Module 2 Lesson 4: Cities as Heat Islands

Thinking of ecosystems as having inputs and outputs is a great way to understand our impact on the ecology of the earth. One of the biggest effects of a city system is the generation of excess heat into the local surroundings. All of the automobile engines, heating systems in buildings and dark energy-absorbing surfaces such as roads contribute to the build-up of heat energy in a city. Factor in the general lack of trees to provide shade and increasing greenhouse gasses in urban ecosystems and you have the recipe for a steamy climate indeed.

In fact, cities give off so much more heat than the surrounding countryside, that they can create a unique local climate. Some cities are so much warmer that they can change the local weather. Climate scientists refer to cities as *heat islands* because they are so much warmer that the rural or suburban areas that lie near them. One such city that has become famous as a heat island is the southern city of Atlanta, Georgia. Scientists from the University of Georgia and the Global Climate Studies Group at NASA found that during the summer of 1996, temperatures in the core of the city were 8-10 degrees hotter than in the surrounding rural areas. Georgia is a warm state to begin with, so this meant that temperatures in Atlanta routinely exceeded 100 degrees Fahrenheit. This was a pioneering study. Research in cities around the world has confirmed that the heat island effect in Atlanta is no fluke. Most cites are indeed islands of heat amidst a cooler landscape. The impacts of these heat islands are significant and need to be addressed by city managers. In this lesson, we begin to understand the city system as a heat island by focusing on the human causes of the excess heat.



Top: Geography Professor C.P. Lo and graduate student Xiaojun Yang of the University of Georgia are geographers who helped discover the Atlanta Heat Island Phenomenon. As geographers, they study the landscape and specialize in making maps and analyzing spatial data. They attribute the heat island effect in Atlanta primarily to a loss of vegetated open space within the city. Between the years 1973 and 1998, Atlanta witnessed the loss of 350,000 acres of forested land was cleared for development. The loss of trees and the increase in dark roads, buildings and parking lots allowed the city to heat up quickly and cool down slowly. Bottom: A computer-generated image of Atlanta from 1993 taken by Georgia State University researchers shows four distinct hotspots in Atlanta (red is hottest, green coolest). In 1972, when the studies were first initiated, there were only two hotspots and they were much smaller than in 1993. *Recent data indicate that the hotspots are* increasing and Atlanta is getting warmer.

The consequences of heat islands in cities are of great concern to both scientists and residents of the neighborhoods. Researchers at the Lawrence Berkeley Laboratories at the University of California found that in Los Angeles, for every one degree hotter a city gets, the smog pollution increases by three percent. If a city heat island is ten degrees warmer, that could mean a 30% increase in certain forms of air pollution. Warmer temperatures also increase chemical reactions. The same 10 degree increase in heat will double the chemical production of ozone. Ozone is a pollutant associated with a variety of health risks such as asthma. High levels of ozone contribute to the faster breakdown of plastics and rubber, causing more rapid failure of such items as tires and hoses.

On a larger scale, hot cites can change weather patterns. Scientists studying weather patterns in Atlanta discovered that the heat island was causing an increase in thunderstorms south of the city. As the city heats up, air pressure falls and the warm air begins to rise. It is replaced by cooler denser air. The city literally creates its own windstorm. These chaotic atmospheric conditions generate fierce thunderstorms in the downwind direction, which in Atlanta is south. Over time, these warmer conditions alter the climate so that they no longer support the same species of animals and plants that were once native to the community. This reduces the local biodiversity.

The causes of urban heat islands are complex, but they are all the result of human activity. Heavy industrial factories generate heat, as do all of the trains, buses cars and truck. All of the heating and cooling systems in the buildings generate enormous amounts of thermal energy. The metabolic activity of the millions of people and other animals that live in the city generate heat as well. However, the biggest contributor to the urban heat island effect is the way in which humans alter the urban landscape. By cutting down trees, draining ponds and lakes and constructing dark concrete surfaces, the city is bound to heat up. In natural systems, trees, ponds and lakes soak up lots of solar energy and thus reduce the excess heat of an ecosystem. Modern cities can be made more healthy by reintroducing some of the vegetative and aquatic features of the ecosystem. In this lesson we engage the challenge of understanding urban heat islands and investigate some of the solutions.



Top left: Green roofs in a futuristic design for homes built in the Dietlkon, Switzerland. Designed by the Architect, Peter Vetsch, these roofs help to insulate and cool the houses so that require less energy to run. Top right: A green roof adorns City Hall in Chicago. Urban green roof design is a critical design tool for mitigating the impacts of the urban heat island effect.