

Some aspects of cloud burst at the onset of southwest monsoon

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ABSTRACT. The cloud burst of 10 June 1976 with high rainfall potential at Chittagong and its neighbouring stations at the onset of southwest monsoon is a rare phenomenon that needed thorough studies and investigations.

Attempts have been made to study the aerological and synoptic conditions together with the hourly sky conditions, temperatures and pressure variations and wind velocity of Chittagong station for some days before the occurrence of the phenomenon to find out a clue to such a violent phenomena of rainstorms and heavy downpour causing a large scale damage due to landslide and flood in the southeastern part of Bangladesh.

1. Introduction

Cloud bursts with high rainfall potential is not uncommon in Bangladesh. It may occur at a station during the monsoon season from June to September or at the advent of southwest monsoon. But its frequency of occurrence is more at the onset of the monsoon.

The critical day of monsoon start over Bangladesh is recognised as 5 June of the English calendar. But the date varies from year to year. The rainfall that occurs during the time of first advance of monsoon may be termed as 'Onset monsoon rain'. Some of the onset monsoon rain are of such heaviest intensity that 10 to 15 inches of rain or above may occur in a single station within less than 5 hours' time. In extreme cases, the duration may be even less than the above limit. Though they are not associated with strong winds as in nor'wester, yet thunderstorm is an associated phenomenon with them. In terms of the extensive damage caused by the high rainfall potential of cloud burst resulting into landslide and subsequent flood over Bangladesh (detailed report published in *The Bangladesh Observer* of 11 June 1976) it calls for more attention of the meteorologist and flood forecaster. So, a thorough

study and investigation of the above type of cloud burst is necessary.

2. Orographical positions of Bangladesh

From the very near to the sea coast upto the extreme border and even to the further east upto the mountainous region of northern Burma—the Arakan hills, the average altitude of which is about 2,600 ft, extends along the eastern border of Chittagong areas with its branches to Tippera H.T. (India) and even upto the southern and eastern parts of Sylhet district. All these hills are parallel to the sea coast and present a barrier almost perpendicular to the southwest monsoon winds. The Khasia hills (average altitude of 4,700 ft) of Meghalaya State with the stretches to northern Sylhet district extends from east to west, perpendicular to the southerly component of monsoon current, upto the extreme west of northern border of Mymensingh district from where it recurved southward with lesser height upto Tangail district (Madhupurer Gar).

In southerly maritime winds, protected by mountains, convective activity is accentuated as the air moves up against the mountains. But as the

monsoon air is heavily charged with water vapour : this must be true in the case of the hilly areas covering the lower tropospheric upper limit.

Fig. 1 represents all the Departmental observatories in Bangladesh with their international index numbers from where daily rainfall records are available.

3. Cloud burst affected area of Bangladesh

Consulting the past records of Bangladesh, it is observed, this type of cloud burst generally happens in the hilly regions of the country, *i.e.*, (i) the Chittagong area consisting of districts of Chittagong Hill Tracts, Chittagong and adjoining Noakhali districts and off-shore islands, (ii) Sylhet district and (iii) hilly side of Comilla district. Very rarely this phenomenon occurs in the plains. The isohyets of 8, 9 and 10 June 1976 represented by Figs. 2 (a), (b) and (c) will justify this.

4. Cloud burst of 10 June 1976

The cloud burst of 10 June which was, of late, personally experienced by the author at the Main Meteorological Office, Patenga, Chittagong is a significant illustration for theoretical explanation of this type of cloud burst. Fig. 2 (c) represents the isohyets of 24-hr rainfall ending at 0300 GMT of 10 June 1976. This shows that two distinct regions of cloud burst areas in the map. One is in the eastern hilly region extending from in between Chittagong and Cox's Bazar to the foot of Khasia hills, the northern border area of Sylhet district across Tippera hills and the other is in the plains around Bogra. Highest amount of rainfall was recorded in the northern part of Chittagong area from the sea coast (near Chittagong Airport) extending northeastwards upto northern Chittagong Hill Tracts including Rangamati town. The available average rainfall in Chittagong area is about 11.36 inches and in Bogra it was counted to be nearly 7 inches.

5. Description of weather experienced at Chittagong on 10 June 1976

The Chittagong Airport Observatory recorded lightning from 1850 GMT of 9th. Thunder-showers started at 2048 GMT. Its intensity was moderate till 2350 GMT. Then heavy thundershowers followed. Heavy to very heavy rain accompanied by heavy thunderstorms and

reducing surface visibility to very often less than 200 m continued for a period of nearly 4 hours till 0350 GMT of 10 June 1976, then with a gradual decrease of intensity rainfall ceased at 1100 GMT. Most unfortunately and due to unavoidable circumstances which arose from the heavy rainfall the entire raingauge submerged with one and a half inch of rainwater flowing above the rim of the raingauge. Chittagong Airport Observatory could not record the rainfall from 0000 to 0300 GMT of 10th. The recorded rainfall from 0300 GMT of previous day to 0000 GMT of 10th was 5.70 inches. It is assumed from the intensity of downpour that about more than 12 inches of rainfall occurred during the period. However, Ambagan Observatory, 6 miles away from Chittagong Airport Observatory recorded 8.90 inches of rain during this period.

6. Object of study

As the cloud burst of 10 June 1976 at Chittagong and its neighbouring station is the subject of our study attempts have been made to analyse the aerological and synoptic conditions together with the hourly observations of surface wind, visibility, cloud type and amount of Chittagong for some days (from 6 June) before the occurrence of the above phenomenon on 10th to find out a clue to such a type of cloud burst and issue advance warning for heavy rainfall.

7. Synoptic condition

Since scientists dealing with tropical weather admits that 'tropical analysis and forecasting consists mainly in looking for minor disturbances and predicting their development and movement, especially with reference to the major rainstorms which they produce'—prevailing synoptic conditions were examined carefully in terms of the above cloud burst.

On 7 June 1976 a low formed at the head Bay which moved northeastwards to Assam giving widespread rain all over Bangladesh on 8th and was responsible to set the southwest monsoon over the country.

At 0300 GMT of 9 June (Fig. 3a) there was a well-marked low pressure area over Uttar Pradesh and adjoining Bihar with its trough extending upto east central Bay. Its another trough ran upto sub-montane West Bengal and adjoining

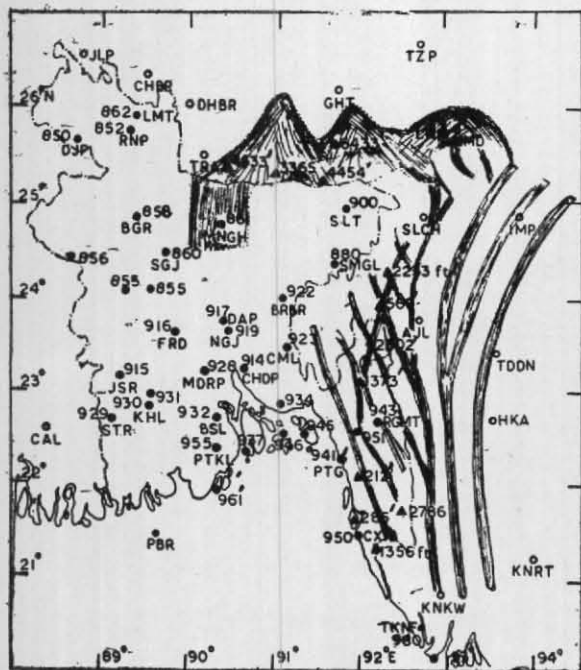


Fig. 1



Fig. 2(b)

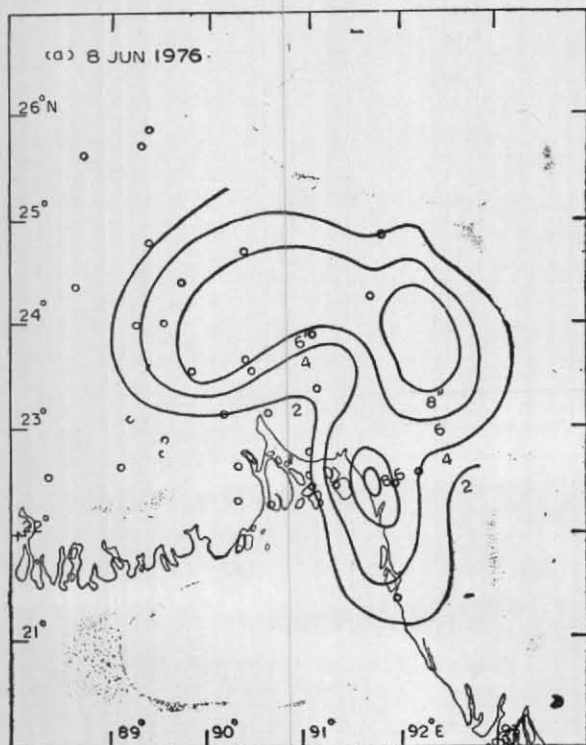


Fig. 2(a)

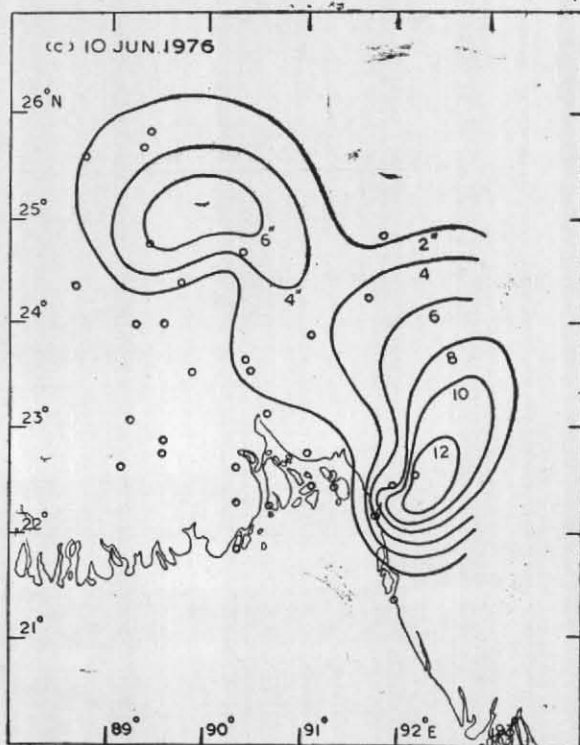


Fig. 2(c)

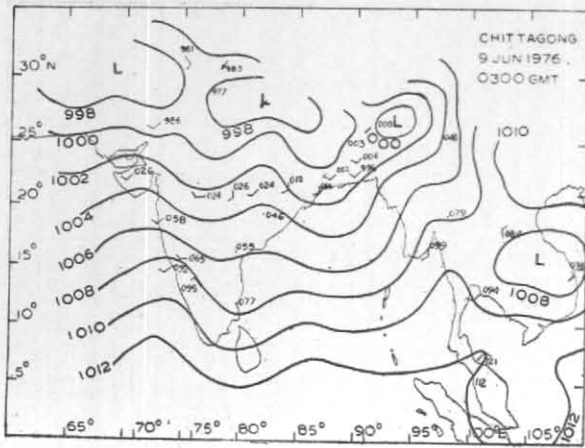


Fig. 3(a)

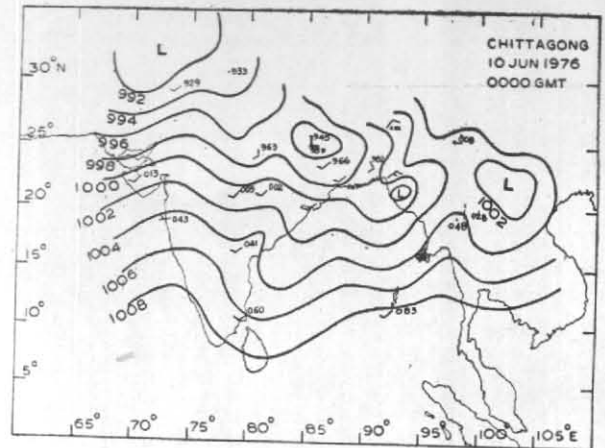


Fig. 3(c)

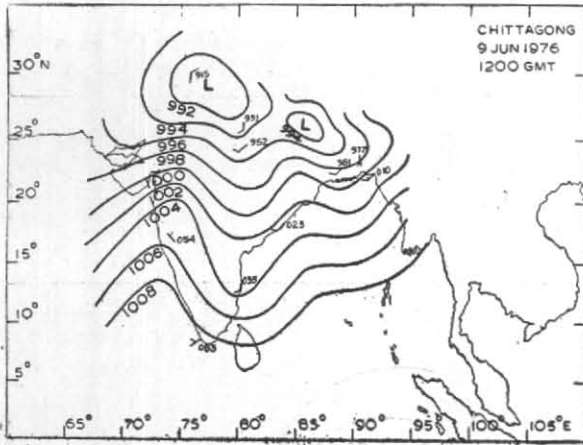


Fig. 3(b)

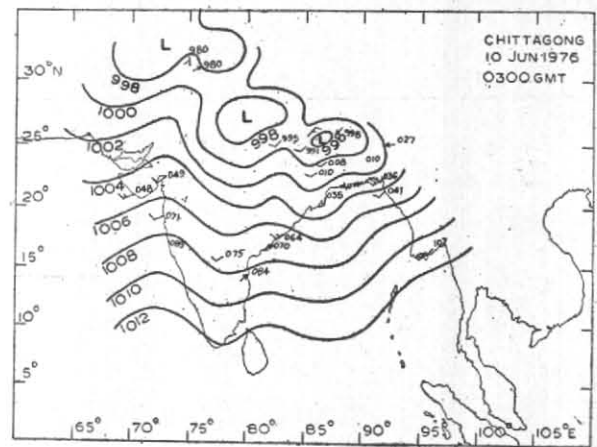


Fig. 3(d)

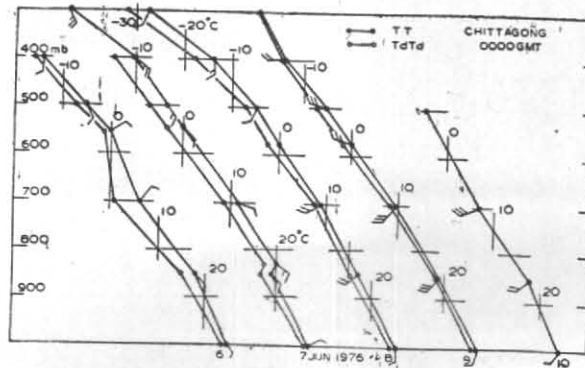


Fig. 5. Curves of dry bulb and dew point temperatures on 6-10 June 1976

Assam and at its peak, a low pressure area lay over extreme northeastern Assam. The prevailing surface winds over Bangladesh stations were generally SW to WSW. At 1200 GMT of 9th (Fig. 3b) the low pressure area moved to Bihar with its trough extending upto northeast Bay. The other trough displaced slightly southward from its previous position, extended upto Assam across northern part of central Bangladesh. Surface winds of the stations, near the coast over Bangladesh recorded at that time SW'ly winds with the gradual backing trend of wind over the northern stations.

At 0000 GMT of 10th (Fig. 3c) the low over Bihar persisted with its trough extending upto southern coast of Bangladesh and at the tip of this trough the existence of one micro low, to the south of Chittagong but somewhere in between Chittagong and Cox's Bazar, became prominent. The other trough shifted a bit northward and extended upto Assam. At 0300 GMT of the same day (Fig. 3d) the micro low, noticed earlier over Chittagong area moved in a NE'ly direction towards the hilly region.

8. Micro analysis

A micro analysis of the hourly wind direction of Chittagong Airport Observatory shows that after 1900 GMT of 9 June the surface wind took a turn from $200^{\circ}/14$ kt to $020^{\circ}/12$ kt and then gradually veering to $110^{\circ}/12$ kt at 0100 GMT on 10 June. At 0200 GMT of 10th the wind became $250^{\circ}/20$ kt and gradually veered to $340^{\circ}/17$ kt at 0400 GMT and the peak hours of downpour was from 0100 to 0400 GMT with visibility reduced to 100 m and the estimated height of base of low cloud at 400 ft. The sudden change of wind direction from SW to NE component shows signs of abrupt cessation of the supply of warm moist air from the lower part of the atmosphere due to the movement of the micro-low over the hilly region. It is of importance to note that when Chittagong experienced such a heavy downpour Cox's Bazar had only 0.18 inches of rainfall upto 0300 GMT of 10th.

9. Upper air circulation

On examination of the constant pressure chart and the upper wind data it is seen that the criteria for the establishment of southwest monsoon has been fulfilled by incursion of easterly jet at lower latitude from 7 June. At 0000 GMT on 8th,

Port Blair recorded E'ly 65 kt at 150 mb, 45 kt at 200 mb and 20 kt at 300 mb.

The combined upper wind data over Chittagong and other neighbouring stations of Bangladesh was SW'ly 25 kt upto 15,000 ft on 8th, 9th which became WSW/30 kt at 0000 GMT on 10th.

10. Instability

From the rawinsonde data of 0000 GMT of Chittagong from the dates 6, 7, 8, 9 and 10th – five respective curves of dry bulb temperature and dew point temperature together with the upper wind data at constant pressure levels are drawn and shown in Fig. 4. It may be noted here that the absence of dew point temperature curve on 10th was due to instrumental trouble. However, from these curves it will be seen that heavy incursion of moisture upto the extreme limit of the days flight (300 mb) was present on 9th morning. Resemblance of dry bulb temperature curve of 10th with that of 9th signifies the continuation of the incursion of moist current. Because of this prevailing condition – a convectional current was evidently present at that period over the area.

11. Discussion

A micro-low moving over the hilly region or heading towards the hilly region and carrying an airmass of extremely humid nature, as in the case of 9th morning – Fig. 3(d), is one of the most suitable and essential condition of cloud burst at the onset of monsoon. In course of its movement over the hills rainfall intensity must gradually increase if constant inflow of moisture prevails – as because, by the effect of the hilly region with the moving micro-low – there caused a sudden cessation of convectional current, as a result raindrops which it had been supporting must have fallen in a much shorter time causing heavy downpour in the hilly region.

12. Conclusion

The occurrences of significant and heavy rainfall amounts from southwesterly moist current during the monsoon season have been well documented. The evidence presented here is an aspect of cloud burst due to the orographical position of the stations particularly of Sylhet, Rangamati and Kaptai.

Another aspect of cloud burst at a coast station, like Chittagong, adjacent to the hilly area may be due to the formation of a micro low at the tip of the monsoon trough and its movement towards the hilly region when the convective current with high latent instability might have ceased abruptly and the supported raindrops and hailstones fell to the ground as a heavy downpour. As no hailstones were reported the hails must have dissolved after descending below 0°C and fell to the ground as raindrops of bigger diameter with an accelerated intensity in the form of a heavy to very heavy downpour over the area in a much shorter duration of time. As the soil was already moist due to rainfall during the past few days there occurred large scale landslide over the area during the heavy downpour of cloud bursts of 10 June 1976 and the subsequent flood after the topographical distribution of rainwaters.

13. Suggestion

Monsoon winds, as stated above, are heavily charged with water vapour. So a slight low level convergence can produce, as in the case of above cloud burst, heavy downpour. But these low level convergences are, sometimes, not detectable on the standard synoptic chart. So, a micro analysis over the enlarged map of the probable affected

area is a must at that time. A micro analysis of the charts of all levels of the lower troposphere together with the help of the simple graph as shown in Figs. 3(a-d) and 4. After finding out the development and movement of the minor disturbances forecast of cloud burst can be given with greater accuracy. Thus damage and destruction of property could be minimised and loss of life could be averted giving a timely warning of the cloud burst at the onset of southwest monsoon.

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REFERENCES

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| Air Ministry, U. K. | 1947 | <i>The Meteorological Glossary</i> (3rd ed.), p. 46. |
| Byers, H. R. | 1959 | <i>General Meteorology</i> (3rd ed.), p. 368. |
| Huq, M. S. | 1970 | Forecasting of heavy rainfall and flood (WMO publication). |
| | — | Survey of Bangladesh—For the altitude of the hills and mountains. |
| Koteswaram, P. | 1960 | <i>Monsoons of the World</i> , India met. Dep., p. 105. |
| Malurker, S. L. | 1960 | <i>Ibid.</i> , p. 92. |
| Mordy, W. A. and Eber, L. E. | 1953 | <i>Quart. J. R. met. Soc.</i> , 80, p. 48. |
| Ramanathan, K. R. | 1960 | <i>Monsoons of the World</i> , India met. Dep., p. 53. |