

GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
RAJYA SABHA
UNSTARRED QUESTION No - 975
ANSWERED ON 15/12/2022

ISOLATED LOCALIZED HEAVY RAINFALL

975. SHRI M. MOHAMED ABDULLA:

Will the Minister of EARTH SCIENCES be pleased to state:

- (a) the details on the isolated localized heavy rainfall that occurred in each State from 2019, State- wise and year-wise;
- (b) whether Government has analyzed the relationship between this rainfall and atmospheric systems based on modern observational technology and developed forecasting techniques in the field of short-range prediction;
- (c) if so, the details thereof and if not, the reasons therefor?

ANSWER

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

- (a) Details about the isolated localized extremely heavy rainfall that occurred in each sub-division from 2019 onwards during monsoon season are attached in **Annexure-I**.
- (b)-(c) Yes Sir. Brief account of the modern observational technology/system for prediction of heavy rainfall and forecasting services of India Meteorological Department is given below:

Modern Observational System

IMD observational system mainly consists of Surface, Upper Air, Radar and Satellite based observations functional at 24x7 covering both land and ocean area that include whole north Indian Ocean. IMD is having a good network of observatories across the country. Details of the same follow:

- IMD is maintaining **216** number of Departmental Surface observatories and 344 number of Part time observatories.
- In addition to that, a network of **918** Automatic Weather stations (inclusive of **198** Agro-AWS) and **1382** Automatic Rain Gauge Stations (ARG) are there.
- A total number of **5211** Daily Rainfall Monitoring Stations (DRMS) are also maintained by IMD.

- There are a total number of **33** Doppler Weather Radars (DWRs) functioning across the country to support monitoring & forecasting of severe weather like thunderstorm, hailstorm, lightning, squall, heavy rain and cyclone etc.
- There are **62** number of Pilot Balloon Observatories and **56** number of Radiosonde Observatories for taking upper air observations.
- There are **34** numbers of High Wind Speed recorders for continuous monitoring of high wind speed and station level pressure along East and West coast of India for monitoring during severe weather especially cyclones.

Methodology / System of weather forecasting

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.

There are three types of numerical weather prediction (NWP) models with the Ministry, viz., individual deterministic models, Multi-Model Ensemble (MME) and single model Ensemble Prediction System (EPS) for short to medium range forecasts upto seven days as mentioned below;

- Global Forecasting System (GFS) model with horizontal resolution of 12 km and forecast up to 10 days;
- Unified Model (UM) with horizontal resolution of 12 km and forecast up to 10 days;
- Global Ensemble Forecasting System (GEFS) model with horizontal resolution of 12 km and forecast up to 10 days;
- UM ensemble prediction system (UMEPS) with horizontal resolution of 12 km and forecast up to 10 days;
- Weather Research Forecast (WRF) Mesoscale model with horizontal resolution of 3 km and forecast up to 3 days;
- Unified Mesoscale regional model (horizontal resolution of 4.5 km and forecast up to 3 days);
- Hurricane WRF (HWRF) for cyclone prediction with horizontal resolution of 2 km and forecast up to 5 days.
- High Resolution Rapid Refresh (WRRR) model with horizontal resolution of 2 km updated every two hours and valid upto next 12 hours.

The establishment of the Ensemble Prediction System (EPS) marked a paradigm shift in the medium range ensemble-based forecasting in India. In the ensemble prediction system (GEFS and UMEPS) of MoES, various probabilistic forecast products are generated for severe weather events, like probabilities of occurrence of different thresholds of rainfall (heavy rain and deficient rain), temperature (heat wave and cold wave) and wind (squall and gale winds) at different locations/regions. Also, Probabilistic Quantitative Precipitation Forecast (PQPF) is generated for all Indian river-basins with 3 to 5 days lead period. To provide city-specific forecast guidance, EPS-grams are prepared based on GEFS and UMEPS for every three hours up to 10 days forecast for various parameters including precipitation, wind, relative humidity and temperature at any location.

Forecast is issued for 36 meteorological sub-divisions from National Weather Forecasting Centre, IMD HQ and is 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 gives 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.

Regarding dissemination of weather forecasts and warnings, IMD is always 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 at central, state and regional level 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.

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.

India Meteorological Department had developed mobile App 'MAUSAM' for weather forecasting, 'Meghdoot' for Agromet advisory dissemination and 'Damini' for lightning alert.

The common Alert Protocol (CAP) developed by NDMA is also being implemented for dissemination of warning by IMD.

➤ **Improvement in Weather Forecast Accuracy:**

- Probability of Detection (POD) for heavy rainfall warning with 24 hr lead period is 74% in 2021, which has improved by 51% in year 2021 as compared to their skill between 2002-20. False Alarm Rate (FAR) and Missing Rate (MR) are 26% in 2021, which has improved by 21% & 53% respectively in year 2021 as compared to their skill between 2002-20.
- Probability of Detection (POD) for heat wave warning with 24 hr lead period is 97% in 2021, which has improved by 15% as compared to their skill between 2014-20. False Alarm Rate (FAR) and Missing Rate (MR) are 2% & 3% respectively in 2021, which has improved by 63% & 82% respectively as compared to their skill between 2014-20.
- The annual average landfall point forecast errors in 2021 have been 16.4 km, 10.6 km and 19.8 km respectively for 24, 36 and 48 hrs against the past five year (2016-2020) average error of 31.9 km, 43.7 km and 61.5 km based on data of 2016-2020.
- The annual average track forecast errors in 2021 have been 63 km, 92 km and 164 km respectively for 24, 48 and 72hrs lead period against the past five year (2016-2020) average error of 77, 117 and 159 km based on data of 2016-2020.
- The track forecast skills compared to climatology and persistence forecast have been 75%, 82% and 68% respectively for the 24, 48 and 72 hrs lead against the long period average (2016-2020) skill of 64%, 76% & 78% respectively.
- The annual average absolute error(AE) in intensity forecast has been 6.2 knots, 9.5 knots and 10.8 knots respectively for 24, 48 and 72 hrs lead period of forecast against the past five year(2016-2020) average error of 7.9, 11.4 and 14.1 knots. The skill in intensity forecast as compared to persistence forecast was 63.2%, 78.4% and 85.6% against the long period average (2016-20) skill of 52.2, 72.1 and 75.1 for 24, 48 and 72 hours lead period.
- Probability of Detection (POD) for thunderstorm warning with 24 hr lead period is 86% in 2021 against 31% in 2016.

Annexure-I

YEAR	STATE	JUNE	JULY	AUGUST	SEPTEMBER
2019	BIHAR	2	56	1	68
2019	CHANDIGARH	0	0	0	0
2019	LAKSHADWEEP	0	1	1	0
2019	PUDUCHERRY	0	0	0	0
2019	Andaman and Nicobar	2	0	4	4
2019	ANDHRA PRADESH	1	2	7	26
2019	ARUNACHALPRADESH	1	12	1	5
2019	ASSAM	16	38	3	6
2019	CHHATTISGARH	1	3	14	5
2019	DELHI	0	0	0	0
2019	GOA	6	13	19	5
2019	GUJARAT	18	31	147	46
2019	HARYANA	0	8	5	0
2019	HIMACHAL PRADESH	0	7	28	1
2019	JAMMU & KASHMIR	0	2	1	0
2019	JHARKHAND	0	0	4	7
2019	KARNATAKA	20	62	165	20
2019	KERALA	6	22	69	2
2019	LADAKH	0	0	0	0
2019	MADHYA PRADESH	2	27	70	46
2019	MAHARASHTRA	76	202	174	113
2019	MANIPUR	0	0	0	0
2019	MEGHALAYA	14	22	2	7
2019	MIZORAM	0	1	0	1
2019	NAGALAND	0	0	0	0
2019	ORISSA	4	24	94	47
2019	PUNJAB	0	6	12	2
2019	RAJASTHAN	9	37	59	17
2019	SIKKIM	2	0	0	0
2019	TAMILNADU	0	0	19	17
2019	TELANGANA	0	9	16	7
2019	TRIPURA	2	6	0	1
2019	UTTAR PRADESH	3	49	16	40
2019	UTTARAKHAND	2	5	4	9
2019	WEST BENGAL	11	47	7	19

YEAR	STATE	JUNE	JULY	AUGUST	SEPTEMBER
2020	BIHAR	15	40	10	35
2020	CHANDIGARH	0	0	1	0
2020	LAKSHADWEEP	0	1	0	0
2020	PUDUCHERRY	0	0	0	0
2020	Andaman and Nicobar	5	0	1	1
2020	ANDHRA PRADESH	6	10	4	25
2020	ARUNACHALPRADESH	5	12	2	7
2020	ASSAM	31	21	7	18
2020	CHHATTISGARH	8	1	18	1
2020	DELHI	0	0	4	0
2020	GOA	16	10	14	10
2020	GUJARAT	3	30	145	5
2020	HARYANA	0	3	9	0
2020	HIMACHAL PRADESH	0	2	13	1
2020	JAMMU & KASHMIR	0	1	4	0
2020	JHARKHAND	2	0	3	2
2020	KARNATAKA	14	43	117	49
2020	KERALA	14	20	40	26
2020	LADAKH	0	0	0	0
2020	MADHYA PRADESH	6	7	74	2
2020	MAHARASHTRA	57	87	153	14
2020	MANIPUR	0	0	0	0
2020	MEGHALAYA	8	15	10	18
2020	MIZORAM	0	0	1	0
2020	NAGALAND	0	0	0	0
2020	ORISSA	19	13	174	2
2020	PUNJAB	1	4	3	0
2020	RAJASTHAN	0	3	51	2
2020	SIKKIM	2	0	0	0
2020	TAMILNADU	5	7	11	6
2020	TELANGANA	5	8	55	16
2020	TRIPURA	4	5	0	0
2020	UTTAR PRADESH	12	22	19	17
2020	UTTARAKHAND	1	8	5	0
2020	WEST BENGAL	23	50	14	30

YEAR	STATE	JUNE	JULY	AUGUST	SEPTEMBER
2021	BIHAR	23	14	17	1
2021	CHANDIGARH	0	0	0	0
2021	LAKSHADWEEP	0	0	0	0
2021	PUDUCHERRY	0	0	0	0
2021	Andaman and Nicobar	1	4	1	5
2021	ANDHRA PRADESH	2	3	1	32
2021	ARUNACHALPRADESH	3	3	5	1
2021	ASSAM	9	6	5	5
2021	CHHATTISGARH	7	4	0	3
2021	DELHI	0	1	5	4
2021	GOA	13	22	0	1
2021	GUJARAT	15	33	6	82
2021	HARYANA	0	26	2	8
2021	HIMACHAL PRADESH	0	18	0	3
2021	JAMMU & KASHMIR	0	4	0	0
2021	JHARKHAND	6	10	2	10
2021	KARNATAKA	31	73	9	12
2021	KERALA	5	8	4	3
2021	LADAKH	0	0	0	0
2021	MADHYA PRADESH	5	28	26	10
2021	MAHARASHTRA	77	201	9	65
2021	MANIPUR	0	0	0	0
2021	MEGHALAYA	14	5	20	0
2021	MIZORAM	0	0	1	0
2021	NAGALAND	0	0	0	0
2021	ORISSA	8	19	3	78
2021	PUNJAB	0	11	1	6
2021	RAJASTHAN	1	26	61	11
2021	SIKKIM	0	1	0	0
2021	TAMILNADU	2	5	3	12
2021	TELANGANA	7	47	6	50
2021	TRIPURA	0	5	3	0
2021	UTTAR PRADESH	18	31	32	33
2021	UTTARAKHAND	4	10	7	1
2021	WEST BENGAL	26	20	43	32

YEAR	STATE	JUNE	JULY	AUGUST	SEPTEMBER
2022	BIHAR	20	6	3	8
2022	CHANDIGARH	0	0	0	1
2022	LAKSHADWEEP	0	0	0	3
2022	PUDUCHERRY	0	0	0	0
2022	Andaman and Nicobar	1	2	0	3
2022	ANDHRA PRADESH	3	6	6	6
2022	ARUNACHALPRADESH	5	5	1	2
2022	ASSAM	62	7	5	1
2022	CHHATTISGARH	1	13	21	2
2022	DELHI	0	1	0	0
2022	GOA	7	23	0	0
2022	GUJARAT	1	123	40	23
2022	HARYANA	0	8	1	9
2022	HIMACHAL PRADESH	0	9	11	3
2022	JAMMU & KASHMIR	3	3	2	0
2022	JHARKHAND	0	0	8	0
2022	KARNATAKA	13	154	59	19
2022	KERALA	3	4	25	7
2022	LADAKH	0	0	0	0
2022	MADHYA PRADESH	1	34	104	11
2022	MAHARASHTRA	23	233	86	37
2022	MANIPUR	2	0	0	0
2022	MEGHALAYA	29	2	6	4
2022	MIZORAM	0	0	2	0
2022	NAGALAND	0	0	0	0
2022	ORISSA	4	30	91	4
2022	PUNJAB	0	3	1	9
2022	RAJASTHAN	2	29	40	5
2022	SIKKIM	2	0	0	1
2022	TAMILNADU	1	14	16	5
2022	TELANGANA	6	91	5	17
2022	TRIPURA	6	1	1	0
2022	UTTAR PRADESH	5	7	9	35
2022	UTTARAKHAND	2	8	10	7
2022	WEST BENGAL	35	13	24	10
