

Pakistan Meteorological Department

Drought Bulletin of Pakistan



October-December 2021

National Drought Monitoring Centre

Pakistan Meteorological Department

Sector H-8/2, Islamabad – 44000, P.O.Box#1214,

Phone # +92-51-9250598, Fax # +92-51-9250368

Website: www.pmd.gov.pk,

Drought Bulletin

October – December, 2021

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Patron in Chief: Dr. Azmat Hayat Khan, Chief Meteorologist, National Drought Monitoring Centre(NDMC), Islamabad.

Chief Editor: Mr. Jan Muhammad Khan, Director, NDMC, Islamabad
Editor: Dr. Shahzada Adnan, Meteorologist, NDMC, Islamabad

Quarterly Drought Bulletin

October – December, 2021

By

National Drought/Environment Monitoring & Early Warning Centre,
Pakistan Meteorological Department,
Islamabad

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 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 the 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 situation arose, were taken on an emergency and ad-hoc basis. It is a thus 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 (RDMC’s) are in Lahore, Karachi, Peshawar and Quetta. These four RDMC’s 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 Raingages at the districts level in four provinces as shown in figure-1.

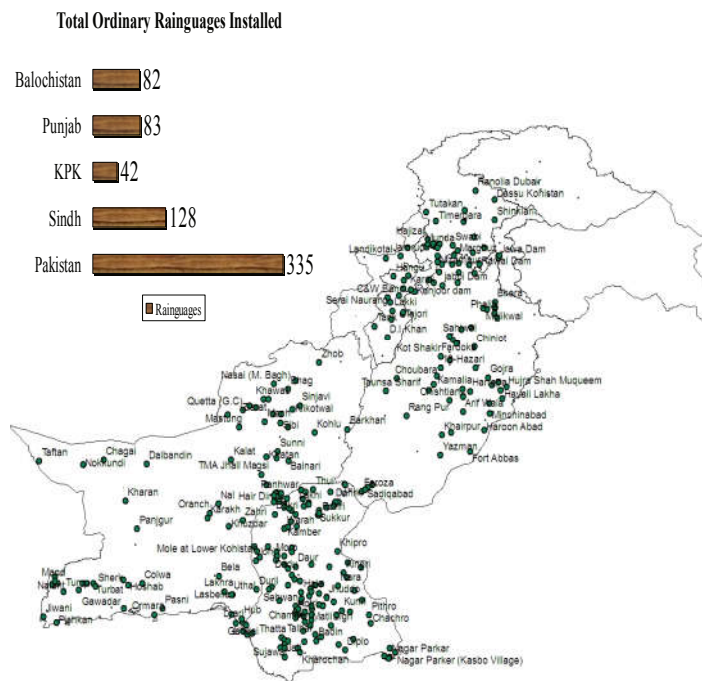


Figure-1 Rain-gauges Network of Pakistan by NDMC

NDMC is monitoring the water level situation of small dams also in 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 NGO's and National Disaster Management Authority (NDMA) for the utilization of drought advisories/bulletin 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 receive 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 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 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. The long term data analysis of the past sixty years (1951-2010) different intensities (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 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 and 2006, 2018. 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 rains 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 flood, urban flood, coastal flood and river flood).

3. Rainfall Distribution (Oct-Dec) 2021

During the last quarter of the year (Oct-Dec) 2021, normal to near normal (-10.79%) 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 2021, well above normal rainfall was observed in Punjab (261.14%) and Balochistan (234.90%), Gilgit-Baltistan and Kashmir (106.28%), whereas it was above normal in Khyber Pakhtunkhwa (48.39%) and Sindh (21.50%).

The country analysis shows well above normal rainfall (140.97%) was experienced during October 2021. In November 2021, the rainfall was well below normal (-100.0%) in Balochistan and Sindh while it was, -99.72% in Punjab, -99.53% in Gilgit-Baltistan and Kashmir and -89.49% in Khyber Pakhtunkhwa. The whole country received well below normal rainfall (-95.72%) during November 2021. The month of December 2021 was also recorded as the drier month of the quarter like November 2021 in most parts of the country in which well below normal rainfall (-71.5%) was received. During this month, rainfall was well below normal in Punjab (-88.1%), Balochistan (-75.0%), Khyber Pakhtunkhwa (-70.5%), Gilgit-Baltistan and Kashmir (-68.9%) whereas it was normal in Sindh (0.0%). The figure-2 depicts the percentage area weighed rainfall departure of different provinces of Pakistan occurred during (Oct-Dec) 2021. Viewing the quarterly rainfall distribution on a province basis, normal to near normal rainfall (-10.79%) was observed. During this period (Oct-Dec, 2021), rainfall was well normal in Khyber Pakhtunkhwa (-34.63%), Balochistan (-24.29%), Gilgit-Baltistan and Kashmir (-23.12%) and it was near normal in Sindh (-2.22%), and well above normal in Punjab (51.77%).

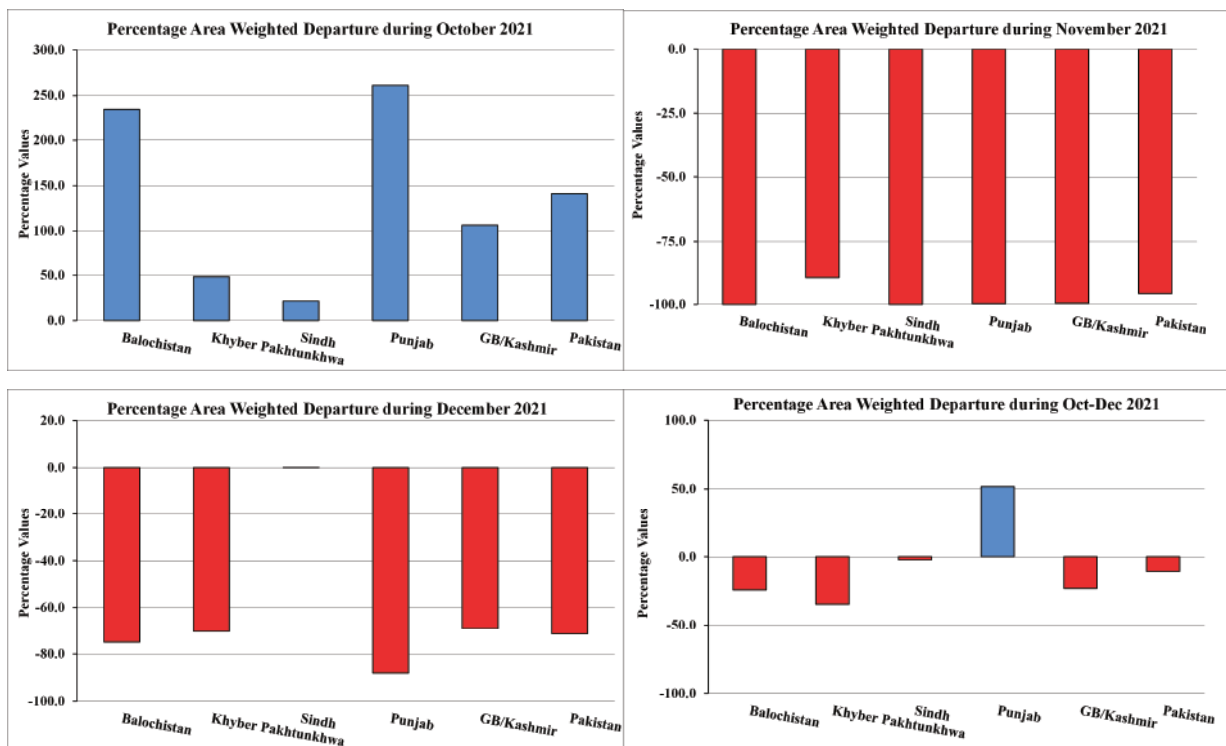


Figure-2: Percentage Area Weighted Departure of rainfall during (Oct-Dec) 2021

The rainfall pattern during October to December, set on by westerly disturbances, showed a systematic gradient from 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 the wheat crop. **La Niña is likely to continue through the Northern Hemisphere winter 2021-22 (~95% chance during January-March), with a potential transition during the spring 2021 (~50% chance of Neutral during April-June).** The monthly and seasonal analyses on a regional and country basis are as shown below in figure-3.

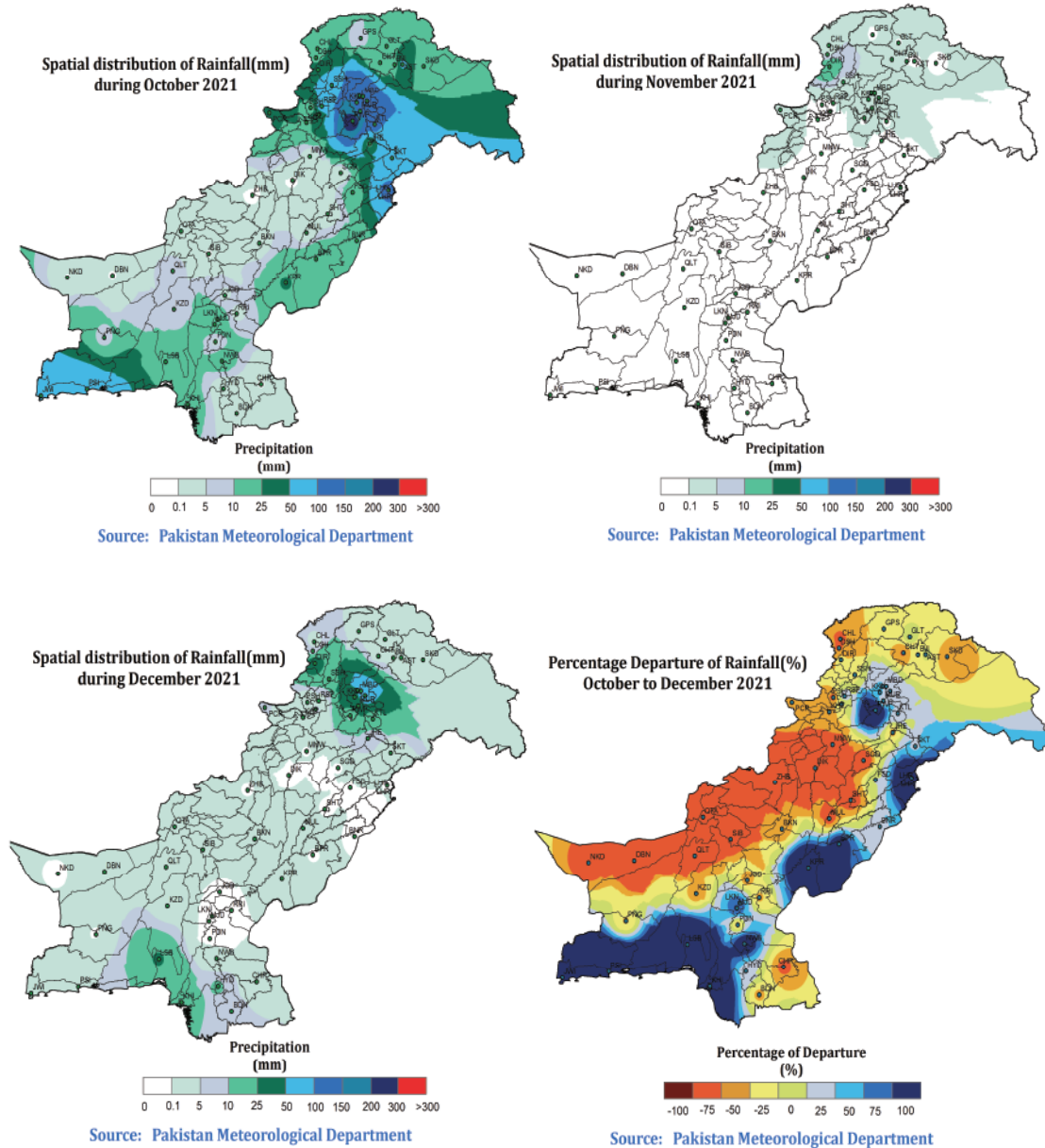


Figure-3: Spatial Distribution of rainfall during (Oct-Dec) 2021 of Pakistan

• **Chief amount of Rainfall**

During **October 2021**, 2-3 rainspells were observed throughout the country.

Chief amount of rainfall (mm) during October 2021					
Sr. No.	Station	Rainfall (mm)	Sr. No.	Station	Rainfall (mm)
1	Chaklala Airbase	257.8	11	Rawalakot	117.6
2	Chakothei	199.1	12	Mandibahauddin	117.5
3	Pashat-Bajaur	198.0	13	Dhulli	116.0
4	Balakot	171.0	14	Kotli	111.0
5	Haraman	157.4	15	Tandali	108.1
6	Kakul	152.7	16	Narowal	97.6
7	ChattarKalas	139.9	17	Muzaffarabad Airport	81.8
8	Murree	129.5	18	Jiwani	78.0
9	Garhi Dupatta	126.5	19	Buner	77.6
10	Shahdara	119.0	20	Risalpur	77.2

During **November 2021**, 2-3 rain spells were received mostly in the northern half of the country with light to moderate below normal rains.

Chief amounts of rainfall(mm) during November 2021					
Sr.No.	Station	Rainfall(mm)	Sr.No.	Station	Rainfall(mm)
1	Kalam	26.2	11	Deolian	3.3
2	Dir	24.0	12	Karachi	3.2
3	Pattan	16.0	13	Chitral	2.8
	Mirkhani	9.0	14	Pashat-Bajaur	2.8
5	Chakothei	6.4	15	BandiAbbaspur	2.5
6	Malam Jabba	5.0	16	Norowal	2.4
7	Tirah-Khyber	4.2	17	Ghari Dupatta	2.2
8	Saidu Sharif	4.0	18	Hajira	2.2
9	Dhulli	4.0	19	Rawalkot	2.0
10	Drosh	3.6	20	Haraman	1.5

During **December, 2021** 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 amounts of rainfall(mm) during December 2021					
Sr.No.	Station	Rainfall(mm)	Sr.No.	Station	Rainfall(mm)
1	Deolian (AJK)	83.6	11	Pashat-Bajaur (KP)	40.4
2	Tandali (AJK)	74.3	12	Kalam	33.2
3	Garhi Dupatta	72.5	13	Rawalakot	30.2
4	ChattarKalas (AJK)	60.8	14	Pattan	29.0
5	Muzaffarabad Airport	60.0	15	Murree	28.1
6	Malam Jabba	52.0	16	Karachi	27.0
7	Haraman (AJK)	50.2	17	Chakothei (AJK)	26.1
8	Balakot	48.0	18	Lasbela	26.0
9	Dir	44.0	19	Dhulli (AJK)	20.5
10	Kakul	41.5	20	Kamra Airbase	20.4

- **Temperature**

Night temperatures were below normal and day temperature remained below normal in November and December. The maximum temperature was observed below normal than the last year, while the minimum temperature was 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 2021 than 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 of time. The water vapors 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, southern parts of Khyber Pakhtunkhwa mainly around Indus River. The fog conditions prevailed in the mid of October over 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, 2021

- **The maximum length of dry Spell**

The maximum length of dry days spell was experienced in some of the southern parts of Pakistan where it reached upto 120 days of no rainfall. The rainfall spell during October to December provided a relief to the northern and central parts of the country whereas, Sindh and Balochistan received slightly less rainfall (which is the climatology of the region).

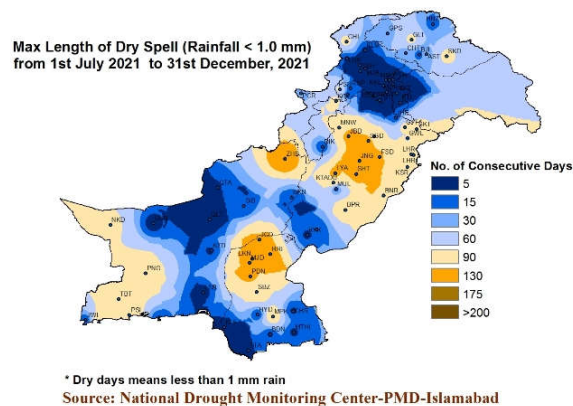


Figure-3a: Maximum length of dry Spell up to December 2021 of Pakistan

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.

The normal to wet conditions continued to prevail throughout the country especially in southern parts of Pakistan due to above-normal rainfall during October and November 2021 whereas the conditions are wetter in the northern half of the country. During the end of the quarter, normal conditions are prevailing throughout the country

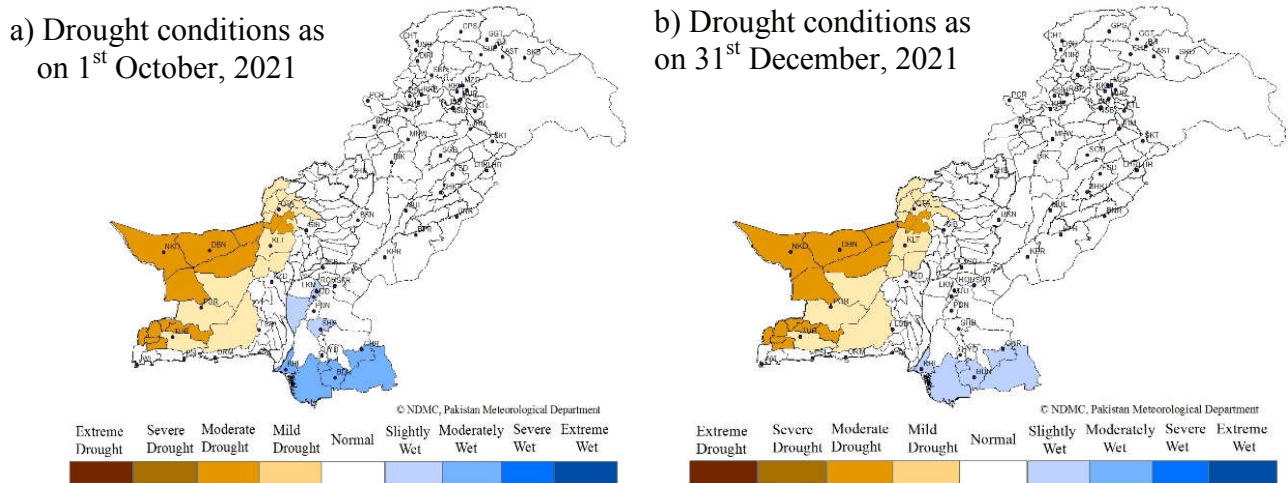


Figure-4 Drought conditions of Pakistan during October to December 2021

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 are 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 2021, it was observed that Cumulative Precipitation Anomaly was positive in almost 90% area of the country especially in southern and northeastern parts except 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 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.

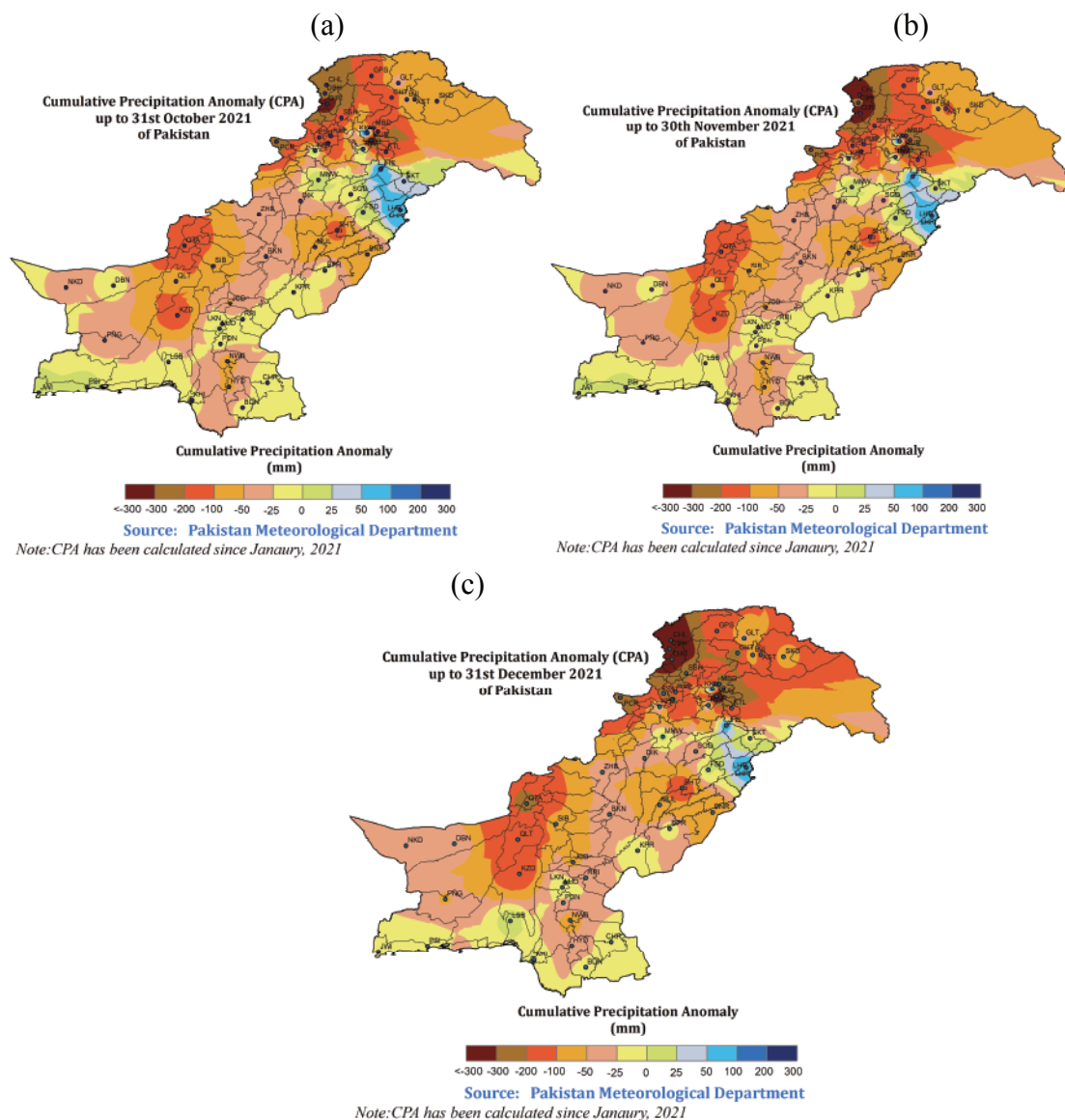
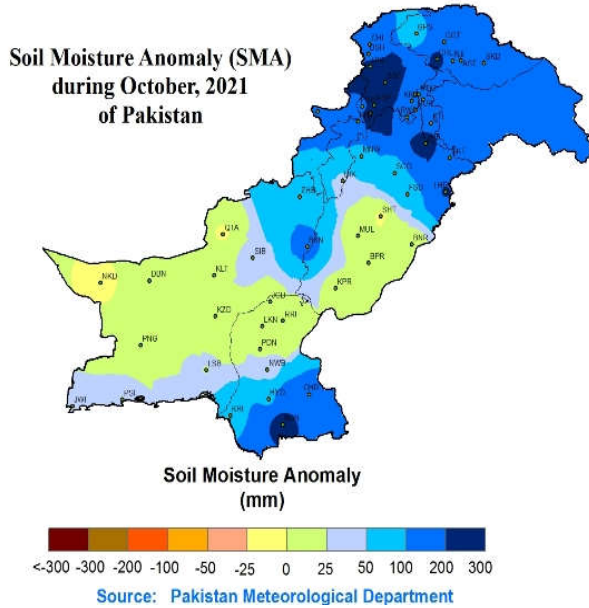


Figure-5 Cumulative precipitation anomaly during (Oct-Dec) 2021 of Pakistan

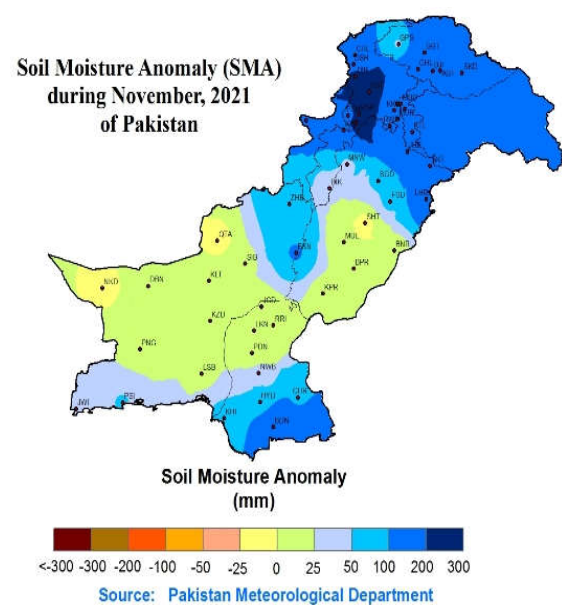
iii. Soil Moisture Anomaly (SMA)

It was observed that the amount of rainfall from October to December was slightly below normal but no significant soil moisture stress was observed as shown in figure-6. It is predicted that rainfall will be below normal from January to March (2021) especially in the southern half of the country due to which soil moisture stress conditions may be observed and it may impact the crop yield in rainfed regions.

a)



(b)



(c)

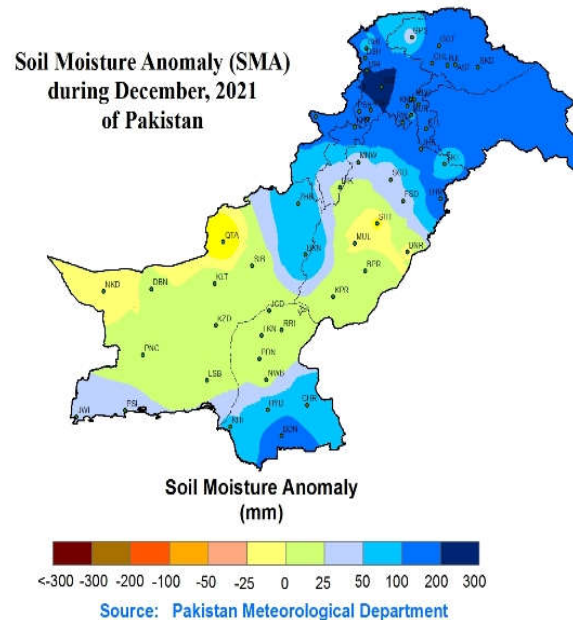


Figure-6 soil moisture anomaly during (Oct-Nov) 2021 of Pakistan

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 1378feet while the maximum conservation level is 1550feet while Mangla has a dead level of 1040feet and the maximum conservation level of 1242 feet. Due to normal to near normal monsoon rains, the water level situation is better in both major reservoirs than the previous year. In addition, satisfactory conditions were observed in small dams in various parts of the country especially in the barani areas. Percentage of average water level during October to December 2021 was calculated for both dams are shown below in figure -7;

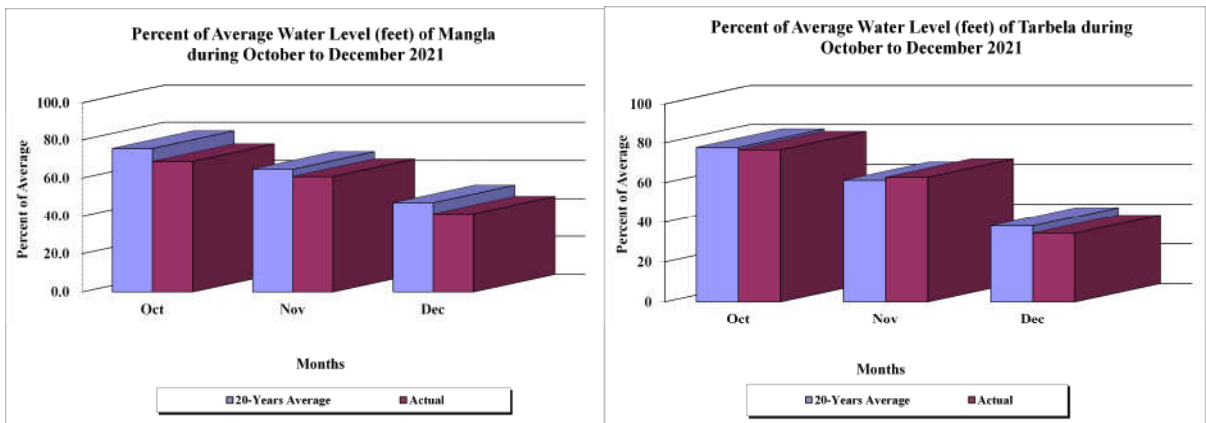


Figure-7 percent of water level of Mangla and Tarbela during (Oct-Dec) 2021

5. Agriculture

Agriculture is the main livelihood of about 70% population of the country. Due to the direct relationship between agriculture and water scarcity/drought, drought mapping data are of vital importance. Efforts are being made to inform farmers of the drought situation in a timely fashion for better utilization of data. Land preparation /sowing operation of Rabi crops started in the latter part of September, mainly for oilseeds and vegetables. The wheat sowing follows in late October-early December.

• Crop Conditions during Oct to Dec 2021.

• October-2021

- Sowing of Wheat generally started in October in Barani areas and lower Sindh that will gradually progress towards the upper parts of the country and will continue till the end of December. This year government has set a higher wheat production target to meet country wheat requirements.
- Cotton picking is at the terminal stage. Better yield and higher prices increased farmers' net margins. This may help to increase cotton yield in the coming years to meet textile

industry demand to boost textile exports. Favourable weather conditions and better crop husbandry measures increased per acre cotton yield from last year.

- Sugarcane crop is at maturity stage. Sugarcane crop growth was generally satisfactory during this year and the insect pest situation was also under control. Sugarcane productivity may increase this year mainly due to an increase in net crop area sown.
- Rice harvesting is in full swing, particularly in lower Sindh. Basmati Rice, however, will be harvested during November in the Kalar tract of Pakistan. Currently, rice is a promising crop for the farming community due to higher rice exports resulting in stable prices in the local market.

- **November/December 2021**

- Wheat crop sowing is in progress. Sowing of wheat generally started in October in barani areas and lower Sindh that is gradually progressing towards the upper parts of the country and will continue till the end of December.
- The cotton crop was at the terminal stage at the end of November. During the current Kharif season, the cotton crop showed better crop health than last year.
- Sugarcane crop is also at the maturity/harvesting stage. Sugar mills have started their operations in mid of November resulting in the stability of sugar prices.
- Rice harvesting, particularly of the basmati, got momentum during November. Rice was the main promising crop for this Kharif season. The Rice area was significantly increased this year.

6. District wise impact of drought

Due to normal seasonal rainfall in the country, the prevailing drought conditions in Sindh and Balochistan have been subsided. The situation in drought-prone districts of Sindh has become wet due to above-normal rainfall during September 2021 whereas the drought severity has been declined in the districts lying the southern Balochistan, especially near the coastal areas. However, the southwestern districts of Balochistan are faced mild to moderate drought from October to December 2021.

7. Rabi season forecast of Mangla and Tarbela Dams (2021-2022)

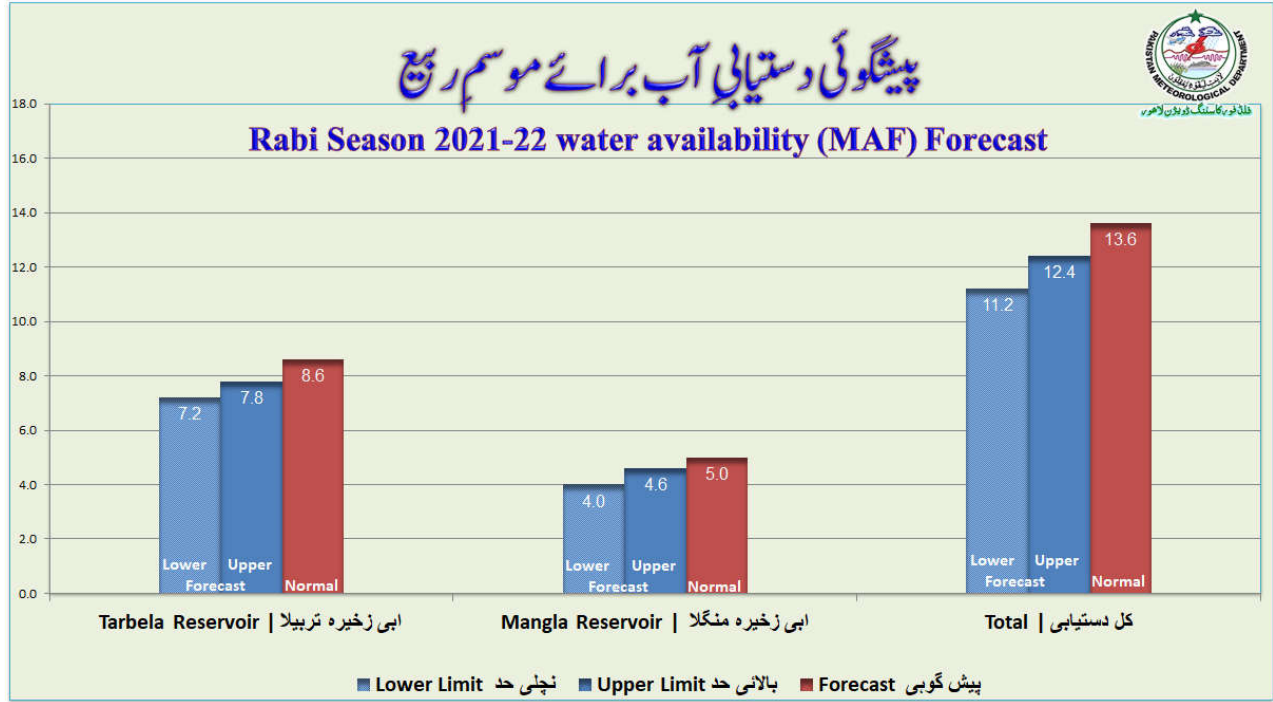


Figure-8 Rabi season forecast of Mangla and Tarbela Dams (2021-2022)

8. Impact based Weather Forecast

- Frequent foggy conditions are likely to prevail in most of the plains areas of the country from January to mid of February, affecting crops growth and transportation in the country.
- Due to prolonged dry and foggy conditions and below than normal temperatures, energy demands will increase during the extreme winter months.
- Due to frequent frost in central and upper Punjab during in January, effecting the growth of seasonal vegetables, fruits and seeding during the period.

9. Government reactions to drought

NDMC is continuously monitoring the drought situation over the country and keeping the stakeholders and general public updated by issuing drought information on a fortnightly, monthly basis. Overall normal conditions are prevailing in the country except Southwestern parts of Balochistan. Intervention is needed by the government in drought-prone regions to minimize its impacts. For detailed information regarding the drought situation in Pakistan, please visit <http://www.ndmc.pmd.gov.pk/index.htm>

10. Recommendations

A natural disaster could not be stopped. Each disaster gives us a lesson to do better planning, management and take 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 fulfil the water requirements of crops during drought periods in the country.
- The water will also help to generate hydropower electricity which is an essential requirement of the country and may reduce unemployment in the country.

11. Acknowledgement

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

12. References:

- 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>