



## URBAN HEAT ISLANDS AND WHAT THEY CAN TEACH US ABOUT CLIMATE CHANGE

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### YOUNG REVIEWERS:



**GENEVIEVE**

AGE: 13



**MUHAMMAD**

AGE: 13

Urban areas typically get much hotter than rural or natural areas. The higher temperatures in cities are caused by the presence of lots of buildings and streets, which heat up in the sun because they are made of materials that can not hold much water. In hot urban areas, called urban heat islands, people and animals stay cool by sweating, panting, and staying in shady areas. Even urban trees can stay cool by transpiring, which is like sweating. In fact, trees transpire so much that they can cool down the air and reduce the urban heat effect—like natural air conditioning. Although the urban heat effect is typically viewed as a problem, scientists can study the plants and animals living in urban heat islands to understand the effects that rising temperatures due to climate change will have on these species in their natural habitats.

Have you ever noticed how hot the sidewalks and streets get on a sunny summer day? Sometimes the pavement gets so hot that you can burn your feet if you try to walk on it barefoot! Asphalt and concrete pavement are impervious surfaces, which means they can not hold a lot of water. Without water to help cool it, pavement tends

to absorb a lot of solar radiation (sunlight) and gets much hotter than grass or other plants. So, the fewer plants a place has—and the more pavement—the hotter it gets!

## MANMADE SURFACES IN CITIES LEAD TO HEAT ISLANDS

Cities tend to be full of impervious streets, buildings, and parking lots. All these manmade surfaces absorb and retain a lot of heat, creating **urban heat islands** (Figure 1). Urban heat islands are developed areas (cities or towns) that are significantly hotter than surrounding rural areas (farms and countryside), due to the replacement of natural, plant-containing areas, like forests and wetlands, with impervious surfaces like pavement and buildings. For example, the city of Washington, D.C. can be up to 13°F (7°C) hotter in the summer than nearby forested neighborhoods! This may not sound like a huge difference, but all that extra heat can have a big impact on the health and behaviors of the people, plants, and animals living in cities.

### URBAN HEAT ISLANDS

Developed areas that are significantly hotter than surrounding rural areas due to the replacement of natural, vegetated areas with impervious surfaces like pavement and buildings, which absorb solar radiation.

#### Figure 1

The urban heat island effect causes urban areas with more impervious surfaces to be hotter than suburban or rural areas that have more vegetation. This graphic shows how temperatures (illustrated by the orange line) are hottest in downtown areas and lowest in rural and farmland areas.

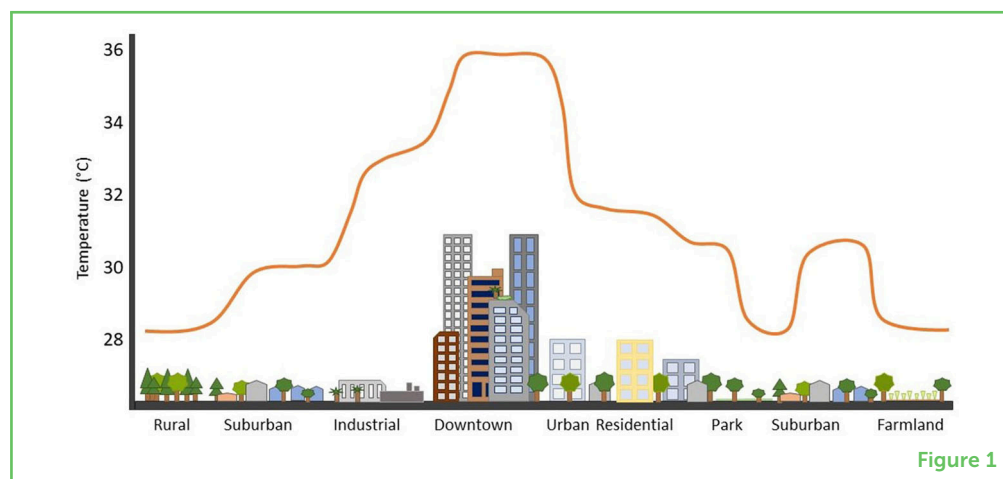


Figure 1

## STAYING COOL IN URBAN HEAT ISLANDS

To avoid overheating, living things need to **thermoregulate**, which means they must use specialized traits and behaviors to control their body temperature. For example, one of the main ways that humans thermoregulate when they get too hot is to sweat. When sweat dries and evaporates, it cools the skin by taking heat away from the body and releasing it into the air. When we are exposed to really hot temperatures for too long, or when we do not have enough water to drink, we can not sweat enough to stay cool and we can develop health issues caused by heat stress and dehydration.

Lots of species besides humans live in cities and can also overheat when temperatures get too high. Dogs can not sweat, so they

### THERMOREGULATE

To maintain or regulate internal temperature (plant or animal), even when surrounding temperatures may be hotter or colder.

## TRANSPIRATION

Evaporation of water from the inside of leaves to the air to regulate the temperature of the plant and to supply water for photosynthesis.

## STOMATA

Tiny holes on the surface of leaves through which water can transpire and carbon dioxide can enter the leaf for photosynthesis.

## ADAPT

To undergo long-term adjustments in characteristics across multiple generations, so that a species can survive and perform better in its habitat.

## ACCLIMATE

To make short-term adjustments, so that a single organism can better survive and perform in its habitat.

thermoregulate by panting and evaporating water off of their tongues. Birds also pant to keep cool. Lizards can not sweat or pant, so they cool off by staying in the shade.

Even plants can thermoregulate to keep their leaves cool, through a process called **transpiration**. When plants transpire, some of the water that is inside their leaves evaporates into the air through **stomata**, which are tiny holes on the surfaces of leaves. Transpiration is basically how plants sweat, and just like sweat helps to keep us cool, transpiration helps plants to keep their leaves cool.

The amazing thing about plants is that when they transpire, they cool themselves *and* the air around them. This means that plants can help to keep cities cool by both creating shade *and* by transpiring. Because of their cooling superpowers, plants are very important for weakening the urban heat island effect. In fact, many urban areas have started programs to plant more trees and create more green spaces such as parks, community gardens, and green roofs (roofs with vegetation planted on them). You can help reduce urban heat by planting a tree in your yard or planting a garden at school!

Plants are only part of the solution. There are many ways that we can reduce urban heating and keep our cities healthy. For example, some cities have started using types of asphalt, concrete, paving stones, and other building materials that can absorb and hold more water than the impervious versions of these materials can. These “wet” materials do not get as hot, and they help to keep temperatures lower in cities. Other cities have started installing lighter-colored or reflective pavements and roofs that do not absorb sunlight, so they stay cooler.

## WHAT CAN URBAN HEAT ISLANDS TELL US ABOUT CLIMATE CHANGE?

Climate change is the term we use for changes in long-term weather patterns. Present-day climate change is caused by air pollution from burning fossil fuels, which releases greenhouse gases like carbon dioxide. Greenhouse gases trap solar radiation, making the world hotter. To understand what climate change will mean for nature, scientists study how various species respond to high temperatures. For example, scientists want to know if plant and animal species can **adapt** to the heat over the long term or **acclimate** in the short term. One way to study these questions is to use urban heat islands, where we already have many creatures living in very hot places.

By studying the creatures living in urban heat islands, scientists have already made some important discoveries. For example, scientists found that some spiders living in hot urban areas grow more slowly and die faster than spiders in cooler areas do [1]. You may think that

## PHOTOSYNTHESIZE

To capture sunlight, water, and carbon dioxide to create sugar, which plants use to get energy.

## ECOSYSTEM SERVICES

The many benefits humans receive from the natural environment. For example, natural places provide wood, fuel, climate regulation, foods, and places to explore and have fun.

this is a good thing—but remember that fewer spiders mean more flies and mosquitos! Another team of scientists working in cities found that trees in hotter urban areas are not able to **photosynthesize** as well, and they grow more slowly than trees living in cooler parts of cities [2–4]. In other words, even though trees help keep cities cool, the trees themselves may be starting to overheat. As the world gets hotter, trees may start to overheat even *outside* of cities. Trees are extremely important and do lots of wonderful things, which scientists call **ecosystem services**. For example, trees keep us cool, they help to filter water, they take pollution out of the air, they give us wood to build our houses, and they give us food to eat. If we make the world so hot that trees overheat, it will be bad news for all of us!

## SUMMARY

Cities tend to be hotter than rural or natural areas. This is because cities have lots of buildings and streets that trap the sun's heat. Plants and animals have a variety of ways that they can thermoregulate to avoid getting too hot. For example, plants transpire water from their leaves into the air, and transpiration helps to cool both the leaves and the areas around plants! Since plants can function as natural air conditioning, parks and other green spaces are very important for reducing the urban heat island effect. Scientists can also study plants and animals living in hot cities to learn how species will be affected by rising temperatures. Research in urban heat islands can help us figure out what the hotter temperatures caused by climate change will mean for various plants and animals—including us!

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## YOUNG REVIEWERS

### GENEVIEVE, AGE: 13

I am a grade 8 student at a Francophone school. I love science and I am super excited to be a part of this project. My favorite food is sushi and I have a pet dog named Pyra. I love being active and I participate in Aerial Arts (think Cirque du Soleil).



### MUHAMMAD, AGE: 13

Hi, I am Muhammad and my curiosity for science originated when I secured first place in my grade 3 science project. It was about photosynthesis, which I chose after knowing the fact that plants are universal food makers. The science textbook of every grade always familiarized me about the magical wonders behind my daily life's surroundings.



## AUTHORS

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Alyssa T. Kullberg is a Ph.D. candidate at the University of Miami. She is an ecologist interested in the impacts of climate change on plants. Alyssa researches the acclimation of subtropical and tropical tree species to increased temperatures along natural and urban thermal gradients. Aside from research, she enjoys baking, pottery, and hiking. \*[alyssa.kullberg@gmail.com](mailto:alyssa.kullberg@gmail.com)



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