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### A SYNOPTIC STUDY OF JULY 1971 AND AUGUST 1975 FLOODS IN RIVER SONE

The river *Sone* experienced very serious flood conditions in the southwest monsoon periods of 1971 and 1975. In both the cases, the attendant meteorological phenomenon was slow movement/stagnation of Bay of Bengal depressions over southeast Uttar Pradesh and adjoining northeast Madhya Pradesh, an area to the northeast of upper *Sone* catchment. Identification of synoptic situations which lead to slow movement/stagnation of Bay depressions over this area has, therefore, great importance in operational flood forecasting for this river. The situations leading to the slow movement/stagnation of monsoon depressions of July 1971 and August 1975 have been studied in this paper.

2. The general movement of Bay of Bengal depressions forming in the southwest monsoon period conforms largely to the high level easterlies at the southern periphery of subtropical anticyclone over Tibet. It is also known that when the winds aloft are weak, the disturbances slow down and sometimes show erratic movement. Srinivasan *et al.* (1972) have reported a case of Bay depression of 10-17 September 1970, which had a slow movement and executed a loop over east Uttar Pradesh when it came under a region of weak upper tropospheric flow (*i.e.*, ridge line). In another study of the movement of cyclonic storms of post monsoon season over Bay of Bengal, Srinivasan and Ramamurthy (1973) have found that when the storm is close to the ridge line at 200 mb, the movement is slow and the system may even be stationary.

Rao *et al.* (1970) had earlier reported a typical case of recurring monsoon depression under the influence of middle latitude disturbance. In the present study the upper air extended charts were examined to ascertain the role of these disturbances in slowing down or stagnation of monsoon depressions. Movement of July 1971 and August 1975 depressions with reference to middle latitude systems which caused displacement/distortion of upper tropospheric flow over the depression fields are discussed in the following section.

#### 3.1. July 1971

A depression formed over northwest Bay on 15 July. It travelled northwestwards across Bihar plateau and on 17th its centre was near Gaya. Till this date its speed of movement was normal, about  $3^\circ$  per day. But it slowed down

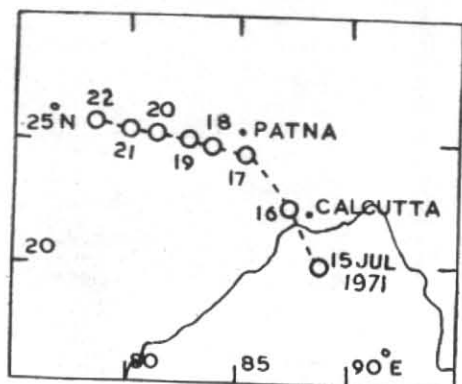


Fig. 1. Track of depression, 15-22 July 1971

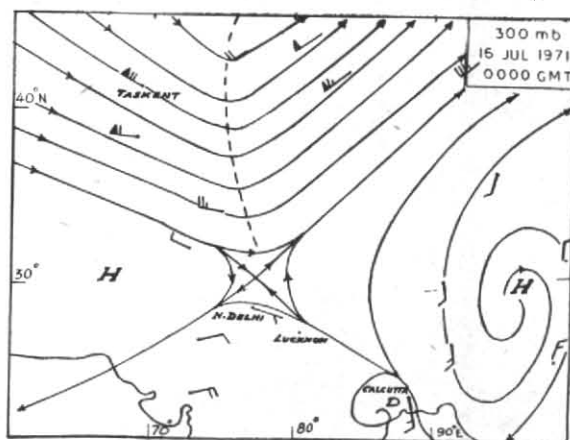


Fig. 2

considerably thereafter and in subsequent four days, 17th to 21st, it moved only  $5^\circ$  of longitude from  $85^\circ$  to  $80^\circ$ E over southeast Uttar Pradesh and adjoining northeast Madhya Pradesh (Fig. 1). Persistent heavy rainfall resulted in upper *Sone* catchment, which lay in its southwest sector, giving rise to heavy floods in river *Sone*.

Upto 16 July 1971 the upper tropospheric ridge was in its normal position for this month along  $30^\circ$ N. Between 15 and 17 July two middle latitude troughs in westerlies emanated from cyclonic disturbances over Russia in mid and upper troposphere. By 16th one of these was extending upto Indian latitudes and by 17th both of these displaced the Tibetan anticyclone southwards bringing the ridge line almost astride the depression (Figs. 2 and 3). The depression slowed down and continued moving slow upto 21st till it remained close to the ridge line (Fig. 4).

#### 3.2. August 1975

A depression formed over northwest Bay on 17 August. It moved northwest with average

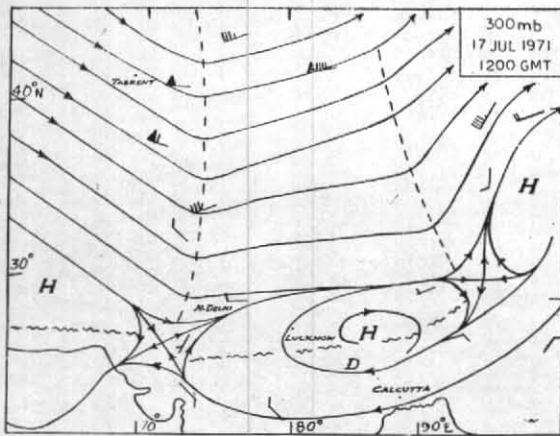


Fig. 3

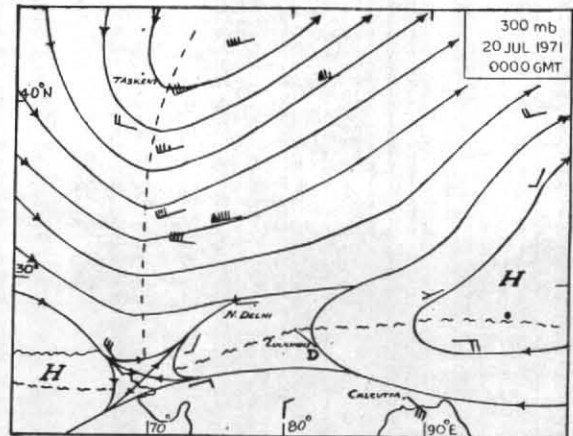


Fig. 4

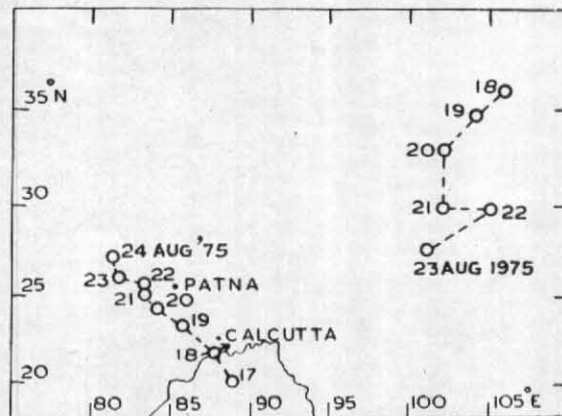


Fig. 5. Track of depression, 17-24 August 1975 and low over China, 18-23 August 1975

speed of  $2.5^\circ$  per day upto 19th. Thereafter, the speed of motion began dropping and on 21st the system became stationary near Varanasi. It resumed motion on 22nd with slow speed. Here again, the upper Sone catchment fell in the heavy rainfall sector of the depression during the period of its slow movement and stagnation upto 22nd. Track of the depression is shown in Fig. 5.

A well marked trough developed over China in the middle and upper troposphere, extending roughly along  $100^\circ\text{E}$  on 17 August 1975 (Fig. 6) and split the subtropical anticyclone belt, which is normally a continuous one along about  $30^\circ\text{N}$  into two. A cut-off low formed in this trough on 18th centred near  $36^\circ\text{N}$ ,  $106^\circ\text{E}$  which retrograded slowly southsouthwest till 23 August when its position was about  $27\frac{1}{2}^\circ\text{N}$ ,  $101^\circ\text{E}$  (Fig. 5). As the low retrograded the upper tropospheric easterly field above the depression was distorted due to readjustment of the two anticyclone cells—one over Tibetan area and the other to the south and

east of it. The surface centre of the depression (marked D Fig. 7) fell right underneath the 'Col' between these two anticyclone cells on 20th and 21st, the dates on which the disturbance remained practically stationary over southeast Uttar Pradesh. The low over China persisted upto 23rd. Upper tropospheric flow over the field of depression remained weak and the depression continued its slow motion upto 24th whereafter it filled up.

4. The foregoing section shows that the weak upper tropospheric flow which caused slow movement and stagnation of depression in the two cases studied, was associated with middle latitude systems. In July 1971 this weak flow was the result of southward displacement of the subtropical anticyclone over Tibet caused by troughs in westerlies emanating from extratropical lows over Russia and extending deep south. In August 1975 the retrograde motion of a cut-off low over China caused displacement of the subtropical ridge and distortions in the field

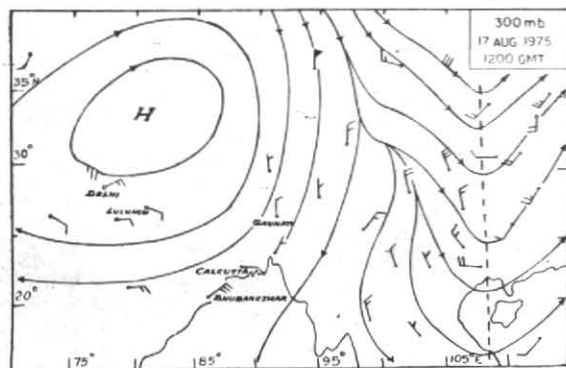


Fig. 6

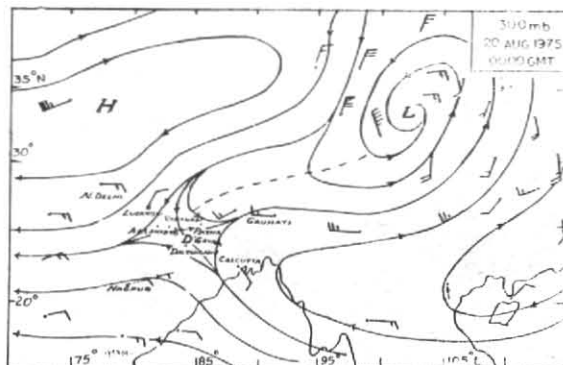


Fig. 7

of upper tropospheric easterlies overlying the centre of depression. The movement of the depression over southeast Uttar Pradesh synchronised with the changes in upper flow pattern, resulting in its slow movement. Incidentally, the second case presents another interesting example of retrograde motion of a low over China making its impact over tropical Indian weather as reported earlier by Prasad and Rao (1974).

5. The study has shown that slow movement and stagnation of monsoon depressions in the mid-monsoon months of July and August, a situation favouring incidence of heavy rainfall, and which occur due to superimposition of weak upper tropospheric flow over the field of depressions, can be traced to development of quasi-stationary disturbances in middle latitude westerlies.

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