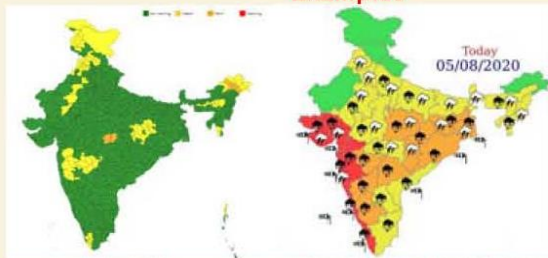


Warning Bulletin and Products for Heavy Rainfall:-

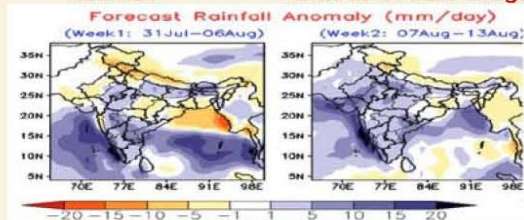
- Nowcast (lead time/ validity up to 03 hours): at station and district level.
- Short to Medium range forecast (lead time/ validity of 1 to 5 days): at station, block, district and meteorological sub-division level.
- Extended range forecast (lead time/ validity up to 4 weeks): probability of heavy rainfall at meteorological sub-division level during week 1 and week 2.

Examples



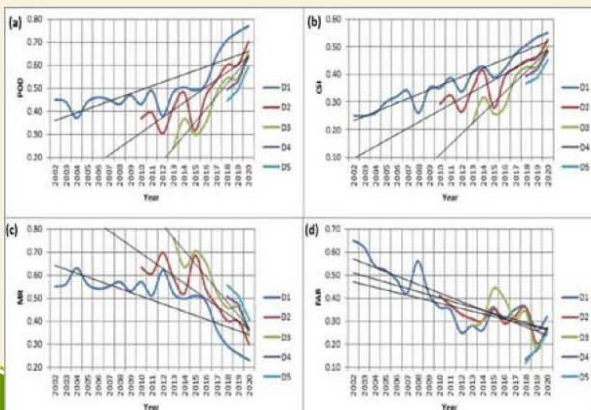
Nowcast

Short to Medium Range

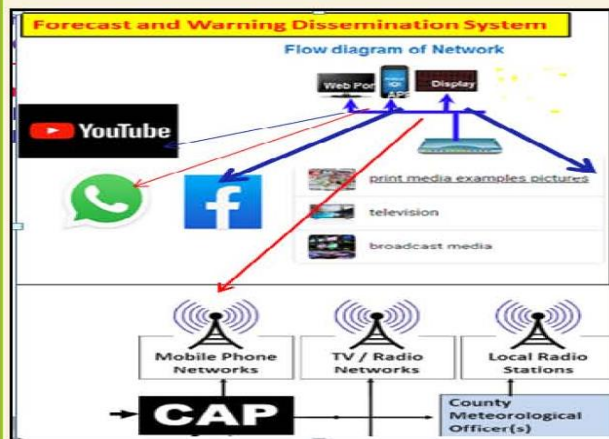


Extended Range

Heavy Rain Warning Skill:-

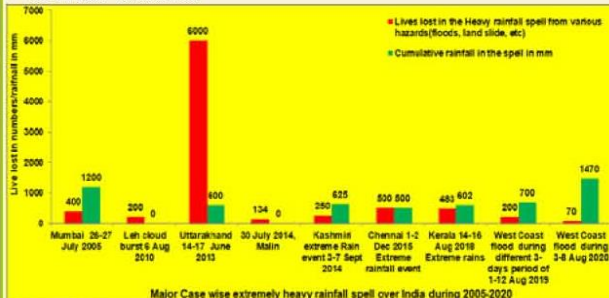


Warning Dissemination Methods:-



Warning Disseminated To:-

- National Disaster Management Authority
- National Disaster Response Force
- State Disaster Management Authority
- Aviation, Railways, Road Transport Authority
- District authorities
- Other Central and State government authorities
- All types of print and electronics Media and Public
- Other users



Rainfall cumulative highest vis-a-vis lives lost during various Major extremely heavy rainfall events of 2005-2020



Heavy Rain Warning Services

India Meteorological Department
Ministry of Earth Sciences
Government of India



Mission

- To generate and disseminate Impact based Forecast for Heavy Rainfall events.
- Analysis of Heavy Rainfall hazard proneness of the country.
- Research on Heavy Rainfall monitoring and prediction.
- Development of tools & technologies and their application in Heavy Rainfall Monitoring, Forecasting and Early Warning System.

Vision

- No Heavy Rainfall hazard to go undetected and unpredicted.
- Accurate warning against Heavy Rainfall with reasonable lead time triggering response from disaster managers and public to save life and property.

Classification of Rainfall:-

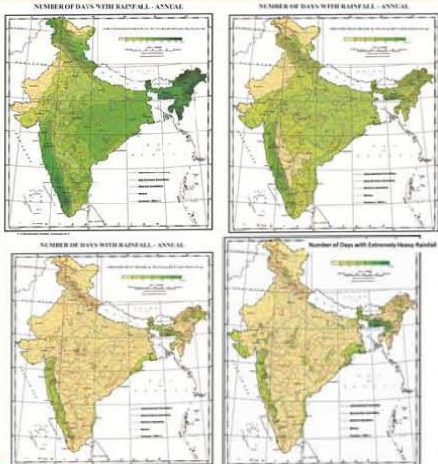
Category	24 hour rainfall over a station ending at 0830 hours IST
Very Light Rain	Trace - 2.4 mm
Light Rain	2.5 – 15.5 mm
Moderate Rain	15.6 – 64.4 mm
Heavy rain	64.5-115.5 mm
Very heavy rain	115.6-204.4 mm
Extremely heavy rain	≥ 204.5 mm

Category of Rain Spell:-

Category	Range of daily Rainfall of a station
Light spell	1 cm/hour
Moderate spell	1-2 cm/hour
Intense spell	2-3 cm/hour
Very Intense spell	3-5 cm/hour
Extremely Intense spell	5-10 cm/hour
Cloud Burst(CB)	> 10 cm/hour

Climatology of Heavy Rainfall: -

Climatology of Annual number of Rainy days, Heavy Rainfall, Very Heavy Rainfall and Extremely Heavy Rainfall days:



Major Factors affecting Heavy Rainfall:-

1. Monsoonal Weather System:
 - Monsoon Trough, Cyclonic Circulation, Low Pressure Area, Depression, Cyclone etc.
 - West coast Off Shore Trough.
2. Interaction of Mid latitude systems with Monsoon Circulation.
3. Other Weather System:
 - Western Disturbance
 - Pre Monsoon Thunderstorm in association with Easterly/Westerly trough, wind discontinuity, cyclonic circulations.
4. Northeast Monsoonal System: Easterly Wave, Trough, Low Pressure Area, Depression, Cyclone.
5. Orographic uplifting of moist air.

Steps for Monitoring and Prediction of Heavy Rainfall: -

- i. Analysis of causative weather system (genesis, evolution, characteristics & dissemination).
- ii. Analysis of current weather system based on surface, RADAR and Satellite observations.
- iii. Comparison of this analysis with model analysis.
- iv. Comparison of model diagnosis & prognosis and hence prediction of heavy rainfall for next five days.
- v. Development of objective consensus based NWP models using decision support system about occurrence and intensity of rainfall.
- vi. Development of subjective consensus among forecasters through video conferencing system through knowledge, experience and expertise.
- vii. Final consensus forecast on occurrence and intensity of heavy rainfall by modulating objective consensus with subjective consensus.
- viii. Warning bulletin, product generation, presentation and dissemination.

Techniques for Heavy Rainfall Forecast: -

- i. Climatology
- ii. Persistence
- iii. Statistical
- iv. Synoptic
- v. NWP Models

Impact based Forecast for Heavy Rain: -

Stage -1: Heavy Rainfall Advisory/Watch: 3-4 days' lead time with 12 hourly update

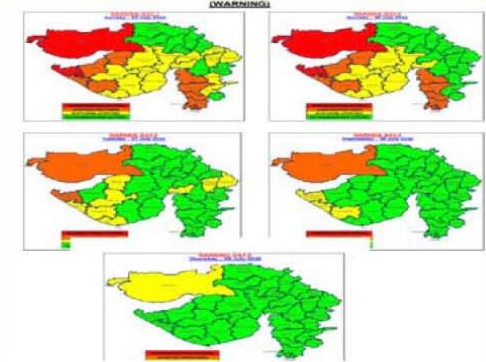
Stage-2: Heavy Rainfall Alert: 48 hours prior to the occurrence of the event with 12 hourly update

Stage-3: Heavy Rainfall Warning: 24 hours prior to the occurrence of the event with 06/12 hourly update

Stage-4: 12-Hours prior to occurrences of maximum Rainfall spell

Example of Impact based Forecast for Heavy Rainfall: -

i. District level IBF over Saurashtra & Kutch



IMPACT BASED FORECAST

Expected impact with respect to red colour warning issued for the Districts namely Dakhneshi Dwarka, Porbandar, Jamnagar, Kutch

- ✓ Major damage to kutchha roads due to inundation.
- ✓ Major disruption in traffic in city areas.
- ✓ Inundation of low lying areas leading to damage to kutchha houses.
- ✓ Water logging in underpass in city areas.
- ✓ Sudden reduction in visibility during heavy downpour leading to road accidents.

ii. Mumbai and Chennai Flooding system

C-FLOWS CHENNAI FLOOD WARNING SYSTEMS

C-FLOWS - An Integrated WMOGS Based Decision Support System to aid the Tamil Nadu Government in Flood Mitigation and Relief Operations

CHENNAI SMART CITY

ONLINE DASH BOARD

FLOOD VULNERABILITY

FLOOD CROWD SOURCING

3D VISUALIZATION

DECISION SUPPORT SYSTEM

The Chennai city of Chennai is prone to flooding and is a hot bed for water and address the problem of urban flooding, the Ministry of Earth System, and the Tamil Nadu State Government have developed a fully operational Chennai Flood Warning System (C-FLOWS), a decision support tool for flood and mitigation operations especially during flooding.

C-FLOWS will be hosted and made operational at the National Centre for Coastal Research (NCCR) with meteorological data inputs from the India Meteorological Department (IMD), National Centre for Medium Range Weather Forecasting (NCMR) and ocean data inputs from the Indian National Centre for Ocean Information Services (INCOIS).

C-FLOWS has been developed by NCCR as a contribution of the project funded by the office of the PM, Chief of staff and former secretary, the IT Cell, IT Infrastructure and also under University, Major projects of C-FLOWS will be setup in the Office of the Commissioner of Revenue Administration, Greater Chennai Corporation (GCC) and IMD.

C-FLOWS is one of the first operational systems for urban flooding in the country and would be spread in the State Government to the local and mitigation operations.