

WEATHER AND CLIMATE FLUCTUATION OF PESHAWAR CITY KHYBER PAKHTUNKHWA, PAKISTAN (1931-2020)

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ABSTRACT: The paper explicates the weather and climate fluctuation of the Peshawar observatory, taking into account normal data (1931-2020). The variables considered are temperature, rainfall, wet days, humidity, wind rate, solar energy, evaporation, and air pressure. The winter and summer periods are categorized as cold (winter), hot (pre-monsoon), wet (monsoon), and dry (post-monsoon) seasons. The city remains hot during June and cold in January, having semi-arid climates. The area remains wet in March and August and dry in June. The data represents continental plain climates amid sizzling long summers (7 months) and short moderate winters (5 months). Climate fluctuation reveals a decrease in maximum and minimum temperature, precipitation, humidity, rainy days, wind speed and an increase in the pressure. The standard deviation and coefficient of variation are below the normal condition, excluding pressure, evapotranspiration and mean temperature.

Keywords- Weather, Climate, Temperature, Precipitation, Humidity, Sunshine, Evaporation

I. INTRODUCTION

Climate is one of the specific factors of the physical environment controlling and affecting the evolutionary process, mode of existence, culture and social characteristics of human beings. Human activities like agriculture, population growth, industrialization, urbanization, and vehicles also affect the climate of a locality. Peshawar district, a gateway to central Asia and the capital of Khyber Pukhtunkhwa Province, is located in the centre of Peshawar Vale from 33⁰-43` to 34⁰-13` North latitudes and 71⁰-22` to 71⁰-46` East longitudes, with an altitude of 1177 feet (359 meters) above mean sea level. Charsadda and Nowshera districts cover the area in the north and northwest, the barren mountains of Khyber and Mohmand districts in the south and southwest, and Kohat district in the east. The area in the north and south slopes to the Kabul River, which takes the whole drainage of the valley (Figure-1). The strategic location of the study area makes it of prime importance in the perspective of defence, economic and industrial development, agriculture, and an international centre of trade and business in Southwest Asia.

Many attempts have been made in the past to study climates in which [1 to 9] are the major contributors, but they could not discuss the climate of Peshawar city in detail.

II. MATERIAL AND METHODS

The study, based on the normal data, covers the time duration of 1931-2020 [10 -12]. The variables proposed for the work are temperature, sunshine, evapotranspiration, pressure, wind speed, rainy days, and relative humidity as dependent variables and rainfall as an independent variable. For seasonal division, based on temperature, the total months have been categorized into winter and summer. Months having a positive deviation of temperature have been considered summer months, otherwise winter. Based on rainfall, these seasons are classified into pre-monsoon, monsoon, post-monsoon, and cold seasons. The weather conditions change after mid-April and mid-September, so each half of the month is included in both seasons. Statistical methods like averages, standard deviation, coefficient of

variation, and deviation from the mean have been calculated

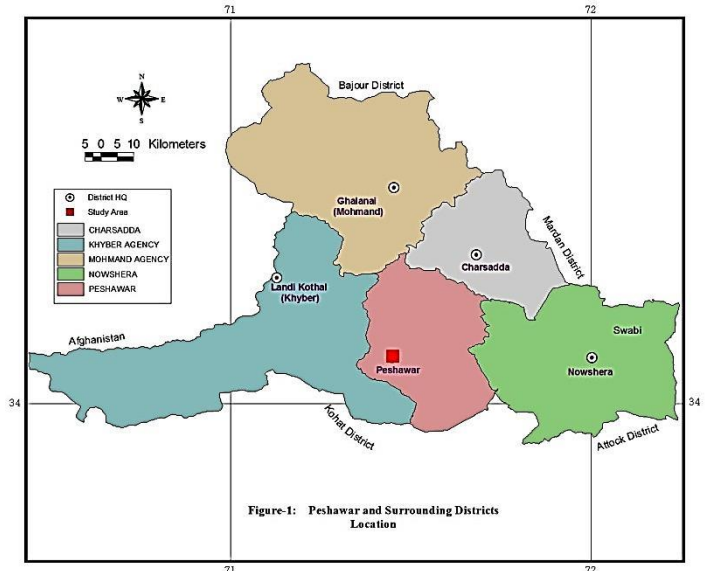


Figure-1: Peshawar and Surrounding Districts Location

for discussing the fluctuation and variation of the target variables throughout the normal periods and to show the results on graphs and charts to analyze the data and explore the net results.

III. RESULTS AND DISCUSSION

3.1. Weather Condition

The annual march of temperature reveals the lowest maximum temperature of 21°C with a minimum of 2°C recorded in January, which increases to 43.4°C maximum, and 22.5°C minimum temperature in June and decreases onward till December (Figure 2). The mean monthly temperature is 22.7°C with 33°C utmost and 13.2°C minima (Table 1). In winters, the mean temperature is 14.3°C amid 26.4°C maxima and 3.1°C minima, while in summers, the mean monthly temperature increases to 28.3°C with a maximum of 40.2°C and a minimum of 17.5 degrees Celsius. June with the highest temperature is the hottest month, whereas January with the lowest temperature is considered

the coldest month of the period. The severe maxima temperature of the city was 50°C observed on 18th June 1995, while the ever-recorded minimum of -3.9°C noted on 7th January 1970.

The annual sunshine is 7.9hr/day with a lowest of 6.1hr/day in January, which increases to 10hr/day in July and then decreases up to 7.8hr/day in November (Table 1). In winters, nights are longer than days; therefore, the area is characterized by minimum sunshine duration with a seasonal average of 6.7 hours/day, while in summers, it increases to an

average of 8.8 hours/day with a maximum in June and a minimum in September. The annual trend of evapotranspiration shows that it is above 7mm (0.28inches) from May to July with a maximum of 8.4mm (0.34inches) in June, while it dropped to below 2mm (0.08inches) in December and January and increases onward till June. Evapotranspiration of the area is 4.5millimeters (0.181 inches) along with 6.1mm (0.241inches) in summers and 2.3mm (0.09inches) in winters.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Deviation
Max T	21.0	23.2	28.3	34.8	40.3	43.4	41.4	38.7	37.1	34.0	28.4	23.7	32.9	-0.1
Mini T	1.9	4.0	8.1	12.8	18.0	22.5	23.8	23.3	19.8	13.7	6.8	2.9	13.2	-0.1
Mean T	11.1	13.3	17.7	23.3	29.3	32.9	32.3	30.9	28.9	23.8	17.6	12.7	22.7	0.0
Humidity	64.8	74.8	63.5	47.3	39.8	37.2	58.8	67.8	61.5	56.3	58.2	64.2	57.8	-4.6
W Speed	1.8	2.3	2.6	2.7	3.2	3.6	3.6	3.3	2.4	1.7	1.5	1.4	2.5	-0.1
Rainfall	1.4	2.0	2.9	2.1	0.9	0.5	1.9	2.3	0.9	0.6	0.5	0.7	1.4	-0.1
Pressure	1020	1017	1014	1009	1003	998	997	1000	1005	1012	1017	1020	1009	0.77
R Days	3.1	4.3	6.2	4.4	2.9	1.2	3.0	3.5	1.9	1.4	1.3	1.8	35.1	-0.1
Sunshine	6.1	7.1	6	8	9.3	10	9.1	9.1	7.4	8.6	7.8	6.5	7.9	Trace
Evapo	1.7	2.3	3.2	4.5	7.3	8.4	7.4	6.3	5	3.9	2.6	1.8	4.5	Trace

Source: [10-12]

The highest pressure of 1020mbs recorded in January, which decreased to 997mbs up to July and then increased till December. The mean monthly pressure of the area is 1009mbs with 1016.5mbs in winters and 1001.8mbs in summers (Table 1). The annual wind speed of the area is 2.5knots, which is a light breeze. It is above 3knots from May to August and decreases to 1.4knots in December, increasing to above 2knots till April. The average winter wind speed of the valley is 2.2knot and in summers, it is 3knots. The ever recorded wind speed is 11km/hr noted on 26th April 2015.

The rainfall reveals an increase from December to March with a turndown till June and then rises as of July to September with the arrival of monsoon lows and onward decreases till November (Table 1). The total rainfall of Peshawar city is 426.7mm (16.8 inches) and is placed in semi-arid climates. The heaviest rainfall of the year is 37.7mm (2.9 inches) in March when the western depressions reached their climax, and the lowest is 12.7mm (0.5 inches) in June and November from local heating. The total winter rainfall of the area is 231.1mm (9.1 inches), while in summers; it is 221mm (8.7inches). The ever-recorded rainfall in 24hrs is 273.8mm (10.78 inches) recorded on 27th July 2010. The sum of rainy days is 35.1. It increases from 1.8 in December to 6.2 in March with a decline of 1.2 in June and increases onward to 3.5 in August with a gradual decrease of 1.3 till November. In winter, the rainy days are 19.8 with 15.3 days in summer. The relative humidity of Peshawar city is 58% with the highest at 68% during August and the lowest at 37% in June. It increases from November to March with a partial decrease up to June and then increases up to July and

decreases till October. The relative humidity in winter reaches 62.9% and remains low up to 52.4% during summers.

3.2. Seasonal division

3.2.1. Cold season

It varies from December to mid-April having a negative deviation of temperature from the mean, and is characterised by cold/cool weather, a low-temperature condition of less than 30°C, sunshine of 7.5hr/day, evapotranspiration of 5mm (0.2 inches), relative humidity of 64.8%, pressure of 1018.7mbs and 205.7mm (8.1inches) rainfall. January is the coldest month when the minimum temperature drops near freezing point. March is the warmest and wettest month, having a maximum temperature of more than 30°C, a mean minimum of 6.1°C and rainfall of 73.8mm (2.9inches). The sum of precipitation from western depressions is higher than other seasons of the year and is considered the moistest season in Peshawar city.

3.2.2. Pre-monsoon Season

Peshawar city carries scarce rains in the pre-monsoon season from 15th April to June, having a high temperature and aridity. During this season, the area experiences longer days and short nights (sunshine 10hr/day). June with more than 43.4°C maximum and 22.5°C minimum temperature constitutes the hottest month. The temperature of the area during this period varies from 38°C to 50°C with 16°C to 25°C minimum temperature. The total rainfall of the season is 127mm (2.5 inches) with the highest of 25.4mm (1 inch) in March and the lowest of 12.7mm (0.5 inches) in June.

3.2.3. Monsoon Season

The season varies from July to mid-September (Figure 2). The total rainfall of the area during this particular season is 119.4mm (4.7 inches), which is less than that of the winter season. The highest rainfall of the season is 58.4mm (2.3 inches) in August, with the lowest of 20.3mm (0.8 inches) in September. The maximum temperature of 41.4°C is noted in July and the minimum of 19.8°C in September.

3.2.4. Post Monsoon Season

It ranges from 15th September to November and is also designated by reversible monsoon rains with a sum of rainfall of 40.6mm (1.6 inches) and the lowest rainfall of 12.7mm (0.5 inches) in November. The highest maximum temperature is 34°C in October, with a minimum of 6.8°C in November. The ratio of evapotranspiration decreases to 2.5mm (0.1 inches) with sunshine of 8hr/day. In general, the season is dry and has scarce rains, but due to the low temperature, the weather is more pleasant.

3.3. Climate Fluctuation

The comparative study of the mean annual temperature of the normal periods (1931-2020) shows no change in mean monthly temperature. The maximum temperature remained 34.4°C in 1931-1960, which increased to 34.7°C in 1961-1990, and then decreased to 29.5°C in 1991-2020, with a total decrease of -0.1°C (Table 1). Moreover, the mean minimum temperature of the valley was 11.5°C in 1931-1960, dropped to 11.4°C in 1961-1990, and then increased to 16.6°C in 1991-2020, with a decrease of -0.1degrees Celsius. The mean monthly maximum temperature of the area shows a partial increase in winter months with a decreasing trend in monsoon for the period of 1961 to 1990 as compared to 1931 to 1960. The statistical analysis of data expresses a 35% coefficient of variation in mean monthly temperature with a standard deviation of 7.9°C, 21% in mean maximum with a standard deviation of 7.4°C, and 70% in mean minimum temperature with a standard deviation of 8.1degrees Celsius. These figures reveal a drastic change in the temperature condition of the area in the past ninety years. The standard deviation of sunshine is 1.2hr/day, with an 18.6% coefficient of variation, which is close to the normal condition. The observation of data indicates a 49.44% coefficient of variation with a standard deviation of 2.2mm (0.08 inches) in the evapotranspiration of the area that is extremely above the normal condition.

The area recorded an average pressure of 1010mb from 1931 to 60 decreased to 1009mb from 1961 to 1990, and further declined to 1008.6mb during 1991-2020, with an increase of 0.8 millibars. The area recorded an average wind speed of 2.6knots from 1931 to 1960, which dropped to 2.3knots from 1961 to 1990, and 2.5knots during 1991-2020, with a decreasing trend of -0.1knots. The standard deviation of wind speed is 0.5 knots, with a coefficient of variation of 18.6 per cent. The total rainfall of the area is 330.2mm (13inches) from 1931 to 1960 that increases to 403.9mm (15.9inches) from 1961 to 1990 (Table 1), and 541.02mm (21.3inches) in 1991-2020, with a decrease of -2.54mm (-0.1inch). The analysis of the data reveals a 64.5% variation with a standard deviation of 20.3mm (0.8 inches), which is close to the normal condition. The area recorded an average humidity of 53.2% from 1931 to 1960 which increased to 62.4% from

1961 to 1890, and 57.8% during 1991-2020, with a decrease of -4.6 per cent. The annual variation of relative humidity from 1931 to 1990 is 9.64% with a 16.9% standard deviation and is close to the normal condition.

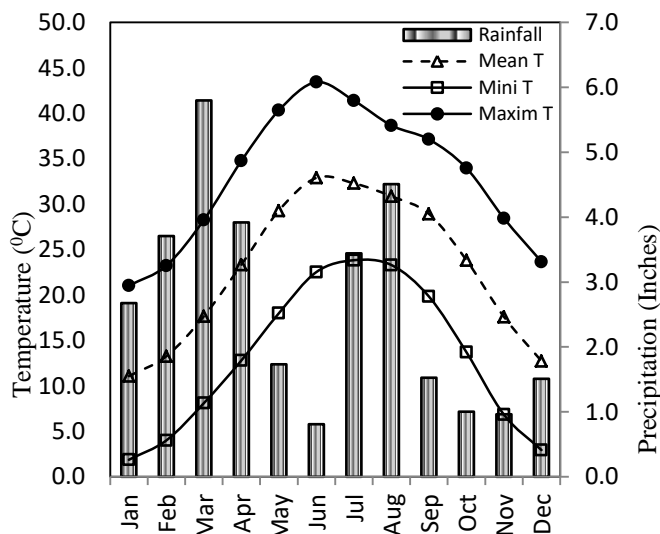


Figure-2: Peshawar Mean Monthly, Mean Maximum, Mean Minimum Temperature and Precipitation (1931-2020)

IV. CONCLUSION

Peshawar city has continental plain semi-arid climates with hot long summers (7 months) and short warm winters (5months). Based on precipitation, the area is characterized by cold and moist or winter, hot and dry or pre-monsoon, hot and moist or monsoon, and warm and dry or post-monsoon season. The highest mean monthly temperature was recorded in June (hottest) and lowest in January (coldest month). Peshawar City has recorded a total of 426.7mm (16.8 inches) rainfall and represents a semi-arid climate, with the heaviest in the winter season and the lowest in the summer. The sum of rainy days is 35.1, with sunshine of 7.9hr/day, evapotranspiration of 4.5mm (0.18inches), relative humidity of 57.8%, pressure of 1009mbs and wind speed of 2.5knots. There is no change in the mean temperature; however, there is a decrease of -0.1°C in the maximum as well as the minimum temperature. The total rainfall of the area shows a decrease of -2.54mm (-0.1inch), with relative humidity of -4.6%, number of rainy days of -0.1, wind speed of -0.1, and an increase of 0.77mb in the pressure. The statistical analysis of data reveals a variation of 0.1% in mean monthly, -0.4% in maximum and -0.8% in minimum temperature from the average condition. The variation observed in wind speed is -3.5%, with 0.1% in pressure, -0.9% in rainfall, -7.9% in relative humidity, 0.4% in evapotranspiration, and -0.3% in the number of rainy days from the mean value.

It is difficult to manage the climate change produced by natural processes; however, it is necessary to control anthropogenic activities, particularly deforestation, radioactive substances from nuclear reactors, emissions from explosive materials in wars, burning of fossil fuels, industrial pollution, vehicles, urbanization, etc. So, policies and further research should be made on a national as well as an

international level to overcome these issues and save the greenhouse from further destruction.

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