GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
RAJYA SABHA
UNSTARRED QUESTION NO. - 976
ANSWERED ON – 10/02/2022

MEASURES TO TACKLE EXTREME WEATHER EVENTS

976. SHRI V. VIJAYASAI REDDY :

Will the Minister of EARTH SCIENCES be pleased to state:

(a) the manner in which Government reacts to the country being listed as the 7th worst hit due to extreme weather events as per Germanwatch;
(b) the estimated loss, in terms of economic, life, property, etc., due to extreme weather events;
(c) the remedial action Government proposes to take to address this problem;
(d) whether it is a fact that coastal areas are most vulnerable and the State of Andhra Pradesh is one of them; and
(e) if so, the special attention that has been paid on coastal areas by Government?

ANSWER
THE MINISTER OF STATE (INDEPENDENT CHARGE) FOR
MINISTRY OF SCIENCE AND TECHNOLOGY
AND EARTH SCIENCES
(DR. JITENDRA SINGH)

(a) The Germanwatch 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, from the Munich Re's NatCatSERVICE. The index calculated for any given year is based on the extreme weather events such as storms, floods and heatwaves occurred in that year. The ranking of India based on CRI since 2010 is given in Annexure-I. From the table it is observed that India is ranked within 20 during most of the years and in the year 2021, India is ranked in the 7th position. It is observed that extreme events are all showing increasing trends in recent decades over the country in line with other parts of the globe which is mainly attributed to climate change. As per the latest IPCC reports, global warming is likely to continue and there is high probability for these extreme events to increase.

The trends of various extreme weather events over Indian region are computed and are given in Figures 1 to 3 in Annexure-I. It contains the ratio of severe cyclonic storm to the total cyclonic storms over the North Indian Ocean for the period 1891 to 2020 (Fig.1), the trend of heavy rainfall events occurred during monsoon season (JJAS) for the period 1989 to 2018 (Fig.2) and trends of heatwave and cold wave over the Indian region (Fig.3 (a) and (b)).

(b) The number of people who died in the extreme weather events for the year 2019 to 2021 are given in the **Annexure-II**. Data related to economic impacts due to extreme events are not available with the Ministry.

(c) India Meteorological Department (IMD) provides early warning services related to severe weather events to support public welfare and disaster management related to Natural Hazards. The country already has a robust early warning and response system for extreme weather and climate events based on scientifically generated weather and climate observations and forecasts. During the past few years, IMD has been continuously improving weather prediction services in terms of accuracy, lead time and associated impact.

For this purpose, IMD follows a seamless forecasting strategy. The long-range forecasts (for the whole season) issued are being followed with extended range forecast issued on every Thursday with a validity period of four weeks. To follow up the extended range forecast, IMD issues short to medium range forecast and warnings at 36 meteorological sub-divisions levels daily four times valid up to next five days with an outlook for subsequent two days. The short to medium range forecast and warning at district and station level are issued by state level Meteorological Centres (MCs)/Regional Meteorological Centres (RMCs) with a validity of next five days and are updated twice a day. The short to medium range forecast is followed by very short range forecast of severe weather up to three hours (nowcast) for all the districts and 1089 cities and towns. These nowcasts are updated every three hours.

While issuing the warning, suitable colour code is used to bring out the impact of the severe weather expected and to signal the Disaster Management about the course of action to be taken with respect to impending disaster weather event. Green color corresponds to no warning hence no action is needed, yellow color corresponds to be watchful and get updated information, orange color to be alert and be prepared to take action whereas red color signals to take action.

IMD is issuing Impact Based Forecast (IBF) which give details of what the weather will do rather than what the weather will be. It contains the details of impacts expected from the severe weather elements and guidelines to general public about do's and don'ts while getting exposed to severe weather. These guidelines are finalised in collaboration with National Disaster Management Authority (NDMA) and is already implemented successfully for cyclone, heat wave, thunderstorm and heavy rainfall.

Regarding dissemination of weather forecasts and warnings, IMD is in a continuous process of improvement. At present the forecasts and warnings are broadcasted or disseminated to users including disaster managers by e-mail on regular basis. In addition to this, WhatsApp groups are created including disaster managers and IMD officials through which these forecasts & warnings are disseminated. The forecasts & warnings are uploaded in social media & website for reference by all concerned. The nowcasts related to Severe Weathers are also disseminated through SMS to the registered users. In addition to this, as and when the situation arises, Press Releases are issued by IMD and the same is also disseminated by all the platforms mentioned above.

Also, IMD has launched seven of its services (Current Weather, Nowcast, City Forecast, Rainfall Information, Tourism Forecast, Warnings and Cyclone) with '**UMANG**' mobile App for use by public. Moreover, IMD had developed mobile App '**MAUSAM**' for weather forecasting, '**Meghdoot**' for Agromet advisory dissemination and '**Damini**' for lightning alert. IMD is also implementing Common Alert Protocol (CAP) developed by NDMA for dissemination of Severe Weather Warning.

Moreover, various new initiatives, as mentioned below, have been undertaken by IMD, MoES for betterment of prediction and dissemination of warnings of extreme weather events that may cause natural disasters.

- The observational network of the department has been enhanced with installation of more number of Automatic Weather Stations (AWSs) and Automatic Raingauges (ARGs) across the country.
- Thirty three Doppler Weather Radars (DWRs) are operational across the country with 4 DWRs commissioned in January 2022 at New Delhi, Leh, Mumbai and Chennai. Doppler Weather Radars provide adequate warning in the event of approach of Cyclonic Storms, Monsoon Depressions, Thunderstorms etc. DWR network also provides vital information for nowcasting purposes on mesoscale convective weather developments anywhere in the country.
- Multi-Mission Meteorological Data Receiving & Processing System has been established and dedicated to the nation for augmentation of satellite derived products.
- New raingauge stations are being added in the District-wise Rainfall Monitoring Scheme to increase the rainfall monitoring network.
- Location specific forecast for 7 days and nowcast for next 3 hours have been extended to 1164 and 1089 stations respectively covering 739 districts in the country.
- NWP Model based gridded rainfall data are provided to Central Water Commission for their flood forecasting model for all 153 river catchments and Extended Range model products for 10 river basins alongwith quantitative precipitation forecast for all river catchments valid upto next five days.
- With operationalization of Flash Flood Guidance system, generation and issue of Flash Flood Guidance has commenced for all watersheds of the country.
- Impact based forecast is already in practice for cyclone. The same is extended to heavy rainfall and heatwaves. Efforts are on to extend the same to all types of severe weather.
- Common Alert Protocol (CAP) has been implemented as per WMO standard for severe weather warning. It is being utilized for Global Multi-Hazard Alert System of WMO.

(d) Yes Sir. The low-lying coastal zones including Andhra Pradesh coasts are vulnerable to impacts of oceanogenic hazards such as Cyclone, Tsunami, Storm & Swell surges, coastal flooding, high waves and sea level rise. However, the level of vulnerability depends on the extent of exposure of life/infrastructure. As compared to the west coast, the east coast of India more vulnerable.

(e) To mitigate the coastal disasters due to cyclones, India Meteorological Department runs a very effective state of art early warning system for monitoring and prediction of cyclones. The cyclone forecast accuracy has significantly improved in recent years as has been demonstrated during the recent cyclones. During recent years, the loss of life due to cyclone has been drastically reduced being limited to double digit figures.

In order to cater to the needs of Cyclone Warning Services and Marine weather services, there are seven established Warning Centres covering the east & west coasts of our country. Among these, three are Area Cyclone Warning Centres (ACWCs) located at Chennai, Mumbai and Kolkata and remaining four are Cyclone Warning Centres (CWCs) located at Ahmedabad, Thiruvananthapuram, Visakhapatnam and Bhubaneswar. Area of responsibility of ACWCs and CWCs is shown in the Table below.

Centre	Coastal area*	Maritime State/UT
ACWC Kolkata	State: West Bengal UT: Andaman & Nicobar Islands	State: West Bengal UT: Andaman & Nicobar Islands
ACWC Chennai	State: Tamil Nadu UT: Puducherry	State: Tamil Nadu UT: Puducherry
ACWC Mumbai	State: Maharashtra & Goa	State: Maharashtra & Goa
CWC Thiruvananthapuram	State: Kerala & Karnataka UT: Lakshadweep	State: Kerala & Karnataka UT: Lakshadweep
CWC Ahmedabad	State: Gujarat UT: Dadra-Nagar Haveli-Daman-Diu	State: Gujarat UT: Dadra-Nagar Haveli-Daman-Diu
CWC Visakhapatnam	State: Andhra Pradesh	State: Andhra Pradesh
CWC Bhubaneshwar	State: Odisha	State: Odisha

*Coastal strip of responsibility extends upto 75 km from the coast line.

From the table, it is clear that the cyclone warning services for Andhra Pradesh are taken care by the established CWC at Visakhapatnam. Also there is a Meteorological Centre at Amravati recently established by IMD to provide services to Andhra Pradesh State.

Apart from the above, Indian National Centre for Ocean Information Services (INCOIS), an autonomous institution under the Ministry of Earth Sciences (MoES) is providing early warning services for Tsunami, storm & Swell surges and high waves for entire coastal areas of the country. In addition, INCOIS, prepared Coastal Vulnerability Index (CVI) maps for the coastline of India including Andhra Pradesh coast at 1:100000 scale using data on sea level rise, coastal slope, shoreline change rate, coastal elevation, coastal geomorphology, tidal range and significant wave height. These services and maps can provide basic inputs to take mitigation measures and prepare the community for coastal hazards.

Annexure-1

Table 1. Climate Risk Index Rank (India) Since 2010	
Year	Year Rank
2010	31
2011	17
2012	46
2013	3
2014	10
2015	4
2016	6
2017	14
2018	5
2019	7
2020	5
2021	7

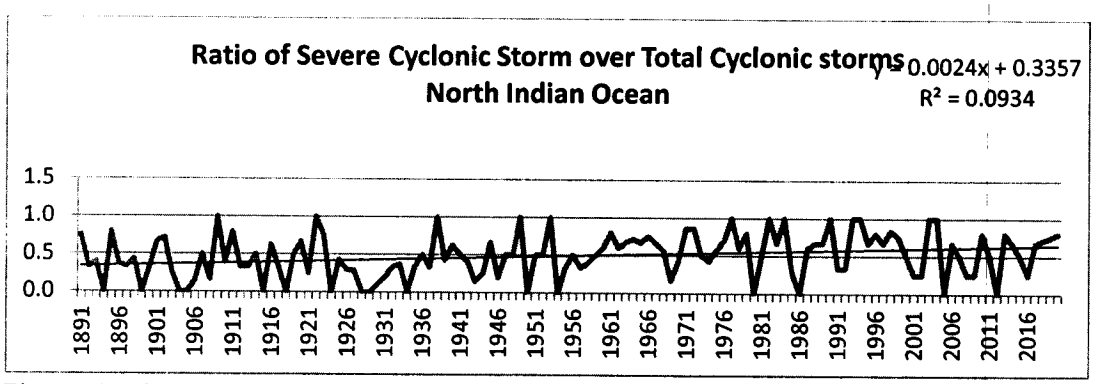

Fig.1. The time series of ratio of severe Cyclonic storms to total cyclonic storm over North Indian Ocean for the period (1891 to 2020).

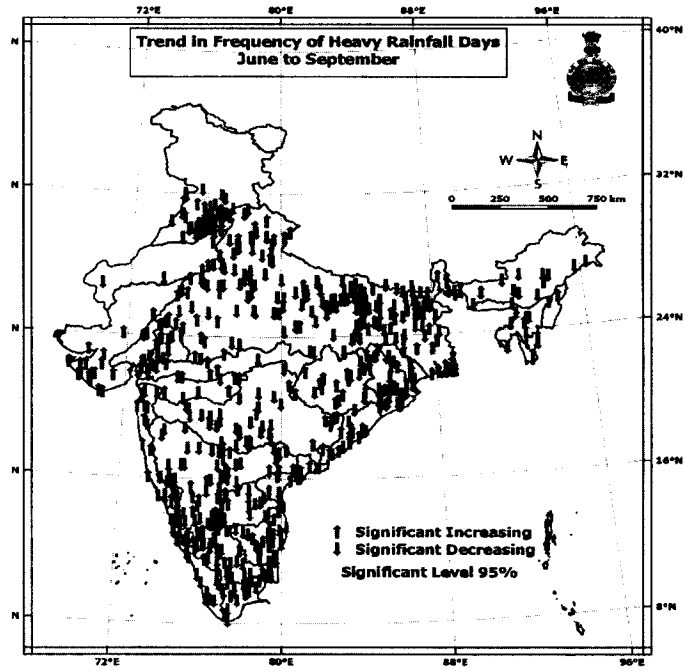

Fig. 2: Trend in Frequency of Heavy Rainfall Days during monsoon (JJAS) season for the period (1989-2018).

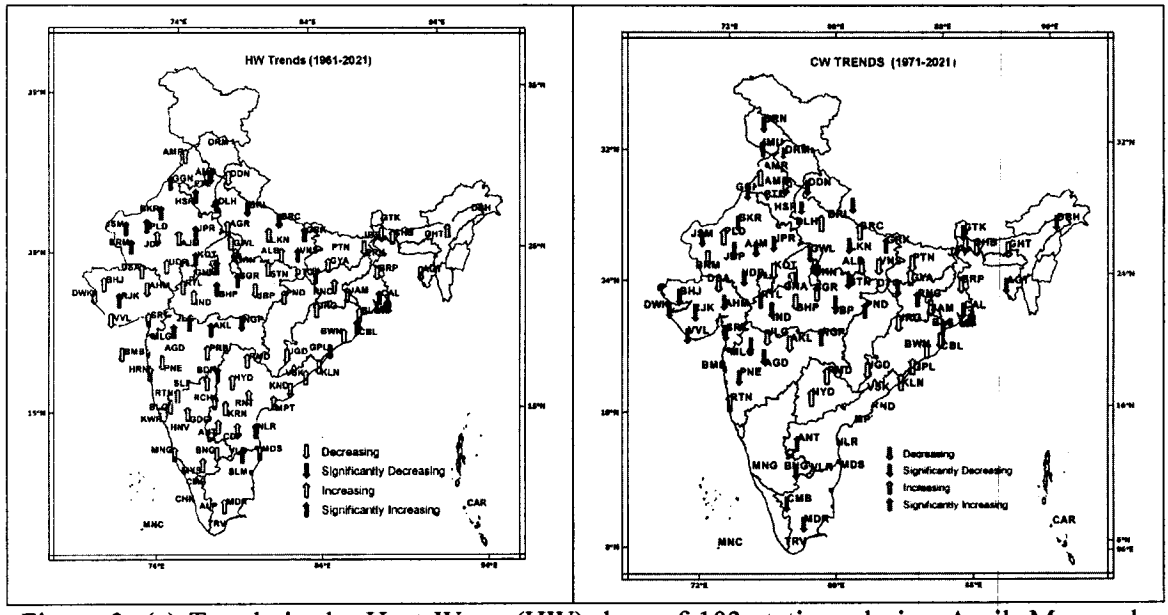

Figure 3: (a) Trends in the Heat Wave (HW) days of 103 stations during April, May and June for the period 1961–2021. (b) Trends in the Cold Wave (CW) days of 86 stations during the December, January and February for the period 1961–2021. Red rising (blue falling) arrows represent the increasing (decreasing) trends. Filled arrows represent the trends significant at 5% level. Nonparametric Mann–Kendall test was used to test the significance of the trends.

Annexure-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

* Number of deaths due to extreme weather events in the year 2020												
State	COLD WAVE	CYCLONIC STORM	DUST STORM	FLOODS & HEAVY RAINS	GALE	HAIL STORM	HEAT WAVE	LIGHTNING	SNOWFALL	SQUALL	THUNDER 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

Loss of lives/causalities during the year 2021 happened due to various weather events

Sum of Deaths	Natural Events									
State / UT	COLD WAVE	CYCLONIC STORM	DUST STORM	FLOODS & HEAVY RAINS	GALE	HAILS TORM	LIGHTNING	SNOW FALL	THUNDERSTORM	Grand Total
Andhra Pradesh		6		46						52
Assam				14						14
Bihar		1		12			73		16	102
Chhattisgarh							1		2	3
Goa		3								3
Gujarat		79		7			6			92
Haryana							1			1
Himachal Pradesh				55				4		59
Jammu & Kashmir	2			21		1	4	4		32
Jharkhand		3					22		32	57
Karnataka		8		33			3		1	45
Kerala		9		53			5			67
Madhya Pradesh	1			34	1		158		2	196
Maharashtra	3	56		215			74		2	350
Odisha		4		3	3		213			223
Rajasthan				14			48			62
Sikkim				2						2
Tamil Nadu				20			14			34
Telangana		3		15			7			25
New Delhi	3			4						7
Uttar Pradesh	2		5	42			43		6	98
Uttarakhand				143				4		147
West Bengal		2		26			58			86
Grand Total	11	174	5	759	4	1	730	12	61	1757

*(The number of deaths reported due to extreme weather events in Appendix is based on media reports only)

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