



# **CURRENT METEOROLOGICAL ALERT SYSTEM IN INDIA**

**SOMENATH DUTTA**

**भारत मौसम विज्ञान विभाग  
INDIA METEOROLOGICAL DEPARTMENT**

# PRESENTATION LAYOUT

- Brief introduction of India Meteorological department([www.imd.gov.in](http://www.imd.gov.in))
- Impact based forecast & warning
- Strategies for Early Warning System and need of users
- Natural Hazards in India
- Weather related natural hazards
- Institutional arrangement
- Early warning system



# Brief introduction of IMD-Mandate

**India Meteorological Department** was established in 1875. It is the National Meteorological Service of the country and the principal government agency in all matters relating to meteorology, seismology and allied subjects.

- To take meteorological observations and to provide current and forecast meteorological information for optimum operation of weather-sensitive activities like agriculture, irrigation, shipping, aviation, offshore oil explorations, etc.
- To warn against severe weather phenomena like tropical cyclones, norwesters, duststorms, heavy rains and snow, cold and heat waves, etc., which cause destruction of life and property.
- To provide meteorological statistics required for agriculture, water resource management, industries, oil exploration and other nation-building activities.
- To conduct and promote research in meteorology and allied disciplines.
- To detect and locate earthquakes and to evaluate seismicity in different parts of the country for development projects.



# Brief introduction of IMD-organizational structure

The Director General of Meteorology is the Head of the India Meteorological Department, with headquarters at New Delhi. There are 4 Additional Directors General at New Delhi and 1 at Pune. There are 20 Deputy Directors General of whom 10 are at New Delhi.

For the convenience of administrative and technical control, there are 6 Regional Meteorological Centres, each under a Deputy Director General with headquarters at Mumbai, Chennai, New Delhi, Calcutta, Nagpur and Guwahati. Under the administrative control of Deputy Director General, there are different types of operational units such as Meteorological Centres at state capitals, Forecasting Offices, Agrometeorological Advisory Service Centres, Flood Meteorological Offices, Area Cyclone Warning Centres and Cyclone Warning Centres.

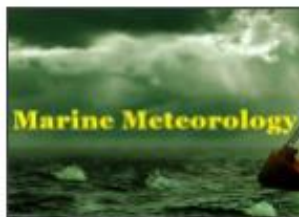
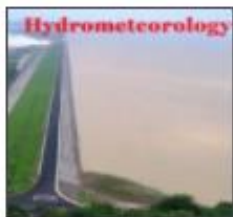
In addition, there are separate Divisions to deal with specialised subjects. They are: -

- Agricultural Meteorology
- Civil Aviation
- Climatology
- Hydrometeorology
- Instrumentation
- Meteorological Telecommunication
- Regional Specialised Meteorological Centre
- Positional Astronomy
- Satellite Meteorology
- Seismology
- Training

At present IMD is under the Ministry of Earth Sciences (MoES).



# Brief introduction of IMD-Services



# IMPACT-BASED FORECASTS AND WARNINGS

- These types of forecasts and warnings are designed to express the expected impacts as a result of the expected weather.

Example : “Severe thunderstorms with gusts over 60 mph will result in damage to trees and power lines.”

- Only hazard and vulnerability are taken into consideration here.
- **A hazard** is defined as a hydro-meteorological-based, geophysical or human-induced element that poses a level of threat to life, property or the environment & **Vulnerability** refers to the susceptibility of exposed elements, such as human beings and their livelihoods and property, to suffer adverse effects when affected by a hazard.(WMO-1150)
- Successful impact-based forecasting requires collaboration with others who have the additional necessary expertise, resources and knowledge to deliver impact services that NMHSs cannot do on their own.



# STRATEGIES FOR EARLY WARNING SYSTEM AND NEED OF USERS

- Due consideration is given to the needs of a wide spectrum of users ranging from the underprivileged who need general protection and to sophisticated individuals who could respond to warnings in accordance with their own acceptable risks.
- Users' requirements may change with the environment and evolving society.
- Constantly monitored for opportunities to improve the processes and presentations of warning information to meet the expectations and needs of the public and special clients, harnessing the advancement in computer and telecommunication technologies and techniques.
- Synergizing the power of the media and innovative telecommunication means to promote the intelligent use of warnings could further enhance the effectiveness of warnings.



# Natural hazards of significant impact in India

❖ Earthquakes

❖ Cyclones

❖ Floods

❖ Droughts

❖ Tsunami

• Landslides

• Heat wave

• Cold wave

• Pest Attacks

• Forest Fires

• Snowfall

• Avalanches

• Thunderstorm

• Lightning

• Tornado

• Squall and gale

• Hailstorm





# LEAD TIME FOR MAJOR NATURAL HAZARDS AFFECTING INDIA

**Earthquakes -Seconds/Minutes**

**Tsunami -Minutes/Hours**

**Thunderstorms -hours**

**Cyclones -Days**

**Floods-Days**

**Landslides-Days**

**Heat & Cold waves -Days/ weeks**

**Droughts-Months**



# Institutional Arrangement

Forecasts / Warnings relating to major Natural hazards are being provided by....

- India Meteorological Department (Cyclones, heavy rainfall/Floods, Deficiency in rainfall, earthquakes).
- Indian National Centre for Ocean Information Services (Tsunami).
- Central Water Commission of the Ministry of Water Resources (Floods).
- Geological Survey of India (Landslides).
- National Centre for Seismology, MoES : Earthquake
- Defense Research and Development Organization : Snow and Avalanches



# MoES Agencies dealing with various Hazards

## **HYDRO-METEOROLOGICAL HAZARDS – IMD, INCOIS**

Tropical Cyclones, Local Severe Storms, Winter Systems.

[Support for Floods, Drought  
Snow Avalanches]

Climate change impacts on severe weather events  
(IITM and IMD)

## **ENVIRONMENTAL IMPACTS**

- Air pollution & Haze, FOG, Smog (IMD)
- Coastal Zone Management (ICMAM)
- Coastal Erosion (ICMAM)
- Eco-system monitoring/ modeling (IITM and IMD)

## **GEOLOGICAL HAZARDS**

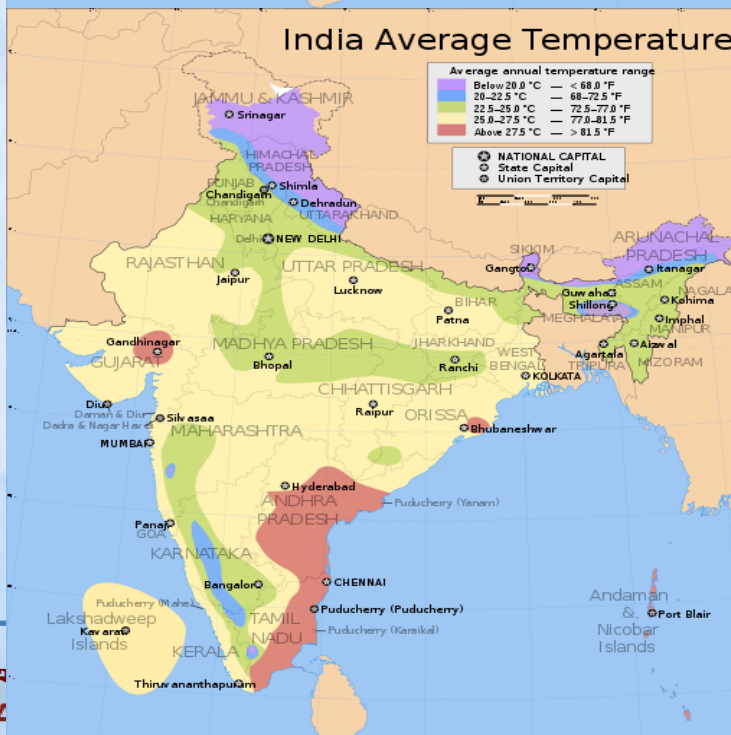
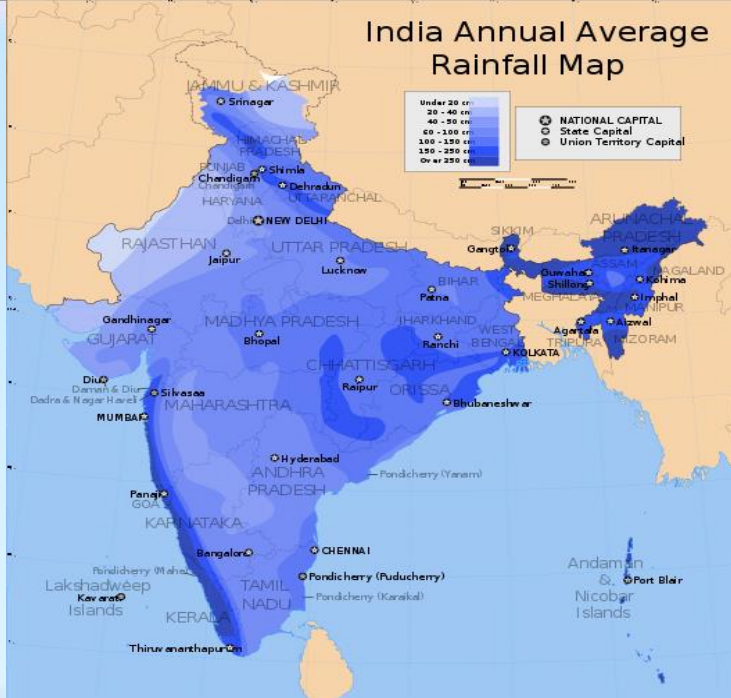
Earthquakes & Tsunamis  
(NCS and INCOIS)

[Support for Rain Induced  
Landslides/Mudslides  
(IMD)]



# Weather related natural hazards

- ❖ **WINTER (JAN-FEB)**
- ❖ **WESTERN DISTURBANCES COLD WAVE, FOG**
- ❖ **PRE-MONSOON (MAR-MAY)**
- ❖ **CYCLONIC DISTURBANCES HEAT WAVE THUNDER STORMS, SQUALLS HAIL STORM TORNADO**
- ❖ **MONSOON (JUN-SEP)**
- ❖ **SOUTHWEST MONSOON CIRCULATION MONSOON DISTURBANCES & Heavy rainfall**
- ❖ **POST-MONSOON (OCT-DEC)**
- ❖ **NORTHEAST MONSOON CYCLONIC DISTURBANCES**



# Warning System of IMD

- ❖ **Goal** : maximizing actions for safety
- ❖ **Components of a warning system:**
  1. **Detection, monitoring and Warning**
    - Global, regional, national and local observations
    - Numerical weather prediction
    - Forecasts on different timescales (nowcasting to several days)
  2. **Timely** issuing and dissemination of authoritative warning information
  3. **Communication**: complete only after information received and understood (vs Fire and Forget)
  4. **Risk Analysis and impact assessment**
    - Who and what is at risk and why? What will the impacts be?
  5. **Mitigation and response**: Actions of recipients depend on:
    - **Content and clarity** of the warning
    - **Credibility** of issuing organization
    - State of **preparedness** of receiving authorities
  6. **Scientific knowledge alone not sufficient**
    - **IMD + Hazards Community** (other government organizations + local officials + emergency managers + media + voluntary and NGOs+...)

# IMD's Forecast & Warning

- ✓ Nowcast, short, medium and extended range Forecast
- ✓ Public Weather Local Forecast
- ✓ Long Range Forecast
- ✓ Tropical Cyclone Forecast & Warnings
- ✓ Warnings related to all other Disaster
- ✓ Sea State Forecast
- ✓ Coastal Zone Forecasts
- ✓ Forecasts to Aviation
- ✓ Forecasts for Agriculture
- ✓ Customized Forecasts to different Sectors- Power, Tourism, Defense, Adventure, Road/Railway transports, Public Utility, VIP functions, Strategic operations, Space, event based etc



# Warnings Parameters

- ✓ Heavy rainfall/snowfall
- ✓ Thunderstorm/Squall/Hailstorm
- ✓ Heat/Cold Wave
- ✓ Frost
- ✓ Fog
- ✓ Strong winds
- ✓ Storm surge

**Warning criterion defined for each parameter.**

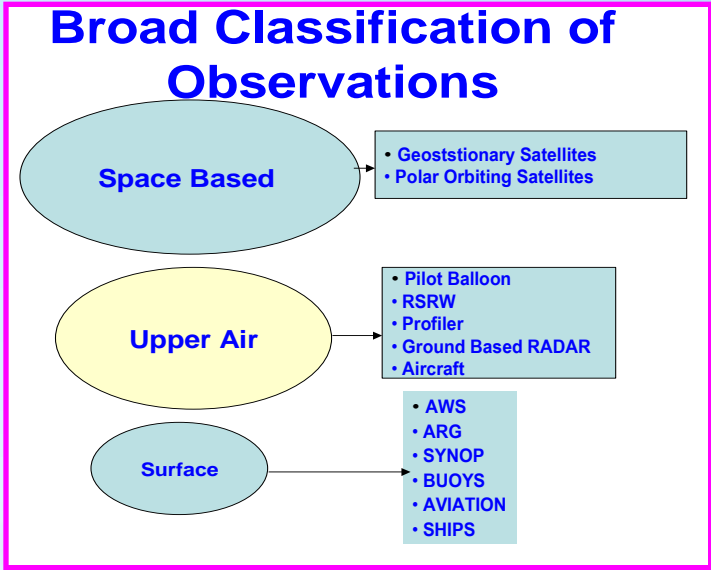
**SOP in place**

**Linkages with Media, Disaster authorities.**

**Scheduled time of issue**

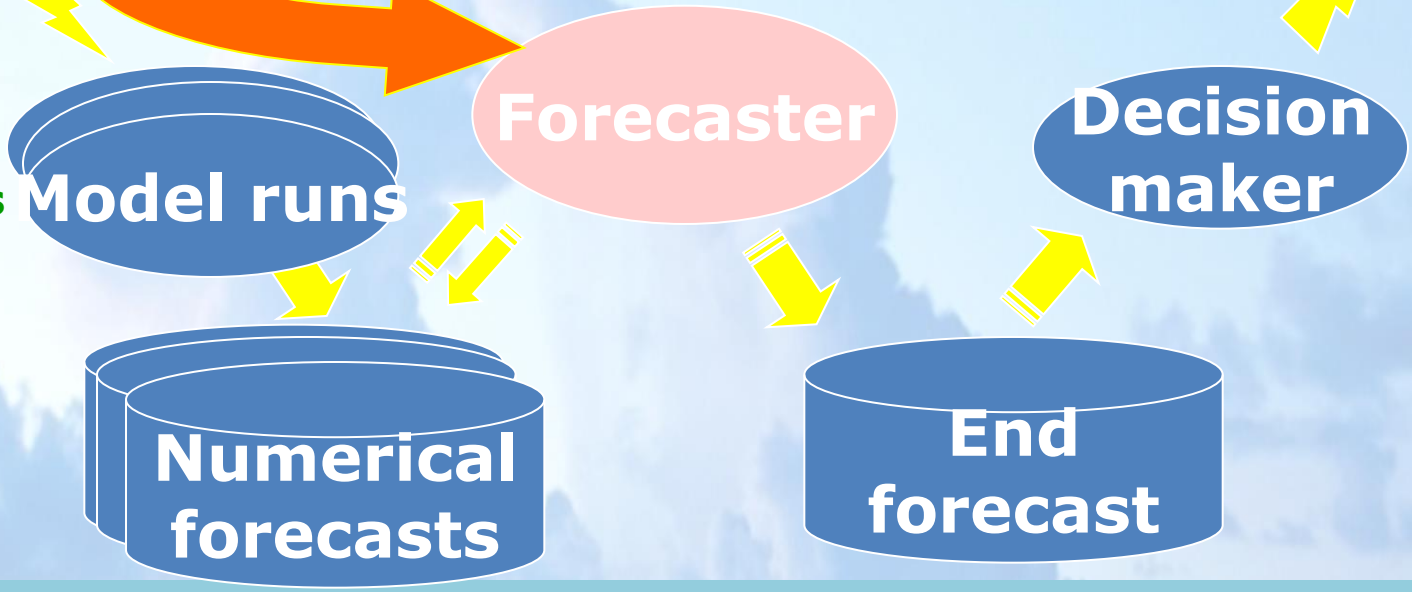


# Early Warning System



**Initial conditions (Observations)**

**Runs of different Models,  
Consecutive runs from the same model,  
Ensemble runs ("choosing the best member")**



**Improved Early warning system with respect to all the above components**



# Improvement in weather forecast & warning Services

- Increased resolution of global NWP models to 12 km & regional 9 & 3 km.
- Improved capabilities for predicting high impact weather events including heavy rain, thunderstorm, cyclone, fog, heat and cold wave etc.
- Increase in validity of forecasts 7 days and at district level. Block-wise expt. forecasts for selected blocks also introduced.
- Specialized services were introduced for Power & health sectors.
- Dedicated forecast for Pilgrimage etc
- Improvement in seasonal forecast of southwest monsoon season rainfall and introduction of monthly forecasts for rainfall and temperature anomalies.
- Introduction of extended range (upto two weeks) and seasonal outlooks



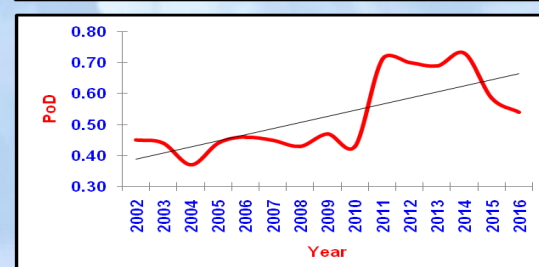
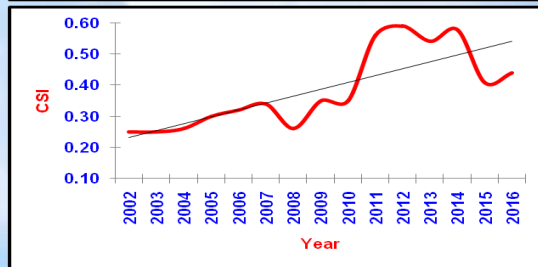
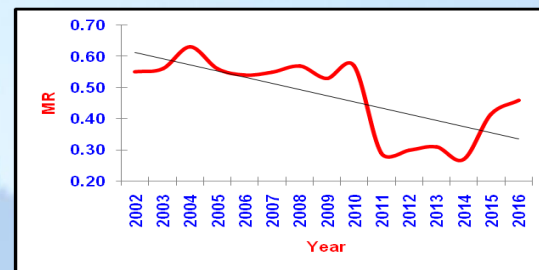
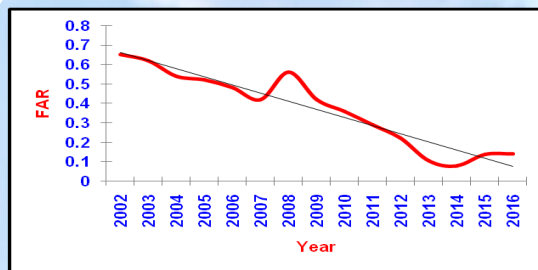
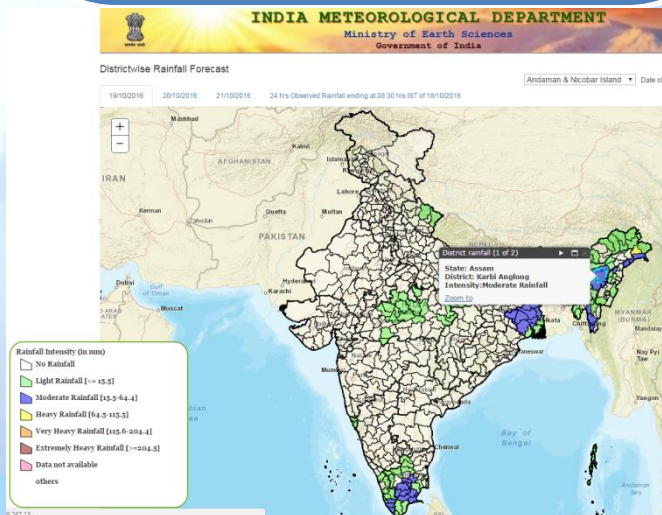
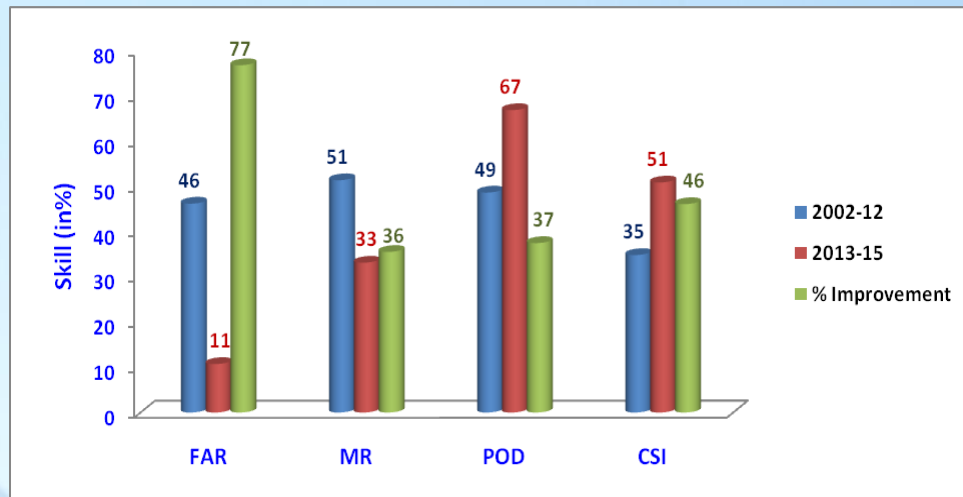
# MONSOONAL HEAVY RAINFALL MONITORING, FORECASTING AND WARNING SERVICES

Types of forecasts/Warning	Temporal range	Spatial scale
Nowcasting	a few couple of hours ahead	Towns/Cities and districts
Short Range	up to 3 days	Towns/Cities, Districts, meteorological subdivisions
Medium Range	3 – 10 days	Districts, meteorological subdivisions



# Improvement in Accuracy of Heavy rainfall Warning

Noticeable improvements achieved in Skills of Heavy Rainfall Forecast (False Alarm Rate reduced from 46% to 11% & Probability of Detection increased from 49% to 67% from 2002-12 to 2013-15)



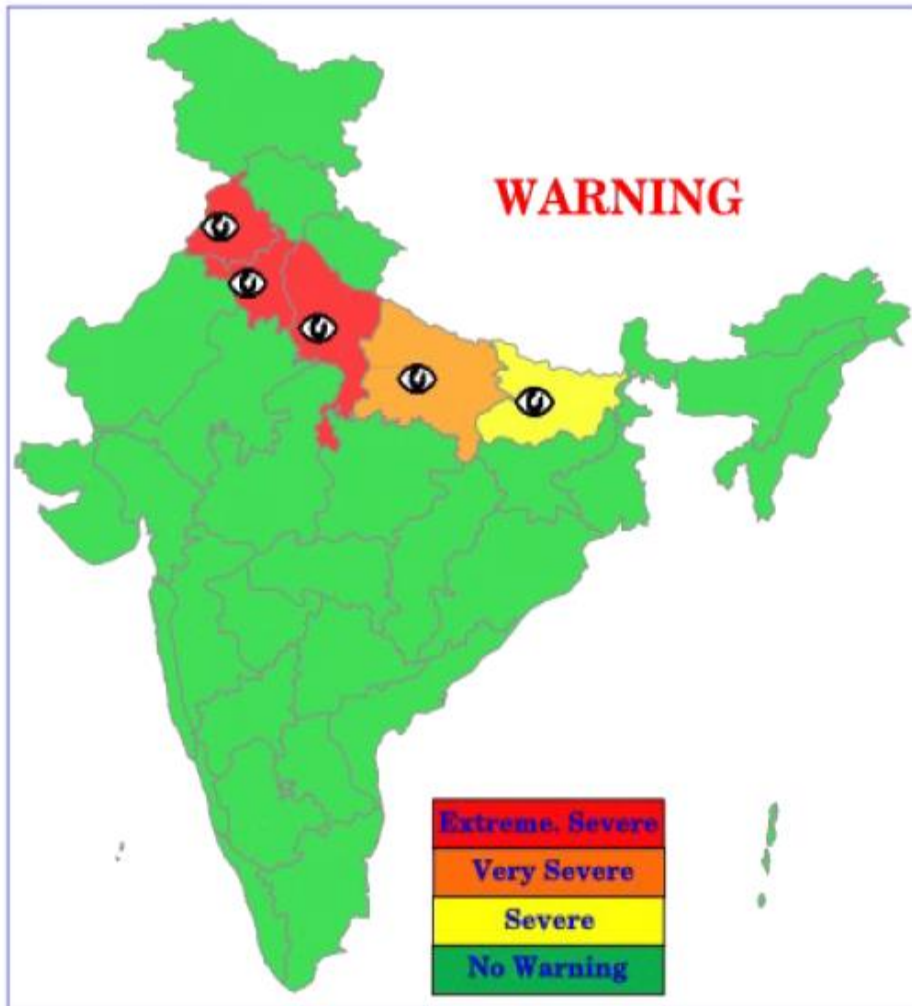
**Target for 2019 : Improvement of accuracy and skill by 20% up to 7 days**

# METEOROLOGICAL ALERT FOR WINTER WEATHER

- Development of a system to warn of fog at least 6-24 hours in advance, calculate its severity, and estimate when it is likely to lift enough for flights to take off and land safely.
- About 30 instruments have been installed along the runways to measure the surface meteorological conditions, radiation balance, turbulence, thermodynamical structure of the surface layer, droplet and aerosols microphysics, aerosol, fog water chemistry, vertical profile of winds, temperature, and humidity, which are used to improve a fog weather model developed by MoES Institute.
- A new 'Fog Alert' system has recently been introduced, which enables to inform passengers about fog probability along the route, severity of fog and its probable impact on train schedules.



# Fog/visibility warning (17 January, 2012)



Visibility at one or two places	<500M	Yellow
Visibility at a few/many places	<200 M	Orange
Visibility at most places	<200 M or less than <50 M	Red
No Warning	Nil	Green



# Heavy rain/snow & hail storm warning (16 January, 2012)



Very heavy snow at one or two to many places	>65 cm	Ths + hail+Squall	
Heavy snow at a few places	>35 cm	Ths+ hail+ squall	
Heavy snow at one or two places	>35 cm	Ths+ squall	
No warning	Nil		



# Cold wave/ visibility & ground frost warning, (11 January, 2012)



Cold wave (5.0 to 6.0°C below normal)	Ground frost at one or two places	Visibility at one or two places < 500 M	Yellow
Severe cold wave ( 7° C below normal)	Ground frost at a few places	Visibility at a few/many places <200 M	Orange
Cold day ( day temp. <15°C) or severe cold wave	Ground frost at many places	Visibility at most places <50 M	Red
No warning	No warning	No warning	Green



# Heat wave & Thundersquall warning (25 May, 2012)

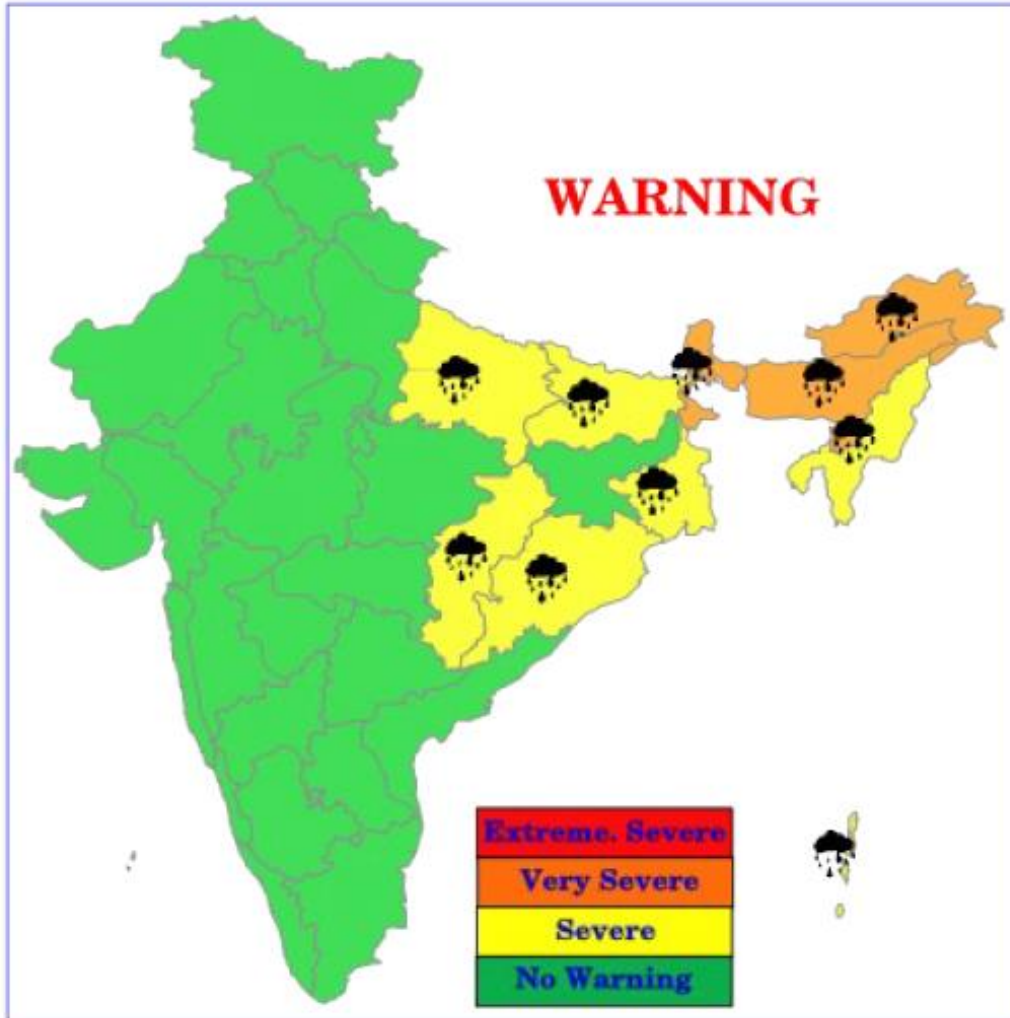


Heat wave (5.0 to 6.0°C above normal)	Thundersquall at one or two places	>22 kts and above	
Severe heat wave (7.0°C above Normal or station reported 45.0°C or more)	Thundersquall at a few places	>22 kts and above	
Severe heat wave (7.0°C above Normal or station reported 45.0°C or more) at wide area	Severe Thundersquall at many places	>22 kts and above	
No warning	No warning	Nil	





# Heavy Rainfall Warning (15 July 2012)

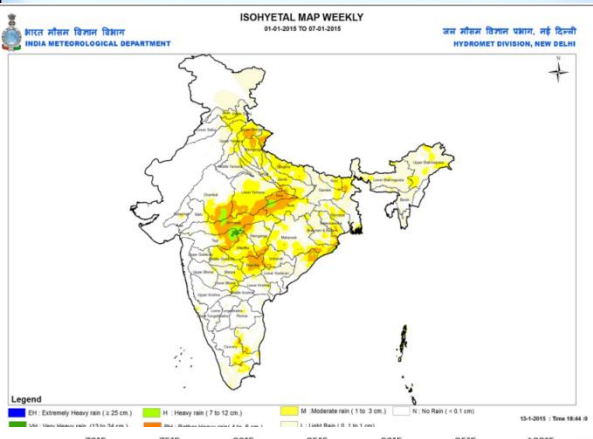


Heavy rain at one or two places	>6.5 cm or more	Yellow
Heavy to very heavy at one or two / at a few places	>12.5 cm or more	Orange
Heavy to very heavy at <b>a few places</b> or <b>extreme heavy</b>	>12.5 cm or more	Red
No warning	Nil	Green



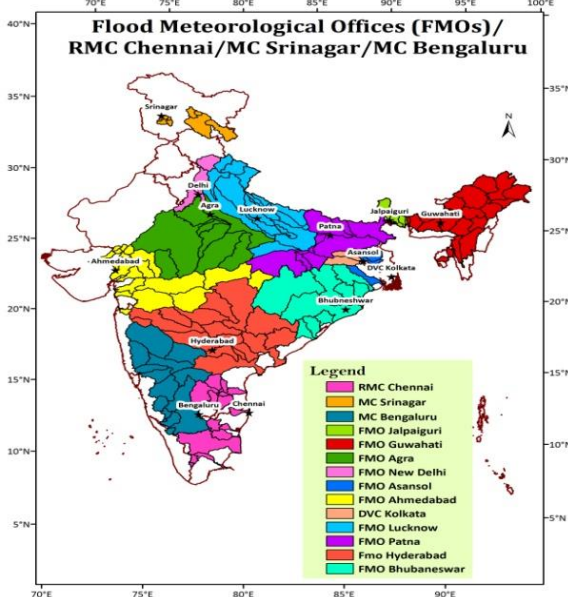
# HYDROLOGICAL SERVICES FOR FLOOD MONITORING AND FORECASTING

- Preparation of Rainfall Statistics; following recommendation by the President of India, daily, weekly & monthly rainfall statistics prepared.
- Provides real-time rainfall information by means of GIS based rainfall products.



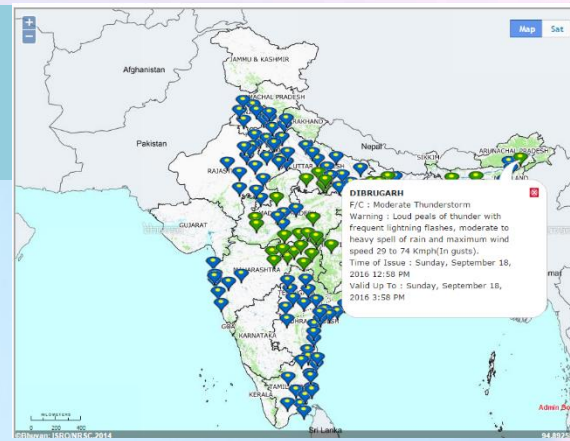
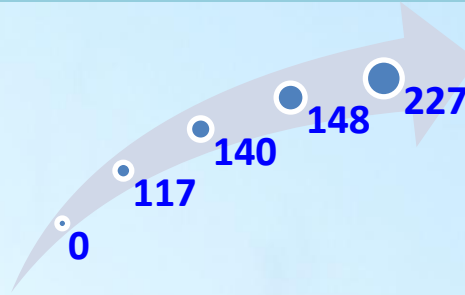
The district-wise and river basin-wise rainfall statistics is helpful to farmers for their agricultural activities and flood forecast/ water management.

- Quantitative precipitation forecast (QPF) to CWC for flood forecast purposes increased from 125 to 146 river sub-basins.
- QPF increased from 5 day to 7 days from flood season 2015.
- Sub catchment wise QPF from NWP models- GFS for 7days in addition to WRF, MME for 3 days
- QPF for 4 new catchments Jhelum, Pennar, Torsa, Sankosh which involves 12 sub catchments.
- Extended range outlook about water equivalent of rainfall over river catchment.

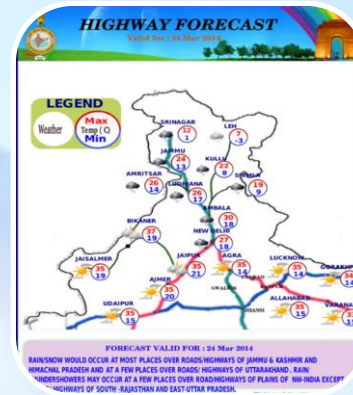


# City specific forecasts

Introduced Thunderstorm /Now cast for cities covered under DWRs for 227 cities.



Introduction of Highway Forecast



Northwest India



Southeast India

Increase in city forecast from around 30 in 2006 to 324 in 2016.

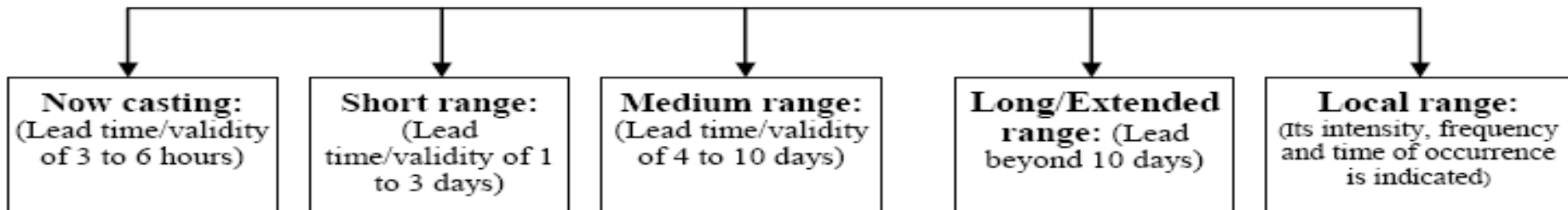


**Target for 2024 : 600 cities and improvement in accuracy and skill by 20%**

# Sectoral Application: Health

- Seasonal and extended range (upto two weeks) outlook
- District level heat wave warning (upto five days)
- **Heat Action plan for 9 cities including Ahmedabad, Nagpur are already in place**

## Temperature Forecast: Specific Range, Time duration and area



### 3.3 Identification of Color Signals for Heat Alert<sup>3</sup>:

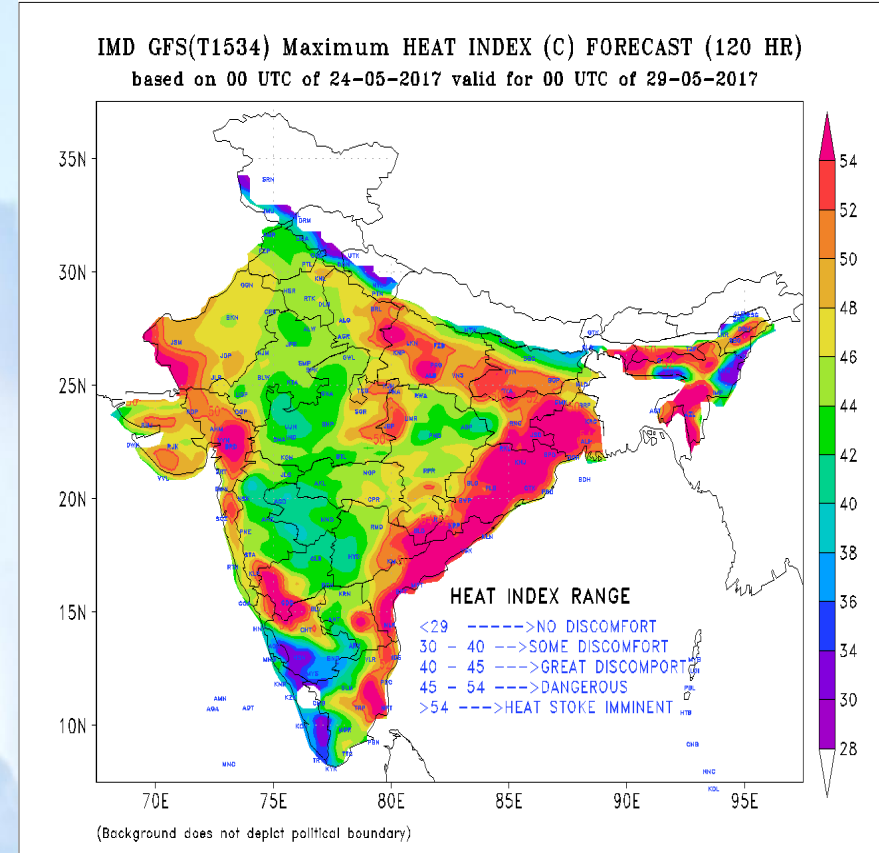
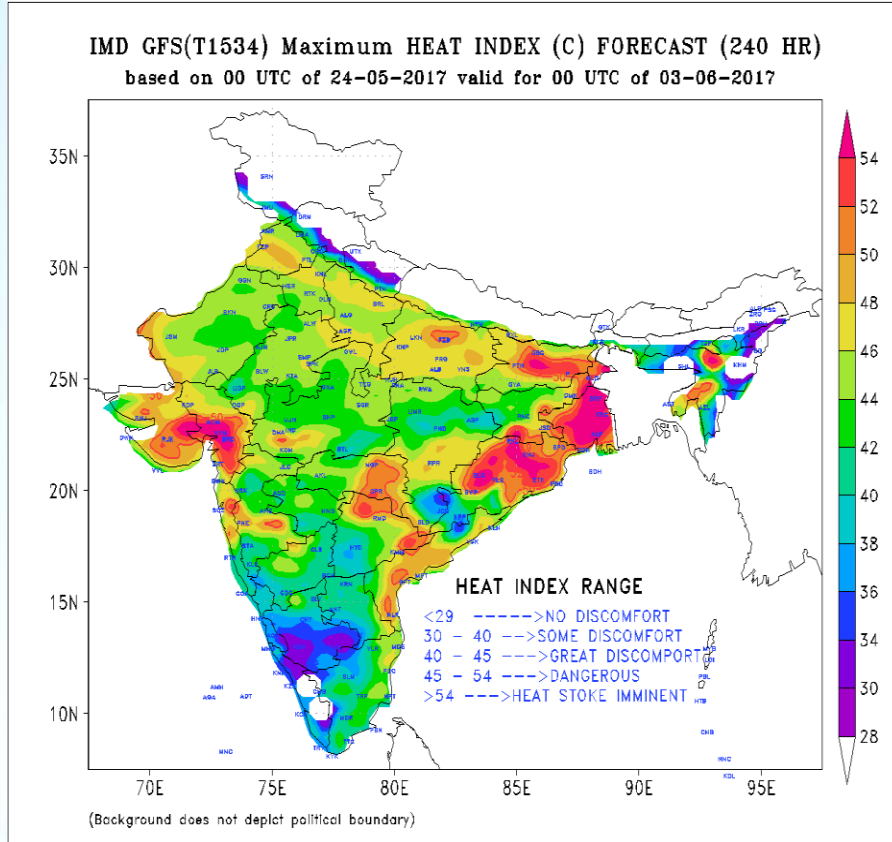
<b>Red Alert (Severe Condition)</b>	<b>Extreme Heat Alert for the Day</b>	<b>Normal Maximum Temp increase 6° C to more</b>
<b>Orange Alert (Moderate Condition)</b>	<b>Heat Alert Day</b>	<b>Normal Maximum Temp increase 4° C to 5° C</b>
<b>Yellow Alert (Heat-wave Warning)</b>	<b>Hot Day</b>	<b>Nearby Normal Maximum Temp.</b>
<b>White (Normal)</b>	<b>Normal Day</b>	<b>Below Normal Maximum Temp.</b>

<sup>3</sup> Ahmadabad Heat Action Plan 2015



# Sectoral application-Health

## Forecast Heat index map



# Sectoral Application: Health

Temporal evolution of the spatial distribution of transmission window for vector borne disease using ERFs model output.

weeks	VBD	Threshold minimum temp (Th-Tmin)	Region(s) with Predicted Tmin within range of Th-Tmin	Threshold maximum temp (Th-Tmax)	Region(s) with Predicted Tmax within range of Th-Tmax
19 <sup>th</sup> May to 25 <sup>th</sup> May	Malaria Plasmodium Falciparum	16–19 °C	Himachal Pradesh and some part of Uttarakhand	33-39°C	Himachal Praedsh, Uttarakhand, Punjab, Haryana, Major part of Uttar Pradesh, whole Bihar, West Bengal, Tamilnadu, Kerala, Karnataka, Konkan, Madhya Maharashtra, Sourashtra & Kutch, Major part of Gujarat region, Northeastern states, Major part of Jharkhand.
	Malaria Plasmodium vivax	14–15 °C	Jammu and Kashmir.		
26 <sup>th</sup> May to 01 <sup>st</sup> June	Malaria Plasmodium falciparum	16–19 °C	Some part of Himachal Pradesh.	33-39°C	Uttarakhand, Himachal Pradesh, Bihar, West Bengal, Tamilnadu, Kerala, Karnataka, Madhya Maharashtra, Konkan, Sourashtra & Kutch, Major part of Jharkhand, Some part of Orissa, Andhra Pradesh, All Northeastern states.
	Malaria Plasmodium vivax	14–15 °C	Jammu and Kashmir.		



# SECTORAL APPLICATION: AGRICULTURE

## Agro-Meteorological Advisory Services (AAS):

- Based on the weekly weather forecast, advisories for farmers are developed in association with State Agricultural Universities and ICARs Krishi Vigyan Kendras (KVKs).
- These services are available in 539 districts of the country currently.
- Through this service, farmers receive weather based farm management services like crop & location -specific advisories with regard to the time of sowing of weather-sensitive high yield variety of seeds, need-based application of fertilizer, pesticides, insecticides, efficient irrigation and harvest.
- The services are made available through multi channel dissemination system like web, radio, TV, newspaper, and mobile.
- Currently around 2 crores farmers have subscribed for receiving this information through mobile in vernacular languages.



# Dissemination of Agromet Advisory

## 1. Mass Mode

- ❖ All India radio, Television, Print Media

## 2. Outreach at Village level

- ❖ Ministry of IT Internet based Village Connectivity
- ❖ Web Pages: IMD, SAUs, ICAR Web Pages
- ❖ Mobile Phones (SMS & IVRS) through Public & private agencies
  - 21.69 million farmers
- ❖ Kisan Call Centres

## 3. Human face for advisory dissemination

- ❖ KVK (ICAR): Training + interaction
- ❖ DAO (SDA): Coordinate Farm inputs with Line Dept. in rhythm of weather forecast
- ❖ NGOs & other intermediary groups, Awareness Programme





# SMS for Farmers

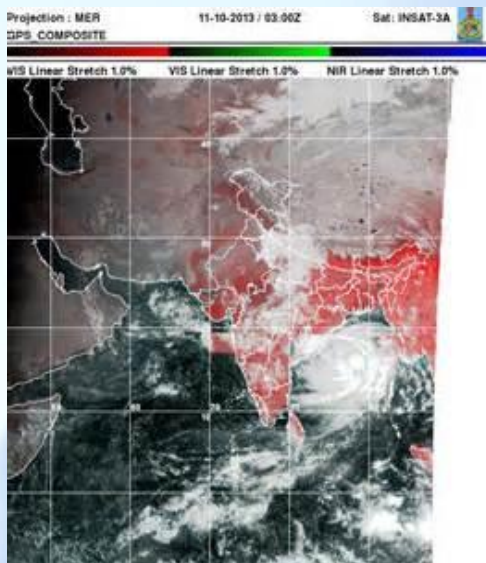
- ❖ SMS is best for sending quick short messages to an individual farmer or a group of farmers, like “Thunderstorm likely today afternoon”
- ❖ It is easy to send SMS messages to even thousands of recipients at a time
- ❖ Regional language SMS is now becoming available
- ❖ **The SMS system needs to be exploited as a means of communicating quickly with farmers**



# Extreme weather - Special Advisories Issued by Agromet Field Unit (AMFU), Bhubaneswar, Odisha

## Advisories for cyclonic storm "PHAILIN" on standing crops

- Drain out the excess water from the rice fields .
- Completely drain out non-paddy crops
- Spray 2% salt solution to standing crop at maturity.
- Harvest non-harvested Matured crops and keep on aerated safe place
- Strait up the lodged crops
- Apply 2<sup>nd</sup> top dressing of nitrogen or foliar spray of urea to long duration rice after flowering
- Control pests such as leaf eating caterpillar
- Harvest groundnut and hang in bunches at aerated safe place.
- Pop the sugarcane crops again.



**IFFCO Kisan Sanchar Limited (IKSL) has saved many lives in coastal Odisha by sounding an alert ahead of the devastating cyclone Phailin through its unique mobile phone message facility.**



# Advisories to fishermen Sudden winds and high waves

Utilise mobile phone technology to develop a sustainable warning service that reduces the vulnerability of communities in the coastal areas in the country



(1)  
Integrated  
Observations



(2)  
Severe Weather  
Forecasting



(3)  
Communication  
via mobile phone



(4)  
Stakeholder  
Engagement

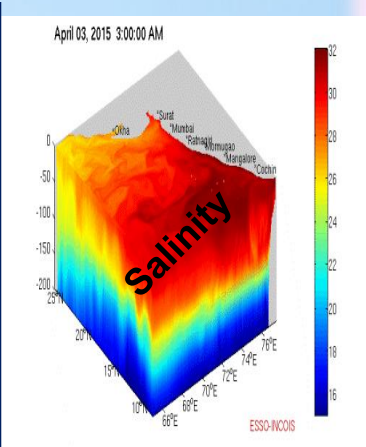
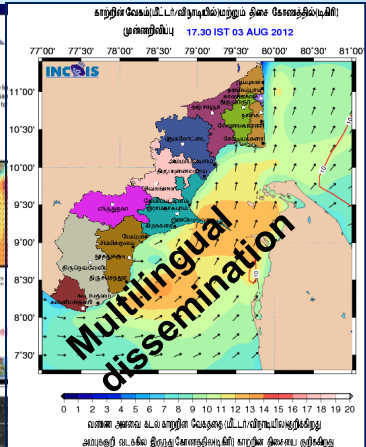
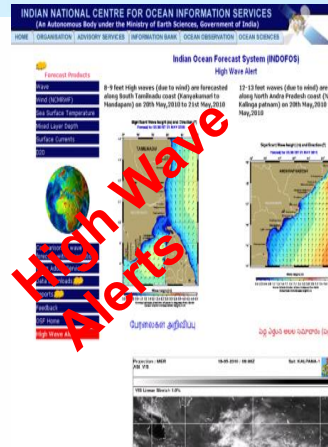
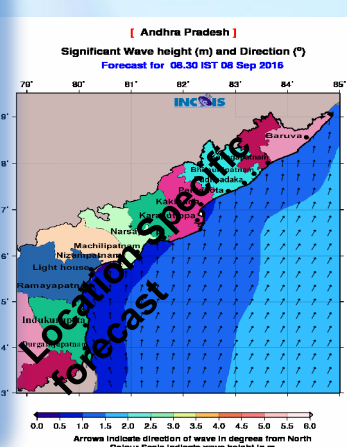


## **OCCURRENCE OF HAIL STORMS AND STRATEGIES TO MINIMIZE ITS EFFECT ON CROPS**

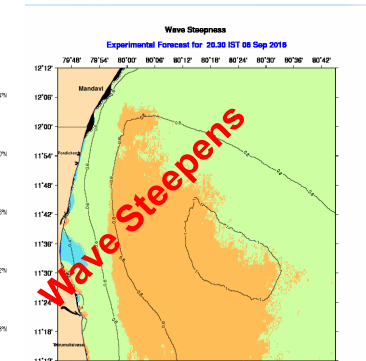
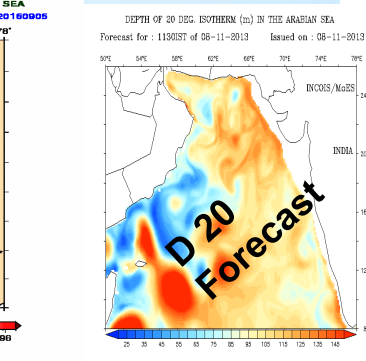
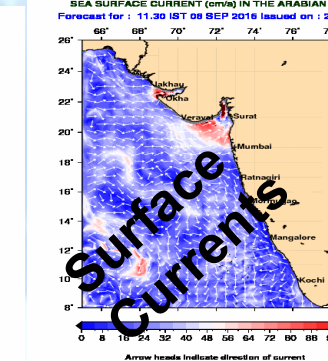
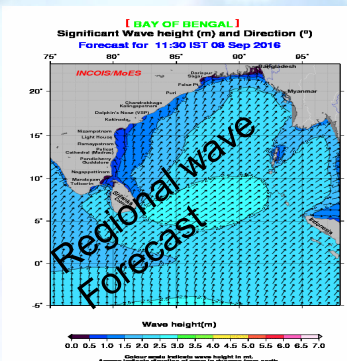


# General Ocean State Forecast Products

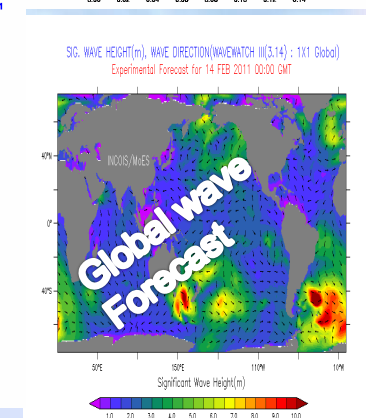
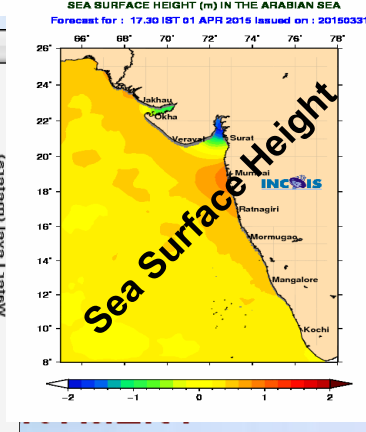
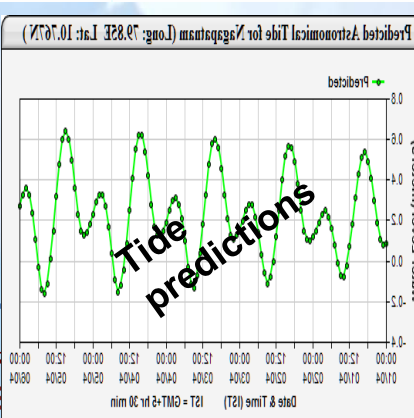
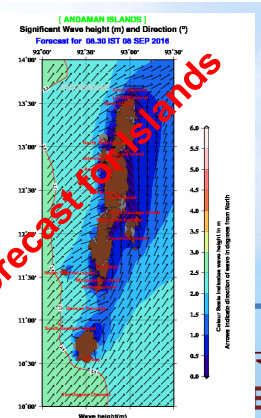
- Global Forecast
- Regional – 7 Regions
- Coastal – 9 Coastal states of India
- Island – A&N and Lakshadweep
- Location specific -100 locations
- Tidal forecast system for 178 locations
- Real time validation System
- Forecast dissemination in local languages
- High resolution Forecast for West Coast of India



- High Wave/swell/bulletins
- Joint INCOIS – IMD Bulletins
- Bulletins on Ocean State Forecast along Standard shipping routes
- Wave surge warning



- Forecast along ship-track
- Eddy Forecasts
- OSF for Neighbouring countries through RIMES
- Navy specific forecast products
- OSF Web Map Services
- Sea State Forecast for ports and Harbours
- Online Oil spill advisories (OOSA)
- Search and Rescue Aid Tool (SARAT)

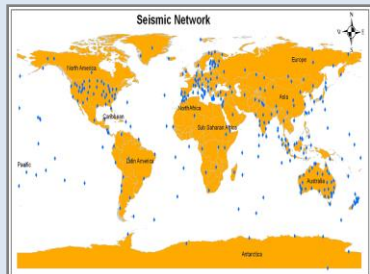


# Tsunami Early Warning System

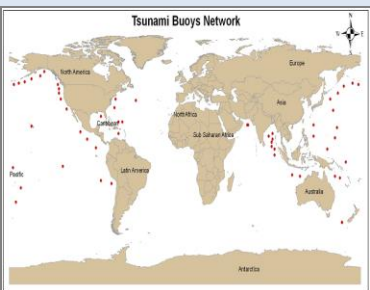
Detection

Warnings

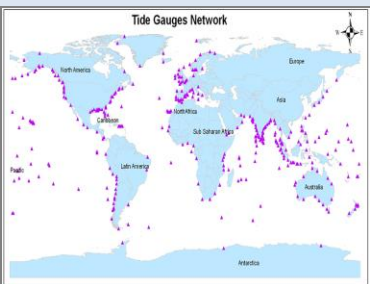
Dissemination



Seismic Network



BPR Network



Tide gauge Network

Observation Networks



VSAT



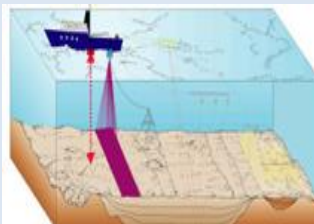
INSAT



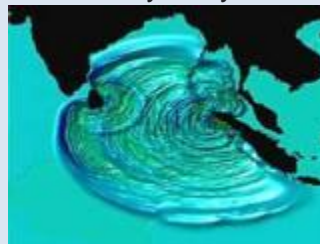
GPRS



INMARSAT



Bathymetry



Tsunami Modelling

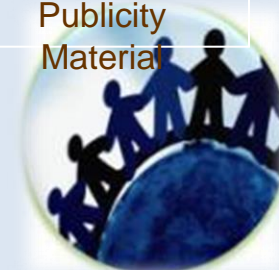


Topography



Costal Vulnerability

COMMS Tests  
Tsunami Drills  
Trainings  
Publicity  
Material



Capacity Building



R & D

Paleo-tsunami  
Modelling  
GNSS Data  
Use

Use

Participating Institutions  
IMD, NIOT, ICMAM, SOI,  
NRSC, INCOIS  
MHA, NDMA, Coastal State

**TSUNAMI  
WARNINGS!!!**



# CYCLONE FORECAST/ WARNING



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INDIA METEOROLOGICAL DEPARTMENT



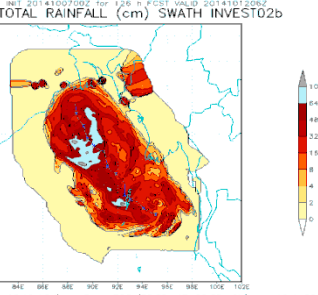
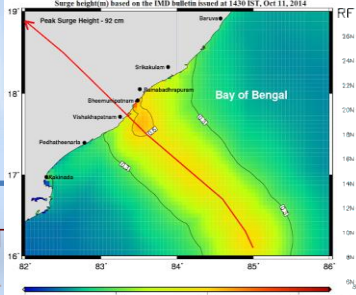
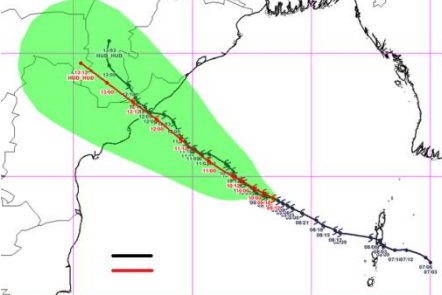
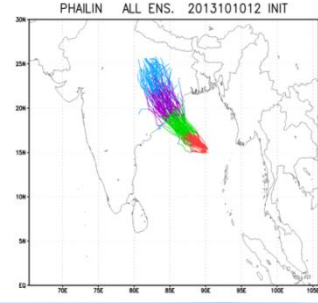
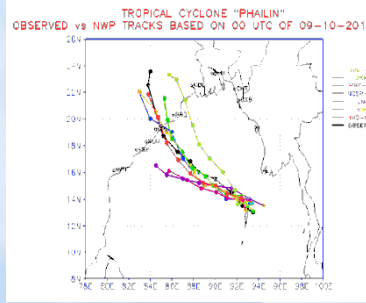
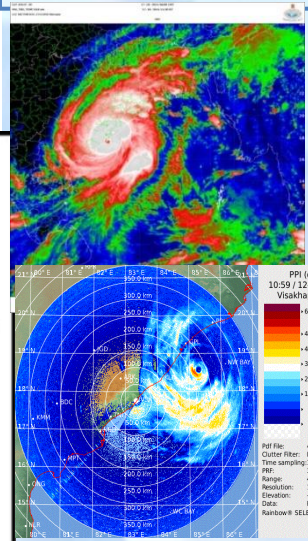
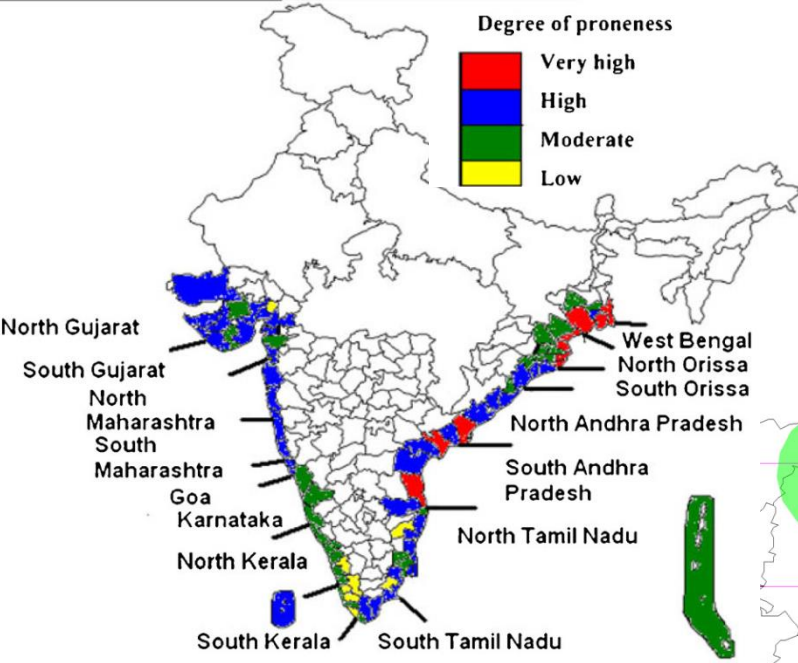
# Cyclone Monitoring & Forecasting Process Accomplishments and Challenges

## Cyclone Hazard Prone Districts

- ✓ Frequency of cyclone
- ✓ Frequency of severe cyclone
- ✓ Probable maximum Precipitation
- ✓ Wind strength
- ✓ Storm surge

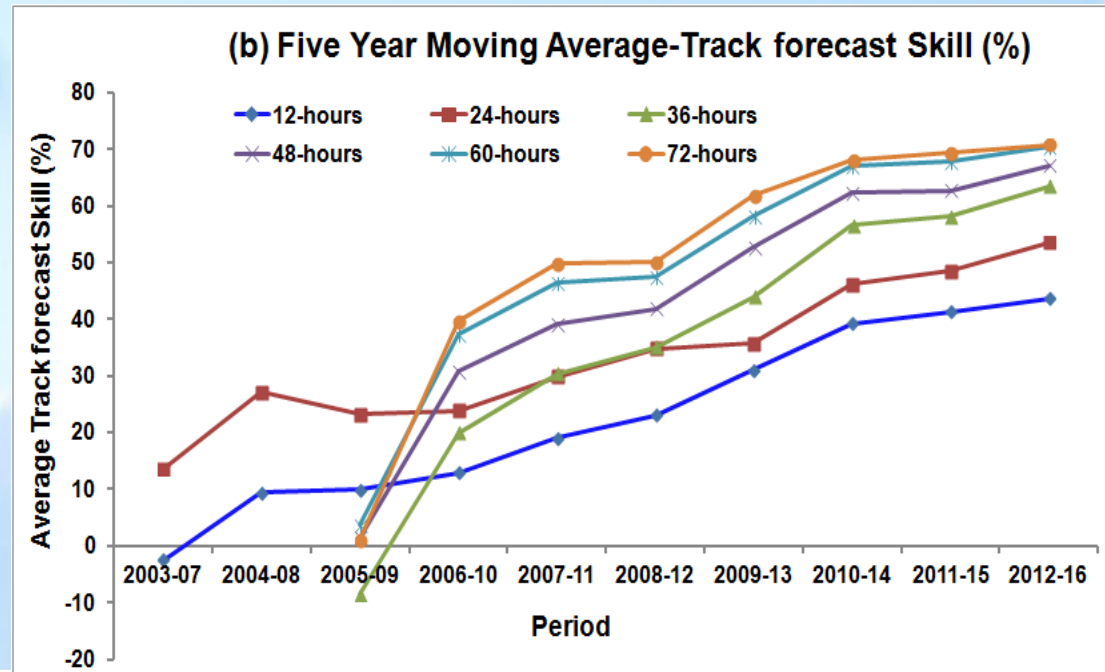
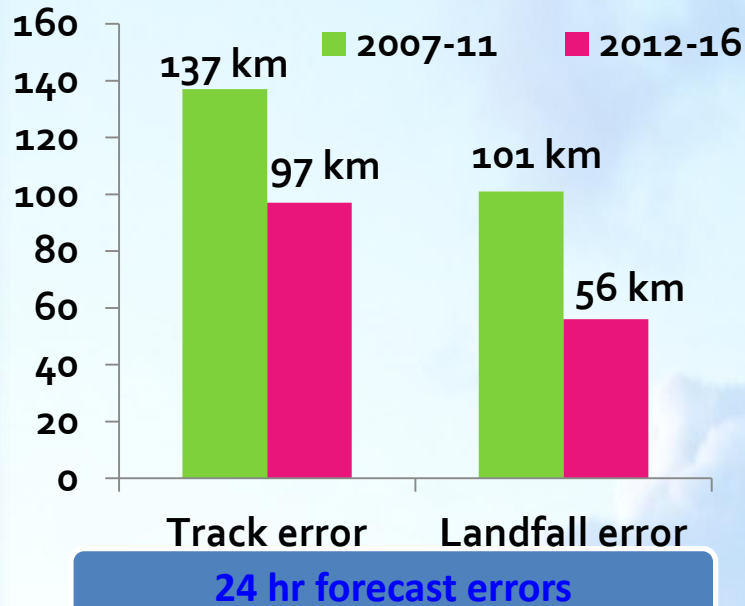
About 4-5 cyclones develop over NIO, 2-3 become severe

- ❖ IMD is nodal agency for cyclone services
- ❖ Probabilistic Cyclogenesis Forecast upto 3days
- ❖ Track and intensity forecast upto 5 days in text and graphics
- ❖ Impact based heavy rainfall, wind and storm surge warning 5 days with advice for action





# Cyclone Forecast Accuracy: Accomplishments and Challenges



Noteworthy improvement in track and intensity forecast of the tropical cyclones (24 hour forecast error in track prediction reduced from 137 km to 97 km and Landfall error from 101 Km to 56 Km during 2007-11 to 2012-16).

Probabilistic genesis Forecast up to 3 days and Track and intensity forecast up to 5 days in text and graphics

**Target for 2024 : Reduction in error and Improvement of skill by 20% up to 7 days**  
**Target for 2024 : Dynamical Impact based Forecast and Warning**

# Warning Dissemination Mechanism

- ❖ Telephone, Tele-fax, Mobile Phones (SMS) through IMD severe weather network, Agromet Network, INCOIS network.
- ❖ VHF/HFRT/Police Wireless, Satellite based system, NAVTEX
- ❖ Aeronautical Fixed Terminal Network
- ❖ Global telecommunication system (GTS)
- ❖ Internet (e-mail), ftp, Websites, Dedicated website for cyclone (rsmcnewdelhi.imd.gov.in), earthquake, webpages for monsoon, thunderstorm, heat wave etc
- ❖ Radio/TV, News Paper network (AM, FM, Community Radio, Private TV) :
- ❖ Social Media (Face book, Twitter)
- ❖ Last Mile connectivity by state Govts under NCRMP for coastal states
- ❖ Last mile for interior states(?)

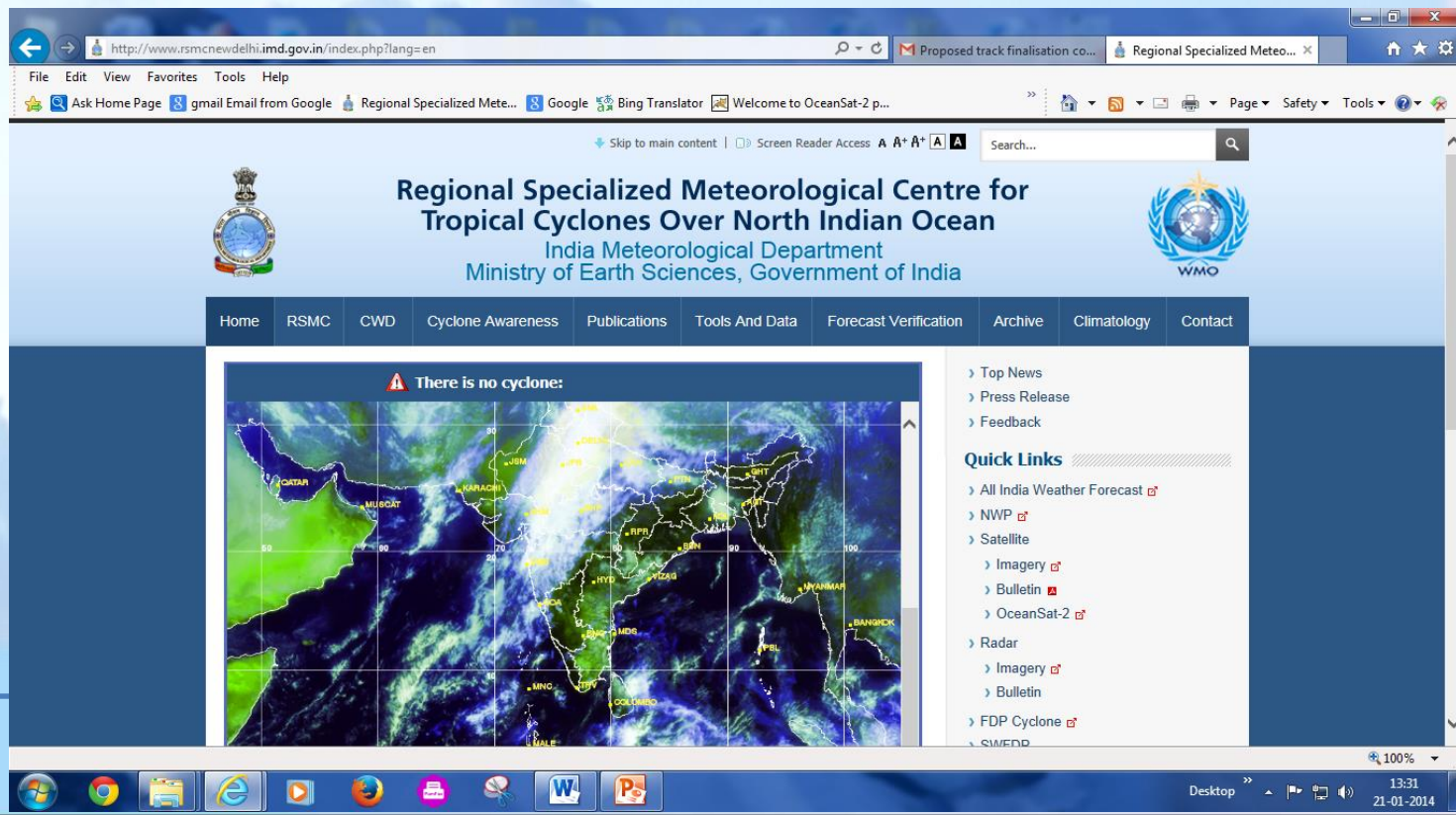
By 2024



- More use of IT to increase reach out to general public, media, disaster managers, specific users and decision making authorities.
- Display System at all mega cities and tourist places
- Mobile APP for cities and tourist places. Common Alert Protocol for all hazards

# Cyclone Bulletins for the Region

- Tropical weather outlook : Once a day based on 0300 UTC observation
- Special Tropical Weather Outlook : Twice a day based on 0300 and 1200 UTC observation during depression stage
- Tropical Cyclone Advisories : Every three hourly during cyclone period
- Tropical Cyclone Advisories for Aviation as per the guidelines of ICAO every six hourly during cyclone period
- Quadrant winds (Structure Forecast): every six hrly
- Storm Surge Guidance (every three hrs during cyclone stage)



Regional Specialized Meteorological Centre for  
Tropical Cyclones Over North Indian Ocean  
India Meteorological Department  
Ministry of Earth Sciences, Government of India

Home RSMC CWD Cyclone Awareness Publications Tools And Data Forecast Verification Archive Climatology Contact

⚠ There is no cyclone:

Quick Links

- > Top News
- > Press Release
- > Feedback
- > All India Weather Forecast
- > NWP
- > Satellite
  - > Imagery
  - > Bulletin
  - > OceanSat-2
- > Radar
  - > Imagery
  - > Bulletin
- > FDP Cyclone
- > SWFDP

13:31 21-01-2014

# WARNING OPERATION

- Scientific and technological advances are translated into effectiveness of TC warnings.
- The forecaster blends scientifically based conceptual models, meteorological datasets, technology and expertise towards the goal of providing clear, concise, useful and relevant warning information to special users and the public in a timely and effective manner.
- Although the process is subjective in nature, basic values and principles are prescribed in the operational guidelines (SOP) set out by IMD.
- Every warning decision is supported by scientific reasoning and would need to be able to withstand queries after the event.



# FOUR STAGE WARNING FOR CYCLONE

1. **Pre-cyclone watch** – Issued to Cabinet Secretary and Senior Officials indicating formation of a cyclonic disturbance – potential to intensify into a Tropical Cyclone and the coastal belt likely to be affected.
2. **Cyclone Alert**- Issued at least 48 hrs in advance indicating expected adverse weather conditions.
3. **Cyclone warning** – Issued at least 24 hrs in advance indicating latest position of Tropical Cyclone, intensity, time and point of landfall, storm surge height, type of damages expected and actions suggested.
4. **Post-Landfall Outlook**- Issued about 12 hrs before landfall & till cyclone force winds prevail; District Collectors of interior districts besides the coastal areas are also informed.
5. **\*\* Finally a 'De-Warning' message is issued when the Tropical Cyclone weakens into Depression stage**



# WARNING PRODUCTS PRESENTATION

- The TC warning system serves primarily as a trigger for action.
- The content of the bulletins should contain information on the TC useful to the targeted audience.
- Precautionary advisories are particularly useful to the underprivileged people for taking protective actions.
- The set of precautionary announcements and advisories based on pre-agreed courses of actions with the parties concerned are selected at the time to reflect prevailing circumstances to give maximum protection.
- Textual warning bulletins are broadcast over radio and TV. As long bulletins are difficult to be read out, it is important to curtail the length of bulletins without sacrificing safety.
- Visual impacts with graphics and animations are the strength of television.



# COMPONENTS OF CYCLONE WARNING BULLETIN

**A cyclone warning bulletin consists of following.**

- **Preamble**
- **Monitoring**
- **Location**
- **Intensity Prediction**
- **Movement**
- **Landfall**
- **Weather (Rainfall, wind and storm surge)**
- **Advice and Suggested action**



# FORMAT FOR CYCLONE WARNING BULLETIN FOR AIR/PRESS / PUBLIC

Cyclone Alert / Warning Bulletin No. \_\_\_\_\_ issued by \_\_\_\_\_ at \_\_\_\_\_  
Hrs. IST on \_\_\_\_\_ (Date) for repeated broadcast at hourly / half  
hourly intervals.

Cyclone Alert / Warning for \_\_\_\_\_ Districts. Cyclone centred at \_\_\_\_\_  
hrs. IST of \_\_\_\_\_ (date) about \_\_\_\_\_ kms. \_\_\_\_\_ of  
(direction) \_\_\_\_\_ (Place). Expected to intensify further and move in a  
\_\_\_\_\_ direction and cross \_\_\_\_\_ coast near / between  
\_\_\_\_\_ (Place) \_\_\_\_\_ (day/time).

Under its influence heavy to very heavy rain/extremely heavy rain likely  
cause floods in \_\_\_\_\_ districts commencing from \_\_\_\_\_  
(time/day). Gales speed reaching \_\_\_\_\_ kmph causing \_\_\_\_\_  
damage \_\_\_\_\_ in districts commencing from \_\_\_\_\_  
(Date/Time) Gale force winds reaching -- kmph likely extend into  
\_\_\_\_\_ Districts, causing damage \_\_\_\_\_ in \_\_\_\_\_  
districts. Tidal wave of \_\_\_\_\_ m Likely inundate low lying area of  
\_\_\_\_\_ Districts at the time of crossing coast.

Fishermen advised not to venture out. Public advised to cooperate with  
the State authorities in disaster management efforts.





# FORMAT FOR STATE/CENTRAL GOVT. OFFICIALS/VITAL INSTALLATIONS / REGISTERED USERS

**Cyclone Alert/ Cyclone Warning Bulletin No.**

**Date and Time of Issue:**

**(i) Information on cyclone :**

The cyclonic storm lay over.....Bay of Bengal/Arabian Sea Center.....kms.....(Direction) of ..... place.

**(ii) Forecast Further intensification:**

**Direction of Movement:**

**Expected landfall area:**

**Expected time of landfall:**

**(iii) Weather Warning**

**(a) Rainfall.....in.....Districts(Names)**

**(b) Gales reaching.....in.....Districts(Names)**

**(c) Gale force winds reaching 35 knots in ..... Districts**

**(d) Tidal waves ..... in coastal areas of ..... Districts (Names)**

**(e) Sea condition: (**

**f) Damage(As per IMD instruction).....Districts(Names)**

**(g) Likely impacts as per IMD Monograph on “Damage Potential of Tropical**

**(iv) Advice**

**(a) Fishermen not to venture into open sea.**

**(b) Evacuation of people from low lying areas to safer places/Cyclone Shelters.**

**(c) General public in the threat area advised to be indoors.**

**(d) Rail & road transport to be regulated.**



# PORT WARNINGS

**Port officers are warned about disturbed weather likely to affect their Ports by IMD.**

**On receipt of warnings, Port officials hoist appropriate visual signals so that they are visible from a distance.**

**Ports are warned 5 to 6 times a day during period of cyclonic storm.**

**Uniform system of storm warning signals introduced from 1st April 1898.**

**GENERAL SYSTEM : General Ports (eleven signals)**

**EXTENDED SYSTEM: Extended Ports (Six section signals + Eleven signals)**

**BRIEF SYSTEM : Brief ports (III, IV, VII, X, XI signals)**

**MINOR PORTS : Special messages. NO signals**



# Regional Support by IMD for Hydro-meteorological Hazards

❖ **IMD/MoES provides regional support under various initiatives as mentioned below**

- **RSMC, New Delhi**
- **SWFDP-Bay of Bengal**
- **Coastal inundation FDP (CIFDP): Bangladesh**
- **South Asia Flash Flood Guidance**
- **FDP-STORM**



# Tropical Cyclones : Role of India in North Indian Ocean

- Established in 1973

- Members

Bangladesh

India

*(RSMC, New-Delhi)*

Maldives

Myanmar

Oman

Pakistan

Sri Lanka

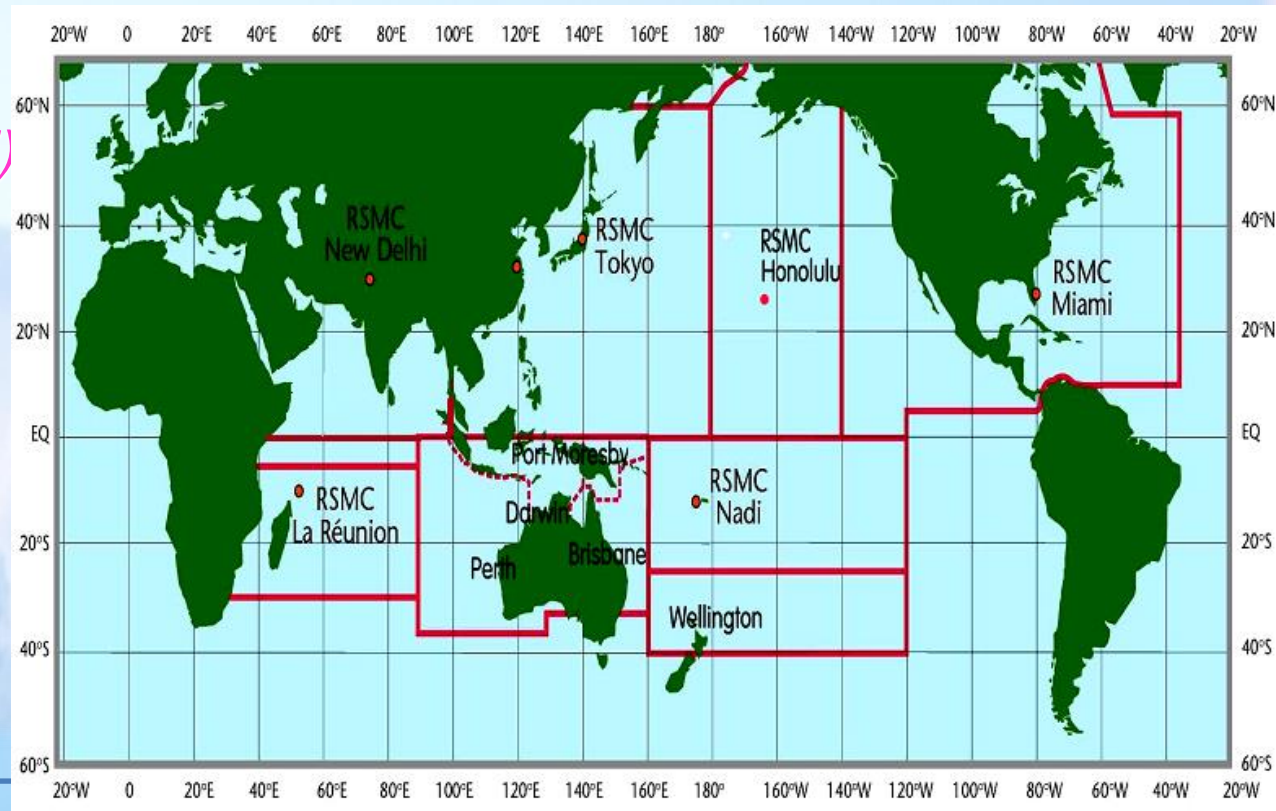
Thailand

Yemen

**IMD acts as Regional specialized Meteorological Centre**

**for**

**WMO/ESCAP Panel on Tropical Cyclones**



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**INDIA METEOROLOGICAL DEPARTMENT**



# **RESPONSIBILITIES OF RSMC – NEW DELHI**

- 1) Round the clock watch over the entire North Indian Ocean.**
- 2) Analysis and processing of global meteorological data for diagnostic and prediction purposes.**
- 3) Detection, tracking and prediction of cyclonic storms in the NIO**
- 4) Running of numerical models for tropical cyclone track, intensity and structure prediction.**
- 5) Issue of Weather outlook and advisory bulletins**
- 6. Implementation of the Regional Cyclone Operational Plan of WMO/ESCAP Panel.**
- 7) Collection, processing and archival of all data pertaining to cyclonic storms viz. wind, storm surge, pressure, rainfall, satellite information etc.**
- 8) Exchange of composite data and bulletins pertaining to cyclonic storms with Panel countries.**
- 9) Preparation of comprehensive reports on each cyclonic storm.**
- 10) Continued research on storm surge, track and intensity prediction techniques.**

# Severe Weather Forecasting Demonstration Project (SWFDP)

## *SWFDP Main Goals*

- ❖ **Improve Severe Weather Forecasting**
- ❖ **Improve lead-time of Warnings**
- ❖ **Improve interaction of NMHSs with users:  
media, disaster management, civil protection  
authorities, public**



# Phases of SWFDP

- ❖ Phase I - Overall Project Planning:
- ❖ Phase II: Regional Subproject Implementation Planning and Execution:
- ❖ Phase III: Regional Subproject Evaluation:
- ❖ Phase IV: Regional Subproject Long-term Sustainability and Future Developments:
- ❖ **Pilot Phase is in progress since 2 May 2016**



# *SWFDP Cascading Forecasting Process*

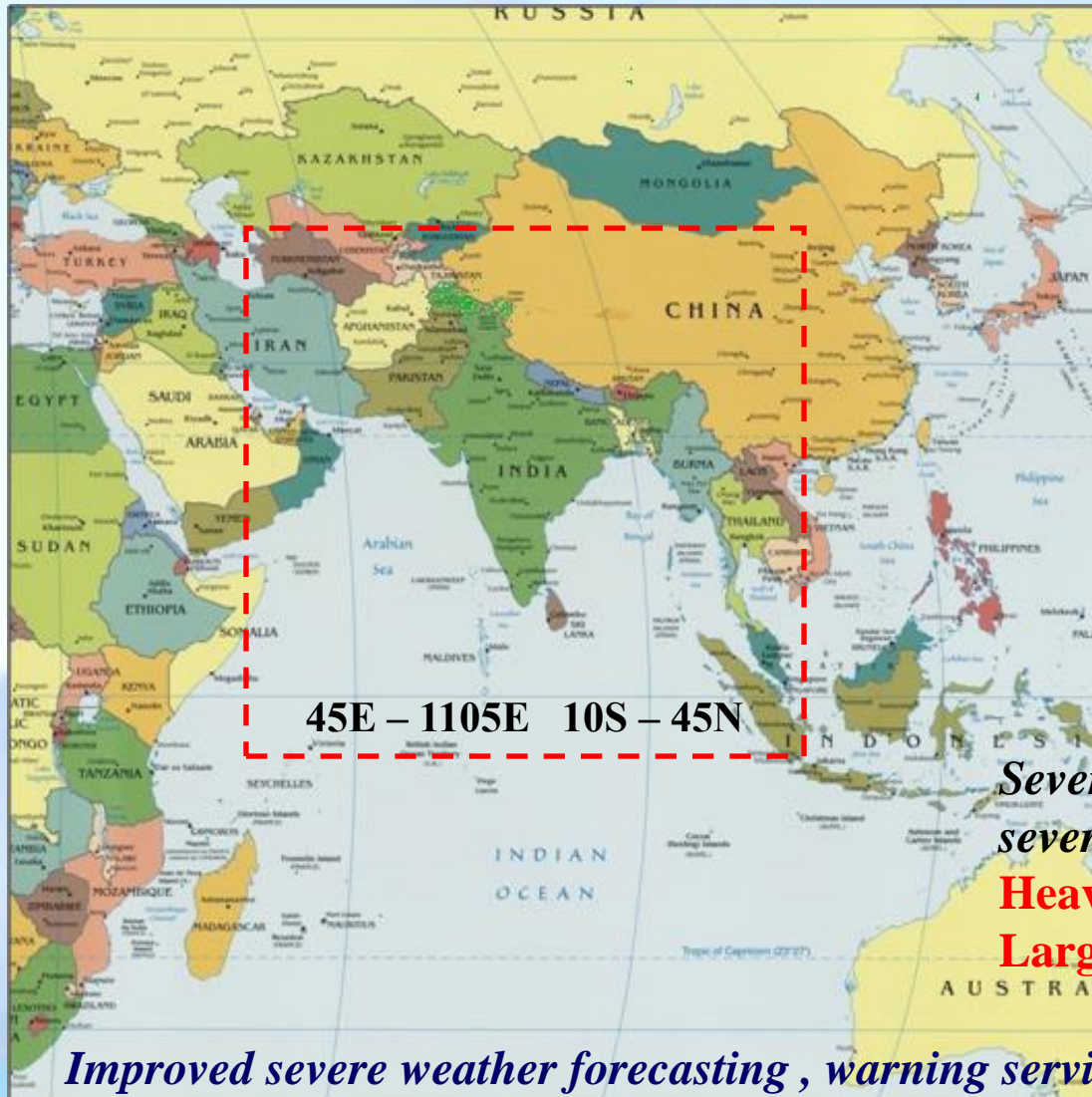
- ❖ Global NWP centres to provide available NWP/EPS and sat-based products, including in the form of probabilities, cut to the project window frame;
- ❖ Regional centres to interpret information received from global centres, prepare daily guidance products (out to day-5) for NMCs, run limited-area model to refine products, maintain RSMC Web site, liaise with the participating NMCs; **RSMC New Delhi acts as Regional centre**
- ❖ NMCs to issue alerts, advisories, severe weather warnings; to liaise with user communities, and to contribute feedback and evaluation of the project;
- ❖ NMCs have access to all products, and maintained responsibility and authority over national warnings and services.





# SWFDP – Bay of Bengal

Focus: Coastal communities and activities



- Bangladesh
- India
- Maldives
- Myanmar
- Sri Lanka
- Thailand
- Bhutan
- Nepal
- Afghanistan
- Pakistan

*Severe Weather from TCs,  
severe thunderstorms and monsoon:  
Heavy precipitation, Strong winds  
Large waves / swell, Storm Surge*

*Improved severe weather forecasting , warning services to disaster management (PWS)  
and with agriculture*



# SWFDP- Bay of Bengal - severe weather events

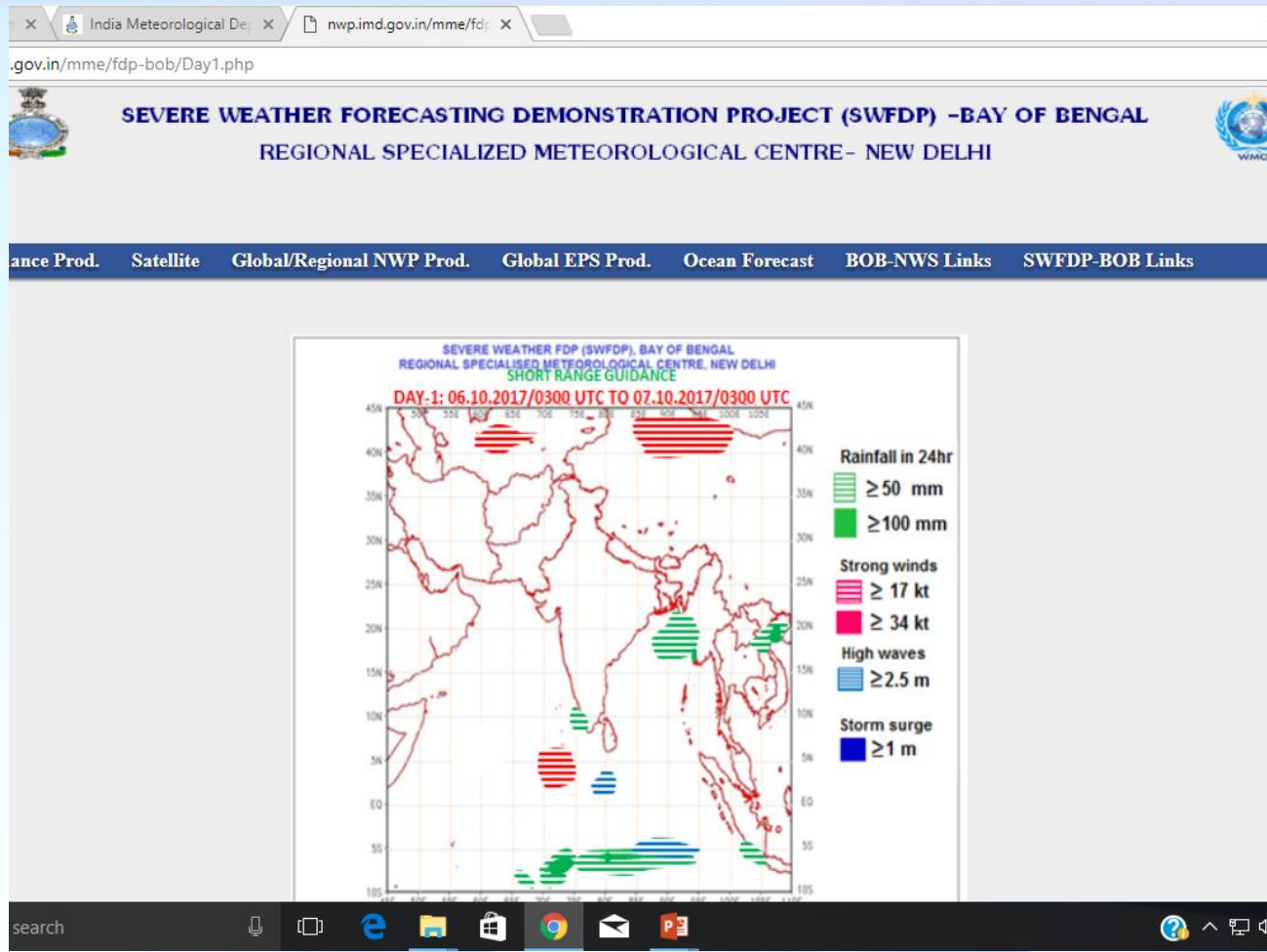
- a) Heavy rain (due to tropical cyclone, thunderstorm, monsoon, etc) /flooding;
- b) Strong winds (due to tropical cyclone, thunderstorm, monsoon, etc);
- c) Deficit of precipitation/dry spells;
- d) High waves / swells;
- e) Storm surge;
- f) Heat waves and cold waves / frost;
- g) Fog



# THRESHOLD VALUES USED IN RSMC DAILY SEVERE WEATHER FORECASTING GUIDANCE

HAZARD	THRESHOLD	COMMENTS
Heavy Rain	$\geq 50$ mm in 24 hours $\geq 100$ mm in 24 hours (the risk over 200mm/24 should be described in discussion in the Regional Guidance)	The operational country-thresholds may differ widely among participating countries of SWFDP-Bay of Bengal. NMHSs may translate the heavy rain into potential flooding in areas likely to be affected by heavy rain depending upon the soil condition, topography and drainage systems in respective areas
Strong winds	$\geq 17$ knots (over land and Sea) $\geq 34$ knots (over Sea)	Affecting oceanic and coastal areas especially. Gusts on land from severe convective systems are not predictable on this time scale effectively
High Waves	$\geq 2.5$ m	NMHSs may use the information contained in the RSMC Guidance Product to generate impact-based forecasts and risk-based warnings for use by the coastal communities, fisheries, disaster managers etc. at national levels.
Storm Surge	$\geq 1$ m	





## SWFDP-Southeast Asia

RSMC, New delhi is a Reional partner for SWFDP-SE Asia

Provides TC advisory support for the region



# Coastal inundation FDP (CIFDP): Bangladesh

- ❖ Coastal Inundation Forecasting Demonstration Project (CIFDP), Bangladesh
- ❖ RSMC, New Delhi to provide TC forecast for running coastal inundation model
- ❖ INCOIS in collaboration with IMD organized training for the forecasters from the WMO/ESCAP Panel region for storm surge, coastal inundation and Ocean waves with the support of UN-ESCAP in 2016
- ❖ Further training is planned in 2018 with support from WMO



# South Asia Flash Flood Guidance (SAsiaFFGS)

- ❖ **IMD, New Delhi is the SAsiaFFGS Regional Centre.**
- ❖ **The responsibilities include: (i) Collection of the required historical hydrometeorological data and spatial (GIS) data needed for system development from the participating countries; and (ii) assisting the HRC in coordinating country-specific reviews of various products created and data sets used during system development.**
- ❖ **Regional Centre will provide appropriate communications, infrastructure facilities and human resources to maintain and operate SAsiaFFGS computational hardware that is used to develop and disseminate regional and country graphical products and data for participating NMHSs in the South Asian region.**



# SAsiaFFGS

- ❖ Regional Centre will provide regional and national verification of SAsiaFFGS flash flood forecasts and warnings and will advise the participating NMHSs of any concerns with system products.
- ❖ Where appropriate, the Regional Centre will assist the participating NMHSs with the issuance of flash flood watches and warnings in a consistent format using the SAsiaFFGS as well as other information and tools that may be available. However, the participating NMHSs retain the responsibility for disseminating forecasts and warnings to users within their respective jurisdictions.
- ❖ Regional Centre, in collaboration with WMO, will organize and provide routine training on system operations, product interpretation, product verification, and other items as deemed appropriate to participating NMHSs forecasters. Regional Centre may provide on-the-job training to forecasters from participating NMHSs.



# SAsiaFFGS

- ❖ Workshop organised by IMD in 2016
- ❖ Implementation plan in progress





# SAARC STORM

- ❖ Under SAARC STORM (Severe Thunderstorm Observation and Modeling), IMD provided monitoring and forecast advisories to SAARC countries
- ❖ Currently it is discontinued
- ❖ However, capacity building through Training Programme is continuing by India through SAARC Disaster management centre at Ahmedabad



# BIMSTEC

- ❖ Under BIMSTEC, India provides capacity building support to Bay of Bengal countries by organising training programmes for hydro-meteorological hazards at NCMRWF, NOIDA, India



# THANKS



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**INDIA METEOROLOGICAL DEPARTMENT**

