

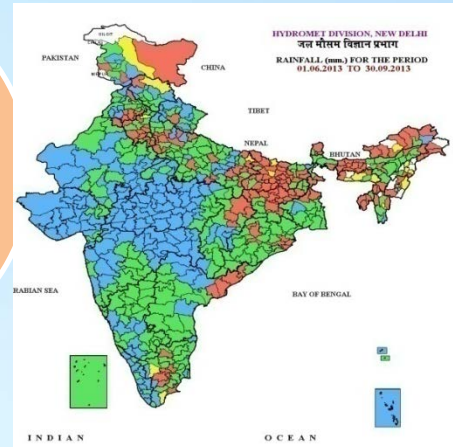


HYDROMET SERVICES FOR FLOOD FORECASTING

Dr. Surinder Kaur
IMD, India, New Delhi

भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT

**Real Time
Rainfall
monitoring**



Hydromet Services

Hyomet design



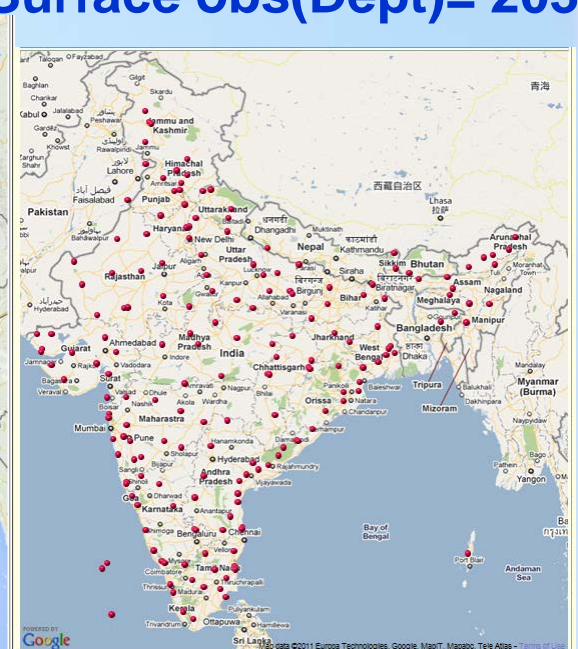
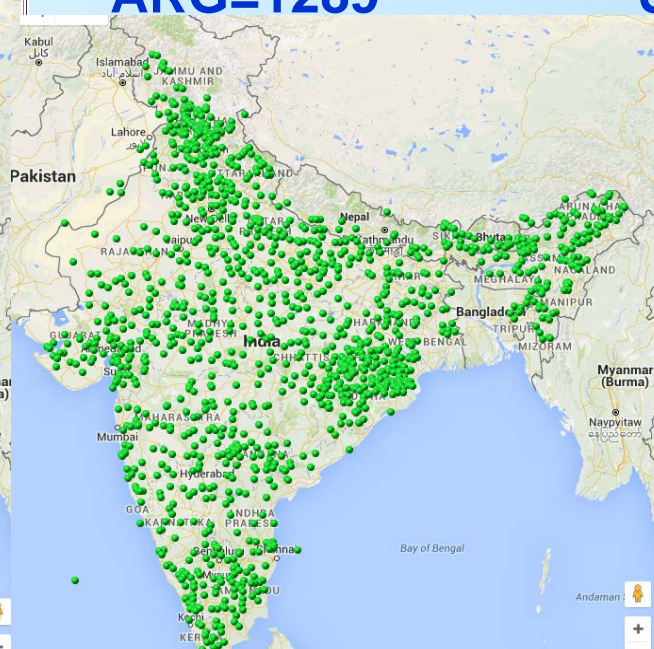
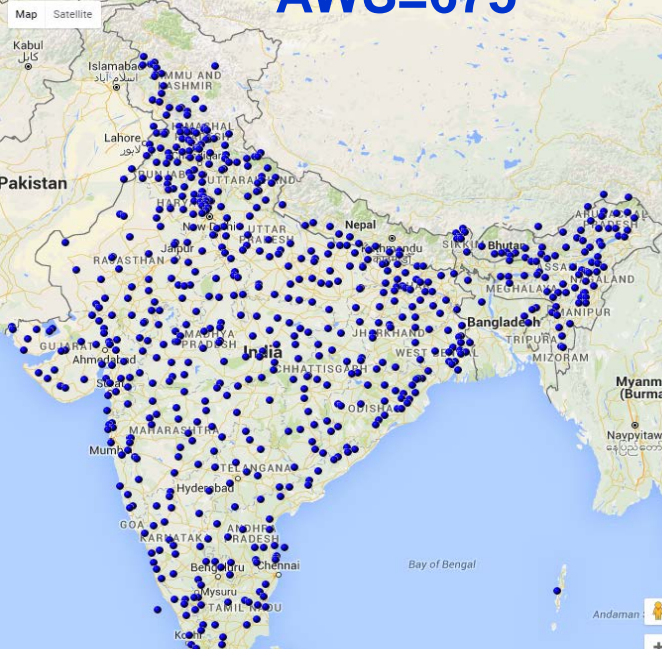
**Flood
meteorological
Services**



AWS=675

ARG=1289

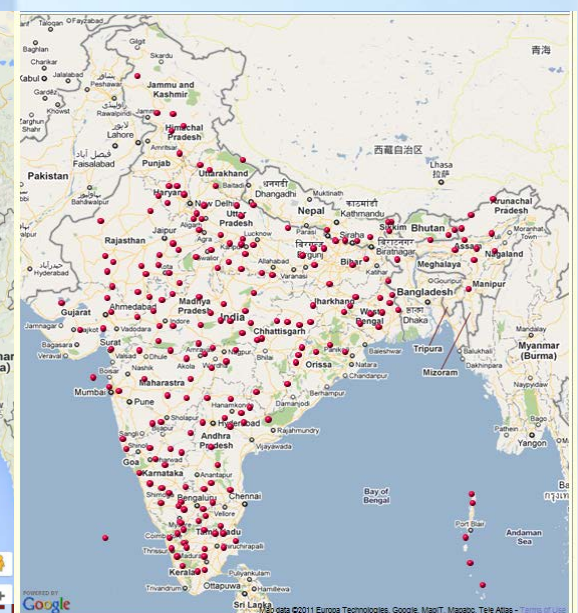
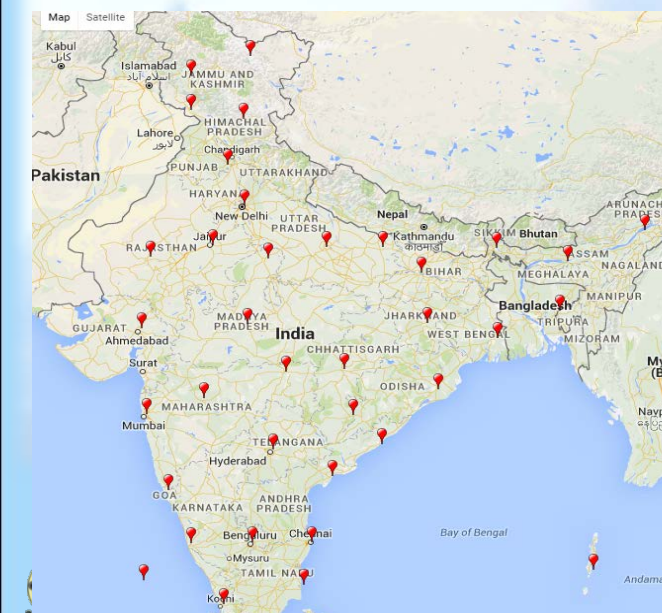
Surface obs(Dept)= 203



RS/RW =39

Pilot Balloon =62

Surface obs(Non Dept)= 247








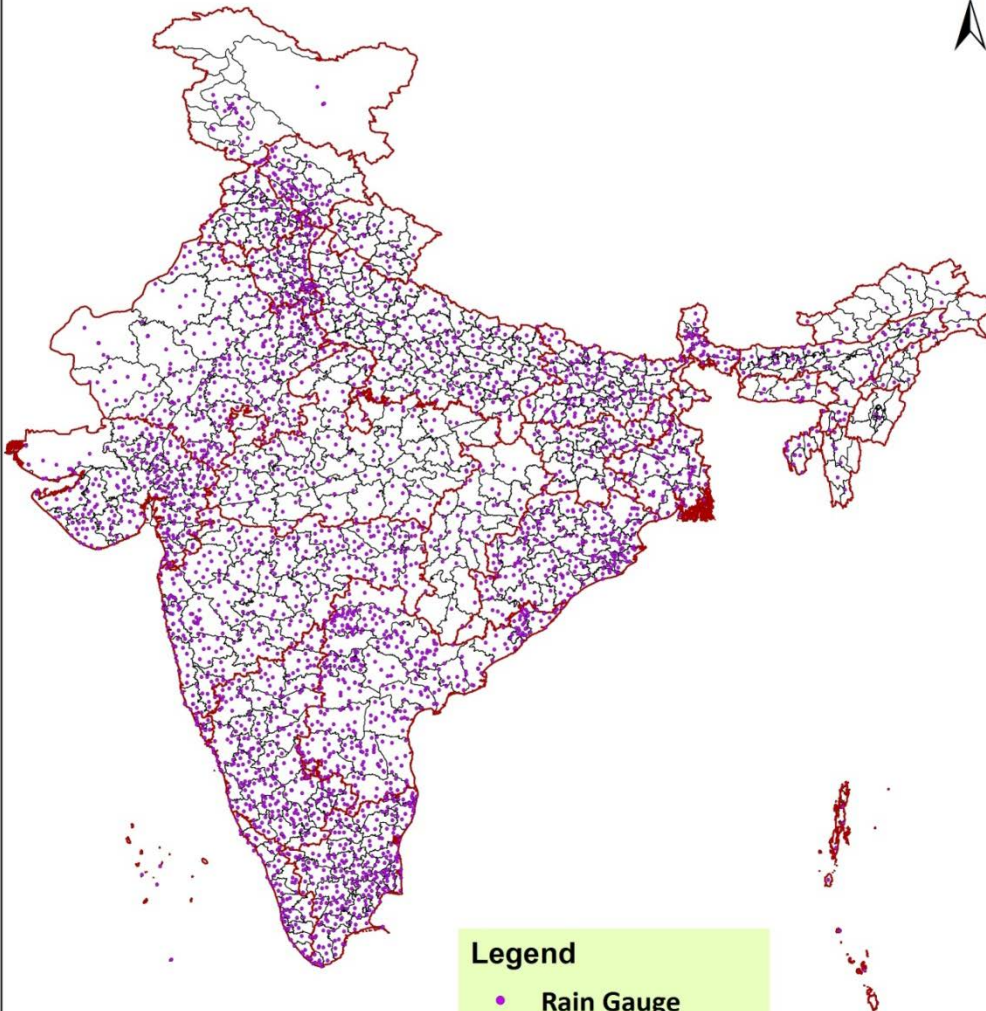
RAINGAUGE NETWORK

(REAL TIME)

NO. OF STATIONS ~ 3700

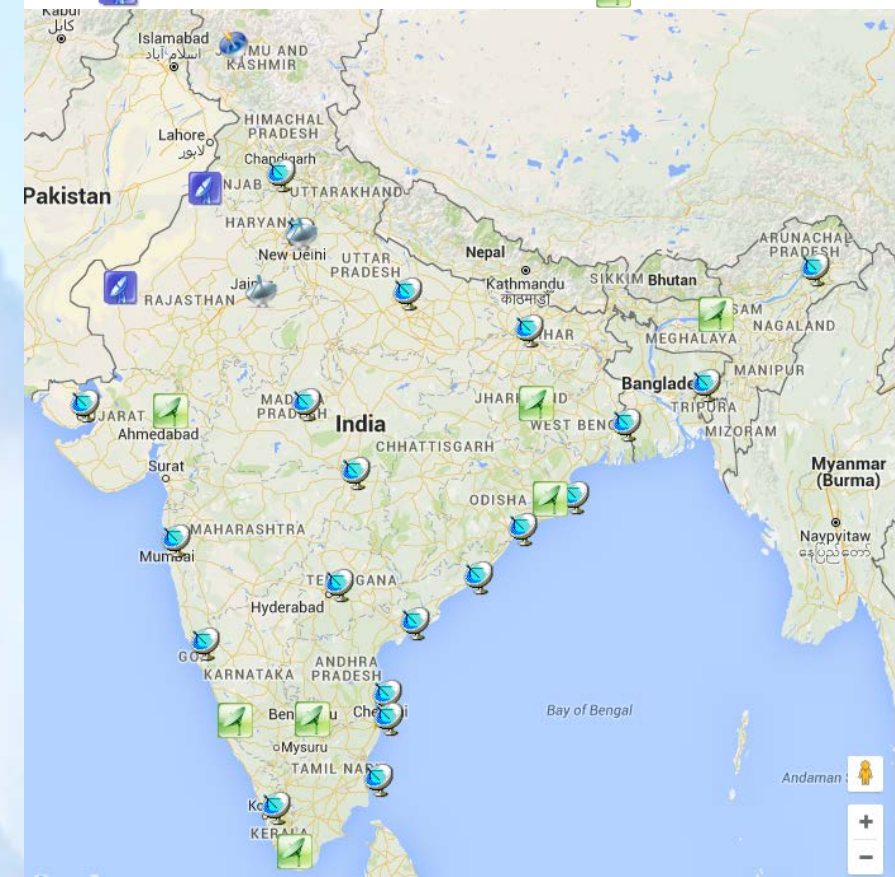
Radar Network (33)

-  : DOPPLER (S-Band) [21]
-  : DOPPLER (C-Band) [2]
-  : DOPPLER (X-Band) [1]
-  : NON-DOPPLER (S-Band) [2]
-  : NON-DOPPLER (X-Band) [7]



Legend

-  Rain Gauge
-  State
-  District Boundary



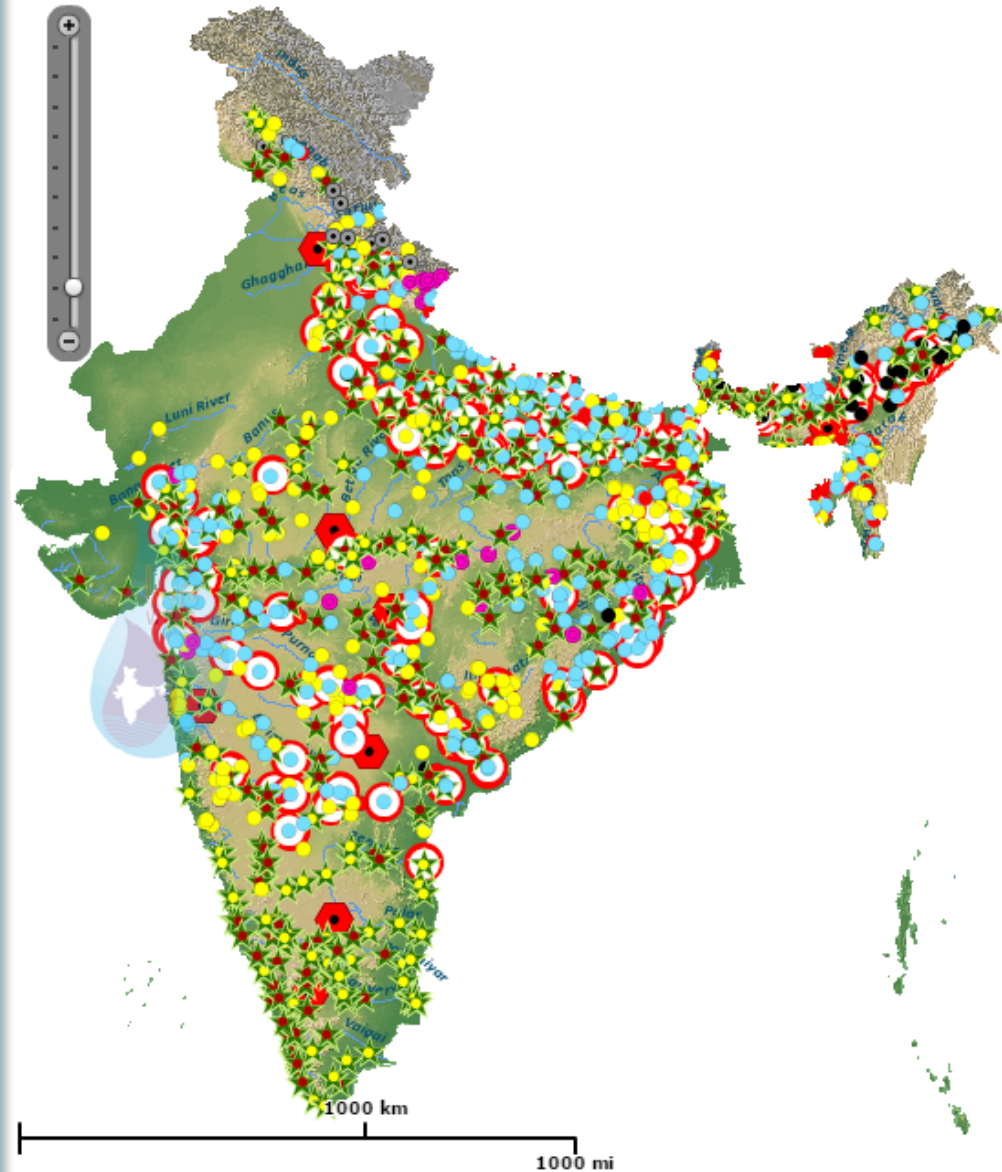
Hydrological Observations

Visualization Layers

India-WRIS Data Set

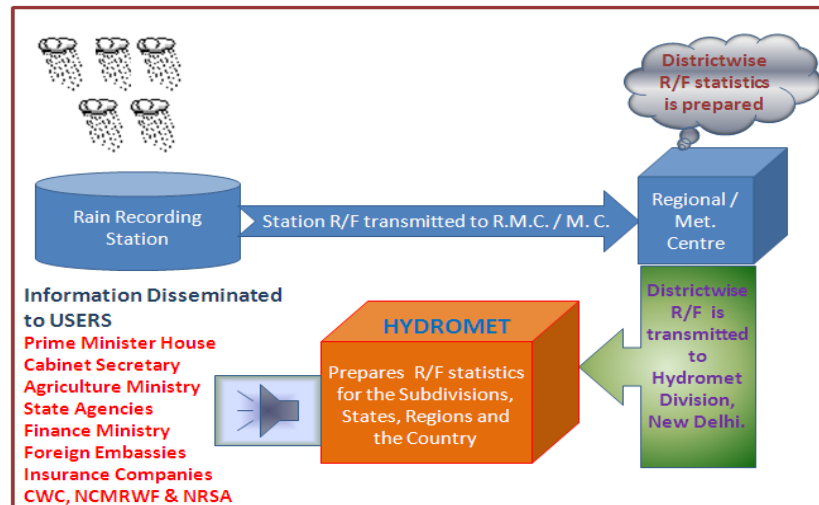
- Water Resource Projects
- Forest Cover
- LULC
- Water Level Layer
- Meteorological Station
- Hydrological Observation
 - CWC Hydro-Meteorological Stations
 - G
 - GD
 - GDQ
 - GDS
 - GDSQ
 - GQ
 - Q
 - Rainfall
 - Snow
 - Flood Forecasting Stations
- CWC Offices
- Water Tourism Layer

Search

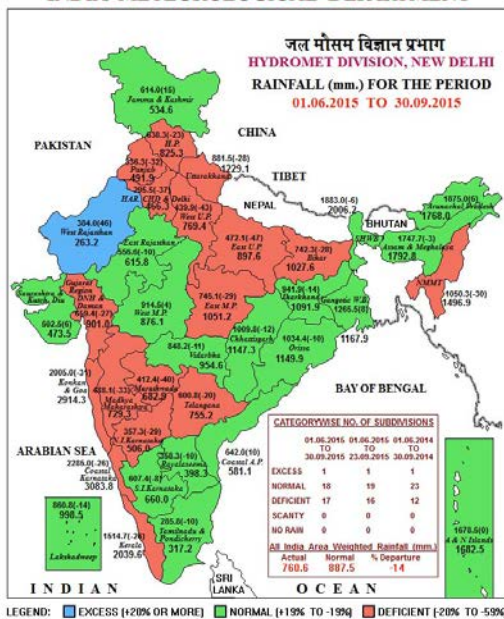


Rainfall Monitoring

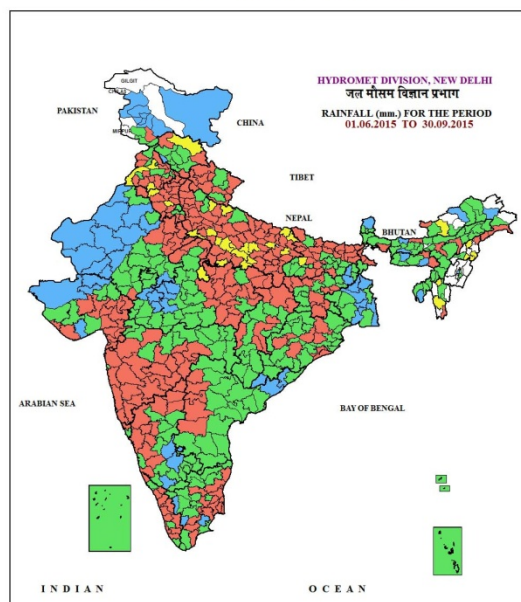
Preparation of rainfall summary every week (Daily in Monsoon season) for all Districts, Met sub Divisions, States, River basins, Regions and country as a whole in tabular and in pictorial form.



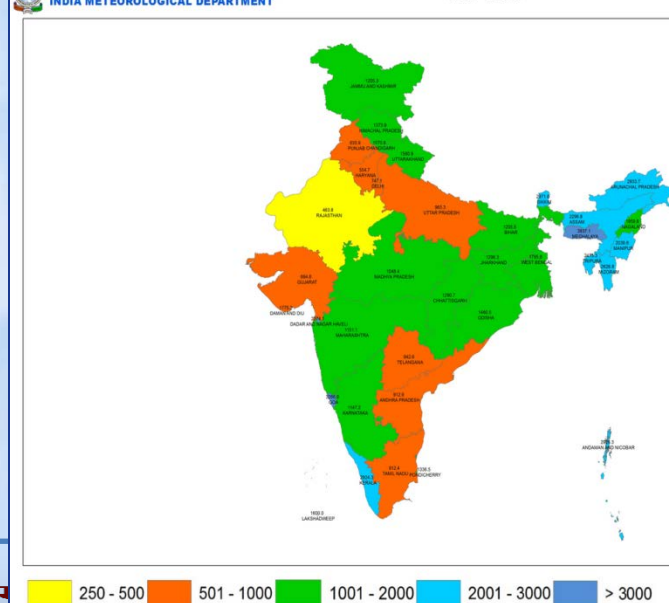
भारत मौसम विज्ञान विभाग INDIA METEOROLOGICAL DEPARTMENT



INDIA METEOROLOGICAL DEPARTMENT भारत मौसम विज्ञान विभाग DISTRICTWISE RAINFALL DISTRIBUTION



STATE RAINFALL NORMALS (mm) Annual (Jan-Dec) 1951 - 2000



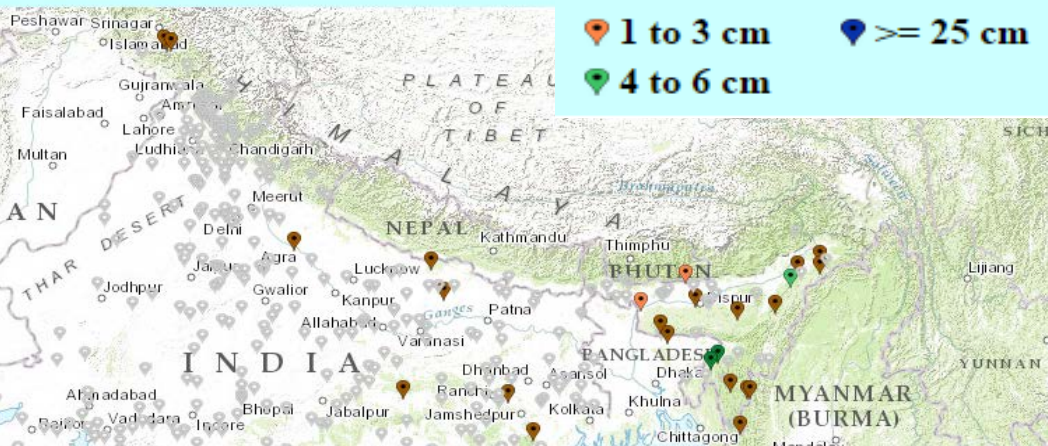
LEGEND: [Blue] EXCESS (+20% OR MORE) [Green] NORMAL (+15% TO -15%) [Red] DEFICIENT (-20% TO -50%)
[Yellow] SCANTY (+60% TO -95%) [White] NO RAIN (-100%) [Grey] NO DATA

NOTES:
(a) Rainfall figures are based on operational data.
(b) Small figures indicate actual rainfall (mm.), while bold figures indicate Normal rainfall (mm.)
Percentage Departures of Rainfall are shown in Brackets.

LEGEND: [Blue] EXCESS (+20% OR MORE) [Green] NORMAL (+15% TO -15%) [Red] DEFICIENT (-20% TO -50%)
[Yellow] SCANTY (+60% TO -95%) [White] NO RAIN (-100%) [Grey] NO DATA

Rainfall (cm)

- No Rain
- 0.1 to 0.9 cm
- 1 to 3 cm
- 4 to 6 cm
- 7 to 12 cm
- 13 to 24 cm
- ≥ 25 cm

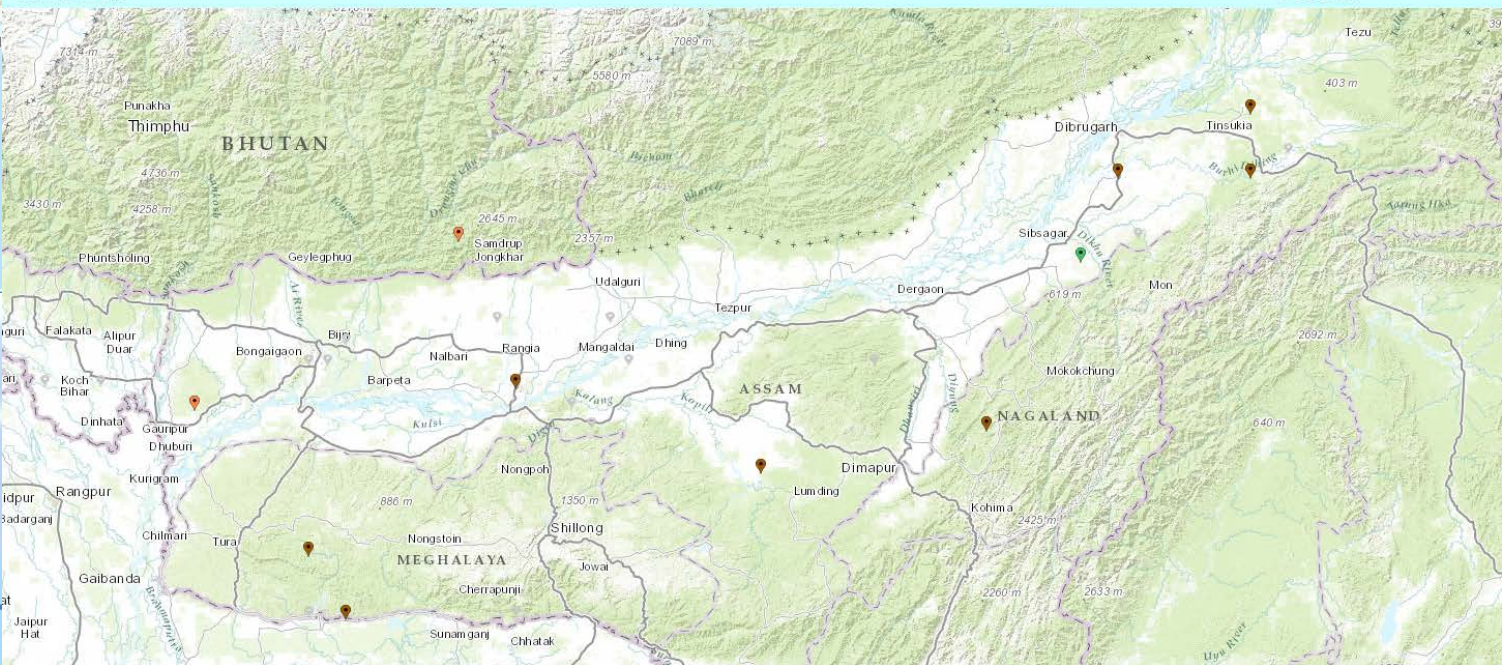


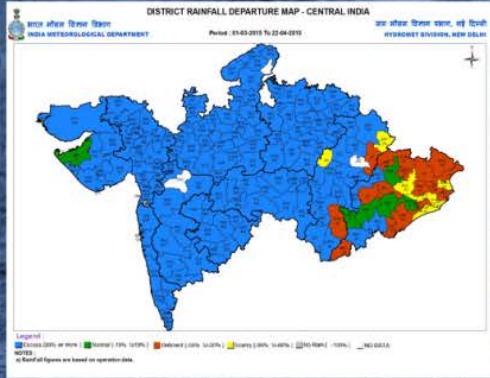
Real time Hourly cumulative (one day) AWS/ARG rainfall data on Pan India. Useful for real time rainfall information, Urban flooding etc.


Hydromet Division
India Meteorological Department
New Delhi-110 003

Customized Rainfall Information System (CRIS)
Cumulative Rainfall Real Time Station Data (ARG/AWS) Dated: 30-04-2015 and Time:03:00 UTC

- Rainfall (cm)
- No Rain
 - 0.1 to 0.9 cm
 - 1 to 3 cm
 - 4 to 6 cm
 - 7 to 12 cm
 - 13 to 24 cm
 - ≥ 25 cm





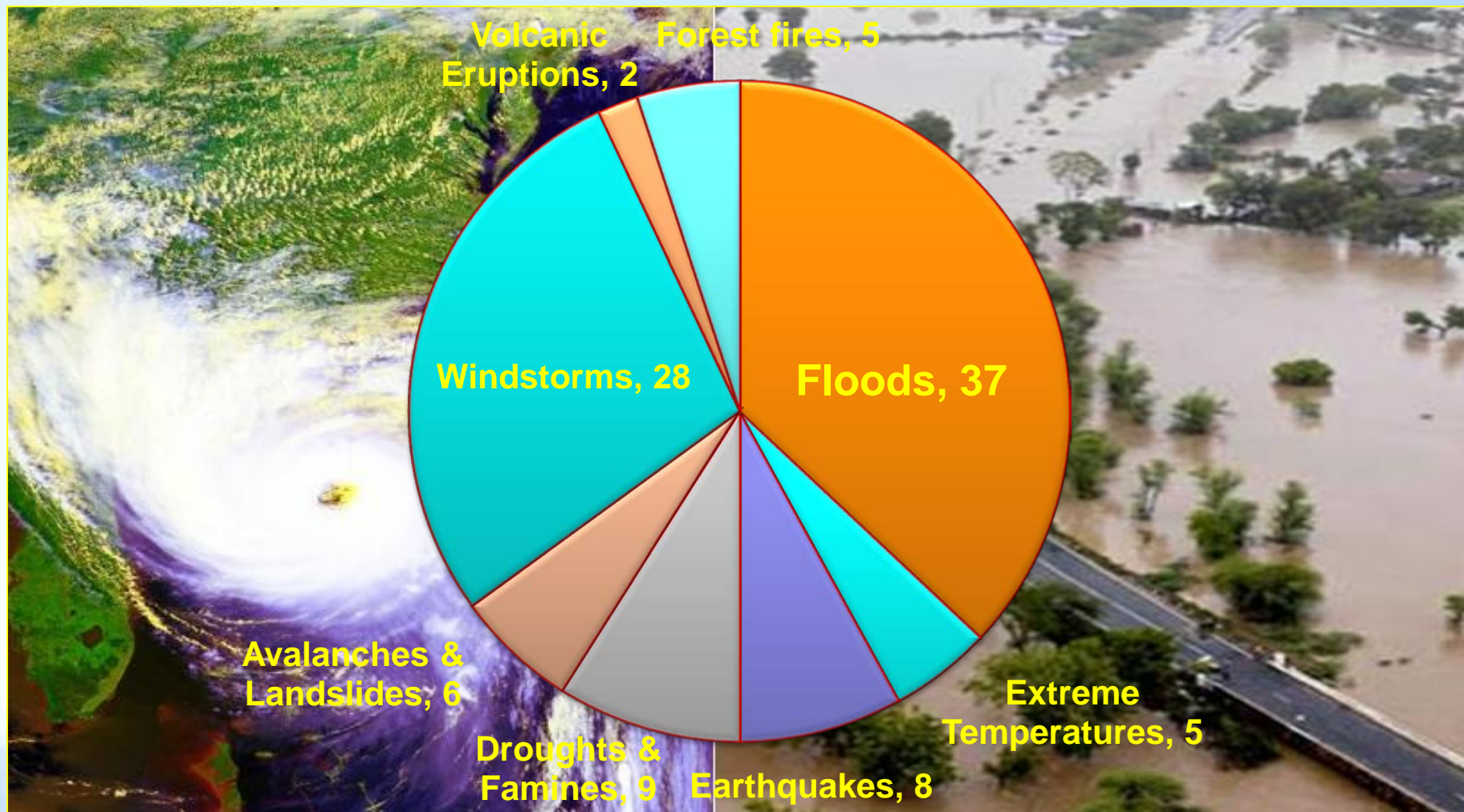
STATE	STATION NAME	RAINFALL (mm) (29.04.2015)
ANDHRA PRADESH	ADILABAD	0.0
ANDHRA PRADESH	AMBAJIPETA	0.0
ANDHRA PRADESH	ANANTHRAJAPETA	0.0
ANDHRA PRADESH	AROGYAVARAM	0.0
ANDHRA PRADESH	ASIFABAD	0.0
ANDHRA PRADESH	ASWARAOPET	0.0
ANDHRA PRADESH	BAFATLA	0.0
ANDHRA PRADESH	BHIMUNIPATTINAM	0.0
ANDHRA PRADESH	DARSI	0.0
ANDHRA PRADESH	GARIKAPADU	0.0
ANDHRA PRADESH	GOLKONDA	0.0
ANDHRA PRADESH	JANGAMESHWARAPURAM	0.0
ANDHRA PRADESH	JANGACON	0.0
ANDHRA PRADESH	KALMAKURTHY	0.0
ANDHRA PRADESH	KAMAREDDY	0.0

<http://www.imd.gov.in/> ➔ **Hydromet Services**

[http://hydro.imd.gov.in/hydrometweb/\(S\(o4sgl4f3rgdk3w55m1vwb445\)\)/landing.aspx](http://hydro.imd.gov.in/hydrometweb/(S(o4sgl4f3rgdk3w55m1vwb445))/landing.aspx)



Global Distribution of Natural Hazards(1993-2002)



Near 90 % of natural disasters were caused by Weather-, Climate and Water-related hazards.

Flood Prone areas in India

~ 40 million Ha (RBA,1980)

✓ Major Flood Prone States Assam, Bihar, West Bengal, UP, Odisha & Andhra Pradesh

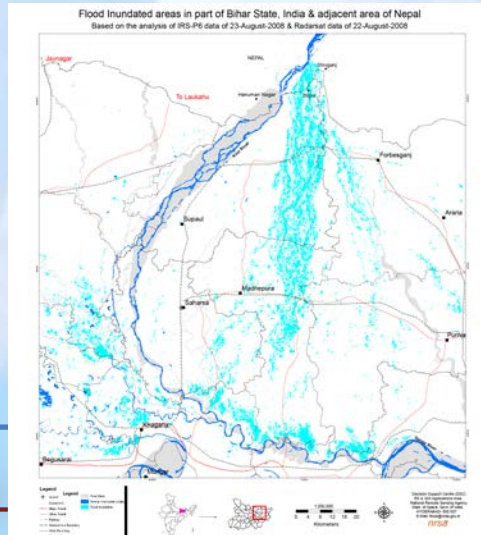
✓ Major Flood Prone Basins

Ganga, Brahmaputra & Mahanadi



FLOODS

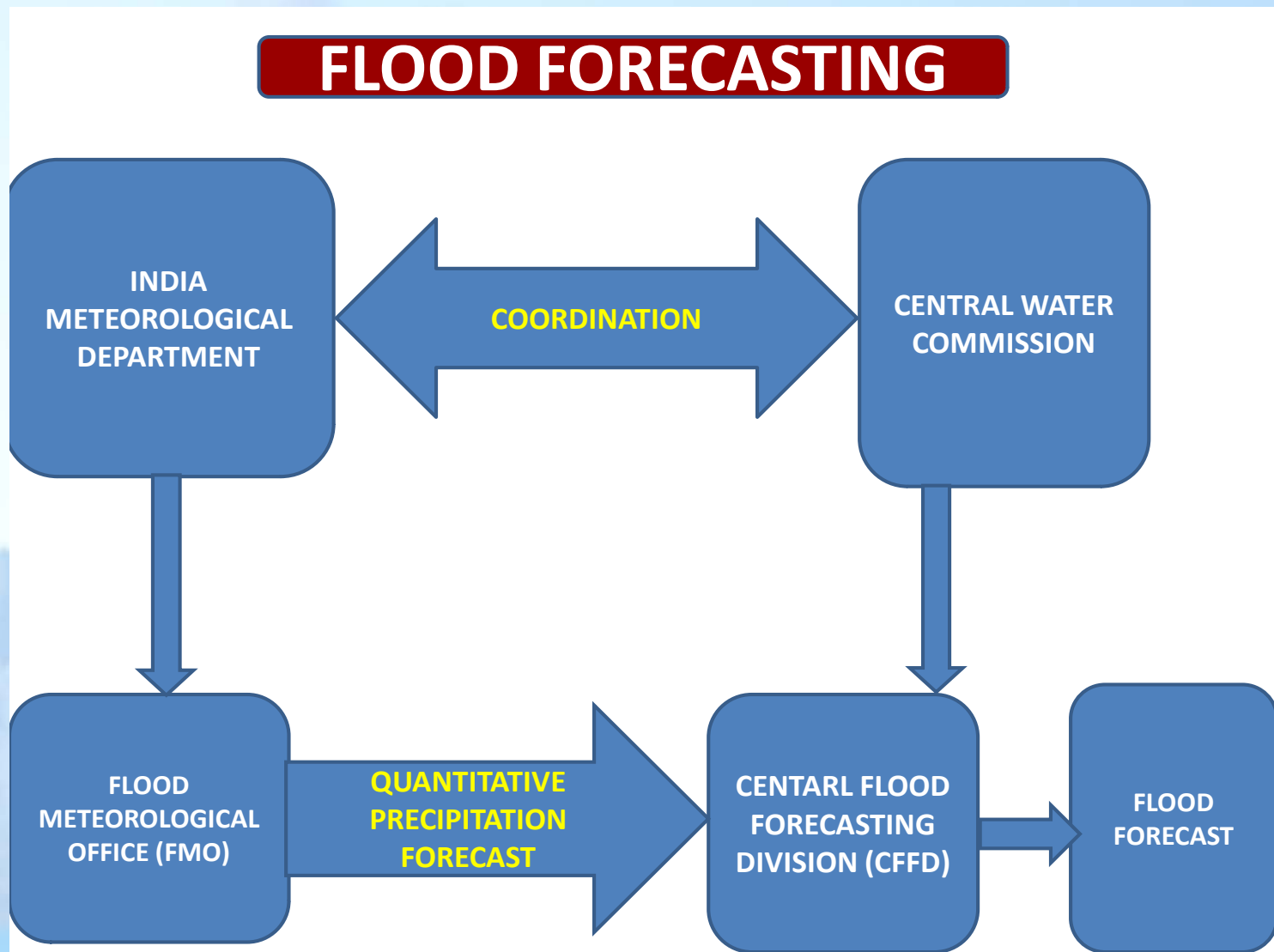
- ❖ HEAVY RAINS IN SHORT PERIOD
- ❖ LANDSLIDES AND AVALANCHES
- ❖ CHANGE IN RIVER MORPHOLOGY
- ❖ FAILURE OF DAMS AND OTHER HYDRAULIC STRUCTURES
- ❖ ENCROACHMENT IN FLOOD PLAIN AREAS
- ❖ CYCLONES, CLOUD BURSTS
- ❖ GLACIAL OUT BURST



रत
MET

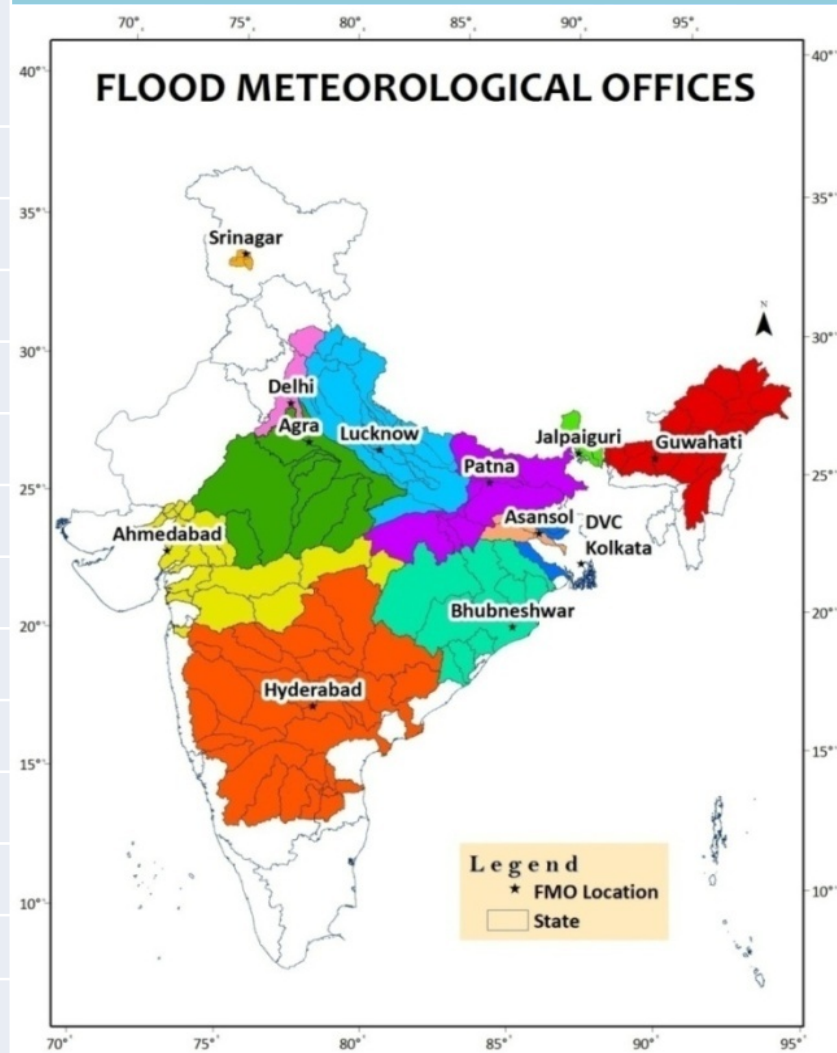
ग
TMENT

Flood Forecasting in India

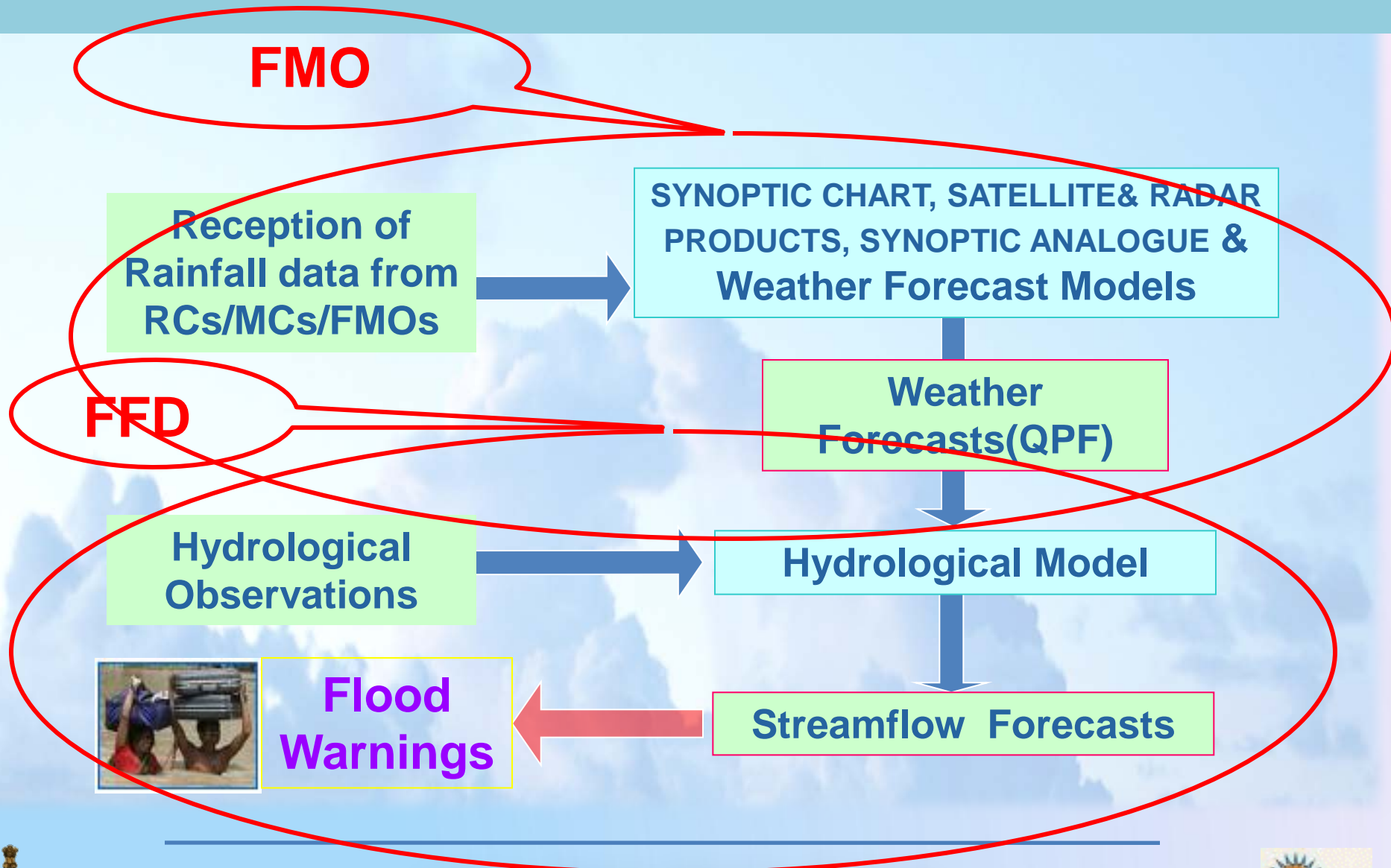


Flood Met Offices

S. No.	FMO/MC	Year Estb.	No of Sub-basin
1	Patna	1973	6
2	Asansol	1980	3
3	New Delhi	1974	3
4	Agra	1985	8
5	Lucknow	1974	14
6	Jalpaiguri	1974	3
7	Bhubaneswar	1974	8
8	Guwahati	1975	17
9	Ahmedabad	1974	19
10	Hyderabad	1977	30
11	Srinagar	2015	4
12	DVC	1949	3
	Total		118



Flood Forecasting: Basic Structure



INPUTS FOR FRAMING QPF

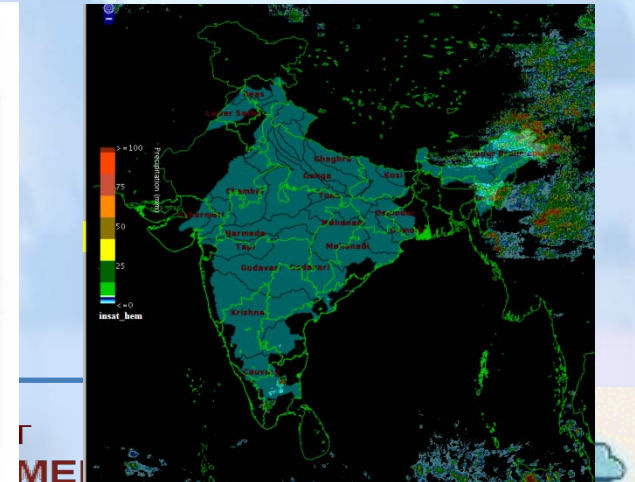
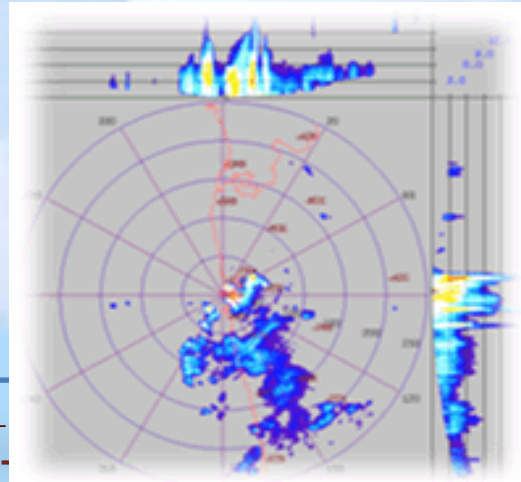
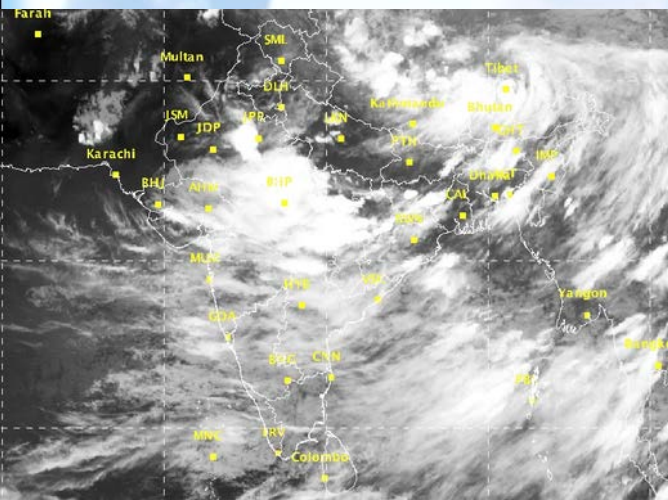
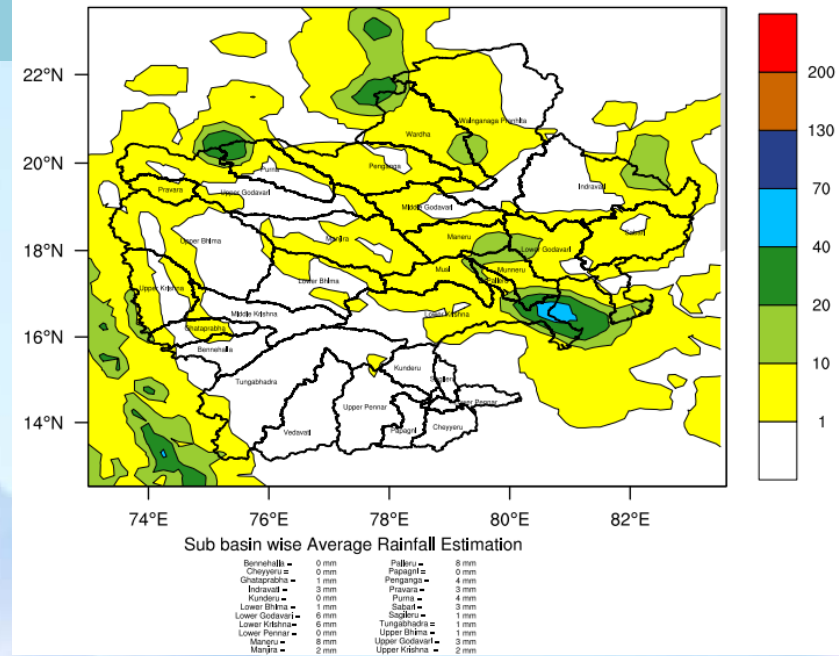
QPF are framed using the following;

- i. Synoptic charts
- ii. Synoptic analogue
- iii. Satellite products
- iv. Radar products
- v. NWP model analysis and forecast
- vi. sub catchment wise rainfall forecast of NWP models-GFS, WRF and MME

FLOOD MET OFFICE HYDERABAD

IMD GFS Rainfall(mm) Forecast (24hr)

Day 1 FCST valid for: 01.07.2015 TILL 08:30 IST



NWP MODELS

- **GFS (T574/L64):** 7 days F/C, 00 & 12 UTC, ~ 22 Km resolution
- **WRF (ARW):** 3 days F/C, 3DVAR assimilation, 00 & 12 UTC at 27, 9 and 3 Km resolution.
- Location specific Forecast for 100 cities.
- **MME:** 3 days F/C, 0.25 x 0.25, NWP models (i) IMD GFS T574, (ii) ECMWF T799, (iii) JMA T899, (iv) UKMO and (v) NCEP GFS



ACTIVITIES OF FLOOD MET OFFICES

DURING FLOOD SEASON, FMOs send QPF Bulletin (9.30AM) and HYDROMET BULLETINS (12.30PM) to CFFD, includes following :

- ❖ **QUANTITATIVE PRECIPITATION FORECAST (QPF) FOR THE NEXT THREE DAYS (CATEGORIES: 0, 1-10, 11-25, 26-50, 51-100 & >100mm) AND OUTLOOK FOR FURTHER FOUR DAYS FOR THE CONCERNED CATCHMENTS/SUB-CATCHMENTS**
- ❖ **PREVAILING SYNOPTIC SITUATIONS**
- ❖ **SUB BASIN WISE AREAL RAINFALL OCCURRED DURING PAST 24-HOURS RECORDED AT 03Z.**
- ❖ **STATIONWISE SIGNIFICANT RAINFALL DURING THE PAST 24-HOURS AT 03Z.**
- ❖ **HEAVY RAINFALL WARNING FOR THE NEXT 3 DAYS**

QPF SHOULD BE ISSUED DURING THE PERIOD OF FLOOD SEASON

- ❑ **GENERALLY IT EXTENDS 15th MAY TO 31st OCTOBER.**
- ❑ **PENNAR- IT IS UPTO 31ST DECEMBER**

If heavy rainfall is expected during non-flood season or in the event of Cyclone, FMO issues QPF/HM Bulletins.



भारत सरकार भारत
मौसम विज्ञान विभाग
(पृथ्वी विज्ञान मंत्रालय)
बाढ़ मौसम कार्यालय, आसानसोल
आसानसोल - 713302
फोन नं. 0341-2272728/29
फैक्स नं. 0341-2272728



GOVERNMENT OF INDIA
INDIA METEOROLOGICAL DEPARTMENT
(Ministry of Earth Sciences)
Flood Meteorological Office,
Sector - H, Kalyanpur,
Satellite Townships,
P.O.: Dakshin Dhadka Dist. Bardhaman,
Bansal - 713302
Phone and Fax: 0341-2272728
e mail: fmoasl@rediffmail.com
fmoasl@gmail.com

RefNo: FM/HM Bulletin/63

Dated: 02/08/2015
Time of Issue: 1230 hrs.

Hydromet Bulletin

SYNOPTIC SITUATION: The depression over Jharkhand and adjoining Gangetic West Bengal has moved west-southwestwards and lay centre over Gangetic West Bengal & adjoining Jharkhand near Lat.23.°N and Long. 86.0°E, about 70 km east northeast of Ranchi (Jharkhand) at 0830 hours IST of today. It would move nearly westwards and weaken into a well marked low pressure area gradually. The axis of monsoon trough passes through centre of low pressure area over central Pakistan & adjoining northwest Rajasthan & Punjab, Firozpur, Karnal, Lucknow, centre of depression over Gangetic West Bengal & adjoining Jharkhand, Krishnanagar and thence southeastwards to north east Bay of Bengal and extends upto 3.6 km above mean sea level.

II. FORECAST

S. No.	BASIN NAME	QPF (mm)			INTENSITY & SPATIAL DISTRIBUTION		
		Day-1	Day-2	Day-3	Day-1	Day-2	Day-3
1	MAYURAKSHI	26-50	11-25	11-25	RH/WS	M/FW	M/F
2	AJOY	26-50	11-25	11-25	RH/WS	M/FW	M/F
3	KANSABATI	26-50	11-25	11-25	RH/WS	M/FW	M/F

III. HEAVY RAINFALL WARNING

NAME OF BASIN	Day-1	Day-2	Day-3
MAYURAKSHI	Heavy to very heavy rain may occur at isolated places	NIL	NIL
AJOY	Heavy to very heavy rain may occur at isolated places	NIL	NIL
KANSABATI	Heavy to very heavy rain may occur at isolated places	NIL	NIL

IV. OUTLOOK FOR SUBSEQUENT FOUR DAYS

NAME OF BASIN	OUTLOOK			
	Day-4	Day-5	Day-6	Day-7
MAYURAKSHI	Decrease in rainfall	No large change	No large change	No large change
AJOY	Decrease in rainfall	No large change	No large change	No large change
KANSABATI	Decrease in rainfall	No large change	No large change	No large change

V. STATIONS RECORDED SIG. RAINFALL (≥5cm) RECORDED AT 0830 HRS IST OF TODAY:

MAYURAKSHI	Rampurhat 6.8 cm, Muraroi 6.8 cm, Narayanpur 9.2 cm, Khusray, 120 cm, Mahara 7.5 cm, Messanjore-6.1 cm, Ramgarh-6.6 cm, Jormundi-13.0 cm, Kathikund 6.3 cm.
AJOY	Mangalkote-10.6 cm, Mankar-8.0 cm, Gheranara 5.6 cm, Sikaria 6.5 cm, Jagdishpur 6.6 cm, Madhupur 8.5, Deoghar 12.8
KANSABATI	Purhansha-5.1 cm, D.P.Ghat 5.9 cm

VI. REALISED BASIN AVERAGE RAINFALL AT 0830 HRS IST OF TODAY:

S.No.	BASINS NAME	REALISED AVERAGE RAINFALL (mm)
1	MAYURAKSHI	48.4
2	AJOY	53.4
3	KANSABATI	37.1

(P.N. HANSDA)
AM-I
FLOOD MET.OFFICE
ASANSOL

LEGEND:

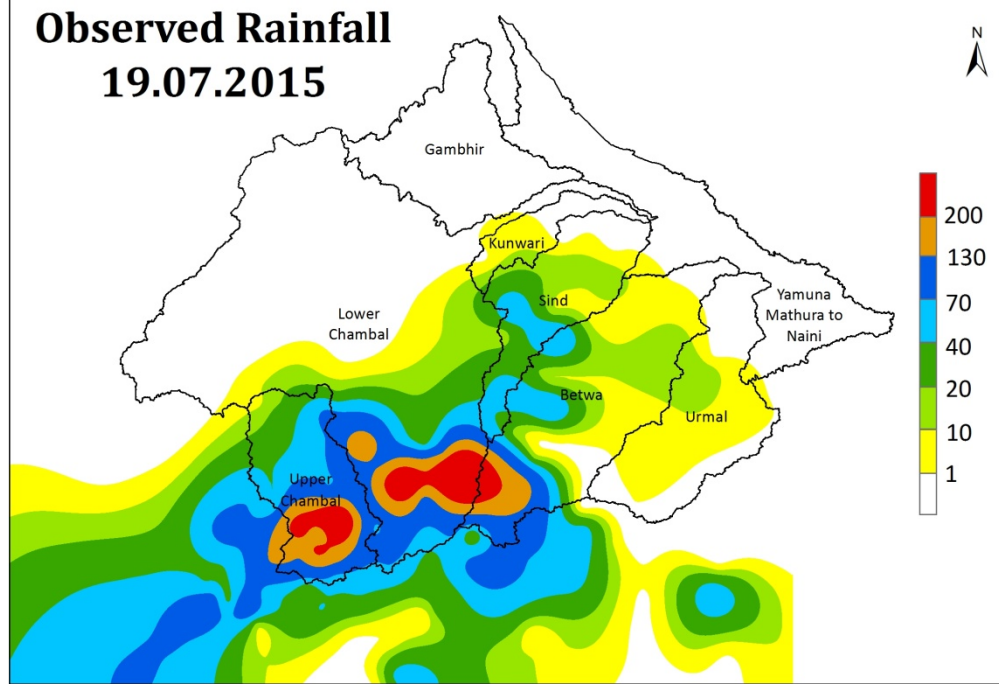
Sub-Basin Name Codes (e.g. B1.....)

W Dry: Mainly Dry
L Light rain (< 1 cm.)
M Moderate rain (1 to 3 cm.)
RH Rather heavy rain (4 to 6 cm.)
H Heavy rain (7 to 12 cm.)
VH Very Heavy rain (13 to 24 cm.)
EH Extremely Heavy rain (≥ 25 cm.)

ISOL: 25% or less number of stations recorded rainfall 2.5mm.
SCT: 26%-50% number of stations recorded rainfall 2.5mm.
FW: 51%-75% number of stations recorded rainfall 2.5mm.
VS: 76%-100% number of stations recorded rainfall 2.5mm.

QPF in Areas (mm): 0, 1-10, 11-25, 26-50, 51-100, >100.
Probability of occurrence: C=0 (0%), C=25% (25-50%),
Would Occur (51-75%), Will Occur (75-100%)

Observed Rainfall 19.07.2015

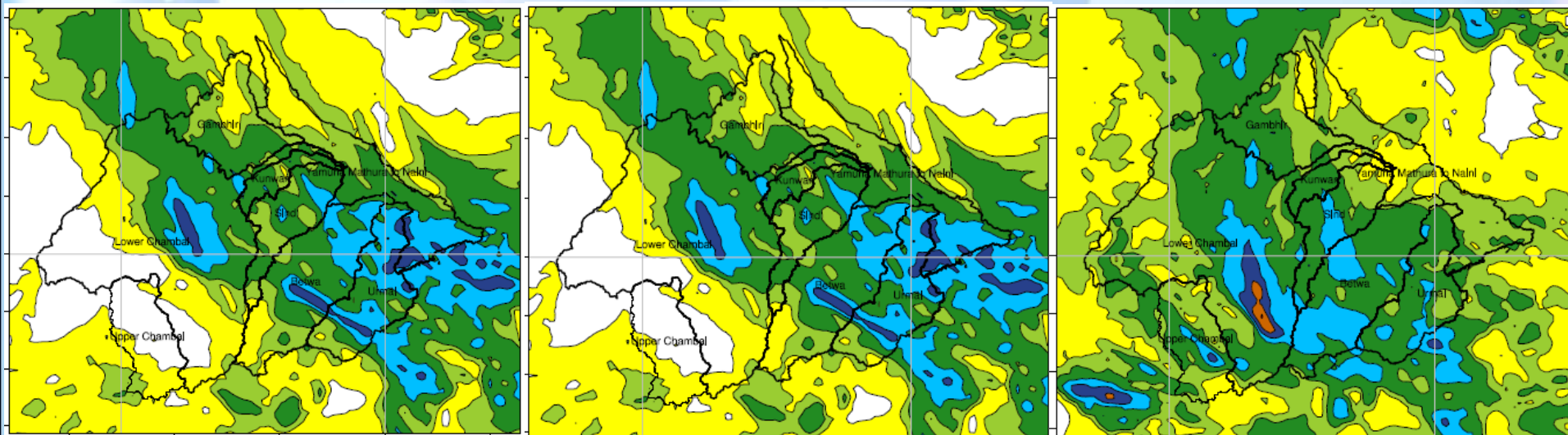


Heavy Rainfall – Ujjain 19th July, 2015 Riven Basin: Chambal Comparison of Observed Rainfall with WRF 00 UTC Products

DAY 3 – July 16

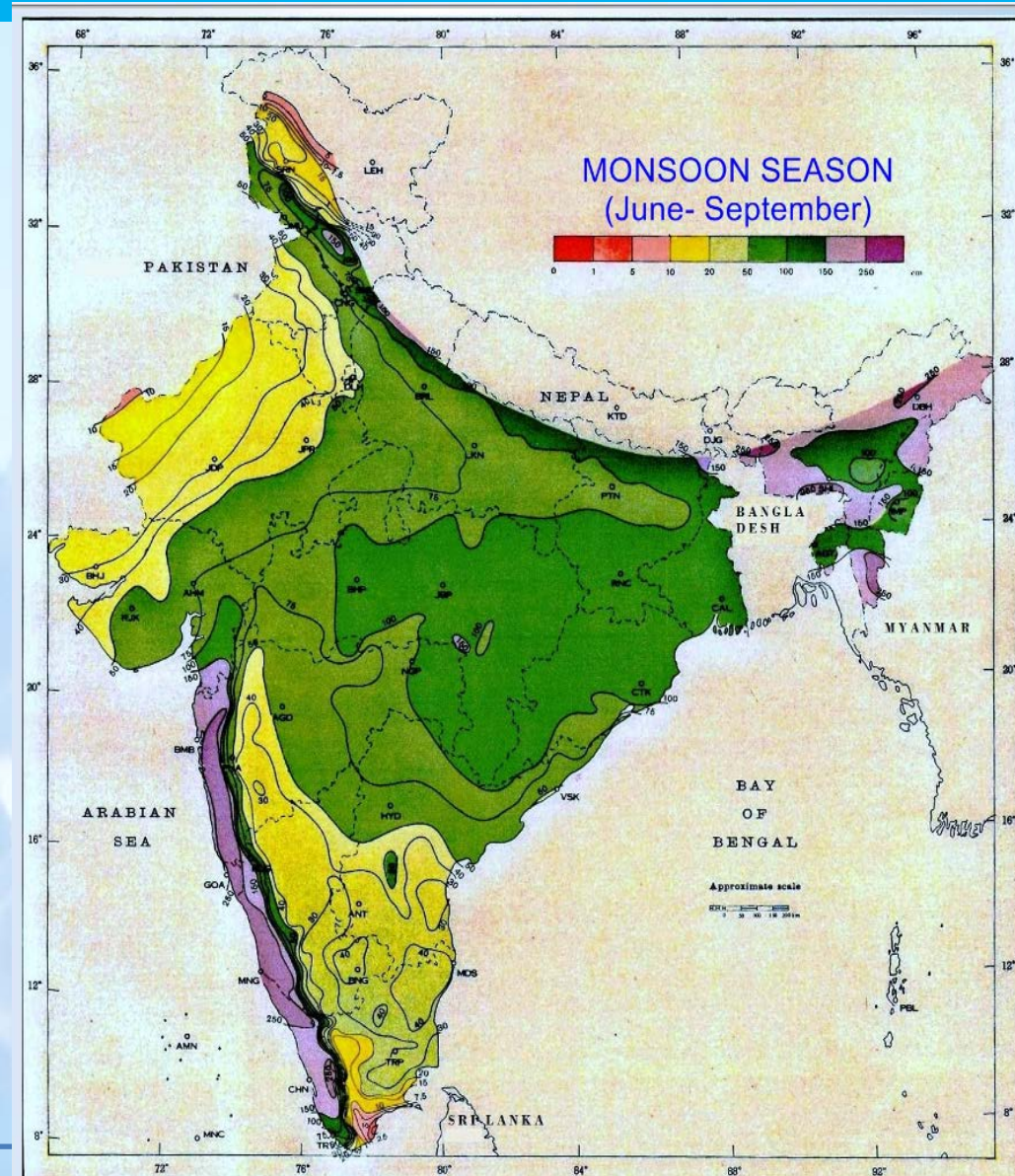
DAY 2 – July 17

DAY 1 – July 18



RAINFALL IN INDIA

- ❖ RAINFALL : 117 cms (ANNUAL),
89 CMS (SW Monsoon)
- ❖ HIGHLY VARIABLE IN SPACE
15% AREA OF INDIA > 150 CMS
64 % AREA OF INDIA 75 – 150 CMS
15% AREA OF INDIA 40 – 75 CMS
6% AREA OF INDIA < 40CMS
- ❖ HIGHLY VARIABLE IN TIME
76 % OF ANNUAL RAINFALL OCCURES DURING 4 MONTHS.
- ❖ HENCE STORAGE STRUCTURES ARE NEEDED TO MANAGE BALANCE 8 MONTHS.



REQUIREMENT OF DAM SAFETY

- ❖ THERE ARE MORE THAN **5000 DAMS** TO MEET THE REQUIREMENT.
- ❖ BECAUSE OF THE HUGE INVESTMENT **SAFETY** OF THESE STRUCTURES NEED TO BE INSURED.
- ❖ THE MAIN CAUSE OF DAM FAILURES PARTICULARLY EARTHEN DAMS IS **OVER TOPPLING BY EXCESS INFLOW**.
- ❖ HENCE **SPILLWAY** SHOULD HAVE **ADEQUATE OUT FLOW CAPACITY**. Otherwise Dam will get washed away.



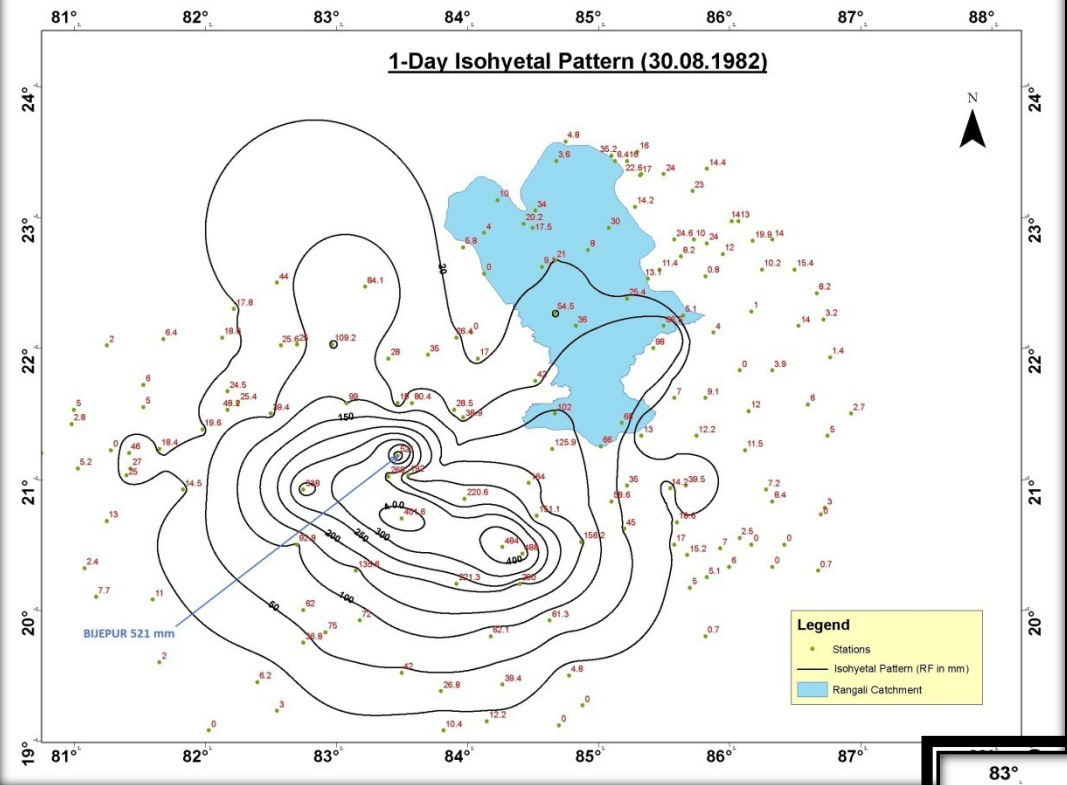
DESIGN STORM STUDIES

Design Storm studies comprising of

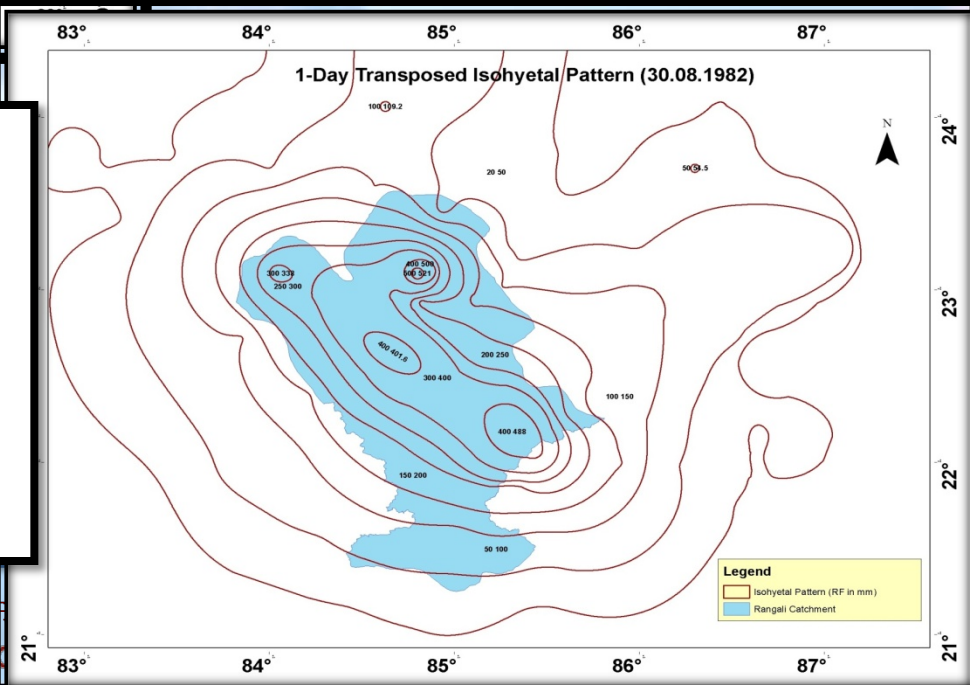
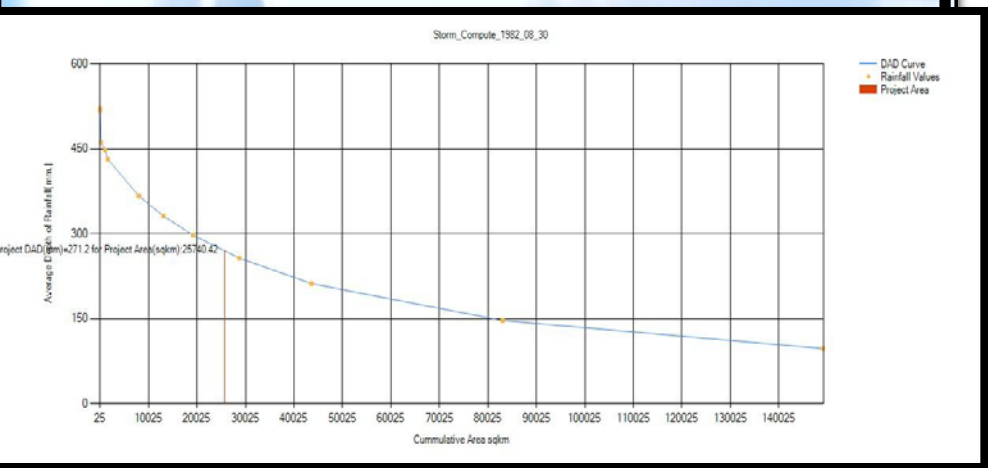
..... “ **Estimation of Probable Maximum Precipitation (PMP)**”

- ❖ The Probable Maximum Precipitation is obtained from
 - **Isohyetal Analysis** of historic rain storms.
 - **Transposition** of artificially selected rainstorm to project basin.
 - Further **maximizing** the rainstorm to **extreme moisture conditions**.
 - **Time distribution curves**

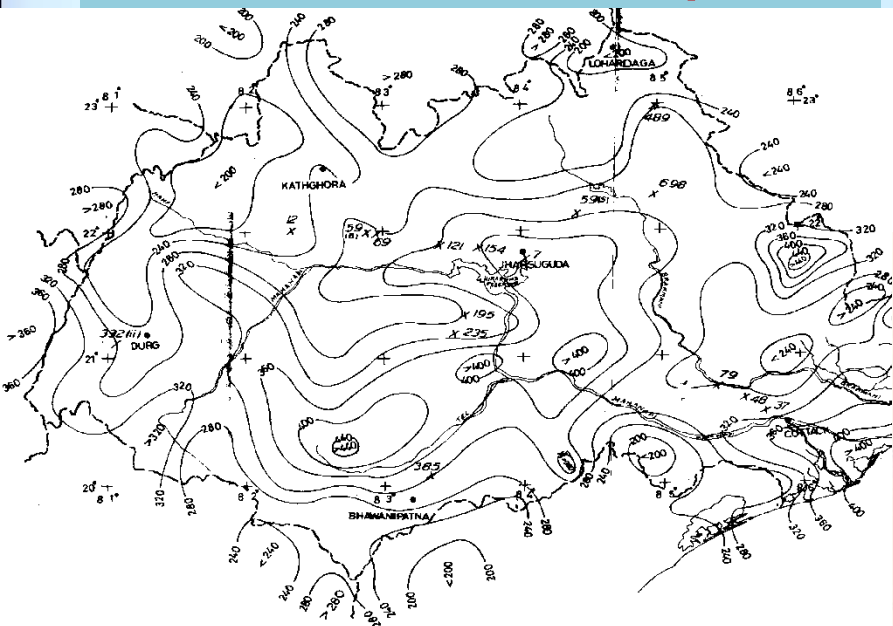




Estimation of PMP



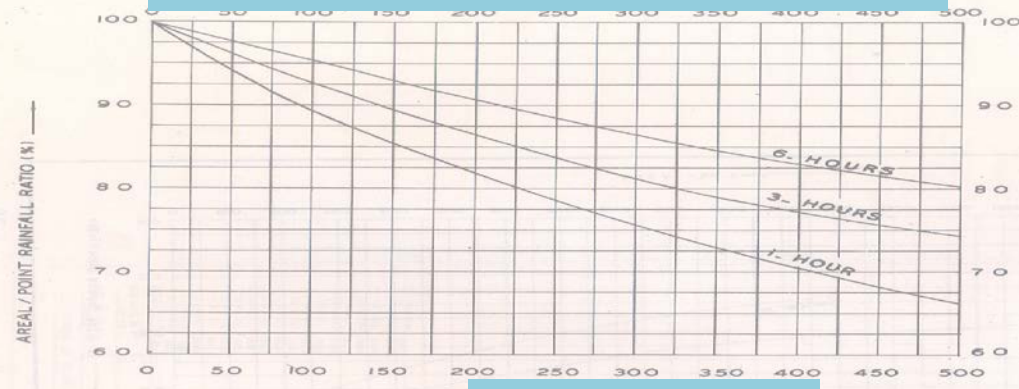
Return Period Map



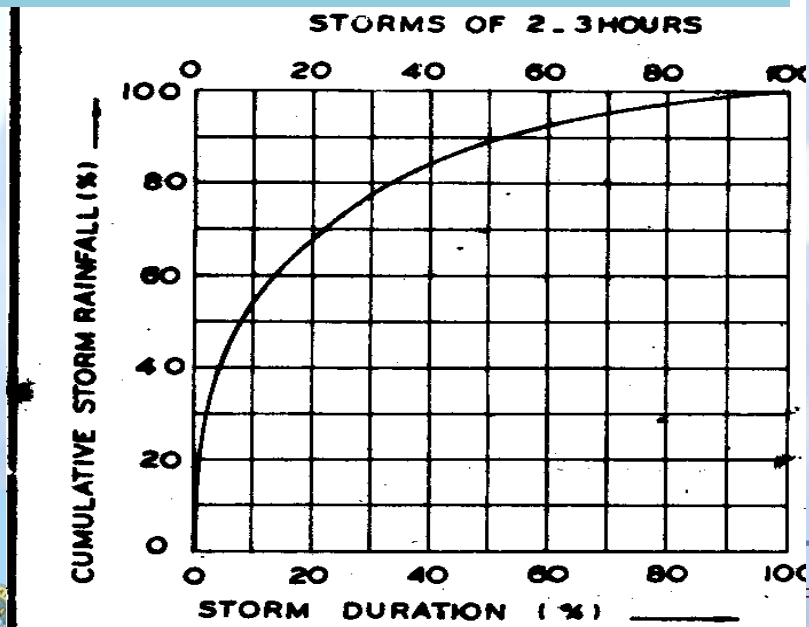
Small/ Medium structures

Depth Duration Frequency Analysis

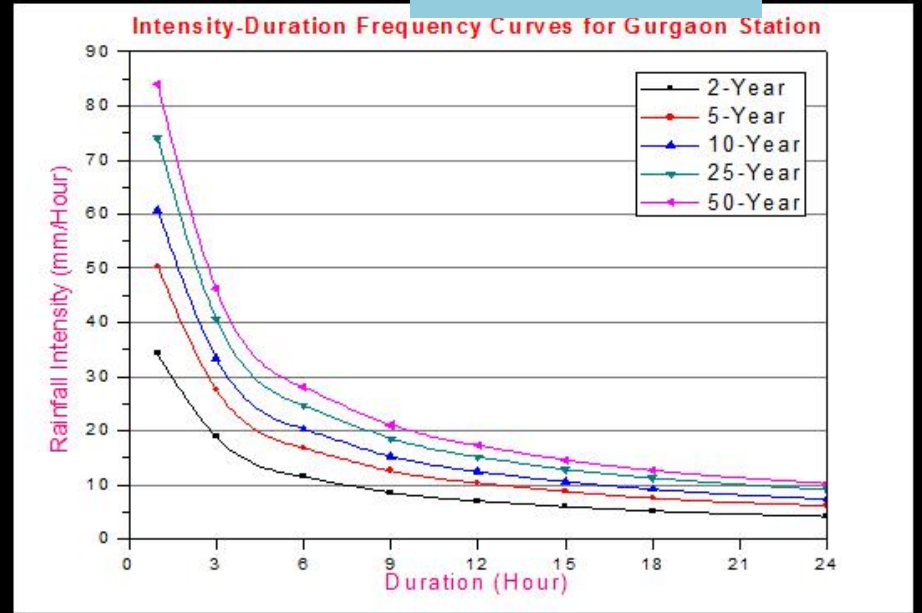
Point to Areal Rainfall curve



Time Distribution curve



IDF Curves



CHALLENGES IN QPF

- ❖ IT SHOULD NOT BE AN UNDERESTIMATE (THERE WILL BE AN AVOIDABLE LOSS OF LIFE AND PROPERTY) OR OVERESTIMATE, RESULTS IN UNNECESSARY DISPLACEMENT OF POPULATION RESULTING IN DIMINISHING CONFIDANCE IN FORECASTS AND WARNINGS.
- ❖ THE RAINFALL RUNOFF MODELS REQUIRE QPF AT HIGHER RESOLUTION GRIDS WITH GOOD ACCURACY
- ❖ HOURLY RAINFALL FORECAST IS ALSO DESIRED IN ADDITION TO DAILY FORECAST.
- ❖ RAINFALL POST PROCESSOR: BIAS CORRECTED RAINFALL FORECAST, PROBABILITY FORECAST.
- ❖ CAPTURING OF EXACT LOCATION AND DURATION OF SYNOPTIC SYSTEMS AND RAINFALL BY NWP MODELS





THANK YOU

भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT

