



## **Monsoon 2023 (1 July - 30 September) Report**

The monsoon is a natural source of fresh water towards land irrigation and acts mostly as a blessing. During the season, the rainwater fills up the rivers, streams and water reservoirs that run the country's irrigation lifeline. Good (surplus) monsoon rains boost up the Kharif crops besides making sufficient water storage for the ensuing Rabi crops in the country, hence enhances the agriculture productivity and ultimately expands the exports/economy. The filled-up dams also play a pivotal role in production of the hydel power. However, an excess rainfall, like the one Pakistan experienced during monsoon 2022 causes massive devastation. Incidentally, Pakistan experienced hugely excessive monsoon rains in last three years (2020-22) with the 2022 excessive rains produced massive flooding, which cost about \$32 billion damages besides taking over 1700 deaths and millions of livestock. On the other hand, the deficient monsoon rains trigger the drought like situation, for instance in the years 1963, 1968, 1987 and 1998-2002 that lead in food insecurity, dry vegetation, lower down water levels in lakes and reservoirs, land subsidence, seawater intrusion, and damage to ecosystems.

The monsoon season in Pakistan this year began on July 3, 2023, which was two days later than its usual start date of July 1. However, there was a significant monsoon rainfall during the month of July, followed by a sudden decline in August 2023. September 2023 saw near-average rainfall. To sum it up, Pakistan experienced near-average rainfall during the entire monsoon season, with a +4% deviation from the normal. On a regional scale, Punjab had near-average rainfall (-1%), while Azad Jammu and Kashmir (AJK) (-14%) and Khyber Pakhtunkhwa (KP) (-17%) received below-average rainfall. Sindh (+29%) and Balochistan (+18%) had above-average rainfall, and Gilgit-Baltistan (GB) experienced exceptionally high rainfall, with a 90% increase.

### **The Climate Drivers that influenced the Monsoon 2023:**

- The Sea Surface Temperature (SST) in the Central and Eastern Pacific started rising since April/May 2023. However, the absence of a full-blown El Niño event in July 2023 and presence of Madden-Julian Oscillation (MJO) in phases 2 & 3 over the Indian Ocean led to excessively above-average rainfall across Pakistan.
- Indian Ocean Dipole (IOD) remained mostly in neutral phase.
- The monsoon axis, a line extending from the center of the seasonal low to the Bay of Bengal in the east, remained close to its normal position during July. In August, it shifted closer to the Himalayan foothills, restricting the inflow of monsoon currents to northern and northeastern Pakistan. In September this axis revived partially.
- Tracks of several low-pressure areas (LPAs) are shown in Figure 3 (with five low-pressure areas (LPAs) moved in during the July with heat-low of average pressure 992hPa persisted over Northwest Balochistan. During August the two LPAs moved over the country with increased heat-low average pressure 994hPa persisted over North-northwest Balochistan. Whereas, only one LPA entered in September with heat low average pressure of 996hPa.

These factors played a significant role in final shape up of the Monsoon 2023.

### July 2023:

- Monsoon currents converged over the country at regular intervals (11-16 July, 17-20 July, 21-26 July, and 27-31 July) during the month, resulting in widespread very heavy rainfall.
- National rainfall was excessively above average (+70%) across Pakistan.
- Regions with excessively above-average rainfall included GB (+233%), Sindh (+143%), Balochistan (+111%), and Punjab (+47%).
- AJK (+31%) and KP (+19%) also observed above-average rainfall (**Fig. 4**).
- Record-breaking rainfall events recorded in Mirpurkhas, Padidan, Sukkur, Sibbi, Astore, and Lahore.

### August 2023:

- Monsoon remained active but in intervals (1-3Aug, 5-8Aug, 11-12Aug, 14-15Aug, and 24-29Aug) resulting in light to moderate rainfall spells.
- In contrast to July, there was a significant decline in rainfall.
- National rainfall was excessively below average (-66%).
- Sindh (-98%), Balochistan (-89%), Punjab (-58%), KP (-51%), and AJK (-55%) all recorded excessively below-average rainfall.
- GB was the only region with above-average rainfall (+28%) (**Fig. 5**).

### September 2023:

- Monsoon produced light to moderate rainfall with intervals (3-5Sep, 9-10Sep, 15-21Sep and 22-26Sep) during the month.
- Rainfall during the month was near average (-7%).
- GB (+1%) and Punjab (+7%) observed near-average rainfall.
- Balochistan (-43%) and AJK (-40%) recorded below-average rainfall.
- Sindh was the only region with above-average rainfall (+25%) (**Fig. 6**).

These variations in rainfall are indicative of the dynamic nature of the monsoon season in Pakistan.

### Minimum and Maximum Temperature anomalies during monsoon:

The mean minimum temperature anomalies ( $-3.5^{\circ}\text{C}$  to  $+4.0^{\circ}\text{C}$ ) were considerably higher over the Western Balochistan (Fig 7). The mean maximum temperature anomalies were in the range of  $-1.4^{\circ}\text{C}$  to  $+2.9^{\circ}\text{C}$  and found higher over AJK (Fig 8).

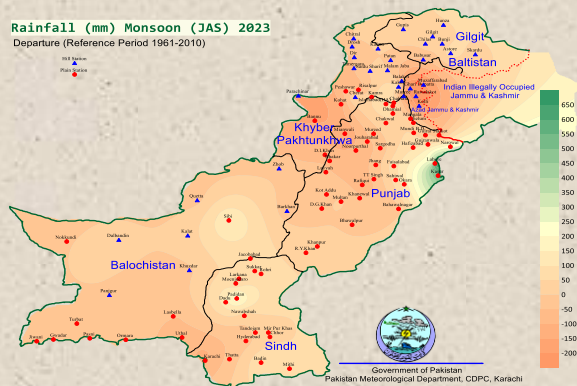


Fig. 1(a). Rainfall departure during Monsoon 2023

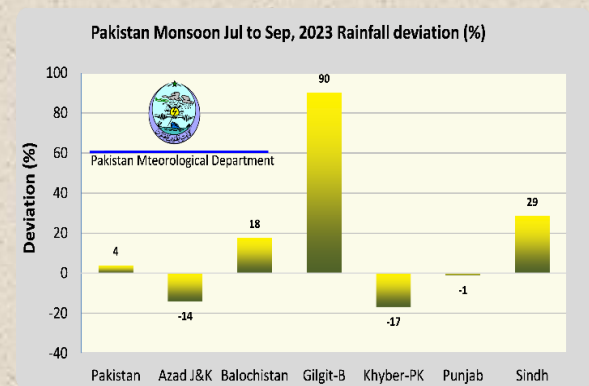


Fig. 1(b). Monsoon Rainfall departure (%) region-wise



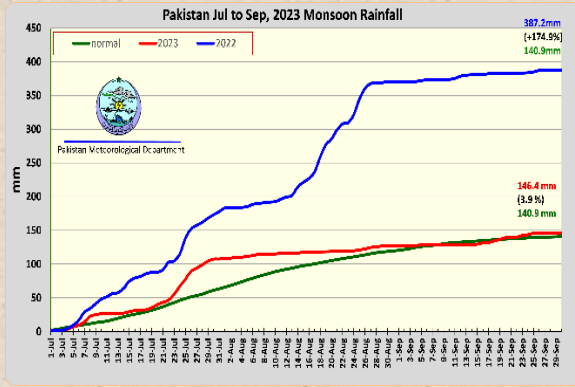


Fig. 2. Comparative cumulative rainfall (2023 & 2022) vs Normal

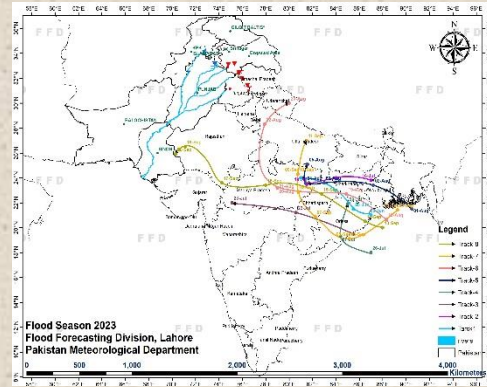


Fig.3. Monsoon LPAs tracks during Jul-Aug 2023

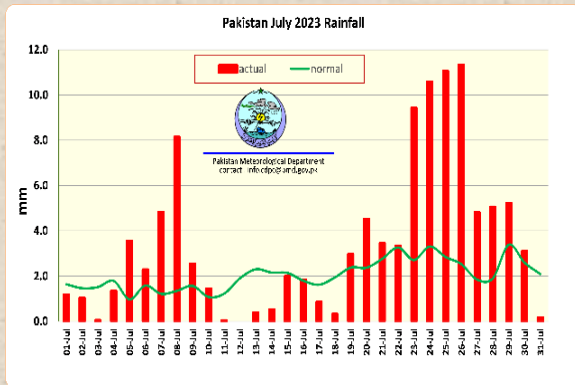


Fig. 4. July 2022 daily rainfall

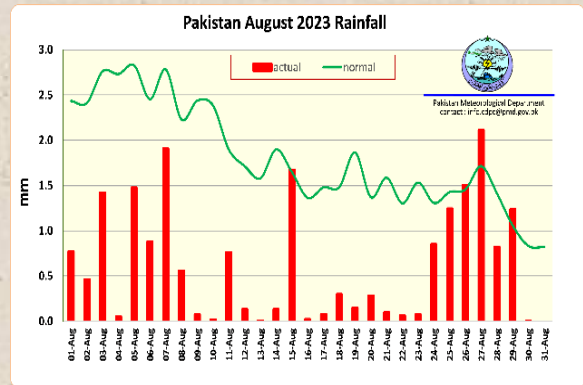


Fig. 5. August 2022 daily rainfall

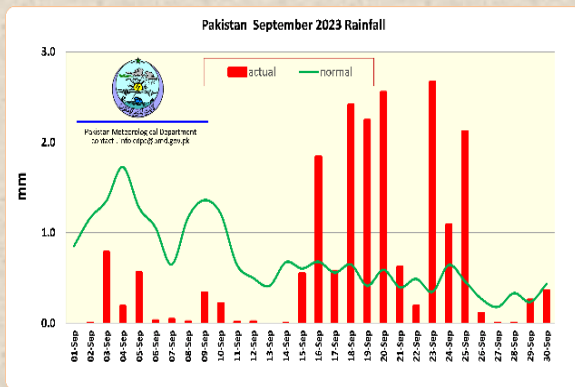


Fig. 6. September 2022 daily rainfall

MONSOON 2023 RAINFALL UPDATE				
	Rainfall (% Deviation)			
	Jul	Aug	Sep	Jul to Sep
Pakistan	70	-66	-7	4
Azad J&K	31	-55	-40	-14
Balochistan	111	-89	-43	18
Gilgit-B	233	28	1	90
Khyber-PK	19	-51	-23	-17
Punjab	47	-58	7	-1
Sindh	143	-98	25	29

Table 1. Monthly & seasonal rains departures, Pakistan & Regions

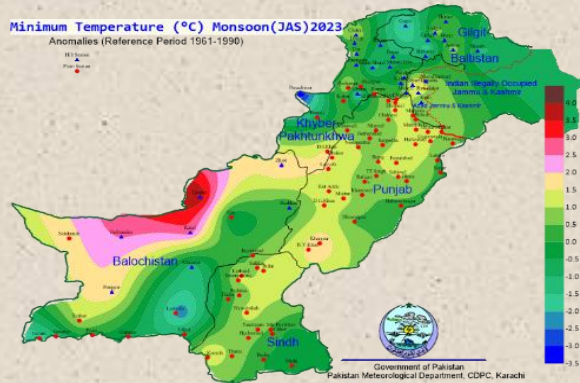


Fig. 7. Minimum Temperature Anomaly Monsoon 2023

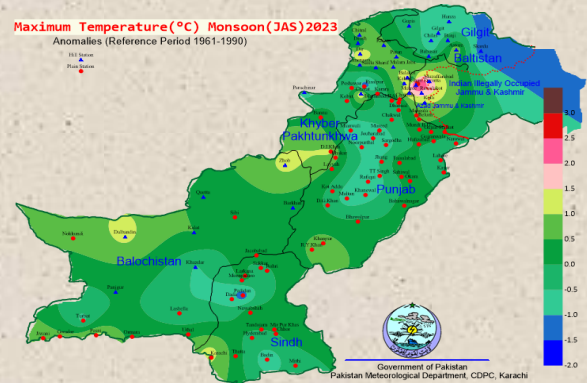


Fig. 8. Max temperature Anomaly Monsoon 2023