GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
RAJYA SABHA
UNSTARRED QUESTION No - 1045
ANSWERED ON 15/12/2022

FREQUENCY OF EXTREME WEATHER EVENTS

1045. SHRI SUJEET KUMAR:
SHRI RAM CHANDER JANGRA:
SHRI DEREK O'BRIEN:

Will the Minister of EARTH SCIENCES be pleased to state:

(a) whether Government acknowledges the findings of the recent study conducted by IIT Gandhinagar, wherein the frequency of extreme weather events such as floods and heatwaves is projected to rise manifold in India due to climate change, especially under the warming climate and variability in the El Nino-Southern Oscillation (ENSO);

(b) if so, the steps taken by Government to strengthen resilience of current infrastructure and mitigate the impacts of extreme weather events; and

(c) State/UT wise details of the fraction of population of India exposed to sequential extremes at the present level of global mean temperature above the pre-industrial level?

ANSWER

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

(a) Yes Sir. Observations indicate that various parts of the country have witnessed increasing extreme weather events in the backdrop of global warming. Complex interactions between the earth system components amidst the warming environment and regional anthropogenic influences have led to a rise in frequency of localized heavy rainfall events, drought and flood occurrences, increase in the intensity of tropical cyclones etc. Studies have reported significant rising trends in the frequency and the magnitude of extreme rainfall across India. Changing monsoon pattern and occurrences of extremes have affected various parts of the country. Regions which are more prone to such events in the changing climate include Central India, northern Indian regions and Western Himalayas (extreme precipitation), and north, northwest India and neighboring Central India (moderate droughts and expansion in semiarid regions) and coastal states (cyclones and heatwaves).

Ministry of Earth Sciences (MoES), has also 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 summary of the Report pertaining to India are given in Annexure.

(b) Like many other countries, India is also vulnerable to climate change. It is reflected with the increase in the frequency of extreme weather events due to which several parts of the country are affected with meteorological hazardous events. India Meteorological Department (IMD) issues various outlook/forecast/warning for Public as well as Disaster Management Authorities for the preparedness of extreme weather events for adaptation and mitigation of various climate related risks.

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 started issuing Impact Based Forecast (IBF) recently 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. Work is in progress to implement the same for other severe weather elements.

IMD has recently brought out a web based online “Climate Hazard & Vulnerability Atlas of India” prepared for the thirteen most hazardous meteorological events, which cause extensive damages, economic, human, and animal losses. The same can be accessed at https://imdpune.gov.in/hazardatlas/abouthazard.html. The climate Hazard and vulnerability atlas will help state government authorities and Disaster Management Agencies in planning and taking appropriate action to tackle various extreme weather events. This product is useful in building Climate Change resilient infrastructure.

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 ‘**Damin**i’ for lightning alert. The common Alert Protocol (CAP) developed by NDMA is also being implemented for dissemination of warning by IMD.

(c) These climate change induced extreme weather events occur throughout the country depending upon the prevailing favourable meteorological conditions and the entire population in those regions are affected. IMD issues the necessary warnings and advisories well in advance for preparedness and possible mitigation.

Annexure

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.

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.

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