GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
RAJYA SABHA
UNSTARRED QUESTION NO. - 980
ANSWERED ON – 10/02/2022

INPROVING ACCURACY OF IMD FORECASTS

980.   SHRI JOHN BRITTAS:
         SHRI AYODHYA RAMI REDDY ALLA:

Will the Minister of EARTH SCIENCES be pleased to state:

(a)   status of the 'Upgradation of Forecast System' programme under Atmosphere and Climate Research – Modelling Observing Systems and Services (ACROSS) Scheme, the details thereof;

(b)   whether this programme has resulted in increased accuracy of weather forecasts;

(c)   if so, the details thereof, and if not, the reasons therefor; and

(d)   the steps Government has undertaken to improve the accuracy of IMD forecasts in the country and in the State of Kerala?

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

(a)   For modernization, expansion and improvement in Weather & Climate services, various plans are underway in India Meteorological Department (IMD) under the umbrella Central Sector Scheme Atmosphere and Climate Research - Modeling Observing Systems and Services (ACROSS). There are 4 sub-schemes of IMD under ACROSS namely, Atmospheric Observation Network (AON), Upgradation of Forecast System (UFS), Weather & Climate Services (WCS) and Commissioning of Polarimetric Doppler Weather Radars (DWR). Main activities under Upgradation of Forecast System (UFS) sub-scheme undertaken during 2017-21 are:

- Upgradation and sustenance of Communication Systems for Data and Product transmission.
- Development of an advanced Operational Forecast System, Delivery System for Forecast and other services.
- Conduct of special campaign for improving Cyclone, Thunderstorm and Fog forecasting through provision of additional observations.
- Integrated Himalayan Meteorological Programme for Western & Central Himalayas.
- Capacity Building, Outreach, Planning and sustenance of specific process related observing systems over India.

(b)-(c) Yes Sir. During the past few years, IMD has been continuously improving weather prediction services in terms of accuracy, lead time and associated impact. The forecasts and warnings are issued by IMD at the national, State and district levels. It has a network of State Meteorological Centres for better coordination with State and district level agencies. With the upgradation of observations and prediction system, noticeable improvements have been made in the recent past in the skill of prediction, especially with respect to heavy-rainfall, heat-wave, thunderstorm and cyclones.

The weather forecast accuracy is verified by IMD and errors and skill scores are calculated seasonwise and annually. Details of improvement in Weather Forecast Accuracy are follows:

- 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. **(Fig.-1 in Annexure-I)**

- 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. **(Fig.-2 in Annexure-I)**

- The annual average Tropical Cyclone (TC) 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. Considering the diameter of the central region (eye) as 10-15 km, there was almost zero error in landfall point forecasts of cyclone in 2021 upto 48 hours in advance.

- The annual average TC track forecast errors in 2021 have been 63 km, 91 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. **(Fig.-3 in Annexure-I)**

- The TC 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. **(Fig.-3)**

- The annual average absolute error(AE) in the TC intensity (wind) forecast has been 6.2 knots, 9.5 knots and 10.8 knots (108 nautical miles per hour) 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. **(Fig.-3)**

- Probability of Detection (POD) for thunderstorm warning with 24 hr lead period is 86% in 2021 against 31% in 2016. **(Fig.-4 in Annexure-I)**

- Probability of Detection (POD) for thunderstorm warning with 3 hourly nowcast during March to June 2021 has been 79%.

(d)   Recognizing the urgent need for improving monsoon prediction capabilities in the country in a systematic and timely manner, the Ministry of Earth Sciences (MoES) had launched an ambitious and well-resourced research programme on Mission mode, called the Monsoon Mission. The first phase of the mission was implemented during 2012-2017 and the second phase (2017-22) is underway. India also augmented its capability of High-Performance Computing (HPC) system, which is close to 10 petaflops capacity now and it is the backbone of the monsoon research and operational services in the country. The Monsoon Mission has helped in the significant improvement of monsoon forecasts in all time scales, right from short-range to seasonal. India is now proud of having one of the best prediction system for generating real time forecasts and warnings in all spatial scales from a location to Block, district, meteorological subdivisions and homogeneous regions and temporal scales of a few hours (nowcast), 3 days (short range forecast), 4-7 days (medium range forecast) 1-4 weeks (extended range forecast) and one month to a season (long range forecast).

For preparing the long range forecast, latest state of the art statistical models, Coupled Atmosphere Ocean Model (MMCFS) and Multi Model Ensemble (MME) method are used. And these models have shown useful skill. Multimodal Ensemble (MME) is a universally accepted technique, which is used to improve skill of forecasts and reduce forecast errors when compared to a single model-based approach. The performance improvements are completely attributed to the collective information of all models used in the MME forecasting system.

IMD has adopted a new forecasting strategy for issuing monthly and seasonal operational forecasts for the southwest monsoon rainfall over the country by modifying the existing two stage forecasting strategy.

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 colour corresponds to no warning hence no action is needed, yellow colour corresponds to be watchful and get updated information, orange colour to be alert and be prepared to take action whereas red colour 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).

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 being 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.
- 203 new raingauge stations have been added in the District-wise Rainfall Monitoring Scheme taking the total number of stations to 4940.
- 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 heat waves.
- 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.
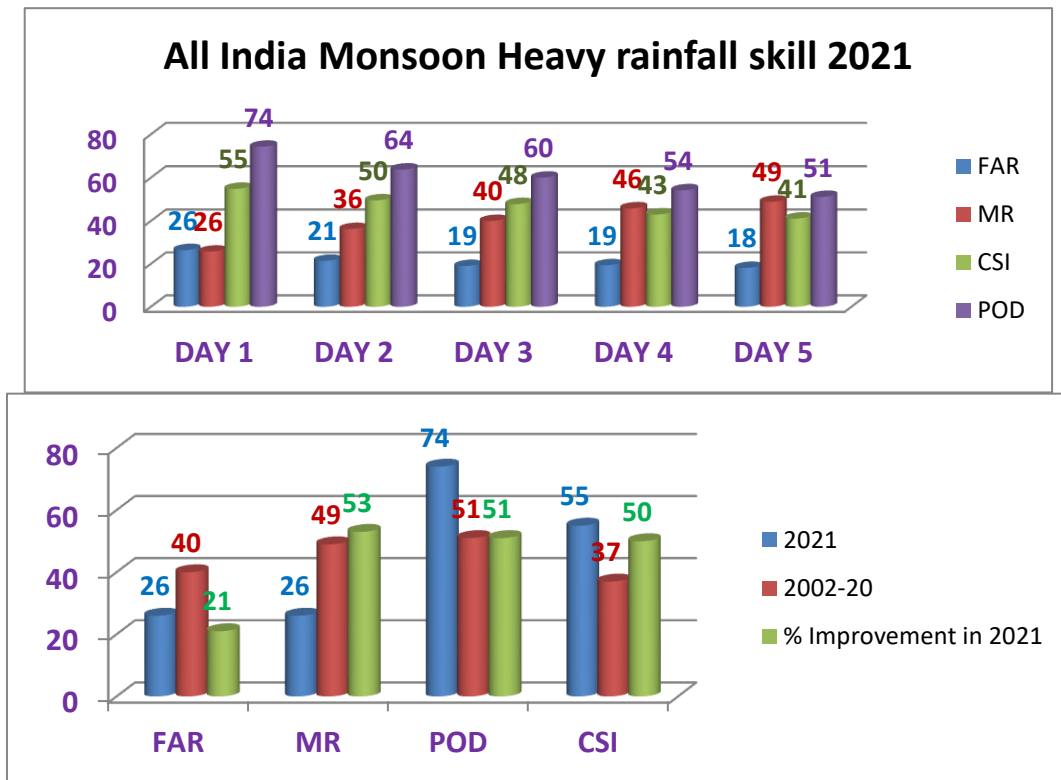
Fig 1: Heavy rainfall warning skill during 2021(FAR (False Alarm Rate), MR(Missing Rate), PoD (Probability of Detection) and CSI (Critical Success Index).IMD has high skill for heavy rainfall warning upto Day 5 as POD for Day 5 is more than 50%.
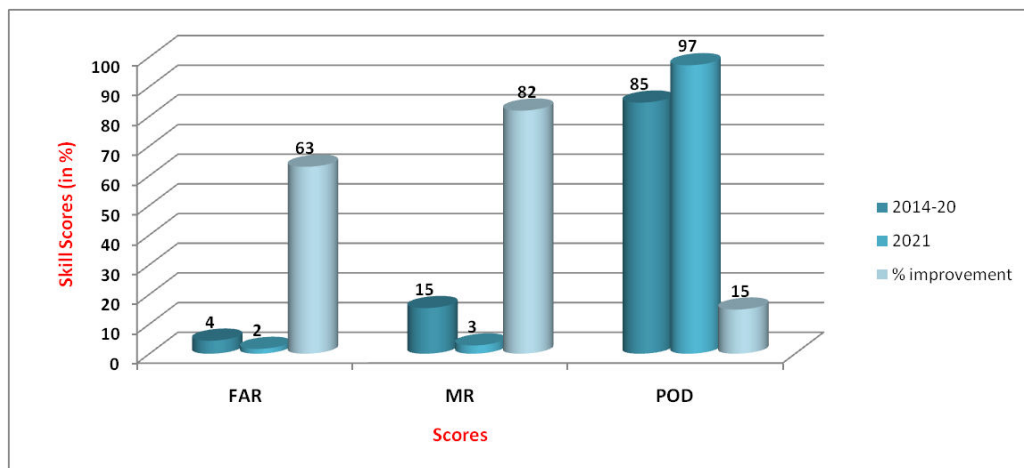

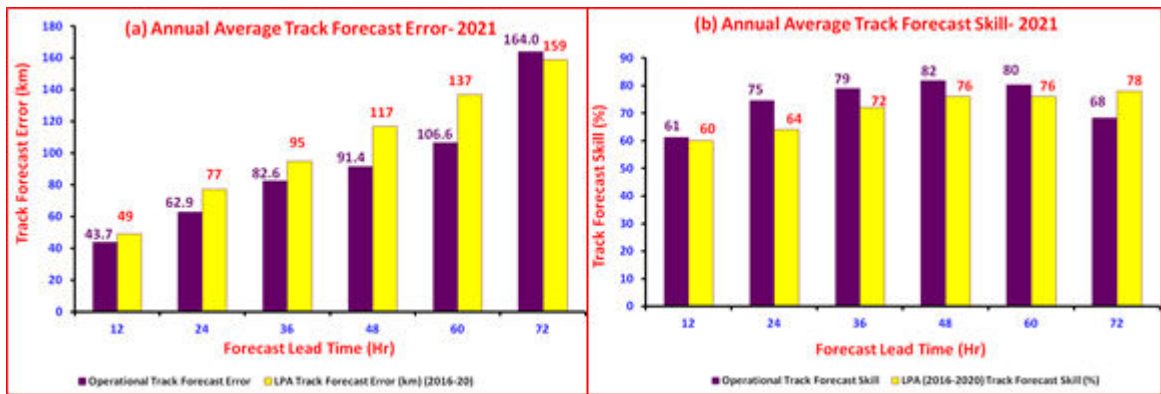Fig 2: All India Summer months (April to June) 2021vs 2014-20 heat wave skill scores

Fig 3: Annual average (a) track forecast errors (km) and (b) track forecast skill (%) during 2021 compared to long period average errors during 2016-20.
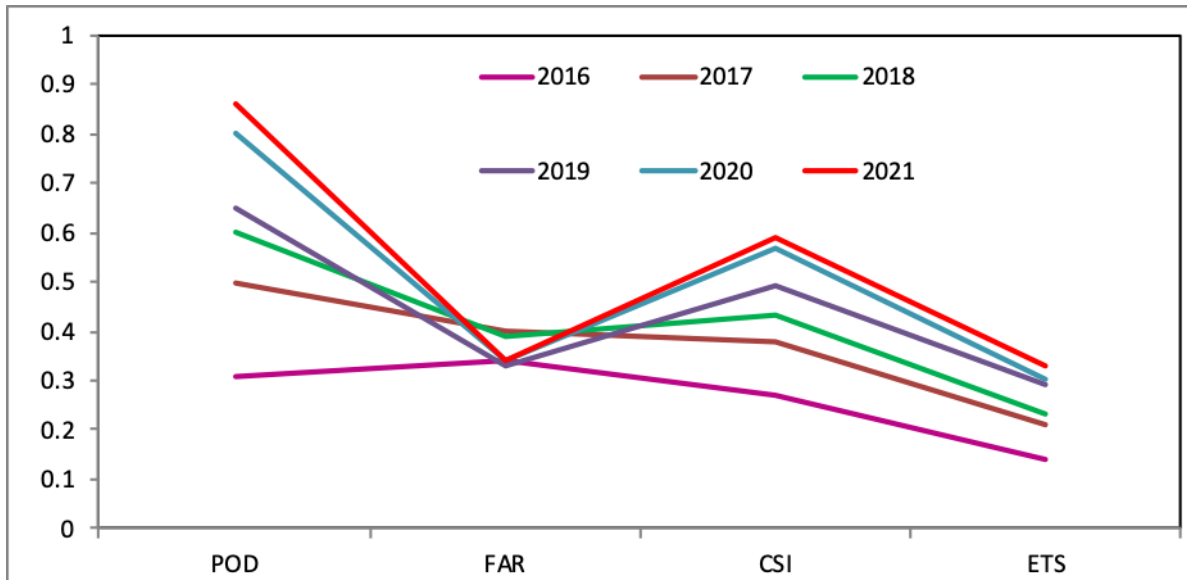

Fig.4. Skill Scores for 24 hr Thunderstorm forecast by IMD during past 6 years (2016 to 2021)

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