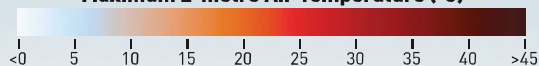




ENVIRONMENT

Maximum 2-metre Air Temperature (°C)



Death by DEGREES

With climate projections indicating a sixfold increase in heatwaves by 2060, heat emergency plans need to be made and implemented immediately to protect vulnerable population groups.

BY ROXY MATHEW KOLL

POPULATION $\geq 1,000,000$



PRAYAGRAJ
45.03°C



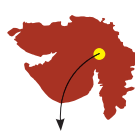
KANPUR
44.95°C



AGRA
44.72°C



LUCKNOW
44.60°C



AHMEDABAD
44.45°C

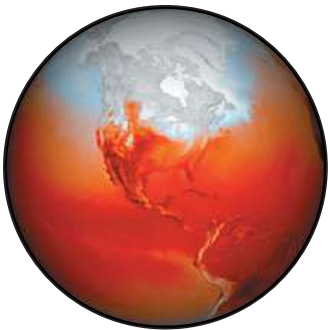
I HAVE LOOKED AT CLIMATE change data clinically for most of my scientific career. But when I first looked at this list of people who died a tragic death, my heart sank.

Fourteen people lost their lives to heatstroke on April 16, 2023, during an official government ceremony held on open ground in Kharghar in Navi Mumbai, Maharashtra. Several hundred were hospitalised. Ten out of the 14 who died were women, all of them mothers, between the ages of 34 and 63 years. This was a tragedy that could have been averted with the right precautions in place.

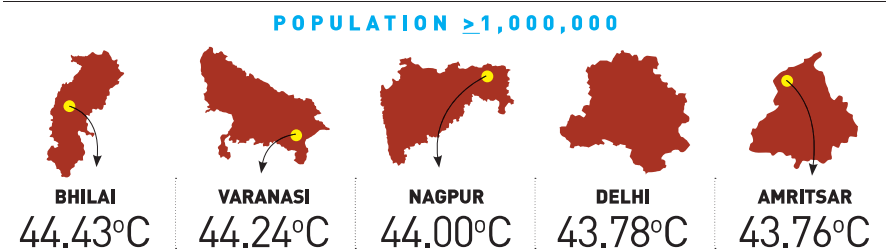
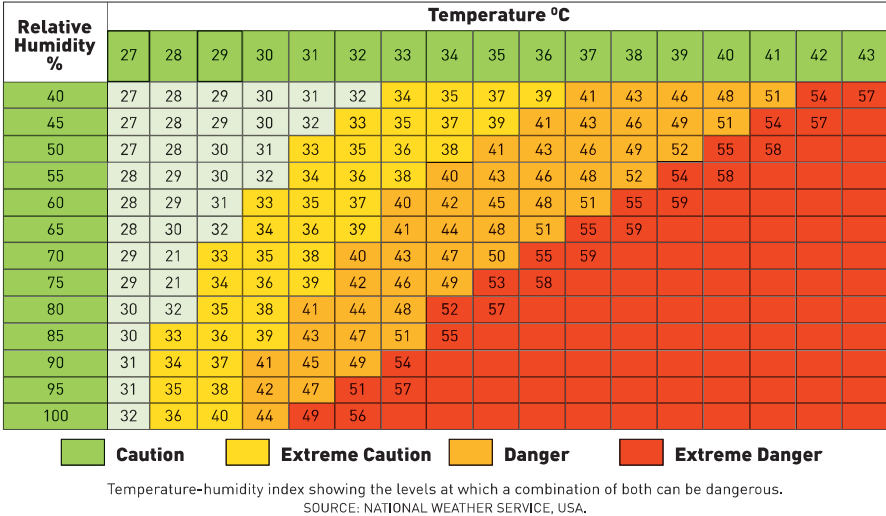
Temperatures have been steadily rising in India. February 2023 was the hottest February on record in the country. Although monthly average temperatures during March and April were above normal, they were

not exceptionally high due to scattered thundershowers bringing down the mercury. Daily maximum temperatures, however, went 2-3 degrees above normal on several days, even while not being classic heatwaves.

On the day of the incident, the closest meteorological observatories recorded a maximum temperature of 34-38 degrees Celsius, along with a relatively high humidity (45 per cent), exacerbating the impact of the heat. People are advised to stay indoors during such peak heat hours. When the air has high levels of humidity along with the heat, the body fails to regulate its internal temperature via sweating as it does not evaporate fast enough. This can result in a heat stroke, leading to multiple organ failure and deaths.

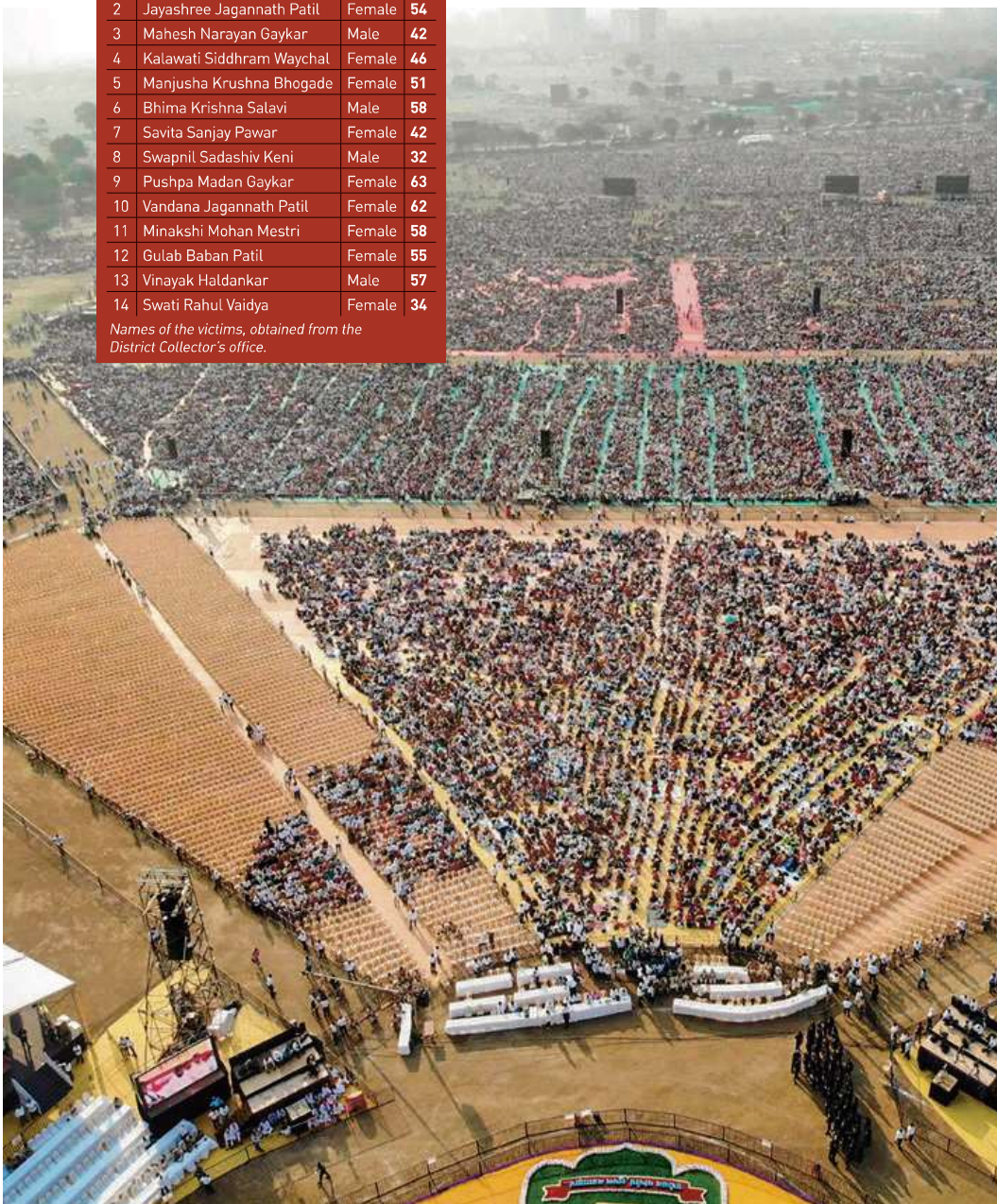


THE MAPS (above, facing page & bottom) show modeled air temperatures on April 27, 2022. They are derived from the Goddard Earth Observing System model, and represent air temperatures at 2 metres (about 6.5 feet) above the ground. Source: NASA Earth Observatory image by Joshua Stevens.



1	Tulashiram Bhau Wagad	Male	58
2	Jayashree Jagannath Patil	Female	54
3	Maresh Narayan Gaykar	Male	42
4	Kalawati Siddhram Waychal	Female	46
5	Manjusha Krushna Bhogade	Female	51
6	Bhima Krishna Salavi	Male	58
7	Savita Sanjay Pawar	Female	42
8	Swapnil Sadashiv Keni	Male	32
9	Pushpa Madan Gaykar	Female	63
10	Vandana Jagannath Patil	Female	62
11	Minakshi Mohan Mestri	Female	58
12	Gulab Baban Patil	Female	55
13	Vinayak Haldankar	Male	57
14	Swati Rahul Vaidya	Female	34

Names of the victims, obtained from the District Collector's office.





The heatwaves in 2022 were record breaking. While the maximum temperature touched 50°C in India, it went beyond 51°C in Pakistan.

However, the fatalities were not solely caused by the heat or humidity. Hazards like heatwaves become lethal when the most vulnerable sections of the population are exposed to it for prolonged periods. In this case, those who lost their lives were mostly middle-aged to older women, in a vulnerable state, who were exposed to the peak heat for several hours. They left their homes at dawn, travelled two to four hours in the heat, then sat down in a heavily packed ground for several hours under the blazing sun. They did not have access to water or toilets. They could not even talk. Though the heat is blamed, it is the lack of basic precautions that saw them die.

HOW DO HEATWAVES OCCUR?

Heatwaves occur when dry and hot air sinks from the upper atmosphere and pushes down towards the surface of the earth. As it descends, the air gets compressed and becomes even hotter, creating a stifling dome of heat. This makes it hard for clouds to form, which means that the sun's heat can directly reach the ground, making the region even hotter. This is why heatwaves often occur on clear, sunny days. This is a typical condition in the Indian subcontinent during April-May. Now we have additional heat accumulating due to climate change, resulting in more intense heatwaves.

The arid northwest Indo-Pakistan region, which is home to about 760 million people, is particularly vulnerable to record-breaking heatwaves. During April-May, temperatures frequently exceed 40°C, sometimes leading to scorching

heatwaves. These events have become more intense, longer lasting, and more widespread in recent years. These heatwaves can be lethal, especially for the elderly and those with preexisting health conditions.

Geographically, the heatwave zone lies diagonally across the Indo-Pak region. In India, the States of Punjab, Himachal Pradesh, Uttarakhand, Delhi, Haryana, Rajasthan, Uttar Pradesh, Gujarat, Madhya Pradesh, Maharashtra, Chhattisgarh, Bihar, Jharkhand, West Bengal, Odisha, Andhra Pradesh, and Telangana lie in the heatwave zone. Between 1971 and 2019, heatwaves claimed about 17,362 lives in India—that is about 350 lives a year on an average.

CLIMATE CHANGE EFFECTS

The increase in these heat extremes is in response to the 1 degree Celsius rise in global mean temperatures, due to historical carbon emissions. All these events are projected to intensify further since the commitments from global nations (historical emitters US, Europe, Russia, etc. and currently China, India, etc.) are insufficient to keep the temperature rise from hitting 1.5°C between 2020 and 2040 and 2°C between 2040 and 2060. That is not too far in the future. That is not just our children or grandchildren. Most of us living now will face a doubling of global temperatures a few decades from now. As we reel under the impact of that 1°C rise, the grave impacts of doubling that are difficult to visualise.

Heatwaves are projected to become more frequent and intense in the future, posing a threat to the growing vulnerable population in the region. In fact, future climate projections indicate an up to sixfold increase by 2060. The region's

THE PACKED VENUE in Kharghar for the Maharashtra Bhushan Award ceremony on April 16, 2023, that resulted in 14 heat-induced deaths.

largely vulnerable population is expected to reach 1 billion by 2050, further raising concerns about the impact of future heatwaves.

URBAN HEAT ISLANDS

Cities turn into urban heat islands when buildings, roads, and other infrastructure absorb and re-emit heat, causing cities to be several degrees hotter than surrounding rural areas. During the day, the sun's rays reach as shortwave radiation and heat up the earth's surface. At night, the heat escapes as longwave radiation. While shortwave radiation can easily penetrate and reach the earth's surface, the longwave gets trapped by concrete and clouds.

High-rise buildings and concrete structures in the cities do not let the excess heat escape at night. As the temperatures do not go down, the heatwave continues into the night. Open green spaces and natural environment with trees can help release the heat faster during

While climate change is aggravating the heat everywhere, urban heat islands that trap this heat are of our own making.

the night. However, in India, we do not appreciate natural space as much as we appreciate skyscrapers. Add haphazard city planning, poor architecture, and unsustainable construction to this equation, and the recipe for an urban heat island is complete.

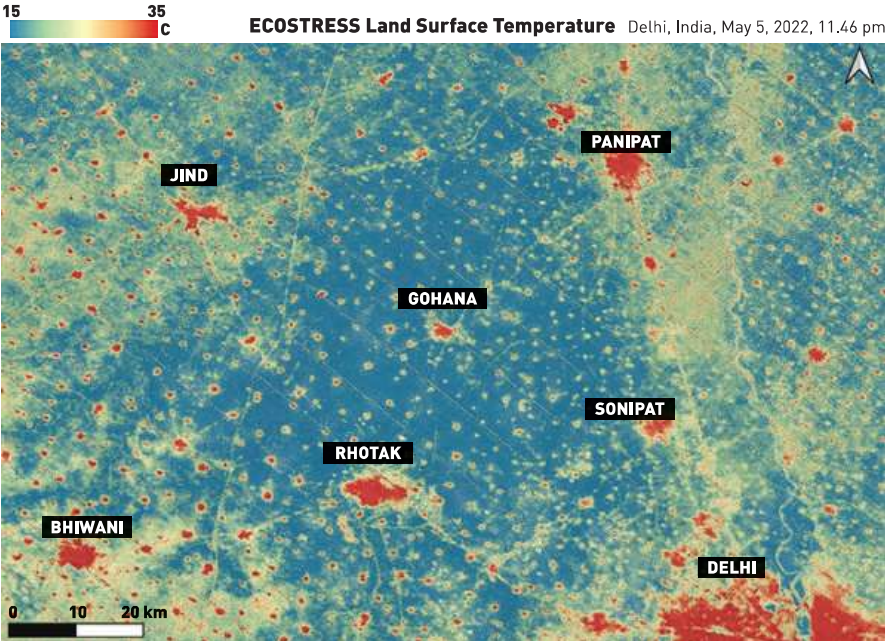
Have a look at the night-time temperatures in Delhi and its sur-

roundings in the month of May. The difference is stark and stunning—up to 20°C between urban and rural areas. While climate change is aggravating the heat everywhere, urban heat islands that trap this heat are of our own making.

HEATWAVES, DRYNESS, FIRES, POLLUTION

The heatwaves in 2022 were record breaking. While the maximum temperatures touched 50°C in India, it went beyond 51°C in Pakistan. This was a season-long heatwave spanning from March to May. The impact was aggravated by the fact that the season did not see the any thundershowers to bring temperatures down. The north-northwestern States of India saw a rainfall deficit of 70-90 per cent, which was not expected.

A combination of heatwave and dry-drought conditions can be deadly, leading to impacts such as widespread fires, crop loss, and water scarcity. The conditions impacted



Land surface temperatures from NASA's ECOSTRESS instrument onboard the International Space Station.

wheat grain size and production. India is the second largest exporter of wheat, but had to curtail wheat exports in May 2022 to ensure national food security. The particular dry and stagnant atmospheric conditions also lead to raised pollution levels as the particles from widespread fires and stubble burning remain in the air. We see more of this kind of overlapping extreme weather conditions—known as compound extreme events—in response to changing climate and land use changes.

High temperatures and less water result in more air-conditioners for cooling and groundwater pumping for irrigation, leading to electricity demand and more emissions. This is a vicious cycle, where the demand for cooling leads to more heating of the planet. Basically, the impacts of such heatwaves are on the food, water, and energy sectors, and they derail us from the mitigation and adaptation strategy that we are currently on.

ACTION PLANS

The India Meteorological Department (IMD) provides heatwave warnings on a six-hourly basis, for the next five days. These forecasts go to all cities and districts of India, where the local governments prepare a yellow (watch), orange (be prepared) or red (take action) alert based on the severity of the heatwave. The forecasts meant for the next two days have an accuracy of 80-90 per cent, which means that they are reliable. There are heatwave outlooks for the next two weeks and for the season, that can help in advance planning.

These forecasts are available in the public domain, and the media often disseminates this information in national and regional newspapers. If your regional media outlet does not do that, call them up. IMD has a FAQ document on heatwaves that has detailed information regarding

heatwave forecasts, and is available on their website. After the fatal heat waves in 2010, the Ahmedabad Municipal Corporation developed a Heat Action Plan for the city in co-ordination with the meteorological forecasts. The community outreach, health alerts, training of healthcare professionals, and efforts specifically targeted at vulnerable groups have helped reduce the impacts of heat stress on the local population. Drawing lessons from Ahmedabad's Heat Action Plan, several cities and States have initiated their own action plans with the help of disaster management agencies and health departments. If you are a city or panchayat without a heat action plan, what is stopping you?

NO RUNNING AWAY

I live in Pune where temperatures are generally mild, but in May last year, the heat reached Pune as well, with temperatures touching 40°C. This was also the time after the COVID-19 lockdown, schools had just started, and children were eagerly sent to school. Unfortunately, they returned home when temperatures were at their peak and they were exposed to the extreme hot air. By the time my children got home, they were almost in a heat-struck situation. We approached the school with the forecasts, and they cut down the school hours to save the children.

Though it was mild this year, Pune saw a few weeks of early heat in April. Since there was no policy in place, and since the school management

had changed, no precautions were taken. We had to repeat the same sequence of events, with the school cutting down the hours close to the summer vacation.

While forecast-based heat action plans are good, they are not sufficient. We need policies considering the fact that heatwaves are here to stay and intensify. We have sufficient data to identify the regions where the heatwaves are increasing and we need to have policies in all those places. We need to redesign our cities to have open spaces and trees that help release the excess heat quickly and also act as hubs for shade and cooling down. Integrating a heat emergency plan into the education system and workplace policies can equip individuals to handle heat emergencies and protect their health and well-being. India needs a long-term vision where we have policies that help us in managing our work hours, public infrastructure, schools, hospitals, workplaces, houses, transportation, and agriculture for heatwaves to come.

Back in Maharashtra, the administration and the political parties are taking precautions for upcoming open-air events, likely in response to the Kharghar incident. They are arranging water bottles, mobile toilets, and on-site doctors to attend to emergencies. If we had taken these precautions beforehand, we would not have lost those 14 lives. □

Roxy Mathew Koll is an author, a reviewer of recent IPCC reports, and a climate scientist at the Indian Institute of Tropical Meteorology.

WOMEN USE TOWELS to cover their heads on a very hot day in the Ranigari Thota area of Vijayawada, Andhra Pradesh, on April 12, 2023. The State falls in India's heatwave zone.



G. N. RAO