



Flood Report 2024

PAKISTAN

Hyderabad

Karachi

فلڈ فور کاسٹنگ ڈویژن لاہور

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Contents

List of Figures	3
List of Tables.....	6
List of Acronyms	7
1 Preface.....	8
2 Executive summary	9
3 Tracks of Monsoon Lows during Monsoon Season-2021	10
4 Significant Hydro-Meteorological events during the month of July 2021	11
4.1 Meteorological events	11
4.2 1 st wet spell of July 2021 (03 rd to 05 th).....	11
4.3 2 nd wet spell of July 2021 (11 th to 14 th).....	13
4.4 3 rd wet spell of July 2021 (19 th to 21 th).....	15
4.5 4 th wet spell of July 2021 (27 th to 29 th).....	17
4.6 Rivers position during the third spell of July-2021	19
4.7 Spatial distribution of rainfall during the month of July 2021	19
4.8 Rainfall Departure during the month of July 2021.....	21
4.9 Temporal Distribution during the month of July 2021.....	22
4.10 Hydrographs during Significant event of July 2021	23
4.11 River position during July 2021	24
5 Significant Hydro-Meteorological events during the month of August-21	25
5.1 Meteorological events	25
5.2 01 st wet spell of August 2021 (01 st to 04 th)	25
5.3 2 nd wet spell of August 2021 (14 th to 16 th)	27
5.4 Hydrographs during August 2021	30
5.5 River position during August 2021	32
5.6 The spatial pattern of rainfall during the month of August 2021	32
5.7 Departure Anomaly during the month of August 2021.....	34
5.8 Temporal Distribution during the month of August 2021.....	35
6 Significant Hydro-Meteorological events during the month of Sep-2021.....	36
6.1 1 st wet spell of September 2021 (08 th to 12 th).....	36
6.2 2 nd wet spell of September 2021 (21 st to 23 rd)	38
6.3 Hydrographs recorded during the month of September 2021 are as below	40
6.4 Rivers position during the month of September-2021	41
6.5 Spatial distribution of rainfall during the month of September 2021.....	41

6.6	Departure Anomaly during the month of September 2021	43
6.7	Temporal Distribution during the month of September 2021	45
7	Seasonal rainfall pattern July to September 2021	46
7.1	Departure Anomaly during the Season July-September 2021	48
8	Pakistan Base Temporal Rainfall Distribution (July-September) 2021	50
9	Reason for No Significant Weather System during Monsoon 2021	51
10	Seasonal area weighted precipitation from July-September 2021.	51
11	Kharif & Rabi Season Forecast.....	53
12	Flow chart of daily routine work at FFD Lahore	54
13	Flood Forecast Dissemination.....	55
14	Internship at Flood Forecasting Division Lahore	57
15	Monsoon Season 2021 Damages/Losses	58
16	Flood limits (in thousands of cusecs).....	58
17	Maximum Flood Peaks Discharge during Flood Season-2021.....	59
18	Facilities Provided By FFD Lahore during the Flood Season	60
19	Revised Lag Time	60

List of Figures

Figure 1: Tracks of Rain Producing System in Monsoon Season 2021.....	10
Figure 2: hPa geopotential Height & winds map July 2021 (3 rd -5 th).....	11
Figure 3: 01 st Wet Spell of July 2021 (3 rd -5 th).....	12
Figure 4: Spatial distribution of rainfall July 2021 (3 rd -5 th).....	12
Figure 5: Satellites Images of July 2021 (3 rd -5 th).....	13
Figure 6: hPa Geopotential Height & winds map of July 2021 (11 th -14 th).	13
Figure 7: 02nd Wet Spell of Rainfall July 2021 (11th-14th).	14
Figure 8: Spatial distribution of rainfall July 2021 (11 th -14 th).....	14
Figure 9: Satellites Images of July 2021 (11 th -14 th).....	15
Figure 10: hPa Geopotential Height & winds map of July 2021 (19 th -21 st).....	15
Figure 11: 3 rd Wet Spell of Rainfall July 2021 (19 th -21 st).....	16
Figure 12: Spatial distribution of rainfall July 2021 (19 th -21 st).....	16
Figure 13: Satellites Images of July 2021 (19 th -21 st).....	17
Figure 14: hPa Geopotential Height & winds map of July 2021 (27 th -29 th).....	17
Figure 15: 04 th Wet Spell of Rainfall July 2021 (27 th -29 th).....	18
Figure 16: Spatial distribution of rainfall July 2021 (27 th -29 th).....	18
Figure 17: Satellites Images of July 2021 (27 th -29 th).....	19
Figure 18: Total Rainfall for the month of July 2021.	20
Figure 19: Spatial distribution of significant rainfall map of July 2021.	21
Figure 20: Rainfall % Departure for July 2021.....	21
Figure 21: Percentage Anomaly rainfall map of July 2021.	22
Figure 22: Temporal distribution of rainfall during July 2021.	22
Figure 23: Hydrographs for the month of July 2021.....	23
Figure 24: hPa Geopotential Height & winds map August 2021 (01 st to 04 th).....	25
Figure 25: 1 st Wet Spell Rainfall of August 2021 (01 st to 04 th).....	26
Figure 26: Spatial distribution of significant rainfall August 2021 (01 st to 04 th).....	26
Figure 27: Satellites Images of August 2021 (01 st to 04 th).....	27
Figure 28: hPa Geopotential height & winds of August 2021 (14 th - 16 th).....	27

Figure 29: 2 nd Wet spell rainfall of August 2021 (14 th - 16 th).....	28
Figure 30: Spatial distribution of significant rainfall of August 2021 (14 th - 16 th).....	28
Figure 31: Satellites Images of August 2021 (14 th - 16 th).....	29
Figure 32: Hydrographs for the month of August 2021.....	31
Figure 33: Total Rainfall for the month of August 2021.	33
Figure 34: Spatial distribution rainfall map of August 2021.	34
Figure 35: Rainfall Departure for of August 2021.....	34
Figure 36: Percentage Anomaly rainfall map of August 2021.	35
Figure 37: Temporal distribution of rainfall August 2021.....	35
Figure 38: hPa geopotential height & hPa winds map of September 2021 (08 th to 12 th)	36
Figure 39: 1 st Wet Spell of Rainfall September 2021 (08 th to 12 th)	37
Figure 40: Spatial distribution of significant rainfall of September 2021 (08 th to 12 th)	37
Figure 41: Satellites Images of September 2021 (08 th to 12 th).....	38
Figure 42: hPa geopotential height & hPa winds map of Sep-2021 (21 st to 23 rd)	38
Figure 43: 02 nd Wet Spell Rainfall of Sep-2021 (21 st to 23 rd)	39
Figure 44: Spatial distribution of significant rainfall map of Sep-2021 (21 st to 23 rd).....	39
Figure 45: Satellites Images of Sep-2021 (21 st to 23 rd)	40
Figure 46: Hydrographs for the month of September-2021.....	40
Figure 47: Total Rainfall for the month of September 2021.....	42
Figure 48: Spatial distribution of significant rainfall of September 2021.	43
Figure 49: Rainfall Departure for the month of Sep-21.....	44
Figure 50: Departure Anomaly rainfall map of September 2021.	44
Figure 51: Temporal distribution of rainfall during September 2021.....	45
Figure 52: Seasonal total Rainfall July- September 2021.....	47
Figure 53: Spatial distribution of significant rainfall map of July-Sep-20.	48
Figure 54: Seasonal Rainfall % departure for July- Sep-20.....	49
Figure 55: Departure Anomaly rainfall map for Season July-Sep-20.....	49
Figure 56: Pakistan Base Temporal Rainfall Distribution July-Sep-21.....	50

Figure 57: Monsoon July-Sept (JAS) 2021 rainfall.	52
Figure 58: Kharif Season forecast & Observed MAF (April-Sep-21).	53
Figure 59: Rabi Season forecast MAF (Oct-2021 to March-2022).	53
Figure 60: FFD Lahore work flow chart.	54
Figure 61: Flood report dissemination chart	56
Figure 62: Maximum flood peaks recorded during the season 2021	59
Figure 63: Revised Lag Times	61

List of Tables

Table 1: Maximum Peaks recorded during the month of July 2021.....	24
Table 2: Maximum Peaks recorded during the month of August 2021.	32
Table 3: Maximum peaks recorded during September 2021	41
Table 5: List of internees.....	57
Table 5: Flood forecast evaluation table	58
Table 7: Flood limit.....	58

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
• PDMA	Provincial Disaster Management Authority
• PMD	Pakistan Meteorological Department
• SDMA	State Disaster Management Authority
• WAPDA	Water And Power Development Authority
• XEN	Executive Engineer
• BoB	Bay of Bengal

1 Preface

Flood forecasting and warning are very important components of modern flood preparedness systems, in the category of non-structural flood protection measures, which may save lives and reduce material losses and human suffering. The system embraces detection of danger of occurrence of a flood-triggering situation, quantitative flood forecasting, preparation of a warning message, issuing and dissemination of warning, response action, and finally post-audit, in order to learn and improve the system for future.

Pakistan has unique flood forecasting problems, which can be understood only if the meteorological causes of the floods are first understood. During summer, although monsoon is the dominating weather system, the westerly waves also continue to affect the country. Intensification of the monsoon weather system and northward recurving of the monsoon depressions is predominantly due to the westerly waves. Floods in Pakistan are mainly caused by the heavy monsoon rains during July to September.

During monsoon 2021, no major rainfall event was observed over the country. The formation of a smaller number of low-pressure systems (PLS) in July and August and their lesser number of days compared to the climatology and absence of their longer westward movements during monsoon 2021, no major weather system contributed over the country. Negative Indian Ocean Dipole over tropical Indian Ocean, unfavorable for monsoon prevailed throughout period, which also contributed to deficient rainfall. Unfavorable Madden Julian Oscillation (MJO) conditions was observed and during most of the days, during monsoon 2021. Less West Pacific Typhoon activity was observed and so also absence of westward movement of their remnants into Bay of Bengal which again caused less formation of LPS over the Bay of Bengal. Most of the days monsoon trough was located north of its normal position which caused subdued rainfall

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2 Executive summary

- Quantitatively, the 2021 All Pakistan monsoon seasonal rainfall during 01st July to 30th September 2021 has been 128.0 mm against the Long Period Average (LPA) of 140.9 mm.
- The seasonal percentage departure map for precipitation during the present Monsoon Season-2021 indicates 9% less precipitation for whole of the country. Calculating on province wise the detail is given as below:
Balochistan 5% and Gilgit Baltistan 19%, received above normal rainfall while Sindh 18%, Punjab 15% and Kashmir 21% received below normal rainfall and Khyber Pakhtunkhwa received normal Rainfall.
- Eight monsoon Lows/Depressions originated during the present monsoon season-2021, only one of these entered Pakistan.
- Eight rain-bearing spells occurred during the monsoon season 2021.
- The supply of hydro-meteorological data from WAPDA, Punjab, Sindh & Khyber Pakhtunkhwa irrigation departments remained satisfactory.
- All the concerned federal and provincial authorities, the general public, along with print and electronic media were kept in touch with the prevailing weather/flood conditions through phone, fax & other electronic sources.
- The overall accuracy of forecast issued by FFD during the Monsoon Season 2021 was up to the mark.

3 Tracks of Monsoon Lows during Monsoon Season-2021

During the monsoon season 2021 (15th June to 15th October) Eight Monsoon Lows/Depressions were developed in the Bay of Bengal. The paths followed by each low/depression are shown in figure 1.

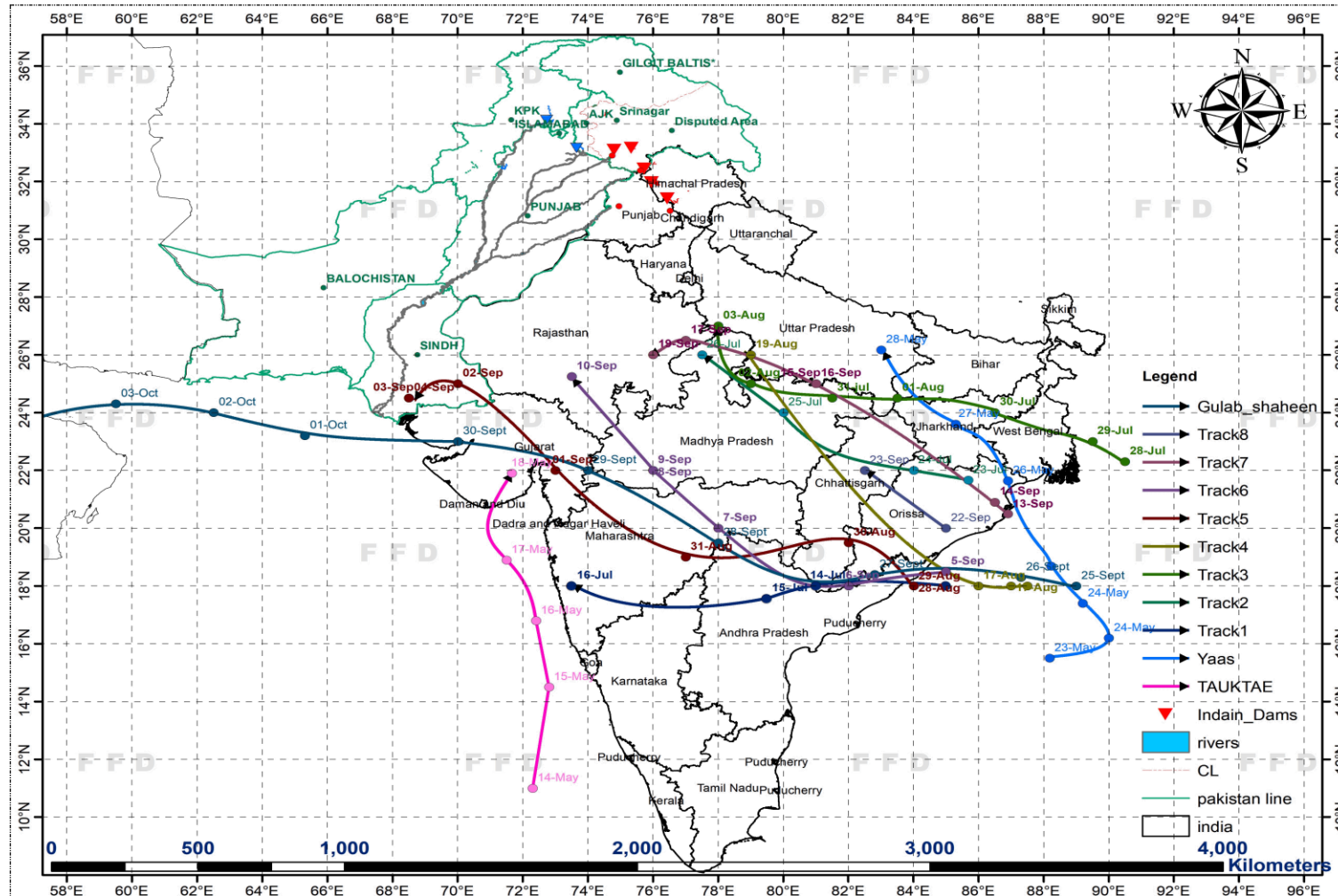
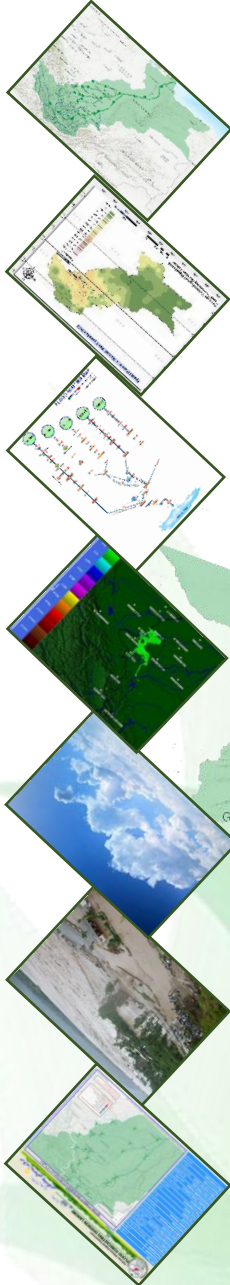
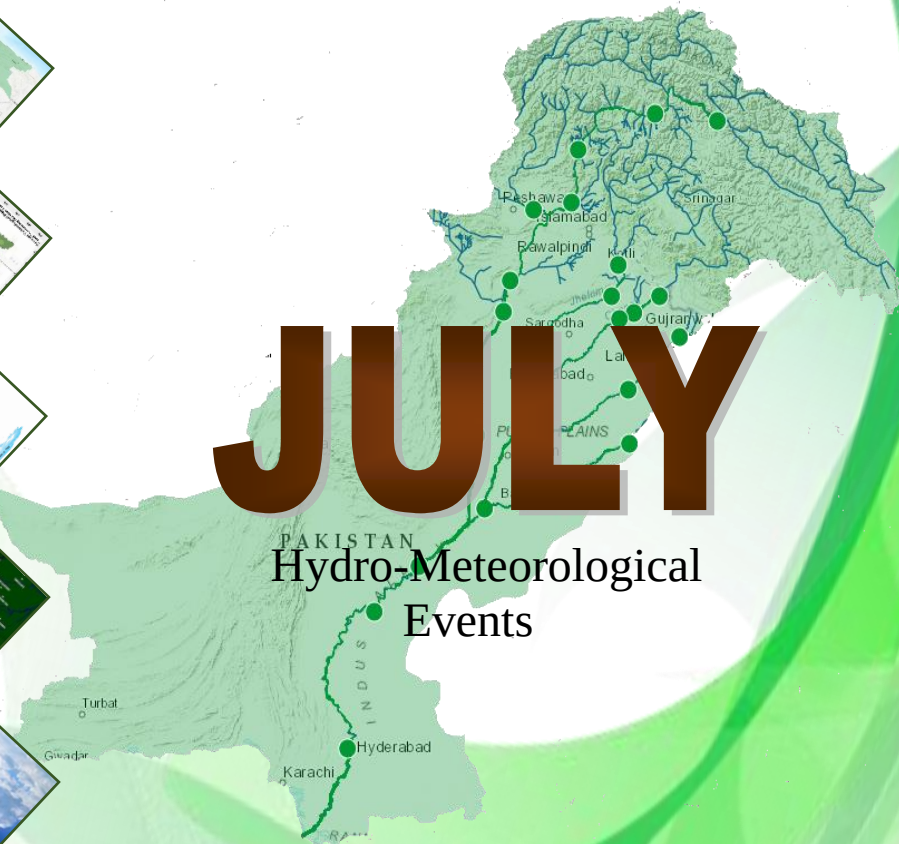


Figure 1: Tracks of Rain Producing System in Monsoon Season 2021



JULY

PAKISTAN
Hydro-Meteorological
Events



4 Significant Hydro-Meteorological events during the month of July 2021

Four rainfall spells were reported during the month of July 2021 over Pakistan. Generally, flows in all the major rivers remained below High flood level.

4.1 Meteorological events

Three Monsoon lows were developed over the Bay of Bengal during the month of July 2021. The rainfall mostly occurred across the country during the month of July 2021 was due to the accentuation of seasonal low over Balochistan and passing of a westerly wave to the north of the country.

4.2 1st wet spell of July 2021 (03rd to 05th)

The first wet spell of July 2021 which remained active for three days was mainly due to the presence of a westerly trough accompanied by weak moist currents from the Arabian Sea. Figures 2 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.

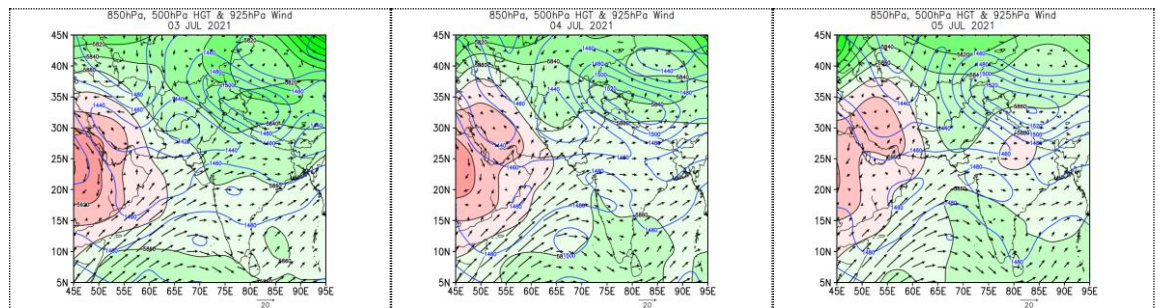


Figure 2: hPa geopotential Height & winds map July 2021 (3rd -5th)

Figure 3 & 4 shows the spatial distribution of significant rainfall during this spell. Maximum rainfall of 45 mm occurred over Malam Jabba. Another maximum of more than 40 mm rainfall is located over Tarbela. Province Sindh and west Balochistan remained almost dry during the spell.

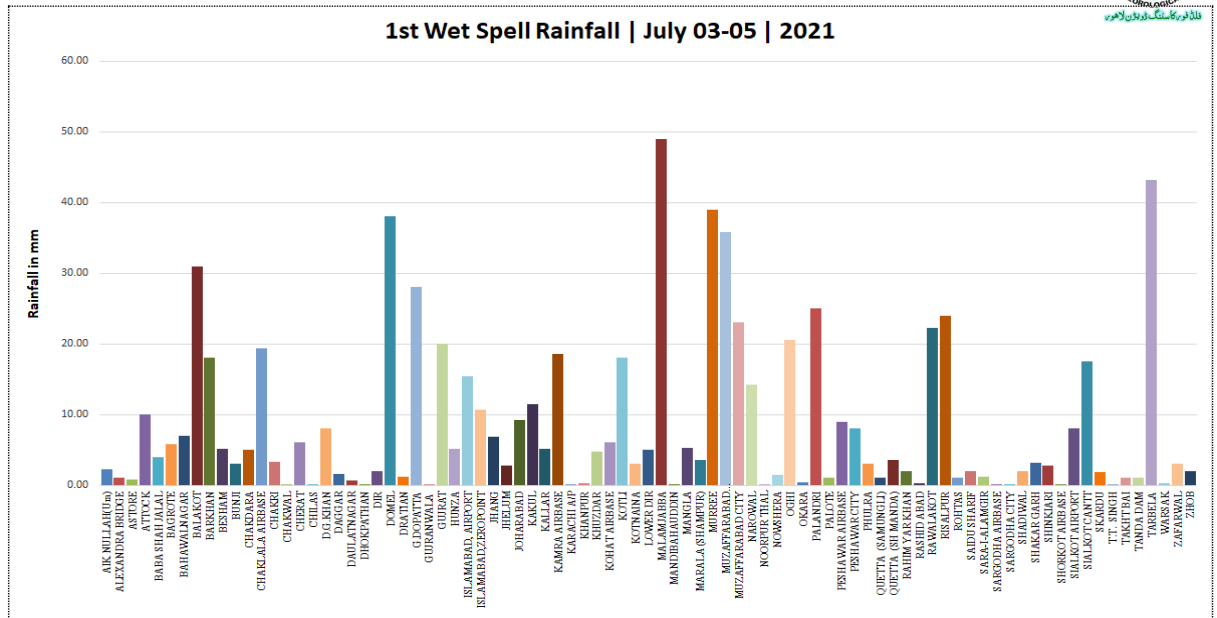


Figure 3: 01st Wet Spell of July 2021 (3rd -5th)

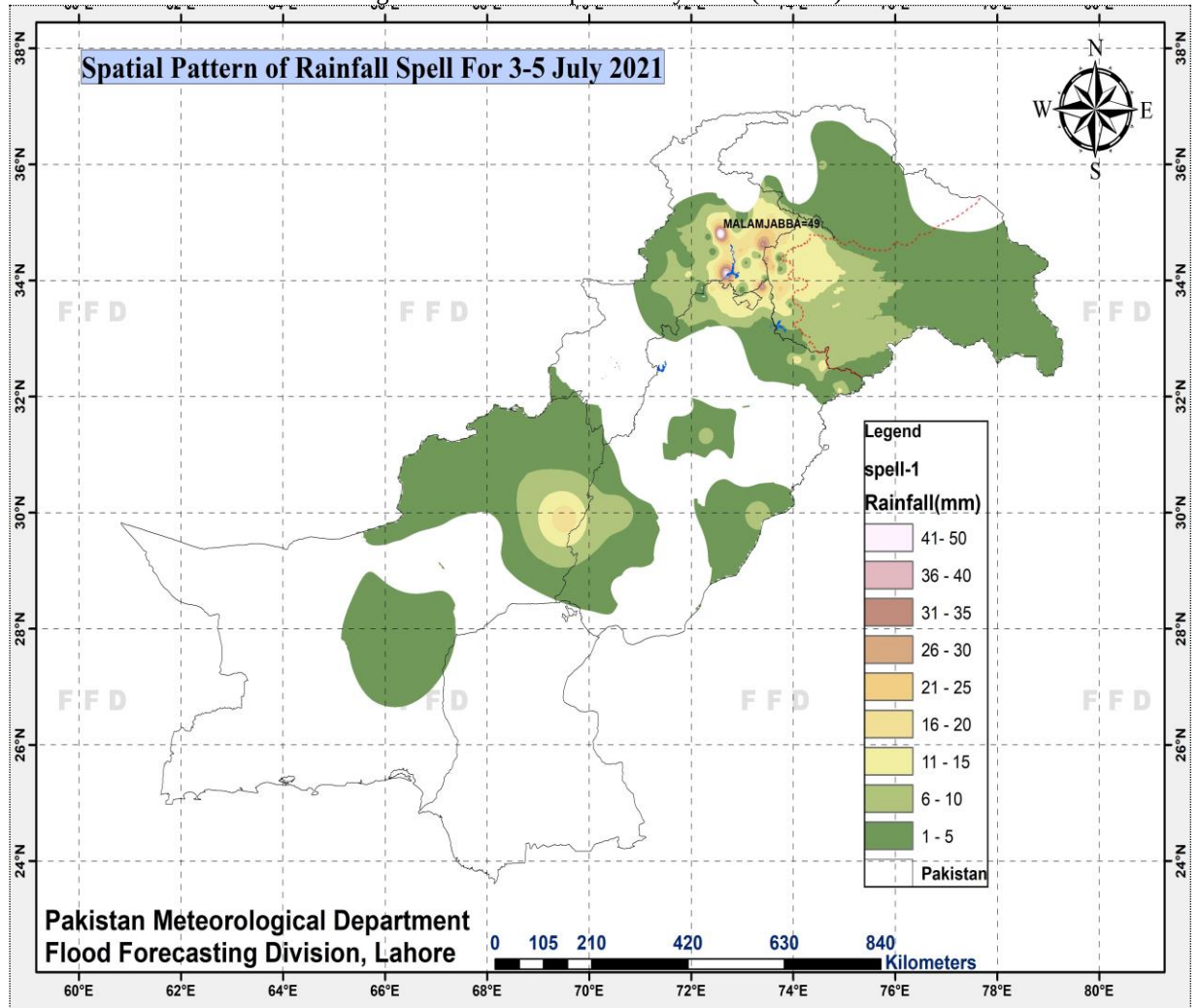


Figure 4: Spatial distribution of rainfall July 2021 (3rd -5th)

Satellite/Radar images in figure 5 showing dense clouds over Khyber-Pakhtunkhwa, Punjab, East Balochistan and Kashmir during the spell of 3rd to 5th July-2021.

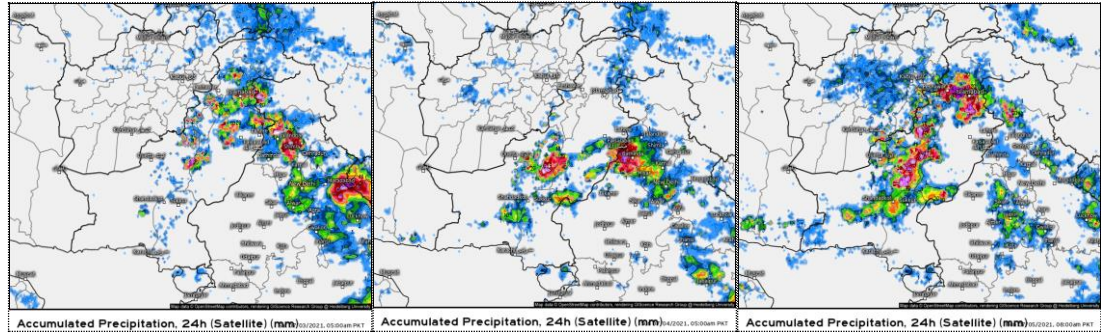


Figure 5: Satellites Images of July 2021 (3rd -5th)

4.3 2nd wet spell of July 2021 (11th to 14th)

The Second wet spell of July 2021 which remained active for four days was mainly due to the presence of a strong westerly trough and an upper air circulation over Gujarat India, accompanied by moist laden winds from the Bay of Bengal. Figures 6 represents 500 hPa and 850 hPa geopotential height patterns along with 925 hPa wind flow during the spell. It indicates that parts of Pakistan are under the influence of the westerly wave. Southeasterly winds at 925 hPa are also present ensuring moderate to strong moisture supply from the Bay of Bengal.

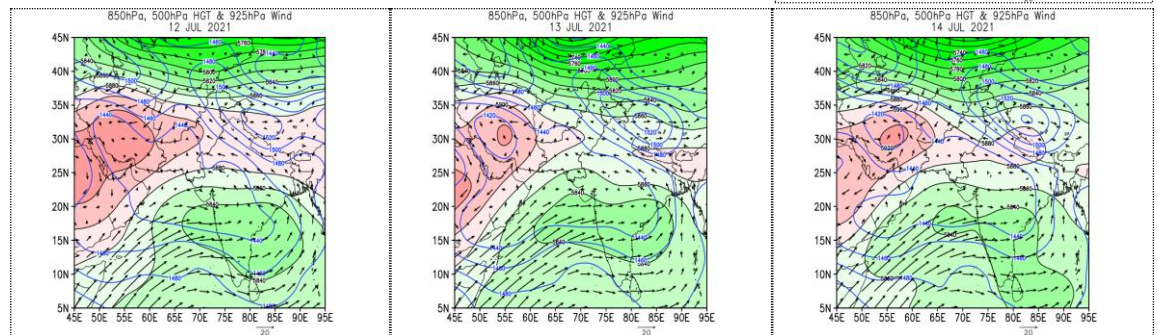


Figure 6: hPa Geopotential Height & winds map of July 2021 (11th-14th).

Figure 7 & 8 shows the spatial distribution of significant rainfall during this spell. Maximum rainfall of more than 200 mm occurred over Sialkot in Gujranwala division and Joharabad in Sargodha division. Other maxima of more than 150 mm rainfall recorded over Mangla. Southeastern Sindh and Eastern Parts of Balochistan also received the moderate rainfall during the period,

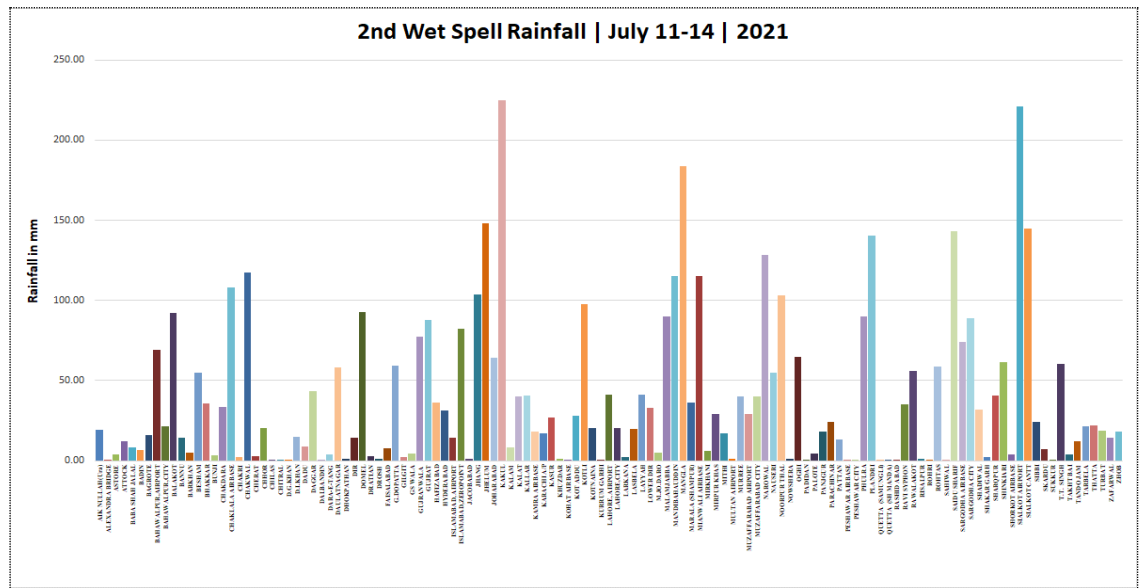


Figure 7: 02nd Wet Spell of Rainfall July 2021 (11th-14th).

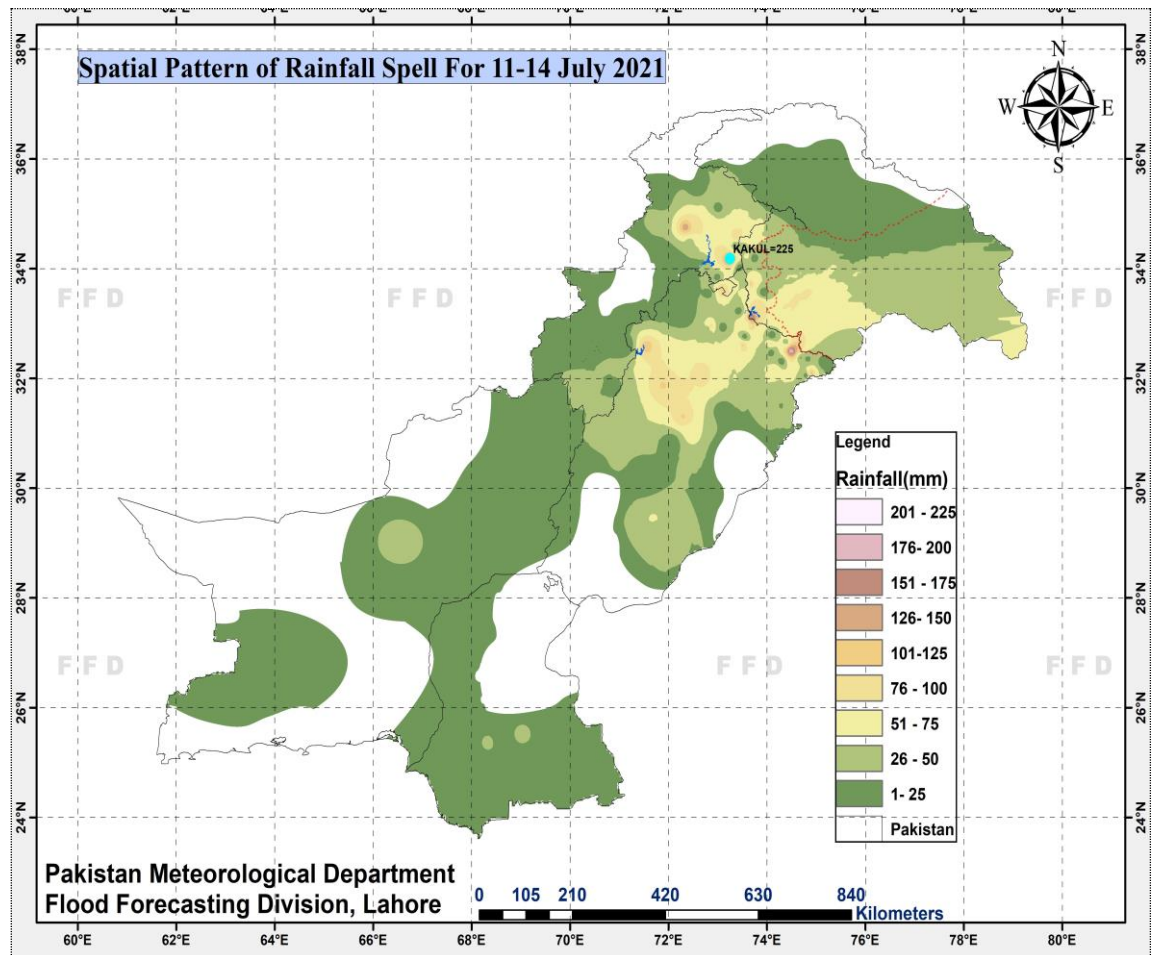


Figure 8: Spatial distribution of rainfall July 2021 (11th-14th)

Satellite/Radar images in figure 9 showing dense clouds over north Punjab, along with Kashmir, Khyber Pakhtunkhwa, Sindh, Balochistan during the spell of 11th to 14th July-2021.

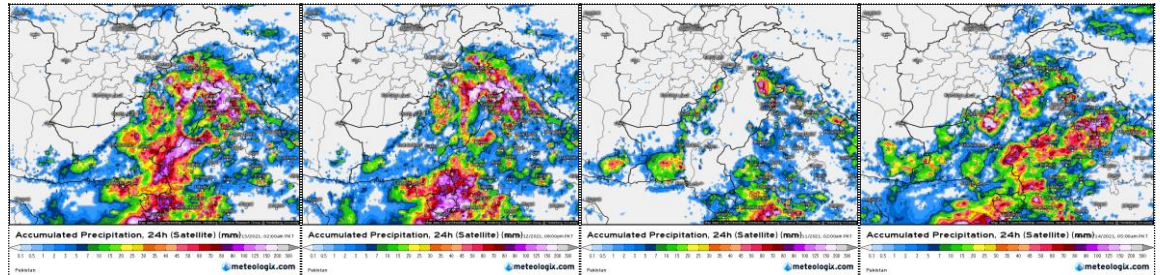


Figure 9: Satellites Images of July 2021 (11th-14th)

4.4 3rd wet spell of July 2021 (19th to 21st)

The third wet spell of July 2021 which remained active for three days was mainly due to the presence of a strong westerly trough accompanied by moist currents from the Arabian Sea along with accentuated seasonal low. Figures 10 represents 500 hPa and 850 hPa geopotential height patterns along with 925 hPa wind flow during the spell. It indicates that most parts of Pakistan are under the influence of the westerly wave. Southwesterly winds at 925 hPa are also present ensuring moderate to strong moisture supply from the Arabian Sea.

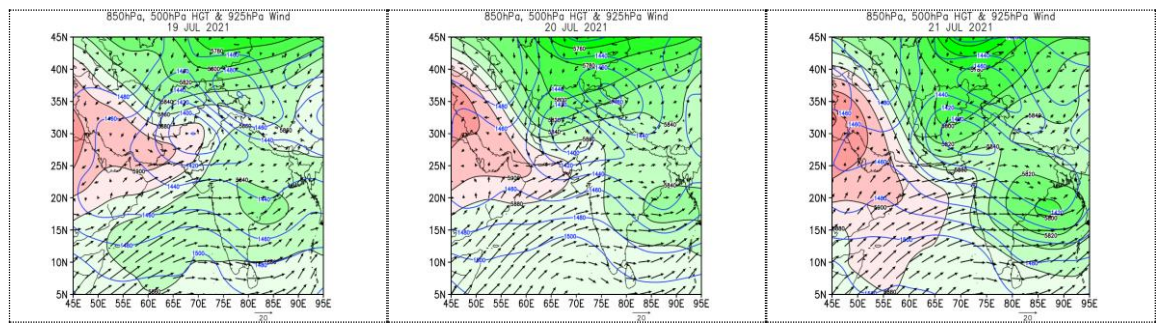


Figure 10: hPa Geopotential Height & winds map of July 2021 (19th-21st)

Figure 11 & 12 shows the spatial distribution of significant rainfall during this spell. Maximum rainfall of more than 160 mm occurred over Tarbela in Khyber-Pakhtunkhwa. Other maxima of more than 140 mm rainfall were recorded over Faisalabad, Gujranwala, Mandibahuddin, Sialkot and Shinkhari. Sindh, most parts of Balochistan and South Punjab remained dry during the spell.



Figure 11: 3rd Wet Spell of Rainfall July 2021 (19th-21st)

Figure 12: Spatial distribution of rainfall July 2021 (19th-21st)

Satellite/Radar images in figure 13 showing dense clouds over north Punjab, along with Khyber Pakhtunkhwa and Kashmir during the spell of 19th to 21st July-2021.

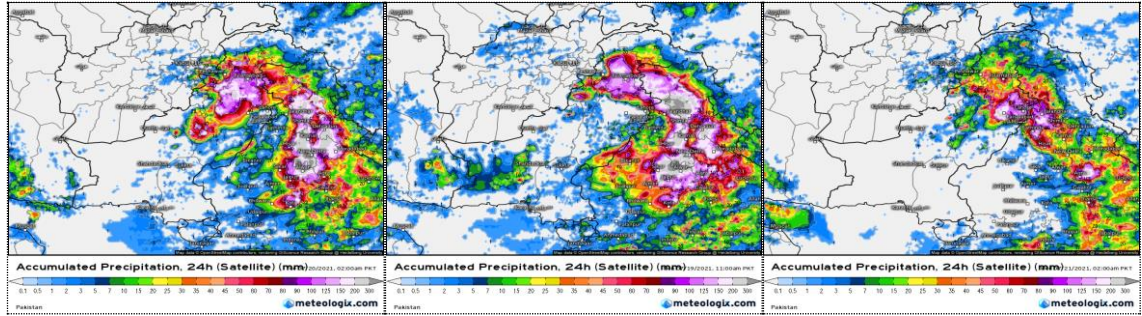


Figure 13: Satellites Images of July 2021 (19th-21st)

4.5 4th wet spell of July 2021 (27th to 29th)

The fourth wet spell of July 2021 which remained active for three days was mainly due to the presence of a westerly trough accompanied by moist currents from the Arabian Sea as well as Bay of Bengal. Figures 14 represents 500 hPa and 850 hPa geopotential height patterns along with 925 hPa wind flow during the spell. It indicates that most parts of Pakistan are under the influence of the westerly wave. Southwesterly winds at 925 hPa are also present ensuring moderate moisture supply from the Arabian Sea.

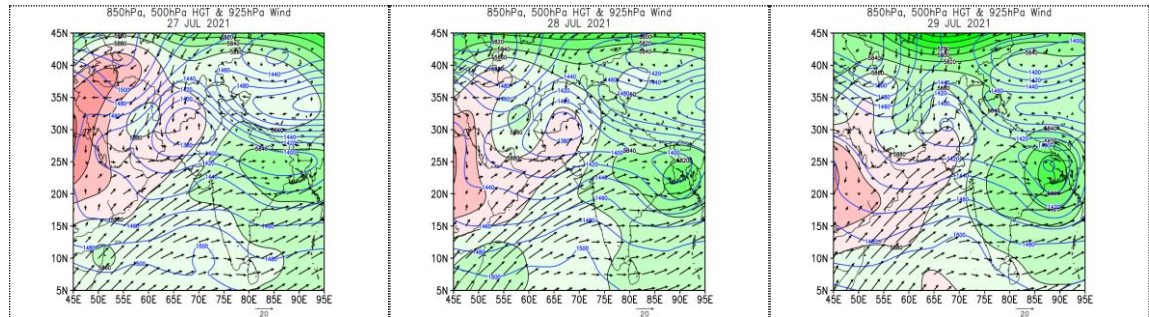
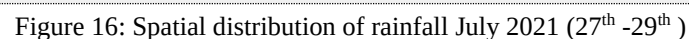


Figure 14: hPa Geopotential Height & winds map of July 2021 (27th-29th)

Figure 15 & 16 show the spatial distribution of significant rainfall during this spell. Maximum rainfall of more than 180 mm occurred over Sialkot in Gujranwala division. Other maxima of more than 120 mm rainfall were recorded over Narowal. Sindh, Balochistan and South Punjab remained dry during the spell.



Satellite/Radar images in figure 17 showing dense clouds over northeast Punjab, along with Khyber Pakhtunkhwa and Kashmir during the spell of 27th to 29th July-2021.

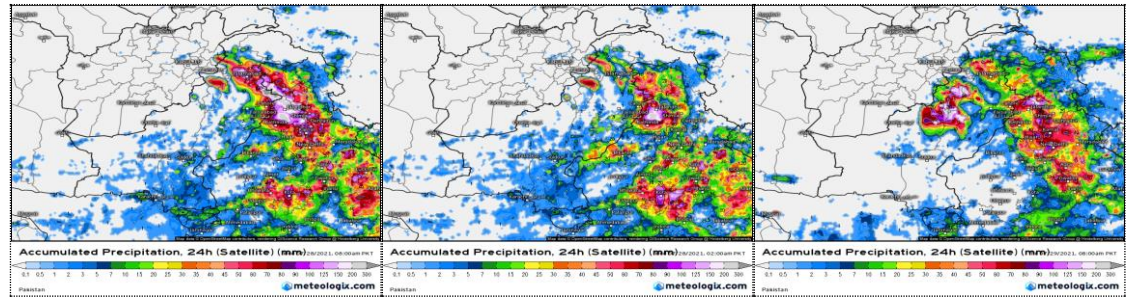


Figure 17: Satellites Images of July 2021 (27th -29th)

4.6 Rivers position during the third spell of July-2021

No High level flood situation was recorded in any of the major rivers.

4.7 Spatial distribution of rainfall during the month of July 2021

The precipitation during the month of July is shown in figure 18 & 19 which indicate that monsoon activity remained active over North & Northeast Punjab and Kashmir. Center of maximum rainfall exceeding 500 mm were recorded at Sialkot and other in Kashmir. While another maximum of 400 mm is located around Mandibahuddin.



Rainfall Departure map for the month of July 2021 indicates that most parts of the country received below normal rainfall, however Sialkot received 200 mm more rain than normal. Mianwali, Bannu, Kakul and Faisalabad also received significantly more rain than their normal. Rainfall Departure map of July 2021 is shown in Figure 20 & 21.



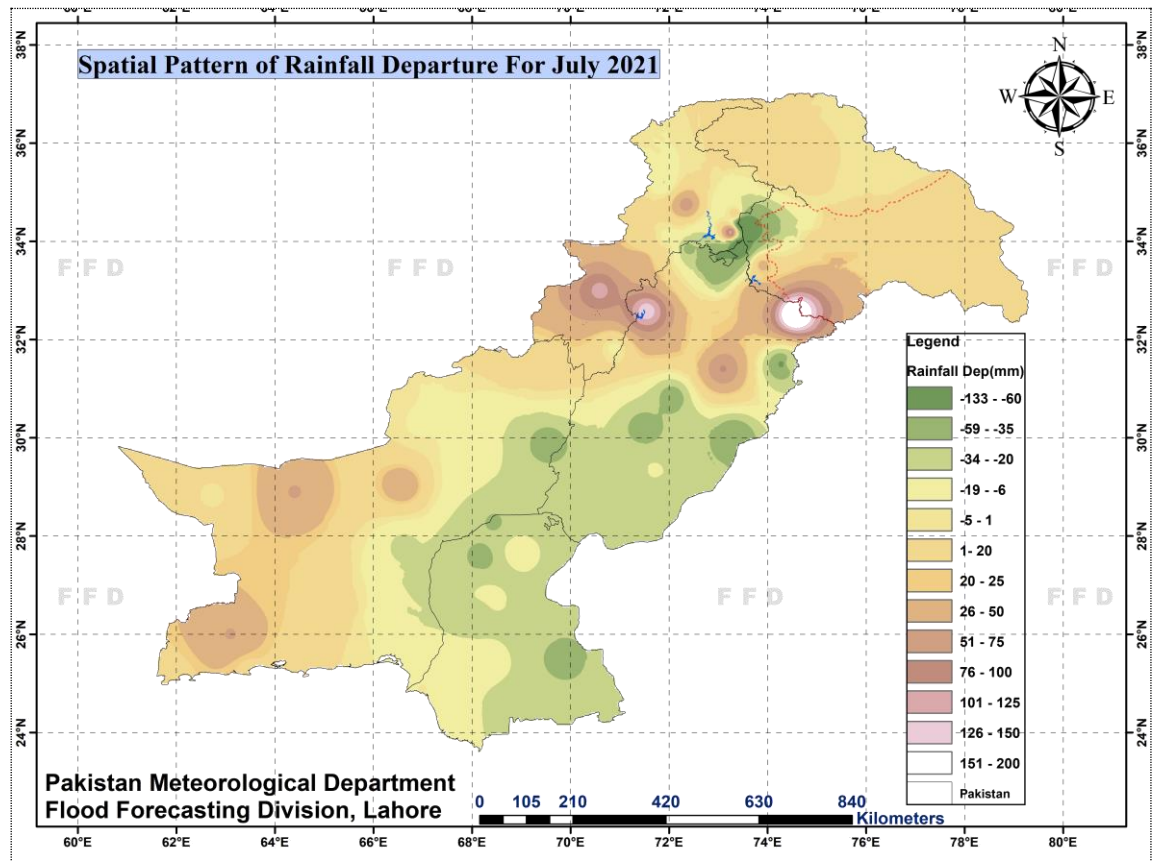


Figure 21: Percentage Anomaly rainfall map of July 2021.

4.9 Temporal Distribution during the month of July 2021

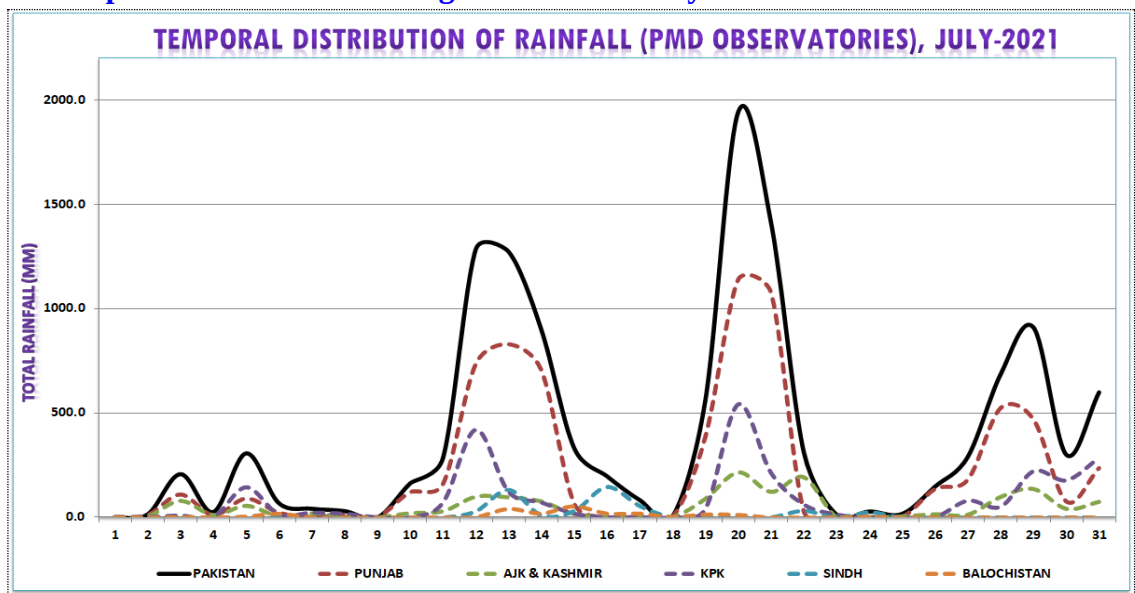


Figure 22: Temporal distribution of rainfall during July 2021.

4.10 Hydrographs during Significant event of July 2021

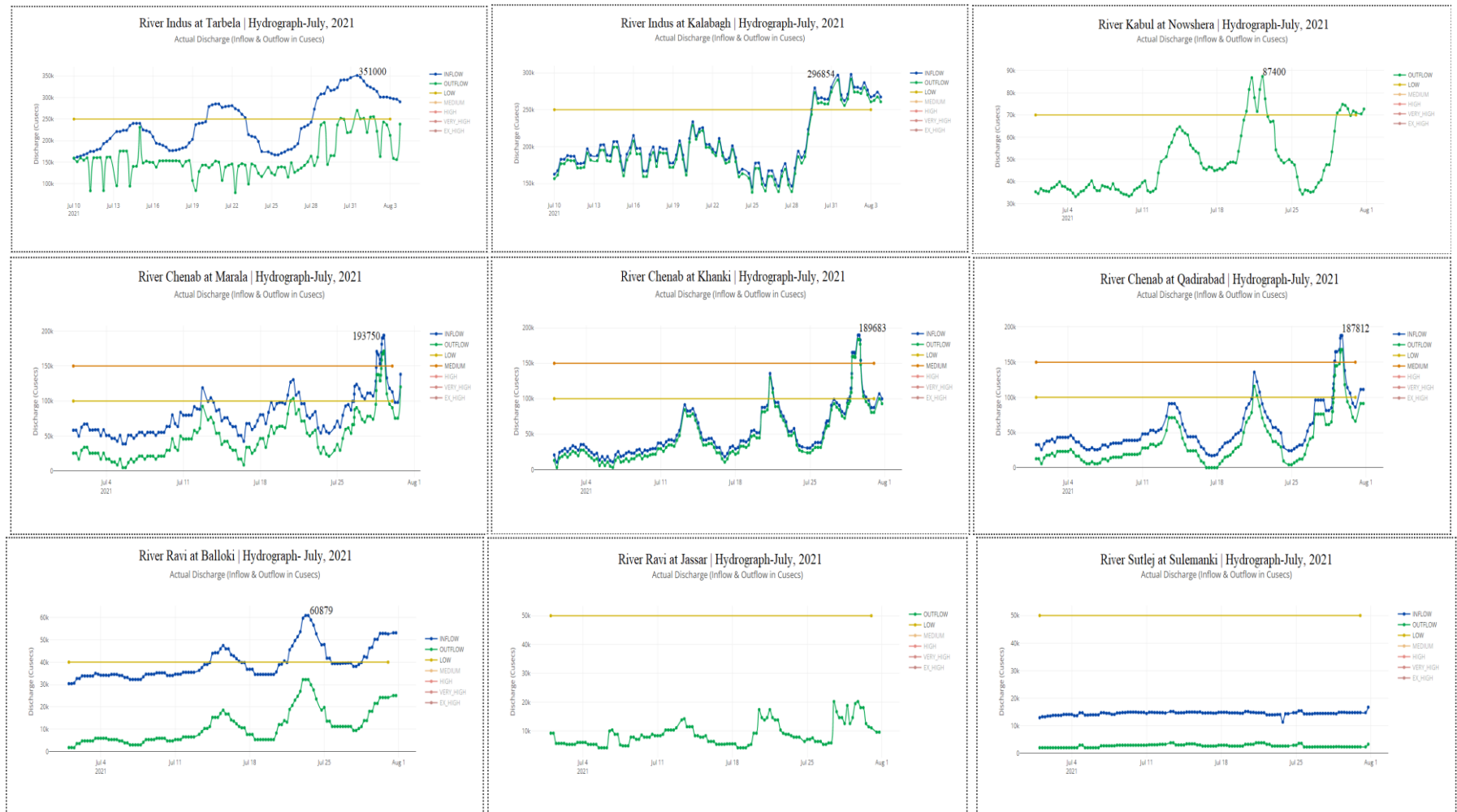


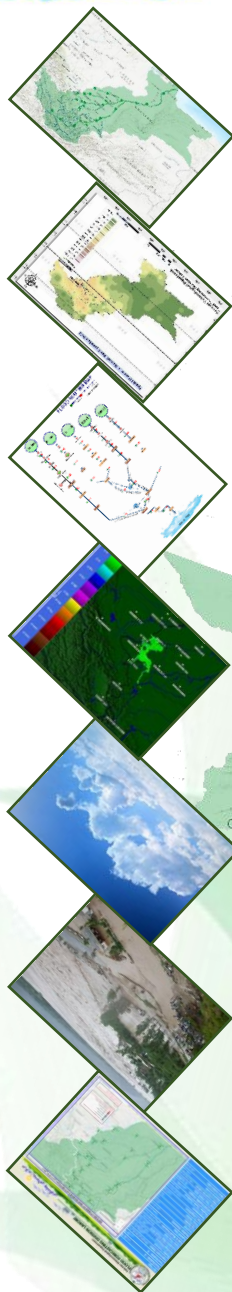
Figure 23: Hydrographs for the month of July 2021

4.11 River position during July 2021

Flood peaks (Cusecs) recorded during July 2021 in different rivers at various points are given in Table 1.

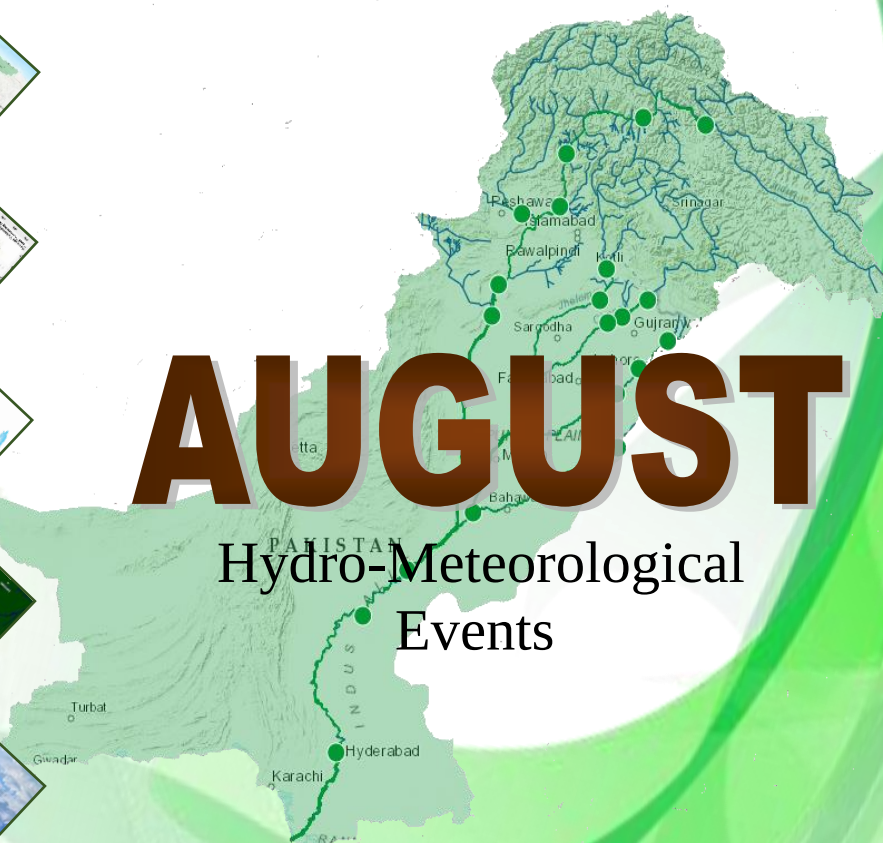
Rivers/Site	Stations	Peaks Inflows	Date	Flood level
Indus	Tarbela	351000	31-7-2021	Low
Indus	Kalabagh	296854	31-7-2021	Low
Indus	Chashma	341603	31-7-2021	Low
Indus	Taunsa	258955	31-7-2021	Low
Indus	Guddu	201855	25-7-2021	Low
Kabul	Nowshera	87400	22-7-2021	Low
Jhelum	Mangla	109000	28-7-2021	Low
Chenab	Marala	193750	29-7-2021	Medium
Chenab	Khanki	189683	29-7-2021	Medium
Chenab	Qadirabad	187812	29-7-2021	Medium
Ravi	Balloki	60879	23-7-2021	Low
Ravi	Sidhnai	30379	27-7-2021	Low

Table 1: Maximum Peaks recorded during the month of July 2021



AUGUST

Hydro-Meteorological Events



5 Significant Hydro-Meteorological events during the month of August-21

Two significant rainfall spells occurred during the month of August 2021, however no High flood situation arised in any of the major rivers.

5.1 Meteorological events

The first spell which occurred from 01st to 04th August 2021 was the result of penetration of moderate moist currents from Arabian Sea and Bay of Bengal, also due to the effect of westerly wave passing over northern parts of the country and the presence of heat low over North Balochistan. The second spell of August was observed from 14th to 16th August 2021. It was caused by the interaction of westerly wave passing over northern parts of the country and the moist influx from Arabian Sea.

5.2 01st wet spell of August 2021 (01st to 04th)

The first wet spell of August 2021 which remained active for four days was result of penetration of moderate moist currents from Arabian Sea and Bay of Bengal, also due to the effect of westerly wave passing over northern parts of the country and the presence of heat low over North Balochistan. Figure 24 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 & Southeasterly winds at 925 hPa are also present ensuring enough moisture supply from the both Arabian Sea & Bay of Bengal.

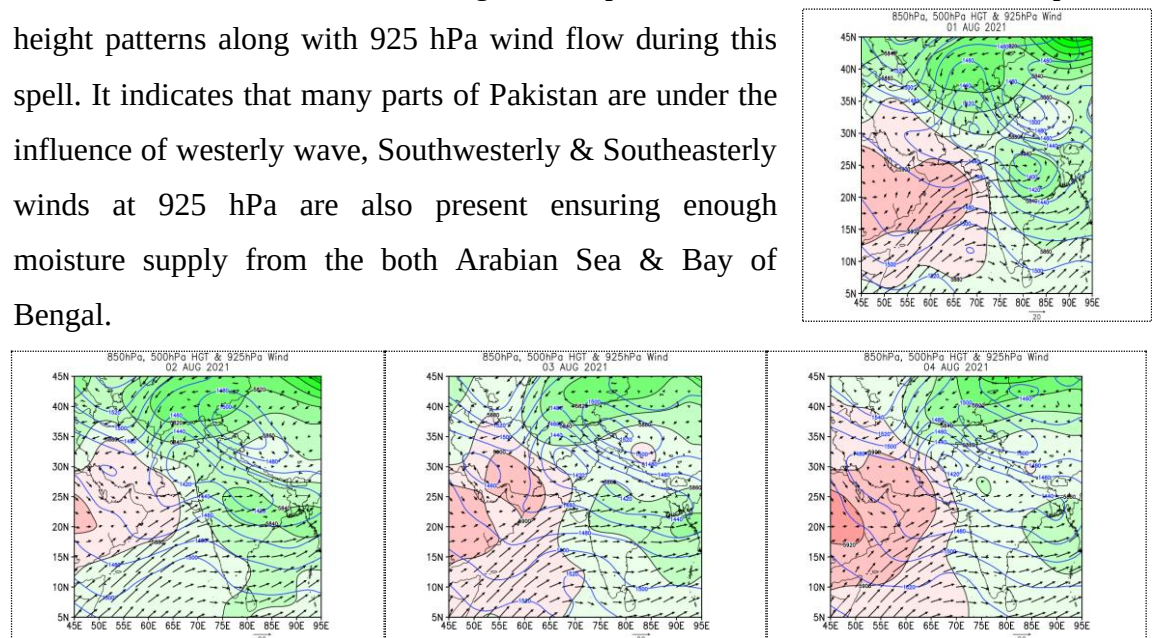


Figure 24: hPa Geopotential Height & winds map August 2021 (01st to 04th)

Figure 25 & 26 indicates the spatial distribution of significant rainfall during the event which shows that moderate rainfall occurred over the most parts of Punjab with

1st Wet Spell Rainfall | August 01-04 | 2021

District	Rainfall (mm)
ASTOR	2.0
BAHAWALPUR	38.0
BAHAWALPUR	14.0
BAHAWALPUR	30.0
BAHAWALPUR	20.0
BALAKOT	5.0
BHAKKAR	102.0
BUNJI	12.0
CHAKIALA	10.0
CHAKI	4.0
CHAKI	12.0
CHIRAT	1.0
CHILLAS	3.0
D.I.KHAN	42.0
D.I.KHAN	6.0
D.I.KHAN	43.0
DOMEL	12.0
DRATIAN	4.0
PASALABAD	4.0
PASALABAD	55.0
PASALABAD	1.0
GHANIALA	1.0
GILGIT	10.0
GUJRANWALA	10.0
GUJRANWALA	5.0
GUJRANWALA	8.0
ISLAMABAD	80.0
ISLAMABAD	10.0
ISLAMABAD	17.0
JHANG	5.0
JOHARABAD	17.0
KAKUL	75.0
KALAM	10.0
KALLAR	25.0
KALLAR	44.0
KALLAR	22.0
KASTUR	8.0
KOTLI	8.0
LAHORE	28.0
LAHORE	81.0
LAHORE	5.0
LOWER DIR	10.0
MALAMABABA	100.0
MANDIBAHAD	4.0
MANGLA	62.0
MINWALI	3.0
MIRREE	35.0
MUZAFARABAD	16.0
MUZAFARABAD	12.0
MUZAFARABAD	6.0
NAURANG	42.0
NAURANG	12.0
NAURANG	12.0
OKARA	12.0
PALOTE	2.0
PARAHAN	28.0
PATTAN	7.0
PESHAWAR	6.0
PESHAWAR	72.0
PHILRA	19.0
PHILRA	24.0
PLANDRI	24.0
RASHID ABAD	4.0
RAVI SYTHON	27.0
RAWALPOTHI	10.0
RAJOUR	10.0
RAJOUR	10.0
SADIQ SHARIF	4.0
SADIQ SHARIF	28.0
SADIQ SHARIF	2.0
SARGODHA	10.0
SARGODHA	1.0
SHARQUR	35.0
SHINKARI	25.0
SHINKARI	3.0
SIALKOT	29.0
SIALKOT	2.0
SIALKOT	2.0
SIBBI	10.0
SKARDI	20.0
T. T. KHAN	20.0
TAKHTI	2.0
URA	2.0
ZHOB	47.0

Spatial Pattern of Rainfall Spell For 01-04 August 2021

FFD FFD FFD FFD FFD

Legend

Rainfall(mm)

- 81 - 100
- 71 - 80
- 61 - 70
- 51 - 60
- 31 - 50
- 16 - 30
- 1 - 15
- Pakistan

Pakistan Meteorological Department
Flood Forecasting Division, Lahore

0 105 210 420 630 840 Kilometers

26

Figure 27 is showing rainfall/clouds remained over the Parts of the country during the spell.

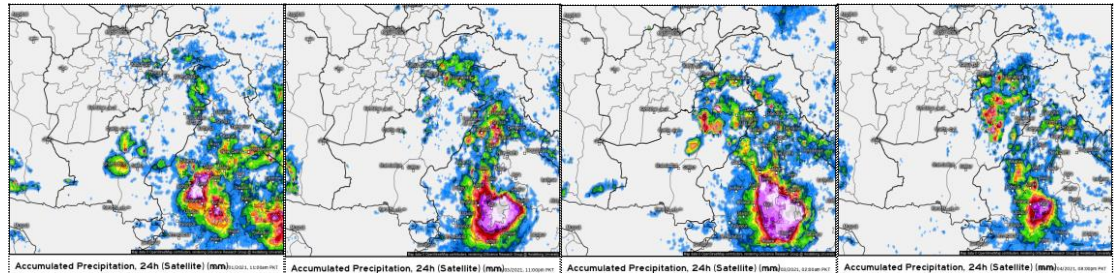


Figure 27: Satellites Images of August 2021 (01st to 04th)

5.3 2nd wet spell of August 2021 (14th to 16th)

The second wet spell of August 2021 which remained active for three days was mainly due to the presence of a westerly trough accompanied by moist currents from the Arabian Sea. Figure 28 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 waves, Southwesterly winds at 925 hPa are also present ensuring enough moisture supply from the Arabian Sea.

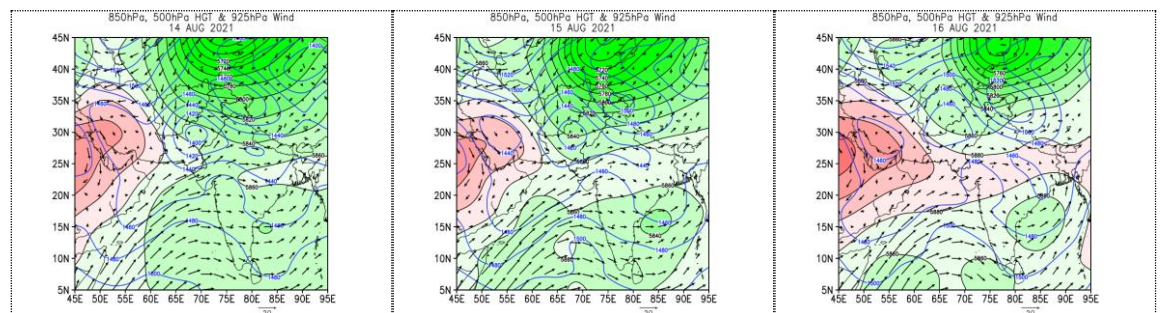


Figure 28: hPa Geopotential height & winds of August 2021 (14th - 16th)

Figure 29 & 30 indicates the spatial distribution of significant rainfall during the event which shows that maximum rainfall of more than 80 mm occurred over Attock. More than 60 mm rainfall was also recorded at Bannu. Light rain also reported from rest of Khyber Pakhtunkhwa, Kashmir and Gilgit Baltistan.



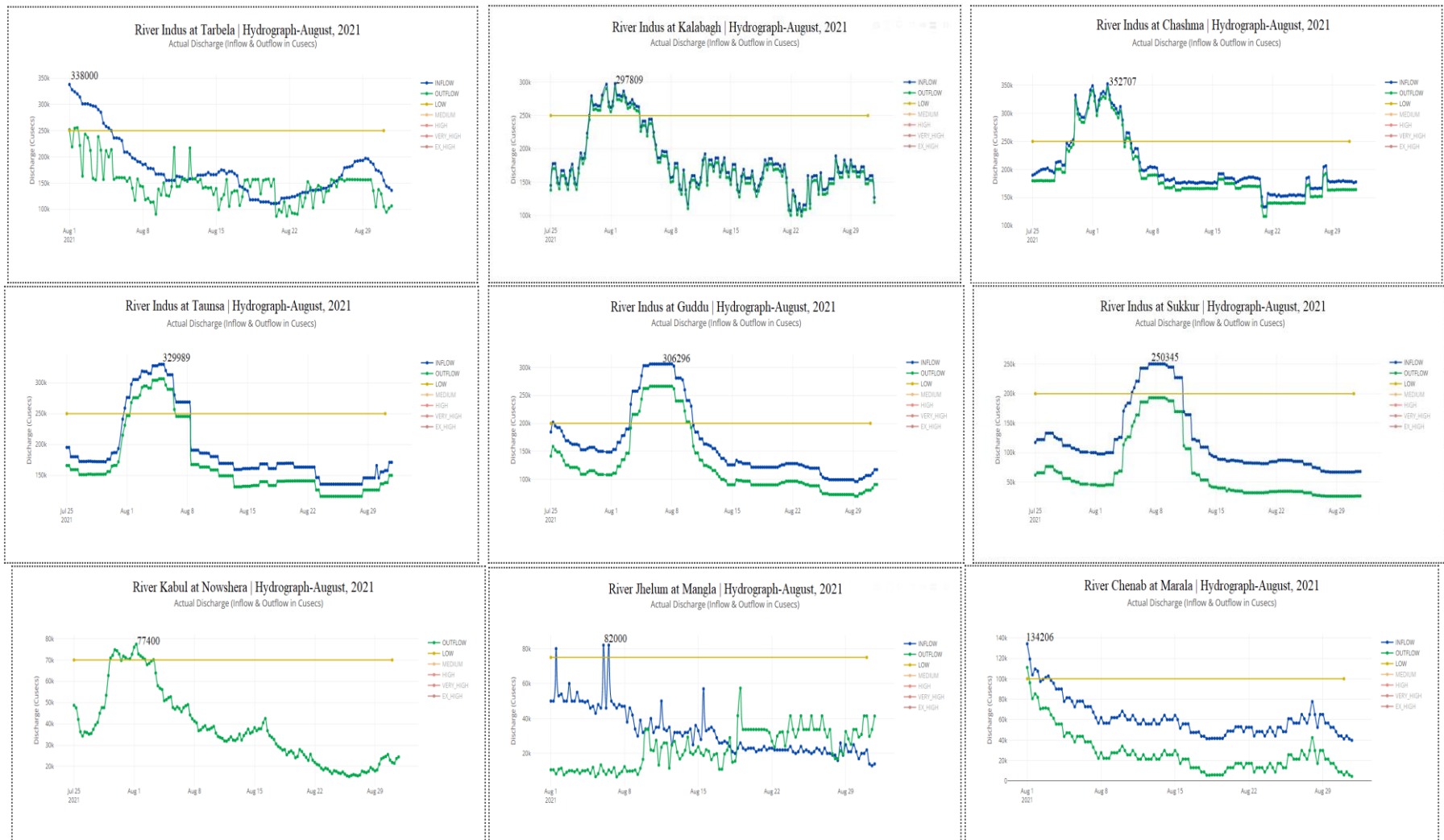
Accumulated Precipitation, 24h (Satellite) (mm) 14/02/21, 0600 UTC

Accumulated Precipitation, 24h (Satellite) (mm) 14/02/21, 1100 UTC

Accumulated Precipitation, 24h (Satellite) (mm) 14/02/21, 1300 UTC

Figure 31: Satellites Images of August 2021 (14th - 16th)

5.4 Hydrographs during August 2021



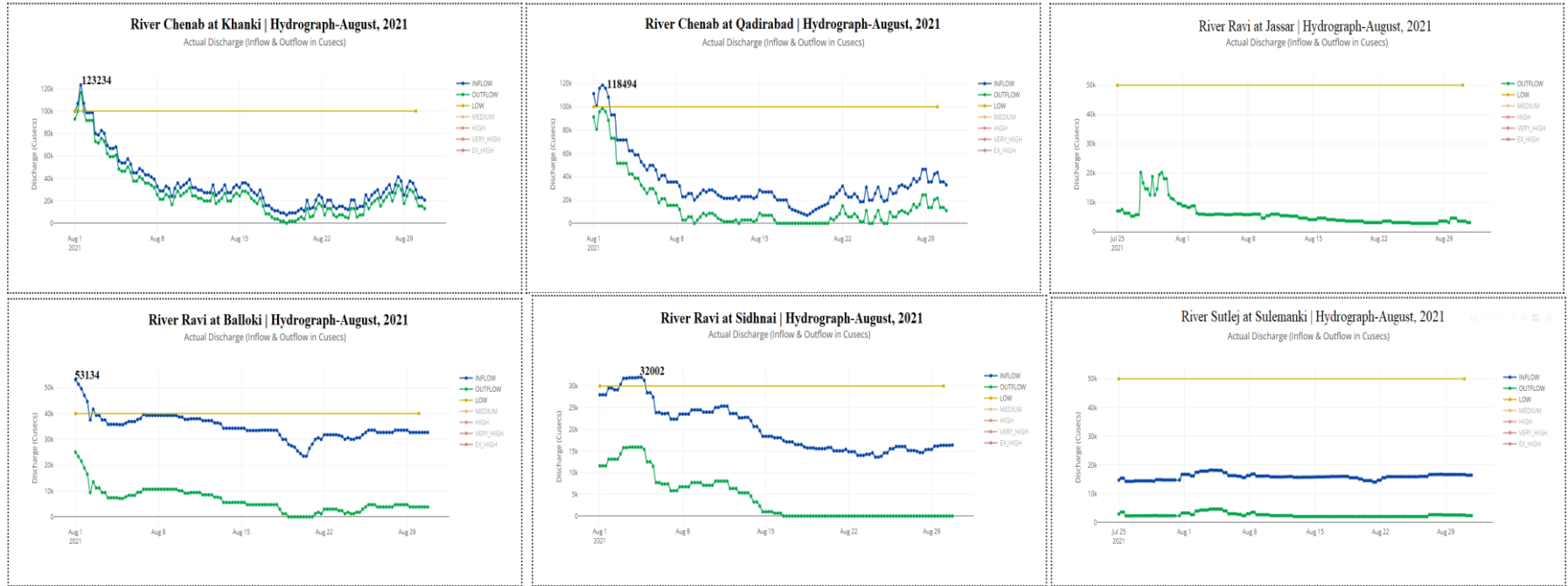


Figure 32: Hydrographs for the month of August 2021.

5.5 River position during August 2021

Flood peaks (Cusecs) recorded during August 2021 in different rivers at various points are given in Table 1.

Rivers/Site	Stations	Peaks Inflows	Date	Flood level
Indus	Tarbela	338000	01-8-2021	Low
Indus	Kalabagh	297809	01-8-2021	Low
Indus	Chashma	352707	02-8-2021	Low
Indus	Taunsa	329989	04-8-2021	Low
Indus	Guddu	306296	07-8-2021	Low
Indus	Sukkur	250345	07-8-2021	Low
Kabul	Nowshera	77400	01-8-2021	Low
Jhelum	Mangla	82000	06-8-2021	Low
Chenab	Marala	134206	01-8-2021	Low
Chenab	Khanki	123234	01-8-2021	Low
Chenab	Qadirabad	118494	01-8-2021	Low
Ravi	Balloki	53134	01-8-2021	Low
Ravi	Sidhnai	32002	04-8-2021	Low
DGK Nullah	Vehova	49715	02-8-2021	Medium

Table 2: Maximum Peaks recorded during the month of **August 2021**.

5.6 The spatial pattern of rainfall during the month of August 2021

Isohyetal map of August 2021 indicates that two maxima rainfall more than 200 mm, one lies over Kakul & other over Malamjabba. Other Maximum rainfall of more than 150 mm occurred over Attock, Chaklala, Dir ,Jhelum ,Lahore , Murree and Palandri. The spatial distribution of rainfall map of August 2021 is shown in figure 33 & 34.

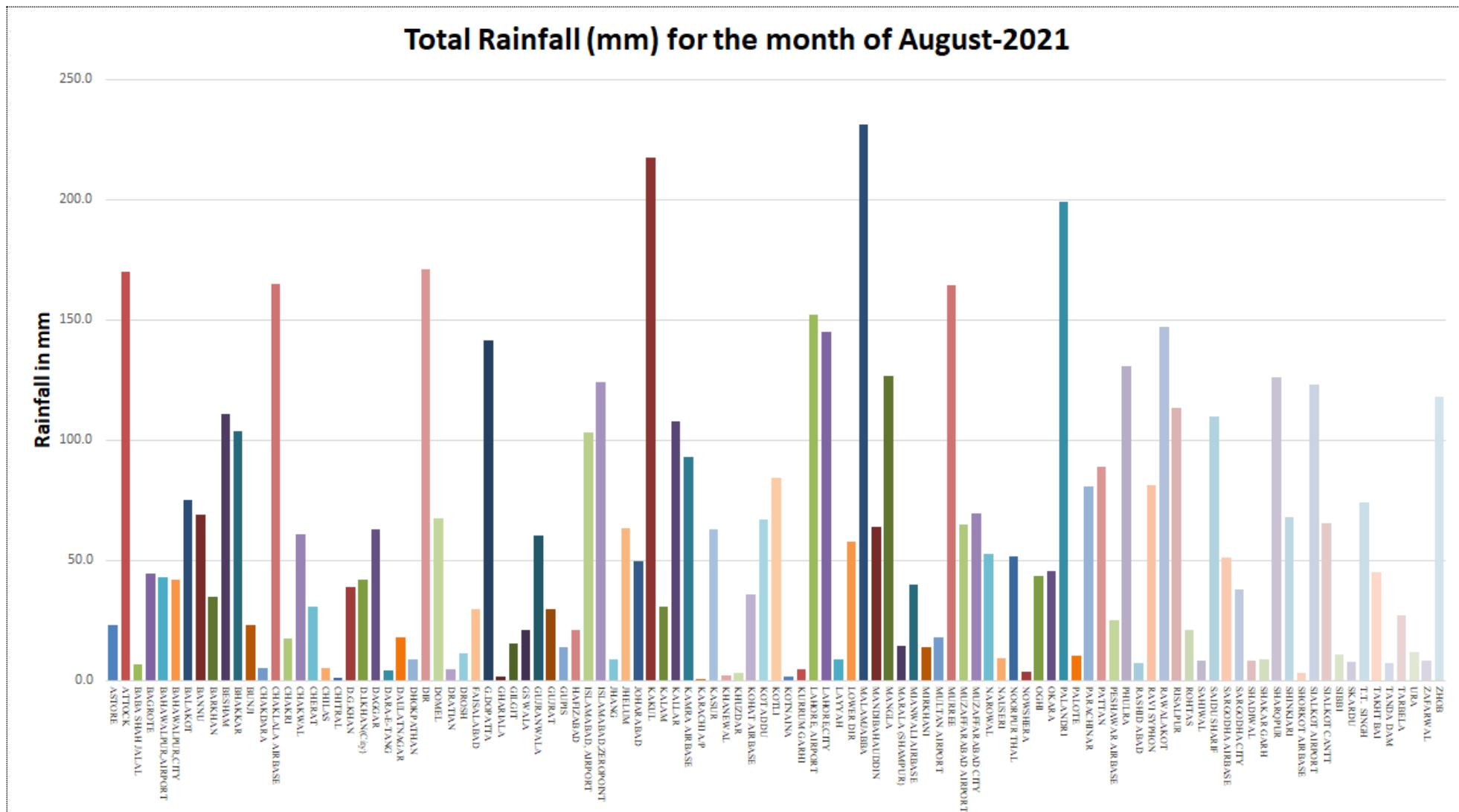


Figure 33: Total Rainfall for the month of August 2021.

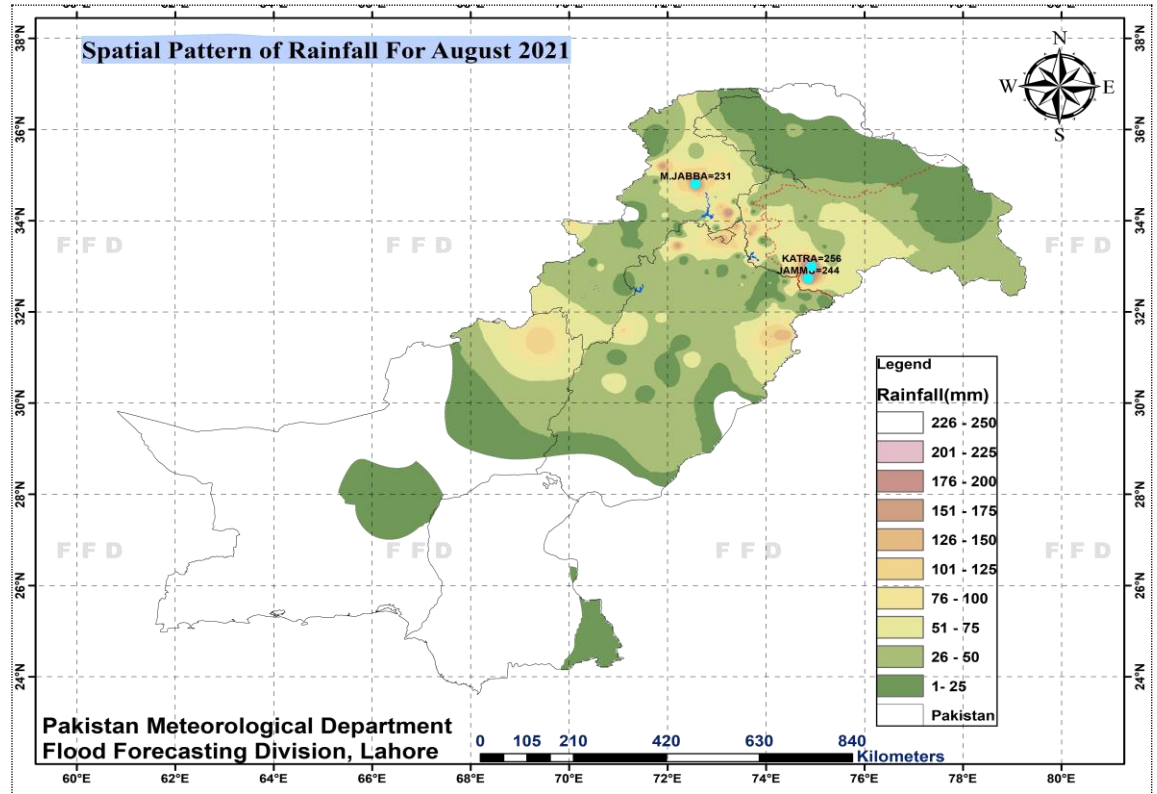


Figure 34: Spatial distribution rainfall map of August 2021.

5.7 Departure Anomaly during the month of August 2021

Departure Anomaly map for the month of August 2021 indicates that Most parts of the country received below normal rainfall. However, Zhob, Dir and Bahawalpur received above normal rain. Departure Anomaly map of August 2021 for the other parts of the country as well is shown in Figure 35 & 36.

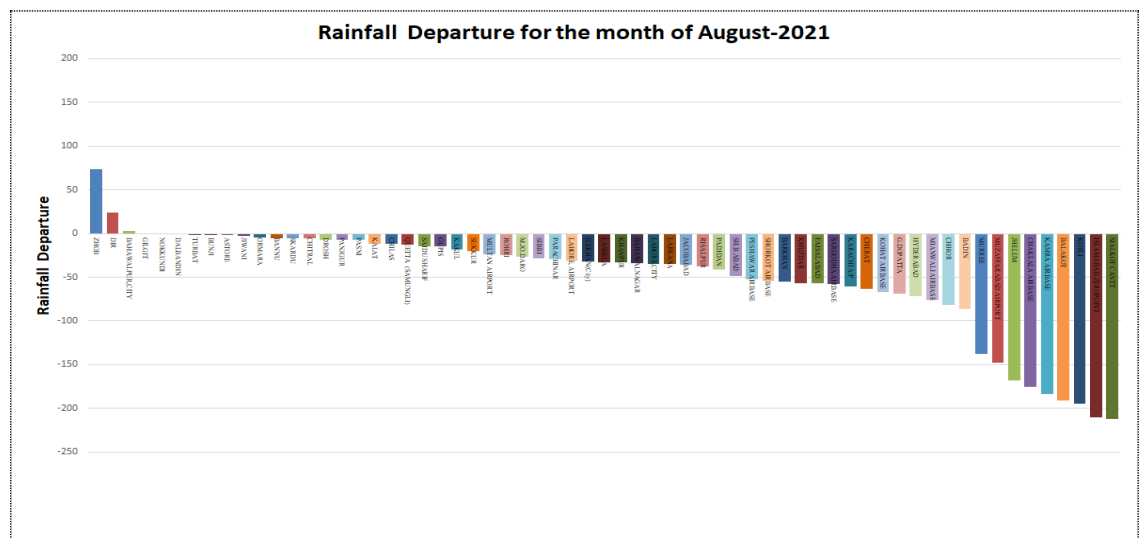


Figure 35: Rainfall Departure for of August 2021.

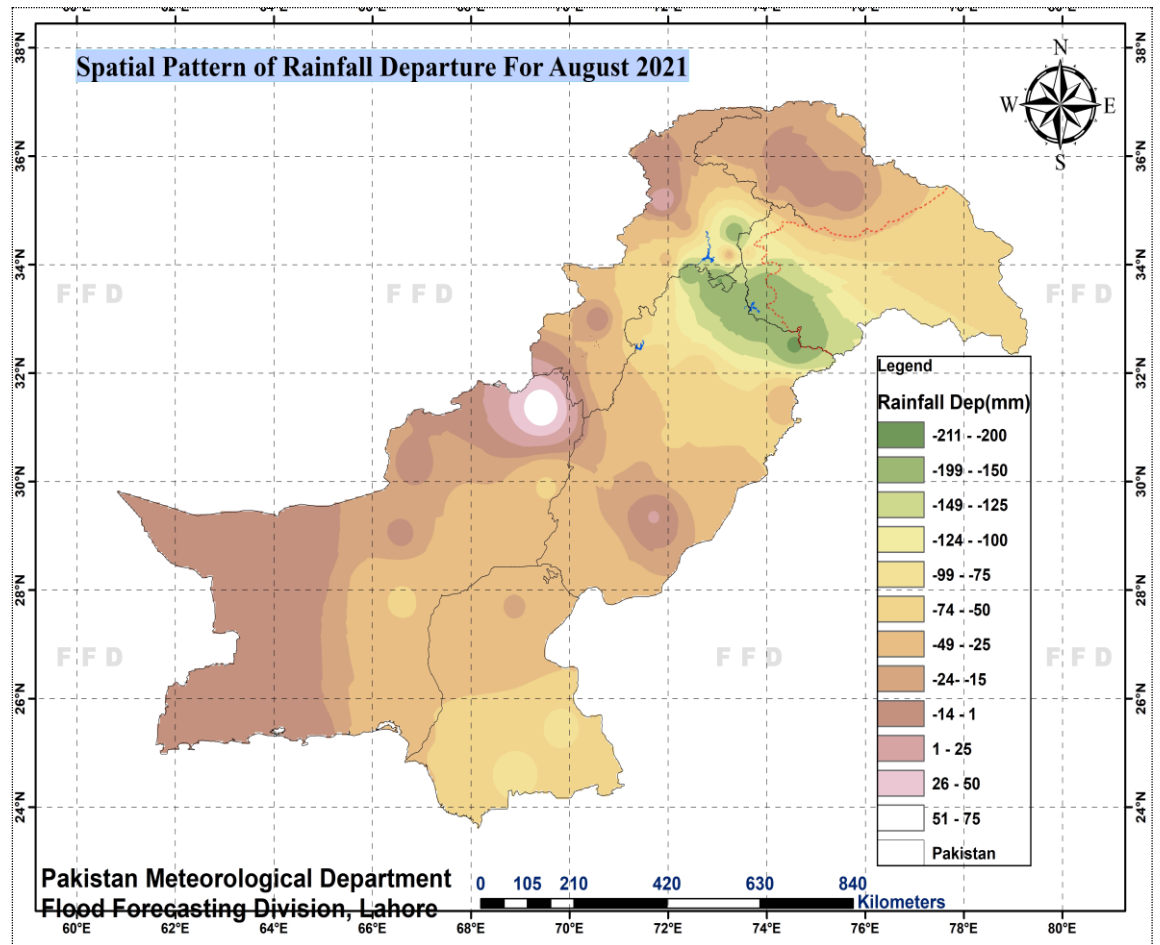


Figure 36: Percentage Anomaly rainfall map of August 2021.

5.8 Temporal Distribution during the month of August 2021

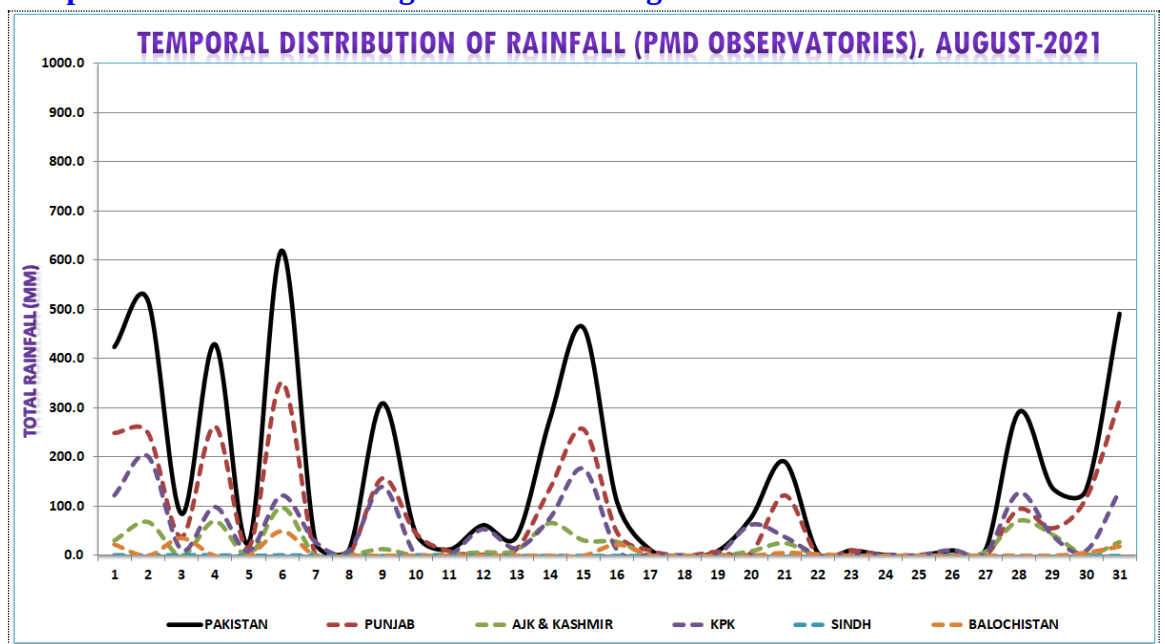
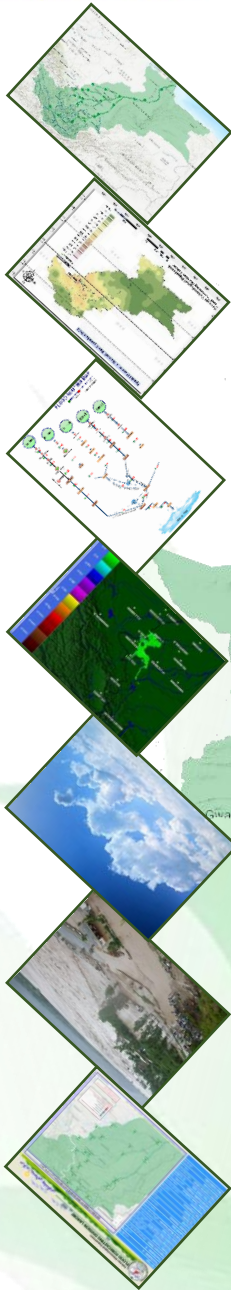
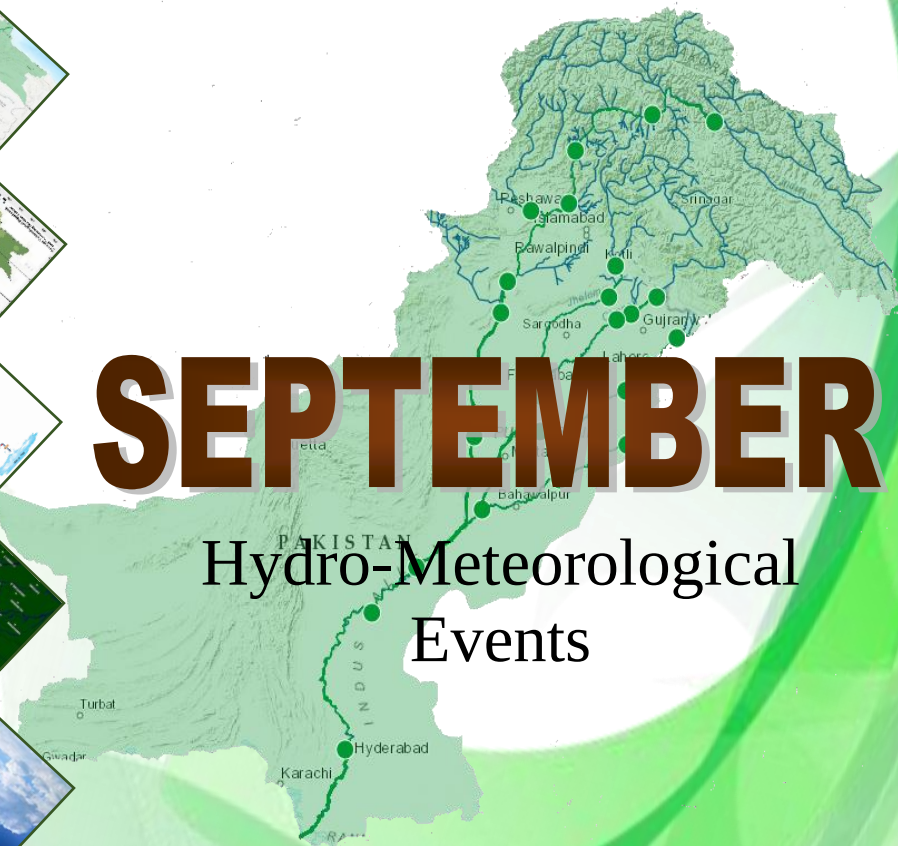


Figure 37: Temporal distribution of rainfall August 2021.



SEPTEMBER

Hydro-Meteorological Events



6 Significant Hydro-Meteorological events during the month of Sep-2021

During the month of September, two wet spells were recorded but no High Flood situation arose during the month.

6.1 1st wet spell of September 2021 (08th to 12th)

This spell occurred from 8th to 12th September 2021. During this event moderate to heavy rainfall was reported from Ravi syphon and Kasur in Lahore division, light to moderate rain also recorded from scattered places of the upper parts of the country. This situation was created by the presence of a westerly wave over north of Pakistan, interacting with the sufficient moisture available as shown in Figure 38.

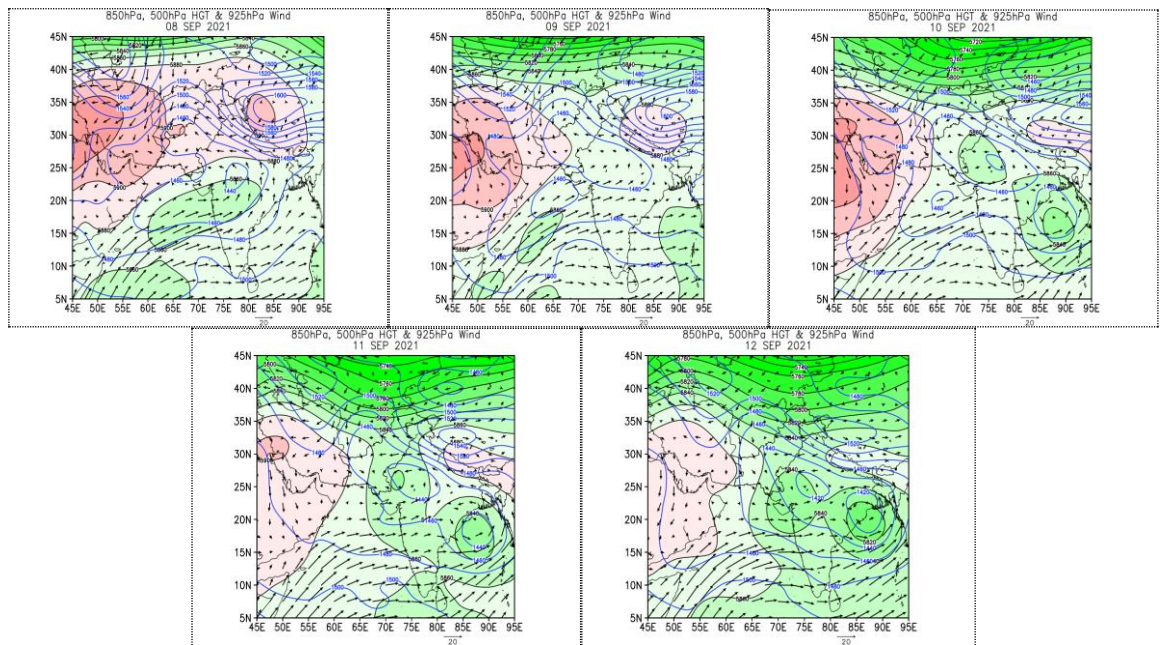


Figure 38: hPa geopotential height & hPa winds map of September 2021 (08th to 12th)

Figure 39 & 40 shows the spatial distribution of significant rainfall more than 250 mm recorded over Ravi syphon & other maxima centre of rainfall more than 200 mm observed around Kasur along with moderate rainfall at scattered places over the upper parts of the country.

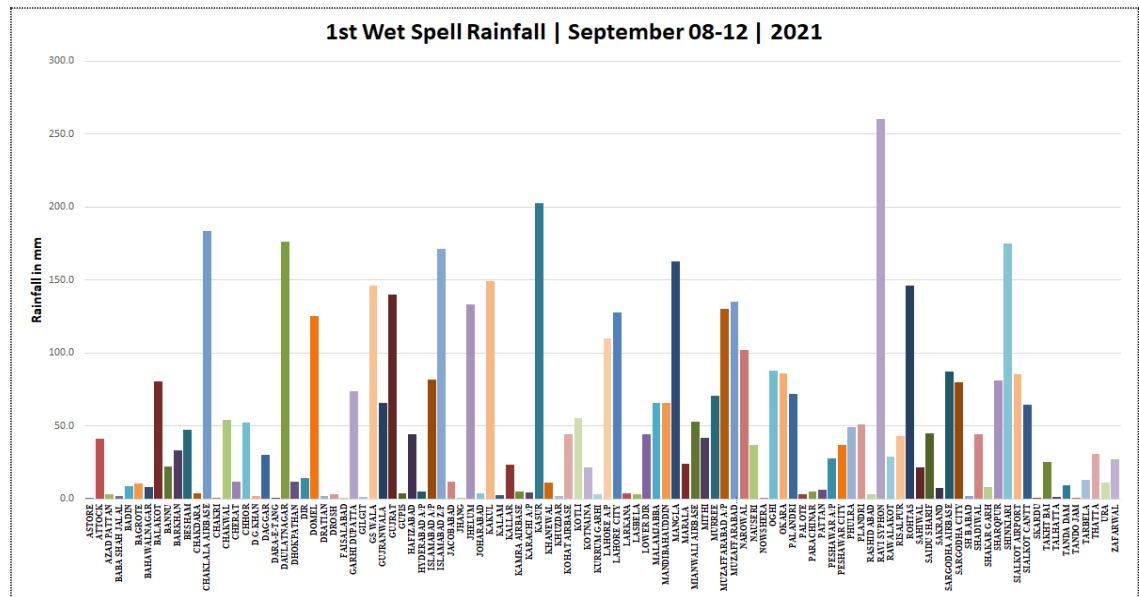


Figure 39: 1st Wet Spell of Rainfall September 2021 (08th to 12th)

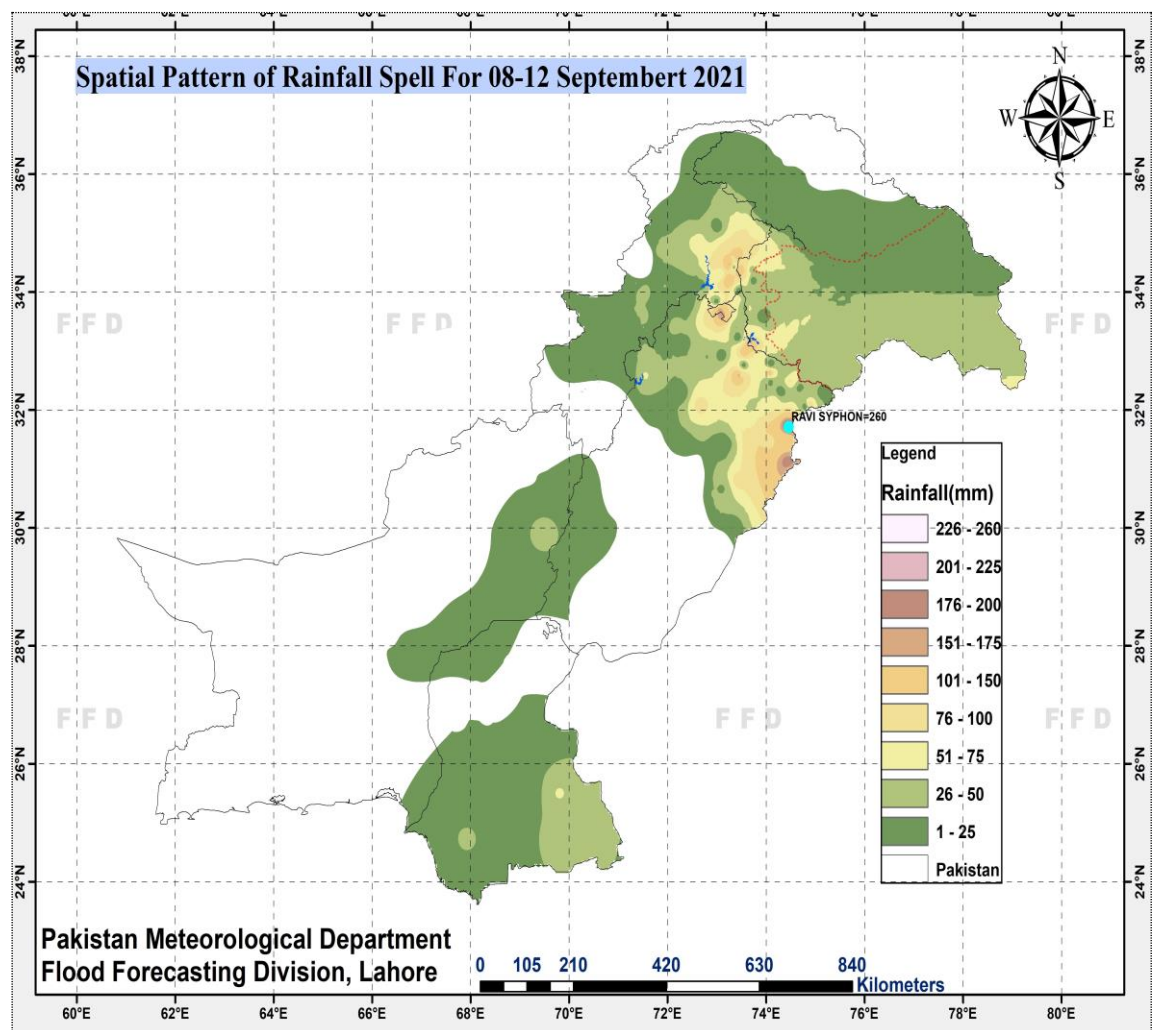


Figure 40: Spatial distribution of significant rainfall of September 2021 (08th to 12th)

The satellite image in figure 41 shows moderate to strong clouds over North Punjab and moderate clouds over south and southeast Sindh and Kashmir.

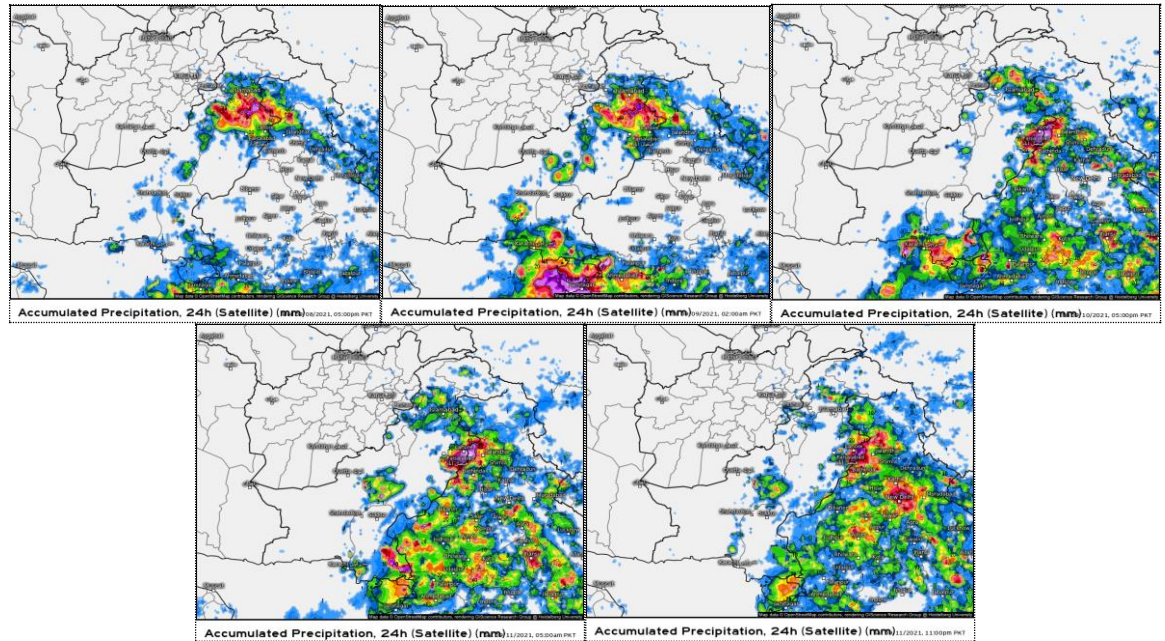


Figure 41: Satellites Images of September 2021 (08th to 12th)

6.2 2nd wet spell of September 2021 (21st to 23rd)

The second rainy spell occurred from 21st to 23rd September 2021 was the last spell of the flood season 2021. During this event light to moderate rainfall was reported from the upper half of the country. situation occurred by the interaction of a westerly wave over the north of Pakistan with the sufficient moisture available as shown in Figure 42.

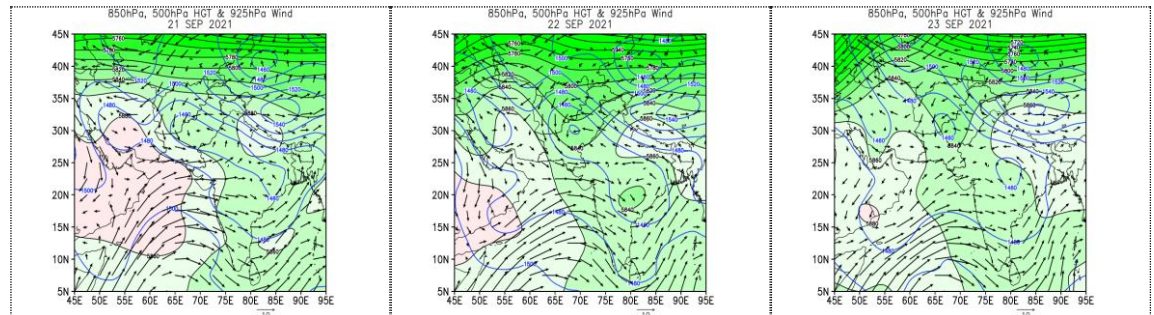


Figure 42: hPa geopotential height & hPa winds map of Sep-2021 (21st to 23rd)

Figure 43 & 44 shows the spatial distribution of significant rainfall of more than 180 mm recorded over Jhelum in Rawalpindi division. light to moderate rain observed over the other parts of the country during the spell is also shown.

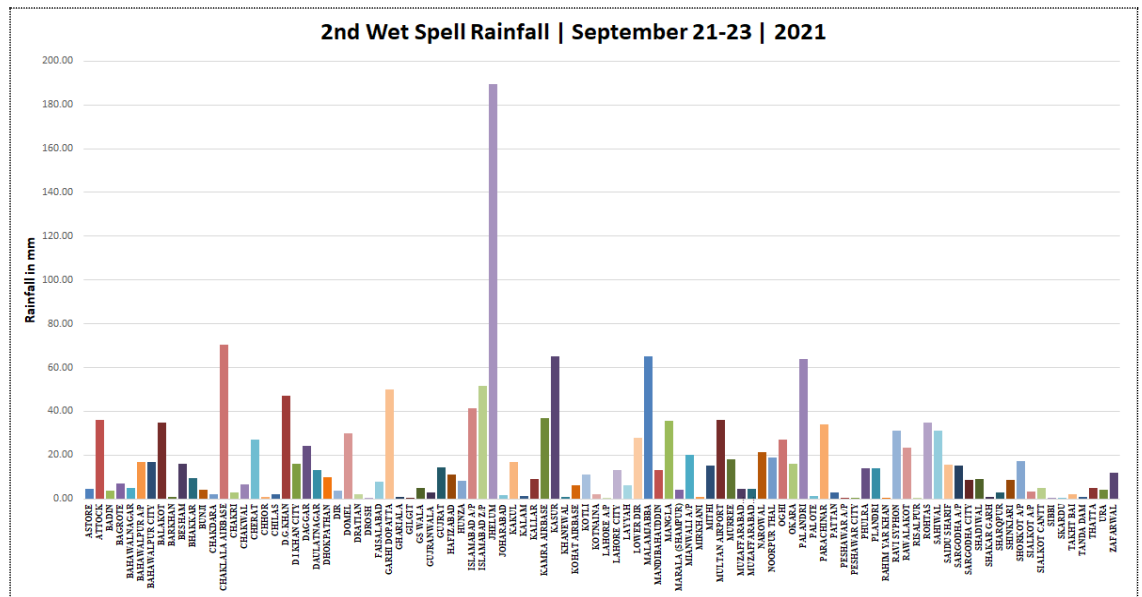


Figure 43: 02nd Wet Spell Rainfall of Sep-2021 (21st to 23rd)

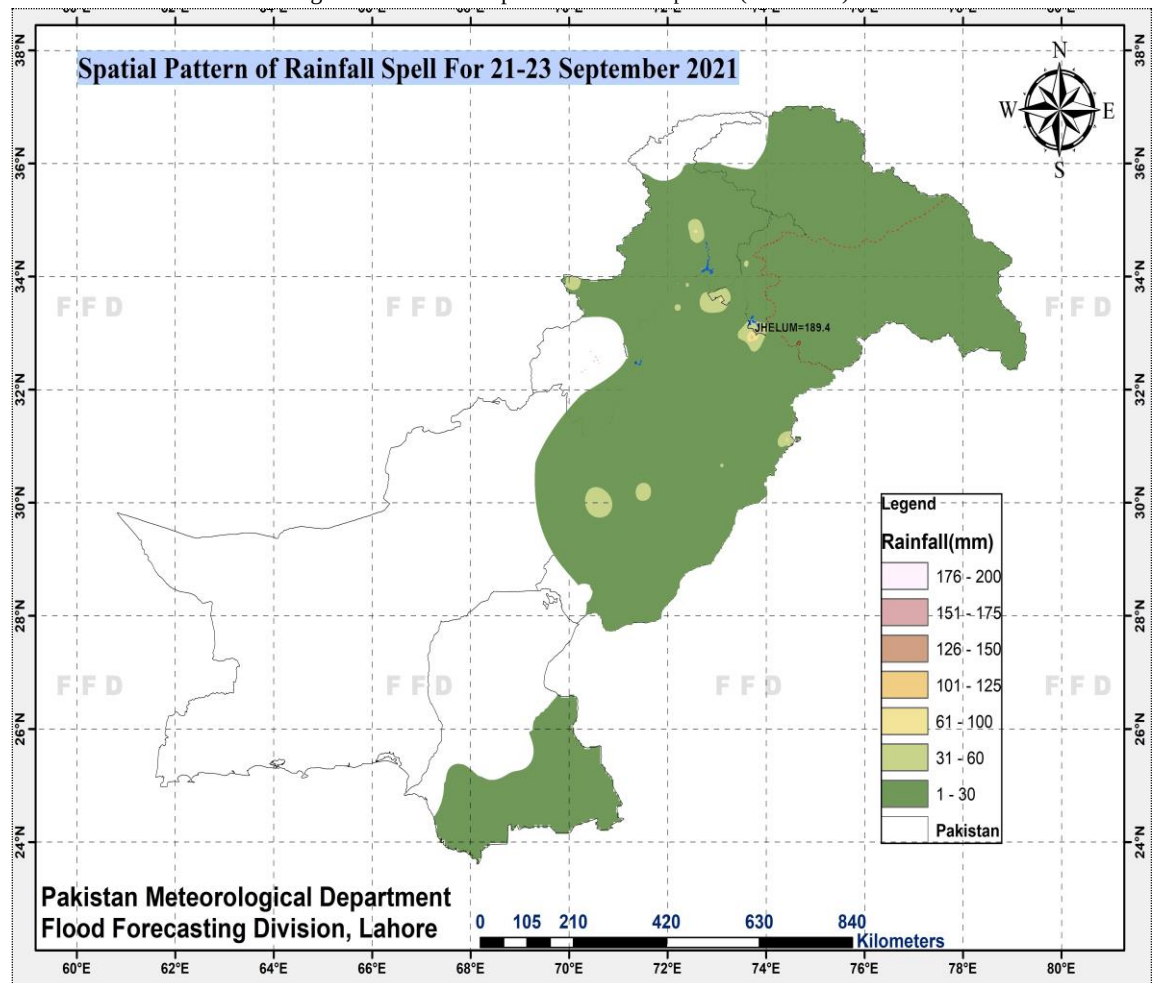


Figure 44: Spatial distribution of significant rainfall map of Sep-2021 (21st to 23rd)

Satellite images in figure 45 show moderate clouds over Punjab & Kashmir.

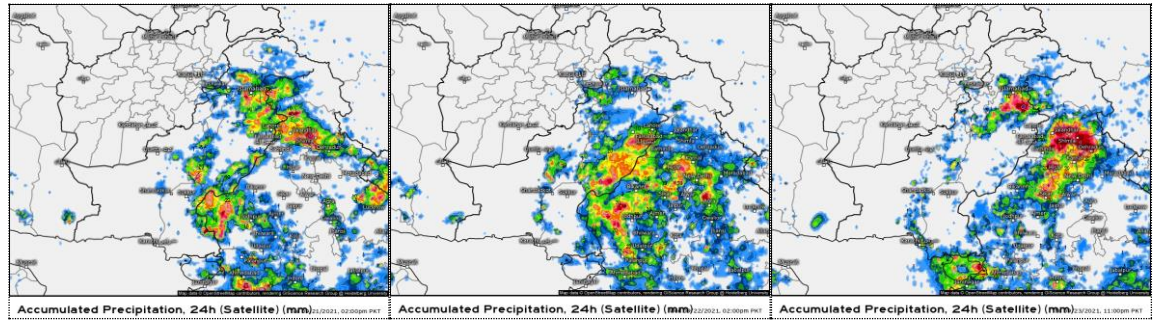


Figure 45: Satellites Images of Sep-2021 (21st to 23rd)

6.3 Hydrographs recorded during the month of September 2021 are as below

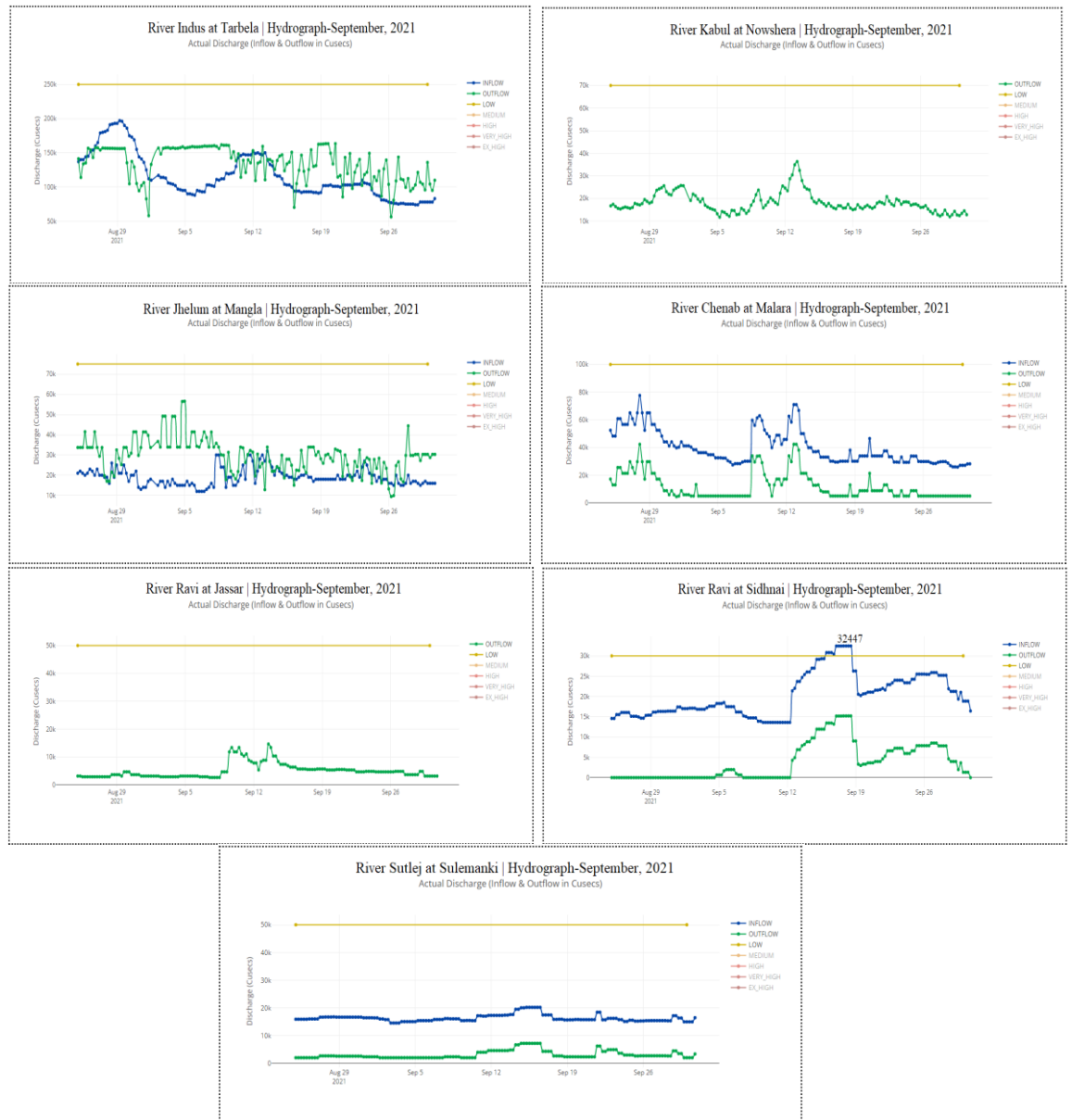


Figure 46: Hydrographs for the month of September-2021.

6.4 Rivers position during the month of September-2021

Flood peaks (Cusecs) recorded during September 2021 are shown in Table 6

Rivers/Site	Stations	Peaks Inflows	Date	Flood level
Ravi	Balloki	56340	12-9-2021	Low
Ravi	Sidhnai	32447	17-9-2021	Low

Table 3: Maximum peaks recorded during September 2021

6.5 Spatial distribution of rainfall during the month of September 2021

The precipitation during the month of September is shown in figures 47 & 48, it indicates monsoon activity remained over North & Northeast Punjab and Kashmir along with Southeast Sindh. One center of maximum rainfall exceeding 300 mm is observed at Jhelum while more than 250 mm recorded at Chaklala, Kasur and Ravi syphon. More than 200 mm of rainfall was also observed at Daulatnagar, Domel, Islamabad, Jhelum and Mangla. While maximum of above 150 mm is also shown in the figures below. west Balochistan remained dry during the month.

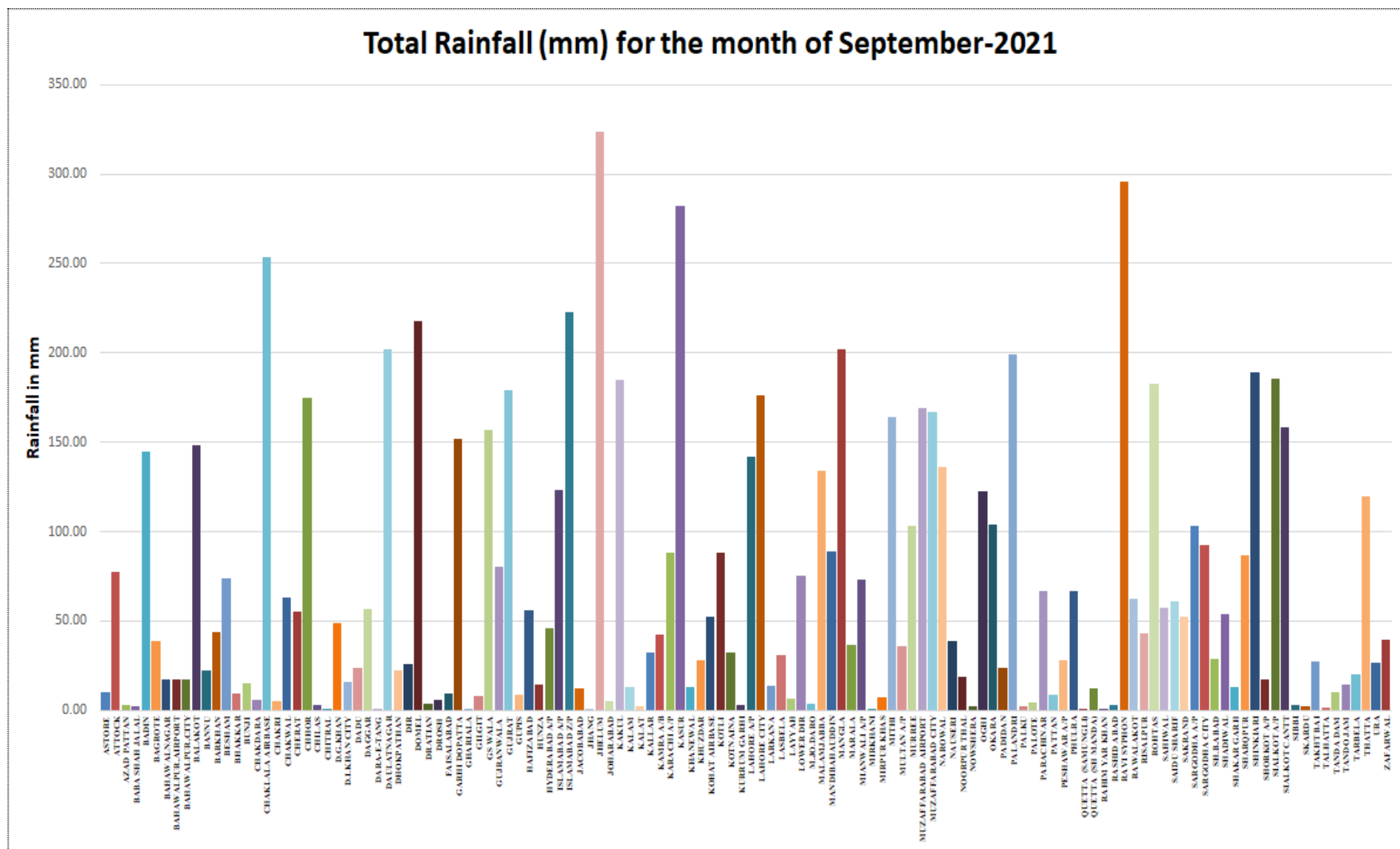


Figure 47: Total Rainfall for the month of September 2021.

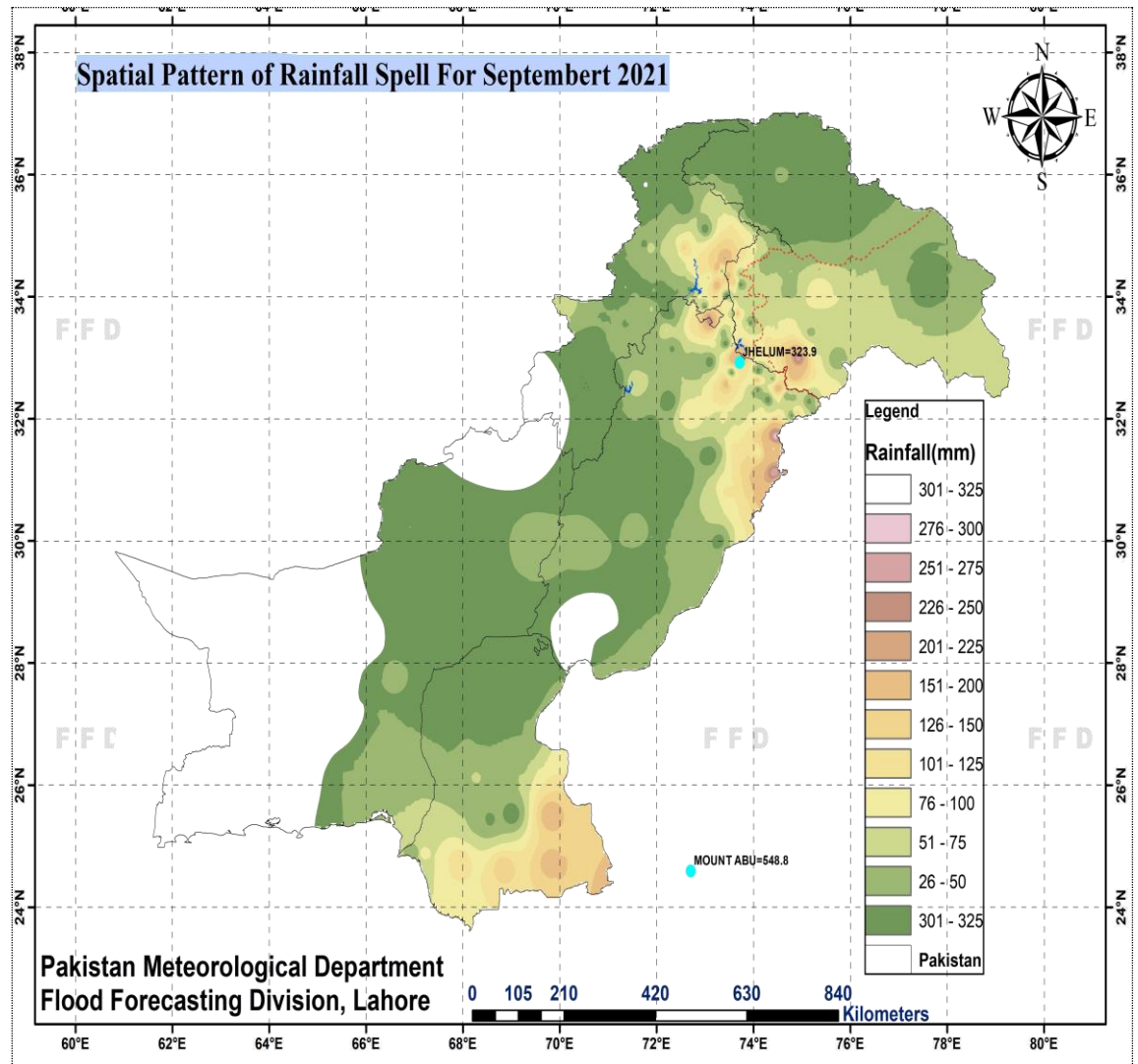


Figure 48: Spatial distribution of significant rainfall of September 2021.

6.6 Departure Anomaly during the month of September 2021

Departure anomaly map for the month of September 2021 indicates that southeast Sindh, North and Northeast Punjab and Kashmir received above normal Rainfall. Significantly above Normal rainfall received at Jhelum. Below normal rainfall recorded in Khyber-Pakhtunkhwa, South Punjab, North Sindh and Balochistan. Percentage Anomaly map of September 2021 is shown in Figure 49 & 50.

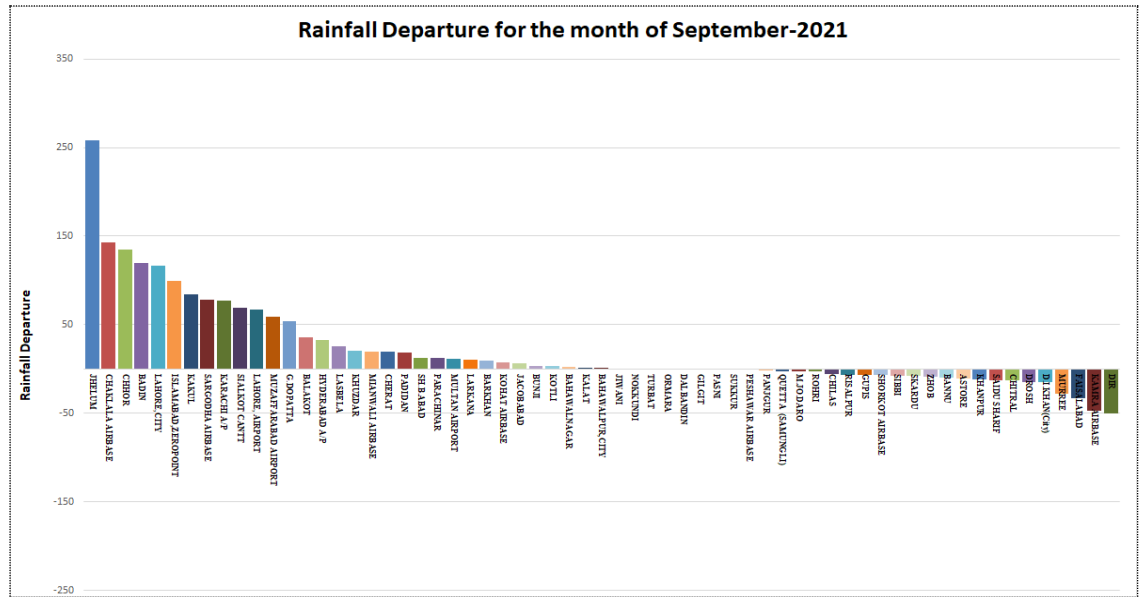


Figure 49: Rainfall Departure for the month of Sep-21.

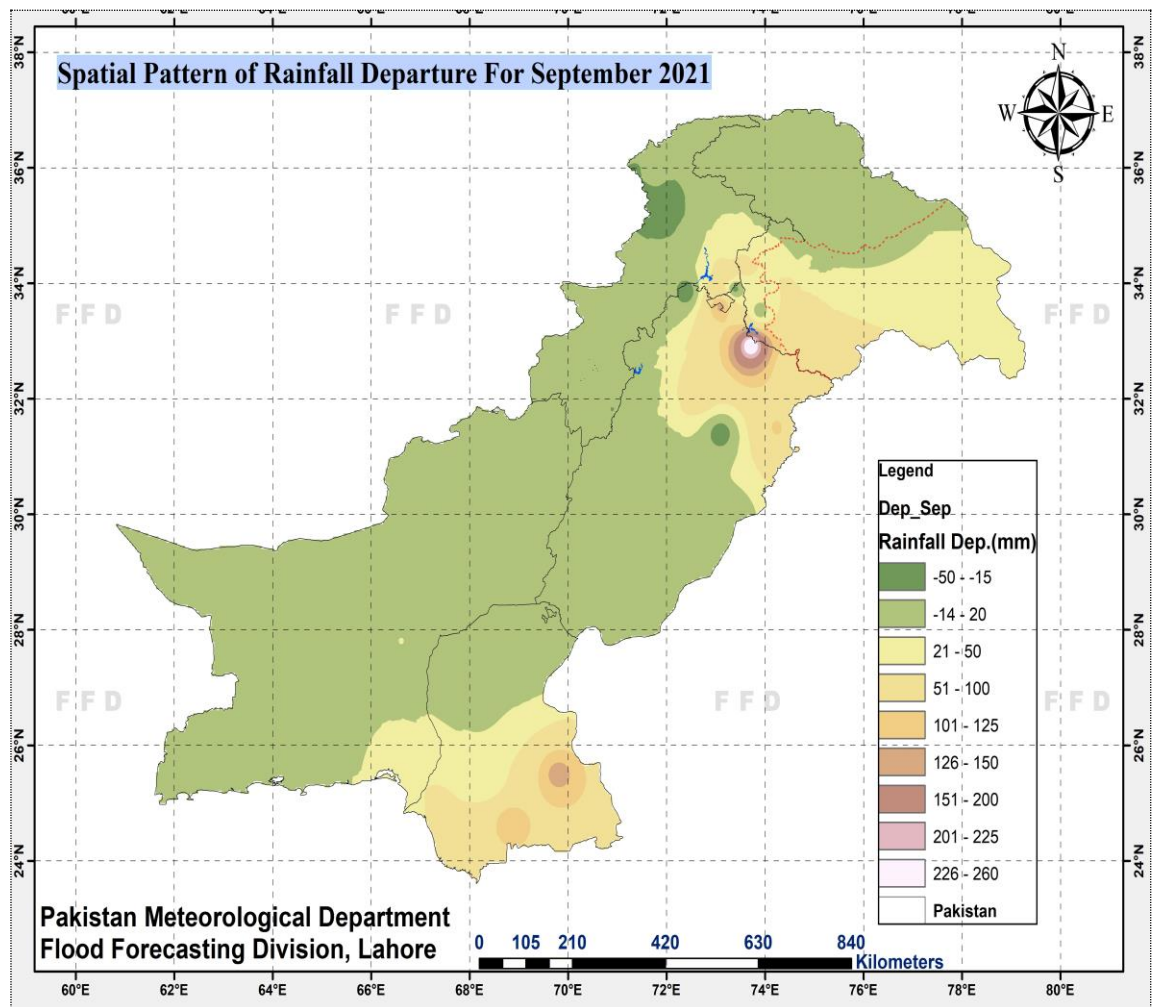


Figure 50: Departure Anomaly rainfall map of September 2021.

6.7 Temporal Distribution during the month of September 2021

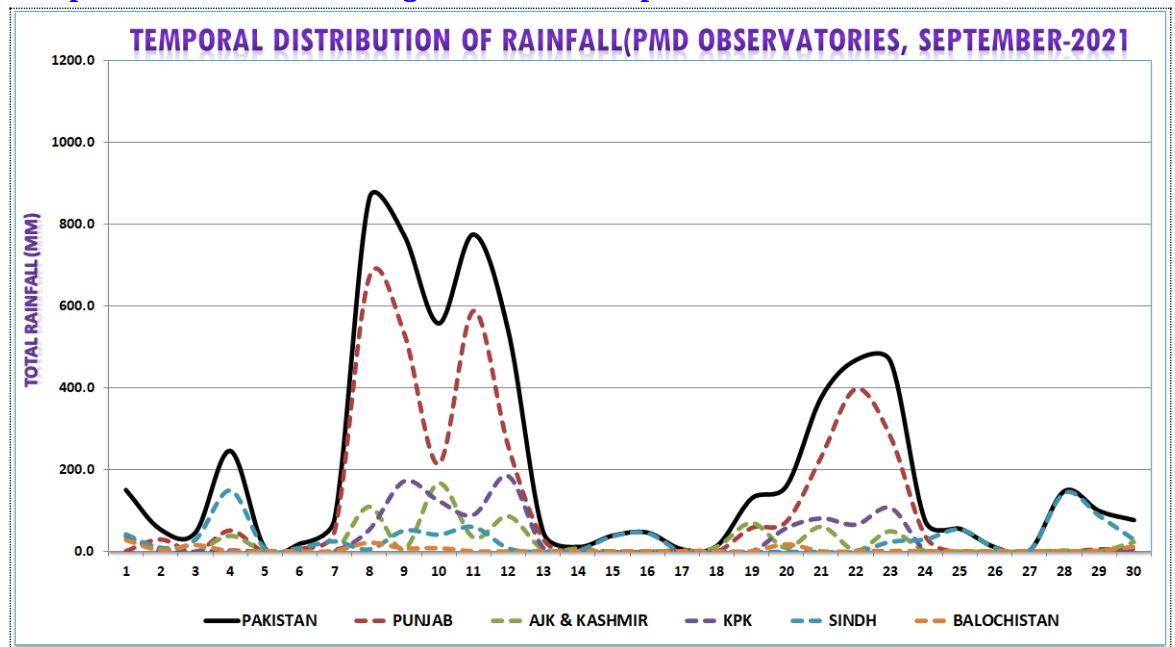
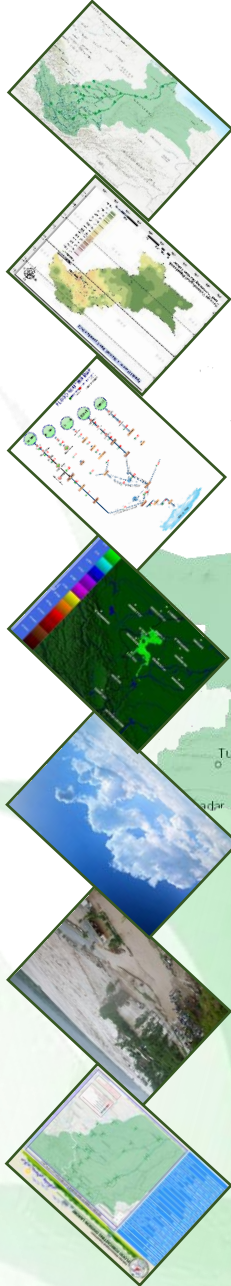


Figure 51: Temporal distribution of rainfall during September 2021.



SEASONAL

Departure Anomaly, Total Rainfall
& Area Weighted



7 Seasonal rainfall pattern July to September 2021

Seasonal rainfall distribution during the season is shown in figure 52 & 53. Region of maximum precipitation (more than 800 mm) is located over Sialkot in Gujranwala division. Another center of extreme rainfall of more than 700 mm is located over Kakul, Mandibahuddin and Palandri (Kashmir). Rainfall recorded on rest of the observatories during the season is also shown in the fig 52. Lowest Rainfall during flood season, recorded over Balochistan and north Sindh.

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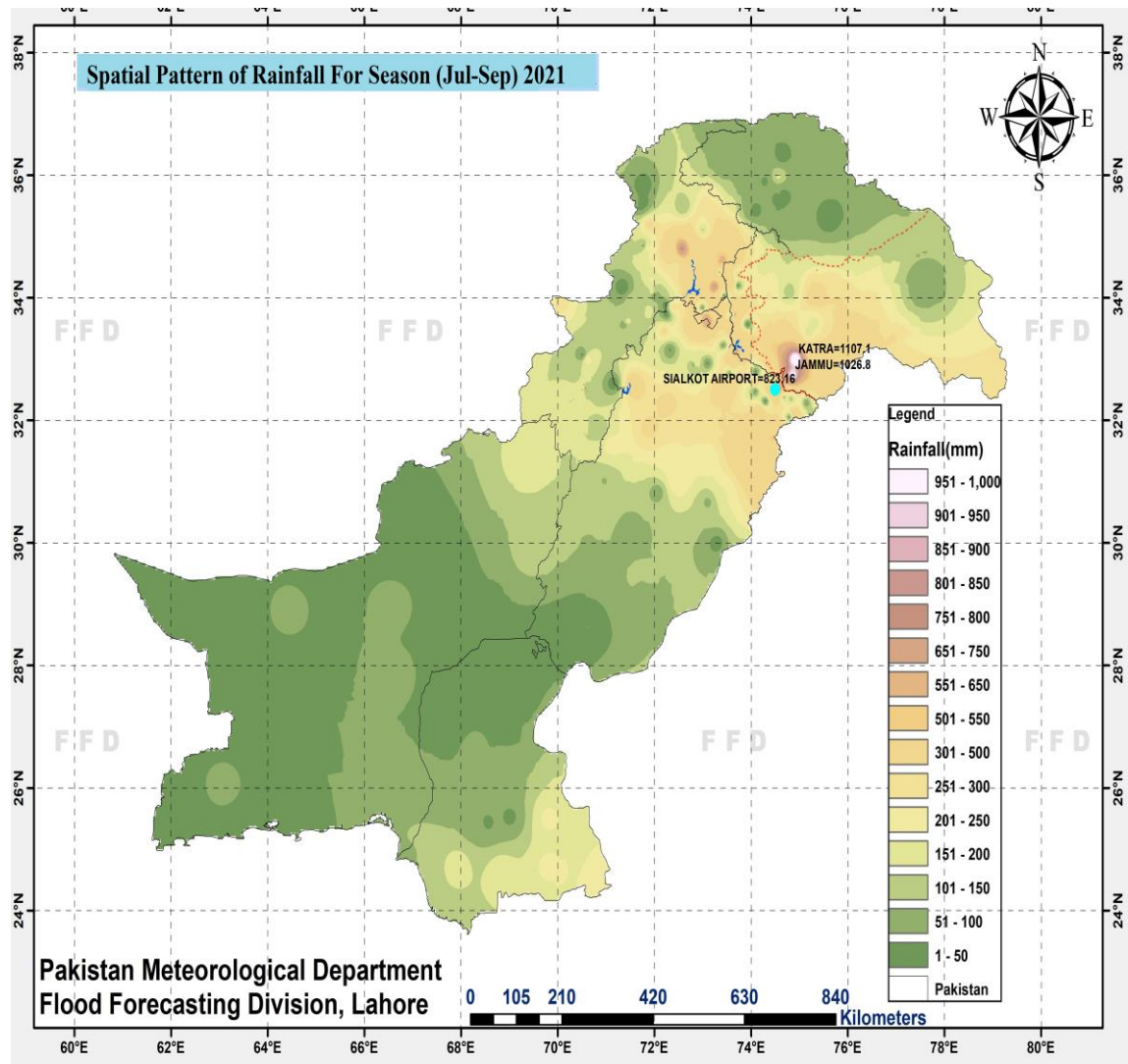


Figure 53: Spatial distribution of significant rainfall map of July-Sep-20.

7.1 Departure Anomaly during the Season July-September 2021

Departure Anomaly map for the months of July-September 2021 indicates that below normal Rainfall recorded over the most parts of the country. However, Kakul, and Jhelum received more than 100 mm, above normal Rainfall while Bannu, Sialkot and Mianwali received 50 mm above normal Rainfall. Percentage Anomaly map of July-September 2021 is shown in Figure 54 & 55.

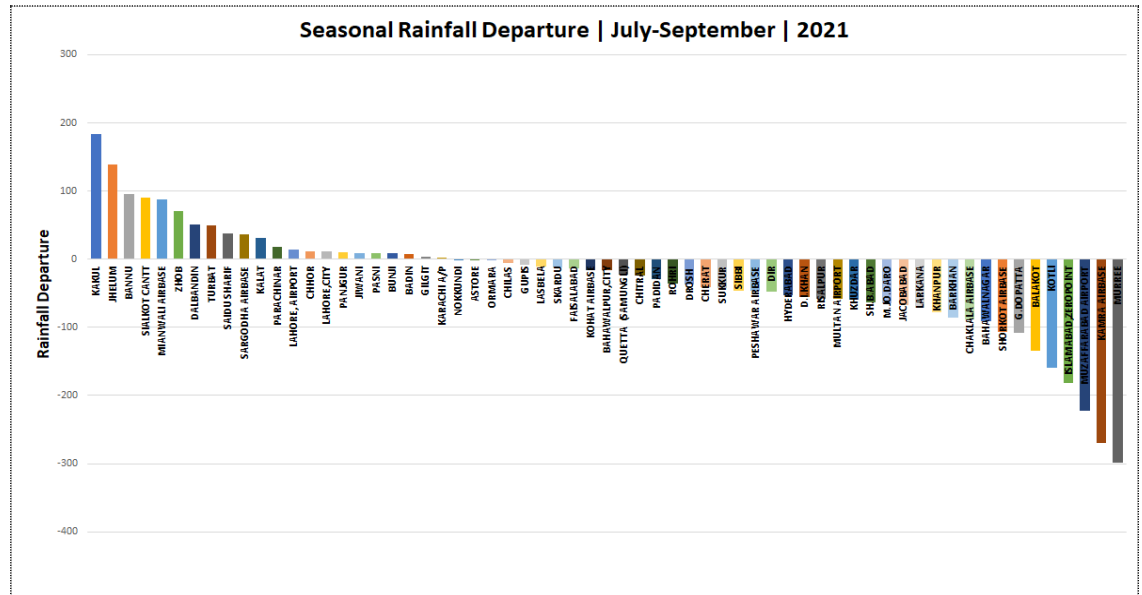


Figure 54: Seasonal Rainfall % departure for July- Sep-20

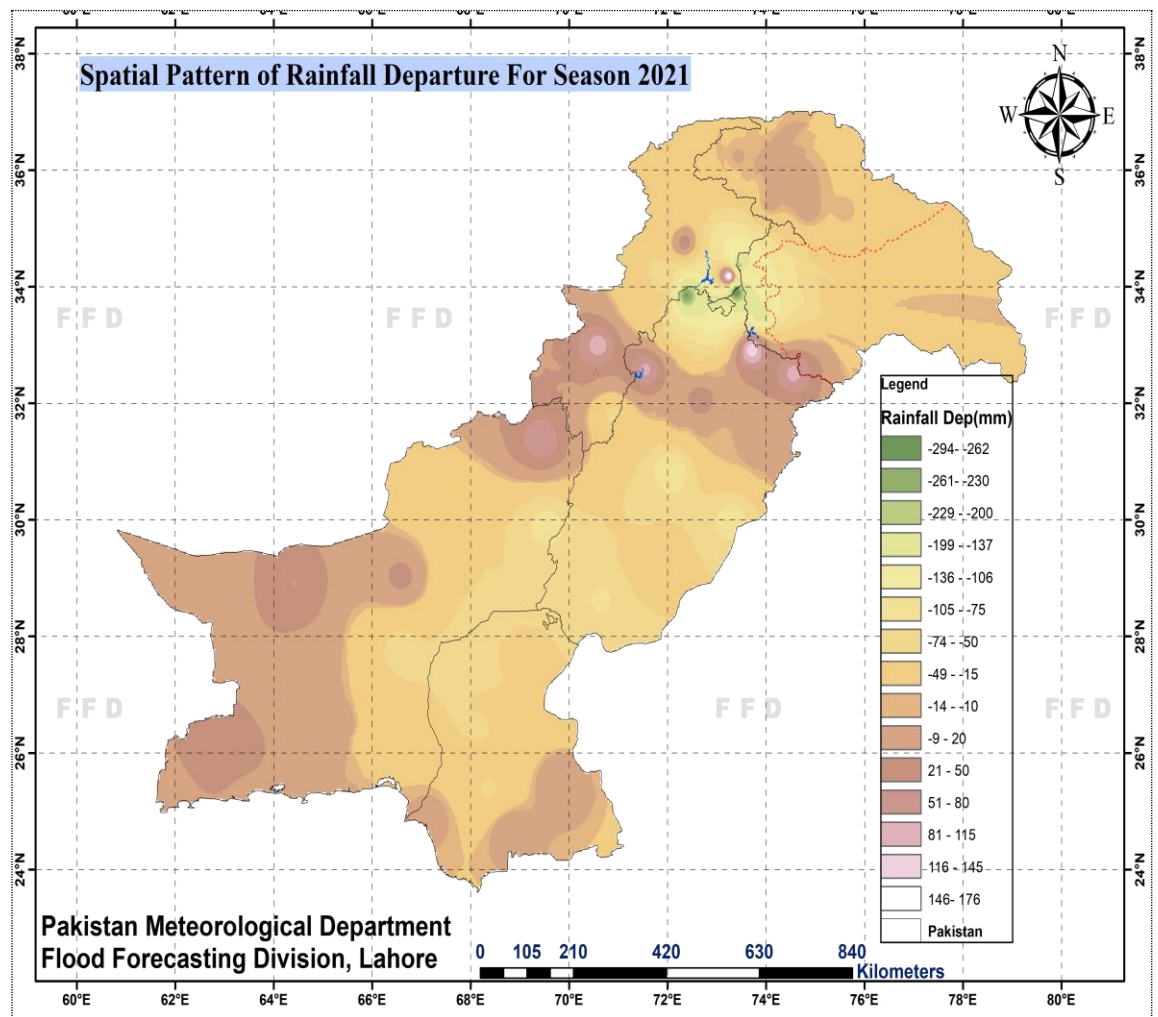


Figure 55: Departure Anomaly rainfall map for Season July-Sep-20.

8 Pakistan Base Temporal Rainfall Distribution (July-September) 2021

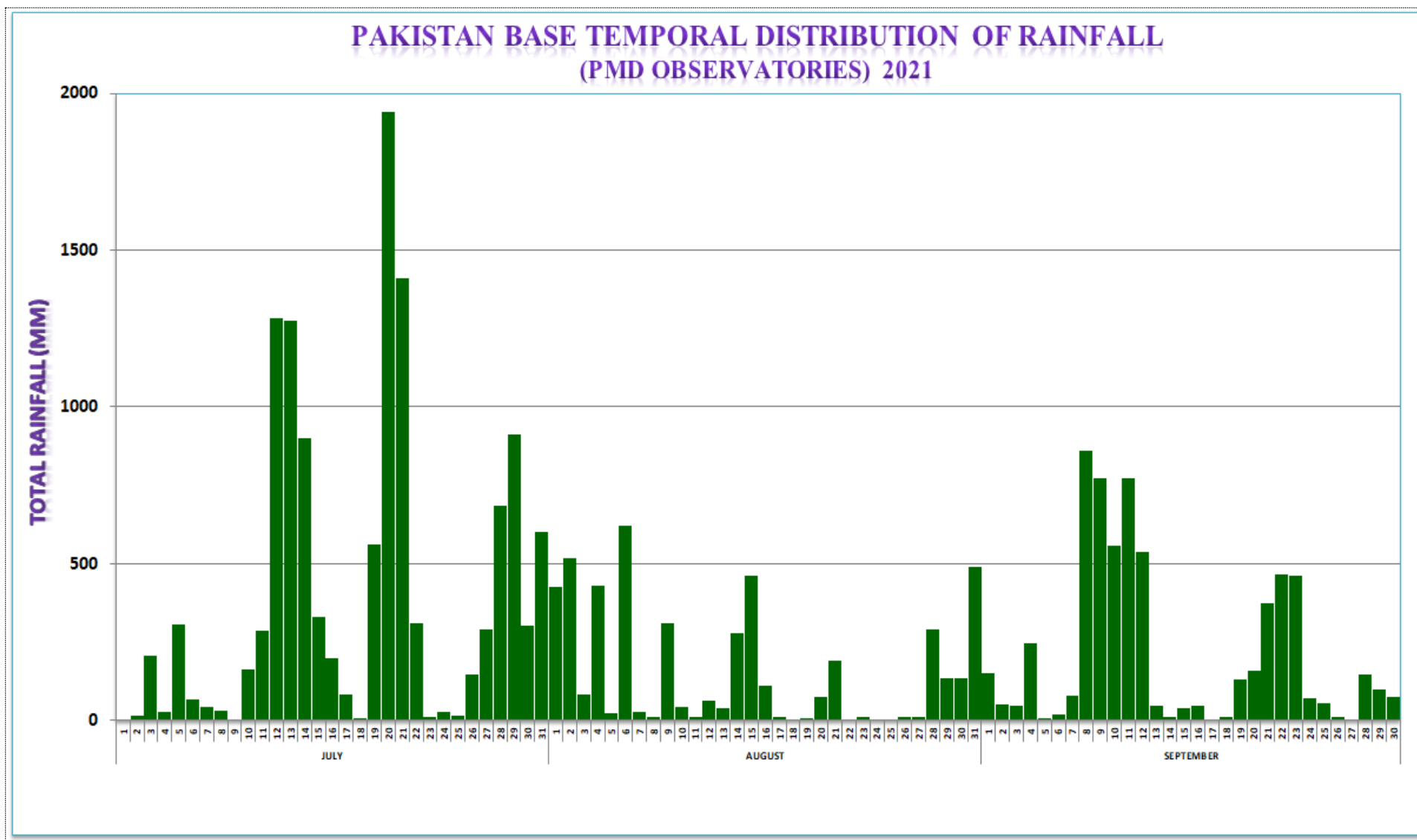


Figure 56: Pakistan Base Temporal Rainfall Distribution July-Sep-21.

9 Reason for No Significant Weather System during Monsoon 2021

- During monsoon 2021, no major rainfall event was observed over the country. The formation of less number of low pressure systems (LPS) and their lesser number of days compared to the climatology and absence of their longer westward movements during monsoon 2021 contributed to the large deficient rainfall over the country.
- Negative Indian Ocean Dipole over tropical Indian Ocean, unfavorable for Indian monsoon prevailed throughout period, which also contributed to deficient rainfall.
- Unfavorable Madden Julian Oscillation (MJO) conditions was observed and during most of the days, during monsoon 2021. Less West Pacific Typhoon activity was observed and so also absence of westward movement of their remnants into Bay of Bengal which again caused less formation of LPS over the Bay of Bengal.
- Most of the day's monsoon trough was located north of its normal position which caused subdued rainfall.
- Winter snow/rainfall remained below normal during winter 2020-21 causing subdued base flows.

10 Seasonal area weighted precipitation from July-September 2021.

Pakistan rainfall, for the country as whole, for the Monsoon season 2021 was close to average. On regional scale, seasonal rainfall was more than average over GB, Balochistan & normal over KP and below average over AJK, Punjab & Sindh.

JULY-2021:

- The current monsoon season of rainfall set in from 5th July 2021 over Pakistan, which was delayed by 5 days on its normal date. (1st July). Notably, a significant continuous rainfall occurred from 10 July onwards,
- National rainfall for the month of July 2021 was close to normal (+4%).
- The GB (+86 %), KP (28 %) and Balochistan (22 %) regions had recorded above normal rainfall.
- AJK (-4 %) & Punjab (+1 %) recorded close to normal rainfall.
- Significant deficiency of rainfall over Sindh (-47 %).

AUGUST-2021

- August 2021 saw considerable reduction of rainfall over country, the national rainfall was 55% below its normal value. All regions/provinces recorded below average rainfall during this month.
- Many PMD stations in Sindh & Balochistan regions reported not even single drop of rain in whole month.

SEPTEMBER-2021

- In contrast to previous, significant amount of rainfall was observed over country, during September. The national rainfall for this period was 60% above its normal value. All regions/provinces recorded above average rainfall except KP & GB where it was close to average and below average respectively.

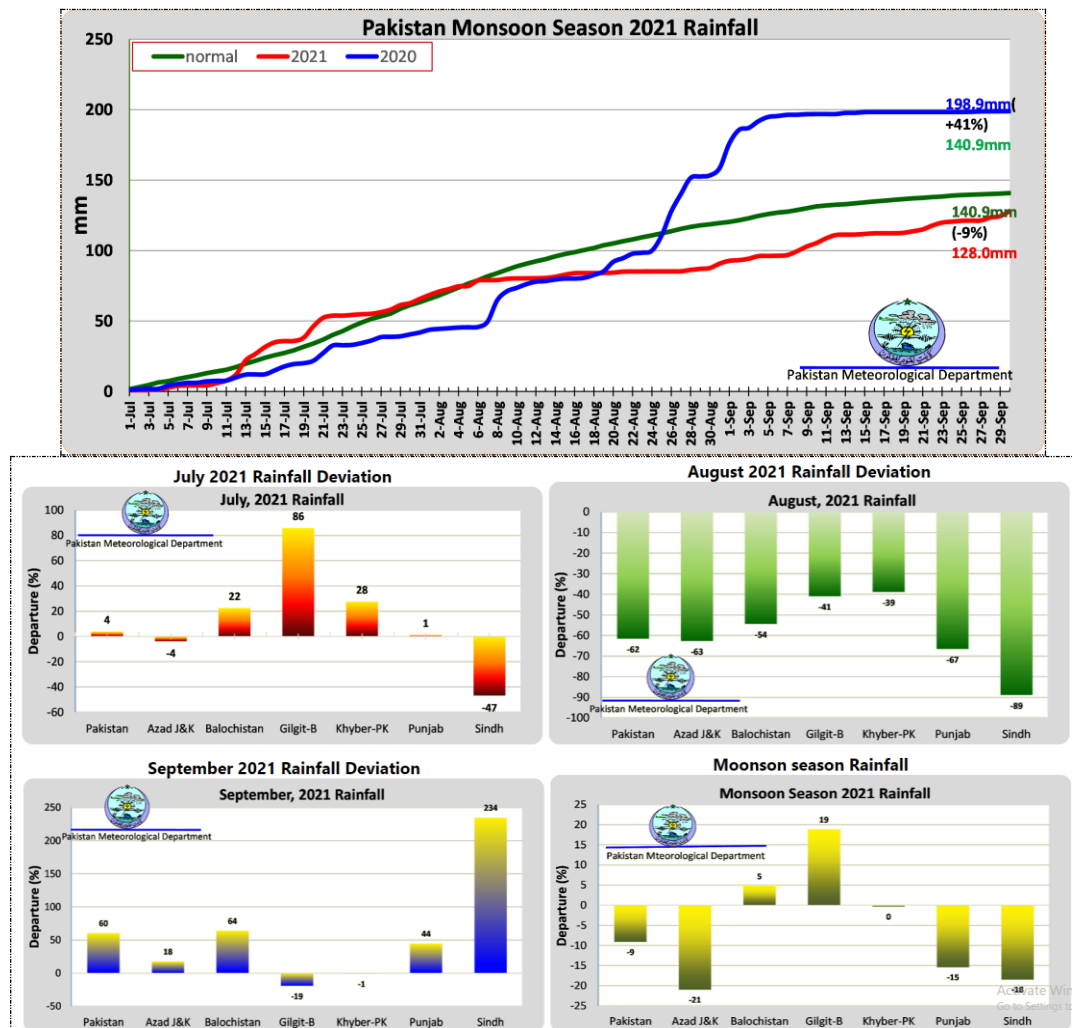
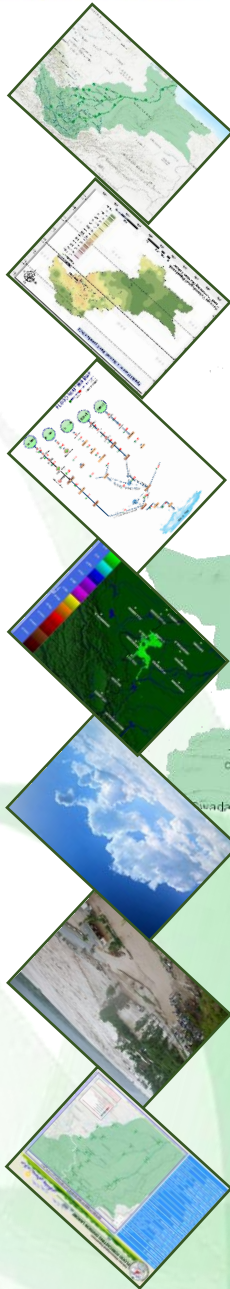


Figure 57: Monsoon July-Sept (JAS) 2021 rainfall.

Source: CDPC Karachi



OTHER

- Kharif & Rabi Season
- FFD Staff daily Work
- Forecasts Dissemination System
- Internship at FFD Lahore
- Season 2021 Damages/Losses
- Flood Limits
- Flood Season 2021 Peaks
- Revised Lag Time Map

- Kharif & Rabi Season
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- Season 2021 Damages/Losses
- Flood Limits
- Flood Season 2021 Peaks
- Revised Lag Time Map

11 Kharif & Rabi Season Forecast

The water availability (in MAF) forecast on the basis of prevailing hydrometeorological conditions was issued on 29th March 2021 for Tarbela at River Indus & for Mangla at River Jhelum. A comparison of forecasted and observed volume (in MAF) is shown below fig 58.

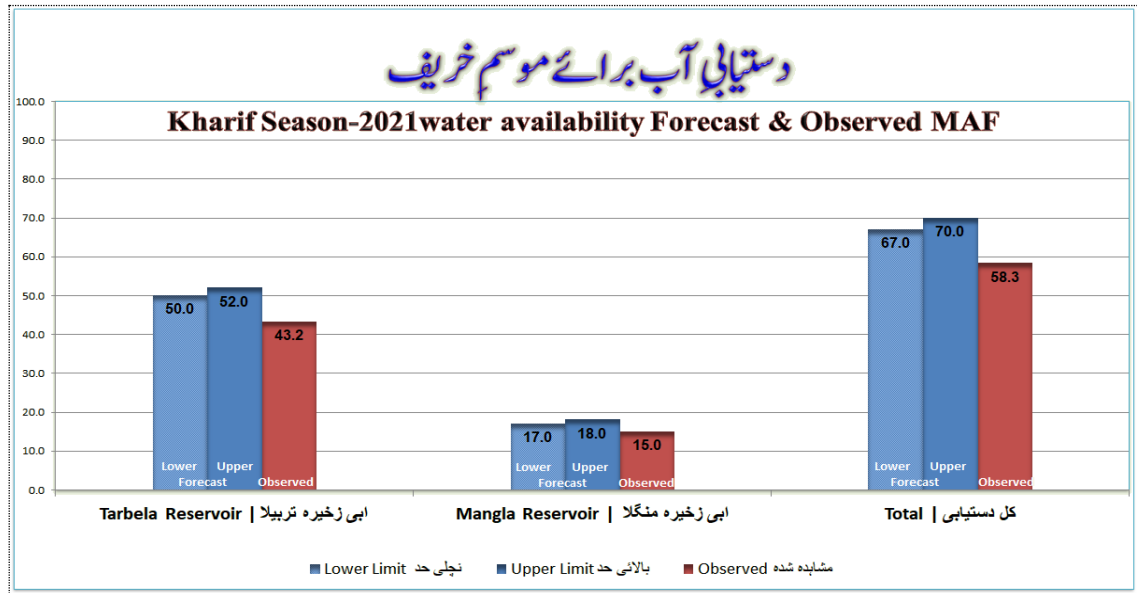


Figure 58: Kharif Season forecast & Observed MAF (April-Sep-21).

Similarly the water availability forecast for Rabi season was issued on 27th September 2021 for Tarbela at River Indus & for Mangla at River Jhelum is shown in fig 59.

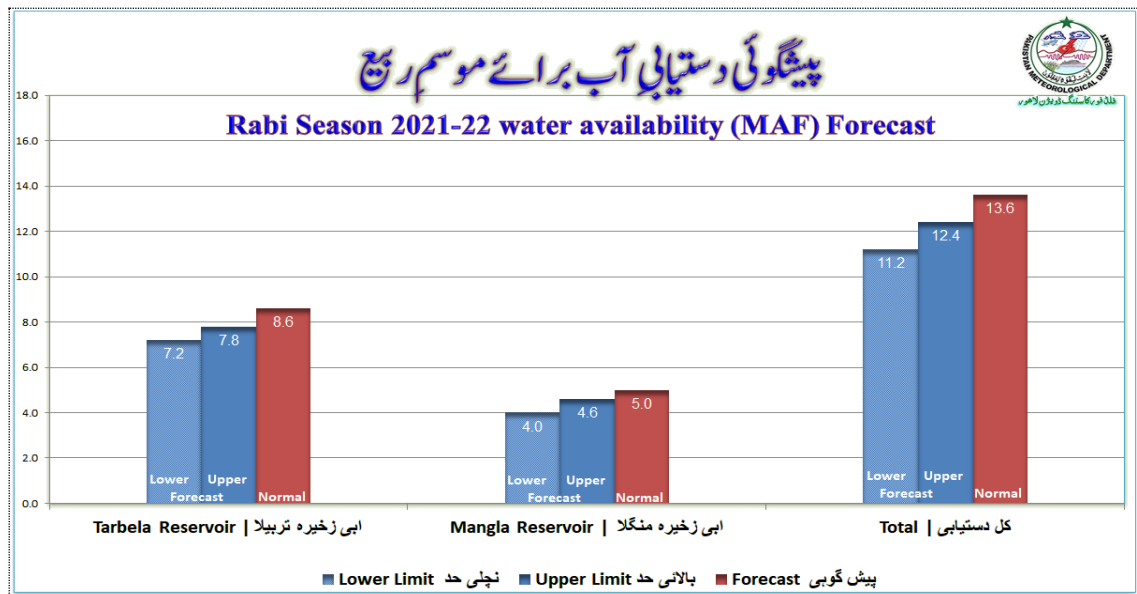


Figure 59: Rabi Season forecast MAF (Oct-2021 to March-2022).

12 Flow chart of daily routine work at FFD Lahore

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

FFD work flow chart

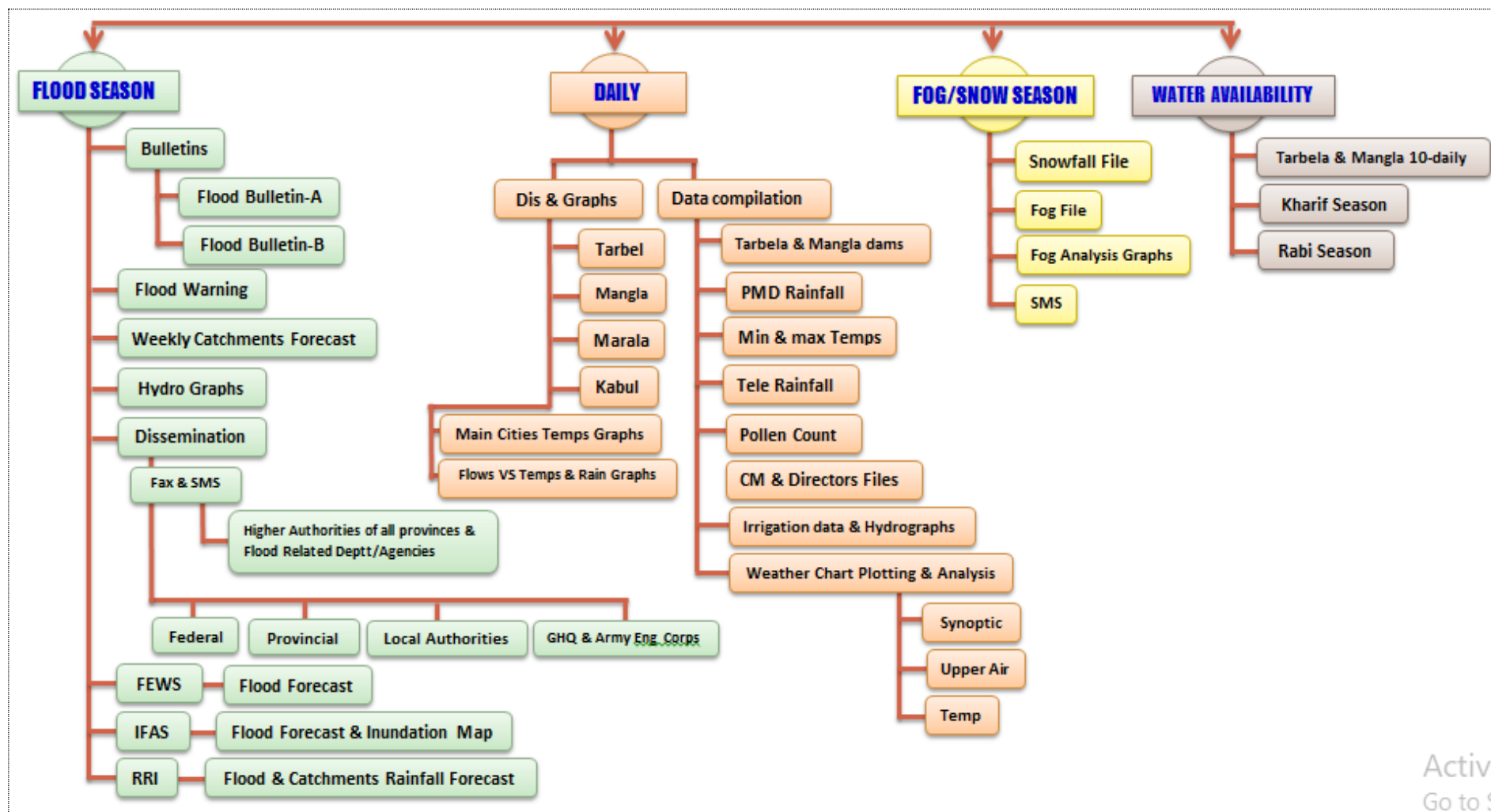


Figure 60: FFD Lahore work flow chart.

Sr#	Work	Time Interval
1	Flood Bulletins A & B	Updated daily
2	Weekly Catchment Forecast	Updated daily
3	Flood Warning	When required
4	Inundation Map	When required
5	FEWS Model Forecast	Twice a day & when required
6	IFAS Model Forecast	Updated daily & when required
7	RRI Model Forecast	Updated daily & when required
8	Hydrographs	Hourly & six-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 data	Updated daily
13	Temperatures data	Updated daily
14	Main Cities Temperature Graphs	Updated daily
15	WAPDA Telemetric Rainfall	Updated daily
16	MAF Forecast (Tarbela & Mangla Dams)	10-day 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 & when required
21	SMS	Hourly & six hourly basis & when required

13 Flood Forecast Dissemination

Dissemination of flood forecasts and warnings is an important part of flood mitigation. Flood information is communicated on daily basis by using different modes of communication i.e phone, fax and cellular networks. Electronic versions of daily flood forecasts are 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.

FFD Lahore Flood Forecasts Dissemination System

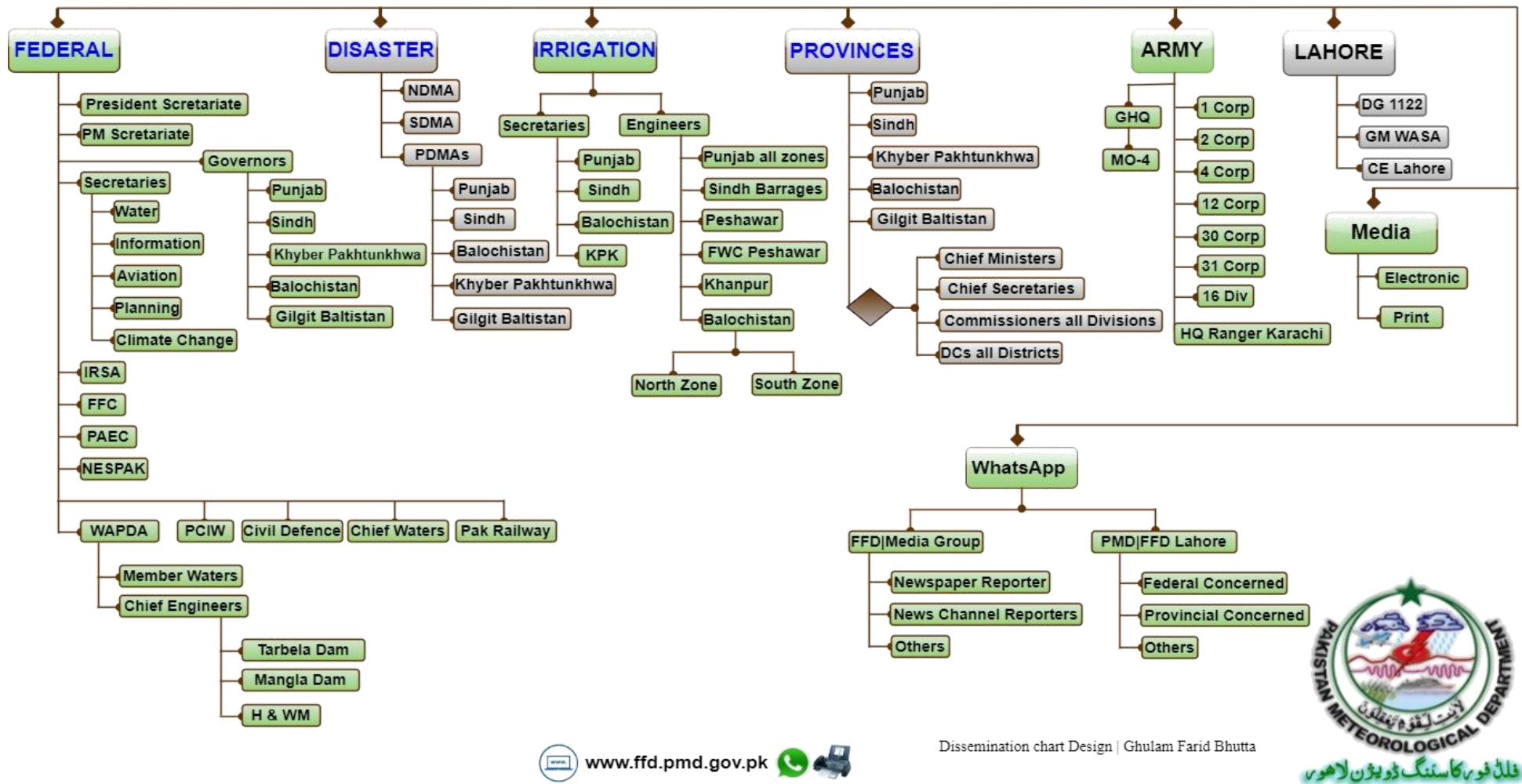


Figure 61: Flood report dissemination chart

14 Internship at Flood Forecasting Division Lahore

FFD Lahore offers an 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 in the practical field and also provides a valuable experience which makes them a strong candidate in practical life. The chart of internee students during 2021 is shown in table 8.

More detail for internees can be followed on this link:

University/College		Students
	Punjab University Lahore	35
	Lahore College for Women University, Lahore	36
	University of Agricultural, Faisalabad	01
	University of Lahore, Lahore	04
	Govt College University Lahore	13
	Govt College University Faisalabad	01
	University of Engineering & Technology Lahore	09
	The Superior College Lahore	13
	Government Post Graduate College for Girls, Samanabad Lahore	01
	University of Central Punjab Lahore	01
	Kanaired College for Women University Lahore	05
	University of Management & Technology Lahore	02

Table 4: List of internees

15 Monsoon Season 2021 Damages/Losses

No of Deaths, Injured Persons and Houses Damaged during the Flood 2021 are shown in table 5.

1st July to October-2021

Province / Region	Deaths				Injured			
	M	F	C	T	M	F	C	T
AJ&K	4	3	2	9	1	2	1	4
Balochistan	15	6	3	24	8	-	1	9
GB	3	2	1	6	-	-	-	0
ICT	-	1	1	2	-	-	-	0
KP	30	17	42	89	50	27	56	133
Punjab	40	5	8	53	116	15	15	146
Sindh	3	5	7	15	3	3	1	7
Total	95	39	64	198	178	47	74	299

Table 5: Flood forecast evaluation table

Source: NDMA Islamabad

16 Flood limits (in thousands of cusecs)

River	Site	Design Capacity	Low	Med	High	V.high	Ex.high
Kabul	Nowshera	-	0.75	1.0	1.5	2.0	4.5
	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

Table 6: Flood limit

17 Maximum Flood Peaks Discharge during Flood Season-2021.

Maximum Flood Peaks recorded during Flood Season-2021 is shown below

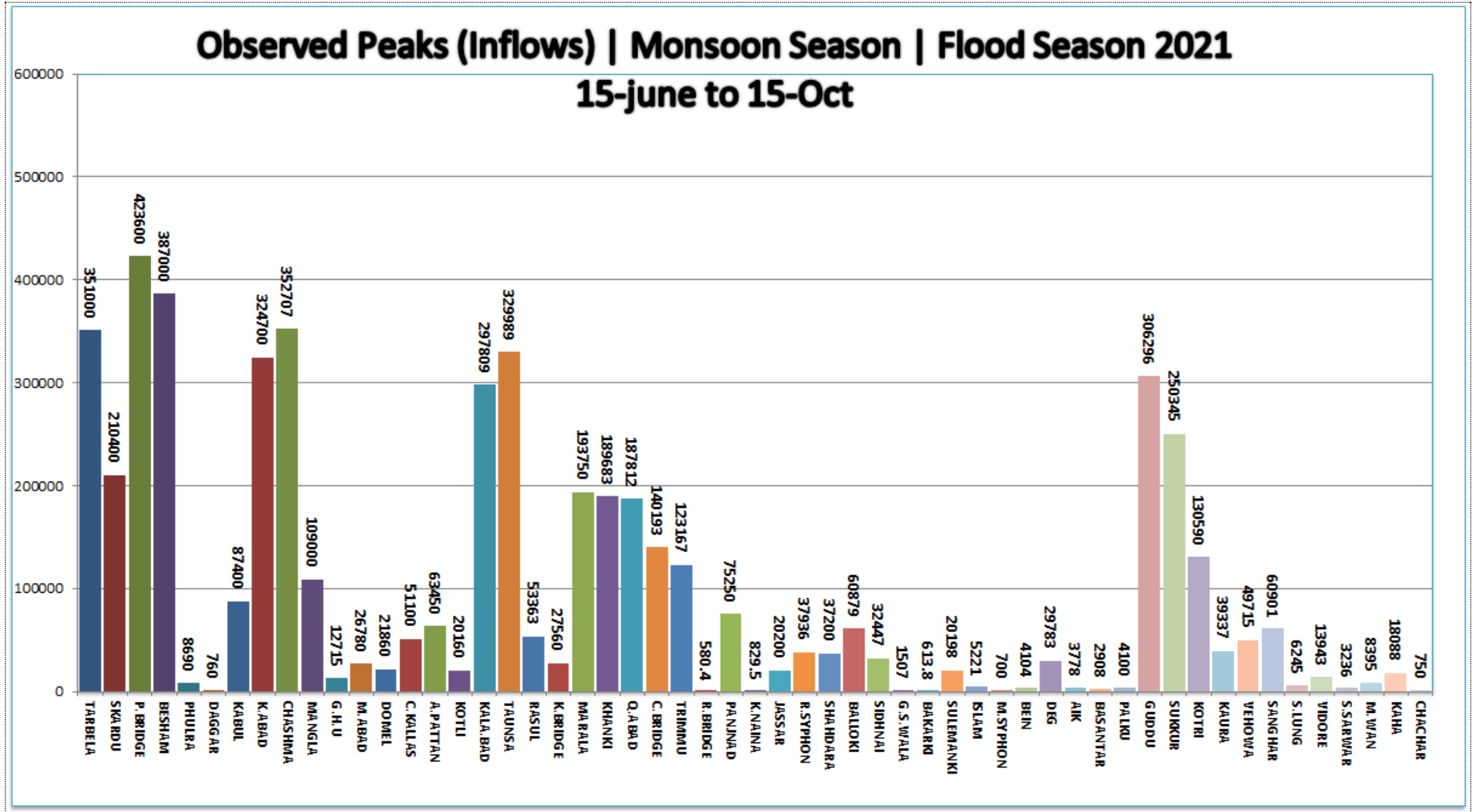


Figure 62: Maximum flood peaks recorded during the season 2021

18 Facilities Provided By FFD Lahore during the Flood Season

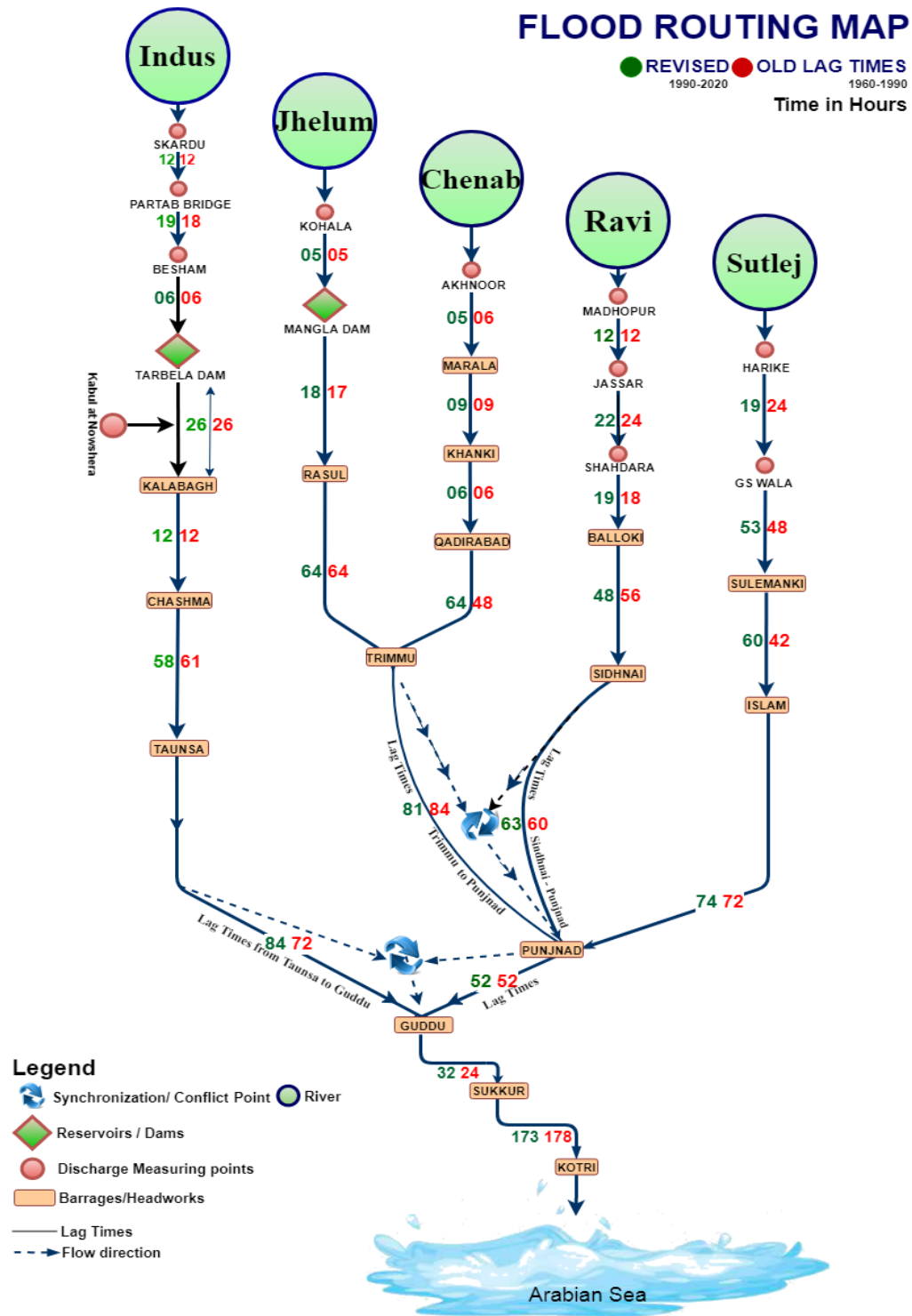
- Flood Forecasting Division Lahore provides semi-furnished accommodation facilities to the Police Tele Communication officers & officials in the office premises.
- Flood Forecasting Division Lahore has provided space & facilities to the Environmental Protection Department (EPD), Punjab to install their instruments to monitor air quality Index of this location.
- Sports facilities were also provided to the flood relating agencies working in FFD during the flood season.
- Flood Forecasting Division Lahore also provided facilities to media for live coverage regarding Flood/Weather events.

19 Revised Lag Time

Joint meetings of Working Group members of all concerned stakeholders regarding Revised Lag Times were held under convenorship of Chief Meteorologist FFD Lahore at Flood Forecasting Division Lahore regarding Revised Lag Times at National Level. The Working Group Members were:

- Federal Flood Commission (FFC)
- Engineering Directorate, GHQ, Rawalpindi
- Indus River System Authority (IRSA)
- Pakistan Council of Research in Water Resources (PCRWR)
- Water & Power Development Authority (WAPDA)
- Water Resource Management (WRM) Gilgit Baltistan
- Irrigation Departments of Punjab, Khyber Pakhtunkhwa, Sindh & Balochistan

The 1st meeting of the Working Group was held on 07th April, 2021, 2nd meeting on 27th May, 2021, 3rd meeting on 21st June, 2021 and 04th (Final) meeting on 09th July, 2021. In the final meeting of the Working Group any member of the working group has not submitted any objection during the meetings regarding Finalized Revised Lag. All the representatives of working group agreed with the Revised Lag Times Maps prepared by FFD Lahore based on recorded Flood Peaks data for use at National Level.



Chief Met FFD Lahore | Head of team: Sahibzad Khan

Flood Routing Map | Revised Lag Time Team
Team member: Akhtar Mahmood, Saqib Hussain, Mamoon, Ghulam Farid

Routing Map designed | Ghulam Farid

Figure 63: Revised Lag Times