# Pakistan Meteorological Department

# Drought Bulletin of Pakistan
# July-September 2022

## National Drought Monitoring Centre
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# Drought Bulletin
# <u>July – September ,2022</u>

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# Quarterly Drought Bulletin
## July – September ,2022

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 country lies between semi arid to very humid. Some regions of the country in each seasons, remain drastically dry and area is always vulnerable to drought. If subsequent seasons fail to generate significant precipitation, the drought conditions then are sure to take the vulnerable regions in the grip. All the provinces of Pakistan have a history of facing major droughts in the past.

Drought differs from other natural disaster (e.g. flood, 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. 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 the damages that result from other natural hazards. Consequently, drought affects more people than any other environmental hazard.

Unfortunately, no organization was dealing with the drought issues existing in Pakistan and the responses to drought for the distressed economic and social sector, whenever such situation arose, were taken on emergency and on adhoc basis. It was thus inevitable need of the time and Pakistan Meteorological Department (PMD) took an initiative to establish 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 drought situation in the country and issue advisory before time. Its national centre is in Islamabad while four Regional Drought Monitoring Centers (RDMC's) are in Lahore, Karachi, Peshawar and Quetta. These four RDMC's cover those regions which come under their jurisdiction. These centers serve as a hub for the monitoring, collection, consolidation and analysis of drought related data from all the possible

sources in the country.  In order 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 Rainguages at districts level in four provinces as shown in figure-1.
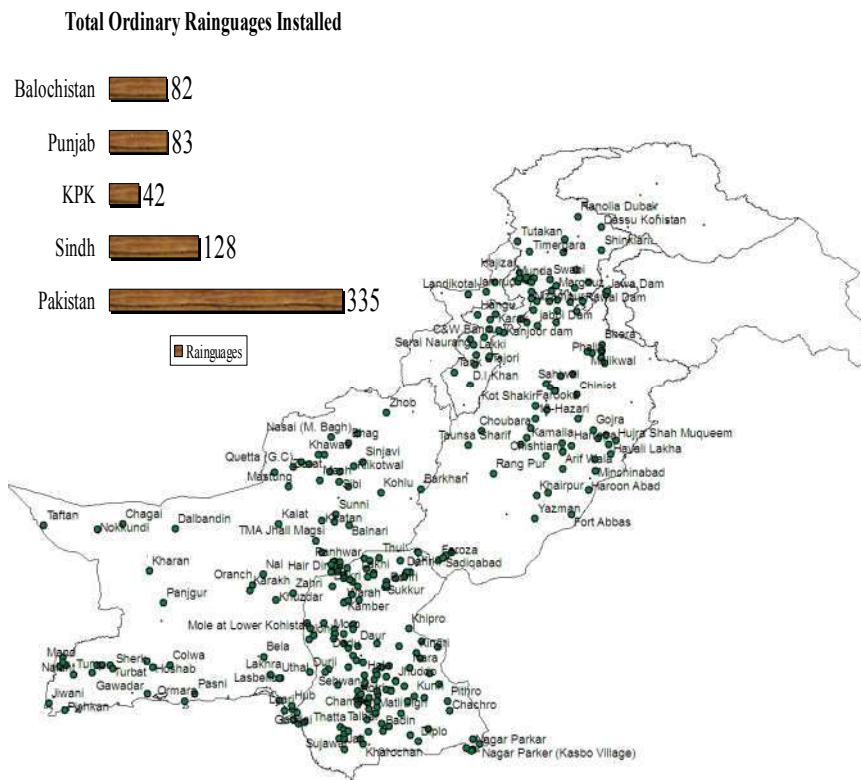


Figure-1 Rain-gauges Network of Pakistan by NDMC

NDMC is monitoring the water level situation of small dams also in Barani areas of the country. NDMC using 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 fortnightly, monthly, quarterly and annually drought bulletins of the country. These bulletins are used by NGO's and National Disaster Management Authority (NDMA).

## 2. **Historical Background.**

The Indian sub-continent is predominantly characterized by a tropical monsoon climate and 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 monsoon. There are two rainfall systems operating in the region (a) southwest or summer monsoon and (b) northeast or the winter monsoon.

Fortunately Pakistan also falls in this region which receive 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, summer monsoon accounts 60 to 70% of the annual rainfall during July to September (Chaudhry, 1992). There is a large variability in the monsoon rainfall on both space and time scales.

Droughts in Pakistan region are mainly due to failures of rains from 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 country. The study conducted at 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 past sixty years (1951-2010) different intensity (mild to extreme) of drought were experienced in the country i.e. 31 in Sindh,23 in Balochistan,22 in Punjab and 18 in Khyber Pakhtunkhwa. The longest episode of 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 and 2003-04, 2009, 2014 and 2018 while Balochistan had 1952,1963-64, 1965, 1968, 1970-71, 1983-84, 1987-88, 1999-2002,2004 and 2006, 2009 and 2018. By analyzing the historical data recorded (1951-2010), the most severe drought years has been identified i.e. 1952, 1969, 1971, 2000, 2001, and 2002 over Pakistan. Over more than hundred year's period between 1871-1988, 11 out of 21 drought years were El Nino years.

## 3. **Monsoon 2022**

- ### **Rainfall Distribution (July-September) 2022**

During Third quarter of the year (July-September) 2022, Very above normal (176.96%) precipitation was observed over Pakistan. During the quarter high temporal and spatial variable

precipitation was observed. Normally, July and August are the wettest months in the country and this year, however very much above normal rainfall was observed during July and August 2022 throughout the country especially Sindh and Balochistan province. However, monsoonal rainfall was below normal in September in the country. The evaporation rate was less as compare to the previous quarter.
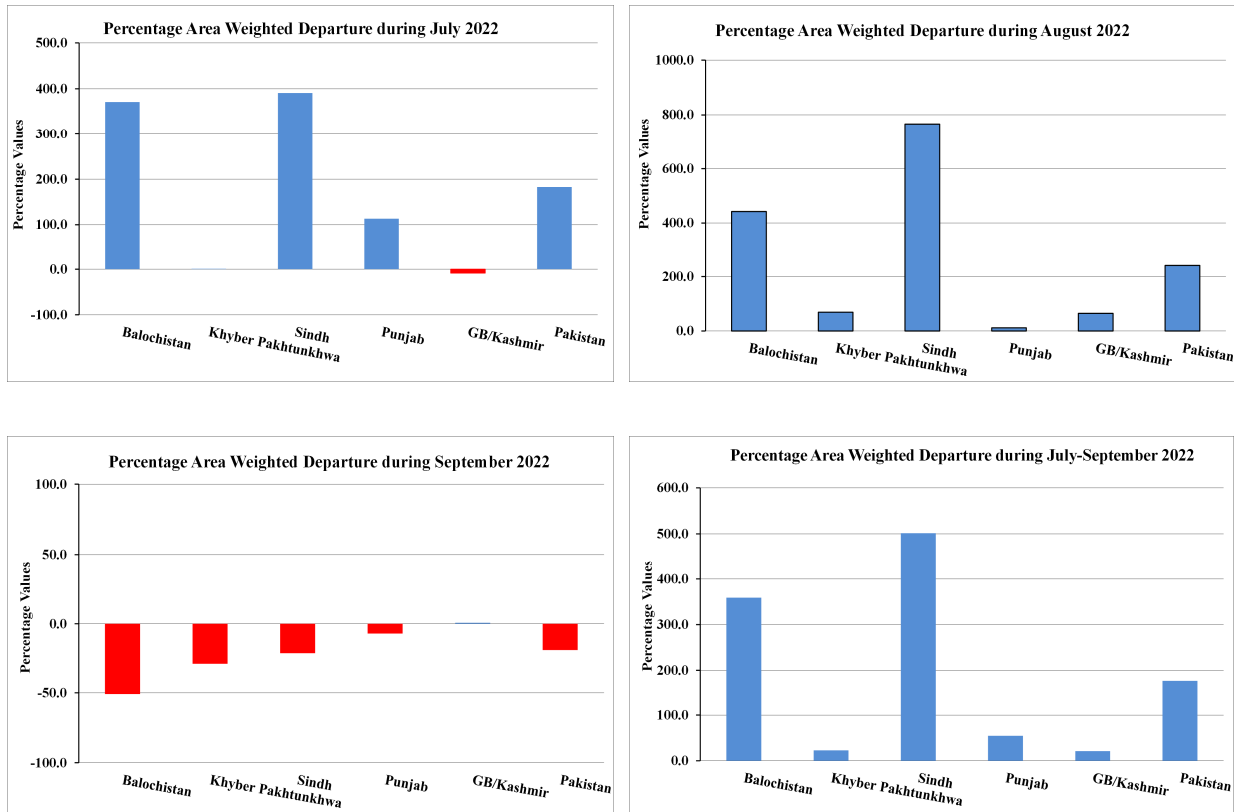


*Note: Normal of 1981-2010 is used to calculate rainfall departure*

Figure-2 Percentage departure of rainfall during (July-September) 2022

During July 2022, very much above normal (182.76%) rainfall was received in the country with maximum the highest positive departure in Sindh (390.89%), Balochistan (371.04%) and Punjab (113.25%). The rainfall was near to normal in Khyber Pakhtunkhwa (0.99%) and Gilgit-Baltistan and Kashmir (-8.46%). During August 2022, rainfall was again very much well below normal (240.78%) in Pakistan. The maximum rainfall positive departure was observed in Sindh (766.56%), Balochistan (442.25%) whereas it was highly above normal in Khyber Pakhtunkhwa (68.98%) and Gilgit-Baltistan and Kashmir (64.70%). Moreover, it was near to normal in Punjab (11.41%). During September, 2022, the amount of rainfall was slightly below normal (-18.72%) in the country with maximum negative departure in Balochistan (-50.97%), Khyber Pakhtunkhwa (-28.50%), Sindh (-20.99%) and it was near to normal in Punjab (-7.02%) and Gilgit-Baltistan and Kashmir (0.73%).

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The figure-2 shows percentage area weighed departure rainfall occurred during (July-September) 2022. Viewing the rainfall distribution on province basis, it was well above normal in Sindh (501.77%), Balochistan (359.18%) and above normal in Punjab (54.49%), Khyber Pakhtunkhwa (22.89%) and Gilgit-Baltistan and Kashmir (21.29%). The high rainfall (July to September) created flood situation in the southern Pakistan which helped to eliminate the prevailing drought conditions over Sindh, Balochistan and southern Punjab. However, due to inundation water conditions it will be great hinderers to carry out the agriculture activity in the country. The spatial distribution of monthly and seasonal analysis of Pakistan is as shown below in figure-3.
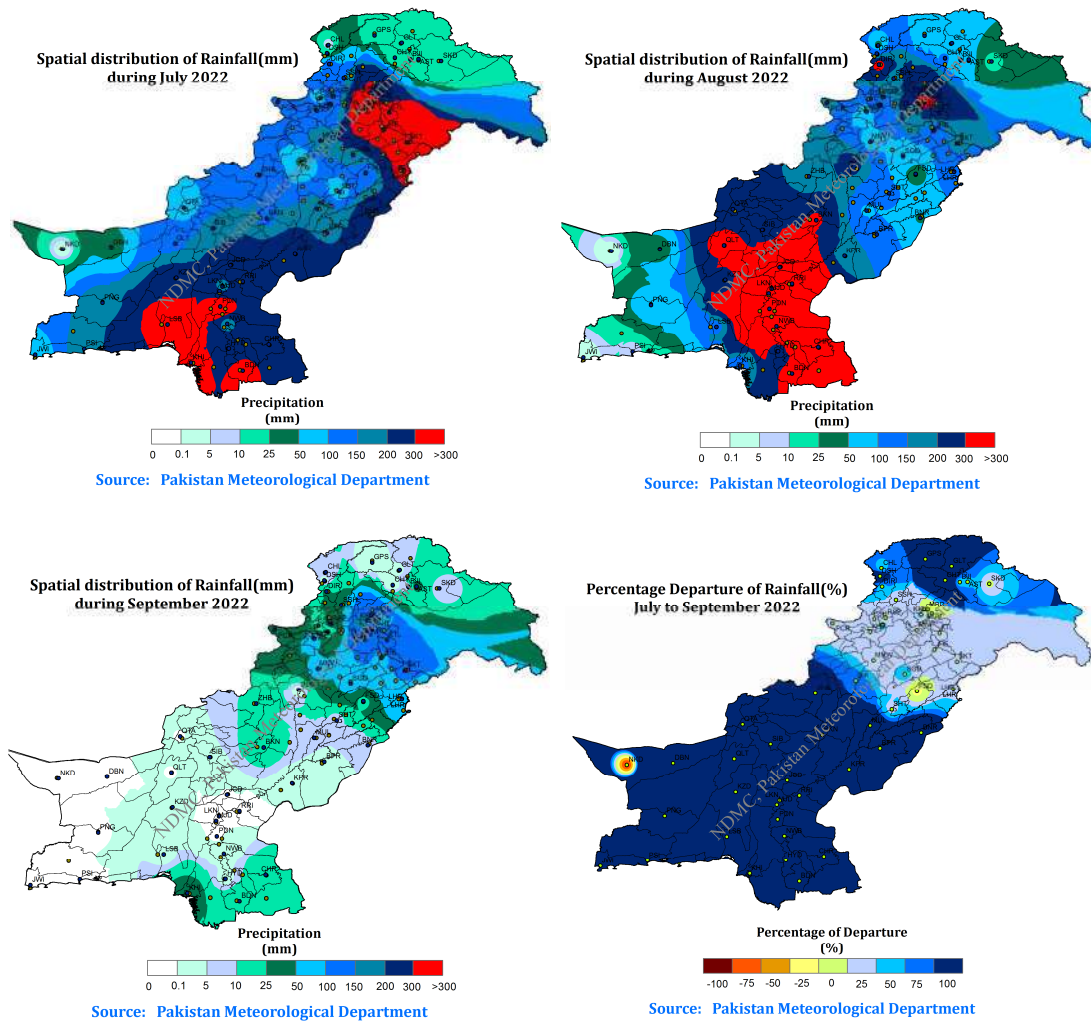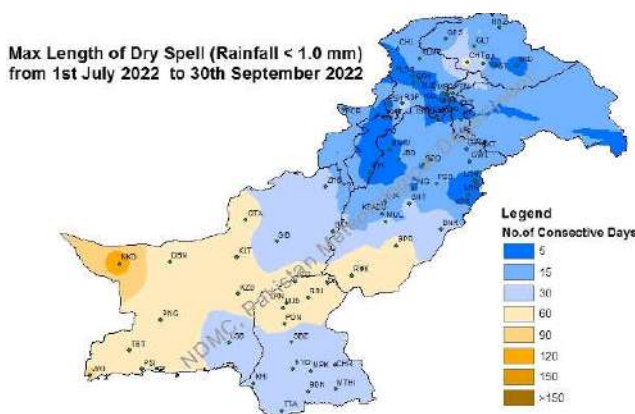


Figure-3 Spatial distribution of rainfall during (July-September) 2022

- ***Maximum Length of Dry days***

The dry days termed as when the amount of rainfall is below 1 mm. It is a good tool to monitor the drought onset and its propagation. The maximum length of dry days has been

calculated since July 2022 for the whole country. The results show that maximum length of dry spell has been observed in Balochistan (Fig-3a).



Source: National Drought Monitoring Center-PMD-Islamabad

Figure-3a Spatial distribution of maximum length of dry spell.

- **Monthly Highest Rainfall**

i. **July 2022**

| Chief amounts of monthly rainfall recorded across Pakistan during July2022 | | | | | |
|---|---|---|---|---|---|
| S. No. | Stations | Rainfall (mm) | S. No. | Stations | Rainfall (mm) |
| 1 | Masroor | 606.0 | 11 | Lasbela | 404.7 |
| 2 | Islamabad, Airport | 573.3 | 12 | Mangla | 391.2 |
| 3 | Padidan | 535.5 | 13 | Jhelum | 383.7 |
| 4 | Bandi Abbaspur | 524.0 | 14 | Chakwal | 383.6 |
| 5 | Gujranwala | 494.0 | 15 | Kotli | 360.0 |
| 6 | Haraman | 469.0 | 16 | Murree | 356.0 |
| 7 | Takht Bai | 456.2 | 17 | Balakot | 352.4 |
| 8 | Mardan | 435.7 | 18 | Kamra Airbase | 349.0 |
| 9 | Gujrat | 424.0 | 19 | Kasur | 344.5 |
| 10 | Sialkot Cantt | 423.1 | 20 | Buner | 340.7 |

ii. **August 2022**

| Chief amounts of monthly rainfall recorded across Pakistan during August 2022 | | | | | |
|---|---|---|---|---|---|
| S. No. | Stations | Rainfall (mm) | S. No. | Stations | Rainfall (mm) |
| 1 | Padidan | 1228.5 | 11 | Lahore | 437.0 |
| 2 | Mohenjo Daro | 779.5 | 12 | Rohri | 420.0 |
| 3 | Larkana | 738.3 | 13 | Murree | 402.5 |
| 4 | Sakrand | 617.0 | 14 | Sukkur | 377.5 |
| 5 | Khairpur | 615.3 | 15 | Dir | 361.0 |
| 6 | Tando Jam | 603.0 | 16 | Kalat | 361.0 |
| 7 | Chhor | 503.9 | 17 | Dadu | 321.0 |

| 8 | Jacobabad | 493.0 | 18 | Badin | 307.5 |
|---|---|---|---|---|---|
| 9 | Shaheed Benazirabad | 488.2 | 19 | Mirpur Khas | 304.0 |
| 10 | Fort Munro | 447.6 | 20 | Garhi Dupatta | 298.3 |

### iii.     September 2022

| Chief amounts of monthly rainfall recorded across Pakistan during September 2022 ||||||
|---|---|---|---|---|---|
| S. No. | Stations | Rainfall (mm) | S. No. | Stations | Rainfall (mm) |
| 1 | Kakul | 229.0 | 11 | Sargodha City | 102.2 |
| 2 | Islamabad (Saidpur) | 171.0 | 12 | Tirah (KP) | 98.2 |
| 3 | Muzaffarabad City | 166.0 | 13 | Malam Jabba | 98.0 |
| 4 | Bandi Abbaspur | 149.0 | 14 | Dhulli (Punjab) | 92.8 |
| 5 | Kotli | 144.0 | 15 | Jhelum | 89.8 |
| 6 | Buner | 129.5 | 16 | Kamra Airbase | 86.4 |
| 7 | Lahore (Lakshmi) | 125.0 | 17 | Pashat-Bajaur (KP) | 86.4 |
| 8 | Rawalakot | 116.2 | 18 | Murree | 85.7 |
| 9 | Sialkot Cantt | 111.1 | 19 | Mangla | 85.0 |
| 10 | Balakot | 103.0 | 20 | Hajira | 73.4 |

## 4.     Drought tools

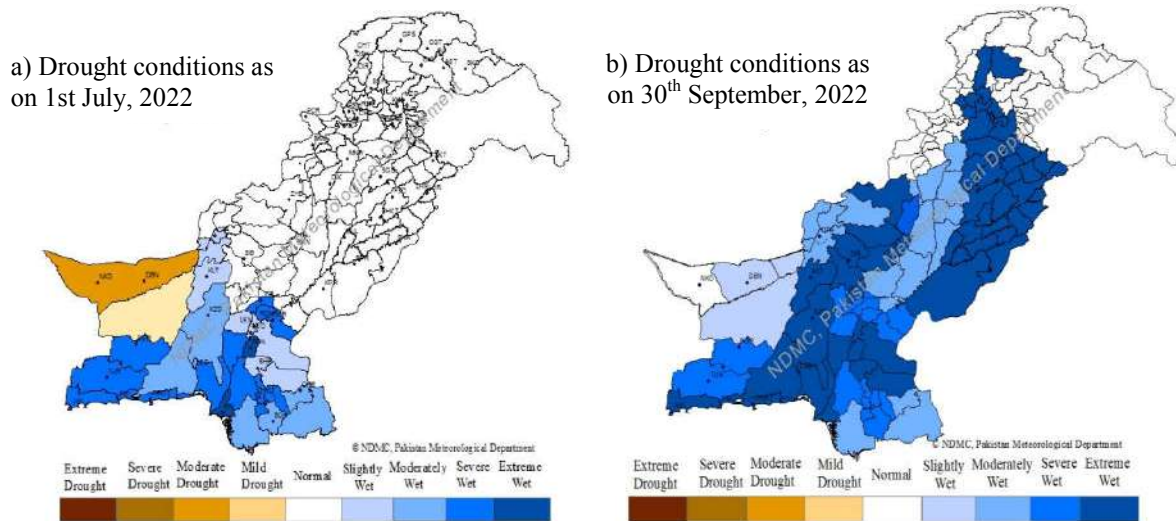### I.     Standardized Precipitation Index (SPI)



Figure-4 Drought conditions of Pakistan during (July-September) 2022

The Standardized Precipitation Index (SPI) was developed for the purpose of defining and monitoring 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. Here we are showing drought conditions during the quarter in the country. Mild to moderate drought prevailed in southwestern Balochistan before start of monsoon season. However, due to good amount of monsoon rainfall, the significant change was observed especially in Sindh and Balochistan province whereas it has become extremely wet. Similarly, the drought conditions have been eliminating due to flooding.
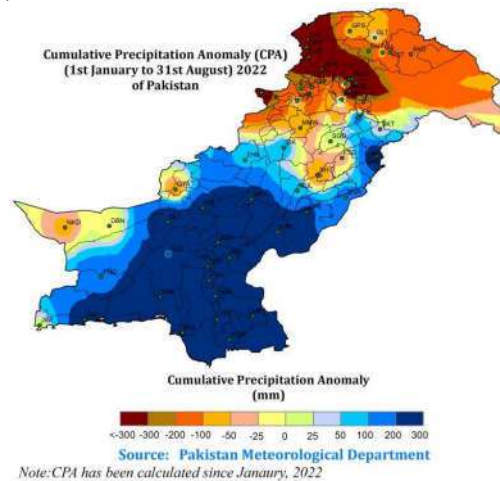
## II. Cumulative Precipitation Anomaly (CPA)

Monsoon precipitation helped to reduce the cumulative precipitation anomaly and showering wet conditions for July to September especially in southern half of the country. The CPA shows water deficit conditions in north western parts of country due to below normal rainfall since January 2022.
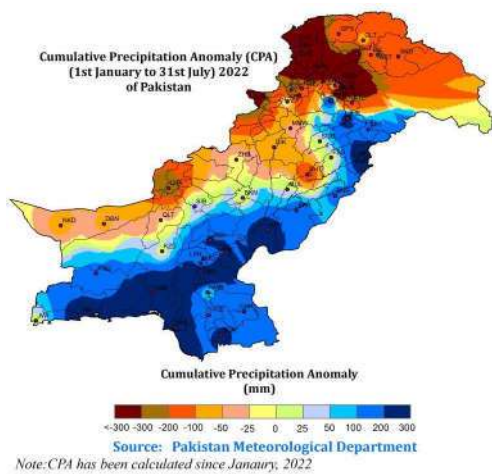
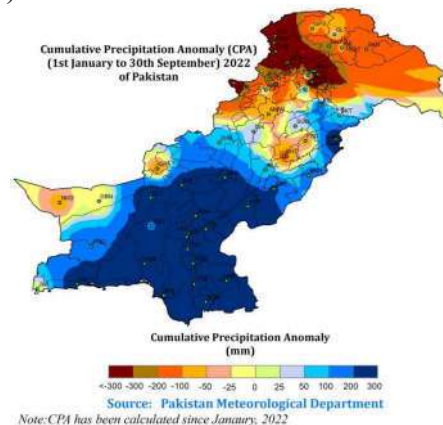(a)                                                      (b)



(c)



Figure-5 Cumulative precipitation anomaly during (July-September) 2022 of Pakistan.

## III. Soil Moisture Anomaly (SMA)

Due to the very much above normal rainfall during July-September, 2022 in the country, most of the moisture stress districts of Khyber Pakhtunkhwa, Potohar region and southeastern Sindh has been eliminated (figure-6). Soil moisture conditions in north eastern Punjab including Barani areas and central & north western parts of the country were towards wetness. It was predicted that rainfall will be above normal during July-September 2022 due to which soil moisture conditions were slightly better in the rain-fed as well as in the agricultural plains of the country. This above normal rainfall caused the flood like situation in southern parts of the country. Overall, soil moisture conditions are good in most parts of the country.
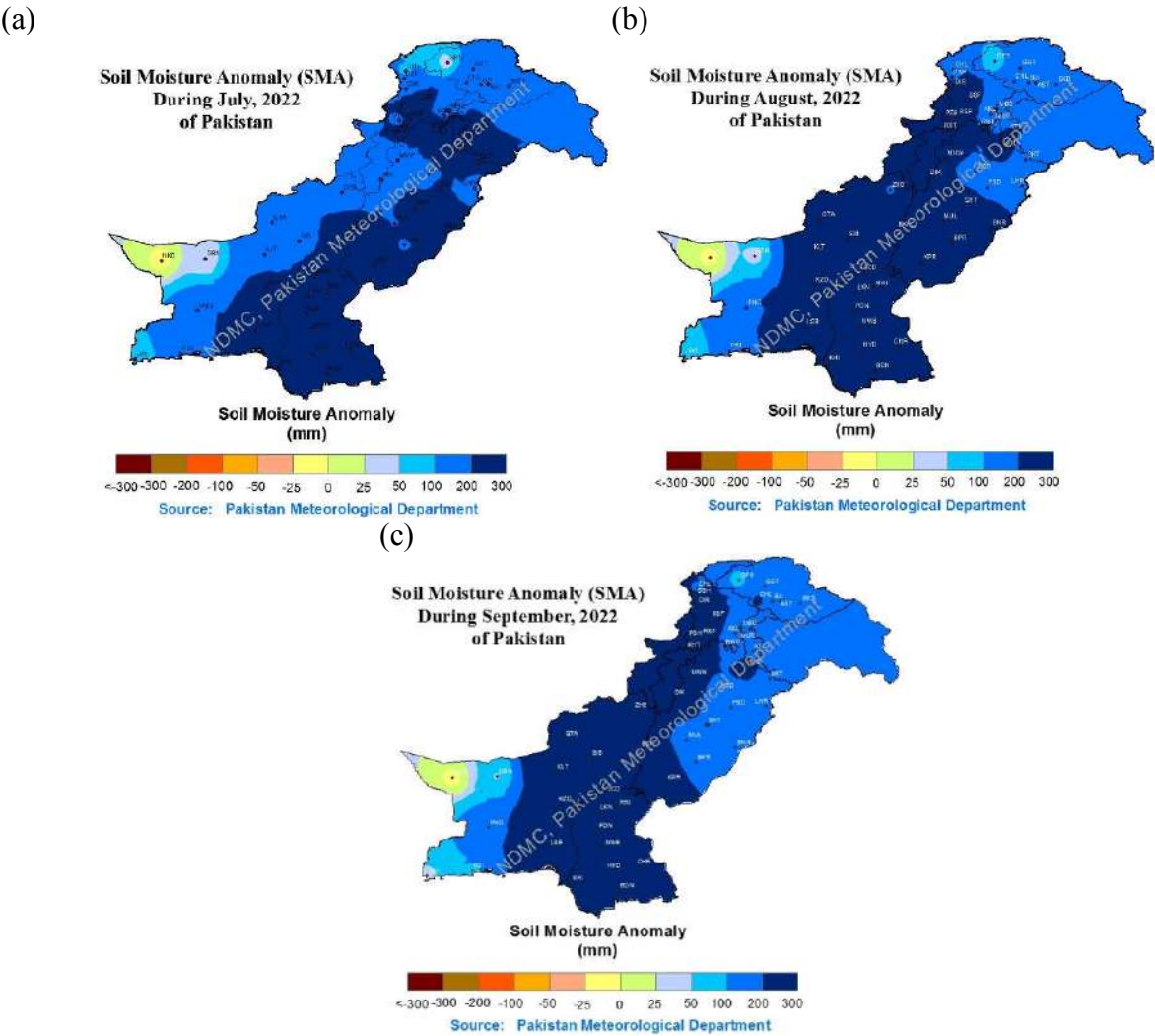
(a)　　　　　　　　　　　　　　　　　　(b)

(c)

Figure-6 soil moisture anomaly during (July-September) 2022 of Pakistan

## IV.    <u>Water Level of Reservoirs</u>

Pakistan has two main reservoirs of water in the form of dam i.e. Tarbela and Mangla. The dead level of Tarbela is 1386 feet while maximum conservation level is 1550 feet while Mangla has dead level of 1050 feet and maximum conservation level of 1242 feet. Due to monsoon rains as well snow and glaciers melting Tarbela reservoirs was filled to its maximum capacity whereas the Mangla reservoir was not completely filled. Water storage sources of dams are rainfall and snow/glaciers melting from May to September. Water stored during this period is a major factor of irrigation water supply and power generation in the next Rabi season 2022-23. Water accumulation in Tarbela and Mangla reservoirs started in early July 2022.  In addition, small dams in various parts of the country were also filled to their capacity that would help to boost agriculture and improve socio-economic activities in the country. However, the small dams i.e., Khanpur and simly located near Islamabad are half filled due to low rainfall in their catchments. Percentage of average water level during monsoon 2022 was calculated for both major dams are shown below;
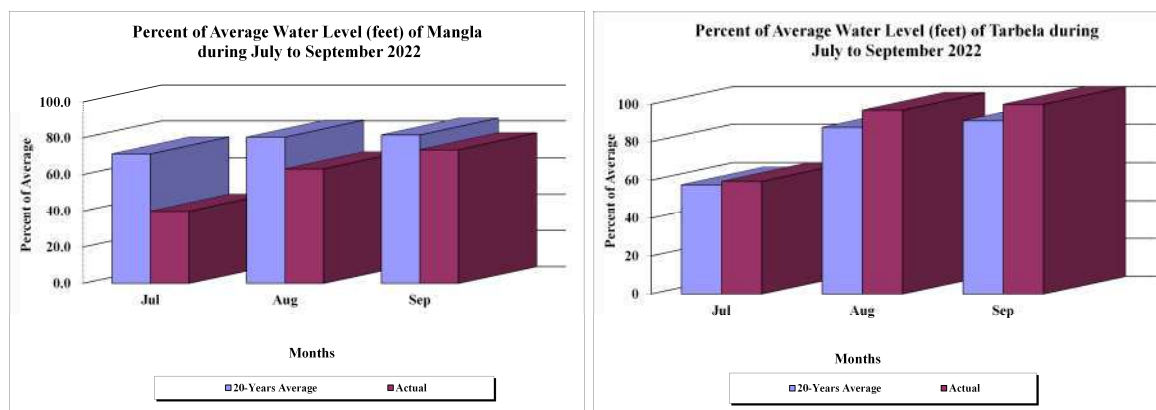


Figure-7 Percentage average water level (feet) of Mangla and Tarbela during (July-September) 2022 of Pakistan

Water availability during Rabi season (2022-23) at Mangla dam is forecasted in the range of 4.0 to 5.0 MAF and normally it remained 5.0 MAF. Similarly, Tarbela dam is forecasted in the range of 8.0 to 9.0 MAF and normally it remained 8.6 MAF. Total water availability is forecasted in the range of 12.5 to 14.0 MAF at both dams where it normally remains 13.6 MAF as shown in fig-9. These forecast shows that water availability for agriculture activity will be satisfactory.
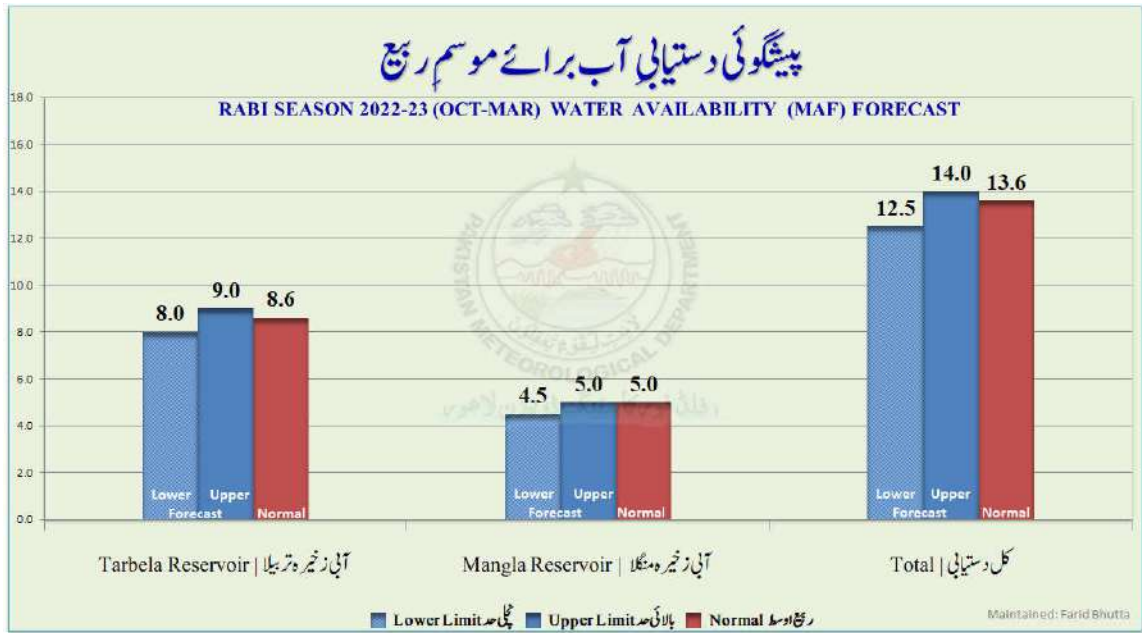
Figure-8 Rabi Season (forecasted) water availability (MAF) of Mangla and Tarbela during (October-March) 2022-23 of Pakistan.

## V.   **Water Discharge**

| Average water discharge at Kabul during Kharif season | | |
|---|---|---|
| S.No | Years | Water discharge (MAF) |
| 1 | Last 20 | 17.22 |
| 2 | Last 10 | 14.77 |
| 3 | Last 5 | 17.94 |

| Average water discharge at Tarbela during Kharif season | | |
|---|---|---|
| S.No | Years | Water discharge (MAF) |
| 1 | Last 20 | 51.78 |
| 2 | Last 10 | 48.28 |
| 3 | Last 5 | 50.27 |
| 4 | Average | 50.53 |

This discharge indicates that this flow is gradually decreasing

| Average water discharge at Mangla during kharif season | | |
|---|---|---|
| S.No | Years | Water discharge (MAF) |
| 1 | Last 20 | 17.01 |
| 2 | Last 10 | 13.78 |
| 3 | Last 5 | 15.51 |
| 4 | Average | 17.28 |

This discharge indicates that this flow is gradually decreasing

**5.** **District wise impact of drought**

Due to very much above normal seasonal rainfall, no negative impacts of drought have been reported in the country during July to September, 2022. In monsoon season, above normal rainfall was observed in most parts of the country especially Sindh and Balochistan, which eliminated the drought conditions in these regions.

**6.** **Government reactions to drought**

All functionaries of the state machinery remained engaged in providing relief to earlier drought prone regions of Balochistan and Sindh. No significant impact of drought during the quarter however flood was more damaging for life, crops and infrastructure. So, the intervention was made earlier at official level by provincial government as well as PDMA. NDMC is closely monitoring drought emergence in the country and this information is updated on a fortnightly/monthly basis at the PMD website: http://www.pmd.gov.pk/ndmc/index.htm

**7. Recommendations**

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 dams for storing water to manage the water needs to avoid drought.
- The water will also be helpful in generating hydropower electricity which is essential requirement of country and reduce the unemployment in the country.

**8. Acknowledgement**

National Drought Monitoring Centre (NDMC), Pakistan Meteorological Department, Islamabad acknowledges SUPARCO for sharing the information.

**9. References:**

- 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.
- 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.

- 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.

- 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.

- 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.

- Chaudhry, Q.Z.1992: Analysis and Seasonal prediction of Pakistan Summer Monsoon Rainfall, Ph.D. Thesis, Univ. of Philippines, Quezon City, Philippines.

- 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/

- Indian Meteorological Department (IMD), 2009, Unified Response Strategy, drought Bulletin-1 September 2009.

- 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.