Pakistan Meteorological Department
Government of Pakistan

FLOOD REPORT 2010

(15th June to 15th October)

FLOOD FORECASTING DIVISION

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INTRODUCTION

Floods and flash floods are the deadliest of natural disasters. A flood is a hazard that can occur in Pakistan and in the rest of the world. Floods bring misery to those that live in the flood prone area. They can cause loss of life and often cause a great disruption of daily life. Its effects can only be reduced by analyzing the current atmospheric conditions on micro scale, future possible variability in it and then possible accurate forecast and its timely dissemination to the concerned authorities, media and public. The floods in Pakistan generally depend upon the current base flow of river sites, intensity and duration of rainfall & topography .These parameters are monitored by weather radars, weather satellites, Hydrometeorological Models, telemetric network & by the network of meteorological observatories and timely reception of hydrological data of different river sites.

Super flood 2010 is the most disastrous in the history of Pakistan. About one-fifth of Pakistan's total land area was underwater. Heavy downpour in KPK, Gilgit Baltistan and Punjab during last weak of July and first week of August caused ever heaviest flood in Indus in the history of Pakistan. In the early August heaviest flood moved southwards along the Indus river from severely affected northern regions toward the plains in the south. The Pakistani economy has been harmed by extensive damage done to the infrastructure and crops. While visiting Pakistan UN Secretary General Ban Ki-moon said that"flooding in Pakistan is the worst disaster I have ever seen, and I urge the world to do more for the flood-ravaged country He also said "This has been a heart-wrenching day for me, I will never forget the destruction and suffering I have witnessed today. In the past, I have witnessed many natural disasters around the world, but nothing like this."

The Flood Forecasting Division Lahore (FFD), since its establishment is serving the nation by issuing flood forecasts during each flood season (15^{th} June, to 15^{th} October). Similarly FFD monitored Historical super flood 2010 carefully through its Hydrometeorological Bulletin, Warnings, and then by keeping informed different government agencies, press and electronic media, in order to minimize mass destruction.

The compilation of flood report after each flood season is a regular feature observed by FFD Lahore. Flood report for the year 2010 has been prepared under the able guidance and kind instructions of Director General, Meteorological Services and Chief Meteorologist FFD. It contains all the details pertaining to flood forecasting like of monsoon lows tracks, rainfall during wet spells, hydrographs of flood peaks, monthly and seasonal Isohyetal maps, normal isopercental maps, area weighted Rainfall, damages and losses due to floods, flood limits, flood evaluation report flood & Annual maximum flood peaks in river Indus.

Chief Meteorologist
Flood Forecasting Division
Lahore

HYDROMETEOROLOGICAL REPORT 2010

2. HIGHLIGHTS

- Monsoon remained very active this year and very heavy rain fell over the upper catchments of all the major rivers especially over river Indus.
- River Indus experienced highest ever recorded flood.
- A total number of five monsoon lows originated form the Bay of Bengal, however, four were able to reach in the vicinity of Pakistan.
- The seasonal precipitation (July 2010 to September 2010) Isopercental pattern is the indicative of above normal rainfall in most areas of the country including Eastern belt of Balochistan, however, the rest of the Balochistan received below normal rainfall.
- On all Pakistan basis 77.4% above normal rainfall was recorded during the monsoon season 2010.
- Nine rain bearing spells occurred during the monsoon season, 2010.
- During July 2010 unprecedented heavy rainfall occurred resulting in historical flood in river Indus and Kabul.
- Monsoon activity started late this year but it was most active which caused 70.5% above normal rainfall during the month of July, 2010.
- In last spell of July 2010 extremely heavy rainfall occurred in Indus catchment which caused exceptionally high flood in Indus River.
- After a short interval another very active system approached Pakistan during first week of August, 2010 which also gave very heavy precipitation in catchment of river Indus, Chenab and Jhelum resulting in a second flood wave in Indus River.

- The supply of Hydro-Meteorological data from WAPDA Punjab and Sindh Irrigation & Drainage Authorities (PIDA&SIDA) remained satisfactory.
- The City District Government, Solid Waste Management (SWM),Water And Sanitation Agency (WASA), Lahore Development Authority (LDA), DCOs, of local government were constantly kept abreast of the impending rain situations in the metropolitan city of Lahore and other areas of Pakistan to help them to carry out their drainage and relief programmes depending upon the weather forecasts.
- The concerned federal and provincial authorities along with press and electronic media were also daily informed the prevailing weather/flood conditions through fax & Internet as well.
- Moreover 60 Significant Flood Forecasts /warnings were also issued by FFD during Monsoon season 2010, whenever the weather/flood situation demanded.
- Overall accuracy of forecast issued by FFD during the season 2010 has been calculated 94.75%.

SUPER FLOOD 2010

3. METEOROLOGICAL ANALYSIS AND RAINFALL PATTERN FOR THE PERIOD 24th to31st JULY 2010.

A well marked monsoon low was developed over Bay of Bengal on 24th July, 2010. This monsoon low crossed Orissa coast on 25th July and started to move in North Westerly Direction. It reached North Madhya Pradesh on 26th July, 2010. At this time, a strong Westerly wave was located over Northern parts of Pakistan.

Sub tropical High over Afghanistan and adjoining areas started to intensify and also shifted southwards developing a jet stream over Northeast Afghanistan and KPK. This jet stream further intensified the trough of westerly wave over the northern region of Pakistan. Under the influence of the Jet stream, the Tibetan High extended towards Southwards which compelled the monsoon low over Madhya Pradesh to move West South Westwards and was located over Gujarat state of India on 27th July 2010 and in the late hours of 27th July 2010 it merged with seasonal low over Balochistan and adjoining Sindh. Due to this merger, the seasonal low became very prominent and started to dispatch moisture in the upper parts of Pakistan.

As described above, the strong westerly wave present over northern parts of the country on 27th and 28th July 2010 helped transport the moisture up to 500 hpa level from Arabian Sea. This created a thick layer of moist air above the mid tropospheric level over the catchments of rivers Kabul & Indus. Due to the interaction of westerly wave, a triggering effect was started and heavy to very heavy rainfall started on 28th July 2010 in the KPK, adjoining

Afghanistan, Azad Kashmir and Gilgit Baltistan. The track of monsoon low and the upper atmospheric charts are shown in the figures 1.

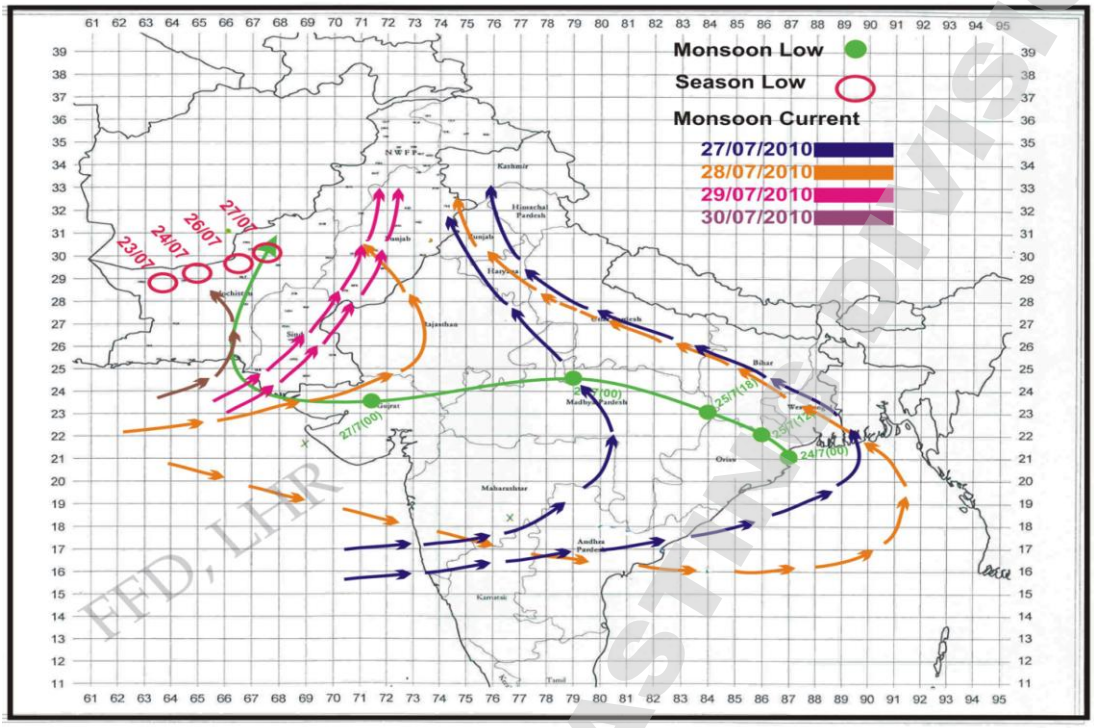

Figure 1: Tracks of monsoon Low super flood 2010, moisture incursion and position of seasonal low

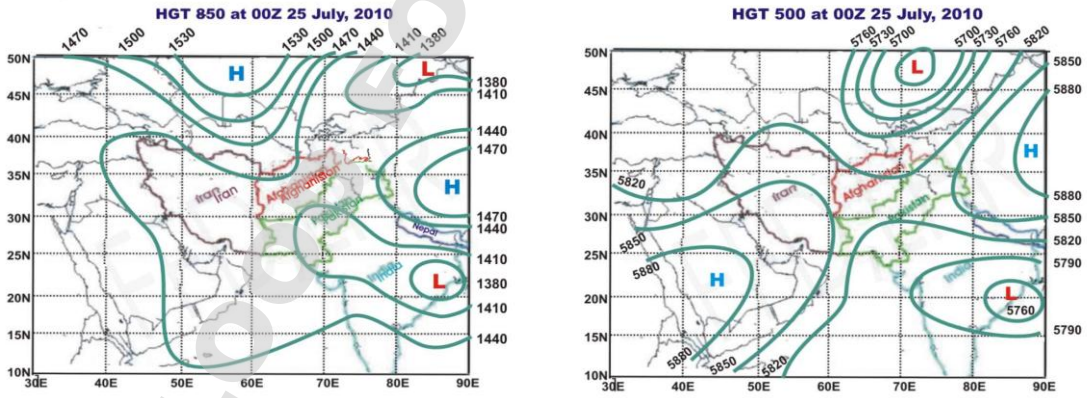

Figure 2: Meteorological situation on 25-07-2010 at 850 and 500 hpa

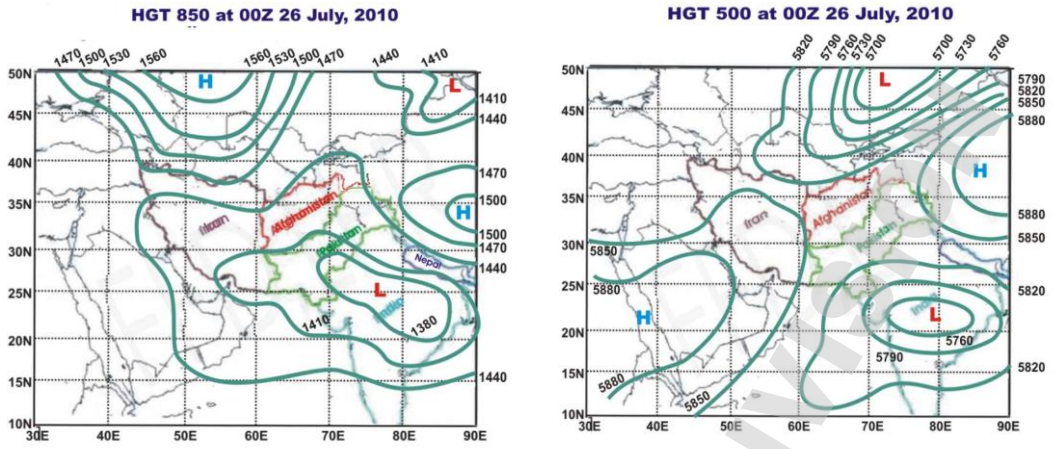

Figure 3: Meteorological situation on 26-07-2010 at 850 and 500 hpa

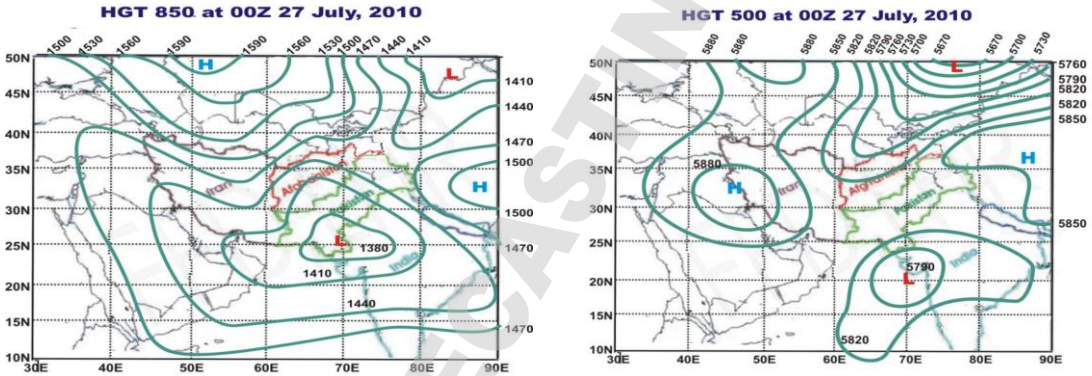

Figure 4: Meteorological situation on 27-07-2010 at 850 and 500 hpa

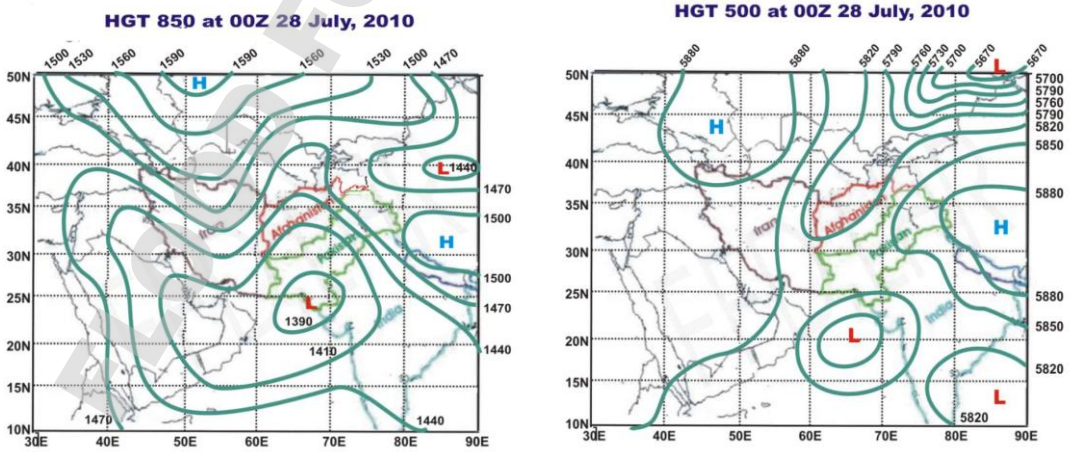

Figure 5: Meteorological situation on 28-07-2010 at 850 and 500 hpa

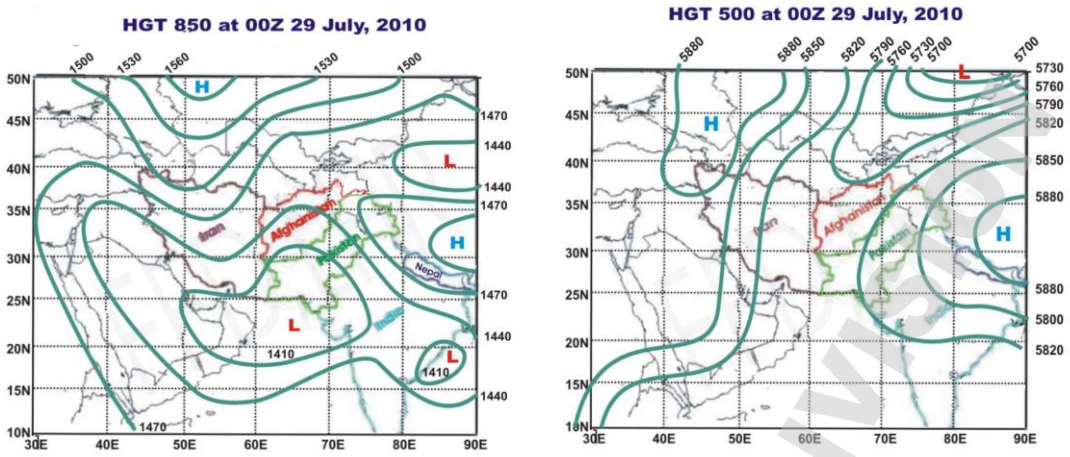

Figure 6: Meteorological situation on 29-07-2010 at 850 and 500 hpa

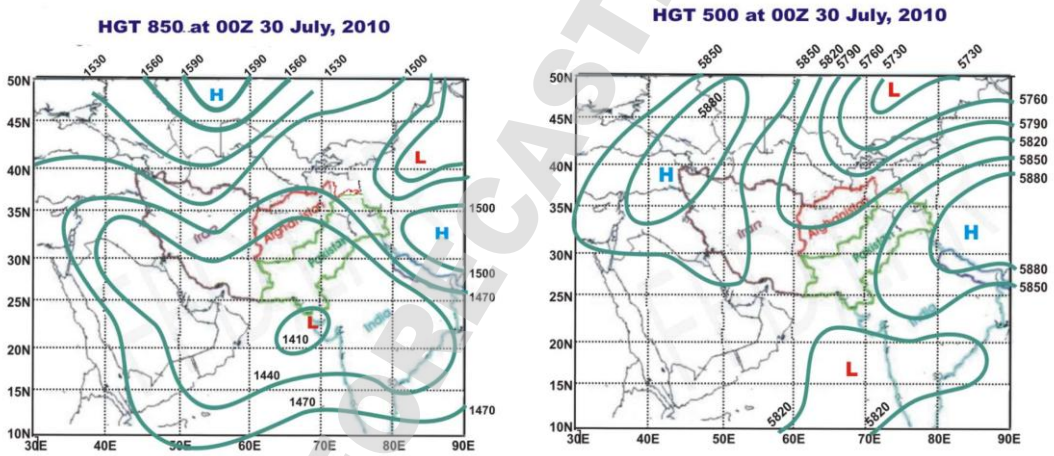

Figure 7: Meteorological situation on 30-07-2010 at 850 and 500 hpa

Due to meteorological factors discussed above a heavy to very heavy rainfall was recorded over the upper catchments of river Kabul and Indus. Formation of clouds is shown in the following satellite Image.

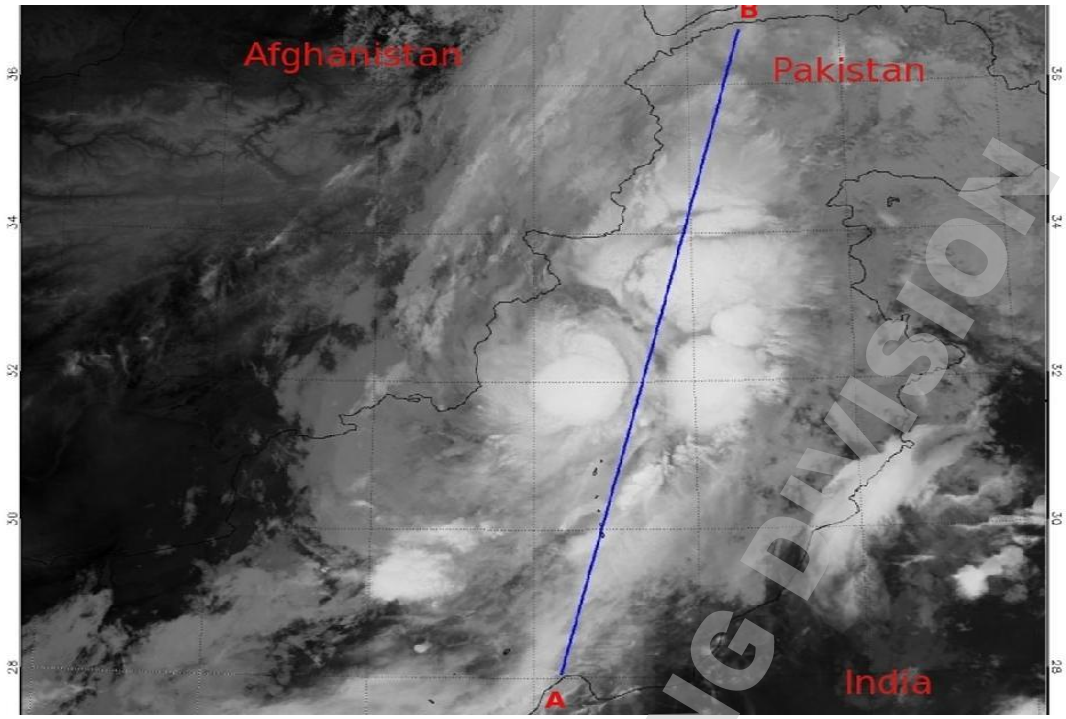

Figure 8: Satellite Image on 28-07-2010

The satellite image of 28th July 2010(fig-8) shows that, a thick cloud cluster over South KPK has developed and another large cell has also developed over Azad Kashmir and North Punjab which traveled in the NE direction and shedded more than 400 mm rain over these areas between 28th and 29th July 2010 which generated a historic flood in river Indus. The bright white shade of clouds suggests heavy thunderstorm activities and the blue vertical line across the image represents the movement of cloud system. The record breaking rains in the northern Parts of the country generated historical peaks at Tarbela (832000 cusecs on 30th July 2010) and in the Kabul river (more than 350000 Cusecs). Distribution of rainfall with respect to time during this spell recorded by PMD and WAPDA network is shown in figure 9 and 10 respectively.

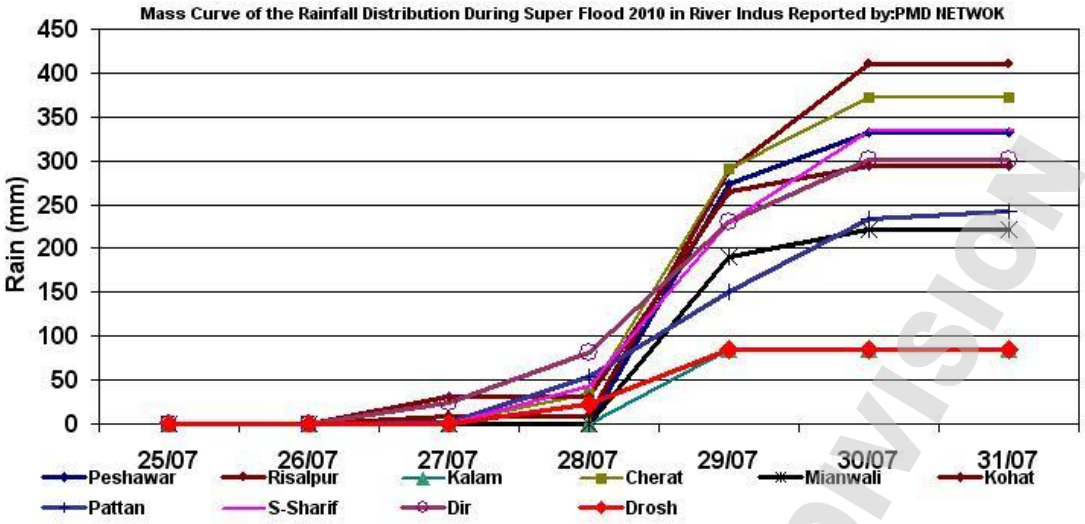

Figure 9: Mass curve from 25th to 31st July 2010

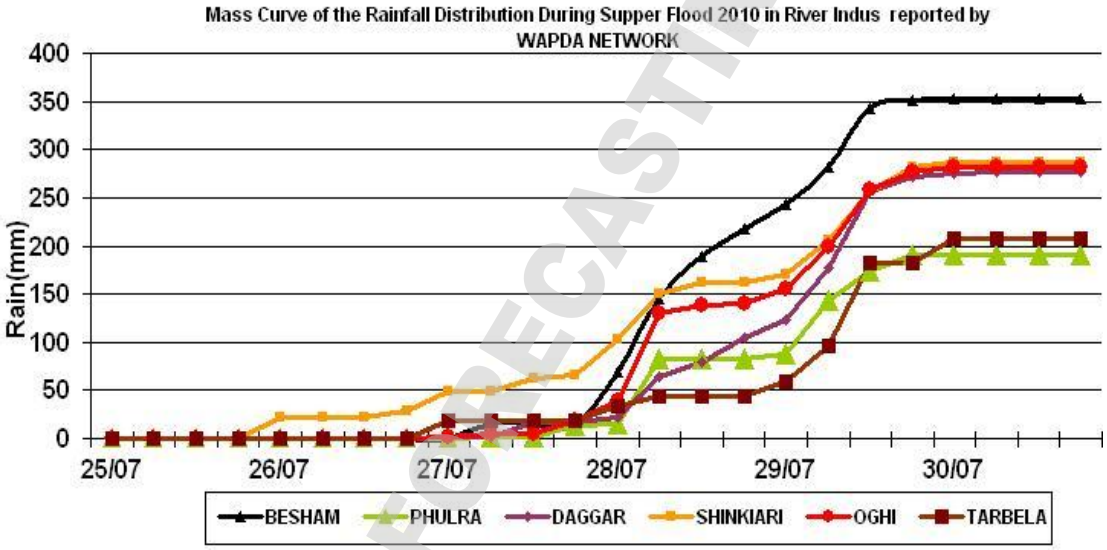

Figure 10: Mass curve from 25th to 30th July 2010

The release of more than 600000 Cusecs from Tarbela was joined by flow of more than 350000 cusecs from river Kabul at Nowshera. This massive flood wave struck Kalabagh barrage on 31st July and this flood wave continued downstream upto Arabian Sea. Comparison of peaks recorded at different sites of river Indus with the past maximum peaks observed is shown in figures 11 to 18.

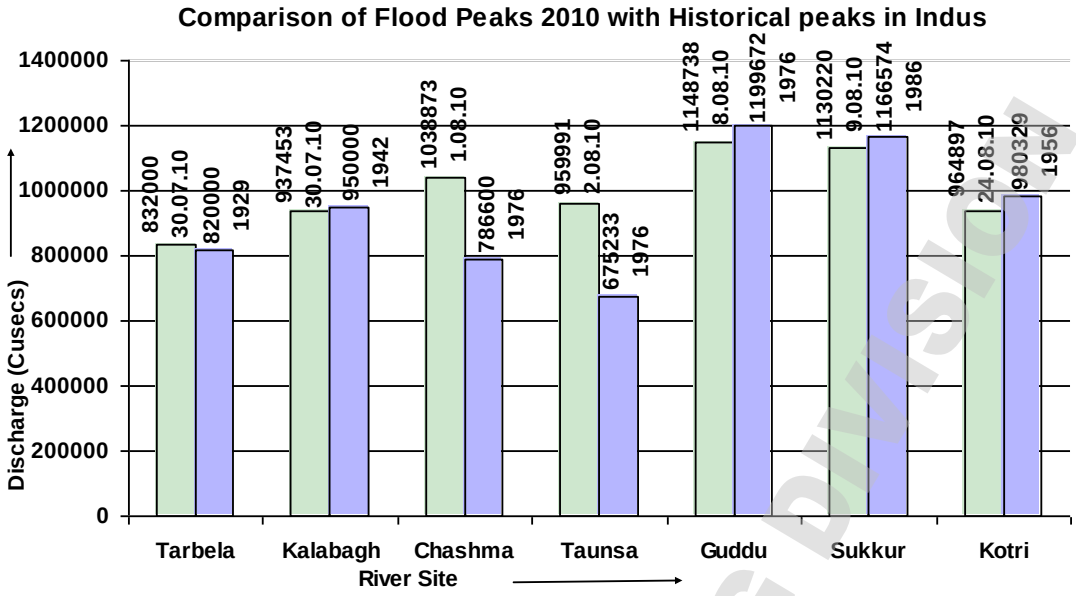

Figure 11: Comparison of Flood Peaks 2010 with Historical peaks in Indus

The annual flood peaks record during last 30 years in river Indus is shown in following figures:

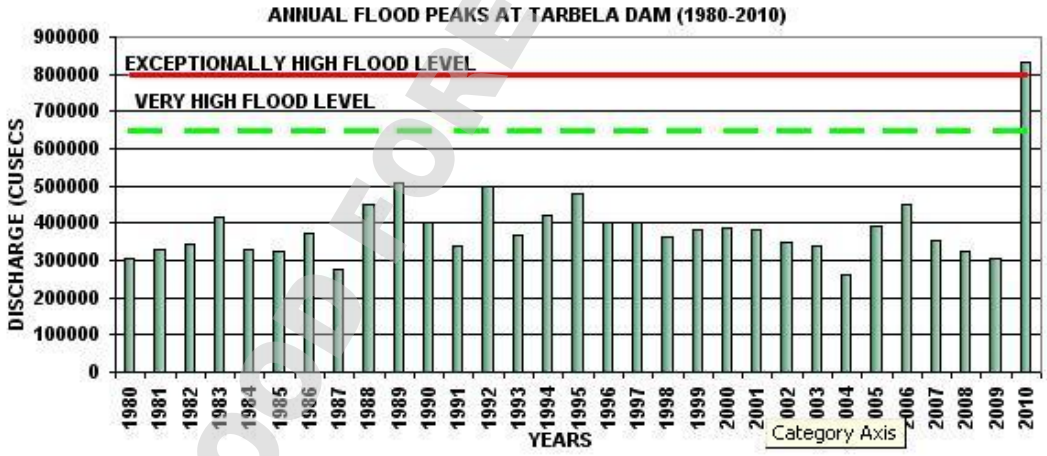

Figure 12: Annual Flood Peaks at Tarbela Dam

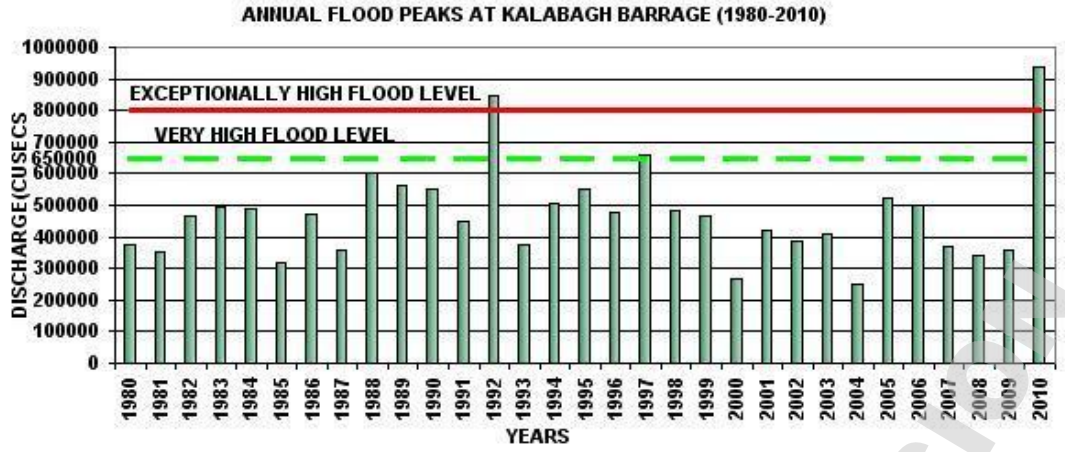

Figure 13: Annual Flood Peaks of Kalabagh Barrage

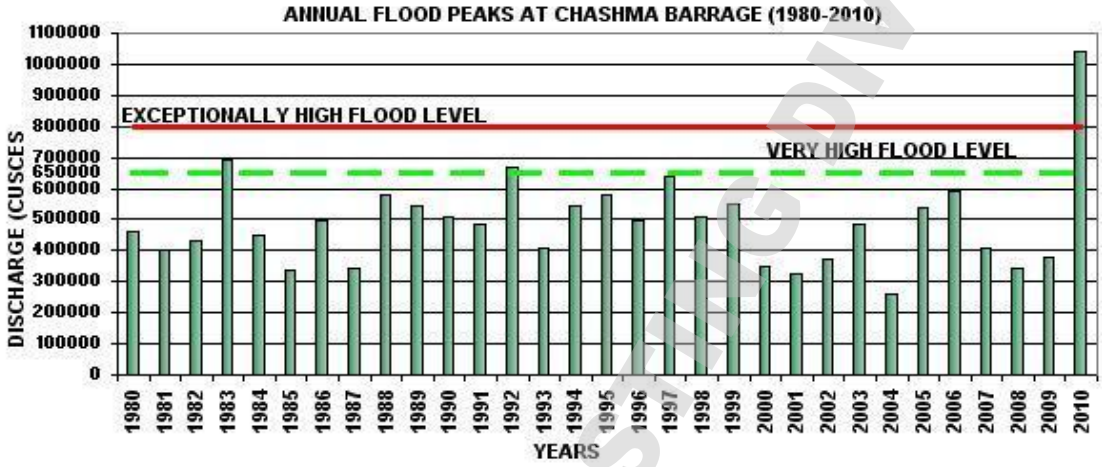

Figure 14: Annual flood peaks at Chashma Barrage

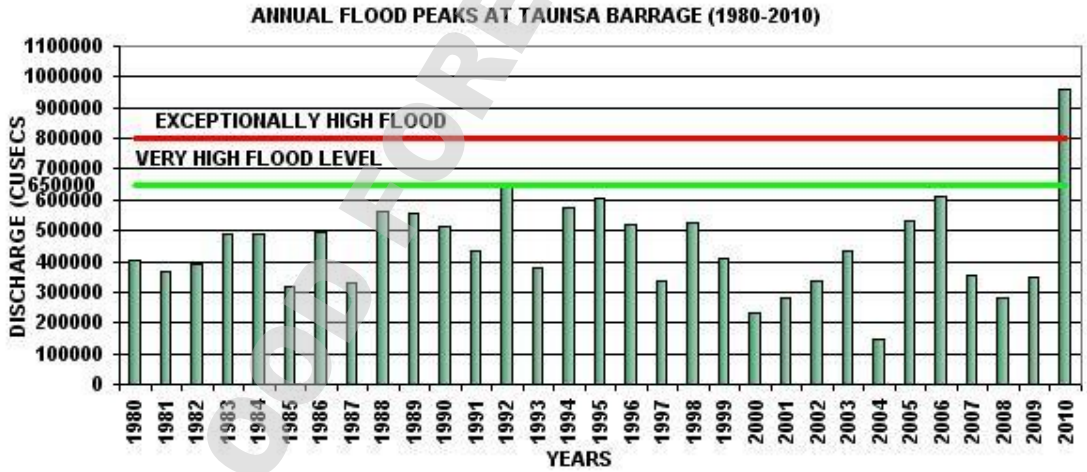

Figure 15: Annual flood peaks at Taunsa Barrage

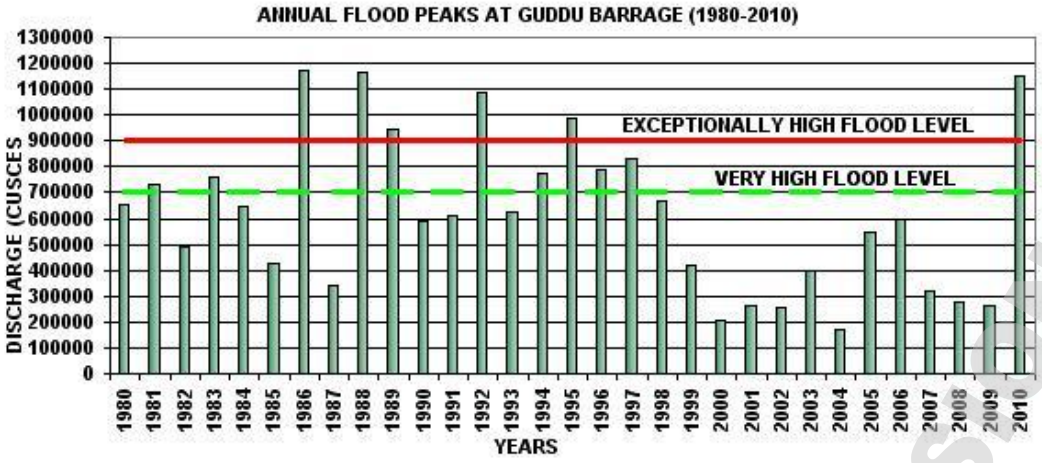

Figure 16: Annual flood peaks at Guddu Barrage

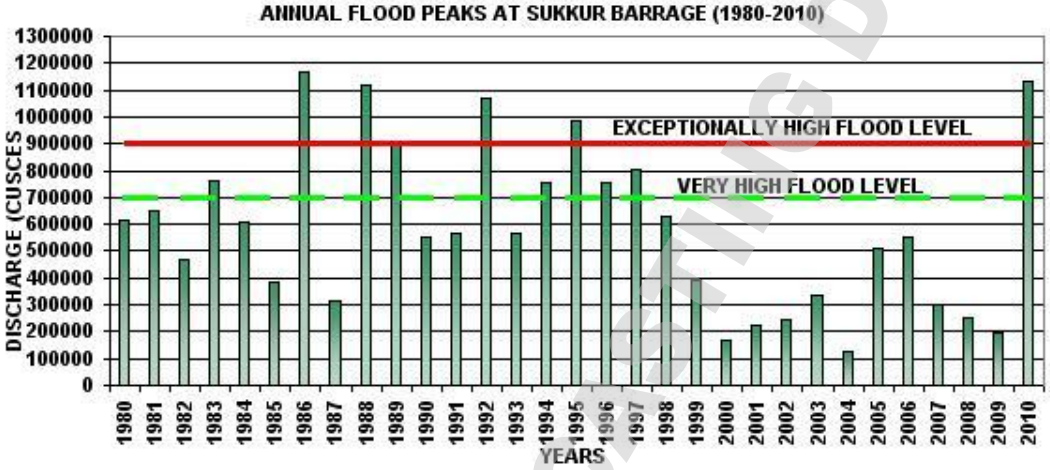

Figure 17: Annual flood peaks at Sukkur Barrage

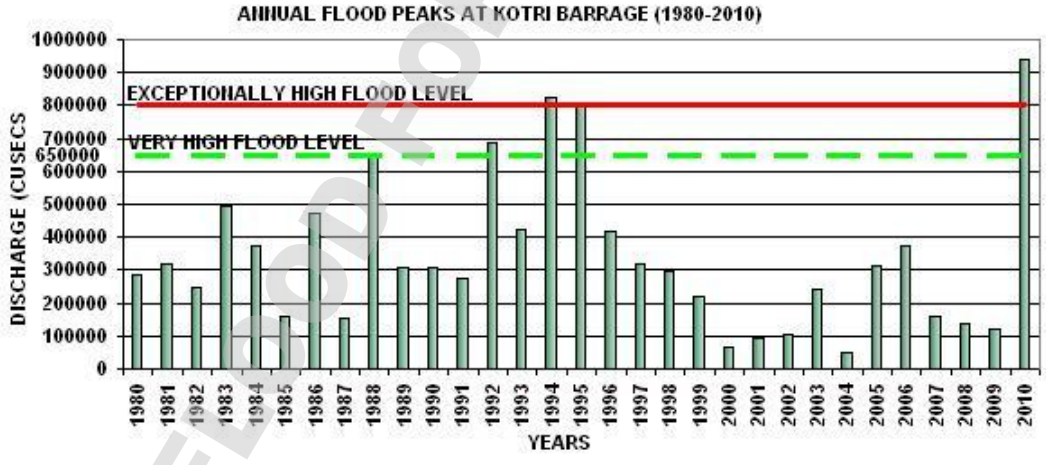

Figure 18: Annual flood peaks at Kotri Barrage

4. TRACKS OF LOWS DURING MONSOON SEASON 2010

During the monsoon season 2010 (15th June to 15th October) five monsoon lows emerged from Bay of Bengal, generally followed the path of Northwest direction. The tracks of the lows are shown in figure-19.

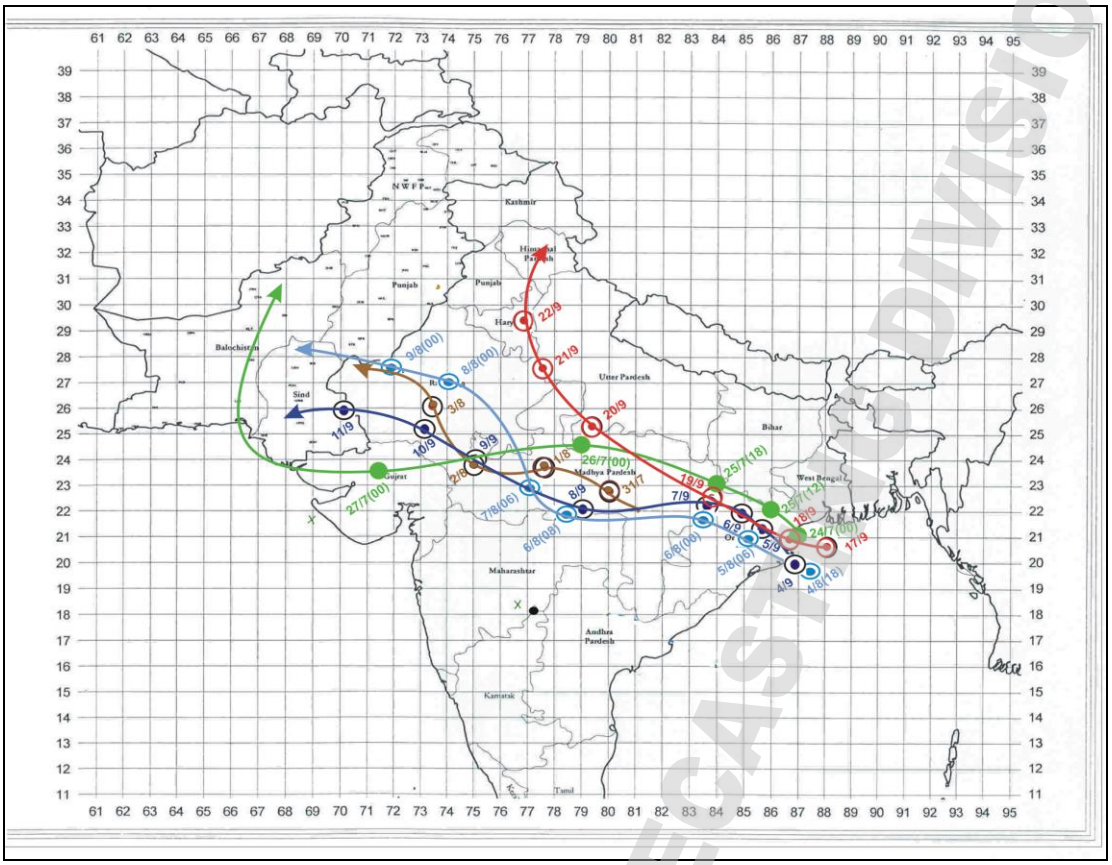

Figure 19: Tracks of monsoon Lows during flood season 2010

5. SIGNIFICANT HYDROMETEOROLOGICAL EVENTS DURING THE MONTH OF JUNE, 2010:

Only one rainfall spell occurred during the period.

5.1 *METEOROLOGICAL EVENTS*:

During the month of June 2010 no Monsoon low was developed over Bay of Bengal and Arabian Sea , which could produce significant rainfall in Pakistan. The rainfall which occurred over Pakistan during June, 2010 was due to the accentuation of seasonal low over Balochistan, passing of westerly

wave in the North of the country and influx of monsoon current from Arabian Sea.

5.1.1 *WET SPELL OF JUNE 2010 (FROM 24-06-2010 TO 26-06-2010):*

During this spell scattered rainfall of Light to Moderate intensity was reported from the upper catchment of rivers Jhelum, Chenab and Indus along with central and upper Punjab. Accumulated significant rainfall during this spell is shown in fig.20.

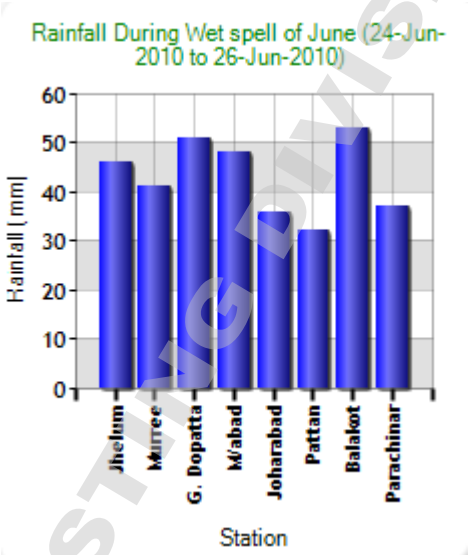

Figure 20. Rainfall during wet spell from 24 to 26 June2010

5.1.2 *RIVER POSITION DURING JUNE 2010:*

Generally all the rivers, hill torrents and nullahs maintained their normal flows during the period; however river Kabul at Nowshera, river Indus at Tarbela attained the level of medium flood which was mainly the result of snow melting during the month. A low flood peak in River Jhelum was also recorded at Mangla, which was the effect of rains in upper catchments of river Jhelum as shown in figure 21. Also river Indus at Chashma rose up to low flood level.

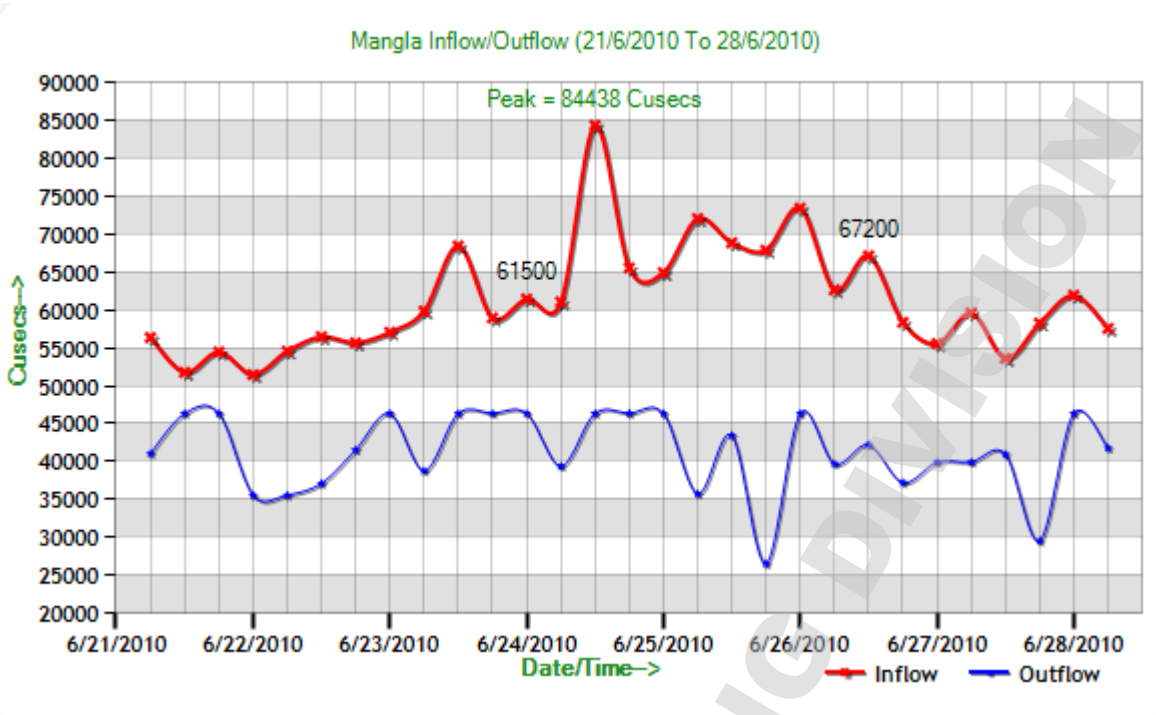

Figure 21: Mangla Inflow/ Outflow from 21st June to 28th June 2010

6. SIGNIFICANT HYDROMETEOROLOGICAL EVENTS DURING THE MONTH OF JULY 2010:

Three rainfall spells occurred during the month of July.

6.1 *METEOROLOGICAL EVENTS:*

First spell occurred from 12th to 14th July 2010. It was mainly due to a trough of westerly wave passing over the Northern parts of the country and moist current from the Arabian Sea which was penetrating in sub mountain areas of Punjab and Kashmir. Second spell of July during 19th to 23rd July 2010 was caused due to the influence of westerly wave passing over the Northern parts of the country. During this spell moist current from Arabian Sea was also penetrating in sub-mountain areas of Punjab and Kashmir. As a result of combined effect of above mentioned factors widespread rains with very heavy falls occurred over Khyber Pakhtoon Khwa, Kashmir, upper Punjab & scattered rainfall also occurred over Southern Punjab & Northeast

Balochistan and Gilgit-Baltistan. Third spell of July was recorded from 27-30 July. This spell was caused due to the movement of monsoon low from Bay of Bengal. The monsoon low developed at the coast of Orissa on 24th July. Continuously moving into north-Northwesterly direction it was located over North Gujarat on 27th July and merged into seasonal low. After merging it changed the orientation of the seasonal low to North Westward, and the presence of westerly wave in the north and strong jet stream caused widespread thunderstorm rain with extremely heavy falls over Punjab, Khyber Pakhtoon Khwa, North Balochistan, Upper Sindh and Kashmir alongwith Scattered rains over Gilgit Baltistan and lower Sindh.

6.1.1 *FIRST WET SPELL (12-07-2010 To-14-07-2010)*

First spell of July 2010 and 2nd of the flood season 2010 lasted for 3 days. It was mainly due to the passage of westerly wave, accentuation of seasonal low and incursion of moist current from Arabian sea. The significant rain during the spell is shown in figure 22.

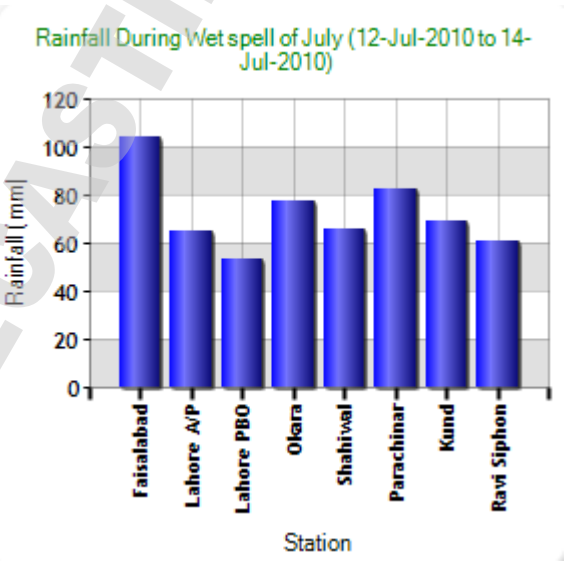

Figure 22: Rainfall during wet spell from 12 to 14 July 2010

6.1.2 *RIVER POSITION DUE TO THE SPELL*

No significant increase in rivers occurred except in Indus River at Tarbela and Chashma, where low flood level was recorded mainly due to snow melting contribution.

6.1.3 *SECOND WET SPELL (18-07-2010 TO 23-07-2010)*

This active spell lasted for 6 days. The rainfall of very heavy intensity recorded in all the divisions of Khyber Pakhtun khwa, Punjab Kashmir and catchments area of the river Indus, Jhelum and Chenab as shown in figure 23.

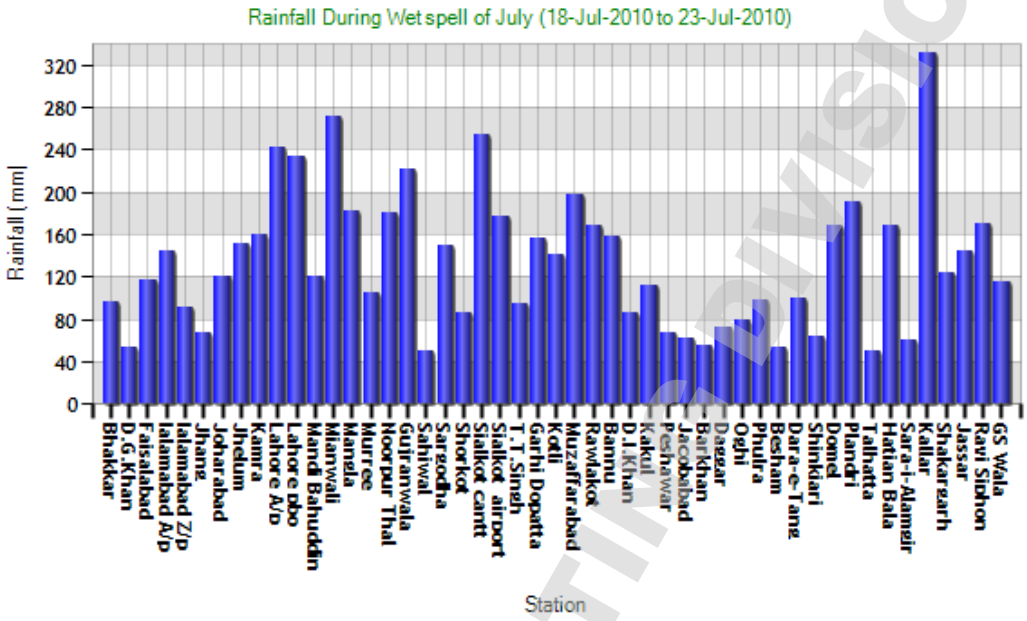

Figure 23: Significant Rainfall during wet spell from 18 to 23 July 2010

6.1.4 *RIVER POSITION DUE TO THE SPELL*

Due to the spell river Indus at Tarbela, Kalabagh, Chashma, River Kabul at Nowshera River Chenab at Marala and River Jhelum at Mangla attained the flood peaks of low to medium levels where as river Chenab at Khanki and Qadirabad attained high flood levels as shown in figures 24 to 29.

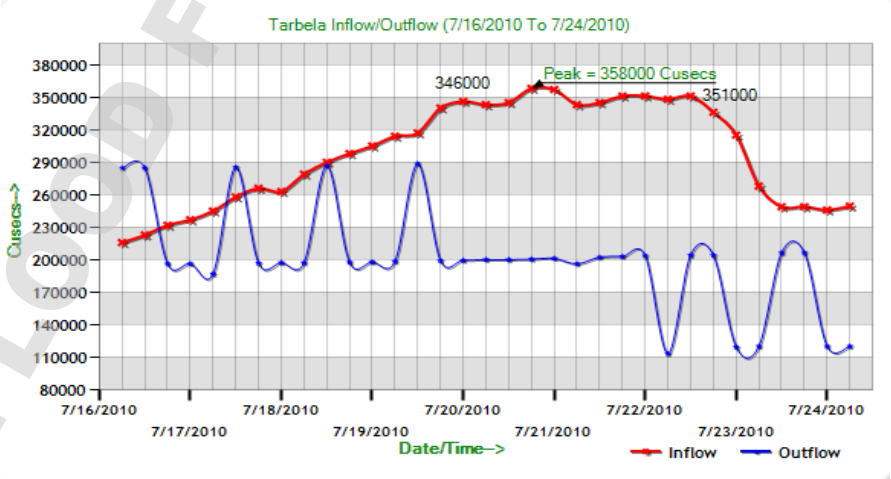

Figure 24: Tarbela Inflow/Outflow from 16th July to 24th July 2010

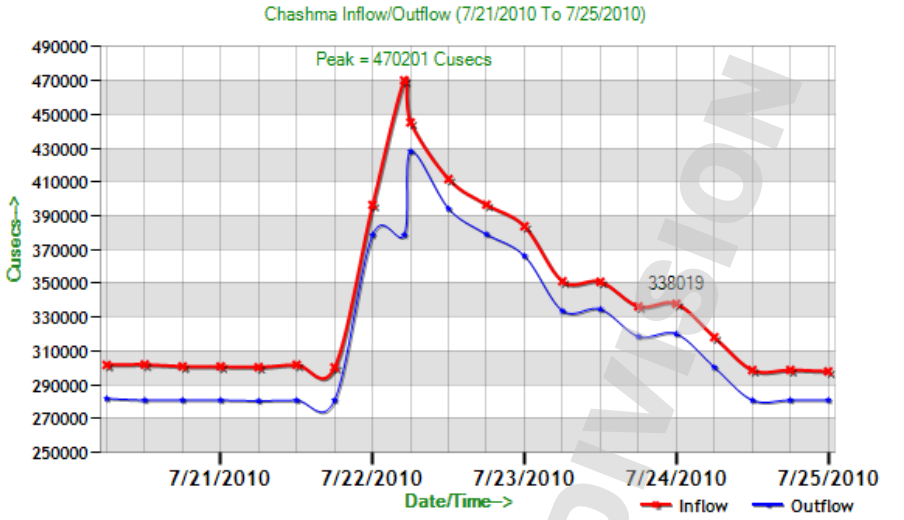

Figure 25: Chashma Inflow/Outflow from 21st July to 25th July 2010

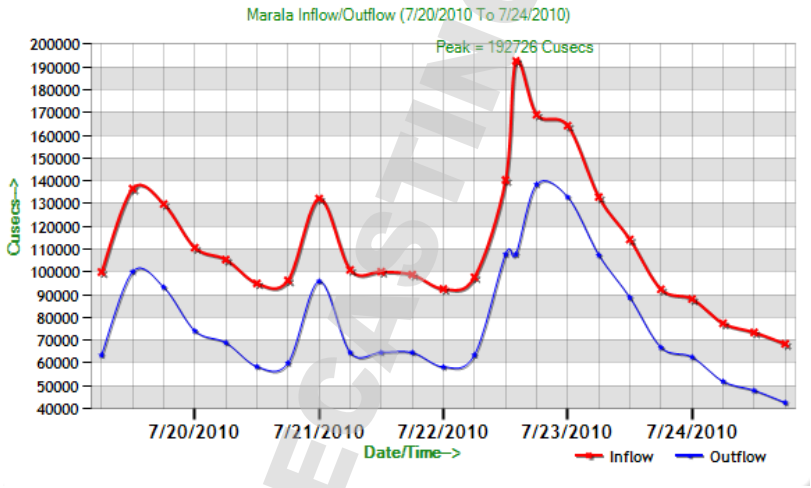

Figure 26: Marala Inflow/Outflow from 20th July to 24th July 2010

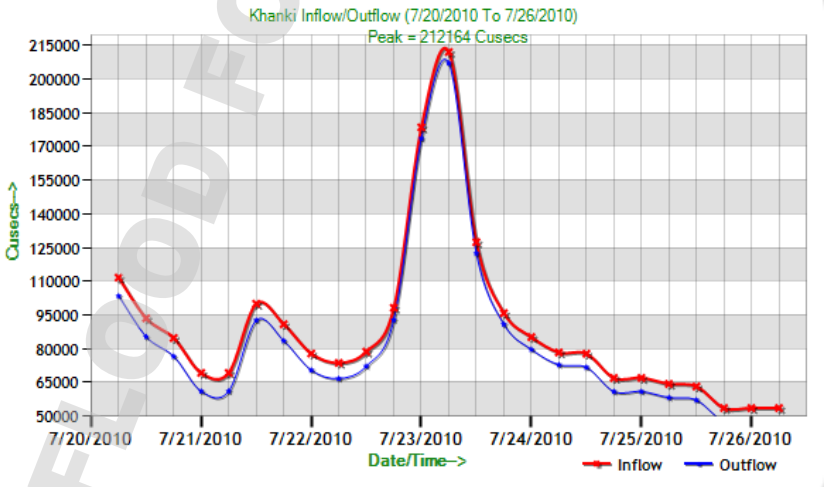

Figure 27 : Khanki Inflow/Outflow from 20th July to 26th July 2010

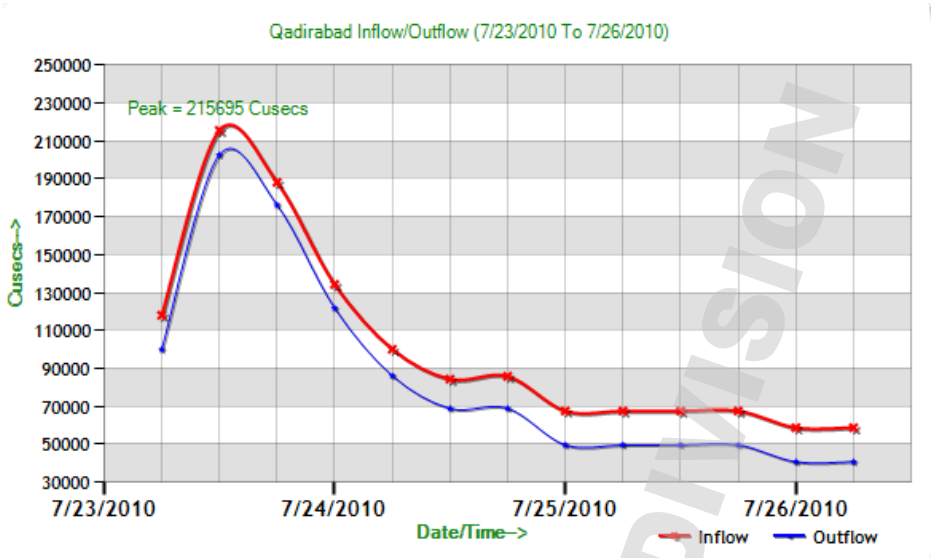

Figure 28: Qadirabad Inflow/Outflow from 23rd to 26th July 2010

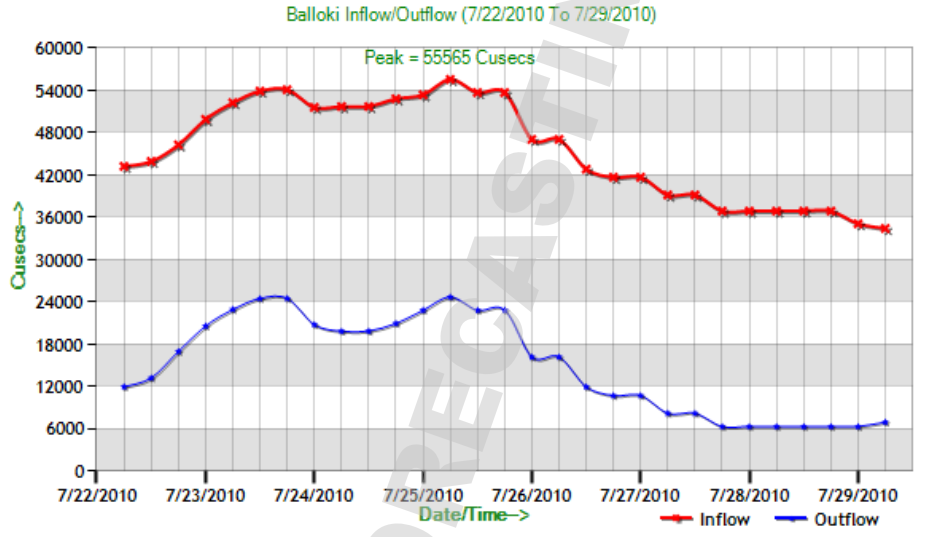

Figure 29: Balloki Inflow/Outflow from 22nd to 29th July 2010

6.1.5 ***THIRD WET SPELL (27-07-2010 TO-30-07-2010)***

The 3rd and final wet spell in the month of July was observed from 27th July to 30th July 2010 and was the most active spell of the season. It gave extremely heavy rainfall over Murree, Kamra, Saidpur, Garhi Dopatta, Cherat, Peshawar, Saidu Sharif and Risalpur as shown in figure 30.

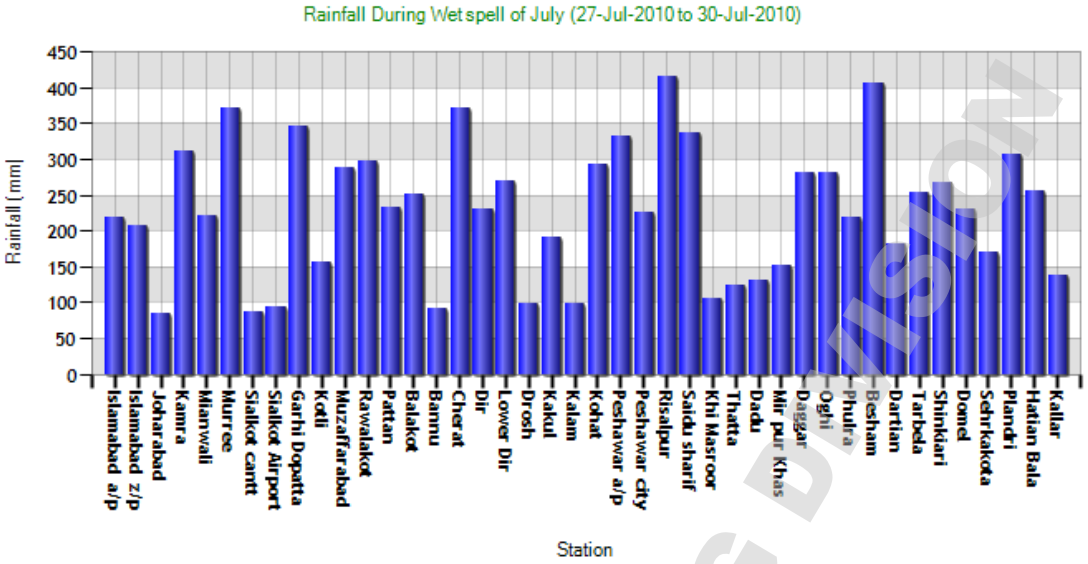

Figure 30: Rainfall during wet spell from 27th July to 30th July 2010

6.1.6 ***RIVER POSITION DURING THE SPELL***

First exceptionally high flood in the history of Tarbela Dam was observed in river Indus , in the morning of 30th July 2010 when 832000 cusecs of inflow was recorded. Due to the release of more than 600000 cusecs of water in the morning of 30th July 2010 from Tarbela Dam and huge discharge of more than 350000 cusecs from River Kabul at Nowshera (It is believed that the measuring gauge was overtopped and the actual flow was not reported) which overflowed, a peak of more than 900000 cusecs was observed at Kalabagh at 2200 hours of 30th July and at Chashma in the morning of 31st July 2010.

This Exceptional high flood wave further moved downstream and reached at Taunsa on 2nd August, Guddu on 6th August, Sukkur on 9th August and at Kotri on 27th August with peak values of 959991, 1148738, 1130995 & 964897 cusecs respectively as shown in figures 31 to 38. The peak values of the flood wave recorded at Guddu and Sukkur were beyond the limits of exceptionally high flood level. Guddu and Sukkur peaks were the peaks of the longest duration .Duration of exceptionally high flood at Kalabagh, Chashma, Taunsa, Guddu, Sukkur and Kotri are given in table:1

Table 1: Duration Of Exceptional High Flood Peaks

Site	Exceptional High Flood Level In Cusecs	Date & Time		Duration In Hours
		From	To	
Tarbela	800000	0600, 30/07/2010	0659, 30/07/2010	01
Kalabagh	800000	1800, 30/07/2010	1400, 31/7/2010	20
		0900, 01/08/2010	2000, 01/08/2010	11
		0100, 01/08/2010	0500, 02/08/2010	04
Chashma	800000	1000, 30/07/2010	1800, 02/08/2010	80
		1400, 11/08/2010	2000, 11/08/2010	06
Taunsa	800000	0900, 02/08/2010	0500, 03/08/2010	20
		0100, 04/08/2010	0500, 04/08/2010	04
Guddu	900000	0000, 06/08/2010	1200, 20/08/2010	348
Sukkur	900000	1100, 07/08/2010	1800, 21/08/2010	343
Kotri	800000	0000, 22/08/2010	0600, 01/09/2010	246

Very high flood was also recorded in Jhelum River at Mangla & at Rasul .River Chenab also attained high floods at Marala & Khanki as shown in figures 39 to 43.

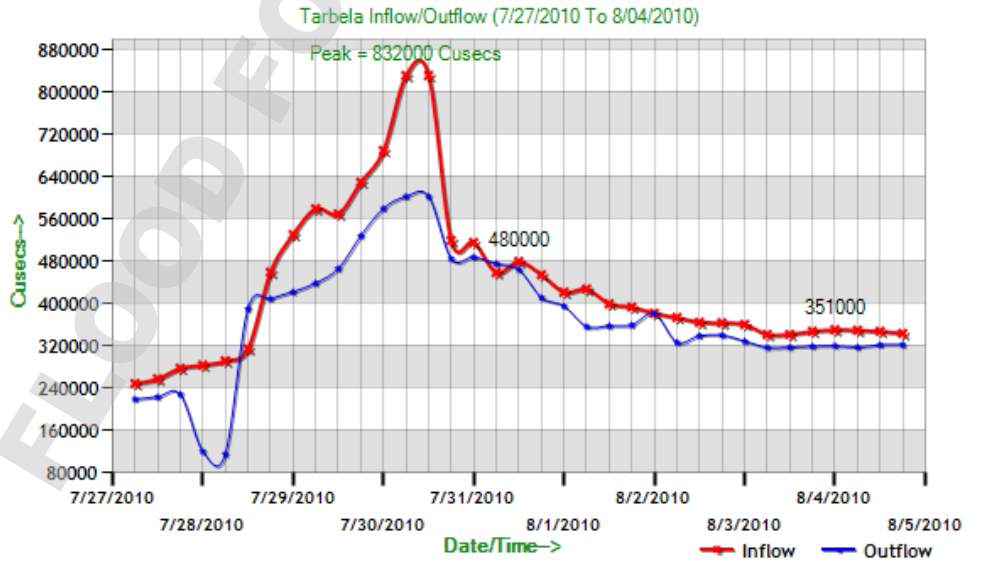

Figure 31: Rainfall during wet spell from 27th July to 30th July 2010

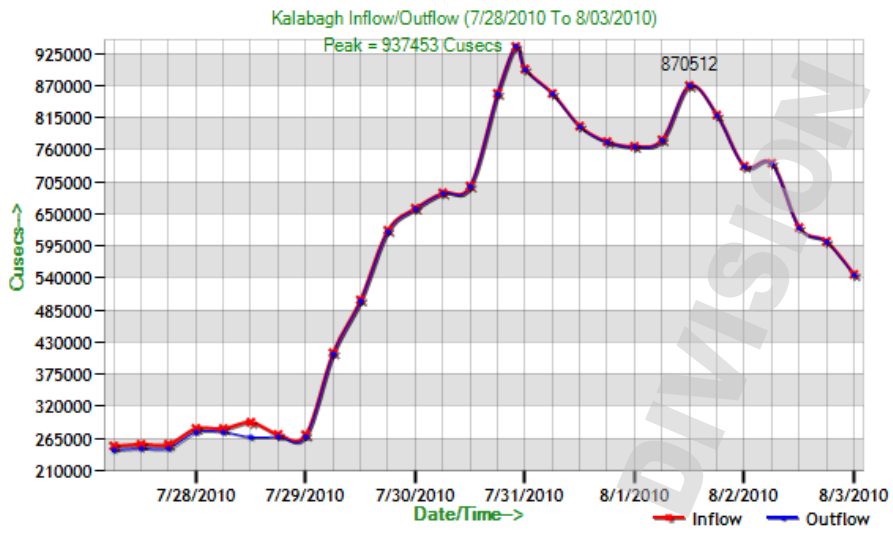

Figure 32: Kalabagh Inflow/Outflow 28th July to 03rd August 2010

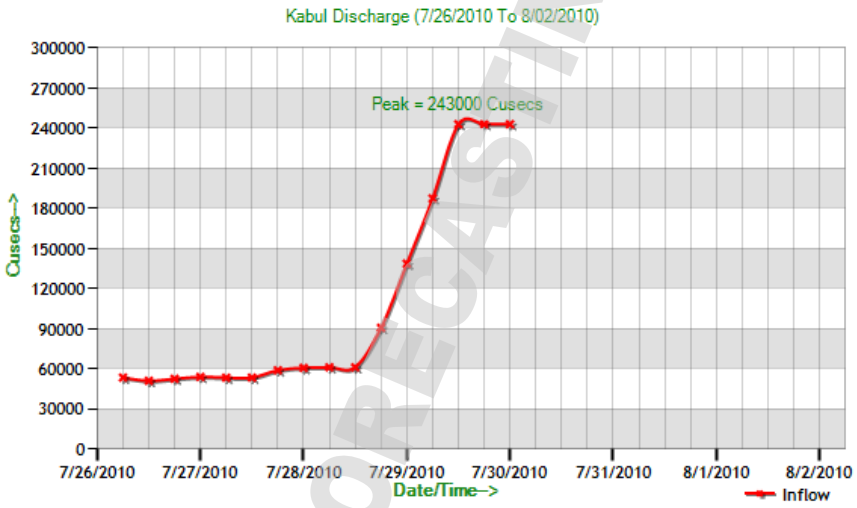

Figure 33: Kabul Discharge from 26th July to 02nd August 2010

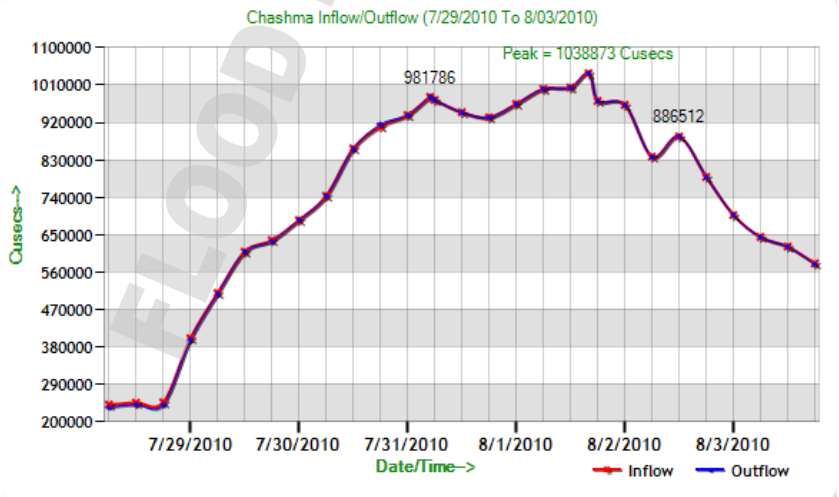

Figure34: Chashma Inflow/Outflow 29th July to 03rd August 2010

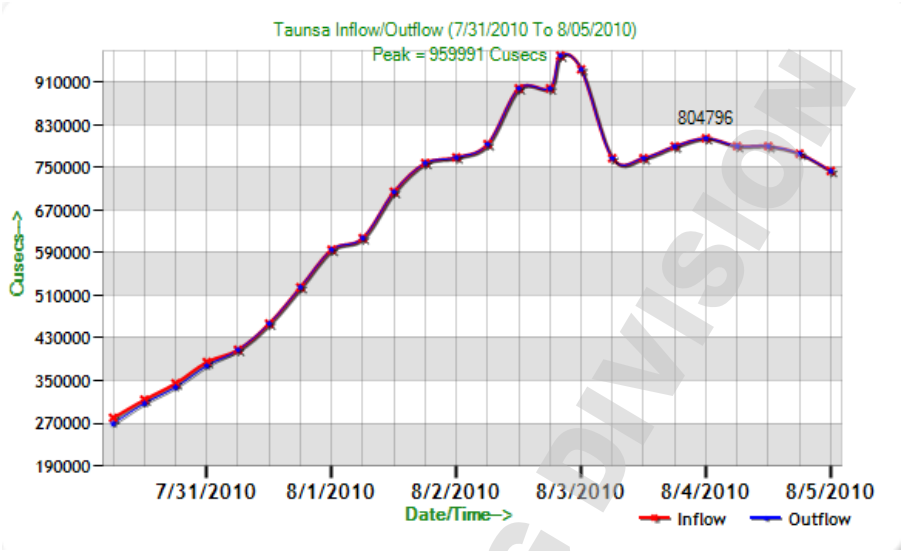

Figure 35: Taunsa Inflow/Outflow 31st July to 05th August 2010

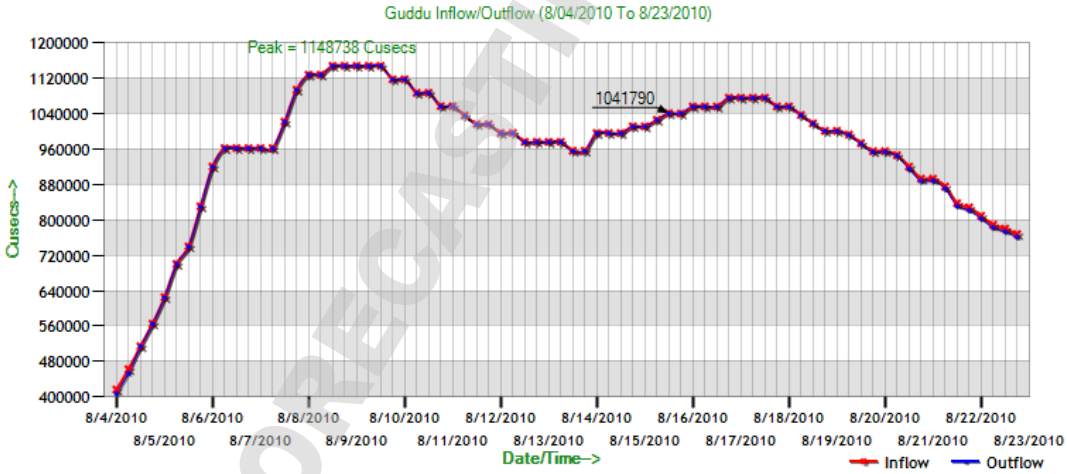

Figure 36: Guddu Inflow/Outflow 04th to 23rd August 2010

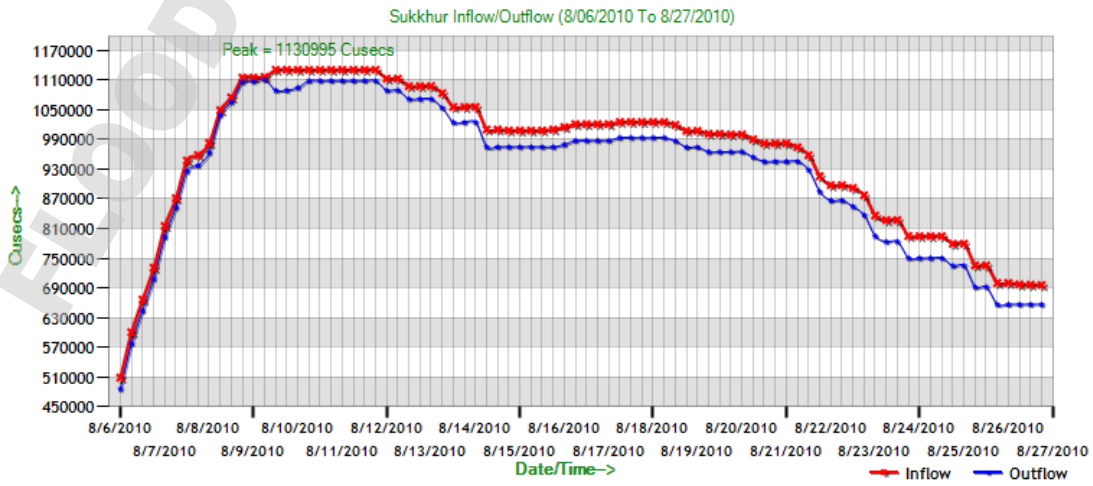

Figure 37: Sukkur Inflow/Outflow from 06th to 27th August 2010

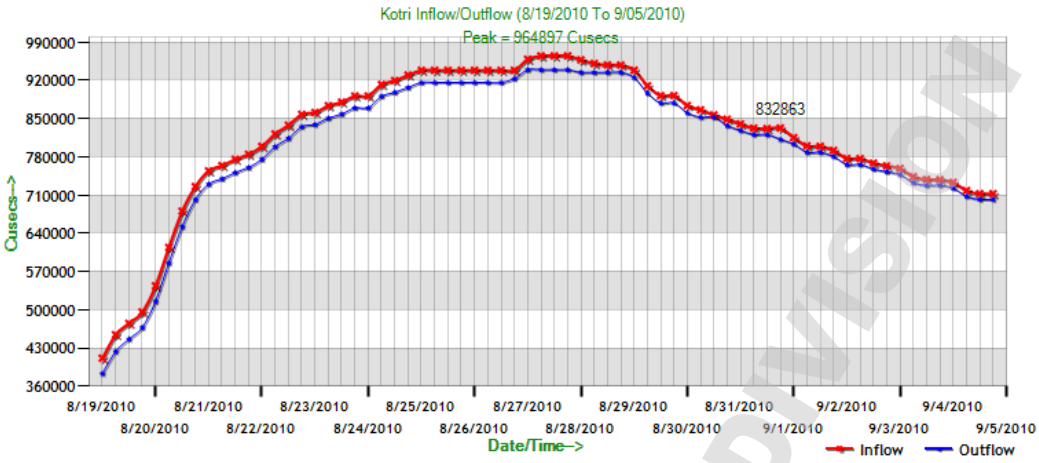

Figure 38: Kotri Inflow/Outflow from 19th to 5th September 2010

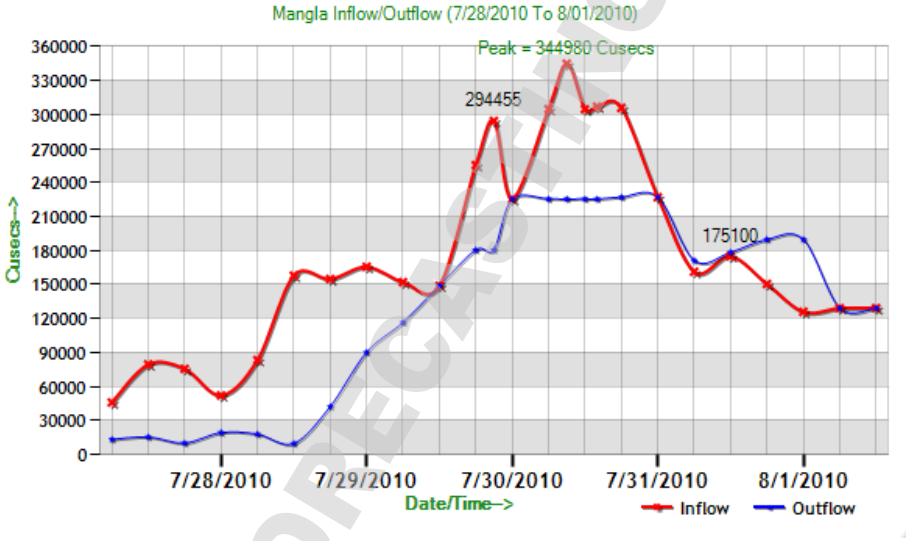

Figure 39: Mangla Inflow/Outflow from28th July to 1st August 2010

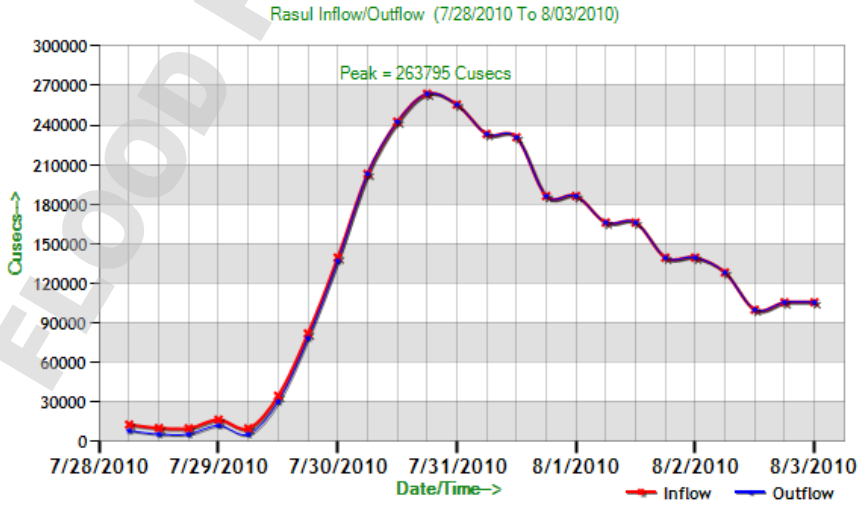

Figure 40: Rasul Inflow/Outflow from 28th July to 3rd August 2010

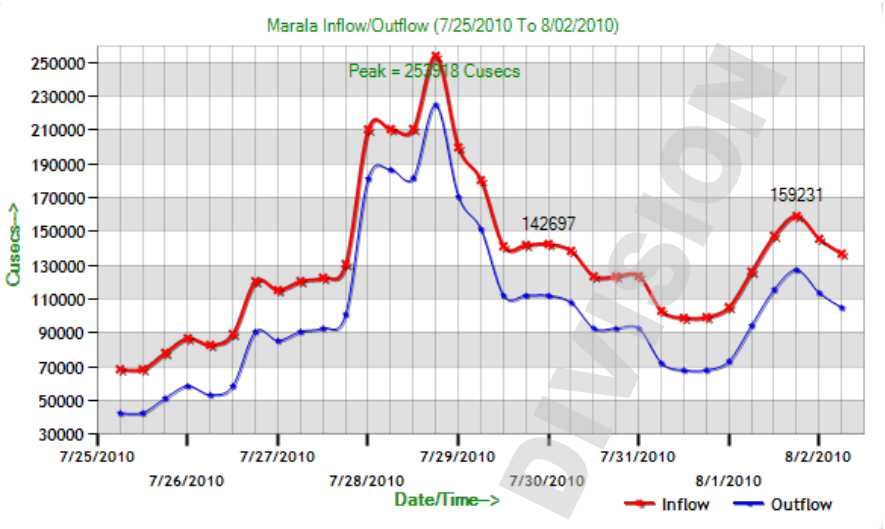

Figure 41: Marala Inflow/Outflow from 25th July to 02nd August 2010

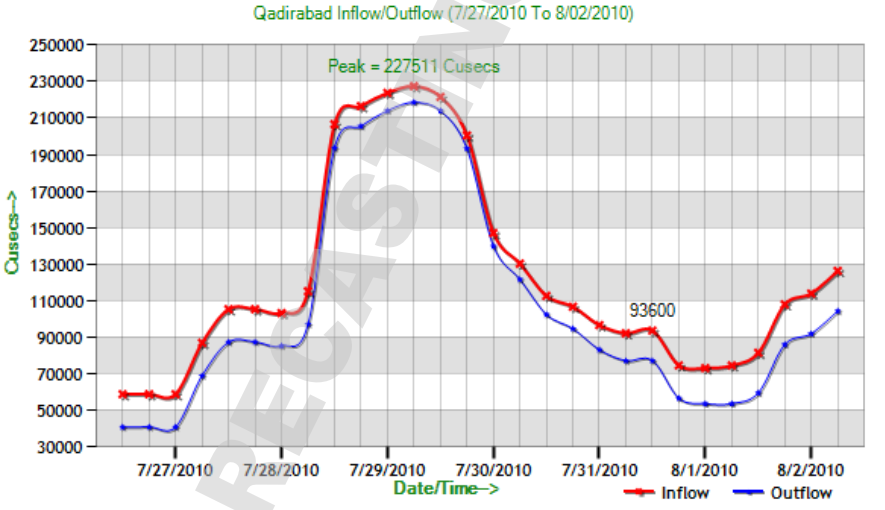

Figure 42: Qadirabad Inflow/Outflow from 27th July to 02nd August 2010

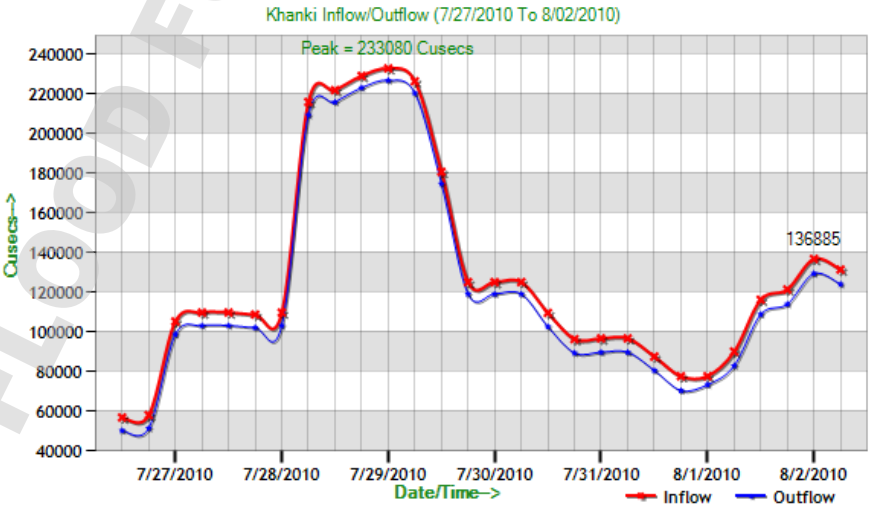

Figure 43: Khanki Inflow/Outflow from 27th July to 02nd August 2010

6.1.7 *ISOHYETAL MAP OF THE SPELL FROM 27-30 JULY, 2010*

The rain pattern during the spell from 27-30 July, 2010 was also indicative of extremely active monsoon spell as shown in fig 44. The Isohyetal pattern indicates that the region of heaviest rainfall lies over upper KPK, Kashmir, Upper parts of Punjab i.e. Garhi Dopatta, Murree, Pattan, Domel, Islamabad, Peshawar Cherat, Risalpur, Saidu Sharif, Dir and Chakdara etc. A prominent area of rainfall was around Risalpur where heaviest rainfall of 415mm was recorded.

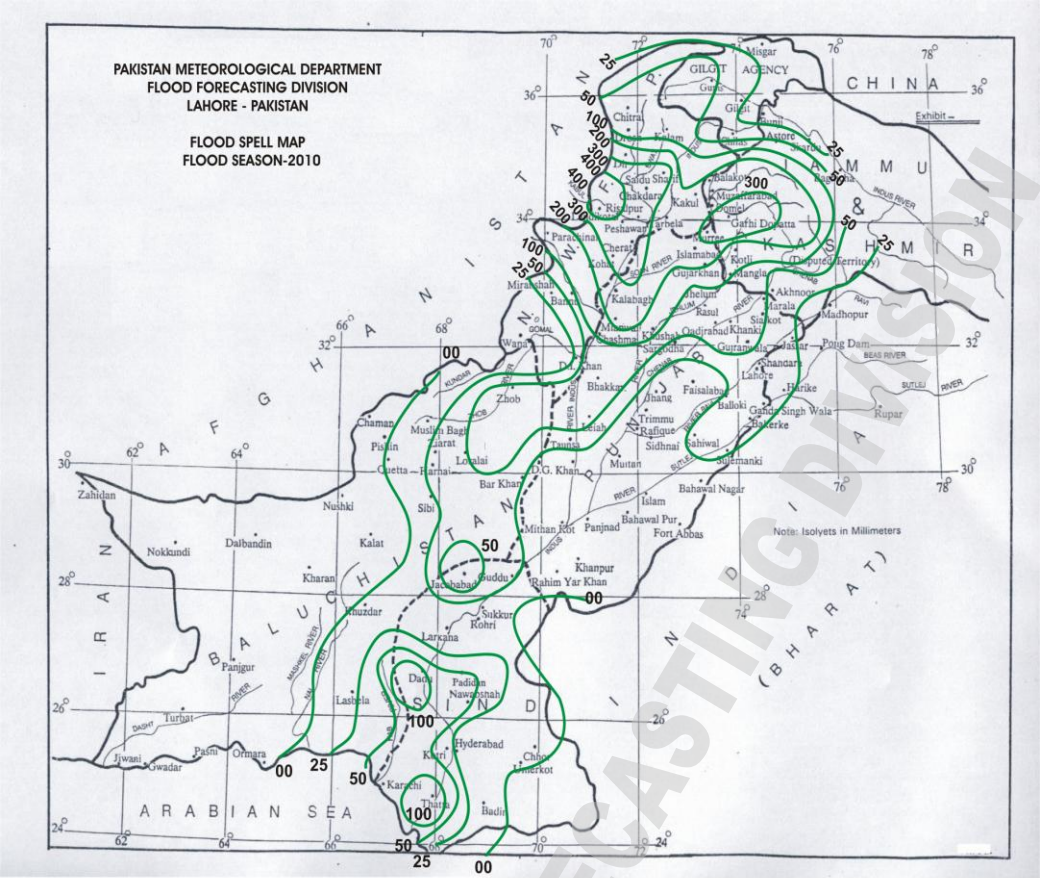

Figure 44: Isohyetal Map of the Spell causing historical flood

6.1.8 *RAINFALL PATTERN FOR THE MONTH OF JULY 2010*

Isohyetal map of July 2010 indicates that the region of exceptionally heavy rainfall (More than 400 mm) lies around Risalpur in Khyber Pakhtoon Khwa along Murree, Garhi Dopatta and Mianwali. Heavy rainfall (More than 300 mm) regions are Upper Punjab, Kashmir and KPK. The precipitation

intensity decreased towards southern parts of the country and less rainfall was observed over Balochistan.

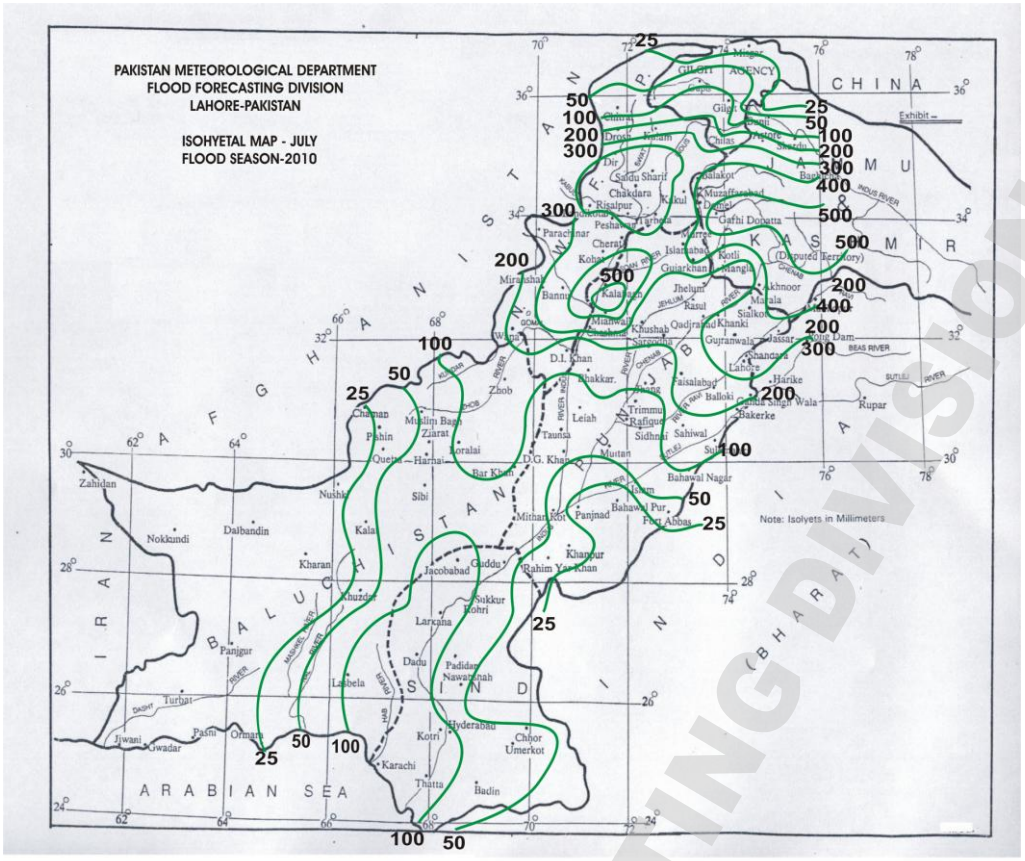

Figure 45: Isohyetal Map of July 2010

On province wise monthly rainfall of July 2010 was, KPK received 179.1% above normal, Punjab 57.1% above normal, Balochistan 20% above normal Sindh 33.5% above normal. On all Pakistan basis 70.5% above normal rainfall was received during the month of July 2010.

7. SIGNIFICANT HYDROMETEOROLOGICAL EVENTS DURING THE MONTH OF AUGUST 2010:

7.1 METEOROLOGICAL EVENTS:

Three rainfall spells occurred during the month of August.

First long spell occurred from 4th to11th August 2010. This spell was caused due to the two monsoon lows. First monsoon low was developed over

Madhya Pradesh on 31st July. Moving continuously in W-NW direction reached over west Rajasthan and adjoining area on 4th August, where it became insignificant.

Second monsoon low developed over northwest Bay of Bengal on 4th August. Initially it was moving in Northwestward direction. After reaching over Madhya Pradesh it diverted to W-NW wards. It moved further in the same direction and merged into seasonal low on 9th August and in the presence of westerly wave widespread rains with heavy to very heavy falls recorded over lower Sindh, Kashmir, Punjab, and Khyber Pakhtoon Khwa and scattered rains over Gilgit- Baltistan, upper Sindh and Northeast Balochistan. These rains generated the Second flood wave in Indus River. During this spell the westerly wave was also present in the northern areas of country.

Third spell was observed on 23rd-26th August. This spell was caused due the accentuation of seasonal low, monsoon current from Arabian Sea at lower level and presence of westerly wave. This rain bearing spell gave heavy rains over upper Punjab, Khyber Pakhtoon Khwa, upper Sindh and Northeast Balochistan.

7.1.1 FIRST WET SPELL (04-08-2010 TO 11-08-2010)

The rainfall during the first spell of August and 5th of the season occurred during 4th to 11th August 2010 which has been shown in figure 46. This spell occurred due to monsoon lows emerging from Bay of Bengal which finally merged into seasonal low. Accentuation of seasonal low occurred and very heavy rains were observed in Southeast Sindh, Punjab, Khyber Pakhtoon Khwa and Kashmir especially in Risalpur, Khanpur, R.Y. Khan, T.T. Singh, and DG. Khan and also in catchment of rivers which caused flash flooding in hill torrents and nullas.

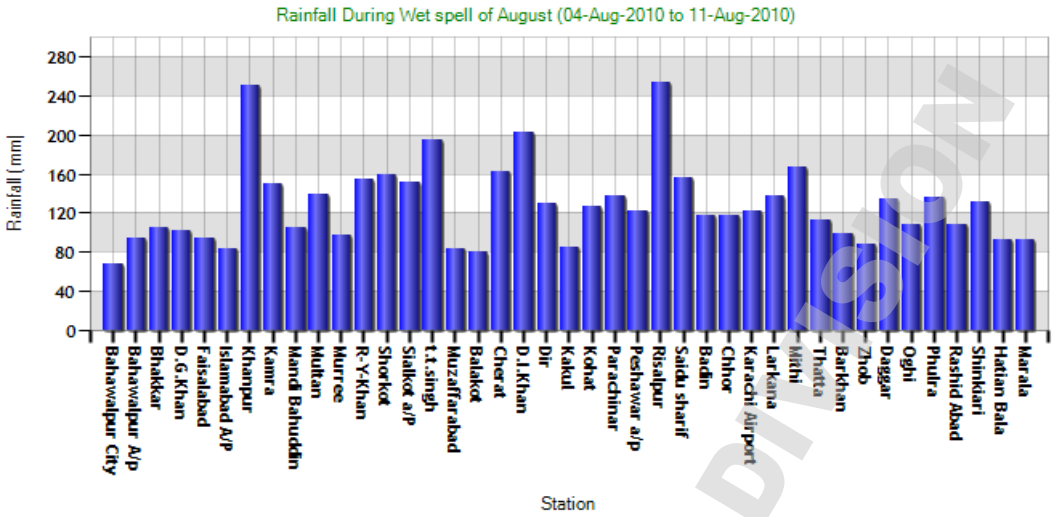

Figure 46: Rainfall during wet spell from 04th August 11th August 2010

7.1.2 ***RIVER POSITION DURING THE SPELL***

During this spell heavy rains occurred in upper catchments of river Indus ,Jhelum and Chenab which produced High to Exceptionally high flood peaks in river Indus at Tarbela, Kalabagh, Chashma and Taunsa which moved down stream to Kotri as a second flood wave immediately following the first flood wave as shown in figures 50 to 54 . Due to the occurrence of the second spell a double peak (one after the other) occurred. The time of travel of the peak prolonged due to the lateral flows generated by the spill over this caused the back water effect also on the forward flows. When second wave arrived, all the storage in the channel were filled up by the first wave, so there was no space for spreading out of second wave, over lapping of the waves occurred and high peak was maintained for a long time at Sukkur, Guddu and Kotri. River Chenab at Marala and Khanki also registered high to medium flood levels respectively. Rasul at Jhelum also was seen in medium flood level as shown in the following figures.

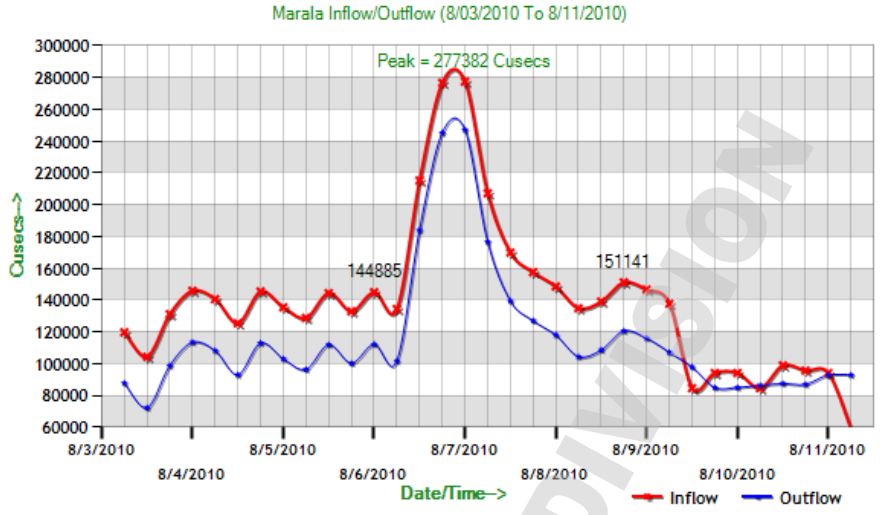

Figure 47: Marala Inflow/Outflow 03rd August to 11th August 2010

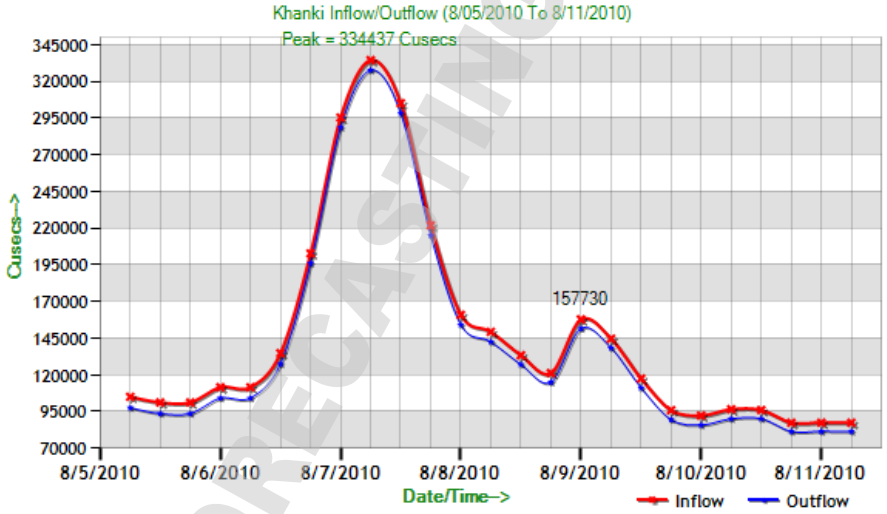

Figure 48: Khanki Inflow/Outflow from 05th August to 8th August 2010

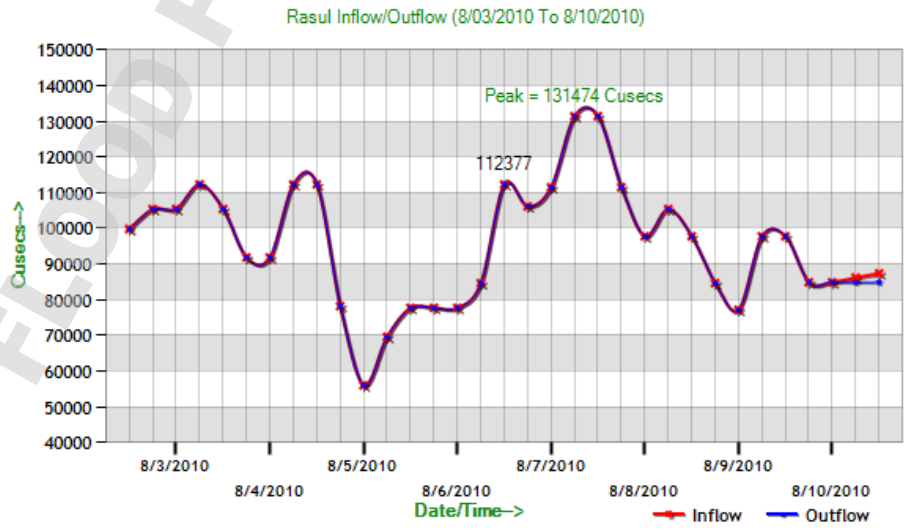

Figure 49: Rasul Inflow/Outflow from 03rd August to 10th August 2010

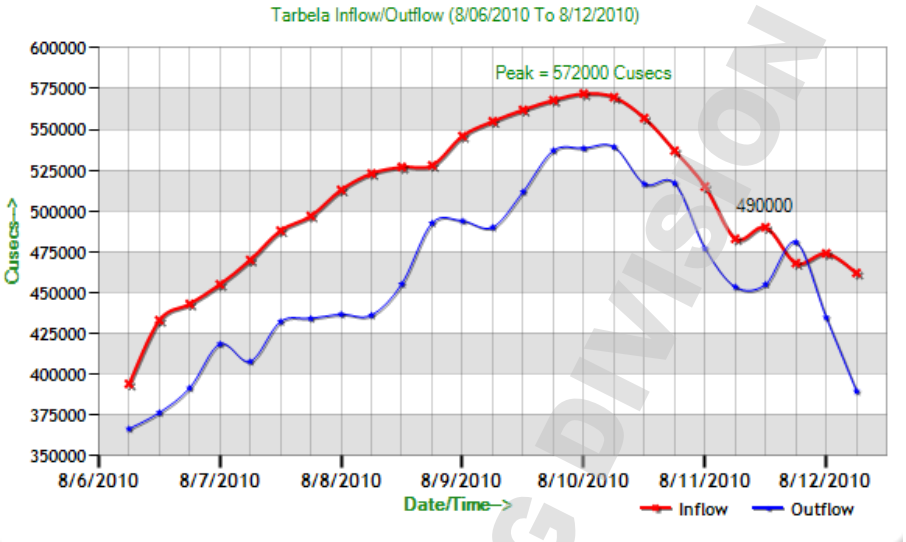

Figure 50: Tarbela Inflow/Outflow from 06th August to 12th August 2010

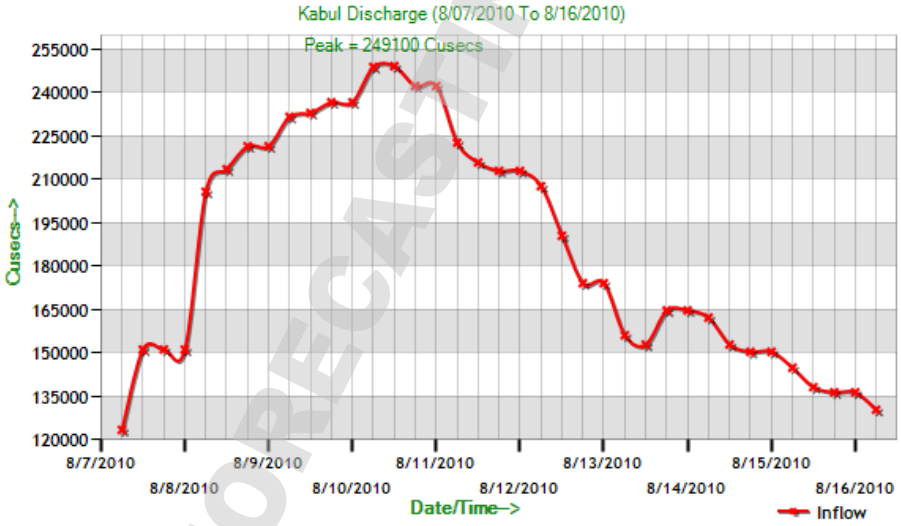

Figure 51: Kabul Discharge from 07th August to 16th August 2010

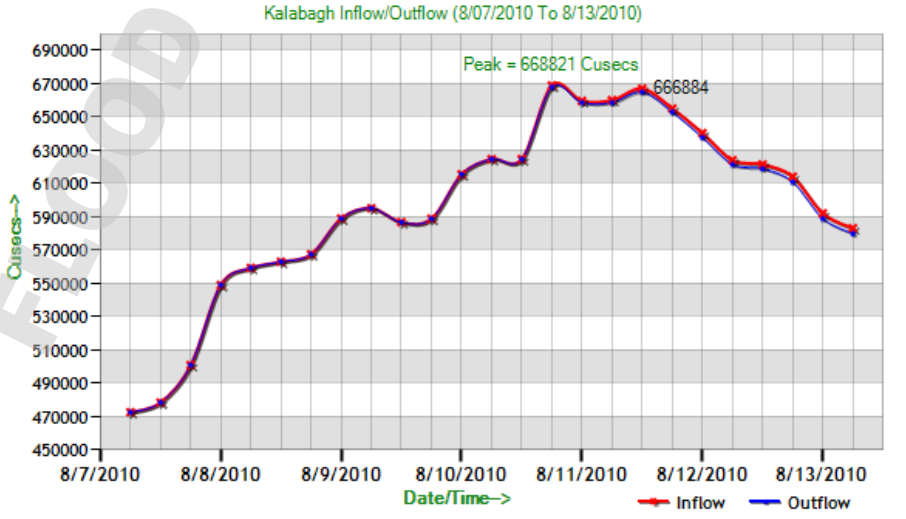

Figure 52: Kalabagh Inflow/Outflow from 07th August to 13th August 2010

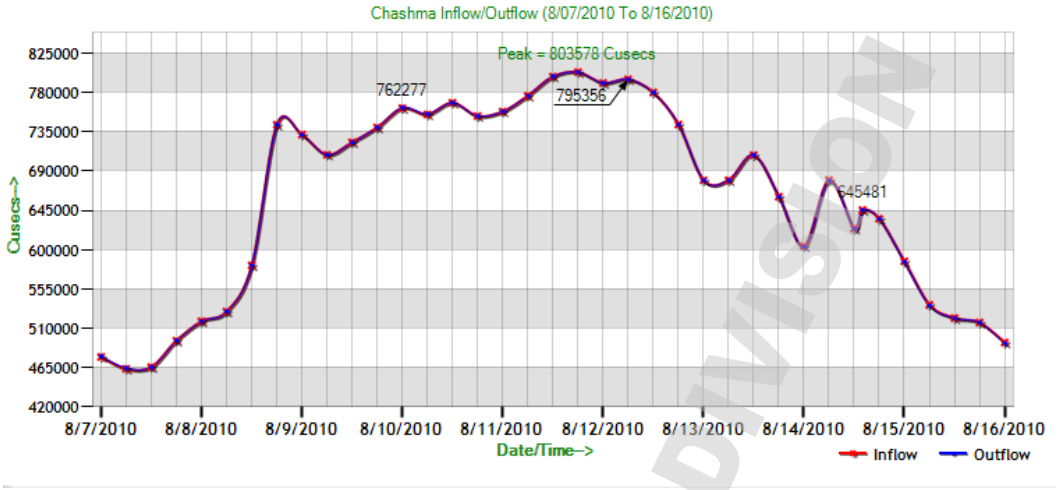

Figure 53: Chashma Inflow/Outflow from 07th August to 16th August 2010

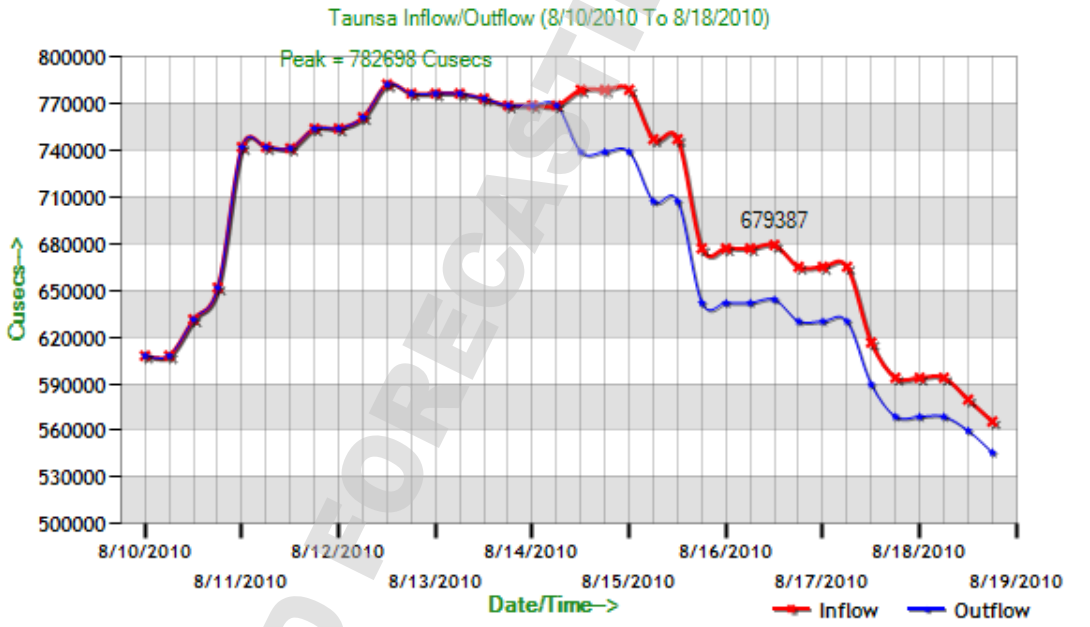

Figure 54: Taunsa Inflow/Outflow from 10th August to 18th August 2010

7.1.3 ***SECOND WET SPELL(13-08-2010 To 17-08-2010)***

This spell lasted for 5 days from 13th to17th August 2010. It was relatively less active. During this spell moderate to heavy rainfall occurred over Bahawalpur, Khanpur, Lahore, Mangla, Murree, Sialkot, D.I. Khan, Cherat, Dir, Kohat, Risalpur and Rawalakot as shown in fig 55.

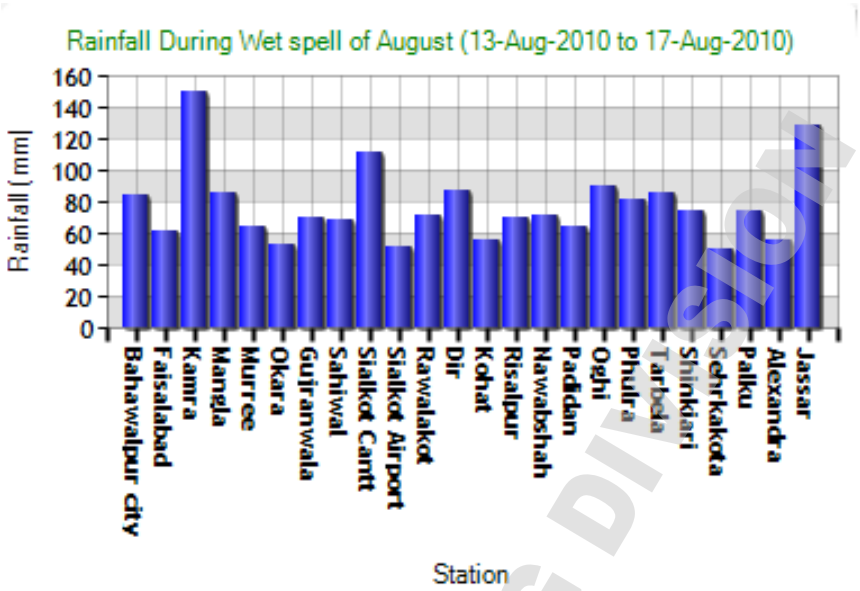

Figure 55: Rainfall during wet spell from 13th t to 17th August 2010

7.1.4 ***RIVER POSITION DURING THE SPELL***

Due to this spell, a rise in the flow was observed in river Indus at Chashma, and River Chenab at Marala .River Ravi at Balloki also attained medium flood level.

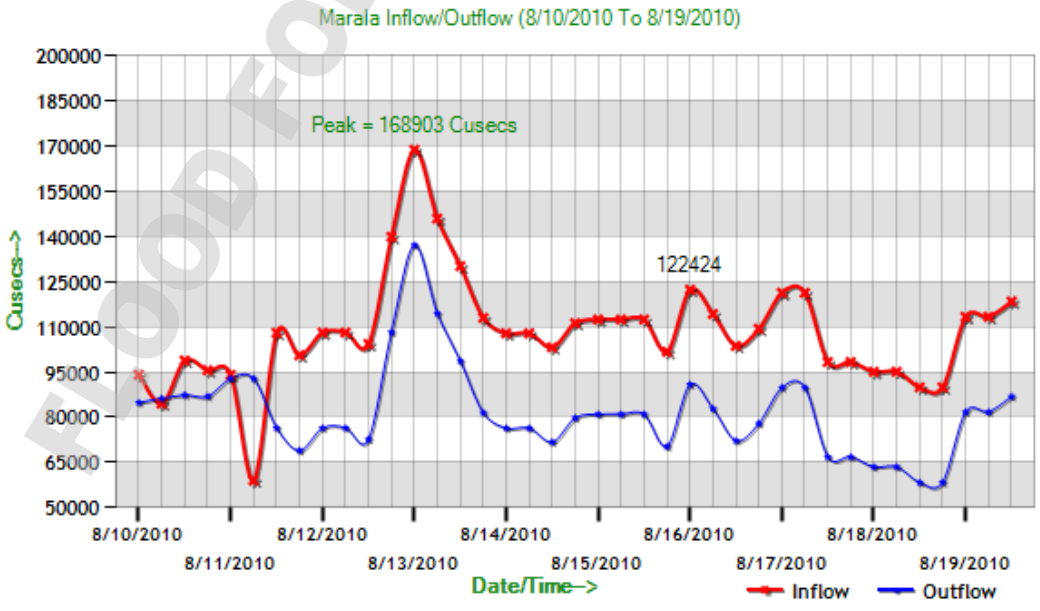

Figure 56: Taunsa Inflow/Outflow from 10th to 18th August 2010

7.1.5 *THIRD WET SPELL AUGUST (23-08-2010 TO 26-08-2010)*

Third rainy spell of August 2010 and 7th of the season was mainly caused due to the trough of a westerly wave (at 500mb Hpa) and presence of well marked seasonal low at Balochistan. During this spell, incursion of Southwest monsoon current from Arabian Sea into sub mountain areas of Punjab caused heavy rainfall over Khyber Pakhtoon Khwa, Upper Punjab and Kashmir. At few places in Southeast Sindh and Balochistan, rain of light to moderate intensity was also observed. Significant amount of rainfall during the spell is shown in figure 57.

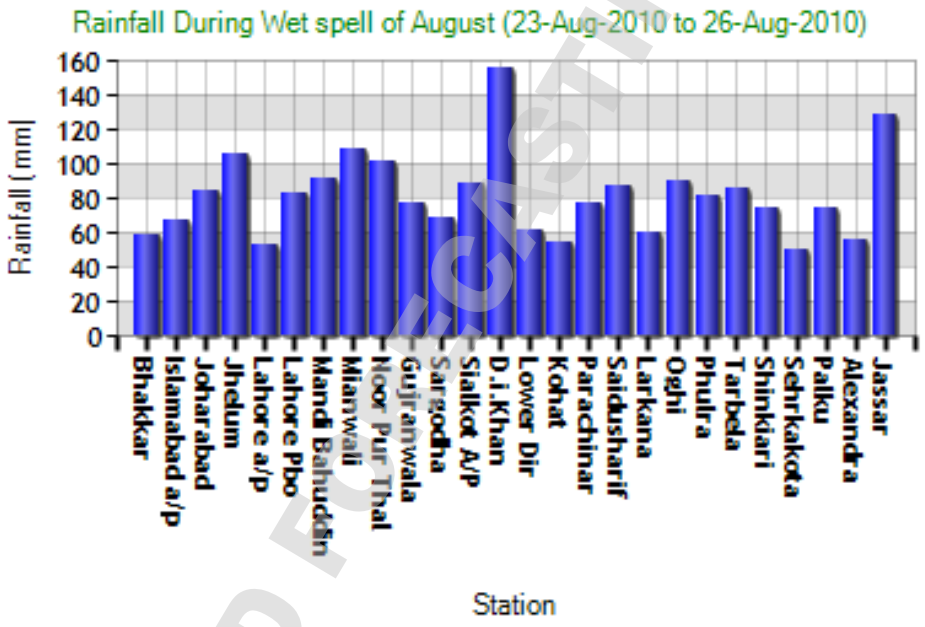

Figure 57: Rainfall during wet spell from 23rd to 26th August 2010

7.1.6 *RIVER POSITION DUE TO THE SPELL*

River Indus at Chashma recorded a High flood peak .River Chenab at Marala and Khanki and River Indus at Kalabagh attained medium flood level. Low flood was also recorded in river Ravi at Balloki as shown in figures 58 to 61.

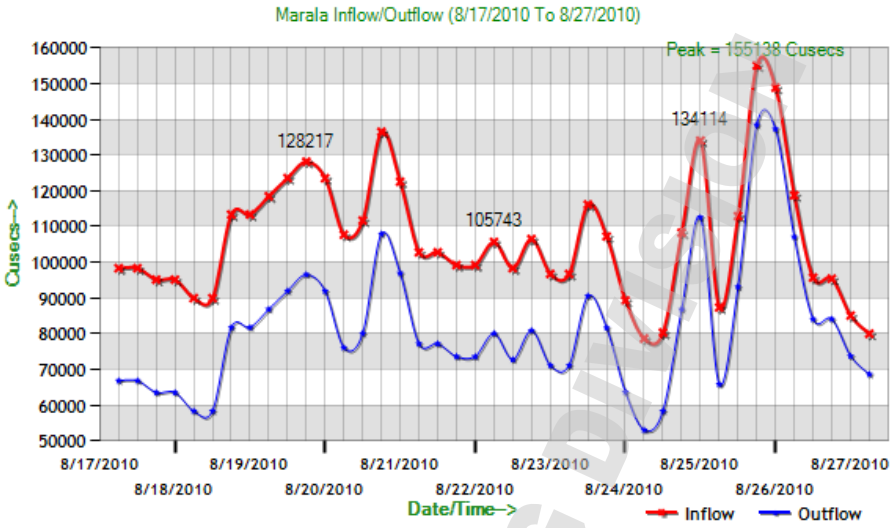

Figure 58: Marala Inflow/Outflow from 17th to 27th August 2010

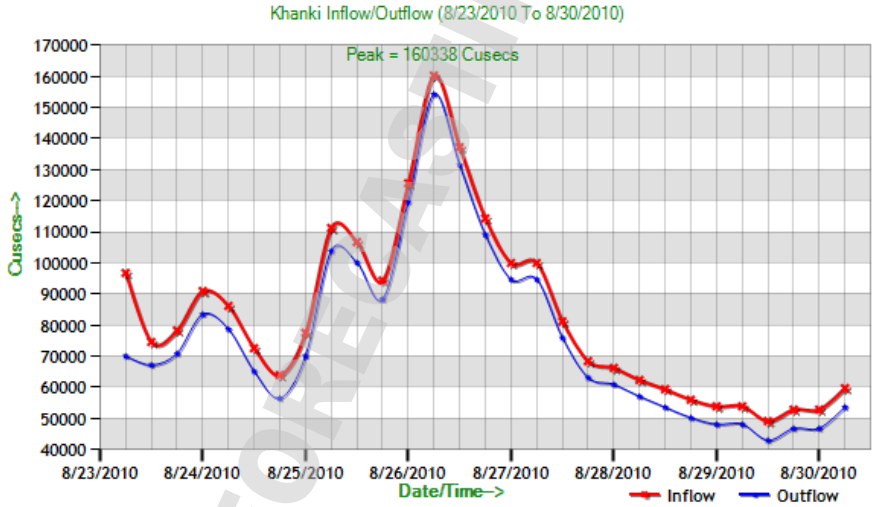

Figure 59: Khanki Inflow/Outflow from 23rd to 30th August 2010

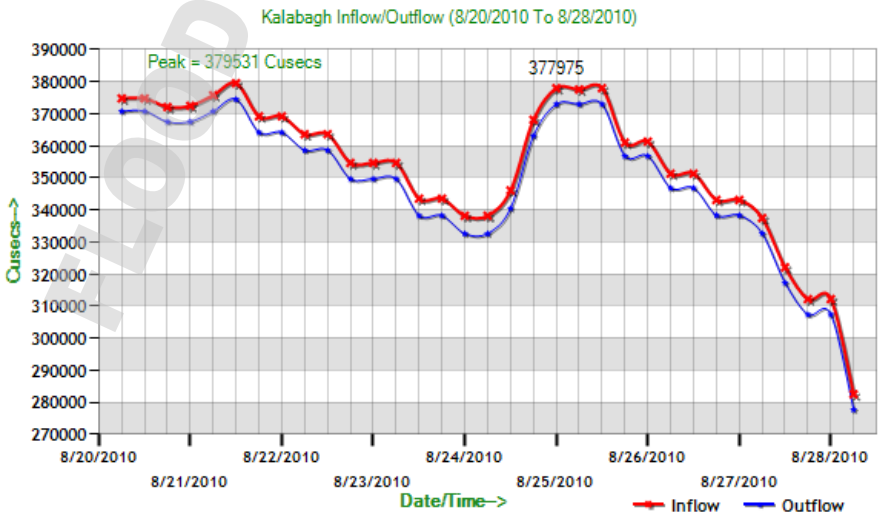

Figure 60: Kalabagh Inflow/Outflow from 20th to 28th August 2010

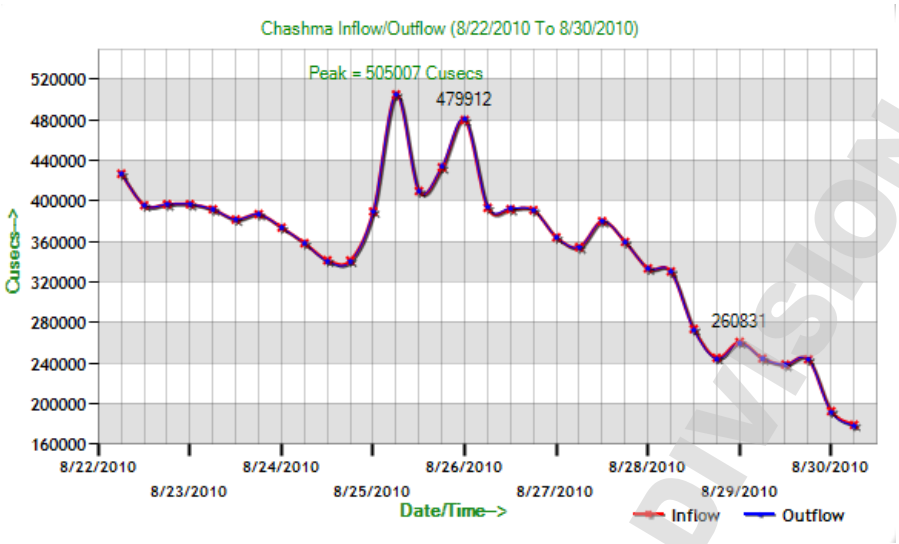

Figure 61: Chashma Inflow/Outflow from 22nd to 30th August 2010

7.1.7 ***RAINFALL PATTERN FOR THE MONTH OF AUGUST, 2010***

The monthly isohyetal pattern during the month of August was indicative of quite active monsoon as shown in fig 62. Rainfall maxima exceeding 400 mm in the month of August 2010 was encompassed around Sialkot. Rainfall maximum of more than 200mm was also located around the upper catchments of river Kabul.

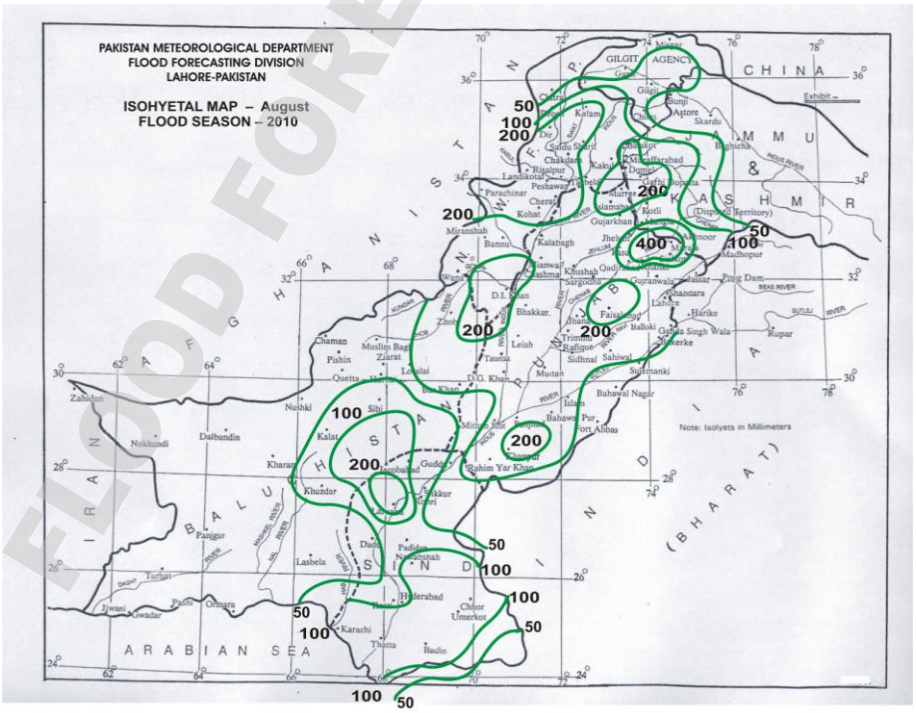

Figure 62: Isohyetal Map of August 2010

As per monthly rainfall of August, 2010 on province wise, KPK received 96.6% above normal rainfall, Punjab received 112.1% above normal rainfall, Balochistan received 62.1% above normal and Sindh received 110.8% above normal rainfall. On all Pakistan Basis, rainfall during the month of August was 102.2% above normal.

8. SIGNIFICANT HYDROMETEOROLOGICAL EVENTS DURING THE MONTH OF SEPTEMBER 2010:

Two rainfall spells occurred in the month of September 2010.

8.1 *METEOROLOGICAL EVENTS:*

First spell was observed from 2nd to 5th September 2010. During this spell moist current from Bay of Bengal was penetrating into sub mountain areas of Punjab and Kashmir. During this period a well marked seasonal low was also present with its trough extending northwards. Westerly wave was also passing over the north of country. Therefore, light to moderate rainfall occurred over scattered places of upper Punjab, upper Khyber Pakhtoon Khwa and at isolated places in lower Sindh.

Second spell occurred from 10th to 15th September 2010. This spell was due to a monsoon low which was developed over Bay of Bengal near the coast of Orrisa on 04th September 2010. After moving in west-northwest direction it it was located over Southern Rajasthan on 10th September 2010. On 11th. September 2010 it moved towards Sindh and became insignificant after producing heavy rains over Southeast Sindh, Kashmir, Khyber Pakhtun khwa North Punjab and North East Balochistan.

8.1.1 *FIRST WET SPELL (02-09-2010 TO 05-09-2010)*

First rainy spell of September occurred during 2nd to 5th September 2010 as shown in figure 63. This spell was not very active. Light to moderate rains

occurred at scattered places of Punjab, Khyber Pakhtun khwa and Southeast Sindh.

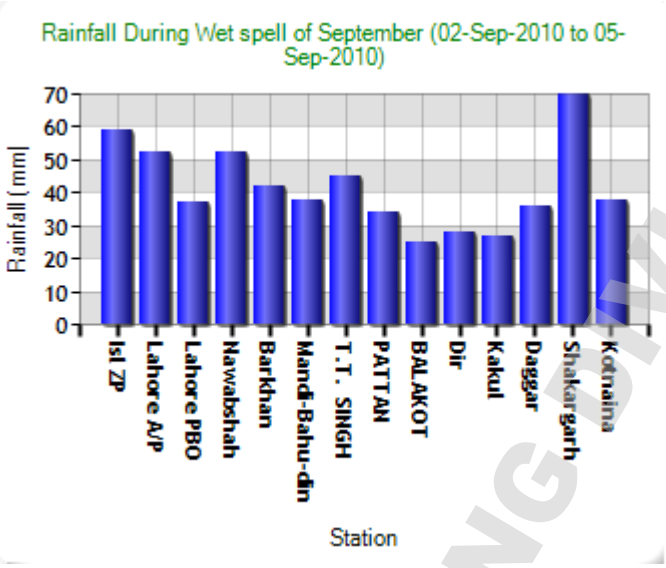

Figure 63: Rainfall during wet spell from 02nd September to 05th September 2010

8.1.2 *RIVER POSITION DUE TO THE SPELL*

No significant change in any river, nullahs and hill torrent was observed.

8.1.3 *SECOND WET SPELL (10-09-2010 TO 15-09-2010)*

This spell was caused due to the movement of monsoon low from Bay of Bengal. It lasted for 6 days. Heavy rains were recorded at isolated places of North Punjab, Upper Khyber Pakhtoon Khwa, Northeast Balochistan and Kashmir as given in figure 64.

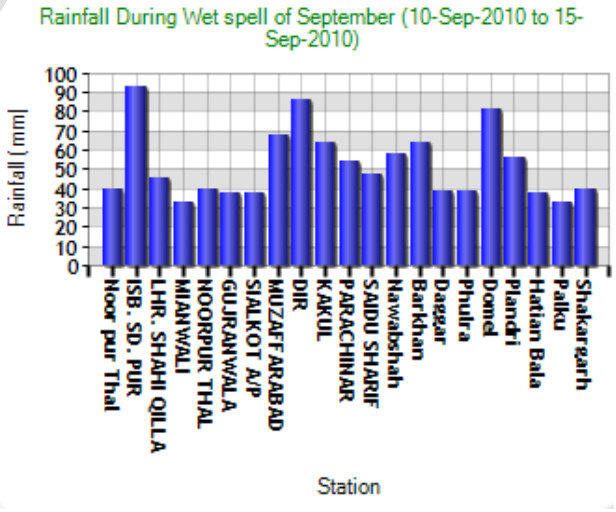

Figure 64: Rainfall during wet spell from 10th September to 15th September 2010

8.1.4 *RIVER POSITION DURING SPELL*

This spell did not cause any marked change in river flows. All the rivers, nullahs and riverines maintained their normal flow.

8.1.5 *THIRD WET SPELL OF SEPTEMBER 2010*

This spell was not active in our region. This was caused due to the moist current influx from Bay of Bengal. However, some rains were observed in the catchments of Sutlej river in Indian Territory. Due to this spell and releases of water from Indian dams, base flow of river Sutlej increased up to low level flood at Sulemanki.

8.1.6 *RAINFALL PATTERN FOR THE MONTH OF SEPTEMBER 2010*

Three rainfall maxima of more than 100 mm rainfall were located around Islamabad, Muzafarabad and Dir during the month of September 2010 as shown in figure 65. Lesser maxima of more than 50 mm and less than 100 mm was also located around Southeastern Sindh, Bar khan, lower Khyber Pakhtoon Khwa, North & Central Punjab and Kashmir.

On all Pakistan basis 29.9% above normal rainfall was observed in the country while on province wise, Sindh received 94.5% above normal rainfall. Khyber Pakhtoon Khwa, Punjab and Balochistan also received above normal rainfall of 30.2%, 10.9% and 10.7% respectively above normal during the month of September2010.

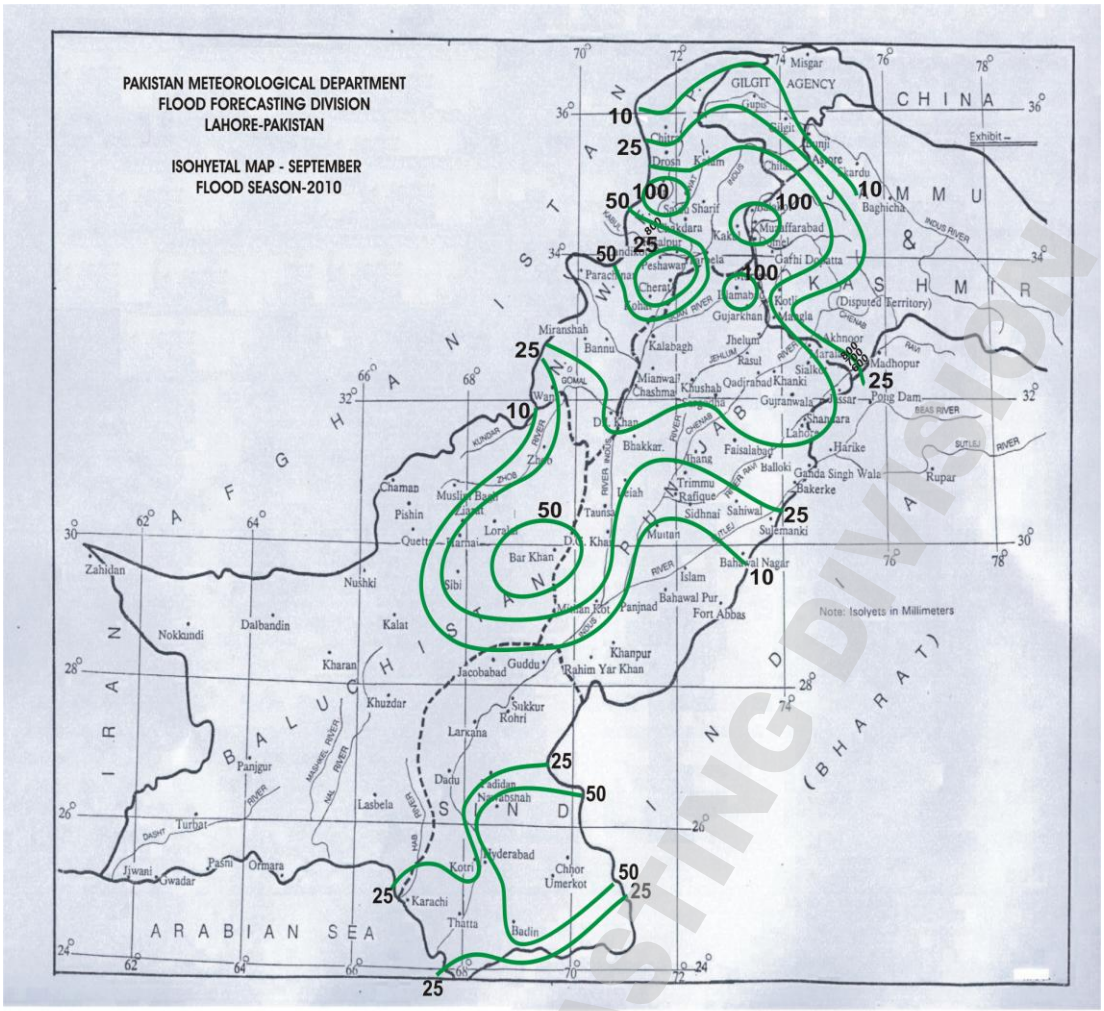

Figure 65: Isohyetal Map of September 2010

9. SEASONAL RAINFALL PATTERN JULY TO SEPTEMBER (2010)

Seasonal rainfall pattern during the season is shown in figure 66.

Regions of maximum precipitation (more than 800 mm) are located one around Risalpur, Saidu Sharif, and Dir and a second over Muzafarabad, Garhi Dupatta, Pattan.

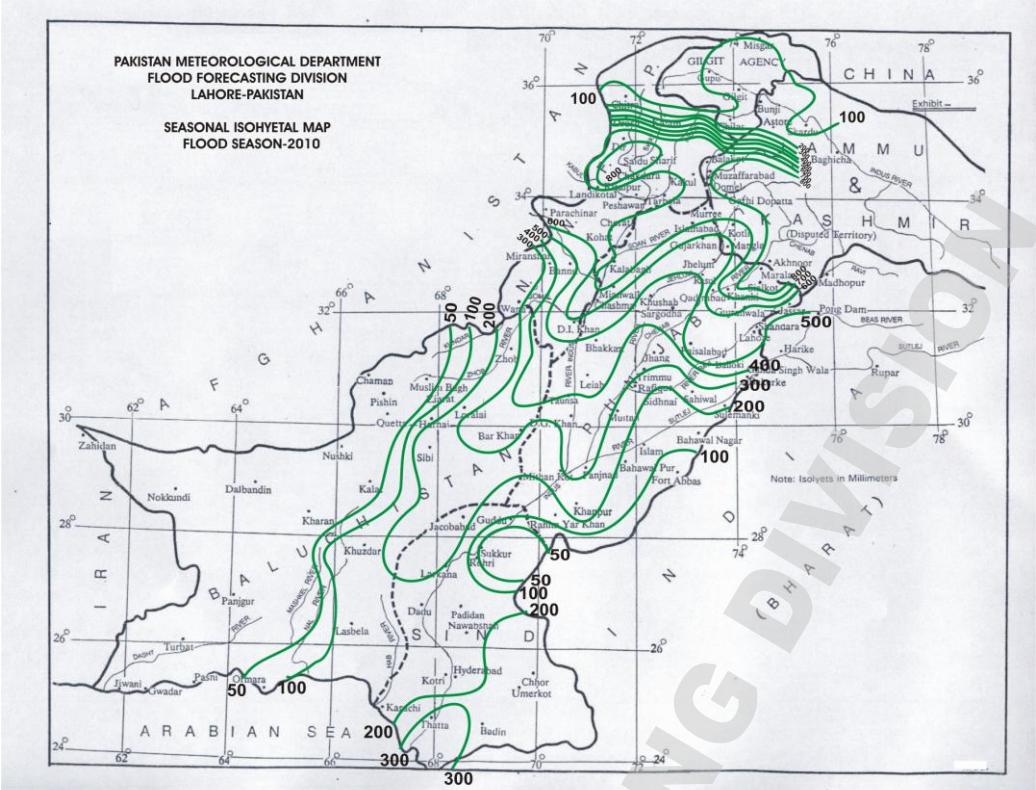

Figure 66: Seasonal Isohyetal Map (July – September) 2010

A lesser maximum of more than 300 mm rainfall was observed over extreme Southern Parts of Sindh.

Viewing the seasonal precipitation (July to September 2010) on all Pakistan basis, 77.4% above normal rainfall was recorded in the country. On province wise basis, KPK received 121.0% above normal rainfall Punjab received 72.3%, Balochistan 35.4%, Sindh 74.0% above normal rainfall during the season.

10. SEASONAL ISOPERCENTAL DEPARTURE MAP OF PRECIPITATION FROM JULY-2010 TO SEPTEMBER-2010

The seasonal precipitation isopercental map indicates that most parts of the country received above normal rainfall. Malakand division received 200% to 300 % more rainfall which resulted into historical super floods in river Indus. More than 300% rain was also recorded around Mianwali and over south Punjab.

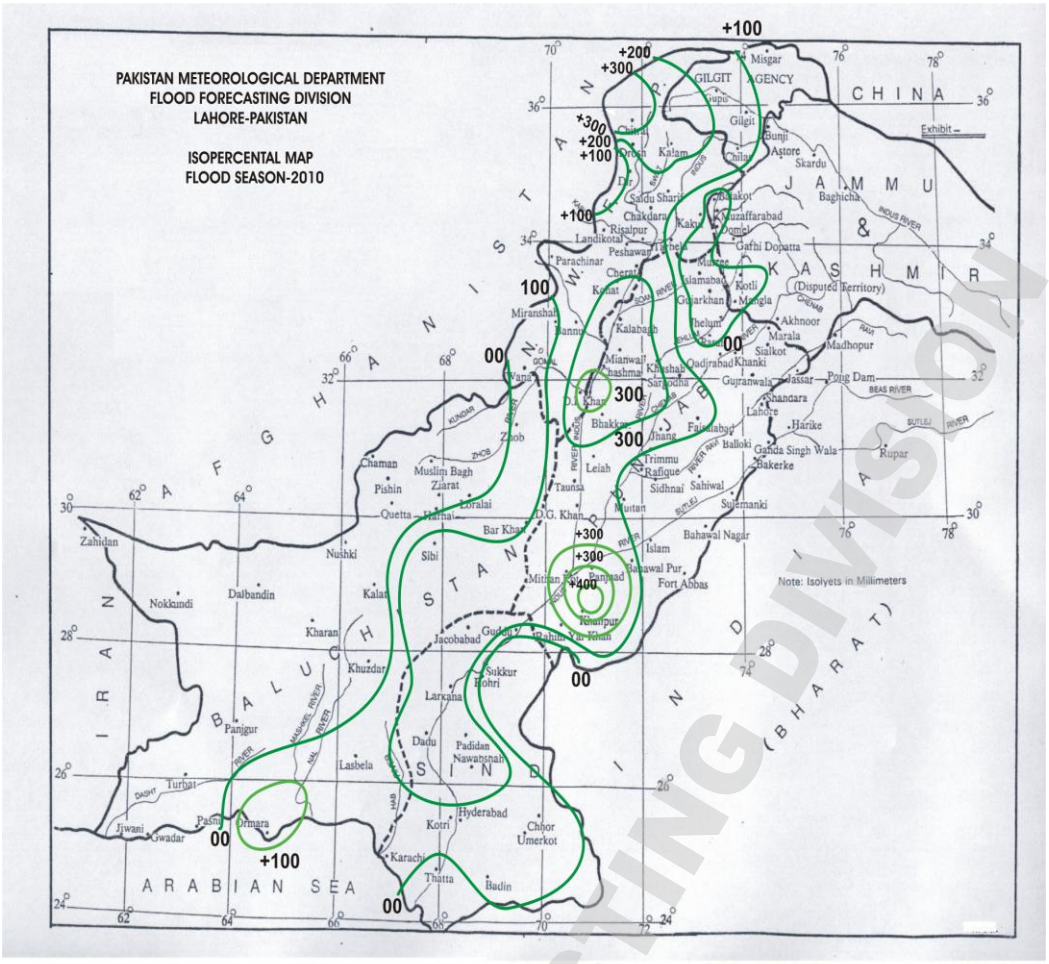

Figure 67: Seasonal Isopercental Map (July – September) 2010

11. SEASONAL PRECIPITATION AND FLOW PREDICTION.

During this monsoon season Pakistan received above normal rainfall (77.4%). All the four provinces also received above normal rainfall during the season. On province wise basis, KPK received 121.0% above normal, Punjab received 72.3% above normal, and Balochistan received 35.4 % above normal rainfall while Sindh received 74.0% above normal rainfall as illustrated in table (2)

Table 2: AREA WEIGHTED RAINFALL (JULY TO SEPTEMBER 2010)

MONSOON (JUL-SEP) 2010 AREA WEIGHTED RAINFALL				
Percentage Departure Area Weighted Rainfall				
Region	**July**	**August**	**September**	**JUL-SEP**
Pakistan	**70.5**	**102.2**	**29.9**	**77.4**
Khyber-PK	**179.1**	**96.6**	**30.2**	**121.0**
Punjab	**57.1**	**112.1**	**10.9**	**72.3**
Balochistan	**20.0**	**62.1**	**10.7**	**35.4**
Sindh	**33.5**	**110.8**	**94.5**	**74.0**

12 DETAILS OF DAMAGES AND LOSES – 2010

This information has been provided by National disaster management authority (NDMA) Islamabad issued on 02 January, 2011.

Deaths	Injured	House Hold Damaged	Population Affected	Crop Area (Hectares)	District Affected
1985	2946	1,744,471	20,184,550	2,244,644	78

13. FLOOD FORECAST EVALUATION REPORT:

The Flood Forecasting evaluation for 2010 for each category of flood is given here as under: -

S#	River	Site	Actual upstream peak Discharge			Forecasted Discharge in thousand of Cusecs	Percentage Accuracy of Forecast
			Date	Discharge in Cusecs	Flood Limit		
1	Jhelum	Mangla	24.06.10	84438	Low	55-70	84
2	Indus	Tarbela	26.06.10	251000	Medium	240-250	96
3	Kabul	Nowshera	24.06.10	76800	Medium	75-85	100
4	Indus	Chashma	30.06.10	256714	Low	210-240	93
5	Ravi	Balloki	25.07.10	55565	Low	50-65	100
6	Chenab	Marala	22.07.10	192726	Medium	100 R 200	100
7	Chenab	Marala	28.07.10	253918	High	200-260	100
8	Chenab	Khanki	23.07.10	212164	High	200-240	100
9	Chenab	Khanki	29.07.10	233080	Low	180-300	100
10	Chenab	Qadirabad	23.07.10	215695	High	210-260	100
11	Chenab	Qadirabad	29.07.10	227511	High	200-250	100
12	Jhelum	Mangla	30.07.10	344490	V-High	260-340	100
13	Jhelum	Rasul	30.07.10	263795	V-High	260-340	100
14	Indus	Tarbela	13.07.10	293000	Low	280-300	100

15	Indus	Tarbela	20.07.10	358000	Medium	340-370	100
16	Indus	Tarbela	30.07.10	832000	Ex-High	500-620	66
17	Kabul	Nowshera	29.07.10	243100	V-High	150-250	95
18	Indus	Kalabagh	16.07.10	280998	Low	240 R 340	100
19	Indus	Kalabagh	21.07.10	345490	Low	280-300	85
20	Indus	Kalabagh	30.07.010	937453	Ex-High	760-900	96
21	Indus	Chashma	06.07.10	269104	Low	235-245	96
22	Indus	Chashma	14.07.10	309435	Low	260-290	93
23	Indus	Chashma	22.07.10	470201	Medium	300-330	57
24	Indus	Chashma	31.07.10	981786	Ex-High	750-900	91
25	Indus	Taunsa	24.07.10	343549	Low	320 R 380	100
26	Indus	Taunsa	29.07.10	280256	Low	230-245	86
27	Ravi	Balloki	23.08.10	69935	Medium	50-65	94
28	Ravi	Balloki	25.08.10	57040	Low	50-60	100
29	Chenab	Marala	06.08.10	277382	High	180-230	79
30	Chenab	Marala	08.08.10	151141	Medium	100-180	100
31	Chenab	Marala	13.08.10	168903	Medium	110-180	100
32	Chenab	Marala	17.08.10	121372	Low	100-150	100
33	Chenab	Marala	20.08.10	136585	Low	110-150	100
34	Chenab	Marala	25.08.10	155138	Medium	60-120	71
35	Chenab	Khanki	01.08.10	136885	Low	100-250	100
36	Chenab	Khanki	07.08.10	157730	Medium	100-170	100
37	Chenab	Khanki	26.08.10	160338	Medium	90-140	86
38	Jhelum	Rasul	31.07.10	233292	High	170-230	98
39	Jhelum	Rasul	04.08.10	112377	Medium	80-110	98
40	Jhelum	Rasul	07.08.10	131474	Medium	100-140	100
41	Indus	Tarbela	09.08.10	572000	High	560-650	100
42	Kabul	Nowshera	10.08.10	249100	V-High	220-260	100
43	Indus	Kalabagh	10.08.10	668821	V-High	650 R 780	100
44	Indus	Kalabagh	24.08.10	377975	Medium	340-380	100
45	Indus	Chashma	08.08.10	743318	V-High	550-700	94
46	Indus	Chashma	11.08.10	803578	Ex-High	780-820	98
47	Indus	Chashma	25.08.10	505007	High	330-370	63
48	Indus	Taunsa	02.08.10	959991	EX-High	850-950	99
49	Indus	Taunsa	12.08.10	782698	V-High	760-780	100
50	Indus	Guddu	08.08.10	1130995	Ex-High	1100-1150	100
51	Indus	Guddu	16.08.10	1076728	Ex-High	1050-1080	100
52	Indus	Sukkur	09.08.10	1130995	Ex-High	1130-1150	100
53	Indus	Kotri	27.08.10	964897	Ex-High	965-980	100

R: Rising
F: falling

The overall accuracy of the forecast issued by FFD Lahore during the flood season 2010 has been calculated which shows a good 94.82% against all odds.

FLOOD LIMITS (IN LACS OF CUSECS):

RIVER	SITE	DESIGN CAPACITY	LOW	MED	HIGH	VERY HIGH	EXCEPTIONALLY HIGH
KABUL	NOWSHERA	-	0.45	0.47	1.0	2.0	4.0
	WARSAK	15.0	0.30	0.45	1.0	2.0	4.0
INDUS	TARBELA	15.0	2.5	3.75	5.0	6.5	8.0
	ATTOCK	-	2.5	3.75	5.0	6.5	8.0
	KALABAGH	9.5	2.5	3.75	5.0	6.5	8.0

	CHASHMA	9.5	2.5	3.75	5.0	6.5	8.0
	TAUNSA	10.0	2.5	3.75	5.0	6.5	8.0
	GUDDU	12.0	2.0	3.5	5.0	7.0	9.0
	SUKKUR	9.0	2.0	3.5	5.0	7.0	9.0
	KOTRI	8.5	2.0	3.0	4.5	6.5	8.0
JHELUM	KOHALA	-	1.0	1.5	2.0	3.0	4.0
	MANGLA	10.6	0.75	1.1	1.5	2.25	3.0
	RASUL	8.5	0.75	1.1	1.5	2.25	3.0
CHENAB	MARALA	11.0	1.0	1.5	2.0	4.0	6.0
	KHANKI	8.0	1.0	1.5	2.0	4.0	6.0
	QADIRABAD	8.07	1.0	1.5	2.0	4.0	6.0
	TRIMMU	6.45	1.5	2.0	3.0	4.5	6.0
	PANJNAD	7.0	1.5	2.0	3.0	4.5	6.0
RAVI	JASSAR	2.75	0.5	0.75	1.0	1.5	2.0
	RAVI SYPHON	4.5	0.4	0.65	0.9	1.35	1.8
	SHAHDARA	2.5	0.4	0.65	0.9	1.35	1.8
	BALLOKI	2.25	0.4	0.65	0.9	1.35	1.8
	SIDHNAI	1.5	0.3	0.46	0.6	0.9	1.3
SUTLEJ	SULEMANKI	3.25	0.5	0.8	1.2	1.75	2.25
	ISLAM	3.0	0.5	0.8	1.2	1.75	2.25