GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
RAJYA SABHA
UNSTARRED QUESTION No. - 1782
ANSWERED ON 22/12/2022

HEAT WAVES ACROSS INDIA

1782. SMT. SULATA DEO:

Will the Minister of EARTH SCIENCES be pleased to state:

(a) whether the Central Government is cognizant of the noticeable increase in the frequency, persistency and spatial coverage of the heat waves mainly over north, northwest, central and the eastern coastal regions;
(b) whether the Central Government has conducted studies on the mechanisms and future projections of heat waves, considering the effects of such events on various societal sectors, such as health, agriculture, etc., and is it necessary to develop a new strategy/criterion for the real-time monitoring and forecasting of such silently catastrophic events over the Indian region; and
(c) if so, the details thereof and if not, the reasons therefor?

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

(a) Yes Sir. The trend in heatwave over the entire country during summer season based on the data for the period from 1961 to 2021 is given as figure in Annexure I. The details of state-wise average number of Severe Heatwave/heatwave days in the country during the last 10 years is given Annexure-II.

(b) As per the recent IPCC Sixth Assessment Report by Working Group I viz. "Climate Change 2021: The Physical Science Basis", the Global mean concentrations of anthropogenic aerosols and green-house gases which are the drivers of climate change have increased in South Asia region which will result in more intense and frequent increase in the heatwaves and humid heat stress during the 21stcentury.

As per the recent book on "Assessment of Climate Change over the Indian Region" published by the Ministry of Earth Sciences (MoES), Government of India, the rise in temperature is largely due to increase in GHG, aerosols and changes in land use and land cover. Due to this the all India averaged annual frequency of warm days and nights have increased, and cold days and nights have decreased since 1951. Report is available in the link(http://cccr.tropmet.res.in/home/docs/cccr/2020_Book_AssessmentOfClimateChangeOverT.pdf). Relevant details related to Indian region attached for ready reference as Annexure-III.

As per the recent IPCC reports, the hydrological system, environment, sea level, food grain production and other related aspects are likely to be affected adversely across the globe including Asian Region.

(c) Heat wave is one of the severe weather phenomena for which IMD issues early warning. In the country, appreciable rise in maximum temperatures as well as heat waves are found to be more in the months of April, May & June. As an initiative IMD is issuing Seasonal Outlook for temperatures for the months of April, May & June in the last week of March for planning purpose. This outlook bring out the expected scenario of heat waves also during the period.

The seasonal outlook is followed by Extended Range Outlook issued on every Thursday for next two weeks. In addition to this, the forecast and the colour coded warnings for severe weather including heat wave warning are issued on daily basis for next five days with outlook for another two days.

IMD issues an additional bulletin on heat wave in the morning (8 a.m.) valid for 24 hours for supporting the planning of activities for the day and this bulletin is also disseminated to all concerned. All these bulletins are posted to IMD website also, on a special page created for Heatwaves.

As an adaptive measure, IMD in collaboration with local health departments have started heat action plan in many parts of the country to forewarn about the heat waves and also advising action to be taken during such occasions. Heat action plan became operational since 2013.

The Heat Action Plan is a comprehensive early warning system and preparedness plan for extreme heat events. The Plan presents immediate as well as longer-term actions to increase preparedness, information-sharing, and response coordination to reduce the health impacts of extreme heat on vulnerable populations. NDMA and IMD are working with 23 states prone to high temperatures leading to heat-wave conditions to develop heat action plans.

Recent advancement made in Heat wave forecast and warning follow:-

- Heat Wave Monitoring and Forecasting Information on GIS

- Issue special heat wave & its impact bulletin (March to June) at 1600 hrs IST by including impact of Minimum Temperature, humidity and wind.

- Heat Wave hazard analysis for entire country for four hot weather months (MARCH, APRIL, MAY & JUNE) considering the Maximum Temperature, Minimum Temperature, Humidity, Wind and Duration is completed. This will lead to identification of hazard scores based on different meteorological parameters aggravating impact of Heat Waves. These scores could in future be utilized as threshold to generate Heat Wave impact based alerts for the specific locations.

The link for Heat Wave information web-page is
https://internal.imd.gov.in/pages/heatwave_mausam.php

Recently IMD brought out 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 for planning and taking appropriate action to tackle various extreme weather events. This atlas serves as a reference to IMD to issue impact based forecast for various extreme weather events, including heatwaves.

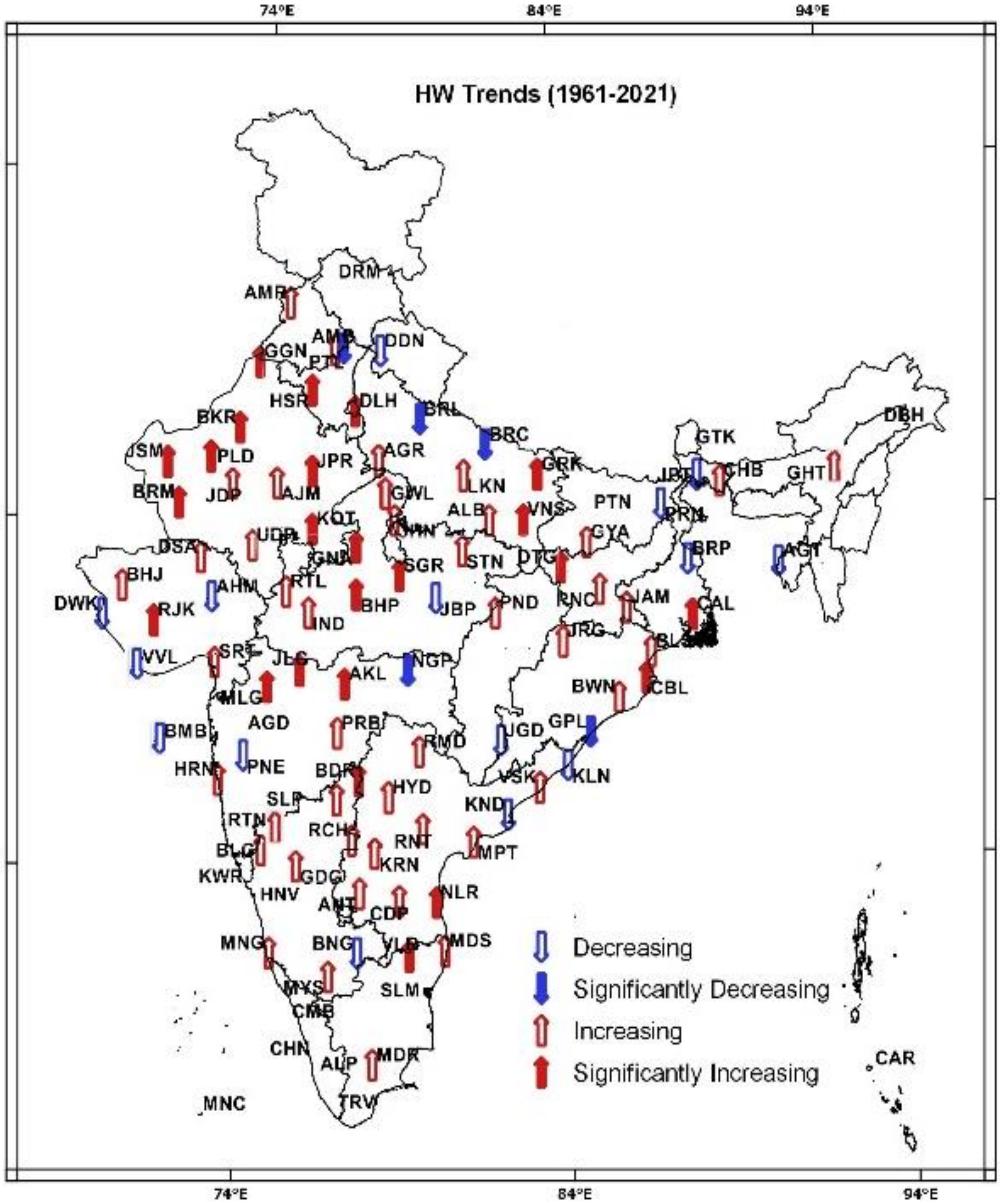

Fig. Trend in the Heat Wave (HW) days of 103 stations during April, May and June for the period 1961–2021. Red rising (blue falling) arrows represent the increasing (decreasing) trends. Filled arrows represent the trends significant at 5% level. Nonparametric Mann–Kendall test was used to test the significance of the trends.

Annexure-II

State-wise Average number of Sever Heat wave/Heat Wave days reported in the recent 10 years.

S. No. □□□. □□	State / UT	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	Andhra Pradesh	8	16	11	16	7	10	10	8	13	3	4
2	Assam	0	0	0	0	0	0	0	0	0	0	0
3	Bihar	1	20	1	9	5	11	3	6	12	1	1
4	Chhattisgarh	1	6	3	6	1	2	3	0	3	0	1
5	Delhi	1	11	7	7	3	2	9	6	8	4	3
6	Gujarat	1	1	1	3	2	3	4	3	4	2	0
7	Haryana	3	8	8	9	4	10	13	9	8	3	2
8	Himachal Pradesh	0	0	0	0	0	0	0	0	0	0	0
9	Jharkhand	1	19	5	7	9	16	10	3	10	1	0
10	Karnataka	0	2	1	1	2	3	0	0	2	4	0
11	Kerala	-	-	-	-	-	-	-	-	-	-	-
12	Madhya Pradesh	2	4	5	10	4	10	7	7	13	2	1
13	Maharashtra	1	3	8	5	5	8	6	8	15	5	0
14	Mizoram	-	-	-	-	-	-	-	-	-	-	-
15	Odisha	2	18	9	17	11	19	9	4	8	2	4
16	Punjab	6	17	11	12	3	5	12	4	8	1	2
17	Rajasthan	7	7	9	11	9	15	14	17	20	6	4
18	Tamil Nadu	3	10	4	5	3	3	8	2	11	4	3
19	Telangana	0	9	6	2	7	14	5	0	10	2	0
20	Uttar Pradesh	2	17	6	9	8	5	4	6	13	2	1
21	Uttarakhand	0	27	2	3	2	9	4	5	13	0	7
22	West Bengal	1	6	3	12	1	5	2	2	3	0	3

Annexure-III

Highlights of the Assessment report

The summary on the variability and change of the regional climate system 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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