



भारतसरकार

**Government of India**

पृथ्वीविज्ञानमंत्रालय(एम. ओ. ई. एस.)

**Ministry of Earth Sciences (MoES)**

भारतमौसमविज्ञानविभाग

**INDIA METEOROLOGICAL DEPARTMENT**

**Climate Research and Services (CRS)**

## **Statement on Climate of India during 2022**

### **HIGHLIGHTS**

The annual mean land surface air temperature averaged over India during 2022 was  $+0.51^{\circ}\text{C}$  above the long-term average (1981-2010 period). The year 2022 was the fifth warmest year on record since nationwide records commenced in 1901. However, this is lower than the highest warming observed over India during 2016 (anomaly of  $+0.71^{\circ}\text{C}$ ) and higher than the previous year 2021 (anomaly of  $+0.44^{\circ}\text{C}$ ).

The all India mean temperatures during the winter (January to February) season was normal with anomaly of  $-0.04^{\circ}\text{C}$  while during other seasons, it was above normal ( pre-monsoon (March to May) season (anomaly of  $\pm 1.06^{\circ}\text{C}$ ), monsoon (June to September) season (anomaly of  $+0.36^{\circ}\text{C}$ ) and post-monsoon (October to December) season (anomaly of  $+0.52^{\circ}\text{C}$ ).

Global mean temperature in 2022 is currently estimated to be  $1.15 \pm 0.13^{\circ}\text{C}$  above the pre-industrial (1850-1900) average, likely making the past eight years (2015-2022) the warmest on record. Despite La Niña conditions keeping global temperature low for the second consecutive year, 2022 is still most likely to be 5th or 6th warmest year on record. (Source: [https://library.wmo.int/doc\\_num.php?explnum\\_id=11359](https://library.wmo.int/doc_num.php?explnum_id=11359)).

The 2022 rainfall over the country as a whole was 108% of its Long Period Average (LPA) value based on the period 1971-2020. The winter season rainfall was 147% of its LPA, pre-monsoon season rainfall was 99% of its LPA, rainfall during the southwest monsoon season was 106 % of its LPA and rainfall during post monsoon season was 119% of its LPA.

During 2022, 15 cyclonic disturbances (three cyclonic storms and 12 depressions) formed over the north Indian Ocean against the normal of 11.2 based on data of 1965-2021. It included three cyclones, seven depressions formed over Bay of Bengal and three depressions over Arabian Sea and two land depressions. In addition to these, extreme weather events like extremely heavy rainfall, floods, landslide, lightning, thunderstorm, droughts etc were also experienced in various parts of the country.

## Temperatures

The annual mean land surface air temperature for the country during the year 2022 was  $+0.51^{\circ}\text{C}$  above the 1981-2010 average, thus making the year 2022 the fifth warmest year on record since 1901 (Fig. 1). The five warmest years on record, in descending order were 2016 ( $+0.71^{\circ}\text{C}$ ), 2009 ( $+0.55^{\circ}\text{C}$ ), 2017 ( $+0.541^{\circ}\text{C}$ ), 2010 ( $+0.539^{\circ}\text{C}$ ) and 2022 ( $+0.51^{\circ}\text{C}$ ). It may be mentioned that 11 out of the 15 warmest years were during the recent fifteen years (2008-2022). The past decade (2012-2021/ 2013-2022) was also the warmest decade on record with the decadal averaged annual mean temperature anomaly (Actual-LPA) of  $0.37^{\circ}\text{C} / 0.41^{\circ}\text{C}$ . The country averaged annual mean temperature during 1901-2022 showed a significant increasing trend of  $0.64^{\circ}\text{C} / 100$  years (Fig.1) while a significant increasing trend was observed in maximum temperature ( $1.0^{\circ}\text{C} / 100$  years) and a relatively lower increasing trend ( $0.28^{\circ}\text{C} / 100$  years) in minimum temperature.

The pre-monsoon period was exceptionally hot in 2022. The country averaged seasonal mean temperature was normal during the winter season (January- February, with an anomaly of  $-0.04^{\circ}\text{C}$ ) while the pre-monsoon season (March-May, with an anomaly of  $+1.06^{\circ}\text{C}$ ), monsoon season (June- September, with an anomaly of  $+0.36^{\circ}\text{C}$ ) and post-monsoon season (October- December, with anomaly  $+0.52^{\circ}\text{C}$ ) were above normal.

The country averaged 2022 monthly mean temperatures for the country during 2022 were above normal for the ten months of the year except for January and February (anomaly  $0.09^{\circ}\text{C}$ ,  $-0.16^{\circ}\text{C}$  respectively) where it was normal. The All India mean temperature during the month of March with an anomaly of  $+1.61^{\circ}\text{C}$  and April with an anomaly of  $+1.36^{\circ}\text{C}$  were second highest since 1901 and December with an anomaly of  $+1.00^{\circ}\text{C}$  was the highest since 1901. The maximum temperature was the highest and the minimum temperature was the third highest for the month of March since 1901. The maximum temperature was the third highest and the minimum temperature was the second highest for the month of April since 1901. Both the maximum temperature and minimum temperature were the second highest for the month of December since 1901.

The temperatures were consistently  $3^{\circ}\text{C}$ - $8^{\circ}\text{C}$  above normal for more than 6 days during the month of March and April 2022 breaking many decadal and some all-time records in several parts of the country, including the western Himalayas, the plains of Punjab, Haryana, Delhi, Rajasthan and Uttar Pradesh. The states of Odisha, Madhya Pradesh, Gujarat, Chhattisgarh, Telangana and Jharkhand also experienced heatwaves, in some areas severe, with temperatures ranging from  $40^{\circ}\text{C}$ - $44^{\circ}\text{C}$  towards end of March. The heatwave conditions continued into April, reaching its preliminary peak towards the end of the month. Heatwaves also increase the risk of forest-fires. By April 29, almost 70 percent of India was affected by the heatwave. Towards the end of April and in May, the heatwave extended into the coastal areas and eastern parts of India.

Anomalously high temperatures during these months adversely affected grain filling and caused early senescence, thus reducing crop yields, especially wheat.

## **Rainfall**

The Indian Monsoon onset was earlier than normal and the withdrawal was later than normal this year. The majority of the Indian Subcontinent received high precipitation totals. The annual rainfall averaged over the country was 108% of its long-period average (LPA) based on data of 1971-2020. The time series of percentage departure of annual rainfall over the country as a whole since 1901 is shown in Fig. 2. Rainfall over the country as a whole during the southwest monsoon season (June-September), which is the principal rainy season of the country, was normal (106 % of LPA). During this monsoon season, among the four broad geographical regions of the country, South Peninsular India received seasonal rainfall which is 122% of its LPA; Central India and Northwest India received seasonal rainfall which is 119% and 101% of its LPA respectively while East & Northeast India received seasonal rainfall which is 82% of its LPA.

The 2022 Northeast/ post-monsoon season (October-December) rainfall over the country as a whole was above normal (119% of LPA). The seasonal rainfall during the post-monsoon season over the core region of the south peninsula (comprising of 5 subdivisions viz. Coastal Andhra Pradesh & Yanam, Rayalaseema, Tamil Nadu Puducherry & Karaikal, South Interior Karnataka, and Kerala & Mahe), was normal (110% of LPA).

The flood associated with heavy rainfall affected many parts of the country. Especially, the state of Assam faced severe floods and landslides since April 6, 2022 due to pre-monsoon showers followed by south-west monsoon 2022. Heavy rainfall in Bangalore on 5th September caused urban floods in most parts of the city resulting in traffic bottlenecks, power outages, flooded houses and inundated roads.

## **Standardized Precipitation Index**

The Standardized Precipitation Index (SPI) is an index used for monitoring drought conditions and is based on precipitation. This index is negative for dry, and positive for wet conditions. As the dry or wet conditions become more severe, the index becomes more negative or positive. Fig.3 gives the district-wise SPI values for the year 2022. Cumulative SPI values of the past twelve months indicate extremely wet-severely wet conditions over parts of A & N Islands, Assam & Meghalaya, Sub Himalayan West Bengal & Sikkim, Odisha, Uttar Pradesh state, Rajasthan state, Madhya Pradesh state, Gujarat Region, Konkan & Goa, Madhya Maharashtra, Vidarbha, Chhattisgarh, Telangana, Rayalaseema, Tamil Nadu, North Interior Karnataka, South Interior Karnataka and Lakshadweep. While extremely dry-severely dry conditions were observed over parts of Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Gangetic West Bengal, Jharkhand, Bihar, Uttar Pradesh state and Chhattisgarh.

## **Impacts of Extreme Weather Events 2022**

### **Tropical Cyclones in the Indian Seas:**

In 2022, there were three cyclones formed over the north Indian Ocean. Of these, two were Severe Cyclonic Storms "ASANI" and "MANDOUS" and one was Cyclonic Storm "SITRANG". All the cyclones formed over the Bay of Bengal.

Among these 3 cyclones, the Severe Cyclonic Storm MANDOUS (6 December to 10 December) formed in the post-monsoon season over the Bay of Bengal, crossed north Tamil Nadu, Puducherry and adjoining south Andhra Pradesh coasts between Puducherry and Sriharikota, close to Mamallapuram (Mahabalipuram) on 9<sup>th</sup> December as a cyclonic storm, claimed 6 lives from Tamil Nadu, Andhra Pradesh & Puducherry.

The other Severe Cyclonic Storm ASANI, (7May to 12 May) formed during the pre-monsoon season over the Bay of Bengal, crossed the Andhra Pradesh coast on 11<sup>th</sup> May as a deep depression, claimed 17 livestock & some damage in Andhra Pradesh.

The Cyclonic Storm SITRANG (22 October to 25 October), formed during the post-monsoon season & crossed the Bangladesh coast on 24<sup>th</sup> October as a cyclonic storm. It caused some damage in Assam & Mizoram.

However, two cyclones viz. ASANI &SITRANG did not claim any human lives.

The tracks of these cyclonic storms formed during the year are shown in figure 4.

### **Impact of Extreme Weather Events:**

Other than Tropical Cyclones, various parts of the country also experienced Extreme Weather Events like extremely heavy rainfall, landslide, lightning, thunderstorm, etc. There was also significant flooding in India at various stages during the monsoon season, particularly in the north-east in June 2022. A few of them are listed below. The casualties caused by these extreme events mentioned here are based on the media and the government reports from Disaster Management Authorities.

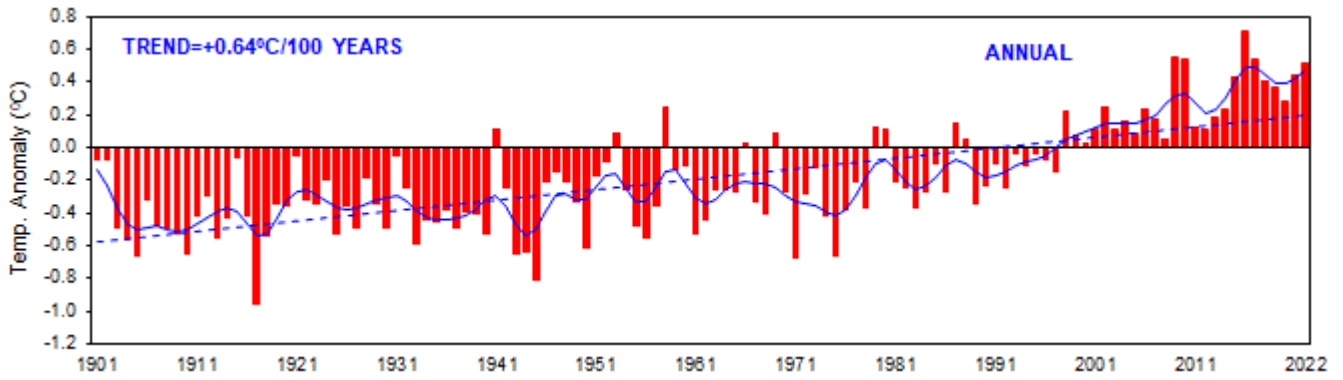
Deaths due to Impacted Extreme Weather Events & associated loss of life, distribution of the Number of Deaths & its percentage, State-wise Distribution of the Number of Deaths and State-wise Number of Districts affected during 2022 are shown in Fig.5, 6, 7, 8 respectively.

Bihar, Assam & Uttar Pradesh were the worst affected states during 2022, which reportedly claimed more than 400, 250 and 200 deaths respectively mainly due to thunderstorms, lightning, extremely heavy rainfall, floods and landslide events.

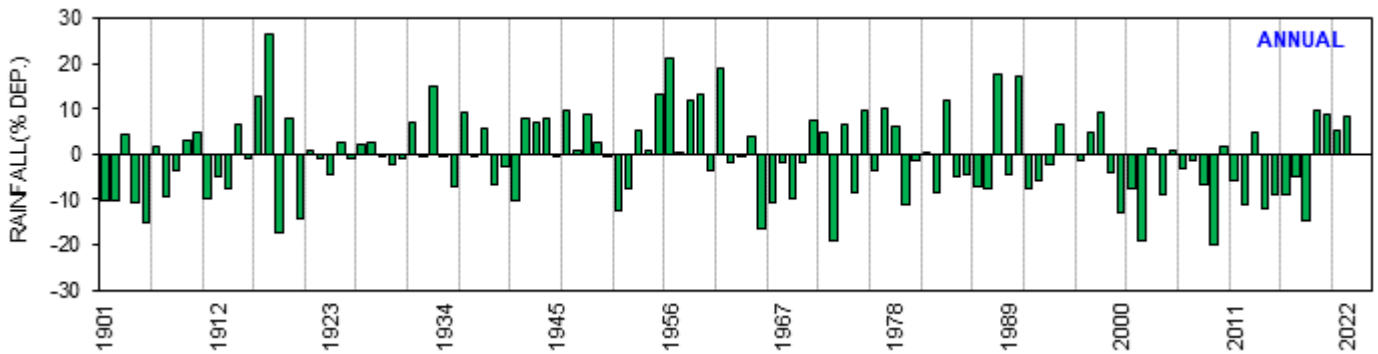
Heavy rainfall, floods & Landslide incidents claimed over 830 lives from different parts of the country. Of these, 198 lives were lost from Assam, 116 from Maharashtra, 98 from Uttar Pradesh, 75 from Himachal Pradesh, 56 from Manipur (due to a Massive Landslide in Noney district on 30<sup>th</sup> June), 48 from Rajasthan and 43 from Jammu & Kashmir and remaining from other states.

Thunderstorms and lightning claimed more than 1280 lives from different parts of the country. Among these, the significant reported deaths were; 415 from Bihar, 122 from Jharkhand, 168 from Odisha, 116 from Madhya Pradesh, 81 from Uttar Pradesh, 78 from Rajasthan, 71 from Chhattisgarh, 64 from Maharashtra, 58 from Assam & remaining from other states.

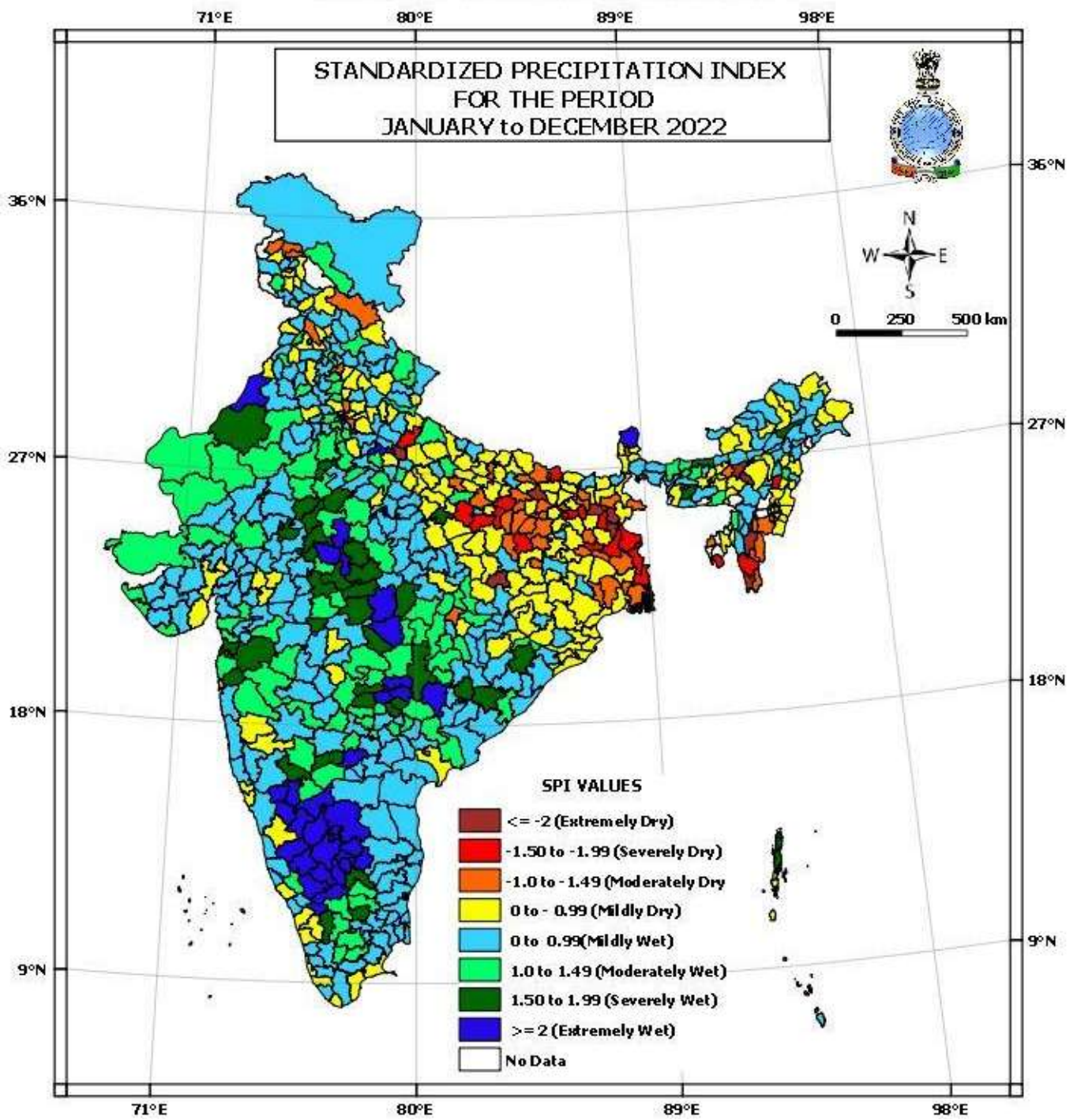
Other events like snowfall, cold waves, heat waves, dust storms, gales, and hailstorms also affected different parts of the country including loss of life, injury, loss of livestock & damage to crops & public and private property.



**Fig.1:** Annual mean land surface air temperature anomalies averaged over India for the period 1901-2022. The anomalies were computed with respect to the base period of 1981-2010. The dotted line indicates the linear trend in the time series. The solid blue curve represents the sub-decadal time scale variation smoothed with a binomial filter.



**Fig. 2:** Time Series of All India Annual Rainfall percentage Departure (1901-2022) from normal based on data of 1971-2020.



**Fig.3:**Standardized Precipitation Index (SPI) for January toDecember 2022

TRACKS OF CYCLONIC STORMS FORMED DURING 2022

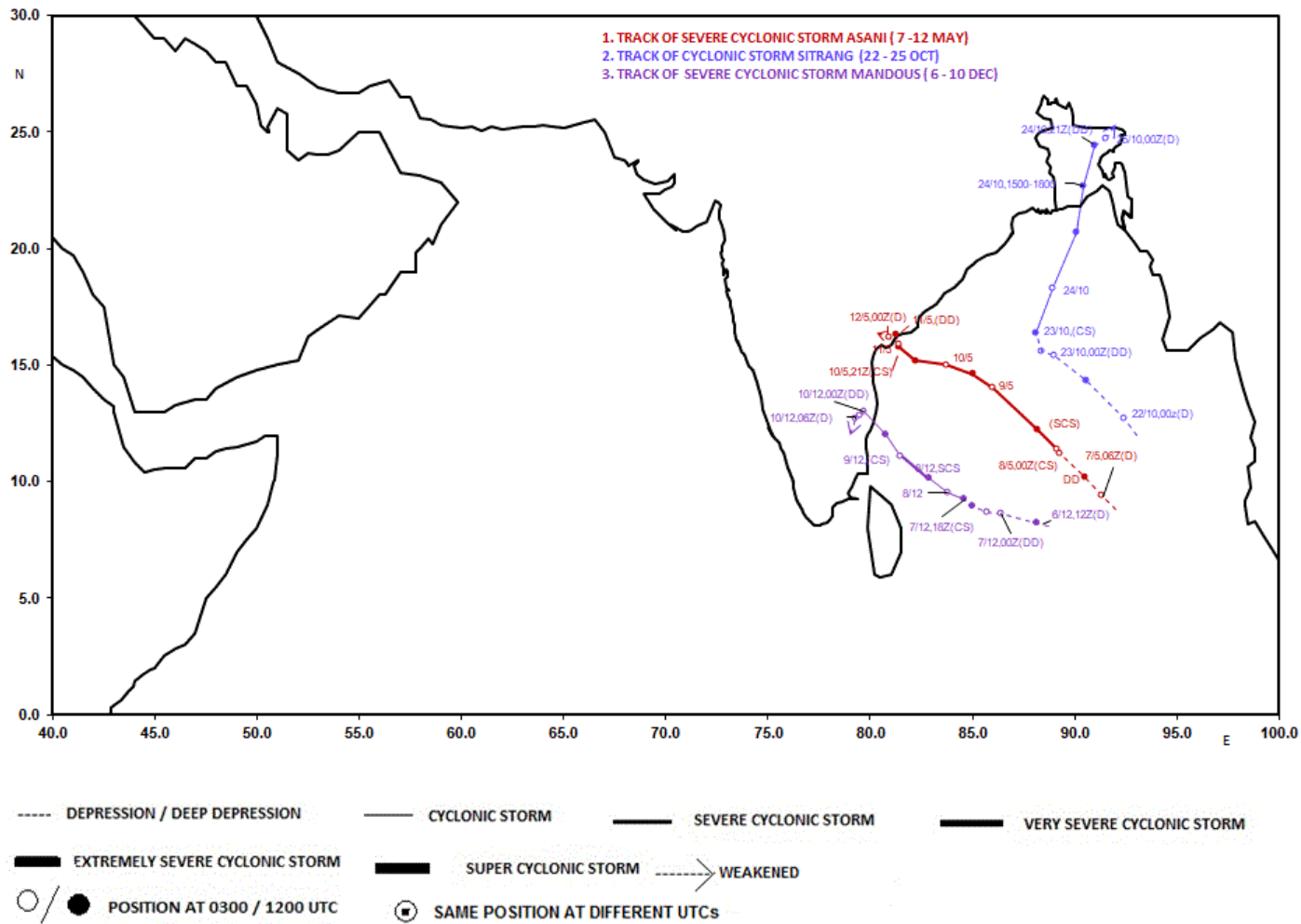
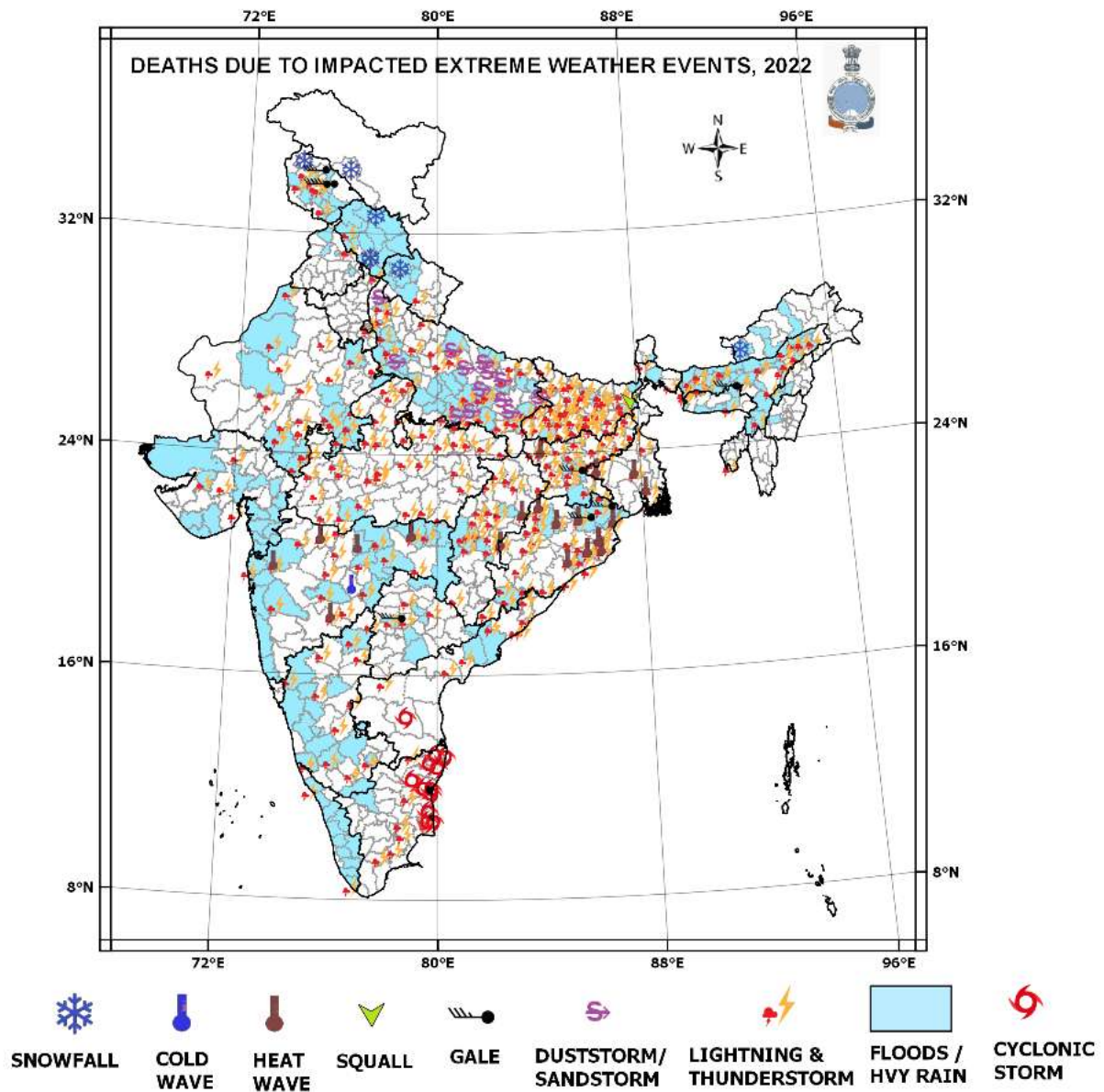


Fig. 4: Tracks of the cyclones formed during 2022





**Fig.5:**The Significant Extreme Weather Events Occurred during 2022.

State wise information about the High Impact Weather Events occurred during 2022 along with loss of life reported by media and other state government agencies .

State /UT	Deaths due to Impacted Extreme Weather Events						Total
	LIGHTNING & THUNDERSTORM	FLOODS & HEAVY RAINS	SNOWFALL	HEAT WAVE	DUST STORM	Other Events	
Andhra Pradesh	18	7				1	26
Arunachal Pradesh		16	7 (6 Feb.)				23
Assam	58 (14 to 17, 27, 29 Apr.; 18 & 19 May; 15, 16, 21, 22 Jun.; 3, 4, 6, 15, 23, 26 Jul.; 6, 7, 8, 13, 18 Aug.; 3 Sep.)	198 (13, 15, 17 to 25, 27, 29 & 31 May; 14 to 30 Jun.; 1 to 9, 12, 14, 17,19 Jul.)				1	257
Bihar	415 (12 Jan.; 4, 24, 27 Feb.; 20, 30 Apr.; 3, 5, 12, 13, 19, 20, 22, 23, 28 May; 18 to 21, 23, 24, 27, 28, 29 Jun.; 1, 2, 3, 9, 11, 14, 15, 19 to 23, 25	3					418



	to 31 Jul.; 1 to 4, 6, 7, 8, 13, 19, 23, 31 Aug.; 1 to 5, 8 to 10, 13 to 19, 22, 24, 27 to 29 Sep.; 4, 6, 10, 11 Oct.)						
Chhattisgarh	71 (21 Apr.; 3, 15, 29 May; 15, 17, 19, 22, 23, 26, 29 Jun.; 2, 3, 23, 26, 28, 29 Jul.; 6 Aug.; 10, 19, 20, 29, 30 Sep.)	7		1			79
Delhi	2	3					5
Gujarat	7	24					31
Himachal Pradesh	3	75 (17 Jan.; 22, 29 May; 29 & 30 Jun.; 6, 14 Jul.; 8, 11, 15, 19, 20 Aug.; 26 Sep.)	10 (10 Jan.; 12 Feb.; 17 Apr.)				88
Jammu & Kashmir	7	43 (5 Jan.; 9 May; 19 Jun.; 7, 8, 13, 23, 27, 30, 31 Jul.; 7, 8, 11, 20 Aug.; 15 Nov.)	3			4	57
Jharkhand	122 (5, 25 Feb.; 4, 20, 23 May; 15, 17, 24 Jun.; 1, 24, 25, 29 to 31 Jul.; 1, 2, 13, 15, 28 Aug.; 3, 7, 10, 15, 20, 22, 26 to 30 Sep.; 1 Oct.)	5		1		2	130
Karnataka	33	34					67
Kerala	2	30					32
Ladakh			1				1
Madhya Pradesh	116 (8 & 9 Jan.; 8 Apr.; 23 May; 1, 11, 15, 16, 17, 22, 23, 25, 27, 28, 29 Jun.; 2, 3, 6, 8, 9, 11, 12, 15, 19, 25 Jul.; 4 to 7 Aug.; 3, 8, 10, 21, 27 Sep.; 7, 11 Oct.)	1					117
Maharashtra	64 (12 Jan.; 7 to 9 Mar.; 6 & 22 Apr.; 20 & 31 May; 8, 11, 12, 16, 18, 19, 20, 21, 23, 24 Jun.; 9, 30 Jul.; 30 Aug.; 8, 10, 11, 12, 16, 21, 28 Sep.; 5, 7, 10, 17, 18, 20 Oct.)	116 (24 Jun.; 6, 9 to 14, 18 & 19 Jul.; 4 to 14, 17 Aug.; 11 to 14, 16, 20, 21 Sep.; 5, 17 to 20 Oct.)		13 (29 to 31 Mar.; 1, 26, 28, 30 Apr.; 10 May)		1	194
Manipur		56 (Massive Landslide at Noney- 30 Jun.)					56
Meghalaya	1	15					16
Nagaland		3					3
Odisha	168 (11 Jan.; 25 Feb.; 25 Mar.; 7, 15, 16, 26, 28, Apr.; 1 to 4, 6, 9, 10, 17, 19, 20, 22, 23, 24, 27 May; 10 to 12, 14 to 17, 19 to 24, 29, 30 Jun.; 1, 2, 4, 8, 14, 15, 22, 24, 28 Jul.; 1 to 4, 6, 7, 12, 13, 17, 18, 19, 21, 22, 24, 27, 28 Aug.; 3 to 5, 7, 9, 10, 15, 17, 18, 23, 25 to 28, 30 Sep.)	12		12 (22 Mar.; 12, 14, 25, 27, 28 Apr.; 3, 5, 21 May; 7, 8, 13 Jun.)		2	194
Puducherry						1	1
Punjab		3					3
Rajasthan	78 (1 to 8, 10, 14 to 17, 19 to 21, 27 Jul.; 1, 4 to 9, 16 Aug.; 1, 10, 11, 12, 14 Sep.; 8, 10 Oct.)	48 (2, 8, 13 to 20, 25 to 28 Jul.; 1, 8, 10, 16, 20, 22 Aug.; 15 Sep.)					126
Sikkim	1	3					4
Tamil Nadu	21	3				4	28
Telangana	6	11				1	18
Tripura	1						1
Uttar Pradesh	81	98			22		201

	(4, 21, 23 May; 28 Jun.; 3, 20, 25, 26 Jul.; 6 Aug.; 22 to 24 Sep.; 9 & 10 Oct.)	(23 May; 13, 16, 17, 21 to 26 Sep.; 6 to 9 Oct.)			(23 May)		
Uttarakhand	1	13	16 (4 Oct.)				30
West Bengal	9	8		3		1	21
Grand Total	1285	835	37	30	22	18	2227

Other Events: COLD WAVE + CYCLONIC STORM + GALE + SQUALL

### Distribution of Number of Deaths & its percentage during 2022 for Impacted Extreme Weather Events

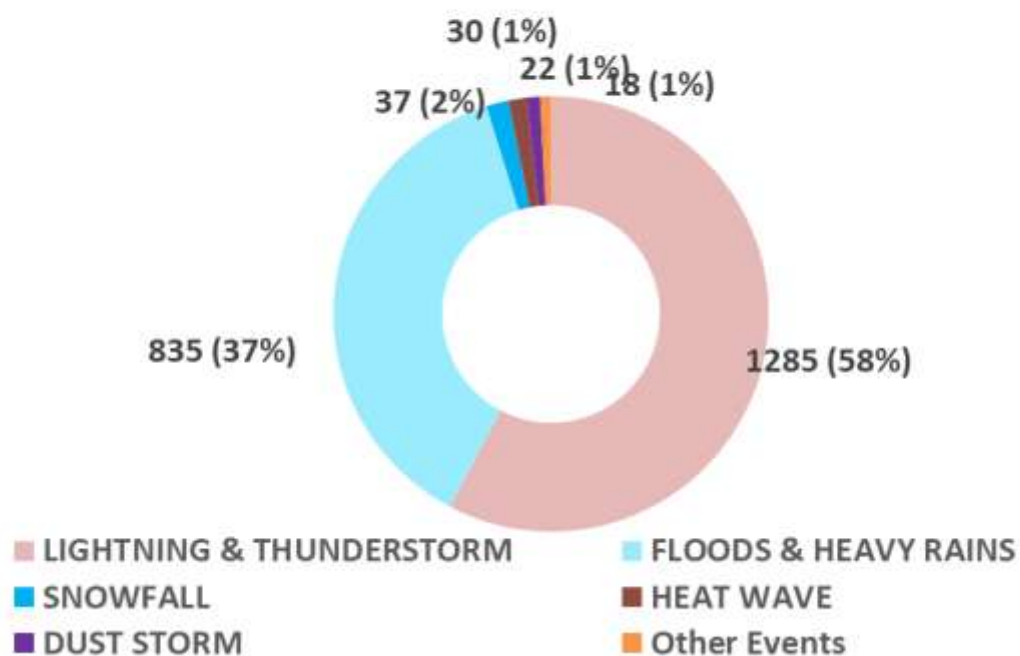


Fig.6: Distribution of the Number of Deaths & its percentage during 2022 due to Extreme Weather Events.

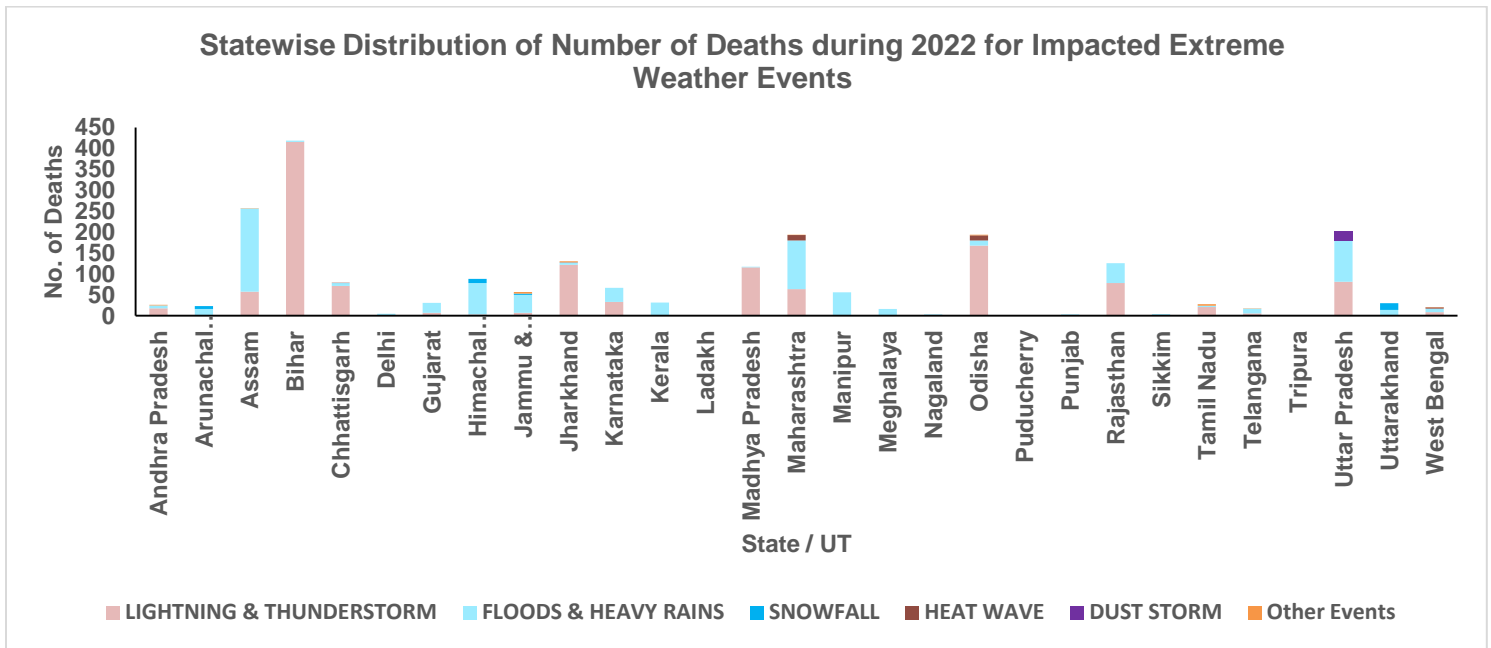


Fig.7: State-wise Distribution of the Number of Deaths during 2022 due to Extreme Weather Events.

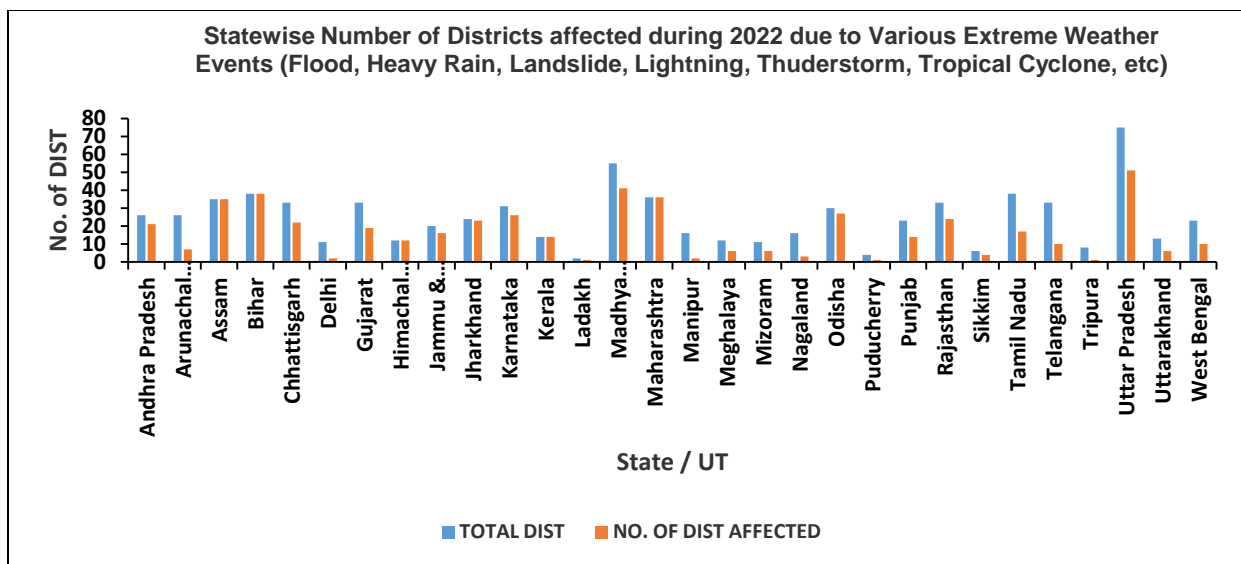


Fig.8: State-wise Number of Districts affected during 2022 due to various Extreme Weather Events.