COOL SOLUTIONS

Cities in South Asia are sizzling, with low-income residents bearing the brunt of urban heat stress. But researchers are finding ways to help them adapt.

A woman in Bhubaneswar's Mahavir Nagar slum wipes cold water over her face in an effort to cool off after coming out of her home on a day when the temperature reached 42.5 C, prompting a heat wave alert in the Eastern Indian city. (Photo: Rohit Magotra/IRADe)

POSTED BY BRIAN BANKS ON OCTOBER 17, 2018

Climate change may be upon us, yet if you say, "Heat wave," a lot of people in developed Western countries still think, "Ah, summer." Trouble sleeping? Crank up the A/C.

But it's a different, distressing and increasingly dangerous story for tens of millions of low-income urban dwellers in major South Asian cities. Not only do many of these people work outdoors in intense heat by day, but they come home at night to small, cramped shanties with tin, concrete or stone slab roofs and no air conditioning. For months at a time, overnight temperatures in these homes never fall below 30 C, higher still during heat waves. And, barring any intervention, these conditions are expected to worsen — producing more frequent catastrophes like the heat wave that caused more than 2,400 heat-related deaths in India in 2015.

"You can't properly sleep, you can't be productive the next day and if it continues for a long time it leads to health risks," says Christian Siderius, a climate adaptation and water resources management expert with Netherlands-based **Wageningen Environmental Research.**

Since 2014, Siderius has been a lead researcher on a multifaceted **project funded by the International Development Research Centre** and the United Kingdom's Department for International Development that focuses on climate change impacts on water, resources and society in the Hindu Kush Himalayan region, including cities in the major downstream river basins. Specifically, he and a team of colleagues in Pakistan, India and Bangladesh have been studying urban heat stress at household, neighbourhood and city-wide scales with a goal of developing solutions to help vulnerable people adapt to and manage the risks.

At one level, there's a lot known on this topic, Siderius says. Planting trees for shade and painting walls white offers some relief, for example. "But what we found is that the evidence in South Asia and the evidence base for poor households was very meagre," he explains. "People knew that some things helped, but we wanted to be

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able say specifically what could help bring levels of heat stress in your home down by, for example, five degrees." Solutions, whether via the private sector, government or NGOs, also have to be extremely low-cost to be viable.

Getting those answers requires data. To obtain it, researchers outfitted cars with temperature and humidity sensors and every two weeks drove them through three cities — Delhi in India, Dhaka in Bangladesh and Faisalabad in Pakistan — recording conditions in different neighbourhoods. In each city, they also installed temperature loggers in the bedrooms of 200 non-air-conditioned homes in different low-income neighbourhoods that took readings every 10 minutes.

The results, plotted on heat maps, paint a complicated but revealing picture that stands in stark contrast to government weather records, which indicate a single temperature for the entirety of one urban area, such as Delhi. Data that researchers collected in that city in 2016, for example, showed that average household temperatures were four degrees higher — 30 C compared to 26 C — than the weather office figure.

Differences between neighbourhoods were equally stark. "We started our survey in shaded [more affluent] areas and then went to east Delhi, where there are the densest, poor neighbourhoods," Siderius says. "During heat waves we saw that some shaded neighbourhoods were six degrees cooler. Of course, it might be difficult to green the whole of Delhi, but it's an indication that keeping your green area, keeping your shading, could be very helpful in keeping the temperature down."

Within homes, the biggest differences stem from building materials and ventilation. The worst homes, where researchers recorded average indoor nighttime temperatures as high as 36 C during protracted heat waves, had no evaporative coolers, poor ventilation and metal roofs. Add perpendicular ventilation, Siderius says, and you get, on average, a two-degree drop. "If you have opposite ventilation — an open door and window, say — it drops another two degrees. Add an evaporative cooler and you get under 30 degrees."

In 2017, Siderius's group began working with a local NGO, the **Mahilia Housing Trust**, to test the effectiveness of prefabricated modular roofs made with non-conductive materials that are cheap, waterproof and easily removed. If the results are positive, they will be factored into the project's final recommendations to local and regional governments.

Kallur Murali, an IDRC project officer in Delhi, says other recommendations will emphasize providing more publicly accessible water stations and revising public-access policies to make it easier for people working outdoors to find shelter in public parks and other shaded locations.

Ultimately, Siderius says, "No single measure is enough to keep a city like Delhi livable. You have to think about neighbourhoods, you have to think about housing construction and you have to understand people's knowledge of how to cope."

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READING AS THINKING

1. What are some of the characteristics of major South Asian cities that make them susceptible to heat-related issues?

2. Why are the urban poor most vulnerable to extreme heat?

3. Christian Siderius and his colleagues want to learn more about the importance of scale in urban heat stress studies, since air temperature can vary at the household, neighbourhood and city-wide scale. In the table below, list some ways that air temperature could be reduced at these different scales:

HOUSEHOLD	NEIGHBOURHOOD	CITY-WIDE

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4. a) Summarize the strategy that Siderius and his colleagues used to collect temperature data:

b) What is the benefit of taking temperature readings every 10 minutes (as opposed to taking readings every hour, for example)?

c) Why did the researchers place the temperature loggers in bedrooms (as opposed to family rooms, for example)?

5. a) What are the three things that Kallur Murali mentions that are necessary to keep a city livable during conditions of extreme heat?

b) What else would you add to this list?

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6. Are heat waves only an issue in underdeveloped cities in South Asia (such as Delhi and Dhaka), or can they also be an issue in developed cities in South Asia and elsewhere in the world? Explain.

7. Why is it important to work towards reducing temperatures in cities across the world?

Think-Pair-Share

Think

8. Siderius explains that land cover and ventilation are major factors that determine the heat level in a certain area. Keeping this in mind, consider your schoolyard and the different surfaces that are found within it (e.g., basketball court, soccer field, gravel, forest, sandbox, track). Do you think the temperature of the air above these different surfaces will be different? Use the table below to identify where you think the air might be relatively warm and where it might be relatively cool, and provide your reasoning):

SURFACE	AIR ABOVE SURFACE IS WARMER OR COOLER	WHY?
Ex: Pond	Cooler	During the day, land heats up faster than water

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Pair

9. a) In groups of two or three, compare your answers in the table above and discuss any predictions that were different.

b) For one week, go outside into the schoolyard every day to take temperature measurements at the same height above the surfaces that you've identified in your tables. Use the data collection sheet (one per group) to record your measurements. **Note to teachers**: Thermometers and measuring tapes are needed for this activity (either mercury or digital thermometers will work, and temperatures should be measured between four and five feet above the ground if possible).

c) Graph your results (with a line or bar graph) using a program such as Microsoft Excel or Minitab.

Share

10.a) Compare your results with the rest of the class and discuss any patterns and trends. Specifically:

- Consider your original predictions and evaluate whether the data you collected reflects your hypotheses.
- What conclusions can be drawn from the results and are they in line with Siderius' comments in the article?
- Are there any outliers in the data? What would cause them?
- How could you improve the experiment in the future?
- Why it is important to conduct experiments like these?
- How can different temperatures affect vegetation, wildlife and people?

b) Finally, decide as a class what type of surface would be the best choice for a schoolyard.

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DATA COLLECTION SHEET

Group members: ______________________________

Time of day: ______________

Surface	Height of Measurement	Air Temp 1(°C)	Air Temp 2 (°C)	Air Temp 3(°C)	Air Temp 4 (°C)	Air Temp 5 (°C)

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ONLINE

- Learn about urban heat islands on the United States Environmental Protection Agency's **website**. Here, you will find examples of temperature data collected during heat island studies, infographics describing the structure of a heat island, webcasts, and more! They also have a list of thing you can do to **reduce urban heat islands.**
- The United States Environmental Protection Agency has a **Student Guide to Global Climate** where students can learn about the **effects of increasing temperature** on different aspects of life.
- Smithsonian has a story about **Why the City is (Usually) Hotter than the Countryside.**
- Frostburg State University has shared **their results of a class experiment** in which students measured temperatures across different surface types.
- The government of Quebec has information about the **effects of heat on human health.**
- The World Health Organization has **information** and illustrations about the effects of exposure to extreme heat and cold.

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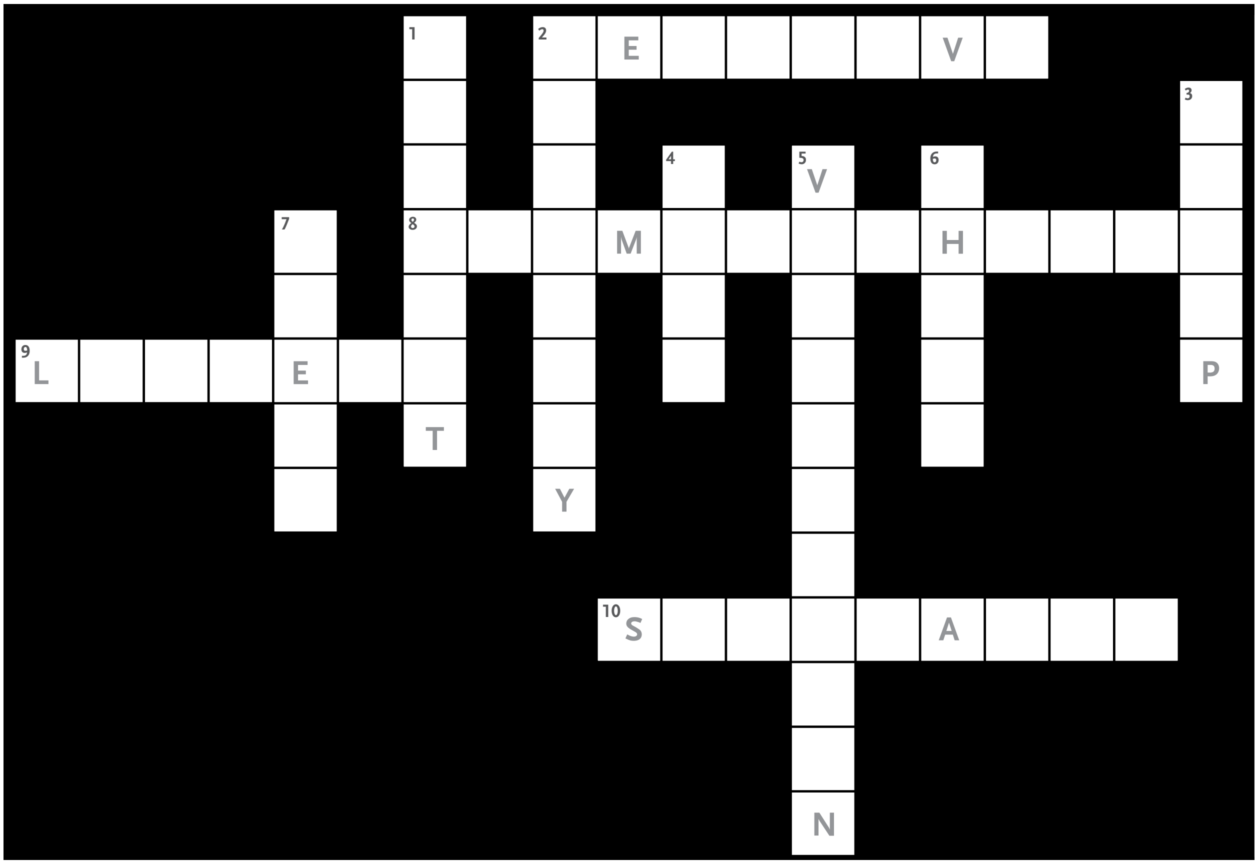

CROSSWORD:

Across

2. A prolonged period of abnormally hot weather (two words)
8. A change in weather patterns over an extended period of time (two words)
9. These can be installed in bedrooms to measure temperature
10. Region where this research was conducted (two words)

Down

1. For solutions to be effective they must first meet this criterion (two words)
2. The cars used for this research were outfitted with sensors that measured this
3. At night, it is often difficult to do this if conditions are too warm
4. More of this needs to be collected to find solutions to urban heat stress
5. This is needed to allow air flow in homes
6. Walls can be painted this colour to reflect solar energy and heat away from city buildings
7. Plants that can provide shade and cool down neighbourhoods