Urban Heat Islands

Listen to it online http://www.kqed.org/quest/radio/view/82
Radio report length 5:30 minutes

QUEST SUBJECTS

Life Science: Biology, Health, **Environment**

Earth Science: Geology, Weather, Astronomy

Physical Science: **Physics**, Chemistry, Engineering

CA SCIENCE STANDARDS

Grade 6

Heat (Thermal Energy)
3. Heat moves in a predictable flow from warmer objects to cooler objects until all the objects are at the same temperature. (a,d)

Energy in the Earth System
4. Many phenomena on Earth's surface are affected by the transfer of energy through radiation and convection currents. (a,b)

Grade 7

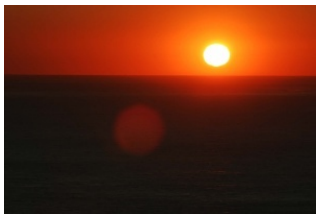
Physical Science
6. Physical principles underlie biological structures and functions. (a,c,f)

Grades 9-12

Physics: Heat/Thermodynamics
3. Energy is not created or destroyed, although in many processes energy is transferred to the environment as heat.(a,c)

PROGRAM NOTES

Do you live in an urban heat island? The community of Sacramento and scientists at Lawrence Berkeley Lab are actively trying to cool down urban areas by planting trees and creating "cool roofs."



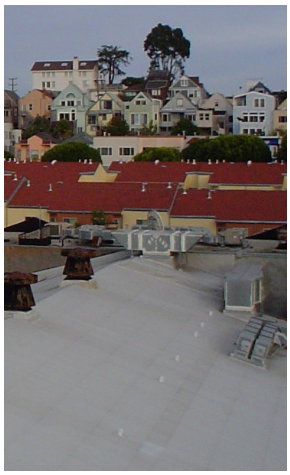
In this segment you will discover…

- what urban heat islands are.
- what effect they have on the atmosphere.
- how homeowners and businesses can cool down their communities.

TOPIC BACKGROUND

The full range of energy that radiates from the Sun is called the **electromagnetic spectrum**, and it's measured in wavelengths. Visible light has a medium wavelength and is just one small part of the spectrum. Some forms of energy with wavelengths shorter than that of visible light include ultraviolet, gamma rays and X-rays. One form of energy with a wavelength slightly longer than that of visible light is **infrared radiation**. Infrared radiation is converted to heat when it strikes surfaces on Earth. Light-colored materials reflect infrared radiation in the same way they reflect light. Dark-colored materials absorb the radiation and warm up.

Large expanses of buildings, concrete and asphalt in urban areas have caused cities to maintain higher temperatures than the surrounding countryside. This increased heat is known as an **urban heat island**. There are a few ways that buildings, as well as human and industrial activities, cause urban heat islands.



- Buildings, concrete, and asphalt have different thermal properties, so they can absorb and retain more heat than other surfaces. This heat is then transferred to the air through **conduction**.
- Urban areas have less water and vegetation, both of which naturally cool areas through **evapotranspiration**, or the movement of water to the air from bodies of water and plants.
- Heat generated by cars, trains and buildings eventually finds its way into the atmosphere, causing higher temperatures.

Higher temperatures in urban areas lead to photochemical reactions which raise smog levels and cloud cover. Various environmental and governmental agencies are working to lower the temperatures of urban heat islands. By switching to light-colored roofs, buildings can use 40 percent less energy. Planting trees not only helps to shade cities from solar radiation, it also increases evapotranspiration and lowers the air temperature.

Media Enhances Education

Video and audio can be powerful tools for meaningful learning. It all depends on you, the educator. The key to using media effectively is preparation. Make the most of learning opportunities by encouraging students to become active viewers and listeners. Pick and choose from the suggested questions and activities to offer an engaging media experience.

Questioning

Oftentimes, teachers and students become frustrated during a media segment when students can't find the answers to a long list of questions. Provide a limited number of questions or topics for students. This focuses their attention during a media segment. It helps to keep them engaged and generally results in higher quality answers. QUEST Ed. has provided a number of options for focus questions, ranging from fact based to opinions, as well as "big picture" ideas.

PRE - LISTENING

- Have you ever heard of Urban Heat Islands?
- Why do you think people are concerned with raising temperatures in cities?
- What role do trees play in regulating the temperature of our environment?
- Go outside on a sunny, hot day and find a spot that has dark-colored asphalt, and a light-colored surface. Stand on both of them with bare feet. Is there a difference in temperature between the two surfaces? If there is, why do you think so?

LISTENING FOCUS

NOTE: you may choose to listen to the radio segment twice with your students; once to elicit emotional responses and to get an overview of the topic and then again to focus on facts and flush out opinions.

- Follow along on the Transcript while you listen and record any questions you have in the Notes/Questions column.
- What is Rachel Aucutt with the Sacramento Tree Foundation doing to reduce 'Urban Heat Islands?'
- Explain what a 'cool roof' is.
- What are some of the drawbacks or challenges that the Lawrence Berkeley Lab scientists face in creating cool roofs?
- How can cooler cities improve air quality?

POST- LISTENING

- **Review** students' answers to the Listening Focus Questions and address any notes or questions students recorded.
- **Design** your own 'Cool City.' Decide individually or with a group how many trees and what kind of buildings and roads your city will have to make it a 'cool city.' Draw your cities on paper and present them to the class.
- **Submit questions** to the Heat Island Group at the Lawrence Berkeley Lab who are designing cool roofs. http://eetd.lbl.gov/HeatIsland/

NOTES/QUESTIONS

Climb into a black car on a really hot day and you can feel a key principle of physics at work: dark colors readily absorb heat.

Now magnify that across an entire city of asphalt roofs, blacktop roads and parking lots--and you have what scientists call an "urban heat island;" an effect that triggers a vicious cycle of higher energy bills and air pollution.

As part of our continuing series, *QUEST*, exploring science and environmental issues, Craig Miller profiles what one community is doing to cool down.

Rachel Aucutt drives around Sacramento in a mid-size sedan covered with decals of leaves.

Awright, we're heading up to North Natomas-two customers.

She's an "urban forester" for the Sacramento Tree Foundation--and her customers are homeowners looking to gird themselves against the brutal Central Valley summer.

Hello, Mr. Licina? Yes. Hi, I'm Rachel with the tree foundation.

Aucutt and homeowner Sam Licina survey his yard, for places where trees could eventually produce some shade in this barren new subdivision.

The trees are mostly dormant now, so it's a good time to transplant.

The foundation supplies the trees at no charge. The Sacramento Municipal Utility District, known around here as "SMUD" picks up the tab. It's part of an effort to reduce the effect of "urban heat islands."

We have to plant a lot of trees.

Misha Sarkovich runs the program for SMUD.

Some estimates is you have to increase the urban canopy by 20% in order to have a measurable impact on the ambient temperature.. Slowly but surely we're getting there.

But the problem is here now.
Lisa Gartland is writing a book on heat islands, which she describes as a kind of "reverse oasis" that can raise air temperatures throughout the metro area by 2-10 degrees.

As the cities get bigger and bigger, you get a more concentrated hot spot in the middle and our suburbs are getting hotter and hotter.

NOTES/QUESTIONS

A few years ago, Sacramento was part of a heat island case study by NASA. In a mid-day summer flyover with infrared equipment, NASA plotted surface temperatures on color-coded maps. The tree-lined Capitol Mall is a cool, blue rectangle surrounded by a sea of orange and red; roads and rooftops where surface temps can run to 140 degrees or more.

Frankly the hottest things we see in those infrared images are rooftops.

In fact, a fifth of Sacramento's total urban acreage is unshaded rooftops. That's why in addition to planting trees, SMUD has subsidized almost 9 million square feet of cool roofing around Sacramento since 2001. It can knock almost 20% off the air conditioning load for a typical flat-roofed commercial building.

A "cool" roof is one that bounces the sun's energy back into the atmosphere, instead of pulling it into the building. But it can't be just reflective. It also has to have high thermal "emittance." Uncoated metal roofing is "uncool," so to speak because it has high reflectance but low emittance—like the wire-framed sunglasses you left on the dashboard last summer that were too hot to handle. So most cool roofs are white polymer coatings or sheeting.

It's not a new idea. Traditional whitewashed buildings in hot climates around the world are no accident.

If you go to the island of Bermuda, all the roofs are white.

Hasham Akbari is a scientist at Lawrence Berkeley National Lab.
He says there is potentially more energy savings from cool roofing of homes than businesses. Of course to sell homeowners on the concept, there'd better be more color choices than white. So that's just what Akbari and his team of scientists are developing.

In their tiny lab in the Berkeley Hills, they use a mass spectrometer to analyze the efficiency of new roofing materials they've developed. He holds up some regular composite shingles in earthy shades of green and brown, right next to their new, cool counterparts. They look identical.

That's exactly the idea. The reason that you do not see any difference in the color because they are being engineered to have exactly the same properties in the visible part of the solar spectrum.

The key word there is "visible." Akbari's team has seized on the fact that only about half of the sun's heat energy hitting your roof is in the part of the color spectrum we can see.

But if you look at the near-infrared part of the solar spectrum, you would find that the cool material is a lot more reflective than the standard one and that's the reason that these products are significantly different.

NOTES/QUESTIONS

How different? On a hot day, the engineered shingle would be 20 degrees cooler, even though they're both the same shade of brown. These "cool" shingles are on the market, though not available everywhere. To make a real difference, these "cool" new products have to be price-competitive and suppliers will have to be convinced to carry them.

Human behavior is probably the hardest thing to combat.

Lisa Gartland.

At the same time you see a lot of potential for so much energy savings and so much monetary savings and such better materials to make our cities so much more comfortable.

…and cleaner. Cooler cities keep down the amount of ozone pollution; that mean fewer Spare-the-Air days. A one or two-degree drop in urban temps can reduce smog by as much as 15%.

For KQED Radio News, I'm Craig Miller.

QUEST QUAD

FIELD NOTES

Go outside and ...

- Plant some trees
  - Plant trees in areas that get a lot of sun around your home or find a tree planting event in your area.

- Measure the effects of cloud cover on temperature
  - Go outside and to the same spot on a cloudy day and a sunny day. Record the temperature. Do clouds keep the surface of the earth cool, or warm it up?

FIELD TRIP

Visit ...

- A local plant nursery
  - Find out what plants would be good to use if you were trying to cool down your home, school, or to plant on your roof.

- A building with a rooftop garden
  - Ask the building manager about the garden and any troubles they had with installation or any benefits they've found from having it.

FIELD RESEARCH

Find out more about…

- How urban heat islands are affecting global climate change. http://www.epa.gov/heatislands/
  - Research what scientists say about the warmer temperatures of cities and its impact on a global scale.

- Air quality, energy use, vegitation, and cool pavements
  - How do heat islands effect energy use and air quality and what effects vegitation and cool pavements have on temperatures in urban areas? http://eetd.lbl.gov/HeatIsland/

- Cool roofing materials
  - What is it about these new technologies that help with heat islands? http://coolcolors.lbl.gov/

FIELD TEST

Experiment with...

- How different colors absorb heat
  - Paint cans or cups different colors (black, white, green), or put construction paper around them. Place a thermometer in the cans/cups and place them outside on a hot day or under a heat lamp.
  - Record the temperature of the cans after 15 mins, 30 mins., an hour, etc.
  - What differences do you find?

- What you and your family can do to reduce your contribution to urban heat islands.
  - Brainstorm ideas on changes that can be made around the home to help keep your neighborhood cool.

Look for the **indicating resources from QUEST partner organizations**

VISIT OUR PARTNERS

The Bay Institute
www.bay.org

California Academy of Sciences
www.calacademy.org

Chabot Space and Science Center
www.chabotspace.org

East Bay Regional Park District
www.ebparks.org

Exploratorium
www.exploratorium.edu

Girl Scouts of San Francisco Bay Area
www.girlscoutsbayarea.org

Golden Gate National Parks Conservancy
www.parksconservancy.org

Lawrence Berkeley National Laboratory
www.lbl.gov

Lawrence Hall of Science
www.lawrencehallofscience.org

Oakland Zoo
www.oaklandzoo.org

The Tech Museum of Innovation
www.techmuseum.org

UC Berkeley Natural History Museums
http://bnhm.berkeley.edu/

OTHER WAYS TO PARTICIPATE IN QUEST

LOG ON

kqed.org/quest

LISTEN

KQED 88.5 FM San Francisco &
89.3 FM Sacramento
Fridays at 6:30am and 8:30am

WATCH

KQED Channel 9
Tuesdays at 7:30pm

Major funding is provided by the National Science Foundation, the Gordon and Betty Moore Foundation, the Richard and Rhoda Goldman Foundation, and The Amgen Foundation. Additional support is provided by the William K. Bowes, Jr. Foundation, Ann S. Bowers -The Robert Noyce Trust, the Dirk and Charlene Kabcenell Foundation, and the Vadasz Family Foundation.