GOVERNMENT OF PAKISTAN
PAKISTAN METEOROLOGICAL DEPARTMENT

Quarterly Drought Bulletin of Pakistan

July - September 2024

National Drought Monitoring and Early Warning Centre
Post Box No. 1214, Sector H-8/2, Islamabad, Pakistan
URL: https://ndmc.pmd.gov.pk/new/

Table of Contents

1. Introduction

Pakistan's latitudinal range contributes to significant variability in rainfall across different seasons. The country's climate exhibits a spectrum from arid to hyper-arid in its southern regions, while the northern half ranges from semi-arid to humid. Certain areas experience persistent dry conditions, rendering them vulnerable to drought throughout the year. Prolonged absence of precipitation can exacerbate these conditions, leading to widespread drought impacts. Historically, all provinces of Pakistan have grappled with significant drought events.

Apart from other natural disasters such as floods, cyclones, and earthquakes, drought sometimes get gradual onset, prolonged duration and sometime flash drought as sometimes heat waves emerge. Its affects are slowly visible and can extend across vast geographical areas, impacting a larger population as compared to other environmental hazards.

The Pakistan Meteorological Department (PMD) established National Drought/Environment Monitoring and Early Warning Centre (NDMC) in 2004-05, following the severe drought of 1999-2001. The primary objective of NDMC is to proactively monitor drought condition nationwide and issue timely advisories/early warnings.

The NDMC operates a central office in Islamabad, complemented by four Regional Drought Monitoring Centers (RDMC's) in Lahore, Karachi, Peshawar and Quetta. These RDMC's serve as focal points for gathering, consolidating and analyzing drought-related data across the country. To enhance monitoring capabilities, Automatic Weather Stations (AWS) have been strategically installed, particularly in drought-prone areas.

NDMC has also Ordinary Rain Gauges (ORG) network across the country covering most of the vulnerable districts in the four provinces, as illustrated in Figure-1.

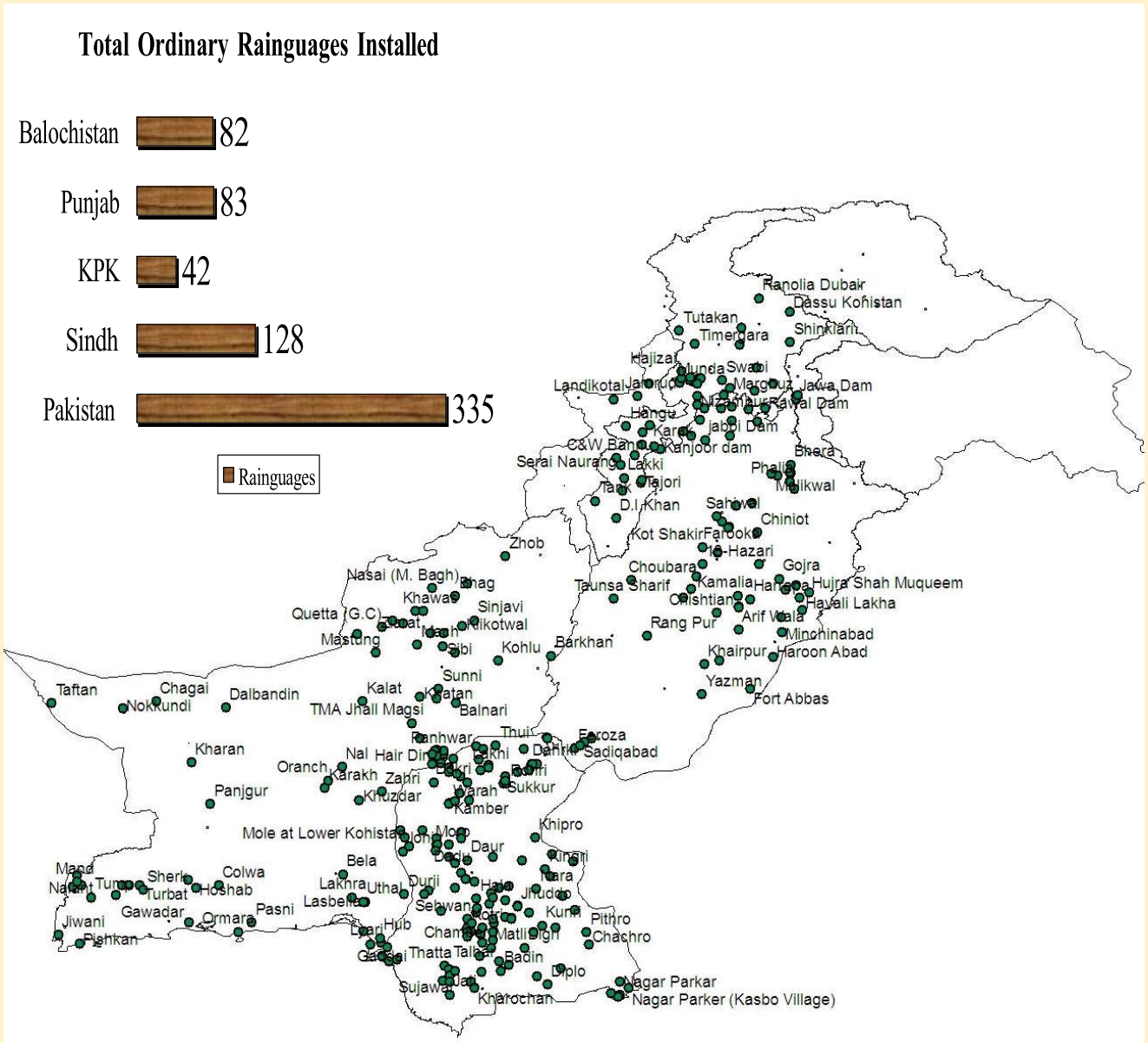

Figure-1: Rain-gauges network of Pakistan by NDMC

2. Historical Background

The Indian subcontinent experiences a tropical monsoon climate, characterized by significant fluctuations in rainfall both in quantity and distribution. Central to this climate are the regional and temporal shifts in atmospheric flow patterns associated with the monsoon. Two primary rainfall systems govern the region: the Southwest or Summer monsoon (from the end of June till September), and the Westerlies (from December to the end of March).

Pakistan, fortunately situated within this region, receives substantial rainfall during the summer months from the Southwest (SW) monsoon and in winter due to western disturbances. The summer monsoon contributes 65% of the annual rainfall in Pakistan from July to September (Waqas and Athar, 2019; Ullah et al., 2021b; Abbas et al., 2022). Monsoon rainfall varies widely across both space and time. Droughts in Pakistan primarily result from rainfall deficiencies associated with the southwest monsoon. Furthermore, there appears to be a correlation between El Niño and La Niña events and weakened monsoon activity.

Pakistan has witnessed several drought episodes with significant impacts across its provinces. The Punjab province experienced severe droughts in 1899, 1920, and 1935. North west of Khyber Pakhtunkhwa (KP) experienced worst droughts in 1902 and 1951, while Sindh endured notable droughts in 1871, 1881, 1899, 1931, 1947, and 1999. Among the most severe nationwide droughts were those in 1999–2000, extending into 2002. These droughts significantly affected agricultural output, with a notable setback during 2000–2001. Major crops experienced a decline of nearly 10% in growth, contributing to an overall negative growth rate of 2.6% for the agricultural sector. The water shortage persisted into 2001–2002, reaching levels of up to 51% below normal supplies, compared to 40% in the previous year (Shahid Ahmad, et al 2020).

Climate change has introduced fluctuations in rainfall patterns, leading to increased precipitation during wet periods and decreased rainfall during dry spells. Consequently, periods of reduced rainfall result in droughts, while heavy rainfall events lead to various types of floods, including flash floods, urban floods, coastal floods, and river floods.

3. Rainfall Distribution (July-Sep) 2024

During the third quarter of 2024 (July-Sep), Pakistan experienced above-average precipitation, an increase of 50%. Month of July experienced significantly decreased rainfall, specifically, Sindh, Khyber Pakhtunkhwa, Gilgit-Baltistan (GB) and Kashmir (below-average precipitation), with departures -44%, -21%, -65% and -46% respectively. In contrast, August witnessed increase in rainfall across all provinces, with a departure range from 13% to 337%. September witnessed below normal rainfall with -30% decrease in rainfall across Pakistan. Kashmir, Gilgit Baltistan KP, Punjab, Sindh, Balochistan experienced a decrease in rainfall with departures -36%, -56%, -43%, -11%, -47%, -29%

respectively. Overall, the quarterly analysis indicates above-average rainfall across the country. The area weighted rainfall is depicted in Figure 2.

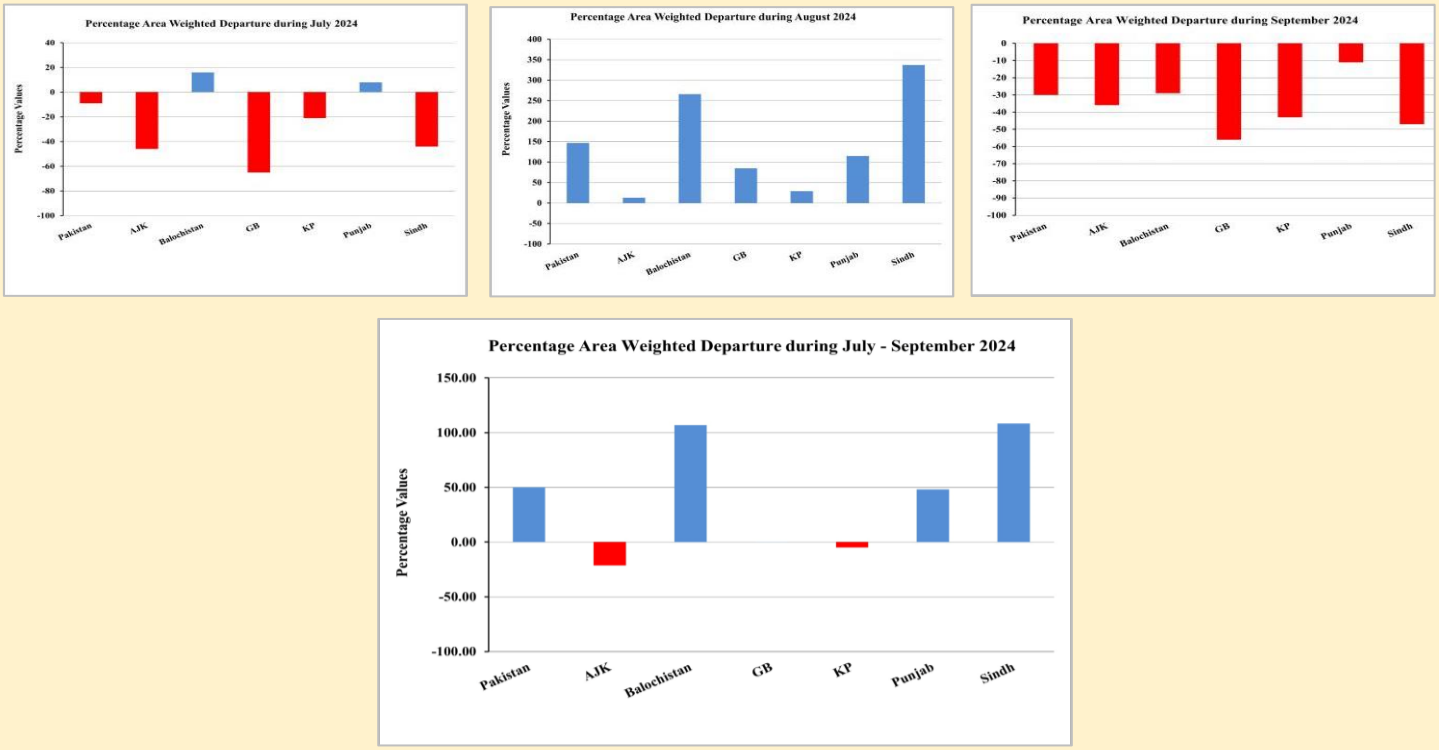

Figure-2: Percentage area weighted departure rainfall during (July-September) 2024

Spatial distribution of rainfall during the quarter (July-Sep) is shown in Figure 3. During the quarter rainfall spells were observed throughout the country, chief rainfall were observed in Upper KP (Hazara Division), Northeast Punjab, Southeast Sindh, Potohar region, Kashmir and adjoining areas. These rains reduced moisture stress on wheat crops in rain-fed areas. Above normal rainfall during July to September reduced the water stress and improved moisture content that provided significant relief in drought vulnerable areas of Pakistan.

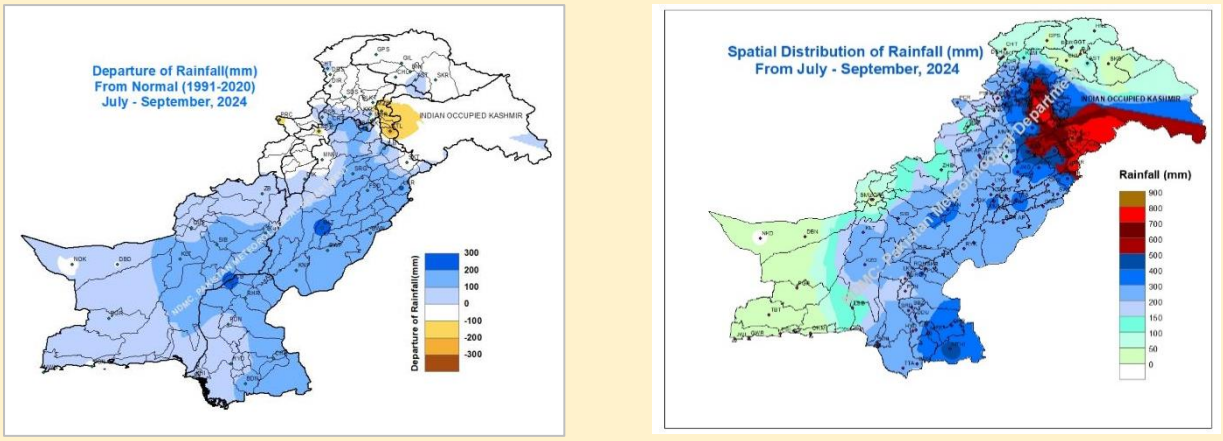

Figure-3: Spatial distribution and departure of rainfall during (July-Sep) 2024 in Pakistan

3.1 PMD Stations with highest rainfall (mm) (July- Sep) 2024

Table1: PMD Stations with Highest Rainfall (mm) during period Jul-Sep 2024					
Sr.No	Station	RF (mm)	Sr.No	Station	RF (mm)
1	Lahore, Airport	951.2	11	Lahore, City	657.3
2	Chaklala Airbase	932.1	12	Sialkot Cantt	654.2
3	Islamabad, Zeropoint	904.9	13	Murree	630.5
4	Sialkot Airport	876.1	14	Gujrat	627.0
5	Mangla	730.9	15	Balakot	614.0
6	Mandibahauddin	714.3	16	Hafizabad	481.6
7	Kakul	713.8	17	Malamjabba	471.0
8	Narowal	708.6	18	Sargodha Airbase	456.2
9	Gujranwala	695.8	19	Cherat	438.0
10	Jhelum	682.9	20	Kamra Airbase	432.3

3.2 The Maximum Length of Dry Days Spell

The maximum length of dry days spell (shown in Figure 4) was observed in southern parts of country where it reached up to 140 days due to no rainfall. The rainfall spell during July and August provided relief to most parts of the country, whereas, Baluchistan received slightly less rainfall (which is the climatology of the region).

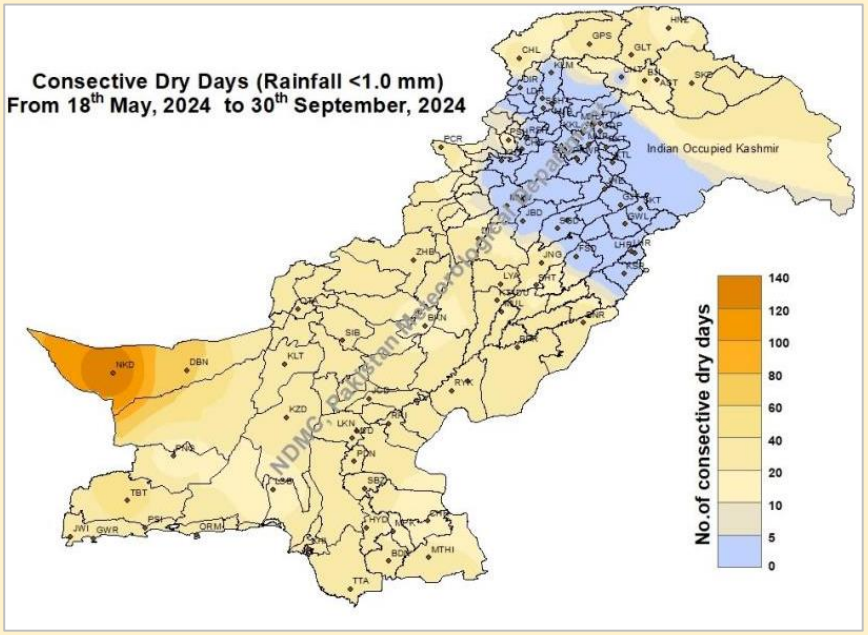

Figure-4: Length of dry days spell upto 30th September 2024

4. Drought Products

4.1 Standardized Precipitation Index (SPI)

The Standardized Precipitation Index (SPI) was developed to define and monitor drought (McKee *et al*., 1993). The SPI calculation for any location is based on a series of accumulated precipitation for a fixed time scale of interest (i.e., 1, 3, 6, 9, 12 months). Such a series is fitted to a probability distribution, which is then transformed into a normal distribution so that the mean SPI for the location and desired period is zero (Edwards and McKee, 1997). Positive SPI values indicate greater than median precipitation, and negative values indicate less than median precipitation. Because the SPI is normalized, wetter and drier climates can be represented in the same way and wet periods can also be monitored using the SPI.

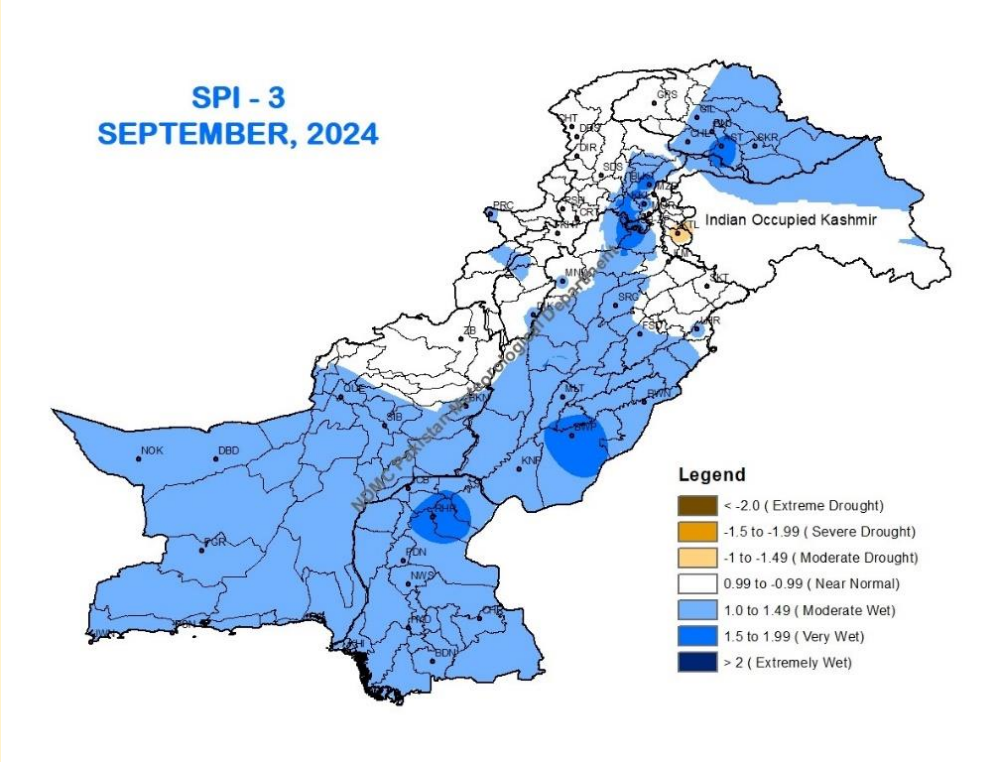

Figure-5: Standardized Precipitation Index, 3-month analysis

4.2 Cumulative Precipitation Anomaly (CPA)

Cumulative Precipitation Anomaly (CPA) was calculated from 1st Oct, 2023 for each month. July, August and September 2024 CPA charts are shown below in Figure 6. Overall, northern half of the country and southern KP received below normal rainfall i.e. negative anomaly. However, central and southern parts of country have experienced positive anomaly i.e. above normal rainfall cumulative during the period.

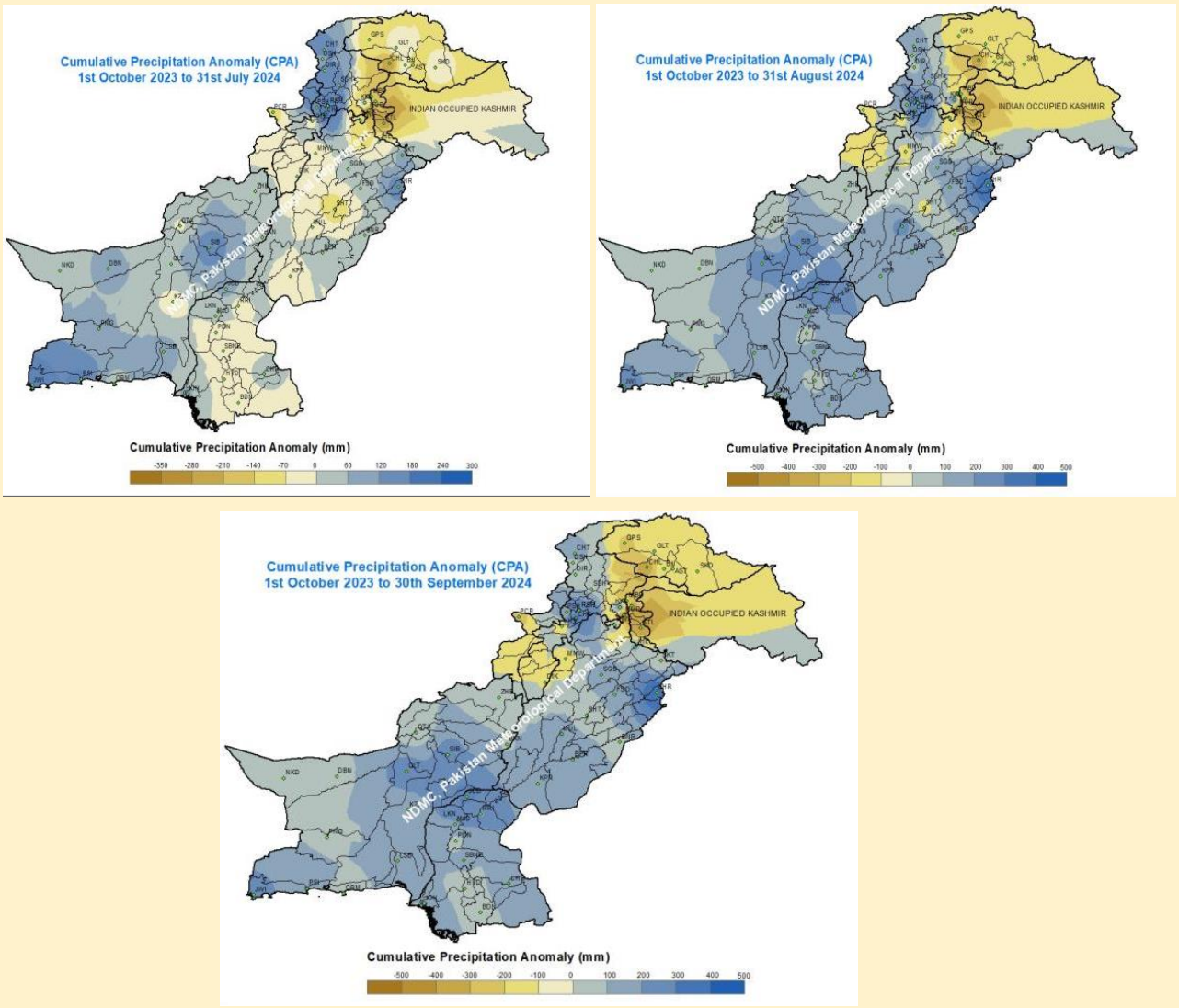

Figure-6: Cumulative precipitation anomaly during (July-Sep) 2024

4.3 Soil Moisture Anomaly (SMA)

It was observed that the amount of rainfall in some areas in the quarter was above normal which improved the soil moisture conditions in the country as shown in Figure 7. Soil moisture conditions are above normal in most parts of the country except Kotli, Kakul and Dir.

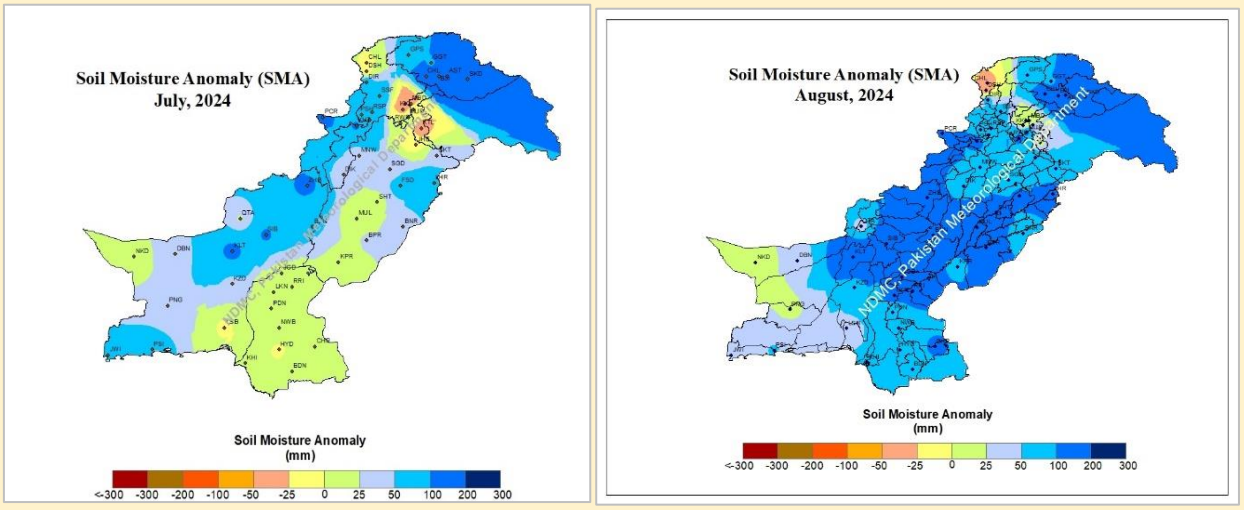

Figure-7: Soil moisture anomaly (Quarter)

4.4 Water Level of Reservoirs

Pakistan has two main reservoirs of water in the form of dams i.e. Tarbela and Mangla. The dead level of Tarbela is 1402 feet while the maximum conservation level is 1550 feet. Mangla has a dead level of 1050 feet and a maximum conservation level of 1242 feet. Pre-monsoon rains, along with the snow melting play an important role in the water levels of dams. In addition, small dams in various parts of the country were also filled that would help boost agriculture and improve socio-economic activities in the country. The water level (%) of Mangla and Tarbela dam in the month of September is above average. The percentage of average water level from July to Sep 2024 calculated for both dams is shown below in Figure -7.

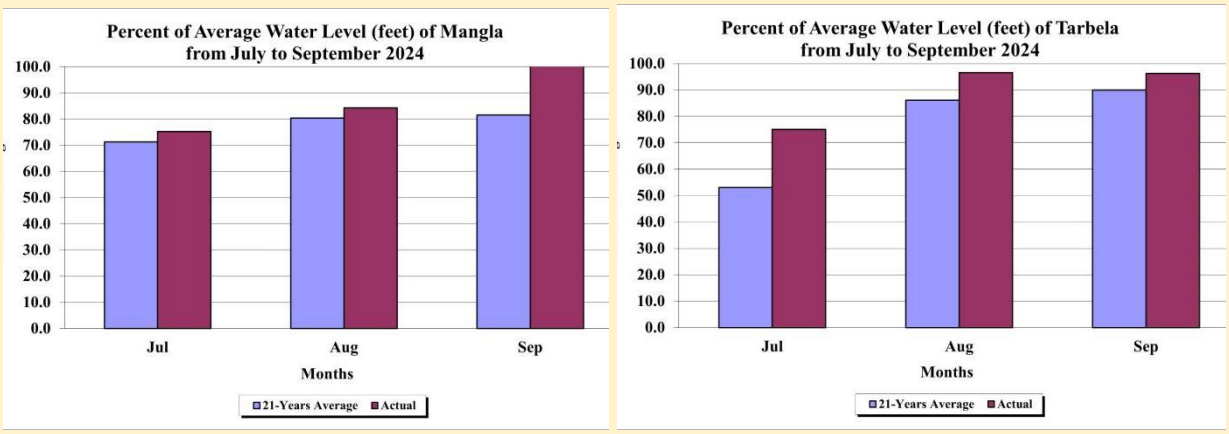

Figure-7 Percent (%) of the water level of Mangla and Tarbela during (July-Sep) 2024

5. District-wise impact of drought

During the quarter mild drought like situation is prevailing in Nokkundi, Dalbandin, Turbat and Gawadar district in Balochistan.

6. Kharif season forecast of Mangla and Tarbela Dams (2024)

The predicted water availability forecast (MAF) forecast in two big reservoirs i.e. Tarbela and Mangle during the Kharif season (April-September) 2024 is shown in Figure 9.

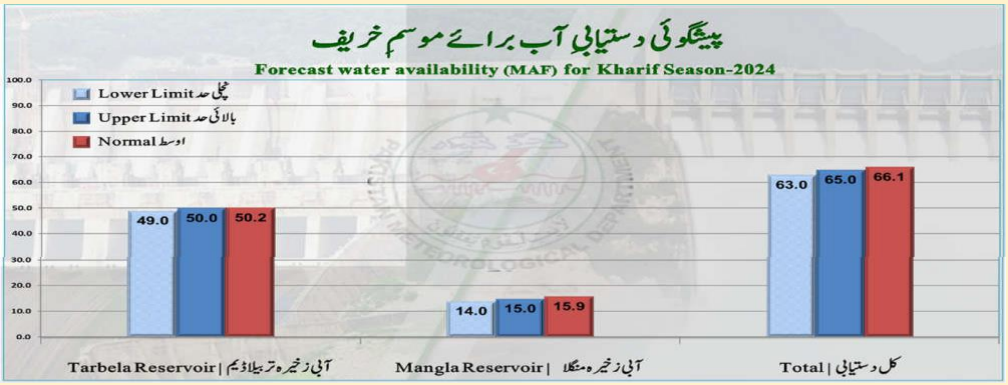

Figure-8 Kharif season forecast of Mangla and Tarbela dams (2024)

7. Crop Report: July-August 2024

In both July and August 2024, the agricultural plains of the country experienced satisfactory monsoon rains, leading to improved soil moisture conditions. These weather conditions were beneficial for standing seasonal crops such as paddy, sugarcane, maize and vegetables. Most crops reported good or satisfactory condition across different provinces. Weeding and hoeing practices were ongoing in July, while fruit harvesting and marketing were key activities.

Punjab

During the Kharif season, major crops in Punjab included cotton, rice, sugarcane, maize, seasonal vegetables and orchards. July brought above-normal rains, leading to satisfactory soil moisture levels, which were beneficial for all standing crops. The crop condition remained good throughout August, with paddy transplantation and maintenance practices like continued weeding. Overall, the crops and orchards in Punjab were reported in good condition in both months.

Sindh

In July, sugarcane, cotton, rice and seasonal vegetables were the main crops. Although good rain was reported in parts of Sindh, certain regions experienced water stress. However, by August, the province received considerable rainfall in most areas, improving soil moisture and benefiting the standing crops. Cotton, rice, sugarcane, maize and orchards were all reported in good condition during August.

Khyber Pakhtunkhwa

In July, land preparation and sowing for late Kharif crops were the primary activities, with general crop conditions, including vegetables and orchards, remaining satisfactory. By August, the standing crops of sugarcane, rice, maize, pulses and seasonal vegetables were thriving, with satisfactory conditions reported throughout the province.

Baluchistan

Across both July and August, the condition of standing crops and seasonal orchards, including apples, grapes and sweet melons was reported satisfactory. Harvesting and marketing of fruit were ongoing and the yield of seasonal vegetables remained consistent and satisfactory.

Gilgit Baltistan

In both July and August, crops like potato and maize continued to grow at a normal pace. The harvesting and marketing of seasonal fruits such as peaches, cherries and grapes were actively progressing during this period, with satisfactory growth conditions of agricultural crops.

8. Recommendations

- A natural disaster could not be stopped. Each disaster gives us a lesson to do better planning, management and taking some precautionary measures to minimize its impacts in future. Following are some recommendations to cope with the floods and droughts in Pakistan
- Pakistan dam's water storage capacity is much less than the neighboring countries like India. Therefore, it is the need of the hour to build large and small dames in catchment areas specially to conserve the rainfall water during the monsoon period.
- Manage the floods and storage of water.
- The stored water will help in protecting food security specially to fulfill the water requirements of crops during drought periods in the country.
- NDMC is continuously monitoring drought situations over the country and keeping the stakeholders and general public updated by issuing drought information on weekly, monthly and Quarterly basis.
- Over all, normal conditions are prevailing in the country so no intervention has been made by the government for drought during this quarter. For detailed information regarding the drought situation in Pakistan, please visit http://www.ndmc.pmd.gov.pk/index.htm

9. Acknowledgement

National drought monitoring Centre, Pakistan Meteorological Department, Islamabad acknowledges SUPARCO and NOAA for sharing the information.

10. References

- Shahid Ahmad, Zahid Hussain, Asaf Sarwar Qureshi, Rashida Majeed and Mohammad Saleem., (2020). Drought mitigation in Pakistan: Current status and options for future strategies.
- Waqas, A., and Athar, H. (2019). Spatiotemporal variability in daily observed precipitation and its relationship with snow cover of Hindukush, Karakoram and Himalaya region in northern Pakistan. Atmos. Res. 228, 196–205. doi: 10.1016/j.atmosres.2019.06.002
- Adnan, S., Ullah, K., Shuanglin, L., Gao, S., Khan, A. H., & Mahmood, R. (2017). Comparison of various drought indices to monitor drought status in Pakistan. Climate Dynamics, 1-15.
- Adnan, S., Ullah, K., Khan, A.H., Gao, S. (2017). Meteorological impacts on evapotranspiration in different climatic zones of Pakistan. Journal of Arid Land, 9(6): 938–952. https://doi.org/ 10.1007/s40333-017-0107-2
- Adnan, S., Ullah, K., & Shouting, G. (2016). Investigations into Precipitation and Drought Climatologies in South Central Asia with Special Focus on Pakistan over the Period 1951– 2010. Journal of Climate, 29(16), 6019-6035.
- Adnan, S., & Ullah, K. (2015). Characterization of drought and its assessment over Sindh, Pakistan during 1951–2010. Journal of Meteorological Research, 29(5), 837-857.
- Azmat H 2007; Drought Monitoring in Pakistan using satellite and ground data. M.S thesis 2007, Comsats University, Islamabad-Pakistan.
- Edwards, D.C.; and T. B. McKee. 1997. Characteristics of 20th century drought in the United States at multiple time scales. Climatology Report Number 97–2, Colorado State University, Fort Collins, Colorado. FAO report available on web at www.fao.org/news/story/en/item/89752/icode/.
- McKee, T.B.; N.J. Doesken; and J. Kleist. 1993. The relationship of drought frequency and duration to time scales. Preprints, 8th Conference on Applied Climatology, pp. 179–184. January 17–22, Anaheim, California. http://www.suparco.gov.pk/pages/pak-scms.asp