Addressing policy challenges from Chennai's 2015 extreme rainfall event

Policy brief

Key messages

- On 1 December 2015, unprecedented rains lashed the city of Chennai in Tamil Nadu, India, for 24 hours. This was due to a warmer patch of water in the Bay of Bengal, just off the coast of Chennai, as well as a very strong El Niño in this period.
- Using multiple, peer-reviewed approaches to study extreme weather attribution to human-caused climate change, scientists concluded that the 2015 extreme rain event in Chennai was not caused by anthropogenic global warming.
- Contrary to global trends, there has not been an increase in sea surface temperature in the western Bay of Bengal over the last 35 to 40 years, probably due to the high levels of aerosols, or air pollutants, that block sunlight and thus cool the globe's surface in the region.
- The extreme rainfall occurrence was, in fact, a 1 in 600–2,500 year event, which would have overwhelmed flood prevention measures in any city.
- The impact of the extreme rain event was exacerbated by a lack of timely desilting of the drainage system,[1] inadequate flood-zone planning, and large-scale settlements in low-lying areas of the city.

Introduction

Studies by the Indian Institute of Tropical Meteorology show that the occurrence of extreme rainfall events in India has risen by about 50% over the last 50 to 60 years. These extreme events are expected to increase further as the Earth becomes warmer. Thus, there is a direct association between increasing rainfall and human-induced climate change, according to climate models.

On 1 December 2015, unprecedented rains lashed the city of Chennai in Tamil Nadu, India for 24 hours.[2] This was due to a warmer patch of water in the Bay of Bengal, just off the coast of Chennai, as well as a very strong El Niño in this period. This event saw a record 494 mm fall, the heaviest one-day rainfall in the region in more than a century.

While any city would have found it impossible to handle this amount of rain, unplanned urbanisation increased the severity of the impacts. The extreme rainfall event cost the Indian economy an estimated US$3 billion.[3]

Key findings from climate attribution studies

Chennai is a coastal megacity in south-eastern India, home to 8.2 million people. It receives most of its rainfall between October and December during the northeast monsoon. This is when the

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coastal area of south-eastern India is most prone to cyclones, tropical storms and other rain storms, because the high sea surface temperature in the Bay of Bengal, coupled with wind patterns, leads to more rains and storms. November 2015 was the second wettest month in Chennai in more than 100 years, with 1,049 mm of rain.

A climate attribution study[4] analysed 40 years of data from 50 regional weather stations of the Indian Meteorological Department, as well as non-public data series for the period 1969–2013. Results from both data sets showed that the extreme heavy rainfall event was rare, with a return time of 600 to 2,500 years. The probability of receiving such an extreme rainfall event at any given weather station is less than 0.2% each year.

The study found no evidence for a positive trend in extreme rainfall events. Data showed a slight increase in extreme rains during El Niño, but this was not significant. There was a stronger connection between mean precipitation and the sea surface temperature in the Bay of Bengal. However, scientists found that over the last 35 years, there was no trend of sea surface temperatures rising, and that this contributed to the lack of a trend in extreme precipitation. These findings contradict the global trend of increasing sea surface temperatures leading to increased extreme precipitation.

Analysis showed that the lack of a trend for rising sea surface temperatures in the Bay of Bengal was due to the presence of the 'brown cloud', caused by increased air pollution, which blocks the sunlight and counters further warming of the sea, especially in the pre-monsoon maximum temperatures. The Chennai extreme rainfall event was therefore not attributable to human-induced climate change.

The making of the disaster

The extreme rainfall event in Chennai was so rare that no metropolitan area could be expected to be fully prepared. However, poor land-use planning and limited governance and oversight exacerbated the impacts unnecessarily.

A Parliamentary Standing Committee on Home Affairs listed the non-protection of the city's wetlands as a major factor that exacerbated the hazard, along with inadequate flood-zone planning and massive encroachment into lakes and onto riverbeds for land and construction.[5]

A lack of timely desilting and a clogged drainage system also reduced the carrying capacity of water evacuation channels. Chennai's drainage system is a complex network of several small lakes and rivers that are predominantly seasonal in nature. However, the Committee said that when the rainfall happened, the city's storm water drains were not functional and the outlets were clogged.

People living in the flood plains, especially those in informal settlements, were the most vulnerable, with over 2.6 million houses in low-lying areas submerged. The Committee suggested that all city governments should prepare a calamity map and develop standard vulnerability indices to minimise the loss of life, property and vital infrastructure. This should include a proper plan for the rehabilitation of people living in flood plains who are affected by similar events in the future.

The Committee used the floods in Chennai to call for long-term disaster preparedness plans in all major cities. The aim of these is to prevent unplanned urbanisation and mitigate the increasing effects of flooding in major cities, including Mumbai, Surat and Srinagar, as well as Chennai.

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Policy recommendations: building urban resilience

Based on climate science studies, India's National Communication to the United Nations Convention on Climate Change (NATCOM 2012) projects a rise in extreme rainfall events in India due to global warming. Extreme heat wave events are also expected to increase, again due to climate change. It should be noted that the NATCOM report[6] considers climate projections across India into the future, whereas the attribution analysis on the Chennai flood considers just one specific event in 2015.

The Chennai flood, and the factors that contributed to the disaster, point to certain policy issues that need to be addressed to build resilience in the rapidly urbanising India.

- The **protection of urban wetlands** should be part of all city development plans and flood-zoning maps. Wetlands absorb excessive run-off and reduce waterlogging during extreme rainfall events. An additional benefit is that during extreme heat events, wetlands help to reduce peak temperatures, regulate the micro-climate and reduce the 'heat island' effect. Wetlands also help to regulate water availability in cities during droughts.
- A **river basin, or ecosystem, approach** is needed to create city-specific flood-zone maps, so that knowledge of upstream rainfall becomes part of the early warning process and leads to well-informed actions.
- **City risk-reduction plans, based on climate science information** – including weather forecasts, climate projections and post-extreme event attribution studies – will ensure that climate variability and change are factored into medium- to long-term urban planning and disaster mitigation plans.
- There needs to be a focus on **reducing vulnerability and exposure** in city development plans and disaster action plans, because the most economically and socially marginalised sections of society are also those that lie in the direct path of many disasters, as these people often live and/or work in low-lying areas. They also often lack basic amenities like water and sanitation.
- Revising building codes to **include water-harvesting structures** will help to regulate run-off, provide adequate water for home use and in public places, and lead to a cooling effect in cities.
- The creation of **city-specific flood action plans** will help decision-makers to consider adequate investment, appropriate infrastructure, early warnings and early action, as well as provide a blueprint for the rehabilitation of those people who face the greatest vulnerability and exposure to extreme events.
- A **communications plan** will make it easier for climate scientists and decision-makers to communicate and understand each other's messages, and enhance communication with practitioners and the public. It would be advisable for the media to play a substantial role in this plan.

Notes

1 TNM (2016) 'Union govt report on Chennai floods puts Chennai Corporation, Sewerage board in the dock'. *The News Minute*, August 18, www.thenewsminute.com/article/union-govt-report-chennai-floods-puts-chennai-corporation-sewerage-board-dock-48416

2 AchutaRao, K., van Oldenborgh, G.J., Otto, F.E.L. and Haustein, K. (2017) 'The heavy precipitation event in Chennai, India, 1 December 2015'. RRA Science Summary. London: Climate and Development Knowledge Network, https://cdkn.org/resource/heavy-precipitation-event-chennai-india-1-december-2015

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3 World Weather Attribution (2015) 'Chennai floods, December 2015'. Oxford: World Weather Attribution, https://wwa.climatecentral.org/analyses/chennai-floods-december-2015
4 This study was part of World Weather Attribution's partnership with the Red Cross Red Crescent Climate Centre and the University of Melbourne and was carried out by the Indian Institute of Technology, Delhi; Climate Central; the Royal Netherlands Meteorological Institute; and the University of Oxford.
5 Down To Earth (2016) 'Chennai floods: Panel report highlights encroachments, faulty drainage system'. *Down To Earth*, 18 August, www.downtoearth.org.in/news/chennai-floods-panel-report-highlights-encroachments-faulty-drainage-system-55329
6 Government of India (2012) *India: Second National Communication to the United Nations Framework Convention on Climate Change (NATCOM)*. New Delhi: Ministry of Environment and Forests.

Further resources

Bagla, P. (2015) 'A month before Chennai floods, the Met Office had issued a warning'. NDTV, December 6, www.ndtv.com/chennai-news/a-month-before-chennai-floods-the-met-office-had-issued-a-warning-1250581

IANS (2015) 'India should prepare to face extreme weather, warn scientists'. *Business Standard*, March 24, www.business-standard.com/article/news-ians/india-should-prepare-to-face-extreme-weather-warn-scientists-115032400458_1.html

Pande, S. (2016) 'Encroachment of lakes and riverbeds caused Chennai floods: parliamentary panel', CNN-News18, August 17, www.news18.com/news/india/encroachment-of-lakes-and-riverbeds-caused-chennai-floods-says-parliamentary-panel-1282591.html

Raising Risk Awareness initiative (2017) 'Film: Aerosols – How they affect atmospheric warming'. London: Climate and Development Knowledge Network, https://cdkn.org/resource/film-aerosols-affect-atmospheric-warming

van Oldenborgh, G.J., Otto, F.E.L., Haustein, K. and AchutaRao, K. (2016) 'The heavy precipitation event of December 2015 in Chennai, India', in Herring, S.C., Hoell, A., Hoerling, M.P., Kossin, J.P., Schreck III, C.J. and Stott, P.A. (eds), 'Explaining extreme events of 2015 from a climate perspective', Special Supplement, *Bulletin of the American Meteorological Society* 97(12): S87–S91.

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