Pakistan Meteorological Department

Drought Bulletin of Pakistan

July-September 2023

National Drought Monitoring Centre

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Drought Bulletin
July-September, 2023

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Quarterly Drought Bulletin
July - September, 2023

By

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1. Introduction

Pakistan has a long latitudinal extent and the rainfall variability during different seasons is considerably high. The climate of the country in its lower southern half is arid and hyper-arid while the northern half of the country lies between semi-arid to very humid. Some regions of the country each season, remain drastically dry and areas are always vulnerable to drought. If subsequent seasons fail to generate significant precipitation, the drought conditions then are sure totake the vulnerable regions in their grip. All the provinces of Pakistan have a history of facing major droughts in the past.

Drought differs from other natural disasters (e.g. floods, tropical cyclones, tornadoes and earthquakes etc.) in the sense that the effects of drought often accumulate slowly over a considerable period of time and may linger for years even after the termination of the event. Because of this drought is often referred to as a "Creeping Phenomena". Drought impacts are less obvious and are spread over large geographical areas than are the damages that result from other natural hazards. Consequently, drought affects more people than any other environmental hazard.

Unfortunately, no organizations dealing with the drought issues exist in Pakistan and the responses to drought for the distressed economic and social sector, whenever such a situation arose, were taken on an emergency and on an adhoc basis. It is thus an inevitable need of the time and Pakistan Meteorological Department (PMD) took an initiative to establish the National Drought/Environment monitoring and Early Warning Centre (NDMC) in 2004-05 after the worst drought during 1999-2001 in Pakistan. The main objective is to monitor the drought situation in the country and issue advisory before time. Its national centre is in Islamabad while four Regional Drought Monitoring Centers (RDMCs) are in Lahore, Karachi, Peshawar and Quetta. These four RDMCs cover those regions which come under their jurisdiction. These Centre's serve as a hub for

the monitoring, collection, consolidation and analysis of drought-related data from all the possible sources in the country. To strengthen the network, 50 Automatic weather stations (AWS) have been installed in different regions, particularly the drought-prone areas of the country. The data of eleven meteorological parameters i.e. air temperature, humidity, wind speed, wind direction, dew point, sea level pressure, station level pressure, solar radiations, soil moisture at standard depths (5,10, 20, 50,100) cm and snow level are transmitted through satellite and GPRS technology after 3 hours. So, it has now become easy to access the data of remote areas of the country. NDMC has installed 335 Ordinary Rain-gauges at the district level in four provinces as shown in figure-1.

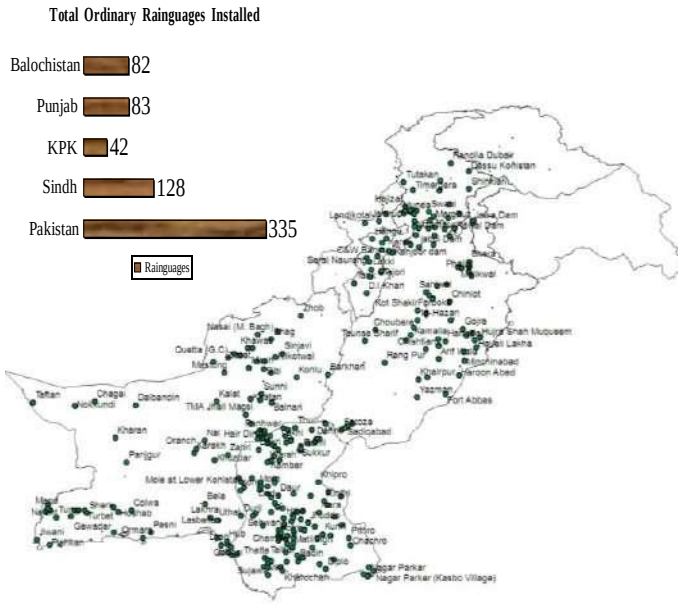


Figure-1 Rain-gauges Network of Pakistan by NDMC

NDMC is monitoring the water level situation of small dams also in Barani areas of the country. NDMC uses different indices like Standardized Precipitation Index (SPI), Normalized difference Vegetation Index (NDVI), Cumulative Precipitation Anomaly (CPA), Rainfall Anomaly Index (RAI), Percent of normal, Probability of occurrence, Percentage departure and soil moisture analysis etc to monitor drought. NDMC issues a fortnightly drought bulletin of the country.Negotiations are underway with NGOs and the National Disaster Management Authority (NDMA) for the utilization of drought advisories/bulletins to end users.

2. Historical Background

The Indian sub-continent is predominantly characterized by a tropical monsoon climate and the entire regime is distinguished mainly by the differences in rainfall both in quantity and distribution. The most important feature is the regional and temporal alteration of atmospheric

flow patterns associated with the monsoon. Two rainfall systems are operating in the region (a) Southwest or Summer monsoon and (b) Northeast or the Winter monsoon.

Fortunately, Pakistan also falls in this region which receives a heavy amount of rainfall in summer due to SW monsoon and in winter due to western disturbances. The summer monsoon accounts for 70 to 80% of the annual rainfall over major parts of South Asia (IMD, 2009). In Pakistan, the summer monsoon accounts for 45% of the annual rainfall from July to September (Adnan et al., 2017). There is a large variability in the monsoon rainfall on both space and time scales.

Droughts in the Pakistan region are mainly due to failures of rains from the southwest monsoon. Also, there seems to be some association between El Nino and La Nina events and weak monsoons. Pakistan frequently experiences droughts in southern parts of the country. The study conducted at the National Drought Monitoring Centre (NDMC) of PMD revealed that the province of Sindh and Balochistan are more vulnerable to drought. In the long-term data analysis of the past sixty years (1951-2010) different intensity (mild to extreme) of the drought was experienced in the country i.e. 31 in Sindh,23 in Balochistan,22 in Punjab and 18 in Khyber Pakhtunkhwa. The longest episode of the drought was experienced during 1999-2002.The Punjab province experienced the worst droughts in 1899, 1920 and 1935,1969,1987-88, 2000-01, Khyber Pakhtunkhwa (KPK) experienced the worst droughts in 1902 and 1951-1952,1970-71,1987- 88,1999-2001, Sindh had its worst droughts in 1871, 1881,1899,1931,1947,1951-52,1958,1966,1969,1972-74, 1987-88, 1999-2001, 2003-04, 2018 and 2021 while Balochistan had 1952,1963-64, 1965, 1968, 1970-71, 1983-84, 1987-88, 1999-2002, 2004, 2006, 2018 and 2021.

Due to climate change, some years we receive more rain in wet spells and in dry spells we receive less rain. Due to less rain, we have drought and heavy rain we have floods (flash floods, urban floods, coastal floods and river floods).

3. Rainfall Distribution (July- September) 2023

During the Third quarter of the year (July-September) 2023, normal (8.90%) precipitation was observed over Pakistan. During this quarter, less temporal and spatial variability in precipitation was observed. Normally July and August are the wettest months in the country. However, the evaporation rate remained high during this quarter. But during this quarter, the amount of rainfall was below normal as predicted by the Pakistan Meteorological Department in the seasonal forecast. In July 2023, above normal (74.45%) rainfall was received in Pakistan

It was above normal (148.26%) in Sindh and above normal in Punjab (54.06%) where in Balochistan (125.33%), Gilgit-Baltistan and Azad Jammu Kashmir (45.45%) and below normal in Khyber Pakhtunkhwa (2.54%). Whereas below normal (-64.85%) rainfall was received in the country during August 2023. It was below normal in Balochistan (-87.30%), Sindh (-99.37%), Gilgit-Baltistan and Azad Jammu and Kashmir (-31.79%), normal in Punjab (-51.82%) and Khyber Pakhtunkhwa (-49.23%).

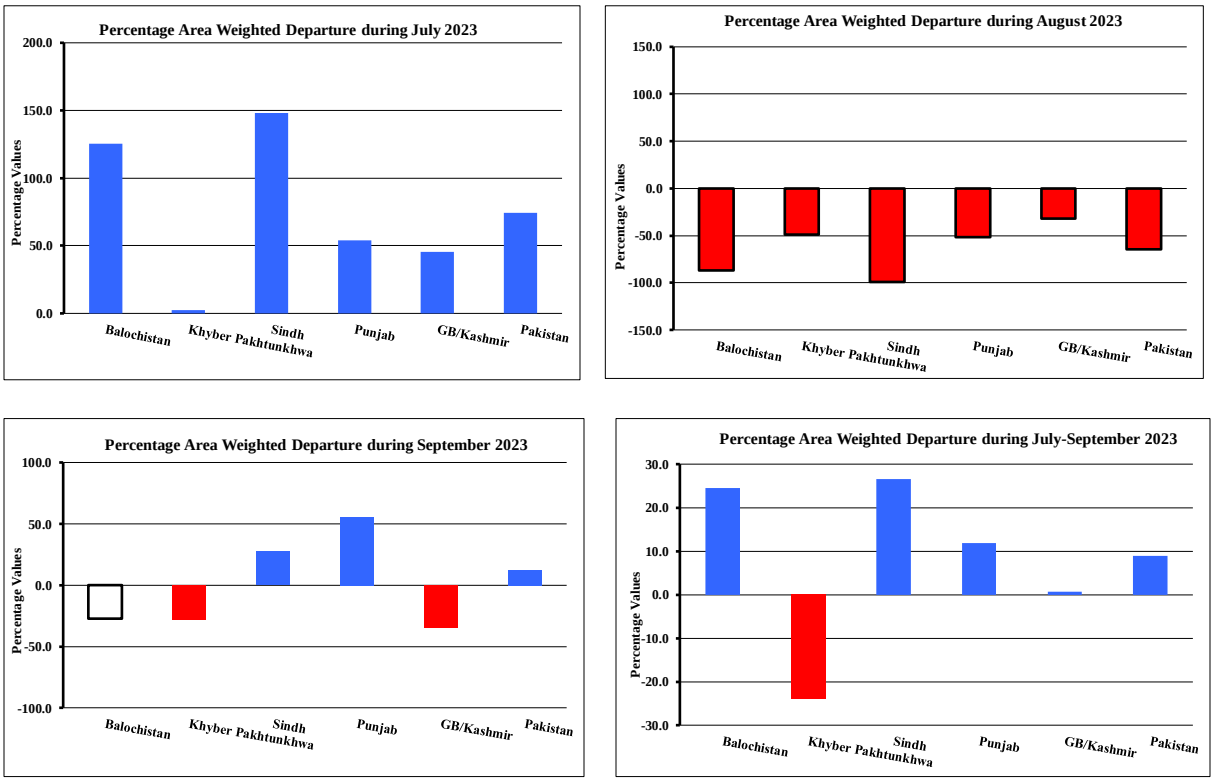


Figure-2 percentage departure of rainfall during (July-Sep) 2023

In September 2023, the amount of rainfall was normal (12.26%) in the country. However, the rainfall was well above normal in Punjab (55.46%), below normal in Khyber Pakhtunkhwa (-28.05%), Balochistan (-27.33%) and below normal in Gilgit-Baltistan and Azad Jammu and Kashmir (-34.41%) whereas normal in Sindh (27.35%). The figure-2 shows the percentage area weighed departure rainfall that occurred during (July-September) 2023 for the whole region of Pakistan in which the country received above below normal (8.90%) rainfall during this quarter. Viewing the rainfall distribution on province basis, below normal rainfall was received over Gilgit-Baltistan and Azad Jammu and Kashmir (0.74%), Khyber Pakhtunkhwa (-23.95%) and above normal in Sindh (26.61%) and in Balochistan (24.49%) and in

Punjab (11.87%). The rainfall was normal as shown in figure-2. The spatial distribution of monthly and quarterly rainfall is shown below in figure-3.

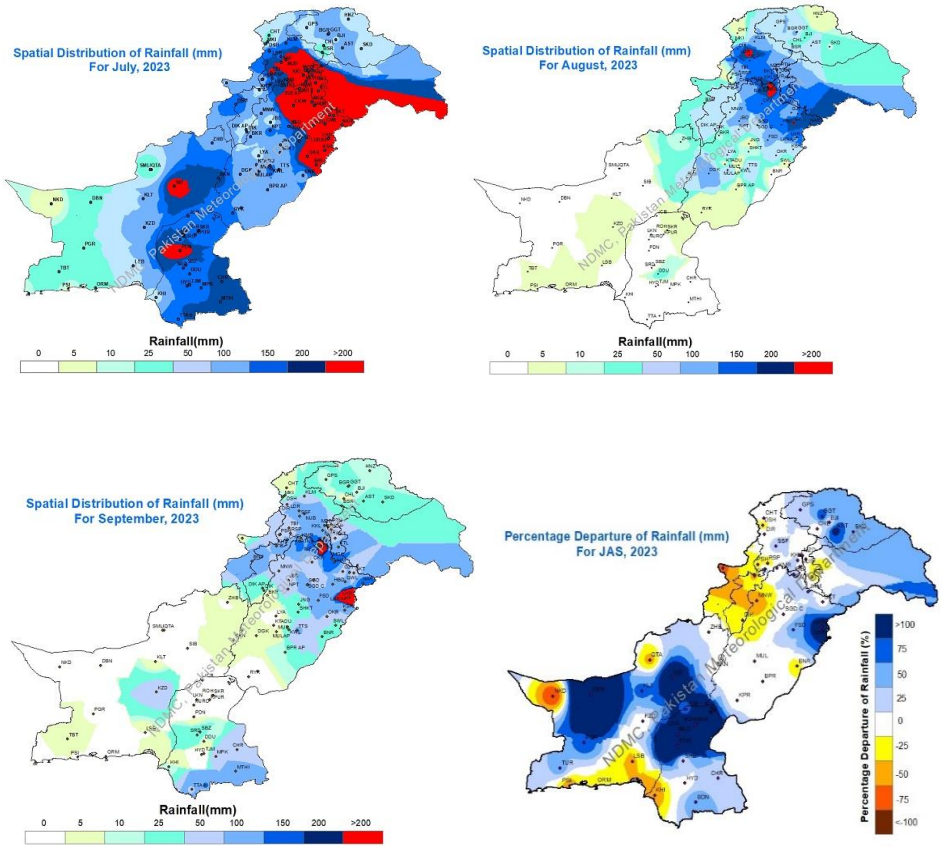


Figure-3 spatial distribution of rainfall during (July-September) 2023 in Pakistan

- **<u>Maximum length of dry Spell</u>**

  A dry spell is defined as when the amount of rainfall is less than 1.0mm over an area.

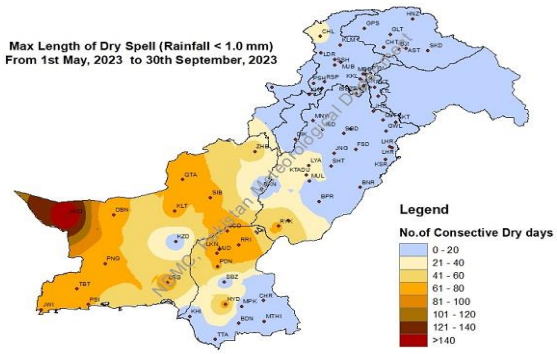


Figure-3b spatial distribution of maximum length of the dry spell

- **Monthly Highest Rainfall**

i. July2023

Chief amounts of monthly rainfall recorded across Pakistan during July 2023					
Sr.No.	**Station**	**Rainfall(mm)**	**Sr.No.**	**Station**	**Rainfall(mm)**
1	Gulshan-E- ravi-Lahore	958.02	11	Murree	415.51
2	Shahi Qilla-Lahore	940.02	12	Buner	411.5
3	Lahore, Airport	668.72	13	Rawalakot	400.9
4	Samnabad-Lahore	483.02	14	Muzaffarabad Airport	392.1
5	Balakot	477	15	Gujranwala	386.5
6	Shamsabad-Rawalpindi	463	16	Chakwal	365.93
7	Islamabad Zeropoint	453.91	17	Haraman	350.2
8	Kasur	442.03	18	Jhelum	346.4
9	Kakul	427	19	Padidan	327.61
10	Sialkot Cantt	422.42	20	Malamjabba	319

ii. August 2023

Chief amounts of monthly rainfall recorded across Pakistan during August 2023					
S. No.	**Stations**	**Rainfall (mm)**	**S. No.**	**Stations**	**Rainfall (mm)**
1	Saidpur-Islamabad	266	11	Mangla	145.61
2	Lower Dir	231	12	Kamra	142.1
3	Islamabad, Zeropoint	216.82	13	Kakul	141.01
4	Chaklala	214.01	14	Chakwal	140.7
5	Gujranwala	203.32	15	Malamjabba	133
6	Barnala	169.4	16	Buner	128.9
7	Sialkot Cantt	166.76	17	Lahore, Airport	125.07
8	Pashat-Bajaur	157	18	Kotli	124
9	Lukshmi	156.01	19	Dir	122.01
10	Narowal	153.61	20	Hafizabad	112.4

iii. September 2023

Chief amounts of monthly rainfall recorded across Pakistan during September2023					
S. No.	**Stations**	**Rainfall (mm)**	**S. No.**	**Stations**	**Rainfall (mm)**
1	Gulshan-E- ravi-Lahore	349.01	11	Attock	108.21
2	Lahore, Airport	307	12	Mangla	108
3	Saidpur-Islamabad	246	13	Islamabad, Airport	104.32
4	Islamabad Zeropoint	233.52	14	Badin	102.21
5	Shamsabad-Rawalpindi	211	15	Murree	100.51
6	Chaklala Airbase	179.3	16	Golra	100
7	Khaar-Bajaur	150.8	17	Kakul	94.81
8	Jehlum	130.01	18	Faislabad Airport	93.02
9	Narowal	121.9	19	Gulistan Colony	90
10	Jhelum	130.01	20	Kotli	88.01

4. Drought products

i. 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). 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. Here we are including one seasonal map that show the drought conditions in the country.

(a) (b)

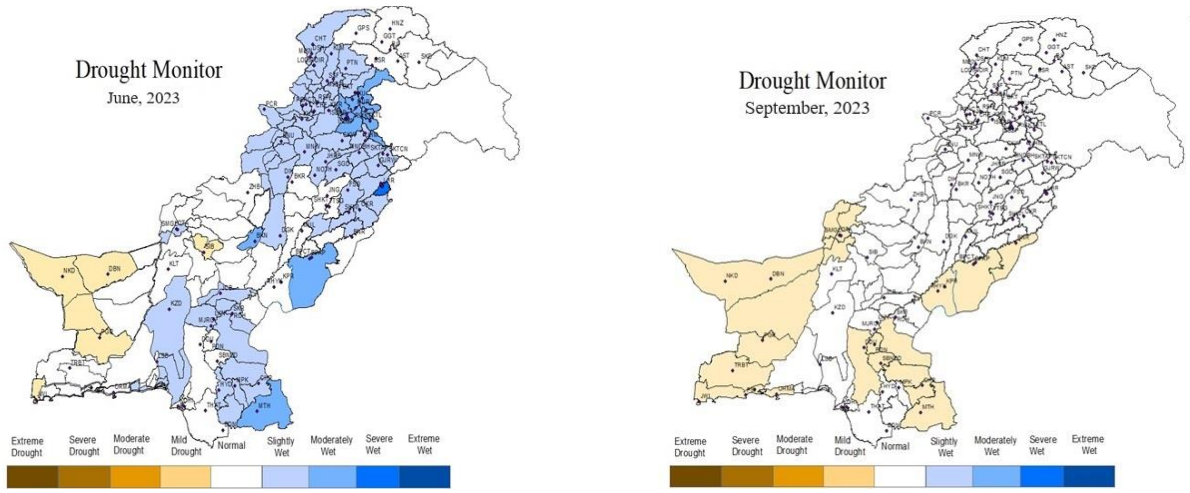


Figure-4 Drought conditions of Pakistan

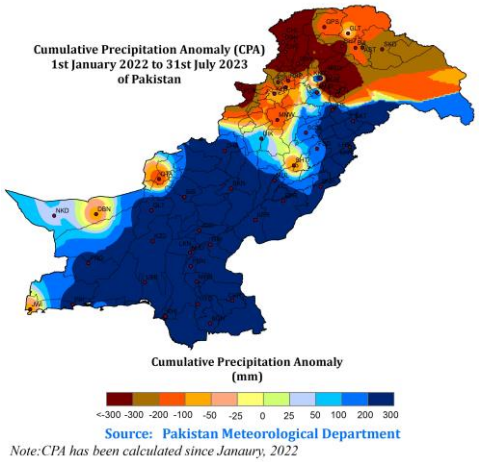
Due to below normal rainfall in August, Mild drought conditions have emerged in eastern and southwestern parts of Pakistan. However, appreciable amounts of rainfall have been recorded over the agricultural plains of the country; therefore the water requirement is satisfactory during the monsoon.

ii. Cumulative Precipitation Anomaly (CPA)

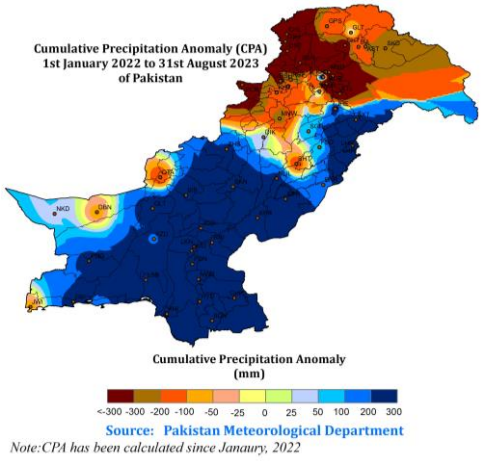
Rain bearing systems remained active over during the quarter (July to Sep) in Pakistan. From July to September 2023, it was observed that the Cumulative Precipitation Anomaly was negative in Upper KP and Gilgit Baltistan regions. Even the daytime temperature and evapotranspiration were less high as compared to the previous quarter, the conditions are satisfactory, and however, moisture stress has been observed especially in south western Balochistan, eastern parts of Punjab and Sindh

The Upper and eastern parts of Punjab and Sindh will be mainly influenced by the frequency of precipitation days and extreme events would be greater in these areas as compared to other parts of the country.

(a)



(b)



(c)

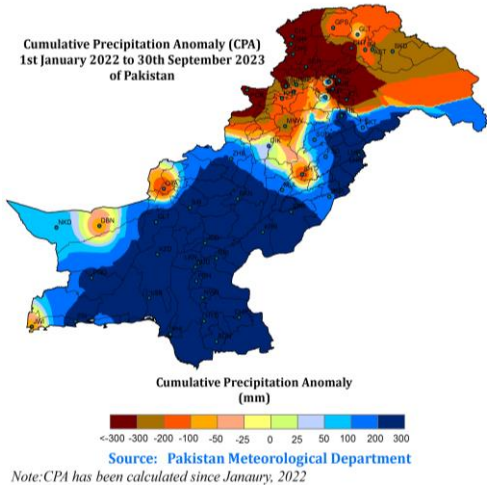
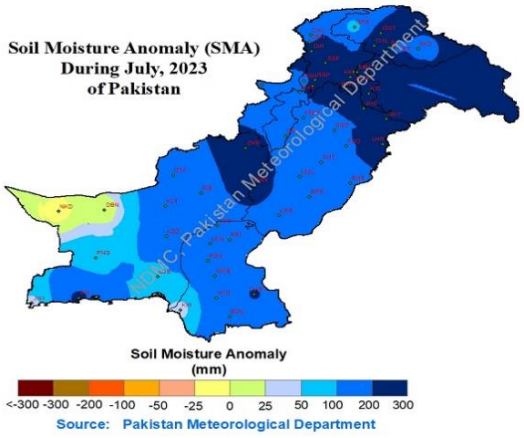


Figure-5 Cumulative precipitation anomaly during (July-September) 2023 in Pakistan

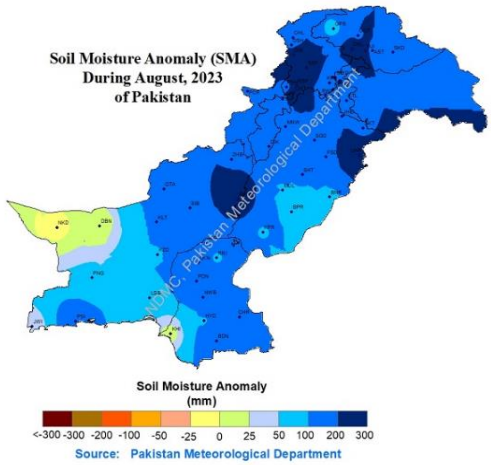
ii. Soil Moisture Anomaly (SMA)

It was observed that the amount of rainfall from July- Sep was below normal as shown in Figure 5. Soil moisture conditions are near normal. Normal rainfall during July- Sep 2023 provided relief to soil moisture stress and conditions are normal in most parts of Pakistan.

(a)



(b)



(c)

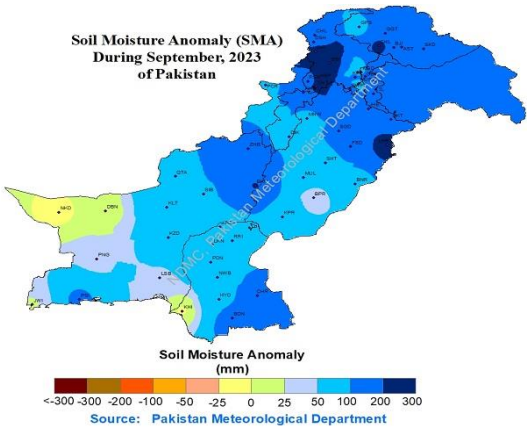
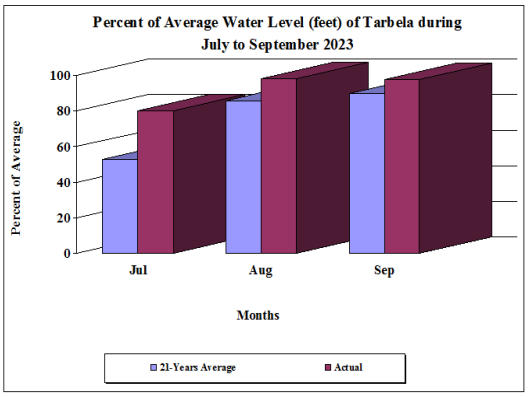


Figure-6 soil moisture anomaly during (July-September) 2023 in Pakistan

iii. 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 whereas 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 improvesocio-economic activities in the country. The water level (%) of the and Tarbela dam is above average whereas Mangla dam is also above the average value, especially in September.

The percentage of average water level from July to Sep 2023 calculated for both dams is shown below in figure -7.



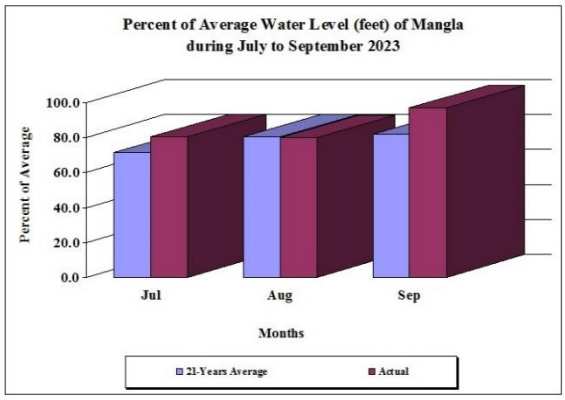


Figure-7 percent of water level of Tarbela and Mangla during (July-September) 2023

5 District-wise impact of drought

Sindh province highly depends upon monsoon season (July-September) which contributes almost 80% of the annual rainfall. August is known to be the 2nd wettest monsoon month in the country. Due to the below-normal rainfall (August 2023), abnormally dry conditions (mild drought) were prevailing in the districts of Sindh **(Umerkot, Tharparkar and Sanghar, Dadu, Jamshoro, Khairpur, Shahdad Kot and Shaheed Benazirabad), central and southern districts of Balochistan (Chagi, Gawadar, Harnai, Kech, Kharan, Mastung Nushki, Pishin, Panjgur, Qila Abdullah, Quetta and Washuk) and the Cholistan region (Bahawalpur, Bhawalnagar and Rahim Yar Khan**) in Punjab. NDMC continuously monitored the drought situation over the country and kept the stakeholders and general public updated by issuing drought information on regular basis. NDMC issued Drought watch regarding the situation.

Link: https://ndmc.pmd.gov.pk/new/assets/bulletins/1695714007.pdf

6 Government reactions to drought

Due to below normal rainfall, mild drought conditions emerged in the country. The water availability in major reservoirs is insufficient due to below-normal snowfall in the catchments areas; currently, the water situation in the dams is improving day by day. NDMC is continuously monitoring the drought situation. It is therefore advised to all stakeholders to adopt an immediate water management strategy to avoid the negative impacts of deficit rainfall on the agriculture sector. And keep themselves regularly updated on a weekly, fortnightly and monthly basis at the PMD website http://www.pmd.gov.pk/ndmc/index.htm.

7 Rabi season forecast of Mangla and Tarbela Dams (2023-2024)

The predicted water availability forecast (MAF) forecast in two big reservoirs i.e. Tarbela and Mangle during Rabi season (October to March) 2023-2024 is shown in figure 8.

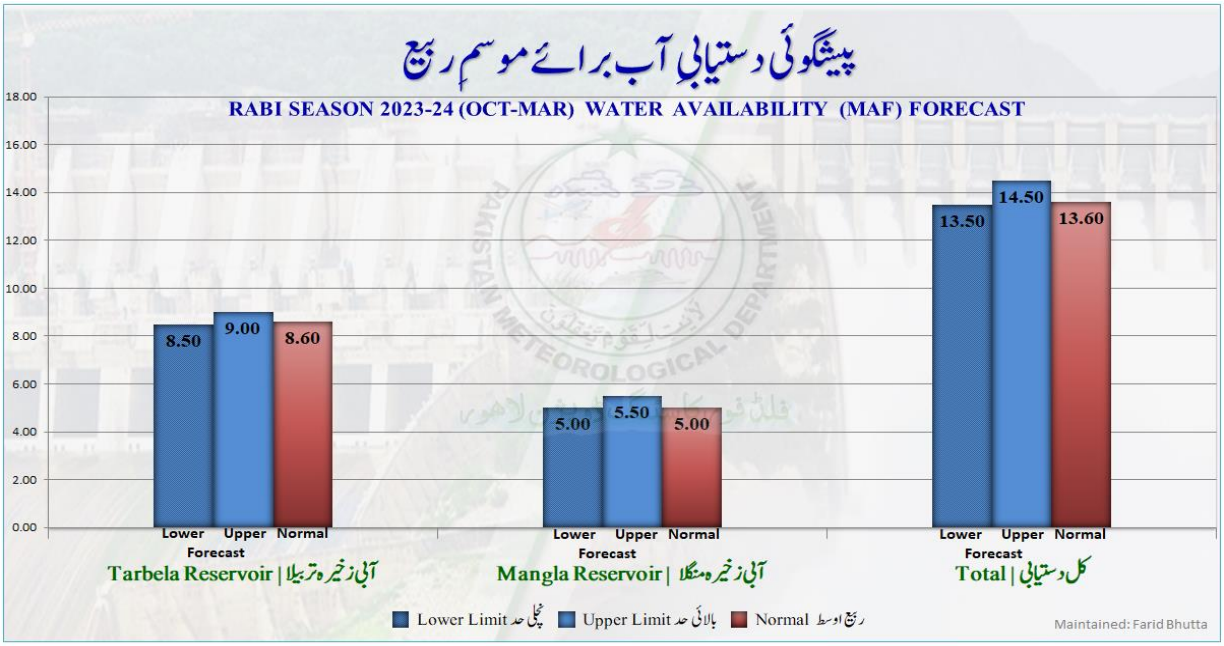


Figure 8: Forecasted water volume (MAF) for Rabi Season 2023-2024 in Tarbela and Mangla

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 that of neighboring countries like India. Therefore, it is the need of the hour to build large and small dams to manage the floods and store the water.
- The stored water will protect food security, especially fulfilling the water requirements of crops during drought periods in the country.
- The water will also help generate hydropower electricity which is an essential requirement of the country and reduce unemployment in the country.

9 Acknowledgement

National drought monitoring Centre, Pakistan Meteorological Department, Islamabad acknowledges SUPARCO and district office agricultural departments for sharing the information.

10 References:

1. **Adnan S,** Ullah K, Shuanglin L, GAO S, Khan AH, Mahmood R. 2017. Comparison of various drought indices to monitor drought status in Pakistan. *Climate Dynamics*, 1-15.
2. **Adnan S,** Ullah K, Khan AH, GAO S. 2017. Meteorological Impacts on Evapotranspiration in different agro-climatic zones of Pakistan. *Journal of Arid Land* **9:** 938-952.
3. **Adnan S**, Ullah K, GAO S, Khosa AH, Wang Z. 2017. Shifting of agro-climatic zones, their drought vulnerability, and precipitation and temperature trends in Pakistan. *International Journal of Climatology* **37:** 529-543.
4. **Adnan S,** Ullah K, GAO S. 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:** 6019-6035.
5. **Adnan S,** Ullah K, GAO S. 2015. Characterization of drought and its assessment over Sindh, Pakistan during 1951–2010. *Journal of Meteorological Research* **29:** 837-857
6. Chaudhry, Q.Z.1992: Analysis and Seasonal prediction of Pakistan Summer Monsoon Rainfall, Ph.D. Thesis, Univ. of Philippines, Quezon City, Philippines.
7. 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.

8. FAO report available on web at www.fao.org/news/story/en/item/89752/icode/
9. 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.
10. http://www.suparco.gov.pk/pages/pak-scms.asp