

How Stuff Works: What is the Urban Heat Island Effect?

(<http://science.howstuffworks.com/environmental/green-science/urban-heat-island.htm>)

If you can't take the heat, get out of the city. Turn on the local weather report and you'll probably notice an odd trend. Temperatures are often a few degrees higher in cities than they are in their surrounding rural areas. This temperature discrepancy is the result of a bizarre phenomenon known as the urban heat island effect.

As the name implies, the effect makes cities into islands of heat. According to the U.S. Environmental Protection Agency, temperatures in U.S. cities can get as much as 10 degrees Fahrenheit higher than their surrounding areas. Normally the temperature disparity is not quite that large, but even a few degrees can make a huge difference. The demand for air conditioning in the summer leads to higher energy bills, and many argue that this increases greenhouse gas emissions from power plants that provide that extra energy. On the other hand, some point out that the reduced need for heat in the winter offsets the costs in the summer. In addition, warmer cities in the winter means fewer icy streets.

What is meant by the urban heat island effect? _____

What are two negative consequences related to the urban heat island effect? _____

Perhaps the worst result of the heat island effect is the number of heat-related deaths. Although damage-inducing storms get the most media attention, the National Oceanic and Atmospheric Administration reports that heat is usually more deadly. In the U.S., heat typically kills more people each year than tornadoes, hurricanes, floods and lightning put together.

To understand the urban heat island effect, we first need to understand a few simple rules of physics. Most importantly, we should understand that objects can absorb and reflect light. In fact, the color of an object depends on what kind of light it reflects. For example, a green object reflects green light and absorbs all the other visible colors of light. When we see a green object, we perceive it as green because it reflects the green wavelength of color back to our eyes. Darker colored objects are excellent absorbers of light. In fact, black surfaces absorb almost all light. On the other hand, lighter colored surfaces do not absorb much light at all—rather they reflect almost all of it.

What color(s) of light does a red object (like an apple) reflect? _____

What color(s) of light does a red object (like an apple) absorb? _____

So what does the absorption of light have to do with heat? When an object absorbs light, it converts that light to thermal energy and emits it back out as heat. So, because black objects absorb more light, they also emit more heat. That's why wearing a black shirt on a hot, sunny day will only make you hotter. The black shirt absorbs light and emits it as heat onto your skin. Wearing a white shirt, on the other hand, will help reflect the sunlight and keep you cooler.

The rate at which an object can reflect solar radiation is called its *albedo*. The bigger the albedo something has, the better it reflects radiation. Traditional asphalt has a low albedo, which means it

reflects radiation poorly and instead absorbs it. When we build and expand cities, we tend to erect buildings with dark surfaces and lay down asphalt pavement. The buildings and the pavement absorb a significant amount of light and radiation and emit it as heat, warming the city. Because more than half of the surfaces in cities are man-made, cities heat up more than rural areas, where structures are less concentrated. This heat absorption is why the temperature difference between cities and rural areas is highest a few hours after sunset. Cities hold on to more heat for a longer period of time than rural areas do.

What causes the urban heat island effect? _____

Is the urban heat island effect considered endothermic or exothermic? Explain your answer. _____

But that's not the only thing that causes the urban heat island effect. Scientists believe that vegetation plays a large part in keeping an area cool through a process called evaporative cooling. Evaporation is when liquid turns into gas. Plants take in water through their roots and depend on it to live. But after the plant is done with it, dry air absorbs that water by turning it into gaseous water vapor. The air provides the heat that drives this process, so during the process, the air loses heat and becomes cooler. We experience the same type of thing when we sweat—when air hits your sweaty skin, it absorbs the moisture and cools the air around you. Because building a city means replacing vegetation with structures, the city loses the evaporative cooling advantages of vegetation.

How does evaporative cooling work? _____

Other factors also contribute to the effect. For instance, cars and air conditioners, which are ubiquitous in urban areas, convert energy to heat and release this heat into the air.

Luckily, since we know what causes the urban heat island effect, we can control it to a significant extent. Certain techniques reduce the demand for air conditioning and reduce energy bills. Because the dark surfaces and low albedo of urban structures heat the area, the logical solution would be to reverse this trend. Urban planners may do this by painting structures white (or other light colors). This basic technique goes a long way in reversing the urban heat island effect.

One fad that's gaining popularity is the installation of green roofs atop city buildings. This solution doesn't have anything to do with color. A "green roof" is simply a roof that includes plants and vegetation. Green roofs harness the same evaporative cooling effect that cities lose when they hack away vegetation. So a green roof not only prevents the building's roof from absorbing heat but cools the air around it, offsetting the urban heat island effect to an extent. Many sustainable buildings use green roofs to reduce their reliance on energy consumption.

How can a "green roof" help offset the urban heat island effect? _____
