OBJECTIVE

- To learn about urban heat islands
- To consider ways that cities can be more adapted to climate change

MATERIALS

- White or light colored paper
- Grass mat or clippings
- Black paper
- Gravel in a container
- Water in a container
- Lamp with incandescent bulb
- Plastic containers
- Thermometer

INSTRUCTIONS

1. Set up each of the 5 “surfaces” under the lamp and incandescent bulb. (Incandescent bulbs work best for this demonstration because they emit heat. Newer CFL and LED lights do not work as well because they are more energy efficient.)

2. Guess which of the 5 materials will feel the warmest after being placed under a heating lamp.

3. Use the thermometer gun to collect objective data about which is the warmest. If you don’t have a thermometer gun, a regular thermometer or just estimating with your hand works fine, too!
   a. Which surfaces were the warmest? Dark asphalt and other concrete buildings can increase temperatures while white stone (or unmelted ice!) and grassy areas can reflect a lot of solar radiation.
   b. What are some ways that we can mitigate climate change with building materials or green spaces in cities? Although climate change is largely caused by CO2 emissions, we can help keep temperatures as low as possible through other methods, such as using light-colored stone and more planted areas.
   c. One of the major effects of climate change is heat rising; how would heat-reducing efforts in cities also help us adapt? By not intensifying the heat that we will already be feeling as a result of climate change.
   d. Why is especially important to address climate change and the melting ice caps, in relation to solar radiation? Loss of ice sheets and glaciers can further contribute to increasing global temperatures.

BACKGROUND INFORMATION

How do cities exacerbate climate change?

- Climate change is a global phenomenon that largely impacts urban life. Rising global temperatures causes sea levels to rise, increases the number of extreme weather events such as floods, droughts and storms, and increases the spread of tropical diseases. All these have costly impacts on cities’ basic services, infrastructure, housing, human livelihoods and health. At the
same time, cities are a key contributor to climate change, as urban activities are major sources of greenhouse gas emissions. Estimates suggest that cities are responsible for 75 percent of global CO2 emissions, with transport and buildings being among the largest contributors.

Heat will be a huge problem in the future. According to NASA, 2016 was the third year in a row to set a new record for global average surface temperatures. A 2016 report from the journal Climate Change concluded that “globally, the probability that any summer during the period 2061–2081 will be warmer than the hottest on record during 1920–2014, is 80%.”

For cities the problem is even bigger. On top of the rising temperatures, the urban heat island effect results in an additional 1.8 to 5.4°F burden for urban dwellers during the day and up to 22°F in the evenings. Concrete buildings, asphalt paved roads radiating accumulated heat throughout the night, and lack of trees contribute to the making of scorching cities. Active measures will be needed to reduce the risk of heat-related health problems.

Surface Albedo

While the Earth’s temperature is dependent upon the greenhouse-like action of the atmosphere, the amount of energy retained by the Earth is strongly dependent on the albedo of Earth surfaces.

Just as some clouds reflect solar energy into space, so do light-colored land surfaces. Scientists use the term albedo to define the percentage of solar energy reflected back by a surface. This surface albedo effect strongly influences the absorption of sunlight. Forests, grasslands, ocean surfaces, ice caps, deserts, and cities all absorb, reflect, and radiate solar energy differently. Sunlight falling on a white glacier surface strongly reflects back into space, resulting in minimal heating of the surface and lower atmosphere. Sunlight falling on a dark soil or rock is strongly absorbed, and contributes to significant heating of the Earth’s surface and lower atmosphere.

Understanding local, regional and global albedo effects is critical to predicting global climate change. Light-colored ice and snow are very weakly absorptive, reflecting 80–90% of incoming solar energy. Dark-colored land surfaces are strongly absorptive and contribute to warming, reflecting only 10–20% of the incoming solar energy. If global temperatures increase, snow and ice cover may shrink. The exposed darker surfaces underneath may absorb more solar radiation, causing further warming. The magnitude of the effect is currently a matter of serious scientific study and debate.

How Much Are Glaciers Melting? Currently glaciers cover about 10% of the Earth’s land surface. In most areas of the world, mountain glaciers are melting. Between 1961 and 1998 small glaciers lost an average of 7 meters of ice thickness. Glaciers in mountainous areas near the equator have been particularly hard-hit. According to global climate models, all of the glaciers in Glacier National Park in Montana will be gone by 2030.

Snow and ice cover near the North Pole is currently decreasing at approximately 0.4% per year. Arctic sea ice has been decreasing at about 2.9% per decade. Since 1974, seven ice shelves, most in Antarctica, have retreated by a total of approximately 13,500 square kilometers.