

Urban Heat Risk in Manchester

Explore this story map to understand who, and where in the city is most vulnerable to extreme heat under current and future climate change.

Met Office in partnership with Manchester City
Council & Manchester Climate Change Agency

February 1, 2023



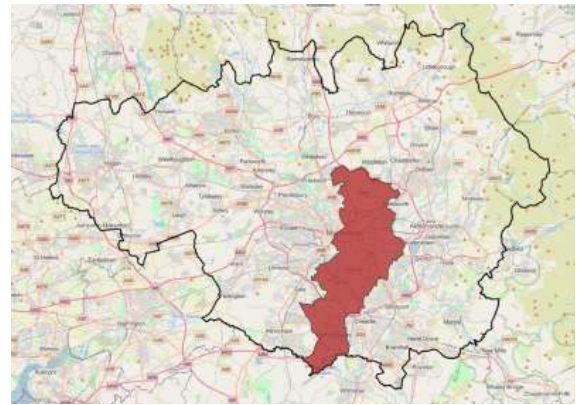
Why is it important to understand heat risk?

The risks to human health, well being and productivity from heat exposure is one of the top climate change risks facing the UK¹.

In the UK, climate change is projected to make our winters milder and wetter and our summers drier and hotter. We can also expect to see an increase in the number of extreme events such as hot days and heatwaves².

This storymap explores current and future heat risks to people within the Manchester City Council area as shown in the map on the right. A Heat Vulnerability Index (HVI) is used to understand who the most vulnerable are to extreme heat and where they are located within the city. This is important for emergency and resilience planning for future heat events under a changing climate.

Scroll through this storymap to understand the impacts of heat on society and explore the HVI for Manchester.



Map showing Manchester City Council area of focus (red) and Greater Manchester boundary (black).

Heat related illnesses

Heat syncope – dizziness and fainting, due to dehydration, vasodilation, cardiovascular disease and certain medications

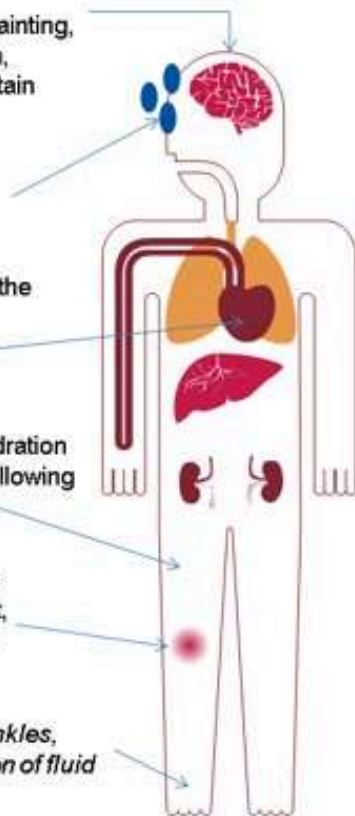
Excessive sweating can deplete fluid and salts

When blood temperature rises, the body stimulates sweat glands, dilates blood vessels and increases the heart rate

Heat cramps – caused by dehydration and loss of electrolytes, often following exercise

Increased blood flow to the skin cools the body by radiating heat, leading to heat rash (small, red itchy papules)

Heat oedema – mainly in the ankles, due to vasodilation and retention of fluid



Health effects of heat

The main causes of illness and death during a heatwave are respiratory and cardiovascular diseases. Additionally, there are specific heat-related illnesses including:

Heat Exhaustion

- Nausea or irritability
- Dizziness
- Muscle Cramps or weakness
- Feeling faint
- Headache
- Fatigue
- Heavy sweating
- High body temperature

Heatstroke

- Hot, dry skin or profuse sweating
- Confusion
- Loss of consciousness
- Seizures
- Very high body temperature

What are the impacts of heat?

High temperatures can cause an increase in heat-related illnesses such as heat stroke and heat exhaustion.

Temperatures greater than 25°C are associated with excess summer deaths.

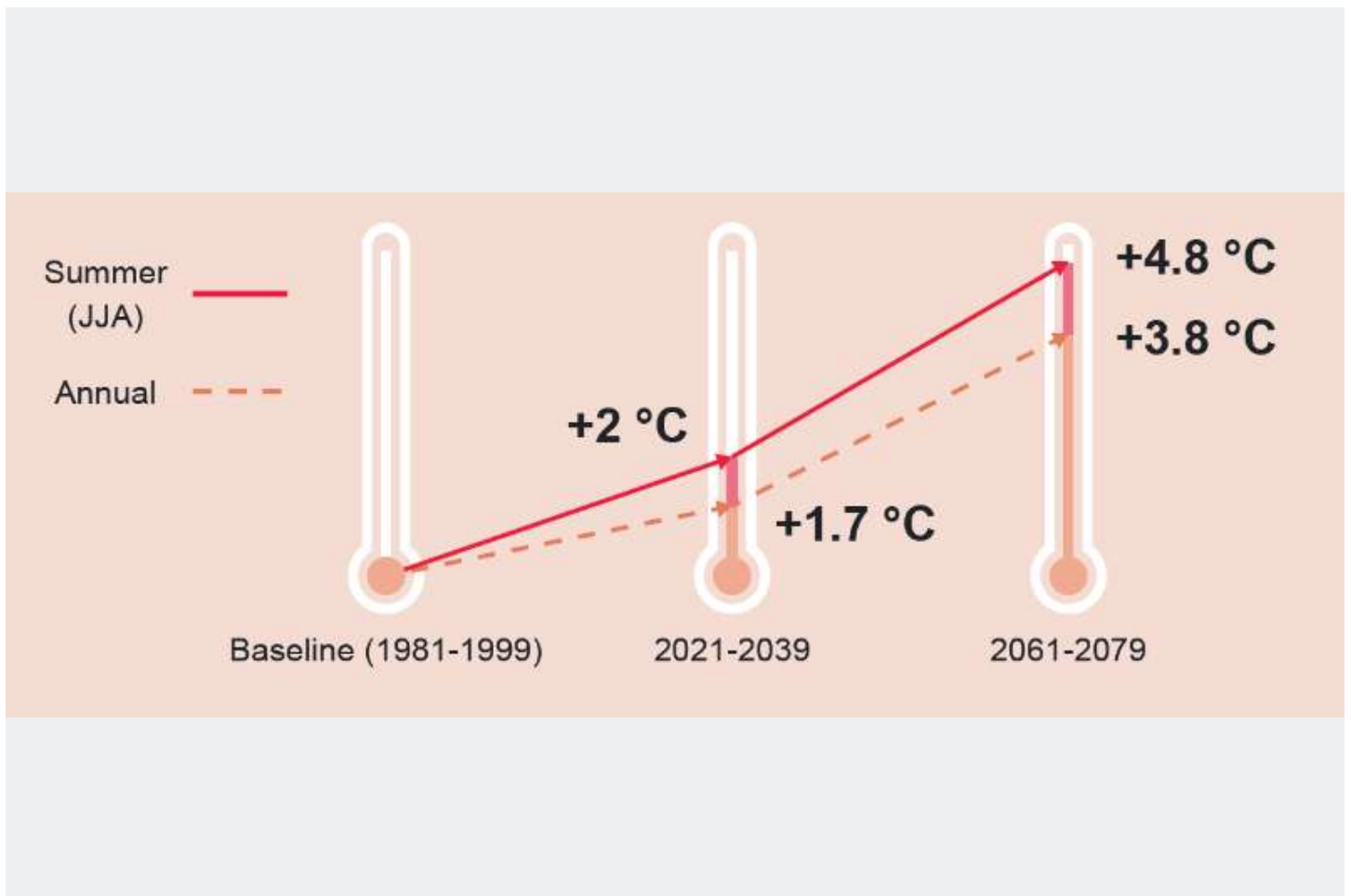
The most vulnerable in our society are particularly at risk including older people, those with chronic and severe illness, infants and homeless people³.

The figure on the right from the UK Health Security Agency shows the health impacts of heat on the human body³.



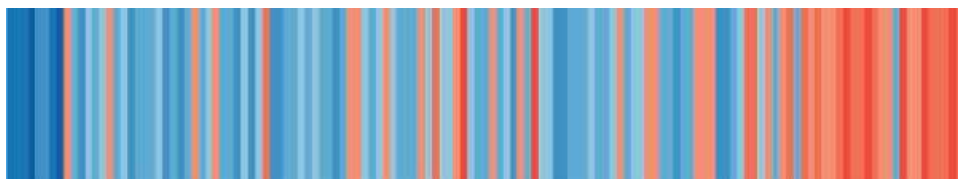
High temperatures can also have negative impacts for our infrastructure, businesses and built environment including:

- Increased water demand.
- Disruption to power supply.
- Delays to railway network as speed restrictions imposed to avoid buckling of tracks.
- Homes and buildings are at greater risk of overheating.
- Reduction in employee productivity¹.
- Greater risk of road melt.



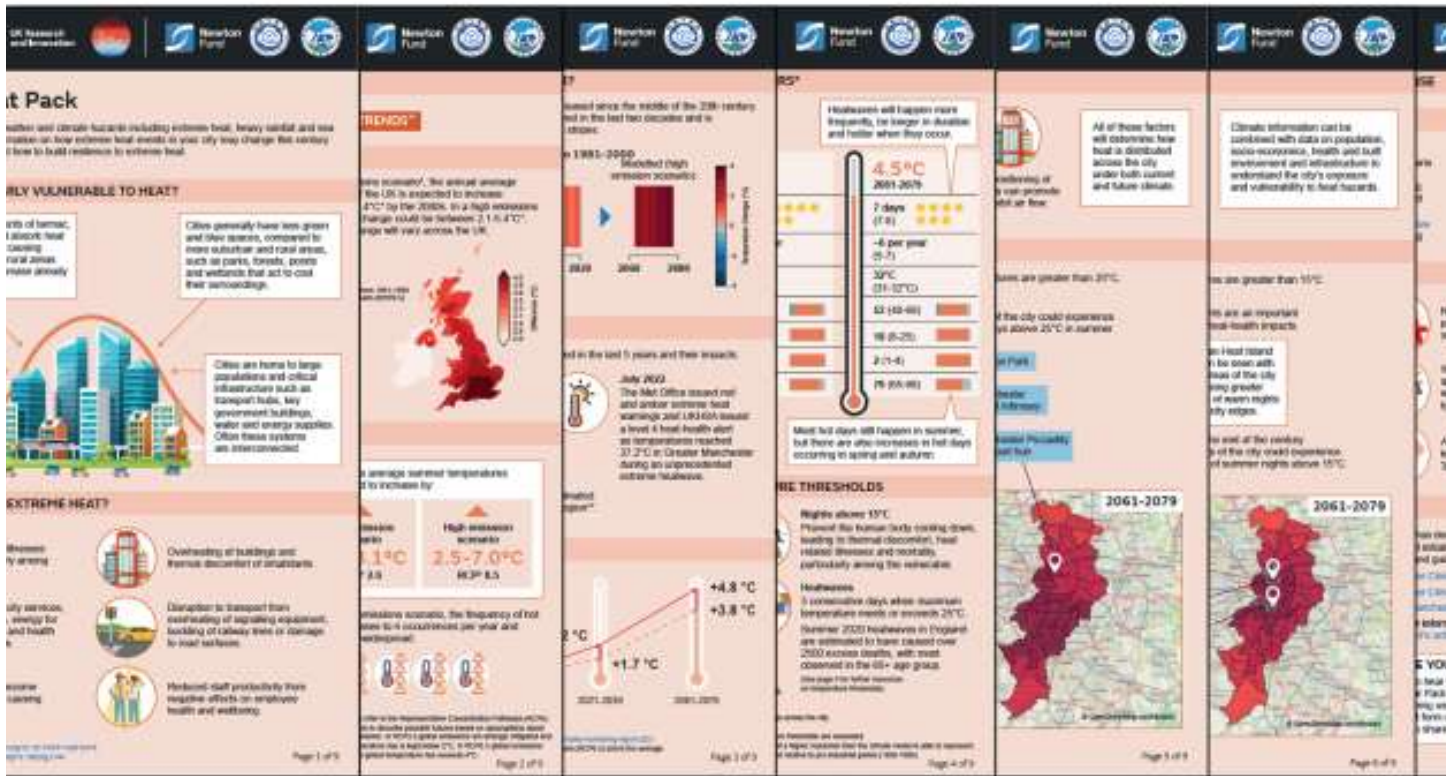
How is temperature changing in Manchester?

Average temperatures in Manchester have increased since the middle of the 20th century. This trend is in line with the rest of UK and most of this warming has occurred in the last two decades as shown by the warming stripe:



Manchester average annual temperature change 1884-2020 (concept from Prof. Ed Hawkins [#ShowYourStripes](#))

If global green house gas emissions continue to grow beyond current policy commitments, Manchester's average annual temperature could increase by 3.8°C and summer average temperature by 4.8°C towards the end of this century.



The Met Office has developed a Heat Pack that provides information on how extreme heat events may change in Manchester during the 21st century. Click the button to view.

Manchester Heat Pack

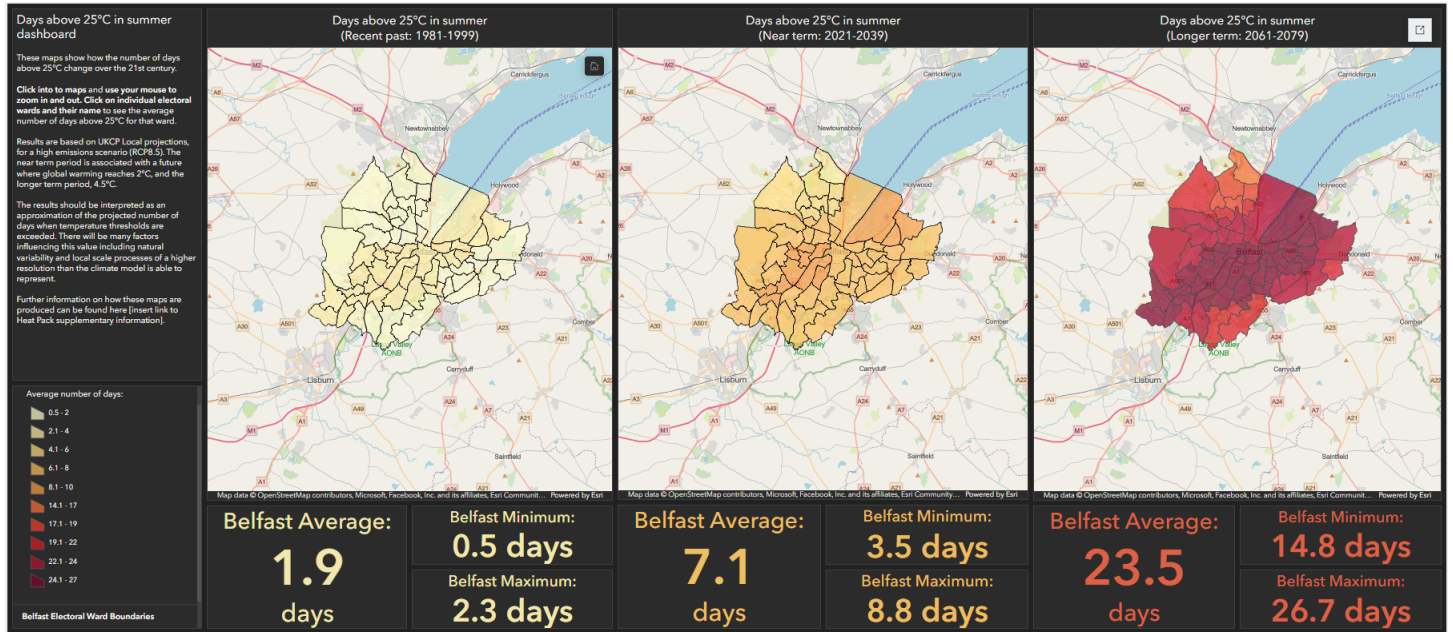
While average temperatures are set to increase, we could also see a rise in the number of hot days and warm nights that can have adverse impacts on health, built environment and infrastructure.

Scroll down to the dashboards below to explore how the number of hot days and warm nights are changing across the city.

Hot Days in Manchester

When daily maximum temperatures rise above 25°C there is an increased risk of heat-related illnesses and mortality. Rail networks begin to implement staged precautions to avoid buckling of tracks. Explore the dashboard below to see how the number of days

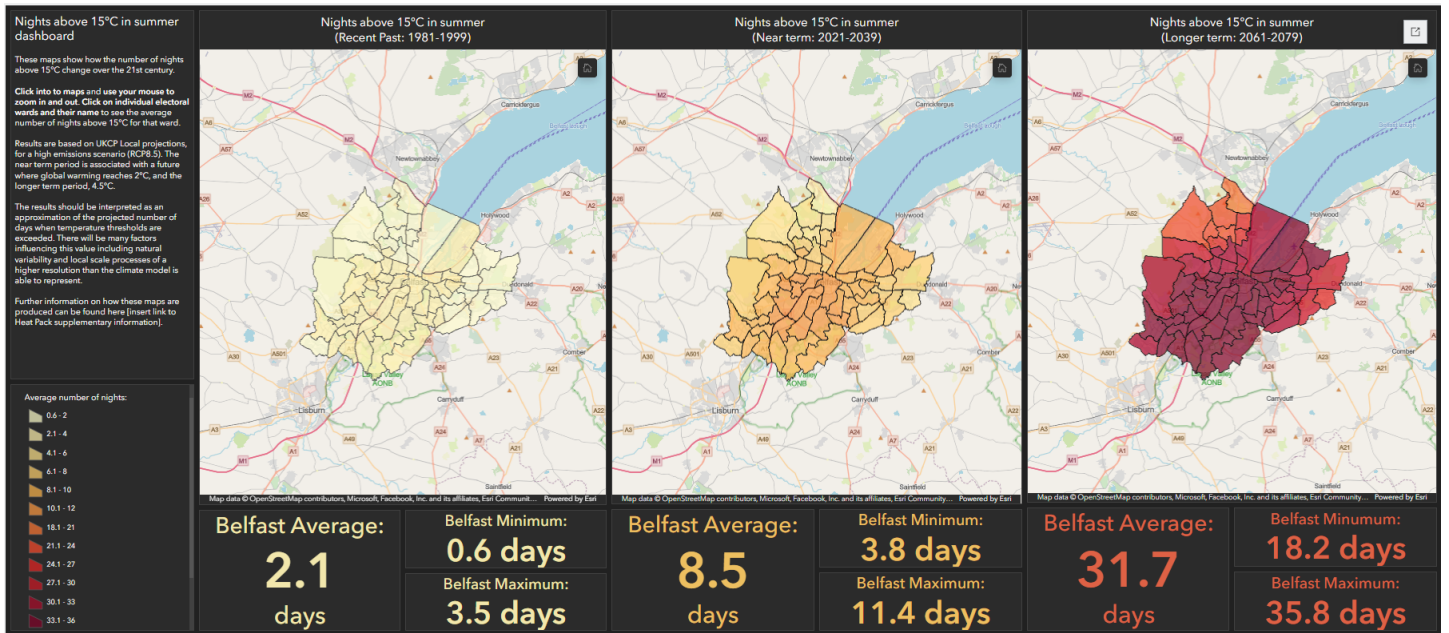
above 25°C is expected to change for Manchester over this century. Follow the instructions in the side panel to interact with the maps.



ArcGIS Dashboards

Warm Nights in Manchester

When daily minimum temperatures are greater than 15°C the body may find it difficult to cool down from high day time temperatures, leading to thermal discomfort, heat related illnesses and mortality, particularly among the vulnerable. Explore the maps below to see how the number of nights above 15°C is expected to change for Manchester over this century.

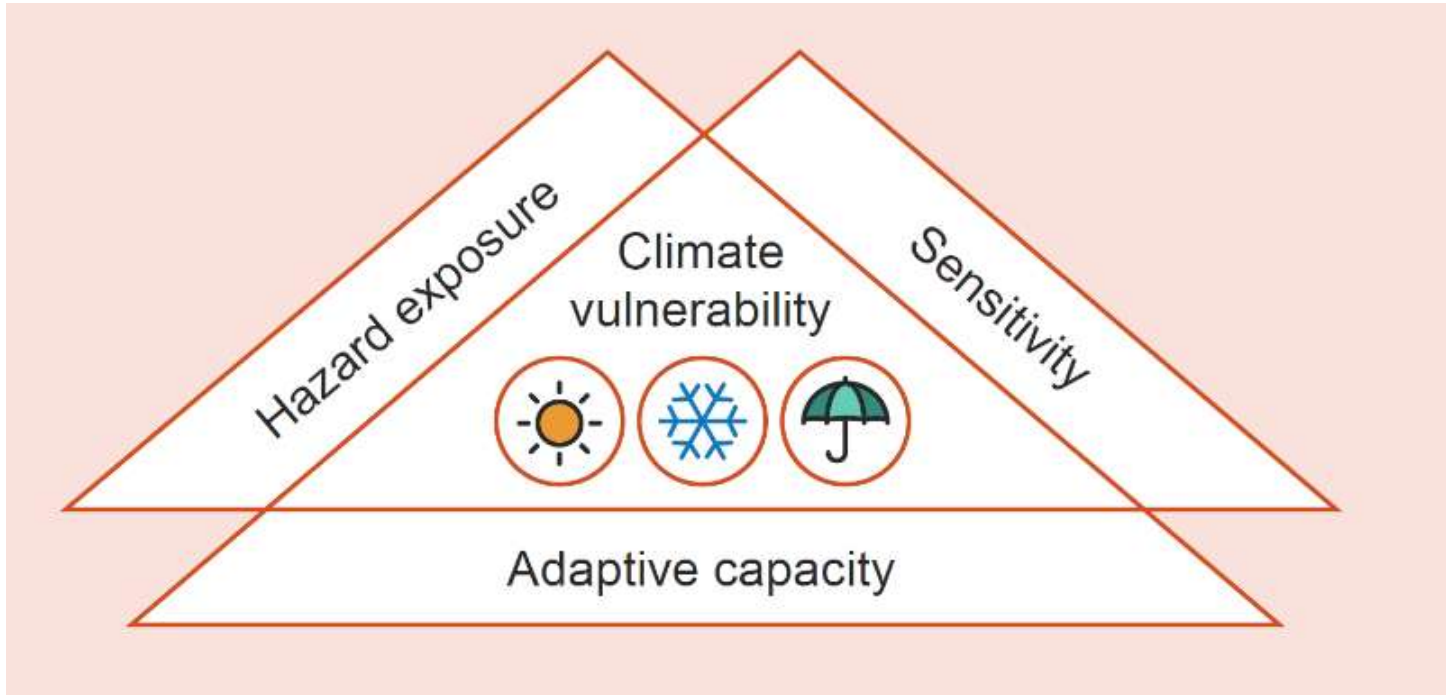


ArcGIS Dashboards

What is a heat vulnerability index?

This storymap explores current and future heat risks to the people of Manchester through a Heat Vulnerability Index. **Heat vulnerability** is the degree to which people, assets or a system are susceptible to, and unable to cope with the adverse affects of extreme heat⁴.

A **Heat Vulnerability Index (HVI)** is a method to assess the degree to which people or systems are at risk to extreme heat. It provides a relative, numerical score that is used to determine which parts of the city are at greater risk to extreme heat than others. The HVI compares heat vulnerability of the 32 wards in the local authority area of Manchester.



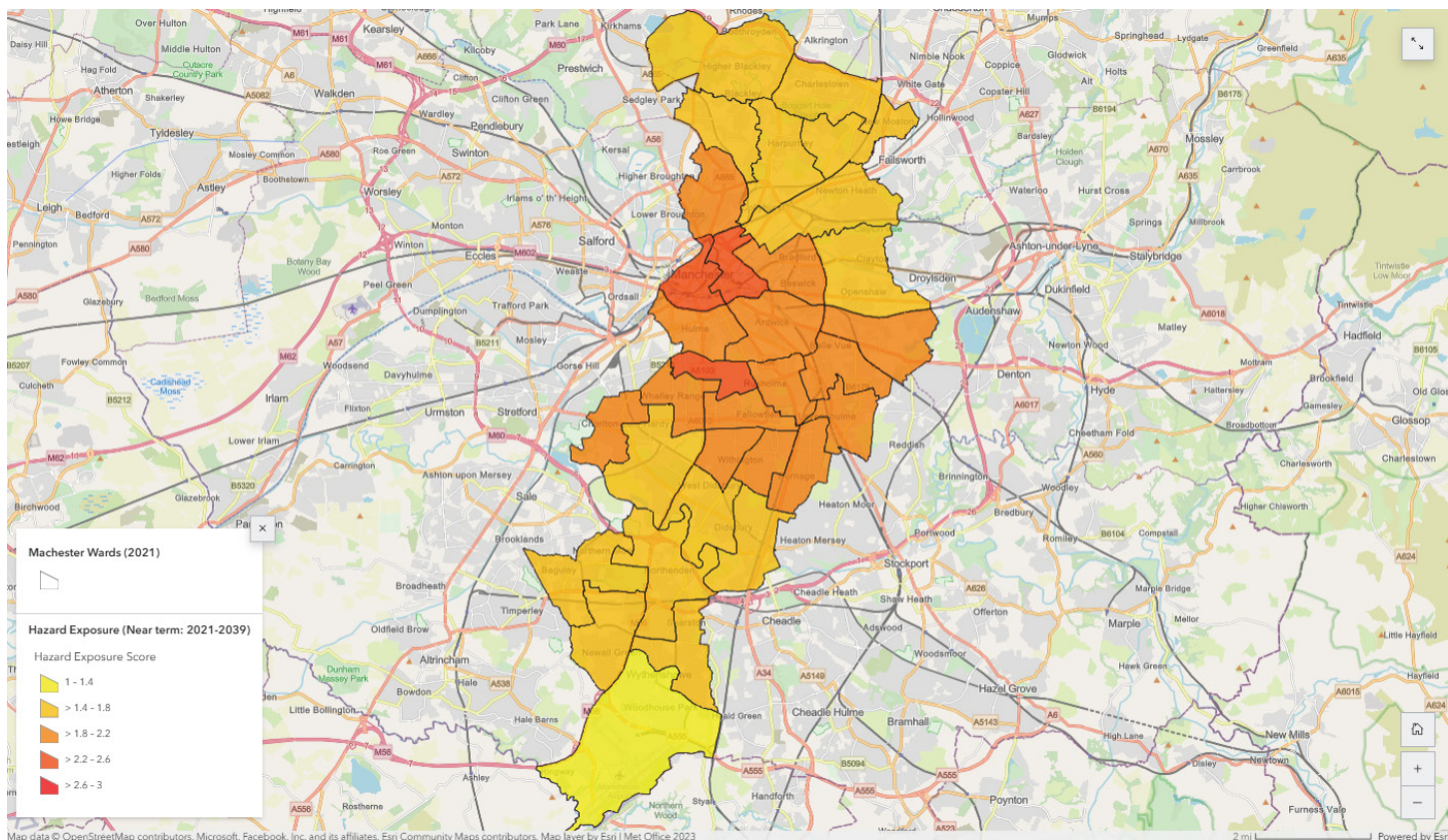
The adverse impacts of heat do not occur equally across populations. How vulnerable people are to heat depends on three aspects:

Hazard exposure - The presence of people in locations that are exposed to high outdoor temperatures or high indoor temperatures due to building characteristics for example.

Sensitivity - The degree to which people are affected, either adversely or beneficially, by high temperatures due to for example, their age or health conditions.

Adaptive Capacity - The ability of people to adjust or respond to potential impacts, or take advantage of opportunities of high temperatures.

Keep scrolling to see which indicators have been used to develop Manchester's HVI.



Hazard Exposure

The map on the right compares the hazard exposure of each ward in the **near term (2021-2039)**.

Click on each ward in the map to see the overall hazard exposure score and the underlying scores for each indicator. The higher the score, the greater the overall exposure to the heat hazard.

The indicators used for hazard exposure in Manchester's HVI are:

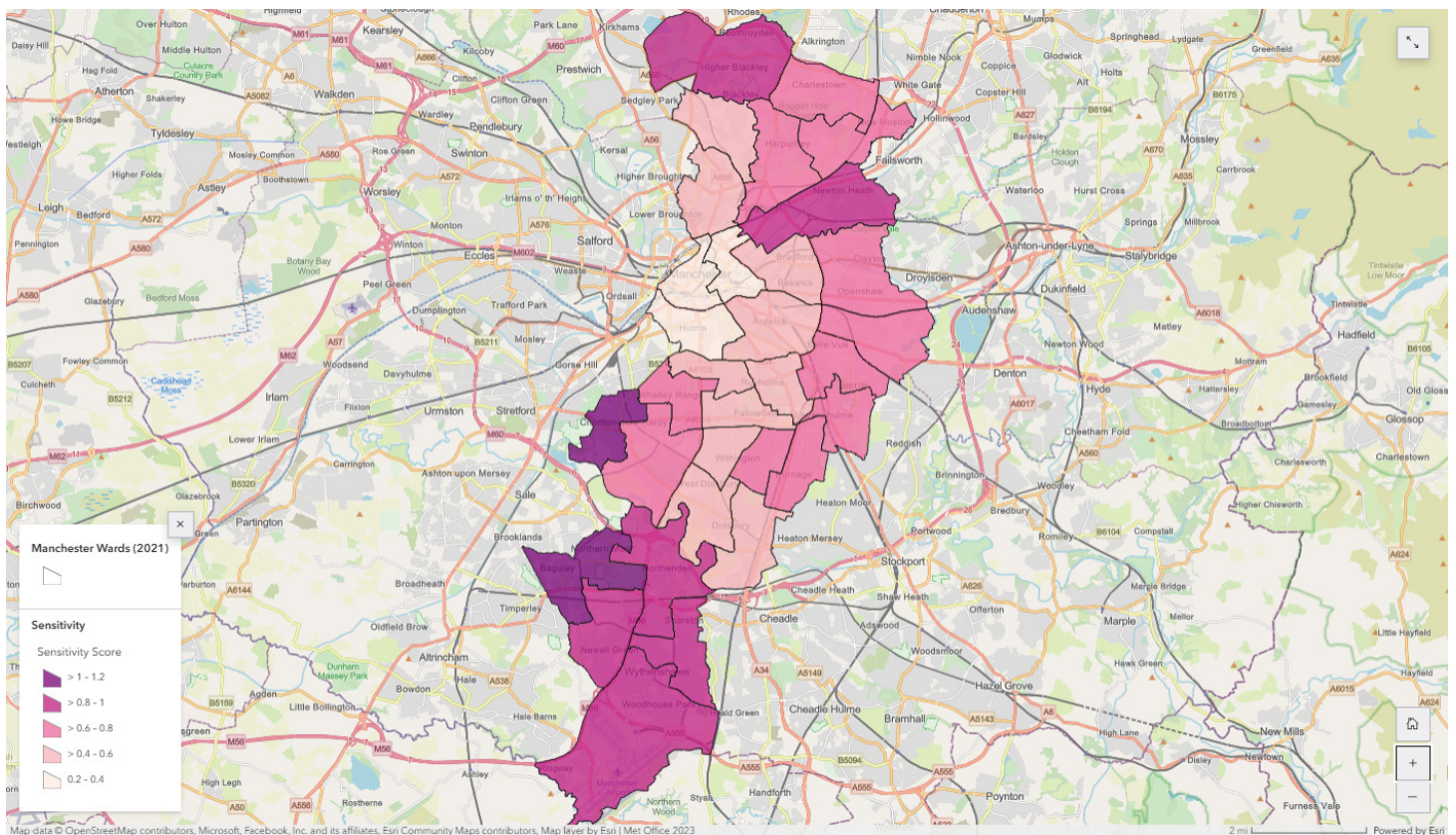
Number of hot days (above 25°C) and warm nights (above 15°C) in summer: High day and night time temperatures prevent the body from cooling down and can cause increased heat-related health conditions and mortality³. Temperatures in the recent past, near term and longer term time periods from the dashboards above have been assessed. The higher the temperature indicator index (between 0-1) the greater number of hot days and warm nights projected for a ward.

Population density (the number of people per square kilometre): Densely populated areas expose more people to the heat hazard⁸. The higher the population density index (between 0-1) the higher the population density in a ward.

Background air quality (PM_{2.5}): Poor air quality can be exacerbated during hot weather and cause negative health impacts⁹. The higher the air quality index (between 0-1) the higher the background concentrations of PM_{2.5} within a ward.

The scores of the three indicators are added together to give the overall hazard exposure score for each ward.

Hazard exposure is lower in the northern and southern most wards which tend to have lower population densities due to a high proportion of these wards being taken up by Manchester airport in south and Heaton Park in the north. They also coincide with cooler parts of the city.



Sensitivity

The map on the right compares the sensitivity of each ward. Click on each ward in the map to see the overall sensitivity score and the underlying scores for each indicator. The higher the score, the higher the sensitivity to heat.

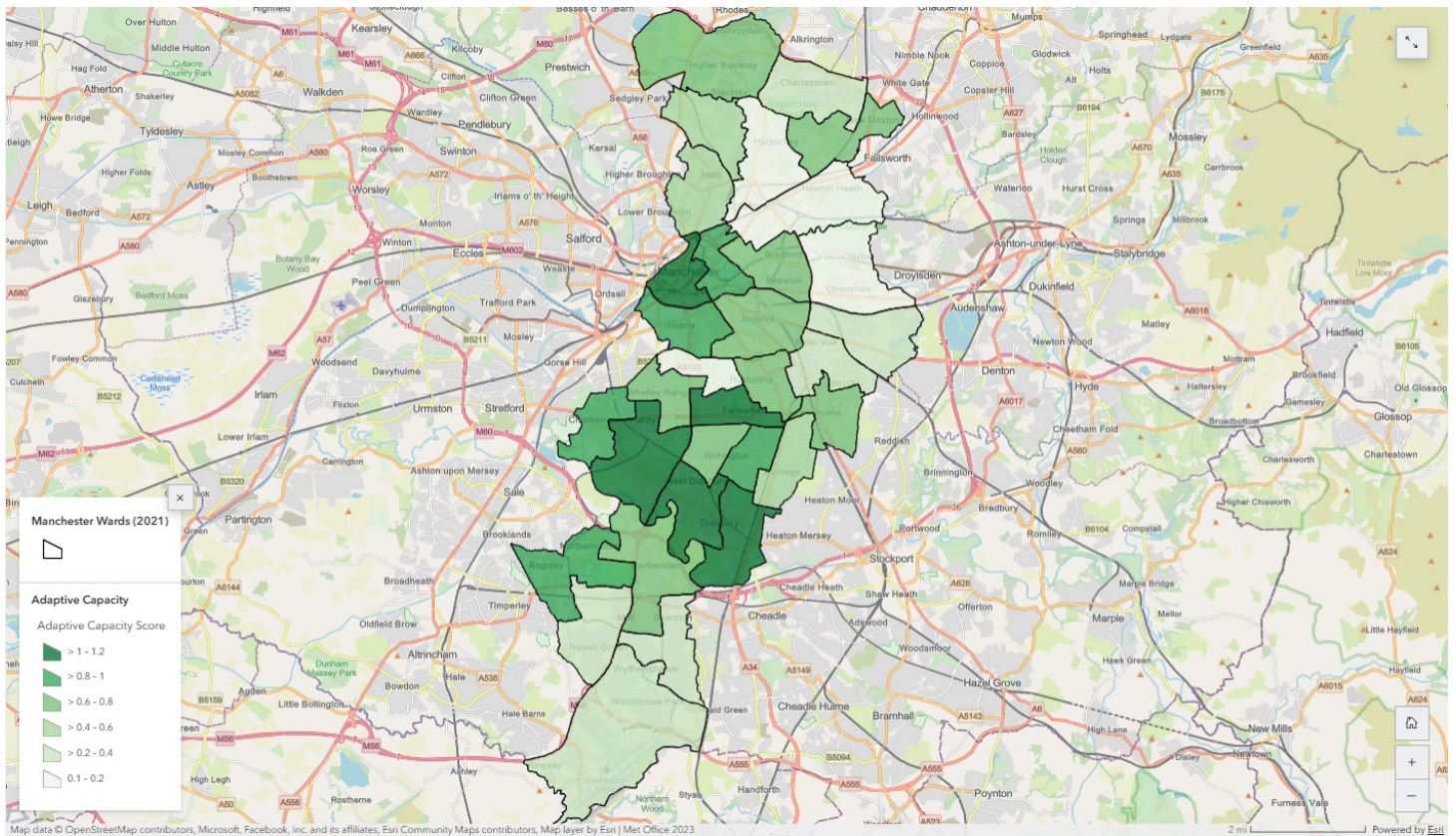
The indicators used for sensitivity in Manchester's HVI are:

Proportion of the population aged 75+: Older people are more susceptible of developing heat related illnesses³. This indicator is given as a value between 0-1, equivalent to the percentage i.e. 0.1 = 10% of ward is aged 75+.

Proportion of the population with a long term health condition (LTC): Those with underlying health conditions are more susceptible to developing heat related illnesses³. The higher the score the greater the number of people in a ward with a LTC.

Both indicators above are added together to give the overall sensitivity score for each ward.

There tends to be an opposite pattern to sensitivity compared with hazard exposure, i.e. lower in the centre and higher in the outer wards. Sensitivity tends to be lower in the city centre where there is a higher proportion of young professionals and students. While the northern and southern most wards tend to have lower population densities, they contain a high proportion of older people and those with LTC's and therefore have higher sensitivity scores.



Adaptive Capacity

The map on the right compares the adaptive capacity of each ward. Click on each ward in the map to see the overall adaptive capacity score and the underlying scores for each indicator. The lower the overall score, the lower the adaptive capacity.

The indicators used for adaptive capacity in Manchester's HVI are:

Income deprivation: High levels of deprivation may prevent people being able to adapt to high temperatures such as having the means to purchase cooling equipment or travel to cooler spaces⁸. If a ward has a low income deprivation index value (between 0-1) then the level of deprivation is high in that ward.

Proportion of public green space: Green space acts to cool its surroundings and can offer residents an area of respite to high indoor temperatures¹⁰. This indicator is given as a value between 0-1, equivalent to the percentage i.e. 0.02 = 2% of ward area is green space.

The scores of the two indicators are added together to give the overall adaptive capacity score for each ward.

Wards in the city centre and towards the south of the centre tend to have higher adaptive capacity scores than wards to the north east. The southern most ward has the lowest proportion of green space as much of this ward is covered by Manchester airport and has higher income deprivation. In comparison, while the city centre wards have smaller proportions of green space they have the lowest levels of income deprivation, therefore score higher in adaptive capacity.

Heat Risk in Manchester

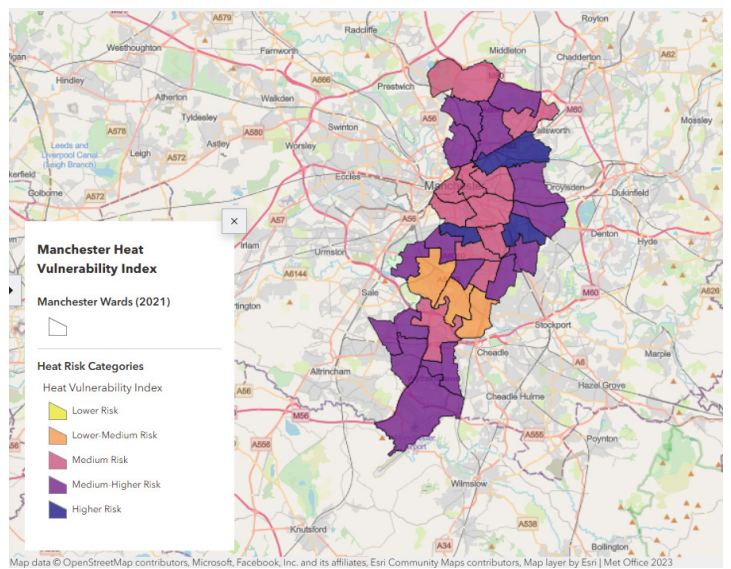
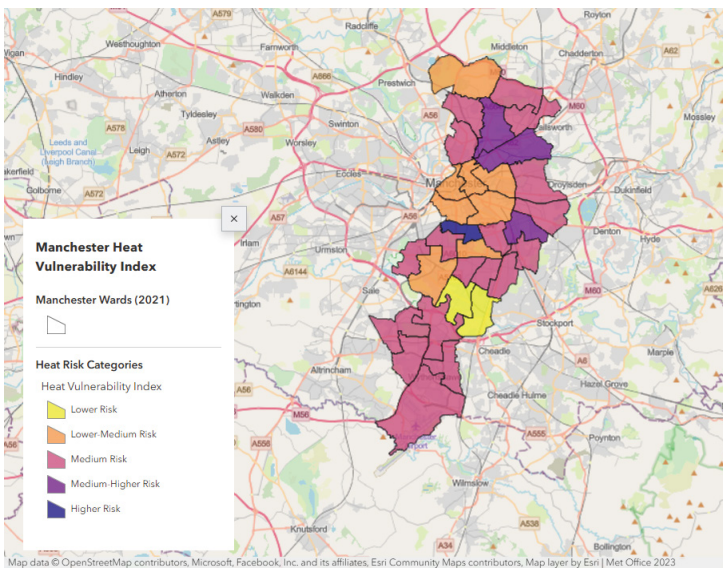
The components above have been combined using the formula below to assess where the most vulnerable parts of the city are to extreme heat:

Heat Vulnerability = Hazard Exposure + Sensitivity - Adaptive Capacity

Each ward has been categorised on its level of heat risk based on its HVI score. The HVI provides a relative comparison of risk between wards ranking them in order from highest risk (rank 1) to lowest risk (rank 32).

Use the slider below to discover how heat risk will change over the 21st century as the number of hot days and warm nights increase and all other indicators remain as they are today.

The map on the left of the slider shows heat risk in the near term (2021-2039), and on the right in the long term (2061-2079). Click on the legend button in the bottom left corner to show the risk categories. Click on the individual wards to see the index scores and ranks.



The map on the left shows heat risk for 2021-2039 (~2°C world) time period, the map on the right is for 2061-2079 (~4.5°C world).

Most wards move into higher risk categories as temperatures rise. Some wards continue to be more vulnerable than others depending on their exposure to the heat hazard, the sensitivity of residents and the capacity to high temperatures.

The HVI demonstrates the importance of considering both people and place when planning interventions and building resilience to extreme heat events. For example, parts of Manchester that have the highest exposure to extreme temperatures may not contain the largest number of vulnerable people who are more sensitive to extreme temperatures, or have the ability to adapt.

It is important to note that these results show the changing heat risk when the temperature indicator changes through time while all other health and socio-economic indicators stay as they are in the present day. It is likely that health and socio-economic factors will change over time as well. This HVI therefore provides decision makers with a scenario that shows how heat risk would change across the city if no mitigation or adaptation measures were put in place.

What can we do to manage heat risk?

There are several steps that we can take to manage heat risk as set out in the UK Climate Change Risk Assessment^{1&6} and the UK

Health Security Agency's (UKHSA) Heatwave Plan for England⁷.
Click the arrow on the right to explore these steps below.



Building community resilience

Increasing public awareness of heat risks along with early warning and action, keep people safe in hot weather.

The [British Red Cross](#) and [UKHSA](#) provide guidance on steps people can take to protect themselves and the vulnerable to reduce risks to health from prolonged exposure to extreme heat.



Green Infrastructure

Creating green spaces and planting urban trees can provide urban cooling along with other benefits for air pollution, flood alleviation and biodiversity.

There are several examples within the city that demonstrates how Manchester is developing climate resilience by improving green and blue spaces.



Heat-proofing buildings

Updating building regulations for new homes and retrofitting existing buildings with shutters, reflective surfaces and natural ventilation can reduce the risk of overheating.

Adaptation responses should be considered alongside net zero carbon goals to prevent maladaptation and realise common benefits in buildings.



Resilient Infrastructure

Mainstreaming climate change adaptation into planning and design of new transport and energy infrastructure and renewal of existing assets to withstand higher temperatures.

Provide your feedback

The Met Office would like to hear your feedback on this StoryMap to improve this service and understand how it is being used. Please complete this short form using the link to share your thoughts. We value your response:

<https://forms.office.com/r/hKimqDDy3c>

If you would like any further information please contact:
urbanclimateservices@metoffice.gov.uk

What data did we use?

Climate data within the HVI is derived from the Local [UK Climate Projections](#) (UKCP) from the Met Office's convection permitting model at a spatial resolution of 2.2km and aggregated to ward level.

Population density and the proportion of population aged 75+ derived from [Manchester Intelligence Hub](#) 2020 population data based on ONS data (©Crown copyright, Office for National Statistics).

Air Quality (PM_{2.5}) concentrations derived from [Defra Estimated Background Air Pollution Maps](#) (base year 2018).

Prevalence of long term health conditions (LTC) data provided by Manchester City Council and derived from GP records of patients who have been diagnosed with a long term health condition that has been identified by the UK Health Security Agency that increase the risk of people experiencing negative outcomes from extreme heat. A population weighted average of the prevalence of each individual long term condition has been calculated. Rates have not been age standardised to take account differences in the age structure of patients living in each ward, therefore areas with an older age structure will tend to have a higher prevalence of LTCs than those with a younger age structure.

Income deprivation obtained from from [Manchester Intelligence Hub](#) and based on 2019 Index of Multiple Deprivation (DCLG, Crown copyright 2019).

Green space data derived from 2022 OS Open Green Space dataset (© Crown copyright and database right 2022), that has been filtered to include public parks, playing fields, sports facilities, play areas and allotments.

References & Resources

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⁴IPCC, 2022: *Climate Change 2022: Impacts, Adaptation, and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Lössche, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. In Press.

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