

**GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
LOK SABHA
UNSTARRED QUESTION No. 3933
TO BE ANSWERED ON FRIDAY, MARCH 19, 2021**

EXTREME WEATHER CONITIONS

3933. DR. SHASHI THAROOR :

Will the Minister of EARTH SCIENCES be pleased to state:

- (a) whether the Government has maintained a comprehensive report of the extreme weather conditions observed within the country over the past year, including extreme temperatures and if so, the details thereof;
- (b) whether there has been an increase in these extreme weather conditions over the past year and if so, the details thereof;
- (c) whether the Government has used this information to enhance preparedness for the same in future and if so, the details thereof;
- (d) whether the Government is aware that India is one of the most vulnerable countries to climate change and extreme weather events as per several reports, and suffers among the countries with highest deaths and economic losses due to the same and if so, the details thereof; and
- (e) whether the Government is working in conjunction with any other countries and international organisations on specific ways to deal with such events and if so, the details thereof?

ANSWER

**MINISTER FOR MINISTRY OF SCIENCE AND TECHNOLOGY AND
MINISTRY OF EARTH SCIENCES
(DR. HARSH VARDHAN)**

(a)-(b) Yes Sir. India Meteorological Department (IMD) has issued 'Statement of Climate of India during 2020' on 4th January 2021. The report contains the details of extreme weather events observed within the country during 2020 including extreme temperatures. The detailed report is given in [Annexure I](#). The highlights of the report are as follows:

Heat wave conditions : Heat wave conditions were rather moderate during the season.

- 13 and 14 April : Over isolated pockets of Gujarat State
- On 21 May : Over Saurashtra & Kutch and west Rajasthan.
- During 22-29 May : On most of the days in Rajasthan, Vidarbha, Madhya Pradesh, on many days in Haryana, Chandigarh, & Delhi, Telangana, Uttar Pradesh, on a few days

in Gujarat, Marathwada and on isolated days in Madhya Maharashtra, Chhattisgarh and coastal Andhra Pradesh.

- During 25-28 May : Severe heat wave conditions were also observed in isolated pockets of west Rajasthan, Haryana, Delhi & East Uttar Pradesh and in some parts of Rajasthan.
- During 15-18 June : Heat wave conditions prevailed over some parts of West Rajasthan, which was severe at one or two places on 16 June.

Cold Wave conditions :

- In the month of January, cold wave conditions prevailed over parts of Saurashtra & Kutch, Haryana, Chandigarh & Delhi, Jammu & Kashmir, Jharkhand, Bihar, Chhattisgarh, Punjab, Himachal Pradesh, Odisha, east and west Rajasthan and West Uttar Pradesh on isolated days.
- In the month of February, cold wave conditions prevailed during the first fortnight (1-13 February) of the month over parts of Haryana, Chandigarh & Delhi and Punjab on many days and over parts of Uttarakhand, Odisha, East and West Madhya Pradesh, Chhattisgarh, Bihar and Jharkhand on few days. During the above period, severe cold wave conditions prevailed on one day each in Punjab and Odisha.
- Cold day conditions at many places with severe cold day conditions at isolated places occurred over Haryana, Chandigarh & Delhi and West Uttar Pradesh during 15-18 and 29-31 December and over East Uttar Pradesh during 19-22 December. The cold day conditions at isolated places occurred over Bihar during 19-23 December over north Madhya Pradesh during 19-20 and 29-31 December.

Extreme Rainfall :

- Episodes of heavy to very heavy and extremely heavy rainfall events occurred over different parts of the country during the monsoon season of 2020. Due to these events parts of Himachal Pradesh, Maharashtra, Kerala, Uttar Pradesh, Assam, Bihar and Telangana suffered flooding.

- (c) The details of extreme weather events are shared with public, state governments and also NDMA for preparing for proper disaster management efforts.
- (d) Yes Sir. India is one of the most vulnerable country for the extreme weather events. The German watch Global Climate Risk Index (CRI) is an analysis based on one of the most reliable data sets available on the impacts of extreme weather events and associated socio-economic data.. The index calculated for any given year is based on the extreme weather events such as storms, floods and heat waves occurred in that year. The ranking of India based on CRI since 2010 is given in the table below. From the table it is observed that India is ranked within 20 during most of the years.

Table-1 Climate Risk Index Rank (India) Since 2010			
Year	Year Rank	Period	20 Year Rank
2010	31	1991-2010	20
2011	17	1992-2011	22
2012	46	1993-2012	18
2013	3	1994-2013	17
2014	10	1995-2014	16
2015	4	1996-2015	14
2016	6	1997-2016	12
2017	14	1998-2017	14
2018	5	1999-2018	17
2019	7	2000-2019	20

It is also observed that extreme events are all showing increasing trends in recent decades in line with other parts of the globe which is mainly attributed to climate change. As per the climate change projections made by IPCC, there is high probability for these extreme events to increase in coming years. The country already has a robust early warning and response system for extreme weather and climate events based on scientifically generated weather and climate information.

The number of people who died in the extreme weather events for the year 2019 and 2020 are given in the **Appendix II & III** respectively. As compared to 2019 the loss of life due to extreme weather events are less in the year 2020.

(e) The details of collaboration in various fields and the MoU signed by Govt. of India with other countries and foreign government agencies are as follow;

1. The MoU for Scientific and Technical Cooperation between Qatar Civil Aviation Authority, State of Qatar and MoES, Govt. of India.

Targeted milestones (next 2 to 3 years)

Capacity building activities related to the seamless coordination of disaster management activities with an effective, efficient and with comprehensive plans of public understanding and preparedness.

2. The MoU for Technical Cooperation in Earth Observations and Earth Sciences between the National Oceanic and Atmospheric Administration (NOAA), USA and MoES.

There are 5 active implementation agreements and IMD is responsible for Tropical cyclone activity part.

Targeted milestones (next 2 to 3 years):

- Customization of Hurricane Weather Forecast (HWRF) model of NOAA has been customized and implementation of real time tropical cyclone forecast (Track, intensity, wind & Rainfall).
- Customization of tailor made real time weather forecast products of extreme rainfall and impact based forecast

3. **Cooperation with World Meteorological organisation:**

➤ **South Asia Flash Flood Guidance System (SAsiaFFGS)**

Targeted milestones (next 2 to 3 years)

Collaboration with WMO has helped in technology transfer from Hydrologic Research Centre (HRC), USA to India for South Asia Flash Flood Guidance System commencing from **monsoon season 2020** and will continue further.

It helped to issue impact based forecast and risk based warning during monsoonal flood situations like heavy rainfall over Mumbai, Heavy rainfall over Dwarka and Heavy rainfall over Bhopal as few examples.

➤ **Regional Specialized Meteorological Centre (RSMC)**

Targeted milestones (next 2 to 3 years)

Collaboration helped India to demonstrate as a Regional Specialized Meteorological Centre (RSMC) for tropical cyclone (**one of the sixth centre in the World**) in providing leadership in the region. The collaboration helped in exchange of meteorological data from Bay of Bengal (BoB) and Arabian Sea countries to IMD and hence improved monitoring and forecast.

➤ **WMO Severe Weather Forecast Demonstration Programme (SWFP):**

Targeted milestones (next 2 to 3 years)

This collaboration in coming 2 to 3 years will further support India to recognise as a regional leader to provide severe weather guidance to the member countries India, Bangladesh, Myanmar, Thailand, Bhutan, Nepal, Pakistan, Sri-Lanka and Maldives). In return, India got access to high resolution NWP model and location specific forecast products from European Centre for Medium Range Weather Forecasts (ECMWF), National

Centre for Environmental Prediction (NCEP), UK Met Office (UKMO), Japan Meteorological Agency (JMA), Korean Meteorological Agency (KMA), China Meteorological Administration (CMA). Also satellite based nowcast (very short range forecast of convective activity like thunderstorm rainfall) was made available for use in the region. This 5 day forecast will help the government in policy and planning.



Press Release
04 January, 2021

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 2020

HIGHLIGHTS

The annual mean land surface air temperature averaged over India during 2020 was above normal. During the year, annual mean land surface air temperature averaged over the country was +0.29°C above normal (based on the data of 1981-2010). The year 2020 was the eighth warmest year on record since nation-wide records commenced in 1901. However, this is substantially lower than the highest warming observed over India during 2016 (+0.71°C). The monsoon and post-monsoon seasons with mean temperature anomalies (Actual temperature-Normal temperature) of +0.43°C and +0.53°C respectively mainly contributed to this warming. Mean temperature during the winter was also above normal with anomaly of +0.14°C. However, during the pre-monsoon season temperature was below normal (-0.03°C).

The Global mean surface temperature anomaly during 2020 (January to October as per WMO state of the global climate) is +1.2°C (source: <https://public.wmo.int/en/our-mandate/climate/wmo-statement-state-of-global-climate>).

The 2020 annual rainfall over the country as a whole was 109% of its Long Period Average (LPA) based on the data of 1961-2010. The monsoon season rainfall over the country as a whole was above normal and was 109% of its LPA.

Temperatures

The 2020 annual mean land surface air temperature for the country was +0.29°C above the 1981-2010 period average, thus making the year 2020 as the eighth warmest year on record since 1901 (Fig. 1). The five warmest years on record in order were: 2016 (+0.71°C), 2009 (+0.55°C), 2017 (+0.541°C), 2010 (+0.539°C), and 2015 (+0.42°C). It may be mentioned that 12 out of 15 warmest years were during the recent fifteen years (2006-2020). Past decade (2001-2010/ 2011-2020) was also the warmest decade on record with anomalies of 0.23°C /0.34°C. The country averaged annual mean temperature during 1901-2020 showed an increasing trend of 0.62°C/100 years (Fig.1) with significant increasing trend in maximum temperature (0.99°C/100 years) and relatively lower increasing trend (0.24°C/100 years) in minimum temperature.

The country averaged seasonal mean temperatures were also above the average during all the seasons except pre-monsoon season. The country averaged mean monthly temperatures were warmer than the normal during all the months of the year except March and June.

The mean temperatures exceeded the normal during September (by 0.72°C, warmest since 1901), August (by 0.58°C, second warmest), October (by 0.94°C, third warmest), July (by 0.56°C, fifth warmest), and December (by 0.39°C, seventh warmest).

Rainfall

The annual rainfall over the country was 109 % of long period average (LPA) of 117.7 cms. 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 SW monsoon season (June-September), which is the principal rainy season of the country, was above normal (109 % of LPA of 88 cms). During this season, among the four broad geographical regions of the country, Central India, South Peninsular and East & Northeast India received seasonal rainfall of 115%, 129% and 106% of its LPA respectively, while Northwest India received seasonal rainfall of 84% of its LPA.

The 2020 Northeast monsoon season (October-December) rainfall over the country as a whole was normal (101% of LPA). The seasonal rainfall during the northeast monsoon season over the core region of the south peninsula (comprising of 5 subdivisions viz. Coastal Andhra Pradesh, Rayalaseema, Tamil Nadu & Puducherry, South Interior Karnataka and Kerala), was also normal (110% of LPA). All the five subdivisions of the core region except Kerala received excess/normal rainfall.

Tropical Storms in the Indian Seas

During 2020, 5 cyclones formed over the North Indian Ocean. These are Super cyclonic Storm **AMPHAN**, Very Severe Cyclonic Storms **NIVAR & GATI**, Severe Cyclonic Storm **NISARGA**, and Cyclonic Storm 'BUREVI'. Of these, **NISARGA & GATI** formed over Arabian Sea, while the remaining 3 cyclones viz. **AMPHAN, NIVAR & BUREVI** formed over the Bay of Bengal. Out of these five most devastating cyclones, the Super Cyclonic Storm **AMPHAN** formed in the pre-monsoon season and crossed West Bengal coast over Sundarbans on 20th May. It claimed 90 lives & about 4,000 livestock mainly in West Bengal. The Severe Cyclonic Storm **NISARGA**, formed in the Monsoon season, crossed Maharashtra coast on 3rd June claimed 4 lives & 2000 livestock in Maharashtra. The remaining three cyclones viz. **NIVAR, BUREVI & GATI** formed during the post monsoon season. The Very Severe Cyclonic Storm **NIVAR** crossed Tamil Nadu & Puducherry coasts close to north of Puducherry and claimed 12 lives & 10836 livestock in Tamil Nadu & Andhra Pradesh. The Cyclonic Storm **BUREVI** claimed 9 lives & 200 livestock in Tamil Nadu. The VSCS "**GATI**" made landfall over Somalia coast. All these weather systems and their remnants and other low-pressure systems caused above normal rainfall over central and peninsular India. The tracks of these cyclones formed during the year are shown in figure 3.

High Impact Weather Events

The country also experienced other high impact weather events like, extremely heavy rainfall, floods, landslide, thunderstorm, lightning, cold waves, etc. (Fig.4). A few are listed below. The casualties mentioned here are based on the media and government reports.

Bihar & Uttar Pradesh were the most adversely affected states during the year which reportedly claimed more than 350 deaths from each state mainly due to thunderstorm, lightning & cold wave events.

Heavy rainfall & flood related incidents reportedly claimed over 600 lives from different parts of the country during pre-monsoon, monsoon & post-monsoon seasons. Of these, 129 lives were reportedly claimed from Assam, 72 from Kerala [Specifically, 65 persons reportedly claimed dead in a single day from Pettimudi in Munnar, Idukki district of Kerala on 7th August due to landslide.], 61 from Telangana (while, 59 lives reportedly claimed only during the period 1st to 20th October), 54 lives from Bihar, 50 from Maharashtra, 48 Uttar Pradesh, & 38 from Himachal Pradesh.

Thunderstorms and lightning reportedly claimed 815 lives from different parts of the country. Among these, 280 from Bihar, 220 from Uttar Pradesh, 122 from Jharkhand, 72 from Madhya Pradesh, 23 from Maharashtra and 20 from Andhra Pradesh were significant.

Cold wave conditions mainly prevailed over central parts the country especially in the month of January. It caused deaths of about 150 people. Of these deaths, 88 deaths were reported from Uttar Pradesh alone, 45 from Bihar only on single day on 1st January & 16 from Jharkhand.

Major Extreme Weather Events occurred during 2020 and associated casualties are shown in Fig. 4.

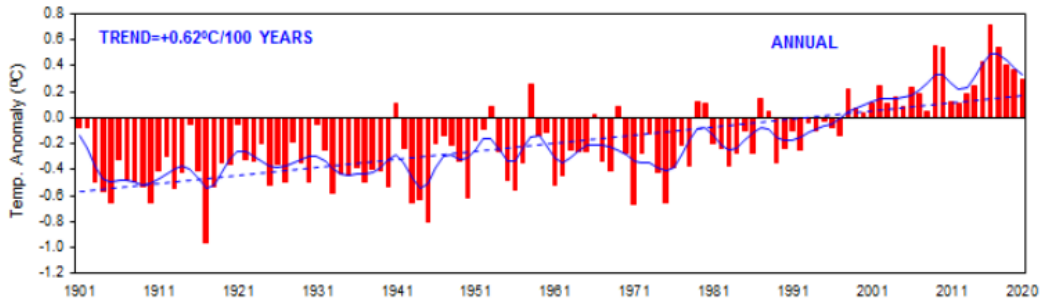


Fig.1: Annual mean land surface air temperature anomalies averaged over India for the period 1901-2020. The anomalies were computed with respect to base period of 1981-2010. The dotted line indicates the linear trend in the time series. The solid blue curve represents the sub-decadal time scale variation smoothed with a binomial filter.

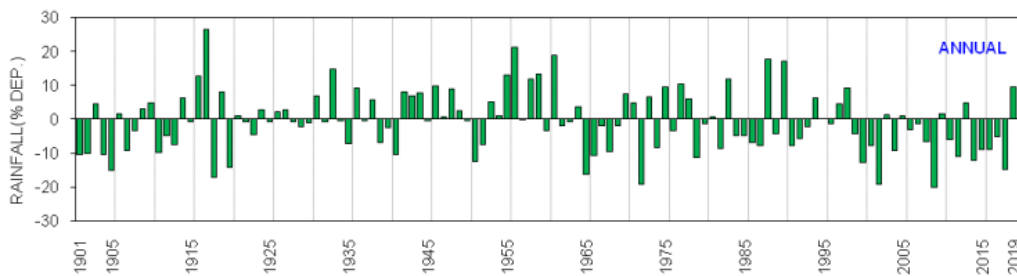


Fig. 2: Time Series of All India Annual Rainfall percentage Departure (1901-2020)

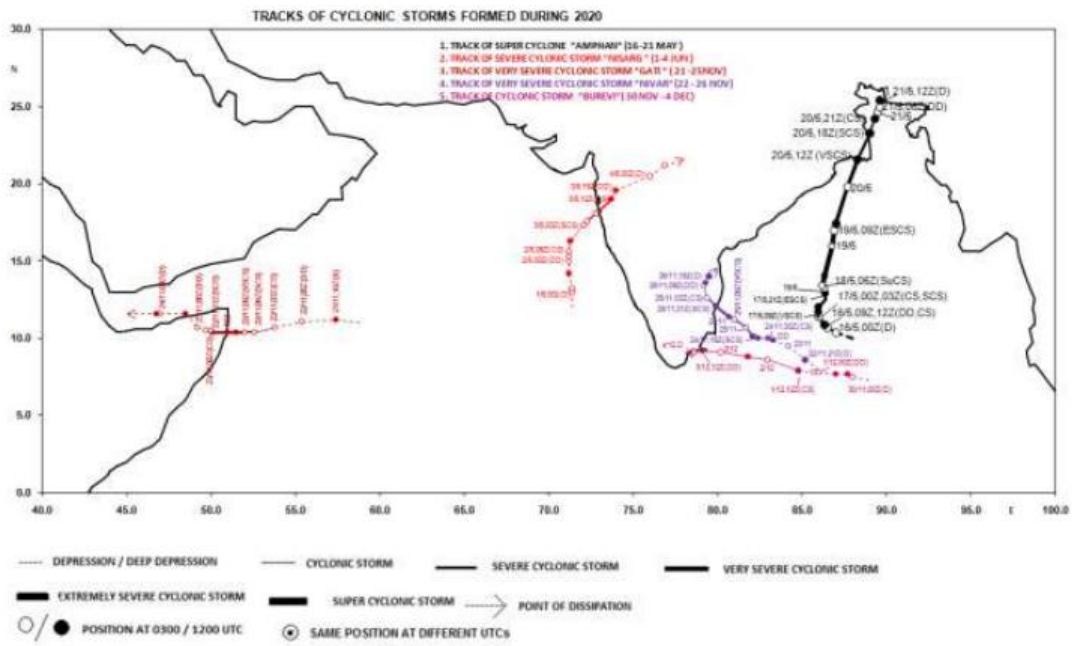


Fig. 3: Tracks of the Cyclonic storms formed during 2020

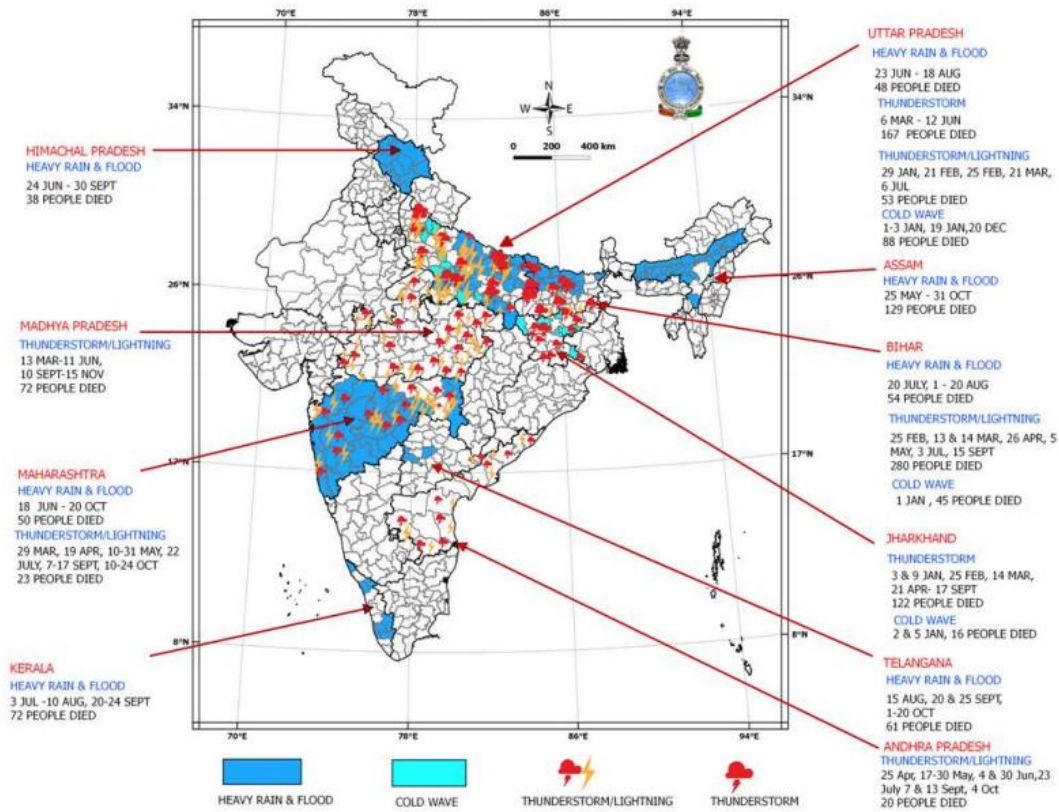


Fig. 4: Major extreme weather events occurred during 2020 and associated casualties.

(*: The casualties mentioned in the above figure are based on media reports)

Appendix II

*Number of death due to extreme weather events in the year 2019												
State	COLD WAVE	CYCLONIC STORM	DUST STORM	FLOODS & HEAVY RAINS	GALE	HAIL STORM	HEAT WAVE	LIGHTNING	SNOW FALL	SQUALL	THUNDER STORM	Grand Total
Andhra Pradesh							45					45
Assam				94				15			11	120
Bihar	19			306			293				72	690
Chhattisgarh				4				2			17	23
Goa				1								1
Gujarat				27							10	37
Himachal Pradesh				26					8			34
Jammu & Kashmir				22		0			57		3	82
Jharkhand	13			5			13			2	126	159
Karnataka				30				21			8	59
Kerala				106	1		13	3				123
Madhya Pradesh	12			21		2		30				65
Maharashtra	7			169			53	64			2	295
Manipur											3	3
Odisha		64						24		1		89
Rajasthan			25	82			3	5			15	130
Sikkim				1								1
Tamil Nadu				18	1							19
Telangana				10	2		66	7				85
Tripura											1	1
Uttar Pradesh	240			32			9	26			64	371
Uttarakhand				39								39
West Bengal		7		3				5			17	32
Grand Total	291	71	25	996	4	2	495	202	65	3	349	2503

Appendix III

* Number of deaths due to extreme weather events in the year 2020												
State	COL D WAV E	CYCLONI C STORM	DUST STOR M	FLOO DS & HEAV Y RAINS	GAL E	HAIL STOR M	HEA T WAV E	LIGHTNIN G	SNOWFA LL	SQUAL L	THUNDE R STORM	Grand Total
Andhra Pradesh		9		21				20				50
Arunachal Pradesh				11								11
Assam				129								129
Bihar	45			54			2				280	381
Gujarat				29				8				37
Harayana				1								1
Himachal Pradesh				38					4			42
Jammu & Kashmir				13	3			5	17			38
Jharkhand	16			4				5		6	122	153
Karnataka				16	1			12				29
Kerala				72				2				74
Madhya Pradesh				10				72			7	89
Maharashtra		4		50				23			1	78
Meghalaya				6								6
Odisha		4		16				16				36
Rajasthan	2		14	18				3				37
Sikkim				5					1		1	7
Tamil Nadu		12						9				21
Telangana				61				6				67
New Delhi (UT)				1								1
Uttar Pradesh	88			48				53			167	356
Uttarakhand	1			4								5
West Bengal		86		3				3				92
Grand Total	152	115	14	610	4		2	237	22	6	578	1740

* (The number of deaths reported due to extreme weather events in Appendix-II & III are based on media reports only)
