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LIST OF ACRONYMS

- AJK — Azad Jammu & Kashmir
- CDPC — Climate Data Processing Centre
- DCO — District Coordination Officer
- FFC — Federal Flood Commission
- FFD — Flood Forecasting Division
- IFAS — Integrated Flood Analysis System
- IRSA — Indus River System Authority
- KPK — Khyber Pakhtunkhwa
- MAF — Million Acre Feet
- NCAR — National Centre for Atmospheric Research
- NCEP — National Centre for Environmental Prediction
- NDMA — National Disaster Management Authority
- PCIW — Pakistan Commissioner for Indus Water
- PDMAs — Provincial Disaster Management Authority
- PMD — Pakistan Meteorological Department
- SDMA — State Disaster Management Authority
- WAPDA — Water And Power Development Authority
- XEN — Executive Engineer

Preface

Issuance of flood report after each flood season is a regular feature of Pakistan Meteorological Department (PMD), Flood Forecasting Division (FFD) Lahore. This report give us a comprehensive overview of all the events occurred during the flood season.

Flood report for the year 2017 has been prepared under the directives of Director General, Pakistan Meteorological Department. It contains all the detail pertaining to flood forecasting, like tracks of monsoon low, rainfall amount during wet spells, flood peaks, monthly and seasonal Isohyetal maps, normal Isopercental maps, flood limits and flood forecast evaluation report. FFD Lahore besides conventional practice of forecasting is also using flood forecasting models. Recently, a new flood routing and inundation model IFAS has been run on experimental basis. The foreign trained FFD experts are on the job to customize the model on local condition. The inundation results produced so far by the model are encouraging and helpful in briefing the flood mitigating agencies to minimize the flood losses in the country.

Chief Meteorologist
Flood Forecasting Division
Lahore

1 Executive summary

- Water Flow in rivers during Flood Season-2017, remained below high flood level, except only one high flood Peak observed in river Chenab at Marala. Only one medium flood peak was observed in river Indus at Kalabagh, which is the confluence point of rivers Indus, Kabul and Soan. Flow in river Jhelum at Mangla remained below low level except for one sharp peak of low level flood .Two Medium Flood Level peaks were observed in River Ravi at Balloki (Upstream) during Monsoon Season-2017.The most significant event of Flood Season-2017 is the torrential rainfall over Sindh at the end of August and in the start of September which due to a Well Marked Monsoon Low which developed over Bay of Bengal on 26-08-2017 and entered in vicinity of the country on 31-08-2017.
- Seasonal percentage departure map for precipitation during the present monsoon season indicates 23% below normal precipitation for whole of country. Calculating on province wise the detail is as given below

  Balochistan 38%, Kashmir 31%, Punjab 21%, Khyber Pakhtunkhwa 18%, Sindh 16% and Gilgit Baltistan 14% received below normal rainfall.
- Six monsoon lows originated during the present monsoon season, One of these entered Pakistan, four reached in the vicinity of the country and the Sixth recurved from central India to North-northeast ward.
- Nine rain bearing spells occurred during the monsoon season 2017.
- No High Flood situation was observed in any major river except one instance of High Flood flow in river Chenab. Only one sharp peak of Low flood was registered in River Jhelum at Mangla upstream.
- Two significant flood forecasts /warnings were issued by FFD during monsoon season 2017.
- The supply of hydro-meteorological data from WAPDA, Punjab and Sindh irrigation departments & Pakistan Commissioner for Indus Water (PCIW) remained satisfactory.
- All the concerned federal and provincial authorities, general public, along with print and electronic media were kept in touch with the prevailing weather/flood conditions through phone, fax & other electronic sources.
- Overall accuracy of forecast issued by FFD during the Monsoon Season 2017 has been calculated as **95.8%.**

2 Tracks of Monsoon Lows during monsoon season 2017

During the monsoon season 2017 (15th June to 15th October) Six Monsoon Lows/Depressions were developed.

1st Monsoon Low was developed over Northwest Behar on 11th July, 2017. Moving Southwest wards it was relocated over northeast Madhya Pradesh on 14th July, 2017. From here it moved northwest wards and centered over northwest Rajasthan on 16th July 2017, where it dissipated.

2nd Monsoon Low was developed on 19th July, 2017 over Northwest Bay of Bengal and adjoining Orissa. It moved northwest ward and reached North Madhya Pradesh on 21st July, 2017. From here it moved west wards for one day, then again Northwest wards and dissipated on 25th July, 2017 near West Rajasthan.

3rd Monsoon Low was developed over west Bengal on 26th July, 2017. After moving west wards, it reached north Madhya Pradesh on 28th July, 2017. From here it moved further West wards and dissipated over Southwest Rajasthan on 30th July, 2017.

4th Monsoon low was developed over north Bay of Bengal on 17th August, 2017 .It first moved Southwest wards then Northwest wards and dissipated over Southwest Rajasthan on 23rd August,2017.

5th Monsoon low was developed over northwest Bay of Bengal on 26th August, 2017 .It moved west northwest wards and after moving reached southeast Sindh where it dissipated.

6th and final Monsoon low was developed over northwest Bay of Bengal on 20th September, 2017 .It first moved Northwest wards then moving Northeast wards it dissipated over Uttar Pradesh on 24th August, 2017 The paths followed by each low/depression is shown in figure 1.

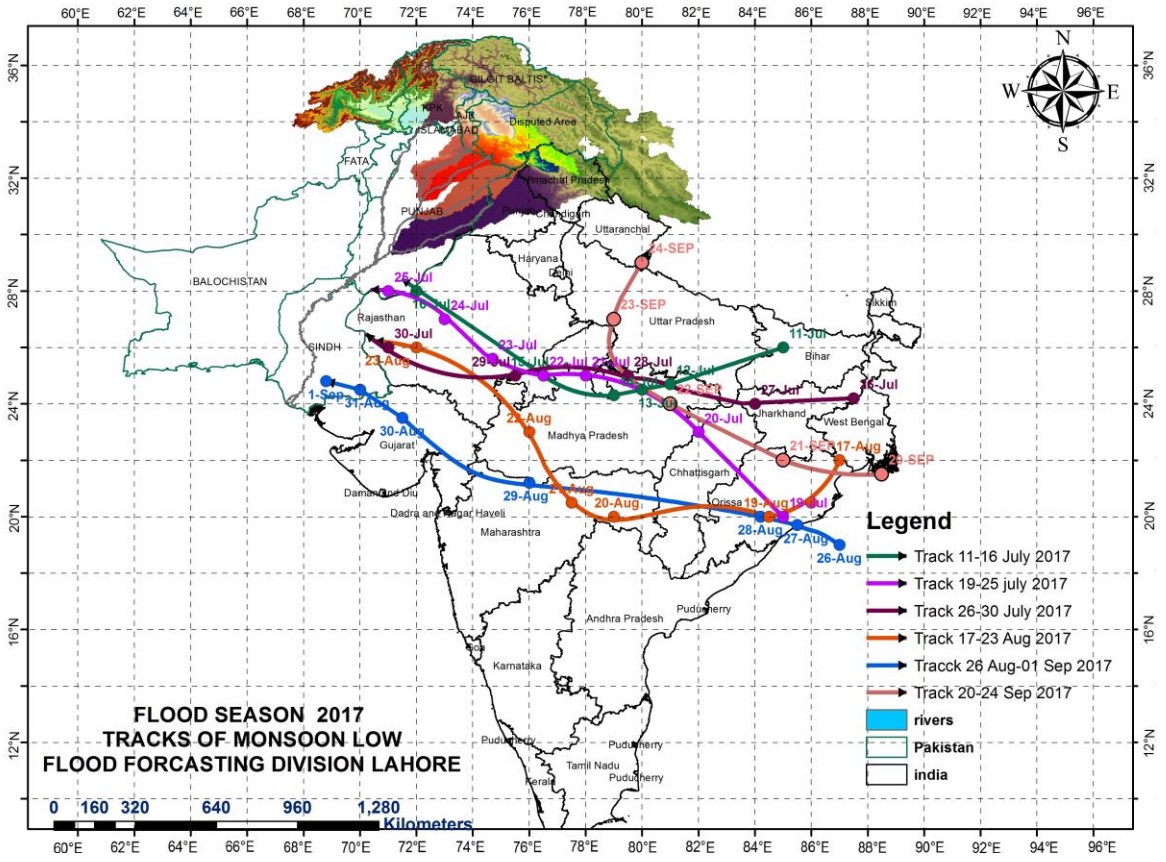


Figure 1: Tracks of Rain producing Monsoon System in Pakistan 2017.

3 Significant hydro-meteorological events during the month of June 2017

Two significant rainfall spells were reported during the month of June 2017 over Pakistan.

3.1 Meteorological events

No monsoon low was developed over Bay of Bengal during the month of June 2017. The rainfall mostly occurred across the country during the month of June 2017 which was due to the accentuation of seasonal low over Balochistan and passing of a westerly wave in the North of the country.

3.2 1st wet spell of June 2017 (19th to 22nd June 2017)

The first wet spell of June 2017 which remained active for four days was mainly due to the presence of a westerly trough accompanied by moist current from Arabian Sea. Figure 2 (a-d) represents 500 hpa and 850 hpa geopotential height patterns along with 925 hpa wind flow during the spell. It indicates that most part of Pakistan is under the influence of the westerly wave. Southwesterly winds at 925 hpa are also present ensuring enough moisture supply from the Arabian Sea.

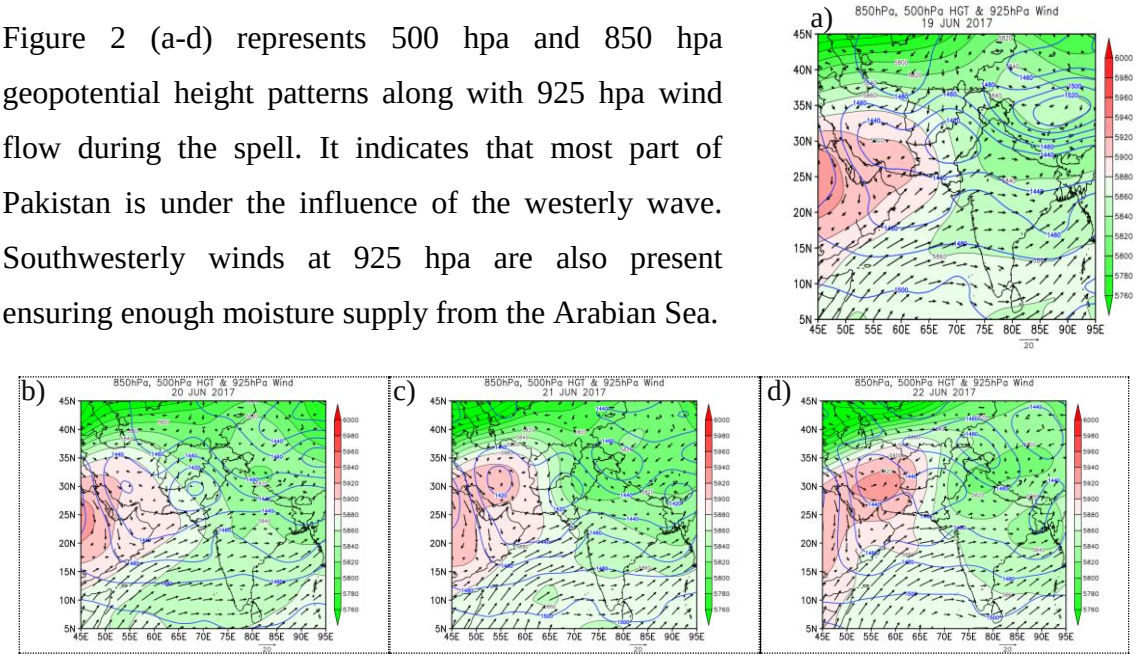


Figure 2: 500 & 850 hpa geopotential Height patterns and 925 hpa winds from 19th to 22nd June 2017.

Figure 3 shows spatial distribution of significant rainfall during this spell which shows maximum rainfall of more than 110 mm occurred over Bahawalpur division.

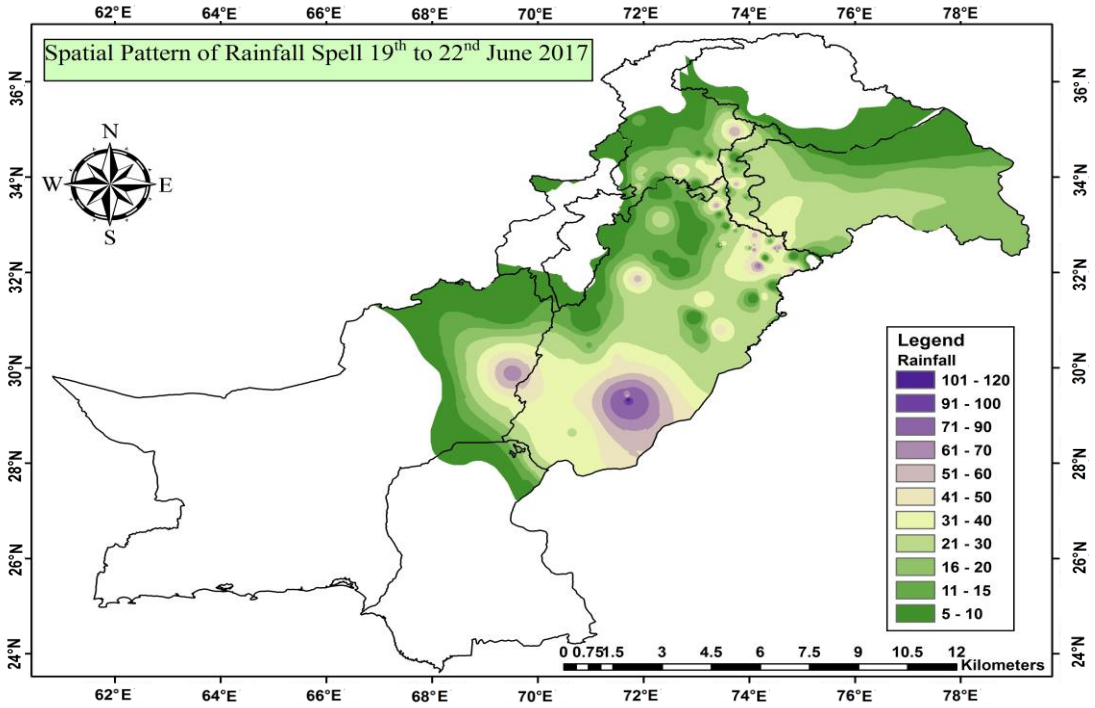


Figure 3: Spatial distribution of significant rainfall map of 19th-22nd June-2017.

Satellite images in figure 4 (a-c) showing dense clouds over south Punjab & thin clouds over north Punjab, Khyber Pakhtunkhwa, Kashmir during the spell of 19th to 22nd June-2017. Rainfall reported by RADAR is also shown below in figure 5 (a-c).

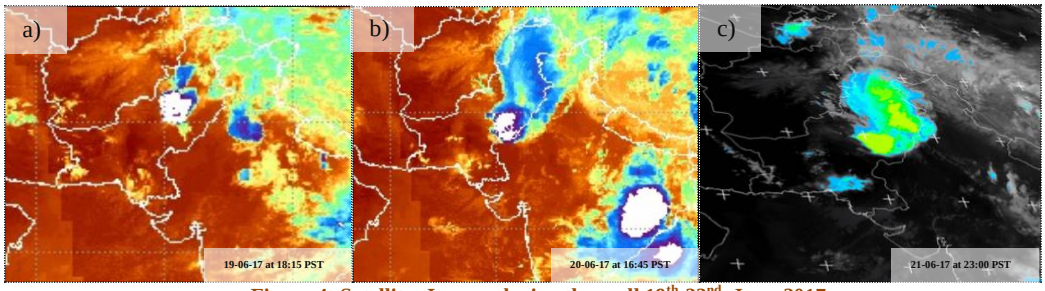


Figure 4: Satellites Images during the spell 19th-22nd June-2017.

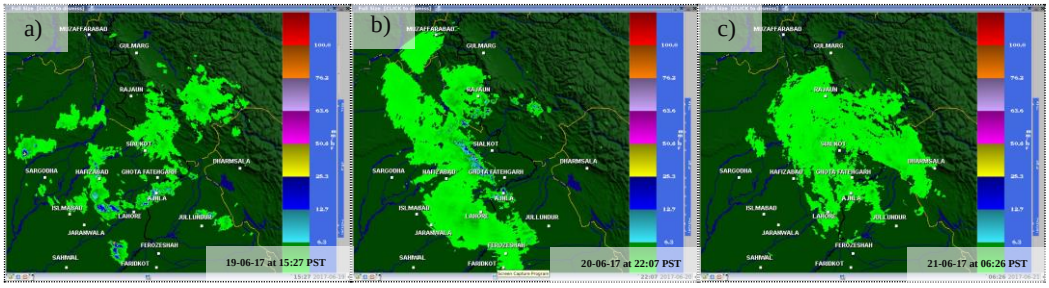


Figure 5: Radar Images during the spell 19th-22nd June-2017.

3.3 2nd wet spell of June 2017 (27th to 30th June 2017)

The second wet spell of June 2017 which remained active for four days was mainly due to the presence of a westerly trough accompanied by moist current from Arabian Sea and Bay of Bengal. Figure 6 (a-d) represents 500 hpa and 850 hpa Geopotential height patterns along with 925 hpa wind flow during this spell. It indicates that many parts of Pakistan are under the influence of westerly wave, Southwesterly winds at 925 hpa are also present ensuring enough moisture supply from the Arabian Sea.

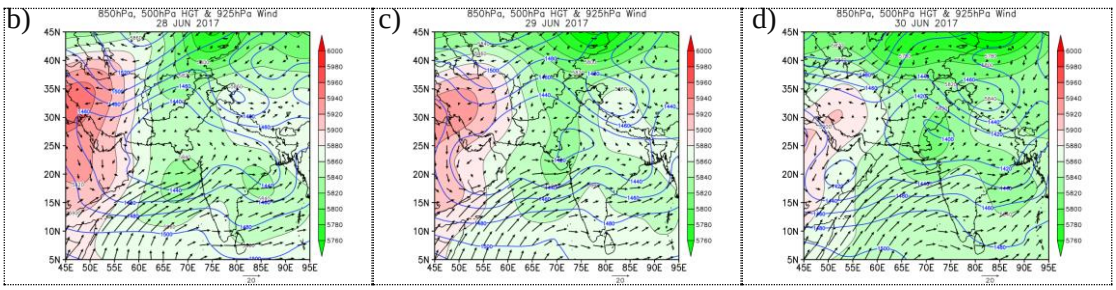


Figure 6: 500 & 850 hpa Geopotential Height patterns and 925 hpa winds from 27th to 30th June 2017.

Figure 7 indicates the spatial distribution of significant rainfall during the event which shows that maximum rainfall of more than 140 mm occurred over Kashmir. Moderate rainfall was also recorded in South and Southeast Sindh.

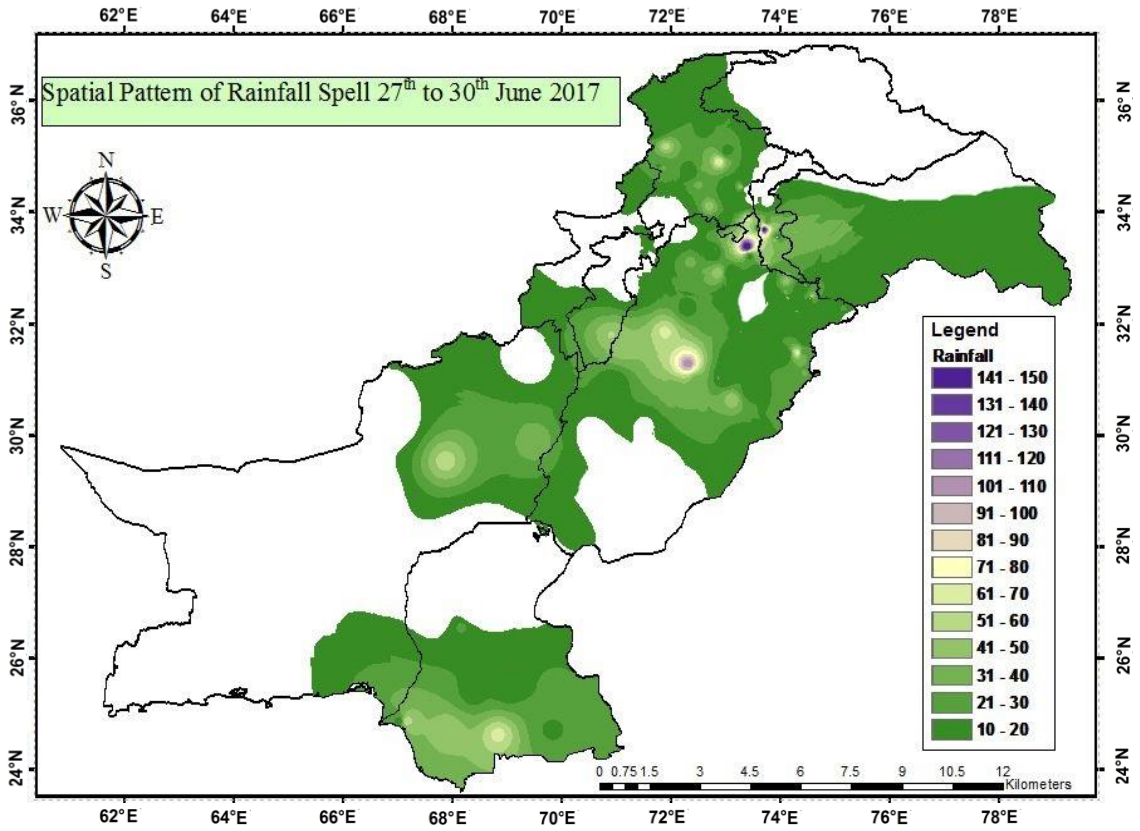


Figure 7: Spatial distribution of significant rainfall map of 28th -30th June-2017.

Satellite images in figure 8 (a-c) are showing dense clouds over Kashmir on 28th June, 2017 and South Sindh on 29th June. Rainfall reported by Radar is also shown below in figure 9 (a-c).

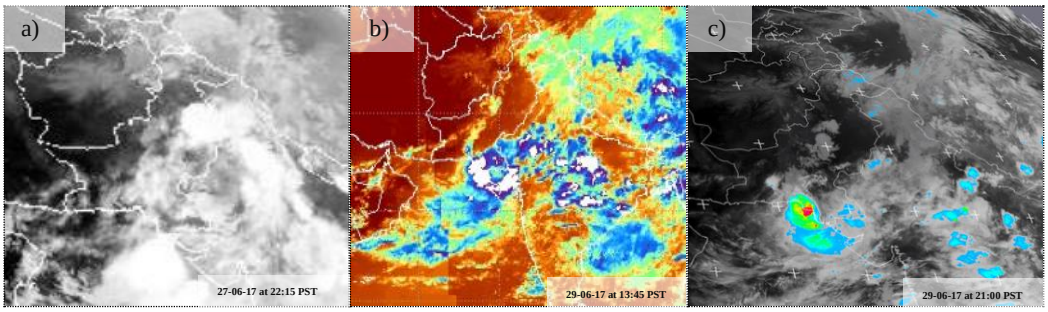


Figure 8: Satellites Images during the spell of 27th-30th June-2017.

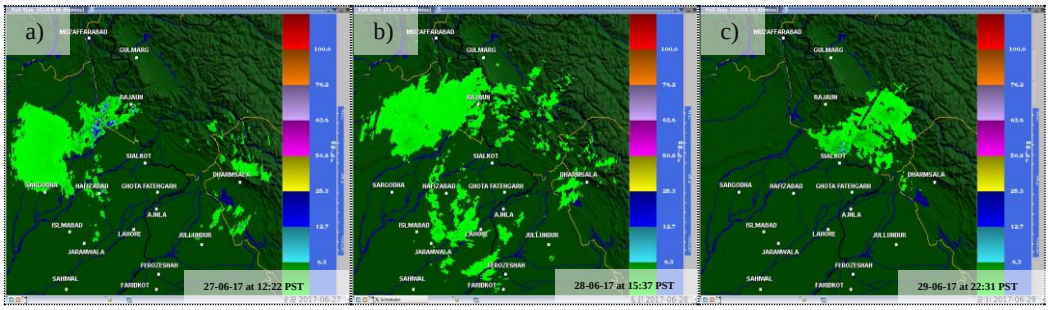


Figure 9: Radar Images during the spell of 27th-30th June-2017.

Figure 10 represents the temporal distribution of rainfall during the month of June-2017.

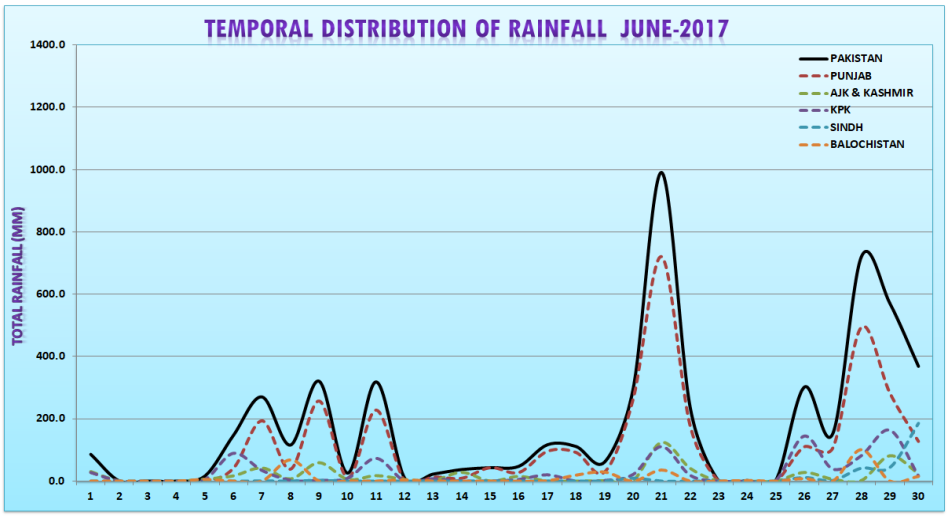


Figure 10: Temporal distribution of rainfall June 2017.

3.4 Rivers position during June 2017

Flood peaks (Cusecs) recorded during June, 2017 in different Rivers at various points are in table.

Date	Rivers	Stations	Peaks Inflows	Flood level
30/06/2017	**Indus**	**Tarbela**	262000	Low
27/06/2017	**Indus**	**Kalabagh**	251237	Low
30/06/2017	**Chenab**	**Marala**	180287	Medium
30/06/2017	**Chenab**	**Khanki**	176585	Medium
30/06/2017	**Kabul**	**Nowshera**	68900	Low

3.5 Hydrographs during June, 2017

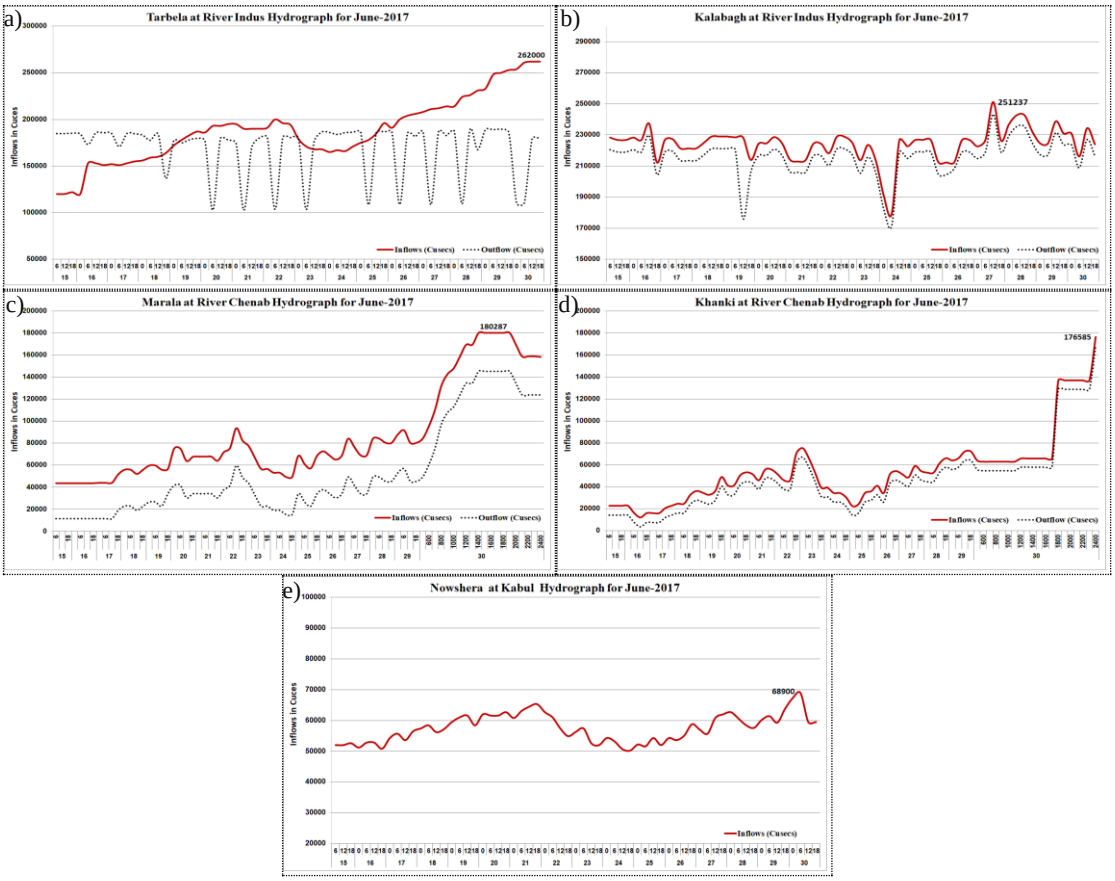


Figure 11: Hydrographs for the month of June-2017.

4 Significant hydro-meteorological events during the month of July 2017

Three significant rainfall spells occurred during the month of July 2017.

4.1 Meteorological events

First spell which occurred from 11th to 15th July 2017 was the result of the penetration of heavily moist current from Arabian Sea and Bay of Bengal into sub mountainous areas of Punjab & Kashmir under the effect of westerly wave passing over Northern parts of the country and accentuation of seasonal low into a well-marked low. The second spell of July was observed during 17th to 21st July, 2017. It was caused by the interaction of westerly wave passing over Northern parts of the country and the moist influx from Bay of Bengal and the monsoon low over Southwest Rajasthan. Third & final spell of the month of July was observed from 23rd to 25th July, 2017. It was also caused by a well-marked monsoon low and strong moist current from Bay of Bengal.

4.2 1st wet Spell of July 2017 (11th to 15th July 2017).

The first spell of July 2017 which was 3rd of the flood season 2017, lasted for 5 days. It was mainly due to the passing of a westerly wave, accentuation of seasonal low and incursion of moist current from Arabian Sea as well as Bay of Bengal. Figure 12 (a) below represents an accentuated seasonal low on 11th July present over northern parts of Balochistan and adjoining areas. Figure 12 (b) shows the influence of a westerly trough over northern parts of the Pakistan. An overall southwesterly trend of 925 hpa winds during spell days can also be witnessed in these charts showing in Figure 13 (c, d & e) which yielded into significant rainfall in Khyber Pakhtunkhwa North Punjab and Kashmir . Light rain was also recorded over Sindh and South Punjab.

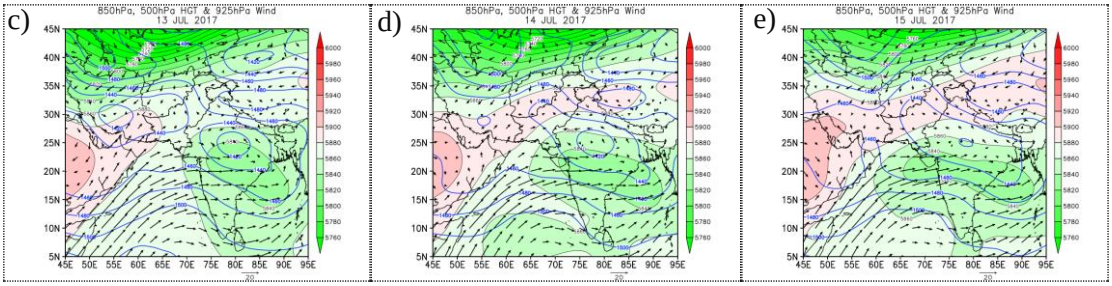


Figure 12: 500 & 850 hpa geopotential height patterns and 925 hpa winds from 11th to 15th July 2017.

Spatial distribution of significant rainfall during the spell is shown in figure 13 which shows that maximum rainfall of more than 160 mm was observed in North Punjab and adjoining Kashmir . Light to moderate rainfall was also observed over southeast Sindh.

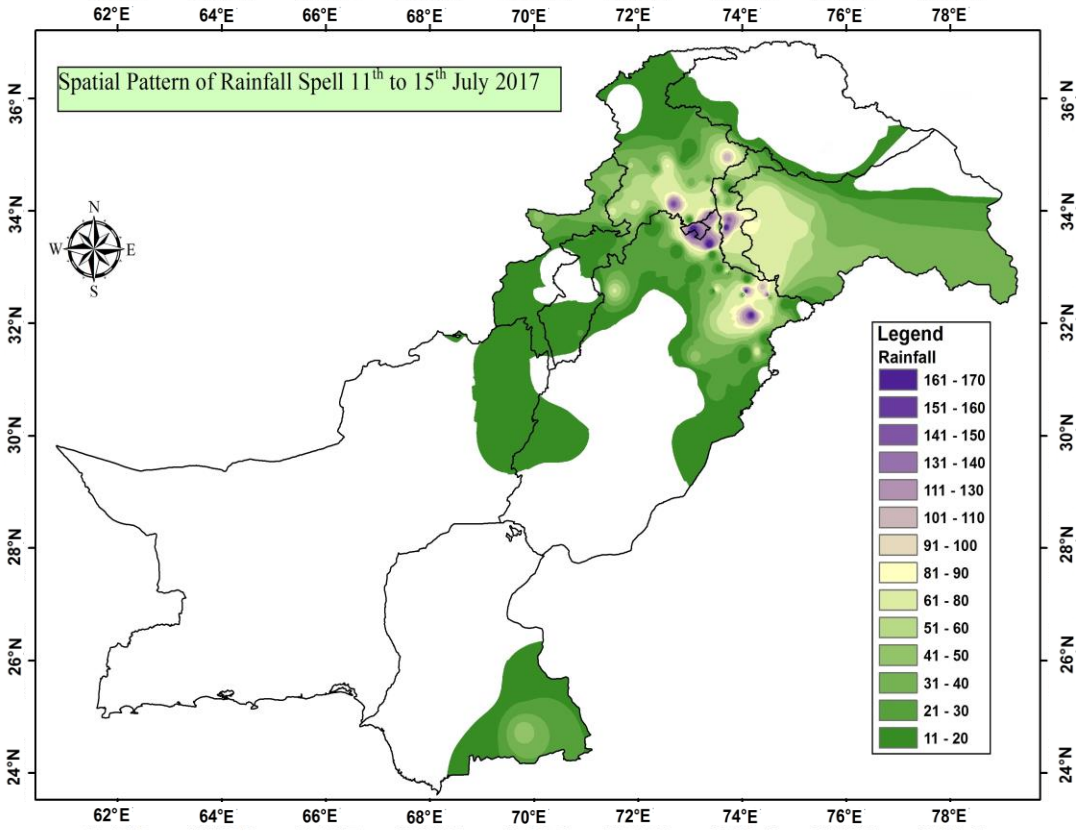


Figure 13: Spatial distribution of significant rainfall mam of 11th to 15th July 2017.

Satellite images during the spell in figure 14 (a-d) are showing dense clouds over Punjab, Khyber Pakhtunkhwa & Kashmir along with southeast Sindh and rainfall reported by radar is also shown below in figure 15 (a & b).

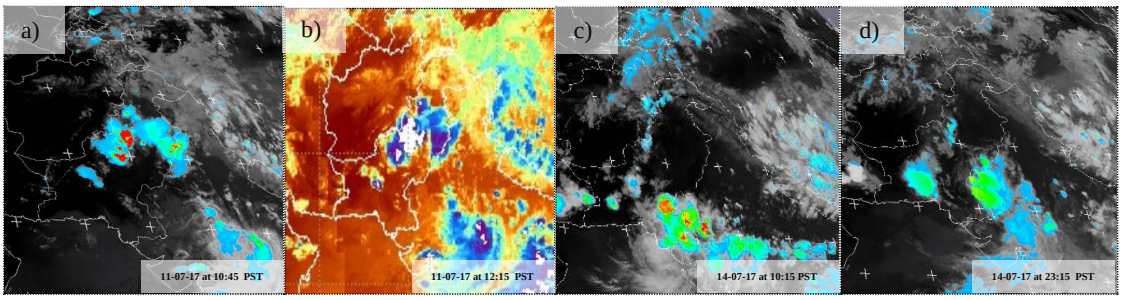


Figure 14: Satellites Images during the spell of 11th to 15th July 2017.

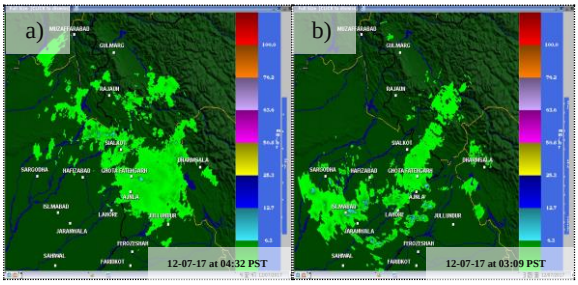


Figure 15: Radar Images during the spell of 11th to 15th July 2017.

4.3 Rivers position due to first wet spell of July

River Chenab at Marala, Khanki, Qadirabad and River Kabul at Nowshera attained the state of medium flood during the period while river Indus at Tarbela, Kalabagh, Chashma, and river Ravi at Balloki attained Low flood level due to this rainfall spell.

4.4 2nd wet spell of July 2017 (17th to 21st July 2017)

This long spell lasted for five days. Moderate rainfall was recorded at scattered places over Kashmir, Khyber Pakhtunkhwa & Punjab. Figures 16 (a-e) represent the geopotential heights at 500 hpa, 850 hpa and winds at 925 hpa during this wet spell. It also shows moderate southwesterly currents at 925 hpa entering most parts of Pakistan. Westerly trough is also seen influencing upper parts of the country.

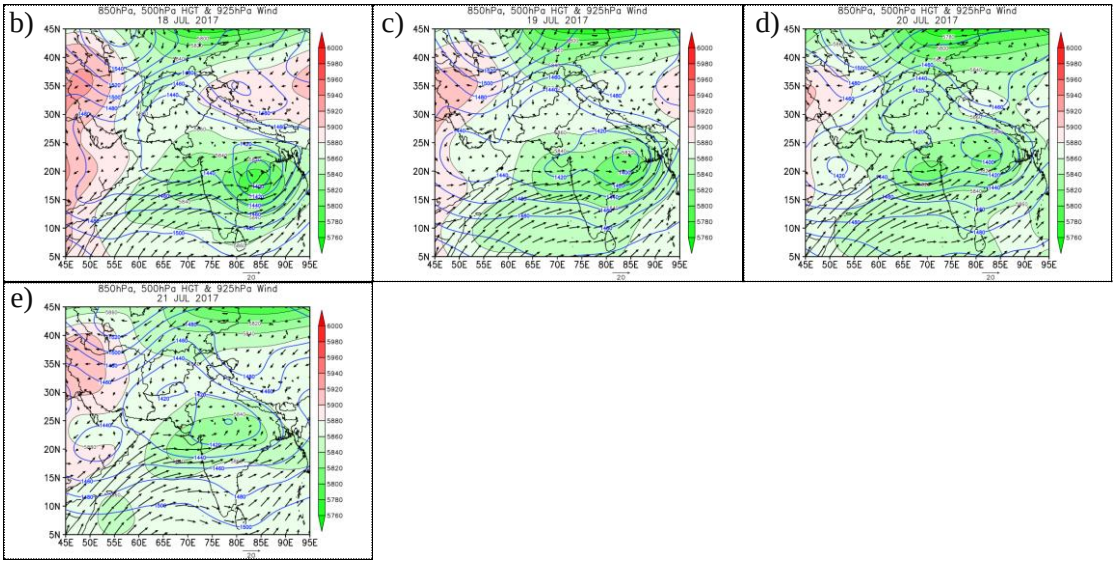


Figure 16: 500 & 850 hpa Geopotential height patterns and 925 hpa winds from 17h -21th July 2017

Spatial rainfall distribution during the spell is shown in figure 17 which shows maximum rainfall of more than 80 mm recorded around Mangla, and more than 70 mm over Marala, Risalpur, Kakul and Jhelum along with Kashmir and South Sindh .

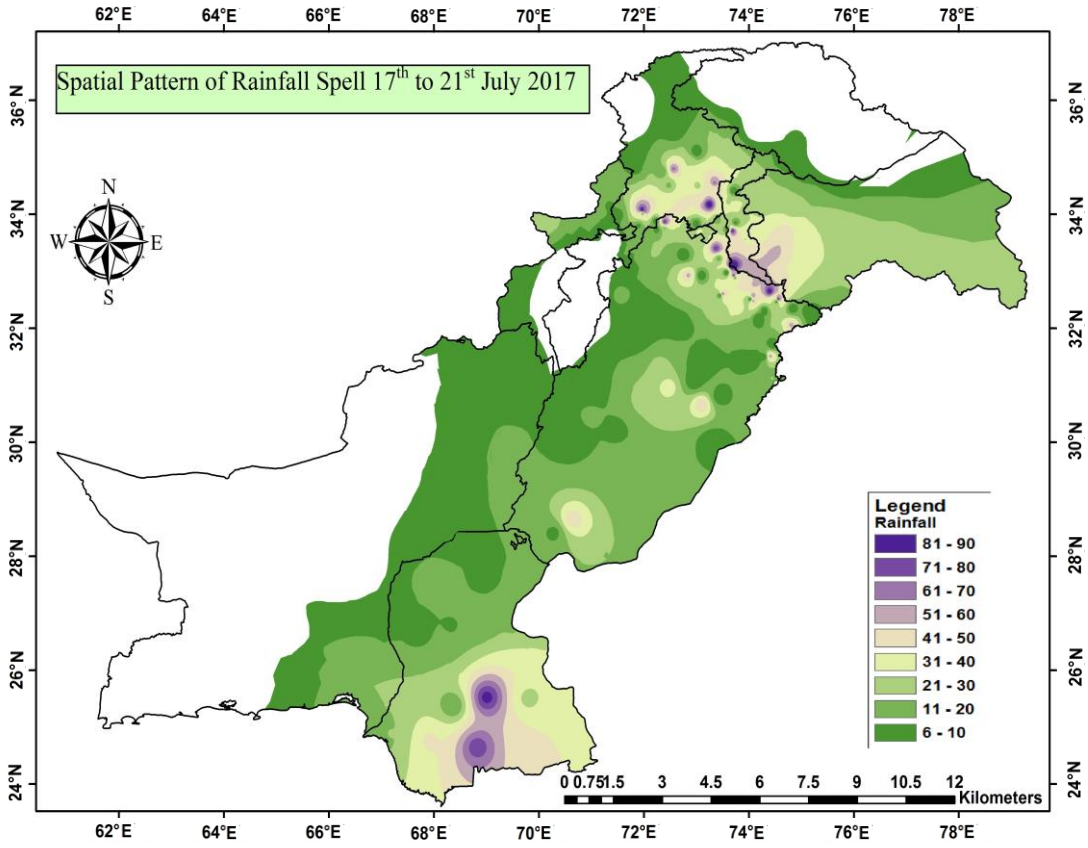


Figure 17: Spatial distribution of significant rainfall map of July 2017 (17-21 July).

Radar images in figure 18 (a-c) shows moderate rainfall intensity in the upper catchments of Rivers Chenab & Jhelum and Satellite images showing dense clouds over Kashmir in figure 19 (a & b).

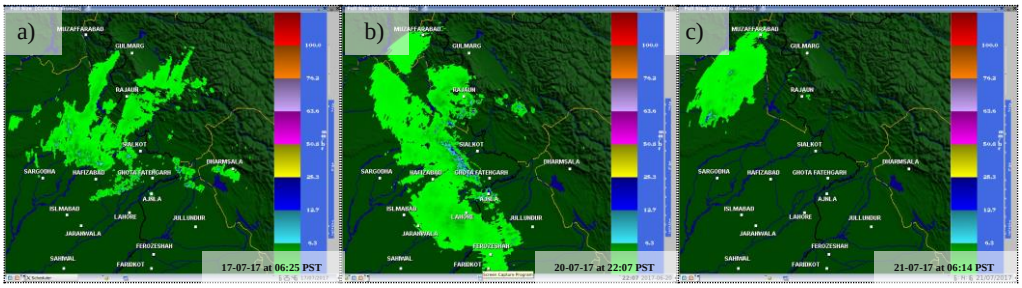


Figure 18: Radar Images during the spell of July 2017 (17-21 July).

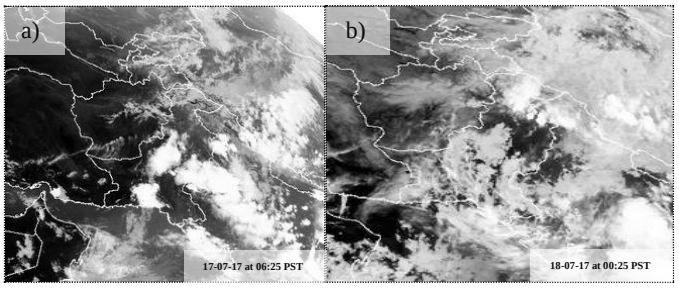


Figure 19: Satellites Images during the spell of July 2017 (17-21 July).

4.5 Rivers position due to second wet spell of July

River Chenab at Marala attained High flood level and Medium flood level at Khanki and Qadirabad respectively. River Kabul at Nowshera & river Indus at Tarbela, Kalabagh, Chashma and Taunsa along with River Jhelum at Mangla attained Low flood level. During this rainy spell all other major rivers remained below Low flood level.

4.6 3rd wet spell of July 2017 (23rd to 25th July 2017)

This spell lasted for three days. The rainfall of heavy intensity was recorded over Kamra while light to moderate rainfall was observed over Kashmir, north & northeast Punjab, northeast Balochistan and southeast Sindh. Atmospheric conditions from 23rd to 25th July 2017 are shown in figure 20 (a-c). Monsoon low over south Rajasthan and moderate southwesterly incursion of moist winds at 925 hpa produced rainfall during this period.

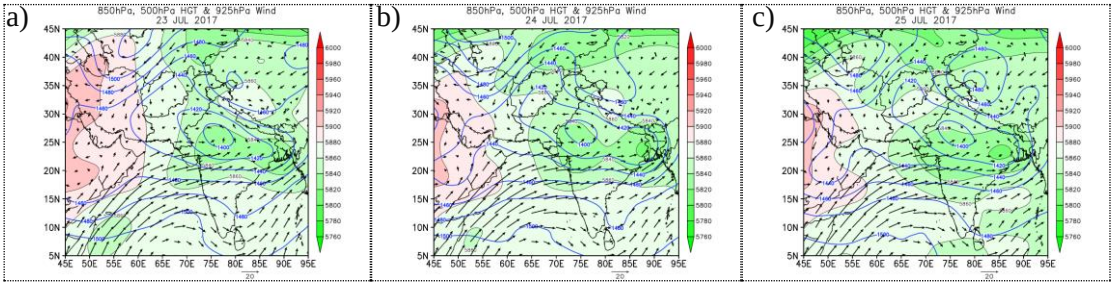


Figure 20: 500 & 850 hpa geopotential height patterns and 925 hpa winds from 23th to 25h July 2017.

Spatial distribution of rainfall during this spell is shown in figure 21 which indicates maximum rainfall of more than 85 mm occurred around Kamra. More than 50 mm rainfall was also observed at Mangla. Light to moderate rainfall was also recorded at Mithi and Mirpur Khas.

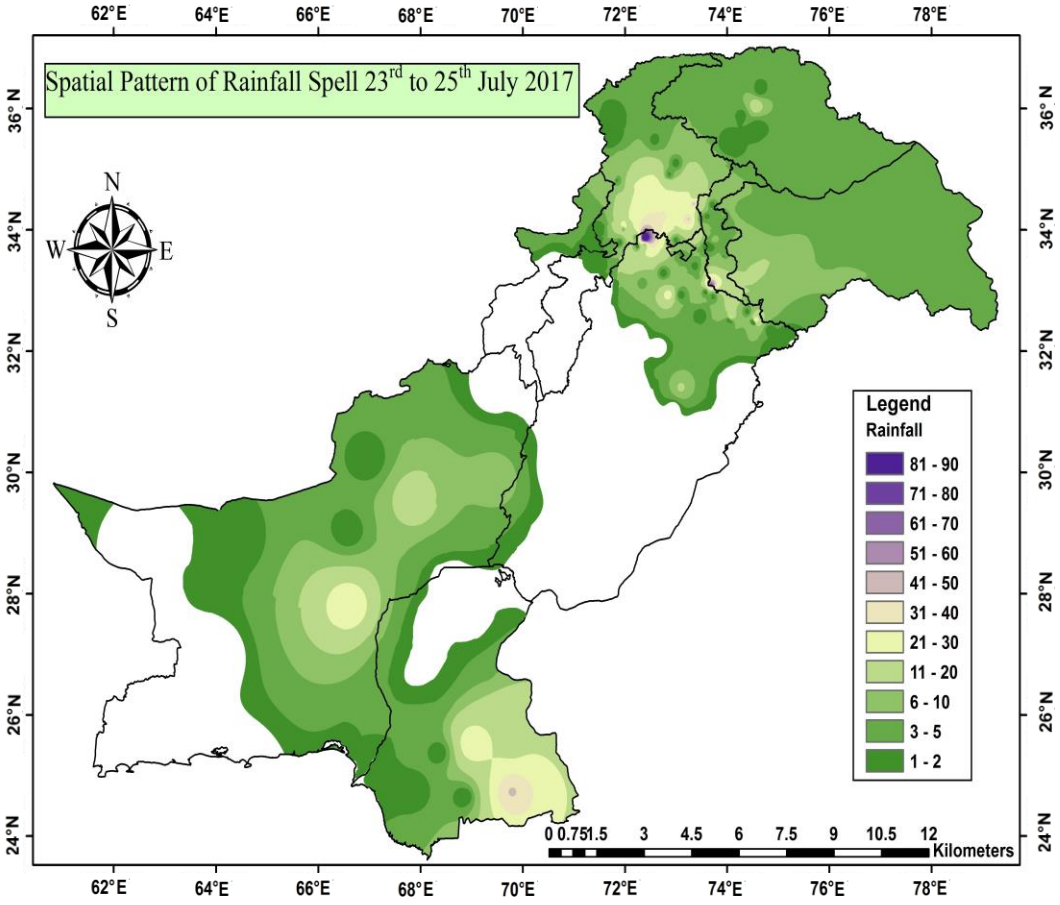


Figure 21: Spatial distribution of significant rainfall map of July 2017 (23-25 July).

Satellite images in Figure 22 (a) show dense clouds over southeast Sindh, rainfall reported by Radar is also shown below in figure 22 (b & c).

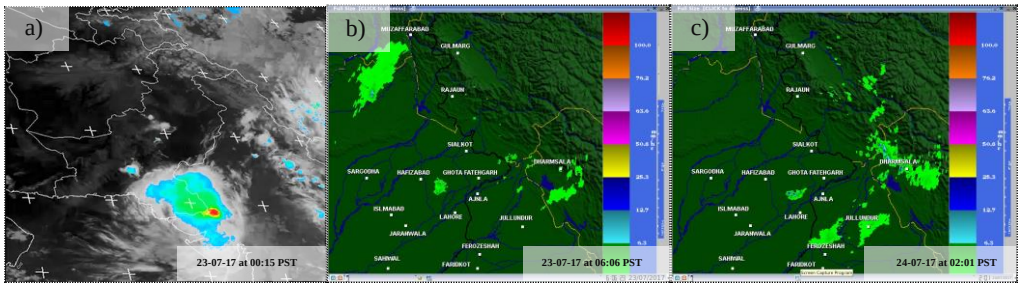


Figure 22: Satellite & Radar Images during the spell of July 2017 (23-25 July).

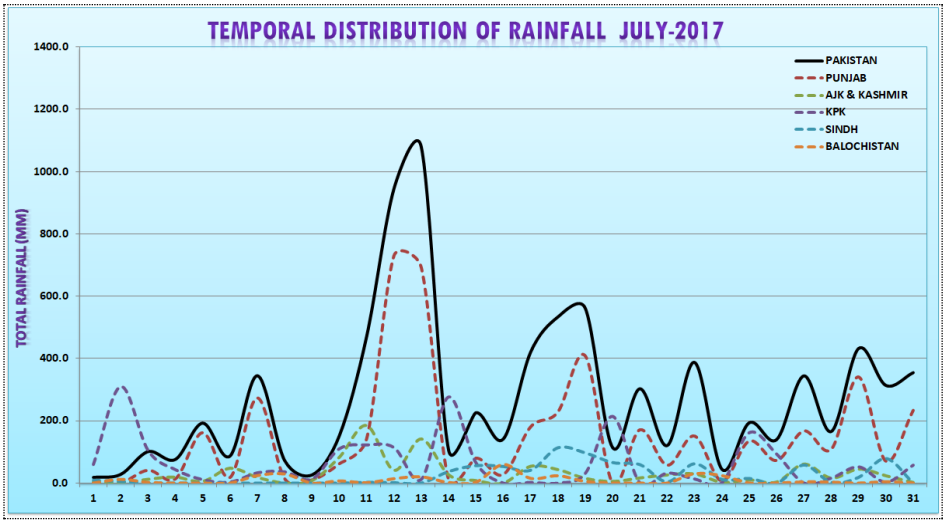


Figure 23: Temporal distribution of rainfall during July 2017.

4.7 Spatial pattern of rainfall during the month of July 2017

Isohyetal map of July 2017 indicates that one maxima rainfall (more than 350 mm) lies over northeast Punjab around Sialkot and another center of rainfall of more than 330 mm lies over north Punjab around Kamra. Two rainfall centers of more than 300 mm also observed over Muzaffarabad and Risalpur as shown in figure 24.

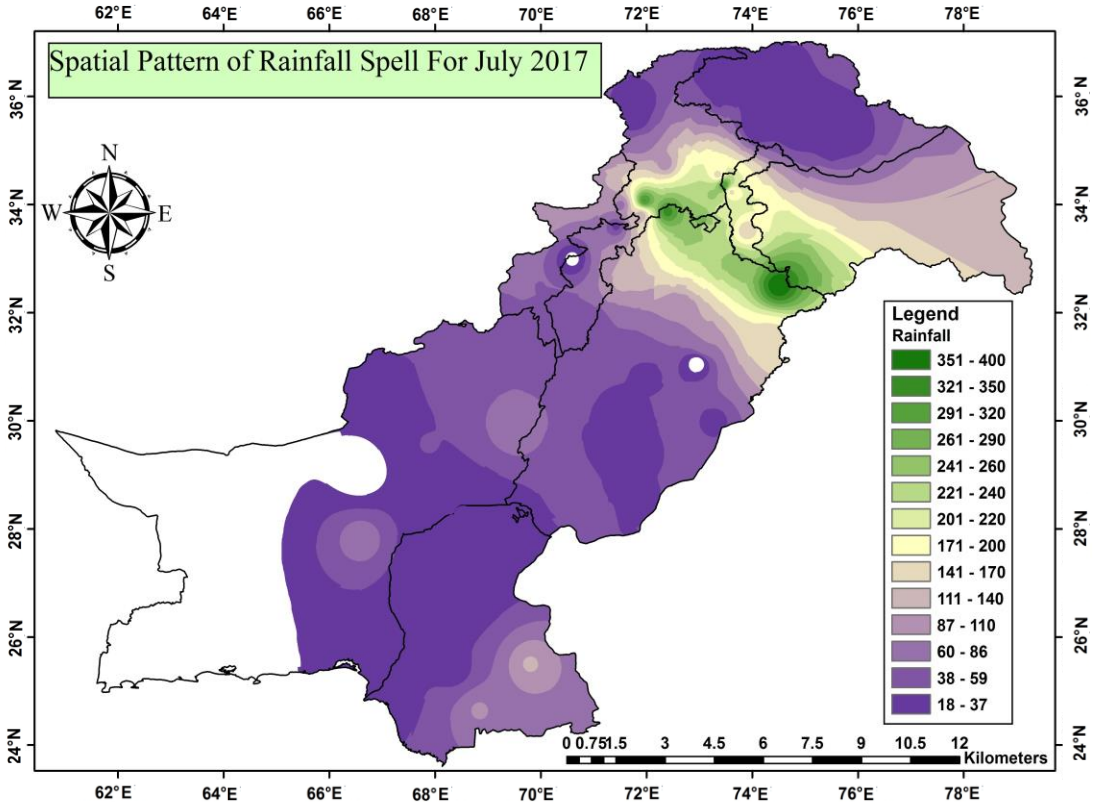


Figure 24: Spatial distribution of significant rainfall map of July 2017.

4.8 Rivers position during the month of July 2017

Flood peaks recorded in rivers during July, 2017 are shown in table.

Date	Rivers	Stations	Peaks Inflows(Cusecs)	Flood level
14/07/2017	**Indus**	**Tarbela**	289000	Low
19/07/2017	**Indus**	**Tarbela**	296000	Low
31/07/2017	**Indus**	**Tarbela**	321000	Low
13/07/2017	**Kabul**	**Nowshera**	87000	Medium
13/07/2017	**Indus**	**Kalabagh**	288357	Low
21/07/2017	**Indus**	**Kalabagh**	308416	Low
19/07/2017	**Indus**	**Chashma**	310227	Low
30/07/2017	**Indus**	**Chashma**	318363	Low
22/07/2017	**Indus**	**Taunsa**	260138	Low
27/07/2017	**Indus**	**Taunsa**	273848	Low
25/07/2017	**Indus**	**Guddu**	245825	Low
30/07/2017	**Indus**	**Guddu**	241699	Low
12/07/2017	**Chenab**	**Marala**	167046	Medium
17/07/2017	**Chenab**	**Marala**	135525	Low
19/07/2017	**Chenab**	**Marala**	216020	High
31/07/2017	**Chenab**	**Marala**	169338	Medium
13/07/2017	**Chenab**	**Khanki**	178251	Medium
19/07/2017	**Chenab**	**Khanki**	192670	Medium
31/07/2017	**Chenab**	**Khanki**	167040	Medium
01/07/2017	**Chenab**	**Qadirabad**	167697	Medium
13/07/2017	**Chenab**	**Qadirabad**	159299	Medium
19/07/2017	**Chenab**	**Qadirabad**	186660	Medium
17/07/2017	**Jhelum**	**Mangla**	94000	Low
16/07/2017	**Ravi**	**Balloki**	50755	Low

4.9 Hydrographs recorded during the month of July 2017 are as below

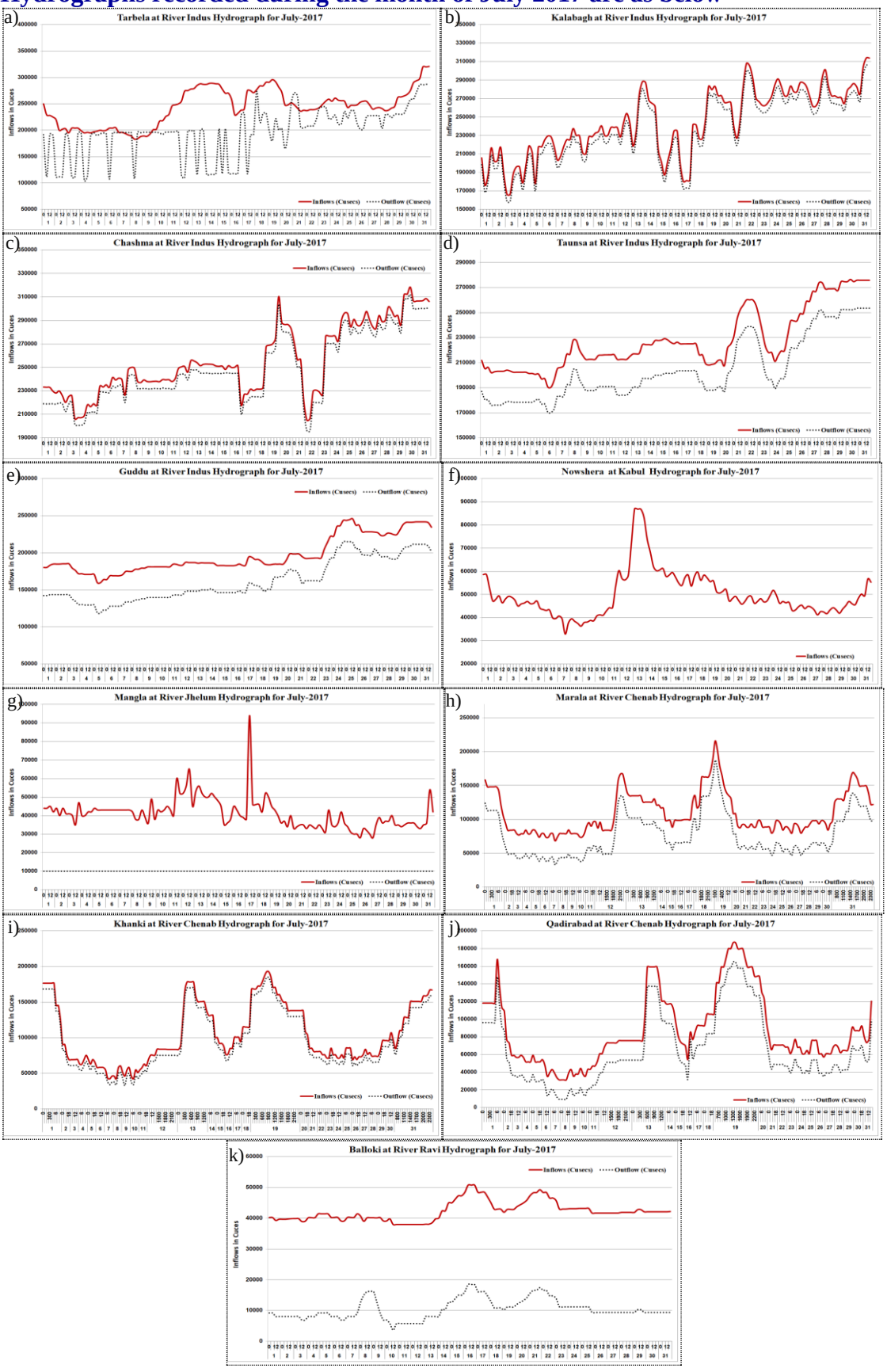


Figure 25: Hydrographs for the month of July-2017.

5 Significant hydro-meteorological events during the month of August 2017

5.1 Meteorological events

Three rainy spells occurred during the month of August-2017. First spell produced rainfall from 2nd to 4th August. This spell was caused by the presence of a seasonal low over northeast Balochistan and moderate moist current from the Arabian Sea. Second wet spell of the August was observed from 24th to 26th. This spell was caused by the interaction of Westerly wave over northern parts of the country and seasonal low along with moist current from the Arabian Sea. Third and final spell occurred from 30th August to 2nd September 2017. This spell was caused by the presence of a Monsoon low over south east Sindh , passing of a westerly wave along with accentuation of seasonal low and penetration of strong moist current from both the sources i.e from Bay of Bengal & Arabian Sea.

5.2 1st wet spell of August (02nd to 4th August 2017)

The rainfall during the first spell of August occurred during 2nd to 4th August 2017. Heavy to very heavy rainfall was observed during this spell at Jhelum in Punjab. Moderate to heavy rain was also observed over northeast Punjab. Atmospheric conditions during this wet spell are shown in figure 26 (a-b) also it shows a southwesterly flow at lower level in Punjab.

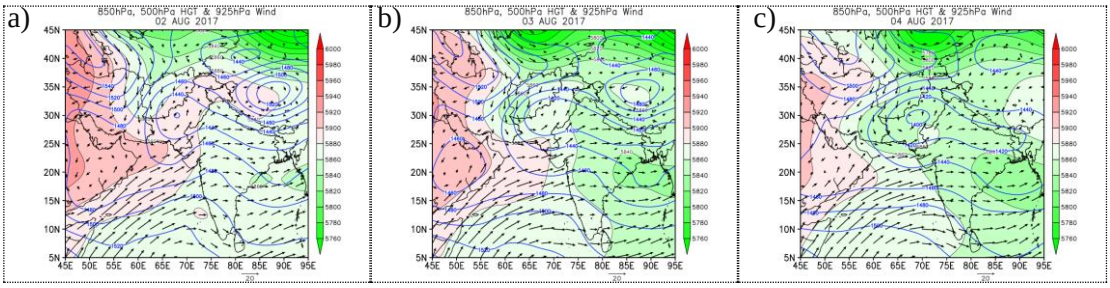


Figure 26: 500 & 850 hpa geopotential height patterns and 925 hpa winds on 2nd to 4th August 2017.

Isohyetal map of 2nd to 4th August 2017 indicates that one maxima of rainfall (more than 150 mm) lies over upper Punjab around Jhelum and another maxima of rainfall of more than 100 mm lies over northeast Punjab. Figure 27 gives the spatial distribution of significant rainfall during this spell.

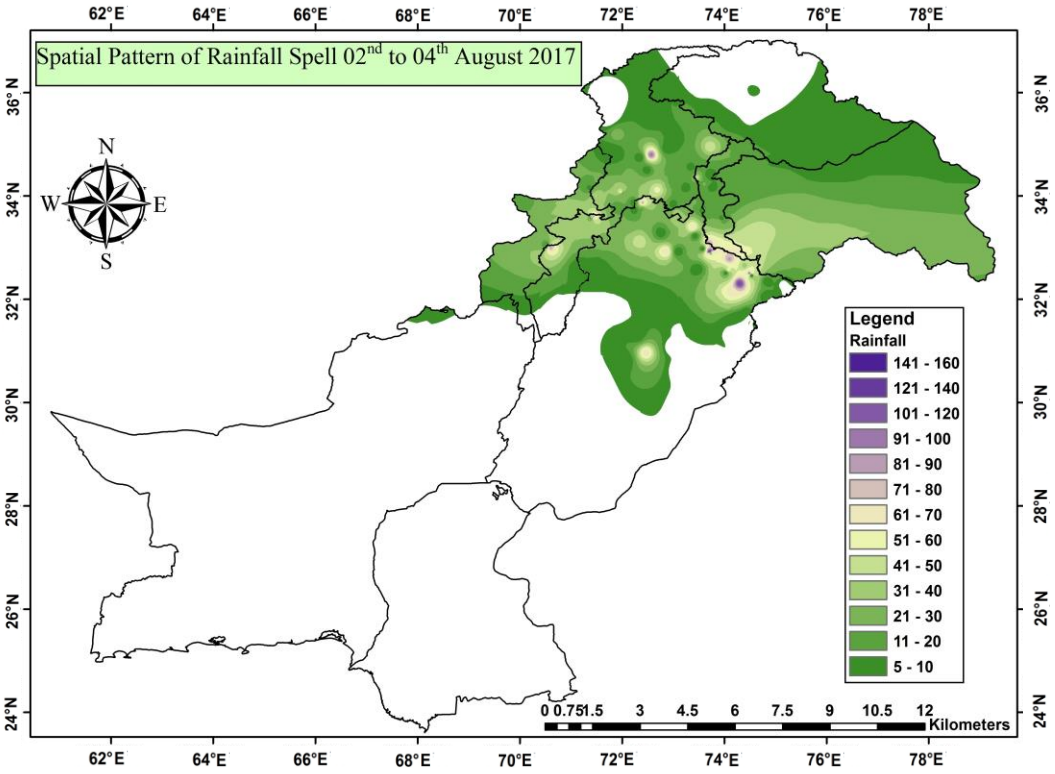


Figure 27: Spatial distribution of significant rainfall map of August 2017 (02-05 August).

Satellite images in figure 38 (a & b) are showing dense clouds over North-Northeast Punjab & Kashmir Rainfall reported by Radar is also shown below in figure 29 (a-c).

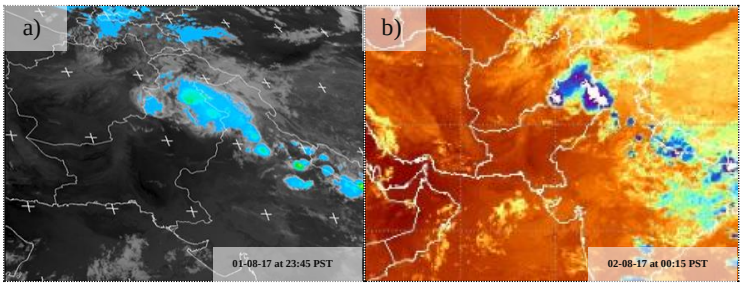


Figure 28: Satellites Images during the spell of August 2017 (02-05 August).

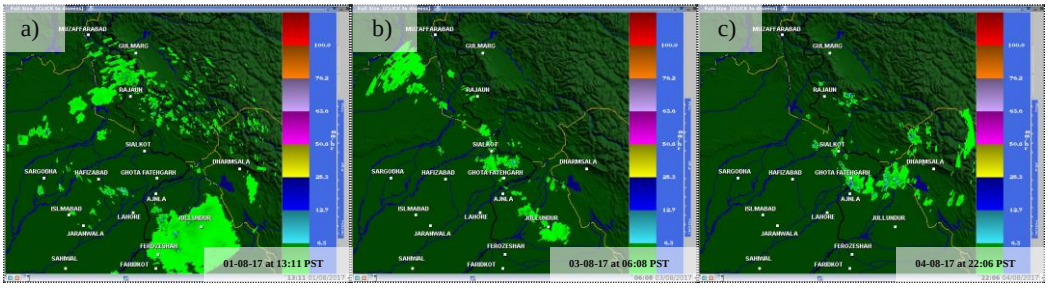


Figure 29: Radar Images during the spell of August 2017 (02-05 August).

5.3 Rivers position during first spell of August-2017

Due to heavy rainfall in the upper catchments of river Chenab in India, Medium level flood was observed in river Chenab at Marala, Khanki, and Qadirabad. Moderately heavy rainfall over the upper catchments of River Indus generated medium level flood at Kalabagh, Chashma & Taunsa during the spell. Low Flood situation was recorded in river Indus at Tarbela, Guddu and in river Kabul at Nowshera. River Ravi at Balloki also recorded a medium level flood situation.

5.4 2nd wet spell of August (24th to 26th August 2017)

Rainfall of moderate to heavy intensity was recorded over North-Northeast Punjab and Kashmir. Figure 30 (a-c) represent the atmospheric conditions during this wet spell. This wet spell was caused by a westerly trough affecting upper parts of the country and the influx of southwesterly currents at 925 hpa.

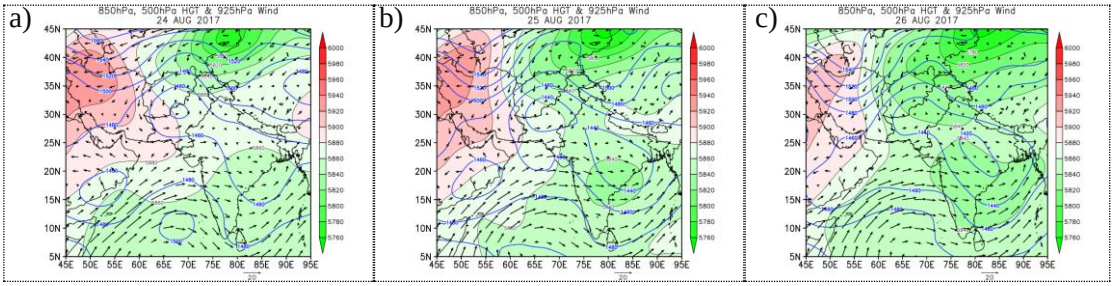


Figure 30: 500 & 850 hpa geopotential height patterns and 925 hpa winds on 24th to 26th August 2017.

Figure 31 shows the spatial distribution of significant rainfall of more than 120 mm recorded over North Punjab.

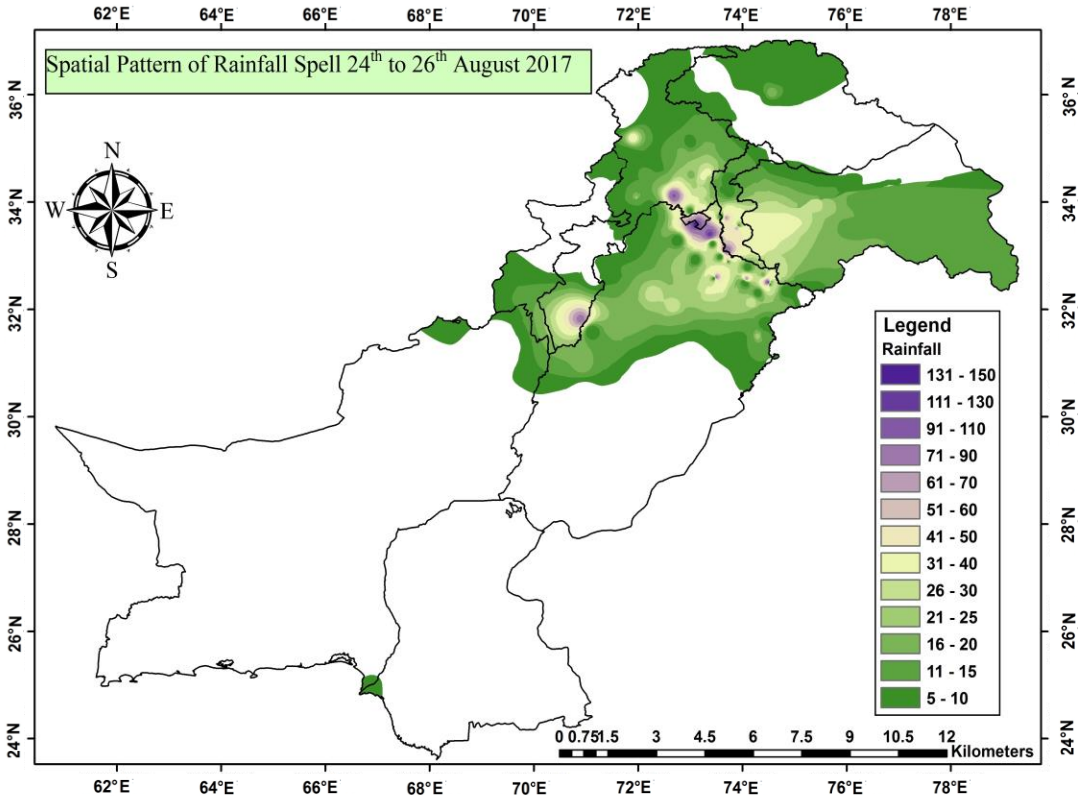


Figure 31: Spatial distribution of significant rainfall map of August 2017 (24-26 August).

Radar image in figure 32 (a) shows rainfall intensity over north Punjab and satellite image in figure 32 (b) is showing dense clouds over north and northeast Punjab.

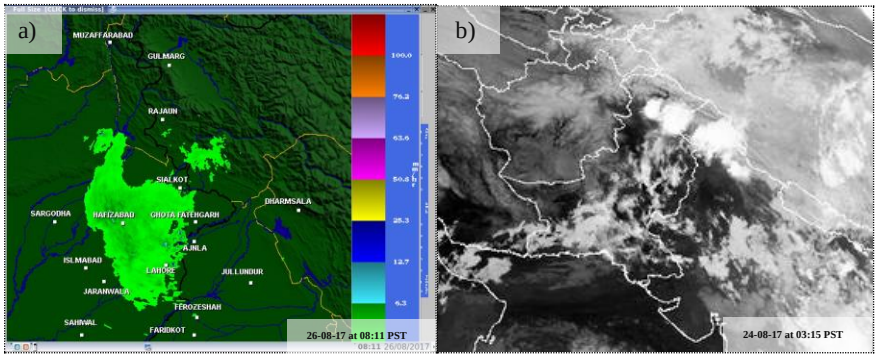


Figure 32: Radar & Satellites Images during the spell of August 2017 (24-26 August).

5.5 Rivers position during the second spell of August-2017

During this spell, Low flood level was recorded in River Ravi only at Balloki.

5.6 3rd wet spell of August (30th August to 02nd September 2017)

Third spell of August was caused by the passing of a westerly wave and accentuation of seasonal low along with presence of monsoon low over southeast Sindh. Figure 33 (a-d) are showing this situation with southwesterly flow at lower level.

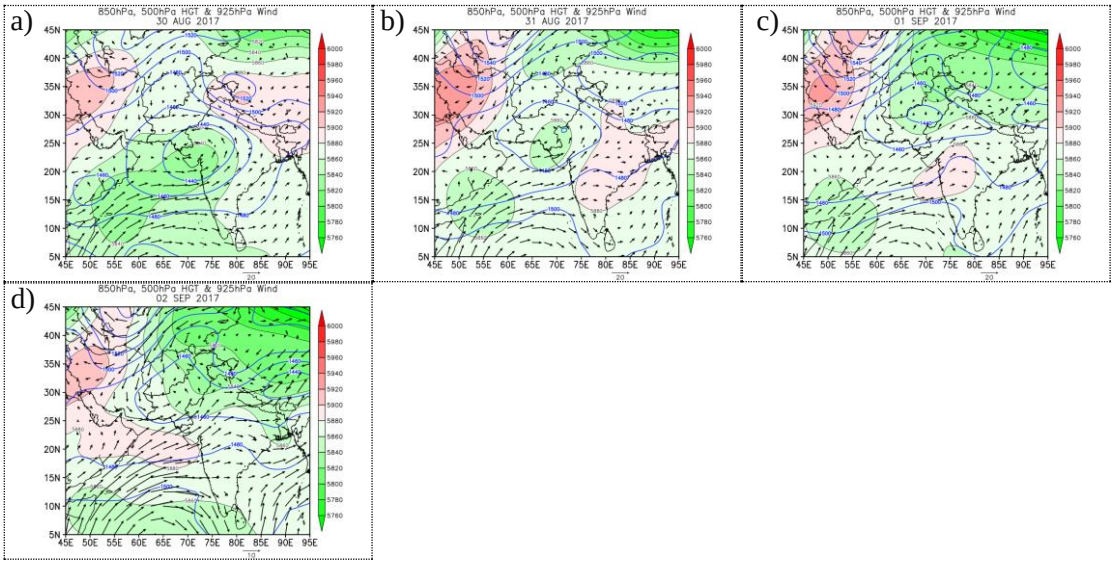


Figure 33: 500 & 850 hpa geopotential height patterns and 925 hpa winds from 30th August to 02nd Sep-2017.

Satellite images in figure 34 (a & b) and Radar images in 35 (a-c) during the spell are showing below.

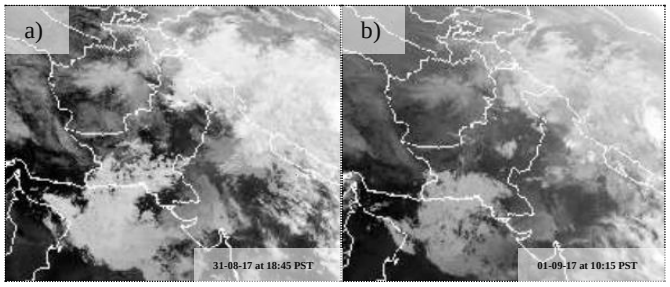


Figure 34: Satellites Images during the spell of August 2017 (30 August-02 September).

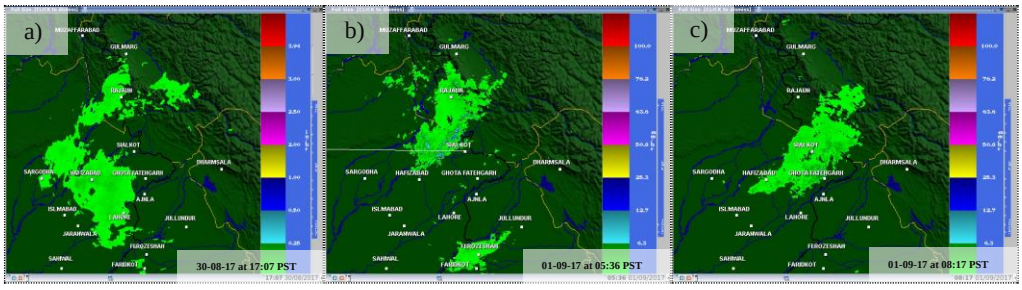


Figure 35: Radar Images during the spell of August 2017 (30 August-02 September).

Isohyetal map of 30th August to 02nd September 2017 indicates that one maxima of rainfall (more than 90 mm) lies over Kakul and another over Jhang. More than 40 mm of rain was also recorded over Sindh at Hyderabad, Karachi, Mithi, Shaheed Benazirabad and Badin as shown in figure 36.

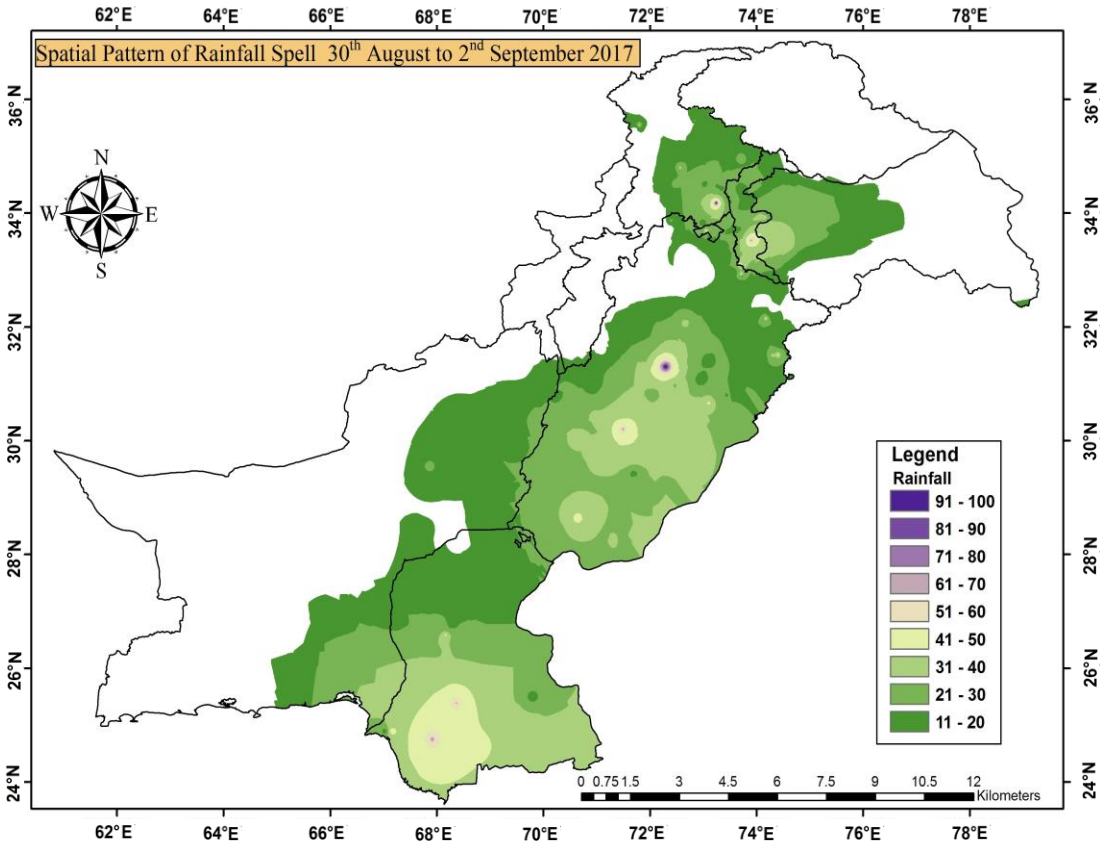


Figure 36: Spatial distribution of significant rainfall map of August 2017 (30 August-02 September).

5.7 Rivers position during the Spell

No significant flood situation was observed in all the major rivers.

5.8 Spatial distribution of rainfall during the month of August 2017

The precipitation during the month of August is shown in figure 37 which indicates below normal monsoon activity over most parts of the country. One center of maximum rainfall exceeding 300 mm is located at Jhelum in north Punjab. While another maxima of slightly above 200 mm is located around Islamabad & Kashmir. More than 100 mm rainfall was also recorded over South Sindh.

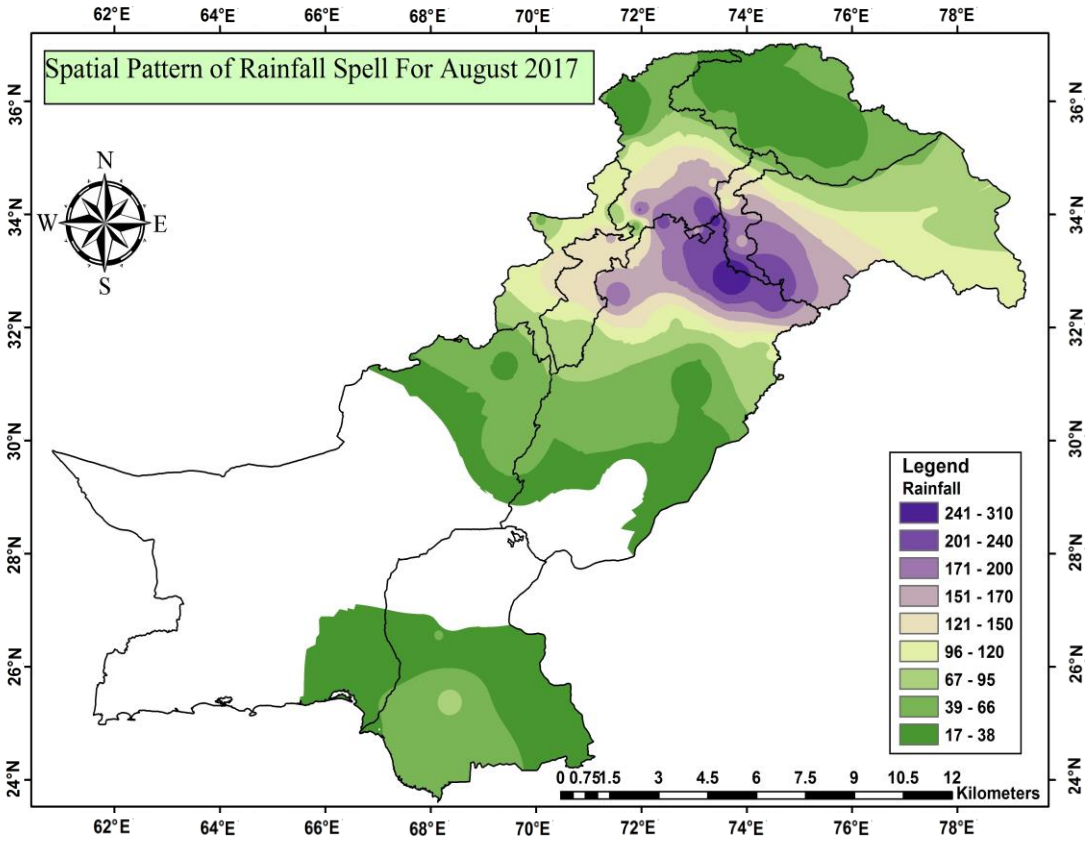


Figure 37: Spatial distribution of significant rainfall map of August 2017.

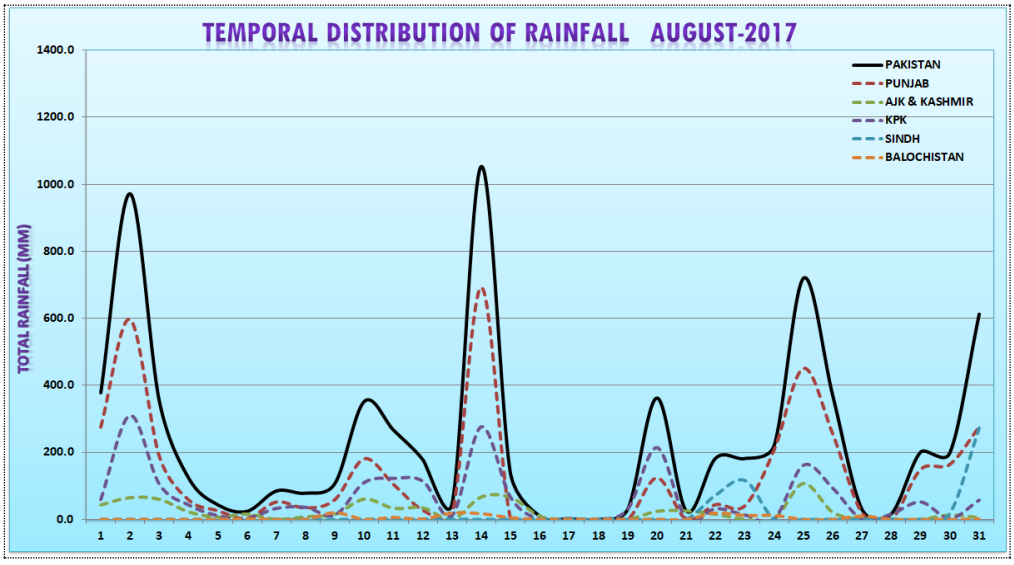


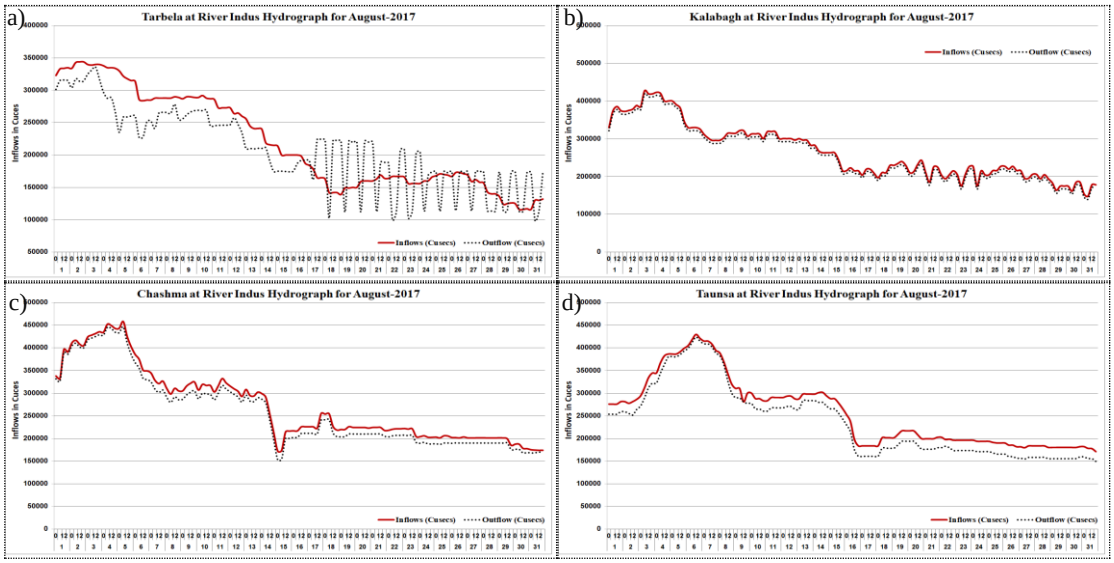
Figure 38: Temporal distribution of rainfall during August 2017.

5.9 Rivers position during the month of August-2017

Flood peaks recorded during August, 2017 are shown in table

Date	Rivers	Stations	Peaks Inflows (Cusecs)	Flood level
02/08/2017	**Indus**	**Tarbela**	344000	Low
04/08/2017	**Kabul**	**Nowshera**	76600	Low
03/08/2017	**Indus**	**Kalabagh**	427460	Medium
05/08/2017	**Indus**	**Chashma**	458245	Medium
17/08/2017	**Indus**	**Chashma**	255406	Low
06/08/2017	**Indus**	**Taunsa**	429861	Medium
09/08/2017	**Indus**	**Guddu**	459811	Medium
11/08/2017	**Indus**	**Sukkur**	390863	Medium
18/08/2017	**Indus**	**Kotri**	251298	Low
02/08/2017	**Chenab**	**Marala**	148700	Low
03/08/2017	**Chenab**	**Khanki**	178546	Medium
03/08/2017	**Chenab**	**Qadirabad**	176420	Medium
04/08/2017	**Ravi**	**Balloki**	68145	Medium
11/08/2017	**Ravi**	**Balloki**	69890	Medium

5.10 Hydrographs observed during the month of August 2017 are as under



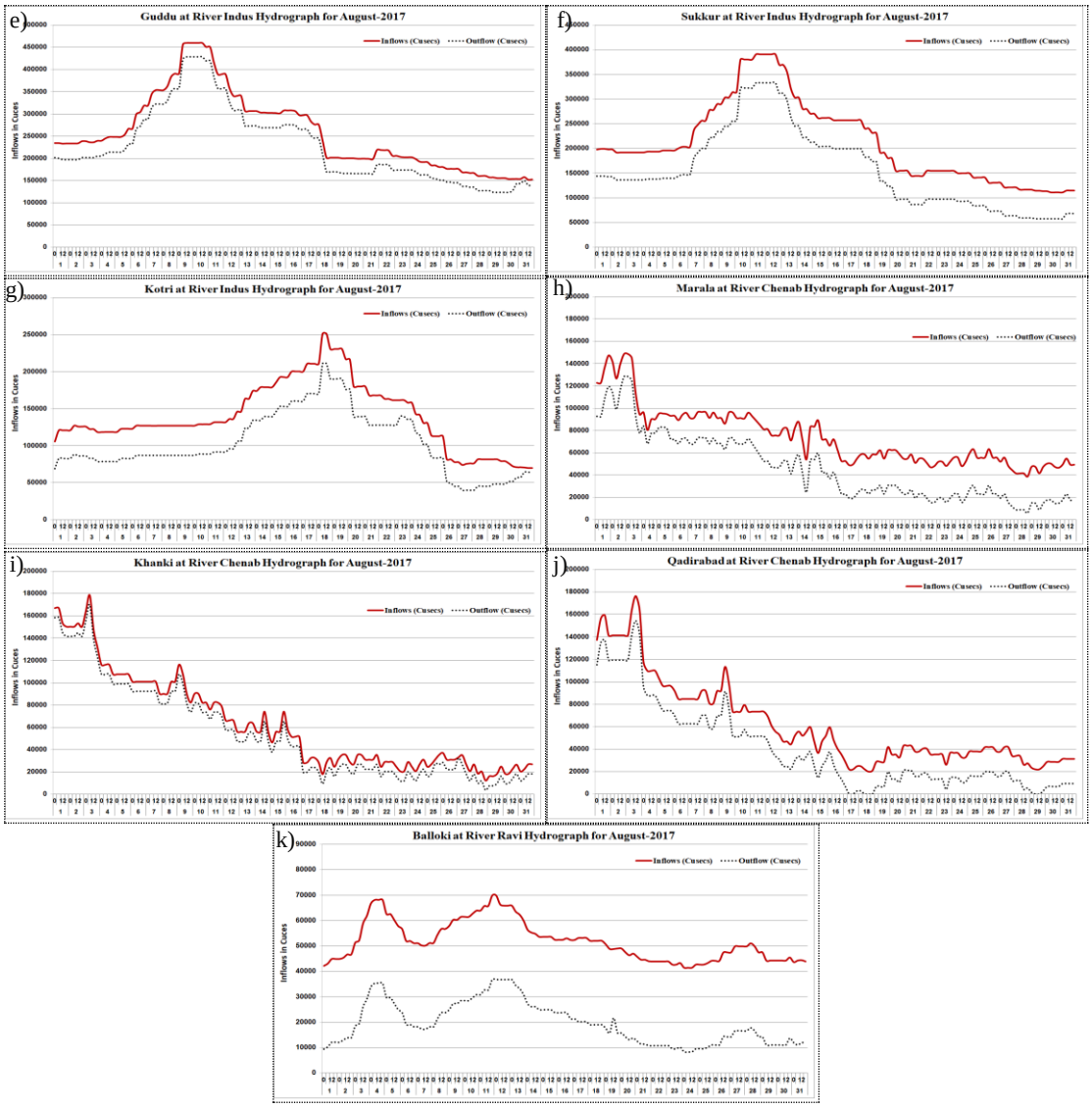


Figure 39: Hydrographs for the month of August-2017.

6 Significant hydro-meteorological events during the month of September 2017

During the month of September only one monsoon low developed over Bay of Bengal and only one wet spell was recorded during the month.

6.1 1st wet spell of September (11th to 15th September 2017)

The only rainy spell of September occurred from 11th to 15th September 2017. During this event moderate to heavy rainfall was reported from Kashmir, North Punjab & Khyber Pakhtunkhwa. This situation was created by the presence of a westerly wave over north of Pakistan interacting with the presence of sufficient moisture available as shown in Figure 40 (a-e). Figure 41 shows the spatial distribution of rainfall during this spell.

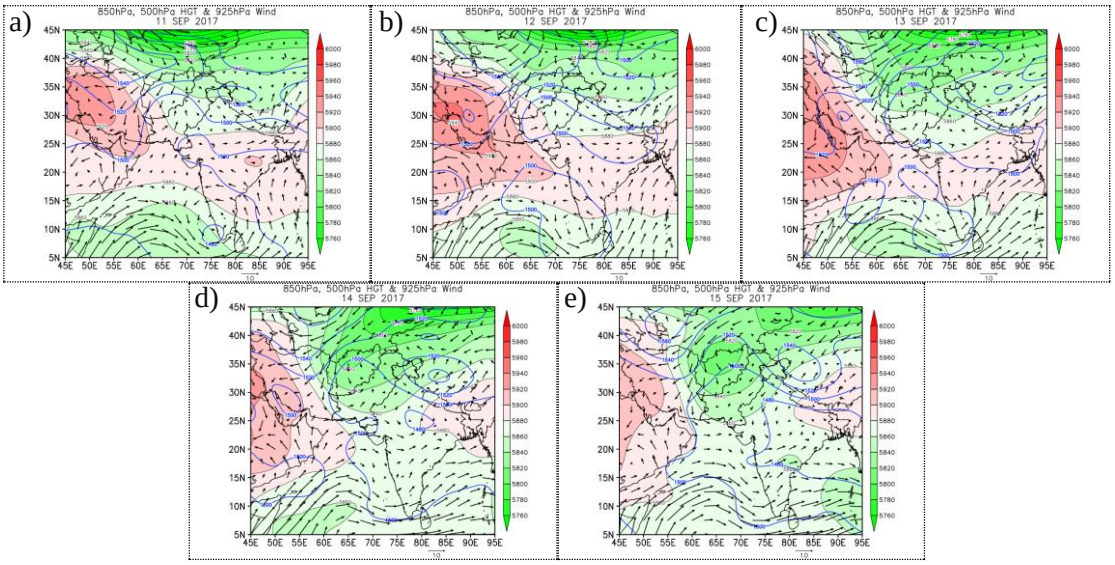


Figure 40: 500 & 850 hpa geopotential height patterns and 925 hpa winds on 11th to 15th September 2017.

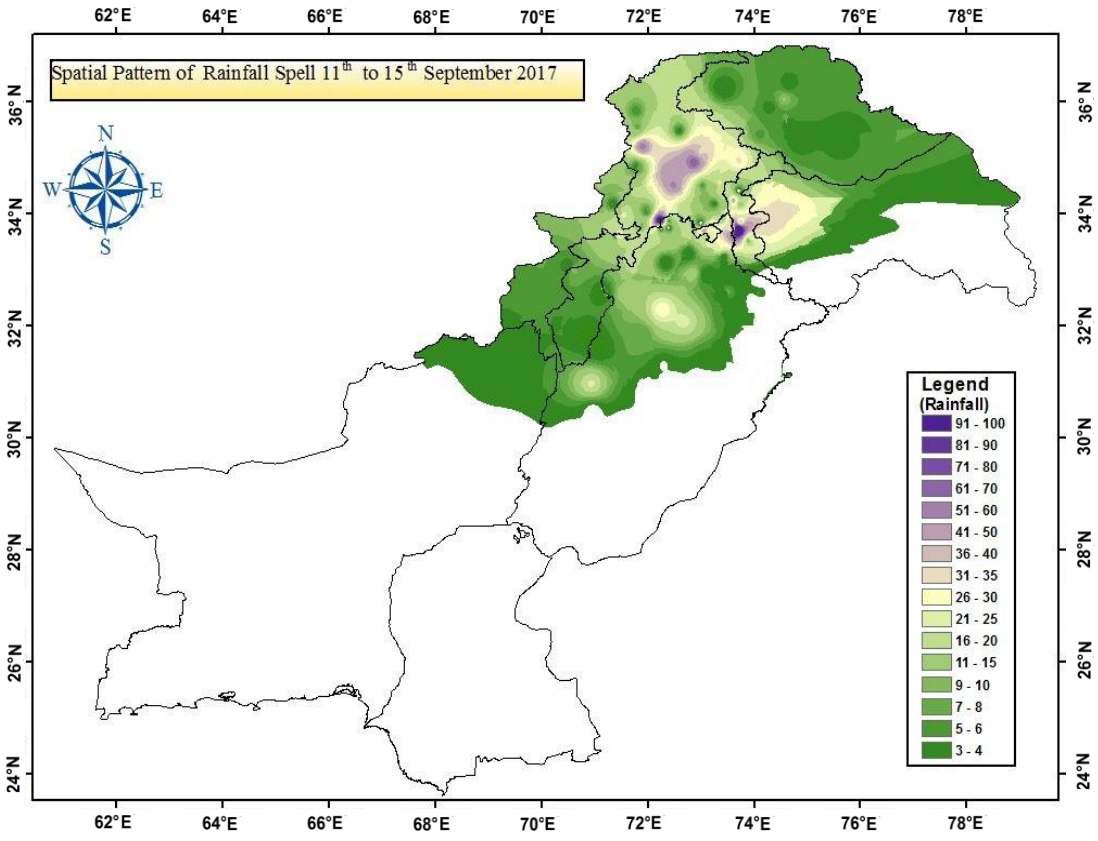


Figure 41: Spatial distribution of significant rainfall map of September 2017 (11-15 September).

Satellite image in figure 42 (a) is showing moderate clouds over North Punjab & upper Khyber Pakhtunkhwa along with Kashmir and Rainfall reported by Radar is also shown below in Figure 42 (b).

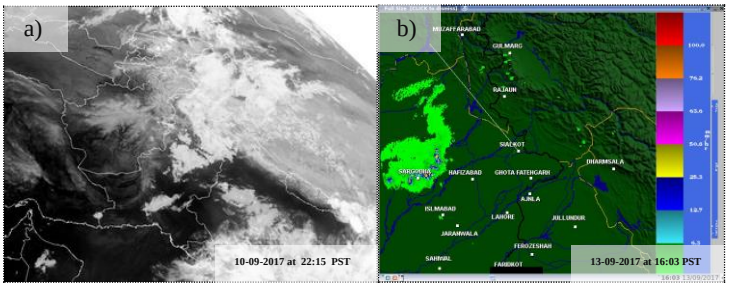


Figure 42: Radar & Satellites Images during the spell of September 2017 (11-15 September).

6.2 Rivers position during the month of September 2017

No significant change in river flow was observed due to this spell.

6.3 Spatial pattern of rainfall during the month of September 2017

A rainfall maxima of more than 100 mm is located at Garhidopatta in Kashmir while another center of moderately heavy rainfall above 90 mm is found at Dir in Khyber Pakhtunkhwa as shown in figure 43.

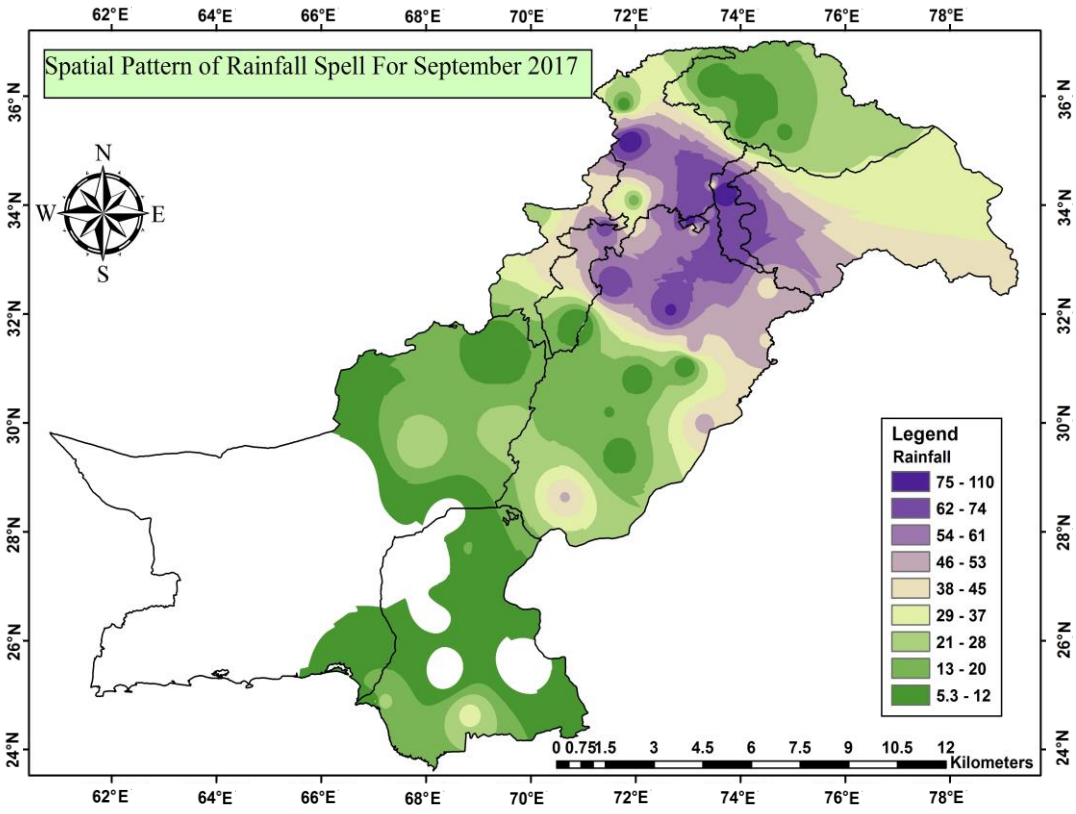


Figure 43: Spatial distribution of significant rainfall map of September 2017.

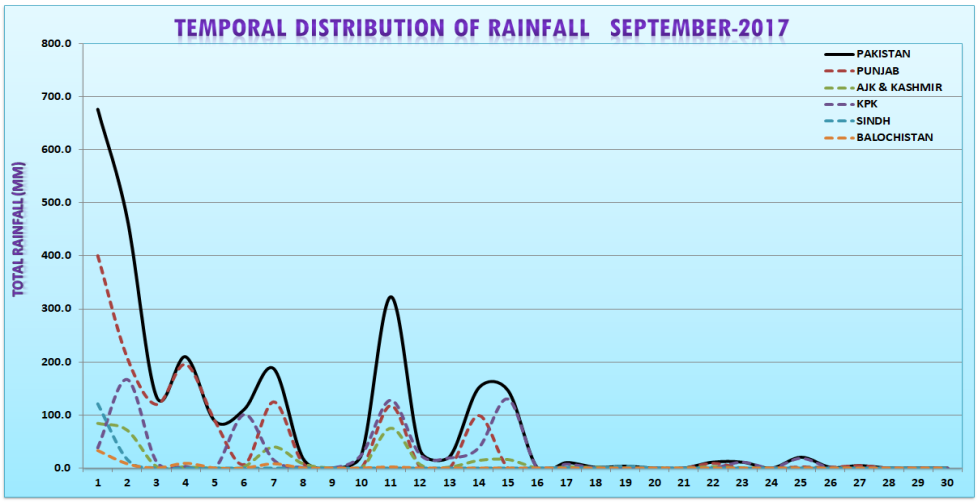


Figure 44: Temporal distribution of rainfall during September 2017 (11-15 September).

6.4 Rivers position during the month of September-2017

No significant flood peak was observed during the month of September-2017.

6.5 Hydrographs recorded during the month of September 2017 are as below

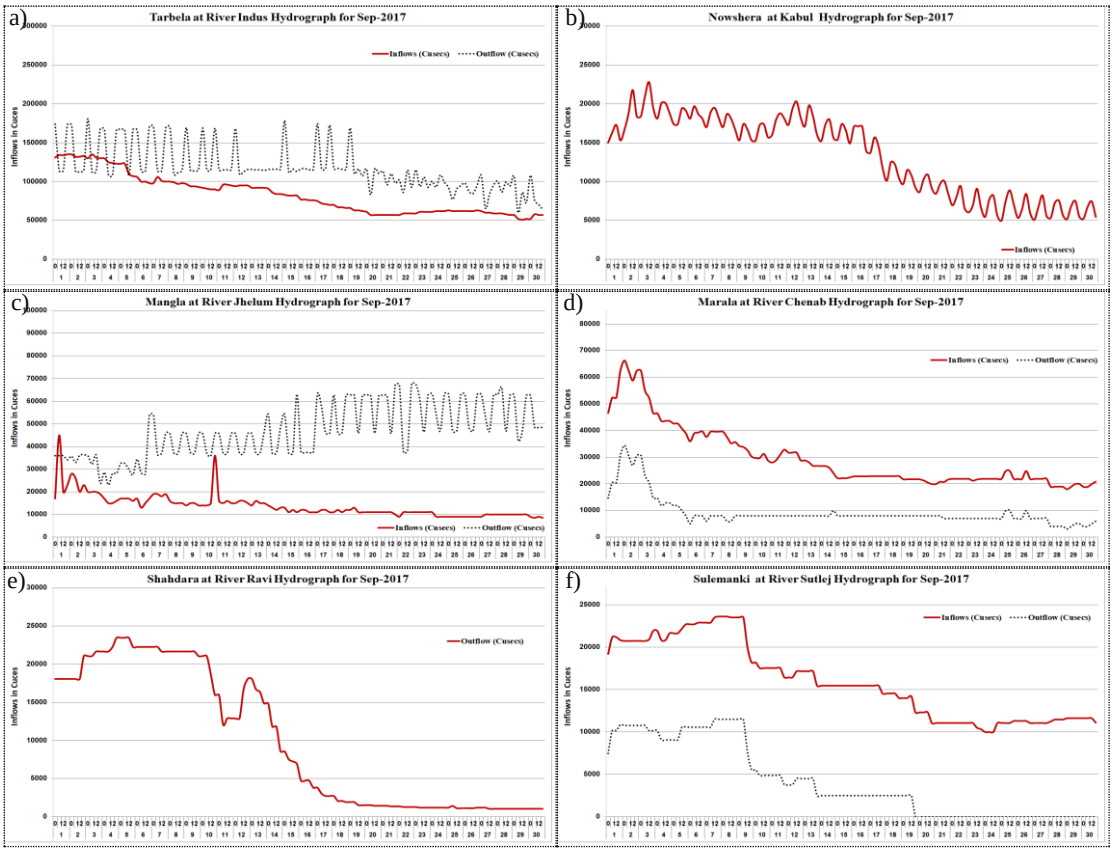


Figure 45: Hydrographs for the month of September-2017.

7 Seasonal rainfall pattern July to September 2017

Seasonal rainfall distribution during the season is shown in figure 46. Region of maximum precipitation (more than 700 mm) is located over Sialkot in Northeast Punjab. Another center of extreme rainfall of more than 650 mm is located over North Punjab. West Balochistan remained almost dry during the season.

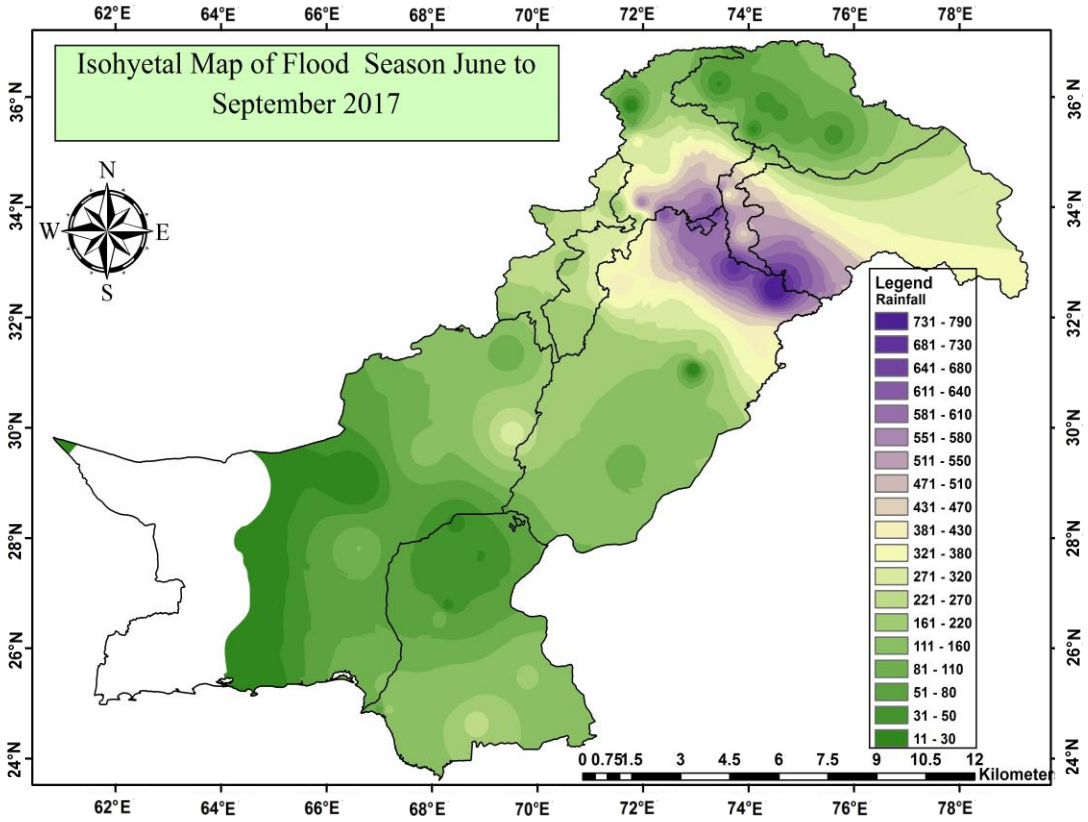


Figure 46: Spatial distribution of significant rainfall map of June-September-2017.

8 Seasonal area weighted precipitation from July-September 2017

The seasonal percentage departure precipitation map obtained from Climate Data Processing Centre (CDPC) of Pakistan Meteorological Department for monsoon season 2017 indicates that 23% less than normal precipitation was recorded on all Pakistan basis. Distributing it at provincial level, it is observed that Punjab, Khyber Pakhtunkhwa, Sindh and Gilgit Baltistan received 21%, 18%, 16% and 14% respectively below normal rainfall while Kashmir received significantly less rainfall where precipitation remained 31% below normal, Balochistan received 38% below normal rainfall as shown in figure 47.Isopercental map of rainfall is also prepared which is shown in figure 48.

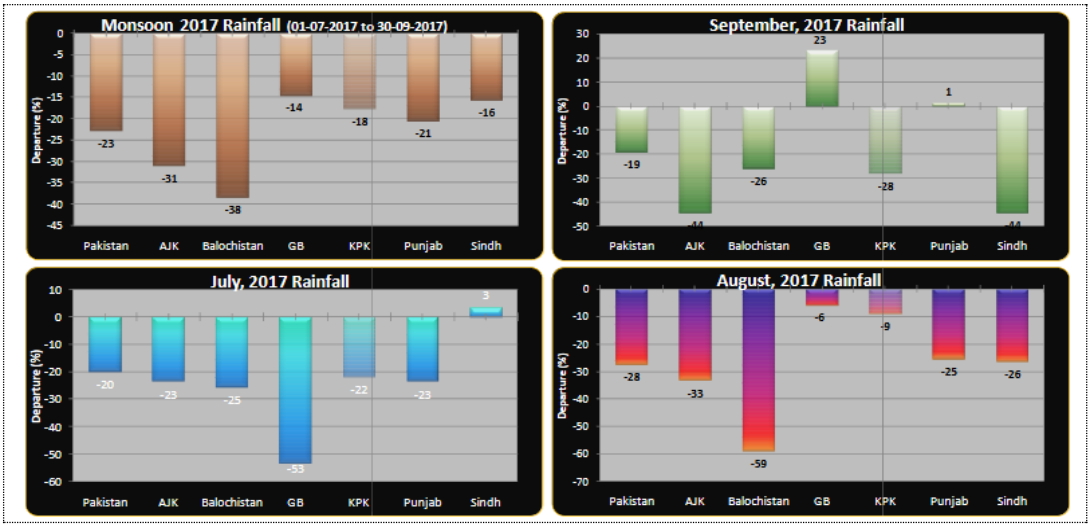


Figure 47: Monsoon July-Aug-Sept (JAS) 2017 rainfall.

Source: CDPC Karachi

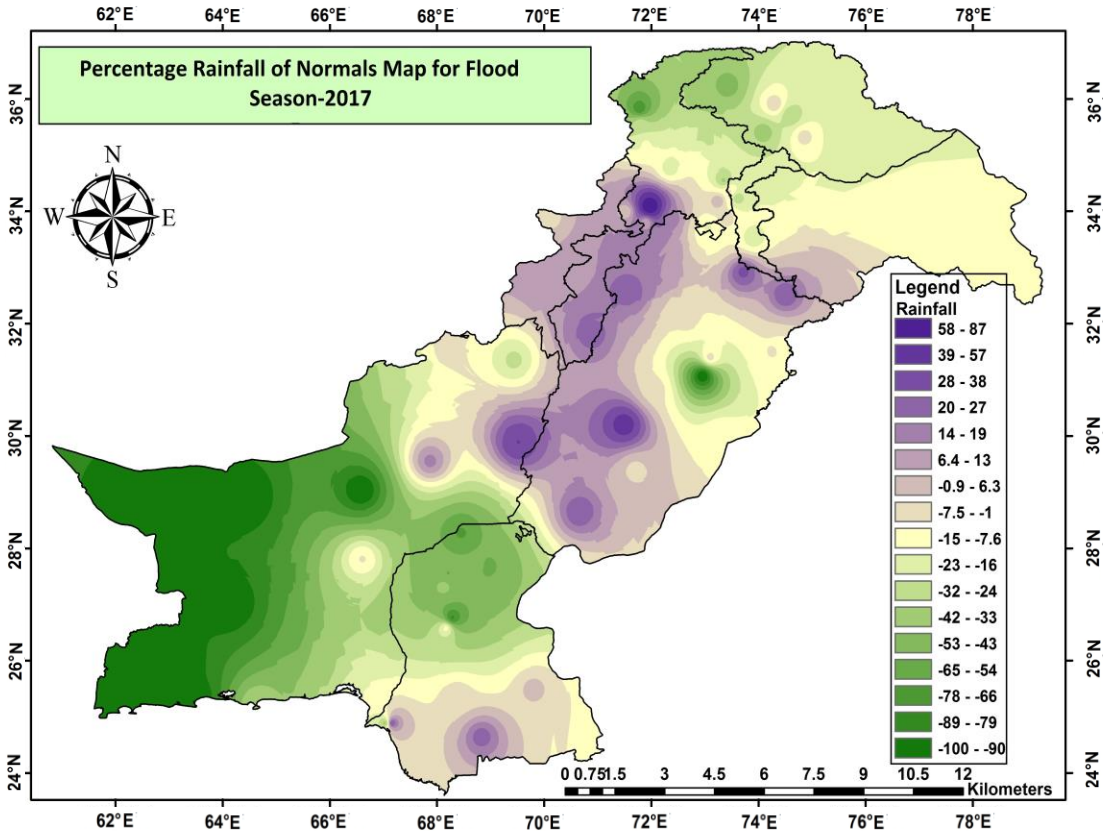


Figure 48: Seasonal percentage departure map (July-September 2017).

9 Kharif season forecast

Water availability (MAF) forecast for Kharif season was issued on 31st March, 2017 for Tarbela at River Indus & for Mangla at River Jhelum. Comparison of forecasted and observed volume (MAF) is shown in fig 49.

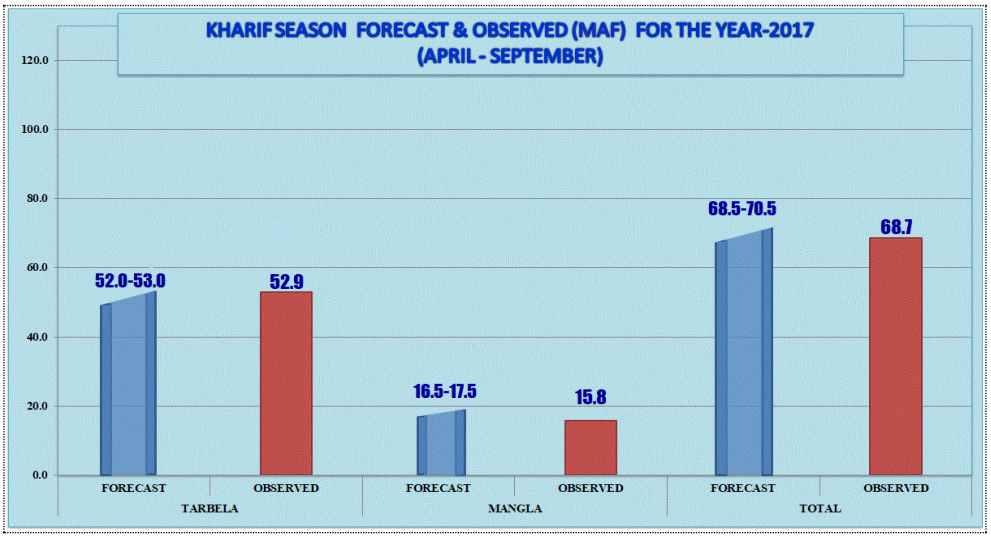


Figure 49: Kharif Season forecast (April-September 2017).

10 Rabi season forecast

Water availability (MAF) forecast for Rabi season was issued on 05th October, 2017 for Tarbela at River Indus & Mangla at River Jhelum is shown in fig 50.

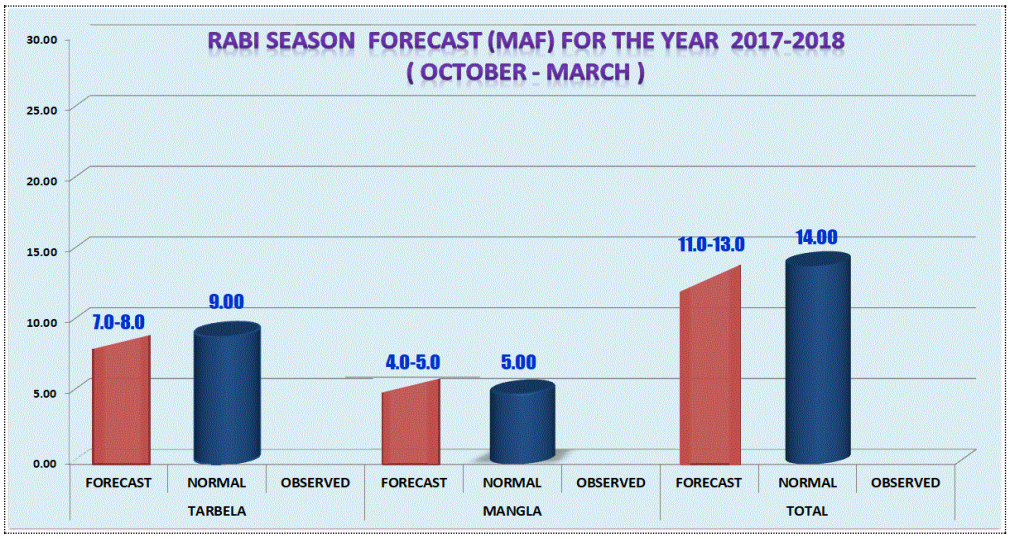


Figure 50: Rabi Season forecast (October-2017 to March-2018).

11 Flood forecast evaluation report

The Flood Forecast evaluation report for 2017 for all categories of flood is given in table

Date	Rivers	Stations	Peaks Inflows	Forecast	Accu %
30/06/2017	**Indus**	**Tarbela**	262000	250-265	100%
27/06/2017	**Indus**	**Kalabagh**	251237	230-255	100%
30/06/2017	**Chenab**	**Marala**	180287	150-200	100%
30/06/2017	**Chenab**	**Khanki**	176585	100-170	96%
30/06/2017	**Kabul**	**Nowshera**	68900	60-80	100%
14/07/2017	**Indus**	**Tarbela**	289000	285-310	100%
19/07/2017	**Indus**	**Tarbela**	296000	280-300	100%
31/07/2017	**Indus**	**Tarbela**	321000	320-360	100%
13/07/2017	**Kabul**	**Nowshera**	87000	50-75	86%
13/07/2017	**Indus**	**Kalabagh**	288357	250-300	100%
21/07/2017	**Indus**	**Kalabagh**	308416	250-300	97%
19/07/2017	**Indus**	**Chashma**	310227	250-280	90%
30/07/2017	**Indus**	**Chashma**	318363	265-275	86%
22/07/2017	**Indus**	**Taunsa**	260138	245-265	100%
27/07/2017	**Indus**	**Taunsa**	273848	265-280	100%
25/07/2017	**Indus**	**Guddu**	245825	235-245	100%
30/07/2017	**Indus**	**Guddu**	241699	230-250	100%
12/07/2017	**Chenab**	**Marala**	167046	120-160	96%
17/07/2017	**Chenab**	**Marala**	135525	100-170	100%
19/07/2017	**Chenab**	**Marala**	216020	200-280	100%
31/07/2017	**Chenab**	**Marala**	169338	140-200	100%
13/07/2017	**Chenab**	**Khanki**	178251	90-130	73%
19/07/2017	**Chenab**	**Khanki**	192670	200-280	96%
31/07/2017	**Chenab**	**Khanki**	167040	90-150	90%
01/07/2017	**Chenab**	**Qadirabad**	167697	100-160	96%
19/07/2017	**Chenab**	**Qadirabad**	186660	200-280	93%
17/07/2017	**Jhelum**	**Mangla**	94000	40-70	74%
16/07/2017	**Ravi**	**Balloki**	50755	45-60	100%
02/08/2017	**Indus**	**Tarbela**	344000	330-350	100%
04/08/2017	**Kabul**	**Nowshera**	76600	50-60	78%
03/08/2017	**Indus**	**Kalabagh**	427460	370-390	91%
05/08/2017	**Indus**	**Chashma**	458245	410-455	99%
06/08/2017	**Indus**	**Taunsa**	429861	390-430	100%
09/08/2017	**Indus**	**Guddu**	459811	450-470	100%
11/08/2017	**Indus**	**Sukkur**	390863	380-410	100%
18/08/2017	**Indus**	**Kotri**	251298	210-220	88%
02/08/2017	**Chenab**	**Marala**	148700	130-240	100%
03/08/2017	**Chenab**	**Khanki**	178546	150-230	100%
03/08/2017	**Chenab**	**Qadirabad**	176420	150-230	100%
04/08/2017	**Ravi**	**Balloki**	68145	55-70	100%
11/08/2017	**Ravi**	**Balloki**	69890	65-70	100%

The overall accuracy of the forecast issued by FFD, Lahore during the flood season 2017 has been calculated which shows a good **95.8%** against all odds.

12 FFD Lahore daily website/page work.

The website (http://ffd.pmd.gov.pk/cp/floodpage.htm) maintained by FFD Lahore is updated regularly. This is a source of real time information to all the stake holders, concerned authorities, organizations and individuals.

FFD work flow chart

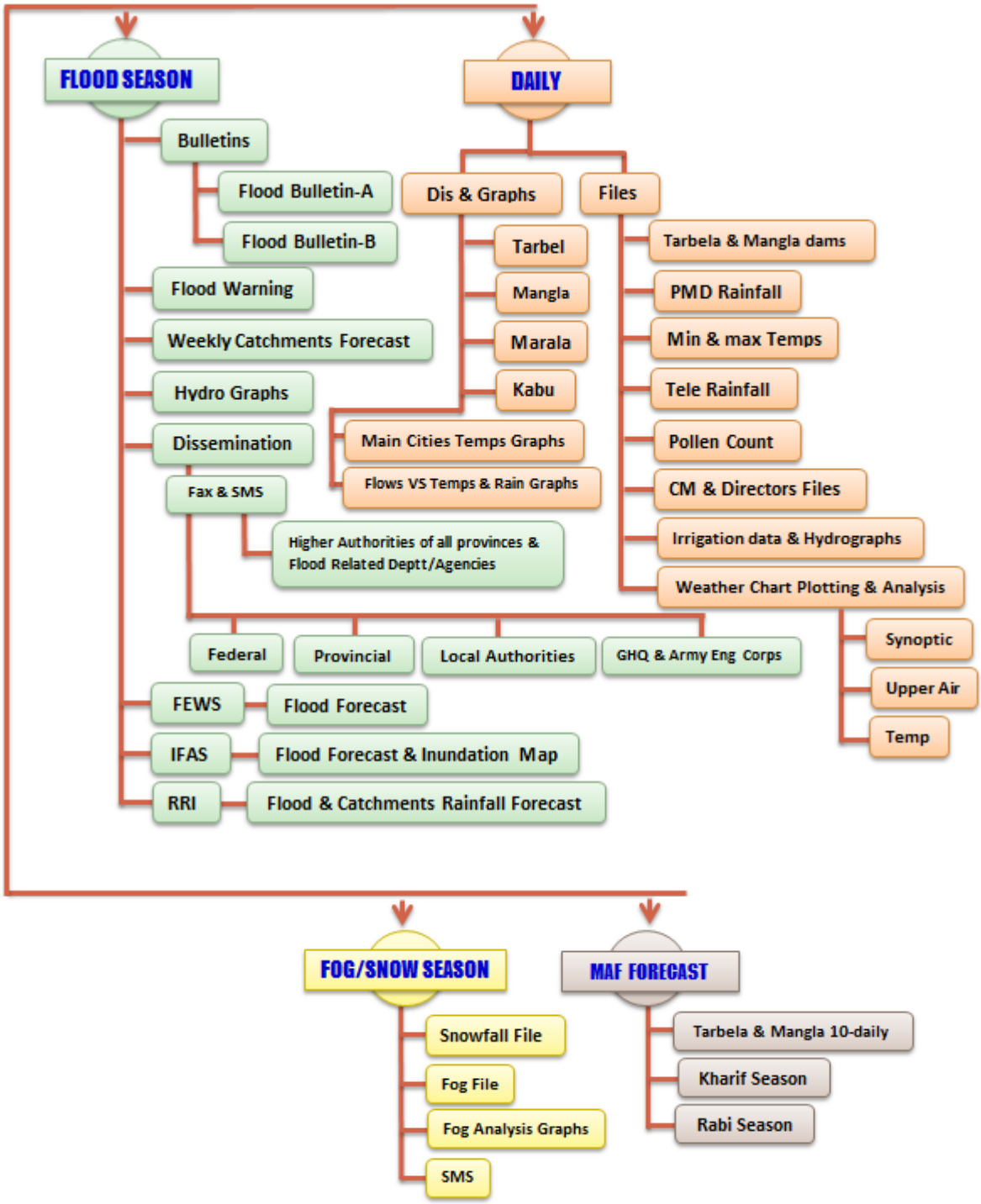


Figure 51: FFD Lahore work flow chart.

FFD Work Flow Chart

Sr#	Work	Time Interval
1	Flood Bulletins A & B	Updated daily
2	Weekly Catchment Forecast	Updated daily
3	Flood Warning	Whenever required
4	Inundation Map	When required
5	FEWS Model Forecast	Twice a day & whenever required
6	IFAS Model Forecast	Updated daily & whenever required at present
7	RRI Model Forecast	Updated daily & whenever required at present
8	Hydrographs	Six hourly & hourly basis
9	Discharge file (Tarbela & Mangla Dams)	Updated daily
10	Discharges Graphs (Tarbela, Mangla, Marala & Kabul)	Updated daily
11	Flows VS Temps & Rain Graphs	Updated daily
12	PMD Rainfall File	Updated daily
13	Temps File	Updated daily
14	Main Cities Temps Graphs	Updated daily
15	WAPDA Telemetric Rainfall	Updated daily
16	MAF Forecast (Tarbela & Mangla Dams)	10-Daily basis
17	Kharif MAF Forecast (Tarbela & Mangla Dams)	Six monthly basis
18	Rabi MAF Forecast (Tarbela & Mangla Dams)	Six monthly basis
19	Pollen Count for Lahore City	Updated daily
20	Fax	Daily & whenever required
21	SMS	Six hourly & hourly basis & whenever required

13 Flood Forecast Dissemination

Dissemination of flood forecast and warning is an important part of flood mitigation. Flood information is communicated on daily basis using different modes of communication i.e phone, fax and cellular networks. Electronic versions of daily flood forecast is also available to different agencies and organizations. This is also made a part of FFD web page. To ensure that flood forecast is disseminated to the right person at the right time, contact numbers are also collected and verified during pre flood season.

Figure 52: Flood report Dissemination chart.

14 Internship at Flood Forecasting Division Lahore

FFD Lahore offers Internship program for the young students of different Universities & Colleges providing a hands-on opportunity to work in the field of Meteorology, Hydrology, Seismology, GIS and Weather Radar. They can learn how theory applies to the practical field and provide a valuable experience that makes them a strong candidate in practical life. The number of internee students during 2017 is as under:

University/College		Students
	National University of Science & Technology, Islamabad	**02**
	Punjab University Lahore	**35**
	University of Engineering & Technology Lahore	**03**
	COMSATS Institute of Technology	**02**
	Lahore College for Women University, Lahore	**44**
	Agriculture University, Faisalabad	**08**
	Kinnaird College for Women, Lahore	**01**
	Government College University Lahore	**08**

15 Facilities Provided By FFD Lahore during the Flood Season

- Flood Forecasting Division Lahore provides semi furnished accommodation facilities to the Police Tele Communication officers & officials in the office premises.
- Flood Forecasting Division Lahore has provided facility to Punjab Environmental Department to install their instruments for recording the data regarding Fog/Smog in office premises.
- Sports facilities were also provided by Flood Forecasting Division Lahore to the flood relating agencies working in FFD during the flood season.
- Flood Forecasting Division Lahore also provides facilities to Media for Live recording regarding any Flood/Weather event.

16 Monsoon Season Damages/Losses-2017

No of Deaths, Injured Persons and Houses Damaged during the Flood 2017 are as under:

Provinces	Deaths				Injured				Houses Damages		
	M	F	C	T	M	F	C	T	P	F	T
Punjab	*	*	*	38	*	*	*	83	*	22	34
KPK	16	2	10	28	13	9	11	33	192	40	232
Sindh	27	2	9	38	8	6	8	22	43	*	43
Balochistan	13	4	9	26	*	*	*	*	36	*	36
AJ & K	11	2	*	13	3	2	*	5	17	13	30
FATA	2	7	9	18	3	8	9	20	7	2	9
Gilgit B.Tan	6	1	1	8	3	1	*	4	29	26	55
ICT	1	1	1	3	*	*	*	*	1	*	1

.

Source: NDMA

Legends:

M: Male, F: Female, C: Children, P: Partially, F: Fully, T: Total

17 Maximum Flood Peaks Discharge during Flood Season-2017.

Maximum Flood Peaks recorded during Flood Season as shown in table below

River	Site	Peak (Cusecs)
Indus	**Tarbela**	344000
Kabul	**Nowshera**	87000
Indus	**Kalabagh**	427460
Indus	**Chashma**	458245
Indus	**Taunsa**	429861
Indus	**Guddu**	459811
Indus	**Sukkur**	390863
Indus	**Kotri**	185529
Jhelum	**Mangla**	94000
Jhelum	**Rasul**	56165
Chenab	**Marala**	216020
Chenab	**Khanki**	192670
Chenab	**Qadirabad**	186660
Chenab	**Trimmu**	102145
Chenab	**Punjnad**	78988
Ravi	**Jassar**	46439
Ravi	**Shahdara**	39313
Ravi	**Balloki**	69890
Ravi	**Sidhnai**	31967
Sutlej	**GS Wala**	15.8
Sutlej	**Sulemanki**	33934
Sutlej	**Islam**	16971

18 Flood limits (in Lacs of cusecs):

River	Site	Design Capacity	Low	Med	High	V.high	Ex.high
Kabul	Nowshera	-	0.45	0.80	1.4	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
	Shahdra	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

19 Time Lag

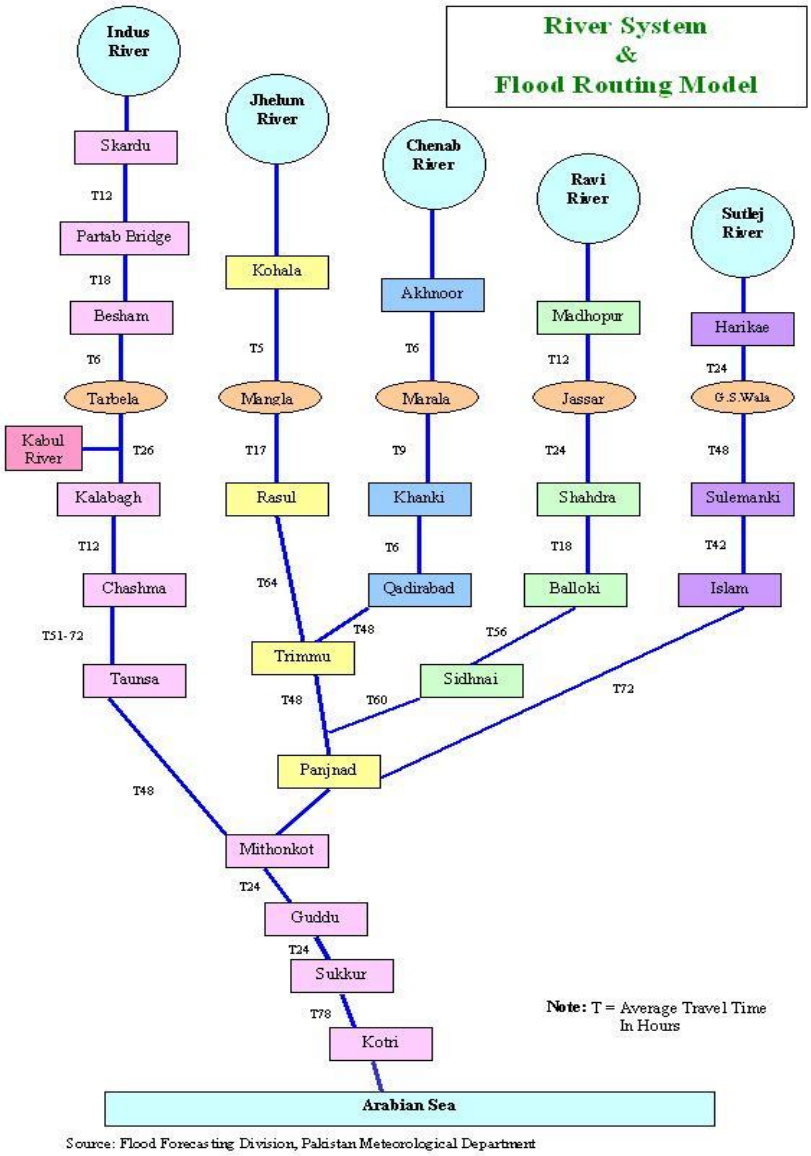
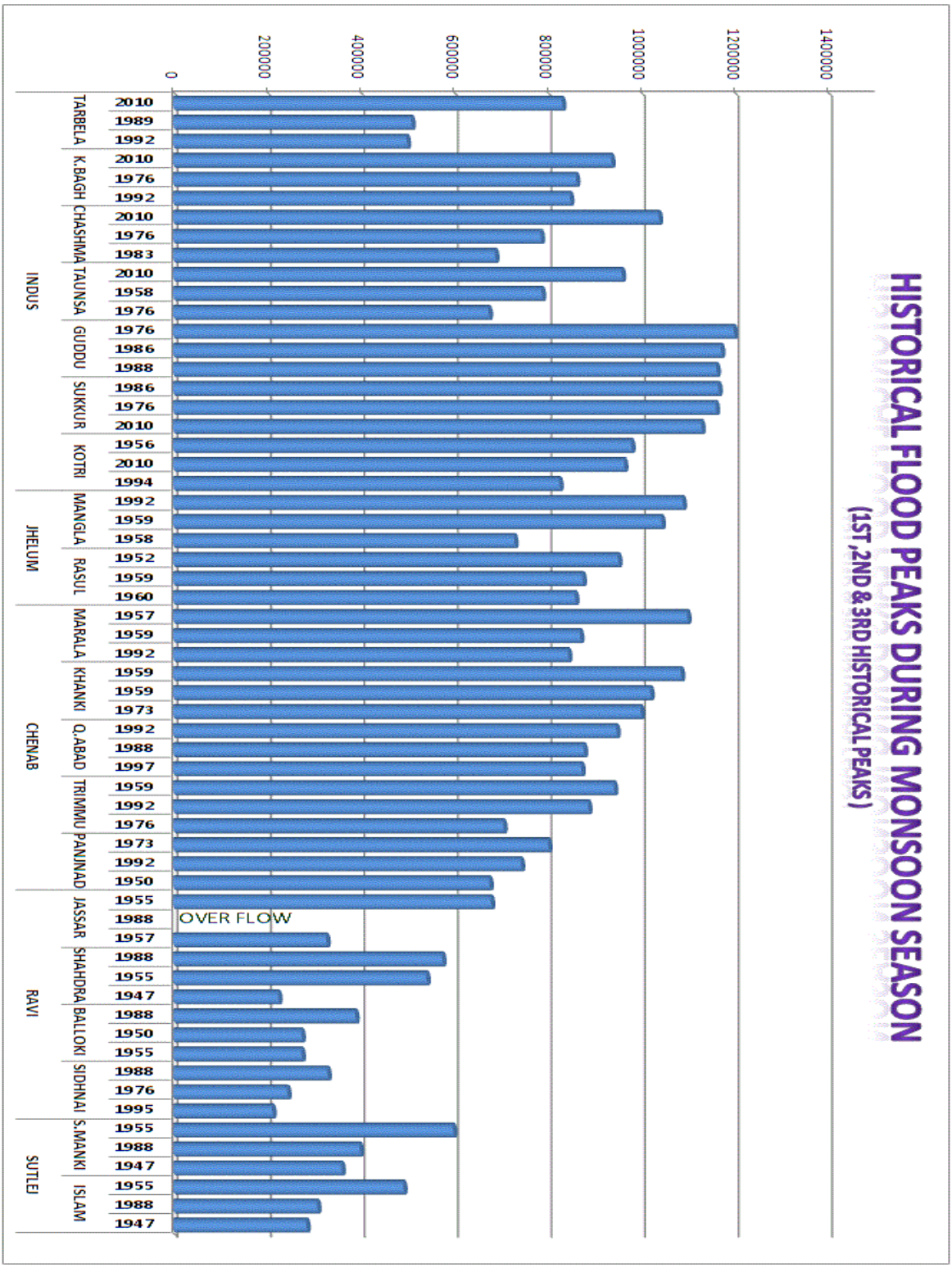


Figure 53: Time Lag


HISTORICAL FLOOD PEAKS DURING MONSOON SEASON
(1ST ,2ND & 3RD HISTORICAL PEAKS)
0
200000
400000
600000
800000
1000000
1200000
1400000
INDUS
TARBELA 2010 1989 1992
K.BAGH 2010 1976 1992
CHASHMA 2010 1976 1983
TAUNSA 2010 1958 1976
GUDDU 1976 1986 1988
SUKKUR 1986 1976 2010
KOTRI 1956 2010 1994
JHELUM
MANGLA 1992 1959 1958
RASUL 1952 1959 1960
CHENAB
MARALA 1957 1959 1992
KHANKI 1959 1959 1973
Q.ABAD 1992 1988 1997
TRIMMU 1959 1992 1976
PANJNAD 1973 1992 1950
RAVI
JASSAR 1955 1988 1957
SHAHDRA 1988 1955 1947
BALLOKI 1988 1950 1955
SIDHNAI 1988 1976 1995
SUTLEJ
S.MANKI 1955 1988 1947
ISLAM 1955 1988 1947
OVER FLOW