Int. J. Econ. Environ. Geol. Vol. 12(2) 65-71, 2021
Journal home page: www.econ-environ-geol.org
Open Access
ISSN: 2223-957X

Climate and Weather Condition of Balochistan Province, Pakistan

Saifullah Khan,[1*] Surriya Shahab,[1] Muhammad Ishaque Fani,[2] Abdul Wahid,[3] Mahmood-Ul-Hasan,[4] Aslam Khan[4]

[1]Department of Social and Cultural Studies, B.Z.U. Multan, Punjab, Pakistan
[2]Department of Pakistan Studies, BZU, Multan, Punjab, Pakistan
[3]Department of Environmental Sciences, BZU, Multan, Punjab, Pakistan
[4]Department of Geography, Peshawar University, Peshawar, Khyber Pukhtunkhwa, Pakistan

*Email: saifullahkhan33@gmail.com

Received:*16 March, 2021* ***Accepted:*** *27 May, 2021*

Abstract: The study discusses the climate of Balochistan with a special focus on the variation of weather condition taking into account the mean monthly precipitation, temperature, humidity, atmospheric circulation, air pressure, evapotranspiration and solar energy covering the time duration of 1931-2020 (normal data). The physical barriers that bring variations in the climate of Balochistan contain geographical location, ocean, geomorphology, land use, natural vegetation, and continental extent. Based on precipitation, the province has been divided into two main regions that are arid and semi-arid, while the temperature zones are hot, warm, mild and cool. The southern and eastern part of the province receives heavy rain in the summers (monsoon), whereas it is from the western depressions during the winter season. Balochistan experiences four rainy seasons in winter (cold), pre-monsoon season (warm), monsoon season (hot), and post-monsoon season (mild). Owing to tropical (coastal) and sub-tropical continental characteristics, the area familiarizes two foremost seasons namely winter and summer. The summers of the area long for 5 months in hilly areas while 7 months in continental plains and coastal regions; whereas, winters cover five months in the plains and seven months in the mountains. Based on the appropriation and fluctuation in climate constituents, Balochistan has been classified into two main, 6 meso, and 9 microclimate and weather zones. According to Global Climate Risk Index, 2021, Pakistan has been ranked at 8th in the list of top ten global climate high-risk countries, which are exposed to the ongoing climate change and requires attention to resolve the issue.

Keywords: Climate, fluctuation, variation, weather elements, climate divisions.

Introduction

This study discusses the general climatology, climate variation and divisions of the Balochistan province in Pakistan. As Balochistan is a center of China Pakistan Economic Corridor and Gwadar Port, are the subiced for current study in the context of economic development of Pakistan and China. Generally, Balochistan province is characterized by a continental semi-arid and arid climate, which is influenced by the topography of the land, altitudes, natural vegetation, desertification, hydrology, marine influence, land-use change, etc. The climate of Balochistan has contributed to a rich fauna and flora biodiversity with an ultimate social inheritance, which allowed survival in the badlands topography of the area. The study area falls in an arid climate zone having scanty precipitation with a high temporal and spatial variability. The annual evapotranspiration of the area is higher than the annual precipitation like a desert. Mostly the lift, springs and karez irrigation system makes it a unique agriculture zone in Pakistan. Historically, the Balochistan province is known as the homeland of Neolithic Mehrgarh civilization (7000 BC) and the place of wheat and cotton cultivation throughout the world. Strategically, the area is an economic corridor for several countries comprising Afghanistan, Iran, Pakistan, Central Asia, Russia and is of prime importance to overcome the food and security, economic development, political instability, social and cultural disruption, environmental degradation, climate change and water resources concerns.

Climate change and some climate related issues are not new phenomena in Pakistan. The archaeological sites of Mehrgarh (7000 BC), Mohen Jo Daro, Harrapa (2500-1900 BC), and Gandhara (7000BC-800 BCE) reveal that this area has experienced the climate change disasters many times. Currently, Pakistan has been ranked 8th on the list of top ten global climate risks countries, which are exposed to environmental fluctuation and catastrophes (GoG, 2021). According to the sixth assessment report of IPCC (2021) on the impact of global warming of 1.5 °C, the area is open to environmental changes, sustainable development, and efforts to eliminate poverty. The warming of climate due to human activities including emissions from the pre-industrial period to the present will persist for centuries to millennia and will continue to cause further long-term changes in the climate system, such as sea-level rise associated impacts. These risks depend on the magnitude and rate of warming, geographic location, level of development, and the implementation of adaptation and mitigation options. Future climate-related risks could be reduced by the up scaling of far-reaching, multilevel and cross-sectorial climate mitigation, also by both incremental and transformational adaptations. These differences include

increases in mean temperature, hot extremes, heavy precipitation, and the probability of drought and precipitation deficits.

Kazi (1951) was the pioneer who classified the climate of Pakistan but considered the Kachi (Sibbi) area in continental sub-mountain west, Zhob and Loralai in a semi-arid, Quetta and Makran (Jhalawan) in southwestern highlands and the remaining province in a very arid climates. Shamshad (1956), classified the climate of Balochistan and discussed the Zhob and Musa Khel in extra-tropical quadruple season type and the remaining areas in sub-tropical double season type. Other scholars who have worked on the climate of Pakistan including Balochistan are; Nasrullah (1968), Raja and Twidell (1990), Khan (1991), Khan (1993), Hasan and Khan (2019).

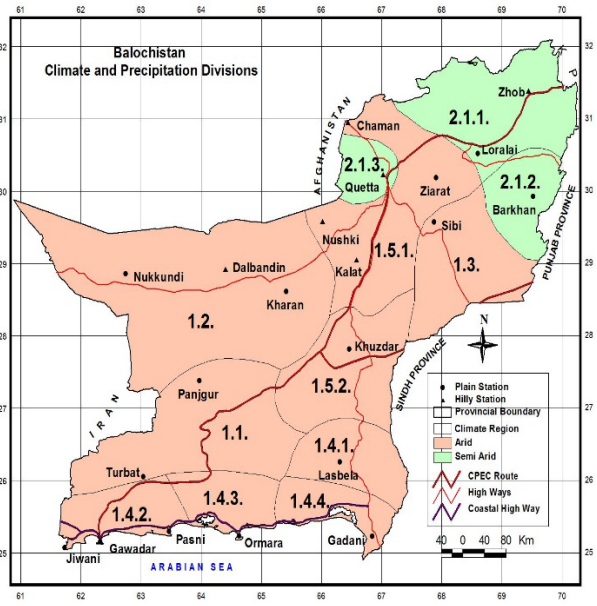


Fig. 1 Balochistan, Pakistan, climate and precipitation divisions (1931-2020)

Balochistan is the major province among the five provinces of Pakistan, covering about 347,220 square kilometers of area and constitutes almost 43 per cent of the country having a 770 kilometers coastal belt. The population of the province is 12.34 million that declared the smallest demographic entity of the country (GoP, 2017). The study area located at 25^0N to 32^0N latitudes and 62^0E to 70^0E longitudes. It covers the southwestern part of the country and is bound by Punjab province in the northeast, Sindh province in the southeast, the Arabian Sea in the south, Iran in the west, Afghanistan in the northwest and Khyber Pukhtunkhwa in the north (Fig. 1).

Many scholars discussed the climate of Balochistan province, in which the prominent contributors are Dost et al (2008), Shah et al (2012), Imran (2013), Salman and Rehman (2013), Hassani et al (2015), Alghafari and Khan (2016), Alghafari and Khan (2017), Aftab et al (2018), Iqbal and Samiullah (2018), Baloch et al (2019), Saleem and Hina (2019), Krakauer et al (2020), Khwajakhail et al (2020). However, all of the contributors did not consider the climate of Balochistan as a single entity. Keeping in view the geological, geomorphologic, economic and environmental importance of the area, this study has been proposed to analyze and discuss the climate of Balochistan province, Pakistan.

Metarial and Methods

The temperature, wind speed, rain, solar radiation, relative humidity, air pressure, evapotranspiration, physiography, flora, maritime effects (dependent variables) and precipitation (independent variable) have been considered to study the distribution of weather elements and climate division of Balochistan. The explicit aim of the study is to understand the variations of different climate variables and to divide the area into dissimilar climate zones taking into account the normal weather data (secondary) for a period of 1931-2020 published by the Pakistan Meteorological Department, Karachi. The data were plotted on maps and charts for the purpose to construct the weather maps (Isopleths) and annual graphs showing the distribution of different variables on land areas and the annual cycle of the seasons. Based on the annual cycle of temperature and precipitation, the Balochistan province was classified into summer and winter. The summer season in the continental plain areas is not the same as that of continental mountains as well as coastal regions. Based on the annual cycle of precipitation, these two major seasons have been further classified into four sub-seasons namely: winter, pre-monsoon, monsoon and post-monsoon seasons. As the month of April and September are close to the average line, therefore, these two months are divided by two and each half of the month is added to both seasons (Fig.1, Fig. 3, Table 1). Keeping in view the variety of different climate elements between meteorological stations, the area has been divided into 2 major, 6 meso and 8 micro divisions. The boundaries of each division have been demarcated on maps in the light of the topography of land, maritime influence, flora and fauna. The different tools used for the study comprise of statistical techniques like mean, deviation from the mean, annual and seasonal trends, graphs and charts. The weather maps have been prepared to evaluate the variation of climate elements as well as isopleths at different locations using GIS and remote sensing technology. The variations at different observatories have been analyzed and compiled as a report using observation, comparative and analytical techniques.

Results and Discussion

Climate and Weather

The climate and weather are the utmost elements of the environment that affect agriculture production, water availability, forests, fauna, desertification and atmospheric circulation etc. of the area. This section

discusses the general distribution of different weather elements consisting of temperature, precipitation, relative humidity, wind speed, atmospheric pressure, sunshine, and evapotranspiration (Table 1). Balochistan province represents an arid continental climate having coastal climate in the south, high altitude weather in the north and pure desert in the southwest.

Temperature and precipitation are the most important climate elements as no description of the environment can be completed without a notation of the prevailing temperature tendency and especially its distribution in time and place. The temperature condition of a place provides working conditions for all physiological and ecological processes. This is revealed by the fact that most of the bio-climate indices are based on temperature condition. Generally, the mean daily temperature of Balochistan is 24^{0}C with a mean daily range of 14^{0}C, mean daily maximum temperature of 29.4^{0}C and mean daily minimum temperature of 15.4^{0}C. The mean monthly temperature of Balochistan remained 22.4^{0}C, having a mean monthly maximum temperature of 34.2^{0}C and a mean monthly minimum temperature of 10.5^{0}C. Thus the mean daily minimum of 5.1^{0}C and a mean monthly minimum of -0.3^{0}C temperature of the province has been recorded in January, which has been declared as the coldest month of the province. On the other hand, the highest mean monthly maximum temperature of 42^{0}C has been noted in June and therefore, it is the hottest month of the area. The extreme minimum temperature -18.3^{0}C was recorded on 8th January 1970 in Quetta, while the extreme maximum temperature of 52^{0}C was observed on 12 June 1979 at Sibbi observatory which constitute the coldest and hottest places of the province (Table 1). Based on temperature, the area has been divided into hot, warm, mild and cold regions. These regions have been further condensed into macro zones based on variation in sunshine duration, evapotranspiration, relative humidity and precipitation (Fig. 2).

Precipitation is the source of affluence for agriculture as well as postural activities in Balochistan province. The crops yield fluctuates with the rainfall variation that shows its importance for the existence of flora and fauna in the area. On one hand, it is of prime importance for flora, fauna and human survival but on the other hand, it also influences the rate of evapotranspiration, control of desertification processes, disasters, and marine life. Balochistan province recorded annual precipitation of 18.6 cm with a maximum of 3.3cm in July and a minimum of 0.2cm in October. The western part of the province mostly receives heavy rainfall from the western disturbance in winter, while it is monsoon at the eastern longitudes during the summer season.

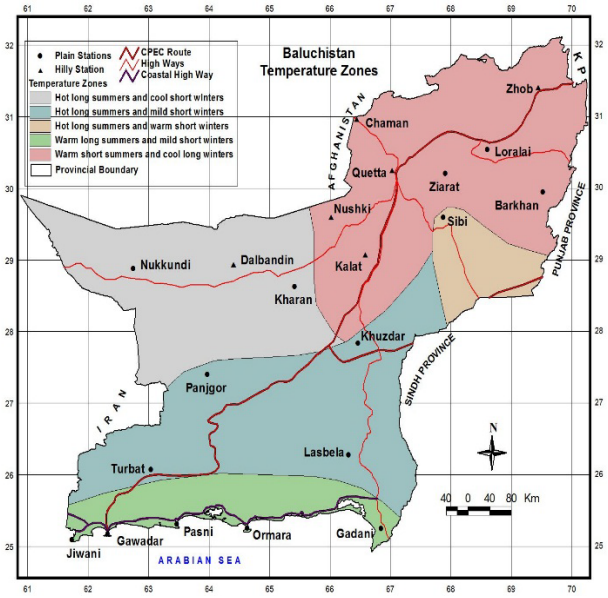


Fig. 2 Balochistan, Pakistan, temperature zones (1931-2021)

The extreme heaviest rainfall of 14.6cm has been recorded on 21st February 1987 at Jiwani and considered as the wettest place of the province (Table 1). The total number of rainy days are 15.3 days with a maximum of 2.4 days in July and a minimum of 0.3 days in October. Furthermore, the relative humidity of the province is 51.8% with a high of 59.4% in January and the lowest of 45.2% in May. The annual atmospheric pressure of the area is 1026 millibars

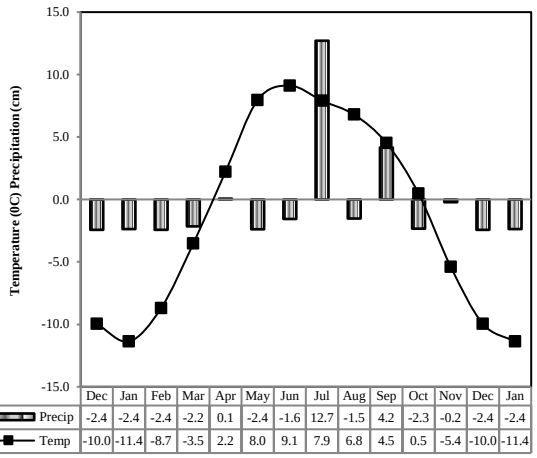
Table 1Balochistan, Normal of Mean Monthly Weather Data (1931-2020), GoP, 2020.

Station. N.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Daily Maxi	18.4	20.7	25.5	30.9	35.4	37.8	36.8	35.5	33.6	30.6	25.6	21.5	29.4
Daily Mini	5.1	7.3	11.8	16.6	21.0	24.1	25.0	23.6	20.1	14.8	9.5	6.0	15.4
Daily Range	13.3	13.5	13.9	14.3	14.5	13.7	11.9	12.0	14.0	16.3	16.4	14.8	14.0
Mean Daily	11.7	14.0	18.7	23.8	28.2	30.9	30.9	29.5	26.9	22.7	17.6	13.7	22.4
Mean Monthly	11.6	13.9	18.5	23.8	28.2	31.0	30.9	29.6	27.0	22.9	17.8	13.6	22.4
MM Maxi	23.5	26.2	31.5	36.8	40.8	42.0	40.6	39.1	37.9	35.7	30.7	25.6	34.2
MM Mini	-0.3	1.5	5.6	10.5	16.1	19.6	21.1	19.7	16.5	9.5	4.6	1.0	10.5
R Humidity	59.4	56.8	54.2	49.6	45.2	46.4	55.0	55.9	51.1	45.5	47.9	55.0	51.8
Rainfall	2.6	2.4	2.4	1.3	0.8	0.7	3.3	2.4	0.7	0.2	0.4	1.4	18.6
Rainy Days	2.1	2.1	2.0	1.3	0.7	0.7	2.4	1.7	0.6	0.3	0.4	1.1	15.3
Pressure	1032.0	1030.4	1028.2	1025.8	1022.4	1017.5	1016.3	1017.9	1022.4	1028.3	1031.8	1032.7	1025.5
Evaporation	1.8	2.5	3.7	5.0	6.6	7.6	7.6	7.0	5.6	4.1	2.7	1.9	4.7
Wind Speed	3.7	4.2	4.8	5.2	5.7	5.8	5.6	5.3	4.8	3.7	3.3	3.1	4.6
Sunshine	6.8	6.9	7.9	8.0	10.0	10.5	10.2	10.1	9.6	9.0	8.2	7.1	8.7

having the highest in December and the lowest in July. The area recorded annual evapotranspiration of 4.7mm with a high rate of 7.6mm in June and July, whereas it remains low during January. The annual sunshine duration of the area is 8.7hrs per day having the longest duration of 10.5hrs per day in June and the shortest of 6.8hrs per day in January. Moreover, the province calculated an annual wind speed of 4.6 knott/hour with a major of 5.8 knott/hour in June and a minor of 3.1 knott/hour in December (Table 1).

Seasonal Distribution

For the seasonal fluctuation, the year has been classified into summer and winter. The climate factors indicate that summer month in the plains may not be the summer month in the coastal belt and hilly areas. Thus months illustrate deviation of temperature, above the average line is considered as summer months otherwise winter.



	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Precip	-2.4	-2.4	-2.4	-2.2	0.1	-2.4	-1.6	12.7	-1.5	4.2	-2.3	-0.2	-2.4	-2.4
Temp	-10.0	-11.4	-8.7	-3.5	2.2	8.0	9.1	7.9	6.8	4.5	0.5	-5.4	-10.0	-11.4

Fig. 3Baluchistan, Pakistan Deviation of mean monthly temperature and precipitation.

Usually, in plains, the summer season proceeds from April to October (7 months) and winter extends from November to March (5 months) and converse in the mountains. Based on precipitation, these two main seasons are divided into four rainy seasons namely winter (Mid-November to mid-April), pre-monsoon (Mid-April to June), monsoon (July to Mid-September) and post-monsoon (Mid-September to Mid-November). Balochistan remains hot in summer excluding hilly areas, where the temperature remains low, and cold in winter except the coastal region, where the temperature remains high due to marine influence. The eastern longitudes receive extensive precipitation from the monsoon lows, while it is from western depressions at the west in winters (Fig. 3).

Climate Divisions

Based on precipitation and temperature, the Balochistan has been classified into an arid and semi-arid climates. (Fig. 1, Fig. 3, Table 1).

Arid Region

It is illustrated by slight rainfall, high evapotranspiration and a sum of rainfall <254mm (<10 inches).

Short mild winters and long hot summers

The Punjgor and Turbat fall in it, where the June temperature is >32ºC (hottest month) and summer season is $>25^0$ Celsius. The region is illustrated by five months winter (moist) and 7 months summer (dry). The winter season of the zone is pleasant, whereas the summers are hot and dry (Fig.1, Fig. 3, Table 1). The mean range of temperature remains between $20\text{-}25^0$ Celsius. The region has recorded 45^0 Celsius extreme temperatures in June (hottest month) and extreme minimum of -7.8^0 Celsius during December (the coldest month).

Cool short winters and hot long summers

Chaghi, Nokkundi, Dalbandin and Kharan fall in it having <127mm (<5inches) rainfall annually. The region is obvious, illustrated by the hot desert, having $>32^0$ Celsius temperature in the hottest month of June and $<-10^0$C temperature in the coldest month of January. The summer temperature remains above 25^0 Celsius. The lowest ever recorded rainfall of the area is 35.6mm (1.4inches) having seven months of summer and cool rainy winters. The coldest temperature of the region is -10^0C (December), while it exceeds to 45^0 Celsius in June (Fig.1, Fig. 3, Table 1).

Short warm winters and hot long summers

Sibbi and Kach districts fall in this climate zone, having a hot desert climate with a 35^0 Celsius temperature in June and $>32^0$ Celsius temperature in January. The summers are burning up and protracted for 7 months, whereas the winters are dry and short. The area is characterized by 127 to 254 mm (5-10 inches) having a standard temperature between $25\text{-}30^0$ Celsius. The ever recorded maximum temperature of Balochistan is 50^0 Celsius recorded at Sibbi the fourth times in the month of June throughout the series (1981-2020) and has been declared as the hottest region. The ever recorded minimum temperature of -3.3^0celsius observed in January and considered as the coldest month (Fig.1, Fig. 3, Table 1).

Warm long summers and mild short winters

Mean temperature remains between $21\text{-}32^0$ Celsius in June, $10\text{-}21^0$ Celsius in November and 25^0 Celsius in summer.

Summers rainfall and winters dry

The climate type portrays naval weather condition with a rainfall of 127-254mm (5-10 inches). Lasbella

incorporates hot wet summers and short warm winters. The mean temperature oscillates between 25-30^0 Celsius and extreme range up to 51^0 Ceslius in May, while the extreme minima is $<0^0$ Ceslius as noted in January (Fig.1, Fig. 3, Table-1).

Winters rainfall and summer dry (Marine Climate)

It is comprised of Pasni, Gawadar and Jiwani, where the annual rainfall remains <127mm (<5 inches) having mild 5 month winters and warm 7 month summers. The annual temperature remains $<30^0$ Celsius with an extreme maximum temperature of about 47^0 Celsius in June and a minimum of 2^0 Celsius in December (Fig.1, Fig. 3, Table-1).

Winters precipitation and summers dry

Ormara fall in it, where the winters are short (5 months) and moist and summers are warm and longer (7 months). The overall rainfall of the area is <10 inches (<254mm). The annual temperature of the region is $<30^0$ Celsius with an extreme maximum temperature of $<48^0$ Celsius in June and the extreme lowest is $<5^0$ Celsius in January.

Uniform rains with winter concentration (Marine climates)

The climate zone comprises Gadani in Balochistan and parts of Karachi in Sindh, which receives an annual rainfall from 127-254mm (5-10 inches). Gadani gets both summer and winter rainfall, however, the share of winter rain is higher as compared to the summer season. The ocean and land breezes make the weather more pleasant both in winter and summer season. The June maximum temperature of the region remains less than 32^0 Celsius and the January minimum temperature is 5^0 Celsius (Fig.1, Fig. 3, Table 1).

Cool long winters and warm short summers

The hottest month June temperature varies from 21-32^0 Celsius and January temperature $<10^0$ Celsius.

Winters precipitation and summers dry

The zone covers Kalat, Ziarat, Nushki and Chaman districts. It is illustrated by cool, moist long winters (7 months) and short dry summer season (5 months). The rainfall remains <10 inches (254mm) having a mean temperature of $<20^0$ Celsius. In June, the extreme maximum temperature rises to 38^0 Celius (Kalat), while the extreme minimum remains below $<-18^0$ Celsius during January (Fig.1, Fig. 3, Table 1).

Summer and winter rainfall with summer concentration

It includes Khuzdar district, with 7 months summers and 5 months winters The mean temperature remains $<25^0$ Celsius with a $<35^0$C maxima and $<10^0$ Celsius minima. The extreme maximum temperature rises to 43^0 Celsius in July, while it is less than -10^0 Celsius during January (Fig.1, Fig. 3, and Table 1).

Semi-Arid region

Areas having the sum of annual rainfall between 254-508mm (10-20 inches).

Cool long winters and warm short summers

Areas, where the mean temperature is $<32^0$ Celsius in June, $<10^0$ Celsius in January and winter temperature $<15^0$ Celsius.

Winter and summer rainfall (winter concentration)

The Zhob, Sherani, Muslimbagh, Musa Khel, Killa Saifullah and parts of Loralai districts cover it, where the winters are cool and 7 months longer, whereas the summers are mild and 5 months shorter. The average temperature remains 15 to 20^0 Celsius (Fig.1, Fig. 3, Table 1). The ever recorded maximum temperature rises to 43^0 Celsius (June) and dropped to $<-9^0$ Celsius (January).

Winter and summer rainfall (summers concentration)

Barkhan district fall in it, having 7 months winters and 5 months summers. The mean temperature remains $<25^0$ Celsius, June extreme maximum of 45^0 Celsius, and -10^0 Celsius in December (Fig.1, Fig. 3, Table 1).

Winters rainfall and summers dry

The region comprises of Quetta, Pishin, parts of Ziarat, and Killa Abdullah district with 7 months-long winters and pleasant 5 month summer. The mean temperature remains $<30^0$ Celsius, maximum $<35^0$ Celsius and minimum $<5^0$ Celsius. In the winter season, due to Siberian winds, the night temperature of the region dropped to -18^0Celius in January and extremely high up to 40^0 Celsius during June.

Conclusion and Recommendations

The climate of Balochistan is dry continental mountainous (North), dry continental plains (South and southeast), dry continental desert (Southwest), and pleasant maritime (South). The climate in the north is under the influence of mountains and forests, southeast and south by the continental plain and desert, southwestern part by continental desert, and the coastal region by Arabian Sea. Based on precipitation, the area is characterized by Arid and Semi-Arid continental climate. In the mountains north, the summers are short and mild, while the winters are longer and the chill except in the coastal and plain areas, where the summers are long and winters are short and pleasant. The agriculture-based on lift, karate, wells and tubewells irrigation system and requires the

construction of dams, trai, Khushkaba, sailaba and barrages. The eastern, southern, and central part of the province remains mild, whereas the eastern part has an extreme high temperature during summer. In Quetta and Zhob region, the temperature remains low due to altitudinal influence during winter and becomes pleasant in summer. The relative humidity remains low in the plain and desert areas, while it is high to moderate in the mountainous north. The northern part of the province recorded the highest number of rainy days as compared to the plain. The air pressure of the province remains low at the Kharan desert as well as Sibbi-Sarawan areas and high at the Quetta and surrounding mountainous region. The forests of the province are very rare for the survival of fauna and human and requires a green revolution. The climate of the area shows three distinct regions that are arid, semi-arid and maritime climate, which are further sub-divided into six meso and nine micro-regions.

References

Aftab, S. M., Durani, I. H., Adnan, S. (2018). Historical and Future Climatological Drought Projections Over Quetta Valley, Balochistan, Pakistan. *Materials Science and Engineering.*, **414**, 1-15.

Alghafari, Y., Khan, S. (2016). Temperature and Precipitation Fluctuation of Madinah-Al-Munawara, Kingdom of Saudi Arabia (1959-2011). *Atmospheric and Climate Sciences.*, **6**, 402-414.

Alghafari, Y., Khan, S. (2017). Temperature, Precipitation and Relative Humidity Fluctuation of Makkah Al Mukarramah, Kingdom of Saudi Arabia (1985-2016). *Transactions on Machine Learning and Artificial Intelligence*, Society for Science and Education United Kingdom., **6** (1), 42-58.

Baloch, S., Kumbhar, M. I., Rind. Z. K., Chang, F. K., Baloch, N. (2019). Effect of Climate Change on the Livelihood of Coastal Areas of Taluka Sonmaini, District Lasbela, Balochistan. *International Journal of Environmental Sciences & Natural Resources.*, **21** (1), 21-29.

Dost, S. K. Gulzar, A. Murshed, Z. (2008). Disaster Risk Management Plan District Quetta, Balochistan. A report of The Director General District Disaster Management Authority Balochistan, 108pages.

GoG. (2021). Berief papers on Global Climate Risk Index, 2021, Germanwatch e.V.Office Bonn Dr. Werner-Schuster-Haus Kaiserstr. 201 D-53113 Bonn, Barlin. 52p. online.https://germanwatch.org/sites/default/files/Global%20Climate%20Risk%20Index%202021_1.pdf

GoP. (1931, 1961, 1991, 2020). Climatic Normal of Pakistan, PMDC Karachi, 820pages.

GoP. (2017), District Census Reports of Balochistan. Population Census Organization, Statistical Division, Islamabad, 400Pages

Hasan, M., Khan, S. (2019). Climate Classification of Pakistan. *Int. J. Econ. Environ. Geol.*, **10** (2), 60-71.

Hasan, M., Khan, S., Javed, Z. H., Wahid, A., Ranjha, A. N. (2020). Climate of Gilgit-Baltistan Province, Pakistan. *Int. J. Econ. Environ. Geol.*, **11** (3), 16-21.

Hassani, T. J., Kanwa, S., Taj, M. K., Saddozai, S., Taj, I., Abbas, F., Ahmed, Z., Samad, A., Sheikh, I. S., Mustafa, M. Z., Samreen, Z. (2015). Water Pollution in Balochistan Province of Pakistan. *International Journal of Engineering and Applied Sciences.*, **2** (6), 89-90.

Imran, Z. (2013). Climate Change and its Impact on the Political Dynamics of Pakistan. CISSM Working Paper, Center for International and Security Studies at Maryland 4113 Van Munching Hall, School of Public Policy University of Maryland College Park, MD, 25pages.

Iqbal, F., Samiullah, M. (2018). Statistical Analysis of Rainfall Trend for the Nari River Basin of Balochistan. *International Journal of Current Research.*, **10** (4), 67576-67582.

IPCC. (2021). Summary for Policy Makers, Sixth Assessment Report, IPCC Secretariat c/o World Meteorological Organization7 bis, avenue de la Paix, P.O. Box 2300CH-1211 Geneva 2Switzerland. 14pages, online. https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf.

Kazi, S. A. (1951). Climatic Regions of West Pakistan. *Pakistan Geographical Review, Lahore.*, **VI** (1), 1-39.

Khan, F. K. (1991-93). A Geography of Pakistan. Environment, People Economy, Oxford University Press Karachi, Pakistan, 245pages.

Khan, J. A. (1993). The Climate of Pakistan. Rahber Publishers, Karachi, 79pages.

Khwajakhail , B. H., Durrani1, H., Syed, A., Khan1, A., Tareen, A., Durrani, N. A. (2020). Understanding Farmers' Risk Perception to Drought Vulnerability in Balochistan, Pakistan. *AIMS Agriculture and Food.*, **6** (1), 82–105.

Krakauer, N. Y., Jamro, S., Channa, F. N., Dars, G. H., Ansari, K. (2020). Exploring the Evolution of

Drought Characteristics in Balochistan, Pakistan. *MDPI, J. Applied Sciences.*, **10** (913), 1-15.

Nasrullah, K. (1968). The climate of West Pakistan According to Thornthwaite System of Classification of Climates. *Pakistan Geographical Review, Lahore.*, **23** (1), 12-25.

Raja, I. A., Twidal, J. W. (1990). Distribution of Global Insulation Over Pakistan. *Journal of Solar Energy*., **44** (2), 21-29.

Saleem, F., Hina, S. (2019). Historical Analysis (1981−2017) of Drought Severity and Magnitude Over a Predominantly Arid Region of Pakistan. *Climate Research.*, **78**, 189–204.

Salman, A., Rehman, A. (2013). A District Level Climate Change Vulnerability Index of Pakistan. CEECC Working Paper No. 5, Centre for Environmental Economics and Climate Change Pakistan Institute of Development Economics, Islamabad, Pakistan, 18pages.

Shah, M.A., Rehman, S., Salma, S. (2012). Rainfall Trends in Different Climate Zones of Pakistan. *Pakistan Journal of Meteorology*, Islamabad., **9** (17), 37-47.

Shamshad, K. M. (1988). The Meteorology of Pakistan. Climate and Weather of Pakistan, Royal Book Company, Karachi, Pakistan, 313pages.