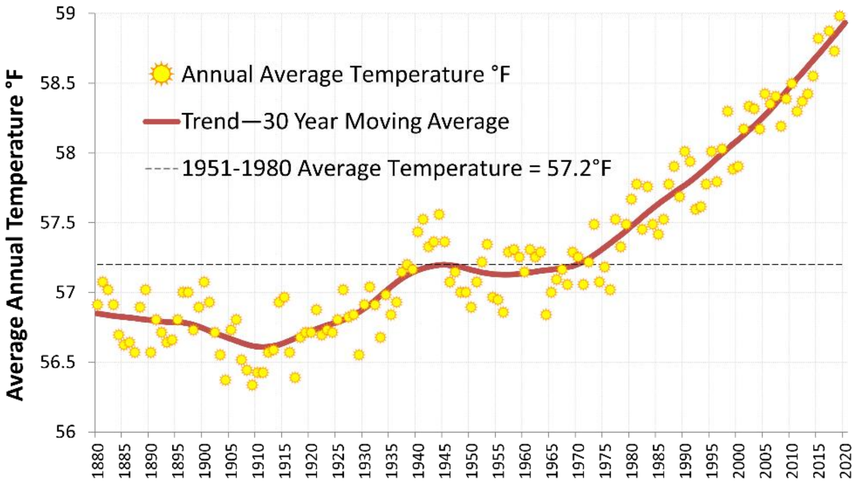
Climate Change and Extreme Heat

The impacts of climate change and extreme heat in a particular municipality are driven by both global climate change and local factors contributing to extreme heat. These are covered in the following sections.

Global Climate Change

At the global level, as the concentration of carbon dioxide (CO_2) and other greenhouse gases in the atmosphere increases, global average temperatures also increase. Figure 2 illustrates this increase from the time when temperatures were recorded in 1880 to the present. Temperatures are warmer now than at any period in this timeline.

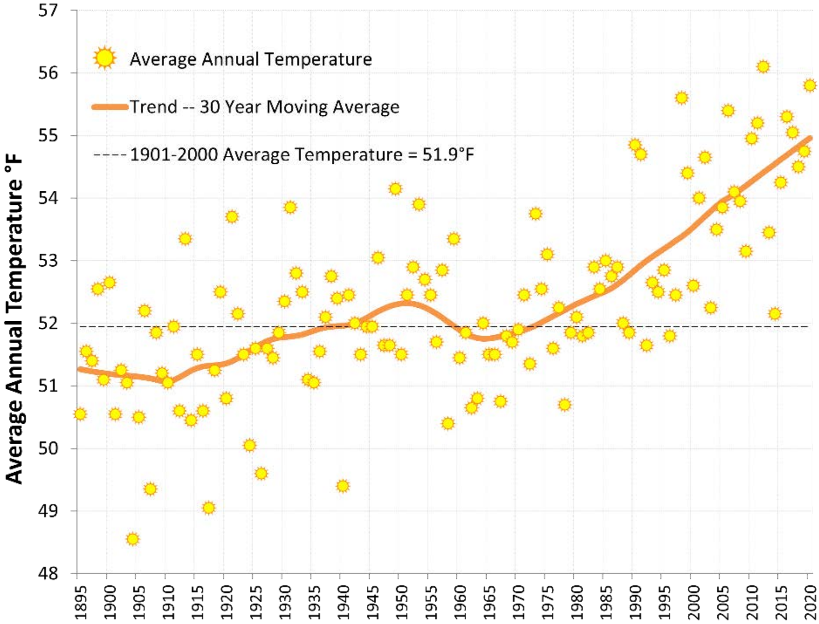
Figure 2: Global Average Temperature - 1880–2020



Source: DVRPC chart using data accessed 01 February 2021 from www.ncdc.noaa.gov/cag/www.ncdc.noaa.gov/cag/.

This is also true at the regional level. Figure 3 shows the increase in average regional temperatures for the Delaware Valley since 1895.

Figure 3: Annual Average Temperature in SE PA and Southern NJ - 1895–2020



Source: DVRPC chart using data accessed 29 January 2021 from www.ncdc.noaa.gov/cag/. Data reflects the average of two regions: Southeastern PA (Climate Div.3) and Southern NJ (Climate Div.2).

As human activities continue to emit more greenhouse gases, average temperatures will continue to rise. Future temperatures depend on the level of current and future greenhouse gas emissions. Climate scientists have developed a set of emissions pathways to use in climate modeling to project future global temperatures for each pathway.

DVRPC has focused on two of these future emissions pathways. For simplicity's sake, this document will refer to these pathways as the optimistic scenario and the pessimistic scenario.[5] The optimistic scenario represents the possible futures when local, state, federal, and global partners actively collaborate to drastically reduce greenhouse gas emissions. The pessimistic scenario represents a passive approach toward GHG emissions reductions. These are shown in Figure 4.

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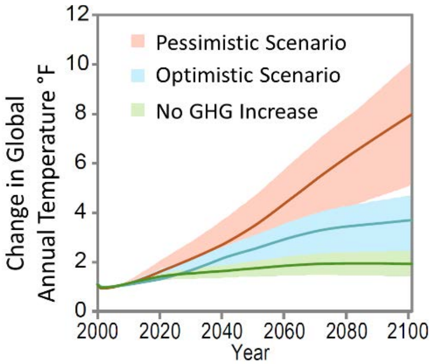
[5] The optimistic scenario is "Representative Concentration Pathway 4.5," or RCP 4.5. The pessimistic scenario is RCP 8.5. The third line on the graph depicts RCP 2.6. For a detailed discussion, see CSSR, pp. 135-141.

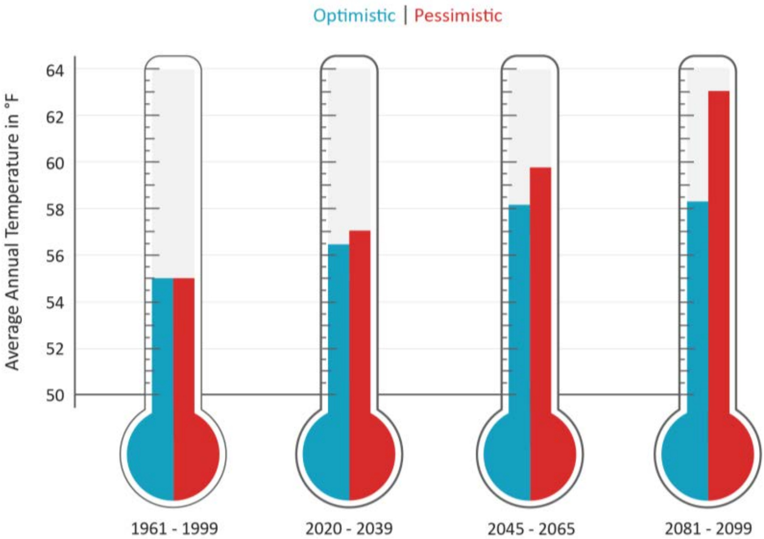
Figure 4: Projected Global Temperature vs. 1960–2000 Average



Source: CSSR, p. 138.

DVRPC worked with the consulting firm ICF to create down-scaled climate projections for Greater Philadelphia based on the optimistic and pessimistic scenarios. As Figure 5 indicates, average annual temperatures in the region are 55°F for the baseline period (1961-1999). By the end of the century, under the optimistic scenario, average annual temperature is projected to increase by 3°F to 58°F. The pessimistic scenario projects average annual temperatures to increase by 8°F to 63°F.

Figure 5: Average Annual Temperature in °F – Historic & Projected DVRPC Region

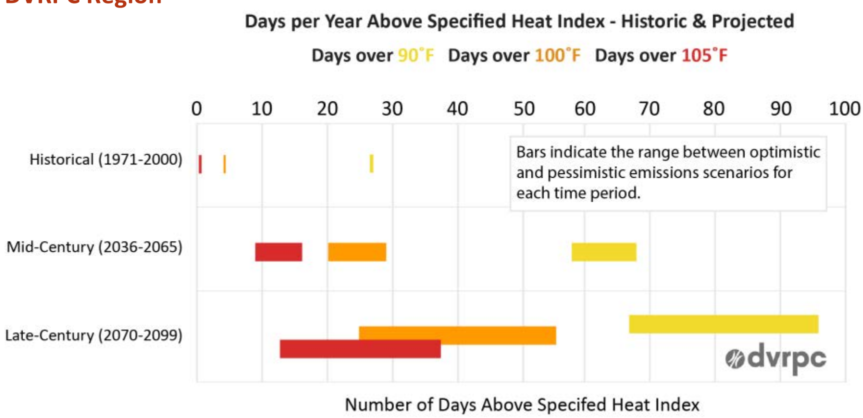


Source: DVRPC chart using data provided by ICF.

Further, global climate change projections show an increase in the number of extremely hot and high heat index days per year, not just the average temperature. These days are expected to become more frequent and occur in succession, increasing the number and duration of heat waves. This increase in the number of high temperature and high heat index days will have dire consequences for public health.

The Union of Concerned Scientists' (UCS) *Killer Heat* report provides projections for the heat index in the Greater Philadelphia region under optimistic and pessimistic global GHG emissions scenarios.[6] The UCS report projects the average regional heat index for three 30-year time periods: Historical (1971–2000), Mid-Century (2036–2065), and Late-Century (2070–2099). These projections are shown in Figure 6.

Figure 6: Days per Year above Specified Heat Index – Historic & Projected DVRPC Region



Source: DVRPC chart using data provided by Union of Concerned Scientists *Killer Heat* report.

As Figure 6 indicates, the region historically has averaged

- 27 days per year with heat index above 90°F,
- 4 days per year with heat index above 100°F,
- 1 day per year with heat index above 105°F.

[6] *Killer Heat, 2019. Data accessed from* ucsusa.maps.arcgis.com/apps/MapSeries/index.html?appid=e4e9082a1ec343c794d27f3e12dd006d

In the optimistic scenario, by the end of the century, the region is projected to average

- 67 days per year with heat index above 90°F,
- 25 days per year with heat index above 100°F,
- 13 days per year with heat index above 105°F.

In the pessimistic scenario, by the end of the century, the region is projected to average

- 96 days per year with heat index above 90°F,
- 55 days per year with heat index above 100°F,
- 37 days per year with heat index above 105°F.

Thus, unfortunately, even if there is effective global action on limiting greenhouse gas emissions, extreme heat is still projected to be a major issue for your municipality.

Local Factors Driving Extreme Heat

The increase in average regional temperatures projected due to climate change will not affect every municipality or neighborhood equally. As Figure 7 illustrates, urban areas have significantly higher temperatures on average than their rural counterparts. Some neighborhoods within cooler municipalities can experience more intense heat than the municipal average. These areas are called heat islands.

There are two major types of heat islands: surface and atmospheric. Surface heat islands are identified by measuring temperatures of exposed surfaces like roofs and pavements. They are typically present day and night but are stronger during the day. They are typically measured indirectly through satellite imagery.[7]

Atmospheric heat islands are identified by measuring ambient air temperatures, generally at the canopy layer where we live, work, and play. They are typically weaker in the morning and peak after sunset due to the slow release of heat from infrastructure materials. Atmospheric heat islands are significantly correlated with surface heat

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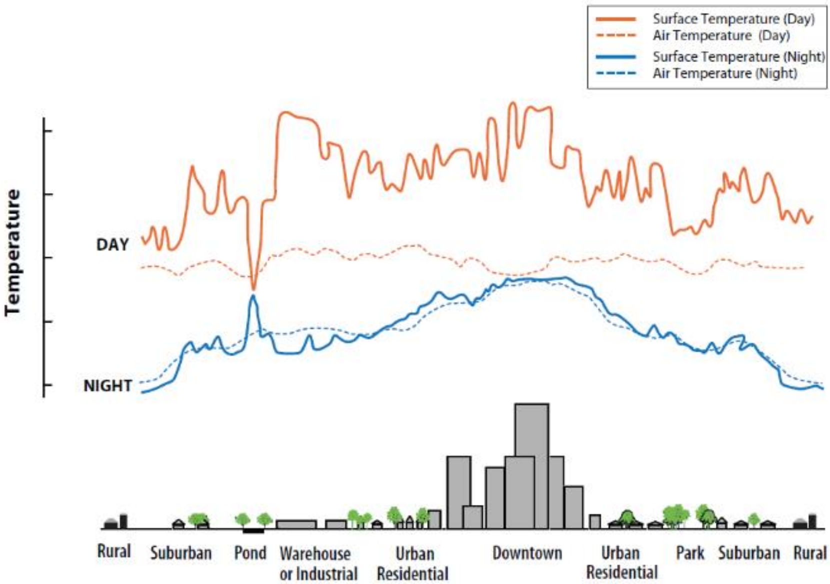
[7] U.S. Environmental Protection Agency. 2008. "Urban Heat Island Basics." In: *Reducing Urban Heat Islands: Compendium of Strategies.* Draft. www.epa.gov/heat-islands/heat-island-compendium

islands. The top half of Figure 7 illustrates the relationship between surface and air temperatures.[8]

Figure 7: Variations of Temperature Due to Heat Island Effect



Source: U.S. Environmental Protection Agency. 2008. "Urban Heat Island Basics." In: Reducing Urban Heat Islands: Compendium of Strategies. Draft. www.epa.gov/heat-islands/heat-island-compendium.

Heat islands are caused by four changes in urban environments: loss of natural vegetation, the thermal properties of urban materials, urban geometry, and emission of waste heat from buildings and vehicles.

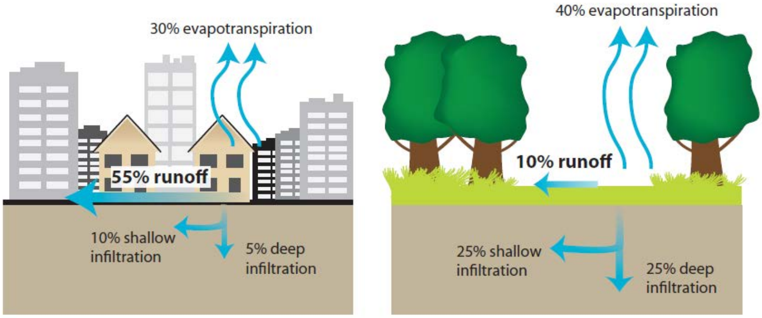
Number 1: Loss of Natural Vegetation

Vegetation keeps heat down in two different ways. Shading provides respite from direct sunlight, lowering surface temperatures. Vegetation can also reduce air temperatures through evapotranspiration, which is the process in which plants release water to the surrounding air, reducing heat in the area. In urbanized areas that are heat islands, this vegetation has been replaced by impervious surfaces, such as conventional roofs, sidewalks, roads, and parking lots with little tree

[8] Ibid.

cover. This loss of vegetation results in less shade and moisture to cool the area.

Figure 8: Impervious Surfaces and Reduced Evapotranspiration



Highly developed urban areas (left), which are characterized by 75%-100% impervious surfaces, have less surface moisture available for evapotranspiration than natural ground cover, which has less than 10% impervious cover (right). This characteristic contributes to higher surface and air temperatures in urban areas.

Source: U.S. Environmental Protection Agency. 2008. "Urban Heat Island Basics." In: Reducing Urban Heat Islands: Compendium of Strategies. Draft. www.epa.gov/heat-islands/heat-island-compendium.

Number 2: Urban Materials

The loss of vegetation is compounded by the thermal properties of the materials replacing it. Typically, these materials—such as asphalt and concrete—are dark. This results in less solar energy being reflected, and more solar energy being absorbed and stored as heat, contributing to higher surface temperatures. During the daytime, surfaces in downtown metropolitan areas can absorb and store twice the amount of heat compared to their rural surroundings. These materials also tend to release heat more slowly, leading to higher temperatures for longer periods of time.

Number 3: Urban Geometry

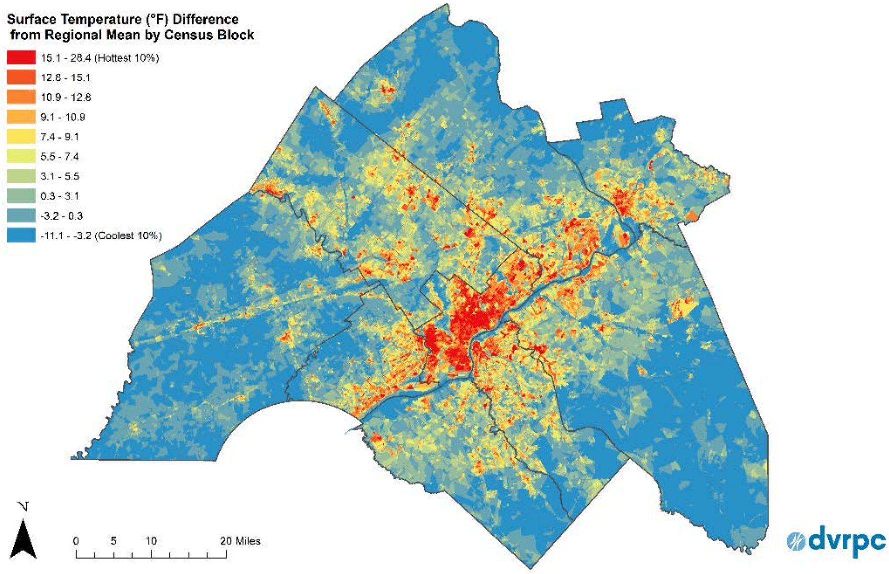
Urban geometry refers to the dimensions and spacing of buildings within a city. Urban geometry affects wind flow, energy absorption, and a given surface’s ability to emit long-wave radiation, like heat, back to space. For example, developed areas typically have structures and surfaces that are often partially obstructed by objects like other buildings, vehicles, etc. These objects stop heat from readily escaping structures and surfaces, meaning that heat is retained much longer than from other surfaces, even into the night. Nighttime heat islands can have even more dire health implications during heat waves.

As a general rule of thumb, the more difficult it is to see the sky, the more likely it is that the area's urban geometry will trap heat.

Number 4: Waste Heat from Buildings and Vehicles

Waste heat from buildings and vehicles refers to heat directly contributed to the atmosphere through human activities. The denser an urban area is, the more likely that heat islands are affected by human activities. Air conditioning and vehicle exhaust are two examples of waste heat contributors to heat island formation.

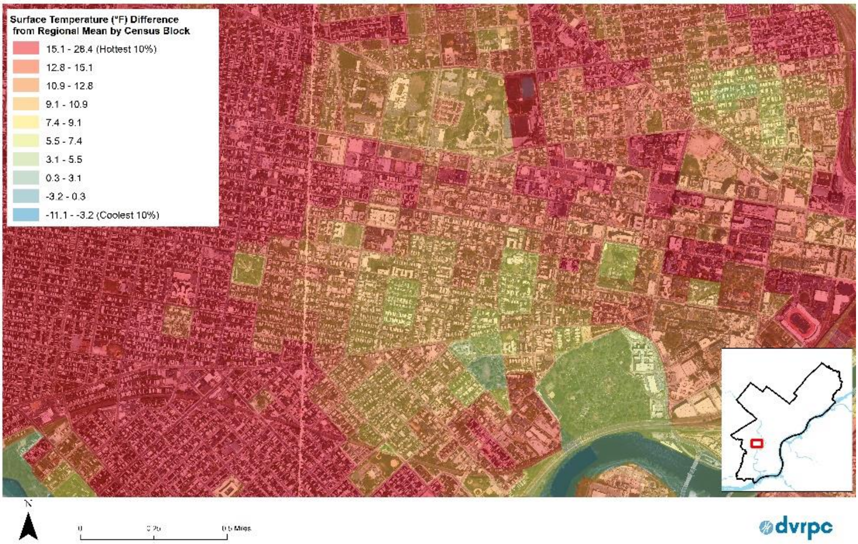
Figure 9: Heat Islands - DVRPC Region



Source: Data are for the seven hottest days on which mostly cloud-free Landsat imagery was available, from 2014-2017 from Remote Sensing Lab. rslab.gr/downloads_LandsatLST.html#

All these factors combine to create heat islands throughout the region. Figure 9 depicts surface temperatures for each census block in the region as derived from satellite imagery. Those temperatures are then compared to the regional average temperature. The blocks in red are those with the highest temperature differential, or the hottest areas in the region. There are heat islands in all 9 counties. Figure 10 shows heat islands in West Philadelphia. Notice how temperature differentials vary across the area and how parks and other vegetation cool large sections of the neighborhood.

Figure 10: Heat Islands in West Philadelphia



Source: Data are for the seven hottest days on which mostly cloud-free Landsat imagery was available, from 2014-2017 from Remote Sensing Lab. slab.gr/downloads_LandsatLST.html#. Aerial imagery from DVRPC, 2015.

Impacts of Extreme Heat

Extreme heat has many adverse impacts on people, nature, and the built environment.

Public Health

Extreme heat is deadly. Heat is the most common cause of climate-related death in the United States, and is responsible for more casualties than hurricanes, floods, and tornadoes combined.[9] In the City of Philadelphia alone, a 1993 heatwave contributed to the deaths of 118 people, and there were 137 heat-related deaths between 2006 and 2018.[10] These numbers may not encompass all heat-related mortality, as heat could have exacerbated underlying chronic health conditions that were ultimately listed as cause of death.

Heat-Health Risks

Extreme heat conditions prevent the human body from cooling itself. As the core temperature rises, the body experiences a variety of symptoms. First, the body may experience heat cramps—cramping in the stomach, arms, or legs—because of excessive sweating that causes the body to lose large amounts of salt and water. If exposure to heat continues, the body may then experience heat exhaustion with symptoms including dizziness, a weak pulse, nausea, and fainting. Finally, with continued exposure, heat stroke becomes possible, causing increased heart and respiratory rates, and even damage to the brain, heart, lungs, kidneys, and liver, potentially leading to death. The NWS has created a guide for determining how our bodies may react to different heat indices, seen in Figure 11.

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[9] Hewitt, Virginia and E. Mackres. 2014. “Cool Policies for Cool Cities: Best Practices for Mitigating Urban Heat Islands in North American Cities.”
[10] Beat the Heat Hunting Park: A Community Heat Relief Plan. Philadelphia Office of Sustainability. Philadelphia, 2019.

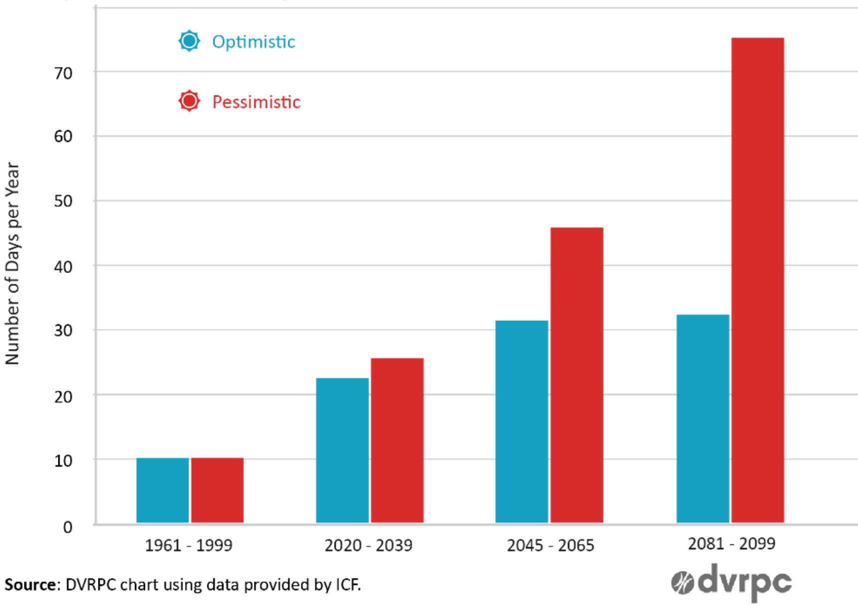
Figure 11: Possible Heat Disorders by Heat Index

Heat Index	Possible Heat Disorders
90°F	Sun stroke, heat cramps, and heat exhaustion are possible for certain risk groups.
100°F	Heat stress or illnesses are possible, especially for elderly adults, children, and others sensitive to heat.
105°F	Even healthy adults are at risk of heat-related illness with prolonged exposure.
130°F	Heat stroke is highly likely with continued exposure.

Source: Adapted from National Weather Service chart. Accessed 2/11/2021. www.weather.gov/ffc/hichart

Nighttime can bring respite from the heat. However, as temperatures continue to rise worldwide, nighttime temperatures are also rising. Thus, for the many people that lack (or cannot afford to use) air conditioning, heat-related illness becomes even more likely.

Figure 12: Days per Year When Temperature Never Falls Below 70°F - Historic & Projected — DVRPC Region



Source: DVRPC chart using data provided by ICF.

Some groups are more at risk from extreme heat than others. Specific high-risk groups are:

- Elderly (aging changes how the body regulates its own temperature and limits sweating)
- Children (children sweat less, reducing their ability to cool down, and they dehydrate more quickly than adults)
- Homeless
- People in low-income households (poorly-equipped housing and/or less able to afford additional cooling equipment)
- People who are socially isolated (fewer connections to resources and check-ins)
- People with mobility restrictions, mental impairments, certain underlying medical conditions (e.g., respiratory or cardiovascular disease), or those on medications that may inhibit the body's ability to regulate its temperature
- Pregnant women (heat-caused dehydration can reduce blood flow, which can lead to pre-term labor and delivery or stillbirths)
- People of racial and ethnic minorities (more likely to live in areas with more impervious surfaces)
- People of foreign birth or with limited English proficiency (may not be able to read resources, materials, or notifications relating to heat waves)
- People engaged in vigorous outdoor exercise or work
- Those under the influence of drugs or alcohol

Air Quality Degradation

In addition to the dangerous effects of extreme heat on the body, heat can degrade local air quality. Higher temperatures increase the formation of ground-level ozone and other secondary air pollutants that are created when heat reacts with emissions from vehicles and power plants.[11] Higher levels of ground-level ozone are associated with increased asthma rates among children. A recent study showed that

[11] California Climate Action Team, Heat Adaptation Workgroup, Preparing California for Extreme Heat: Guidance and Recommendations, Sacramento, CA, 2013.

higher ozone levels in New Jersey were associated with increases in pediatric emergency department asthma visits in 2004–2007.[12] Another study showed that ozone was positively associated with pediatric asthma emergency department visits in Newark, NJ, during the warm season (April–September) during the same four year time frame.[13]

A 2005 study showed that the 10°F degree difference between 80°F and 90°F can cause a city or neighborhood to go from low levels of ground-level ozone to dangerous levels of ozone pollution.[14]

These impacts can occur at the neighborhood level as well. As Figure 9 shows, heat islands in Greater Philadelphia can cause temperature differences almost 30°F above the regional average. These differences can be large even between neighborhoods that are close together, such as can be seen in the map of West Philadelphia in Figure 10.

These impacts on air quality further compound the health hazards posed by extreme heat, with those having underlying cardiopulmonary conditions facing increased risk. As of 2020 there is another prominent vulnerability to consider: pandemic viruses. Those with respiratory issues acquired by exposure to poor quality air have a higher risk of mortality from COVID-19 than those without these issues.[15]

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[12] Gleason, Jessie A., Leonard Bielory, and Jerald A. Fagliano. 2014. Associations between ozone, $PM_{2.5}$, and four pollen types on emergency department pediatric asthma events during the warm season in New Jersey: A case-crossover study. *Environmental Research* 132: 421-429.doi.org/10.1016/j.envres.2014.03.035.
[13] Gleason, Jessie A. and Jerald A. Fagliano. 2015. Associations of daily pediatric asthma emergency department visits with air pollution in Newark, NJ: utilizing time-series and case-crossover study designs. *Journal of Asthma* 52(8): 815-822, DOI: 10.3109/02770903.2015.1033726
[14] Akbari, H. 2005. *Energy Saving Potential and Air Quality Benefits of Urban Heat Island Mitigation.* Berkeley, CA: Lawrence Berkeley National Laboratory.
[15] Wu, X., Nethery, R. C., Sabath, M. B., Braun, D. and Dominici, F., 2020. Air pollution and COVID-19 mortality in the United States: Strengths and limitations of an ecological regression analysis. *Science Advances 6*(45): p.eabd4049.

Vulnerable Populations and Equity Considerations

The combination of extreme heat and poor air quality take their toll on the most vulnerable and disenfranchised people in the region. As discussed previously, the elderly, children, the poor, and those with disabilities are all at high risk to extreme heat, as well as complications from increased air pollution. A 2020 study by Bekkar et al. has found that pregnant women exposed to high temperatures and higher levels of ozone and particulate matter are more likely to have children who are premature, underweight, or stillborn. Black mothers were found 2.4 times more likely to have children with low birth weight than white women. This adds to the growing body of evidence that minority communities are at greater risk to the impacts of climate change than are white communities.[16]

Figure 13 shows the score, at the census tract level, used for DVRPC's Indicators of Potential Disadvantage (IPD).[17] The IPD score is a composite of the percentage of residents belonging to the following groups: older adult (65+), racial minority, ethnic minority, foreign born, limited English proficiency, disability, and low income. Higher IPD scores indicate more potentially disadvantaged census tracts.

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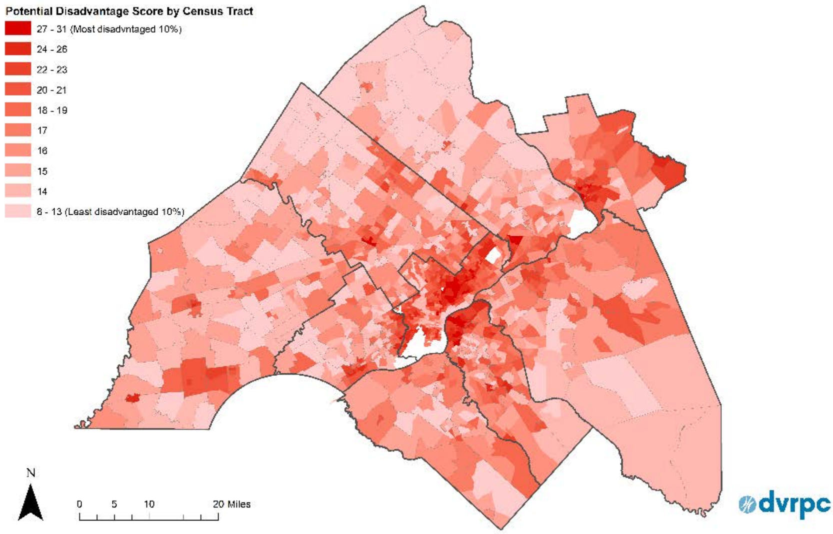
[16] Bekkar, B., S. Pacheco, R. Basu, and N. DeNicola. 2020. Association of Air Pollution and Heat Exposure With Preterm Birth, Low Birth Weight, and Stillbirth in the US: A Systematic Review. *JAMA Netw Open 3*(6):e208243. doi:10.1001/jamanetworkopen.2020.8243

[17] DVRPC. *Indicators of Potential Disadvantage*. www.dvrpc.org/webmaps/IPD/

Figure 13: Indicators of Potential Disadvantage by Census Tract – DVRPC Region



Source: DVRPC map using DVRPC's Indicators of Potential Disadvantage, which are calculated using the American Community Survey's 2014-2018 5-year estimates. White areas indicate tracts missing data to calculate scores.

Comparing the map of IPD scores (Figure 13) and the map of heat islands (Figure 9) shows a high coincidence of the most disadvantaged areas with the hottest areas. DVRPC's analysis has shown that this is especially true for racial and ethnic minority neighborhoods and low-income neighborhoods, which tend to have a much higher ratio of impervious surface to vegetation cover than neighborhoods with a lower IPD score. Recent studies have attributed this disparity to past practices of redlining.[18] Figure 14 combines the census tract IPD score with exposure to high surface temperatures. Perhaps not surprisingly, many of the same census tracts with high scores for potential disadvantage are those with higher than average surface

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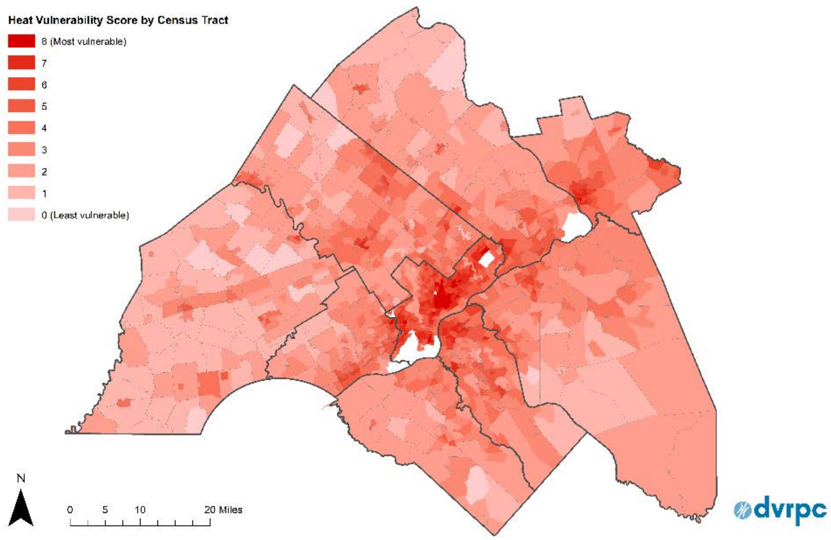
[18] Hoffman, Jeremy and Shandas, Vivek and Pendleton, Nicholas. 2020. The Effects of Historical Housing Policies on Resident Exposure to Intra-Urban Heat: A Study of 108 US Urban Areas. *Climate*. 8. 12. 10.3390/cli8010012.

temperatures.[19] These high temperature census tracts would also pose greater health risks to those working outdoors or in poorly-ventilated spaces within those census tracts.

Figure 14: Heat Vulnerability Index by Census Tract - DVRPC Region



Source: DVRPC map using DVRPC's Indicators of Potential Disadvantage, which are calculated using the American Community Survey's 2014-2018 5-year estimates and Landsat imagery from the Remote Sensing Lab. White areas indicate tracts missing data to calculate scores.

DVRPC has completed a more fine-grained, detailed heat vulnerability analysis using data available at the census block group level. To calculate the heat vulnerability score, DVRPC looked to the American Community Survey's 2015–2019 5-year estimates for ethnic and racial minorities, children under the age of 5, adults over 65 years old living alone, households with limited English proficiency, and household income. That analysis was again combined with exposure to high surface temperatures at the block group level to create a heat vulnerability score. Figure 15 demonstrates the most heat vulnerable block groups in Greater Philadelphia.

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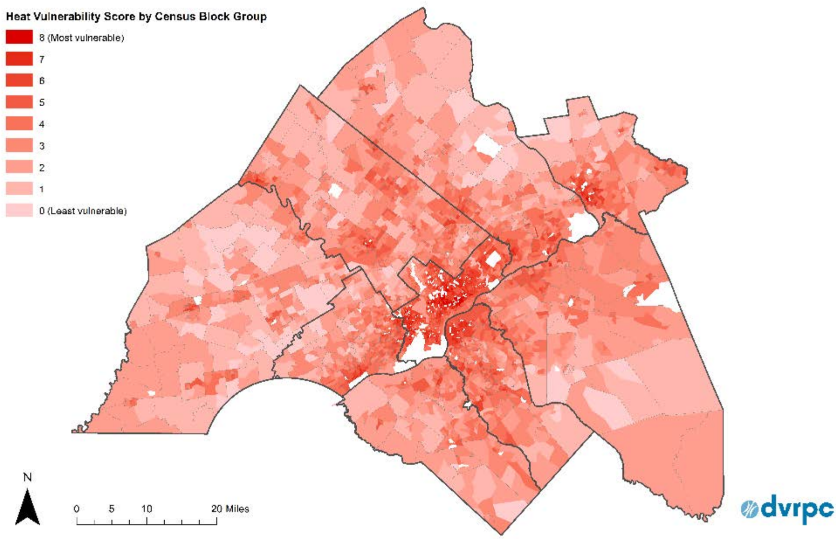
[19] This analysis has been completed region-wide. If you are interested in identifying vulnerable and historically disadvantaged communities suffering from extreme heat in your municipality, please contact DVRPC.

Figure 15: Heat Vulnerability Index by Census Block Group - DVRPC Region



Source: DVRPC map using data from the American Community Survey's 2015-2019 5-year estimates and Landsat imagery from the Remote Sensing Lab. White areas indicate block groups missing data to calculate scores.

Transportation Infrastructure

Rising temperatures present significant risks to property and public infrastructure. Transportation infrastructure is increasingly stressed as temperatures rise. Dark paving surfaces, such as asphalt, soften and expand under prolonged heat exposure, making them more vulnerable to potholes and ruts, already a problem in the region. Tires wear out more quickly in high heat and on impaired roadways. Heat can also warp railroad tracks and cause overheard power lines to sag, causing delays in or disruption to transit and freight service. Hot air impedes aircraft liftoff and climb, potentially requiring longer runways or reduced payloads. More extreme heat means more money must be spent to maintain and repair roads, railroad tracks, and other transportation infrastructure. As most transportation infrastructure is meant to last decades, incorporating extreme heat projections into project design is important to the longevity of transportation and infrastructure projects.

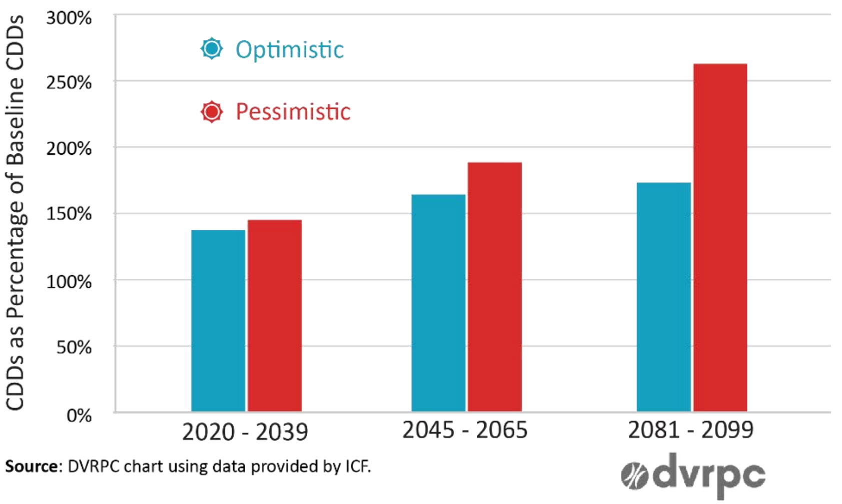
Utility Infrastructure

Extreme heat impacts utility infrastructure as well. As temperatures rise, air conditioning use rises. Figure 16 shows the projected change in cooling degree days (CDDs) for the DVRPC region due to climate change. Cooling degree days are a measure of how much cooling is needed to be considered comfortable by building occupants. As Figure 16 indicates, even under optimistic levels of GHG emissions, CDDs are expected to increase 1.5 times their 1961-1999 levels by the end of the century. Under pessimistic levels of GHG emissions, CDDs are expected to increase by over 2.5 times their 1961-1999 levels.

This added cooling load will cause strain on the existing electrical system. Further, extreme heat causes metal power lines to expand and impedes the efficiency with which transformers shed heat, lowering the overall efficiency of the system. Increased demand and inefficiency of the power system may overwhelm power generation capacity, leading to unplanned blackouts or intentional power outages by utilities.

Water demand tends to increase with increasing temperatures as well. As periods of extreme heat lengthen, water delivery systems may become increasingly stressed, resulting in potential water main breaks.

Figure 16: Projected Change in Cooling Degree Days (CDD) from Historical Baseline – DVRPC Region



Source: DVRPC chart using data provided by ICF.

What Municipalities Can Do About Extreme Heat

Heat waves sometimes happen, regardless of the changing climate and built environment. However, increasing global temperatures and urbanization will increase the severity, duration, and frequency of extreme heat events. There are two main avenues for municipalities to address extreme heat: reducing temperatures by counteracting the heat island effect and preparing for extreme heat events when they inevitably occur. The first step, however, is to better understand the problem in your municipality.

Identify Hot Spots and Vulnerable Populations

The first step for both reducing temperatures and preparing for extreme heat is to identify heat-prone areas in your municipality and understand how vulnerable populations are affected. DVRPC's analysis can help identify where heat islands intersect areas with heat-vulnerable residents. However, your residents are most familiar with trouble spots. Not only is it important to mitigate extreme heat in residential areas; it is also important to ensure walking or cycling routes between their homes and places of work and commerce remain protected against extreme heat. Your municipality can hold public meetings to speak with residents, identify where they feel most endangered by heat, and combine multiple strategies to create cool corridors that mitigate heat along frequently traveled pathways. Listening to your residents' stories about how heat impacts

Storytelling as Data

During community engagement for their *Heat Action Planning Guide*, the Nature's Cooling Systems Project in Maricopa County, AZ, collected stories from their residents on their experiences with extreme heat. Storytelling is a great way to promote citizen engagement. It honors various forms of expertise, puts residents, organizations, and experts on equal footing, and allows decision-makers to better understand how heat affects residents' everyday lives.

their lives will lead to more successful interventions and fewer heat-related health incidents.[20]

Mitigating Extreme Heat

The first strategy municipalities can take is to minimize extreme heat. The US EPA's *Reducing Urban Heat Islands: Compendium of Strategies* provides a wealth of recommendations for local governments interested in reducing extreme heat in their communities.

Trees and Vegetation[21]

Planting and maintaining trees and other vegetation is one of the most effective ways to combat the heat island effect. Trees cool areas in two ways.

- They provide shade. Shaded surfaces may be anywhere from 20°F to 45°F cooler than unshaded surfaces.
- They also cool areas further through evapotranspiration, which can help reduce peak temperatures a further 2°F to 9°F.

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[20] The Nature Conservancy. 2019. "Heat Action Planning Guide for Neighborhoods of Greater Phoenix." repository.asu.edu/attachments/220853/content/Greater%20Phoenix%20Heat%20Action%20Planning%20Guide.pdf

[21] U.S. Environmental Protection Agency. 2008. "Trees and Vegetation." In: *Reducing Urban Heat Islands: Compendium of Strategies*. Draft. www.epa.gov/heat-islands/heat-island-compendium.

The cooling effect of vegetation provides additional co-benefits. It helps reduce the impact of heat on both utility and transportation infrastructure. Cooler areas mean less air conditioning is needed, reducing strain on the electrical grid. This reduces the waste heat produced by air conditioners as well, further helping areas stay cool.

Trees have been shown to improve water quality by reducing stormwater runoff. Similarly, trees can improve air quality through absorption of gaseous pollutants and blockage of particulate matter. They remove and sequester carbon from the atmosphere. They protect pavements from heat and the sun, slowing deterioration. Finally, trees improve quality of life by providing habitats for species, reducing noise pollution, and adding aesthetic value to urban areas.

Planting trees and other vegetation tends to be one of the more cost-effective ways to combat extreme heat due in part to the co-benefits noted. However, there is still a cost associated with this strategy. According to the US EPA, primary costs are purchasing materials, initial planting, and ongoing maintenance such as pruning, pest and disease control, and irrigation. Pruning is typically the largest cost, accounting for between 25 and 40 percent of total annual costs. Despite that, the benefits of tree plantings almost always outweigh the costs. A 2018 study found that of the 26 papers developing cost-benefit analyses for urban forests mostly in North America, 22 found that the benefits outweighed the costs.[22]

Cool Roofs[23]

Cool roofs reflect much more sunlight than conventional roofing. Unlike green roofs (see page 30), they can be installed on steep-sloped roofs common to residences as well as on the flat or low-sloped roofs typical of commercial and industrial buildings. They can help roofs stay up to 50°F to 60°F cooler than conventional materials during peak summer weather.

Cool roofs come in many different forms depending on roof type. Low-sloped roofs can use cool roof coatings, a paint-like substance applied to the roof surface, or single-ply membranes, a prefabricated sheet applied to the roof. Steep-sloped roofs can use conventional roofing materials manufactured with cool colorings, with some incorporating infrared-reflecting pigments. ENERGY STAR and the Cool Roof Rating Council both provide information on the reflectance of different roofing materials.[24,25]

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[22] Song, Xiao Ping, Puay Yok Tan, Peter Edwards, and Daniel Richards. 2018. The Economic Benefits and Costs of Trees in Urban Forest Stewardship: A Systematic Review. *Urban Forestry & Urban Greening* 29: 162–170.
[23] U.S. Environmental Protection Agency. 2008. "Cool Roofs." In: *Reducing Urban Heat Islands: Compendium of Strategies.* Draft. www.epa.gov/heat-islands/heat-island-compendium.
[24] www.energystar.gov/
[25] coolroofs.org/

Cool roofs reduce energy use by reflecting more solar energy, and transferring less heat to the building, particularly during the hottest parts of the day, lowering peak electricity demand. This usually results in a net savings in annual energy costs, even though buildings with cool roofs may require extra heating in the winter months. Cool roofs tend to last longer and require less maintenance than conventional roofs. They reduce air pollution and GHG emissions by lowering energy use and improve human health and comfort by reducing air temperatures in buildings without air conditioning.

Green Roofs[26]

Green roofs are another way to combat the heat island effect and extreme heat. A green roof is a vegetative layer grown on a rooftop, combining many benefits of both vegetation and cool roofs. They are typically installed on flat or low-sloped roofs common on commercial and industrial buildings. Green roof temperatures can be 30°F–40°F lower than those of conventional roofs due to the shade they provide and evapotranspiration of the vegetation. Green roofs can reduce city-wide ambient temperatures by up to 5°F if widely deployed.

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[26] U.S. Environmental Protection Agency. 2008. "Green Roofs." In: *Reducing Urban Heat Islands: Compendium of Strategies.* Draft. www.epa.gov/heat-islands/heat-island-compendium.

There are two types of green roofs. An extensive green roof is one that is fairly lightweight and rugged, requiring little maintenance once established. They typically include succulents and other hardy plants. Intensive green roofs are essentially parks or large gardens placed on a roof. They require higher initial investment and more maintenance than extensive green roofs. Intensive roofs also need more structural support to accommodate the weight of plantings and irrigation systems that retain and reuse rainwater. Some projects may combine both extensive and intensive green roofs.

Green roofs have many benefits in addition to cooling their buildings and the surrounding air. They provide more insulation than conventional and cool roofs, reducing overall building energy use in both winter and summer. They reduce air pollution and sequester carbon dioxide. They enhance stormwater management and water quality by slowing and filtering stormwater runoff.

Green roofs are more expensive than conventional roofs. However, green roofs can offset some of their upfront costs by reducing building energy costs, stormwater management fees, and longer lifetimes when compared to conventional roofs. Green roofs do require some maintenance, including fertilization, irrigation, weed control, and replanting when necessary. A U.S. General Services Administration report estimated that green roofs on commercial and public buildings provide a payback of about 6.2 years nationally, an internal rate of return of 5.2 percent, and an ROI of 224 percent, based on 50-year average annual savings.[27]

Cool Pavements[28]

Cool pavements are made with materials that reflect more solar heat, enhance water evaporation, or have been otherwise modified to remain

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[27] "Green Roofs." GSA, September 30, 2019. www.gsa.gov/governmentwide-initiatives/federal-highperformance-buildings/resource-library/integrative-strategies/green-roofs.

[28] U.S. Environmental Protection Agency. 2012. "Cool Pavements." In: *Reducing Urban Heat Islands: Compendium of Strategies.* Draft. www.epa.gov/heat-islands/heat-island-compendium.

cooler than conventional pavements. These pavements can be created from existed paving technologies like asphalt and concrete, or they can incorporate newer approaches like innovative coatings or grass paving. Currently there are no official standards or labeling programs for cool pavements, as the technology is relatively new compared to cool and green roofs.

Cool pavements can reduce energy use by decreasing surface and ambient air temperatures. Reduced pavement temperatures would also decrease ground-level ozone formation. Cool pavements by themselves lower the temperature of stormwater runoff, reducing shock to aquatic life in waterways. They also reduce tire noise and provide better nighttime visibility, reducing lighting needs. Cool pavements increase the life of pavements, reducing the likelihood of cracking and rutting from heat stress.

In 2017, Los Angeles, CA pilot-tested cool pavement coatings. Early results showed that these coatings could lower surface temperatures by as much as 10°F. Later studies verified the surface temperature reductions, but noted that pedestrians may feel warmer during certain parts of the day due to increased reflectance.[29] Phoenix, AZ has begun pilot testing a cool pavement coating as of September 2020, with results expected by end of 2021.[30]

Permeable, or porous, cool pavements provide extra benefits by absorbing and filtering stormwater, which subsequently enhances road safety by improving traction and reducing water spray from vehicles. The Federal Highway Administration has found that permeable pavements cost between 10 and 25 percent more than conventional materials. These pavements also require maintenance to prevent

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[29] Stone, Erin. “'Cool Pavement' Experiments Help Urban Planners Find Ways to Ease Rising Temperatures.” The Arizona Republic. Arizona Republic, May 15, 2020. https://www.azcentral.com/story/news/local/arizona-environment/2020/05/15/climate-change-cool-pavement-tool-fighting-excessive-heat-heatwaves-arizona/3121783001/.

[30] “Cool Pavement Pilot Program.” City of Phoenix. Accessed May 4, 2021. https://www.phoenix.gov/streets/coolpavement.

clogging, including vacuuming and sweeping, adding further costs.[31] Porous pavements may also crack during winter freezes. Municipalities should determine whether the benefits outweigh the costs over the life of the pavements.

Cooling Public Spaces

In areas where planting trees and other vegetation for shade is not feasible, consider installing other shade structures where people are likely to wait or gather and experience extreme heat. Bus stops are great candidates for shade structures to protect those waiting for transit. Also consider placing drinking water fountains along well-traveled routes to keep people hydrated and cool.

The Urban Design Forum recommends creative programming for adding shade infrastructure to the most heat-vulnerable areas. This can include leveraging nearby institutions or public and organizational art programs to create public artworks with shade components. Other pop-up and mobile organizations that typically provide temporary shade structures can be encouraged to hold events in neighborhoods that lack sufficient green infrastructure and shade.[32]

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[31] Hoverter, S. P. 2012. *Adapting to urban heat: a tool kit for local governments.* Georgetown Climate Center.

[32] Urban Design Forum. 2020. "Turning the Heat: Resiliency in New York City's Heat-Vulnerable Neighborhoods."

Municipalities may also build and operate public pools, sprinklers, and spraygrounds to help residents stay cool. Spraygrounds—also known as spray parks, splash parks, and splash pads—have nozzles that spray water directly upward into the air and have no standing water, eliminating the need for lifeguards.

Prioritization

Your municipality may have to prioritize heat island mitigation interventions based on budget availability. Urban heat management studies for Louisville, KY, and Dallas, TX, offer some guidance on prioritization based on modeling analyses conducted for the plans.

The *Louisville Urban Heat Management Study* notes that cool materials strategies, cool roofs, and cool pavements may be prioritized in commercial and industrial areas with extensive impervious cover.[33] These areas offer fewer opportunities for cost-effective vegetation enhancements like landscaping and tree planting. In contrast, tree planting and other vegetative strategies should be prioritized in residential zones where there are lower cost planting opportunities.

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[33] Stone B, Lanza K, Mallen E, Vargo J, and Russell A. 2019. Urban Heat Management in Louisville, Kentucky: A Framework for Climate Adaptation Planning

Residential areas are also where more people are exposed to harmful temperatures.

The *Dallas Urban Heat Island Management Study* found that tree planting and preservation was over 3.5 times as effective as cool materials strategies in lowering temperatures.[34] However, combining both tree planting and cool materials strategies can reduce the heat-related mortality by more than 20 percent.

Finally, areas most vulnerable to extreme heat and those that have historically received little vegetation should be prioritized over other neighborhoods. Your municipality should direct resources to hot spots and neighborhoods with vulnerable populations identified using the techniques found in the section "Identify Hot Spots and Vulnerable Populations." This will help direct spending to the areas that need these interventions the most.

Strategies to Implement Mitigation Activities

The following methods for local governments to enact strategies to reduce heat islands in their communities are summarized from EPA's *Reducing Urban Heat Islands: Compendium of Strategies* unless otherwise noted.[35] These short- and long-term approaches are split into two categories: voluntary efforts and policy efforts.

Fostering and Leveraging Voluntary and Pilot Efforts

Municipalities can encourage and support local initiatives to address extreme heat. These voluntary and pilot efforts tend to be the most popular type of extreme heat mitigation strategies, as they encourage and cultivate local involvement without top-down policy requirements. Five ways to foster these efforts are described: demonstration projects, incentives, urban forestry programs, weatherization, and outreach and education programs.

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[34] Texas Trees Foundation. 2017. *Urban Heat Island Management Study: Dallas 2017.*

[35] U.S. Environmental Protection Agency. 2008. "Heat Island Reduction Activities." In: *Reducing Urban Heat Islands: Compendium of Strategies.* Draft. www.epa.gov/heat-islands/heatisland-compendium.

Demonstration projects are a great way for you to lead your community by example. They provide an avenue to show the community how effective extreme heat mitigation strategies can be, which can draw increased support and investment from your residents and the private sector. The most effective demonstration projects do three things:

- Target high-visibility projects, specifically those that also provide benefits to the most vulnerable residents in your community.
- Measure benefits, like temperature reductions and energy savings.
- Convey lessons learned to make them easier to replicate and improve.

Incentives are highly effective in encouraging individual extreme heat mitigation projects. Types of incentives include below-market loans, tax breaks, product rebates, grants, and giveaways. Municipalities may also offer permitting cost reductions. Many extreme heat mitigation projects reduce energy use, so many energy efficiency incentive programs can be used to fund these types of heat mitigation efforts.

Urban forestry programs—or tree planting programs—generally emphasize the benefits of more trees within communities. They unite diverse stakeholders for short- or long-term projects related to tree planting and upkeep. These efforts should ideally be focused in vulnerable, low-income areas that have little tree cover. Successful programs provide education and training on proper planting techniques and long-term care. Planting is easy but maintenance is more challenging and key to survival of the urban tree canopy. Shade tree commissions, environmental action committees, and other citizen-led committees can be a great way to provide guidance on best tree species to plant, how to maintain those trees, and further protect and preserve existing and future tree plantings. For information on what types of trees to plant in a warming climate see DVRPC's Climate Adaptation Forum, *Forests, Urban Trees, and Climate Change* from October 25, 2016.[36] In addition, DVRPC is working on community forestry

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[36] www.dvrpc.org/Resiliency/CAF/ForestsTrees/

management plans for the City of Camden, Gloucester City, and Trenton, NJ.

Weatherization programs generally involve making the homes of low-income or heat-vulnerable residents more energy efficient at no or reduced cost to the resident. These help residents stay cooler in the summer, warmer in the winter, and spend less on energy bills all year long. Municipalities generally have a role in educating their residents about these types of programs and assisting in applying for them.

Outreach and education programs provide materials or learning opportunities for students and adults on how to properly maintain trees, mitigate extreme heat, promote heat health safety, and other ways to stay cool and help their fellow residents stay cool. These outreach and education campaigns can effectively be combined with the other initiatives listed earlier that municipalities may provide.

Policy Efforts

Local governments can also include extreme heat mitigation strategies in policies or regulations. They can prescribe minimum requirements, remove barriers in municipal processes, and provide incentives for implementing extreme heat reduction strategies. Six types of policy efforts are described: procurement, resolutions, comprehensive plans and design guidelines, zoning codes, building codes, and green building standards.

Updating **procurement practices** is a good way to mitigate heat. Municipalities can start procuring cool technologies for municipal buildings. Local governments who must put construction work and material supplies out for bid can revise their bid specifications to include cool products like cool roofs or pavements.

Resolutions are documents stating a group's awareness of and interest in an effort, such as extreme heat mitigation projects. They do not necessarily mean that a program or project will be financially supported. However, resolutions are a good first step toward creating awareness for new regulations or policies centered on extreme heat mitigation.

Comprehensive plans and design guidelines can also be avenues for local governments to attack extreme heat in their communities. Comprehensive and other community-wide plans can include mitigating heat islands as a core goal, giving more authority to future regulatory initiatives and guidelines for doing so. Design guidelines can provide a connection between general planning policies and implementing regulations, such as zoning codes and subdivision regulations.

Zoning codes implement the goals and objectives of a comprehensive plan. Typical zoning regulations for an area include function, building height, building bulk, population density, and parking requirements. Zoning codes can also promote extreme heat mitigation by providing density bonuses for construction that adopts heat mitigation strategies such as cool and green roofs.

Zoning codes also encompass other ordinances that enable or require efforts to reduce heat islands. The ordinances that are most useful from a heat island perspective are tree protection, street trees, and parking lot shade ordinances.

- **Tree protection ordinances** prohibit the removal or pruning of trees without a permit and typically apply to native trees or trees with historical significance. Some ordinances also protect the ground around the tree to prevent damage to the roots. Protection can vary by tree age, significance, size, or location.
- **Street tree ordinances** govern the planting and removal of trees along public rights-of-way and land that is privately owned but accessible by the public. They designate the numbers or types of trees that should be planted. They should include guidelines on tree selection, installation, and maintenance to lengthen a street tree's life and minimize problems with pavement, overhead wires, and buildings.
- **Parking lot shade ordinances** require the use of shading in parking lots to cool pavement and cars. This can be done by requiring a certain percentage of area to be shaded by trees after a certain growth period. These ordinances can also require a certain number of plantings by development type.

Building codes are regulations adopted at the state and local level that establish standards for construction, modification, and repair of buildings and other structures. In the DVRPC region, only Philadelphia can implement municipal building codes more stringent than those enacted at the state level. Philadelphia used this power to pass an amendment to their building code in 2010 requiring ENERGY STAR rated reflective roofs in all new construction.[37] Other municipalities could lobby their state governments to adopt building codes requiring reflective or green roofs.

While building codes are controlled at the state level, municipalities have the ability to provide **green building programs and standards** for residential and commercial buildings in their jurisdictions. These programs can encompass a wide variety of strategies for green building practices, including ways to reduce the heat island effect and improve energy efficiency. For instance, Doylestown Borough in Bucks County, PA, has a Green Points Program that provides permitting fee reductions based on the number of points gained from green building measures.[38]

To see examples of how local governments are working to mitigate urban heat islands, see the US EPA's Heat Island Community Action Database.[39]

Preparing for and Adapting to Extreme Heat

Regardless of what measures put into place to mitigate heat islands and extreme heat, heat waves—or excessive heat events (EHEs)— will still occur. The US EPA has crafted guidance to help you prepare your municipality for EHEs.[40]

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[37] "City of Philadelphia Cool Roof Law and Building Code." City of Philadelphia Cool Roof Law and Building Code | Adaptation Clearinghouse. Accessed February 12, 2021. www.adaptationclearinghouse.org/resources/city-of-philadelphia-cool-roof-law-and-building-code.html.
[38] storage.googleapis.com/dtown/Pages/GREEN-POINTS-20172.pdf
[39] www.epa.gov/heat-islands/heat-island-community-actions-database
[40] "Adapting to Heat." EPA. Environmental Protection Agency, November 21, 2019. www.epa.gov/heatislands/adapting-heat.

Comprehensive Heat Response Planning

Comprehensive heat response plans are effective ways to protect your residents and infrastructure from extreme heat events. These plans combine individual strategies into an integrated approach that incorporates the necessary local government offices and agencies. Typically, comprehensive heat response plans will include the following components: forecasting, monitoring, and notifying; education and awareness; and heat wave response.

Bordentown Township in Burlington County, NJ, has received Sustainable Jersey recognition for its extreme temperature event plan.[41,42] If there are two consecutive days over 95°F, a heat event is declared. Residents are then notified via Nixle (community information platform), social media, digital road signs, and reverse-911 of the heat event. Finally, The Township's Senior Center is opened as a cooling center.

Forecasting, Monitoring, and Notifying

EPA recommends that local officials use and evaluate the meteorological data in the National Weather Service's (NWS) 5-day regional forecasts to forecast and monitor heat.

Each county in the region, except for Delaware County,[43] has a public health office that provides notification of extreme heat events. These usually follow the NWS's recommendations discussed previously. Municipalities should consider linking to their county health departments on their own websites to direct those interested in learning more about extreme heat warnings.

If your county does not provide extreme heat warnings, consider the following when implementing these warning systems:

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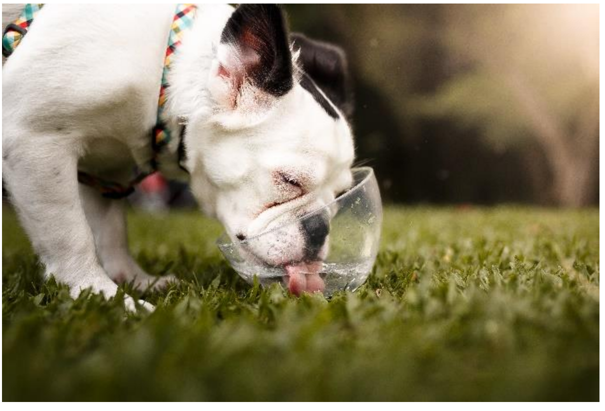
[41] Sustainable Jersey offers recognition and technical assistance for heat island identification, extreme temperature event plans, and more for all New Jersey municipalities. Find out more at www.sustainablejersey.com/

[42] Township of Bordentown. 2019. *Memo*. sj-site-persistent-prod.s3.amazonaws.com/fileadmin/cicbase/documents/2019/9/6/15677442366816.pdf

[43] As of this writing (January 2021), Delaware County does not provide notification of extreme heat events, but the County has voted to establish a public health office.

- Communicate the anticipated arrival, duration, and severity of the potential heat wave.
- Remind the public who is most at risk from extreme heat.
- List the symptoms of heat exhaustion and heat stroke to watch for.
- Consider providing a heat health hotline.

Philadelphia has received broad recognition for its comprehensive heat alert system. The City declares a Heat Health Emergency (HHE) when daytime temperatures reach 90°F or above with high humidity for two or more days. The City sends out notifications via their website and their free mass notification system. These notifications explain symptoms to watch out for, how to keep yourself cool and safe, and a link to the City's website for more information. The Heatline, a special helpline number, is then opened for calls, and the City opens cooling sites. Residents are also encouraged to visit public pools or one of the City's more than 90 spraygrounds and sprinklers.[44] The Office of Homeless services increases their outreach. Residential utility shutoffs are stopped. Finally, additional pet safety measures are enforced by Philadelphia's Animal Care & Control Team.[45]



[44] Philadelphia Parks & Recreation Finder. Accessed February 12, 2021. www.phila.gov/parks-rec-finder/#/locations/sprinklers-and-spraygrounds.
[45] Reyes, Sarah. 2019. "What Happens When the City Declares a Heat Health Emergency: Department of Public Health." City of Philadelphia, June 11, 2019. www.phila.gov/2019-06-11-what-happens-when-the-city-declares-a-heat-health-emergency/.

Education and Awareness

It is important to communicate to your residents about just how deadly extreme heat can be. Consider holding public meetings to discuss the dangers of extreme heat. These meetings should be held in the spring before the summer heat arrives: The first heat wave of the season is typically the most fatal.

These meetings should discuss the following:

- Dangers of extreme heat.
- Potential risk factors that contribute to higher instances of heat health emergencies.
- Symptoms of excessive heat exposure.
- Recommended response and treatment.
- Ways to stay up to date on weather forecasts and how to access heat wave notifications.
- Information on utility programs for weatherization, air conditioning, bill pay assistance, no electricity cut-off programs, etc.

Responding to Heat Waves

First and foremost, municipal responses to heat waves should focus on protecting residents. As this document discussed previously, there are a myriad of health risks associated with extreme heat. There are two primary avenues to protecting residents during heat waves:

1. Make it safer to stay at home.
2. Give residents somewhere safe to go.

Making it safer to stay at home is often the first priority of extreme heat action. Most people do not want to leave their homes during extreme heat events. Often, designated areas for residents to find cooling are more uncomfortable than one's home: they do not have the privacy and amenities of home, and most do not allow pets.

To address making it safer to stay at home, municipalities should ensure proper functioning of both electricity and water infrastructure. These utilities tend to be more stressed during heat waves, so it is beneficial to encourage residents to conserve energy as much as possible to offset the increased energy demand from air conditioning. If your municipality owns its utilities, consider implementing a no shutoff program during extreme heat events. Otherwise, look to your local utility and communicate any no shutoff programs they may have to your residents.

Programs preventing utility shutoffs work well in conjunction with other programs that provide air conditioning units for free or discounted costs. This allows those unable to afford AC units—and the higher electricity bills that follow their use—to have access to them during extreme heat events.

Finally, some municipalities have implemented buddy programs for residents to look after one another during extreme heat events. This is especially important for at-risk individuals that may live alone, including the elderly. These types of community buddy programs can also help individuals decide when it is no longer safe to stay at home and help them find safe places to go during heat waves.

Cooling centers are air-conditioned or cooled buildings that have been designated to provide safety during extreme heat events. These can be municipally-owned buildings, community centers, religious centers, or private businesses.

However, these cooling centers are not much use if no one goes to them. Researchers and public health advocates in Sacramento, CA, and Phoenix, AZ, have identified several issues with cooling centers that may prevent them from being most effective in keeping people cool and safe during heat waves. These issues include limited access via public transportation, fear of leaving home or inability to leave home, not wanting to leave pets behind, populations not self-identifying as vulnerable, and the general stigma of cooling centers being just for "old people" or the disadvantaged.[46]

To make sure that cooling centers provide respite to those that need it most, consider the following:

- Cooling center locations and hours should be publicized along with the extreme heat warnings.
- Cooling center hours should correspond with the hottest times of the day. Many cooling centers close at 5 pm, but that leaves vulnerable people without cooling during one of the hotter times of the day.
- Cooling centers should be in locations accessible to people with disabilities and by multiple modes of transportation.
  Provide some simple programming (such as board games) at cooling centers to help people feel comfortable and engaged.

As an alternative, municipalities may decide to open outdoor cooling sites, typically public pools, sprinklers, and spraygrounds. They may also decide to extend operating hours for these sites. A 2017 study by Widerynski et al. surveyed local health departments in New York State and found that these types of outdoor cooling sites were used more often than indoor cooling centers.[47]

In lieu of cooling centers or pools, some municipalities are thinking of creative ways to keep their residents cool during heat waves. For instance, Richmond, VA, is looking at which neighborhoods have the greatest exposure to heat waves and the most vulnerable residents. Where those places intersect, they are considering closing streets to traffic and creating impromptu social spaces for people to gather in the

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[46] Kerlin, Kat. 2020. "Becoming Arizona: Lessons from Phoenix." *Science and Climate,* August 6, 2020. climatechange.ucdavis.edu/news/becoming-arizona-lessons-from-phoenix/.

[47] Widerynski, Stasia, Schramm, Paul, Conlon, Kathryn, Noe, Rebecca, Grossman, Elena, Hawkins, Michelle, Nayak, Seema, Roach, Matthew, & Hilts, Asante. 2017. *The Use of Cooling Centers to Prevent Heat-Related Illness: Summary of Evidence and Strategies for Implementation.* Climate and Health Technical Report Series Climate and Health Program, Centers for Disease Control and Prevention. 10.13140/RG.2.2.32267.59688.

evenings, when outdoor temperatures are likely to be cooler than indoor temperatures.[48] In July 2020, Philadelphia worked with SEPTA to use transit buses as mobile cooling centers.[49]

Cooling Centers in the Time of COVID-19[50]

COVID-19 is a dire public health emergency, but climate change waits for nothing. Extreme heat compounds respiratory risks associated with COVID-19. Cooling centers are safe havens from extreme heat, but because they bring unrelated people into the same space, they may also increase the likelihood of transmission of the SARS COV-2 virus and development of COVID-19. To safely operate cooling centers during the COVID-19 pandemic and future pandemic events, the Center for Disease Control recommends the following best practices:

- **Plan for staff and volunteer absences**. Identify essential functions and positions and cross-train staff to plan for coverage of those functions.
- **Implement verbal screening and temperature checks before admitting visitors.** Provide alternative cooling sites for those showing symptoms of COVID-19 or those who have been

[48] Flavelle, Christopher. 2020. "Coronavirus Makes Cooling Centers Risky, Just as Scorching Weather Hits." The New York Times, The New York Times, 6 May 2020, www.nytimes.com/2020/05/06/climate/coronavirus-climate-change-heat-waves.html.

[49] Wood, Anthony R. 2020. "Philly Heat Emergency Continues; Strong Storms Possible Late Wednesday and Thursday." *The Philadelphia Inquirer*, 22 July 2020, www.inquirer.com/weather/philadelphia-heat-emergency-weather-storms-20200721.html.

[50] "COVID-19 and Cooling Centers." Centers for Disease Control and Prevention, Centers for Disease Control and Prevention, www.cdc.gov/coronavirus/2019-ncov/php/cooling-center.html#:~:text=Physical%20Distancing,distancing%20in%20a%20cooling%20center.

vaccinated. Designate an alternate site for visitors with mild illness who remain at the cooling center.

- **Require face coverings for all visitors.** Provide face coverings for visitors who may not have them.
- **Maintain physical distancing within cooling centers of at least six feet.** Limit the number of visitors if the necessary space is not available. Consider setting up a greater number of smaller cooling centers to offset the limited capacity. If necessary, emergency alternatives like parked transit buses can be used.
- **Equip cooling centers with appropriate air filtration.** Use air exchange systems and buildings with tall ceilings where possible. Use the highest efficiency filters that are compatible with the HVAC system. Ceiling fans with upward airflow rotation and upper-air ultraviolet germicidal irradiation (UVGI) disinfection systems can be used.
- **Continue routine cleaning and disinfection every day.** Focus on high touch surfaces, especially in common areas and bathrooms.
- **Communicate with visitors about COVID-19.** Keep your visitors informed about public health recommendations from trusted sources to prevent disease spread.
- **Provide COVID-19 prevention supplies onsite.** Have materials such as soap, alcohol-based hand sanitizers, and tissues.

Protecting Infrastructure

Municipal infrastructure can also be at risk from extreme heat. To protect vulnerable transportation infrastructure during heat waves, implement load and speed restrictions for older roads, bridges, and rail. For utility infrastructure, promoting energy efficiency and conservation efforts can reduce stress on electricity and water systems during heat waves to avoid system outages.

In the longer term, municipal officials can use materials for roads, bridges, and other structures that are more resilient and heat tolerant. These can include the heat island reduction measures discussed previously, such as cool pavements. Similarly, using heat island reduction measures can decrease energy use, helping to avoid stressing electrical infrastructure during heat waves.

Additional Information

This brochure provides an overview of the issues related to extreme heat in the DVRPC region and some resources to assist municipalities in mitigating and adapting to higher temperatures. Please visit the climate change section of DVRPC's website at www.dvrpc.org/EnergyClimate for supporting materials on extreme heat, additional information and resources on energy and climate change, and for contact information to consult with DVRPC's staff.

The Delaware Valley Regional Planning Commission is the federally designated Metropolitan Planning Organization for a diverse nine-county region in two states: Bucks, Chester, Delaware, Montgomery, and Philadelphia in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer in New Jersey.

DVRPC's vision for the Greater Philadelphia Region is a prosperous, innovative, equitable, resilient, and sustainable region that increases mobility choices by investing in a safe and modern transportation system; that protects and preserves our natural resources while creating healthy communities; and that fosters greater opportunities for all.

DVRPC's mission is to achieve this vision by convening the widest array of partners to inform and facilitate data-driven decision-making. We are engaged across the region, and strive to be leaders and innovators, exploring new ideas and creating best practices.

DVRPC fully complies with Title VI of the Civil Rights Act of 1964 and related nondiscrimination mandates in all activities. For more information about DVRPC's Title VI Program or to obtain a Title VI Complaint Form, visit www.dvrpc.org/GetInvolved/TitleVI, call (215) 592-1800, or email public_affairs@dvrpc.org.

The authors are solely responsible for the findings and conclusions herein, which may not represent the official views or policies of the funding agencies.

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