### Brief Report on Western Disturbance which caused widespread precipitation accompanied with hailstorm over Northwest India on 12<sup>th</sup> & 13<sup>th</sup> December 2019

#### 1. Introduction:

An Intense Western Disturbance (WD) & its induced cyclonic circulation (CC) caused fairly widespread to widespread rain/snow over Western Himalayan Region (Jammu & Kashmir, Himachal Pradesh and Uttarakhand) and rainfall over Punjab, Haryana, Chandigarh & Delhi, Rajasthan, West Madhya Pradesh and Uttar Pradesh on 12<sup>th</sup> & 13<sup>th</sup> December, 2019. In addition, there was heavy falls coupled with thunderstorm, lightning and hailstorm over entire region during same period. As per the media a report, Jammu- Srinagar road was closed due to heavy snowfall and many flights were diverted from IGI International Airport Delhi on these days. Brief history of Western Disturbance, observed weather and forecast & warnings issued by IMD in the following sections.

#### 2. Brief History (Meteorological Analysis):

- A Western Disturbance seen as a cyclonic circulation extending upto midtropospheric levels eastern parts of Iran and adjoining Afghanistan on 09<sup>th</sup> & 10<sup>th</sup> December. It moved eastwards and laid as a cyclonic circulation over north Afghanistan & neighbourhood at mid-tropospheric levels on 11<sup>th</sup>. Under its influence, an induced cyclonic circulation formed over west Rajasthan & neighbourhood at lower tropospheric levels on same day.
- Thereafter, it was seen as a cyclonic circulation over central Afghanistan & adjoining Pakistan between 3.1 & 4.5 km above mean sea level with a trough aloft in mid & upper tropospheric levels with its axis at 5.8 km above mean sea level roughly along Long. 62°E to the north of 24°N on 12<sup>th</sup>. The induced cyclonic circulation persisted over west Rajasthan & neighbourhood at lower tropospheric levels.
- Thereafter, the system laid as a cyclonic circulation over north Pakistan and adjoining Jammu & Kashmir between 3.1 & 4.5 km above mean sea level with the trough aloft in mid & upper tropospheric levels with its axis at 5.8 km above mean

sea level roughly along Long. 70°E to the north of 22°N on 13<sup>th</sup>. The induced cyclonic circulation laid over northeast Rajasthan & neighbourhood at lower tropospheric levels.



## Figure 1: 12<sup>th</sup> December IMD-GFS Analysis charts based on 0000 UTC a) 925 hPa b) 850 hPa c) 700 hPa d) 500 hPa

There was high moisture feeding from the Arabian Sea over the region at lower & mid-tropospheric levels along with high wind convergence. The system is supported by high jet stream winds (> 100 knot) mainly in the right entrance of the trough in upper tropospheric levels which provided high divergence of order 20X10<sup>-5</sup> sec<sup>-1</sup> and maintained its maximum intensity on 12<sup>th</sup> & 13<sup>th</sup>.

Along with above favourable meteorological features, there was wind confluence zone over plains of northwest India & adjoining central India at lower tropospheric levels between easterlies & westerlies (Fig. 1 & 2), which contributed in the thunderstorm along with hailstorm activity over the region. Thereafter, the system has moved away east-northeastwards.



Figure 2: 13<sup>th</sup> December IMD-GFS Analysis charts based on 0000 UTC a) 925 hPa b) 850 hPa c) 700 hPa d) 500 hPa

#### 3. Realized Weather:

**Widespread Rain/snow** over Jammu & Kashmir, Uttarakhand, Himachal Pradesh and widespread Rainfall over Punjab, Haryana, Chandigarh & Delhi and Uttar Pradesh on 12<sup>th</sup> & 13<sup>th</sup> December. Fairly widespread rain over East Madhya Pradesh and scattered

over West Madhya Pradesh, Rajasthan and Bihar on 12<sup>th</sup>. Widespread rain over Bihar on 13<sup>th</sup>. **Heavy rainfall** observed at a few places over Jammu & Kashmir and at isolated places over Himachal Pradesh on 12<sup>th</sup> and at isolated places over Jammu & Kashmir, Himachal Pradesh,Uttarakhand and West Uttar Pradesh on 13<sup>th</sup>. **Thunderstorm accompanied with hailstorm/lightning** observed at isolated places over Uttar Pradesh, Bihar, East Madhya Pradesh, Haryana, Chandigarh & Delhi, Rajasthan and Gujarat Region on 12<sup>th</sup> and **Thunderstorm accompanied with lightning** at isolated places over Himachal Pradesh,Uttarakhand, Uttar Pradesh, Haryana, Chandigarh & Delhi on 13<sup>th</sup>.

Under the impact of this WD, On 12 Dec night, Delhi NCR also received widespread rainfall with reports of frequent thunderstorm accompanied with lightning and hailstorms during 2000-2210 hrs IST. The 24-hour accumulated rainfall recorded at 0830 hrs IST of 13 Dec was 33.5mm at Safdarjung(SFD) airport and 40.2mm at Palam airport which have broken records for December month 24-hour rainfall of 52 years for SFD and 68 years for Palam.



Figure 3: 24-hr accumulated Rainfall realized at 0830 hrs IST of (a) 13<sup>th</sup> & (b) 14<sup>th</sup> December, 2019

# Table 1: Chief amount of 24 hours accumulated precipitation (≥50mm) recorded at 0830 hours IST:

SI No.	Sub-Division	13.12.2019		14.12.2019	
1.	Jammu & Kashmir	PAHALGAM	80.1	PAHALGAM	86.3
		BADARWAH	69.4	QAZI GUND	70.2
		JAMMU	97.4	BANIHAL	70.2
		KATHUA	59.2	BATOTE	59.0
		RAJHANI AWS	50.0	KATRA	51.9
		QAZI GUND	62.2		
		BANIHAL	79.6		
		BATOTE	79.4		
		GOVINDPURA AWS	51.0		
		KATRA	101.6		
		SAMBA AWS	60.0		
		KAWA AWS	75.0		
2.	Himachal Pradesh	KHERI	52.2	NAINA DAVI	58.2
		DHARMSALA	66.4	CHAMBA AWS	62.0
		KANGRA AERO	50.5	DHARMSALA	86.4
		BANJAR	52.3	KANGRA AERO	56.6
		KHADRALA	57.0	PALAMPUR	56.0
				BANJAR	55.4
				GOHAR	56.0
2	littarakband			UNA	50.6
5.	Ollarakilariu	DEOPRAYAG	71.0	DWARHAT	50.5
				KARNAPRAYAG	56.2
				BANBASA	50
				DEOPRAYAG	79
				HALDWANI	53
					50 52
4.	Punjab &	DHANSA	57.8	PHANGOTA	51.8
	Harvana,		54.0	NANGAL	69.2
	Chandigarh &		59.2	ROPAR	52.0
	Dolbi	ΜΑΓΑΝΙ ΟΚ	63.6		
	Deini	ΡΗΛΝΩΟΤΛ	52.2		
		TIRRI	52.2 60.0		
5.	East Uttar	MFIA	71.0	NANPARA	55 0
	Pradesh	MEJA	/ 1.0	MUHAMMADI	54.4
				NIGHASAN	81.2
6.	West Uttar	BILARI	51.0	BAHERI	69.0

F	Pradesh	RAMPUR	51.2	HAPUR	58.0
		SUAR	50.2	MORADABAD	71.4
		SAMBHAL	78.0	MORADABAD	<u> 00 0</u>
		SHΔΗΙΔΗΔΝΡΙΙΒ (Τ)	84.2	OBSY	89.2
		Simily minimum on (1)	04.2	THAKURDWARA	65.4
				SHAHJAHANPUR	
				(T)	89.3
				SHAHJAHAPUR	
				OBSY	63.0

#### 4. Monitoring and forecasting process:

IMD utilized all its resources to monitor round the clock forecast with a lead period of 05 days and warn against adverse weather to the general public, disaster managers, media and other stake holders.

For monitoring the Western Disturbances & its associated weather, IMD used all type of Synoptic charts, INSAT- 3D half hourly imagery, every 10 minutes DWR products for Srinaagar, Patiala, Delhi, Lucknow, Jaipur and Bhopal. Various Numerical Prediction Models like IMD GFS, WRF, ECMWF, NCMRWF NCUM, GEFS and various international models were utilized for this purpose.

The digitized decision support system known as SYNERGIE was utilized for decision making and for development of consensus forecast.

#### 5. Warning Services:

First indication of this active WD and its associated precipitation was given in FDP Winter Bulletin issued on 03.12.2019. Weather Outlook issued in mid-day bulletin of 06<sup>th</sup> December had forecast likelihood of thunderstorm/hailstorm activity with isolated heavy rain over north & central India on 11<sup>th</sup> and 12<sup>th</sup> December. Similarly, Weather Outlook issued in mid-day bulletin of 07<sup>th</sup> December had forecast likelihood of thunderstorm/hailstorm activity with isolated heavy rain over north & central India on 07<sup>th</sup> December had forecast likelihood of thunderstorm/hailstorm activity with isolated heavy rain over north & central India on 12<sup>th</sup> and 13<sup>th</sup> December. From 08<sup>th</sup> December onwards warnings for 12<sup>th</sup> and 13<sup>th</sup> December were consistently issued. Four Press Releases were issued by IMD well in advance on 08<sup>th</sup>, 09<sup>th</sup>, 12<sup>th</sup> and 13<sup>th</sup> December predicting 'Intense Wet spell over Western Himalayan region and adjoining plains of northwest India on 12<sup>th</sup> & 13<sup>th</sup> December, 2019'. In the 1<sup>st</sup> press release dated 08<sup>th</sup> December, 2019, IMD issued alert

for heavy rain/snow spell for Jammu & Kashmir, Himachal Pradesh and Uttarakhand and heavy rainfall warning for adjoining plains for the same period.

Bulletins are issued four times daily by National Weather Forecasting Centre (NWFC). In addition to these bulletins, special mountain weather bulletins are also issued two times daily by Mountain Meteorology Cell of NWFC for Western Himalayan region. These bulletins are issued to higher officials of Central & State government and Print & Electronic media.

#### 6. Verification of forecast & Warnings for northwest India:

#### Warning issued on 08<sup>th</sup> December for 12 December (Day 5):

- Thunderstorm/hailstorm accompanied with lightning likely at isolated places over Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Punjab and Haryana, Chandigarh & Delhi and Thunderstorm accompanied with lightning at isolated places over West Uttar Pradesh.
- Heavy rain/snow likely at isolated places likely over Jammu & Kashmir, Himachal Pradesh and Uttarakhand and Heavy rain at isolated places over Punjab.



#### Warning issued 09<sup>th</sup> December for 12 December (Day 4):

Thunderstorm/hailstorm accompanied with lightning likely at isolated places over Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Punjab, Haryana, Chandigarh & Delhi and West Uttar Pradesh. Heavy rain/snow likely at isolated places over Jammu & Kashmir, Himachal Pradesh and Uttarakhand and Heavy rain at isolated places over Punjab.



#### Warning issued 09<sup>th</sup> December for 13 December (Day 5):

- Thunderstorm/hailstorm accompanied with lightning likely at isolated places over Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Punjab, Haryana, Chandigarh & Delhi and West Uttar Pradesh.
- Heavy rain/snow likely at isolated places over Jammu & Kashmir, Himachal Pradesh and Uttarakhand and Heavy rain at isolated places over Punjab and north Haryana.



#### Warning issued 10<sup>th</sup> December for 12 December (Day 3):

- Thunderstorm/hailstorm accompanied with lightning likely at isolated places over Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Punjab, Haryana, Chandigarh & Delhi, West Uttar Pradesh, Rajasthan, Madhya Pradesh and Vidarbha.
- Heavy rain/snow likely at a few places over Jammu & Kashmir and at isolated places over Uttarakhand and Himachal Pradesh and Heavy rain at isolated places over Punjab and Haryana, Chandigarh & Delhi.



Warning issued 10<sup>th</sup> December for 13 December (Day 4):

- Thunderstorm/hailstorm accompanied with lightning likely at isolated places over Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Punjab, Haryana, Chandigarh & Delhi, Uttar Pradesh, Rajasthan, Vidarbha and Chhattisgarh and Thunderstorm accompanied with lightning at isolated places over Tamilnadu, Puducherry & Karaikal.
- Heavy rain/snow likely at a few places over Jammu & Kashmir and Himachal Pradesh and at isolated places over Uttarakhand.



#### Warning issued 11<sup>th</sup> December for 12 December (Day 2):

- Thunderstorm/hailstorm accompanied with lightning very likely at isolated places over Jammu & Kashmir, Himachal Pradesh and Uttarakhand; with lightning very likely at isolated places over Punjab, Haryana, Chandigarh & Delhi, West Uttar Pradesh, North Rajasthan and Madhya Pradesh.
- Heavy rain/snow very likely at a few places over Jammu & Kashmir and at isolated places over Uttarakhand and Himachal Pradesh and Heavy rain at isolated places over Punjab and Haryana, Chandigarh & Delhi.



#### Warning issued 11<sup>th</sup> December for 13 December (Day 3):

- Thunderstorm/hailstorm accompanied with lightning very likely at isolated places over Jammu & Kashmir, Himachal Pradesh and Uttarakhand; with lightning very likely at isolated places over Punjab, Haryana, Chandigarh & Delhi, Uttar Pradesh, North Rajasthan, Chhattisgarh and Madhya Pradesh.
- Heavy rain/snow very likely at isolated places over Jammu & Kashmir, Uttarakhand and Himachal Pradesh and Heavy rain at isolated places over Punjab, West Uttar Pradesh, Haryana, Chandigarh & Delhi.



LEGENDS:						
We	WIDE SPREAD / MOST		FWS	FAIRLY WIDE SPREAD / MANY PLACES		
vv3	PLACES (76-100%)			(51% to 75%)		
SCT	SCATTERED / FEW		ISOL	ISOLATED	DRY	NO STATION
	PLACES (26% to 50%)			(up to 25%)		REPORTED RAINFALL
Heavy Rainfall (64.5- Heavy		to Very Heavy Rainfall		Extremely Heavy Rainfall		
115.5 mm)		(1	115.6-204.4 mm)		(204.5 mm or more)	

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