

Report on Extreme Weather Events during June-December 2019

1. Introduction

As per the classification of the seasons, June to September (JJAS) constitute the monsoon season whereas October-December (OND) constitute the post-monsoon season. The monsoon season during JJAS is associated with the formation of low pressure areas and monsoon Depressions over the Bay of Bengal (BoB) which move inland over India giving rise to heavy rainfall over different parts of the country. Sometimes the Depression intensifies into a Tropical Cyclone particularly during the onset phase (June) or the withdrawal phase of monsoon (September). The heavy rainfall leading to flooding is very common phenomenon during the monsoon season. This season is also characterized by the formation of low pressure systems over the north Indian Ocean and occasionally their intensification into cyclones. The post-monsoon season from October to December (OND) is mainly associated with Tropical Cyclones over north Indian Ocean, easterly waves over the southern peninsula India leading to heavy rainfall over Tamil Nadu and adjoining regions. The northern part of India witnesses Western Disturbances and Fog particularly in the months of November and December. In this report, an attempt is made to bring out the details of the extreme weather phenomena and their impact during the monsoon and post-monsoon seasons of 2019.

2. Low Pressure Systems during June-September 2019

During the monsoon season 2019, fourteen low pressure systems (2 Cyclonic Storms, 1 Deep Depression, 1 Depression, 2 Well Marked Low Pressure Areas & 8 Low Pressure Areas) were formed. The frequency and place of origin of these 4 systems (two Cyclones and two Depressions) formed over the Indian region during the monsoon season is shown in Figure 1.

The first intense system of the season was formed as a Very Severe Cyclonic Storm (VSCS) "VAYU" over the Arabian Sea (AS) during 10 -17 June; the

second system as Deep Depression was formed over the BoB during 6-9 August, the third system was a Very Severe Cyclonic Storm (VSCS) "HIKAA" over the Arabian Sea during 22-25 September and the fourth system was a Depression during 29 September to 1 Oct formed near the Gujarat coast. In addition to these 4 intense systems, the season also witnessed 10 low pressure areas over the north Indian Ocean affecting Indian region.

2.1 Very Severe Cyclonic Storm 'VAYU' over East-central Arabian Sea (10-17 June 2019)

In the leading edge of the monsoon flow, a cyclonic vortex gradually concentrated into a Depression over Southeast Arabian Sea (AS) and adjoining Lakshadweep & East Central AS in the early morning of 10th June. It gradually intensified into Cyclonic Storm 'VAYU' by late night of 10th June over East Central & adjoining southeast AS. It further intensified into a VSCS by late night of 11th June over East Central AS. Skirting Saurashtra coast during 13-14 June, it started moving away from the coast, weakened into a Severe Cyclonic Storm on 16th early morning and then into a Cyclonic Storm in the night of 16th June, over north AS. Then it started re-curving eastwards and gradually weakened into a Depression by the afternoon of 17th. It weakened further and laid as a Well Marked Low Pressure Area over Northeast AS and adjoining Saurashtra & Kutch in the night of 17th. It further weakened into a Low Pressure Area and laid over Kutch and adjoining areas in the morning of 18th June.

2.2 Deep Depression over northwest BoB off north Odisha-West Bengal coasts (6-9 August, 2019)

A low pressure area concentrated into a Depression over northwest BoB off north Odisha-West Bengal coasts in the morning of 6th August. It intensified into a Deep Depression over the same region in the early morning of 7th and crossed north Odisha-West

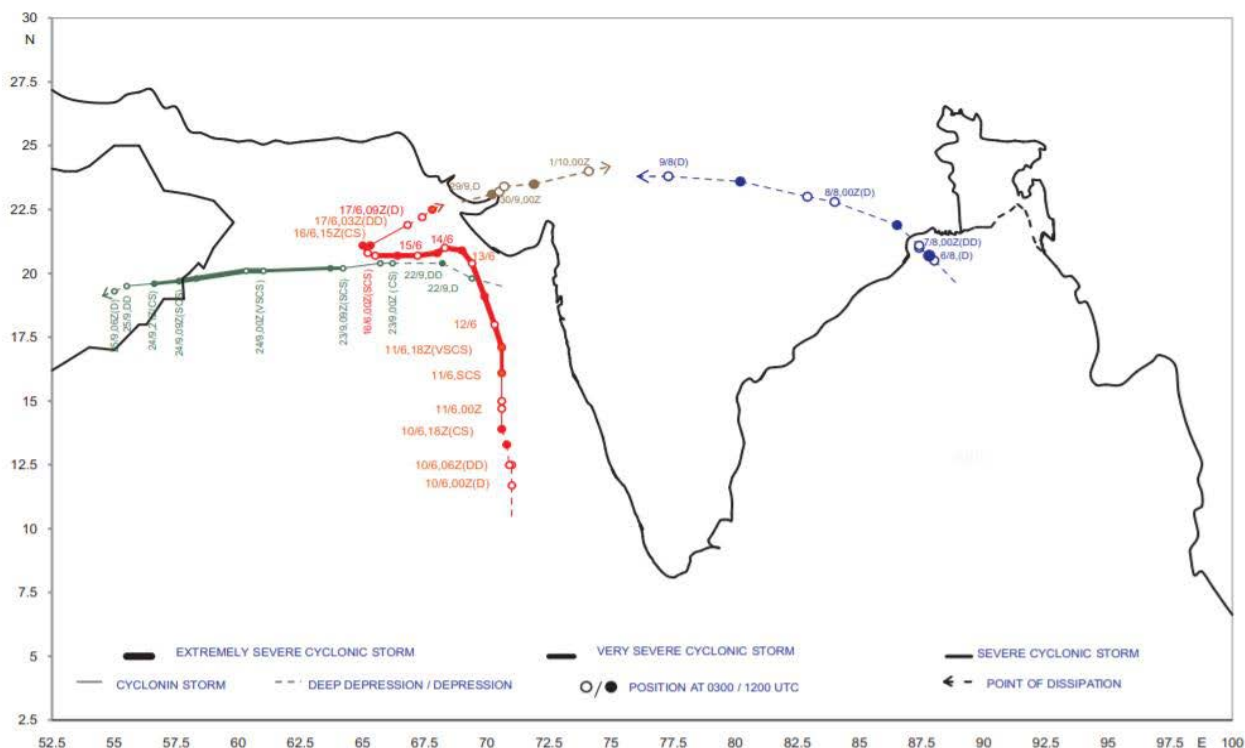


Figure 1: Tracks of Depressions and Cyclones during June to September, 2019.

Bengal coasts close to north of Balasore in the afternoon of 7th. It weakened into a Dover northeast Chhattisgarh & neighbourhood in the early morning of 8th August, further into a well marked low pressure area over southeast Rajasthan & neighbourhood in the evening of 9th August and into a low pressure area over northwest Arabian Sea and neighbourhood in the evening of 12th.

2.3 Very Severe Cyclonic Storm ‘VAYU’ over East central Arabian Sea (10-17 June 2019)

A Depression was formed over East Central and adjoining Northeast Arabian Sea off Gujarat coast on 22nd September. Moving nearly westwards, it gradually intensified into Cyclonic Storm 'HIKAA' over Northeast and adjoining East Central AS on 23rd early morning and into a Severe Cyclonic Storm over Northeast and adjoining Northwest and Central AS by the afternoon of the same day. Moving nearly westwards further, it rapidly intensified into a VSCS in the early morning hours of 24th over Northwest and adjoining West-central Arabian Sea. Moving west-southwestwards, it crossed Oman coast close to north of Duqm between 1930 and 2030 hours IST of 24th

September as a VSCS. After crossing the coast it moved westwards further and weakened rapidly.

2.4 Depression over Gulf of Kutch and adjoining areas (29 September-01 October, 2019)

A low pressure area formed over northeast Arabian Sea & adjoining coastal areas of Saurashtra & Kutch on 28th September. It concentrated into a Depression over Gulf of Kutch and neighbourhood in the evening of 29th, close to Kandla (Gujarat). It moved east-northeastwards and weakened into a well marked low pressure area over southeast Rajasthan & neighbourhood in the morning of 01st October.

3. Western Disturbances during June to September 2019

During the month of June, about 6 Western Disturbances (WDs) affected northwest India during June 2019. Out of these, three WDs caused fairly widespread to widespread rainfall/thunderstorms over Western Himalayan Region and isolated to

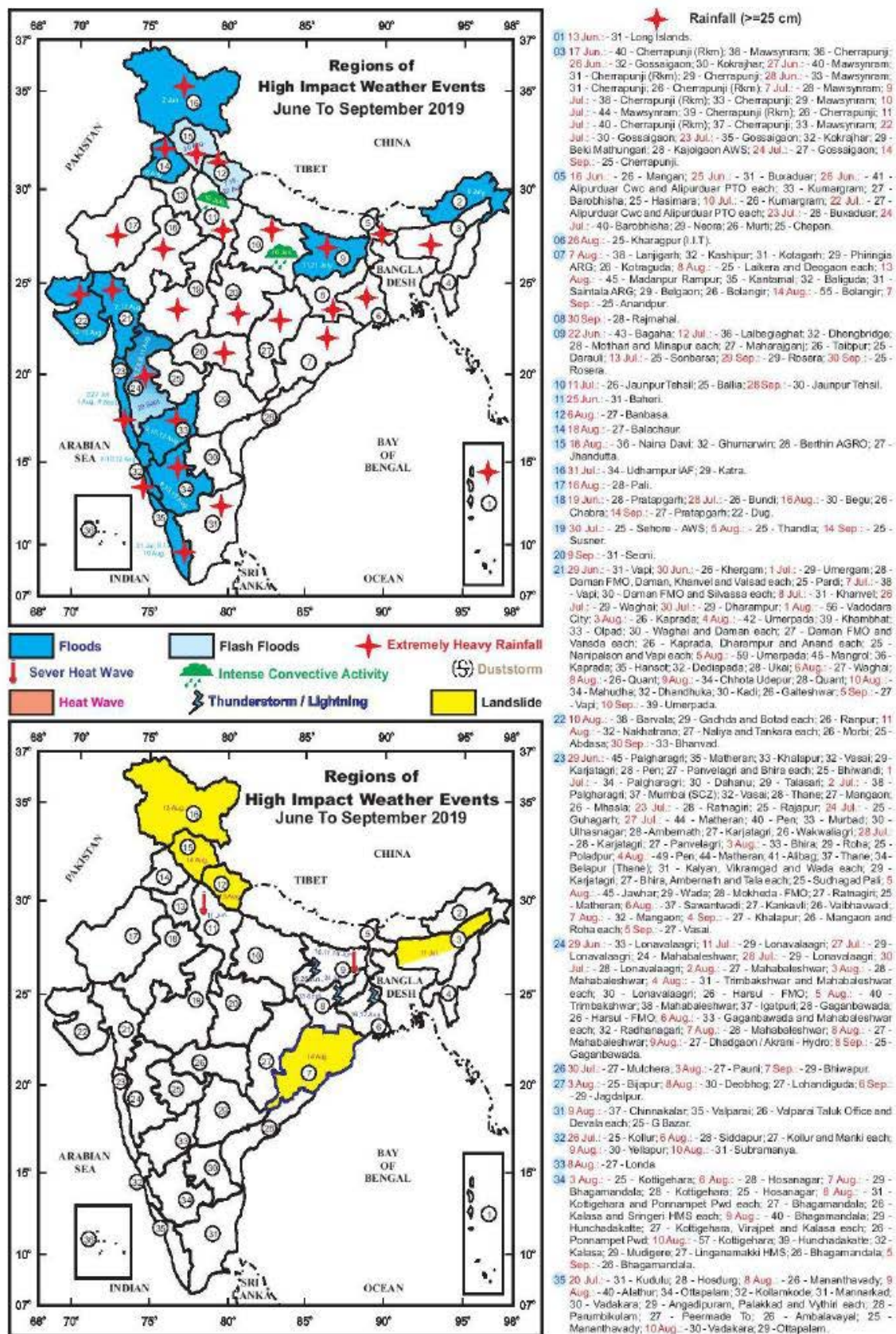


Figure 2: High Impact Weather Events pertaining to events & dates as per legends (Source : Sunitha et al., monsoon report 2019).

scattered rainfall/thunderstorm activity over adjoining plains. During the month of July, 4 WDs affected northwest India during 4th –5th July, June, 7th –9th July, 12th –18th July, 25th –30th July. Out of these, three of them caused fairly widespread to widespread rainfall/thunderstorms over Western Himalayan Region upon their interaction with the monsoon flow.

4. Significant Weather during June to September 2019

The monsoon season (June-September) witnessed many significant weathers or high impact weather events like, floods, landslides, Thunderstorms & Lightning, Dust storms and Heat waves as shown in Figure 2. This figure also indicates areas that experienced isolated extremely heavy rainfall (rainfall amount ≥ 20 cm reported during the 24 hours ending at 0300 UTC) events during the season. Thus, the ‘floods’ remained to be the most frequent and widespread phenomenon. Incessant rainfall associated with the formation and movement of the monsoon low pressure systems in the presence of strong cross equatorial flow often caused flood situations over various areas during different parts of the season Maharashtra experienced one of the worst flood situations during past 50 years, due to frequent heavy rain spells and several extremely heavy rain events, especially during August & September. Several record-breaking extreme rainfall and resultant Flood events caused human casualty and property damage in states including Maharashtra, Karnataka, Kerala, West Bengal, Odisha, Uttar Pradesh and Madhya Pradesh during later part of July to September. In addition, due to Heat wave, 293 people were reportedly claimed dead from different parts of Bihar during 15-18 Jun and 34 people were reportedly claimed dead from Bihar due to Thunderstorm.

5. Cyclonic Disturbances During October-December 2019

The post-monsoon season from October to December 2019 witnessed many severe cyclonic systems over the north Indian Ocean. However, majority of them were formed over the AS and did not affect Indian coast except the one which formed

in the month of November. Figure 3a-c shows the month wise cyclonic disturbances formed over the north Indian Ocean during October, November and December, 2019 respectively. As seen from Figure 3, one Super Cyclone named KYAAR and one Extremely Severe Cyclonic Storm named MAHA were formed over AS during October. One Very Severe Cyclonic Storm named BULBUL also formed over the Bay of Bengal during November. One Cyclonic Storm called PAWAN (2-7 Dec) and two Depressions (3-5 Dec) and (8-10 Dec) formed over AS during December. The details of the systems formed during October to December 2019 are :

- (i) Super Cyclonic Storm (SuCS) KYARR over east-central AS during 24 Oct.-02 Nov.
- (ii) Extremely Severe Cyclonic Storm (ESCS) MAHA over the AS during 30 Oct.-07 Nov.
- (iii) Very Severe Cyclonic Storm (VSCS) BULBUL over the BoB during 05-11 November
- (iv) Cyclonic Storm PAWAN over the southwest AS during 02-07 December
- (v) DD over East Central AS during 03-05 December
- (vi) Depression over southwest AS during 08-10 December

As mentioned above, the year 2019 witnessed development of Super Cyclonic Storm (SuCS), Kyarr which was the 7th Super Cyclonic Storm over NIO during the period 1965-2019. It was the second SuCS over AS during this period after cyclone Gonu in June, 2007. However, Gonu crossed Oman coast as a Very Severe Cyclonic Storm while Kyarr weakened over the AS.

The only system that crossed Indian coast (West-Bengal) during post-monsoon season 2019 is the Very Severe Cyclonic Storm (VSCS) BULBUL, which originated from the remnant of Severe Tropical Storm MATMO (28th October-2nd November) over west Pacific Ocean that emerged into north Andaman Sea. It formed as a low pressure area over north Andaman Sea in the early morning (0000 UTC) of 4th November.

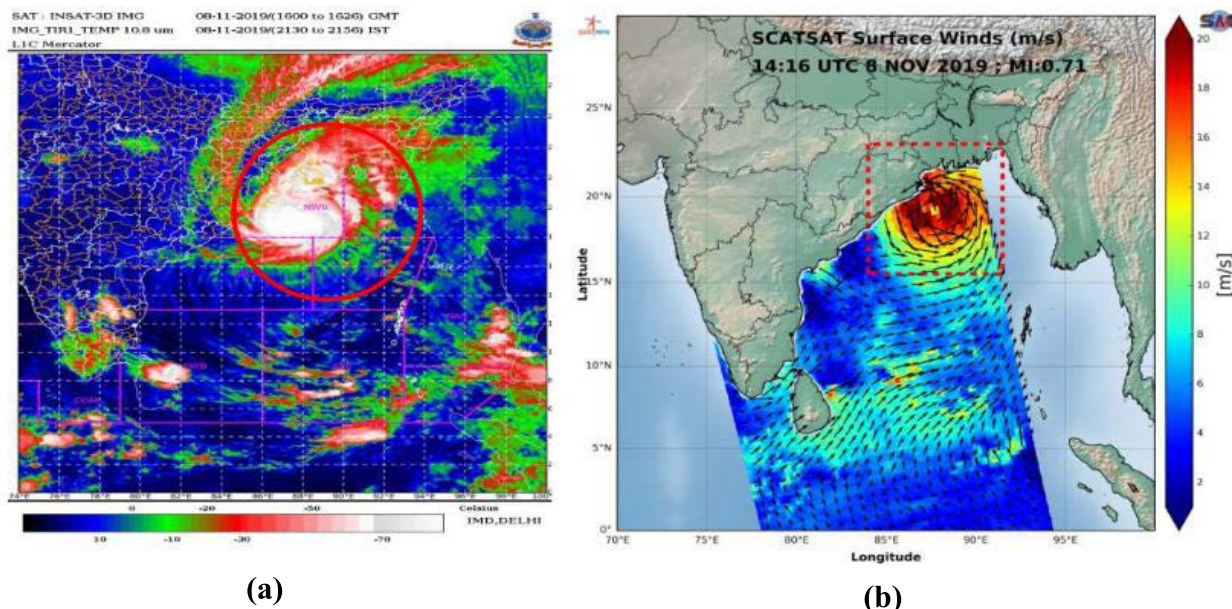


Figure 4: Typical satellite imagery from (a) INSAT 3D at 1600UTC of 8th and (b) SCAT SAT based sea surface winds at 1400 UTC of 8th November for VSCS BULBUL over the Bay of Bengal.

It intensified into a VSCS in the early morning (0000 UTC) of 08th November over West Central and adjoining East Central BoB. Subsequently, it weakened into a SCS and crossed West Bengal coast close to Sunderban Dhanchi Forest near 21.55°N/88.5°E during the night (1500 to 1800 UTC) of 9th November as a Severe Cyclonic Storm with maximum sustained surface wind speed of 110-120 kmph gusting to 135 kmph. The track of the system is shown in Figure 3b. Typical satellite imagery and SCASAT based Sea Surface Winds associated with VSCS Bulbul are presented in Figure 4a-b respectively.

6. Other Significant Weather Events during October-December 2019.

In addition to the Cyclonic Storms, the country experienced cold waves, snow fall, lightening & thunderstorm, heavy rain & floods, during the post-monsoon season 2019 as shown in Figure 5. In total, 199 persons reportedly claimed dead. The casualties mentioned here are based on the media and government reports.

Cold Wave: Total 57 persons reportedly claimed dead from northern parts of the country during 27 to 31 December. 28 persons reportedly claimed dead from Banda, Kanpur, Lucknow, Mahoba, Mainpuri, Shravasti, Varanasi districts of Uttar

Pradesh. 19 persons reportedly claimed dead from Begusarai, Bhojpur, Darbhanga, East Champaran, Muzaffarpur, Nawada, Rohtas, Samastipur, Saran, Sitamarhi, th West Champaran districts of Bihar on 30 December. While 10 persons reportedly claimed dead from Bhind, Datia, Guna, Harda, Mandla, Rewa, Shabdol, Shivpuri, Vidisha districts of Madhya Pradesh during the period 27 to 30 December.

Snowfall: In total, 22 persons reportedly claimed dead during 7 November to 20 December. Out of this total, 8 were reportedly claimed dead due to snow avalanche from Leh (18 & 30 November) and 14 from Bandipora,, Baramulla, Budgam, Kulgam, Kupwara, Pulwama, Ramban Srinagar districts Jammu & Kashmir (7 & 11 November and 4 & 20 December).

Lightning: In total, 30 persons reportedly claimed dead during the season. Of this number, 17 claimed dead from Akola, Amaravati, Dhule, Jalana, Nanded, Osmanabad, Pune, Satara, Yavatmal districts of Maharashtra (4, 6, 10 & 30 Oct.). 7 persons reportedly claimed dead from Khamam district of Telangana (5,7 Oct.) and 4 from Bharatpur district of Rajasthan on 28 November. While, 2 from Raisen, Vidisha districts of Madhya Pradesh on 12 December.

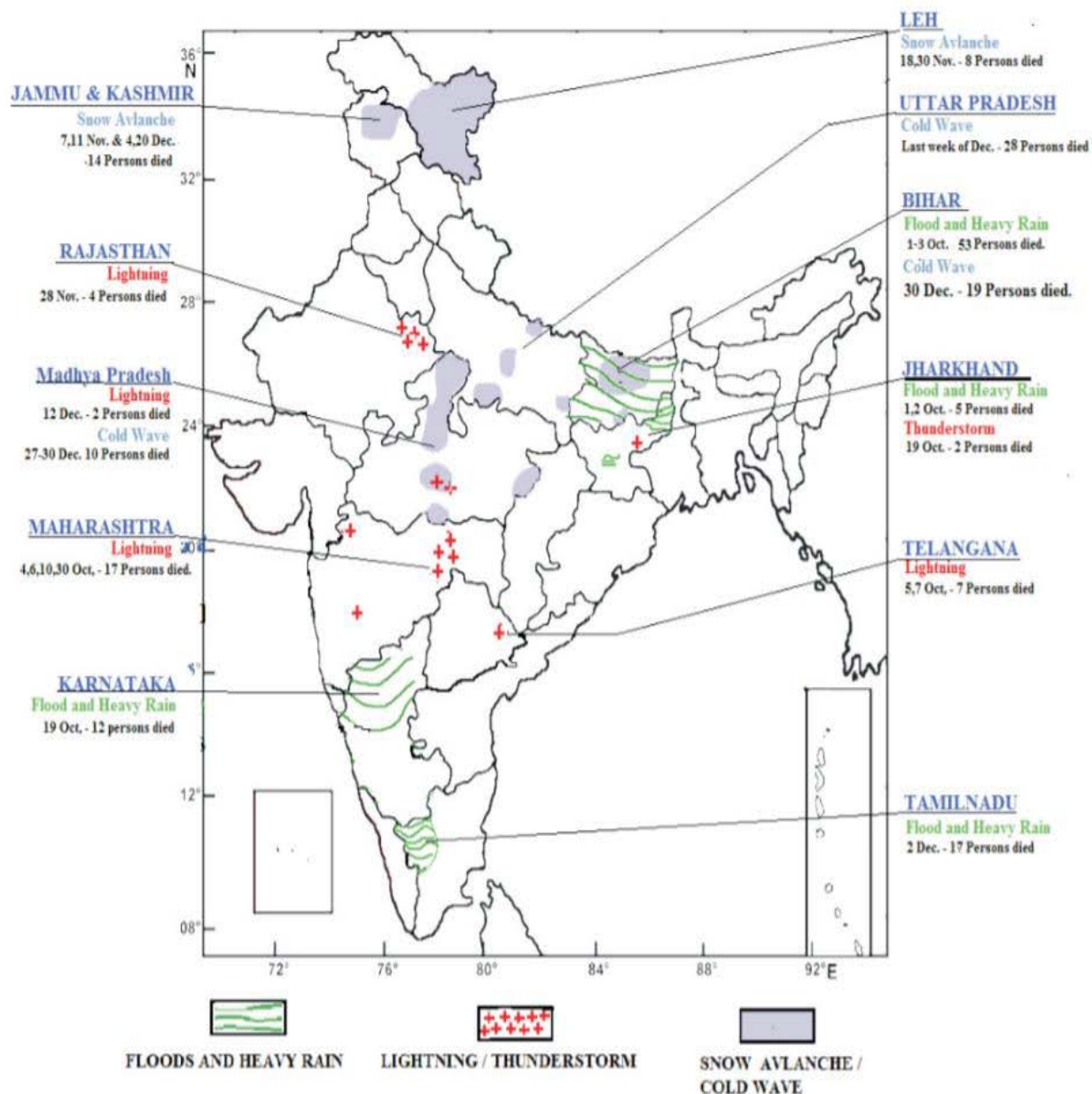


Figure 5: Significant Weather Events formed during Oct-Dec 2019 based on the real time data.

Heavy Rain: It is reported that 88 persons claimed dead during the season. Of these, 53 persons were from Arwal, Begusarai, Bhaglapur, Bhojpur, Buxar, Darbhanga, Jehanabad, Kathihar, Khagaria, Lakhisarai, Nawada, Nalanda, Patna, Samastipur, Siwan, Vaishali districts of Bihar during the period 1 to 3 October. While, 17 persons reportedly claimed dead from Cuddalore, and Thoothukudi, Tirunelveli districts of Tamil Nadu on 2 December. Also 12 persons reportedly claimed dead from parts

of Karnataka and 5 from Jharkhand and one from Jammu & Kashmir.

Thunderstorm: 2 persons reportedly claimed dead from Dhanbad, Ranchi district of Jharkhand.

Acknowledgements

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