GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
RAJYA SABHA
UNSTARRED QUESTION NO. - 2424
ANSWERED ON – 24/03/2022

INCREASE IN INCIDENCES OF EXTREME WEATHER CONDITIONS

2424. Dr. Kirodi Lal Meena:

Will the Minister of EARTH SCIENCES be pleased to state:

(a) Whether it is a fact that incidences of extreme weather conditions have increased in the country and globally in the last decade;
(b) if so, the details of extreme weather events recorded in the country during the last decade along with the number of casualties/fatalities and estimated property damage occurred therefrom, event-wise;
(c) whether Government has taken any steps to improve adaptation and mitigation against extreme weather events;
(d) if so, the details thereof; and
(e) whether India is considered more vulnerable to climate change and if so, the details of areas in the country which are most vulnerable to extreme weather events?

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

(a)-(b) Yes, Sir. There is an increase in the number of recorded disasters attributed to weather, climate and water hazards over the decade at Global level as per the Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019) published by WMO (for more details please refer: https://library.wmo.int/doc_num.php?explnum_id=10902). Figure 1 from this report shows that the number of disasters has increased by a factor of five over the 50 years period: when 711 disasters were recorded for 1970–1979, about 3536 were recorded in 2000–2019 globally.

The details of the extreme weather event wise casualties during the period 1997-2019 are given in Figure 2. The information on loss of lives due to various disastrous weather events which happened since 2010 is provided in Table 1.

(c)-(d) Yes, India Meteorological Department (IMD) issues various outlook/forecast/warning for Public as well as Disaster Management Authorities for the preparedness and for mitigation measures related to extreme weather events.

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 daily 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.

Forecast is issued for 36 meteorological sub-divisions from National Weather Forecasting Centre, IMD HQ and updated four times a day. The forecasts and nowcasts are issued at District Level and Station Level by State Level Meteorological Centres and Regional Meteorological Centres.

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 implementing 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.

(e) The Ministry of Earth Sciences (MoES), has recently published a Climate Change report entitled "Assessment of Climate Change over the Indian Region" (http://cccr.tropmet.res.in/home/docs/cccr/2020_Book_AssessmentOfClimateChangeOverT.pdf). The report highlights the effects of human-induced climate change. The summer monsoon precipitation (June to September) over India has declined by around 6% from 1951 to 2015, with notable decrease over the Indo-Gangetic Plains and the Western Ghats. There is an emerging consensus, based on multiple datasets and climate model simulations, that the radiative effects of anthropogenic aerosol forcing over the Northern Hemisphere have considerably offset the expected precipitation increase from Green House Gas (GHG) warming and contributed to the observed decline in summer monsoon precipitation. The Hindu Kush Himalayas (HKH) experienced a temperature rise of about 1.3°C during 1951–2014. Several areas of HKH have experienced a declining trend in snowfall and also retreat of glaciers in recent decades. In contrast, the high-elevation Karakoram Himalayas have experienced higher winter snowfall that has shielded the region from glacier shrinkage. This report also highlighted projected change in the rainfall pattern over Indian region in coming years.The main summary of the Report given in Annexure II.

Annexure-I

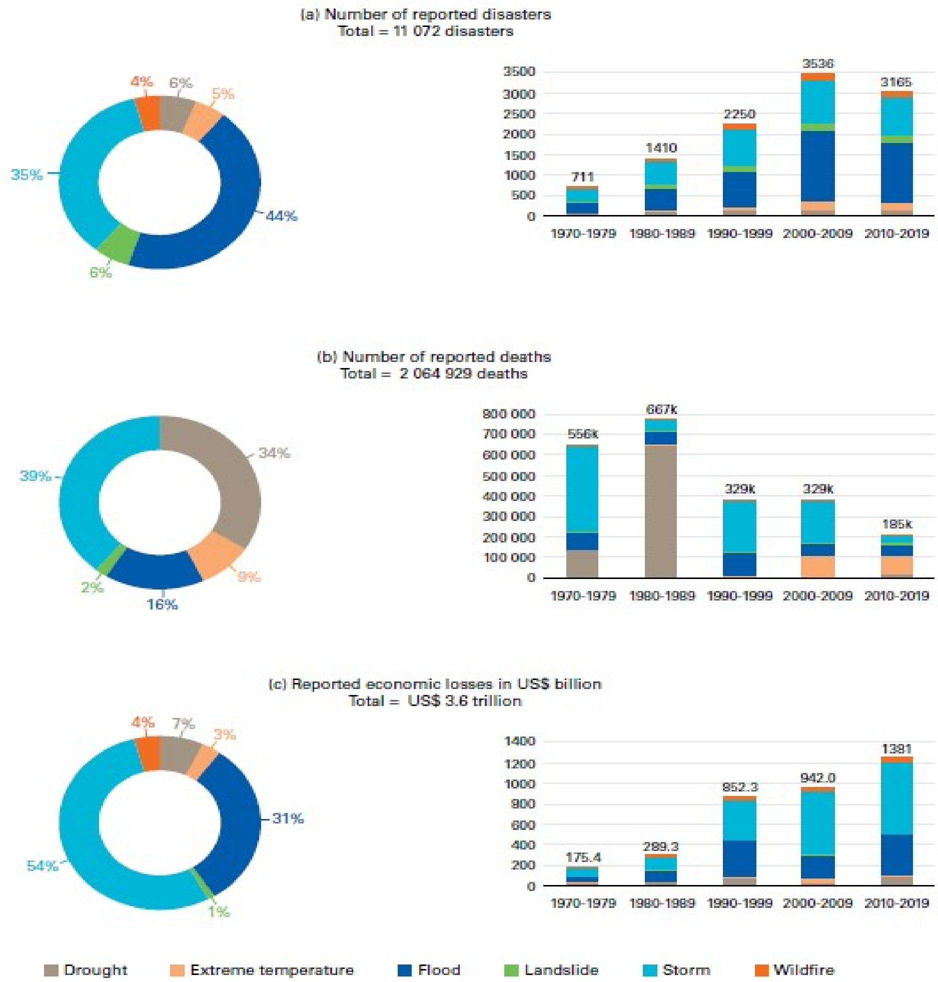

Fig 1. Distribution of (a) number of disasters, (b) number of deaths and (c) economic losses by hazard type by decade

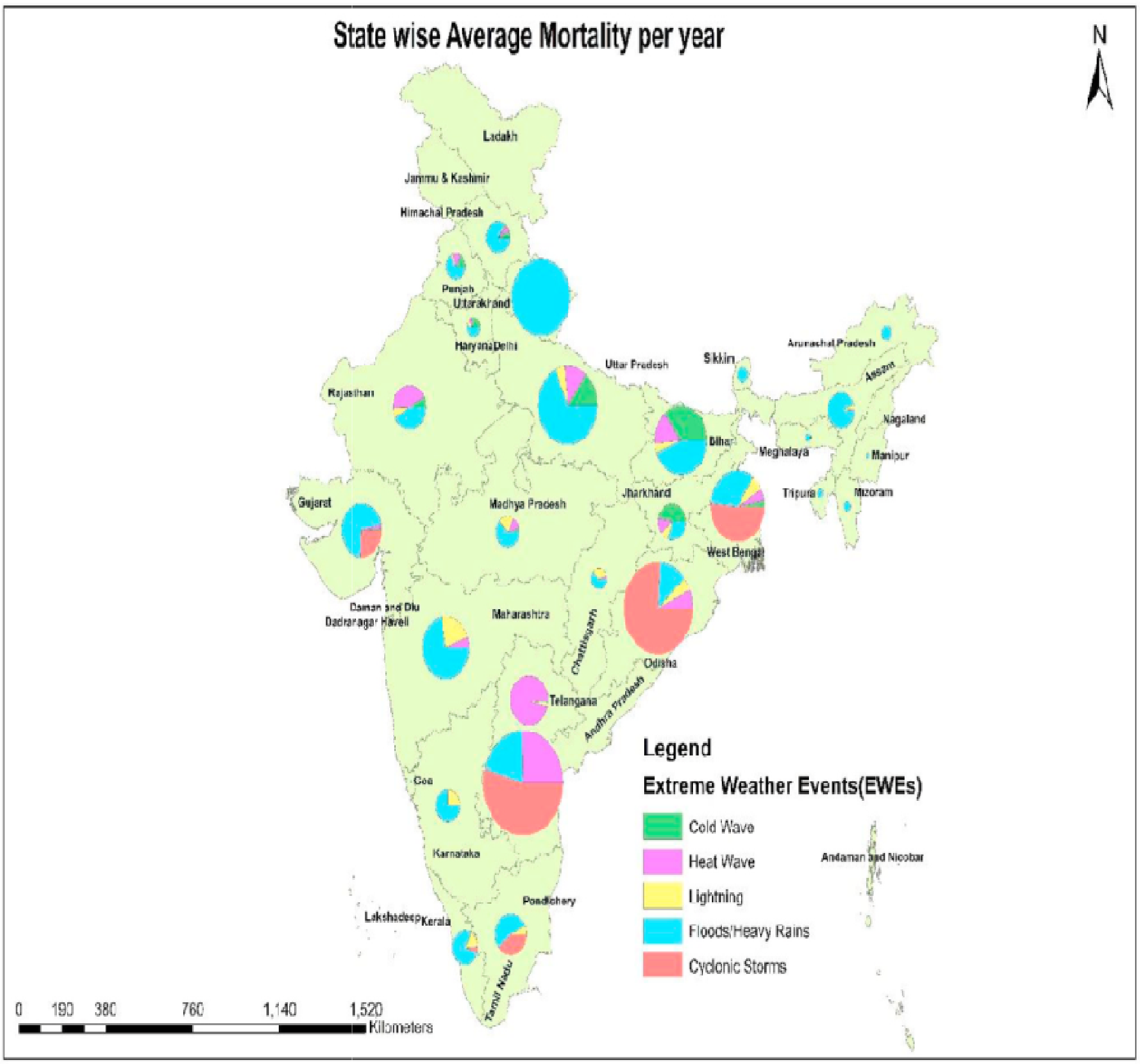

Fig. 2. Extreme weather event (EWE) wise distribution of mortality in various Indian states during 1970–2019. The size of the circle represents the average mortality of each state, while the different sectors of the circle represent mortality due to different EWEs.

The information of loss of lives due to various disastrous weather events which happened since 2010 in India is given in **Table1**.

	DEATHE TO DISASTROUS WEATHER EVENTS FOR THE YEAR (2010-2021)											
YEAR	हिमपात / SNOW FALL	शीतलहर / COLD WAVE	उष्णलहर / HEAT WAVE	अंधड़ / SQUALL	झंझा / GALE	आंधी / DUST STORM	मेघविद्युत / LIGHTNING	गर्जकेसाथतूफान / THUNDER STORM	ओलावृष्टि / HAILSTORM	बाढ़औरभारीवर्षा / FLOODS AND HEAVY RAINS	चक्रवातीतूफान / CYCLONIC STORM	TOTAL (WHOLE YEAR)
YEAR	SNOW FALL	COLD WAVE	HEAT WAVE	SQUALL	GALE	DUST STORM	LIGHTNING	THUNDER STORM	HAILSTORM	FLOODS AND HEAVY RAINS	CYCLONIC STORM	TOTAL (WHOLE YEAR)
2021	20	11			4	5	730	61	1	760	174	1766
2020	22	162	25	6	13	14	652	506		995	119	2514
2019	65	291	505	3	6	25	415	348	2	1297	60	3017
2018	18	280	33		8	237	342	655	8	1099	157	2837
2017	38	51	375	15	11	5	840	289	4	1077	46	2751
2016	22	42	510	8	3	11	670	216	28	714	34	2258
2015	12	18	2081	1	5	30	498	324	39	917	94	4019
2014	62	58	547	9	3	51	352	246	35	953	46	2362
2013	30	271	1433	1	3	1	326	327	54	5528	50	8024
2012	31	139	729	5	5	5	434	190		395	61	1994
2011	14	722	12		4	21	177	331		654	46	1981
2010	25	450	269		3	41	431	373	45	1058	22	2717

Annexure II

Highlights of the Assessment report

The summary on the variability and change of the regional climate system based on the 12 chapters in this book is as follows.

Observed Changes in Global Climate

The global average temperature has risen by around 1°C since pre-industrial times. This magnitude and rate of warming cannot be explained by natural variations alone and must necessarily take into account changes due to human activities. Emissions of greenhouse gases (GHGs), aerosols and changes in Land Use and Land Cover (LULC) during the industrial period have substantially altered the atmospheric composition, and consequently the planetary energy balance, and are thus primarily responsible for the present-day climate change. Warming since the 1950s has already contributed to a significant increase in weather and climate extremes globally (e.g., heat waves, droughts, heavy precipitation, and severe cyclones), changes in precipitation and wind patterns (including shifts in the global monsoon systems), warming and acidification of the global oceans, melting of sea ice and glaciers, rising sea levels, and changes in marine and terrestrial ecosystems.

Projected Changes in Global Climate

Global climate models project a continuation of human-induced climate change during the twenty-first century and beyond. If the current GHG emission rates are sustained, the global average temperature is likely to rise by nearly 5°C, and possibly more, by the end of the twenty-first century. Even if all the commitments (called the "Nationally Determined Contributions") made under the 2015 Paris agreement are met, it is projected that global warming will exceed 3°C by the end of the century. However, temperature rise will not be uniform across the planet; some parts of the world will experience greater warming than the global average. Such large changes in temperature will greatly accelerate other changes that are already underway in the climate system, such as the changing patterns of rainfall and increasing temperature extremes.

Climate Change in India: Observed and Projected Changes

Temperature Rise Over India

India's average temperature has risen by around 0.7°C during 1901–2018. This rise in temperature is largely on account of GHG-induced warming, partially offset by forcing due to anthropogenic aerosols and changes in LULC. By the end of the twenty-first century, average temperature over India is projected to rise by approximately 4.4°C relative to the recent past (1976–2005 average), under the RCP8.5 scenario. Projections by climate models of the Coupled Model Inter-comparison Project Phase 5(CMIP5) are based on multiple standardized forcing scenarios called Representative Concentration Pathways (RCPs). Each scenario is a time series of emissions and concentrations of the full suite of GHGs, aerosols, and chemically active gases, as well as LULC changes through the twenty-first century, characterized by the resulting Radiative Forcing (A measure of an imbalance in the Earth's energy budget owing to natural (e.g., volcanic eruptions) or human-induced (e.g., GHG from fossil fuel combustion) changes) in the year 2100 (IPCC 2013). The two most commonly analyzed scenarios in this report are "RCP4.5" (an intermediate stabilization pathway that results in a Radiative Forcing of 4.5 W/m2 in 2100) and "RCP8.5" (a high concentration pathway resulting in a Radiative Forcing of 8.5 W/m2 in 2100).

In the recent 30-year period (1986–2015), temperatures of the warmest day and the coldest night of the year have risen by about 0.63°C and 0.4°C, respectively.

By the end of the twenty-first century, these temperatures are projected to rise by approximately 4.7°C and 5.5°C, respectively, relative to the corresponding temperatures in the recent past (1976–2005 average), under the RCP8.5 scenario.

By the end of the twenty-first century, the frequencies of occurrence of warm days and warm nights are projected to increase by 55% and 70%, respectively, relative to the reference period 1976-2005, under the RCP8.5 scenario.

The frequency of summer (April–June) heat waves over India is projected to be 3 to 4 times higher by the end of the twenty-first century under the RCP8.5 scenario, as compared to the 1976–2005 baseline period. The average duration of heat wave events is also projected to approximately double, but with a substantial spread among models.

In response to the combined rise in surface temperature and humidity, amplification of heat stress is expected across India, particularly over the Indo-Gangetic and Indus river basins.

Indian Ocean Warming

Sea surface temperature (SST) of the tropical Indian Ocean has risen by 1°C on average during 1951–2015, markedly higher than the global average SST warming of 0.7°C, over the same period. Ocean heat content in the upper 700 m (OHC700) of the tropical Indian Ocean has also exhibited an increasing trend over the past six decades (1955–2015), with the past two decades (1998–2015) having witnessed a notably abrupt rise.

During the twenty-first century, SST and ocean heat content in the tropical Indian Ocean are projected to continue to rise.

Changes in Rainfall

The summer monsoon precipitation (June to September) over India has declined by around 6% from 1951 to 2015, with notable decreases over the Indo-Gangetic Plains and the Western Ghats. There is an emerging consensus, based on multiple datasets and climate model simulations, that the radiative effects of anthropogenic aerosol forcing over the Northern Hemisphere have considerably offset the expected precipitation increase from GHG warming and contributed to the observed decline in summer monsoon precipitation.

There has been a shift in the recent period toward more frequent dry spells (27% higher during 1981–2011 relative to 1951–1980) and more intense wet spells during the summer monsoon season. The frequency of localized heavy precipitation occurrences has increased worldwide in response to increased atmospheric moisture content. Over central India, the frequency of daily precipitation extremes with rainfall intensities exceeding 150 mm per day increased by about 75% during 1950–2015.

With continued global warming and anticipated reductions in anthropogenic aerosol emissions in the future, CMIP5 models project an increase in the mean and variability of monsoon precipitation by the end of the twenty-first century, together with substantial increases in daily precipitation extremes.

Droughts

The overall decrease of seasonal summer monsoon rainfall during the last 6–7 decades has led to an increased propensity for droughts over India. Both the frequency and spatial extent of droughts have increased significantly during 1951–2016. In particular, areas over central India, southwest coast, southern peninsula and north-eastern India have experienced more than 2 droughts per decade, on average, during this period. The area affected by drought has also increased by 1.3% per decade over the same period.

Climate model projections indicate a high likelihood of increase in the frequency (>2 events per decade), intensity and area under drought conditions in India by the end of the twenty-first century under the RCP8.5 scenario, resulting from the increased variability of monsoon precipitation and increased water vapour demand in a warmer atmosphere.

Sea Level Rise

Sea levels have risen globally because of the continental ice melt and thermal expansion of ocean water in response to global warming. Sea-level rise in the North Indian Ocean (NIO) occurred at a rate of 1.06–1.75 mm per year during 1874–2004 and has accelerated to 3.3 mm per year in the last two and a half decades (1993–2017), which is comparable to the current rate of global mean sea-level rise.

At the end of the twenty-first century, steric sea level in the NIO is projected to rise by approximately 300 mm relative to the average over 1986–2005 under the RCP4.5 scenario, with the corresponding projection for the global mean rise being approximately 180 mm.

Tropical Cyclones

There has been a significant reduction in the annual frequency of tropical cyclones over the NIO basin since the middle of the twentieth century (1951–2018). In contrast, the frequency of very severe cyclonic storms (VSCSs) during the post-monsoon season has increased significantly (+1 event per decade) during the last two decades (2000–2018). However, a clear signal of anthropogenic warming on these trends has not yet emerged.

Climate models project a rise in the intensity of tropical cyclones in the NIO basin during the twenty-first century.

Changes in the Himalayas

The Hindu Kush Himalayas (HKH) experienced a temperature rise of about 1.3°C during 1951–2014. Several areas of HKH have experienced a declining trend in snowfall and also retreat of glaciers in recent decades. In contrast, the high-elevation Karakoram Himalayas have experienced higher winter snowfall that has shielded the region from glacier shrinkage.

By the end of the twenty-first century, the annual mean surface temperature over HKH is projected to increase by about 5.2°C under the RCP8.5 scenario. The CMIP5 projections under the RCP8.5 scenario indicate an increase in annual precipitation,but decrease in snowfall over the HKH region by the end of the twenty-first century, with large spread across models.

Conclusions

Since the middle of the twentieth century, India has witnessed a rise in average temperature; a decrease in monsoon precipitation; a rise in extreme temperature and rainfall events, droughts, and sea levels; and an increase in the intensity of severe cyclones, alongside other changes in the monsoon system. There is compelling scientific evidence that human activities have influenced these changes in regional climate.

Human-induced climate change is expected to continue apace during the twenty-first century. To improve the accuracy of future climate projections, particularly in the context of regional forecasts, it is essential to develop strategic approaches for improving the knowledge of Earth system processes, and to continue enhancing observation systems and climate models.

*****