TIMES EVOKE

THE HEAT IS ON

In the 1950s, Ella Fitzgerald sang 'Summertime', the jazz classic celebrating how, in the season of golden languor, 'the living is easy'. Those summers, of shimmering warmth and slow-ripened joys, are now a memory. With epochal greenhouse gas emissions — the IPCC finds atmospheric CO_2 concentrations higher than in the prior two million years — temperatures have exceeded the last 6,500 years. Gentler summers have been replaced by intense heatwaves. In 1936, North America recorded a 38°C heatwave. In 2003, Europe experienced 47°C. In 2016, India witnessed 51.0°C and in 2021, Canada experienced 49.6°C. In 2022, Antarctica is 40°C hotter than usual.

The impacts of such heat are devastating for health, assets and stability. The UNEP notes humans face 220 million more heatwave exposures now than in 1986. While climatological disasters — heatwaves bring drought and disease too — have increased five-fold since 1950, the population affected has grown by 40%, impacting the elderly, children and lower-income groups most. The ILO finds at 34°C, workers can lose upto 50% of their work capacity. Currently, $41 trillion in GDP is at risk from heat stress globally. By 2030, heat productivity loss could equal 80 million full-time jobs and $2,400 billion, impacting tropical countries like India most. At 1.5°C of global warming, scientists warn 'twice in a century' heatwaves could occur every six years.

However, timely mitigations are possible. As Times Evoke's global experts emphasise, nature offers us refuge from the damages wreaked upon her. Green spaces are a panacea, the UN noting that investing $100 million in street trees globally can bring 77 million people a 1°C reduction. Waterways help — restoring Seoul's Cheonggyecheon stream lowered temperature by 5.9°C. While renewable energy generation must increase, smaller mitigations, like air vents below roofs, painting surfaces albedo or pale shades and heat-sensitive window placements, make a difference. As the world warms, governments should orient health services to heat warnings and treatments — alongside, communities should actively protect the most vulnerable. Our world is experiencing its hottest years ever. Join Times Evoke in learning how cooler ideas and warm hearts can help us lower the heat.

'The world is seeing unprecedented heat conditions — these will test our social cohesion'

Benjamin Zaitchik *teaches earth and planetary sciences at Johns Hopkins University. Speaking to* ***Srijana Mitra Das*** *at* ***Times Evoke,*** *he discusses why heatwaves are rising globally, how India is particularly vulnerable — and the most important and timely adaptations to make:*

What is the core of your research?

■ I'm a climate scientist and am particularly interested in regional climate processes. Our research group studies variability and change at a human scale, looking at regional dynamics and focusing on extremes in weather and hydrology. We examine what causes events like heatwaves, storms and droughts. We try to understand these events, predict them through forecasting and project what these phenomena might look like in a changing climate.

How would you describe the current heat situation the world faces?

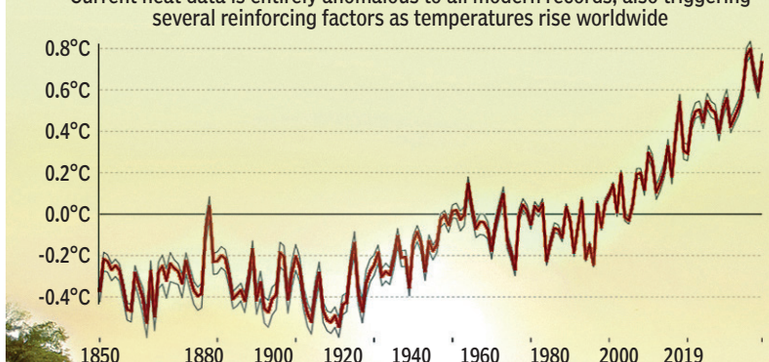
■ We are seeing heat extremes that are unprecedented in the historical records of modern times. Climate scientists find the probability and intensity of these heat extremes could be in excess of timelines beyond the modern era too.

What is driving such heatwaves even in the Arctic and Antarctic regions?

■ The primary driver is greenhouse gas emissions which are changing the entire climate system. Under greenhouse warming, we actually expect the Arctic and Antarctic to warm the fastest. Reasons include the fact that when ice melts, there is a direct feedback which warms the atmosphere further. Overall, when the average temperature increases, the variability in temperature tends towards higher absolute magnitudes. Now we are seeing changes in variability itself — not only is the average temperature warming, especially in some of these high latitude areas, but the variability around the average is getting larger. With larger variability, you get heatwaves that are super-charged.

BEYOND SWELTERING

Current heat data is entirely anomalous to all modern records, also triggering several reinforcing factors as temperatures rise worldwide



Data Courtesy: The Hadley Centre via Our World in Data

THE NEW ABNORMAL

Do heatwaves have further climatic repercussions?

■ Absolutely. As temperatures grow hotter, evaporative demand increases. This is manifest in our lived experience with people sweating more in warmer climes. We see this in our natural systems too where a hot, dry extreme causes more evaporation from plants and soil which means a more rapid drying-out of the surface. A dry surface emits more heat and increases temperatures in the atmosphere. So, a heatwave can bring what I term 'cascading extremes', triggering the next damaging weather phenomenon.

What are your findings on heatwaves in India?

■ Our team studied the 2015 heatwave which impacted India. We examined if there was a relationship between rainfall patterns, soil moisture and the temperature extreme. We found a local reinforcing effect where an unusually dry phase meant that soil moisture dropped to a remarkably low level — that reinforced the heat to a much more extreme point.

How does extreme heat impact human health and well-being?

■ The 2015 heatwave caused huge mortality in India. The loss of lives is the most tragic result but heat has underestimated effects as well. Heat impacts peoples' quality of life, harms those who suffer from respiratory and cardiovascular conditions and exacerbates asthma in children, affecting their ability to develop in a healthy way. We have not been able to measure all of this yet, so heat is costing us more than we know.

What are your projections for further heat events in India?

■ There is no question that this situation is going to get worse. The fact is, the world is getting hotter everywhere. In India specifically, there is the additional possibility of amplifying feedbacks associated with transitional climate zones that change from, say, the aridity of Rajasthan to the more humid east. These zones are very sensitive to climatic changes — these areas go very green in the event of good rain and turn extremely brown when facing dry heat. So, India will see both the increase in temperature in general and find these feedbacks specifically intensifying the impacts of a warming climate.

What are the most important adaptations you'd suggest?

■ The good news is that there are many options. When I work with health and emergency services, I'm very impressed by the simplicity of multiple interventions. Mortality caused by heat tends to impact the health-vulnerable and older people most. Simply checking in on these groups to ensure they are getting enough hydration and ventilation is very effective. Heatwaves will be a test of our social cohesion too — we must strengthen our ability to remember the vulnerable.

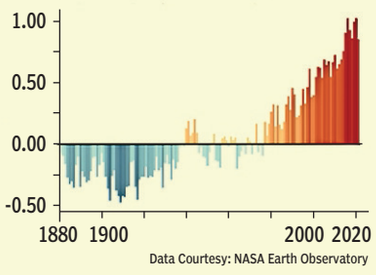
We also need better awareness of heat in medical systems which should recognise heat stress symptoms and keep treatments handy. Early warnings and paying attention to combined heat and air quality advisories is also important. The more there are cool environments in place for people to access, the better.

As the world warms, we need more air-conditioning — but this adds to emissions which further heat Earth. How do we solve this dilemma?

■ The combination of responsible efficiency and technology can help. There is growing discussion in the US about alternatives to highly energy-intensive air-conditioning. In dryer environments, evaporative or desert coolers can provide relief but that won't work in humid areas. There is a big move towards two-way heat pumps that allow for climate control in a more efficient manner. None of this is energy-free though — so, adaptation also needs to prioritise efficiency and green energy production.

OUR HEATED HISTORY

From 2015 onwards, we are experiencing the warmest years on modern record, with 2021 joining 2016, 2019 and 2020 as the hottest years ever



Data Courtesy: NASA Earth Observatory

IN COOLER TIMES

- **Handheld fans** originated in Egypt **4,000 years ago** — popular in **courtly cultures,** these became widespread in East Asia where flat fans evolved into **folding fans** made of paper, bamboo or silk. Portuguese traders brought fans to Europe in the 16th century where they even became **part of Spain's flamenco dance**
- The **first electric fan was made in 1886** with **overlapping metal blades** similar to water turbines, a motor driving a rotating shaft. By the 1920s, these were made of plastics, eventually becoming **vital to computers by keeping microchips cool**
- The **desert cooler,** relying on drenched pads to cool air, was invented in 1908 — but soon, **air-conditioning** emerged. Starting in the 19th century's textile industry where atomised water sprays were used for cooling, the **Milam Building in Texas was the first fully air-conditioned office made in the 1920s**
- **Heat pumps** are now considered **climate-friendly adaptations** — a heat pump can warm or cool an interior by **transferring heat in or out of buildings.** The roots of cooling devices also lie in a traditional Indian practice of using mats of **wet vetiver or khus grass which cool air by evaporation**

Research: Encyclopaedia Britannica, BBC, Smithsonian Magazine

Photos: iStock

THEY FEEL IT TOO

- When air temperature exceeds body temperature, animals and birds can only cool themselves through **evaporative water loss** which brings the risk of dehydration. During heatwaves, this might not even work — over 2,000 **koalas** perished in Australia's 2019 heatwave, their plight exacerbated by their main nourishment, **eucalyptus trees, drying out**

- **Salmon** are **migratory fish** and travel from the oceans up rivers to spawn. They now face dams blocking their natural path — **in heatwaves, they also face higher water temperature, which means lower oxygen in warmer waters.** Meanwhile, dams and other habitat fragmentation are reducing refuges like cooler, deep pools at the bottom of waterbodies

- **Bumblebees** are vanishing in regions that have grown hotter recently — scientists have found the probability of bees occupying a given site **fell by 46% in North America between 2000 to 2014.** Bumblebees are affected by rises in average temperatures and the frequency of heatwaves, increasing **crop diseases, the onset of parasites and higher pesticide use** than the little pollinator can endure

Research: National Geographic, Yale Environment 360, MIT Technology Review

'Heat exposure is already impacting productivity in India'

Drew Shindell *teaches earth science at Duke University. He tells* ***Times Evoke*** *about labour productivity reducing as the world warms:*

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My research is focused on understanding the drivers of climate change, their impacts and solutions. Part of my research findings show us how the effects of heat exposure and the high humidity coming with it are incredibly large — this is already causing losses upto two trillion dollars and a two-degree Celsius rise in temperatures could cause a further loss in labour productivity of $1.6 trillion.

The positive note here is that while we often think it is too expensive to alter our energy systems to reduce emissions, these findings show that there are enormous costs to not taking action. Just the effects on labour productivity due to heat can be the same size as the expenditure needed to shift to a climate-friendly economy.

The industries that are mainly impacted are agriculture, construction, fisheries, forestry and sectors which are primarily outdoor and demand heavy effort. The lost productivity impacts are greatest in the tropics — India could be the most affected country in the world, followed by China, Indonesia, etc. India, being at a low latitude and subject to heat and humidity extremes, already has the equivalent of about $600 billion lost in labour productivity. The other worrying finding is that as the climate warms, it gets harder to adapt to extreme heat — an agricultural worker could get up earlier in the morning and try to do more then instead of the middle of the day. But as the planet keeps warming, this option will become less and less effective.

MELTING MOMENTS

An important adaptation is to provide shade and water breaks to outdoor workers. This is more straightforward for construction workers as compared to farmers since agriculture is in large, open fields. Wearing protective gear to lower heat exposure and taking regular rest and water breaks is important. But even in advanced economies, including parts of the United States where migrant workers often do agricultural tasks, virtually none of these benefits are currently provided.

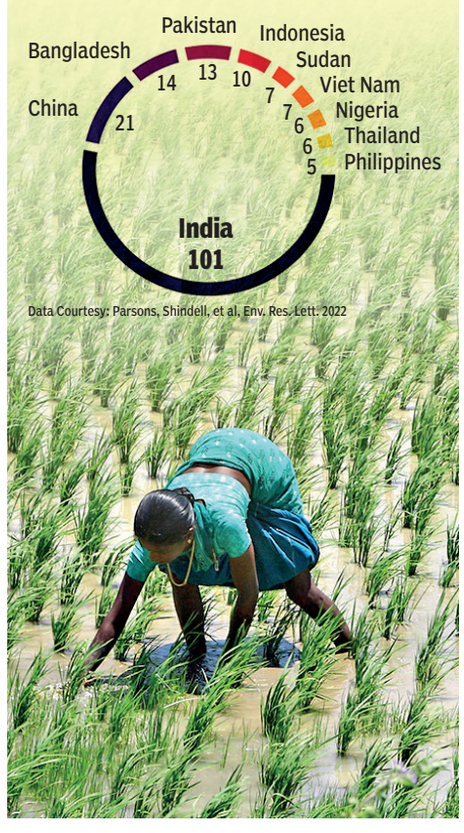
But people simply cannot work uninterrupted outdoors for several hours at a time when it is so hot — both their productivity and health will collapse. It should be mandatory to recognise these conditions as dangerous and ensure workers take suitable intervals. We need to reimagine the work day now — we should learn from earlier practices like taking a break in the hottest parts of the day, as was done in Spain where shops were closed for siesta in the afternoon. An adjustment to cooler hours should become more widespread but as the planet warms, there will be decreasing benefits to this. There are places like coastal India and the Persian Gulf where, because of warm air coming off the waters, night-time temperatures don't drop much. So, unless we reduce climate change itself, we find ourselves facing less effective adaptations.

In the US, the Occupational Safety and Health Administration traditionally looked after worker safety in construction, mining, etc. — they have now started to examine heat exposure in work conditions. This is a very wise move which needs to be echoed by comparable agencies world over. I'm from south-eastern America, the hot and humid part of the US which isn't even that different from tropical countries — we already suffer lost worker productivity from heat and humidity. So, while adaptations should examine local conditions, we need global awareness of these impacts and universal concern for those facing their brunt.

HOW MUCH LONGER?

As the world warms, outdoor work is growing harder and needs safeguards for workers and productivity

12-hour workday population weighted loss, Global sum: 228 billion hours

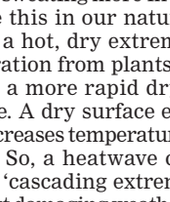


Data Courtesy: Parsons, Shindell, et al, Env. Res. Lett. 2022

'Urban heat is a huge challenge — India has a history of mitigations like city trees'

Vivek Shandas *teaches climate adaptation at Portland State University. Speaking to* ***Times Evoke,*** *he discusses why the world's cities are heating up:*

My area of research is the intersection of climate change, cities and adaptation to climate stressors. I use spatial analyses techniques, systematic scientific approaches and community engagement to understand climate stressors and adaptations in cities.



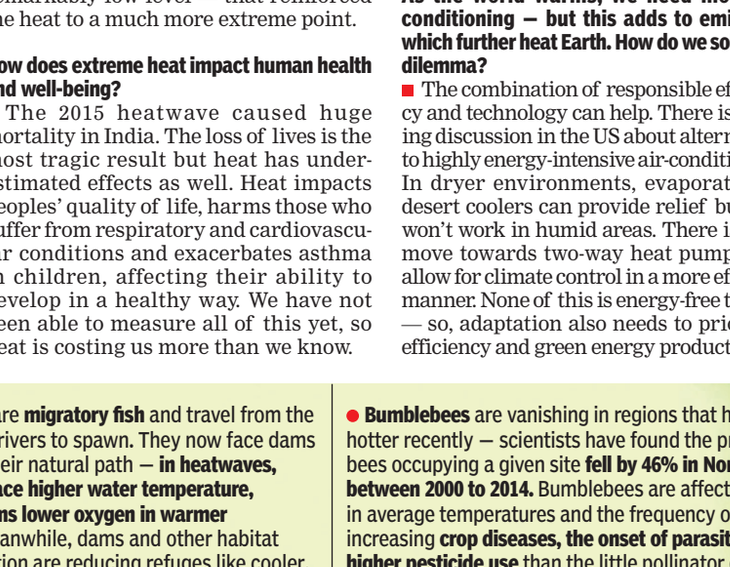
One of the phenomena I research is the 'urban heat island' effect, first documented in the 1850s. This measures the differentiation between a city in temperature and humidity compared to adjacent areas which don't have built environments or roads, buildings, etc. That difference is the 'urban heat island' effect. We've learnt of factors since that contribute to this phenomenon — these include materials used to build cities like asphalt, concrete, bricks and other supplies which are very dense in their composition. Often, the darker colours we paint these in also absorb and retain short-wave radiation from the sun.

This contrasts with green spaces that absorb such radiation but dissipate it relatively quickly. Trees and plants also transpire water which cools the environment further. Hard materials hold onto heat and amplify temperatures — this is a primary contributor to urban heat. Other factors include the configuration of buildings — with big buildings amassed along a waterway, like in Mumbai and other coastal cities, the wind coming off the waterway can get blocked. When buildings are placed close together as well, they reduce the convective movement of air which makes it stagnate and heat.

Data Courtesy: V. Shandas

THE DIFFERENCE YOU MAKE

Apart from being so beautiful, trees cool the surrounding atmosphere, as data from Portland, Oregon, shows



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HEAT IN THE CITY

We've also found temperature anomalies within a city — these are termed 'hot spots' where the relative difference between neighbourhoods or streets can vary upwards of twelve degrees Celsius. That suggests physical factors amplify heat even between streets. As it gets hotter — last year, India saw more days above 40 degrees than any prior year — that difference also increases. On a 40-degree Celsius day, a ten-degree difference between two neighbourhoods can become 20 degrees. This is hugely concerning.

Our studies show hotter areas tend to have more built-up infrastructure. This doesn't mean only tall buildings — relatively lower but large, low-slung buildings, one to two stories tall, made of bricks or cinder blocks, surrounded by concrete or built-up parking lots, let the sun's radiation hit surfaces, holding that heat for a long time. Planners should ensure such areas have place to plant trees which significantly reduce the temperature.

As physical scientists, we've measured city temperatures across North America, the Middle East, Latin America and Asia — we found the hottest locations tend to coincide with lower-income areas. Some term this 'the luxury effect' or the fact that wealthier people have space for greenery. However, this only points a finger of blame at the individual. I felt this was more of a systemic issue, driven by a larger set of policies. In 2020, we published a landmark study, showing how, in the US, the 1930s' policies of segregation and exclusionary red-lining, where certain areas were marked out with red lines for immigrants, the poor and non-white populations, had a consistent correlation with the hottest city spaces. This showed the effects of a systemic policy and planning protocol in who experiences the hottest temperatures now.

These findings have resonances for India where over 7,40,000 people perish annually due to heat, most from lower-income groups. With 481 million urban residents and cities growing fast with in-migration, we are confronting severe impacts on those with the least capacity to cope. We need to examine whether we are building cities in ways that amplify temperatures. From a planning approach, we must increase green spaces. India has a rich history of cooling trees in cities. I grew up in Bengaluru amidst sprawling banyans and lush mango groves — this has changed over the last two decades with vast urban deforestation. We need to reverse this trend, creating city afforestation. If we start planting today, by the time the even hotter 2030s arrive, those trees will provide life-saving shade.

Globally, temperatures are breaching 50 degrees Celsius regularly now — but our built environment is not ready for this. I live in the Pacific northwest of the US. When the heat dome phenomenon descends on us, railway tracks buckle, electricity lines melt and roadways crack. The scale at which these high temperatures are impacting urban environments is unprecedented. It makes planning for adaptations and mitigations urgent.

READERS WRITE

Dear Times Evoke,

TOI-Times Evoke is for people who want to learn something truly interesting in their lives. I was mesmerised by Kim Valenta on colours (5th March). Looking forward to more Times Evoke scholars.

—Atul Sharma, Lucknow

Thank you, TE, for exploring colours in the world of nature. Against troubling geopolitical conflict, this was ideal. The colours of plants and animals are vital for biodiversity. Humanity must preserve these.

—Revansidh Halloli, academic, Sangameshwar College, Solapur

Vinod Kumar Saranathan's research is so richly informative! We learnt how pitta birds' gyroids give them their intense blue! Kudos!

—Sujata Venkat, Pune

I recently started reading TOI's TE and I literally felt like why didn't I start earlier! In TE's feature on colours, I learnt about how special the visual perspective of animals and birds is. These topics are simply fascinating. Thank you, TOI!

—Jatin Lalwani, Jaipur

Every colour in nature has a meaning, which Hopi Hoekstra revealed. We need to be mindful of nature's intricacies. A beautifully presented Times Evoke page.

—Shanker Jha, IPSHEM-ONGC, Goa

I'm an ardent TOI reader and I find Times Evoke extremely interesting and beneficial. Such information is usually featured in magazines of National Geographic's level.

—Om Dutt Chawla, Delhi

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