

Pakistan Meteorological Department

Drought Bulletin of Pakistan



October-December 2023

National Drought Monitoring Centre

Pakistan Meteorological Department

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Drought Bulletin

October – December 2023

S.No.	Contents	Page No.
1.	Introduction	3
2.	Historical Background	5
3.	Rainfall Distribution (Oct-Dec) 2023	5
	• Chief amounts of Rainfall (mm)	8
	• Temperature	9
	• Mist And Fog Development	9
	• Maximum length of dry Spell	9
4.	Drought products	
	i. Standardized Precipitation Index	10
	ii. Cumulative Precipitation Anomaly	10
	iii. Soil Moisture Anomaly	11
	iv. Water Level of Reservoirs	12
5.	District-wise impact of drought	12
6.	Rabi season forecast of Mangla and Tarbela Dams (2023-2024)	12
7.	Seasonal forecast and its Impacts (JFM-2024)	14
8.	Government reactions to drought	14
9.	Recommendations	14
10.	Acknowledgement	15
11.	References	15

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Quarterly Drought Bulletin

October – December 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 in each season, remain drastically dry and these areas are always vulnerable to drought. If subsequent seasons fail to generate significant precipitation, the drought conditions then are sure to take 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 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 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 Adhoc basis. It is thus an inevitable need of the time and the 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 advisories 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 centres 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 Raingauges at the districts level in four provinces as shown in figure-1.

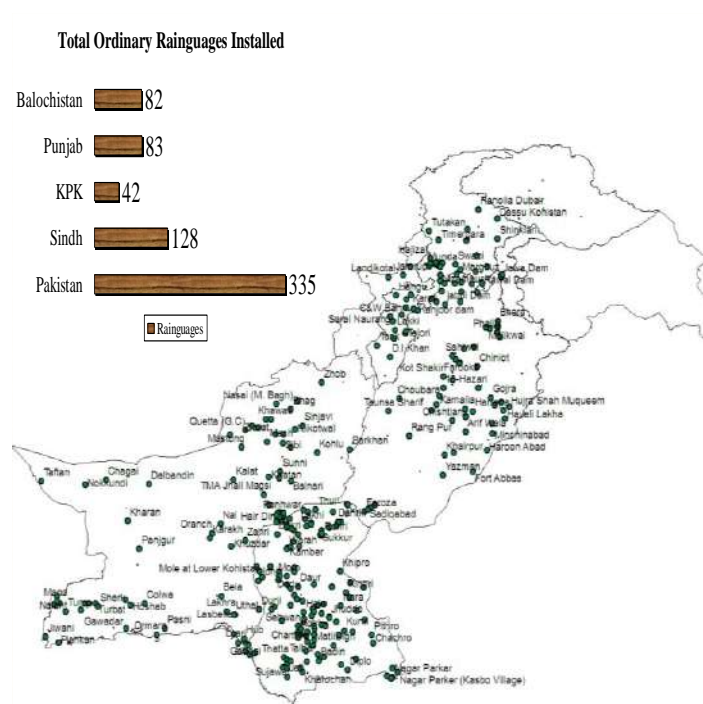


Figure-1 Rain-gauges Network of Pakistan by NDMC

NDMC is monitoring the water level situation of small dams also in the Barani areas of the country. NDMC uses different indices like the 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 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) the Southwest or Summer monsoon and (b) the Northeast or the Winter monsoon.

Fortunately, Pakistan also falls in this region which receives a heavy amount of rainfall in summer due to the 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 60 to 70% of the annual rainfall from July to September (Chaudhry, 1992). 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 the 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 the more vulnerable to drought. The long-term data analysis of the past sixty years (1951-2010) of different intensities (mild to extreme) of the drought 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 1999-2001. The Punjab province experienced the worst droughts in 1899, 1920 and 1935, 1969, 1987-88, 2000-01, Khyber Pakhtunkhwa (KP) 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 and 2003-04, 2018 while Balochistan had 1952, 1963-64, 1965, 1968, 1970-71, 1983-84, 1987-88, 1999-2002, 2004, 2006, 2018 and 2021. Over more than a hundred year's period between 1871-1988, 11 out of 21 drought years were El Nino years.

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 (Oct-Dec) 2023

During the last quarter of the year (Oct-Dec) 2023, below normal (1.13%) precipitation was observed over Pakistan. During the quarter high temporal and spatial variability in precipitation was observed in most of the northern parts of Pakistan. Normally, October and November are the driest months in

the country. In October 2023, well below normal rainfall was observed in Sindh (-67.44%), Balochistan (226.6%), Khyber Pakhtunkhwa (18.40%), Gilgit-Baltistan and Kashmir (66.32%) and Punjab (234.5%). The country analysis shows well normal rainfall (101.25%) was experienced during October 2023. In November 2023, the rainfall was well above normal i.e., (171.4%) in Punjab, (211.5%) in Balochistan, (17.05%) in Khyber Pakhtunkhwa, (-5.51%) in Gilgit-Baltistan and Kashmir while it was well below normal (156.2%) in Sindh. The whole country received well above normal rainfall (84.62%) during November 2023. The month of December 2023 was also recorded as the drier month of the quarter like October 2023 in most parts of the country in which well below normal rainfall (-91.7%) was received. During this month, rainfall was well below normal in Sindh (-100.0%), Khyber Pakhtunkhwa (-86.3%), Gilgit-Baltistan and Kashmir (-85.2%), Punjab (-98.0%) and Balochistan (-93.8 %). The figure-2 depicts the percentage area weighed rainfall departure of different provinces of Pakistan that occurred during (Oct-Dec) 2023. Viewing the quarterly rainfall distribution on a province basis, below-normal rainfall (-32.98%) was observed. During this period (Oct-Dec, 2023), rainfall was well below normal in Sindh (-96.68%) and below normal in Balochistan (-38.46%), Gilgit-Baltistan and Kashmir (-34.45%) and Khyber Pakhtunkhwa (-28.52%) while it was near normal in Punjab (-9.74%).

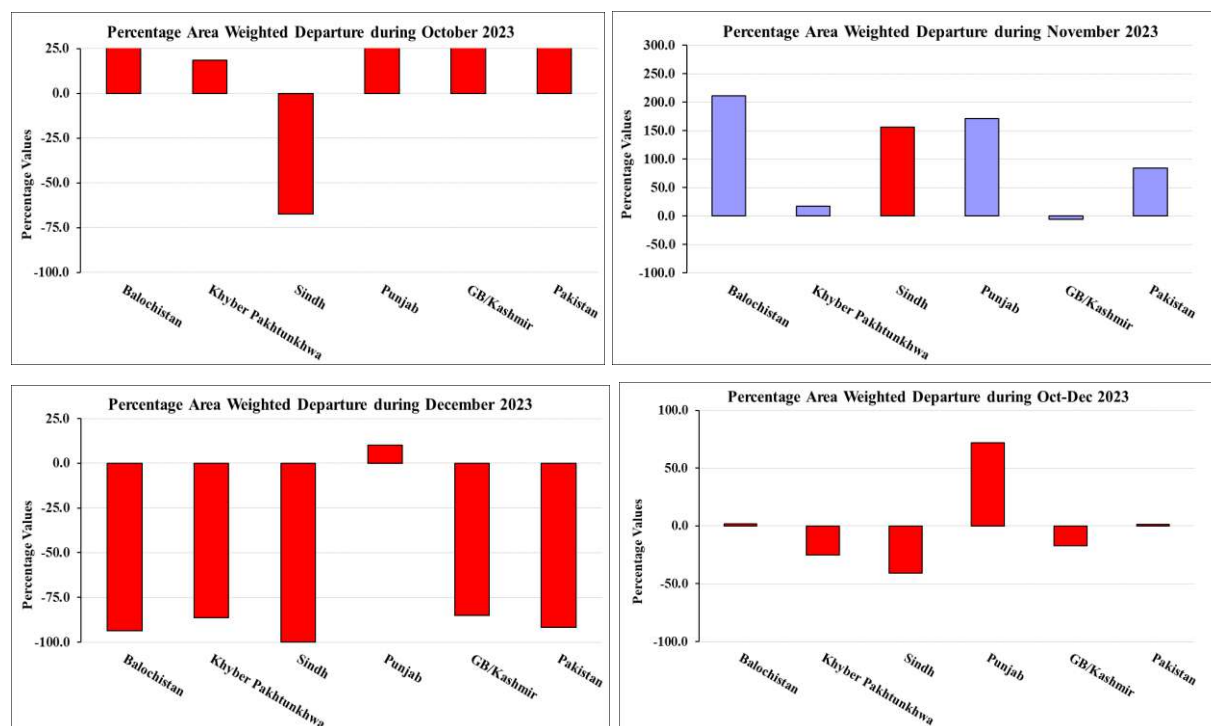


Figure-2: Percentage Area Weighted Departure of rainfall during (Oct-Dec) 2023

The rainfall pattern from October to December, set on by westerly disturbances, showed a systematic gradient from the northern to southern areas of the country. This upshot of rainfall on vast areas of the country is highly timely and is likely to sustain a good stand (tillering) of wheat crops. **El Niño is expected to gradually decrease from 2 C to – 0.2 C for January-June 2024. The probability El Niño conditions is also expected to gradually decrease from 99.6% to 56.5% for the same period.** The monthly and seasonal analyses on a regional and country basis are shown below in figure-3.

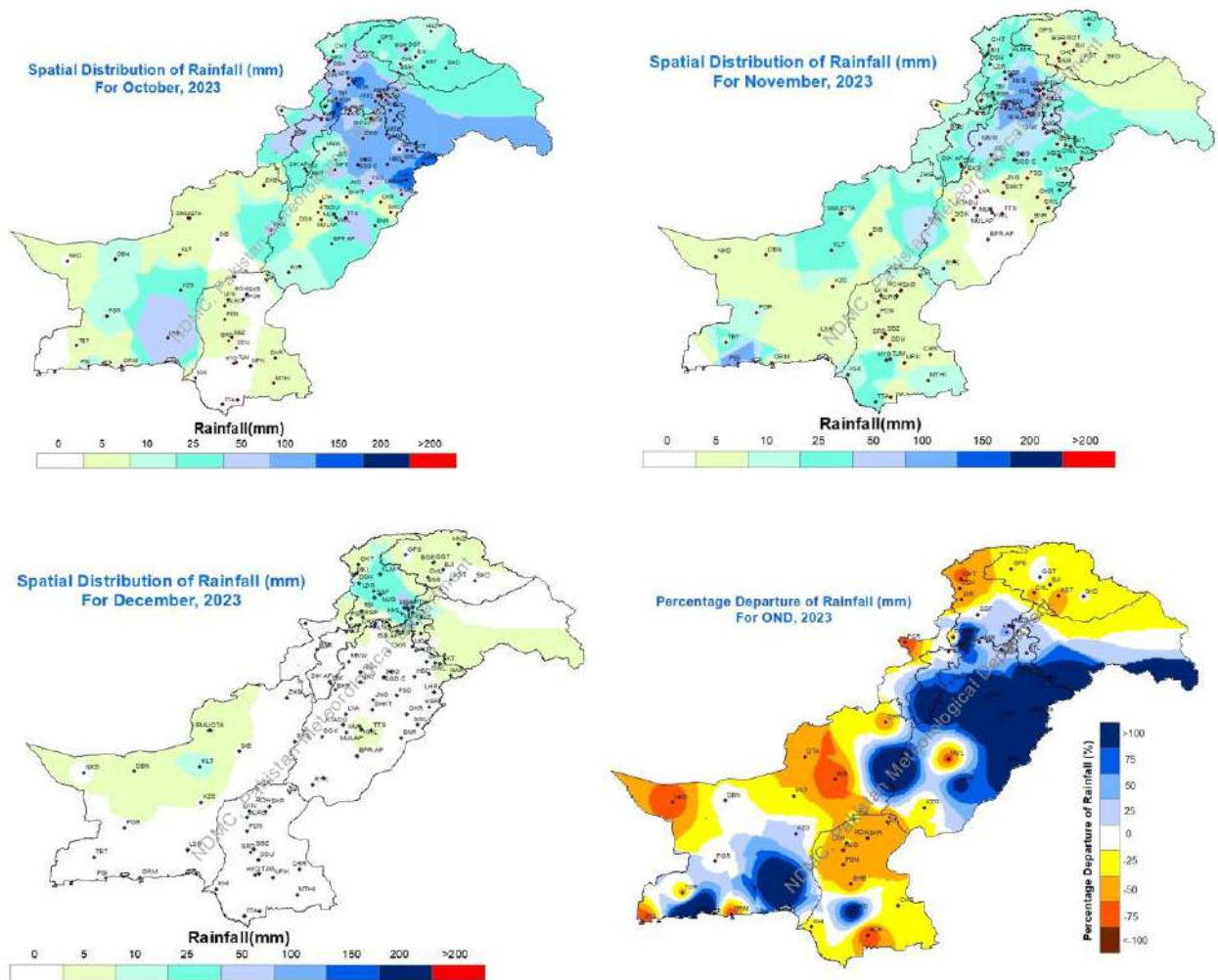


Figure 3: Spatial Distribution of rainfall during (Oct-Dec) 2023 in Pakistan

• **Chief amount of Rainfall**

During **October 2023**, 2-3 rain spells were observed throughout the country.

Chief amount of rainfall recorded across Pakistan during the month of October, 2023					
Sr.No.	Station	Rainfall (mm)	Sr. No.	Station	Rainfall (mm)
1	Attock	118.6	11	Kotli	40.0
2	Dir (Lower)	116.0	12	Kalam	39.8
3	Buner	71.0	13	Bandi Abbaspur (AJK)	37.7
4	Pattan	58.0	14	Sialkot Cantt	34.8
5	Dhulli	55.2	15	Cherat	33.0
6	Murree	50.0	16	Gujranwala	30.0
7	Kakul	50.0	17	Chattar Kalas (AJK)	29.9
8	Islamabad (Said Pur)	49.0	18	Malam Jabba	29.0
9	Muzaffarabad City	47.0	19	Mangla	27.6
10	Garhi Dupatta	44.5	20	Hajira (AJK)	25.8

During **November 2023**, 2-3 rain spells were received mostly in the northern half of the country with light to moderate below normal rains.

Chief amount of rainfall recorded across Pakistan during the month of November, 2023					
Sr.No.	Station	Rainfall(mm)	Sr.No.	Station	Rainfall(mm)
1	Kalam	132.4	11	Tirah (KP)	88.4
2	Pattan	130.5	12	Chattar Kalas (AJK)	82.5
3	Rawalakot	101.5	13	Dhulli (Punjab)	81.1
4	Muzaffarabad Airport	100.8	14	Garhi Dupatta	77.8
5	Balakot	100.0	15	Kakul	73.0
6	Murree	95.0	16	Hajira	72.7
7	Dir	91.0	17	Chaklala Airbase	65.5
8	Malam Jabba	91.0	18	Kotli	60.0
9	Haraman	90.3	19	Cherat	57.0
10	Bandi Abbaspur	89.6	20	Chakwal	52.6

During **December 2023** two rain spell was received mostly in the upper parts of the country. Rain-bearing systems produced moderate to heavy rainfall at isolated places in the country. The lower parts of Pakistan generally received very little rainfall.

Chief amount of rainfall recorded across Pakistan during the month of December, 2023					
Sr.No.	Station	Rainfall(mm)	Sr.No.	Station	Rainfall(mm)
1	Turbat	44.2	11	Cherat	13.0
2	Kakul	24.0	12	Mandi Bahauddin	12.0
3	Malamjabba	21.0	13	Chakwal	12.0
4	Balakot	19.0	14	Parachinar	12.0
5	Gari Dopatta	15.5	15	Joharabad	10.0
6	Quetta (Sh Manda)	15.0	16	Risalpur	10.0
7	Dir	15.0	17	Murree	10.0
8	Kalat	15.0	18	Pattan	10.0
9	Panjgur	15.0	19	Noorpur Thal	9.7
10	Kakul	41.5	20	Astore	9.2

- **Temperature**

Night temperatures were below normal and day temperatures remained below normal in November and December. The maximum temperature was observed below normal than the last year, while the minimum temperature also well remained well below normal. In November, Both maximum and minimum temperatures were observed slightly lower in the first half of the month while in the second half dropped more rapidly than the last year. Both maximum and minimum temperatures were observed lowest in December 2023 than in the previous last ten years.

- **Mist, Fog and Smog**

Mist and Fog are atmospheric natural phenomena where small water droplets become suspended in the air for a longer period. The water vapours condense into the fog when ambient temperatures become cooler. In the South Asian region, fog formation starts from the foothills of the Himalayas in India and moves towards the eastern parts of Pakistan in Punjab. It finally covers large parts of Punjab, major areas of Sindh crossing into adjoining districts of Balochistan across Sibbi, and southern parts of Khyber Pakhtunkhwa mainly around the Indus River. The fog conditions prevailed in the mid of October over the agricultural plains of Punjab and Sindh province and become denser during the daytime in November and December whereas Smog prevailed in the metropolitan city of Lahore and adjoining areas from 15th of October to 30th November,2023

- **The maximum length of dry Spell**

The maximum length of dry days spell was experienced in some of the south western parts of Pakistan where it reached up to 243 days of no rainfall. The rainfall spell during November and December provided relief to the northern and central parts of the country whereas, Sindh and Balochistan received less rainfall (which is the climatology of the region).

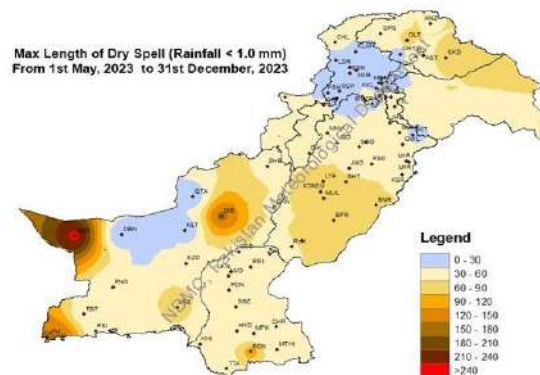


Figure-3a: Maximum length of dry spell up to December 2023 in Pakistan

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). 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.

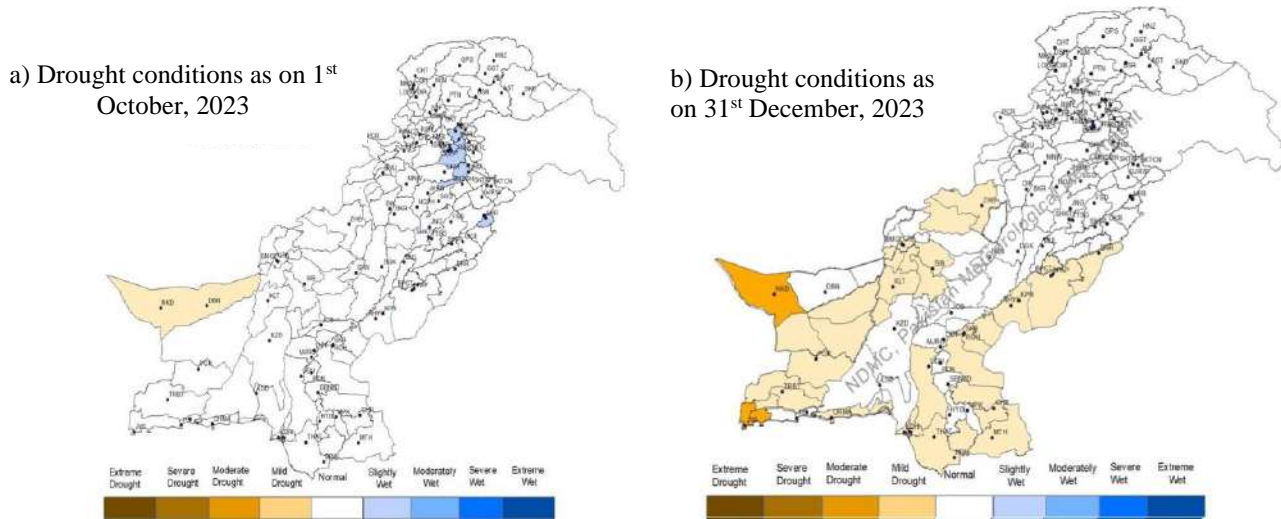


Figure-4 Drought conditions of Pakistan from October to December 2023

The normal conditions continued to prevail throughout the country especially in southern parts of Pakistan due to above-normal rainfall during monsoon and latterly in November 2023 the conditions were wetter in the country. During the end of the quarter, normal conditions are prevailing throughout the country

ii. Cumulative Precipitation Anomaly (CPA)

October and November are the transitional months between the summer & winter seasons, which are the characteristic of dry weather. These were the hottest month in coastal areas, whereas dry, cold weather starts to prevail in the remaining part of the country. During December, winter weather systems commonly known as “Western Disturbances” become active over the country. Three to four troughs of Westerly waves were experienced to pass across the upper Khyber Pakhtunkhwa, sub-

mountainous areas and snowfall over the hills. Generally, the northern half of the country receives precipitation more frequently than the southern half under the influence of western disturbances. From October to December 2023, it was observed that Cumulative Precipitation Anomaly was positive in almost 65% area of the country, especially in the southern and northeastern parts except in some of the extreme northern regions, where it was negative. The daytime temperatures remained low and evapotranspiration was relatively stumpy as compared to the previous quarter. No significant moisture stress was observed in the country even though rainfall was slightly below normal. Some spells of rainfall brought significant relief to water stress areas and helped to eliminate the emerging drought conditions especially southern half of Pakistan.

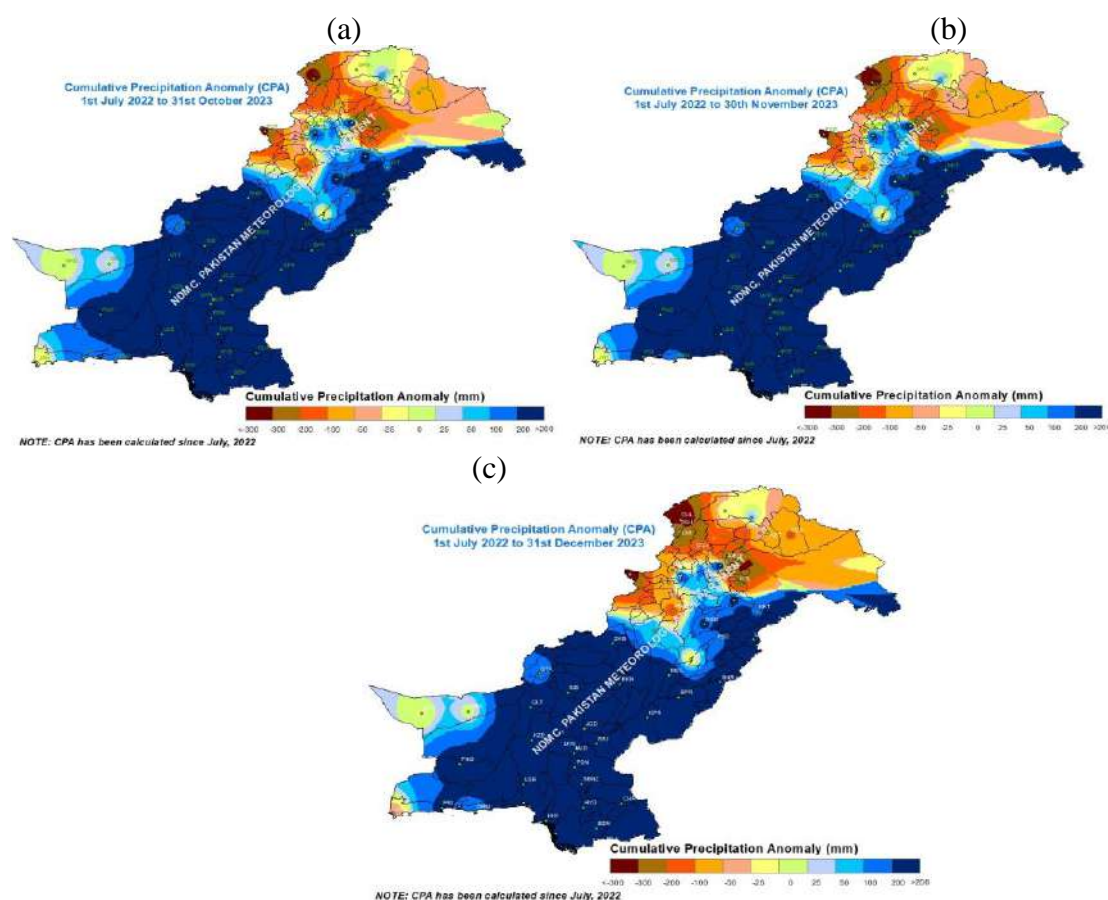
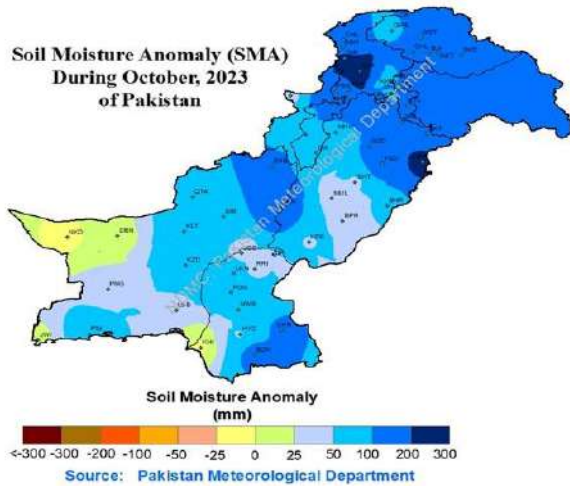


Figure-5 Cumulative precipitation anomaly during (Oct-Dec) 2023 in Pakistan

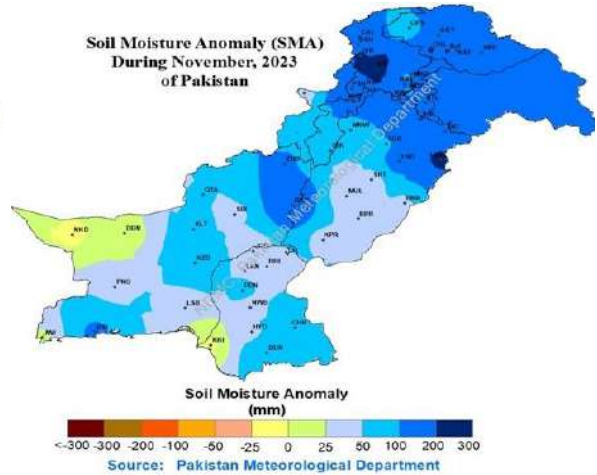
iii. Soil Moisture Anomaly (SMA)

It was observed that the amount of rainfall from October to December was below normal. However, the monsoon rainfall provided significant relief in soil moisture stress as shown in figure-6. It is predicted that rainfall will be below normal from January to March (2023) especially in the southern half of the country due to which soil moisture stress conditions may be observed and may impact the crop yield in rainfed regions.

a)



(b)



(c)

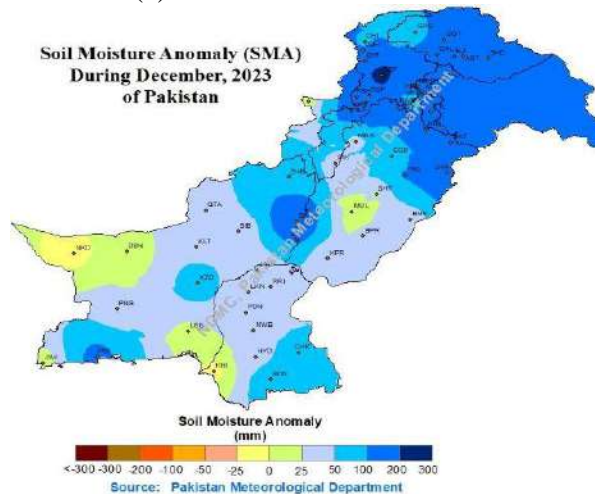


Figure-6 soil moisture anomaly during (Oct-Nov) 2023 in Pakistan

iv. 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 1378 feet while the maximum conservation level is 1550 feet Mangla has a dead level of 1040 feet and a maximum conservation level of 1242 feet. Due to well above normal monsoon rains, the water level situation is better in Tarbela however, the Mangala reservoir was below (10-20%) the average value. In addition, satisfactory conditions were observed in small dams in various parts of the country, especially in the barani areas. The percentage of average water level during October to December 2023 was calculated for both dams are shown below in figure -7;

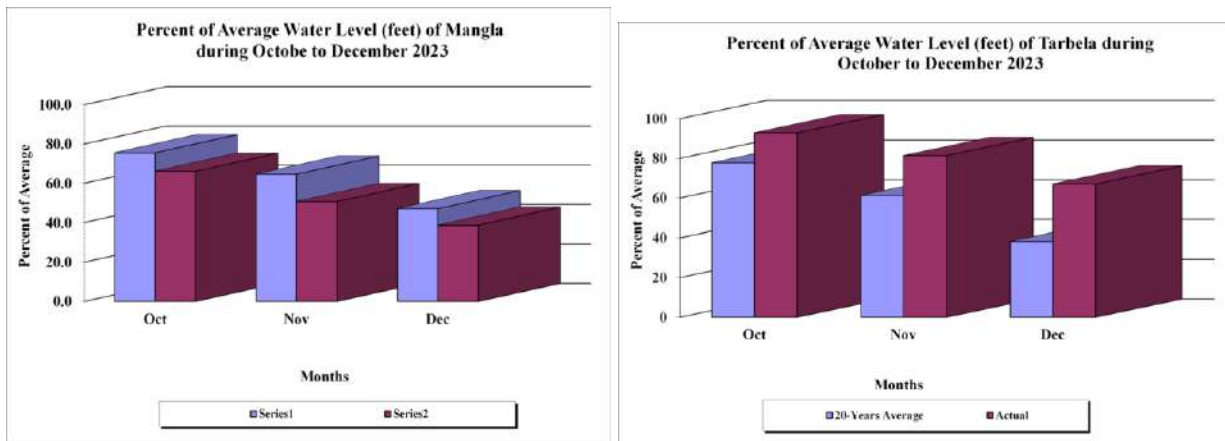


Figure-7 percent of the water level of Mangla and Tarbela during (Oct-Dec) 2023

5. District-wise impact of drought

No impacts of drought have been reported from any part of the country.

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

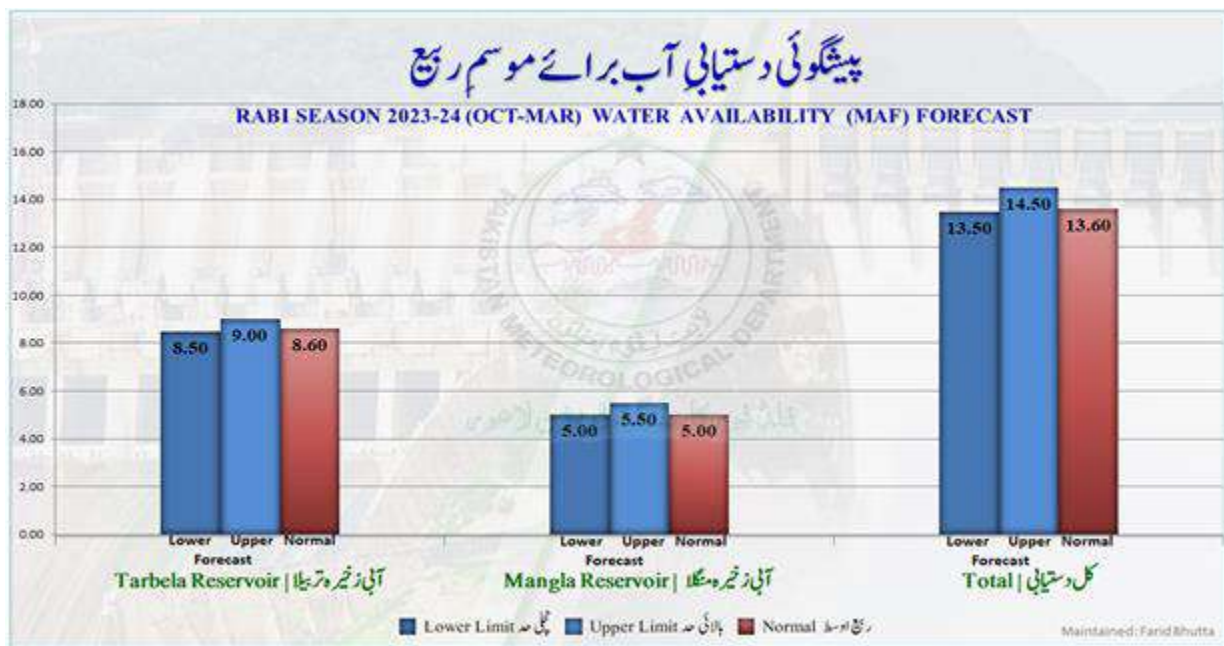


Figure-8 Rabi season forecast of Mangla and Tarbela Dams (2023-2024)

7. Seasonal forecast and its Impacts (JFM-2024)

Overall, a tendency for **normal to slightly below normal precipitation** is likely over the country with maximum negative departure over northern parts. Northern Punjab, upper Khyber Pakhtunkhwa, Kashmir, and Gilgit-Baltistan may receive slightly below normal precipitation whereas southern Punjab, most parts of Balochistan and Sindh are expected to receive nearly normal precipitation during the forecast season. The temperatures are expected to remain above normal over northern parts of the country; slightly above normal over western to south-western parts while nearly

normal over eastern parts with a tendency towards below normal night time temperatures over southwestern parts during the forecast season

- Frequent foggy conditions are likely to prevail in most of the plains areas of the country from January to mid of February, affecting crop growth and transportation in the country.
- Due to prolonged dry and foggy conditions and below-normal temperatures, energy demands will increase during the extreme winter months.
- Due to frequent frost in central and upper Punjab during January, affecting the growth of seasonal vegetables, fruits and seeds during the period.
- High temperatures could shorten the Rabi crop season in Sindh and Punjab.
- Less water will be available in river beds

8. Government reactions to drought

NDMC is continuously monitoring drought situations over the country and keeping the stakeholders and general public updated by issuing drought information on a fortnightly, and monthly 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. 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 neighbouring countries like India. Therefore it is the need of the hour to build large and small dams in catchment areas especially 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 especially to fulfill 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 may reduce unemployment in the country.

10. Acknowledgement

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

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