MAUSAM, **63**, 4 (October 2012), 653-666

Weather in India

POST MONSOON SEASON (October-December 2011)†

1. Introduction

The Bay of Bengal as well as the Arabian Sea had been cyclogenetically active and the season witnessed formation of a Very Severe Cyclonic Storm (Thane), a Cyclonic Storm (Keila) and three Deep Depressions. Out of these five intense low pressure systems, only the Very Severe Cyclonic Storm (Thane) crossed the Indian coast. The Cyclonic Storm (Keila) crossed Oman coast, the deep depression over the Bay of Bengal crossed the Bangladesh coast, where as both the Deep Depressions over the Arabian Sea moved northwestwards and dissipated over the sea area.

The Very Severe Cyclonic Storm (Thane) which crossed north Tamil Nadu coast caused extensive damage in Tamil Nadu and adjoining areas of Kerala, Rayalaseema and coastal Andhra Pradesh.

The commencement of northeast monsoon rains occurred simultaneous with the withdrawal of the southwest monsoon from the south peninsula on 24th October. Northeast monsoon was excess in Tamil Nadu and normal over Rayalaseema, south interior Karnataka and Kerala during the period.

The easterly winds regime dominated the overall weather over the country during most parts of the season. Even though some perturbations in the mid-latitude westerlies moved across the northern parts of the country in the form of upper air cyclonic circulations and troughs in the mid & upper tropospheric levels, they did not cause much precipitation over the northwestern parts of the country.

Severe cold wave / cold wave conditions manifested over parts of central & northwest India towards the third week of December. They prevailed over northwest and central India and parts of peninsular and northeast India. The major weather related disasters that occurred over the south peninsula were caused by heavy rainfall and that over north India by *cold wave* and dense fog.

2. Seasonal rainfall (October–December)

The meteorological sub-divisionwise rainfall departures from normal are given in Fig. 1 and Table 1.

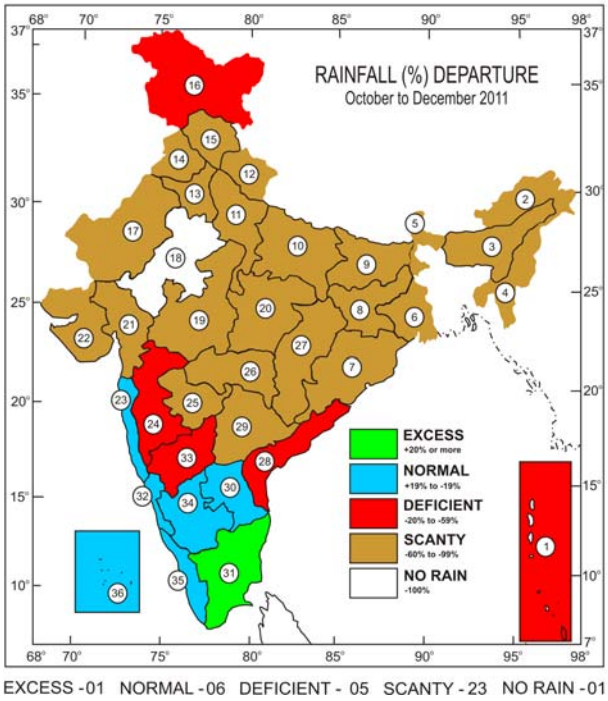

Fig. 1. Sub-division wise seasonal rainfall departure from normal (%) for Post monsoon season (October to December 2011). Sub-divisions are indicated by number on the map & bold letters in legend. The rainfall anomaly values for these 36 sub-divisions are indicated below :

1	–20	**7**	–83	**13**	–99	**19**	–99	**25**	–75	**31**	22
2	–71	**8**	–72	**14**	–90	**20**	–97	**26**	–94	**32**	–2
3	–72	**9**	–87	**15**	–83	**21**	–93	**27**	–77	**33**	–44
4	–67	**10**	–98	**16**	–45	**22**	–88	**28**	–45	**34**	–1
5	–65	**11**	–99	**17**	–99	**23**	–19	**29**	–85	**35**	–7
6	–82	**12**	–88	**18**	–100	**24**	–46	**30**	–18	**36**	–6

Out of the 36 met. sub-divisions of India, the seasonal rainfall was excess in 1, normal in 6, deficient in 5 and scanty in 23 sub-divisions. There was no rain in one (east Rajasthan) sub-division.

A large seasonal rainfall deficiency realized over the most parts of the country despite of quite normal activity of westerly system which moved across the northern parts of the country in the form of upper air cyclonic circulations and troughs in the mid & upper tropospheric

* Terms in Italics other than the sub-titles are explained in Appendix.

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TABLE 1

Sub-divisionwise rainfall (mm) for each month and season as a whole (October-December 2011)

S. No.	Meteorological Sub-divisions	October			November			December			Season		
		Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)
1.	A. & N. Islands	183.8	296.7	–38%	126.0	253.7	–50%	246.3	145.5	69%	556.2	695.9	–20%
2.	Arunachal Pradesh	46.8	183.0	–74%	19.8	45.8	–57%	10.3	38.4	–73%	77.0	267.2	–71%
3.	Assam & Meghalaya	36.8	154.8	–76%	14.8	28.4	–48%	2.4	11.8	–80%	54.0	195.0	–72%
4.	Naga., Mani., Mizo. and Tri.	79.8	179.8	–56%	0.0	50.7	–99%	0.0	12.5	–99%	79.9	243.0	–67%
5.	Sub-Himalayan West Bengal & Sikkim	40.1	154.2	–74%	21.1	20.3	4%	3.6	10.8	–67%	64.8	185.3	–65%
6.	Gangetic West Bengal	28.6	129.3	–78%	0.9	23.3	–96%	0.0	7.5	–100%	29.5	160.1	–82%
7.	Orissa	23.3	111.6	–79%	0.0	27.7	–99%	0.9	4.8	–81%	24.2	144.1	–83%
8.	Jharkhand	25.7	75.2	–66%	0.0	9.9	–100%	0.1	6.5	–99%	25.7	91.6	–72%
9.	Bihar	7.3	64.8	–89%	2.9	6.9	–58%	0.1	5.8	–98%	10.3	77.5	–87%
10.	East Uttar Pradesh	1.1	49.2	–98%	0.0	4.5	–100%	0.0	6.7	–100%	1.1	60.4	–98%
11.	West Uttar Pradesh	0.0	42.1	–99%	0.0	4.7	–100%	0.0	7.6	–100%	0.0	54.4	–99%
12.	Uttarakhand	6.0	58.6	–90%	2.1	9.7	–78%	2.3	21.3	–89%	10.5	89.6	–88%
13.	Haryana, Chandigarh & Delhi	0.0	17.6	–100%	0.0	4.9	–100%	0.2	6.9	–97%	0.2	29.4	–99%
14.	Punjab	0.6	22.0	–97%	0.2	5.7	–97%	3.4	13.3	–75%	4.1	41.0	–90%
15.	Himachal Pradesh	7.6	42.5	–82%	0.6	20.3	–97%	9.6	45.4	–79%	17.9	108.2	–83%
16.	Jammu & Kashmir	26.2	38.9	–33%	15.5	33.0	–53%	31.3	59.9	–48%	73.0	131.8	–45%
17.	West Rajasthan	0.1	5.4	–99%	0.0	2.5	–100%	0.0	1.6	–100%	0.1	9.5	–99%
18.	East Rajasthan	0.0	16.9	–100%	0.0	7.4	–100%	0.0	3.3	–100%	0.0	27.6	–100%
19.	West Madhya Pradesh	0.1	34.4	–99%	0.0	11.0	–100%	0.0	7.7	–100%	0.1	53.1	–99%
20.	East Madhya Pradesh	1.6	37.5	–96%	0.0	9.9	–100%	0.0	10.4	–100%	1.6	57.8	–97%
21.	Gujarat region	2.4	23.7	–90%	0.0	9.5	–100%	0.0	1.7	–100%	2.4	34.9	–93%
22.	Saurashtra & Kutch	3.3	17.9	–82%	0.1	10.3	–99%	0.0	0.8	–100%	3.4	29.0	–88%
23.	Konkan & Goa	109.5	121.0	–10%	11.6	22.3	–48%	0.0	5.3	–100%	121.1	148.6	–19%
24.	Madhya Maharashtra	58.6	79.0	–26%	0.0	22.7	–100%	0.0	6.1	–100%	58.6	107.8	–46%
25.	Marathawada	25.4	72.3	–65%	0.0	21.2	–100%	0.0	8.1	–100%	25.4	101.6	–75%
26.	Vidarbha	4.6	59.6	–92%	0.0	13.2	–100%	0.1	9.0	–99%	4.7	81.8	–94%
27.	Chattisgarh	13.7	62.3	–78%	0.0	8.8	–99%	3.6	5.8	–37%	17.4	76.9	–77%
28.	Coastal Andhra Pradesh	104.1	193.2	–46%	60.6	106.6	–43%	14.7	27.6	–47%	179.4	327.4	–45%
29.	Telangana	15.7	92.2	–83%	1.7	21.6	–92%	0.0	5.5	–100%	17.4	119.3	–85%
30.	Rayalaseema	89.2	129.4	–31%	71.0	66.1	7%	18.7	23.7	–21%	178.9	219.2	–18%
31.	Tamil Nadu	220.5	180.2	22%	252.4	170.0	48%	63.9	88.0	–27%	536.8	438.2	22%
32.	Coastal Karnataka	169.7	189.5	–10%	87.6	59.6	47%	0.1	13.7	–99%	257.5	262.8	–2%
33.	North interior Karnataka	78.5	112.0	–30%	2.3	27.3	–91%	0.0	6.0	–99%	80.8	145.3	–44%
34.	South interior Karnataka	151.6	147.7	3%	54.6	49.2	11%	2.2	12.7	–83%	208.5	209.6	–1%
35.	Kerala	230.9	292.3	–21%	165.8	150.9	10%	50.0	37.5	33%	446.7	480.7	–7%
36.	Lakshadweep	117.4	157.1	–25%	180.8	117.7	54%	14.9	58.8	–75%	313.1	333.6	–6%

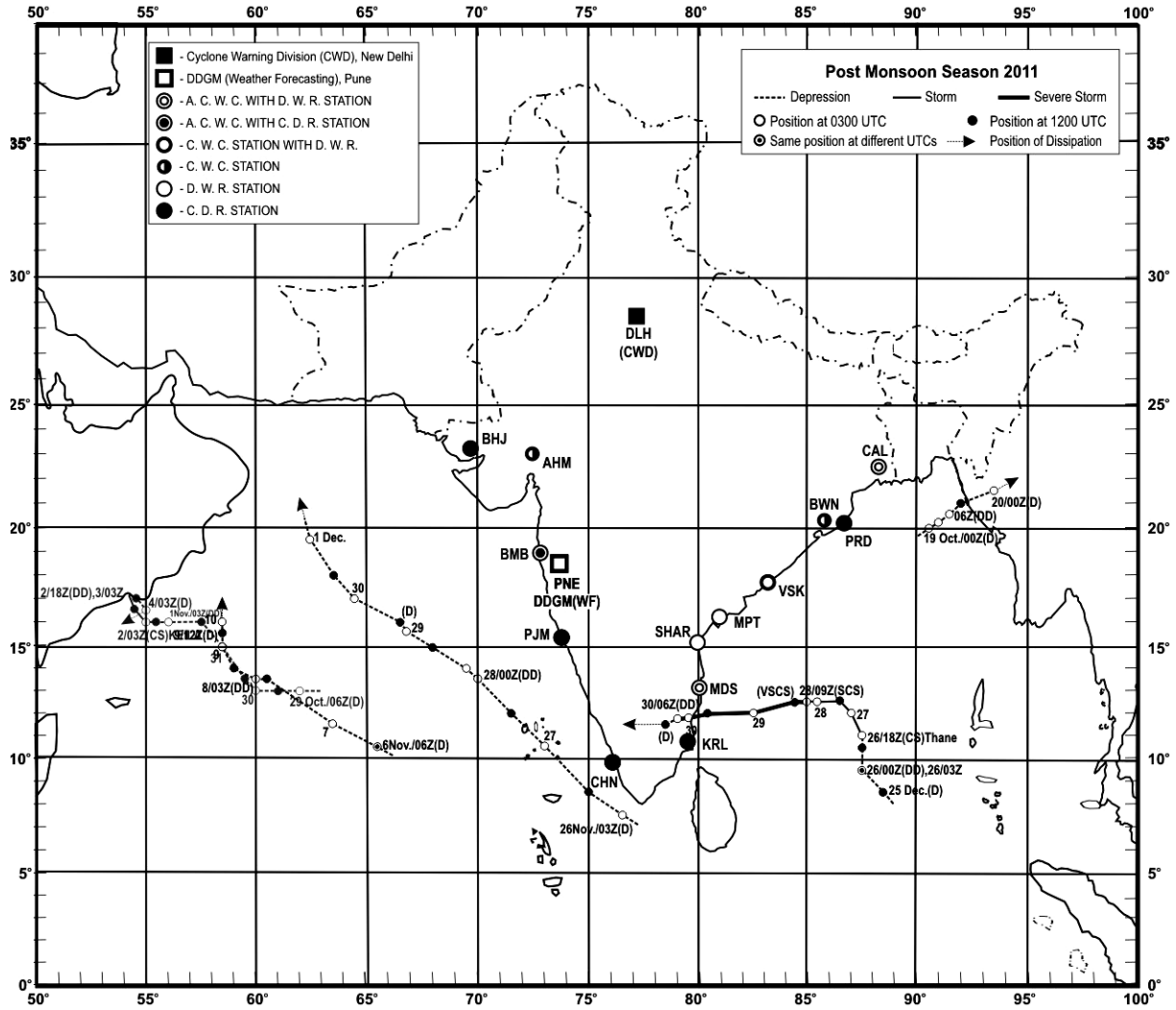

Fig. 2. Tracks of cyclonic storms and depressions during the period October to December, 2011

levels. At the same time, the systems in the easterlies contributed to the *normal/excess* rainfall over the south Peninsula. However, out of the 5 intense low pressure systems mentioned in the beginning, only two; *viz*., (Very Severe Cyclonic Storm (Thane)) and Deep Depression (26 November - 1 December) contributed to the rainfall over the south Peninsula.

3. Monthly features

3.1. *October*

3.1.1. *Withdrawal of southwest monsoon*

There was considerable delay in the withdrawal of southwest monsoon due to the prevalence of moisture in the lower levels and conducive conditions for rainfall created by the presence of mid-latitude westerlies in the upper levels of the atmosphere over the north western parts of the country.

The withdrawal of the southwest Monsoon from west Rajasthan started on 23rd September, with a delay of more than three weeks with respect to the normal date of withdrawal from extreme western parts of Rajasthan (1st September). On 30th September, the monsoon further withdrew from some more parts of Uttar Pradesh and Madhya Pradesh. The subsequent withdrawal of the monsoon was delayed due to the presence of various transient synoptic scale systems including troughs and cyclonic circulations causing moisture incursion and rainfall over the region. The southward shifting of the

TABLE 2

Details of the weather systems during October, 2011

S. No.	System	Duration	Place of first location	Direction of movement	Place of final location	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(**A**)	*Cyclonic storm*					
1.	Cyclonic storm (Keila)*	29 Oct - 4 Nov	West central and adjoining southwest Arabian Sea	West/north-west/ northnorth-west	Near Lat. 16.5° N/ Long. 55.0° E	First seen as a trough of low at mean sea level extended from Lakshadweep area to Karnataka on 24. It re-organised into a low pressure area over central parts of south Arabian Sea and adjoining central Arabian Sea on 28 and subsequently concentrated into a depression
(**B**)	*Depression/deep depressions*					
1.	Deep Depression*	19-20	East central Bay of Bengal and neighbourhood	Northwest and then northeast	Myanmar and adjoining Bangladesh and Mizoram and northeast Bay of Bengal	It was seen as a cyclonic circulation extending upto mid tropospheric levels over southeast and adjoining east central Bay of Bengal during 10-16. Under its influence, a low pressure area formed over east central Bay of Bengal and neighbourhood on 17
(**C**)	*Western disturbances /eastward moving systems*					
(*i*)	*Upper air cyclonic circulation*					
1.	Up to 4.5 kms a.s.l.	4-10	North Pakistan and adjoining Jammu & Kashmir	Northeast	-	Moved away on 11
2.	Mid tropospheric levels	11-16	North Pakistan and neighbourhood	Do	Jammu & Kashmir and neighbourhood	Moved away on 17
3.	Upper air system	22-24	Jammu & Kashmir and adjoining north Pakistan	Do	Jammu & Kashmir and neighbourhood	Moved away on 25
4.	Up to 4.5 kms a.s.l.	26	Jammu & Kashmir and neighbourhood	Do	Eastern parts of Jammu & Kashmir	Moved away on 27
5.	Up to 4.5 kms a.s.l.	27 Oct - 5 Nov	North Pakistan and neighbourhood	Eastnortheast	Jammu & Kashmir and neighbourhood	Moved away on 6 Nov
(*ii*)	*Trough in westerlies*					
1	At 5.8 kms a.s.l.	12-14	Long. 68° E to the north of 25° N	Northeast	Lat. 42°N/ Long. 74° E to Lat. 25° N/ Long. 64° E	Less marked on 15
2.	Do	20-24	Long 70° E to the north of 22° N	Do	Long 78°E to the north of 20° N	Moved away on 25
3.	Mid and upper tropospheric levels	26	Long 80° E to the north of 25° N	Stationary	*In-situ*	Moved away on 27
(**D**)	*Other upper air cyclonic circulations*					
1.	Mid tropospheric levels	4-9	Gangetic West Bengal and neighbourhood	Southwest	Northwest Bay of Bengal off Orissa coast	Less marked on 10
2.	Up to 4.5 kms a.s.l.	8-9	Assam & Meghalaya and neighbourhood	Stationary	*In-situ*	Less marked on 10
3.	Upto 2.1 kms a.s.l.	17-18	Lakshadweep area and neighbourhood	West	Southeast Arabian Sea and neighbourhood	Moved away on 19

TABLE 2 (*Contd*.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
4.	Upto 1.5 kms a.s.l.	20-23	South Tamil Nadu and adjoining Sri Lanka	Quasi-stationary	South Tamil Nadu and adjoining Sri Lanka	Less marked on 24
5.	Up to 3.6 kms a.s.l.	21-23	West Uttar Pradesh and neighbourhood	Southeast	Gangetic west Bengal and neighbourhood	Less marked on 24
6.	Up to 3.1 kms a.s.l.	22-24	Lakshadweep area and neighbourhood	Stationary	*In-situ*	less marked on 25
7.	Upto 1.5 kms a.s.l.	26-27	Lakshadweep area and neighbourhood	Do	Do	Merged with cyclonic circulation associated with the low pressure area over central parts of south Arabian Sea and adjoining central Arabian Sea on 28
8.	Up to 3.1 kms a.s.l.	26-31	Assam & Meghalaya	Do	Do	Less marked on 1 November
9.	Upto 1.5 kms a.s.l.	26	Southwest Bay of Bengal off southeast Sri Lanka	Do	Do	Less marked on 27
(**E**)	*Troughs in easterlies*					
1.	Trough of low at mean sea level	24-28	Southwest to west central Bay of Bengal	West	South Bay of Bengal to south Arabian Sea	Less marked on 29
2.	Do	29 Oct - 5 Nov	Southwest Bay of Bengal to west central Bay of Bengal	Quasi-stationary	Southwest and adjoining west central Bay of Bengal off Tamil Nadu-south Andhra coast	It persisted over same area upto 30 and from southwest Bengal off Tamil Nadu coast on 31 October to 5 November
(**F**)	*North-south trough*					
1.	Lower tropospheric levels	30 Sep - 9 Oct	Assam & Meghalaya to Tamil Nadu	Oscillatory	Assam & Meghalaya to Lakshadweep	Less marked on 10
(**G**)	*East-west shear zone*					
1.	Mid tropospheric levels	10-17	Southeast and adjoining east central Bay of Bengal to Lakshadweep area	Oscillatory	East central Bay of Bengal and neighbourhood to Lakshadweep area	Less marked on 18

* - The other details of the system are given in the 'Cyclones and Depressions 2011' in the July 2012 issue of journal 'Mausam'

upper tropospheric anticyclone caused a reduction in the rainfall activity over the east and northeastern parts from 10th October.

The southwest monsoon withdrew from some more parts of north & central India on 11th October and from the entire north, east, northeast & some more parts of central India on 13th October. On 24th October, it withdrew from the entire country, including south peninsula, the Bay of Bengal and the Arabian Sea followed by a simultaneous commencement of northeast monsoon rains over Tamil Nadu, Kerala and adjoining areas of Andhra Pradesh & Karnataka.

The tendency of delayed withdrawal of southwest monsoon from Rajasthan is being continued since 2006.

3.1.2. *Commencement of northeast monsoon rains*

The normal onset date of the northeast monsoon is 20th October. The onset during last two years was on 29th October. This delay could be attributed to formation of

TABLE 3

Details of the weather systems during November 2011

S. No.	System	Duration	Place of first location	Direction of movement	Place of final location	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(**A**)	*Depression/ Deep-Depressions*					
1.	Deep Depression*	6-10	Southeast and adjoining east central Arabian Sea	Northwest	West central Arabian Sea off Oman coast	
2.	Deep Depression*	26 Nov – 1 Dec	Comorin area and neighbourhood	Northwest	West central Arabian Sea	It was first observed as a cyclonic circulation (upto 3.1 kms a.s.l.) over southwest Bay of Bengal and adjoining south Sri Lanka and north equatorial Ocean on 24 November morning and intensified as a low pressure area in the evening
(**B**)	*Western disturbances/eastward moving systems*					
(*i*)	*Upper air cyclonic circulations*					
1.	Up to 4.5 kms a.s.l.	7-11	North Pakistan and neighbourhood	Northeast	Jammu & Kashmir and adjoining north Pakistan	Moved away on 12
2.	Do	12-18	Do	Do	Jammu & Kashmir and neighbourhood	Moved away on 19
3.	Up to 3.6 kms a.s.l.	19-21	Jammu & Kashmir and adjoining north Pakistan	Do	Do	Moved away on 22
4.	Up to Mid Tropospheric levels	25-28	North Pakistan and neighbourhood	Do	Jammu & Kashmir	Moved away on 29
(*ii*)	*Troughs in westerlies*					
1.	Lower tropospheric levels	17	Assam & Meghalaya to northeast Bay of Bengal along Long. 92° E	Stationary	*In-situ*	Moved away on 18
(**C**)	*Other upper air cyclonic circulations*					
1.	Up to 3.6 kms a.s.l.	11-13	Southwest Bay of Bengal off south Tamil Nadu coast	East	Sri Lanka and adjoining south Tamil Nadu	Less marked on 14
2.	Up to mid tropospheric levels	22-24	Nagaland–Manipur-Mizoram-Tripura and adjoining Bangladesh	West	Gangetic West Bengal and neighbourhood	Less marked on 25
(**D**)	*Troughs in easterlies*					
1.	Trough of low at mean sea level	16-18	Southwest Bay of Bengal off Sri Lanka-Tamil Nadu coasts	West	Southwest Bay of Bengal off Tamil Nadu coast	Less marked on 19
2.	Do	23-26	Southeast Bay of Bengal	Do	Comorin area to the West central Bay of Bengal	Less marked on 27
3.	Do	30 Nov - 2 Dec	Southwest Bay of Bengal off Sri Lanka coast	Stationary	*In-situ*	Less marked on 3 December

* - The other details of the system are given in the ‘Cyclones and Depressions 2011’ in the July 2012 issue of journal ‘Mausam’.

TABLE 4

Details of the weather systems during December 2011

S. No.	System	Duration	Place of first location	Direction of movement	Place of final location	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(**A**)	*Cyclonic storm*					
1.	Very severe cyclonic storm (Thane)*	25-31	Southeast Bay of Bengal and neighbourhood	Northwest, north and west	North Tamil Nadu	It was first observed as a trough of low at mean sea level over equatorial Indian Ocean to southeast and adjoining southwest Bay of Bengal on 23. It organized into a low pressure area over the southeast Bay of Bengal and neighbourhood on 24
(**B**)	*Western disturbances /Eastward moving cyclonic circulations*					
(*i*)	*Upper air cyclonic circulations*					
1.	Up to 4.5 kms a.s.l.	3-7	North Pakistan and adjoining Jammu & Kashmir	Northeast	Jammu & Kashmir and neighbourhood	Moved away on 8
2.	Upto mid tropospheric levels	8-10	North Pakistan and neighbourhood	Do	Do	Moved away on 11
3.	Do	11-12	North Pakistan and adjoining Jammu & Kashmir	Northeast	Northern parts of Jammu & Kashmir	Moved away on 13
4.	Upto 4.5 kms a.s.l.	17-23	Northeast Afghanistan and adjoining north Pakistan	Do	Jammu & Kashmir and neighbourhood	Moved away on 24
5.	Do	26-30	North Pakistan and neighbourhood	Do	Northern parts of Jammu & Kashmir	Moved away on 31
(*ii*)	*Induced cyclonic circulations*					
1.	Upto 3.1 kms a.s.l.	8-9	Haryana, Punjab and neighbourhood	Stationary	*In situ*	Less marked on 10
(*iii*)	*Troughs in westerlies*					
1.	Mid and upper troposphere (at 7.6 kms a.s.l.)	15-16	Long. 65° E, to the north of 35° N	Northeast	Long. 80° E, to the north of 30° N	Moved away on 17
2	Do	20-25	Long. 65° E, to the north of 25° N	Do	Long. 85° E, to the north of 30° N	Moved away on 26
3	Do	31st Dec 2011 - 2nd Jan 2012	Long. 66° E, to the north of 20° N	Eastnorth-east	Long. 81° E, to the north of 25° N	Moved away on 3
(*iv*)	*Troughs in easterlies*					
1.	Trough of low at mean sea level	11-14	Southeast to east central Bay of Bengal	West	Comorin area and adjoining south Tamil Nadu coast	Less marked on 15
2.	Do	15-16	Southwest Bay of Bengal off Sri Lanka coast	Do	southwest Bay of Bengal and adjoining Sri Lanka coast	Became less important on 17
3.	Do	17- 22	Southeast Bay of Bengal and neighbourhood	Do	Comorin area to southwest Bay of Bengal	Less marked on 23

TABLE 4 (*Contd*.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
(**C**)	*Other cyclonic circulations*					
1.	Upto mid tropospheric levels	2	Kerala and adjoining Lakshadweep	Stationary	*In-situ*	Less marked on 3
2.	Upto mid tropospheric levels (upto 3.1 kms a.s.l)	3-5	South Tamil Nadu and adjoining Sri Lanka	Do	Do	Less marked on 6
3.	Mid tropospheric levels	4-6	Assam & Meghalaya and neighbourhood	Do	Do	Less marked on 7
4.	Do	6-8	Southwest Bay of Bengal and neighbourhood	Do	Do	Less marked on 9
5.	Upto 3.6 km a.s.l.	11-12	Assam & Meghalaya and neighbourhood	Do	Do	Less marked on 13

disturbances over Bay of Bengal and their subsequent northward movement leading to delay in the onset of easterlies. This year too, a low pressure area formed over east central Bay of Bengal on 17th October, which eventually intensified into a deep depression before crossing Bangladesh coast and caused delay in the onset of easterlies. As such, the northeast Monsoon rains commenced on 24th October.

3.1.3. *Storms and depressions*

A Deep Depression (19th - 20th October) over the Bay of Bengal and a Cyclonic Storm (Keila) (29th October - 4th November) over the Arabian Sea formed during the month. The tracks of these systems are given in Fig. 2. The details of both the systems are given in the 'Cyclones and Depressions 2011' in the July 2012 issue of the journal 'MAUSAM'.

3.1.4. *Other synoptic features and associated weather*

Table 2 gives a summary of the synoptic features for the month of October 2011. The sub-divisionwise percentage departures from normal and significant amounts of rainfall are given in Tables 1 & 5 respectively.

3.1.5. *Temperature*

The day temperatures were generally *above/appreciably above* normal over most parts of the country except over south peninsula on a few days of the month. No *heat wave* condition occurred during the month.

The month's and the season's highest maximum temperature in the plains of the country was 39.6° C recorded at Idar (Gujarat Region) on 16th October 2011.

No *cold wave* condition occurred during the month.

The month's lowest minimum temperature in the plains of the country was 10.5° C recorded at Mandla (east Madhya Pradesh) on 31st October 2011.

3.1.6. *Disastrous weather events and associated damage*

As per press reports, heavy rains and lightning took a toll of 14 people in Andhra Pradesh, 8 in Karnataka, 7 in Vidarbha, 5 in Tamil Nadu, 3 in Jharkhand, 2 in Kerala and 1 each in Assam, West Bengal & Bihar. Floods were reported from Bihar, Orissa and Karnataka. Heavy rains disrupted traffic and uprooted trees in Karnataka.

3.2. *November*

3.2.1. *Storms and depressions*

The Bay of Bengal had been cyclogenetically inactive and two Deep Depressions (6th – 10th November & 26th November - 1st December) formed over the Arabian Sea during the month. The details of the systems

TABLE 5

Some Representative Rainfall amounts (in cms; 1cm and above) (October – December 2011)

Date	October	November	December
(1)	(2)	(3)	(4)
1.	Nahar Katia, Khanapur, Honakere & Lunglei 7 each, Deomali, Sudhagad, Velhe, Matheran & Hatkanangale 5 each, Mundagod & Patoda 3 each, Narla, Wankaner & Jat 2 each, Maya Bandar 1	Sirkali & Pamban 9 each, Avanigadda 7, Karkala, Haripad & Taliparamba 5 each, Bantwal 4, Barapani 3, AIE NH Xing, Rayalpadu, Agathi & Golaghat 2 each, Chepan, Ziro, Tawang & Minicoy 1 each	Andipatti 8, Manamelkudi 7, CIAL Cochi 6, Kottayam 4, Tondi 3, Pamban & Kanyakumari 2 each, Alapuzha & Car Nicobar 1 each
2.	Murnadu 9, Kolasib 8, Karimganj 6, Kundagol & Peint 5 each, Gargoti 4, Bhira, Tuting, Subramanya & Murbad 3 each, Maya Bandar 2, Kannad 1	Marakkanam & Kollengode 12 each, Parambikulam & Cuddalore 11 each, Tada 9, Satyavedu 8, Mulki 7, Sevoke & MM Hills 4 each, Basaralli, Gajoldoba, Dharmasthala & Agathi 3 each, Rangia 2, Jorhat 1	Car Nicobar & Boothapandi 4 each, Pamban & Hut Bay 3 each
3.	Ilkal 10, Igatpuri & Alamatti 8 each, Hoshalli & Rahuri 6 each, Kolasib & Khalapur 5 each, Dholai & Ashti 4 each, Car Nicobar, Tuting, Navsari & Karjat 2 each	Palacode 11, Vellanikkara 10, Papanasam, Mudibidre, Panambur & H D Kote 9 each, Vadakara & Mangalore 6 each, Kaveli 5, Quepem & Sanguem 3 each, Medikeri 2, Hyderabad, Gangtok & Darjeeling 1 each	Punalur 11, Haripad 8, Shenkottah 6, Tenkasi & Port Blair 5 each, Hut Bay & Long Island 3 each, Nagercoil & Thiruvananthapuram 2 each
4.	Gulbarga 12, Kalkada 10, Kola 7, Edgar 6, AIE NH Xing 5, Tuting 4, Agartala & Sholapur 3 each, Car Nicobar, Dahanu & Sinnar 2 each, Keonjhargarh 1	Aravakurichi 13, Tozhudur 12, Gudur 11, Rapur 10, Kodungallur 9, Vellanikkara 8, KR Sagara 7, Mudibidre & Sakaleshpura 6 each, Chickmagalur & Dharmasthala 5 each, Kaveli & Tirupathi 4 each	Visakhapatnam 2, Maya Bandar 1
5.	Alamatti & Washi 4 each, Akkalkot, Kankadahad, Car Nicobar, Gangtok, Palghar, Junnar & Alland 2 each, Vikramgad & Tadong 1 each	Venkatagiri 14, Bellur & Kibbanahalli 4 each, Bangalore, Gund, Kollur & Gulmarg 3 each, Car Nicobar 2, Dharmasthala, Nilambur, Koppa, Srinagar & Punalur 1 each	Tenkasi 5, Shenkottah & Alapuzha 4 each, Sivagiri 3, Chittur, Minicoy & Barapani 2 each, Baghdogra, Sevoke & Long Island 1 each
6.	Javli 6, Pen & Patan 5 each, Karjat, Dharani & Shirhatti 4 each, Varud & Bapatla 3 each, Ambikapur, Narsapur & Madurai 2 each, Bankura, Quazi Gund & Thakurmunda 1 each	Vadakara 21, Poonamallee, Chittur & Tiruvallur 9 each, Mannarkad & Kundapur 8 each, Siddapura, Lakkavalli & Halli 6 each, Anekal 5, Agumbe 4	Kanjirapally 3, Kayamkulam & Alapuzha 2 each
7.	Sethiyathope 13, Sirkali 8, Karaikal 4, Cuddalore, Karanja, Hosahalli & Khanapur 3 each, Bhubaneswar & Paradip 2 each, Jamshedpur, Satna, Bhivpuri & Tumkur 1 each	Pollachi & Kollidam 11 each, Ottapalam & Arakalgud 10 each, Pattambi 9, Hosdurg & Vadakara 8 each, Yelandur 5, Subramanya, Kollur & Harangi 4 each, Dharmasthala 3, Mandya & Panambur 2 each, Gulmarg 1	Long Island 2, Solan, Ambala, Nancowry, Maya Bandar & Patiala 1 each
8.	Denkanikottai 8, Ranpur 6, Rayagadda, Jamshedpur, Tiptur & Nandadih 5 each, Sangameshwar & Badami 4 each, Diamond Harbour, Sambalpur, Churk, Dehra Dun & Gaganbavada 3 each	Kollam 23, Thodupuzha 16, Nagarcoil 13, Kanyakumari & Thrissur 10 each, Dharmasthala 2, Belthangady, Subramanya, Hut Bay & Gulmarg 1 each	Quazigund & Banihal 2 each, Karaikal 1
9.	Vellore 9, Somwarpet & Napoklu 7 each, Mahad & Koyna 5 each, Sohela 4, Maya Bandar, Paradip, Mangaon& Pali 3 each, Titlagarh, Pune, Paud, Visakhapatnam, Tirupattur & Chitradurga 2 each	Kupwara, Hut Bay & Nancowry 1 each	Tirupathi 5, Pahalgam 4, Ponneri, Quazigund & Kupwara 3 each, Bhuntar, Mandi & Srinagar 2 each, Chandigarh, Ludhiana & Karaikudi 1 each

TABLE 5 (*Contd*.)

(1)	(2)	(3)	(4)
10.	HD Kote & Sakaleshpura 9 each, Dodaballapura & Sangameshwar 7 each, Burla 6, Salem, Tumkur & Ambadola 4 each, Hut Bay, Ratnagiri & Bangalore 3 each, Car Nicobar & Mahabaleshwar 2 each	Hut Bay 3	Passighat 4, Ambur, Dibrugarh & Mohanbari 3 each, Puducherry, Khowang, Daporijo, Tezu, Tinsukia& Kullu 2 each, Kulgam, Anantnag & Long Island 1 each
11.	Perinthalmanna 9, Taliparamba, Angadipuram & Jat 8 each, Devanahalli & Bagepalli 7 each, Jhumpura 5, Mulchera, Kozhikode & Anantpur 4 each, Chandrapur, Kaveli, Hyderabad & Mysore 3 each	Hut Bay, Banihal, Srinagar & Dhundi 1 each	Passighat 3, Jorhat, Tezu, Tuting & Pamban 2 each, Car Nicobar, Long Island, Daporijo & Neamatighat 1 each
12.	Pune 11, Mudibidre 10, Mangalore & Karkala 9 each, Shiggaon & Perumbavur 8 each, Kandukur, CIAL Cochi, Kanjirapally, Sholapur, Paranda, Nugehalli, Bhagamandala & Rasipatnam 7 each	Car Nicobar 2	Muthupet, Mudukur & Puttukottai 2 each, Adirampattinam, Mangan, Nancowry, Nedumangad & Cherthala 1 each
13.	Krishnagari 17, Dharwad, Parambikulam & Hut Bay 9 each, Tiruvarur & Maddur 8 each, Kakinada & Mumbai 7 each, Kiravatti & Satara 5 each, Mani & Belapur 4 each, Osmanabad & Narsapur 3 each, Mahabaleshwar 2	Maya Bandar 4, Long Island 3, Port Blair & Gangtok 1 each	Car Nicobar 6, Nancowry 3
14.	Chikkanahalli & Tondi 9 each, Sivakasi 8, Belthangady 7, Ghatagaon 6, Kundagol & Bhira 5 each, Port Blair, Belapur & Parbhani 2 each, Hasimara, Angul & Satara 1 each	Gangtok 4, Maya Bandar 2, Nagapattinam & Tondi 1 each	Tiruchendur 8, Sathankulam & Manamelkudi 4 each, Karaikal 3, Vedaranniyam 2, Pamban 1
15.	Mudigere 12, Kongevam 10, Mettupalayam 9, Peermade & Thodupuzha 7 each, Siddapura, Hut Bay & Kittur 4 each, Hanagar 3, Mumbai 2, Barapani & Khammam 1 each	Maya Bandar & Thiruvananthapuram 3 each, Mangan 2, Tuting, Tawang, Long Island, Bankura, Gyalsing & Vedaranniyam 1 each	Guindy 8, Minambakkam 6
16.	Natham, Mettupalayam, Thodupuzha & Aryankavu 7 each, Balehonnur & Pune 5 each, Bijapur & Harnai 4 each, Mehbubnagar, Long Islands, Dharmasthala, Bhira & Kolhapur 3 each	Tezpur 7, Jia Bharali 4, Goalpara 3, Dhekiajuli, Thakurganj, Long Islands & Khanitar 2 each, Daporijo, Maya Bandar, Durgachack & Tadong 1 each	Tiruvarur 7, Karaikal & Nannilam 6 each, Kodavasal & Chengam 5 each
17.	Thodupuzha 15, Pullambadi & Srivaikuntam 9 each, Lakkavalli 7, Aurangabad & Annigere 5 each, Karkala 4, Nashik, Arogyavaram & Mumbai 3 each, Mahabaleshwar 2, Long Islands 1	Karaikal 5, Vedaranniyam & Jia Bharali 4 each, Dhekiajuli 3, Tezpur, Raiganj 2, Sevoke & Tawang 1 each	Nancowry 2, Car Nicobar 1
18.	Tiruppuvanam, Sivaganga, Perinthalmanna, Mannarkad & Amreli 9 each, Murnadu 4, Mudibidre 3, Ahmednagar & Bhagalpur 2 each, Joshimath, Guttal & Imphal 1 each	Kalppakkam 7, Cuddalore 5, Chennai 3, Jowai, Parangipettai & Karaikudi 2 each, Tirupathi & Mathabhanga 1 each	Nil
19.	Mettupatti 7, Karipur, Panagarh, Puttur & Karkala 6 each, Bhagamandala 5, Silchar 3, Burdawan 1	Vedaranniyam 3, Karikal, Parangipettai & Pamban 2 each, Minicoy 1	Rameshwaram 11, Pamban 9, Ramanathapuram 5
20.	Bhavani 10, Chiplun, Vadakkancherry & Vizianagaram 9 each, Peermade & Patlikonda 7 each, Hidkal 6, Siddapura, Arasalu & Nancowry 4 each, Jat & Garubathan 3 each, Banarpal, Akkalkot & Maya Bandar 2 each	Pamban 3	Gund, Pahalgam, Rameswaram, Mylaudy & Manimuthar 1 each
21.	Parambikulam 10, Vizianagaram 9, Coonoor 8, Silchar 6, Sringeri & Thodupuzha 5 each, Kotraguda 4, R. Udaigiri & Jhalda 3 each, Car Nicobar 2, Karimgani, Dimapur, Kiravatti, Chiplun & Contai 1 each	Tondi 2, Minicoy 1	Gund 3, Kupwara 2, Pahalgam 1

TABLE 5 (*Contd.*)

(1)	(2)	(3)	(4)
22.	Hindol 12, Satyamangalam 10, Bhavanisagar, Idukki, Burdawan & Gajoldoba 7 each, Barobhisha 6, Phulbani & Thalasserry 5 each, Kailashahar, Uppinangady, K R Nagara& Kolkata 4 each, Deomali 3	Nancowry 4, Minicoy, Pamban & Vedaranniyam 1 each	Nil
23.	Kanjirapally 9, Balasore 8, Saro & Canning 7 each, Kottayam 5, Kupwara, Gund & Bishalgarh 3 each, Lengpui 2, Tezu, Bihubar, Srinagar & Malda 1 each	Car Nicobar 12, Karaikal & Nancowry 4 each, Parangipettai & Hut Bay 3 each, Nagapattinam 1	Car Nicobar 6, Nancowry 4
24.	Chengannur 11, Sargur & Sankarankoil 10 each, Red Hills 9, Dharmasthala 8, Piravom 7, Gund 2, Contai, Jowai, Dharmasala, Nancowry & Maya Bandar 1 each	Port Blair 5, Car Nicobar 3, Hut Bay 2	Nancowry 7, Car Nicobar 6, Minicoy 3
25.	Muthupet 9, Cuddalore 8, Puttur & Haripad 6 each, Dharmasthala 5, Mavelikara, Lakkavalli & Nancowry 4 each, Gajoldoba 1	Tiruvadani 20, Kollidam 17, Tirupathi 4, Thiruvananthapuram, Car Nicobar & Hut Bay 2 each	Thiruvananthapuram 8, Car Nicobar & Maya Bandar 4 each, Hut Bay 3, Port Blair 2
26.	Mahabalipuram 15, Manimuthar 11, Belthangady 9, Kaveli & Kandakur 8 each, Mudibidre & Lakkavalli 7 each, Gopalpur & Yelahanka 6 each, Karatagi 4, Similiguda 3, Sanguem, Kozhikode & Cochi 1 each	Venkatagiri Town 23, Utheriramerur 20, Maduranthagam 19, Tirumalla 10, Tirupathi 9, M.M. Hills 4, Minicoy 3, Bangarpet 2, Thiruvananthapuram & Agathi 1 each	Port Blair 11, Nancowry 10, Car Nicobar & Hut Bay 5 each, Long Island 1
27.	Puducherry 19, Varkala 14, Ramanathapuram 16 Kaveli 13, Kandukur 8, Kollam 7, Nellore 5, Ramagiri 4, Amini Divi 3, Siddapura, Hut Bay, Kakatpur & Minicoy 2 each, Kota, Car Nicobar 1	Varkala 18, Pallipattu & Coonoor 16 each, Kavaratti & Puttur 11 each, Venkatagiri Town 10, Agathi & Thiruvananthapuram 7 each, Tirupathi 5, Rayalpadu 4, Nancowry 3, Gudibande & Hut Bay 2 each, Mysore 1	Maya Bandar 19, Long Island 6, Port Blair 4, Hut Bay 3, Car Nicobar & Nancowry 1 each
28.	Perinthalmanna 11, Uthamapalayam 9, Jayamkondam 8, Dharmasthala & Subramanya 6 each, Anavatti, Lakkavalli & Kozhikode 5 each, Byadgi, Yadgir & Kaveli 3 each, Mapusa & Tawang 2 each, Nancowry 1	Ennore Port 21, Nellore 19, Agathi 8, Kaveli 6, Alapuzha 5, Chitradurga & Nancowry 3 each, M.M. Hills 2, Minicoy 1	Nil
29.	Nellore 13, Coonoor 9, Barur 8, Venkatagiri Town & Vinjamur 7 each, Bomdila 3, Harnai, Shahapur, Aluva & Perumbavur 2 each, Port Blair & Seppa 1 each	Sirkala 16, Siddapura 8, Kudal 7, Hanagal 6, Mandya, Sirsi & Thyagarthi 5 each, Vengurla 2, Nancowry, Karwar & Dabholim 1 each	Hut Bay 1
30.	Mancompu, Vinjamur, Tiruchirapalli & Usilampatti 8 each, Haripad & Chittoor 7 each, Lakkavalli 6, Ratnagiri, Karkala, Kalasa & Munirabad 4 each, Maya Bandar & Islampur 3 each, Canacona 2, Bhira 1	Mylaudy 10, Kanjirapally 7, Manchikeri 4, Punalur, Sirsi & Quepem 3 each	Puducherry 15, Kalppakkam 10, Utheriramerur 9, Puttur & Rapur 7 each, Tirupathi 4, Rayalpadu & Srinivaspura 1 each
31.	Peravurani & Srivaikuntam 9 each, Quilandy 7, Kayamkulam 6, Nellore 5, Nancowry, Lakkavalli, Barapani & Agathi 3 each, Murti, Dharmasthala, Mudibidre, Panambur, Amini Divi & Shillong 2 each	-	Haripad 22, Thiruvananthapuram & Kallakurichi 18 each, Nedumangad 16, Sankarapuram & Nagarcoil 14 each, Jeypore & MM Hills 4 each, Tumkur, Belur & Halebeedu 1 each

are given in the 'Cyclones and Depressions 2011' in the July 2012 issue of the journal 'MAUSAM'.

3.2.2. *Other synoptic features and associated weather*

A summary of the synoptic systems for the month of November 2011 is given in Table 3. The sub-divisionwise percentage departure of rainfall from normal and the significant amounts of rainfall during the month are given in Tables 1 & 5 respectively.

During the month, rainfall activity was mainly confined to south peninsular India.

3.2.3. *Temperature*

Severe cold wave conditions occurred on one day in Sub-Himalayan West Bengal & Sikkim. *Cold wave* conditions also prevailed on 1 to 3 days in Nagaland-Manipur-Mizoram-Tripura, Jammu & Kashmir and Madhya Maharashtra during the month.

Many places in Jammu & Kashmir, including Drass (*minus* 12° C), reported sub-zero temperatures.

Month's lowest minimum temperature over the plains of the country was 6.6° C, recorded at Najibabad (Uttar Pradesh) on 29th November 2011.

3.2.4. *Disastrous weather events and associated damage*

As per press reports, incessant heavy rains during the first and the last weeks of the month took a toll of 70 persons in Tamil Nadu and 1 in Kerala. Heavy rains also took a toll of 2 persons in Karnataka. It also caused damage to standing crops over thousands of hectares of land and trees were uprooted. Many villages were cut off due to landslides. High sea waves damaged 20 canoes and fishing nets off Goa coast. Snow/avalanche claimed 3 soldiers in Jammu & Kashmir. Foggy conditions in Punjab, Haryana and Delhi affected vehicular, rail and road transport.

3.3. *December*

3.3.1. *Storms and depressions*

Only one intense low pressure system; *viz*., a Very Severe Cyclonic Strom (Thane, 26 – 31 December) formed over the Bay of Bengal during the month. The details of the system are given in the 'Cyclones and Depressions 2011' in the July 2012 issue of the journal 'MAUSAM'.

3.3.2. *Weather and associated synoptic features*

Table 4 gives a summary of the synoptic systems during the month of December 2011. The sub-divisionwise percentage departure of rainfall and the significant amounts of rainfall during the month are given in Tables 1 & 5 respectively.

The rainfall activity was subdued over major parts of the country. It was confined only to the Bay Islands and Kerala.

Thick fog prevailed over the northern plains during many days, except second week, of the month.

3.3.3. *Temperature*

Minimum temperatures remained above normal over most parts of the country during first week of the month. *Severe cold wave* / *cold wave conditions* prevailed over many parts of the country during the second fortnight of the month.

Many stations in Jammu & Kashmir reported sub zero temperatures *e.g*., *minus* 18.4° C in Leh and *minus* 12.0° C in Gulmarg.

The month's and season's lowest minimum temperature in the plains of the country was *minus* 1.4° C recorded at Churu (Rajasthan) on 25th December 2011.

3.3.4. *Disastrous weather events and associated damage*

According to media reports, cold wave and fog related incidents claimed 125 lives in Jharkhand, 63 in Uttar Pradesh, 23 in West Bengal, 13 in Punjab, 11 in Bihar, 2 each in Madhya Pradesh & Vidarbha and 1 in Haryana.

Dense fog prevailed over parts of Punjab, Haryana and Uttar Pradesh severely affecting road and rail traffic in the last week of the month.

Strong squally winds and heavy rains associated with the Very Severe Cyclonic Storm (Thane) claimed 46 lives in Tamil Nadu. About 73 thousand thatched houses were fully damaged and 94 thousand houses were partially damaged due to the system. Six thousand people were shifted to temporary shelters. About 67 thousand hectares of crops in agricultural sector and 28 thousand hectares in horticulture sector were damaged. Hundreds of country-boats, 67 motorized boats, 58 catamarans and 4 mechanized boats were fully damaged. Thousands of

electric poles & transformers as well as 27 electric towers also were damaged due to the system.

Appendix

Definitions of the terms given in '*Italics*'

Rainfall

Excess - percentage departure from normal is + 20% or more.

Normal - percentage departure from normal is –19 % to + 19 %.

Deficient - percentage departure from normal is –20 % to –59 %.

Scanty - percentage departure from normal is –60 % to –99 %.

Heavy rain - rainfall amount from 6.5 cm to 12.4 cm.

Very heavy rainfall - rainfall amount 12.5 cm to 24.4 cm.

Extremely heavy rain rainfall amount 24.5 cm and above.

At most places - 76% or more stations of a meteorological sub-division reporting at least 2.5 mm rainfall.

At many places - 51% to 75% stations of a meteorological sub-division reporting at least 2.5 mm rainfall.

At a few places - 26% to 50% stations of a meteorological sub-division reporting at least 2.5 mm rainfall.

At isolated places - 25% or less stations of a meteorological sub-division reporting at least 2.5 mm rainfall.

Monsoon activity

(a) Southwest monsoon

Vigorous - rainfall exceeding 4 times the normal with, at least two stations reporting rainfall more than or equal to 8 cm along the west coast and 5 cm elsewhere. Rainfall in that sub-division should be fairly widespread or widespread.

Active - rainfall more than 1½ to 4 times the normal, with at least two stations reporting rainfall more than or equal to 5 cm along the west coast and 3 cm elsewhere. Rainfall in that sub-division should be fairly widespread or widespread.

(b) Northeast monsoon

Vigorous - rainfall exceeding 4 times the normal with at least two stations reporting rainfall more than or equal to 5 cm in coastal Tamil Nadu and south coastal Andhra Pradesh and 3 cm elsewhere in the northeast monsoon region. Rainfall in that sub-division should be fairly widespread or widespread.

Active - rainfall more than 1½ to 4 times the normal, with at least two stations reporting rainfall more than or equal to 3 cm in coastal Tamil Nadu and south coastal Andhra Pradesh and 2 cm elsewhere in the northeast monsoon region. Rainfall in that sub-division should be fairly widespread or widespread.

Temperatures

(a) Maximum / Day temperature

According to the revised criteria, since 1 March 2002, Heat Wave will be declared only when the maximum temperature of a station reaches at least 40° C for plains and at least 30° C for Hilly regions.

Severe heat wave conditions - Departure of maximum temperature from normal is +6° C or more for the regions where the normal maximum temperature is more than 40° C and +7° C or more for regions where the normal maximum temperature is 40° C or less.

Heat wave conditions - + 4° C to + 5° C for the regions where the normal maximum temperature is more than 40° C and departure of maximum temperature from normal is + 5° C to + 6° C for regions where the normal maximum temperature is 40° C or less. (declared only when the maximum temperature of a station reaches at least 40° C for Plains and at least 30° C for Hilly region).

Markedly above normal - departure from normal is +5° C to +6° C (where the normal maximum temperature is 40° C or less).

Appreciably above normal - departure from normal is +3° C to +4° C (where the normal maximum temperature is 40° C or less).

Above normal - departure from normal is +2° C.

Normal - departure from normal is +1° C to –1° C.

(b) Minimum / Night temperature

Severe cold wave conditions - departure of WCT_n from normal minimum temperature is –7° C or less for the regions where normal minimum temperature is $\underline{\geq}$ 10° C and –6° C or less elsewhere

Cold wave conditions when the wind chill effective minimum temperature (WCT_n) is 10° C or less: For stations whose normal minimum temperature is ≥ 10° C, when the departure from normal is –5° to –6° C, and for –4° to –5° C. Also when WCT_n stations whose normal minimum temperature is less than 10° C when the departure from normal is is ≤ 0° C, cold wave is declared irrespective of the departure for those stations whose normal minimum temperature is greater than 0° C.

Cold day conditions For inland plain stations, when the day temperature is less than or equal to 16° C.

Markedly below normal - departure from normal is –5° C to –6° C (where the normal minimum temperature is 10° C or more).

Appreciably below normal - departure from normal is between –3° C to –4° C (where the normal minimum temperature is 10° C or more).

Below normal - departure from normal is –2° C.

Normal - departure from normal is +1° C to –1° C.