



**Lecture 3- Introducing methodology and DSS for Urban Heavy rainfall IBFW including hazard and impact modeling(case of Mumbai):
Exercise on Hazard(including met event), Impact, Vulnerability and Exposure (the map exercise) and preparation of Risk matrix for preparation of IBFW)**

**IMD FUNCTIONAL GROUP-SPECIAL INPUT FROM RMC MUMBAI-Miss Nitha. T.S
UNDER THE GUIDANCE OF DR M. MOHAPATRA, DGM IMD**

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National Weather Forecasting Center(NWFC)

IMD, New Delhi

Workshop on Impact-based Forecast and Warning Services (IBFWS)-1st WMO-PTC/GCC Workshop by Panel on Tropical Cyclones and Gulf Countries Council at Muscat



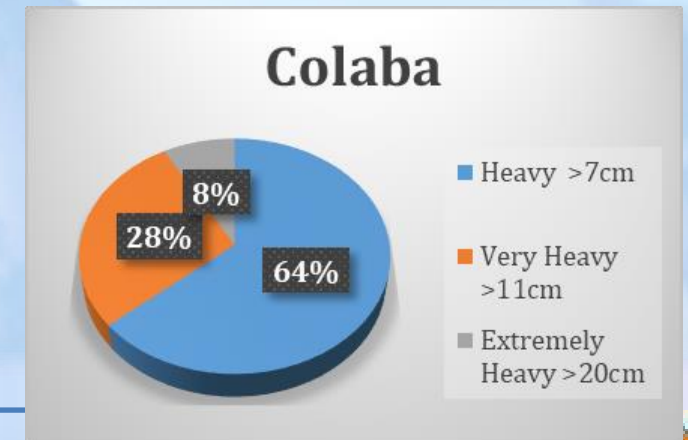
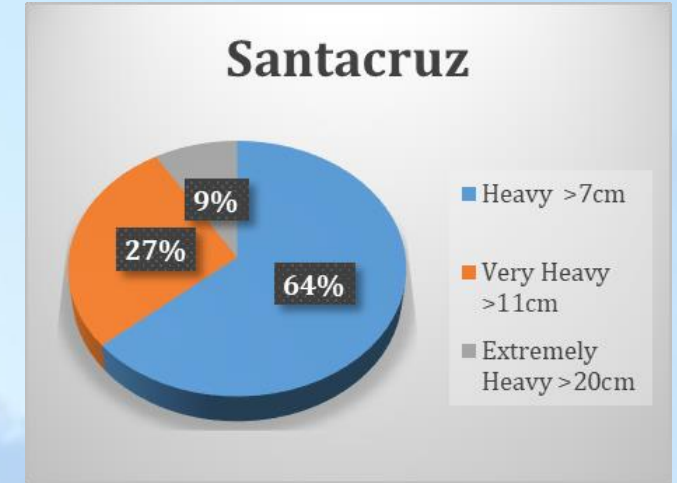
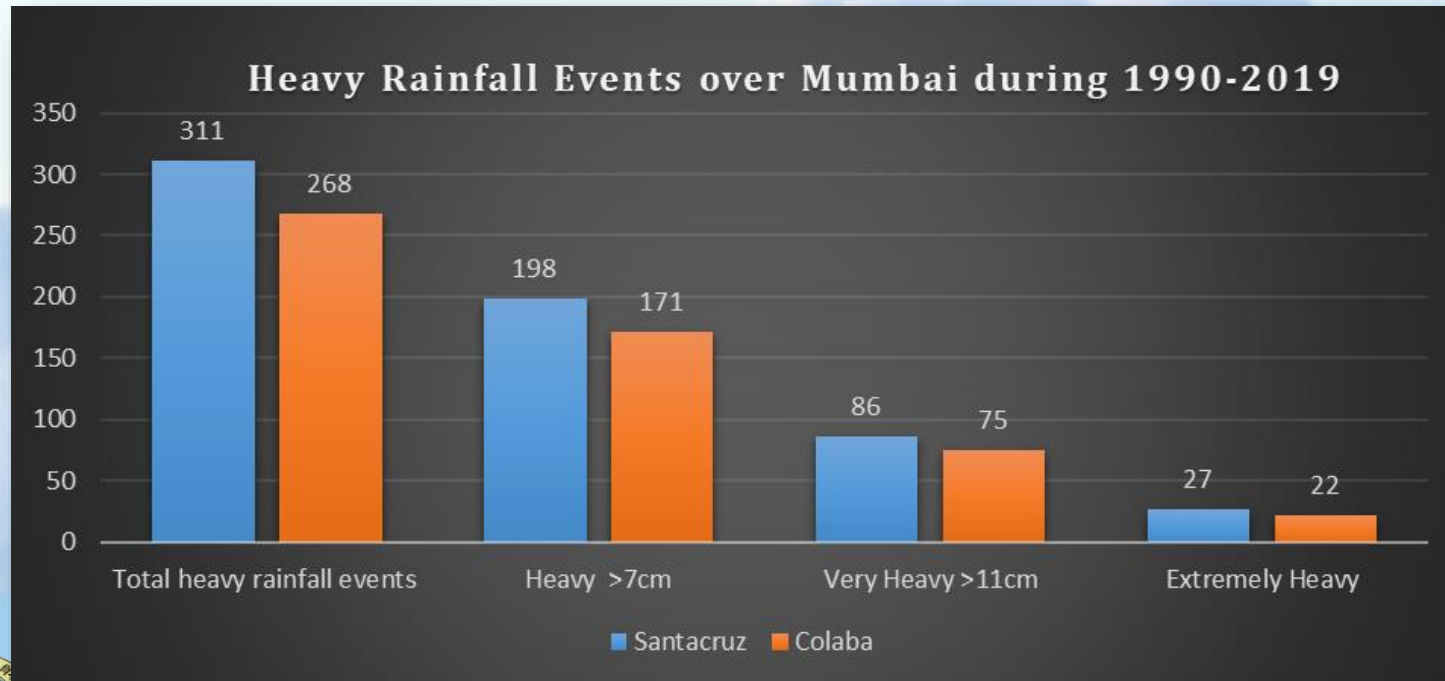
Objective

- **Collection of HIVE Data for Mumbai and computation of Risk and impact matrix**
- ✓ **Data sources and types**
- ✓ **Excel sheet of all historical data -rain and impact data for exercises**
- **Preparation Impact matrix-use different data file of Excel sheet**
- **Monitoring System**
 - **City rainfall network and flood gauges for depth -High density observational urban network**
 - **RADAR**
- **Event –rainfall forecast from Urban high resolution NWP products**
- **Flood models- I-FLOWS, FFGS**
- **Hazard with Impact models**
- **SOP and Real time IBFW-4 stages IBFW(examples from case of heavy rainfall in 2020-2023)**
- **Issue, Challenges and Suggestions**



Analysis of Historical rainfall event data, Exposure, Impact and hazard analysis(vulnerability part)-preparation of Risk and response matrix- Mumbai IBFW-Heavy rainfall Modules –refer EXCLE SHEETS

- Rainfall Data of Mumbai (June – Sept) from past 30 years (1990 -2019) to assess the high impact events.
- Data of **Colaba & Santacruz** stations were considered



Correlating the Rainfall data & Disaster data: Threshold Calculation

Cumulative approach as well as individual heavy rainfall days were analyzed

Month	Date	Santacruz	Colaba	Date/ Month	Event Type	Location Name District (Area Affected)	Casualties(Human lives and Livestock)		Intensity	
6	5	71.9	47.9							
6	27	116.3	36.9	26.06.1990	27.06.1990	Floods and Heavy Rains	Bombay	10	3	Heavy rains
6	28	105.2	86.2							
6	29	78.5	87.5							
8	11	88	54.2							
8	13	76.5	126.8							
8	14	67.5	0.4							
8	15	74.4	259	15.08.1990	15.08.1990	Floods and Heavy Rains	Bombay	2		Heavy rains
8	16	76.7	85.8							
9	25	147.1	97.4							
9	26	82.4	39.7							
6	9	351.5	396.8	07.06.1991	10.06.1991	Floods and Heavy Rains	Bombay and Thane	74	2550	Heavy rains
6	10	399	477.6	07.06.1991	10.06.1991	Floods and Heavy Rains	Bombay and Thane	74	2550	Heavy rains
7	5	65.1	2							
7	13	121.7	45.7							
7	17	100.3	9							
7	18	100.1	13.9							
7	27	72.2	2.8	27.07.1991	27.07.1991	Floods and Heavy Rains	Bombay	4		Heavy rains
7	28	132.6	5.4							
7	9	69.7	5.1							
7	18	109.2	4.5	18.07.1992	19.07.1992	Floods and Heavy Rains	Bombay	7		Heavy rains
7	19	101.8	19.2	18.07.1992	19.07.1992	Floods and Heavy Rains	Bombay	7		Heavy rains
8	5	73.3	0.6							
8	12	215.4	39.1							

Flood Dates		Daily Rainfall						Cumulative Rainfall
		D-5	D-4	D-3	D-2	D-1	D	
26.06.1990		21-Jun	22-Jun	23-Jun	24-Jun	25-Jun	26-Jun	
	CLB	0	0	1.2	0	2	20.5	23.7
	SCZ	0.2	0.7	2.9	1.1	1.4	116.8	123.1
15.08.1990		10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	
	CLB	88	20	76.5	67.5	74.4	20.5	346.9
	SCZ	54.2	12.3	126.8	0.4	259	116.8	569.5
17.08.1990		12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	
	CLB	20	76.5	67.5	74.4	76.7	40.9	356
	SCZ	12.3	126.8	0.4	259	85.8	73.7	558
21.08.1990		16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	
	CLB	76.7	40.9	26.6	36.3	13.9	26.5	220.9
	SCZ	85.8	73.7	40.8	32.6	7.5	17.2	257.6

Single day heavy rainfall leading to flooding events increasing in the recent years



Threshold for Mumbai

Correlating the Rainfall data & Disaster data : Impact Response Matrix

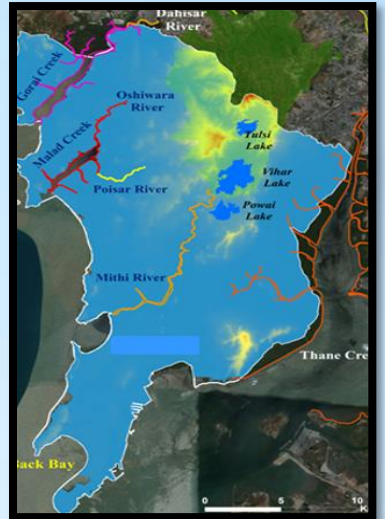
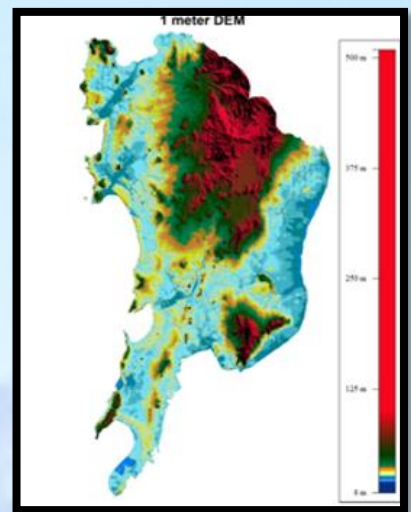
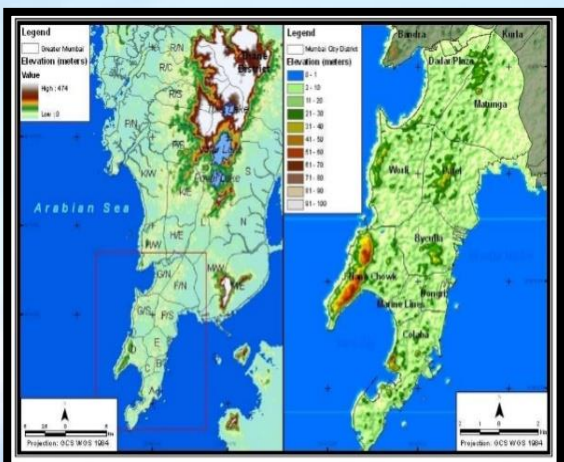
Single day / 2 consecutive heavy rainfall days leading to high impact events over Mumbai

Rainfall category	Expected Impact	Action Suggested
Moderate rain (<6cm)	<ul style="list-style-type: none"> ▪ Traffic Congestions ▪ Slippery roads 	Nil
Heavy rain (7-11cm) with moderate to intense spell	<ul style="list-style-type: none"> ▪ Localized flooding/water logging of low-lying areas ▪ Traffic Congestions 	Traffic may be regulated effectively
2 consecutive days of heavy rainfall (>= 12 cm in 48 hours)	<ul style="list-style-type: none"> ▪ Localized flooding/water logging of low-lying areas ▪ Possibility of danger to very old buildings and unmaintained structures 	Traffic may be regulated effectively People living in very old buildings and unmaintained structures may take caution
Very heavy rainfall (12-20cm)	<ul style="list-style-type: none"> • Water logging/ flooding in many parts of low-lying area and river banks • Localized and short-term disruption to municipal services (water, electricity, etc.) • Major disruption of traffic flow. Major roads/local trains affected. • Possibility of danger to very old buildings and unmaintained structures, falling of trees etc ▪ Closure of roads crossing low water bridges 	Traffic may be regulated effectively People living in very old buildings and unmaintained structures may take caution
Extremely heavy rainfall (>20 cm)	<ul style="list-style-type: none"> • Widespread and severe water logging/ flooding in most parts of low-lying area and also on river banks. • Major disruption of traffic flow. • Major roads/local trains and travel routes severely affected • Localized and short-term disruption to municipal services (water, electricity, etc.) • Possibility of danger to very old buildings and unmaintained structures, falling of trees etc • Possibility of local landslides in elevated hilly areas • Closure of roads crossing low water bridges 	Traffic may be regulated effectively People living in very old buildings and unmaintained structures may take caution

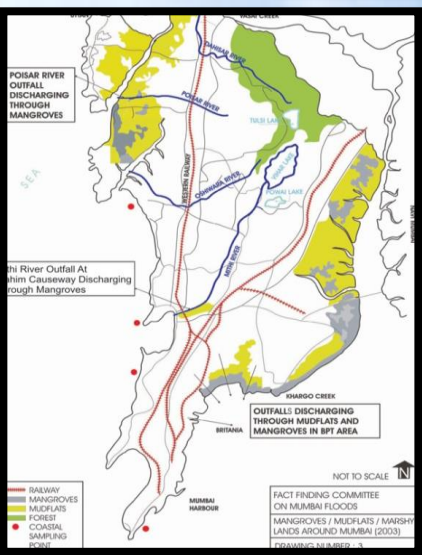
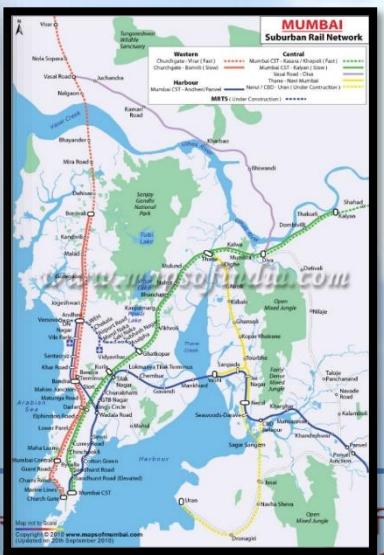
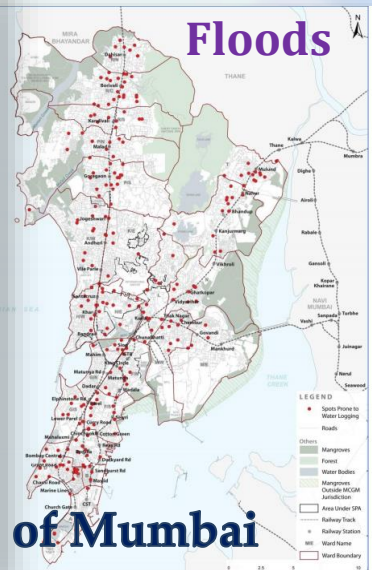
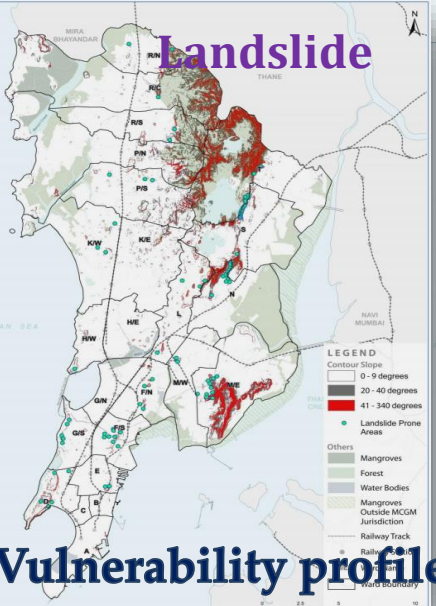


Collection of Impact Based Data for Mumbai

1. Meteorological Data
2. Geophysical data
3. Physical data
4. Socio-economic data
5. Vulnerability



The Maps show the composition of Greater Mumbai namely, Mumbai Suburban District and Mumbai City (District).



Vulnerability profile of Mumbai

Updated Impact Response Matrix

Minimal	Minor	Significant	Severe
<ul style="list-style-type: none"> •Slippery roads •Traffic Congestions •Increased travel times 	<ul style="list-style-type: none"> • Localized flooding/water logging of low-lying areas of city, western and eastern suburbs ▪ Traffic Congestions.. ▪ Increased travel times 	<ul style="list-style-type: none"> • Water logging/ flooding in many parts of low-lying areas in city, western and eastern suburbs • Flooding/inundation of river banks (especially banks of Mithi River) and other major lakes in suburbs • Major disruption of traffic flow • Major roads and local trains affected. • Flight operations may be affected. • Inundation of coastal areas coinciding with high tides. • Localized and short-term disruption to municipal services (water, electricity, etc.) • Possibility of danger to very old buildings and unmaintained structures. • Falling of trees/branches in gusty winds. • Slum areas along railway track, coastal areas, river banks and drains may be severely affected • Closure of roads crossing low water bridges • Squally weather along the coast and rough Sea conditions 	<ul style="list-style-type: none"> • Water logging/ flooding in most parts of low-lying areas in city, western and eastern suburbs •Flooding/inundation of river banks (especially banks of Mithi River) and other major lakes in suburbs. •Severe disruption of traffic flow. •Most roads/local trains and travel routes severely affected. •Flight operations will be affected. •Inundation of coastal areas coinciding with high tides •Localized and short-term disruption to municipal services (water, electricity, etc.) •Possibility of danger to very old buildings and unmaintained structures. •Falling of trees/branches in gusty winds. •Slum areas along railway track, coastal areas, river banks and drains may be severely affected •Closure of roads crossing low water bridges •Squally weather along the coast and rough Sea conditions •Possibility of local landslides in elevated hilly areas of Kurla, Sakinaka, Chembur, Bhandup, Vikhroli, Ghatkopar and Mulund areas.

Action suggested			
<ul style="list-style-type: none"> • Nil 	<ul style="list-style-type: none"> • Traffic may be regulated effectively 	<ul style="list-style-type: none"> • Traffic may be regulated effectively • People living in very old buildings, unmaintained structures and river banks (specially banks of Mithi river) may take caution and move to safer places. 	<ul style="list-style-type: none"> • Traffic may be regulated effectively • People living in very old buildings, unmaintained structures and river banks (specially banks of Mithi river) may take caution and move to safer places. • People in the affected areas may restrict their movement.



Forecasts and Warnings issued by IMD

❑ Impact based bulletins were also issued as per SOP followed by regular rainfall updates with possible impacts, till the event was over.

❑ Flood guidance provided from I - flows Mumbai were also provided to the state and Mumbai disaster management authorities.

प्रादेशिक मौसम केंद्र, कोलाबा, मुंबई
Regional Meteorological Centre, Mumbai

Date: 03 Aug 2020 Time of issue: 1300 hrs IST

IMPACT BASED FORECAST FOR HEAVY RAINFALL OVER MUMBAI

Date	03 Aug 2020	04 Aug 2020
Forecast & Warning	Heavy to very heavy rainfall at isolated places	Heavy to very heavy rainfall at a few places with extremely heavy rainfall at isolated places
Impact Expected	<ul style="list-style-type: none"> Water logging/ flooding in many parts of low lying area and river banks Localized and short term disruption to municipal services (water, electricity, etc.) Major disruption of traffic flow. Major roads/local trains affected. Possibility of danger to very old building and unmaintained structures, falling of trees etc Closure of roads crossing low water bridges 	<ul style="list-style-type: none"> Widespread water logging/ flooding in most parts of low lying area and also on river banks. Major disruption of traffic flow. Major roads/local trains and travel routes Localized and short term disruption to municipal services (water, electricity, etc.) Possibility of danger to incredibly old and unmaintained structures, falling of trees etc. Possibility of landslides in elevated hilly areas Closure of roads crossing low water bridges
Action Suggested	<ul style="list-style-type: none"> Traffic may be regulated effectively People in the affected area may restrict their movement 	<ul style="list-style-type: none"> Traffic may be regulated effectively People in the affected area may restrict their movement

प्रादेशिक मौसम केंद्र, कोलाबा, मुंबई
Regional Meteorological Centre, Mumbai

Date: 04 Aug 2020 Time of issue: 13:00 hrs IST

IMPACT BASED FORECAST FOR HEAVY RAINFALL OVER MUMBAI

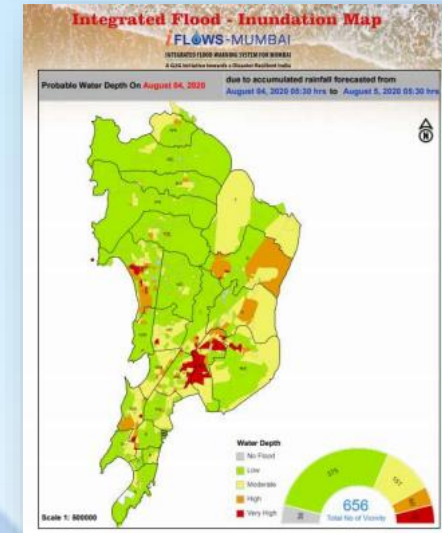
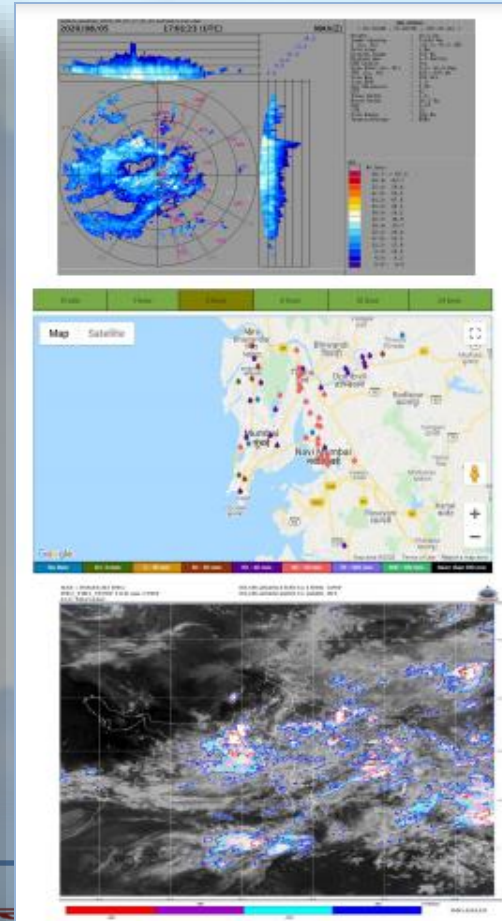
Date	04 Aug	05 Aug
Forecast & Warning	Heavy to very heavy rainfall at a few places with extremely heavy rainfall at isolated places	Heavy to very heavy rainfall at a few places with extremely heavy rainfall at isolated places
Impact Expected	<ul style="list-style-type: none"> Widespread water logging/ flooding in most parts of low lying area and also on river banks. Major disruption of traffic flow. Major roads/local trains and travel routes severely affected. Localized and short term disruption to municipal services (water, electricity, etc.) Possibility of danger to incredibly old and unmaintained structures, falling of trees etc. Possibility of local landslides in elevated hilly areas Closure of roads crossing low water bridges 	<ul style="list-style-type: none"> Widespread water logging/ flooding in most parts of low lying area and also on river banks. Major disruption of traffic flow. Major roads/local trains and travel routes severely affected. Localized and short term disruption to municipal services (water, electricity, etc.) Possibility of danger to incredibly old and unmaintained structures, falling of trees etc. Possibility of local landslides in elevated hilly areas Closure of roads crossing low water bridges

प्रादेशिक मौसम केंद्र, कोलाबा, मुंबई
Regional Meteorological Centre, Mumbai

Date: 05 Aug 2020 Time of issue: 2230 hrs IST

IMPACT BASED FORECAST FOR HEAVY RAINFALL OVER MUMBAI
Updates of Ongoing Heavy Rainfall Event

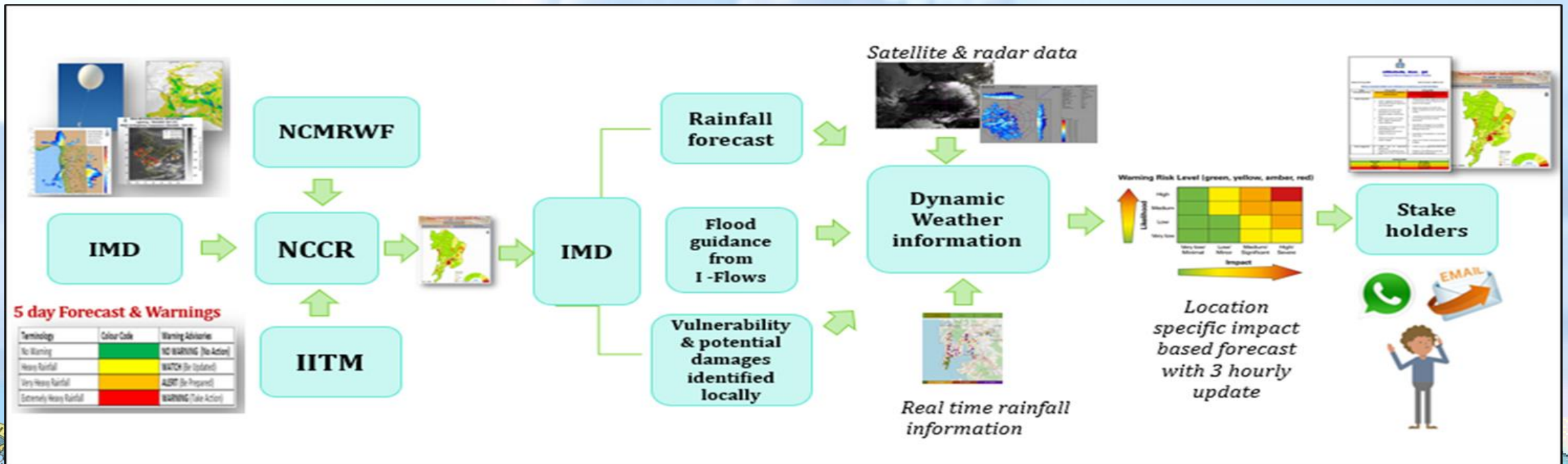
Date	04 Aug 2020
Rainfall Realized at 2230 hrs of 5 Aug 2020 (from 0830 hrs IST of 5 rd Aug)	Mumbai city and suburbs experienced intense spell to very intense spell of rainfall during past 3 hrs. (Map enclosed) Santacruz - 103.00 mm Colaba - 293.8 mm Strong winds with average speed reaching 70-80 kmph were reported at Colaba between around 0830 pm, with maximum wind gusting to 100 kmph.
Forecast	As per latest satellite and radar observations, Mumbai city and suburbs are very likely to receive intense spell of rainfall [2-3 cm/hr] during next 3-4 hrs, accompanied with strong winds reaching 70-80 kmph occasionally gusting to 100 kmph hrs. during next 3-4 hrs. Possibility of thunder and lightning in some areas
Impact Expected	<ul style="list-style-type: none"> Localized flooding/water logging of low lying areas Widespread water logging/ flooding in most parts of low lying area and also on river banks. Major disruption of traffic flow. Major roads/local trains and travel routes severely affected. Localized and short-term disruption to municipal services (water, electricity, etc.) Possibility of danger to incredibly old and unmaintained structures, falling of trees etc Possibility of local landslides in elevated hilly areas Closure of roads crossing low water bridges
Action Suggested	<ul style="list-style-type: none"> Traffic may be regulated effectively People in the affected area may restrict their movement



Sl. No.	Area	First Respondent Number	Vulnerability	
7	MW	Chembur	1234567890	VERY HIGH
8	MW	Chembur	1234567890	VERY HIGH
9	ME	Four Bungalows	1234567890	VERY HIGH
10	ME	Sanjay Gandhi Nagar	1234567890	VERY HIGH
11	ME	Municipal Colony	1234567890	VERY HIGH
12	L	Shiv Shakti Nagar (Kurla East)	1234567890	VERY HIGH
13	L	Police Colony (Kurla East)	1234567890	VERY HIGH
14	KW	Ashok Nagar (Juhu)	1234567890	VERY HIGH
15	KW	Four Bungalows	1234567890	VERY HIGH
16	KW	Four Bungalows	1234567890	VERY HIGH
17	KW	Gulmohar Colony	1234567890	VERY HIGH
18	KW	Vidha Nagar (Juhu)	1234567890	VERY HIGH
19	KW	Indian Oil Nagar (Four Bungalows)	1234567890	VERY HIGH
20	KW	Vallabh Nagar (Juhu)	1234567890	VERY HIGH
21	KW	Sainath Nagar	1234567890	VERY HIGH
22	KW	Suvarn Nagar (Juhu)	1234567890	VERY HIGH
23	KW	Dn Nagar (Four Bungalows)	1234567890	VERY HIGH
24	KW	Marish Nagar (Four Bungalows)	1234567890	VERY HIGH
25	KW	New Lic Colony (Four Bungalows)	1234567890	VERY HIGH
26	HW	Vaishya Nagar (Bandra West)	1234567890	VERY HIGH

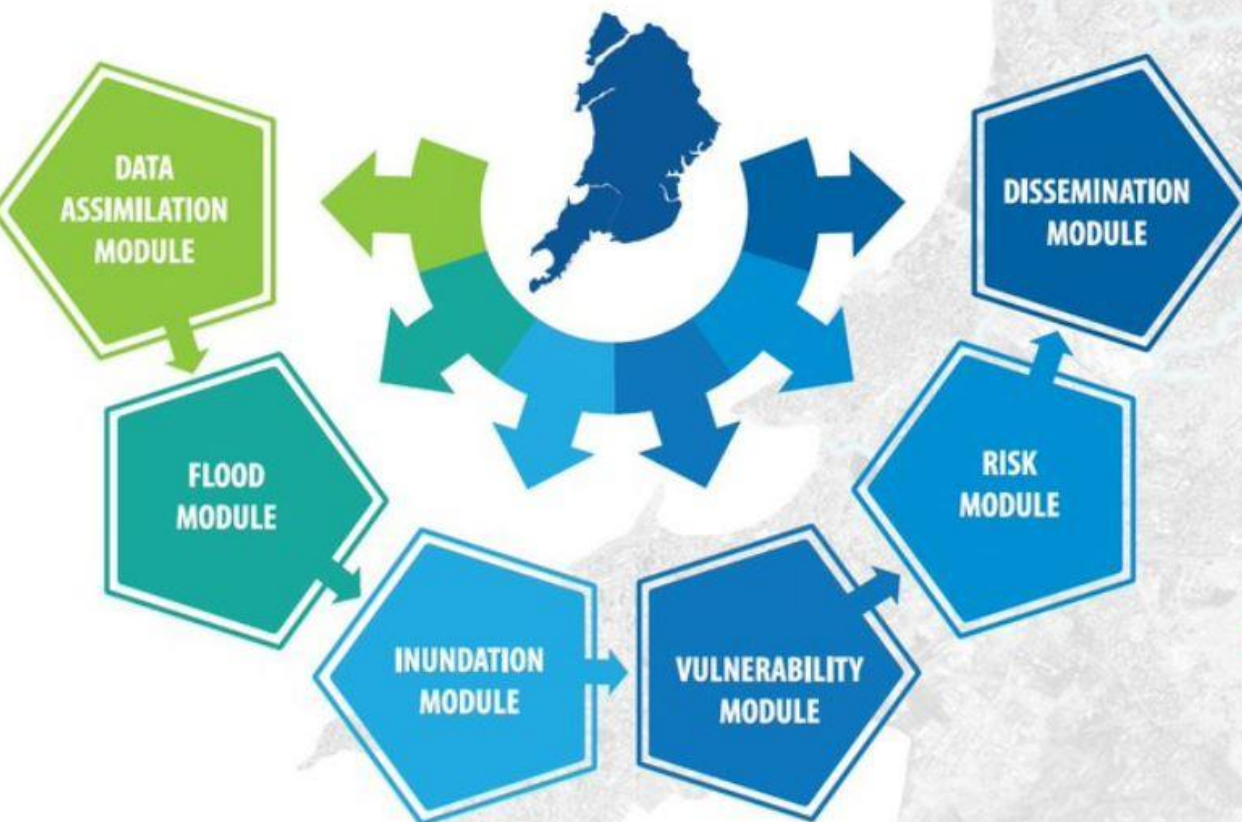
Impact Based Flood Forecasting Operational Set up

- 5 day district wise warning
- As per SOP, advisory/ alert 72 hrs prior to stake holders
- Impact Based Forecast Warning – 24/48 hrs prior
- 3 hourly IBF update throughout the event
- Based on the rainfall forecast generated by IMD 5 day forecast , if the rainfall is expected to be “heavy” and more flood inundations models are run and ward wise **I - flows flood guidance** are generated by NCCR and sent to IMD.



Mega-city Integrated Flood warning System –A collaboration of stake holder-NCCR-IMD-IITM-NCRMWF-Municipal Authority –C-FLOWS and I-FLOWS for Chennai and Mumbai

iFLOWS-MUMBAI



The coastal city of Chennai is prone to flooding and in a bid to tackle and address the problem of Urban Flooding, the Ministry of Earth Sciences and the Tamil Nadu State Government have roped a fully operational Chennai Flood Warning System (C-FLOWS) as a decision support system for relief 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 (NCMRWF) and ocean state forecast is from the Indian National Centre for Ocean Information Services (INCOIS).

C-FLOWS has been developed by NCCR as a culmination of the project initiated by the office of the PSA, Govt. of India and premier institutes like IIT-Delhi, IIT-Madras and IRS-Anna University. Mirror images of C-FLOWS will be setup in the Office of the Commissioner of Urban Administration, Greater Chennai Corporation (GCC) and IMD.

C-FLOWS is one of the first operational system for urban flooding in the country and would benefit to the State Government in the relief and mitigation operations.

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

CHENNAI SMART CITY

Chennai Smart City houses a GIS database of all datasets pertaining to Chennai (administrative boundaries, infrastructure, drainage, buildings etc.) that can be used for planning and management purposes at all times.

ONLINE DATA HUB

Online Data Hub is a data input module that receives Meteorological data, ocean state data, field observations, satellite data, discharge and flow data from various institutions.

FLOOD VULNERABILITY

This module houses the Flood Inundation Library from which the expert system selects the closest scenario based on the forecasted rainfall and tidal conditions. Simultaneously models will also be run in real time based on the actual datasets.

FLOOD CROWD SOURCING

Three mobile based applications are built into the system as a part of the operations related to:

1. Flood Preparedness
2. Flood Management
3. Fishermen safety

3D VISUALIZATION

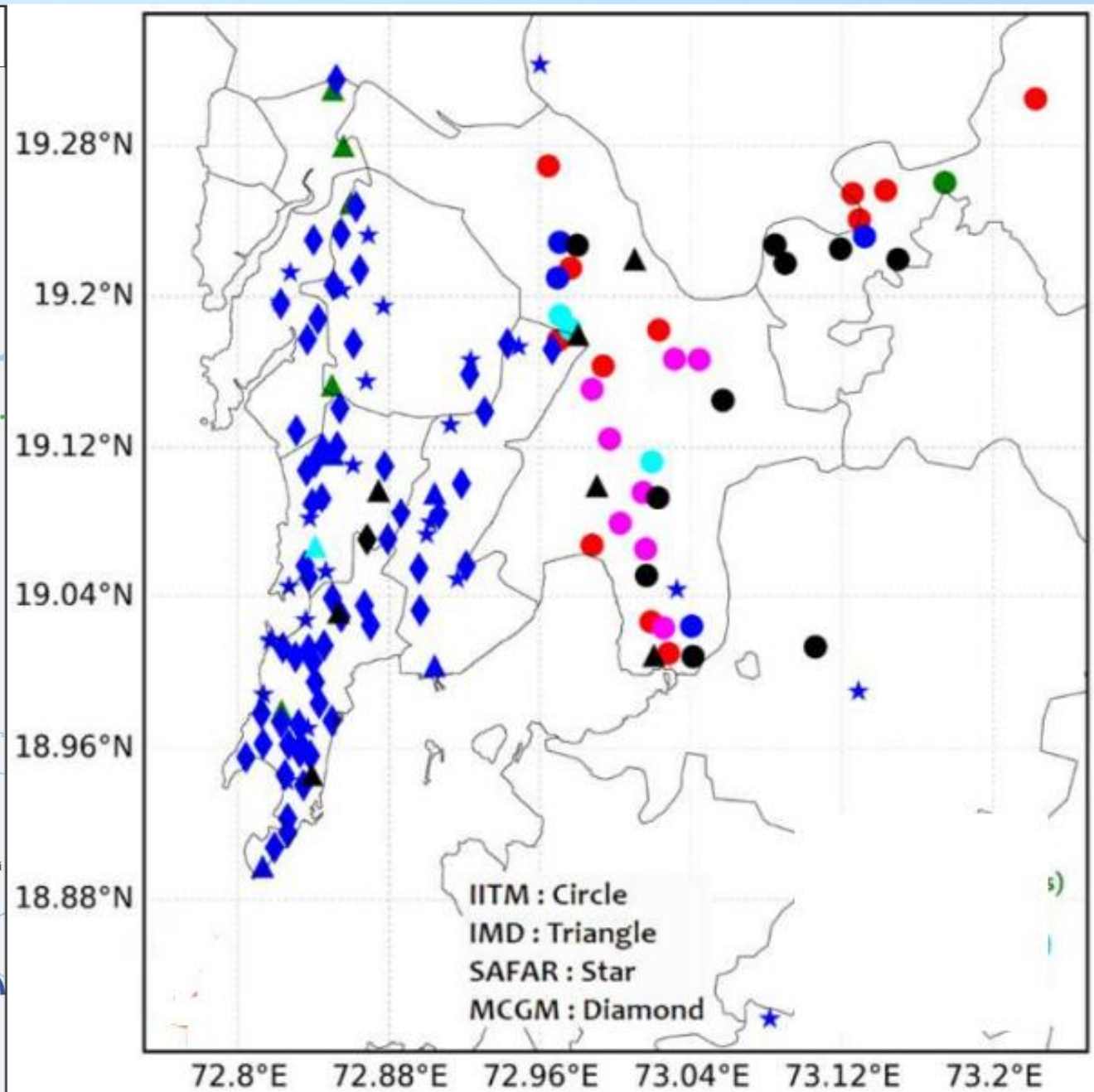
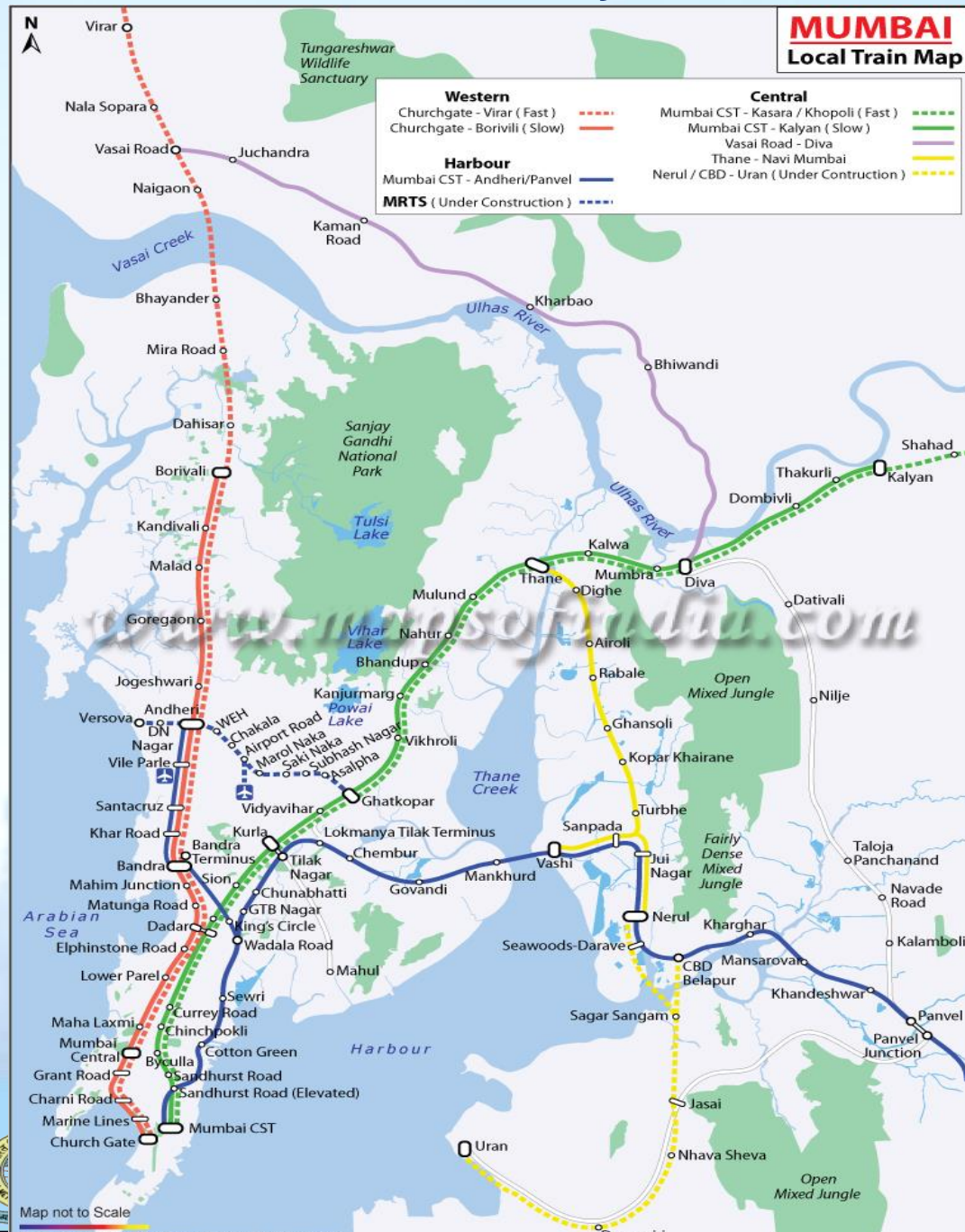
A 3D GIS based visualization module drapes the inundation scenarios on the urban landscape for better visualization of the flooded and non flooded areas.

DECISION SUPPORT SYSTEM

This is the heart of the DSS and will enable the decision maker to take appropriate decisions based on queries related to area-wise inundations, severely affected locations, flood depth, movement and mobilization of resources, shelters etc.



Mumbai city and sub-urban areas and Rainfall network stations



Integrated Flood Warning System (IFLOWS)-MUMBAI

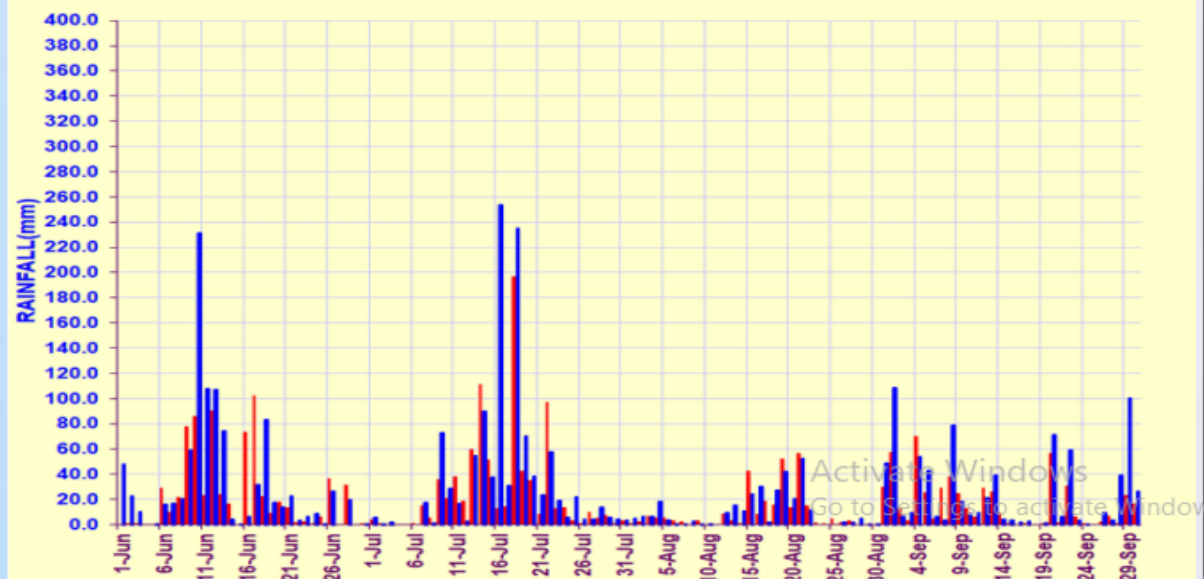
- ❑ **Developed by:** Ministry of Earth Sciences (MoES), in coordination with the Municipal Corporation of Greater Mumbai (MCGM).
- ❑ **Working:** Comprises of 7 modules
 - **Data assimilation**
 - **Flood & inundation**
 - **Vulnerability**
 - **Risk**
 - **Dissemination**
 - **Decision Support System (DSS)**
- ❑ Weather forecasts from **NCMRWF & IMD** and field data from the rain gauge network stations.

Benefits: This will boost the city's resilience by providing early warning for flooding specially during high rainfall events and cyclones.

❑ GIS based DSS

- Land topography, land use, infrastructure, population, lakes, creeks
 - River **bathymetry** of all rivers (Mithi, Dahisar, Oshiwara, Poisar & Ulhas).
- ❑ The system has provisions to capture the city drainage data and predict the areas of flooding.

DAILY RAINFALL OVER MUMBAI FROM JUNE 2021



SOP-Four stage City IBF from 2023

- Four-stage Impact Based early warning System using all objective and automated integrated products for end to end solutions and to effectively help disaster managers and other stake holders, to manage all urban Heavy Rainfall events and associated urban floods for all Major Cities of India
- Stage -1: Heavy rainfall Advisory(Watch)-(3-4 days lead time with 12-h updates)
- Stage-2: Heavy rainfall Alert (48 hours prior to the occurrence of the event at 12 hourly updates)
- Stage-3: Heavy rainfall Warning and IBF from likely flash floods (24 hours prior to the occurrence of the event at 06/12-hourly updates)
- Stage-4: 12-Hours prior to occurrences of maximum rainfall spell and color coded IBF from likely flash floods).
- All these informations and warnings are delivered, at Disaster managers Desk for timely decision at real time, at lead time 3-12 hours, with guidance at 3-5 days lead period, for taking early actions
- ✓ Actions to divert the traffic/closed the flooded roads, and all other safety actions well in advance before flood hits an area.
- ✓ It uses all latest digital dissemination system like CAP, API, WhasAPP, etc for timely dissemination to users



Impact Based Forecast Format



प्रादेशिक मौसम केंद्र, कोलाबा, मुंबई
Regional Meteorological Centre, Mumbai

Dated: 03 Aug 2020

Time of issue: 1300 hrs IST

IMPACT BASED FORECAST FOR HEAVY RAINFALL OVER MUMBAI

Date	03 Aug 2020	04 Aug 2020
Forecast & Warning	Heavy to very heavy rainfall at isolated places	Heavy to very heavy rainfall at a few places with extremely heavy rainfall at isolated places
Impact Expected	<ul style="list-style-type: none"> Water logging/ flooding in many parts of low lying area and river banks Localized and short term disruption to municipal services (water, electricity, etc.) Major disruption of traffic flow. Major roads/local trains affected. Possibility of danger to very old buildings and unmaintained structures, falling of trees etc Closure of roads crossing low water bridges 	<ul style="list-style-type: none"> Widespread water logging/ flooding in most parts of low lying area and also on river banks. Major disruption of traffic flow. Major roads/local trains and travel routes Localized and short term disruption to municipal services (water, electricity, Possibility of danger to incredibly old and unmaintained structures, falling of trees etc. Possibility of landslides in elevated hilly areas Closure of roads crossing low water bridges
Action Suggested	<ul style="list-style-type: none"> Traffic may be regulated effectively People in the affected area may restrict their movement 	<ul style="list-style-type: none"> Traffic may be regulated effectively People in the affected area may restrict their movement

COLOR CODES	
Very Low	No action
Low	Be updated
Medium	Be prepared
High	Take Action



प्रादेशिक मौसम केंद्र, कोलाबा, मुंबई
Regional Meteorological Centre, Mumbai

Dated: 04/08/2020

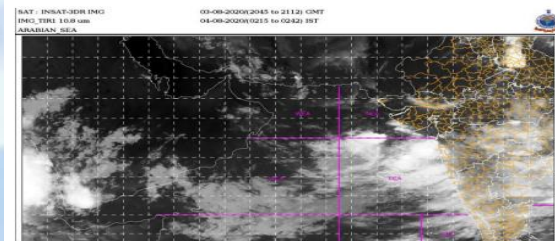
Time of issue: 0230 hrs

IMPACT BASED FORECAST FOR HEAVY RAINFALL OVER MUMBAI

Updates of Ongoing Heavy Rainfall Event

Date	04 Aug
Rainfall Realised at 0230 hrs of 4 Aug 2020 (from 0830 hrs IST of 3 rd Aug)	Mumbai city and suburbs experienced intense spell of rainfall during past 3 hrs. (Map enclosed)
Forecast	As per latest satellite and radar observations, Mumbai city and suburbs are very likely to receive very intense spell of rainfall (3-5 cm/hr) during next 3-4 hrs.
Impact Expected	<ul style="list-style-type: none"> Widespread water logging/ flooding in most parts of low lying area and also on river banks. Major disruption of traffic flow. Major roads/local trains and travel routes severely affected. Localized and short-term disruption to municipal services (water, electricity, etc.) Possibility of danger to incredibly old and unmaintained structures, falling of trees etc Possibility of local landslides in elevated hilly areas Closure of roads crossing low water bridges
Action Suggested	<ul style="list-style-type: none"> Traffic may be regulated effectively People in the affected area may restrict their movement

COLOR CODES	
Very Low	No action
Low	Be updated
Medium	Be prepared
High	Take Action



Legends:

Rainfall Intensity			
Terminology	Rainfall Range	Terminology	Rainfall Range
Light Spell	1 cm/hr	Very Intense Spell	3-5 cm/hr
Moderate Spell	1-2 cm/hr	Extremely Intense Spell	5-10 cm/hr
Intense Spell	2-3 cm/hr	Cloud Burst	>10 cm/hr

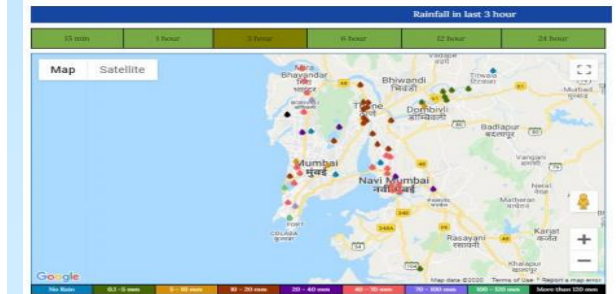
Rainfall Categories			
Terminology	Rainfall (in mm)	Terminology	Rainfall (in mm)
Very Light Rainfall	Trace-2.4	Heavy Rainfall	64.5-115.5
Light Rainfall	2.5-15.5	Very Heavy Rainfall	115.6-204.4
Moderate Rainfall	15.6-64.4	Extremely Heavy Rainfall	>>204.5

Regional Weather Forecasting Centre

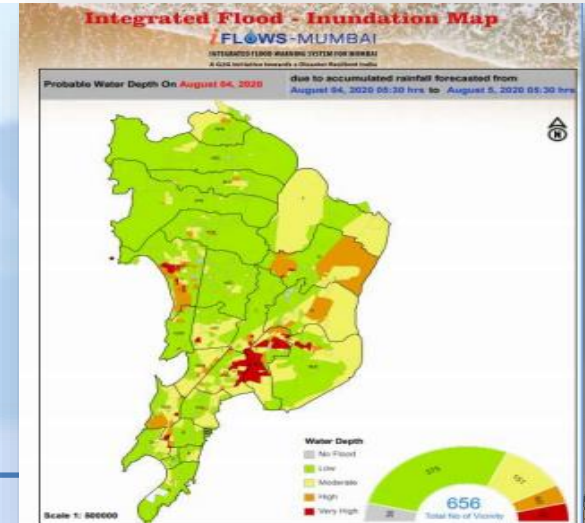
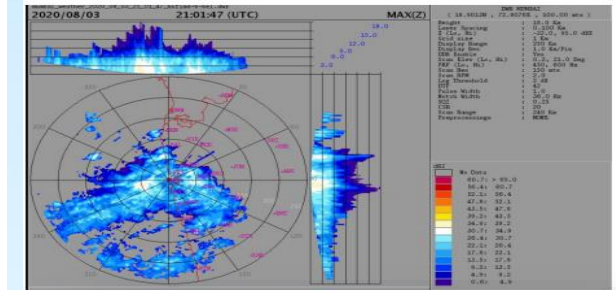
RMC Mumbai

Phone: +91 022 22150431/22174719/22174735

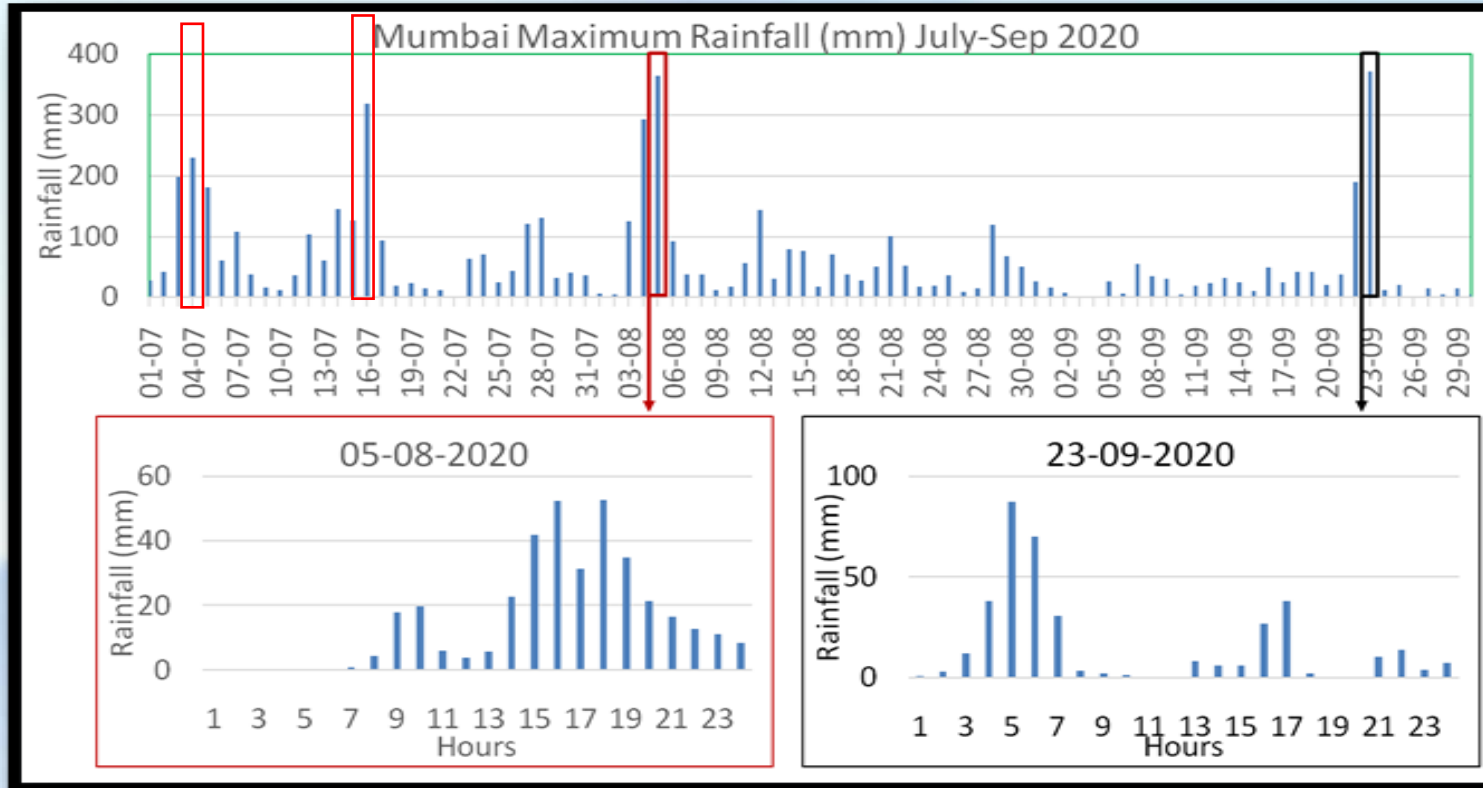
Rainfall during past 3 hours:



Current satellite & Radar Imageries:



Mumbai Monsoon 2020



- 4 high impact events over Mumbai during monsoon 2020
- IBF was issued on all 4 occasions
- 43 Impact Based Forecast bulletins issued



Extremely heavy rainfall event over Mumbai & around 4-6 Aug 2020

With the active monsoon conditions and development of a low-pressure system over North Bay of Bengal, the entire coastal belt of Konkan including Mumbai received an intense rainfall spell during the period 4-6 Aug 2020.



❑ **Santacruz** recorded 24 hr accumulated rainfall of **268.6mm, 84.3mm and 162.3mm** consecutively during 4-6 Aug 2020


❑ **Colaba** recorded **252.2mm, 53.2mm and 331.8mm** consecutively.



Forecasts and Warnings issued by IMD

Very good feedback was received from the user's side including general public, media and other stake holders for timely communication of severe weather warnings in advance.

Press Releases were issued from 1st Aug 2020 indicating the possibility of high impact event over the region.


Government of India
India Meteorological Department
Regional Meteorological Centre
Mumbai - 400005


Press Release Dated: 1/08/2020
Time of Issue: 1600 hrs. IST

Sub: Active Monsoon conditions over West coast and interior Maharashtra

Due to the strengthening of monsoon currents and likelihood formation of a low-pressure area over North Bay of Bengal around 4th August 2020, the rainfall intensity is very likely to increase over Konkan including Mumbai and adjoining ghat areas of Madhya Maharashtra during next 4-5 days. Enhanced rainfall is also expected over districts of interior Maharashtra.

The detailed district wise forecast and warnings for the region are as follows:

District	1-Aug-20	2-Aug-20	3-Aug-20	4-Aug-20	5-Aug-20
	Sea	Sea	Wides	Wides	Wides
Palghar	Intensity	Light to moderate rain	Light to moderate rain	Heavy to very heavy rain at a few places	Heavy to very heavy rain at a few places
	Probability	Very Likely	Very Likely	Very Likely	Likely
Thane	Intensity	Light to moderate rain	Light to moderate rain	Heavy to very heavy rain at a few places	Heavy to very heavy rain at a few places
	Probability	Very Likely	Very Likely	Very Likely	Likely


Government of India
India Meteorological Department
Regional Meteorological Centre
Mumbai - 400005

Press Release Dated: 3/08/2020
Time of Issue: 1530 hrs. IST


Sub: Active Monsoon conditions over West coast and interior Maharashtra

Due to the strengthening of monsoon currents and likelihood formation of a low-pressure area over North Bay of Bengal around 4th August 2020, the rainfall intensity is very likely to increase over Konkan including Mumbai and adjoining ghat areas of Madhya Maharashtra during 3-6 August 2020. Enhanced rainfall is also expected over districts of interior Maharashtra.

Weather Systems:

- A Low-Pressure Area is likely to form over north Bay of Bengal by 04th August 2020.
- The east-west shear zone now runs roughly along Lat.16°N between 5.8 km & 7.6 km above mean sea level.
- A cyclonic circulation lies over East-central Arabian Sea off north Maharashtra coast between 3.6 & 4.5 km above mean sea level.

District		3-Aug-20	4-Aug-20	5-Aug-20	6-Aug-20	7-Aug-20
		Mon	Tue	Wed	Thu	Fri
Thane	Intensity	Heavy to very heavy rain at isolated places.	Extremely heavy rain at isolated places.	Extremely heavy rain at isolated places.	Heavy to very heavy rain at isolated places.	Light to moderate rain
	Probability	Very Likely	Very Likely	Very Likely	Likely	Likely
Mumbai	Intensity	Heavy to very heavy rain at isolated places.	Extremely heavy rain at isolated places.	Extremely heavy rain at isolated places.	Heavy to very heavy rain at isolated places.	Light to moderate rain
	Probability	Very Likely	Very Likely	Very Likely	Likely	Likely
Raigad	Intensity	Extremely heavy rain at isolated places.	Extremely heavy rain at isolated places.	Extremely heavy rain at isolated places.	Heavy to very heavy rain at isolated places.	Heavy rain at isolated places.
	Probability	Very Likely	Very Likely	Very Likely	Likely	Likely
Ratnagiri	Intensity	Extremely heavy rain at isolated places.	Extremely heavy rain at isolated places.	Heavy to very heavy rain at a few places.	Heavy to very heavy rain at isolated places.	Heavy to very heavy rain at isolated places.
	Probability	Very Likely	Very Likely	Very Likely	Likely	Likely


Government of India
India Meteorological Department
Regional Meteorological Centre
Mumbai - 400005

Press Release Dated: 05/08/2020
Time of Issue: 1630 hrs. IST

Sub: Active Monsoon conditions over West coast and interior Maharashtra

Monsoon remained widespread vigorous over Konkan yesterday with heavy to very rainfall at many places and isolated extremely heavy falls. Extremely heavy rainfall also occurred at isolated places in the ghat areas of Madhya Maharashtra. Mumbai also experienced scattered heavy to very heavy rainfall yesterday. The intense rainfall activity over the region is expected till 6th Aug 2020 with gradual reduction thereafter.

Realized Rainfall over Mumbai and around:
Mumbai received widespread rainfall with scattered heavy to very heavy rainfall. The maximum rainfall realized over Mumbai and around was over Mira Road 187mm.

Rainfall (in mm) realised over Mumbai and around at 8.30 hrs of 5th Aug 2020



Weather Systems:

- The well-marked low pressure area over northwest Bay of Bengal off north Odisha-West Bengal coasts along with associated cyclonic circulation extending upto upper



Forecasts and Warnings issued by IMD

□ Impact based bulletins were also issued as per SOP followed by regular rainfall updates with possible impacts, till the event was over.

□ Flood guidance provided from I - flows Mumbai were also provided to the state and Mumbai disaster management authorities.

प्रादेशिक मौसम केंद्र, कोलाबा, मुंबई
Regional Meteorological Centre, Mumbai

Dated: 03 Aug 2020 Time of issue: 1300 hrs IST

IMPACT BASED FORECAST FOR HEAVY RAINFALL OVER MUMBAI

Date	03 Aug 2020	04 Aug 2020
Forecast & Warning	Heavy to very heavy rainfall at isolated places	Heavy to very heavy rainfall at a few places with extremely heavy rainfall at isolated places
Impact Expected	<ul style="list-style-type: none"> Water logging/ flooding in many parts of low lying area and river banks Localized and short term disruption to municipal services (water, electricity, etc.) Major disruption of traffic flow. Major roads/local trains affected. Possibility of danger to very old buildings and unmaintained structures, falling of trees etc Closure of roads crossing low 	<ul style="list-style-type: none"> Widespread water logging/ flooding in most parts of low lying area and also on river banks. Major disruption of traffic flow. Major roads/local trains and travel routes severely affected. Localized and short term disruption to municipal services (water, electricity, etc.) Possibility of danger to incredibly old and unmaintained structures, falling of trees etc. Possibility of local landslides in elevated hilly areas

Dated: 4th Aug 2020 Time of issue: 13:00 hrs IST

IMPACT BASED FORECAST FOR HEAVY RAINFALL OVER MUMBAI

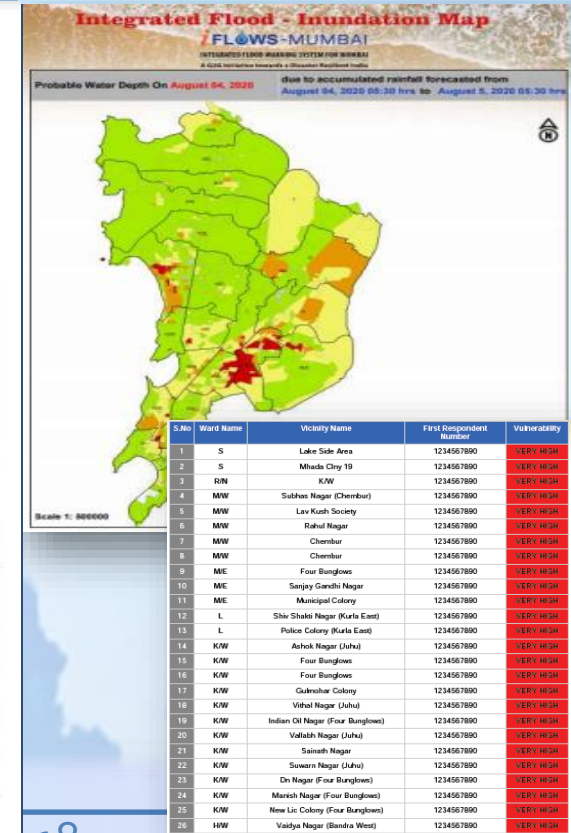
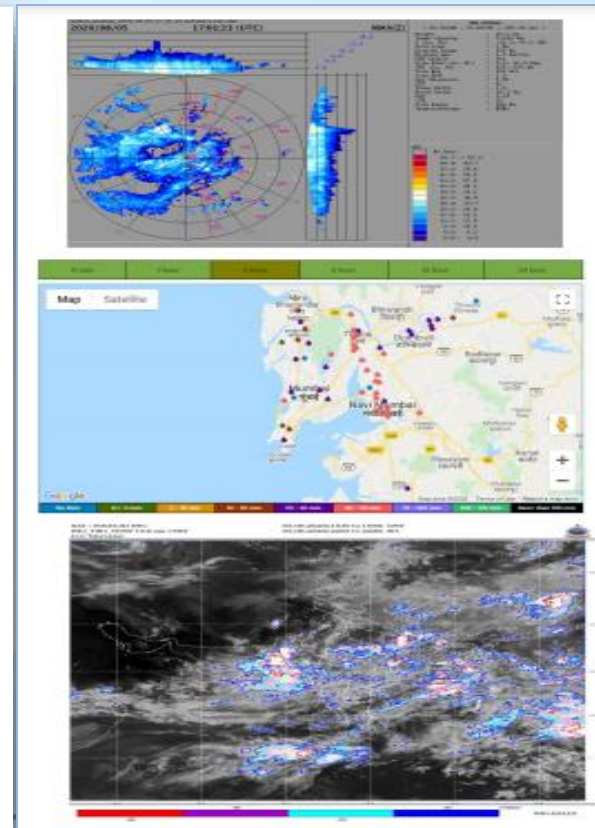
Date	4 th Aug	5 th Aug
Forecast & Warning	Heavy to very heavy rainfall at a few places with isolated extremely heavy rainfall at isolated places	Heavy to very heavy rainfall at a few places with isolated extremely heavy rainfall at isolated places
Impact Expected	<ul style="list-style-type: none"> Widespread water logging/ flooding in most parts of low lying area and also on river banks. Major disruption of traffic flow. Major roads/local trains and travel routes severely affected. Localized and short term disruption to municipal services (water, electricity, etc.) Possibility of danger to incredibly old and unmaintained structures, falling of trees etc Possibility of local landslides in elevated hilly areas Closure of roads crossing low water bridges. 	<ul style="list-style-type: none"> Widespread water logging/ flooding in most parts of low lying area and also on river banks. Major disruption of traffic flow. Major roads/local trains and travel routes severely affected. Localized and short term disruption to municipal services (water, electricity, etc.) Possibility of danger to incredibly old and unmaintained structures, falling of trees etc Possibility of local landslides in elevated hilly areas Closure of roads crossing low water bridges.

प्रादेशिक मौसम केंद्र, कोलाबा, मुंबई
Regional Meteorological Centre, Mumbai

Dated: 05 Aug 2020 Time of issue: 2230 hrs IST

IMPACT BASED FORECAST FOR HEAVY RAINFALL OVER MUMBAI
Updates of Ongoing Heavy Rainfall Event

Date	04 Aug 2020
Rainfall Realised at 2230 hrs of 5 Aug 2020 (from 0830 hrs IST of 5 rd Aug)	Mumbai city and suburbs experienced intense spell of rainfall during past 3 hrs. (Map enclosed) Santacruz - 103.00 mm Colaba - 293.8 mm Strong winds with average speed reaching 70-80 kmph were reported at Colaba between around 0830 pm, with maximum wind gusting to 100 kmph.
Forecast	As per latest satellite and radar observations, Mumbai city and suburbs are very likely to receive intense spell of rainfall (2-3 cm/hr) during next 3- 4 hrs. accompanied with strong winds reaching 70-80 kmph occasionally gusting to 100 kmph hrs. during next 3-4 hrs. Possibility of thunder and lightning in some areas
Impact Expected	<ul style="list-style-type: none"> Localized flooding/water logging of low lying areas Widespread water logging/ flooding in most parts of low lying area and also on river banks. Major disruption of traffic flow. Major roads/local trains and travel routes severely affected. Localized and short-term disruption to municipal services (water, electricity, etc.) Possibility of danger to incredibly old and unmaintained structures, falling of trees etc Possibility of local landslides in elevated hilly areas Closure of roads crossing low water bridges
Action Suggested	<ul style="list-style-type: none"> Traffic may be regulated effectively People in the affected area may restrict their movement



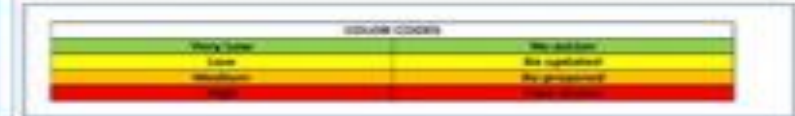
Forecasts and Warnings Issued

Mumbai & around Extremely Heavy Rainfall on 5th -6th Aug 2020 with Flood Guidance and IBF



Date	4 th Aug	5 th Aug
Forecast & Warning	Heavy rain is expected to fall along with moderate to heavy rain over the coastal areas.	Heavy rain is expected to fall along with moderate to heavy rain over the coastal areas.
Impact Expected	<ul style="list-style-type: none"> Underground water logging/ flooding in most parts of low lying area and also on river banks. Major disruption of traffic flow. Major roads/local trains and travel routes severely affected. Localized and short term disruption to municipal services (water, electricity, etc.) Possibility of danger to incredibly old and unmaintained structures, falling of trees etc. Possibility of local landslides in elevated hilly areas. Closure of roads crossing low water bridges. 	<ul style="list-style-type: none"> Underground water logging/ flooding in most parts of low lying area and also on river banks. Major disruption of traffic flow. Major roads/local trains and travel routes severely affected. Localized and short term disruption to municipal services (water, electricity, etc.) Possibility of danger to incredibly old and unmaintained structures, falling of trees etc. Possibility of local landslides in elevated hilly areas. Closure of roads crossing low water bridges.

Action Suggested	<ul style="list-style-type: none"> Traffic may be regulated effectively. People in the affected area may restrict their movement. 	<ul style="list-style-type: none"> Traffic may be regulated effectively. People in the affected area may restrict their movement.
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Rainfall Verification

District		3-Aug-20 Mon	4-Aug-20 Tue	5-Aug-20 Wed	6-Aug-20 Thu	7-Aug-20 Fri
Thane	Intensity	Heavy to very heavy rain at isolated places.	Extremely heavy rain at isolated places.	Extremely heavy rain at isolated places.	Heavy to very heavy rain at isolated places.	Light to moderate rain.
	Probability	Very Likely	Very Likely	Very Likely	Likely	Likely
Mumbai	Intensity	Heavy to very heavy rain at isolated places.	Extremely heavy rain at isolated places.	Extremely heavy rain at isolated places.	Heavy to very heavy rain at isolated places.	Light to moderate rain.
	Probability	Very Likely	Very Likely	Very Likely	Likely	Likely
Raigad	Intensity	Extremely heavy rain at isolated places.	Extremely heavy rain at isolated places.	Extremely heavy rain at isolated places.	Heavy to very heavy rain at isolated places.	Heavy rain at isolated places.
	Probability	Very Likely	Very Likely	Very Likely	Likely	Likely
Ratnagiri	Intensity	Extremely heavy rain at isolated places.	Extremely heavy rain at isolated places.	Heavy to very heavy rain at a few places.	Heavy to very heavy rain at isolated places.	Heavy to very heavy rain at isolated places.
	Probability	Very Likely	Very Likely	Very Likely	Likely	Likely

Rainfall (in mm) realised over Mumbai and around at 8.30 hrs of 5th Aug 2020

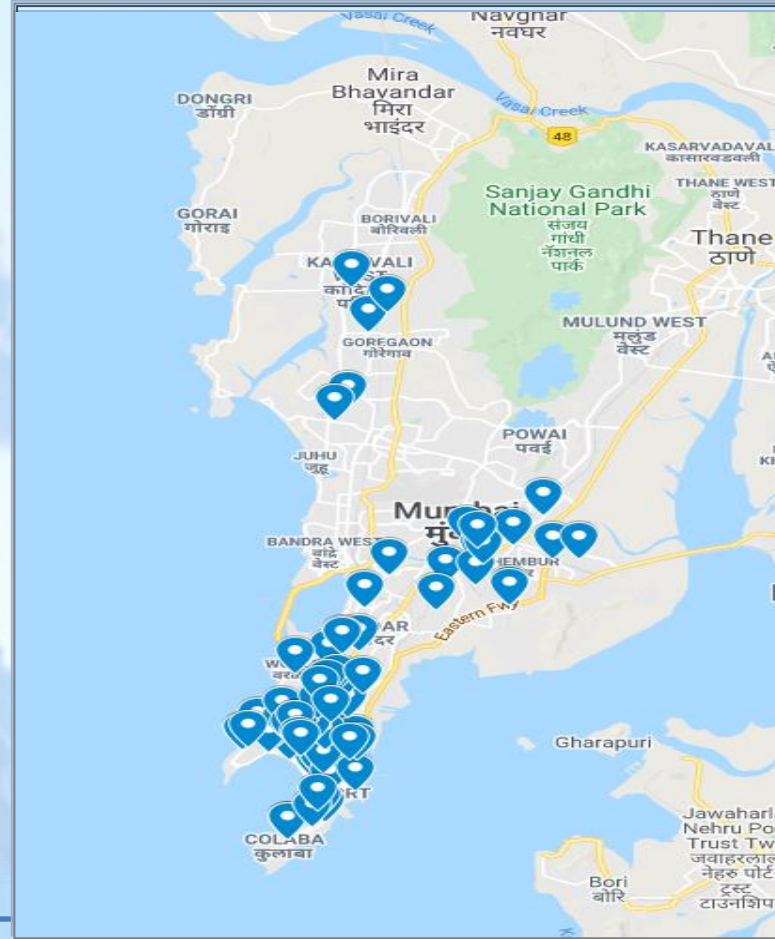
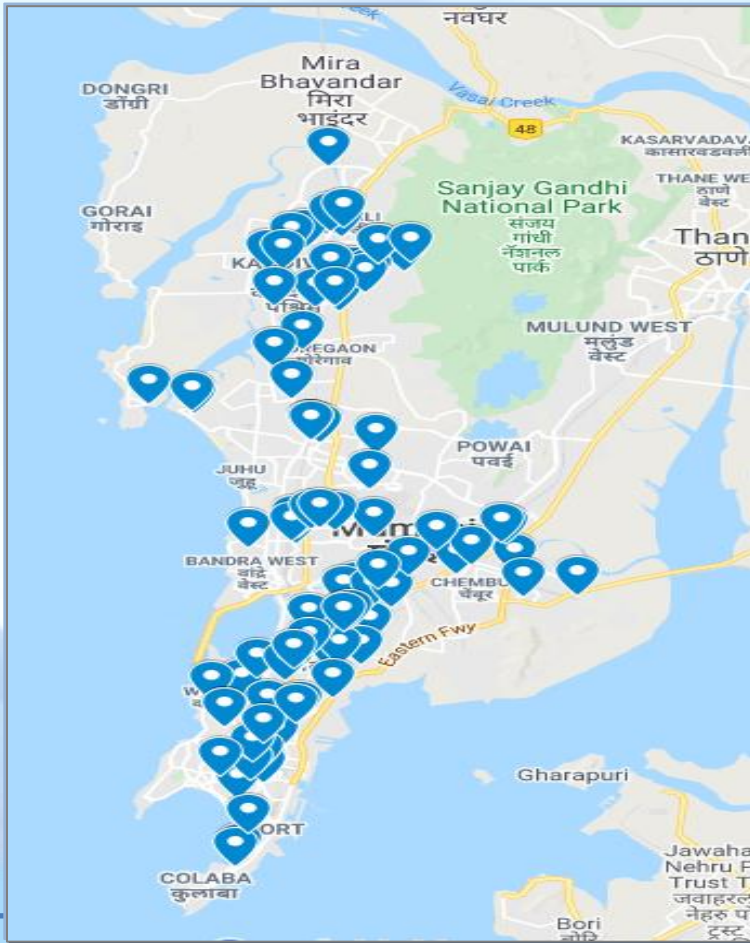


24 hour rainfall (in mm) realised at 8.30 hrs IST of 6th Aug 2020



Validation Based on MCGM Flood Point data

Flood points observed during 4th- 5th Aug 2020 showing extensive floods as indicated in the impact





प्रादेशिकमौसमकेंद्र, कोलाबा , मुंबई
Regional Meteorological Centre, Mumbai

Dated: 03 Aug 2020

Time of issue: 1300 hrs IST

IMPACT BASED FORECAST FOR HEAVY RAINFALL OVER MUMBAI

Date	03 Aug 2020	04 Aug 2020
Forecast & Warning	Heavy to very heavy rainfall at isolated places	Heavy to very heavy rainfall at a few places with extremely heavy rainfall at isolated places
Impact Expected	<ul style="list-style-type: none"> Water logging/ flooding in many parts of low lying area and river banks Localized and short term disruption to municipal services (water, electricity, etc.) Major disruption of traffic flow. Major roads/local trains affected. Possibility of danger to very old buildings and unmaintained structures, falling of trees etc Closure of roads crossing low water bridges 	<ul style="list-style-type: none"> Widespread water logging/ flooding in most parts of low lying area and also on river banks. Major disruption of traffic flow. Major roads/local trains and travel routes Localized and short term disruption to municipal services (water, electricity, etc.) Possibility of danger to incredibly old and unmaintained structures, falling of trees etc. Possibility of landslides in elevated hilly areas Closure of roads crossing low water bridges
Action Suggested	<ul style="list-style-type: none"> Traffic may be regulated effectively People in the affected area may restrict their movement 	<ul style="list-style-type: none"> Traffic may be regulated effectively People in the affected area may restrict their movement

COLOR CODES	
Very Low	No action
Low	Be updated
Medium	Be prepared
High	Take Action

Based on Media Reports



ग़राफ़ के मुंबई में रविवार यानी कि 5 जुलाई को तेज बारिश हो रही है जिसकी वजह से मुंबई के कई हिस्सों जल भराव शुरू हो गया है. मुंबई के वडाला एंटोप हिल, सांताक्रूज वकोला पुलिस स्टेशन के नजदीकी क्षेत्रों सड़कों और घरों में भी पानी भर गया है. वहीं शनिवार को मुंबई में काफी बारिश हुई थी और रविवार सुबह भी मुंबई के कई हिस्सों में बारिश हो रही है. इसी बीच मुंबई में एक बार फिर तेज बारिश शुरू हो गई है. ये में एक फ्लाइट को हैदराबाद एयरपोर्ट पर लैंड कराया गया है.

Widespread water logging in Low lying areas & River banks inundated



S.No	Ward Name	Vicinity Name	First Respondent Number	Vulnerability
1	S	Lake Side Area	1234567890	VERY HIGH
2	S	Mhada City 19	1234567890	VERY HIGH
3	R/N	K/W	1234567890	VERY HIGH
4	M/W	Subhas Nagar (Chembur)	1234567890	VERY HIGH
5	M/W	Lav Kush Society	1234567890	VERY HIGH
6	M/W	Rahul Nagar	1234567890	VERY HIGH
7	M/E	Four Bungalows	1234567890	VERY HIGH
8	M/E	Sanjay Gandhi Nagar	1234567890	VERY HIGH
9	M/E	Municipal Colony	1234567890	VERY HIGH
10	K/W	Gulmohar Colony	1234567890	VERY HIGH
11	K/W	Four Bungalows	1234567890	VERY HIGH
12	K/W	Four Bungalows	1234567890	VERY HIGH
13	H/W	Vaidya Nagar (Bandra West)	1234567890	VERY HIGH
14	G/S	Dighe Nagar (Parel)	1234567890	VERY HIGH
15	G/S	BDD Chawl Lower Parel	1234567890	VERY HIGH
16	E	Siddharth Nagar	1234567890	VERY HIGH
17	E	RBI Staff Colony	1234567890	VERY HIGH
18	A	Mantralaya	1234567890	VERY HIGH
19	A	Church Gate	1234567890	VERY HIGH
20	A	Church Gate	1234567890	VERY HIGH
21	S & M/W	Tiak Nagar, Kurla East	1234567890	HIGH
22	S	Vikhroli East	1234567890	HIGH
23	R/S	Samata Nagar	1234567890	HIGH
24	P/S	Cama Indl Eastate-goregaon East	1234567890	HIGH
25	P/N	Gailwad Nagar	1234567890	HIGH
26	N	Vikhroli East	1234567890	HIGH

Based on Media Reports



Due to very heavy rain and tree branches approaching near track at Churchgate, Mumbai Central and in between Marine Lines and Charni Road, the special suburban trains have been suspended temporarily between Mumbai Central, and Churchgate, Western Railway update said. (Express photo)

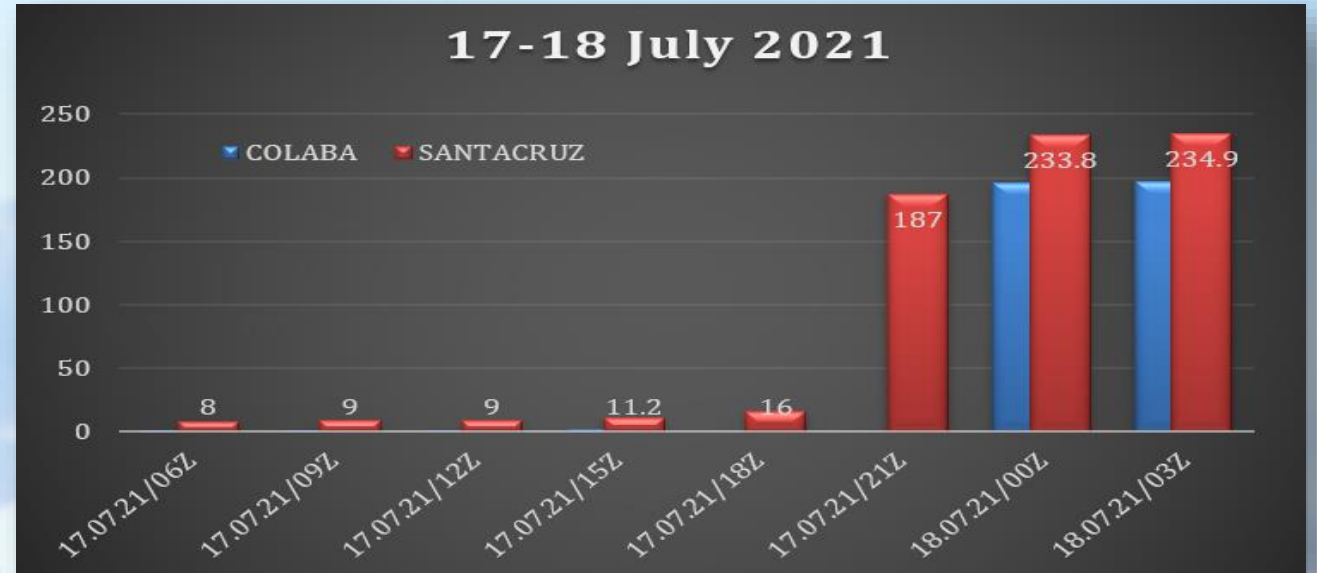
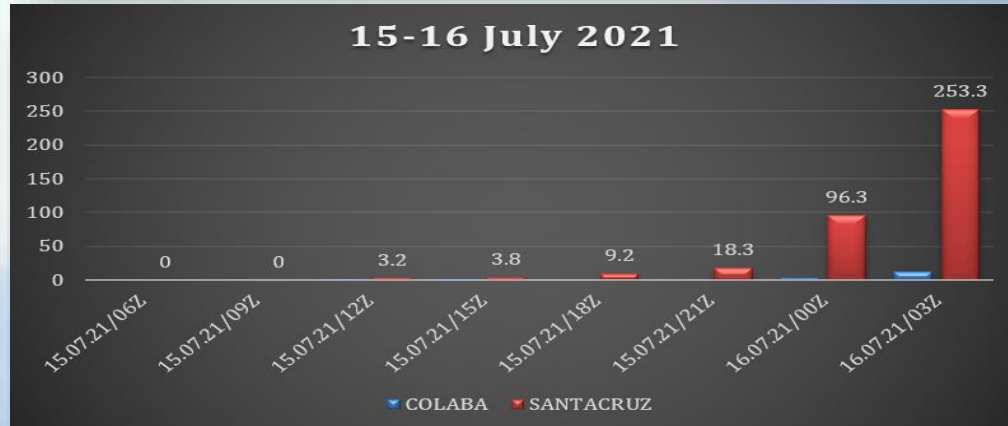


Water-logging was reported in low-lying areas of Chembur, Parel, Hindmata, Wadala and other areas of Mumbai. In pic: Areas around Oval Maidan and Churchgate were also flooded. (Express photo)

Mumbai Rains: RP rescue around 200 people stranded between Masjid Bunder and Byculla stations
By Swapnil Mishra



Extreme Rainfall Events over Mumbai in 2021



Intense to very intense spells during very short duration
Highly localized activity



Continuous Monitoring with Nowcast updates & Impact Based Forecast Updates



प्रादेशिकमौसमकेंद्र, कोलाबा, मुंबई
Regional Meteorological Centre, Mumbai

Dated: 17 July 2021

Time of issue: 2230 hrs

IMPACT BASED FORECAST FOR HEAVY RAINFALL OVER MUMBAI

Updates of Ongoing Heavy Rainfall Event

Rainfall Realised at 2230 hrs (from 0830 hrs IST of 17 July 2021)	Mumbai city and suburbs experienced light to moderate spell of rainfall during past 3 hrs. Santacruz (AWS) – 12 mm, Colaba (AWS) – 4.5 mm, Ram Mandir -19 mm, Juhu Airport – 11.5mm
Forecast for next 3-4 hours	As per latest observations, Mumbai city and suburbs are very likely to experience thunderstorm accompanied with lightning, gusty winds and moderate to intense spells of rainfall with during next 3-4 hours.
24 hours Warning for Mumbai (valid from 8.30 hrs of the day to 8.30 hrs of next day)	Heavy rainfall very likely at isolated places. Possibility of thunder/lightning at isolated places.
Impact Expected	<ul style="list-style-type: none"> ❖ Water logging in some parts of low lying areas. ❖ Localized and short term disruption to essential municipal services (water, electricity, etc.) ❖ Disruption of traffic flow. Increased travel times. ❖ Possibility of danger to very old buildings and unmaintained structures. ❖ Possibility of cloud to ground lightning. ❖ Traffic may be regulated effectively
Action Suggested	<ul style="list-style-type: none"> ❖ People in the affected area may restrict their movement and take caution.

COLOR CODES

Very Low	No action
Low	Be updated
Medium	Be prepared
High	Take Action



प्रादेशिकमौसमकेंद्र, कोलाबा, मुंबई
Regional Meteorological Centre, Mumbai

Dated: 18 July 2021

Time of issue: 0100 hrs

IMPACT BASED FORECAST FOR HEAVY RAINFALL OVER MUMBAI

Updates of Ongoing Heavy Rainfall Event

Rainfall Realised at 2330 hrs IST of 17 July 2021 (from 0830 hrs IST of 17 July 2021)	Mumbai city and suburbs experienced moderate to intense spell of rainfall during past 3 hrs. Colaba – 64.0 mm, Santacruz -17.0 mm, Juhu Airport-13.5 mm, Mira Road-10.0 mm, Ram Mandir- 20.5 mm
Forecast for next 3-4 hrs	As per latest observations, Mumbai city and suburbs are very likely to experience thunderstorm accompanied with lightning, gusty winds and intense to very intense spells of rainfall during next 3-4 hours.
Warning for 24 hours (from 0830 hrs of the day to 0830 hrs of next day)	Heavy to very heavy rainfall at a few places with possibility of thunder/lightning and gusty winds.
Impact Expected	<ul style="list-style-type: none"> • Water logging in many parts of low lying areas and river banks • Disruption of traffic flow. Increased travel times • Major roads and local trains affected. • Possibility of danger to very old buildings and unmaintained structures • Occasional gusty winds with speed reaching 45-55 gusting to 60 kmph along and off the coast resulting in possibilities of damage to vulnerable /temporary structures. • Rough Sea conditions along the coast. • Possibility of cloud to ground lightning.
Action Suggested	<ul style="list-style-type: none"> • Traffic may be regulated effectively • People staying in vulnerable places may take caution.

COLOR CODES

Very Low	No action
Low	Be updated
Medium	Be prepared
High	Take Action



प्रादेशिकमौसमकेंद्र, कोलाबा, मुंबई
Regional Meteorological Centre, Mumbai

Dated: 18 July 2021

Time of issue: 0300 hrs

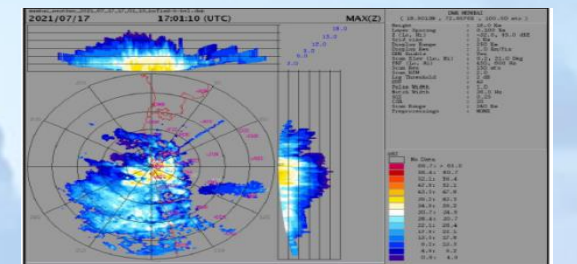
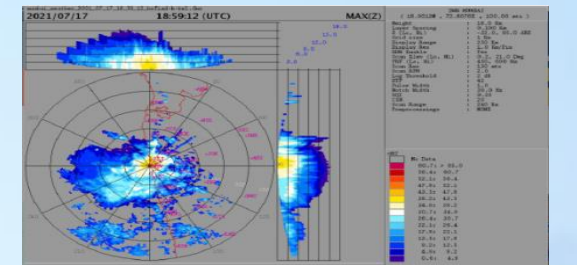
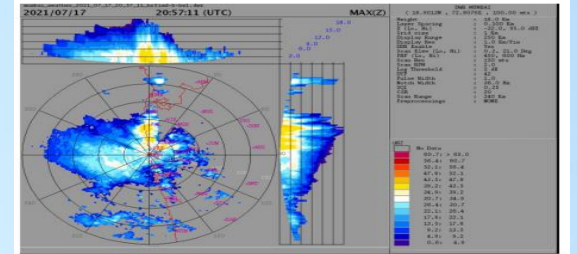
IMPACT BASED FORECAST FOR HEAVY RAINFALL OVER MUMBAI

Updates of Ongoing Heavy Rainfall Event

Rainfall Realised at 0300 hrs IST of 18 July 2021 (from 0830 hrs IST of 17 July 2021)	Mumbai city and suburbs experienced intense to very intense spell of rainfall during past 3 hrs. Colaba (AWS) –174.5 mm, Santacruz -213 mm, Juhu Airport-197.5mm, Bandra -197.5 mm, Bhayander -164.5mm, Ram Mandir -171.5mm, Mahalaxmi – 154.5mm
Forecast for next 3-4 hrs	As per latest observations, Mumbai city and suburbs are very likely to experience intense to very intense spells of rainfall (greater intensity towards northern parts of suburbs) during next 3-4 hours. Possibility of thunder/lightning and gusty winds in some areas.
Warning for 24 hours (from 0830 hrs of the day to 0830 hrs of next day)	Heavy to very heavy rainfall at a few places with extremely heavy rainfall at isolated places Possibility of thunder/lightning and gusty winds.
Impact Expected	<ul style="list-style-type: none"> • Water logging/inundation in most parts of low lying areas and river banks • Disruption to road, rail, air and ferry transport. Major roads and local trains affected. • Possibility of flash floods coinciding with high tide. • Local disruption of municipal services (Water, electricity etc.) • Flow of water over low-lying roads and bridges. • Possibility of danger to very old buildings and unmaintained structures • Occasional gusty winds with speed reaching 45-55 gusting to 60 kmph along and off the coast resulting in possibilities of damage to vulnerable /temporary structures. • Landslide/Mudslides and rock falls in vulnerable areas.

COLOR CODES

Very Low	No action
Low	Be updated
Medium	Be prepared
High	Take Action



Evaluation of the IBF issued for Mumbai

Warning for 24 hours (from 0830 hrs of the day to 0830 hrs of next day)	Heavy to very heavy rainfall at a few places with extremely heavy rainfall at isolated places Possibility of thunder/lightning and gusty winds.
Impact Expected	<ul style="list-style-type: none"> Water logging/inundation in most parts of low lying areas and river banks Disruption to road, rail, air and ferry transport. Major roads and local trains affected. Possibility of flash floods coinciding with high tide. Local disruption of municipal services (Water, electricity etc.) Flow of water over low-lying roads and bridges. Possibility of danger to very old buildings and unmaintained structures Occasional gusty winds with speed reaching 45-55 gusting to 60 kmph along and off the coast resulting in possibilities of damage to vulnerable /temporary structures. Landslide/Mudslides and rock falls in vulnerable areas.
	<ul style="list-style-type: none"> Rough Sea conditions along the coast. Possibility of cloud to ground lightning.
Action Suggested	<ul style="list-style-type: none"> Traffic may be regulated effectively People staying in vulnerable places may take caution.

MUMBAI NEWS

22 dead, several injured in Mumbai landslides after heavy rains

Mumbai reported heavy rainfall overnight especially between 12am to 2am leading to waterlogging in several areas of the city.

by PTI Correspondent | Updated by Nishikant Nay, Mumbai

UPDATED ON JUL 18, 2021 01:46 PM IST



Several people were killed after a wall collapsed on some shanties in Chembur's Bharat Nagar area due to a landslide in Mumbai. (HT Photo/Satish Bate)

At least 22 people were killed and several others injured in Mumbai and one of its suburbs after they were trapped under houses that collapsed due to landslides following heavy rains that lashed the city and nearby areas on Saturday night and on Sunday morning, officials said.

Mumbai rains LIVE: 25 die in multiple incidents, Maharashtra CM calls high-level meeting



Mumbai: Commuters wade through a waterlogged road at Dadar after heavy rains in Mumbai, Sunday, July 18, 2021. (PTI)



Powai lake overflows

Mumbai: Following heavy rains in Maharashtra, Mumbai's Powai lake has started overflowing, the Brihanmumbai Municipal Corporation said on Saturday.

As per the release by BMC, "Powai Lake, one of the most important artificial lakes in the BMC area, has started flowing at around 3 pm today. The same lake was completely flooded on July 5 last year. Considering this, this year the lake has started filling up and flowing about 24 days earlier than last year."

Mumbai rain: 25 people died in rain-related incidents as incessant heavy downpour overnight during a major thunderstorm pummeled Mumbai. The Western Railway and Central Railway briefly suspended suburban train services in Mumbai after the heavy rains, and many long distance trains

people died as a compound wall came crashing down on some houses located on a hillock after a landslide, a fire official said. The retaining wall of the Bharatnagar locality in Mumbai's Mahul area collapsed at 1 am.

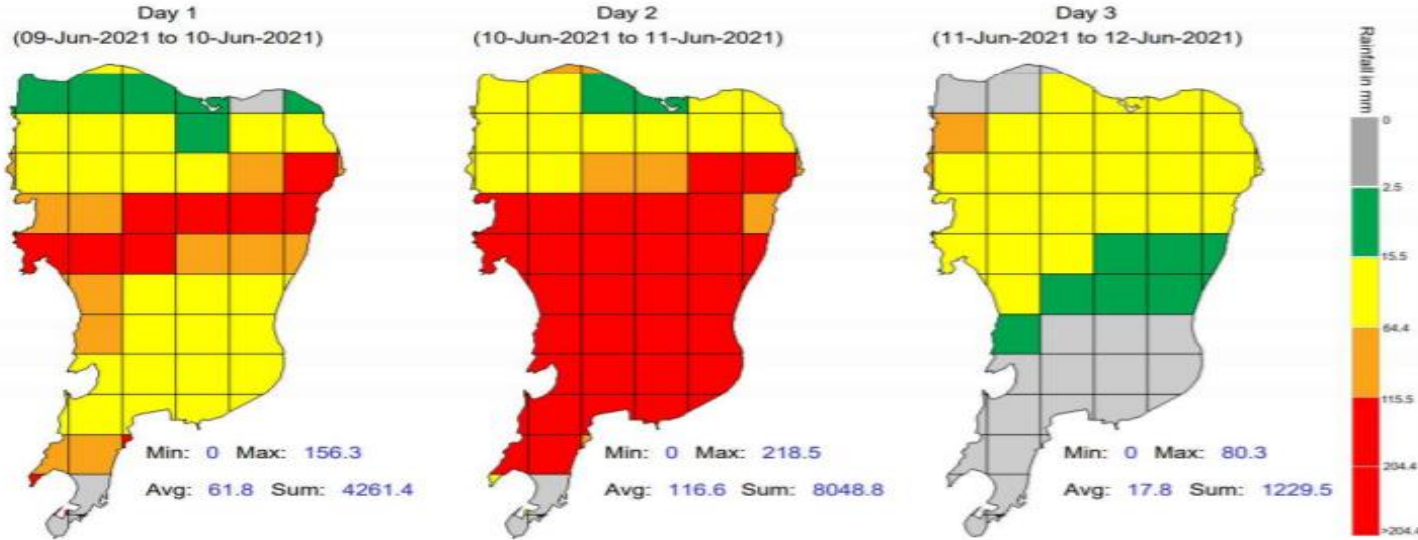


Watch: High tide at Mumbai's Marine Drive as heavy rain lashes city - The Economic Times Video | ET Now



Integrated Flood Warning System (i-Flows Mumbai)

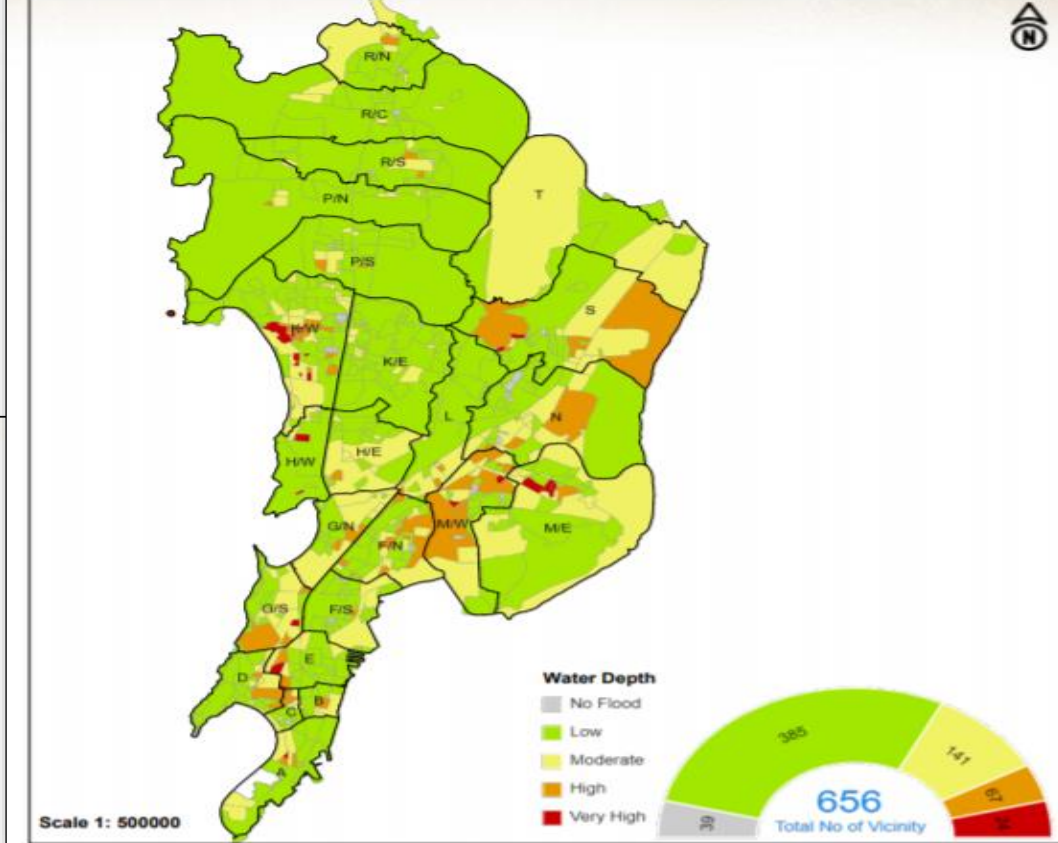
NCUM Rainfall Forecast : 09-Jun-2021



Integrated Flood - Inundation Map

iFLOWS-MUMBAI
INTEGRATED FLOOD WARNING SYSTEM FOR MUMBAI
A G2G Initiative towards a Disaster Resilient India

Probable Water Depth On **June 10, 2021**



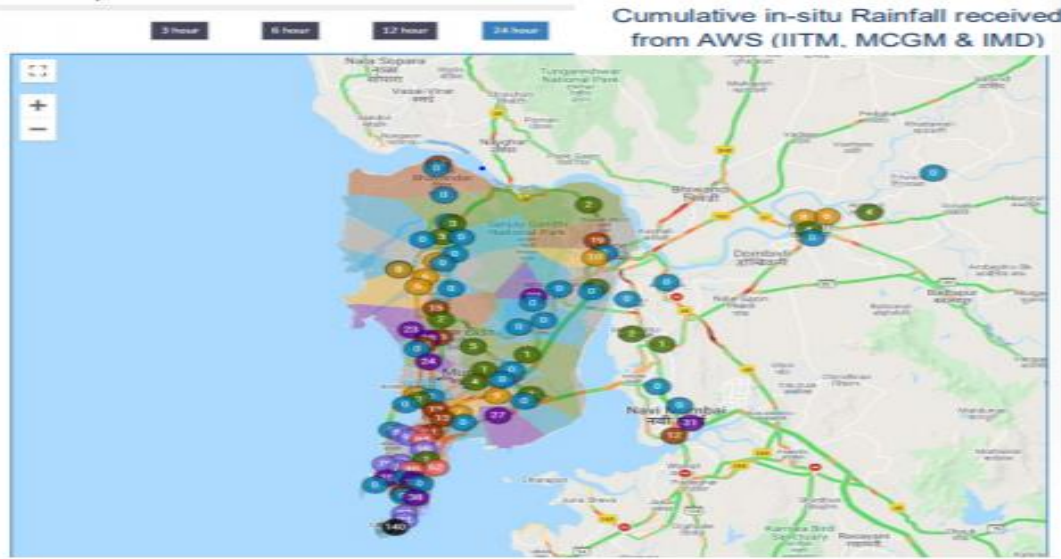
Rainfall Statistics

Last 24 Hours
 Max rain station:
Colaba Pumping Station
 Total rainfall (mm): **139.73**
 Last updated time:
 2021-06-08 20:45:00
 *WMO Rainfall Warning

Map Tools
 Enable Traffic
 Data markers
 Map Type: Road map

Classification

0 mm (no rainfall)	32
0.25 - 5 mm (very light)	16
5.0 - 10 mm (light)	10
10 - 20 mm (moderate)	10
20 - 40 mm (heavy)	10
40 - 70 mm (very heavy)	8
70 - 100 mm (flood)	8
100 - 120 mm (flood)	0
>120 mm (flood)	1

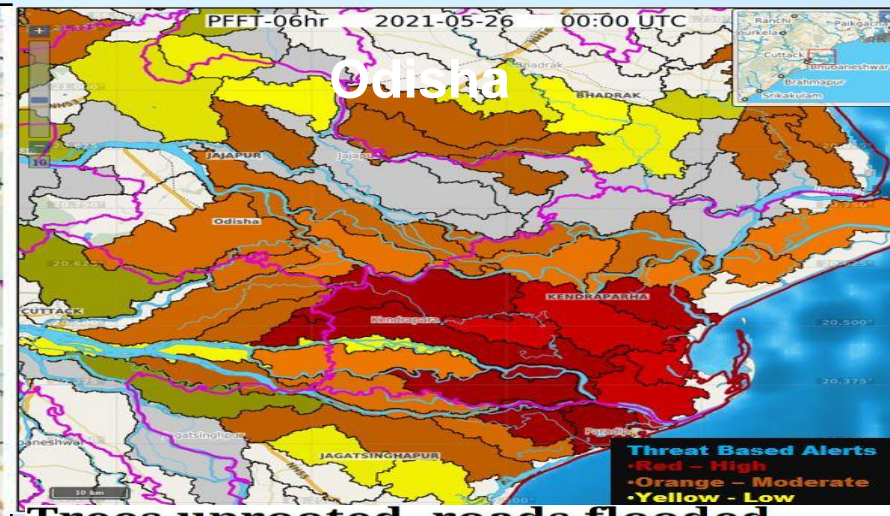
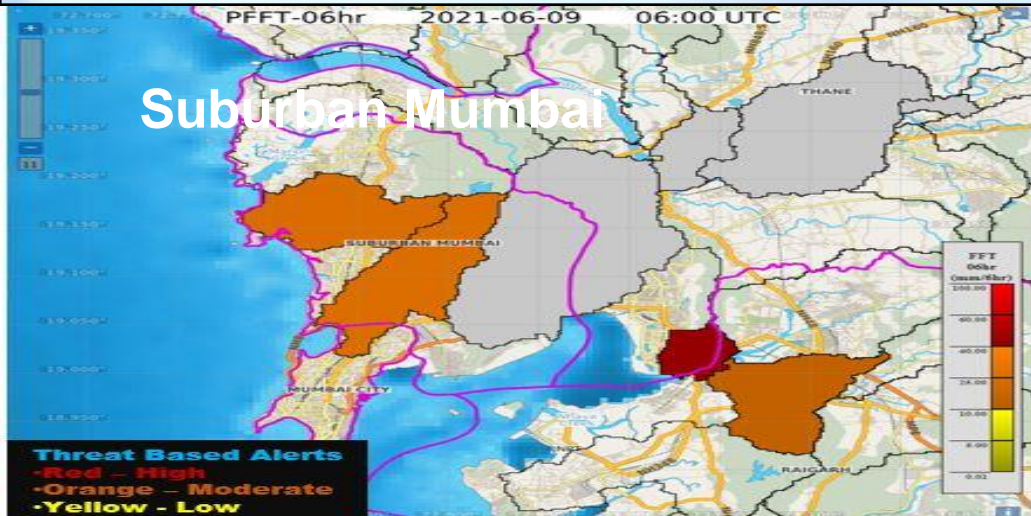


South Asia Flash Flood Guidance System

Flash Flood Threat for Mumbai on 9 June 2021 – Rainfall received: 210 mm in 24 hours.

Flash Flood Threat for Odisha on 26 May 2021 – Rainfall received: 300 mm in 24 hours.

- 30000 watersheds with 4X4 km resolution.
- Flash Flood Threat issued for next 6 hours.
- Flash Flood Risk is issued up to next 36 hours.



Roads waterlogged, rail services hit as heavy rain lashes Mumbai | See photos, videos

Trees uprooted, roads flooded, people living in darkness as cyclone Yaas batters Odisha

System put in operations with effect from 23 October 2020.

India Today Web Desk
New Delhi
June 9, 2021 | UPDATED: June 9, 2021 17:46 IST

Officials are yet to assess the damages caused by the storm in the two districts but said that it appears that devastations have been less than previously feared.

Published: 26th May 2021 09:47 PM | Last Updated: 26th May 2021 11:25 PM



City IBFW-Heavy rainfall-SOP in place over 30 major cities since July 2020



- Four Stages of Forecast and Warning System
- » Stage -1: Heavy rainfall Advisory(Watch)-(3-5 days lead time with 12-h updates)
- » Stage 2: Heavy rainfall Alert (1-3 days lead time with 12-h updates)
- » Stage-3: Heavy rainfall Warning (24 hours prior to the occurrence of the event at 06/12- hourly updates) with IBFW
- » Stage-4: Heavy rainfall Warning (6-12 hours prior to the occurrence of the event at 01/03- hourly updates) with IBFW



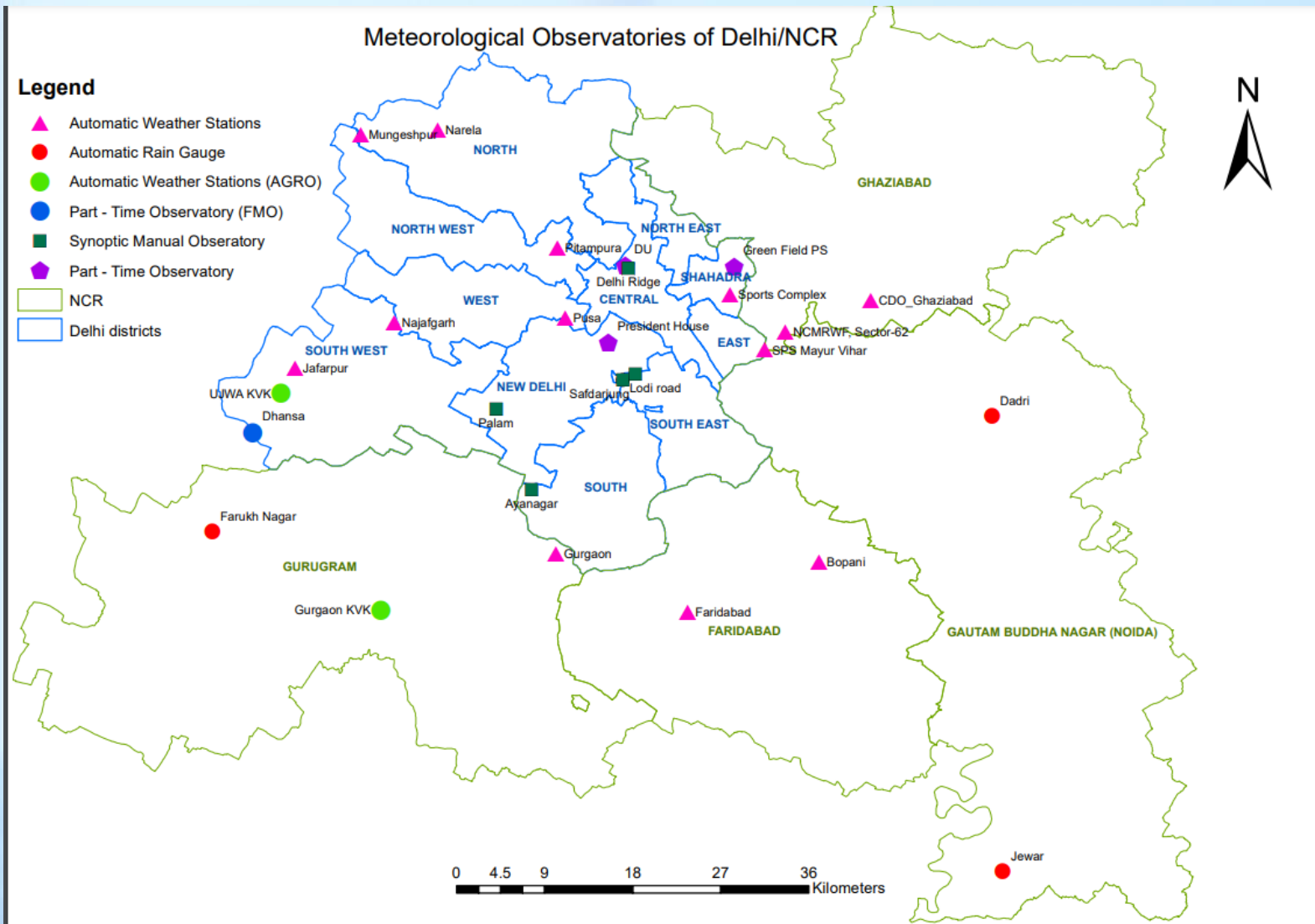
Issue, Challenges and Suggestions



भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT



Delhi NCR- Surface Rainfall stations(IMD) with DWRs



Mumbai- has Dense rain networks-Similar will come up at Guwahati, Chennai, etc



Urban Meteorological Services and Web-portal-Delhi NCR

Setting up High Density Meso-network and high resolution Modeling framework for major cities for Early Weather and Air pollution Monitoring/Forecast

- 1) Current Weather Observations
- 2) Current Air quality Observations
- 3) Radar, Lightning and Satellite
- 4) Weather warning of District/City-wise
- 5) Nowcasting (District/City-wise)
- 6) Issuing Bulletin daily basis

MINISTRY OF EARTH SCIENCES
INDIA METEOROLOGICAL DEPARTMENT
URBAN METEOROLOGICAL SERVICES FOR DELHI/NCR

ABOUT US OBSERVATIONS WEATHER/AIR QUALITY FORECAST WARNING BULLETIN

August 4, 2022 August 5, 2022 August 6, 2022 August 7, 2022 August 8, 2022

No warning Watch Alert Warning

Integrated Display of weather and Thunderstorm Warnings

Current Weather across Delhi/NCR

New Delhi					
Station	Temp	Wind	Humidity	Wind Dir	Wind Spd
New Delhi	29.4°	Southeasterly 3.6 km/h	83%		
Palam	30°	East-southeasterly 14.7 km/h	77%		
Ayanagar	28.8°	Calm 0 km/h	84%		
Jafarpur	34°	Northerly 3.6 km/h	99%		
Najafgarh	31.7°	Southeasterly 1.8 km/h	87%		
Pitampura	31.4°	—	91%		

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Cumulative in-situ Rainfall received from AWS (IITM, MCGM & IMD)

3 hour 6 hour 12 hour 24 hour

Map showing cumulative rainfall received from AWS (IITM, MCGM & IMD) across the Delhi/NCR region. The map displays various stations with colored markers indicating rainfall amounts.

Urban Meteorological Services

Setting up High Density Meso-network and high resolution Modeling framework for major cities for Early Weather and Air pollution Monitoring/Forecast

- 1) Current Weather Observations
- 2) Current Air quality Observations
- 3) Radar, Lightning and Satellite data
- 4) Weather warning of District/stations
- 5) Nowcasting (District/stations)
- 6) Daily Bulletin

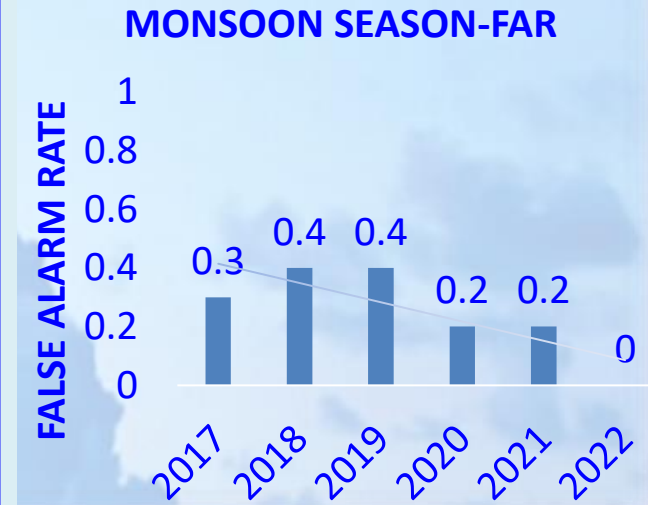
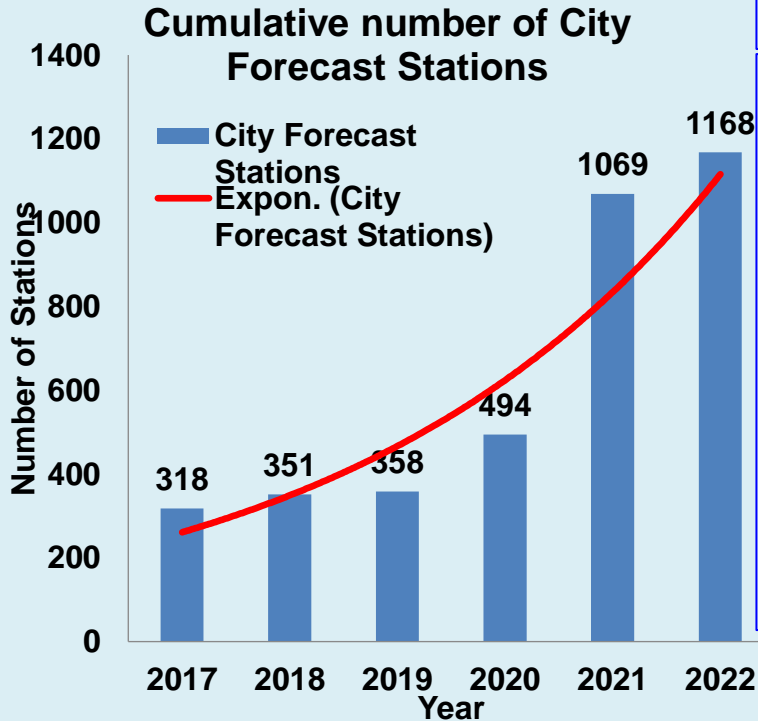
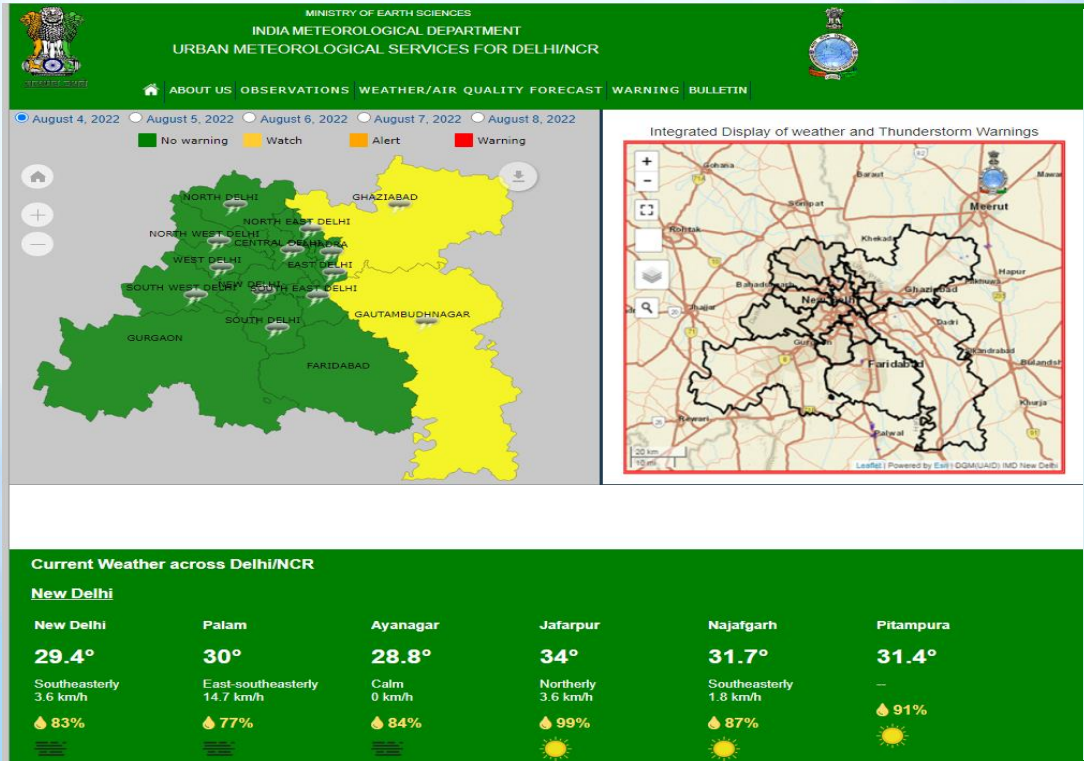
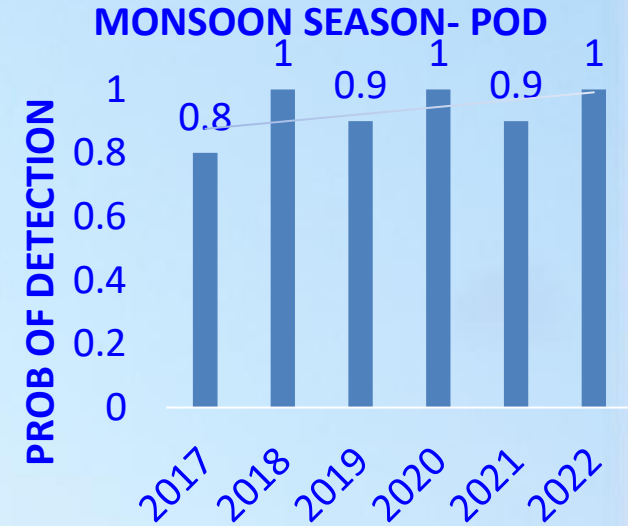
Augmentation:

Commissioning of 5X-Band DWRs and 200AWS/ ARGs in major cities for development of Urban Meteorological Services

Future Plan:

More than 100 Smart Cities

City forecast skill over Delhi



❑IMD has taken up Impact Based Forecasting (IBF) in a big way and i-FLOWS provides a very effective framework for generating IBF for India's megacities

❑Strengthening of rainfall monitoring network in non representative pockets of Mumbai especially on eastern side and up western coast.

❑Model consistency during the events

❑Changing Rainfall Pattern

❑Precise Mechanism of verification

❑Receiving disaster data from state govt.

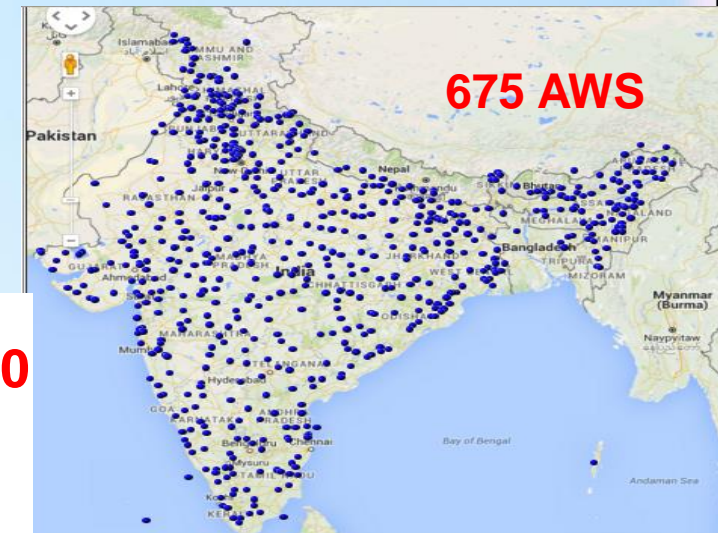
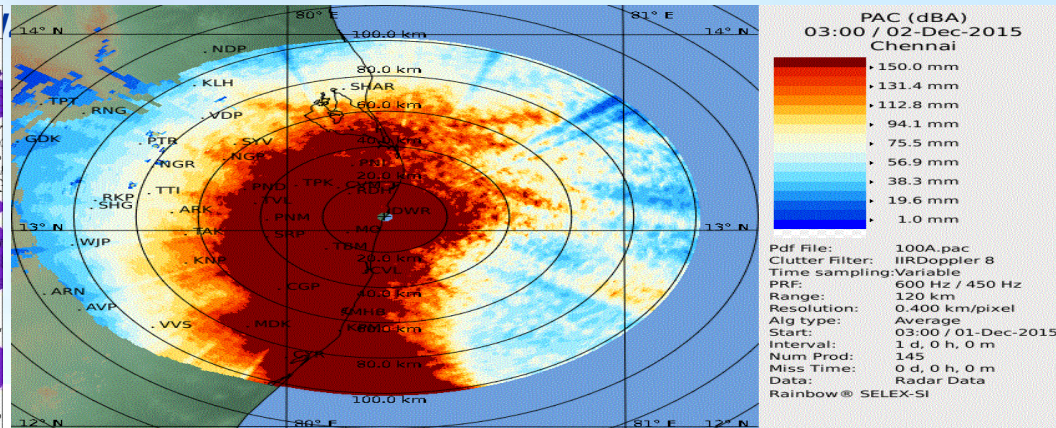
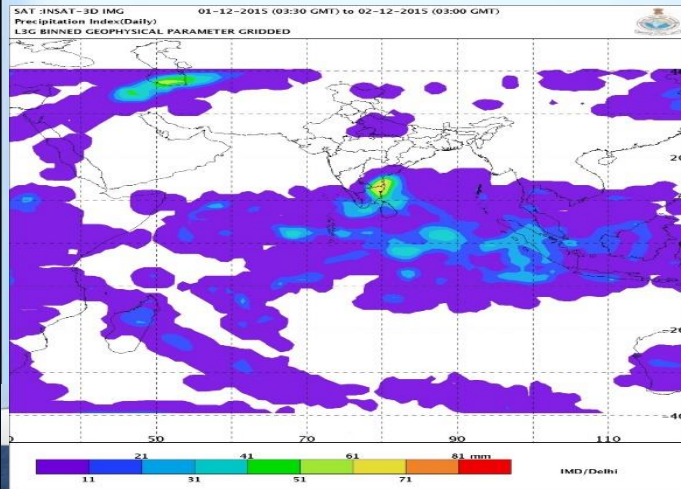
❑Interactive platform required for sharing the feedbacks even from the general public (***Crowd Sourcing***)



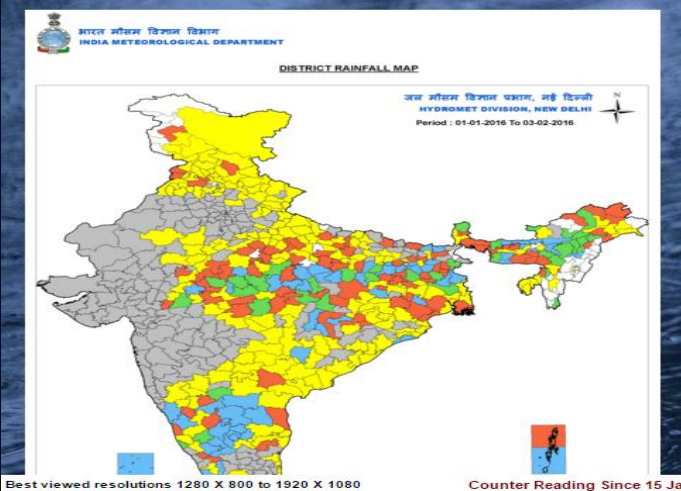
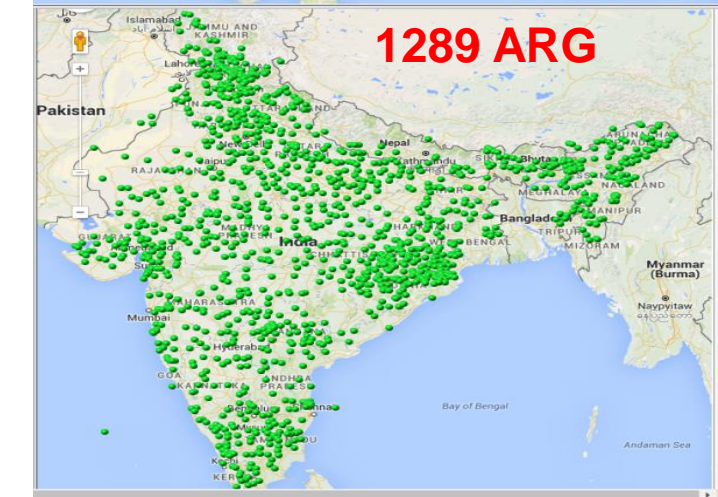
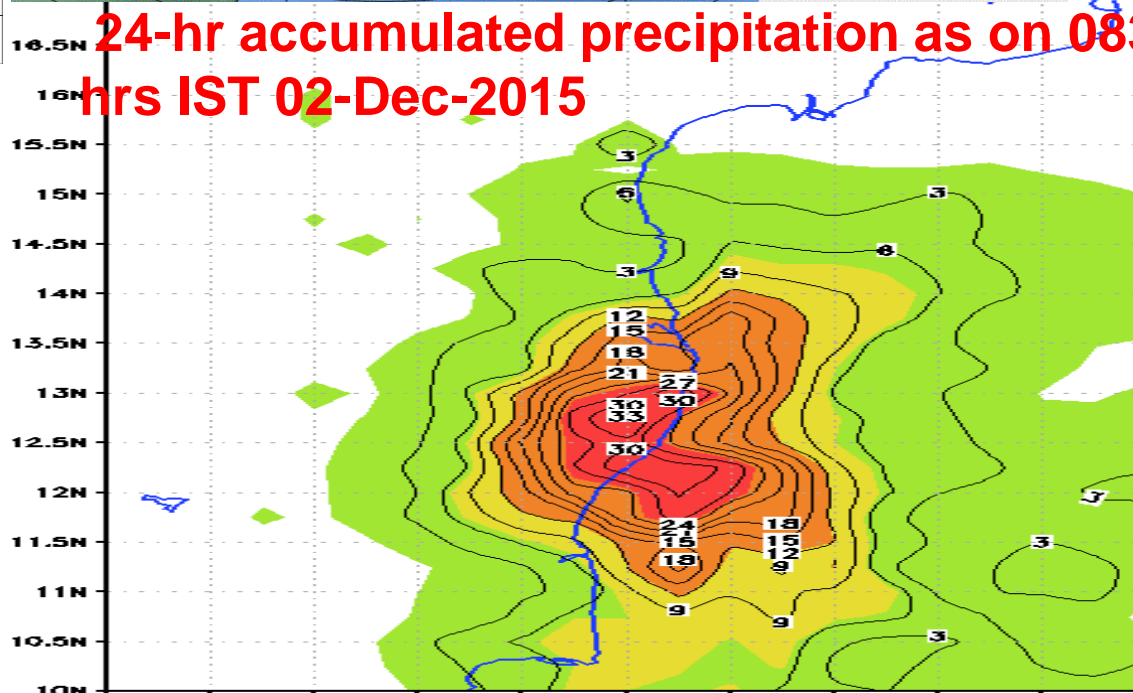
Existing Rainfall monitoring system and need

DWR Chennai – 24-hr rainfall, 02-12-2015/
0830 hrs IST


Enhanced observational network (both direct and remotely sensed) alongwith merged dataset for monitoring every hourly



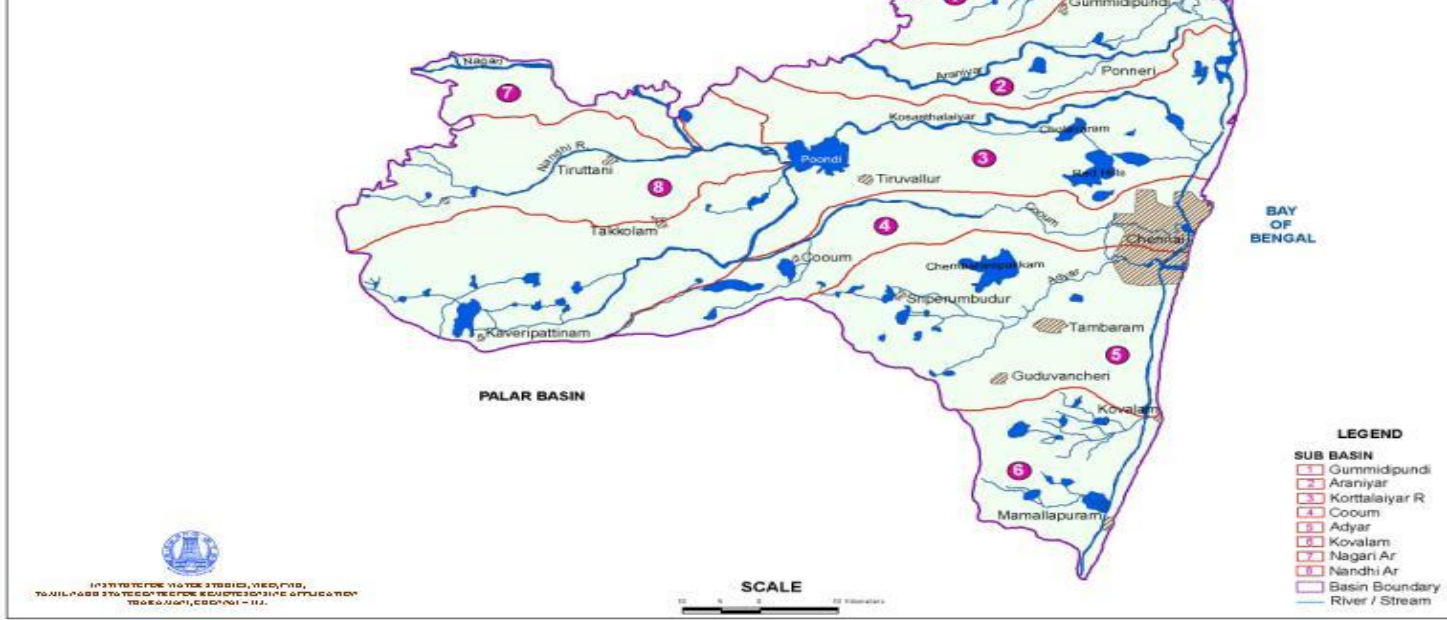
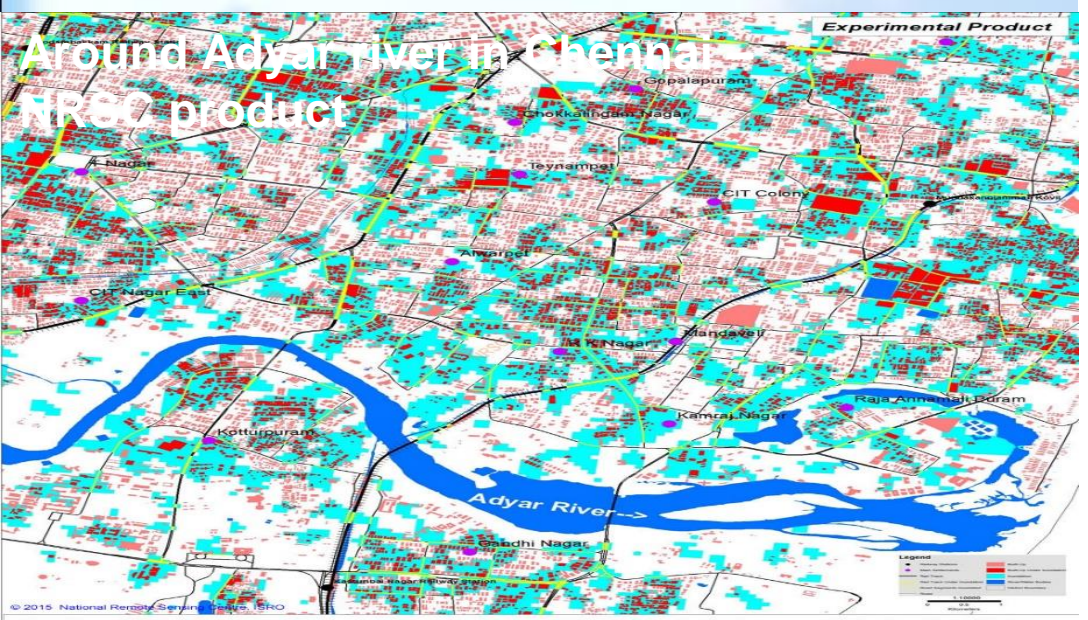
24-hr accumulated precipitation as on 0830 hrs IST 02-Dec-2015



Issues: Real time MONITORING OF WATER BODIES

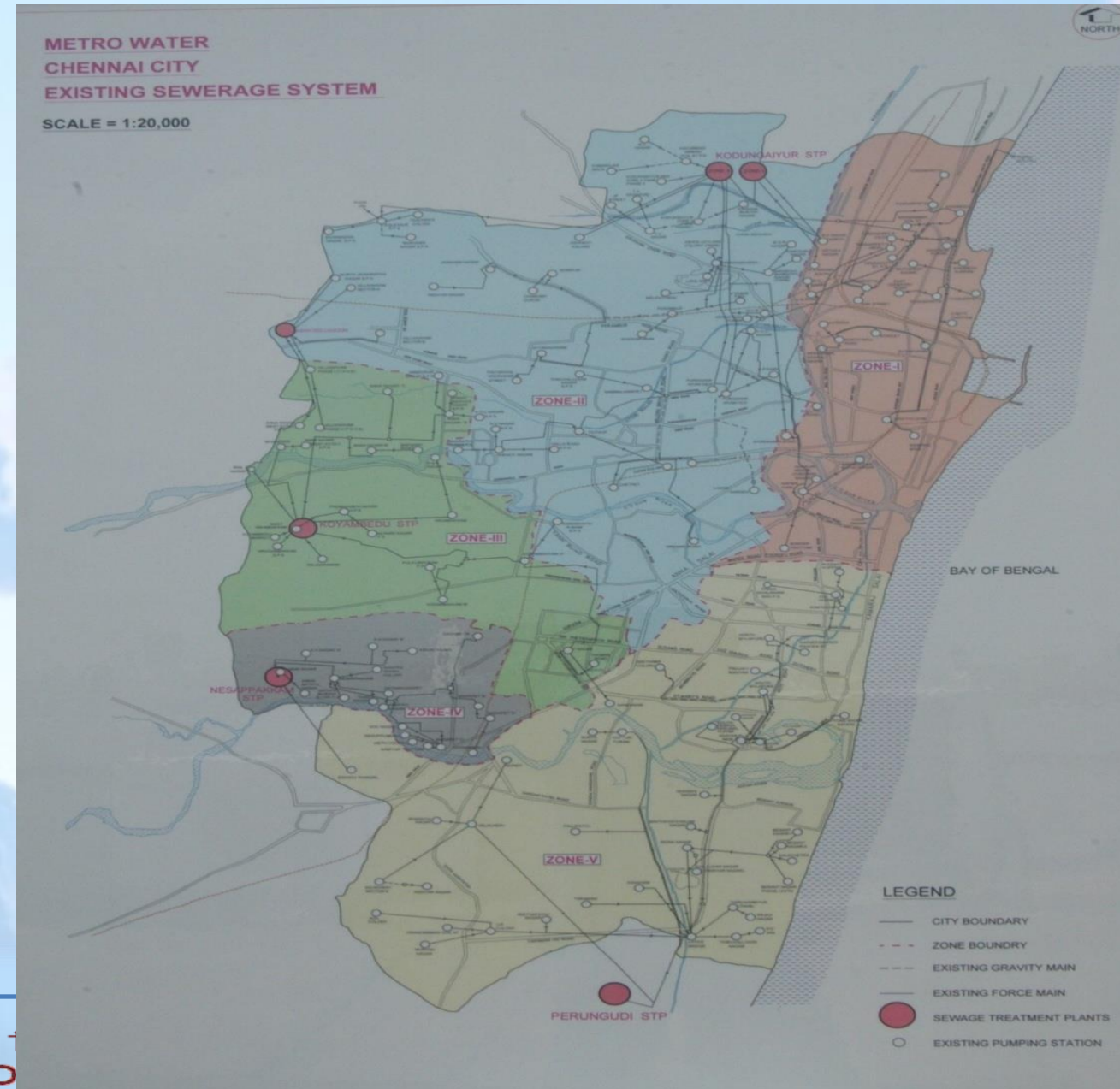
 RESERVOIR	Full Tank Level (ft.)	Full Capacity (mcft)	Level (ft)	Storage (Mcft)	Inflow (cusecs)	Outflow (cusecs)	Rainfall (mm)	Storage as on same day last year (mcft)
POONDI	140.00	3231	138.75	2745.00	8329	8552	74.6	280.00
CHOLAVARAM	64.50	881	60.32	595.00	423	400	36.0	61.00
REDHILLS	50.20	3300	47.90	2790.00	1027	1050	27.0	1329.00
SUB TOTAL	-	7412	-	6,130.00	-	-	-	1,670.00
CHEMBARAMBAKKAM	85.40	3645	83.48	3141.00	960	900	17.0	1189.00
TOTAL	-	11057	-	9,271.00	-	-	-	2,859.00
ENTRY POINT	-	-	-	-	0	-	106.0	-
KORATTUR ANICUT	-	-	-	-	-	-	5.0	-
TAMARAIPAKKAM	-	-	-	-	-	-	69	-

- ❖ No operational mechanism exists for daily monitoring of all water bodies
- ❖ Local, DISTRICT and catchment level R/F FORECAST



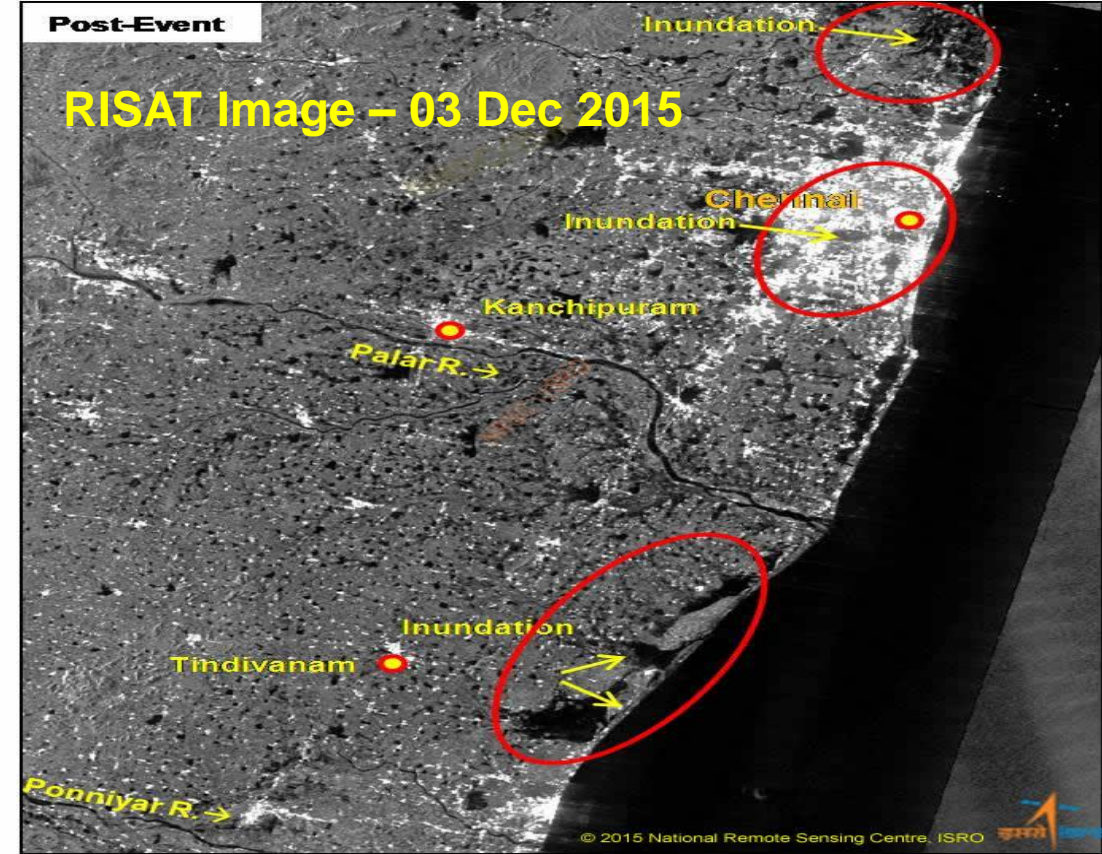
Defining city specific drainage system and topography

- Information on drainage system including drainage capacity at different locations / areas in a city.
- Digital data on drainage system are needed
- Cartosat data at 30 m resolution freely available
- 2 metre data are needed for mega-cities
- Vertical resolution of 0.5 m needed.



Decision support system

- Observation (Rainfall, water level)
- Drainage system data
- Digital elevation model
- **Prediction**
- Meteorological Models
- Hydrological and hydrodynamical Model
- Vulnerability model
- Terrain model
- Coastal inundation model



npsc / ISRO

Version - 1.2

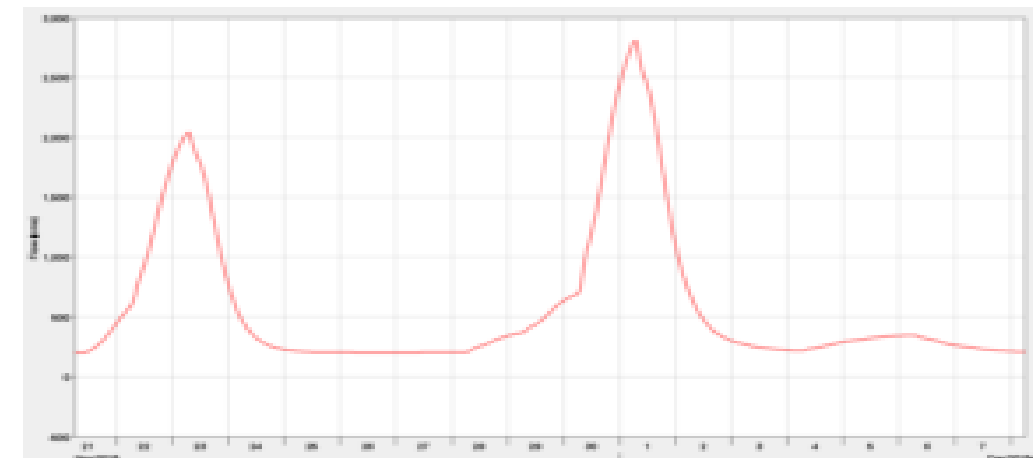


Fig. 6 Computed flood hydrograph of Adyar River

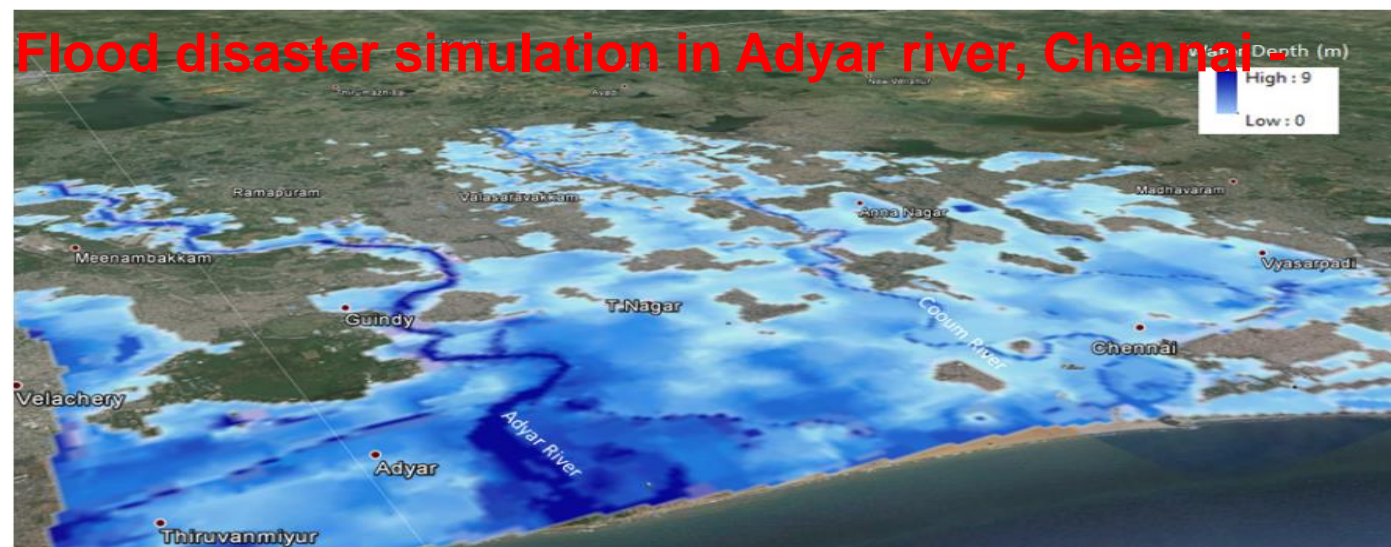


Fig.8 Flood inundation simulations (Northern part of Chennai , up to 20 km from the coast)

Thank you



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