

MANGLA CAT-III FLOOD FORECASTING PROCEDURE

Abdul Majid¹, Nazia Akhtar²

Abstract:

Cat-III floods are the most severe floods for the rivers Satluj, Ravi, Chenab and Jhelum. Generation of the floods is caused by the approach of an intense tropical depression from the Bay of Bengal. The depression upon reaching the northwest part of Rajasthan comes under the grip of the westerly trough moving eastwards along the northern latitudes of Pakistan. Under this situation, when the 500 mb westerly trough and the tropical depression get mutually juxtaposed along the northsouth axis, the tropical depression tends to intensify and move northwards. Intense rainfall extending over period from 15 – 36 hours occur under the situation resulting in the extremely heavy floods.

Timely prediction of this category of floods for the vigilant tracking of tropical depression to the point of its interaction with the westerly. Intensity of the rainfall is dependent upon the intensity of the tropical depression and position of its track in relation to the river catchment. The study can be pursued further to formulate a methodology for qualitative forecasting of the catchment rainfall for use in the computational model. Cat-III depression track runs along Lahore, Gujranwala divisions moving further north to the Jhelum and northwards to Rawalpindi division.

Introduction:

Floods have been classified into three categories in relation to the intensity and meteorological situation (Majid, 1994). The severest of the three categories is the Cat-III flood which causes the wide spread devastation as and when it occurs. Such floods have in past occurred in the rivers Ravi, Chenab and Jhelum. The most prominent of which is the floods of 1992 and 1997. Extremely heavy rainfall occurring in the upper catchments of the rivers generate the flood peak which then travels down streams along the channel. Rim stations of the rivers record the peaks first. The biggest challenge for a flood forecaster is timely prediction of the peak both in time and magnitude. Any system based upon the actual measurement of the rainfall and discharge data of the catchment above the rim station is not practicable due to the extremely short time of travel of the peak to the rim station.

Consequently in order to forecast, the approach of the flood at the rim station, a meteorological based approach, whereby the rainfall prediction could be made at least 24 hours in advance is required.

The paper brings out the flood producing meteorological situation in such detail as to constitute a forecasting procedure for a flood forecaster. Detailed study of 1992 & 1997

¹ Hydromet Expert, Pakistan Meteorological Department.

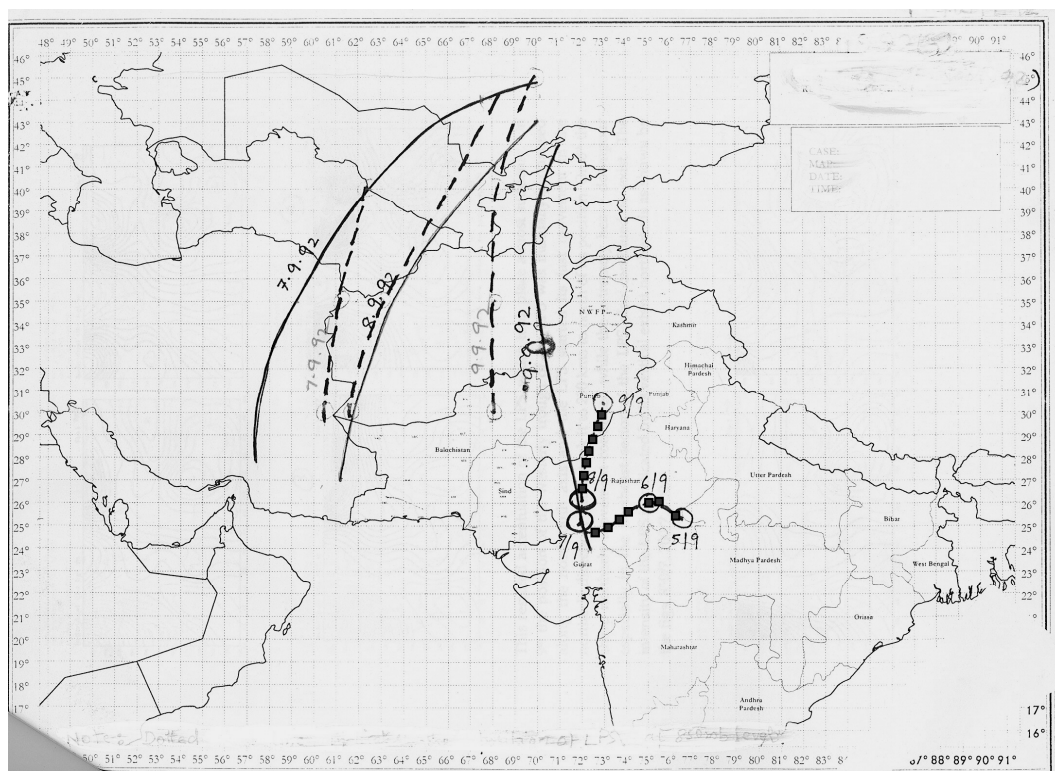
² Pakistan Meteorological Department.

flood situations have been conducted and results combined to yield the steps constituting the forecasting procedure.

Meteorological Situation: 1992 Flood Event

A tropical depression emerged out of Orissa coast on 01st September. The depression moved along North West direction. On 04th September it reached South of Jabalpur (M.P) and by 06th it arrived over southern Rajasthan. When it was at this position its intensity was only that of a monsoon low and not that of a depression. The movement of the tropical along the northwest north direction was an account of the wind flow at 200 mb level. The position of the Tibetan high was such that, the centre of the high was at around 95° E and 30° N. This is a favourable situation for westward movement of depression and thus the depression would have most probably continued to move westwards had it not been affected by the approaching westerly wave.

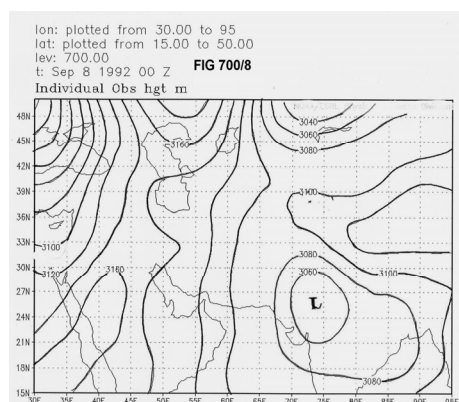
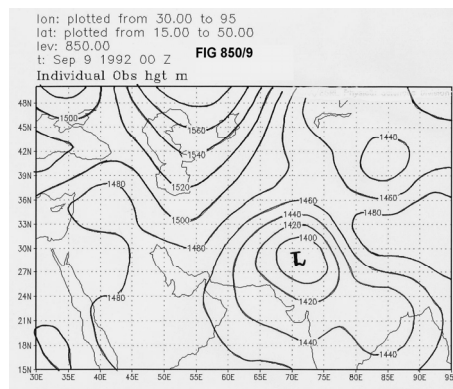
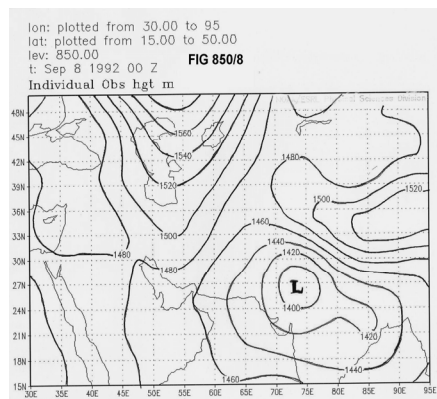
The position of the westerly trough at 500 mb level on 7th, 8th and 9th of September in relation to surface position of the LPS is shown in fig. wtl 92.



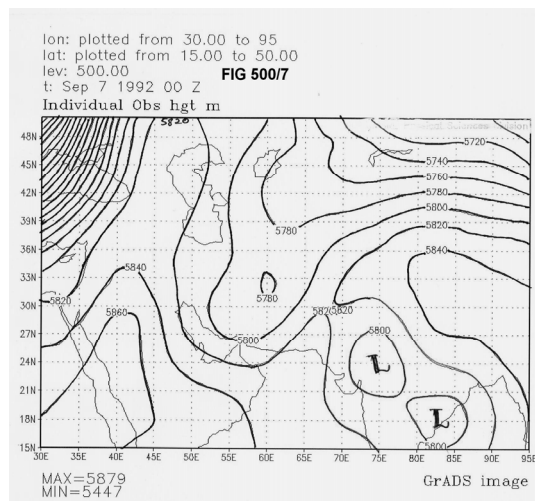
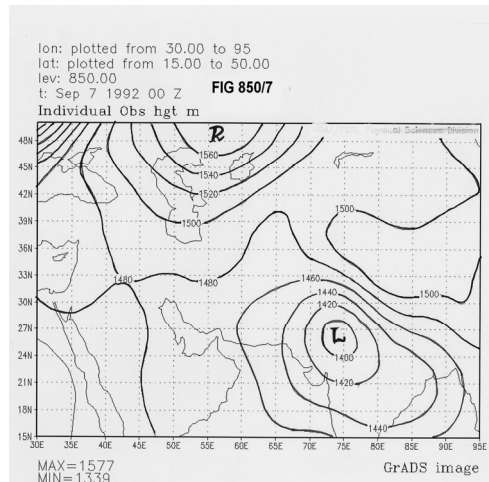
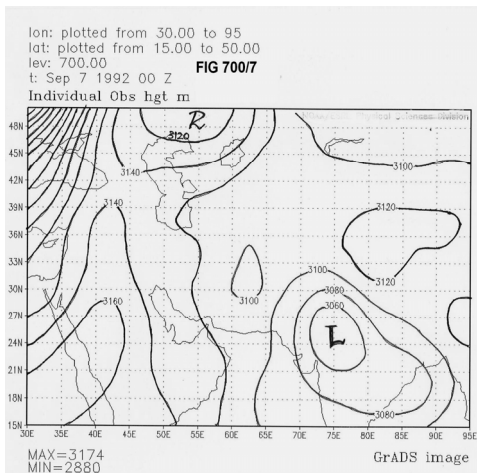
NOTE: SQUARED LINE INDICATES THE POSITION OF LPS AT 850 MB LEVEL.

FIG WTL 92: POSITION OF WESTERLY TROUGH LINE FROM 5-7 SEPT 1992

The LPS came under the influence of approaching westerly from 7th onwards which resulted in the reduction of its westward movement to the extent that it became almost static on 6th & 7th with very little movement northward. On 8th the LPS came under the direct grip of the westerly wave between 8th and 9th as shown in figs. 850/8, 700/8, 500/8 and 850/9, 700/9, 500/9.



This resulted accentuation of the LPS, which took place almost suddenly. On 9th the position of the westerly trough of the LPS was mutually juxtaposed along the northsouth axis and the LPS started its fast movement in the northerly direction, which took it to 290 kms to north of its position. On 8th the sharp northerly movement continued while the extremely heavy downpour especially in the northeast sector of the LPS also continued to exist. The intensity of the LPS is indicated by its vertical extent northwards as shown by the figs. 850/7, 700/7, 500/7.



The depression was so strong that even at 500 mb, it existed as closed contour system. The extremely heavy rainfall and consequently the severest Mangla flood was the result of its movement along track over Jhelum district as indicated in the fig. track92.

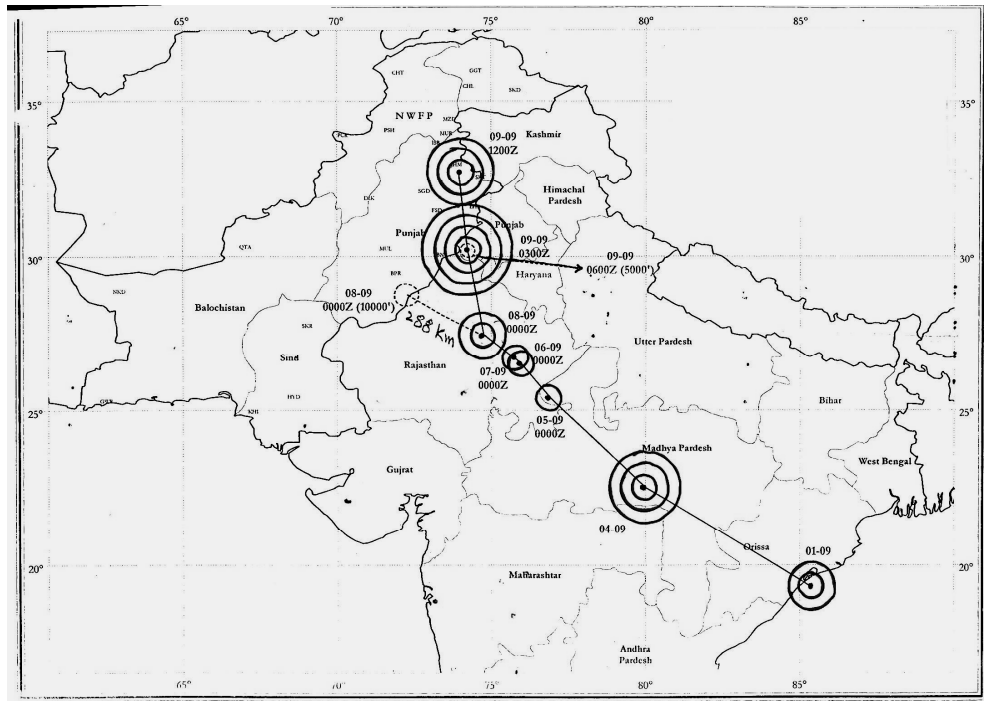


FIG TR 92: TRACK OF MONSOON LOW / DEPRESSION DURING 1 TO 9 SEPT 1992

Heaviest rain occurred on early morning of the 9th extending upto early morning of 10th as shown in fig. mas92. The storm isohyetal map is shown at fig. iso92. The pressure was reduced to the value of 994 mb as given in the fig. Pr92.

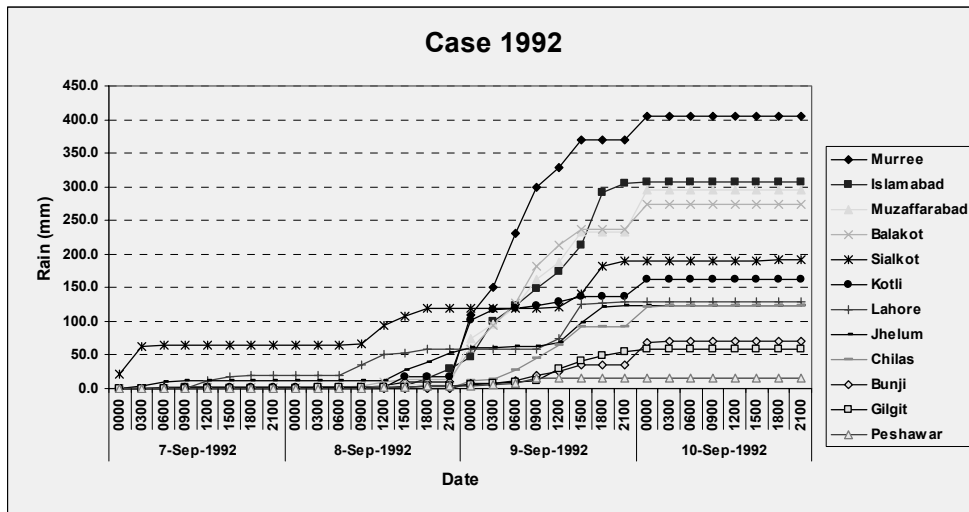


FIG Mass 92: Mass curve of various stations from 7-10 Sept 1992



FLOOD SITUATION OF 1992:

Mangla recorded one of the historical flood during the period starting from late night on 9th extending to mid day on 10th. Heaviest flood was also recorded at the rivers Indus, Chenab and Ravi as well. During the period from morning of 10th up to the morning of 11th shown in fig. Hydro92.

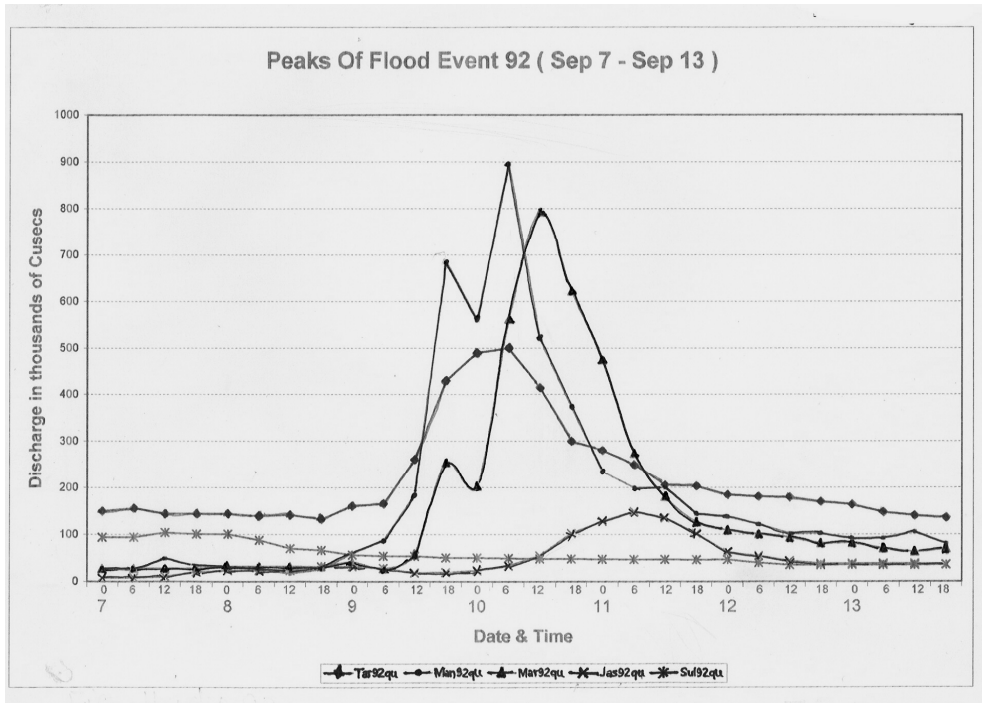


FIG HYDRO 92: HYDROGRAPH SHOWING PEAKS OF FLOOD AT TERBELA , MANGLA, JASSAR AND SUTLAJ

1997 Flood Event:

The system emerged out of the Bay of Bengal on 20th August 1997. At this stage it was the tropical depression with the three closed isobars. It intensified into a deep depression by 21st with five closed isobars as shown in fig. Tr97.

By 22nd it moved Westwards by about 500 kms to arrive North of Raipur. The intensity decreased to four closed isobars. On 23rd the system was still very significant with four closed isobars and lay 330 kms westnorthwest of its previous position. On 24th it had moved by about 370 kms in the North Westerly direction with intensity slightly reduced to that of three closed isobars. After this it changed direction to move in the northerly direction and reduced speed to cover a distance of about 140 kms to arrive East of Ajmair. Next day's movement took the depression by another 200 kms North West to arrive South of Biknair on 26th. Intensity of the depression remained unchanged. On 27th it took a northnorth easterly track and moved very fast to cover a distance of 430 kms to arrive South of Lahore, while still maintaining its intensity of three closed isobars as shown in fig. 850/25, 700/25, 850/26, 700/26 and 850/27, 700/27 .

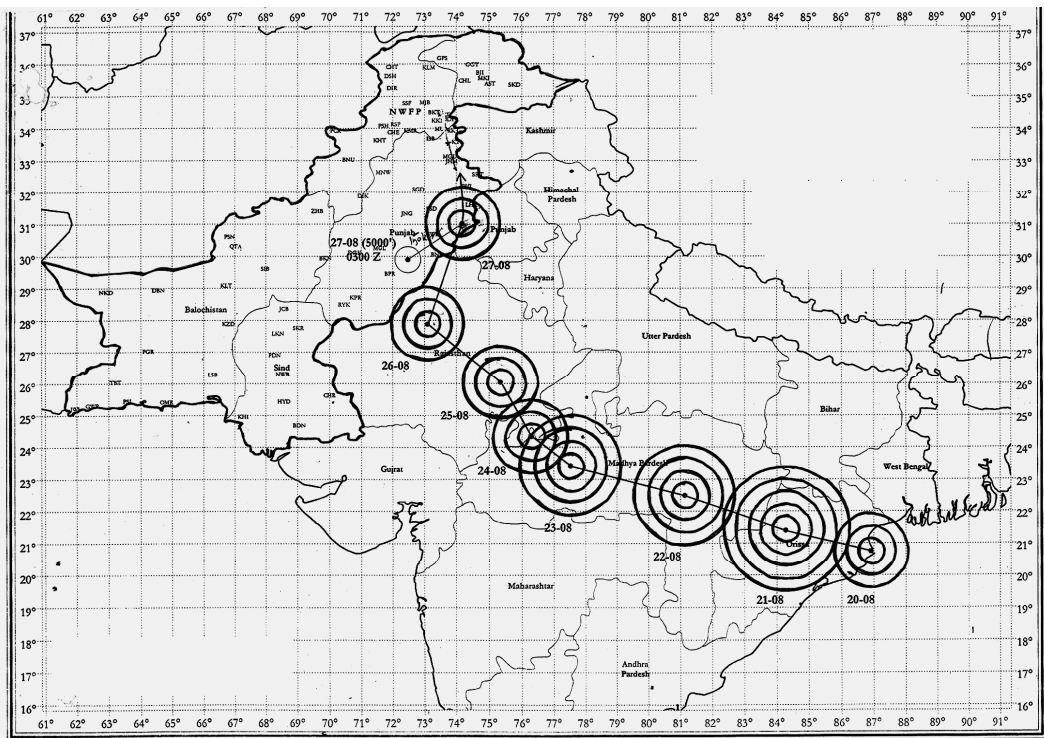
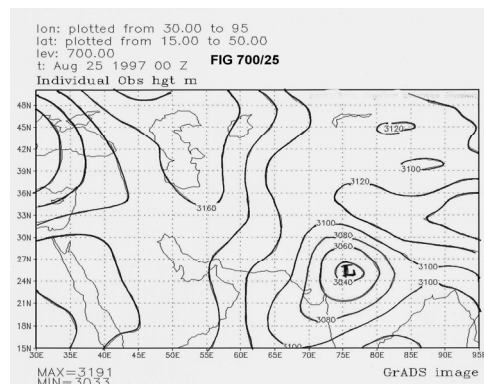
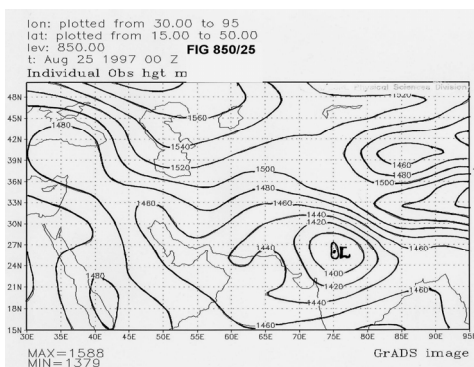
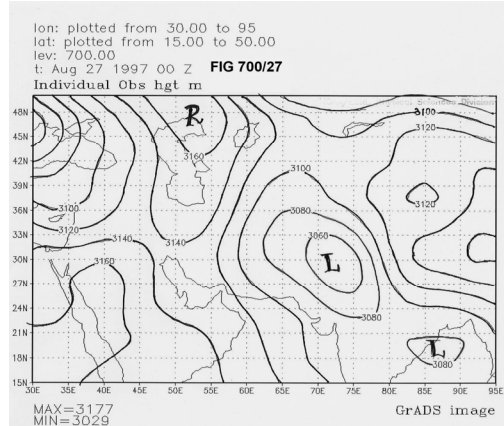
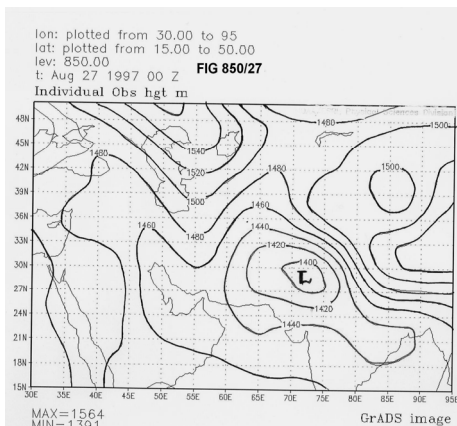
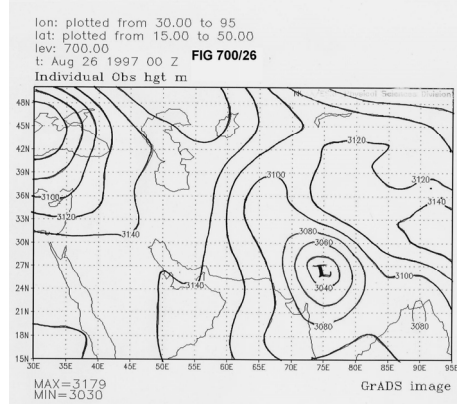
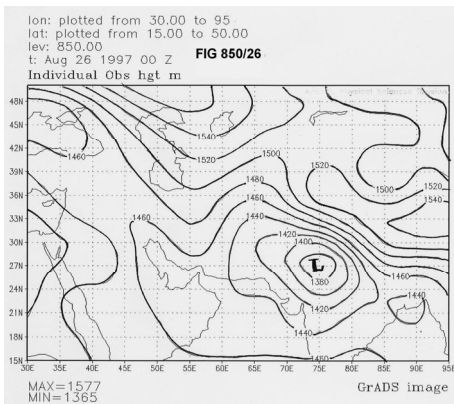


FIG TRACK 97: TRACK OF MONSOON LOW / DEPRESSION DURING 20 AUG TO 27 AUG 1997

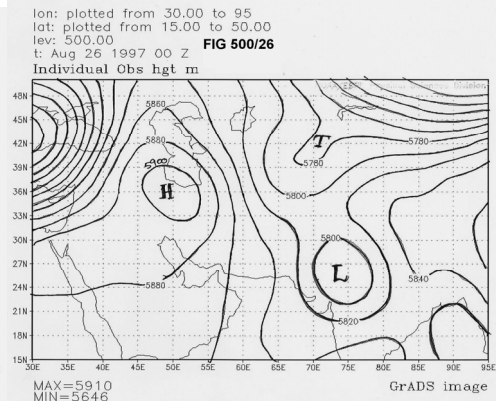
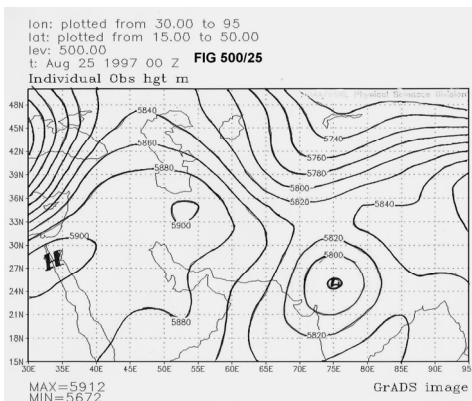
Subsequently the depression continued to move north northeast to finally fizzle out over Sialkot and Gujrat districts after causing heavy rain in the northeastern Punjab and adjoining Kashmir.

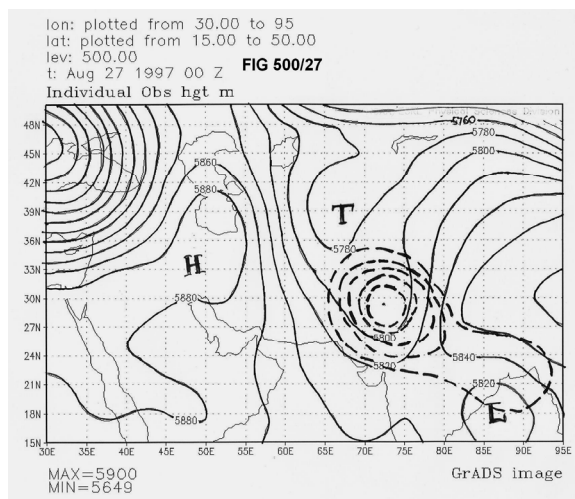
The tropical depression maintained its intensity almost until the end. It was reflected at 500 mb and closed contour system on 25th, 26th and also on 27th as depicted in fig. 500/25, 500/26 and 500/27.





The position of the westerly trough at 0000 GMT on 26th was bit westwards of the position of the tropical depression. While on 27th at 0000 GMT surface position of depression was exactly below the southern tip of the westerly trough at 500 mb Tibetan high as well as west asian high were significant on 24th and 27th.





Consequently westerly wave appears to be only factor in causing the northeasterly movement of the depression. The daily shift of westerly trough towards east is indicated in the fig. wt197.

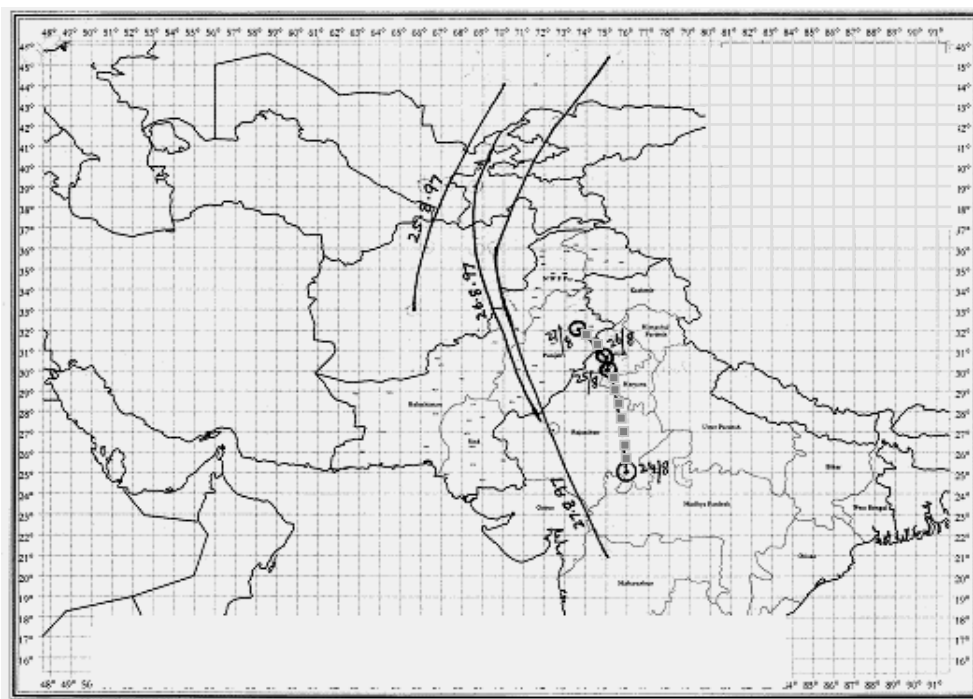


FIG WTL 25-27 AUG 1997: SQUARED LINE INDICATES THE POSITION OF LPS AT 850MB LEVEL.

Centre of maximum rainfall is over Mangla. Rainfall first started in Murree at 0300 hours of 25th August. Period of heaviest rainfall was from 26th afternoon to 27th evening. Rainfall became intermittent and finally ceased by 28th morning as shown in the fig. mas97. The storm isohyetal map is shown at fig. iso97. The pressure was reduced to the value of 994 mb as given in fig. Pr97.

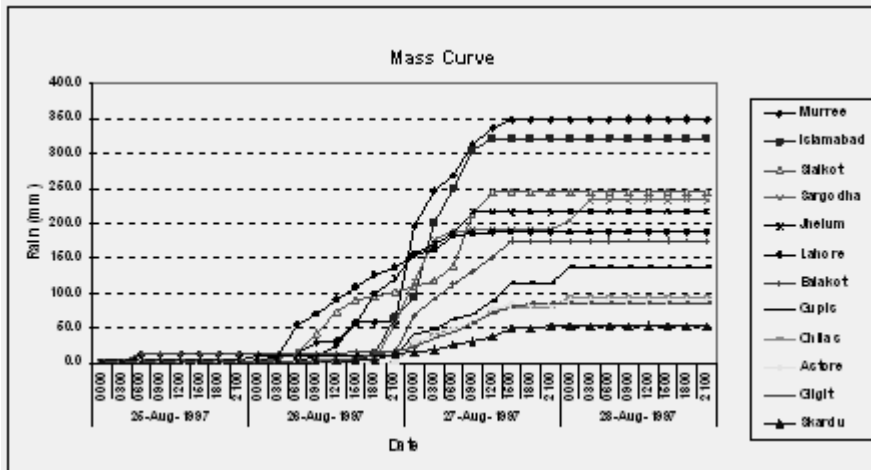
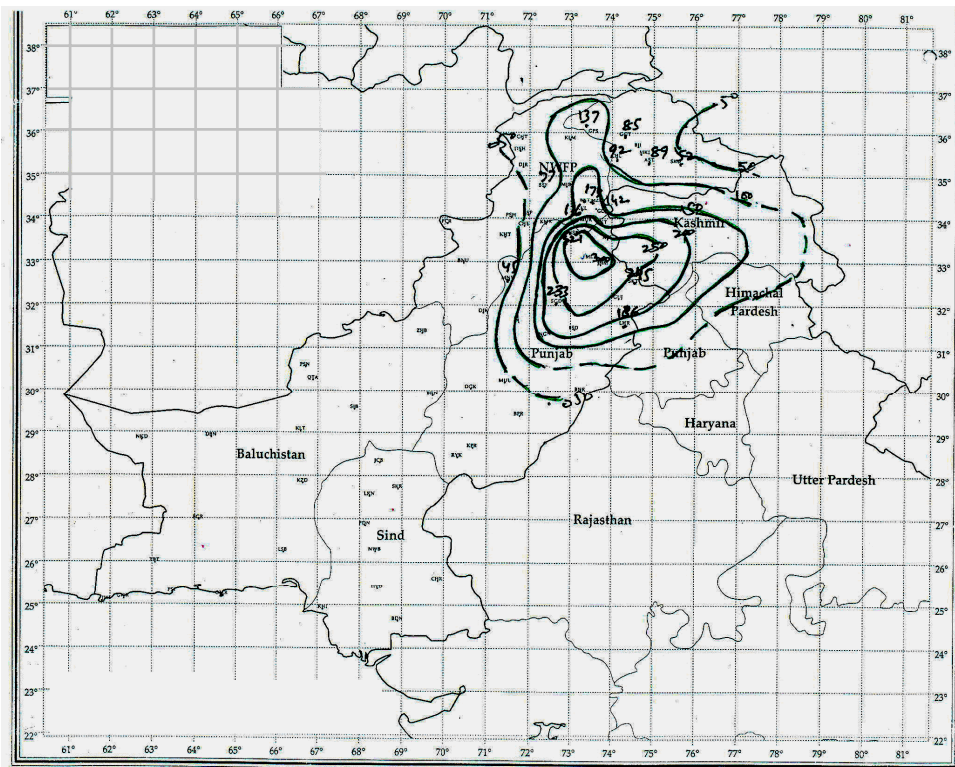


FIG Mas 97: MASS CURVE OF VARIOUS STATIONS / CITIES FROM 25-28 AUGUST 1997

FIG ISO 97 ISOHYETAL MAP FROM 25-27 AUG 1997



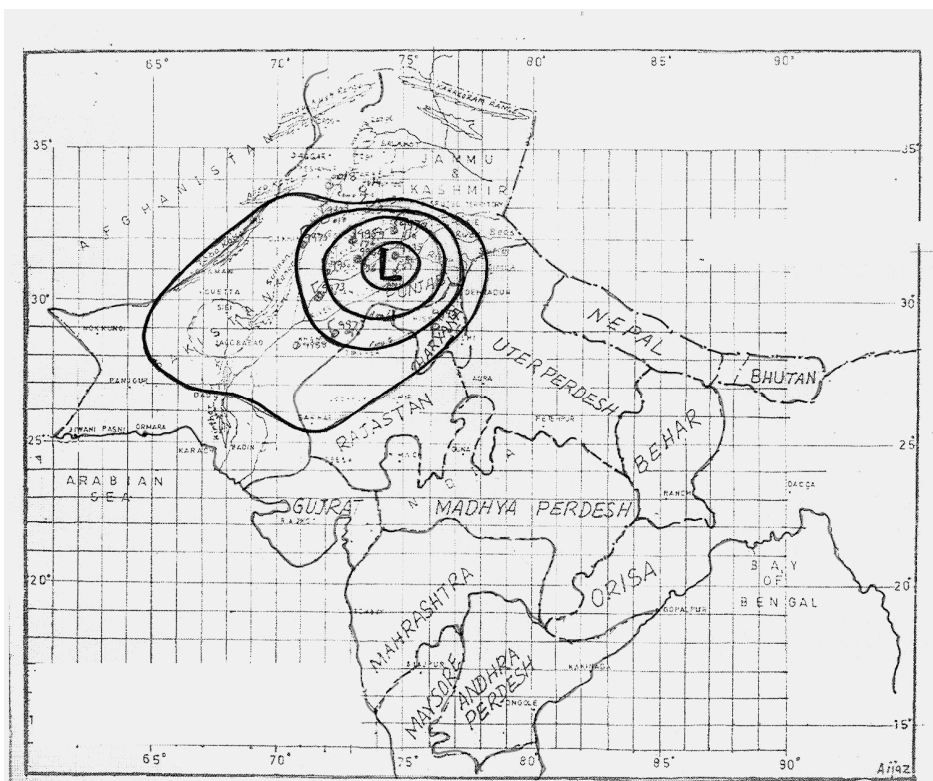


FIG PRV 97: SURFACE POSITION OF LPS ON 27 AUG 1997 AT 0300 Z AND LOWEST PRESSURE

Flood Situation of 1997:

Extremely heavy floods were recorded in the rivers Indus, Jhelum, Chenab and Ravi. The flood at the river Chenab at Marala exceeded 7 lac cusecs while the flood peak of more than 5 lac cusecs was recorded at Mangla as shown in fig. Hydro97. Tarbela recorded a flood peak of 4 lac cusecs. Most of the peaks occurred around mid day of 27th except for Marala at which it occurred on 28th.

Comparison of 1992 & 1997 Meteorological Situations:

Essentially the two major flood events occurred under very similar meteorological conditions.

In case of 1992 flood the tropical depression upon reaching Rajasthan became very weak at the surface level and remained dormant at this position for full one day. The subsequent movement to the north was caused by the strong westerly wave which intensified the system because of the divergence aloft.

In case of 1997 the depression was strong even at the surface upon reaching Rajasthan. The westerly wave at 500 mb even though quite significant, didn't extend sufficiently southwards with result that upper air divergence was not as strong as in case of 1992. This is perhaps the reason as to why 1997 storm centre did not reach north of Jhelum. Comparison of this situation is depicted by the figs. (500/25, 97) and (500/7, 500/8, 92).

With regards to vertical extent of the LPS both the depressions extended up to 500 mb which indicate tremendous intensity. As the west asian high is much significant in case of 1997 and relatively weak in case of 1992. The lowest surface level pressure was also similar in both the cases and equals to 994 mb.

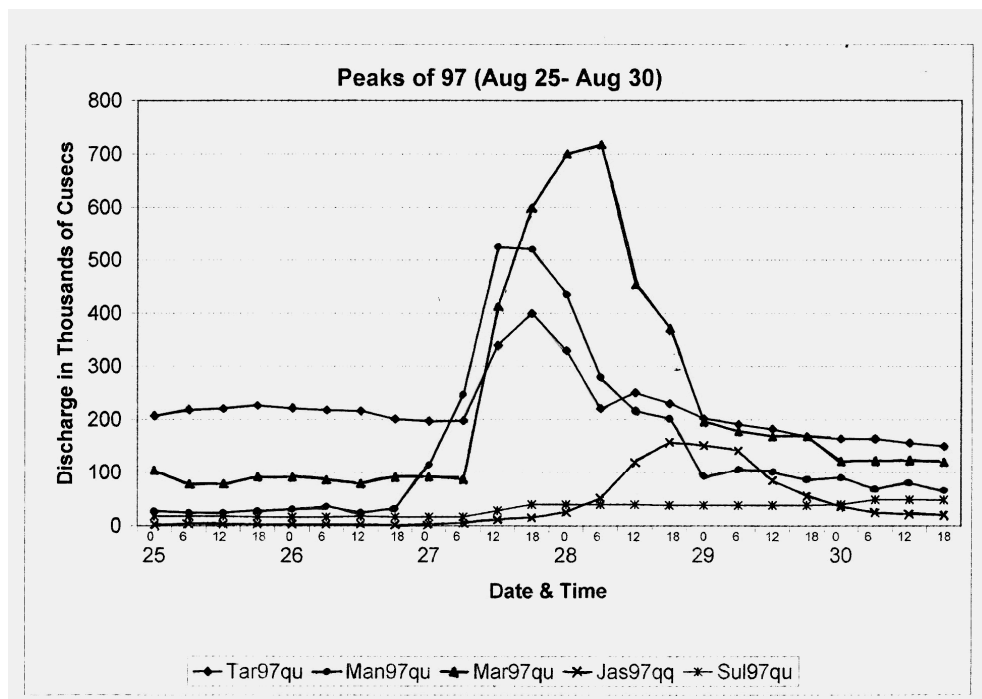


FIG HYDRO 97: HYDROGRAPH SHOWING THE PEAKS OF FLOOD DURING 25-30 AUG 1997

Inferences:

Cat-III floods shall be caused by the intense monsoon depressions which shall follow the track similar to the one followed by those of 1992 & 1997 flood events.

The recurving of the tropical depressions to the north shall occur essentially under the effect of the westerly wave which would reflect clearly at 700 mb and 500 mb levels

The extent of the upper air trough southwards constitutes one of the most important factors in causing the northwards movement of the tropical depression.

Impact of the approaching westerly trough upon the tropical depression may start when the trough line arrives within 3-400 miles (west) of the surface position of the depression.

Fast Northwards movement of the depression shall normally start when the 500mb level westerly trough arrives within 300kms of the depression

Extremely heavy rainfall in the Mangla Catchment shall last from 15 to 20 hrs and shall occur when the depression starts to move northwards from its position south of Lahore division.

Peaks at Mangla and Terbela shall occur almost at the same time, while the Peak at Marala shall be lagged by few hours (approximately 6-10 hrs).

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