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Extreme weather events in India

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Extreme weather events in India

Introduction

India has been experiencing a significant increase in the frequency and intensity of extreme weather events, including heatwaves, floods, cyclones, and heavy rainfall, leading to substantial human and economic losses. These events are increasingly impacting various regions across the country, with some areas experiencing a higher frequency of extreme weather days and others facing more severe impacts. As per the interactive atlas on extreme weather events in India managed by the Delhi-based think tank Centre for Science and Environment (CSE) and Down To Earth (DTE), India has experienced extreme weather events on 87 of the 90 days from January 1 to March 31, 2025, which has claimed 122 lives and has affected 24,807 hectares (ha) of crop area. Similarly in the year 2024, the same interactive atlas highlights that out of 366 days India on 322 days witnessed extreme weather events across its 35 states and union territories. These extreme weather events in the year 2024 itself resulted in 3,472 human deaths, damaged 291,592 houses and damaged 4,072,523 hectares of crop area in the country. This bi-monthly issue of NTS digest aims to provide the overview of various aspects of extreme weather events that has happened recently in the past.

Heatwaves

India experienced over 280 heatwave days across 16 Indian states from March 11 to May 18, 2022—an alarming rise, signaling a worrying trend of more frequent, intense, and prolonged heatwaves, particularly affecting vulnerable populations and straining essential infrastructure such as healthcare, water supply, and power grids. India lies in the tropics and experiences high temperatures given its global location. With climate change, temperatures have risen exceedingly, thus presenting adverse effects of various kinds. Projections further indicate a rise in maximum and minimum temperatures across the subcontinent, along with an increase in the number of hot days in the coming decades. As a result of this temperature rise, heatwave conditions have become more frequent.

India has been identified as one of the top countries that will experience the most significant increase in the gap between water availability and demand under warming scenarios. This will not only impact food production but will also impact the health of populations. In a report in 2024, the International Labour Organization (ILO) warned that more than 70% of all workers worldwide are at risk of exposure to excessive heat. It added that

India lost an estimated $100 billion from heat-induced productivity losses. Small businesses and informal workers like construction workers, farmers, street vendors and food delivery partners bore the brunt. Excessive heat can have a devastating impact on agriculture. Studies show that just 1 degree of warming reduces wheat yields by about 5.2% in India. Heatwaves, late in the rice growing season, can reduce yield.

The Indian Meteorological Department (IMD) has given the following criteria for Heat Waves in the country:

- Heat Wave need not be considered till maximum temperature of a station reaches atleast 40°C for Plains and atleast 30°C for Hilly regions
- When normal maximum temperature of a station is less than or equal to 40°C Heat Wave Departure from normal is 5°C to 6°C Severe Heat Wave Departure from normal is 7°C or more
- When normal maximum temperature of a station is more than 40°C Heat Wave Departure from normal is 4°C to 5°C Severe Heat Wave Departure from normal is 6°C or more
- When actual maximum temperature remains 45°C or more irrespective of normal maximum temperature, heat waves should be declared. Higher daily peak temperatures and longer, more intense heat waves are becomingly increasingly frequent globally due to climate change. India too is feeling the impact of climate change in terms of increased instances of heat waves which are more intense in nature with each passing year, and have a devastating impact on human health thereby increasing the number of heat wave casualties.

Dealing with heatwaves

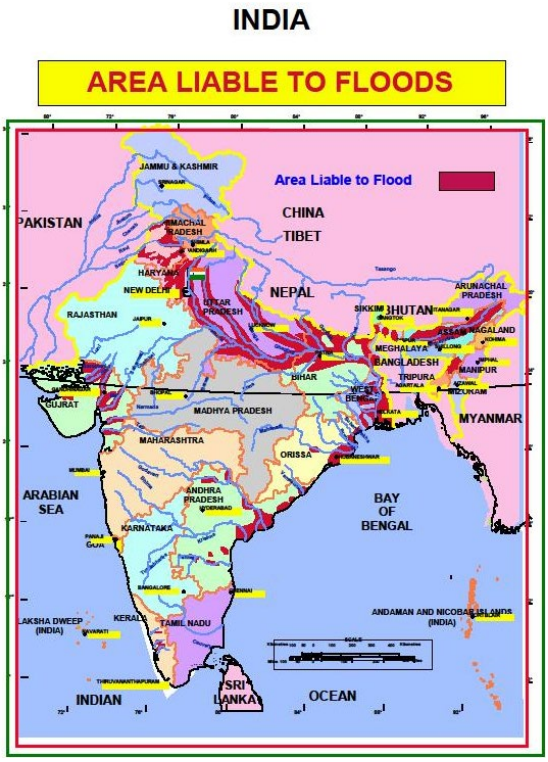
Governments, both at the Central and State levels, is taking action. The National Disaster Management Authority, in collaboration with the Union Ministry of Home Affairs has published guidelines for protecting the Indian workforce. These guidelines, which stress on providing education and regulating work schedules, providing water, medical facilities and appropriate workwear, can be used by officials preparing heatwave action plans for the cities and towns. Several States and cities have their own heat action plans, with some cities making plans down to the ward-level to implement solutions on the ground.

Floods

India is highly vulnerable to floods. Out of the total geographical area of 329 million hectares (mha), more than 40 mha is flood prone. Floods are a recurrent phenomenon, which cause huge loss of lives and damage to livelihood systems, property, infrastructure and public utilities. It is a cause for concern that flood related damages show an increasing trend. The Union Ministry of Home Affairs (MHA) has recently highlighted that according to the information received from the various State governments as of January 27, a total of 2,936 people were reported killed, 3,63,381 houses or huts were damaged, and 61,826 cattle were lost due to hydro-meteorological disasters.

Urban Floods

Urban flooding is significantly different from rural flooding as urbanization leads to developed catchments, which increases the flood peaks from 1.8 to 8 times and flood volumes by up to 6 times. Consequently, flooding occurs very quickly due to faster flow times (in a matter of minutes). Urban areas are densely populated and people living in vulnerable areas suffer due to flooding, sometimes resulting in loss of life. It is not only the event of flooding but the secondary effect of exposure to infection also has its toll in terms of human suffering, loss of livelihood and, in extreme cases, loss of life.



Source: Indian Meteorological Department (IMD)

In India, significant flood incidents were recorded in Hyderabad in 2020 and 2021; in Chennai in November 2021; in Bengaluru and Ahmedabad in 2022; in parts of Delhi in July 2023; and Nagpur in September 2023 (forcing many residents to abandon the city and flee). Smaller cities like Chandigarh and Gurugram (Haryana), Patna and Gaya (Bihar), Pune (Maharashtra), Jaipur and Sikar (Rajasthan), Bhopal and Indore (in Madhya Pradesh), Lucknow (Uttar Pradesh), Kochi (Kerala), and many in the hill states (such as Dehradun in Uttarakhand and Shimla in Himachal Pradesh) have also faced flood incidents in recent years. Notably, in October 2023, many towns in the Northeastern state of Sikkim experienced

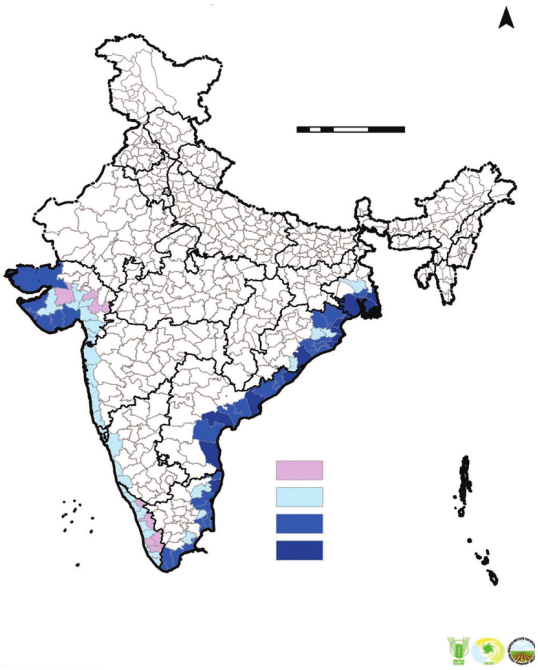
flash floods, with a significant number of deaths and widespread destruction.

Cyclones

Indian subcontinent with a long coastline of 8041 kilometres is exposed to nearly 10 per cent of the world's tropical cyclones. Of these, the majority of them have their initial genesis over the Bay of Bengal and strike the East coast of India. On an average, five to six tropical cyclones form every year, of which two or three could be severe. More cyclones occur in the Bay of Bengal than the Arabian Sea and the ratio is approximately 4:1. Cyclones occur frequently on both the coasts (the West coast - Arabian Sea; and the East coast - Bay of Bengal).

Tropical cyclones occur in the months of May-June and October-November. Cyclones of severe intensity and frequency in the North Indian Ocean are bi-modal in character, with their primary peak in November and secondary peak in May. The disaster potential is particularly high during landfall in the North Indian Ocean (Bay of Bengal and the Arabian Sea) due to the accompanying destructive wind, storm surges and torrential rainfall. Of these, storm surges cause the most damage as sea water inundates low lying areas of coastal regions and causes heavy floods, erodes beaches and embankments, destroys vegetation and reduces soil fertility.

Cyclones vary in diameter from 50 to 320 km but their effects dominate thousands of square kilometers of ocean surface and the lower atmosphere. The perimeter may measure 1,000 km but the powerhouse is located within the 100-km radius. Nearer the Eye, winds may hit at a speed of 320 km. Thus, tropical cyclones, characterized by destructive winds, torrential rainfall and storm surges disrupt normal life with the accompanying phenomena of floods due to the exceptional level of rainfall and storm surge inundation into inland areas. Cyclones are characterized by their devastating potential to damage structures, viz. houses; lifeline infrastructure-power and communication towers; hospitals; food storage facilities; roads, bridges and culverts; cropss etc. The most fatalities come from storm surges and the torrential rain flooding the lowland areas of coastal territories.



Areas prone to cyclones in India. Source: Rama Rao et al. (2013); NDMA website

From 1970 to 2019, India experienced 117 cyclones, resulting in over 40,000 deaths. A study indicates that while cyclones have caused significant loss of life, the mortality rate has decreased significantly in the last decade. In the past 50 years, extreme weather events, including cyclones and floods, led to 141,308 deaths, with cyclones accounting for 28% of those fatalities.

Cloud Bursts

Cloudbursts in India have caused significant damage and casualties in the past, particularly in mountainous regions like Uttarakhand and Himachal Pradesh. Examples include the 2013 Uttarakhand floods, which were triggered by a cloudburst and subsequent landslides, and the 2010 Leh cloudburst that resulted in flash floods and mudslides. More recently, cloudbursts in Himachal Pradesh and Jammu & Kashmir have also caused considerable damage.

In the past decade, the southern rim of the Himalayas experienced several anomalous weather events such as cloudbursts, extreme precipitation, flash floods, and avalanches due to a changing climate. The topography and orography process of the Indian Himalayas facilitates a favorable condition to cloudbursts. These events mostly appear during the monsoon period and are elusive corresponding to their geographical position and associated impacts due to a lack of monitoring and data observations. The sudden downpour of rainfall in a range of 100–250 mm/h in a short span covering a smaller spatial extent similar to 1 km2 is typically defined as a cloudburst event. On the other hand, according to the India Meteorological Department, if the rainfall occurs more than 100 mm/h with strong winds and lightning over an area of 20–30 km2 is termed a cloudburst. Interestingly, the elevation band where the occurrence of such events is frequent lies between 1000 to 2000 m which are densely populated valley folds of the Himalayas. Some studies derived that mostly cloudbursts occur and are expected to occur in low elevation high-temperature zones of topoclimate regimes of the Himalayas which receive low rainfall and exhibit high land surface temperature ranging from 18° C to 28° C in July and August.

Developments on recent Extreme Weather Events developments in India

Mumbai, Delhi, Chennai and five other cities to experience two-fold increase in heatwave days

The study titled 'Weathering the Storm: Managing Monsoons in a Warming Climate' was unveiled at the International Global-South Climate Risk Symposium in New Delhi as part of the 62nd session of the

United Nations Framework Convention on Climate Change to be held in Bonn, Germany from June 16 to 26, 2025

The study revealed that extended heat wave conditions are likely to trigger more frequent, incessant, and erratic rainfall events and eight out of ten districts in India are going to experience multiple instances of such rainfall extremes by 2030.

India has witnessed a 15-fold increase in extreme heat wave days across the March-April-May (MAM) and June-July-August-September (JJAS) months in the last three decades between 1993-2024. Alarmingly, the last decade alone has witnessed a 19-fold increase in extreme heat wave days. The study also found that monsoon seasons in India are witnessing an extended summer-like condition, except on non-rainy days. The research has highlighted that that meteorological phenomenon like El Niño (warmer phase) and La Niña (colder phase) are going to gain stronger momentum, resulting in abrupt surge in climate extremes like flood, cyclones, storm surges and extreme heat. This report has further highlighted that around 72 per cent of the tier-I and tier-II cities are going to witness an increased occurrence of heat stress and extreme rainfall events, accompanied by storm surges, lightning and hailstorms.

Dozens feared dead as floods and landslides rip through Himalayas in northern India

Hundreds of houses, shops, roads and bridges in Himachal Pradesh were washed away after 23 flash floods and 16 landslides, triggered by the torrential weather. Report by various agencies points that in the first half of the 2025 itself, dozens of people in the state are feared dead. The state disaster management authority has pointed that since 20 June 2025 80 people have died in rain-related incidents in Himachal Pradesh. The authorities have highlighted that in just few weeks about 19 cloudbursts have taken place in the state that has resulted in heavy loss to life and property.

In 2023 as well, large swathes of essential infrastructure in Himachal Pradesh was destroyed and more than 300 people lost their lives after destructive flooding across north India. Studies show the monsoon in South Asia is getting worse due to the climate crisis, with a rise in the number of "extreme rain days", which means more rainfall falling over shorter periods, overwhelming the infrastructure.

Floods in Gujarat, Maharashtra, Telangana and Haryana

Satellite imagery analysed by India Today's OSINT team in June, 2025 using

Sentinel-1 SAR (Synthetic Aperture Radar) data revealed that large areas of land were submerged under floodwaters across the states of Gujarat, Telangana, and Maharashtra. The India Meteorological Department (IMD) issued fresh weather warnings on June 25 as the monsoon gained strength across the country. Heavy rainfall, lightning, and strong winds were reported from Gujarat to Haryana, Telangana, and Maharashtra. Several states have experienced flash floods, landslides, and widespread waterlogging.

Due to limited satellite coverage, flood points could only be visualised in the western districts of Gujarat — Kutch, Morbi, Jamnagar, and Devbhumi Dwarka — where remote sensing data indicated moderate to heavy flooding. IMD reports also indicate severe flooding in several eastern districts of the state, including Surat, Nandod, Dahod, Chhota Udepur, Panchmahal, Valsad, and Tapi. Heavy rains caused the Tapi river, which passes through the city and various creeks, to swell, resulting in waterlogging in low-lying residential areas. Some villages were completely submerged in rain water, creating a flood-like situation.

Floods wreak havoc on India's financial capital as monsoon rains arrive early

India's financial capital and one of its largest cities has experienced its wettest May in more than a century, with the unusually early arrival of the monsoon season causing a ferocious weekend downpour that turned roads into rivers and flooded a newly inaugurated underground train station. In May 2025 Mumbai, a city of more than 12 million, has recorded more than 400 millimeters of rainfall. The deluge caused chaos and delays across transport networks, including at the newly inaugurated Worli Metro Station. India's $4 trillion economy is heavily dependent on the monsoon, which brings rains that farmers depend on to support the country's agricultural sector, which employs nearly half of the country's 1.4 billion people. The rains, which usually arrive in June and last through September, are needed to grow crops, irrigate farmland and replenish India's reservoirs. But this year's early arrival has caused serious concerns.

Indians worried about extreme weather or related impacts: Survey

Most Indians have personally experienced at least one extreme weather event or

related impact in 2024, finds a recently published survey, highlighting that the impact of climate change is an everyday reality, deeply impacting daily life and public perception.

About 71% of those surveyed said they had experienced severe heat waves, while more than half had experienced other extreme weather-related impacts such as agricultural pests and diseases (60%), water pollution (53%), droughts and water shortages (52%), and severe air pollution (52%). The Yale Program on Climate Change Communication (YPCCC) and CVoter surveyed a representative sample of 10,751 Indians from December 5 to February 18, 2025, on experiences and worries about extreme weather events.

Public worry about extreme weather impacts on local environment runs high with 62% of those surveyed saying they are "very worried" about agricultural pests and diseases. 61% were worried about extinctions of plant and animal species and more than half expressed similar concern about heat waves, water scarcity, pollution, and food shortages.

Some Suggested Readings

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Non-Traditional Security Centre

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