Climate attribution science: a useful tool to plan for extreme heat events

Policy brief

Key messages

- The frequency and magnitude of extreme heat events are increasing in India. This is leading to detrimental health impacts, especially on marginalised communities in urban areas, including dehydration, heat cramps, heat exhaustion and heat stroke.
- Climate scientists are now able to study specific extreme heat events to assess whether they can be attributed to anthropogenic climate change or not. They have found that the heat waves such as the 2015 events in Andhra Pradesh and Telangana have become twice as likely because of anthropogenic climate change.
- Climate attribution studies also help local administrators and other decision-makers prepare better for future extreme heat events and address the needs of those most affected.
- Studies show that peak temperatures rise when air pollution decreases, as aerosols prevent the sun's heat from reaching the ground. Humidity levels, for instance from irrigation in and around towns, also increase the impacts of extreme heat events on the human body.
- Cities in India are the first in the world to prepare heat action plans. Planners can make better medium- to long-term heat preparedness plans based on attribution studies.

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Introduction

Recent studies by Indian meteorologists show that extreme heat events, with abnormally high temperatures for several days, are becoming very common across India from April to June. Most of the affected states are in north, north-west, central and north-east India. These include Andhra Pradesh, Bihar, Chhattisgarh, Delhi, Gujarat, Haryana, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Telangana, Uttar Pradesh and West Bengal, and the plains of Himachal Pradesh and Jammu and Kashmir.

The National Disaster Management Authority's guidelines on heat waves say that, on average, five to six heat events now occur every season over northern India. Peak temperatures continue,

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at times, for over a week, and in 2015 ranged from 44°C to 48°C. The year 2016 was the warmest recorded globally, and in India. The town of Phalodi in Rajasthan recorded an all-time high temperature of 51°C – 0.4°C degrees above the previous record from 1956 – and the extreme heat event lasted for three days.

Extreme heat events can lead to people suffering from dehydration, heat cramps, exhaustion and life-threatening strokes. It can aggravate pre-existing pulmonary and cardiac conditions, kidney disorders and psychiatric illness. The human death toll is often high – over 22,500 people died between 1992 and 2015 – but there is little data from real-time studies. People who work in the open, or live in poorly ventilated slums or houses, face greater vulnerability and exposure to extreme heat events.

City governments across several states have started to develop heat actions plans in response to the sheer number of people being affected. These plans bring together several government departments, providing a coordinated approach to dealing with vulnerabilities and exposure.

Climate change and extreme heat events

While heat waves differ with geographical location, humidity levels, atmospheric parameters and built-up infrastructure, scientific advances are making it possible to assess the influence of climate change on specific heat events. Climate scientists are now able to attribute heat wave events to climate change with a sufficient level of confidence.

Attribution studies show why a specific heat wave event happened, and the likelihood of it happening again. This helps to answer important questions, including: is the heat wave a temporary, one-off event, or does it indicate a trend towards more frequent events due to climate change? This is useful information for decision-makers and local administrators preparing medium- to long-term heat action plans, which need to factor in climate variability and climate change adaptation measures.

As well as the results of attribution studies, decision-makers need to consider vulnerability and exposure to peak temperatures. City temperatures are sometimes high due to local factors such as the lack of green spaces, and excessively built-up areas. Together, these create what is known as an 'urban heat island effect', where an urban or metropolitan area is significantly warmer than the surrounding rural areas due to human activities. Such an effect increases the vulnerability and exposure to peak temperatures of those in the affected areas, as the following examples demonstrate (see Boxes 1 and 2).

Box 1. Heat wave in Andhra Pradesh and Telangana, 23–24 May 2015

This heat event killed around 2,500 people. A recent study by attribution scientists from the University of Oxford, UK and the Indian Institute of Technology, New Delhi found "very strong attribution, linking more extreme heat waves to human-induced climate change".[1] Thus, more frequent heat waves are expected in this region.

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Box 2. Heat wave in Phalodi, Rajasthan, 19 May 2016

An all-time high temperature of 51°C made people in Phalodi wonder if this event was caused by global warming. A few months later, attribution scientists from the Royal Netherlands Meteorological Institute, the Red Cross Red Crescent Climate Centre, Columbia University, USA and the Indian Institute of Technology, New Delhi used both observational data and models to assess the cause.

These studies warned of even higher temperatures for the town in the future. They also indicated more frequent heat waves in Andhra Pradesh and Telangana (see Box 1).

The role of air pollution in extreme heat events

The studies identified air pollution as one factor that is keeping temperatures *down* in Phalodi, Andhra Pradesh and Telangana. The extensive presence of aerosols – haze, dust, particulate air pollutants, smoke – reflects the sun's heat back, pushes temperatures down, and leads to less rainfall and drier conditions. However, high aerosol concentrations can also exacerbate the effects of heat waves, increasing death rates. As city authorities adopt clean fuels and stringent pollution standards, climate scientists indicate that heat waves are also likely to increase in intensity and frequency.[2]

Heat and humidity

As well as attribution studies, planners need to base their decisions on levels of humidity in the air, because higher relative humidity reduces ground temperatures. Attribution scientists found that relative humidity has significantly increased in the northern and central regions of India, corresponding with areas that have higher irrigation cover. This has resulted in a lowering of heat wave temperatures, as more of the sun's heat is used up in evaporation than in heating the ground. Higher relative humidity also masks the trend for higher pre-monsoon maximum temperatures.

Vulnerability and exposure

Heat impacts are not the same for everyone. People who are more exposed to heat waves include those who work out of doors – such as farmers and farm labourers, construction workers, vendors, rickshaw pullers and even taxi drivers. Children, pregnant women and the elderly are also statistically more vulnerable. People living in slums or along roadsides are more likely to be exposed to peak temperatures, as are those who live in arid areas of villages and 'concrete jungles' in cities. It is imperative, therefore, that early warnings reach these people. Increasingly severe heat waves require a special focus on vulnerability and exposure in heat action plans.

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Health impacts

Both aerosols and higher humidity levels have large health 'footprints'. People who suffer from pulmonary and air pollution-related diseases are more vulnerable to heat stresses. People are at greater risk of these in poorly ventilated, high-density slums. Further, people who have to bear high temperatures and high levels of humidity are more vulnerable than those who are exposed to dry heat. Attribution studies help to inform decisions on different dimensions of heat waves, which can help people who are more vulnerable or at a higher risk of exposure[3].

Recognising the need for decisive action on extreme heat events, the National Disaster Management Authority formulated a set of guidelines in 2016 to help state governments, local authorities and other decision-makers prepare action plans to manage extreme heat incidences. These guidelines acknowledge the growing role of climate change in triggering heat waves of higher severity, frequency and duration in India.

The guidelines also combine air temperature with relative humidity to create the Heat Index, which helps local authorities to prepare. For instance, if the air temperature is just 34°C but the relative humidity is 75%, it really feels as if it is 49°C; this is the Heat Index for that day. It also includes the health of the local populace as a factor.

Attribution and heat action plans

Decisions based on real-time analysis of heat waves address both local issues, such as aerosols and irrigation, and the macro-level issues of ecosystem management and climate change. Attribution studies connect data, explain climate conditions in real time and use multiple models. The subsequent changes they effect in policy, practice and investment mean cities are better able to manage the integrated risks that stem from changes in the micro and macro environment.

Authorities in India are making heat action plans to respond to extreme events. The city of Ahmedabad was the first, followed by the state of Odisha. Some of the key strategies being used are listed here; these indicate how the results of attribution studies can factor in variability and vulnerability within these.

Promote climate attribution studies to understand the changing risks associated with the occurrence of extreme heat events. Real-time studies give decision-makers an opportunity to take corrective actions as they move from one annual plan to the next. Real-time analysis also helps in better investment planning, for instance ensuring that slums that are more exposed to a higher heat index are prioritised for resettlement.

Include early warnings based on the short to medium term and seasonal forecasts issued by the Indian Meteorological Department, and colour-coded to indicate the severity of the extreme event. This includes early warnings on both temperature and relative humidity, combined with aerosol levels issued by the pollution boards. These are critical when the frequency and/or intensity of heat waves are on the rise. They must be understandable and issued in real time, so that they trigger immediate and appropriate action. Clear indices linked to these warnings must be evolved with specific do's and don'ts depending on the severity of the event, as well as addressing the needs in terms of vulnerability and exposure.

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Coordinate among various departments to cover risks related to first aid and emergency medical facilities, health, water availability, school timings, cool and shady shelters, comfortable transport and 24/7 power, among others. The focus on these issues needs to be at the planning stage, not just the response stage. This will ensure appropriate budgeting for mitigating extreme heat wave events, with expanded budgets for those sections of society that are more vulnerable and exposed to these risks. Departments dealing with infrastructure and housing also need to be involved.

Public outreach should be done by the city commissioner, but also by other departments. This includes early warning messages, do's and don'ts, and information on benefits available from the local administration. Much more needs to be done on this front to ensure that the results from real-time attribution studies are communicated by scientists to decision-makers, so they can co-produce knowledge that is nuanced but understandable, as well as comprehensive but action-oriented. It is also important for the local administration to base its decisions on real-time climate science projections and to ensure that communication from its end reaches the most vulnerable and exposed people.

Furthermore, non-governmental organisations (NGOs) and academic institutions need to do field-based and policy research, as well as acting as watchdogs, to ensure interventions address vulnerability and exposure, and are inclusive and beneficial.

Capacity-building underlies all actions and includes building the understanding and skills of health personnel, as well as raising public awareness. A whole new capacity-building space has opened up for key stakeholders, including decision-makers, implementing agencies, NGOs, research institutions and the general public. A multi-pronged strategy must be rolled out for the above stakeholders, to cover a wide spectrum of concerned citizens, organisations and institutions, including the young 'decision-makers in the making' at India's training institution for higher civil servants, the Lal Bahadur Shastri National Academy of Administration.

Notes

1 Gupta, J. (2016) 'Andhra-Telangana repeat ten times more likely'. The Third Pole, March 1, www.thethirdpole.net/2017/03/01/andhra-telangana-heat-wave-repeat-ten-times-more-likely
2 CDKN (2017) 'Film: Attributing extreme weather events'. London: Climate and Development Knowledge Network, https://cdkn.org/resource/attributing-extreme-weather-events
3 Ibid.

Further resources

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Websites

Climate and Development Knowledge Network: www.cdkn.org
Climate Central: www.climatecentral.org
National Oceanic and Atmospheric Administration: www.noaa.gov
Climate Centre: www.climatecentre.org

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