MAGAZINE

Too hot to live: Millions worldwide will face unbearable temperatures

A warming climate is likely to push entire regions out of their comfort zones—and make staying cool a matter of survival.

DASHT-E LUT, IRAN

A morning traveler surveys what might be Earth's hottest place: the Lut Desert. In 2014 French researchers measured an unofficial 142°F in the shade here—a potential world record, if repeated with standard instruments. As Earth warms, more of it may become like the Lut—inhospitable to humans.

PHOTOGRAPH BY MATTHIEU PALEY

BY **ELIZABETH ROYTE**

The human body has evolved to shed heat in two main ways: Blood vessels swell, carrying heat to the skin so it can radiate away, and sweat erupts onto the skin, cooling it by evaporation. When those mechanisms fail, we die. It sounds straightforward; it's actually a complex, cascading collapse.

As a heatstroke victim's internal temperature rises, the heart and lungs work ever harder to keep dilated vessels full. A point comes when the heart cannot keep up. Blood pressure drops, inducing dizziness, stumbling, and the slurring of speech. Salt levels decline and muscles cramp. Confused, even delirious, many victims don't realize they need immediate help.

With blood rushing to overheated skin, organs receive less flow, triggering a range of reactions that break down cells. Some victims succumb with an internal temperature of just 104 degrees Fahrenheit (40 degrees Celsius); others can withstand 107 degrees for several hours. The prognosis is usually worse for the very young and for the elderly. Even healthy older people are at a distinct disadvantage: Sweat glands shrink with age, and many common medications dull the senses. Victims often don't feel thirsty enough to drink. Sweating stops being an option, because the body has no moisture left to spare. Instead, sometimes it shivers.

NEW DELHI, INDIA

40°C, or 104°F. Less than 10 percent of Indian households have air-conditioning, but the market is booming.
PHOTOGRAPH BY SAUMYA KHANDELWAL, NEW YORK TIMES VIA REDUX

PARIS, FRANCE

The Trocadéro fountain offers relief during a record-smashing 2019 heat wave. A disastrous predecessor in 2003 had triggered reforms, such as a requirement for cooling in nursing homes. They paid off: The 2019 death toll in France was 90 percent lower.
PHOTOGRAPH BY SAMUEL BOIVIN, NURPHOTO VIA GETTY IMAGES

A heart attack may fell the infirm at this point, but the more fit may persist to suffer tunnel vision, hallucinations, and perhaps the stripping of clothes that, with nerve endings aflame, feel like sandpaper. Fainting is now a blessing, as blood vessels begin to lose their integrity. Muscle tissues, including those of the heart, may go next. Once the digestive tract starts to

massive, last-ditch clotting effort that further endangers vital organs kidneys, bladder, heart. Death is near.

In the summer of 2003 an area of high atmospheric pressure camped out above western and central Europe. Superheated over the Mediterranean, the giant swirling air mass rebuffed incursions of cooler Atlantic air for several weeks. In France, temperatures rose steadily, topping out for eight days at an astonishing 104°F (40°C). As the heat built up, people began to die.

Many physicians and first responders were away on their annual vacations, and hospitals soon were overwhelmed. Morgues filled up, and refrigerated trucks and food-market freezers took up the slack. Visiting caregivers found clients slumped on their floors or dead in armchairs. (At the time only a few percent of French households had air-conditioning.) Police were called to break doors open, "only to find corpses behind them," recalls Patrick Pelloux, president of the French association of emergency room doctors. "It was absolutely appalling." Many of the bodies were not discovered for several weeks.

LEFT: PARIS, FRANCE

After another record heat wave in 2019, the public transit agency experimented with misters on the Parc de St.-Cloud tram platform. As the tiny droplets of filtered water evaporate, they cool the air enough to refresh passengers.

RIGHT: PARIS, FRANCE

Designed in 2011 as a place of respite, this bosky glade in the courtyard of the French Ministry of Culture in Paris has become a model for engineers and ecologists working to

PHOTOGRAPHS BY WILLIAM DANIELS

France eventually attributed more than 15,000 deaths to the heat wave. Italy fared even worse, with nearly 20,000. Across the continent, more than 70,000 people—most of them poor, isolated, and elderly—lost their lives. Europe's hottest summer in 500 years, scientists later determined, was clearly linked to climate change. In Paris it had raised the risk of heat-related mortality that year by about 70 percent. *(Past decade was the hottest on record.)*

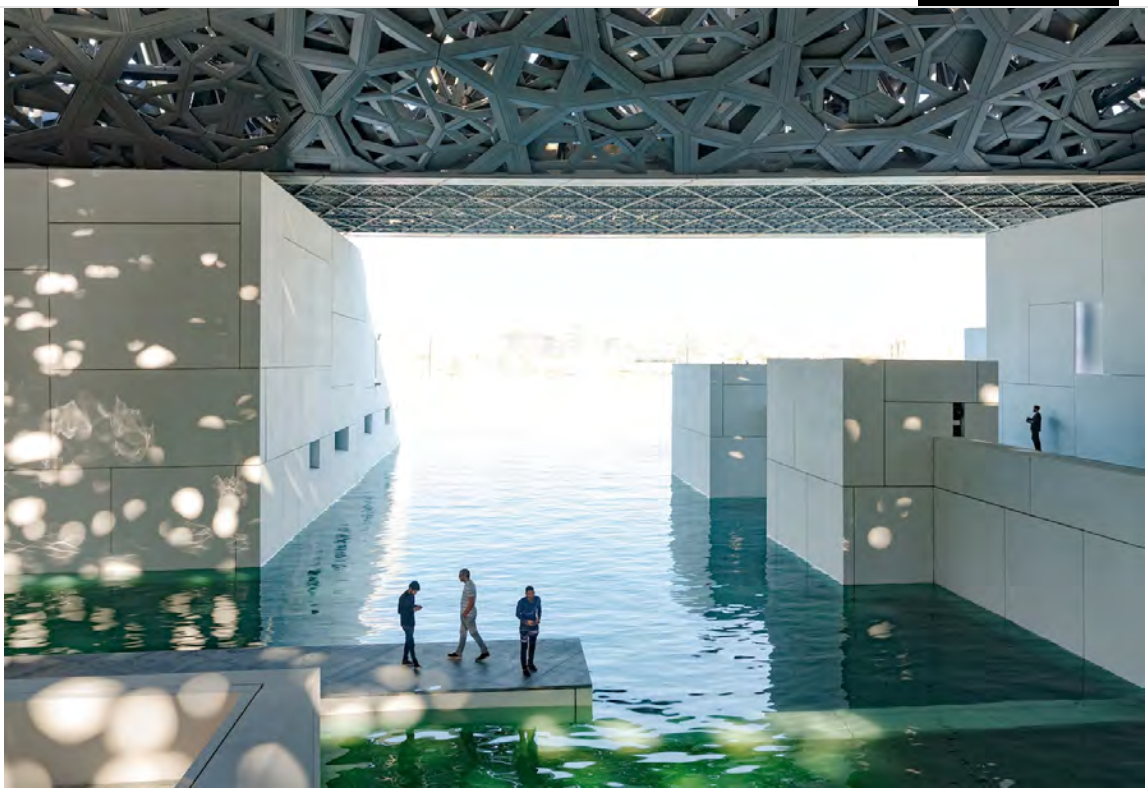
Among the many climatic threats that scientists associate with global warming—stronger and more destructive hurricanes, drought, rising sea levels, longer fire seasons—an uptick in heat waves is the most intuitive and immediate. As greenhouse gases released by human activities continue to increase in the atmosphere, heat waves will become longer and individual days will become hotter. Globally, the past six years have been the warmest ever recorded. In the southwestern United States, days with triple-digit temperatures are arriving weeks earlier than they did a century ago and lingering three weeks longer. And in Europe, the dreadful summer of 2003 has proved to be no mere statistical blip: Major heat waves have hit the continent five times since then, and 2019 brought all-time temperature records in six western European countries, including 114.8°F in France.

The ultimate solution to global warming, of course, is to drastically reduce our greenhouse gas emissions. If we fail utterly to do that, by 2100 the heat-related death toll could rise above 100,000 a year in the U.S. Elsewhere the threat is far greater: In India, for example, the death toll could reach 1.5 million, according to recent research. And even if we do rein in emissions, the planet will continue to warm for decades. A juggernaut is in motion, and it will fundamentally change how most of the planet lives.

MECCA, SAUDI ARABIA

COVID-19 restrictions thinned the crowds circling in the Great Mosque in July 2020. Normally the annual hajj draws millions of pilgrims, many of them elderly, for five days of outdoor rituals. When the hajj falls in summer, they'll be at increasing risk of heatstroke, climate sci... Read More

PHOTOGRAPH BY XINHUA/EYEVINE/REDUX



ABU DHABI, U.A.E.

Echoing the open lattices of Middle Eastern moucharaby screens, a fretted dome shades the Louvre Abu Dhabi museum. Beneath it, evaporation from the Persian Gulf cools the air, while stone floors and walls retain the nighttime chill.
PHOTOGRAPH BY MATTHIEU PALEY

Extreme heat has pernicious effects even when it isn't lethal. Researchers link higher temperatures with a greater incidence of premature, underweight, and stillborn babies, and heat exhaustion affects mood, behavior, and mental health. Hotter weather makes people more violent, across income levels. It lowers children's test scores and shrinks productivity. The International Labour Organization predicts that high heat levels will, by 2030, cut total working hours by 2.2 percent, equivalent to losing 80 million full-time jobs, mostly in low- to middle-income countries. Even in affluent ones, low-wage outdoor workers—in construction or agriculture, for example—will be hit hard. By 2050, high heat and humidity in the American Southeast likely will render the entire growing season "unsafe for agricultural work with present-day work practices," researchers at the University of Washington have reported. *(See how your city's climate might change by 2070.)*

Humans, along with their crops and their livestock, evolved over the past 10,000 years in a rather narrow climate niche, centered on an annual average temperature of about 55°F (nearly 12.8°C). Our bodies readily adapt to higher temperatures, but there are limits to how much heat and humidity we can tolerate.

In 50 years, a third of the world's people could live in places that feel like the Sahara—where the average summer high tops 104 ˚ F.

Even the fittest, heat-acclimated person will die after a few hours' exposure to a 95° "wet bulb" reading, a combined measure of temperature and humidity that takes into consideration the chilling effect of evaporation. At this point, the air is so hot and humid it no longer can absorb human sweat. Taking a long walk in these conditions, to say nothing of harvesting tomatoes or filling a highway pothole, could be fatal. Climate models predict that wet-bulb temperatures in South Asia and parts of the Middle East will, in roughly 50 years, regularly exceed that critical benchmark.

By then, according to a startling 2020 study in *Proceedings of the National Academy of Sciences,* a third of the world's population could be living in places—in Africa, Asia, South America, and Australia—that feel like today's Sahara, where the average high temperature in summer now tops 104°F. Billions of people will face a stark choice: Migrate to cooler climates, or stay and adapt. Retreating inside air-conditioned spaces is one obvious work-around—but air-conditioning itself, in its current form, contributes to warming the planet, and it's unaffordable to many of the people who need it most. The problem of extreme heat is mortally entangled with larger social problems, including access to housing, to water, and to health care. You might say it's a problem from hell.

ARIZONA, U.S.

In downtown Tempe, Arizona, the deepest, most protective shade comes from buildings, not trees. Arizona State University researcher Ariane Middel and her colleagues discovered that by roaming the streets with MaRTy, a "biometeorological robot" that records temperature, solar radiation, wind speed, and humidity.

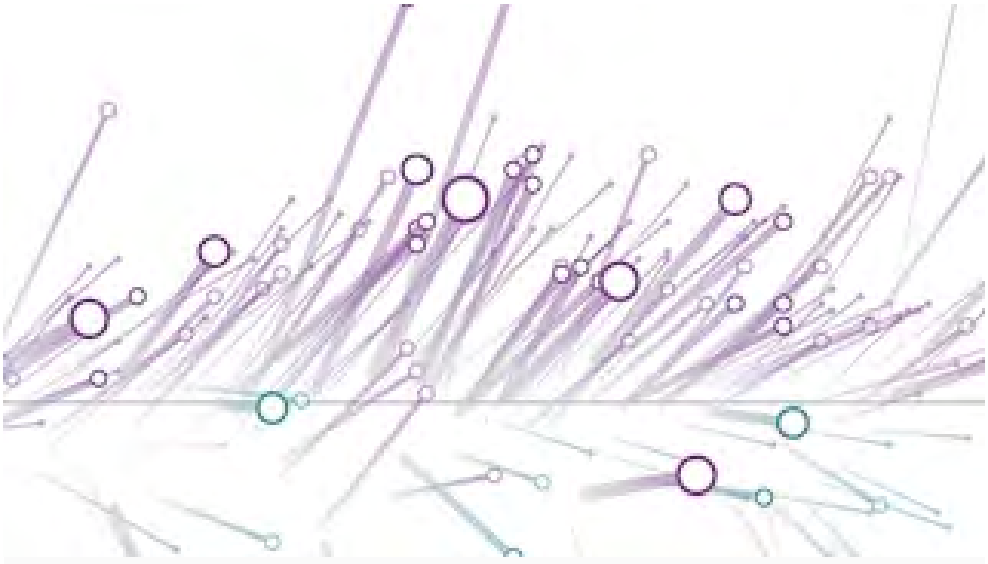
PHOTOGRAPH BY JESSE RIESER

Phoenix, Arizona, is the hottest city in the U.S., with more than 110 triple-digit days a year. Unsurprisingly, it also regularly records the most heat-related deaths. In 2020, Maricopa County logged an all-time-record 207, according to its medical examiner's office, which occupies a two-story, desert-tone building in downtown Phoenix and is required by law to investigate all nonnatural deaths, which include those related to temperature.

When a potentially heat-related death is reported, says Melanie Rouse, the office's chief investigator, her staff first interviews anyone with recent knowledge of the decedent. Was she or he sweating profusely or not at all, complaining of headache or nausea? Doing yard work? Using alcohol or drugs, which interfere with thermoregulation? "What we're trying to find out," Rouse says, "is what led to this turn in their life. We're trying to see if there are other compelling causes of death."

At the death scene, investigators measure the temperature of the body and the room. (The highest indoor temperature they've recorded was 145°F in 2017.) They extract vitreous fluid from the victim's eyeball for chemical analysis. Cells break down quickly in high heat, explains Rouse, "but the globe of the eyeball is a protected space." Chemists and physicians will analyze this fluid to determine if the decedent was dehydrated, had high blood sugar, or had decreased kidney function—all of which increase susceptibility to heat.

Slightly more than half of Maricopa County's heat-related deaths occur outdoors, mostly among the homeless. Many of the indoor deaths occur in mobile homes, whose poor insulation makes them hard to cool. Even in the richest of countries, inadequate housing contributes massively to heat exposure. In poorer countries, matters are far worse.



advise people to stay inside and drink cool water. But the advice is not helpful to the tens of millions whose homes are hotter inside than out, who lack electricity to operate fans or misters—only 8 percent of Indian households have air-conditioning—or who, like Noor Jehan, don't have homes at all.

Jehan, 36, has lived outdoors, in a South Delhi park, all her life. Every morning she stacks her meager belongings—a sack of bedding, a few pots and bowls—near a concrete perimeter wall, then trudges to her job at a construction site. She works even when the thermometer reaches 118°. Like millions of other daily wage laborers, she can't feed her three children if she skips work. "When I come back home," she says, "there's no water to even take a bath to clean the grime and dust and cool down." Her drinking water source is more than a mile away.

Jehan's husband pulls a rickshaw, but, undernourished and dehydrated, he frequently faints in the heat. Her sister Afsana and her three children cope by placing mats on the sidewalks, to rest or even sleep. "The passing cars create a bit of breeze," Afsana says. But the sidewalks often don't cool off until about 2 a.m.

NEW YORK CITY, U.S.

At Columbia University, a panel coated with a novel polymer film radiates heat through the atmosphere to outer space—and thus, as this infrared image shows, is dramatically cooler than its surroundings. Deployed on rooftops, such panels could reduce the need for air-c...**Read More**

PHOTOGRAPH BY JYOTIRMOY MANDAL

In Phoenix, David Hondula of Arizona State University studies the social and health impacts of unrelenting urban heat. Usually he can be found analyzing data in an air-conditioned office, but lately he's been pounding the city's blistering pavement to map the best places to plant tens of thousands of shade trees—an increasingly common urban response, around the world, to rising temperatures. "Less heat exposure reduces risk," Hondula says, "but I don't think we should rely on tree planting to prevent people from dying of heat." *(To prepare for rising temperatures, scientists map urban 'hot spots.')*

Asked what a more appropriate response might be, he does not hesitate.

"Increasing access to air-conditioning."

luxury, with especially frigid indoor temperatures signifying power and prestige. But in many places it's becoming a public health necessity, essential for preventing heat-related deaths. The good news, according to the Climate Impact Lab, a consortium of climate researchers, is that by 2099 economic development is expected to increase both air conditioner use and access to health care, saving millions of lives a year. The International Energy Agency projects that the number of AC room units will soar to 5.6 billion by mid-century, from 1.6 billion today.

The bad news is that current air-conditioning technology exacts a steep price on the planet. In most systems a liquid refrigerant is pumped through an evaporation coil within the indoor part of an AC unit; as the liquid changes to gas inside the coil, it pulls heat and moisture from the air. Outside the building a compressor, a condenser, and a fan convert the gas back to a liquid, releasing the heat and the condensed water.

CALIFORNIA, U.S.

In Los Banos, in the San Joaquin Valley, tomato pickers start at 5 a.m. to avoid some of the day's heat. State law requires growers to provide water, shade, and rest breaks, but pickers paid by the bucket may disregard such safeguards. Outdoor work will become increasingly... **Read More**

PHOTOGRAPH BY KARLA GACHET

There are three problems with this ingenious, century-old approach. First, the hydrofluorocarbons that typically are used as refrigerants are themselves greenhouse gases, and when they leak to the environment—should they be improperly disposed of—they have a global warming potential thousands of times greater, molecule for molecule, than carbon dioxide. Second, conventional air conditioners don't make heat vanish; they just dump it outside. In Phoenix, according to one study, ACs raise the outdoor temperature at night by as much as two degrees Fahrenheit, forcing all units to work even harder.

And third, air conditioners suck huge amounts of electricity—about 8.5 percent of total global consumption. Most of that energy is still produced by burning fossil fuels. In 2016 air-conditioning accounted for 1.25 billion tons of carbon dioxide emissions; by 2050, that number is expected to nearly double.

Clearly, new ideas are needed. To stimulate them, the Rocky Mountain Institute, a Colorado-based think tank, recently helped run an international competition. It challenged engineers to produce a room air conditioner that has one-fifth the climate impact of today's standard products, uses at most one-fourth the energy, and is no more than twice as expensive as a current baseline model.

LEFT: CALIFORNIA, U.S.

On a 98°F day in Caruthers, California, near Fresno, Marina Acosta takes a break from picking grapes that will be dried for raisins. She and her husband work seven days a week, earning between $82 and $130 a day, depending on how much fruit they can pick.

his niece, 17-year-old Maria Isabel, near where she died in 2008 after laboring nine hours in 95°F with no access to water or shade. Her death spurred the state to improve and better enforce heat-protection laws.

PHOTOGRAPHS BY KARLA GACHET

Some entries dispensed with liquid refrigerants and vapor compression in favor of promising new technologies that weren't quite ready for prime time. One used solid-state refrigeration, in which pressure is cyclically applied to crystalline materials that switch readily from hot to cold; it's likely to prove more suitable for spot applications, such as quickly cooling a soda can, than for chilling an entire room. Another entrant proposed rooftop panels coated with nanomaterials that reject solar heat, radiating it back out to space at an infrared wavelength that passes right through the atmosphere. That could, in principle, reduce a building's heat gain by several degrees Fahrenheit, "but it isn't a solution on its own," says Rocky Mountain Institute senior fellow Iain Campbell. "It doesn't work in humid conditions, and the panels have to face the sky." Not so helpful, that is, for residents on the third floor of a 10-story building.

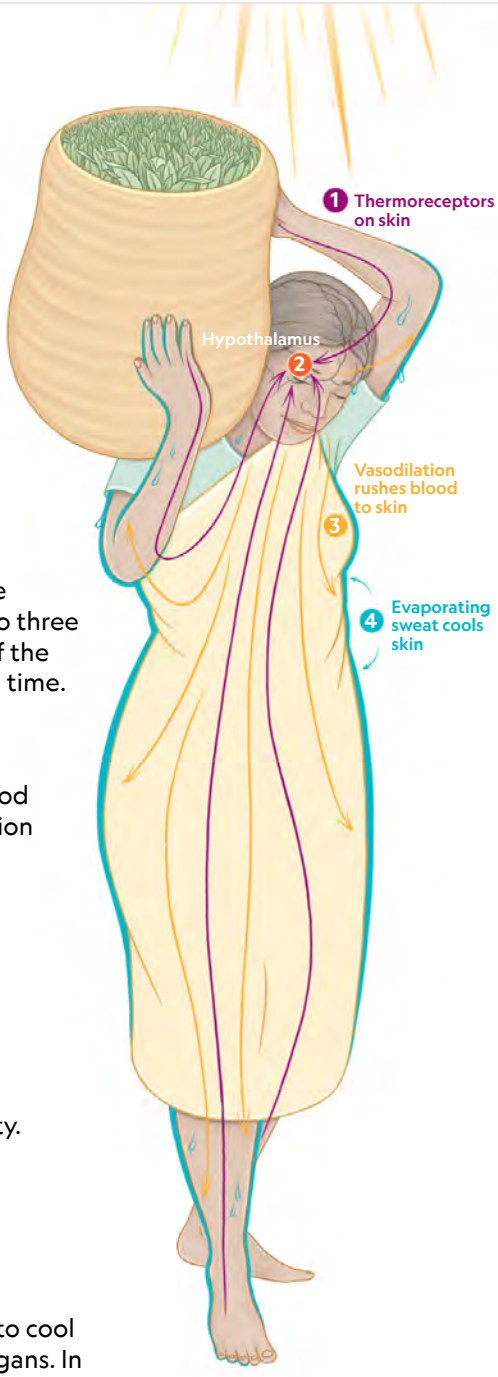
The final four contestants, which battled it out in 2020 during a post-monsoon "chill off" in a Bahadurgarh, India, apartment building, all relied on conventional vapor compression. But they were seriously souped up, using new refrigerants with low or no greenhouse-warming potential and hyperefficient evaporator and condenser systems. The co-champions, designed by Team Daikin and Team Gree, cool their condensers with water instead of air to reduce their energy demand, and one sports solar panels to supply some of its electricity. They are expected to be on store shelves by 2025, at about twice the price of the baseline model. But their operating costs are so low, Campbell says, that the payback period will be just three years.

HOW THE BODY HANDLES HEAT

Maintaining a constant internal temperature of about 98.6°F is a balancing act. Muscles and organs generate heat that is shed through the skin. But the body also

A system for cooling off

The body transfers heat to anything it touches, including clothes and the surrounding air. Heat radiating from the skin and sweat evaporating from it provide most of the body's cooling.



1 HEAT STRESS IS DETECTED

Receptors in the skin and other parts of the body sense that a person is starting to overheat. Climate, activity level, and clothing can all affect internal temperature.

2 THE BODY'S THERMOSTAT TAKES NOTE

The brain's hypothalamus signals eccrine glands in the skin to release sweat—up to three pounds an hour. Only about 5 percent of the 2.5 million glands are active at any given time.

3 THE BODY'S THERMOSTAT TAKES NOTE

Blood vessels dilate, funneling more blood into capillaries in the skin. This vasodilation carries heat from the body's core to its surface, where it can be radiated away.

4 BLOOD AND SWEAT COOL THE BODY

Blood and sweat dissipate the vast majority of body heat through the skin; breath carries away most of the rest. Sweat cools when it evaporates, which can be nearly impossible in high humidity.

When things go wrong

The longer blood and fluids are diverted to cool the skin, the harder it is on our internal organs. In extreme heat, stress can progress to exhaustion and then stroke—and ultimately to death.

HEAT EXHAUSTION

Nausea, fatigue, cramps, rash, and dizziness—often caused by a combination of high temperatures, physical exertion, and high humidity—are signals the body sends to the brain to reduce activity and cool down. These symptoms can progress to more deadly heatstroke.

HEATSTROKE

Headache, confusion, vomiting, and loss of consciousness can occur when the body hits 104°F. Heatstroke requires emergency care. It can quickly damage the brain, heart, kidneys, and muscles and end in coma and death.

Jason Treat and Eve Conant, NGM Staff; Kelsey Nowakowski. Art: Gaby D'Alessandro
Sources: Ollie Jay, University of Sydney; Jason Lee, National University of Singapore

At Princeton University in New Jersey, Forrest Meggers, an architect and engineer, is developing another type of system that might prove enormously helpful in hot and humid environments. It didn't meet the criteria for the Rocky Mountain Institute competition, though, because it doesn't cool a room's air: It cools only people—by absorbing the heat that radiates from their skin with wall-mounted panels of water-filled tubes.

A prototype of the invention, called Cold Tube, hangs from a hook in Meggers's lab. It resembles a woven mat of blue plastic straws. On an 85° day like today, Meggers explains during my visit, filling those skinny tubes with 60° water would give lab occupants a feeling of 75°, even with the lab's sliding doors wide open because of the COVID-19 pandemic. Unfortunately, the tubes aren't filled on this muggy afternoon. Meggers is dressed head to toe in wicking clothing.

Architects have employed radiative cooling panels before, on ceilings and on walls, but almost always with dehumidifiers, to keep water from condensing on the panels and raining down on computers and heads. By shrouding his panels with a simple polyethylene membrane, which keeps humid air away from the tubes but not radiated heat, Meggers says, he has solved that problem.

KARBALA, IRAQ

In Karbala, Iraq, a mother with just a small fan struggles to soothe her child suffering from heat rash on a 109°F day. Only the wealthiest here can afford air conditioners and backup generators. Power outages are frequent, and when demand soars during heat waves, they can l... Read More

PHOTOGRAPH BY ABDULLAH DHIAA AL-DEEN

In superhumid Singapore, where the Cold Tube was first deployed, the system produced a comfortable—but hardly cold—environment using less than half the energy of a conventional air conditioner and generating half the waste heat. The energy savings aren't quite as spectacular in arid environments, where ACs don't work so hard to dehumidify air. But the membrane-insulated radiative panels, Meggers says, are still more efficient than conventional systems.

work well even in outdoor settings, such as bus shelters or cafés. The biggest challenge to wider adoption of the technology, Meggers suspects, is attitudinal. “Engineers are accustomed to thinking about summertime comfort and cooling in terms of air-conditioning,” he says. Adapting to a hotter world is going to require a paradigm shift, and not just among engineers.

New York City, where I live, ranks its neighborhoods’ vulnerability to heat based on risk factors such as poverty, access to air-conditioning, and availability of green space. The upper Manhattan neighborhood of East Harlem scores five—the worst—on this index. Its poverty rate of 31 percent is nearly twice the city average, and it has among the lowest rates of air conditioner ownership—88 percent—in the city. But race matters too.

On a sizzling summer day I meet Sonal Jessel, the policy director for the nonprofit WE ACT for Environmental Justice, to walk through East Harlem. As we walk, Jessel draws my attention to a tenement building, where towels and rags fill the gaps between air conditioners and window frames.

BALOCHISTAN, PAKISTAN

Devotees making the arduous Hinglaj, a Hindu pilgrimage through the desert of western Pakistan, often faint in the extreme heat—104°F when this picture was taken. As body temperature rises, the heart works harder to pump blood to the skin. If it can’t kee...

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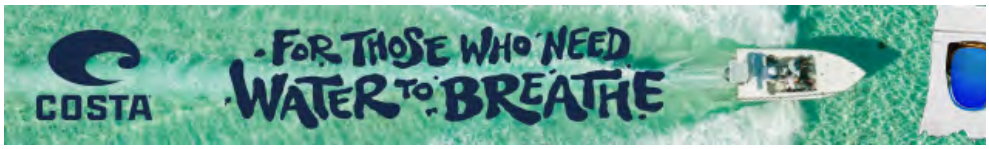

“Their bill must be through the roof,” she says. East Harlem is 27 percent Black, and Black households pay, on average, hundreds of dollars more per year for energy than do white households of comparable income, Jessel says, citing a study from the University of California, Berkeley.

Black Americans use more energy, that study suggested, in part because a legacy of racial discrimination has left them with less accumulated wealth and thus less ability to invest in insulation or the most efficient air conditioners. Their buildings are older and leakier, Jessel says, and their living conditions may be more crowded. “If you’re trying to work or study in the air-conditioned living room and there’s three noisy people there,” she says, “you move to another room and turn on another AC.”

We head east. Street trees are scarce, and heat radiates off sidewalks, buildings, and the engine blocks and exhaust pipes of cars, buses, trucks, and construction vehicles that creep along 125th Street, which connects to several highways and bridges. Jessel and I pass weed-filled lots, commuters fanning themselves at unshaded bus stops, and shops shuttered since long before the pandemic. “It tears the neighborhood apart to have these spaces vacant,” Jessel says. *(Los Angeles confronts its shady divide.)*

If we improve the lives of the most vulnerable among us, we also will improve our resilience to extreme heat.

It also may make residents more vulnerable to heat: When New York University sociologist Eric Klinenberg studied Chicago’s 1995 heat wave, in which more than 700 died, he discovered that low-income neighborhoods

heat-related deaths. People in less affluent neighborhoods were far less likely to step outside for relief or visit with caring neighbors, he surmised, because they didn't know one another, had few places to go, and were sometimes scared to walk the streets. And so they stayed inside—often with windows closed to guard against burglars—sweltered, and died.

Like many cities around the world, New York operates several dozen cooling centers: libraries, schools, senior centers, and other buildings that open their doors to the public during heat waves. In New York the centers are closed at night, and many people who might find relief in such places aren't aware they exist. Some refuse to visit them for fear their empty apartments will be burgled, as Klinenberg found in Chicago. In Phoenix, homeless people would rather roast in tent cities on asphalt parking lots than leave their worldly goods behind while seeking indoor relief, says Ash Uss, advocacy coordinator of that city's André House of Hospitality.

Getting people into those air-conditioned spaces will save lives, as ASU's David Hondula noted. But reducing social isolation may be equally important. In New York, Black residents die of heat-related causes at twice the rate that white ones do, but whites succumb at three times the rate of Hispanics and five times the rate of Asians—in part perhaps because whites are more likely to live alone.

Coping with extreme heat is more complicated than it sounds because it's a nested problem, inseparable from larger social issues. But that's also its silver lining: If we improve the lives of the most vulnerable among us, we also will improve our resilience to extreme heat.

DASHT-E LUT, IRAN

Nomads make camp in the Lut Desert, which isn't as lifeless as it looks. Scientists hypothesize that the carcasses of migratory birds—which regularly fly off course and die here—provide sustenance for foxes, geckos, and locusts.

PHOTOGRAPH BY MATTHIEU PALEY

The European heat wave of 2003 was a watershed event. It triggered national reckonings, endless finger-pointing, and major reforms. Within a year, France mandated "cool rooms" in previously un-air-conditioned nursing homes, launched telephone check-in systems for the vulnerable, beefed up heat-warning systems, and inaugurated a massive public education campaign on preventing heatstroke. When high temperatures returned, such measures were credited with reducing mortality 10-fold.

air conditioners alone won't eliminate all heat deaths. People still need and want to go outside.

And so in hot cities around the world, crews are planting shade trees and creeping vines to block sunlight. They're painting rooftops; installing rooftop gardens; erecting shade structures on sidewalks and in parks; hooking up misters and spray showers in playgrounds; and experimenting with roughly textured permeable pavement, which cools surrounding air by absorbing and then evaporating rainwater. In New York City, researchers from Columbia University's Earth Institute calculated that planting trees over 17 percent of the city's land surface and treating all roofs to reflect, rather than absorb, solar radiation could lower the city's overall temperature by 1.6 degrees Fahrenheit, or nearly a degree Celsius.

"We don't know if these tools will be enough to survive another half degree [Celsius] of warming," let alone the projected three degrees (5.4 degrees F) by century's end, says Kristie Ebi, who studies the impact of global warming on human health at the University of Washington. "But doing nothing is certainly not sufficient."

Rethinking how we build will be key to surviving a warmer future. Up until the mid-20th century, most buildings were developed with the climate in mind. In warmer latitudes, architects incorporated transoms, cupolas, skylights, air shafts, and operable windows to promote cross ventilation and updrafts. Awnings, light-filtering screens, louvered shades, overhangs, and porches defended rooms against the sun. Ceiling fans, which use up to a thousand times less energy than a room air conditioner, were ubiquitous. But as the cachet and influence of modernist architecture—with its inoperable windows and curtain walls of aluminum and glass—spread from the U.S. and Europe around the globe, so did dependence on mechanical air-conditioning.

Climate-savvy architecture is starting to be a thing again. But we still have to live in the cities that are already built. We're not likely to tear down or substantially retrofit hundreds of thousands of poorly insulated, energy-intensive towers. Instead, suggests architect Daniel Barber, of the University of Pennsylvania, we might try to retrofit our expectations.

Now is the time, Barber says, to "condition ourselves to embrace, and even value, discomfort." Being a little too warm in summertime used to be something that even the affluent accepted, perhaps with the help of an iced beverage. Barber thinks we should learn to accept it again. In this paradigm the lavish chill of our conference rooms, or the "thermal delight" that greets the sweaty pedestrian as the doors to a high-end emporium whoosh open, would become artifacts of a fleeting late 20th-century insanity.

In Barber's vision, the energy-hogging global North, where excess comfort abounds, would transfer its ration of "thermal wealth" to the energy-impoverished global South, at least until we've given up fossil fuels. It would be a sort of comfort reparations—for having started climate change in the first place. "Architects already have the tools and knowledge to reduce our reliance on mechanical cooling," Barber says. Their project now is to make discomfort culturally desirable, even stylish.

Of course, style gets one only so far. Self-imposed discomfort will be a hard ethic to sell to a mass audience in wealthy countries, and even Barber—a provocateur with a serious point—recognizes the limits of the human body. "When it's 140 degrees, I hope to God I have an air conditioner, and that you do too," he says. "But when it's 85 out, please just open the window."

A frequent contributor to *National Geographic* in print and online, **Elizabeth Royte** covers consumption and waste, food, and agriculture. She's the author of three books.

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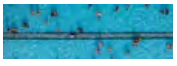

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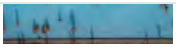

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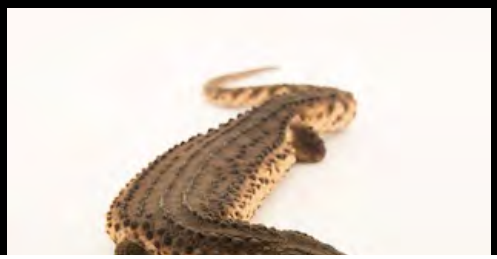

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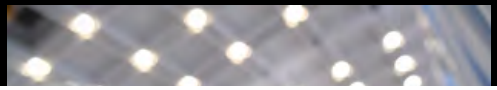

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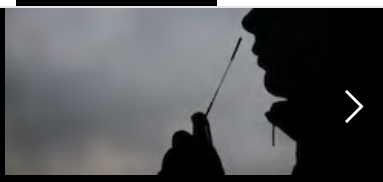

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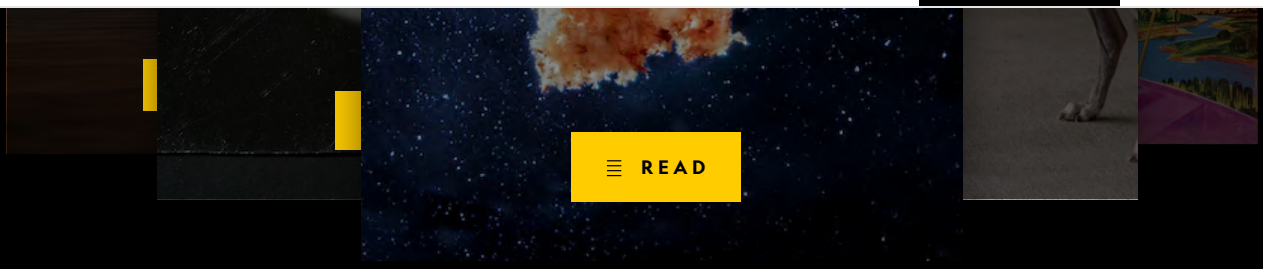

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