Lecture 4- Introducing methodology for Heavy rainfall related IBFW smaller areas (District and cluster of Districts) and using at real time:

Exercise on Hazard(inclding met event), Impact, Vulnerability and Exposure (the map exercise) and prearation of Risk matrix for prearation of IBFW)

IMD FUNCTIONAL GROUP

UNDER THE GUIDANCE OF DR M. MOHAPATRA, DGM IMD with input from *Dr. Gayatri Vani Kanchibhotla* and Sri Atul Kumar Singh

Presentation- DR RAJENDRA KUMAR JENAMANI

jenamanirk@gmail.com

National Weather Forecasting Center(NWFC)

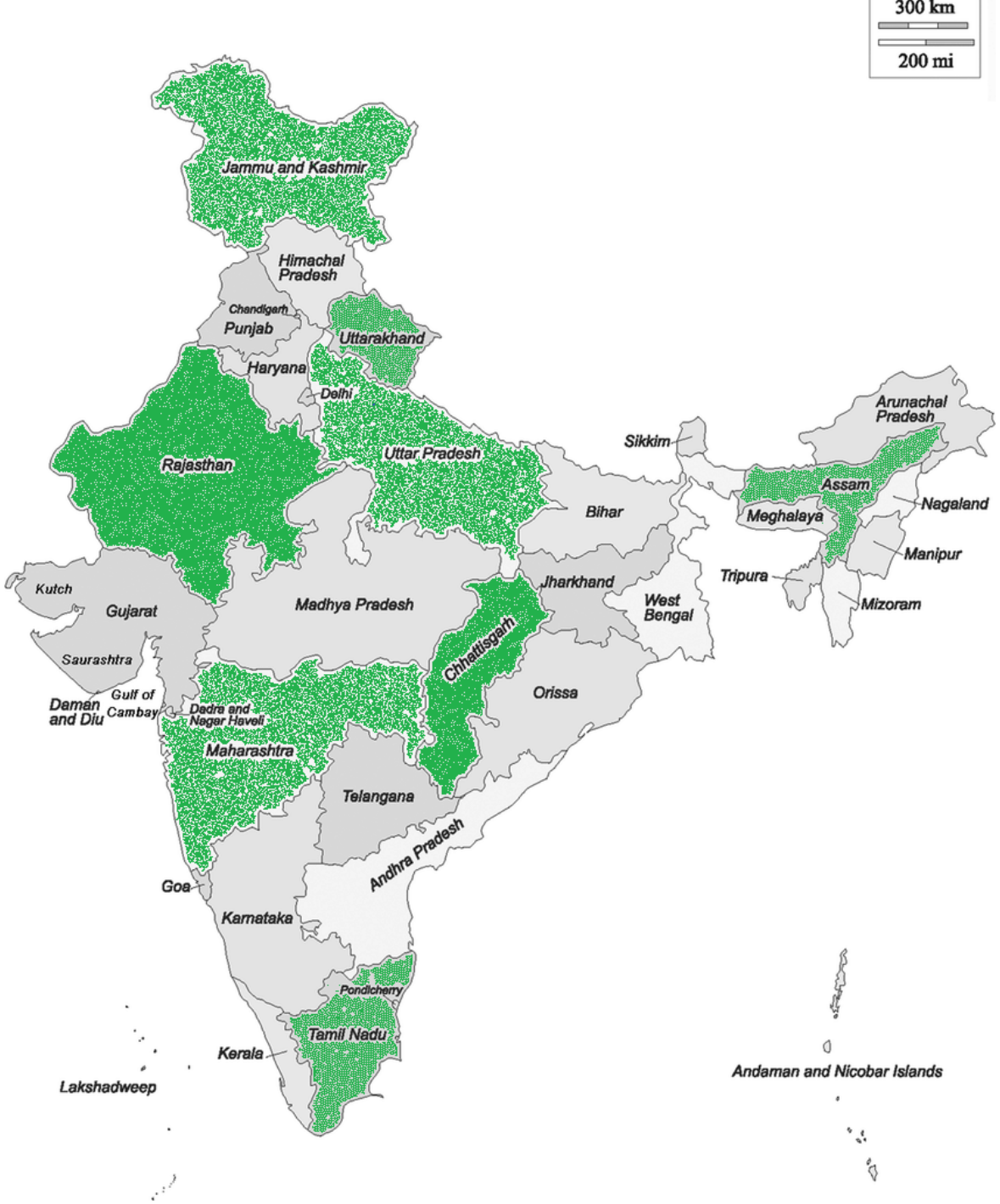
IMD, New Delhi

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

OBJECTIVES

- How to compute District-wise Risk matrix using Stage III methodology using HIVE data and Met event intensity (rainfall thresholds)
  - ➢ Example state in East Central India
  - ➢ Cluster method-For a state of North India
- IBFW HEAVY RAINFALL REAL TIME –IMD examples
- Issues and challenges

How to compute District-wise Risk matrix as Stage I and Stage III using past data of HIVE- Met event intensity (rainfall thresholds for Heavy rainfall IBFW)-Multi parameters(Exposures, hazards and impacts and Vulnerability) Indicator methods to compute Risk matrix from rain thresholds at scale of low, moderate, high, very high



How to compute District-wise Risk matrix as Stage I and Stage II using past data of HIVE- Met event intensity (rainfall thresholds)

Example state in East Central India –By Dr VK Gayatri and Dr Jenamani IMD, India

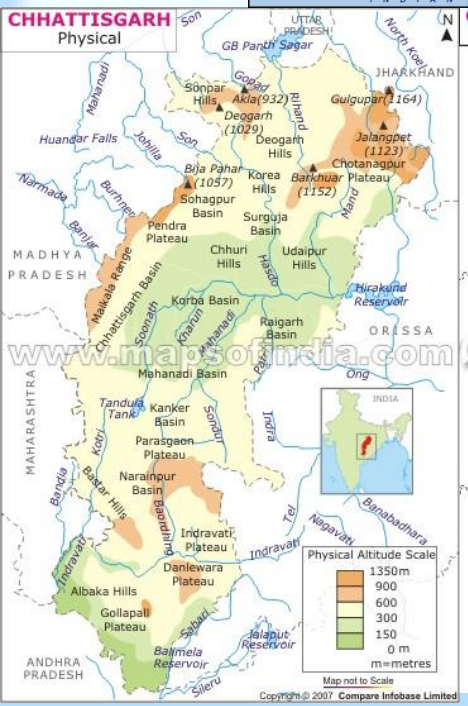
Weather Hazards over Chhattisgarh

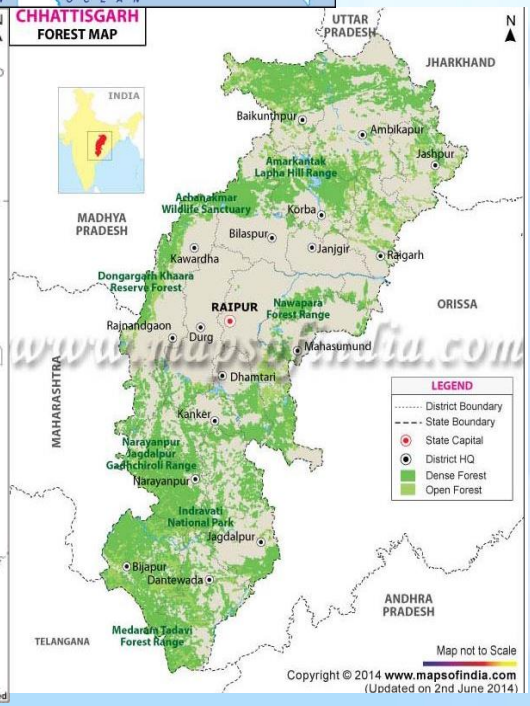
Hazard	Period
Heat Wave	April-June
Lightning	Lightning with Hail: Feb, March Lightning with Gusty Winds: Apr, May Lightning (CG Lightning Associated with Deaths) : June - Oct
Flood	July-Sep
Urban Flood (Only Raipur, Bilaspur and Durg Districts)	July-Sep

Major Impact : Human/Livestock Death

Major Impact : Crop Damage

Geo Physical features of Chhattisgarh





- Two Major river basins (Out of five): Mahanadi basin (eight sub basins) and Godavari Basin (three sub basins)
- Mainly Plateau region over South, Plains over Central and hills over North CG.
- There are 12 major dams (excluding the minor ones with lower capacity)
- Largest dam is in Korba district with live capacity of 2894 FRL in M Cu
- Major Economy: Agriculture and Power sector
- 33 Districts in the state

DATA

	Data Type
Hazard	Rainfall
Impact	**1.** Deaths due to flood in monsoon season (10 year data)
Vulnerability	**2.** Villages Vulnerable to flood in each district
	3. Catchment/Area of river Basin
Exposure	**4.** Population
	5. Live Stock
	6. Agricultural Land (Area Cultivable and Crop Calendar)

- Heavy Rainfall is the threshold weather parameter.
- The impact matrix was developed with SIX parameters consisting of Impact, Vulnerability and Exposure.

Methodology

- District wise Risk assessment based on past Impact data, Vulnerability and Exposure
- Contribution analysis is carried out for each data set.
- Based on percentage contribution of each district in each category, districts are categorized
- Equal weight is given to all of the indicators

Risk factor	Category
>50%	Red
49-25 %	Orange
24-10%	Yellow
<10%	Green

Results and Discussion

	Population	% contri	Livestock	% contri	Agri	% contri	Deaths	% contri	Villages	% contri	River Basin	% contri
BALOD			108736	1.2559824	255.8	4.81512	1	0.04498	7	0.34774	3404.39	2.51996
BALODA BAZAR			107067	1.2367042	280.9	5.2876	85	3.82366	83	4.1232	4661.19	3.45025
BALRAMPUR			677832	7.8294684	177.9	3.34875	0	0	35	1.7387	6251.86	4.62767
BASTAR	1413199	5.5321513	203487	2.3504276	52.189	0.98239	204	9.17679	37	1.83805	5386	3.98676
BEMETARA			126918	1.4659982	342.4	6.44526	8	0.35987	110	5.46448	2862.25	2.11866
BIJAPUR	255230	0.999131	80907	0.9345366	40.722	0.76654	0	0	90	4.47094	9378.71	6.94219
BILASPUR	2663629	10.427122	3115620	35.98775	289.2	5.44384	389	17.4989	132	6.55738	5530.58	4.09378
DANTEWADA	533638	2.0889954	22895	0.2644544	102.6	1.93132	145	6.52272	17	0.84451	2885.05	2.13554
DHAMTARI	799781	3.1308467	51095	0.5901856	218.5	4.11299	21	0.94467	77	3.82514	4077.92	3.01851
DURG	3343872	13.090022	269331	3.1109752	548.3	10.3211	0	0	92	4.57029	2260.14	1.67297
GARIABAND					161.5	3.04004		0		0	4837.21	3.58054
JANJGIR	1619707	6.3405537	196824	2.2734649	260	4.89418	101	4.54341	60	2.98063	3859.56	2.85688
JASHPUR	851669	3.3339691	72318	0.8353272	326.7	6.14973	239	10.7512	732	36.3636	5854.56	4.33359
KABIRDHAM	822526	3.219885	304066	3.5121905	3.085	0.05807	0	0		0	4188.4	3.10029
KANKER	748941	2.931827	78712	0.9091827	228.1	4.2937	65	2.92398	78	3.87481	7200.44	5.32982
KONDAGAON			192276	2.2209321	137.5	2.58827	82	3.68871	41	2.03676	5063.26	3.74786
KORBA	1206640	4.7235492	93155	1.0760102	289.2	5.44384	156	7.01754	41	2.03676	6604.49	4.88869
KORIYA	658917	2.5794163	1869076	21.589231	133	2.50356	0	0	0	0	6605.23	4.88924
MAHASAMUND	1032754	4.0428499	75159	0.8681429	302.1	5.68666	170	7.64732	31	1.53999	4745.36	3.51255
MUNGELI			162465	1.8765927	208	3.91534	60	2.69906	50	2.48385	2774.67	2.05383
NARAYANPUR	139820	0.5473436	25607	0.2957801	32.9	0.6193	66	2.96896	14	0.69548	3748.77	2.77487
RAIGARH	1493984	5.8483947	431897	4.9887346	6.632	0.12484	0	0		0	7030.79	5.20424
RAIPUR	4063872	15.908555	117388	1.3559195		0	0	0	43	2.13612	2903.92	2.1495
RAJNANDGAON	1537133	6.017307	139395	1.6101169	19.403	0.36524	0	0	129	6.40835	8054.69	5.96214
SUKMA			58022	0.6701977	97.3	1.83155	78	3.50877	50	2.48385	5443.83	4.02956
SURAJPUR			77198	0.8916948	177.9	3.34875	353	15.8794	64	3.17933	5451.48	4.03523
SURGUJA	2359886	9.2380807		0	620.6	11.682	0	0		0	4032.48	2.98487

	% Contribution from All six parameters	Cummulative Contribution
BILASPUR	80	13
JASHPUR	62	24
DURG	33	29
KORIYA	32	34
SURAJPUR	27	39
KORBA	25	43
SURGUJA	24	47
JANJGIR	24	51
BASTAR	24	55
MAHASAMUND	23	59
RAIPUR	22	63
RAJNANDGAON	20	66
KANKER	20	69
BALODA BAZAR	18	72
BALRAMPUR	18	75
RAIGARH	16	78
BEMETARA	16	81
DHAMTARI	16	83
KONDAGAON	14	86
BIJAPUR	14	88
DANTEWADA	14	90
MUNGELI	13	92
SUKMA	13	94
KABIRDHAM	10	96
BALOD	9	98
NARAYANPUR	8	99
GARIABAND	7	100

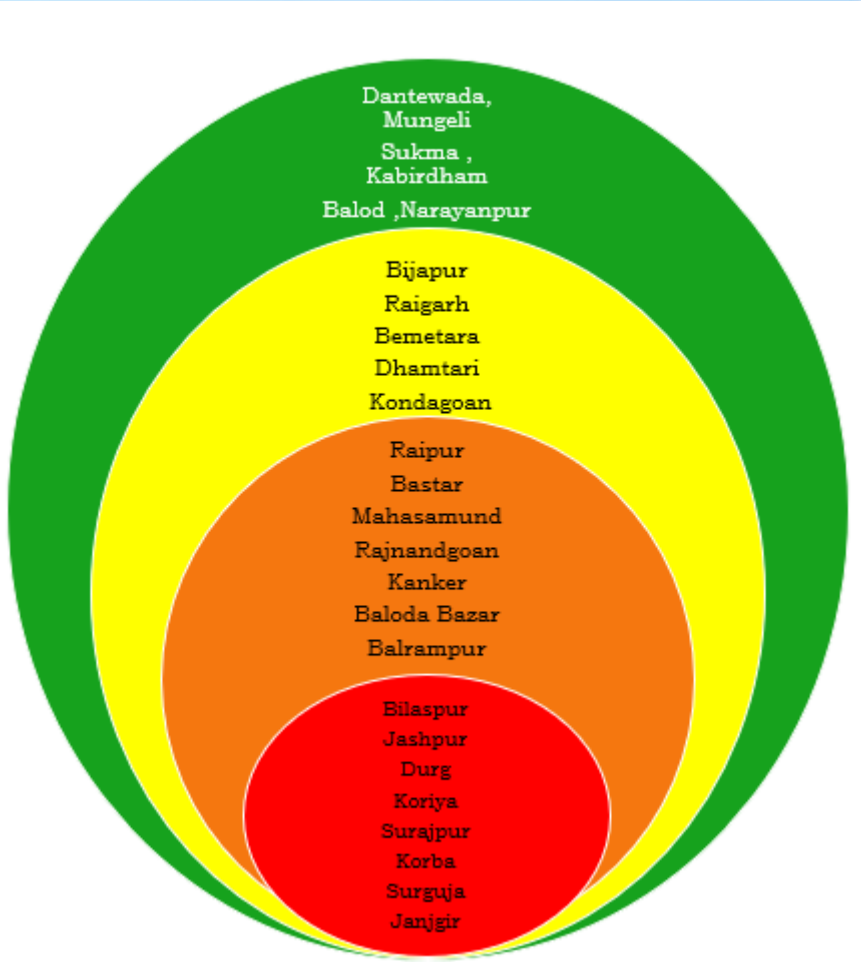


Fig: Stacked Venn representing risk factor of each district during Heavy rainfall activity based on Impact, Vulnerability and Exposure

Limitation

This categorization is purely based on the six observational categories.
Additional data like the type of housing and roads might change the matrix.
Missing data from few districts.

Cluster	Districts	Rainfall Threshold	Impact
Central Plains	Rajnandgoan, Balod Durg, Bemetara, Raipur, Dhamtari, Gariaband, Mahasamund Baloda Bazar Bilaspur Raigarh Janjgir	a) Rainfall of 65-110 mm for one single day	
		a) Rainfall > 110 mm on single day. b) Rainfall of 60-110 mm for 2 days (after 2 days of yellow alert)	• Water logging over roads and agricultural fields. • Closure of low lying bridges over canals and tributaries • Flower/Leaf/Fruit drop due to water logging in agricultural fields
		a) Rainfall >200 mm on single day. b) Rainfall of 151 - 200 mm for 2 days c) Rainfall of 110 - 150 mm for 2 days (after 2 days of orange alert)	• Widespread and severe water logging. • River bank bursting of Mahanadi tributaries • Damage to kutcha houses. Agricultural crop and roads. • Disruption in road and rail traffic and municipal services (water and electricity) • Falling of trees due to damp soil

Cluster	Districts	Rainfall Threshold	Impact
Northerly Hills	Jashpur, Surguja, Korba Koriya, Kawardha, Mungeli Balrampur.	a) Rainfall of 65-110 mm for one single day	
		a) Rainfall > 110 mm on single day. b) Rainfall of 60-110 mm for 2 days (after 2 days of yellow alert)	• Closure of low lying bridges over canals • Water logging in agricultural fields
		a) Rainfall >200 mm on single day. b) Rainfall of 151 - 200 mm for 2 days c) Rainfall of 110 - 150 mm for 2 days (after 2 days of orange alert)	• Widespread and severe water logging. • Flooding around banks of Hasdeo river • Damage to kutcha houses., agricultural crop and roads. • Falling of trees due to damp soil • • Possibility of mudslides

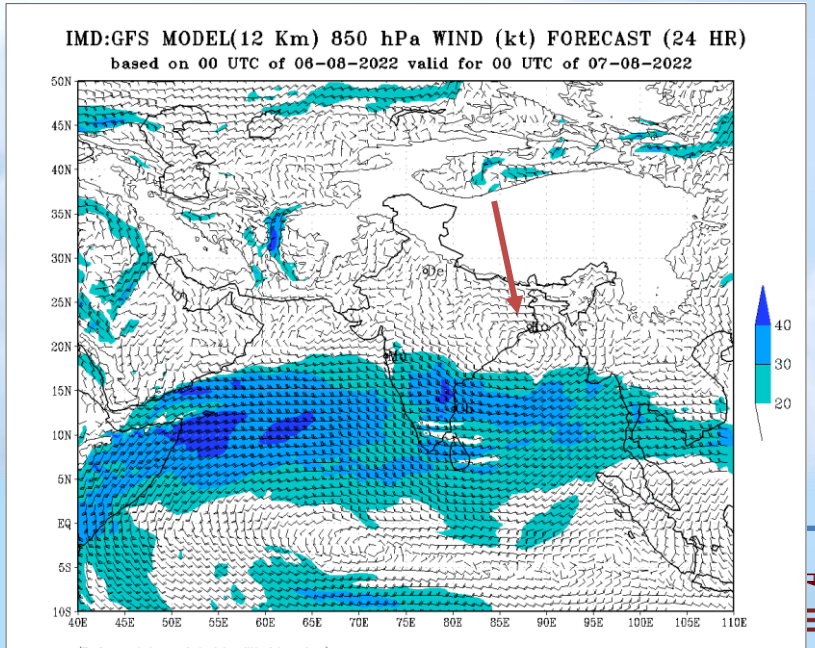
IBF – Monsoon 2022

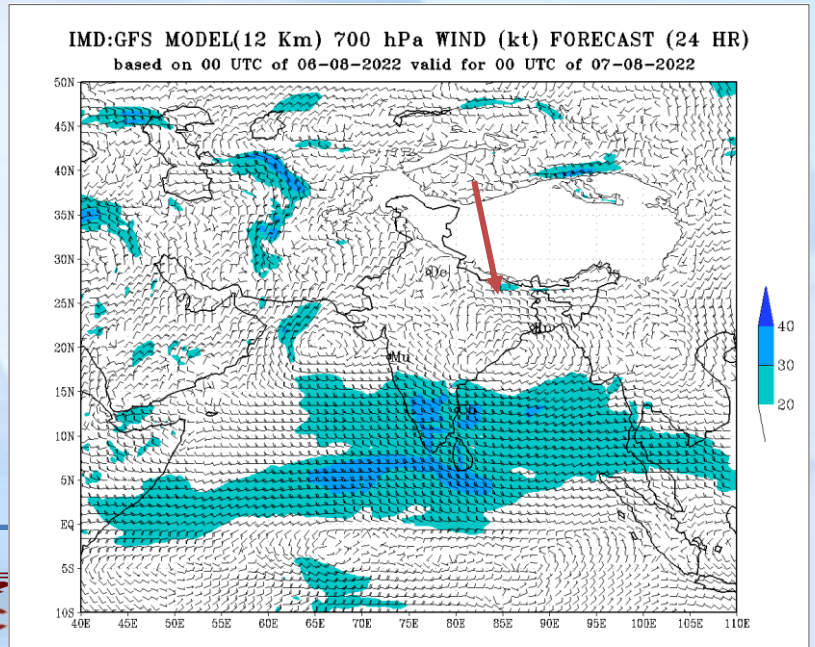
Total No of IBF Bulletins: 48 Hrs Prior – 8
24 Hrs Prior – 11

Extended spells causing major impact : 08th to 13th July 2022
06th to 15th August 2022

Every day of the spell witnessed Very heavy to Extremely heavy rainfall over 50 % of the stations in Bastar Subdivision

Synoptic Feature: A low pressure area over North west Bay of Bengal extending up to mid tropospheric levels tilting southwestwards- This causes very heavy to extremely heavy rainfall activity over Chhattisgarh





IBF – Monsoon 2022

Very Heavy to Extremely Heavy Rainfall very likely over Raipur, Dhamtari and adjoining Districts during the next 24 hours

→ Very Heavy to Extremely Heavy Rainfall very likely over Mahanadi Basin causing flooding over river banks of Tandula, Kharun, Arpa, Hamp, Agar and Maniyari.

Heavy rainfall over Raipur district likely during the next 48 hours

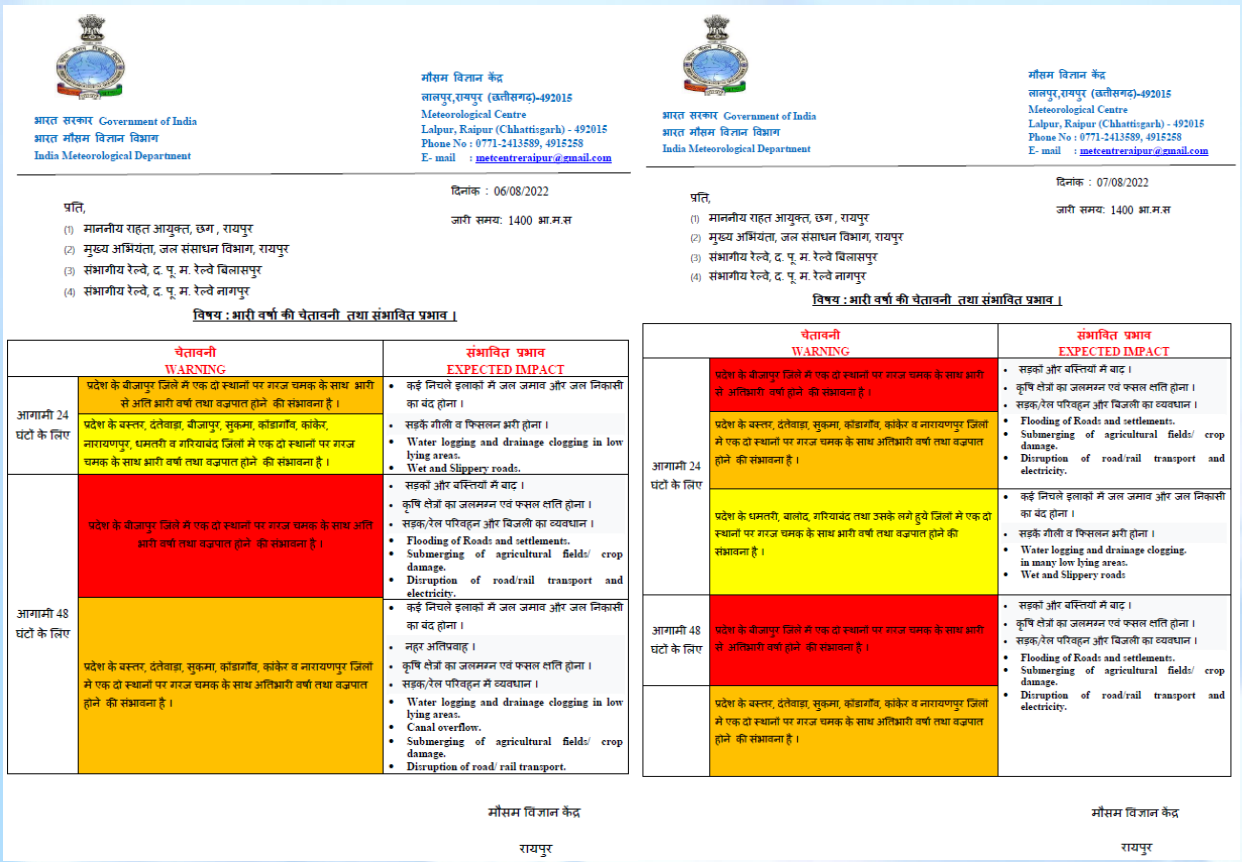
→ Heavy rainfall over Raipur likely during the next 48 hours causing traffic congestion in the city limits and over flow of drainages. Flower/Leaf/Fruit drop due to water logging in agricultural fields

% correct for Rainfall Distribution Forecast - Monsoon 2022					
	Day-1	Day-2	Day-3	Day-4	Day-5
Raipur	77.4	87.1	83.9	77.4	80.6
Bilaspur	83.9	87.1	90.3	90.3	90.3
Ambikapur	77.4	83.9	87.1	80.6	83.9
Jagdalpur	80.6	83.9	80.6	83.9	80.6
Durg	77.4	77.4	74.2	80.6	80.6
Rajnandgaon	80.6	71	77.4	83.9	74.2
Pendraroad	80.6	80.6	87.1	83.9	83.9
Labhandi	54.8	61.3	58.1	64.5	67.7
Mana A.P.	80.6	80.6	83.9	77.4	87.1

?

Subjective verification indicated the decrease in false alarm

IBF – Monsoon 2022



भारत सरकार Government of India
भारत मौसम विज्ञान विभाग
India Meteorological Department

मौसम विज्ञान केंद्र
लालपुर,रायपुर (छत्तीसगढ़)-492015
Meteorological Centre
Lalpur, Raipur (Chhattisgarh) - 492015
Phone No : 0771-2413589, 4915258
E- mail : metcentreraipur@gmail.com

दिनांक : 06/08/2022

जारी समय: 1400 भा.म.स

प्रति,

(1) माननीय राहत आयुक्त, छग , रायपुर
(2) मुख्य अभियंता, जल संसाधन विभाग, रायपुर
(3) संभागीय रेल्वे, द. पू. म. रेल्वे बिलासपुर
(4) संभागीय रेल्वे, द. पू. म. रेल्वे नागपुर

विषय : भारी वर्षा की चेतावनी तथा संभावित प्रभाव ।

	चेतावनी WARNING	संभावित प्रभाव EXPECTED IMPACT
आगामी 24 घंटों के लिए	प्रदेश के बीजापुर जिले में एक दो स्थानों पर गरज चमक के साथ भारी से अति भारी वर्षा तथा वज्रपात होने की संभावना है ।	• कई निचले इलाकों में जल जमाव और जल निकासी का बंद होना ।
	प्रदेश के बस्तर, दंतेवाड़ा, बीजापुर, सुकमा, कांडागाँव, कांकेर, नारायणपुर, धमतरी व गरियाबंद जिलों में एक दो स्थानों पर गरज चमक के साथ भारी वर्षा तथा वज्रपात होने की संभावना है ।	• सड़कें गीली व फिसलन भरी होना । • Water logging and drainage clogging in low lying areas. • Wet and Slippery roads.
आगामी 48 घंटों के लिए	प्रदेश के बीजापुर जिले में एक दो स्थानों पर गरज चमक के साथ अति भारी वर्षा तथा वज्रपात होने की संभावना है ।	• सड़कों और बस्तियों में बाढ़ । • कृषि क्षेत्रों का जलमग्न एवं फसल क्षति होना । • सड़क/रेल परिवहन और बिजली का व्यवधान । • Flooding of Roads and settlements. • Submerging of agricultural fields/ crop damage. • Disruption of road/rail transport and electricity.
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मौसम विज्ञान केंद्र

रायपुर

भारत सरकार Government of India
भारत मौसम विज्ञान विभाग
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Meteorological Centre
Lalpur, Raipur (Chhattisgarh) - 492015
Phone No : 0771-2413589, 4915258
E- mail : metcentreraipur@gmail.com

दिनांक : 07/08/2022

जारी समय: 1400 भा.म.स

प्रति,

(1) माननीय राहत आयुक्त, छग , रायपुर
(2) मुख्य अभियंता, जल संसाधन विभाग, रायपुर
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	प्रदेश के बस्तर, दंतेवाड़ा, सुकमा, कांडागाँव, कांकेर व नारायणपुर जिलों में एक दो स्थानों पर गरज चमक के साथ अतिभारी वर्षा तथा वज्रपात होने की संभावना है ।	
	प्रदेश के धमतरी, बालोद, गरियाबंद तथा उसके लगे हुये जिलों में एक दो स्थानों पर गरज चमक के साथ भारी वर्षा तथा वज्रपात होने की संभावना है ।	• कई निचले इलाकों में जल जमाव और जल निकासी का बंद होना । • सड़कें गीली व फिसलन भरी होना । • Water logging and drainage clogging, in many low lying areas. • Wet and Slippery roads
आगामी 48 घंटों के लिए	प्रदेश के बीजापुर जिले में एक दो स्थानों पर गरज चमक के साथ भारी से अतिभारी वर्षा होने की संभावना है ।	• सड़कों और बस्तियों में बाढ़ । • कृषि क्षेत्रों का जलमग्न एवं फसल क्षति होना । • सड़क/रेल परिवहन और बिजली का व्यवधान । • Flooding of Roads and settlements. • Submerging of agricultural fields/ crop damage. • Disruption of road/rail transport and electricity.
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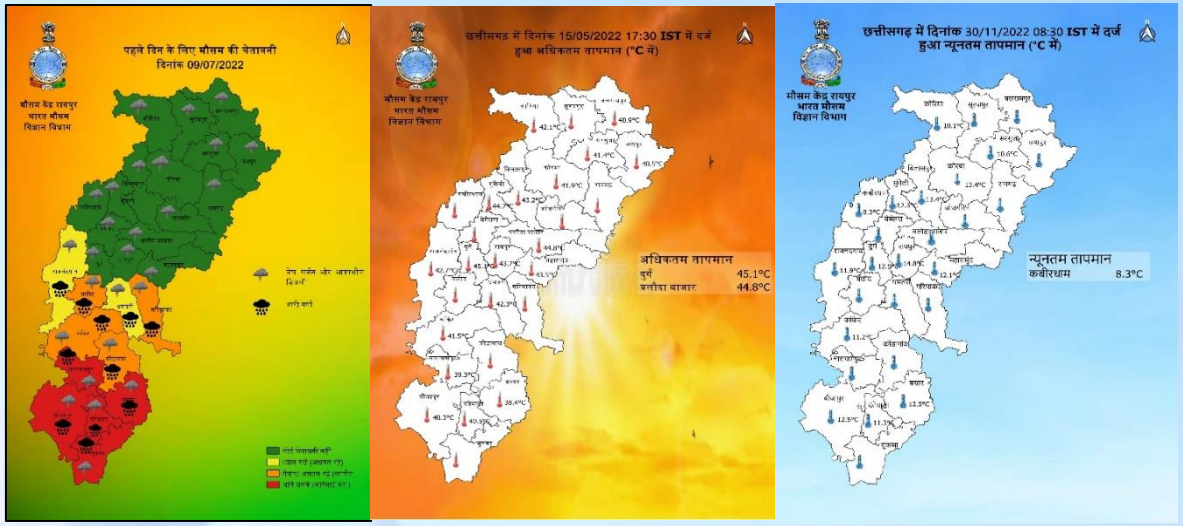
मौसम विज्ञान केंद्र

रायपुर



Textual and Pictorial display of Weather information for better understanding

Dissemination

- State Government agencies
- Disaster Management Authority
- Print and Electronic Media
- Social Media
- Through WhatsApp to farmers (in Local Language with agricultural impact)

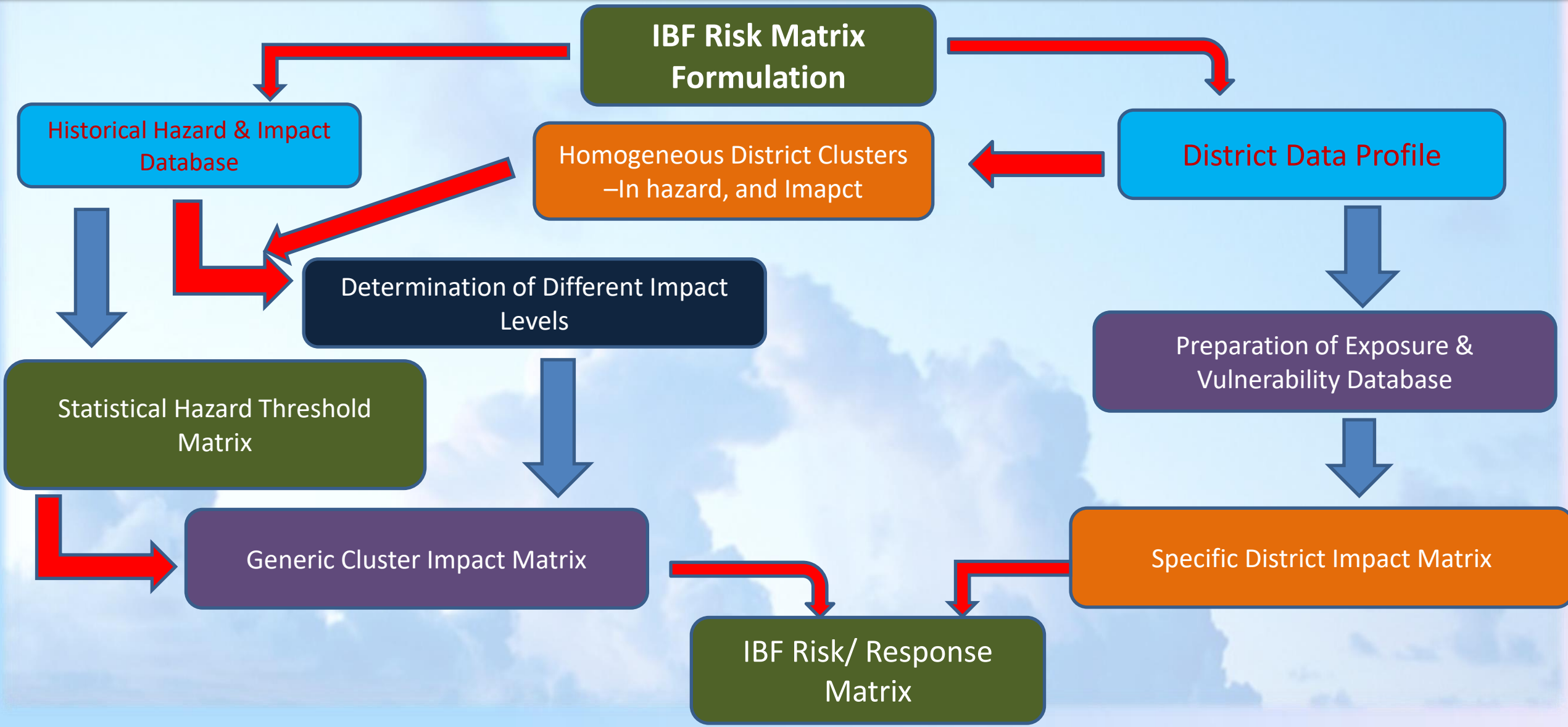
CHALLENGES and LIMITATIONS

- Need for Sector Based: Agriculture, Mining, Power, Transportation, etc
- Non availability of localized information for risk assessment
- Quantitative Verification of IBF requires ground reports from all the exposures which is unavailable
- Authenticity of the ground reports of Impact by citizens/Media ?

FUTURE WORK

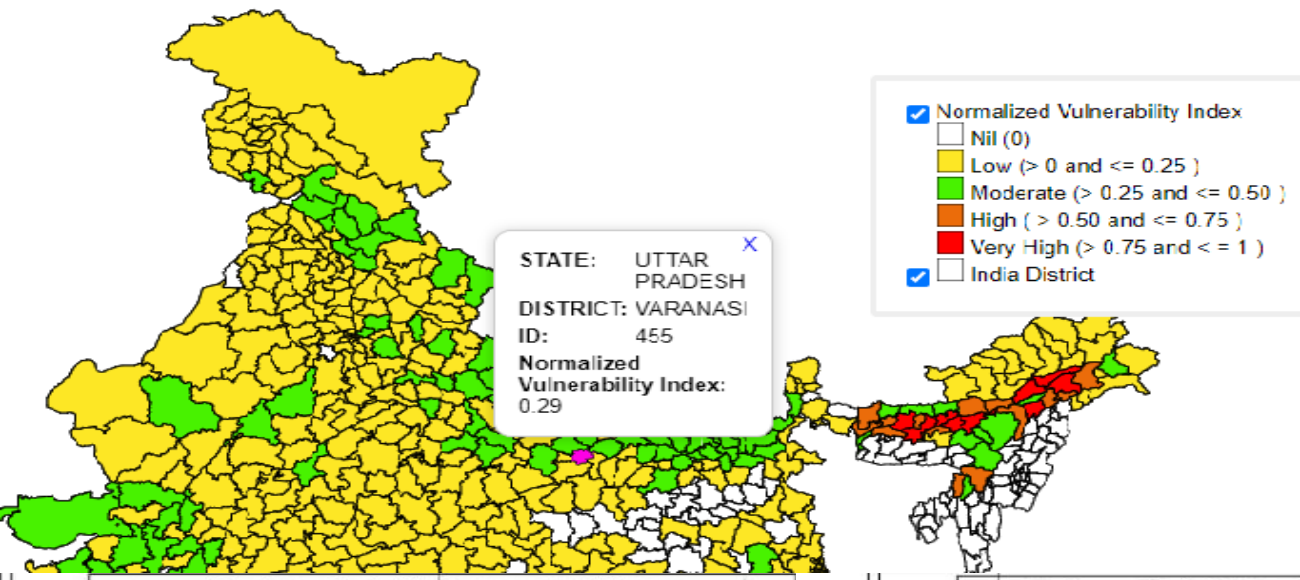
- Addition of Infrastructural Impact and Exposure of roads for the risk Assessment
- Based on Crop type fixing the rainfall thresholds.
- Quantification of Impact matrix

IBF Methodology-Clustering using past heavy rainfall and impact data

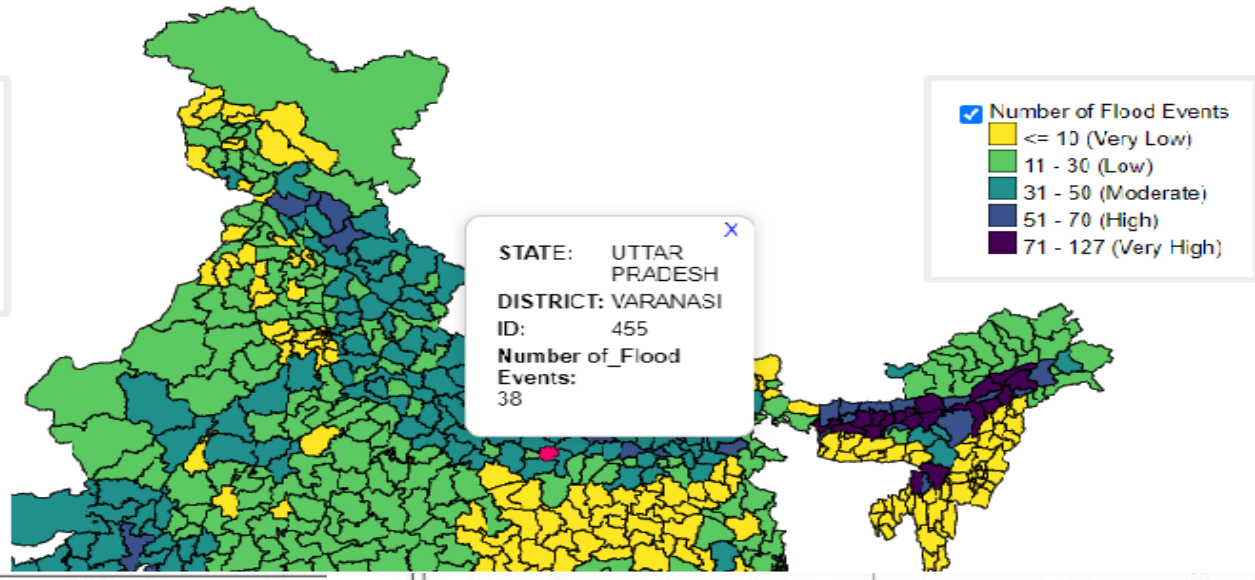


Extreme Rainfall Climatology/Frequency/Vulnerability of UP

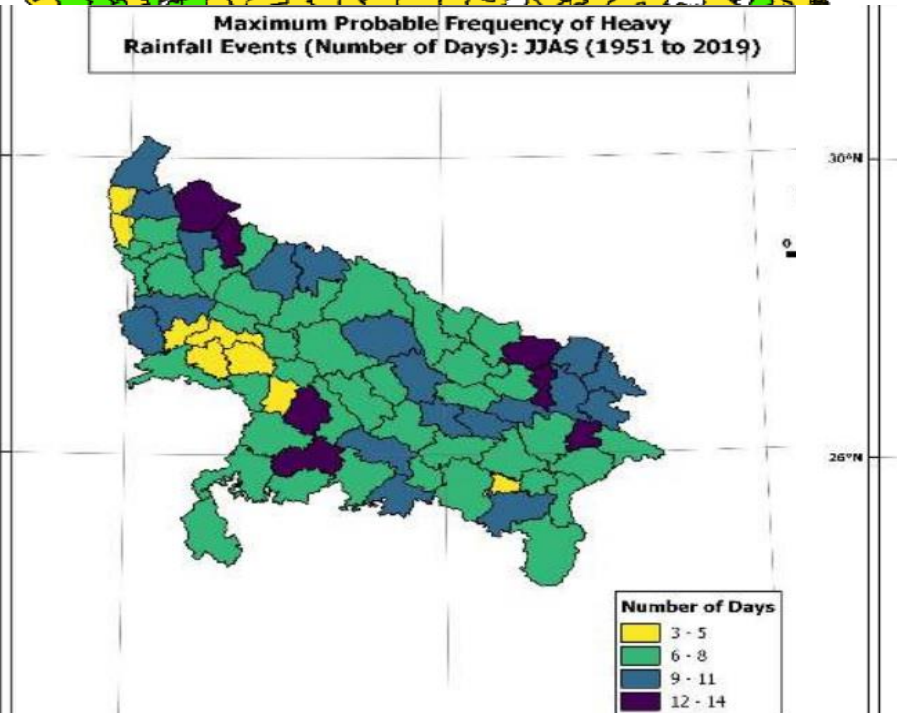
Flood: Normalized Vulnerability Index Annual



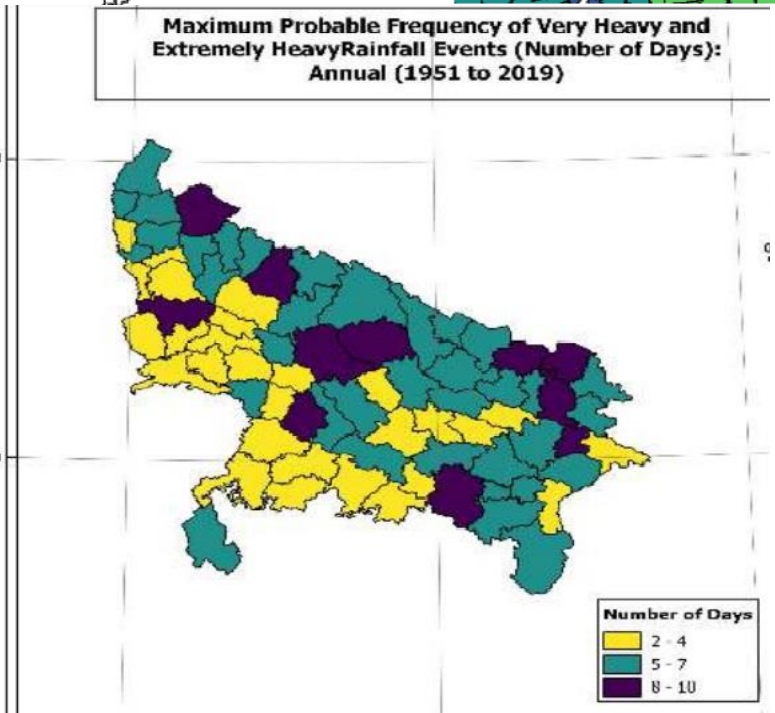
Total Number of Flood Events During the Period from 1969 to 2019



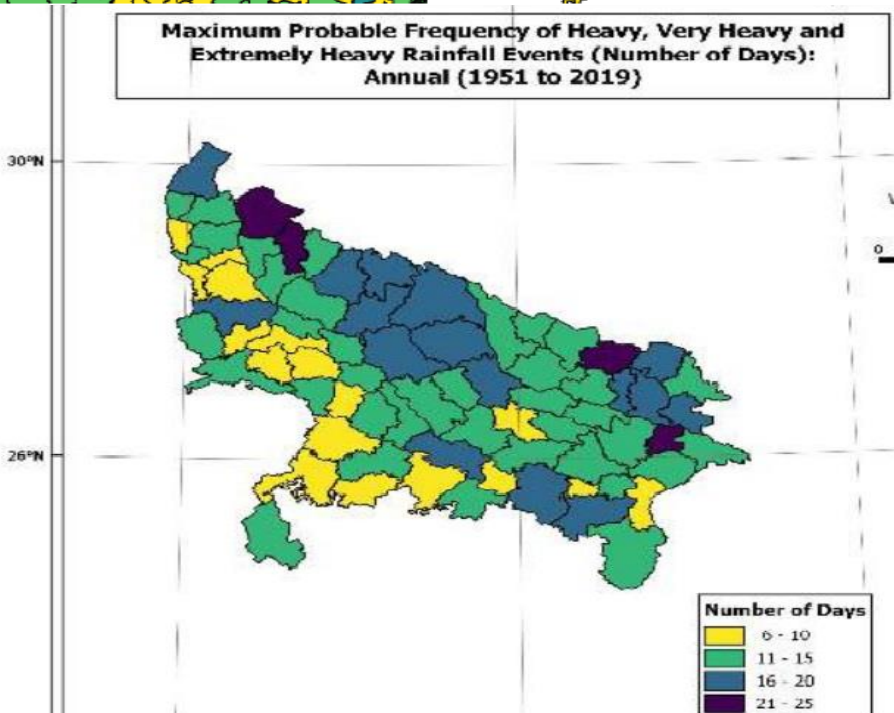
Maximum Probable Frequency of Heavy Rainfall Events (Number of Days): JJAS (1951 to 2019)



Maximum Probable Frequency of Very Heavy and Extremely HeavyRainfall Events (Number of Days): Annual (1951 to 2019)

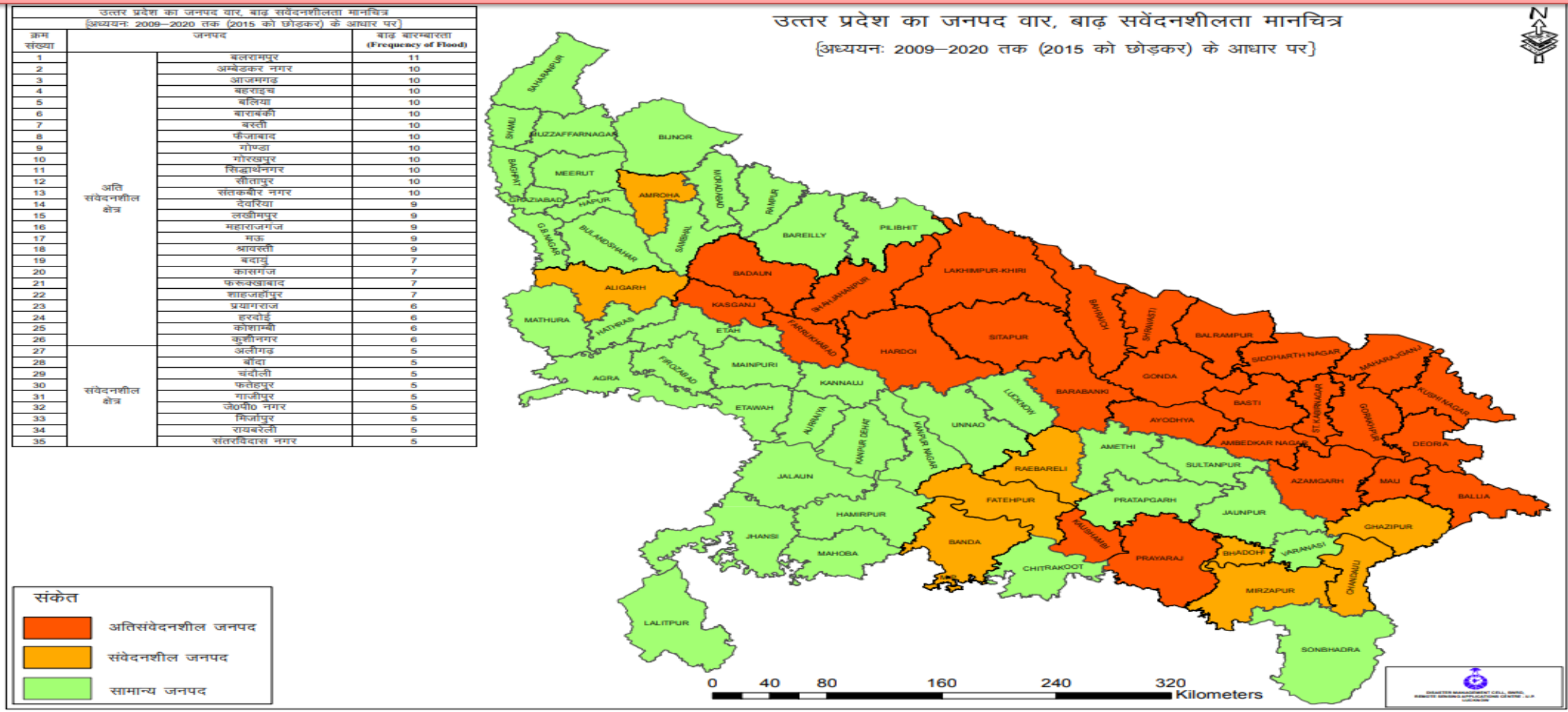


Maximum Probable Frequency of Heavy, Very Heavy and Extremely Heavy Rainfall Events (Number of Days): Annual (1951 to 2019)

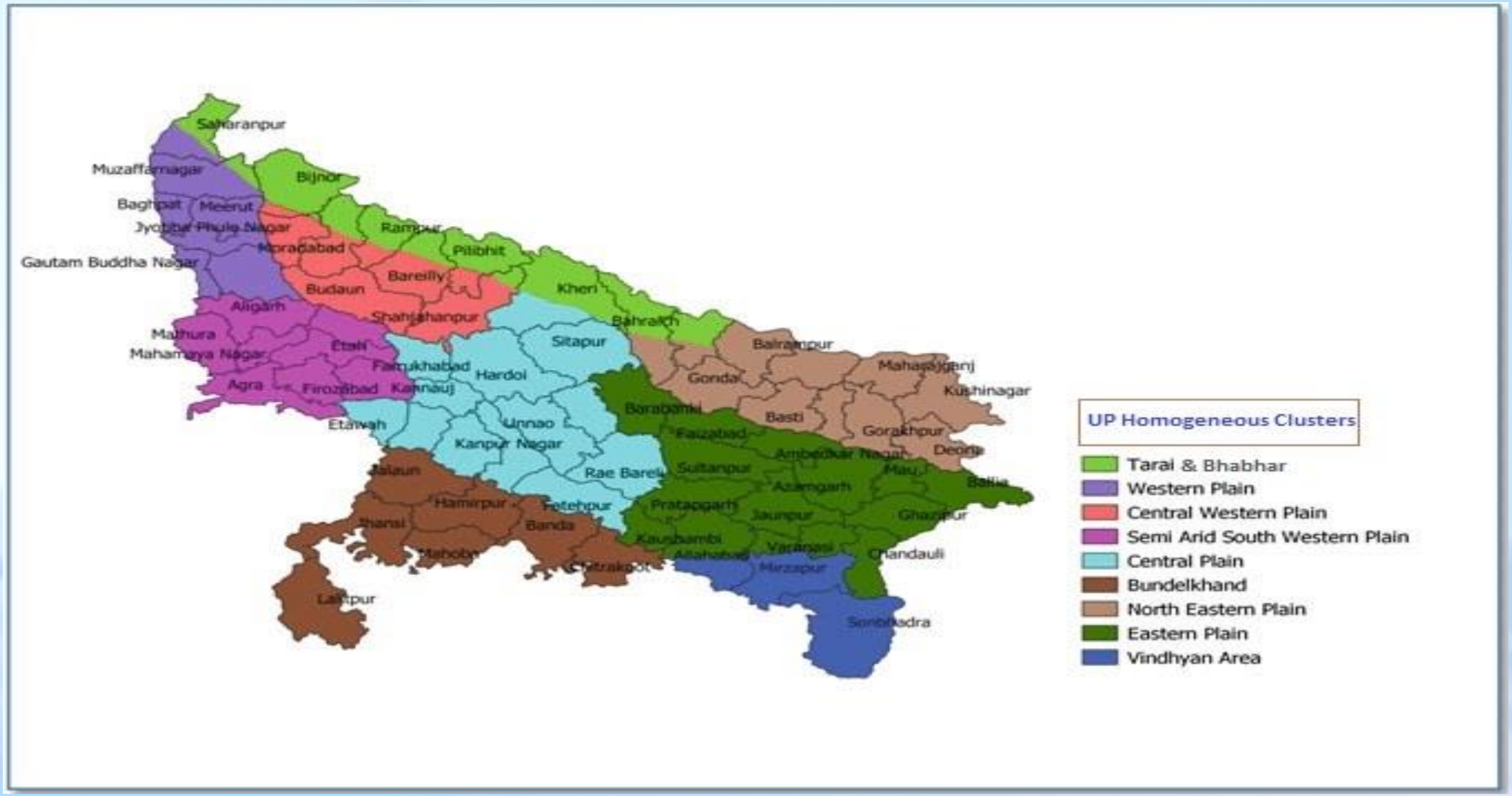


District-wise Flood Frequency/Sensitivity/Vulnerability of UP

उत्तर प्रदेश का जनपद वार, बाढ़ सवेंदनशीलता मानचित्र (अध्ययनः 2009–2020 तक (2015 को छोड़कर) के आधार पर)			
क्रम संख्या	जनपद		बाढ़ बारम्बारता (Frequency of Flood)
1	अति संवेदनशील क्षेत्र	बलरामपुर	11
2		अम्बेडकर नगर	10
3		आजमगढ़	10
4		बहराइच	10
5		बलिया	10
6		बाराबंकी	10
7		बस्ती	10
8		फैजाबाद	10
9		गोण्डा	10
10		गोरखपुर	10
11		सिद्धार्थनगर	10
12		सीतापुर	10
13		संतकबीर नगर	10
14		देवरिया	9
15		लखीमपुर	9
16		महाराजगंज	9
17		मऊ	9
18		श्रावस्ती	9
19		बदायु	7
20		कासगंज	7
21		फरूखाबाद	7
22		शाहजहाँपुर	7
23		प्रयागराज	6
24		हरदोई	6
25		कोशाम्बी	6
26		कुशीनगर	6
27	संवेदनशील क्षेत्र	अलीगढ़	5
28		बाँदा	5
29		चंदौली	5
30		फतेहपुर	5
31		गाजीपुर	5
32		जे0पी0 नगर	5
33		मिर्जापुर	5
34		रायबरेली	5
35		संतरविदास नगर	5



Homogeneous Clusters of Uttar Pradesh



Major Exposure/Rainfall Threshold- Vindhyan Cluster

Cluster/Districts	Characteristics	Major Exposures	Rainfall Thresholds
Vindhyan Cluster Sonbhadra, Mirzapur, Prayagraj	**Rainfall** 9-11 cm annually (Moderate Frequency of H-VH) **Climate** Sub-Humid **Topography** Mostly Plateau **Soil** Undulated Rocky Soil, Red Alluvial, Laterite, Black Clay **Water Holding Capacity** Low **Flood Frequency** Moderate **Population Density** Low to Medium	1. Religious (Vindhyachal)/ Pilgrim (Sangam/Kumbh Mela) Sites & Tourist Attractions/Natural Resource/Water Fall/ Ponds/Lakes/Dams 2. Chandraprabha Wild Life Sanctuary 3. Mining & Cement Industry. 4. Anpara/Rihand/Obra Hydro-Electric Proj 5. Settlements along vulnerable zones in flood plains of Ganga/Yamuna/Son River basin, Rivulets & Seasonal stream 6. Airports(IAF-PRG)/Bridge//Barrages/ Railway(NCR)/ Road/ Highway (NH-02/07/24/27/75/76/127 & SH-05/77/87/160/162) 7. Sensitive Defense Establishments. 8. Standing Paddy, Millet, Vegetables, Horticulture crop & harvested crop/grain. 9. Ferry Transport Services.	**Red warning (Take Action)** a) Rainfall >15 cm on single day. b) Cumulative Rainfall >20 cm for 2 days (On 2nd Day) **Orange warning (Stay Alert)** a) Rainfall >11 cm for single day. b) Cumulative Rainfall >16 cm for 2 days (On 2nd Day) c) Cumulative Rainfall >20 cm for 3 days (On 2nd/3rd Day) **Yellow warning (Be Updated)** a) Rainfall ≥7 cm on single day b) Cumulative Rainfall >10 cm for 2 days.

Impact/Response Matrix- VINDHYAN Cluster

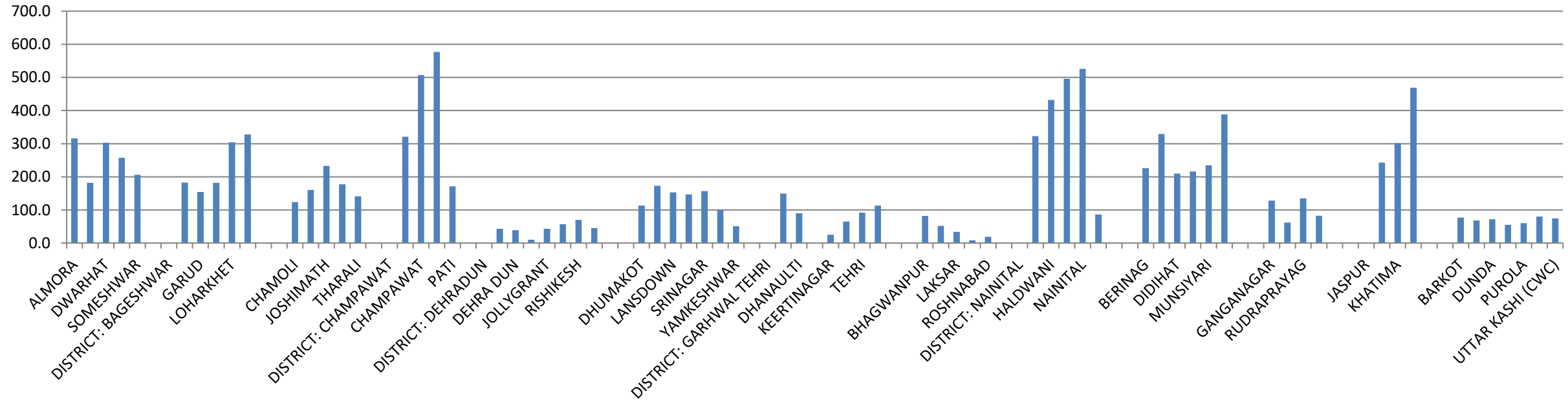
Red Alert (Severe Impact : Take Action)	Suggested Actions
Severe Waterlogging in Mines & Low-lying areas/Underpass	✓ Stay away from areas prone to flash floods & avoid taking shelter of trees.
Possibility of Mud/Rock slide & Mine Sink	✓ Take safe shelters inside safe & maintained pucca houses.
Moderate Flood/Severe flash flood and inundation	✓ Temporary & unsecured structures should be vacated or secured properly.
Major Damage to Kuccha & unsecured Temporary structures	✓ Keep Agricultural Grains/damaging products at raised platforms.
Slippery Rock & muddy Road conditions & Poor Visibility conditions during intense spells of Rain may lead to Moderate/Major disruption of Air/Road/Rail traffic flow.	✓ Avoid Irrigation/Harvesting & Fertilizer Application in Agriculture ✓ Backup plan for Major Failure in Community Services is essential. ✓ Pre plan/Postpone due to expected delays/closure of Traffic
Large Scale Disruption of community services (water, electricity etc.)	✓ Stay Away & safe from rivulets and seasonal rain-fed streams
Possibility of danger to very old buildings and unmaintained structures, uprooting of trees etc.	✓ Avoid Driving on Kuchcha/Water Logged Roads & to take caution while driving through Slippery Road conditions & Poor Visibility conditions during intense spells of Rain.
Significant Rise in River Water Levels may lead to inundation of Pilgrim Ghats, River Bank Erosion & major disruption of Ferry Services	✓ Closure/Complete Suspension of Mining Activities & Ferry Services. ✓ Avoid visiting Barrages/Banks/Beds of River flowing close to WL/DL/HFL ✓ Take necessary measured to restrict the erosion of embankments/barrages. ✓ To avoid overflowing bridges & submerged Underpasses.
Washout/Closure of roads & crossing low water bridges along rivulets due to Water Overflow.	
Moderate/Major damage to harvested crops, plantation/horticulture crops and Moderate damage to agriculture & associated products	
Large scale Devastation of Slum Areas.	
Few instances of damage to life, livestock and property.	

Orange Alert (Moderate Impact : Remain Alert/Be Prepared)	Suggested Actions
➢ Flooding of Low-lying areas	✓ Stay away from areas prone to flash floods & avoid tree shelter.
➢ Moderate Damage to Kuchcha and unsecured and Temporary structures	✓ Take safe shelters inside secured/pucca houses.
➢ Localized and short-term disruption to municipal services (water, electricity etc.)	✓ Temporary & unsecured structures should be secured properly or vacated.
➢ Slippery Road conditions & Poor Visibility conditions during intense spells of Rain may lead to Minor/Moderate disruption of Road/Rail Transport.	✓ Backup electricity plan can be made ✓ Pre plan due to expected delays in Traffic ✓ Stay Away from rivulets and seasonal rain-fed streams
➢ Feeble Possibility of danger to very old buildings and unsecured structures etc.	✓ To take caution while driving through Slippery Road conditions & Poor Visibility conditions during intense spells of Rain.
➢ Partial/Temporary Closure of roads & crossing low water bridges along rivulets and seasonal rain-fed streams due to Water Overflow	✓ To avoid (or at least to take precaution while crossing) overflowing bridges & submerged Underpasses. ✓ Partial Closure/Temporary Suspension of Ferry Services. ✓ Partial Closure/Temporary Suspension of Mining Activity.
➢ Moderate/Major disruption of Mining Activity & Ferry Services	
➢ Minor flash flood and inundation in plains	
➢ Significant Impact on Slum Areas.	
➢ Moderate damage to plantation/horticulture crops and Minor damage to agriculture.	
➢ Occasional instances of damage to life, livestock and property.	

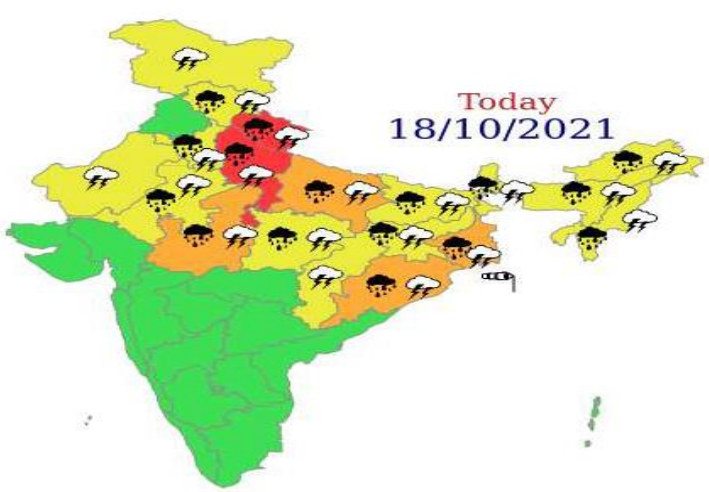
Yellow Alert (Low Impact : Keep Watch/Be Updated)	Suggested Actions
➢ Partial /Temporary Flooding of Low-lying areas	✓ Stay away from areas prone to flash floods.
➢ Kuccha and unsecured temporary structures may be Partially Vulnerable	✓ Take safe shelters inside secured permanent structures.
➢ Temporary Disruption of Community Services.	✓ Backup electricity plan can be made
➢ Localized Traffic Congestion due to Partial Disruption of traffic.	✓ Pre plan due to expected delays in Traffic

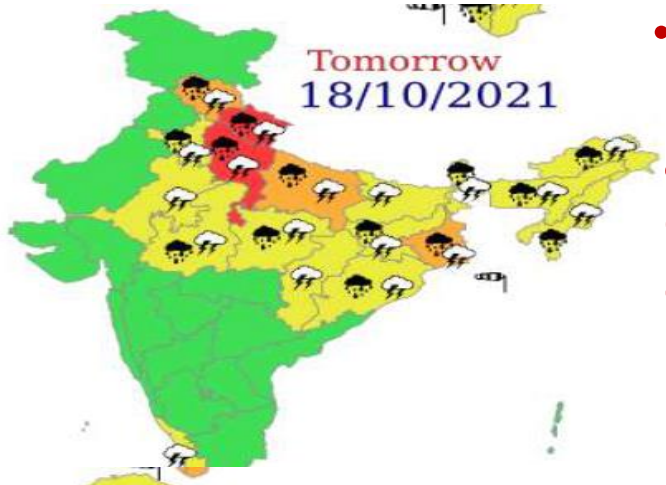
IBFW HEAVY RAINFALL REAL TIME –IMD

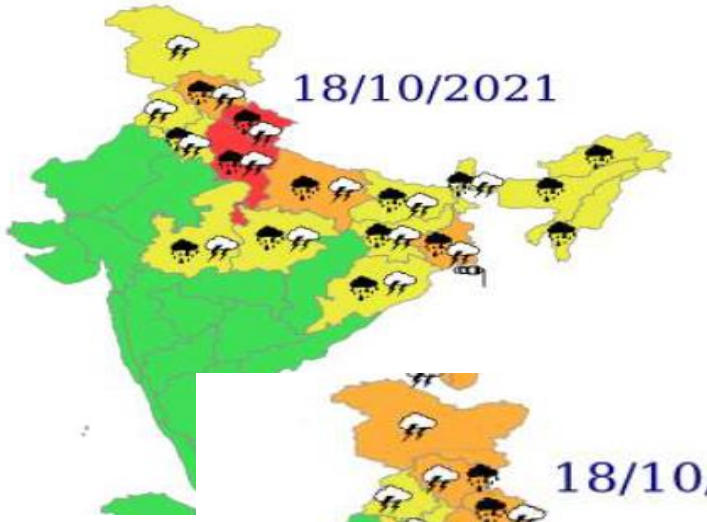
17-20 Oct 2021 Extreme rain spell over Uttarakhand

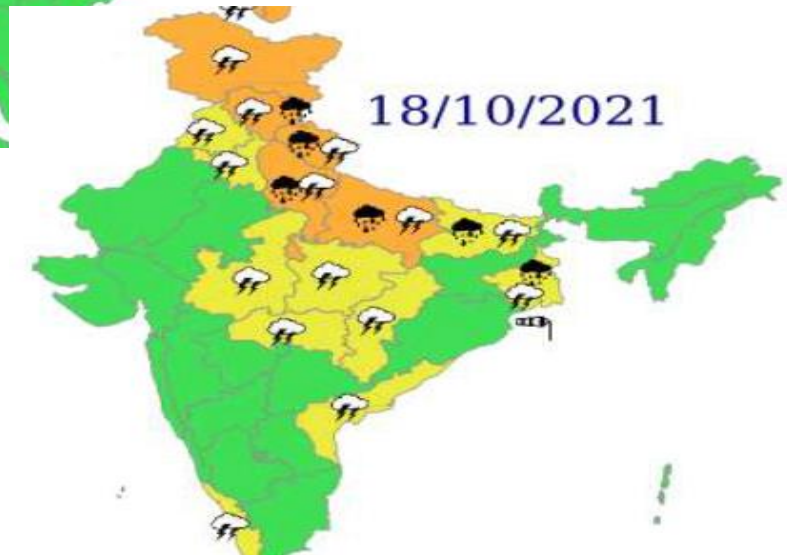


18-19 Oct-CHAMPAWAT: CHAMPAWAT (AWS)-58, PANCHESHWAR (AWS)- 51, DEVIDHURA (AWS)-37, LOHAGHAT-32, CHALTHI (AWS)-29, BASTIA (ARG)-25, NAINITAL: NAINITAL (AWS)-53, NAINITAL(JEOLIKOT)_KVK (AGRO)-49, NAINITAL-40, BHIMTAL (ARG)-40, MUKTESHWAR-34, HALDWANI-33, RAMNAGAR (AWS)-23 UDHAM_SINGH_NAGAR: RUDRAPUR(AWS)-48, GULARBHOJ (ARG)-47, KHATIMA (AWS)-21, KASHIPUR (AWS)-18, BAJPUR (AWS)-8



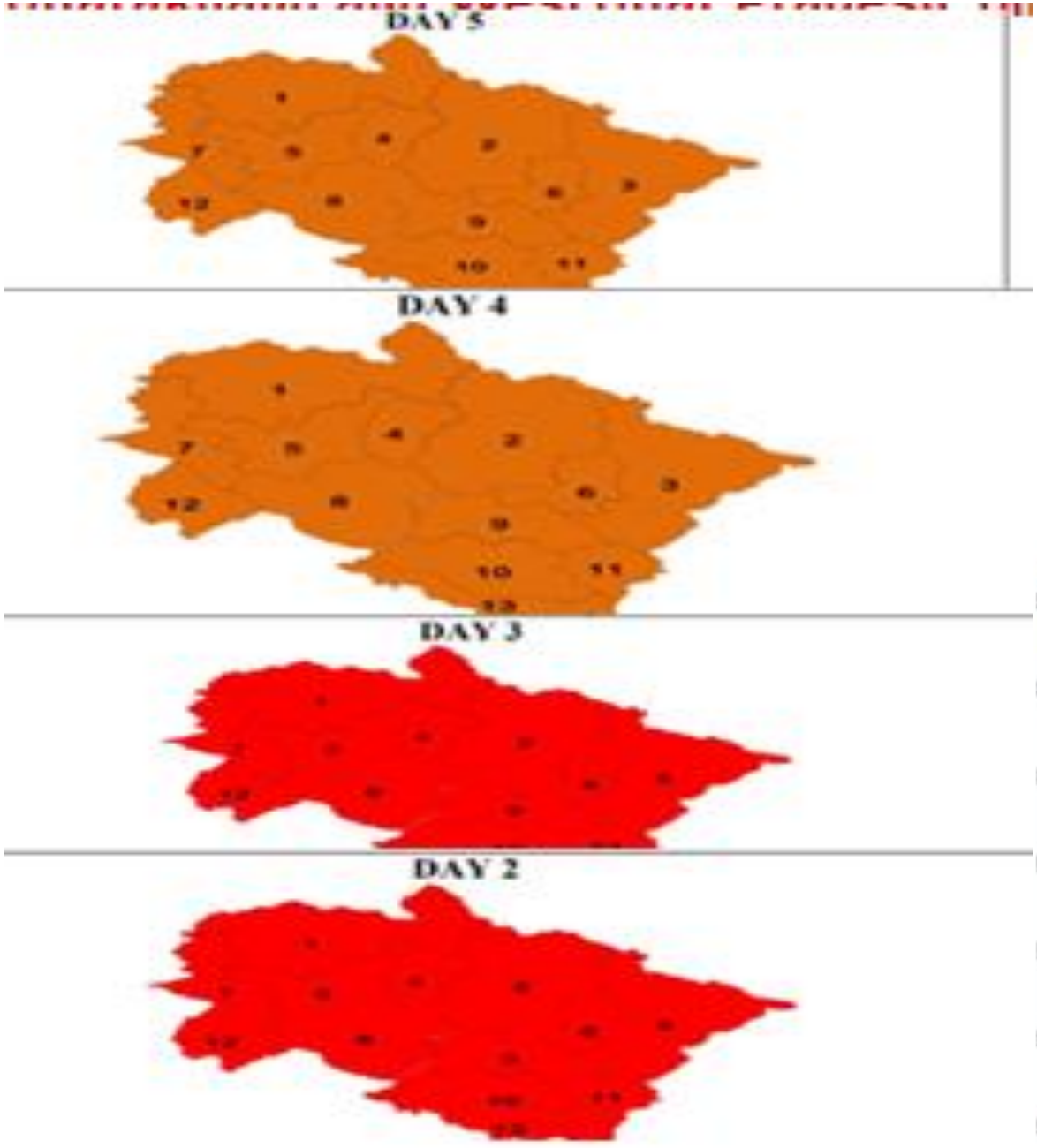


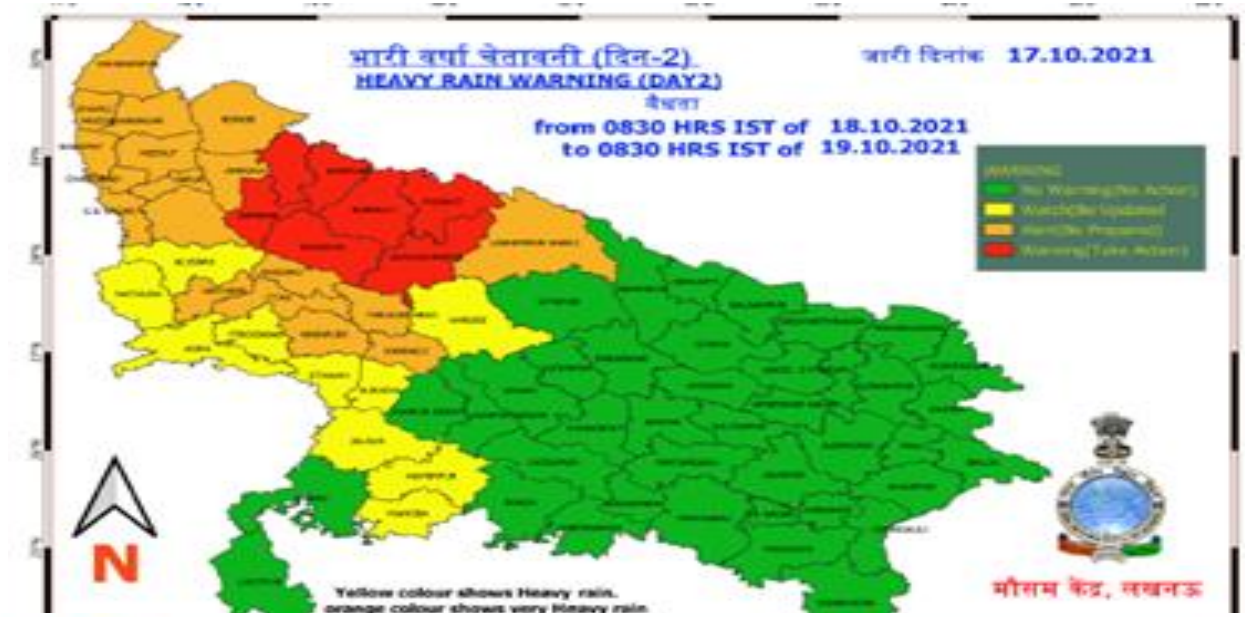




- **Heavy rainfall spell with isolated Extreme rain spell over Uttarakhand and West Uttar Pradesh during 17-19 Oct and heavy to very heavy rainfall over adjoining northwest India during 17-19 Oct due to interaction of northwest-ward moved Low Pressure Area and intense WD**
- **It caused flash floods, riverine flooding over Uttarakhand and west Uttar Pradesh. Landslides also reported from Uttarakhand**

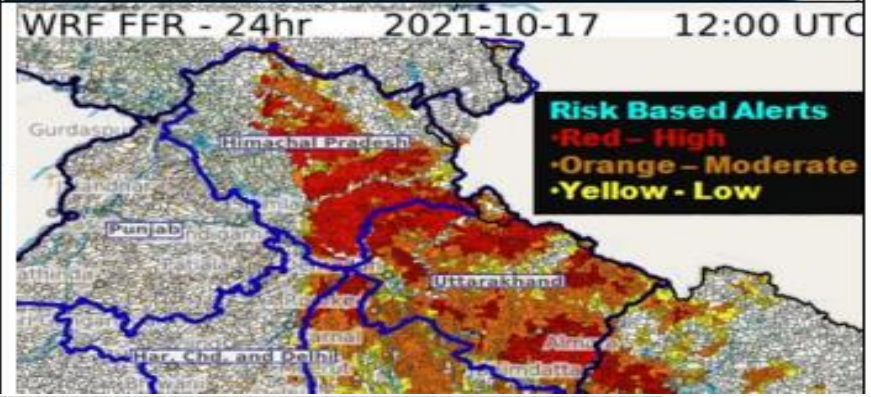
District level Heavy rainfall warning issued for Extreme rain spell over Uttarakhand and West Uttar Pradesh on 18 Oct at Day 4 to Day 1





24 hours Outlook for the Flash Flood Risk (FFR) till 1730 IST of 18.10.2021:

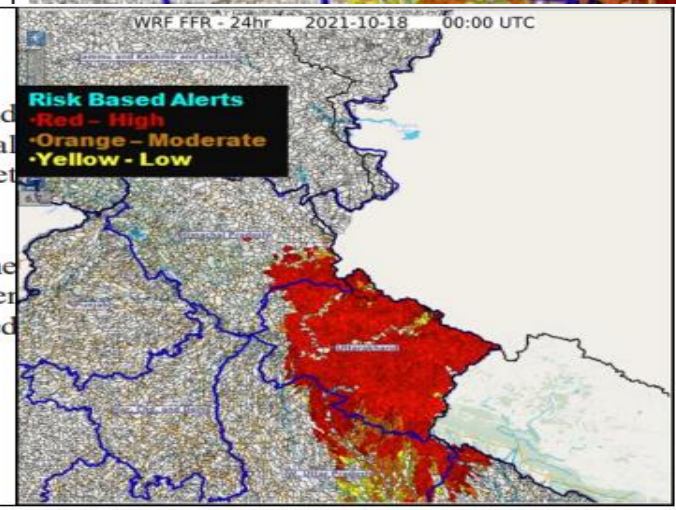
Moderate to High Risk likely over few watersheds and neighbourhoods of **Uttarakhand and Himachal Pradesh** met subdivisions in **next 24 hours.**



24 hours Flash Flood Risk Outlook Till 0630 IST of 19.10.2021:

High Risk likely over few watersheds and neighborhoods of Uttrakhand, Himachal Pradesh and adjoining West UP met subdivisions in next 24 hours.

Surface runoff/ Inundation may occur at some fully saturated soils & low-lying areas over AoC as depicted in map due to expected rainfall in next 24 hours.

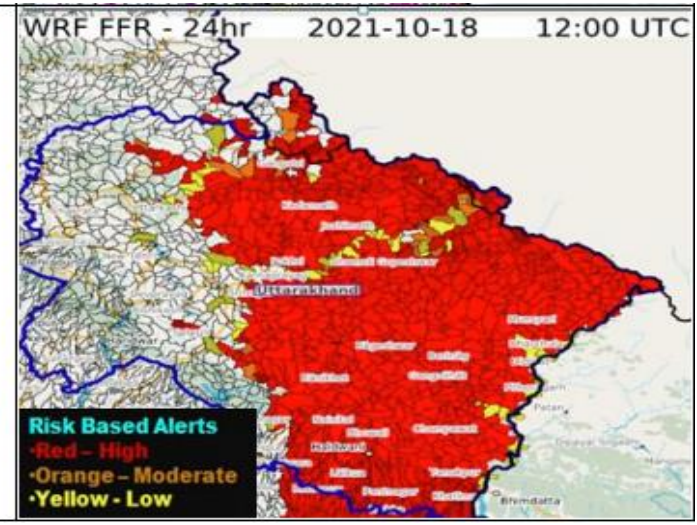


Note: Next Bulletin will be issued based on 1130 IST of 18.10.2(

24 hours Outlook for the Flash Flood Risk (FFR) till 1730 IST of 19.10.2021:

High Risk likely over few watersheds and neighborhoods of Uttarakhand met subdivisions in next 24 hours.

Surface runoff/ Inundation may occur at some fully saturated soils & low-lying areas over AoC as shown in map due to expected rainfall occurrence in next 24 hours.



Some Record breaking rainfall for Himachal Pradesh during 8-12 July 2023 in mm- (Some of stations have data as since 1871 like Shimla, Ambala and Chandigarh as 1957)

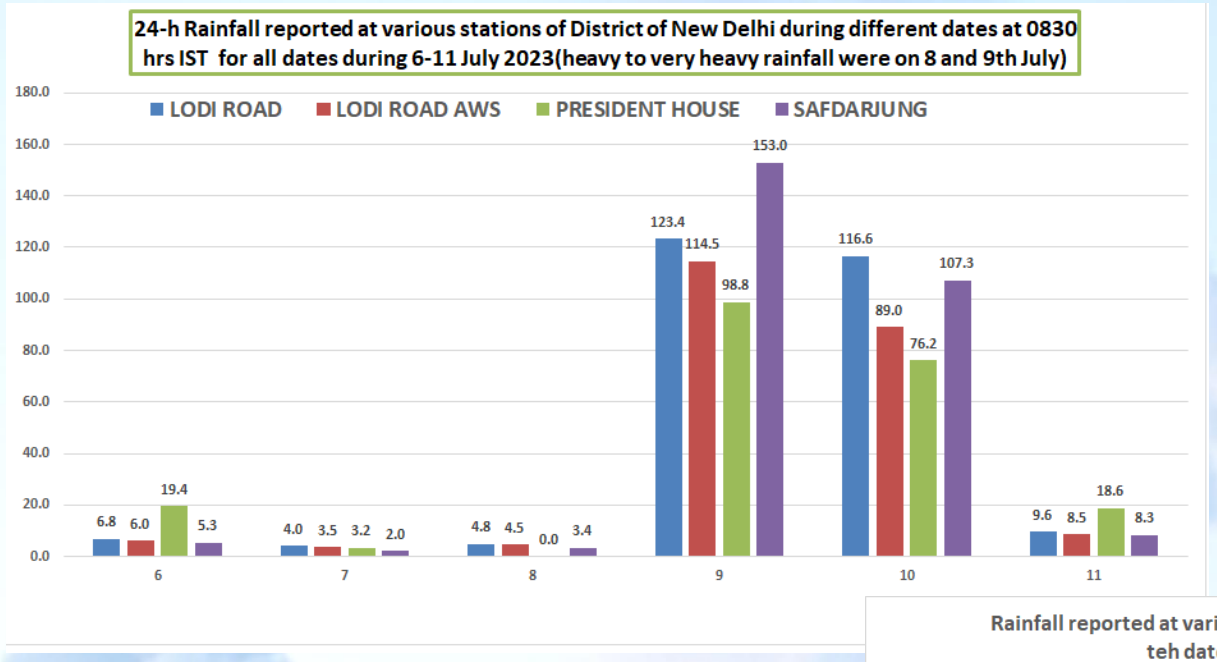
Stations	District	New All Time Record		Previous record	
		Rainfall	Date	Rainfall	Date
Manali	Kullu	131.3	9 July 2023	105.1	09 July, 1971
Solan	Solan	107	9 July 2023	105	17 July, 2015
Rohru	Shimla	185	9 July 2023	170	25 July, 1966
Ghamroor	Kangra	166	9 July 2023	164.8	19 July, 2021
Pachhad	Sirmaur	220	10 July 2023	189.2	26 July, 1973
Nadaun	Hamirpur	160.5	9 July 2023	146	30 July, 1996
Keylong	Lahaul & Spiti	83*	9 July 2023	78	28 July, 1951

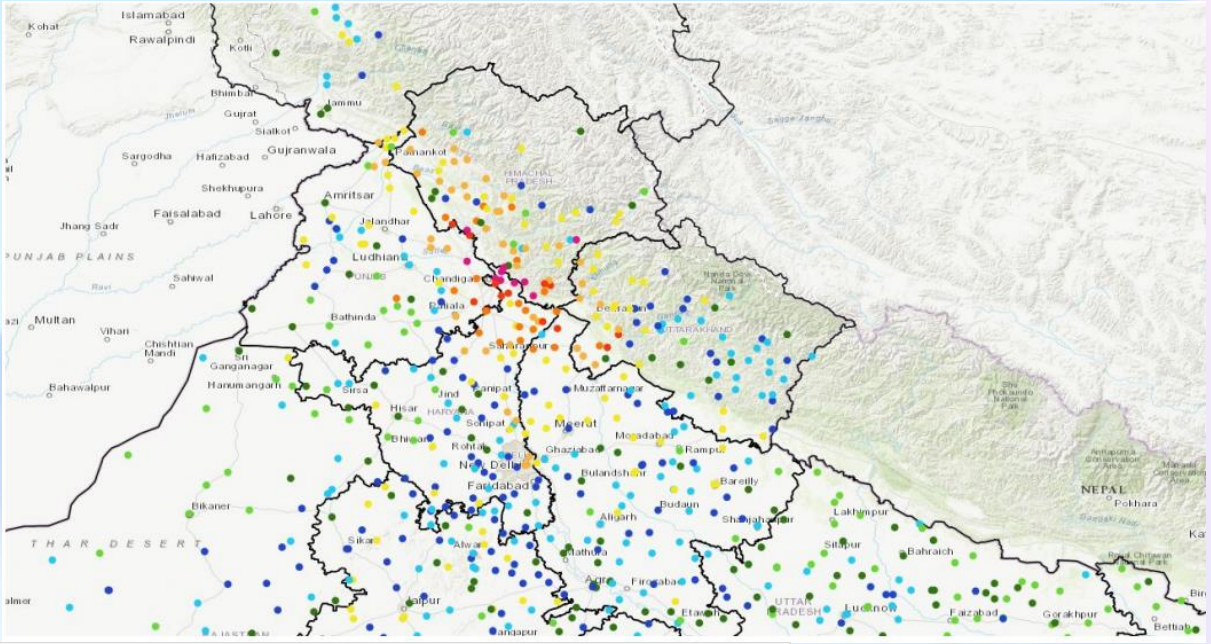
Five Highest Rainfall Records of 24-hour rainfall in the month of July for New Delhi (Safdarjung) during 1958-2023

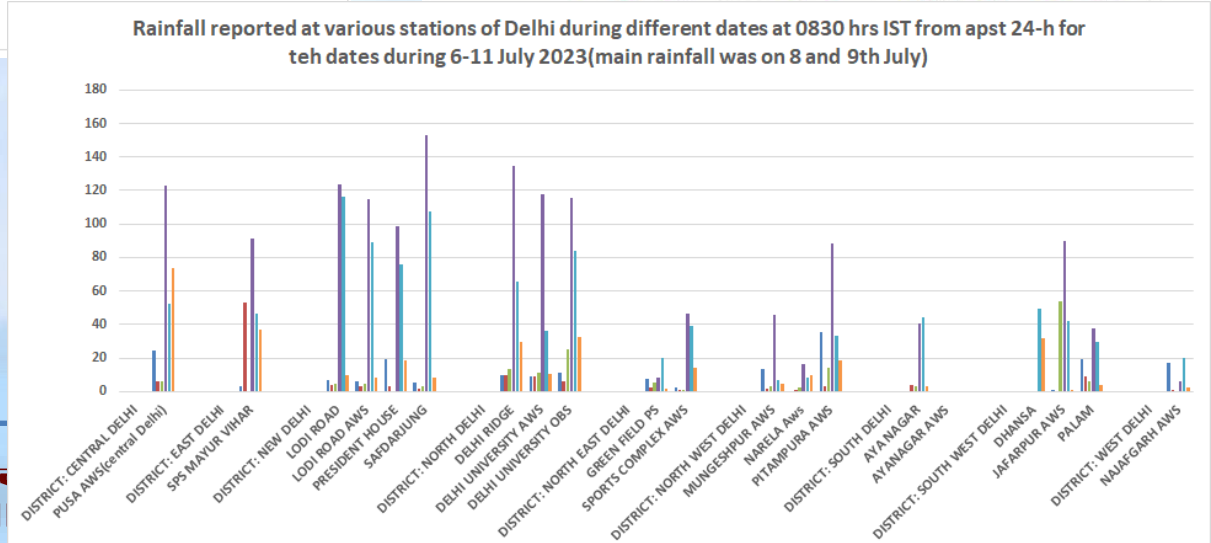
Year	Date	Rain (in mm)	Rank
1958	20th-21st July	266.2	1st
1982	25th-26th July	169.9	2nd
2023	08th-09th July	153	3rd
2003	09th-10th July	133.4	4th
2009	27th-28th July	126	5th

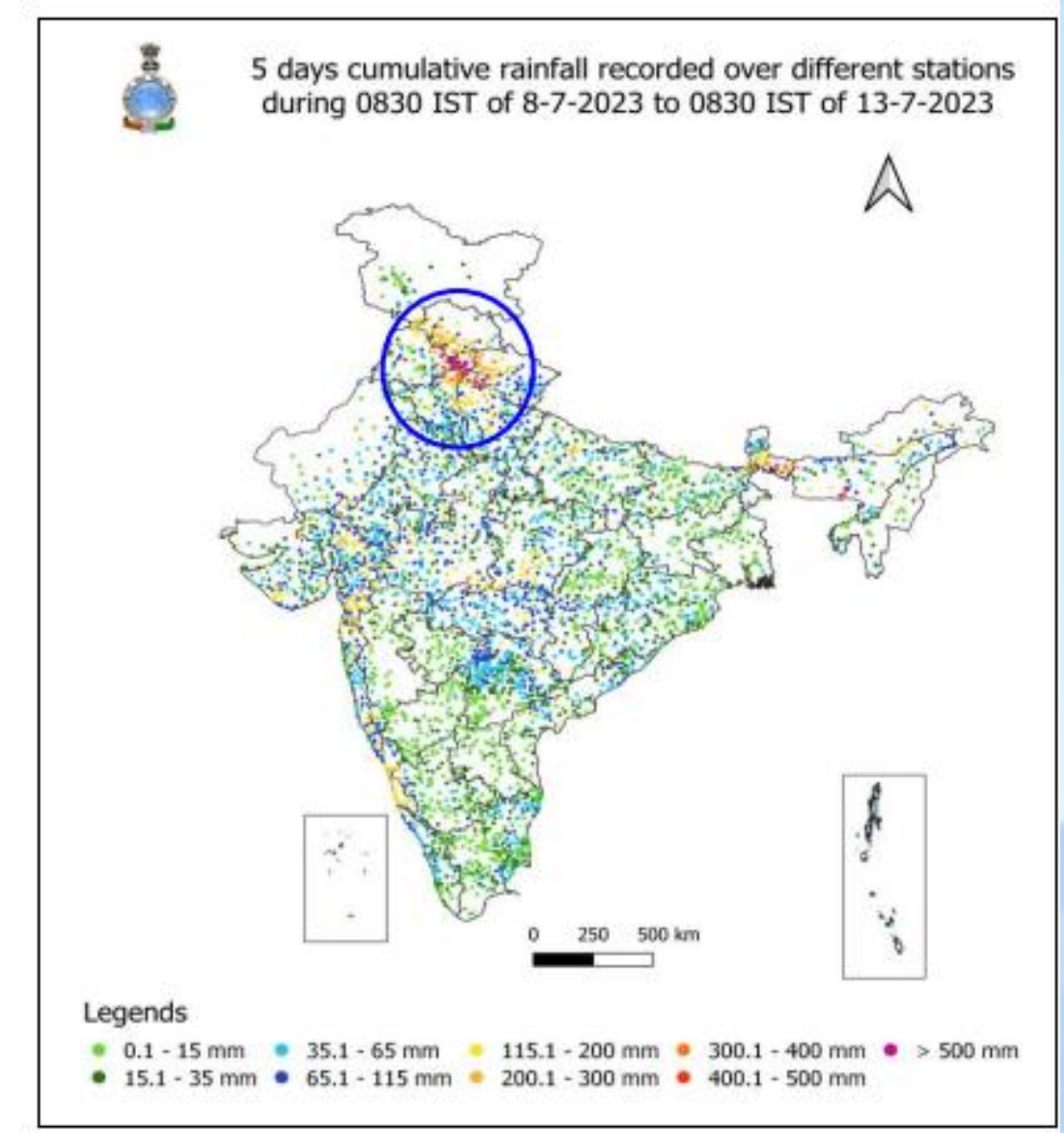
State	Station	All time Record (mm)in July	Previous Record(mm) in July
Chandigarh	Chandigarh City	302.2 (09.07.2023)	120.8(28.07.2017)
	Chandigarh Airport	286.0(09.07.2023)	262.0(17.07.2000)
Haryana	Ambala	224.1(09.07.2023)	206.7(16.07.2001)

Extremely Heavy rainfall Event over Western Himalayan region and adjoining plains of northwest India 8-13 July 2023








5 days cumulative rainfall recorded over different stations
during 0830 IST of 8-7-2023 to 0830 IST of 13-7-2023
0 250 500 km
Legends
0.1 - 15 mm
15.1 - 35 mm
35.1 - 65 mm
65.1 - 115 mm
115.1 - 200 mm
200.1 - 300 mm
300.1 - 400 mm
400.1 - 500 mm
> 500 mm

Impact based Forecast and Warning were issued and updated at lead time 3-4 days lead time starting from 5th July

Government of India
Ministry of Earth Sciences
India Meteorological Department

Press Release
Date: 05th July, 2023
Time of Issue: 1345 hours IST

Subject: Intense spell of rainfall likely to continue over south Peninsular India and Konkan & Goa till 06th and over Gujarat on 07th & 08th July, 2023.

Weather observed during past 24 hours ending at 0830 hours IST of today (Annexure I):

Significant Weather features, Forecast and Warning during next 5 days: (Annexure II)

- The Monsoon trough at mean sea level runs to the south of its normal position.
- The east-west shear zone roughly along Lat. 15°N in middle tropospheric levels persists.
- The off-shore trough at mean sea level runs from south Gujarat coast to north Kerala coast.
- A cyclonic circulation lies over North & adjoining Central Bay of Bengal in lower and middle tropospheric levels.
- A fresh Western Disturbance is likely to affect Western Himalayan Region from the night of 8th July.

Weather Forecast and Warning:

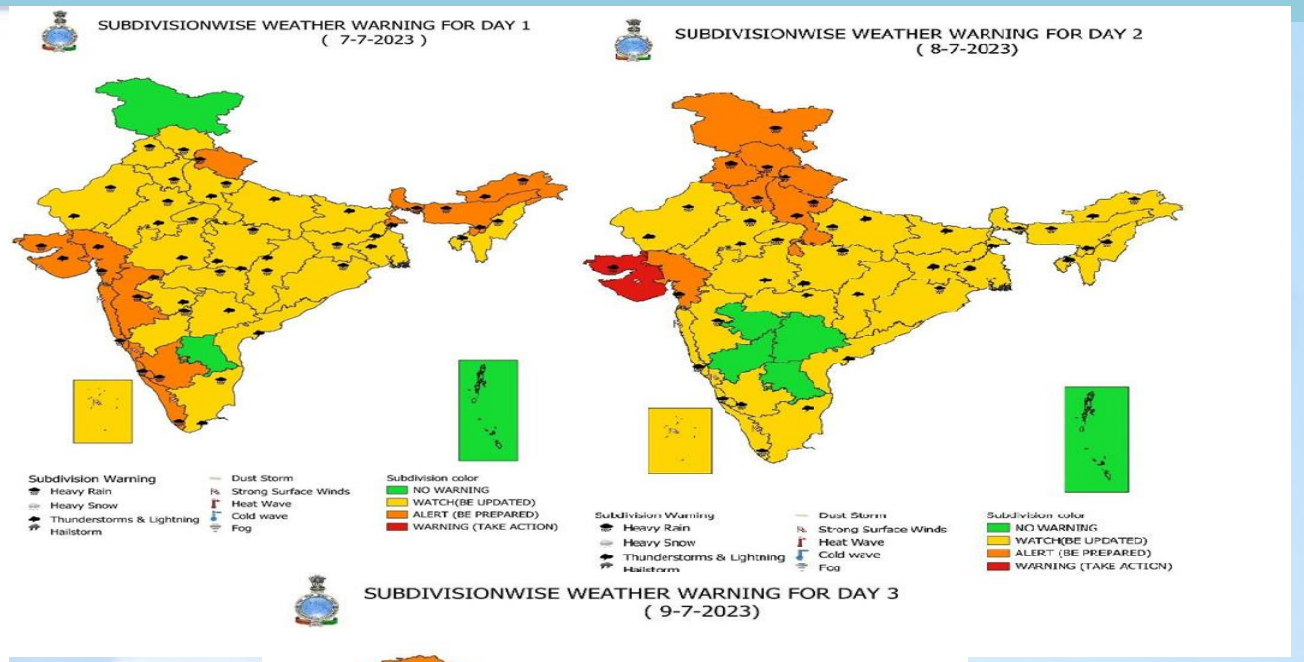
South India: Light/moderate widespread rainfall with **isolated heavy to very heavy rainfall** very likely to continue over the region during next 2 days & decrease thereafter. Isolated **extremely heavy rainfall** also likely over Kerala and Coastal Karnataka on 05th July, 2023.

West India: Light/moderate widespread rainfall with **isolated heavy to very heavy rainfall** very likely over Konkan & Goa, ghat areas of Madhya Maharashtra and Gujarat state during next 5 days. Isolated **extremely heavy falls** also likely over Konkan & Goa on 05th & 06th; ghat areas of Madhya Maharashtra on 06th; over Gujarat region on 07th and Saurashtra & Kutch on 07th & 08th July.

Northwest India: Light/moderate fairly widespread to widespread rainfall with **isolated heavy rainfall** is very likely over the region during next 5 days. Isolated **very heavy rainfall** is also very likely over Uttar Pradesh on 05th July. Thereafter, under the influence of a Western Disturbance and its interaction with monsoonal winds; isolated **heavy to very heavy rainfall** is also likely over Jammu-Kashmir-Ladakh-Gilgit-Baltistan-Muzaffarabad, Himachal Pradesh, Uttarakhand, Punjab and Haryana-Chandigarh on 09th July.

Central India: Light/moderate fairly widespread to widespread rainfall with **isolated heavy rainfall** is very likely over the region during next 3 days. Isolated **very heavy rainfall** is also very likely over Vidarbha on 05th & 06th; Chhattisgarh on 06th July.

East & adjoining Northeast India: Fairly widespread to widespread light/moderate rainfall with isolated **Heavy rainfall** very likely over Sub-Himalayan West Bengal & Sikkim, Odisha, Bihar during next 5 days; over Assam &



Impact based Forecast and Warning with daily press udaptes/nowcast were issued and updated at lead time 3-4 days lead time starting from 5th July(by IMD Cnetral forecst office and MC Shimla on 5th July)

राष्ट्रीय मौसम पूर्वानुमान केन्द्र
भारत मौसम विज्ञान विभाग
पृथ्वी विज्ञान मंत्रालय

National Weather Forecasting Centre
India Meteorological Department
Ministry of Earth Sciences

Friday, July 07, 2023
Time of Issue: 1330 hours IST
(MID-DAY)

All India Impact Based Weather Warning Bulletin

Impact & Action Suggested due to very heavy/extremely heavy rainfall over Coastal & South Interior Karnataka, Kerala & Mahe, Konkan & Goa and ghat areas of Madhya Maharashtra on 07th; Gujarat state during 07th-09th July; Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Haryana on 08th & 09th; Punjab on 08th July.

A. Impact Expected

- Localized Flooding of roads, water logging in low lying areas and closure of underpasses mainly in urban areas of the above region.
- Occasional reduction in visibility due to heavy rainfall.
- Disruption of traffic in major cities due to water logging in roads leading to increased travel time.
- Minor damage to kutcha roads.
- Possibilities of damage to vulnerable structure.
- Localized Landslides/Mudslides
- Damage to horticulture and standing crops in some areas due to inundation.
- It may lead to riverine flooding in some river catchments (for riverine flooding please visit Web page of CWC).

B. Action Suggested

- Check for traffic congestion on your route before leaving for your destination.
- Follow any traffic advisories that are issued in this regard.
- Avoid going to areas that face the water logging problems often.
- Avoid staying in vulnerable structure.

भारत मौस
INDIA METEOR

Government of India
Ministry of Earth Sciences
India Meteorological Department
Meteorological Centre, Shimla (HP)

Dated: 05th July,2023

Press Release for wet spell for the State of Himachal Pradesh

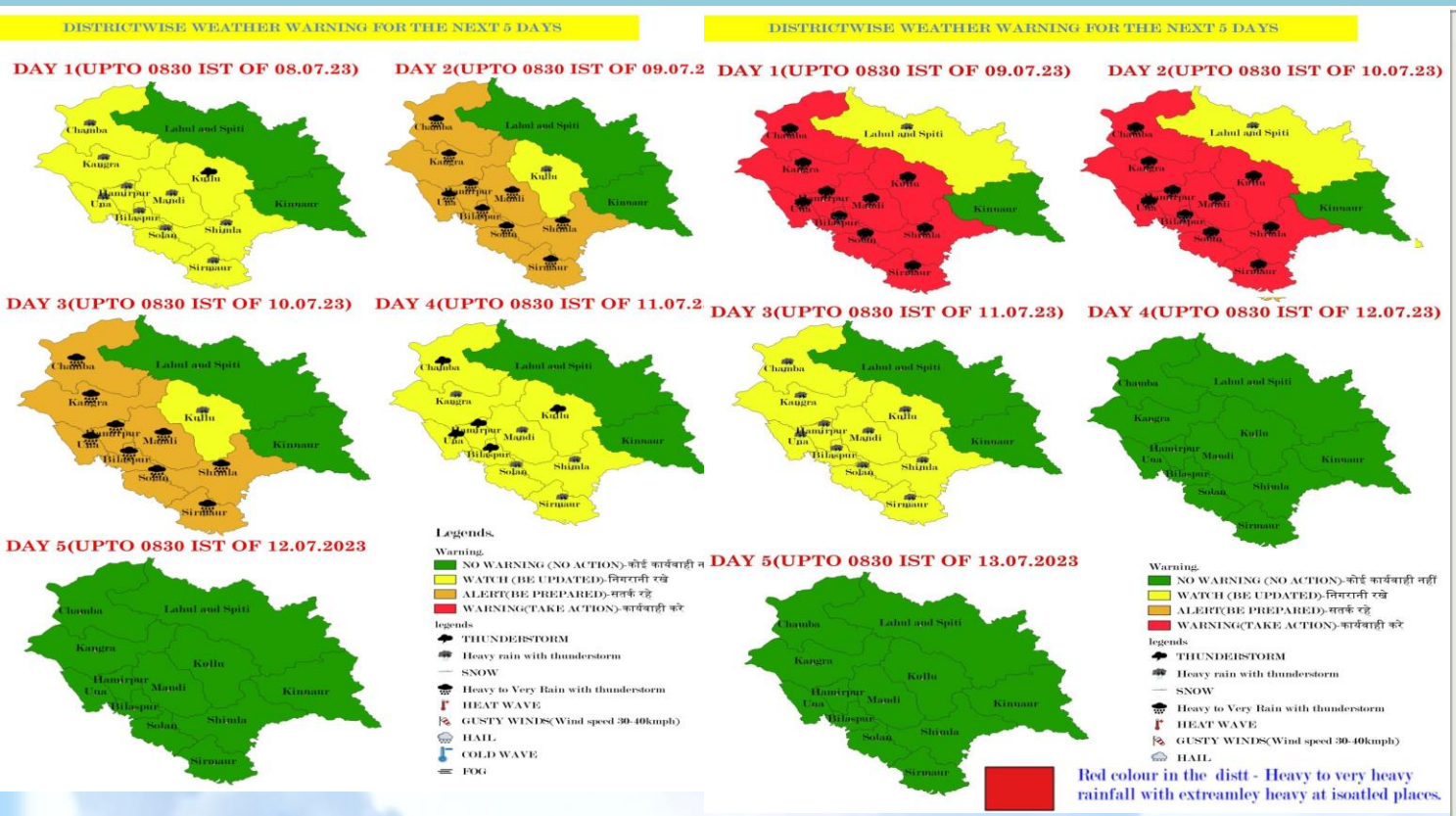
Weather Forecast for Himachal Pradesh for next five days valid till 0830IST of 10th July 2023.

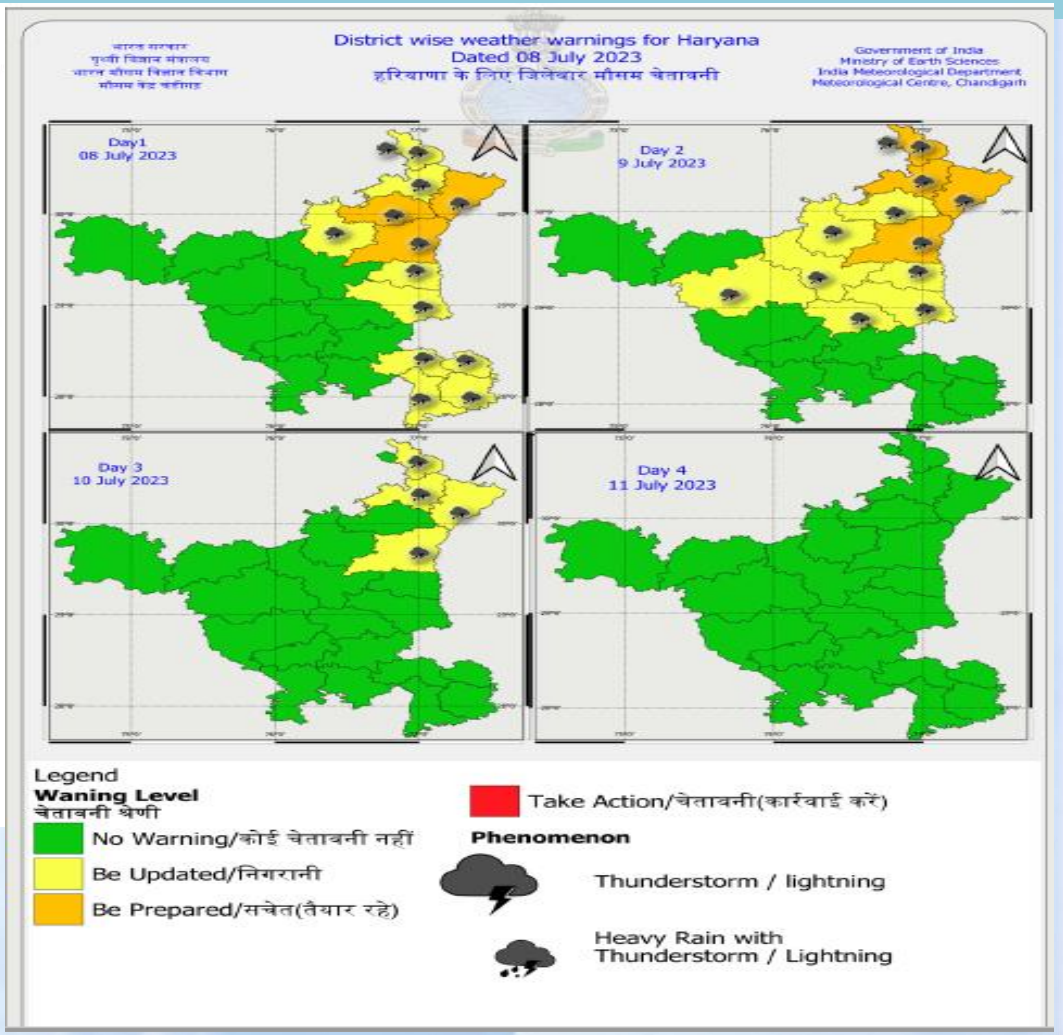
- Light to moderate precipitation associated with thunderstorm/lightning is likely to continue in most parts of the State for subsequent 4 to 5 days. The Ongoing rainfall activities likely to be associated with spells of heavy to very heavy rainfall in low and mid hill districts of HP during this period. A fresh Western Disturbance is likely to affect Western Himalayan Region including Himachal Pradesh from the night of 8th July, 2023 and under its influence precipitation activity is likely to get intensified with possibility of heavy to very heavy rainfall in the districts of Chamba, Kangra, Shimla, Kullu, Mandi, Solan and Sirmaur at isolated places on 09th July, 2023. Possibility of light snowfall activity at very higher reaches of the districts of Chamba, Lahaul-Spiti, Kinnaur, Kangra, and Kullu during this period.
- Aforesaid Spell is also likely to accompany with thunderstorm/lightning in low and mid hill/district.
- The average Maximum temperatures are likely to be 2 to 4 degree below normal for next 4 to 5 days.
- The average Minimum temperatures are likely to be normal for next 4 to 5 days.

Impact and Advisory

- In view of expected rainfall there could be disruption of traffic and other essential services in hilly district of state.
- Flashfloods along watershed and other channels in district of Shimla, Mandi, Kullu, Shimla, Sirmaur, Solan
- Disruption of power and communication facilities in low and mid hill district of state in view of expected thunderstorm/lighting.
- Localized flooding of roads
- Occasional reduction in visibility due to heavy rainfall.
- Avoid going in open areas in view of expected thunderstorms.
- Poor visibility conditions in hilly district of state creating difficulty to commute.
- Follow the advisories and guidelines issued by the concerned departments.
- Check for traffic congestion on your route before leaving for your destination.

Color coded Impact based Warning issued at district level worst affected states of Himachal Pradesh, Chandigarh, Haryana and Delhi





Warnings disseminated timely through CAP/Social media and WhatsApp 5-12 July 2023

Warning Dissemination system

- Telephone, Tele-fax, Mobile Phones (SMS) through IMD severe weather network, Agromet Network, INCOIS network.
- VHF/HFRT/Police Wireless, Aeronautical Fixed Terminal Network
- Global telecommunication system (GTS) :
- NAVTEX , Internet (e-mail), ftp
- Mass Media: : Radio/TV, News Paper network (AM, FM, Comminity Radio, Private TV) : Prasar Bharati and private broadcasters, Websites, Dedicated websites and web pages, Social media, Weekly and daily Weather Video
- GAMES and NAVIK

- Social Media and Mobile Apps
- IMD Apps: Mausam/ Meghdoot/DAMIN/RAIN ALARM, UMANG
- Social Media: Facebook, Twitter, Instagram, BLOG
  - Twitter: https://twitter.com/Indiametdept
  - Facebook::https://www.facebook.com/India.Meteorological.Department/
  - Blog: https://imdweather1875.wordpress.com/
  - Instagram:https://www.instagram.com/mausam_nwfc
  - Youtube:https://www.youtube.com/channel/UC_qxTReoq07UVARm87CuyQw
- CAP/IMD APIs

APIs

- More than 30 Organisations are using IMD's 16 **APIs**
- **NITI Aayog,**
- **National Disaster Management Authority**
- **Incredible India**
- **NAM**

Mobile Apps

UMANG

App	Download
Mausam	204250 25500
Damini	5L+
Meghdoot	276447 7900
Umang	1 crore
Crowsourc	2079

Common Alert Protocol

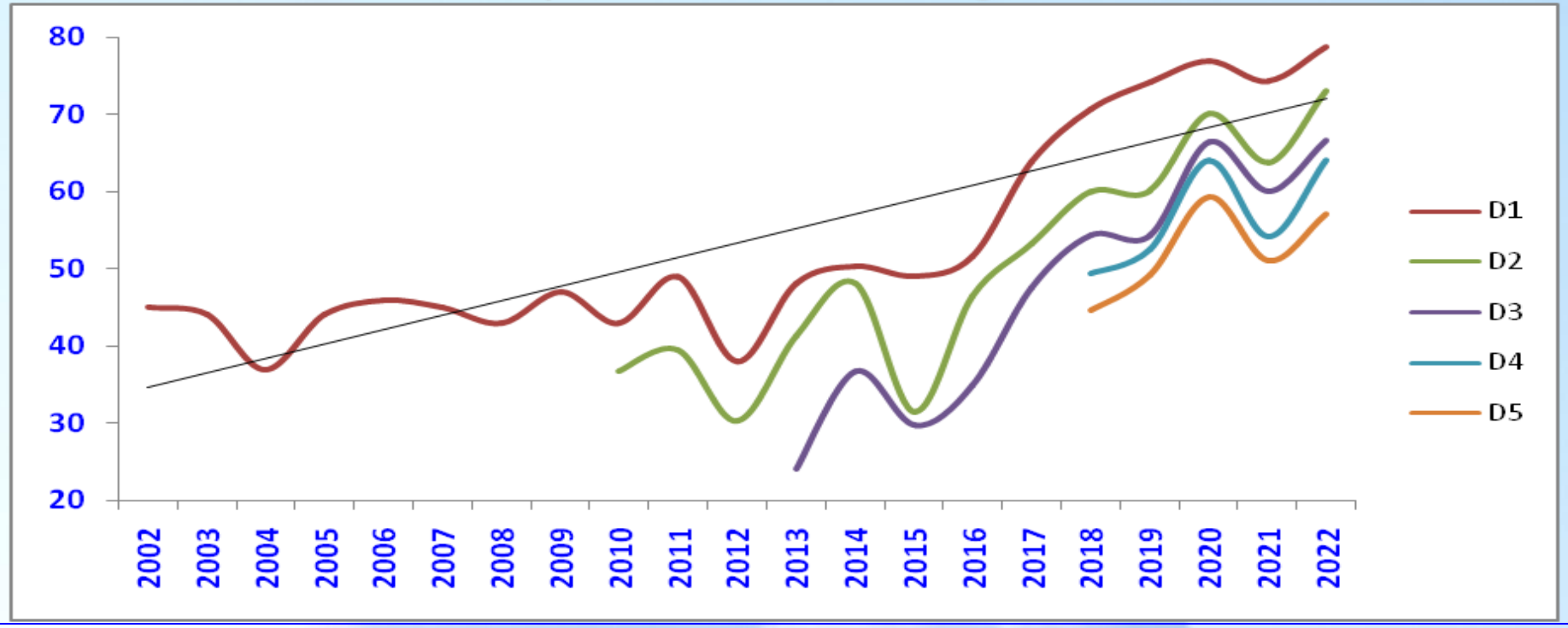
Pilot project is operational in Tamil Nadu state of India since March 2020

- **Statistics so far:**
- **65 Million SMS** for Heavy rainfall and Thunderstorm in different part of the states.
- TN-SDMA also disseminated approx. **7.6 Million SMS** in Tamil during Cyclone Burevi crossed over Tamil Nadu.
- **1.4 Million SMSs** in Tamil to warn the people regarding flood situation due to water release from Chembarambakkam lake and potential flood threat

Statistics of Warning disseminated

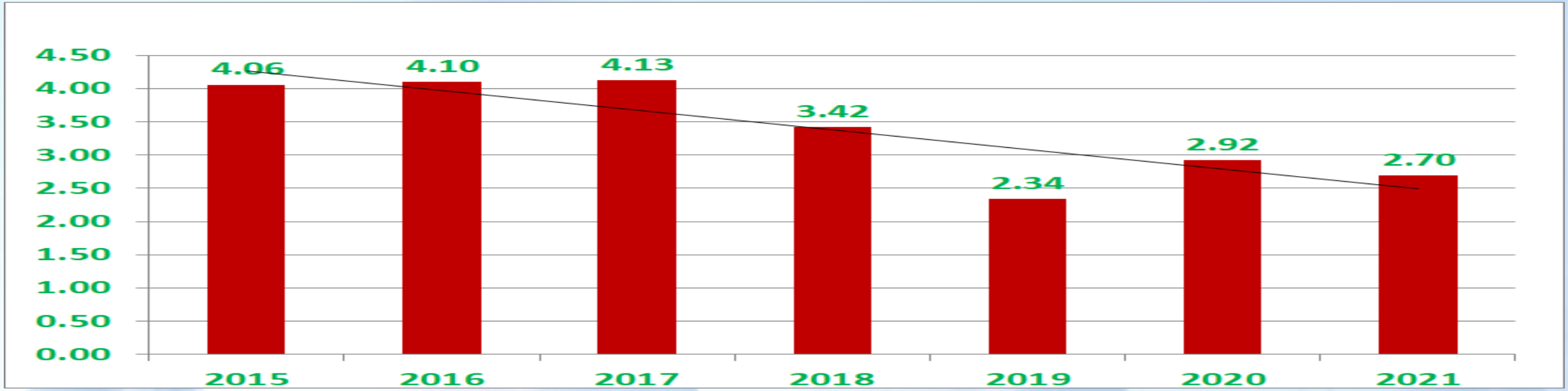
SNO	IMD center	No of warning Generated	No of SMS sent	No of SMS sent in units
1	IMD Srinagar	15	15284584	1.52 cr
2	IMD Ahmedabad	4	47425906	4.74 cr
3	IMD Goa	1	4764004	47.64 lac
4	IMD Guwahati	22	146599286	14.65 cr
5	IMD Dehradun	1	5773205	57.73 lac
6	IMD Ranchi	2	29294925	2.92 cr
7	IMD Patna	6	25464956	2.54 cr
8	IMD Kolkata	3	90310701	9.03 cr
9	IMD Thiruvananthpuram	1	42596	42.5 k
	Total	55	364960163	36.49 cr

Heavy rainfall warning skill



- Probability of Detection (PoD) from 2002 to 2022 (1 June to 31 July) for Day 1 (D1) to Day 5 (D5)
- Forecast issued 24 hr ahead has the accuracy on 79% in 2022 (June-July)
- D5 skill in 2022 (57%) is better than D1 skill in 2016 (52%) and all proceeding years. Hence there is improvement in lead period of forecast by 4 days
- There is high improvement in recent 5 years (2018-22) as compared to previous 5 years (2013-17)

Number of Lives lost per one extremely heavy rainfall case over India During 2015-2021-Reduced from 4.13 in 2017 to 2.70 in 2021 (by 35% per rain reported station based extremely heavy rainfall event)



Extremely heavy rainfall event Uttarakhand 15-18 June 2013 vs 17-20 Oct 2021

Extremely heavy rainfall event	Red color warning issued	CM Preparatory with IMD prior to event	Live lost	Houses damaged	Livestock lost	Any strict Tourist restriction imposed
15-18 June 2013	-	-	Nearly 7000 people lost their lives	2513	11091	**No Destruction of bridges and roads left about 300,000 pilgrims and tourists trapped in the valleys**
17-20 Oct 2021	2-days in advance with likely impact	Yes. All preparation were in place	Around 79 deaths were reported in the state	232	-	All Chrdham Yatra were stopped and all tourists were restricted

Development of Multi-Hazard Early Warning System-Aug 2019 DGM Plan

2019- 20

Supply order for Decision support system.

•Establishment of Test Bed for Centre for Thunderstorm and lightning (CTL) and other activities finalized

2020-21

Commissioning of Decision Support System (DSS) Centre established with full functionality

2021-22

2022-23

Impact based Forecast system for Heavy rains and thunderstorms

2023-24

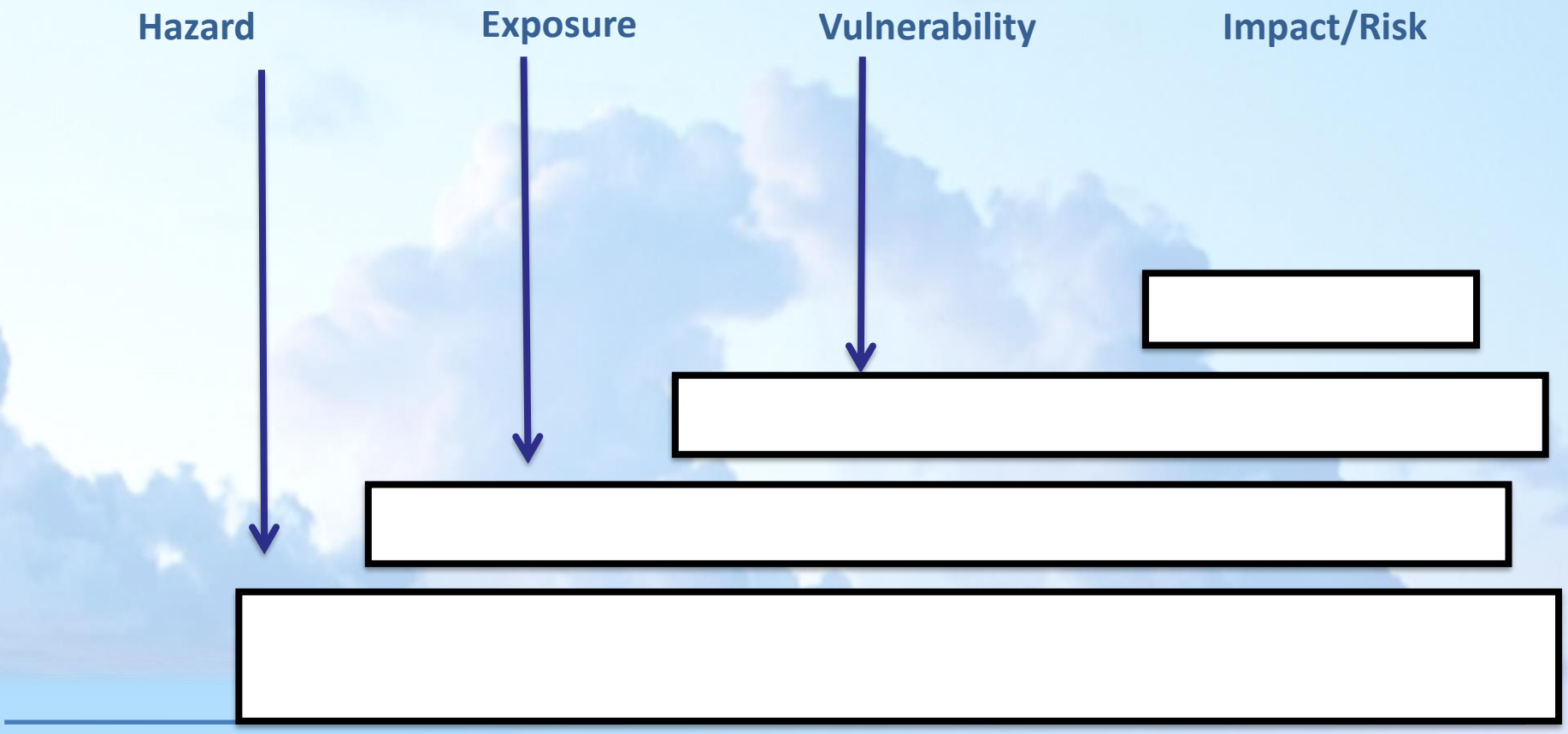
Impact based Forecast system for Urban floods

2024-25

Impact based Forecast system for Urban floods

Key Essentials for Impact based

Forecasting Translating hazard information into impact scenarios



Source: Modified from Francis Ghesquiere, The World Bank

Target 2024- IBFW- Adding Risk for various major exposures and to improve response from users and trigger actions

- Use of Risk matrix at granular scale for all major exposures
- Aimed at individuals, communities and enterprises that are vulnerable and exposed to the impact of a hazard or group of hazards.
- To create paltform for Social and behavioral response of public and DMs and stake holders to take safety action, to IBF and warning

Thank You