Local Climate and Urban Heat Islands Information Pack

Introduction

The Urban Heat Island effect is a term that describes how built environments like towns and cities become warmer than the natural environments that surround them. This happens because urban environments absorb, store and release heat in different ways to natural or rural areas.

There are different things that can impact a local climate – sometimes also called a microclimate.

It's important to understand Urban Heat Islands so we can take action to reduce the negative effects. More than half the world's population lives in cities and temperatures are predicted to rise over the next century.

FACT

Met Office

Luke Howard first identified London's urban heat island at the turn of the 19th century. He also created the names for the main types of clouds, which are still used today[1].

Different environments

What is an urban environment?

An urban environment is made up of man-made structures like buildings, roads and bridges and has a high population density – many people living in a small space.

What is a rural environment?

A rural or natural environment has a much lower population density and fewer man-made structures. It has more natural features, like fields, rivers, hills or lakes.

What is a green space?

Green space is any area of grass, trees or vegetation in an urban area, like a park or woodland.

Working with the Met Office

The information in this pack has been written for the Pod by the Met Office and is part in a series of resources that we're working on together to help educate children about weather and climate science.

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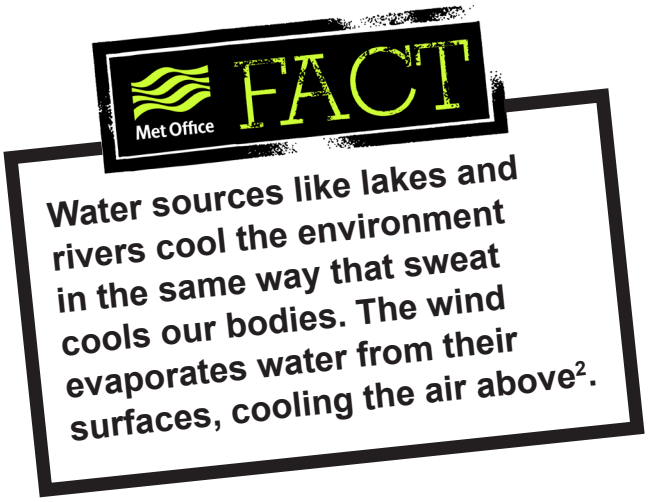
The Water Cycle

In a natural environment water moves easily from the earth into the atmosphere as part of the water cycle. Water can evaporate from porous materials like soil and from water bodies, such as rivers and lakes. Trees and other plants transpire: they draw water from the ground into their roots and transport this water to their leaves, where it enters the atmosphere. Together, these two processes are called evapotranspiration.



Evapotranspiration has a cooling effect. As the water enters the atmosphere it draws heat from the ground and plants, just like how perspiration cools people down. Evapotranspiration is an important part of the water cycle.

Cities are generally made from materials that do not absorb, store or release water, like glass, tarmac and concrete. This reduces how much evapotranspiration is able to cool cities.

How do materials absorb heat?

Nearly all materials absorb the Sun's energy and warm up. But this happens much more easily in built environments. Materials like concrete and asphalt are dark and absorb much more energy than lighter materials like grass, so they get a lot warmer. Narrow streets and tall buildings create the 'canyon effect', where buildings trap energy between them and reduce air flow.

These man-made materials can absorb much more heat energy during the day than they reflect, and they then release this heat energy at night. And because towns and cities are well drained, there is less cooling evaporation from the ground.

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How do we measure the weather?

We can make observations of the weather using different equipment. Some observations you can take are:

OBSERVATION	WHAT THIS MEASURES	EQUIPMENT	UNIT
Temperature	How hot or cold something is.	Thermometer	Degrees Celsius (°C)
Precipitation	Any form of water - liquid or solid - falling from the sky. It includes rain, sleet, snow, hail and drizzle, plus more unusual things like ice pellets, diamond dust (tiny ice crystals) and freezing rain.	Rain Gauge	Millimetres (mm)
Wind speed	The speed of the air over the surface of the Earth.	Anemometer	Miles per hour (mph) or metres per second (m/s)
Wind direction	The direction the wind is coming from (e.g. a northerly is a wind flowing from the north, towards the south).	Wind vane	Points of the compass or degrees (e.g. a northerly = 0°)

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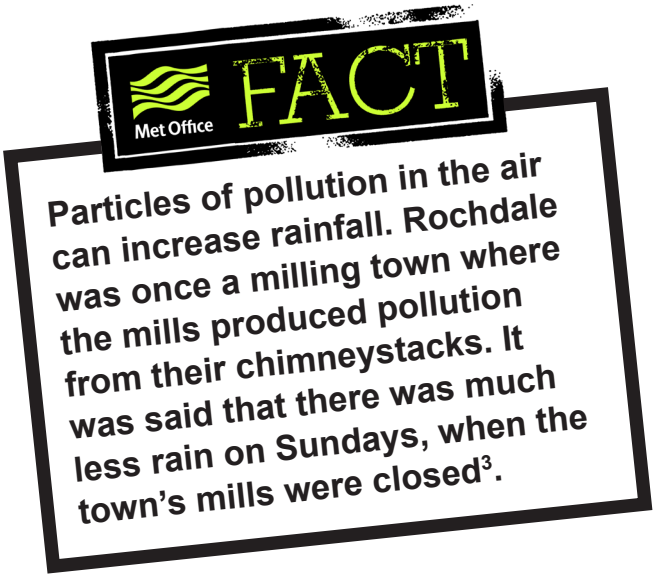
Observing urban and rural environments

Weather observations help us understand the differences between urban and rural climates. When taking observations it is important to make these a 'fair test' and reduce any differences between observations:

- Use the same equipment and set it up in the same way, i.e. calibration.
- Take measurements in the same way. For example take temperature measurements at the same height above the ground in each location.
- Work with others to take measurements from different places at the same time to reduce the effect of any changes in weather conditions.
- Take as many measurements as possible to help identify any wrong values.



The urban environment in the future climate

Around the world more and more people are moving to cities. Summer temperatures around the world are predicted to rise over the next century and heat waves will become more common. This will make cities warmer than they are today. Heat waves can kill: a heat wave in the UK in July 2013 is believed to have caused as many as 760 additional deaths, while in summer 2003 nearly 15,000 people died in Paris from heat related illnesses, and there were around 80,000 deaths across Europe.

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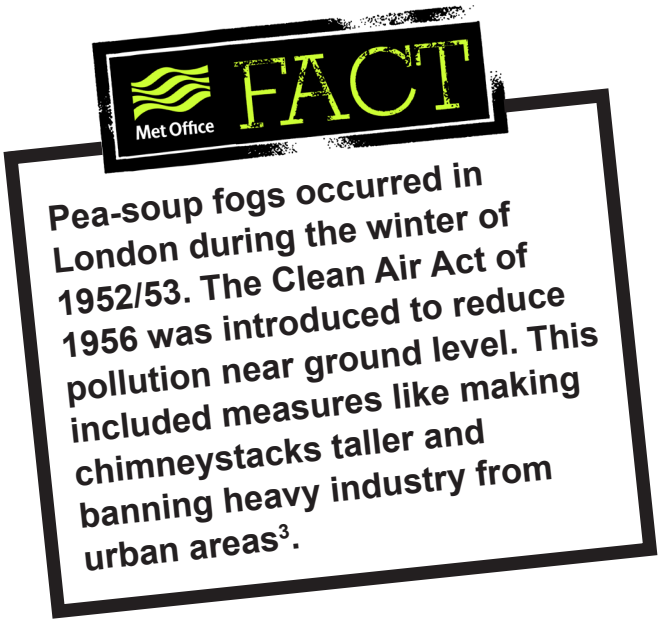
Energy demand

The temperature difference between urban and rural areas can cause many problems. Towns and cities can be much less comfortable to live in. To address this, buildings need to use air conditioning to keep their occupants cool and comfortable. This can use a lot of energy and also produce more waste heat. If this energy comes from power stations that use fossil fuels; this can contribute to climate change.



Making cities more comfortable will use even more energy. This will put pressure on our ability to generate energy in power stations or by using renewable sources. It may also require larger power cable networks to bring electrical power into towns and cities. In some countries already, areas that are affected by heat waves can face blackouts as energy is diverted to where it is most needed. Any increase in energy use from fossil fuels will add to the pace and extent of climate change.

Improving the urban environment

However, better urban planning can help reduce the Urban Heat Island effect and can enhance towns and cities for the people who live there:

- More green spaces that include grass and trees can allow more evapotranspiration to take place as well as providing shade, cooling these areas.
- 'Green roofs' covered in plant materials reduce the energy absorbed by buildings.
- Better building design and layout can reduce the energy they absorb and allow better air circulation between buildings, which also increases the cooling effect.
- There are also suggestions for creating 'heat wave refuges' – cooler areas in towns and cities where those most vulnerable to heat-related illnesses can stay during times of extreme heat.

This is already underway. For example, the Mayor of London has set targets to:

- Increase tree cover by 5% by 2025
- Increase greenery in central London by 5% by 2030 and a further 5% by 2050
- Have 100,000m^2 of green roofs by 2012
- Enhance 280 hectares (2.8 million m^2) of green space by 2020[2]

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Urban Heat Island terms

Cliff

In general, the temperatures are highest in the centre of urban areas and gradually get cooler towards the suburbs. In some cities, a temperature 'cliff' occurs, where the change in temperature between these two areas is very sudden[3].

Plateau

A plateau is an area where the temperature changes very little over distance.

Urban canopy layer

The urban canopy layer is all the space below roof level and between buildings, like the canopy in a forest. This is where urban temperatures are measured[3].

Urban canyon

The space between tall buildings is called a canyon, just like a deep valley between two cliffs. The positions of tall buildings affect how the wind speed is reduced and how much surface area there is to absorb heat[3].

Venturi effect

Tall buildings in towns and cities create turbulence in the air that flows over them. The venturi effect is the name for how winds can be 'funnelled' between buildings. This causes vortices where the air rotates in circles. Vortices can cause litter to swirl around and can make walking difficult[3].

Other weather terms

Prevailing wind direction

The prevailing wind direction at any location is the direction from which the wind blows most of the time. In Britain the prevailing wind direction is from the south-west. This brings in moist air from the Atlantic, which is why rain falls often.

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Urban Heat Island terms - continued

Rainfall in urban areas

Urban areas create and store heat. This can cause convection (rising warm air), which causes clouds to form. Evidence shows these tend to cause rain downwind of the city. However this is quite a small effect.

A rain shadow is a drier area in the lee (downwind) of a mountainous area. This is very different to how rainfall is distributed across cities.

Sources

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   http://static.london.gov.uk/mayor/environment/climate-change/docs/UHI_summary_report.pdf

3. MetLink. Weather for Teachers and Schools: Microclimates.
   http://www.metlink.org/secondary/key-stage-4/microclimates/