



INDIA METEOROLOGICAL DEPARTMENT

SOUTHWEST MONSOON 2008 END OF SEASON REPORT

HIGHLIGHTS

- ❖ The cumulative seasonal rainfall for the country as a whole was near normal. Rainfall for the season (1st June to 30th September, 2008) was 98% of its long period average (LPA).
- ❖ Seasonal rainfall was 107% of its LPA over Northwest India, 96% of its LPA over Central India, 96% of its LPA over south Peninsula and 94 % of its LPA over Northeast India.
- ❖ Out of 36 meteorological subdivisions, 30 meteorological subdivisions recorded normal rainfall. Only 2 (Punjab and Orissa) and 4 (Nagaland, Manipur, Mizoram & Tripura, West Madhya Pradesh, Vidarbha and Kerala) subdivisions recorded excess and deficient rainfall respectively.
- ❖ Out of 36 meteorological subdivisions, 92% of the country's area comprising 32 meteorological subdivisions received excess/normal rainfall and the remaining 8% received deficient rainfall during the season.
- ❖ Monsoon rainfall was marked by large temporal variations for the country as a whole, as rainfall was 24% above LPA in June and in July it was 17% below LPA. The rainfall was near normal during August and September as it was 3% and 1% below the LPA respectively.
- ❖ While, there was rapid progress of monsoon over most parts of the country after the onset over Kerala on 31st May, there was delay in withdrawal of monsoon from northwest India. Monsoon covered the entire country on 10th July against its normal date of 15th July. The withdrawal of monsoon from west Rajasthan commenced on 29th September 2008 against normal date of 1st September.
- ❖ IMD's long range forecast for the seasonal rainfall over the country as a whole and over different homogeneous regions except northwest India have been accurate. However, the seasonal rainfall over northwest India and rainfall during July for the country as a whole have not been accurate. While the prediction overestimated the rainfall during July for the country as a whole, it underestimated the seasonal rainfall over northwest India.

1. ONSET OF SOUTHWEST MONSOON

Southwest monsoon advanced over parts of southeast Bay, most parts of Andaman Sea and Bay Islands on 10 May, 2008, about 5 days ahead of its normal date (Fig. 1). The monsoon set in over Kerala on 31 May, one day prior to the normal date. Further, advance took place quite rapidly mainly due to a depression (5 – 6 June) over the east central Arabian Sea and a well marked low pressure area (9 – 11 June) over Saurashtra & Kutch and neighbourhood. By 16 June, southwest monsoon had covered most parts of the country except for some parts of Rajasthan. The rapid advance of monsoon could be attributed to the interaction of the monsoon circulation with mid-latitude westerly system. Subsequently, there was a hiatus in the further advance due to the weakening of the monsoon current. The monsoon covered the entire country by 10 July, against normal date of 15 July.

2. CHIEF SYNOPTIC FEATURES

The mid latitude westerly intrusion, which occurred during advance phase, resulted into above normal rainfall over most parts of north India (North of Lat. 20° N) during June. The monsoon trough with normal southward tilt with height could not be active due to the absence of normal large scale north-south horizontal temperature gradient. The break monsoon conditions also prevailed over the country during second fortnight of July. It adversely affected the rainfall over the central and south peninsular India in July.

Compared to last two years, the frequency of monsoon depressions has been less with development of only four depressions during this monsoon season. These included one depression over the Arabian Sea and another over Bay of Bengal during June, one land depression over coastal Orissa during August and one deep depression over the Bay of Bengal during September. The tracks of these systems are shown in Fig. 2. The month of July was devoid of any monsoon depression like the previous July of 1995, 1998, 2000, 2001, 2002 and 2004. However, seven low pressure areas developed during the season and contributed to the seasonal rainfall.

From Fig.2, the depression over the Arabian Sea during 5th to 6th June moved away westwards and weakened over the Ocean. The second depression over the Bay of Bengal during 16th to 18th June crossed Bangladesh coast and moved across Gangetic West Bengal and Jharkhand. It then moved as a low pressure area upto east Uttar Pradesh and adjoining east Madhya Pradesh. The system caused heavy to extremely heavy rainfall over Gangetic West Bengal, north Orissa and Jharkhand leading to flood over these regions. The third system was a land depression (9 – 10 August) over coastal Orissa and was short lived with the life period of less than 12 hours. The fourth system was a deep depression (15–19 September) over the northwest Bay of Bengal which crossed Orissa coast near Chandbali and moved across north Orissa, north Chhattisgarh, northeast Madhya Pradesh and central Uttar Pradesh. The remnant low pressure area moved upto northwest Uttar Pradesh. This system caused heavy to extremely heavy rainfall over Orissa and Chhattisgarh leading to severe flood over Orissa. This system also interacted with mid-latitude westerly systems and caused good rainfall over northwest India and led to flood over Haryana and Himachal Pradesh.

Apart from the above systems, 7 low pressure areas formed during the season.

3. FLOOD SITUATIONS

The uneven temporal rainfall distribution caused flood situation in many states viz. Assam, Meghalaya, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, West Bengal, Orissa, Bihar, Uttar Pradesh, Haryana, Delhi, Punjab, Himachal Pradesh, Rajasthan, Gujarat, Maharashtra and Andhra Pradesh.

4. WITHDRAWAL OF SOUTHWEST MONSOON

There was a delay in the commencement of withdrawal of southwest monsoon from extreme west Rajasthan. The southwest monsoon withdrew this year from entire Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana, Chandigarh & Delhi, west Rajasthan, most parts of Uttarakhand, west Uttar Pradesh and east Rajasthan, some parts of north Gujarat State and north Arabian Sea on 29th September. The normal date of withdrawal of southwest

monsoon from west Rajasthan is 1 September. The delay was mainly due to the presence of systems in westerlies over northwest India interacting with the monsoon circulation. Comparing with recent years (1990-2007), the latest withdrawal in recent years from west Rajasthan took place on 30 September during 2007.

5. RAINFALL DISTRIBUTION

The southwest monsoon rainfall (June to September) for the period 1 June to 30 September 2008 for the country as a whole and four broad homogeneous regions are as follows

| Region | Actual (mm) | Normal (mm) | Percentage Departure |
|----------------------|-------------|-------------|----------------------|
| All-India | 873.2 | 892.2 | -2% |
| Northwest (NW) India | 651.7 | 611.6 | 7% |
| Central India | 956.9 | 993.9 | -4% |
| South peninsula | 692.5 | 722.6 | -4% |
| Northeast (NE) India | 1346.0 | 1427.3 | -6% |

For the country as a whole, the seasonal rainfall from 1st June to 30th September was 98% of its LPA. Seasonal rainfall over NW India, Central India, NE India and South Peninsula was 107%, 96%, 94% and 96% of the LPA respectively. The sub-division wise cumulative rainfall distribution is shown in Fig.3. The spatial distribution of seasonal monsoon rainfall during 2008 was largely uniform with 30 meteorological subdivisions recording normal rainfall. Only 2 (Punjab and Orissa) subdivisions recorded excess and 4 (Nagaland, Manipur, Mizoram & Tripura, West Madhya Pradesh, Vidarbha and Kerala) subdivisions recorded deficient rainfall.

Out of 36 meteorological subdivisions, 92% of the country's area comprising 32 meteorological subdivisions received excess/normal rainfall and the remaining 8% received deficient rainfall during the season.

Thus during the 2008 monsoon season, rainfall activity was near uniformly distributed in space with most parts of the country receiving near normal seasonal rainfall.

Monsoon rainfall was marked by large temporal variation. Monsoon rainfall over the country as a whole was 24% above LPA during June and 17% below LPA in July. It was near normal during August (97% of LPA) and September (99% of the LPA). The monthly rainfall over India as a whole is given in the following Table.

**Monthly rainfall over the country as a whole during
different monsoon months**

| Month | Actual rainfall (mm) | Long period average (mm) | Percentage departure from long period average |
|-----------|----------------------|--------------------------|---|
| June | 201.9 | 162.2 | 24 |
| July | 243.0 | 293.3 | -17 |
| August | 254.3 | 262.0 | -03 |
| September | 173.4 | 174.6 | -01 |

The excess rainfall in June for the country as a whole was mainly due to the excess rainfall over north and adjoining central India, which could be attributed to the mid-latitude westerly systems interacting with the monsoon circulation. The excess rainfall over eastcentral & adjoining northeast India, Bihar, Jharkhand and West Bengal was mainly associated with the monsoon depression (16-18 June), which developed over north Bay of Bengal and moved northwestwards across Bangladesh, Gangetic West Bengal and Jharkhand. The deficient rainfall in July was mainly due to the deficient rainfall over central and south peninsular India, excluding southeast peninsula. At the same time, the rainfall in July was higher along the foothills of the Himalayas, especially over east Uttar Pradesh, Bihar and Arunachal Pradesh. This type of rainfall distribution was mainly due to the break monsoon condition, which developed during 14-24 July. The deficient rainfall over south peninsular India during June and July was

compensated by the excess rainfall during August. Specifically, the deficient rainfall over Maharashtra and Gujarat during June and July was compensated with excess rainfall during August and September. The spatial distribution of monthly rainfall is shown in Fig.4.

Fig. 5 depicts the monsoon rainfall for the country as a whole as received week by week. In June, the weekly rainfall was above normal during the first three weeks. It was maximum for the week ending 18 June in association with the monsoon depression (16-18 June). In July, the rainfall was below normal during all the weeks. The rainfall was highly deficient for the week ending 23 July due to break monsoon condition, which prevailed during this period. In August, the rainfall was above normal during the first two weeks and significantly below normal during last week. Significantly higher rainfall for the week ending 13 August could be mainly attributed to the depression (09-10 August), which developed over coastal Orissa and moved northwestwards, apart from other features. Significantly deficient rainfall for the week ending 27 August and 3 September may be attributed to break monsoon condition during this period. The rainfall was significantly above normal for the weeks ending 17 and 24 September due to a low pressure area and a deep depression (15-19 September), which developed over the Bay of Bengal and moved northwest wards. Large rainfall deficiency was observed during last week of September. It may be mentioned that the withdrawal of southwest monsoon commenced from northwestern part on 29 September.

The week by week progress of cumulative rainfall during the season is presented in Fig.6. The cumulative rainfall was excess for the country as a whole in the beginning of the season. It had decreasing trend till the week ending 23 July. However, the excess rainfall condition for the country as a whole continued till the week ending 9 July. From the week ending 23 July, the cumulative seasonal rainfall over the country as a whole continued to remain near normal, as the rainfall departure from the LPA was within about $\pm 2\%$.

6. LONG RANGE FORECAST OF MONSOON RAINFALL

6.1. Onset of monsoon over Kerala:

Using an indigenously developed statistical model, IMD predicted that monsoon onset over Kerala would take place on 29th May with a model error of ± 4 days. This year, the monsoon onset over Kerala was on 31st May, just one day earlier than its normal date and hence within the forecast range.

6.2. Long range forecast of rainfall:

The Table below gives the summary of the verification of the long range forecasts issued for the 2008 Southwest monsoon.

Table: Details of long range forecasts and actual rainfall.

| Region | Period | Issued on | Forecast | Actual |
|-----------------|-------------------|----------------|----------------------|-------------|
| All India | June to September | 16 April, 2008 | 99% of LPA \pm 5% | 98% of LPA |
| | | 30 June, 2008 | 100% of LPA \pm 4% | |
| All India | July | 30 June, 2008 | 98% of LPA \pm 9% | 83% of LPA |
| Northwest India | June to September | 30 June, 2008 | 96% of LPA \pm 8% | 107% of LPA |
| Northeast India | | | 101% of LPA \pm 8% | 94% of LPA |
| Central India | | | 101% of LPA \pm 8% | 96% of LPA |
| South Peninsula | | | 98% of LPA \pm 8% | 96% of LPA |

As per the long range forecast for the 2008 Southwest monsoon seasonal rainfall issued on 16th April, the seasonal rainfall for the country as a whole was expected to be 99% of LPA with a model error of \pm 5%. In the updated forecast issued on 30th June, the forecast for the country as a

whole was revised as 100% of LPA with a model error of $\pm 4\%$. The forecast came correct as the actual area-weighted rainfall for the country as a whole was 98% of the LPA. IMD had also issued the long range forecast for July 2008 rainfall over the country as a whole as 98% of its LPA with a model error of $\pm 9\%$. But the actual rainfall in July was 83% of LPA, much less than the lower limit of the predicted value. Considering 4 broad homogenous regions of India, rainfall was expected to be 96% of its LPA over NW India, 101% of LPA over Central India, 101% of LPA over NE India and 98% of LPA over South Peninsula with a model error of $\pm 8\%$. The actual rainfall over these 4 regions was 107%, 96%, 94% and 96% of the LPA respectively. Thus the long range forecasts for the seasonal rainfall over all the homogeneous regions except NW India were accurate. Over NW India the actual seasonal rainfall was slightly more than the higher limit of the predicted value.

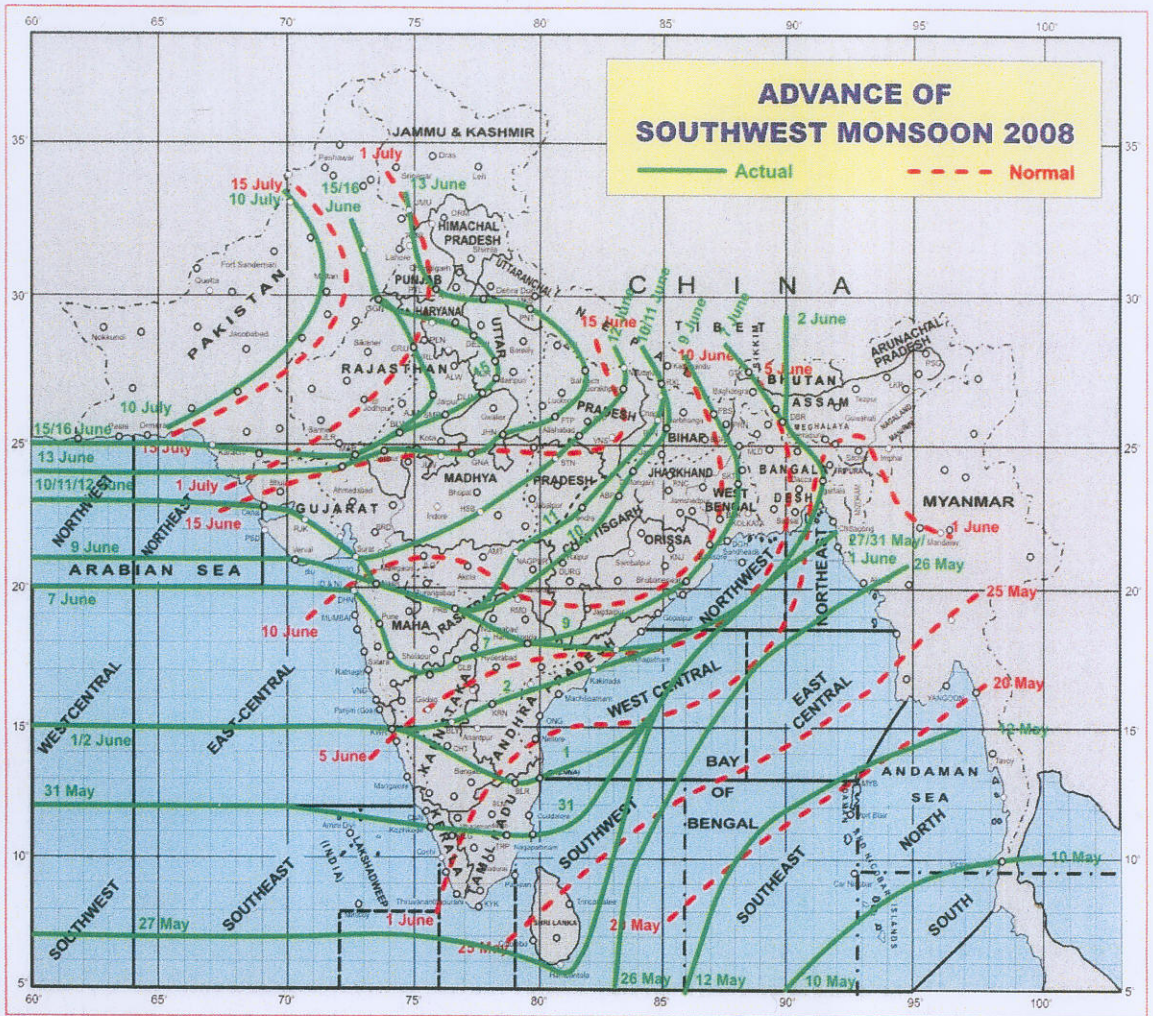


Fig.1. : Progress of Southwest Monsoon – 2008

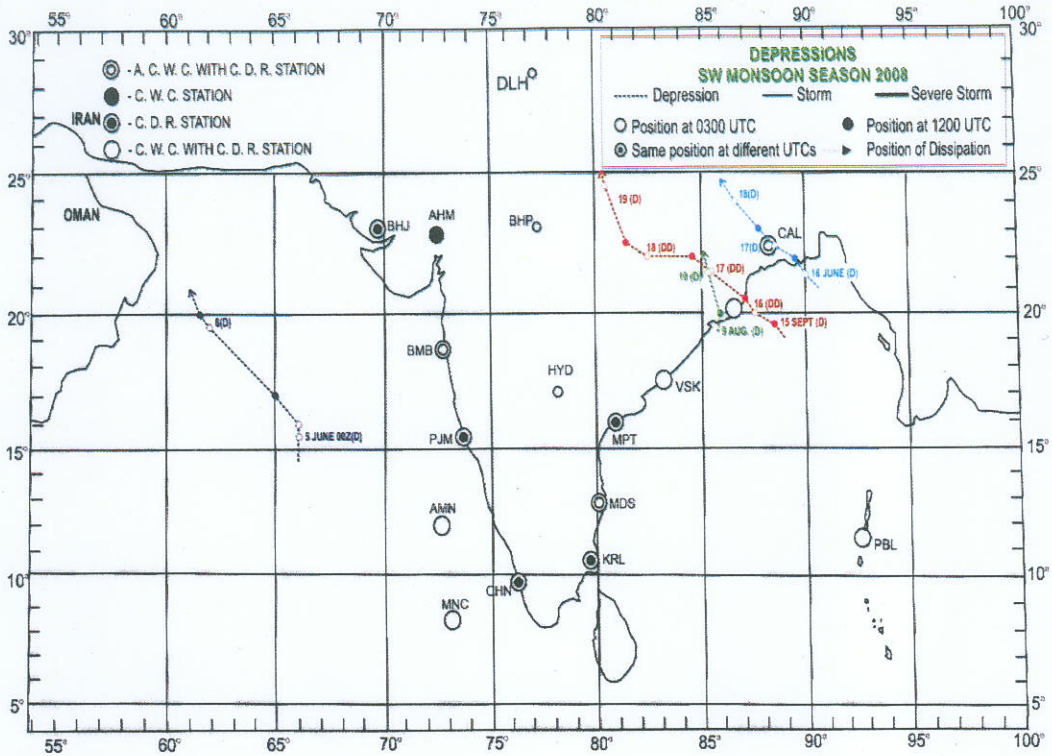
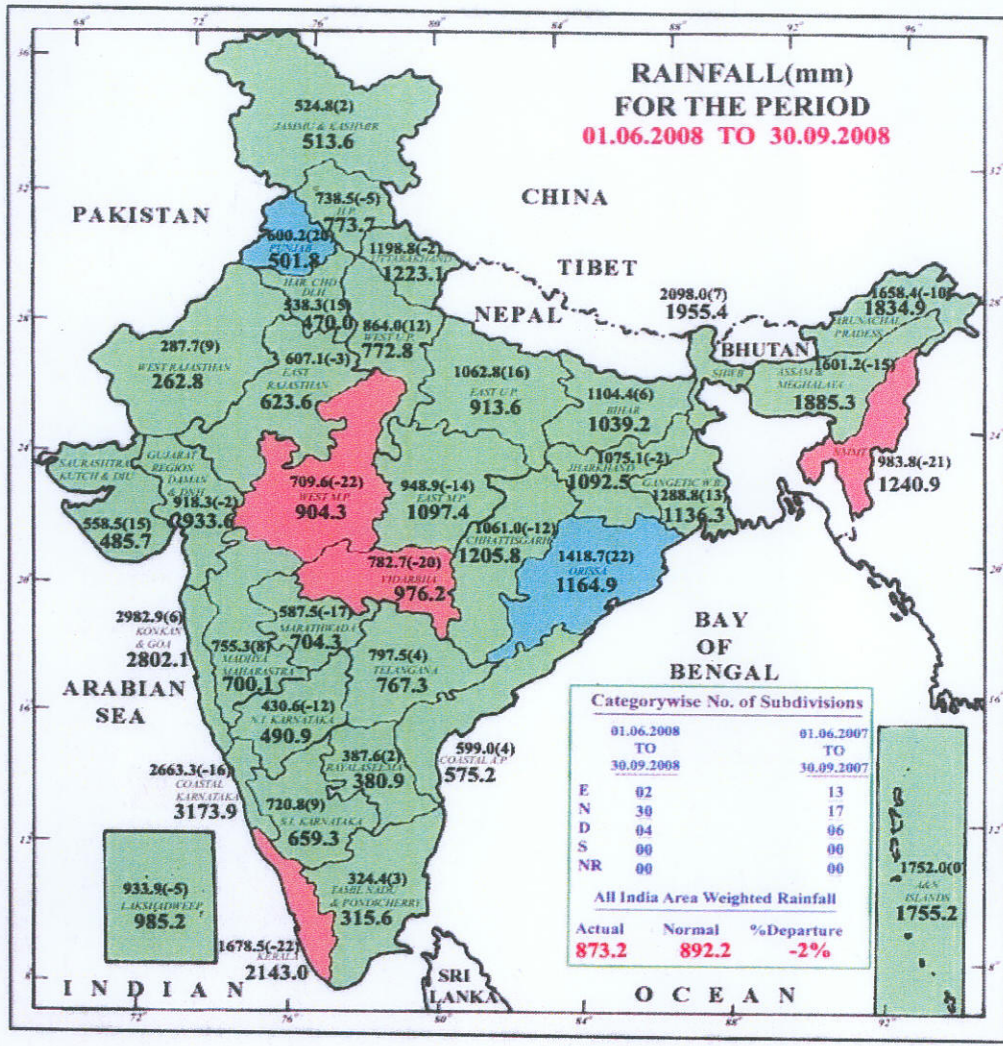


Fig.2. : Tracks of the low pressure systems over Indian seas during the Southwest Monsoon Season– 2008

भारत मौसम विज्ञान विभाग INDIA METEOROLOGICAL DEPARTMENT

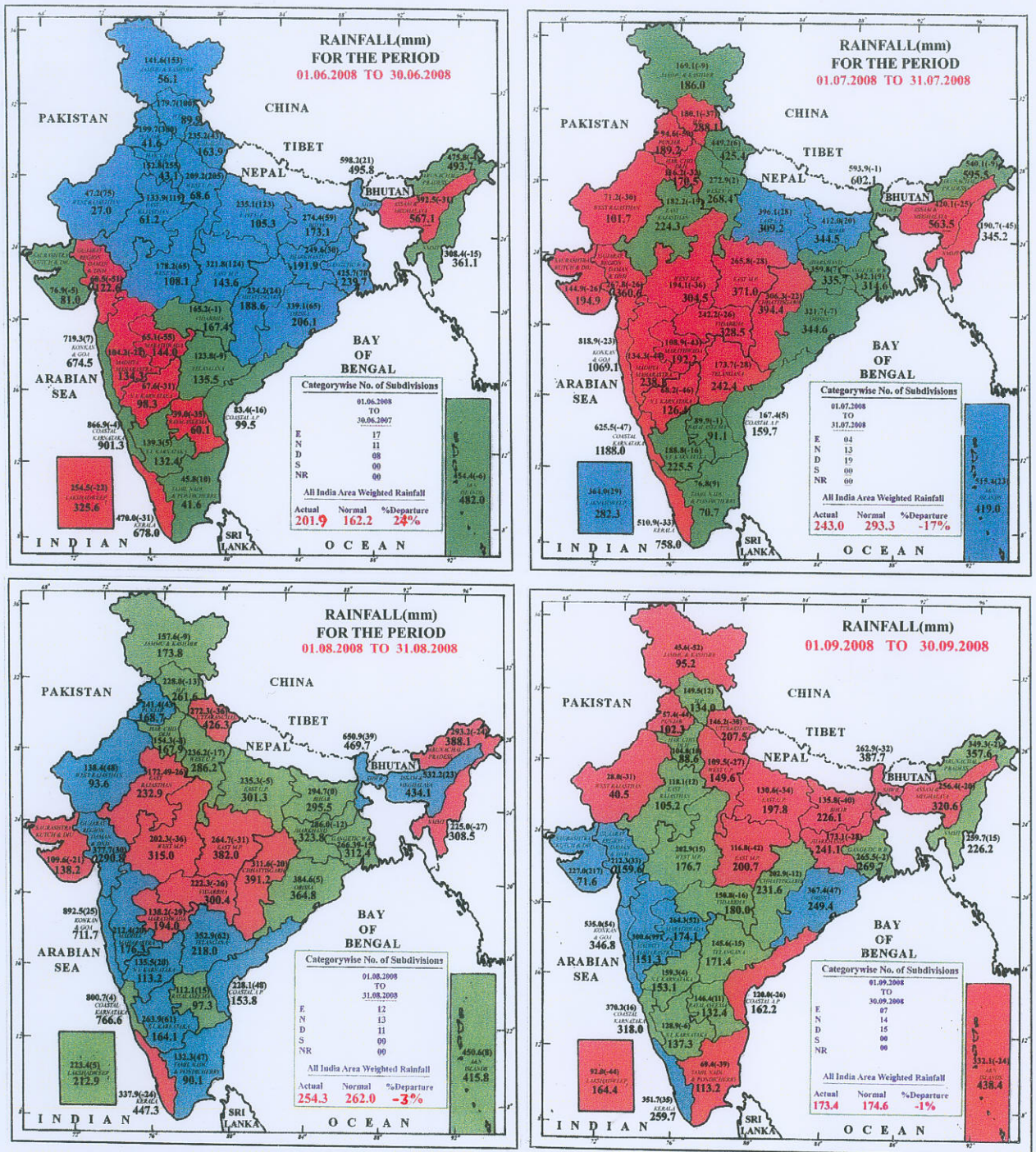


LEGEND :

- EXCESS (E)**
+ 20% OR MORE
- NORMAL (N)**
+19% TO -19%
- DEFICIENT (D)**
-20% TO -59%
- SCANTY (S)**
-60% TO -99%
- NO RAIN (NR)**
-100%
- NO DATA**

Fig.3: Sub-division wise rainfall distribution over India during southwest monsoon season (June to September) – 2008

भारत मौसम विज्ञान विभाग INDIA METEOROLOGICAL DEPARTMENT



LEGEND :

- EXCESS (E)**
+ 20% OR MORE
- NORMAL (N)**
+19% TO -19%
- DEFICIENT (D)**
-20% TO -59%
- SCANTY (S)**
-60% TO -99%
- NO RAIN (NR)**
-100%
- NO DATA**

Fig.4: Sub-division wise monthly rainfall distribution over India during southwest monsoon season – 2008

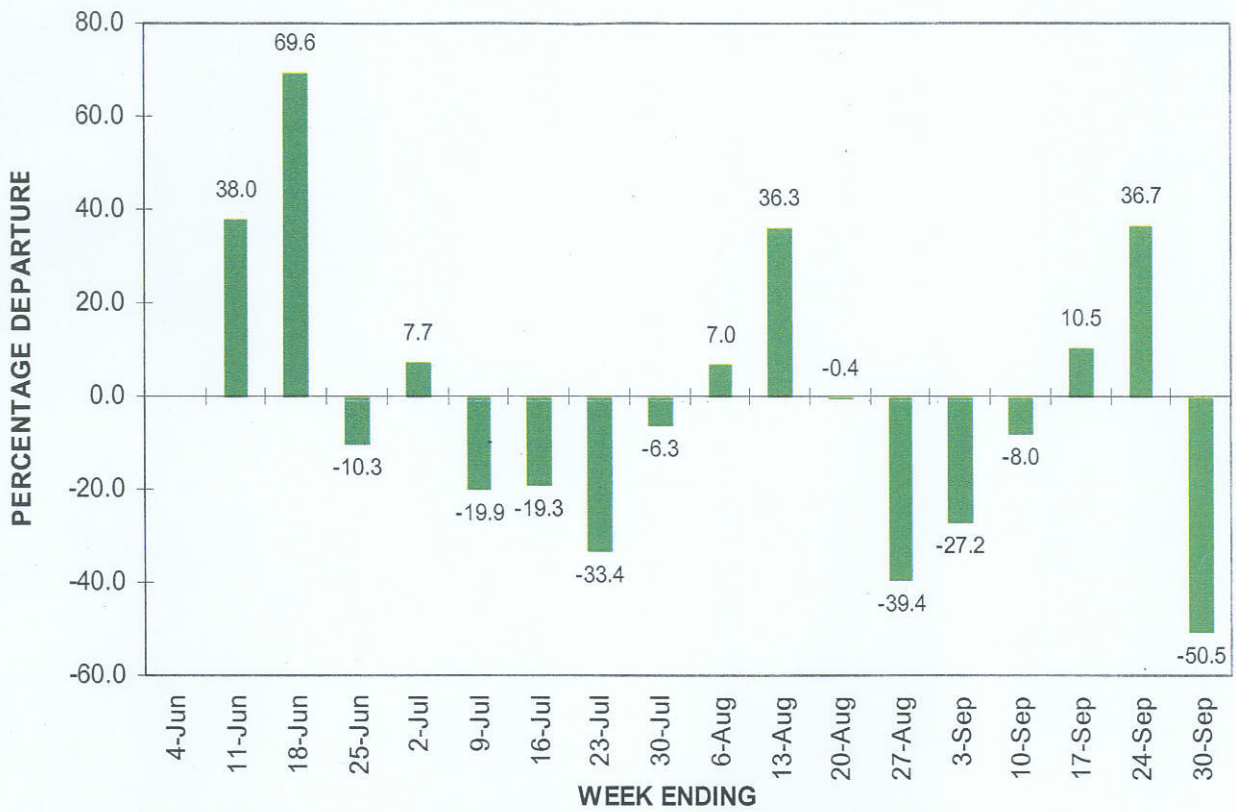


Fig.5: Week - by - Week Progress of the Monsoon Rainfall – 2008

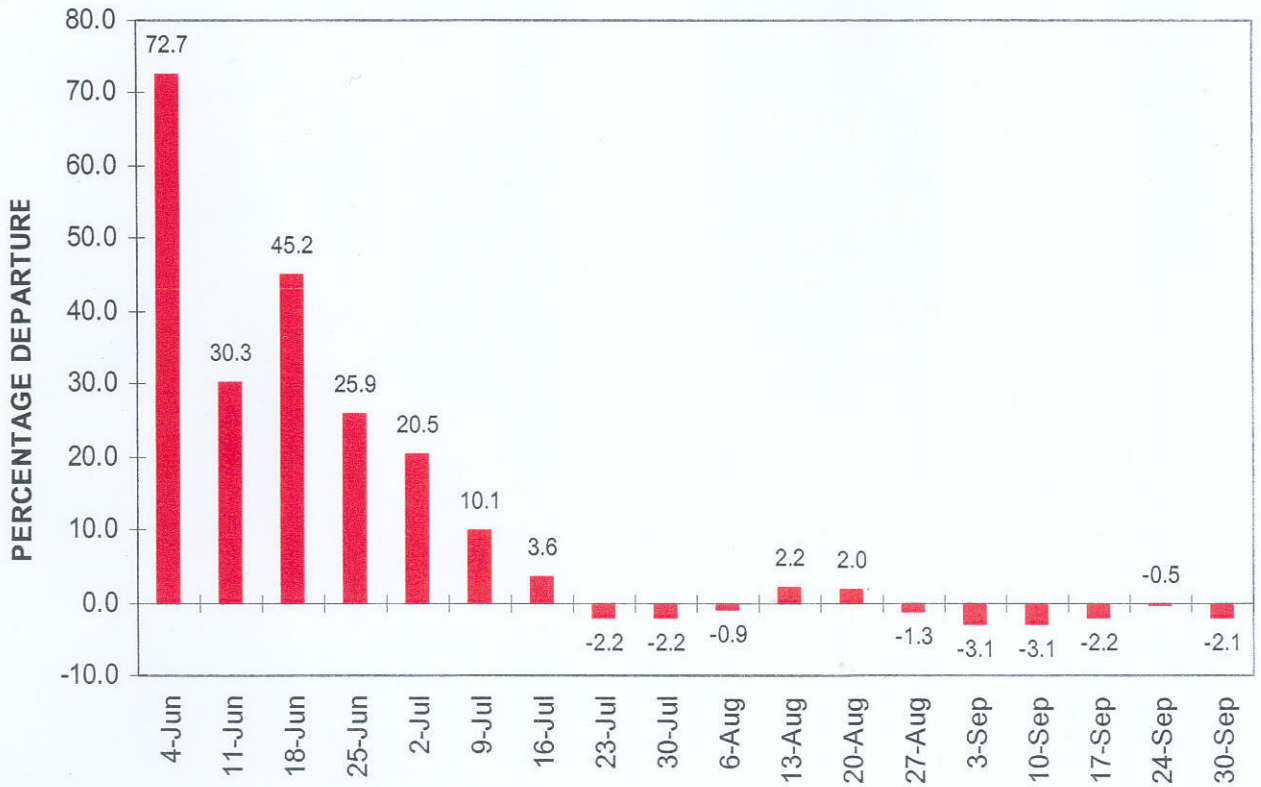


Fig.6. : Week - by - Week Progress of the Monsoon Rainfall - 2008 (Cumulative)