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IS EXTREME HEAT MAKING INDIA UNLIVABLE?

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2020 is on track to becoming one of the hottest years ever recorded globally. But nowhere is extreme heat and humidity as much a threat as in India

In the summer of 2015, an intense series of heatwaves swept across much of India. Over a period spanning nearly two weeks between end-May and early June, northwest India, the Indo-Gangetic plain and eastern coastal India sweltered as temperature spikes were recorded all through the region. Among others, Hyderabad recorded 46 degrees Celsius on 21 May, Delhi 46.4 degrees Celsius on 25 May, Palamau 47 degrees on 29 May, Allahabad 47.8 degrees on 9 June and Bhubaneswar 44 degrees on 10 June.

But the individual temperature spikes were just the tip of the problem, as heatwave conditions persisted throughout this period. In Telangana, Andhra Pradesh, Odisha and West Bengal, high heat turned lethal in conjunction with high humidity: 1,735 people died in Andhra Pradesh, 585 in Telangana, while the total number of deaths recorded in the country was over 2,400. Daily death tolls were high, like on 26 May, when 74 people died in Telangana. On 25 May, taxi unions in Kolkata refused to work between 11am-4pm after two drivers died of heat stroke. According to the International Disaster Database, it was the fifth deadliest heatwave ever recorded.

But 2015 wasn’t an isolated phenomenon. The next year, on 19 May, Phalodi in Rajasthan, on the India-Pakistan border, hit 51 degrees Celsius, a new record for the highest day-time temperature in India. This spike was part of a heatwave where the temperature hovered within 1 degree of that value for three consecutive days. July 2019 was the hottest July ever recorded in India, according to the India Meteorological Department (IMD), while a heatwave swept across much of north and central India in May and June, killing over 180 people in Bihar alone. There were also reports of elderly passengers dying in train compartments owing to the heat. That summer, Delhi set a new maximum record of 48 degrees Celsius, while Churu in Rajasthan hit 50.8 degrees Celsius. On 26 May this year, Delhi hit 47.8 degrees Celsius, while Churu again recorded a high of 50 degrees Celsius as another heatwave swept through north and central India.

Rising Heat And Heatwaves

India knows heat. Although the country is vast enough to host a variety of regional climates, for much of the subcontinent, summer heat is a way of life. But even by India’s standards, cases of extreme heat, and overall heat stress, are rising at an alarming rate. In June, the Union ministry of earth sciences (MoES) published India’s first national climate change report, *Assessment Of Climate Change Over The Indian Region*. The report said India’s average temperature had risen by 0.7 degrees Celsius from 1901-2018.

This rise is primarily due to global warming caused by greenhouse gas (GHG) emissions. In a business-as-usual world of current GHG emissions, the assessment says, India’s average temperature will rise by almost 4.4 degrees Celsius by 2100, compared to the recent past (1976-2005). What’s more, the frequency of summer heatwaves is projected to increase by two-three times, while the duration of these heatwaves is expected to double (both relative to the baseline period of 1976-2005).

One of the authors of the assessment report is physicist and climatologist Chirag Dhara from the Indian Institute of Tropical Meteorology (IITM), Pune. He says that one of the reasons India is

very susceptible to climate change impacts when it comes to heat is because the country's temperatures are already very high. "You take any system, and when you are already on the edge and you stress the system some more, the impacts are much higher. India's baseline temperatures are already very high. And particularly in the coastal areas and in the Indo-Gangetic plains, the humidity also being high, even a slight jump over there is much worse than the same quantum of jump in an area with a much lower baseline temperature," he says.

Humidity is an important part of this equation. For example, the 2015 deaths in Andhra Pradesh and Telangana were due to high temperature and high humidity. This is reflected in the heat index (HI), a measure of how hot it feels when relative humidity is factored into the air temperature. Another measure is the wet-bulb temperature, which measures heat stress as a combined effect of temperature and humidity on the human body. Human beings, even those who have adapted to high heat, find it difficult to carry out normal activities in a wet-bulb temperature of 32 degrees Celsius. The survivability threshold of the human body is reached at the wet-bulb temperature of 35 degrees. At that level, even if a human being is in the shade, the results are fatal. This comes down to the human body's cooling system: sweating.

"The higher the temperatures, the more the body sweats. But then that sweat needs to evaporate to actually cool the body. So when sweat evaporates readily from our skin, it is grabbing a lot of heat from our skin and transferring it into the atmosphere," says Dhara. "When there's already very high relative humidity, the water cannot evaporate efficiently from the skin. So the heat just stays there, it's unable to dissipate." Dhara says that global warming—which increases not just the temperature but also near-surface humidity—makes hot, humid days more frequent and intense, which in turn makes the body's heat control mechanism less efficient. That's heat stress. And this is the kind of thing that increases the risk of heat strokes.

This lethal combination of heat and humidity has emerged as a major source of worry in South Asia. In August, the McKinsey Global Institute published a paper titled *Climate Risk And Response In Asia: Research Preview*, which looks at a nearer time-frame of 2030-50. Referring to wet-bulb heatwaves, the report says that "…large cities in parts of India, Bangladesh, and Pakistan could be among the first places in the world to experience heat waves that exceed the survivability threshold". Another study, *The Emergence Of Heat And Humidity Too Severe For Human Tolerance*, published in May in *Science Advances*, identifies north-west India, the Indo-Gangetic plain and eastern coastal India as a global heat hot spot, where wet-bulb temperatures of 31 degrees Celsius are already common. The McKinsey paper further says that by 2050, 500-700 billion people in India, Pakistan and Bangladesh could be living in regions which would have a 20% probability of lethal wet-bulb heatwaves every year. Since wet-bulb temperatures severely affect the ability to work, the three South Asian nations could see a hit to their GDP to the tune of 13%.

According to the United Nations Development Programme (UNDP), India lost 3.6% of daytime working hours due to heat in 2015. The International Labour Organization (ILO), in its 2019 report *Working On A Warm Planet*, says India is projected to lose the equivalent of 34 million full-time jobs in 2030 due to heat stress, with agriculture and construction being the worst-hit sectors. In 2019, a study conducted by the University of Chicago's Climate Impact Lab and Tata Centre for Development highlighted the fact that an additional 1.5 million people may die in India each year due to extreme heat by 2100. According to an interactive map on the Climate Impact Lab website, a high emissions scenario would see mortality costs for India rise to 4% of the GDP by 2080.

While heatwaves could have high, concentrated impacts, there's also the impact of chronic heat—high heat conditions that last for extremely long periods of time. To understand this, I spoke to adaptation and water resources specialist Christian Siderius. In 2019, he co-wrote a

policy brief for the London School of Economics and Political Science (LSE) titled *Cities, Climate Change And Chronic Heat Exposure*. In the paper, the authors employed the measurement value of wet-bulb globe temperature (WBGT), which takes into account temperature, humidity, wind speed, sun angle and solar radiation (whether there is any cloud cover). In a WBGT of above 30 degrees Celsius, any physical activity is dangerous.

In the LSE brief, Siderius and his co-authors show that three Indian cities—Delhi, Mumbai and Kolkata—have daytime WBGT approaching 30 degrees Celsius. The heat stress indicators for these cities fall in the "Very Hot (danger)" range. A fourth city, Bengaluru, falls in the "Warm (Caution)" range. The paper states that though this is based on the three hottest months of the year (April, May and June), the danger of heat exposure doesn't really diminish till early October. In a climate change scenario where the world heats up by 3-4 degrees Celsius above pre-industrial levels by 2100, the number of days with dangerous, constant heat could rise to between 100-250.

"The main thing is that of course there is this extreme level above which people really can't physically survive for a very long period. And we are coming closer to that threshold," says Siderius. He says heatwaves are already more regular, but that the period over which the weather is very hot will also be much longer. "Because individual heat events start to merge all together, and you get a very long hot season, and that will grind down people's health. It will also be costly." He says that as average temperatures go up, "you see more extremes, and the extreme is also in the length of heat exposure".

One person who has studied both the 2015 and 2016 heatwaves in great detail is climate scientist Krishna AchutaRao, from the Centre for Atmospheric Sciences at the Indian Institute of Technology, Delhi. In a 2018 paper that he co-authored, *Extreme Heat In India And Anthropogenic Climate Change*, AchutaRao and his co-researchers noted two findings. The first is that the 2016 Phalodi high of 51 degrees Celsius is likely to become more frequent due to climate change. According to climate models, the return period of such an event is once every 7-10 years in our warming world. As a counterfactual, in a world with no climate change, such an incident would take place once every 20-30 years. The other thing they found was that a strong concentration of aerosols in the atmosphere—India's high pollution—reduces surface solar radiation and thus keeps temperatures low by counteracting the warming due to GHGs. High soil moisture due to irrigation also adds to this cooling effect, though it increases the humidity.

"We were trying to understand why there hasn't been a dramatic shift (in India's extreme temperatures). It is a shift, but very subtle. And that's where we hypothesized that both pollution and irrigation might be masking this," he says.

Look at it this way: India's temperature may have risen by just 0.7 degrees Celsius in a century but take away the pollution and we could be looking at a much higher increase in temperature. This is a fact that the MoES assessment report too suggests. Ironic as this may be, AchutaRao's paper makes clear that atmospheric pollution actually exacerbates health risks during a heatwave.

Urban Heat Traps

India is urbanizing at a rapid rate. According to the 2018 UN *World Urbanization Prospects* report, 20% of India's population lived in cities in 1950. By 2018, that figure had increased to 34%, with 461 million urban dwellers. The country is forecast to add a further 416 million urban dwellers by 2050. By 2030, India will add Ahmedabad and Hyderabad to its existing five megacities (cities with populations of over 10 million) of Delhi, Kolkata, Chennai, Bengaluru and Mumbai.

This is a level of urbanization unprecedented in human history. And it is in this same period that climate change impacts will be really felt in the country. Already, the Urban Heat Island (UHI) effect is playing a major role in heating up urban areas. Siderius and other scientists studied the heat stress of three South Asian cities, including Delhi, in 2019. While the city has seen a temperature increase of 1.2 degrees Celsius between 1981-2019, UHI temperatures in parts of the city have gone up by as much as 8 degrees Celsius.

The researchers found that the amount of heat faced by urban dwellers depended on income levels. Higher-income neighbourhoods possess favourable conditions like shading from trees and open green spaces, which reduces the chances of heat getting stored over the day and turning nights warmer. On the other hand, low-income neighbourhoods are densely-built, which means greater heat exposure and greater amounts of stored-up heat. A typical house in an informal neighbourhood in Delhi could be 8 degrees Celsius hotter than the outside temperature at night.

"If it’s very dense, if there’s less green space and less shade, the UHI effect is higher," says Siderius. "During the night, because of all the concrete and the built-up material, it stays very hot and you will have difficulty sleeping. And if that continues for a long period of time, for a couple of weeks, of course then that affects your health." He adds that as Indian cities develop rapidly and densely, they are losing their green cover. "There are few parks, few places with enough shade to accommodate a number of people in a city. In light of the changes in the future, that makes it questionable how liveable cities will be if adjustments aren’t being done," he says.

Minal Pathak is a senior scientist with the Intergovernmental Panel on Climate Change (IPCC) and a member of faculty at the Global Centre for Environment and Energy at Ahmedabad University. Earlier this year, she co-authored a report for the National Institute of Urban Affairs titled *Climate Change, Heat Waves And Thermal Comfort—Reflections On Housing Policy In India*. The study focused on low-income neighbourhoods in Ahmedabad. "The more you build, the more concrete you add in urban areas, even with minor climate change the UHI effect is a significant problem. And now, both of these problems are at their peak. So you have rapid urbanization where we are building over green spaces, open spaces, blue spaces. That’s adding to the heat burden, and the other problem is global warming," says Pathak. She adds that lower-income houses also suffer from poor ventilation, a higher density of people living in cramped spaces, and no ownership of cooling appliances, in some cases even fans.

"This is also going to affect middle-income households because of rising energy costs. Because (with rising heat) air conditioning doesn’t become a luxury, but a necessity. And people are compelled to buy air conditioners and the rising cost of paying for those electricity bills is also an equity issue," she says. Nor is a rise in the use of air conditioning desirable, for it adds to the UHI by shifting greater localized heat outdoors.

According to urban planner and architect Lubaina Rangwala, who works with research organization World Resources Institute (WRI) India’s Sustainable Cities Centre, lack of awareness of the impacts of heat hampers community action. "In India, we worked in Surat where heat stress is one of the bigger climate stresses for the city. We realized that communities don’t consider heat as a life risk or as a health risk. They see it more as a nuisance," says Rangwala.

She says that unlike flooding, which is a visible stress and therefore motivates people to act as communities to demand action, heat isn’t a rallying point for people to ask for increased green areas, or heat shelters. "We have to make those connections and understand the costs that cities and families and people are incurring by not acting. We have coastal cities with wet, humid conditions. But unless the temperature goes above 40 degrees Centigrade, cities are not even

taking it seriously. So you don’t even capture the extent of exhaustion because of the wet-bulb temperature," she says.

This is a point echoed by Siderius. "Actually when we started this research only a couple of years ago, the reply we often got was that in India we are used to this. Not such a big issue," he says. "There wasn’t really that much interest, and it was only in 2015-16, with heatwaves really becoming more prominent, that interest grew." Indians do know how to deal with heat, he says, but there needs to be a recognition that conditions are a lot more severe than in the past.

Planning For A Hot Future

The 2015 heatwaves prompted the National Disaster Management Authority (NDMA) to publish guidelines on preventing and managing heatwaves a year later. It acknowledged the fact that heatwaves are not listed as a "disaster" under the Disaster Management Act, 2005. However, it urged cities and states to prepare Heat Action Plans (HAPs) that focus on early warning systems, training healthcare professionals, raising public awareness and encouraging collaboration with NGOs and civil society. The NDMA highlighted the Ahmedabad HAP, which was launched in 2013, as a model to follow. Since then, many Indian cities, including Delhi, Hyderabad, Bhubaneswar and Nagpur, have developed HAPs, while some states like Maharashtra and Odisha have formulated state-level HAPs as well. The NDMA identifies heat-prone states every year, and for both 2019 and 2020, this number was 23.

However, despite some progress on this front, analysts say HAPs are still not implemented properly. "The Ahmedabad HAP is among the best in the country, and we really have a foolproof programme, but the implementation has not reached the desired level," says Pathak. She says such plans need to go beyond just early warning systems. "I think the HAP needs to expand way beyond that. You are telling a person that it’s going to be really hot. But then where will he or she go? I think shelters or cooler spaces where people could stay in the afternoon, like community shelters, are really needed." She also highlights the fact that there is no respite for the poorest, like pavement dwellers. "People on the pavement just have a plastic sheet protecting them. What kind of sustainability would that be?" she says.

Rangwala says the invisible risk of heat has to be made visible. "Cities like Ahmedabad and Hyderabad, which are cities in the hot and arid areas of the country, now have HAPs and there’s a significant amount of capacity building and awareness in these cities," she says. Although still marginal, Rangwala says the heat factor has begun to influence some labour laws and certain aspects of building regulations. However, the amount of concrete being poured into cities as they develop actually hamper any attempts by HAPs to counter heatwaves. "We need to break the notion of this kind of materiality that comes with the vision of growth. We need to be able to employ more passive design and green building methods," says Rangwala.

"There’s no single magic bullet that will solve it," says Siderius. According to him, it comes down to accumulating small gains from individual steps. "If you are able to organize your city in such a way that there is airflow, that there is shading at street level, that not everything is concrete or built up, that lowers maybe the outer temperatures at night by a couple of degrees," he says. Creating safe and comfortable green spaces where people would like to go in the evenings, would help. Painting house roofs in a light colour that reflects heat, and then maintaining it, or planning for proper home ventilation, helps too. "But the main thing is that once you have a better temperature range outdoors within your neighbourhood, because you have a better organized city, then it’s also easier to take effective measures indoors," he says.

One way to help plan the process is to use the heat maps for cities. Raj Bhagat Palanichamy is a data analyst and a Geographic Information System (GIS) and remote sensing analyst at WRI

India’s Ross Center for Sustainable Cities. Some of his work focuses on preparing heat maps for use by city planners. He uses thermal infrared bands from satellite images for surface temperatures and air temperature data from IMD and local agencies to plot heat for a city. "The maps try to figure out the hot spots in a city. Surface temperature is very helpful in figuring out our interactions with hot bodies. For example, a tar road is hotter for the human body than the shade under a tree," he says.

According to Palanichamy, the hottest spots turn up in massive "tar-concrete" complexes like bus depots or industrial areas. This is followed by areas with low-income houses. "Bengaluru is our most studied city. For example, if you are looking at Kalasipalayam, which is more dense, it’s the old town, and in those sections it is very hot. And if you are looking at a somewhat planned layout like Jayanagar or Langford Town, it is cooler because of the amount of vegetation that is there. You have a proper gridded street network with tree-lined avenues," he says, adding that solutions for urban resilience have to be very local.

AchutaRao too says that solutions have to be local. For example, he says, if heat waves begin earlier, then a heat-stressed state might have to shift the entire school year, so that children are not subjected to them. "It’s one thing to deal with a heatwave forecast by IMD. It’s a different thing altogether if you expect heatwaves to become more frequent. If every year you are going to end up with a hotter peak, you will have to change all your activities. If you are planning on pre-monsoon construction, do you want to put your labour out there in a heatwave?" he says.

There are any number of sectoral impacts with heat, says AchutaRao, but they will be specific to different geographies. "There are regions in India which have almost no incidents of heatwaves. Let’s say, in the future, these regions start experiencing heatwaves. It could potentially change a lot of things that are specific to that region, whether it is human or agricultural or natural systems."

India’s situation with regard to climate change is unique, since the impacts of global warming on the country are going to be multifaceted. Whether it’s sea-level rise, extreme weather events, melting glaciers or an unpredictable monsoon, there are multiple threats for the country to adapt to. But the most worrying impact remains extreme heat. When I ask Pathak about her perception of this challenge, her answer is emphatic. "I always hesitate to use the word ‘worried’ because I think if I started using it then my work wouldn’t mean anything. But if I had to point the finger at one top climate or environmental challenge, I would say that would be the impact from heat."

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