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Research Article

Effect of Global Warming on Agriculture Areas in Pakistan

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Abstract

In this study, long-term average temperature and precipitation data for Pakistan between the years 1991-2021 were evaluated. In addition, long-term average humidity, number of rainy days and sunshine durations between the years 1999-2019 were analyzed. For this purpose, climate data were evaluated with regression analysis and the relationship between monthly changes was tried to be revealed. As a result of the study, it was seen that the long-term average temperature in Pakistan was 20.3 ºC ± 7.288; the average minimum temperature was 14.2 ºC ± 7.404; the average maximum temperature was 26.7 ºC ± 6.650. In addition, the long-term total precipitation average was 1377 mm ± 70.923; Humidity is calculated as 61% ± 11,057; the number of rainy days is 111 days ± 4.770 and the average sunshine duration is 9.8 hours ± 1,370. According to the results of study, Pakistan is negatively affected by global warming and climate change. According to research, Pakistan, which is highly vulnerable to weather conditions, is the 8th worst affected country in the world by climate change due to its impact on agriculture and livelihoods.

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KÜRESEL ISINMANIN PAKİSTAN'DAKİ TARIM ALANLARINA ETKISI

Özet

Bu araştırmada Pakistan 1991-2021 yılları arasındaki uzun yıllar ortalama sıcaklık ve yağış verileri değerlendirilmiştir. Ayrıca 1999-2019 yılları arasındaki uzun yıllar ortalama nem, yağışlı gün sayıları ile güneşlenme süreleri analiz edilmiştir. Bu amaçla iklim verileri regresyon analizi ile değerlendirilmiş ve aylık değişimler arasındaki bağıntı ortaya konulmaya çalışılmıştır. Çalışma sonucunda Pakistan da uzun yıllar ortalama sıcaklığın 20.3 ºC ± 7.288; ortalama minimum sıcaklığın 14.2 ºC ± 7.404; ortalama maksimum sıcaklığın 26.7 ºC ± 6.650 olduğu görülmüştür. Ayrıca uzun yıllar toplam yağış ortalamasının 1377 mm ± 70.923; Nem'in %61 ± 11.057; Yağışlı gün sayısının 111 gün ± 4.770 ve ortalama güneşlenme süresinin ise 9.8 saat ± 1.370 olduğu hesaplanmıştır. Çalışmanın sonuçlarına göre, Pakistan küresel ısınma ve iklim değişikliğinden olumsuz olarak etkilenmektedir. Araştırmalara göre, hava koşullarına karşı oldukça savunmasız olan Pakistan, tarım ve geçim kaynakları üzerindeki etkileri nedeniyle iklim değişikliğinden en kötü etkilenen Dünyada 8. ülke konumundadır.

Anahtar Kelimeler
Küresel ısınma
İklim değişikliği
Tarım
Çevre
Pakistan

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1. INTRODUCTION

Long-term changes in temperatures and weather patterns are referred to as climate change, and they are the primary result of human activity [1]. One of the biggest issues the world is dealing right now is climate, which is changing by each passing day. The 2000s was by far the hottest decade on record and the warmest year was 2016 [2]. The observed mean temperature has been increasing over the last few decades, with a range of 0.78 to 1.5 °C and is expected to range from 2 to 4 °C at the end of this century [3,4]. So , all global economic sectors are under considerable threat from climate change, particularly the agriculture sector is especially vulnerable because of its high dependence [5]. Therefore, climate change has direct impact on the production of agriculture in all over the world [6,7].

The effect of global warming on agricultural production varies from area to area. The primary reason for this is the variation in several climatic variables, such as annual average precipitation, rainy days, sunshine hours, humidity, temperature, irrigation water availability, and land use patterns, all of which affect agricultural productivity. [8,9,10]. More than 70% of Pakistan's agriculture previously depended directly on rainfall and temperature.

These two variables have always played a significant role in Pakistan's agricultural system [11,12,6]. More than two-thirds of the population (62%) pakistan depends on agriculture, as agriculture contributes (21%) to the Gross Domestic Product-GDP and 44% of the workforce [13]. According to previouse reports, Pakistan is currently regarded as one of the 10 nations in the world that face the greatest threat from climate change [14,15]. According to weather of Pakistan, two different types of crops are grown annually. They are (i.e. Rabi) and (kharif crops). Rabi crops grown in (Oct-April) which include (oil seeds, gram, wheat and barley) and kharif crops grown in (May-Oct) months include (maize, cotton, Rice, Sorghum and sugarcane) [16]. Some major studies predict global warming will have negative effect on i.e. Rabi and Kharif crops. So, frequent climatic fluctuations in Pakistan have directly caused a number of

detrimental consequences on food production, and agriculture reflecting major economic and traditional loss [17]. According to numerous earlier research [18,19,20]. Pakistan is anticipated to suffer from the largest agricultural output losses in line with current trends and predicted scenarios of climate change in the future as well. This research focused on effect of global warming on agriculture area in Pakistan.

One of the largest nations in South Asia is Pakistan, which situated in a strategically significant and advantageous area [21]. With a population of more than (249.5) million, it is the fifth-most populated nation in the world [22]. As well as, Pakistan is the second-largest nation in South Asia and the 33rd-largest nation in the world [23,24]. It is surrounded by India to the east, Afghanistan to the west, Iran to the southwest, and China to the northeast. It has a 1,046 kilometer (650-mile) coastline along the Arabian Sea and Gulf of Oman in the south [25]. According to climate classification, Pakistan's climates vary due to factors like latitude, sea level, topography, and vegetation. As well as Pakistan has been divided into four temperature-based regions: hot, warm, mild, and cold. Pakistan's southern regions have high temperatures (28°C in Hyderabad), which drop to 10°C in the north at Astore. As well as there are four distinct rainfall regions: desert, semi-arid, sub-humid, and humid [25].

2. MATERIAL AND METHOD

This study focused on the impact of global warming on agricultural areas in Pakistan. The standard deviation has been used to calculate data as a measure. Higher standard deviation values suggest greater data variable variability, whereas lower standard deviation values denote less variability in data. Another statistical method which is used in this study is linear regression approach to modeling the relationship between actual value and predicted value of climatic parameters (precipitation, rainy days, sunny hours, Humidity and temperature).

Figure 1. The location of Research Area (Pakistan)

Calculated data included weather parameters from (1991-2021) for temperature and Precipitation and from (1999-2019) for humidity, rainy days and sunny days. Linear regression model was used to evaluate the data. Regression analysis is a method for describing quantitative connections between one or more explanatory factors and a response variable [27,28] .

3. RESULT AND DISCUSSION

The climatic variability statistics are shown in Figures 2 include the minimum, maximum temperature, the average temperature and precipitation. Figures 3 include the Rainy days, humudity and sunny days. As well as all climatic parameters' values are shown in table 1.

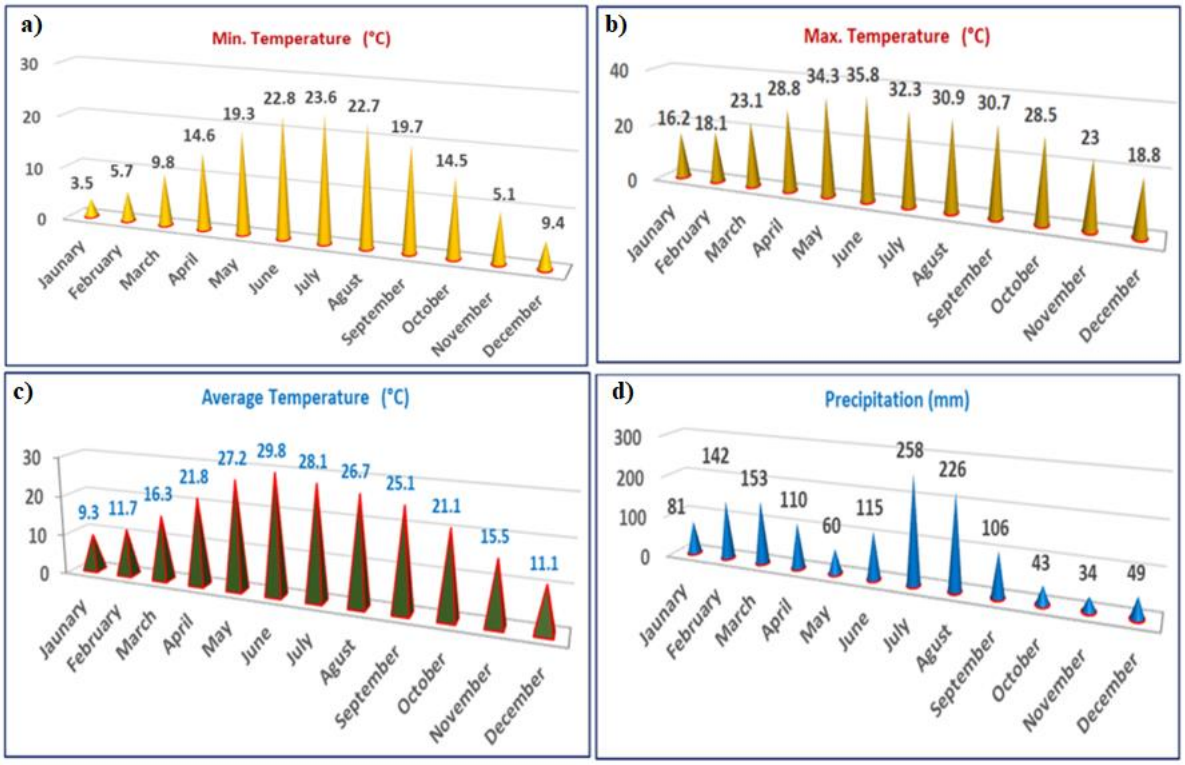
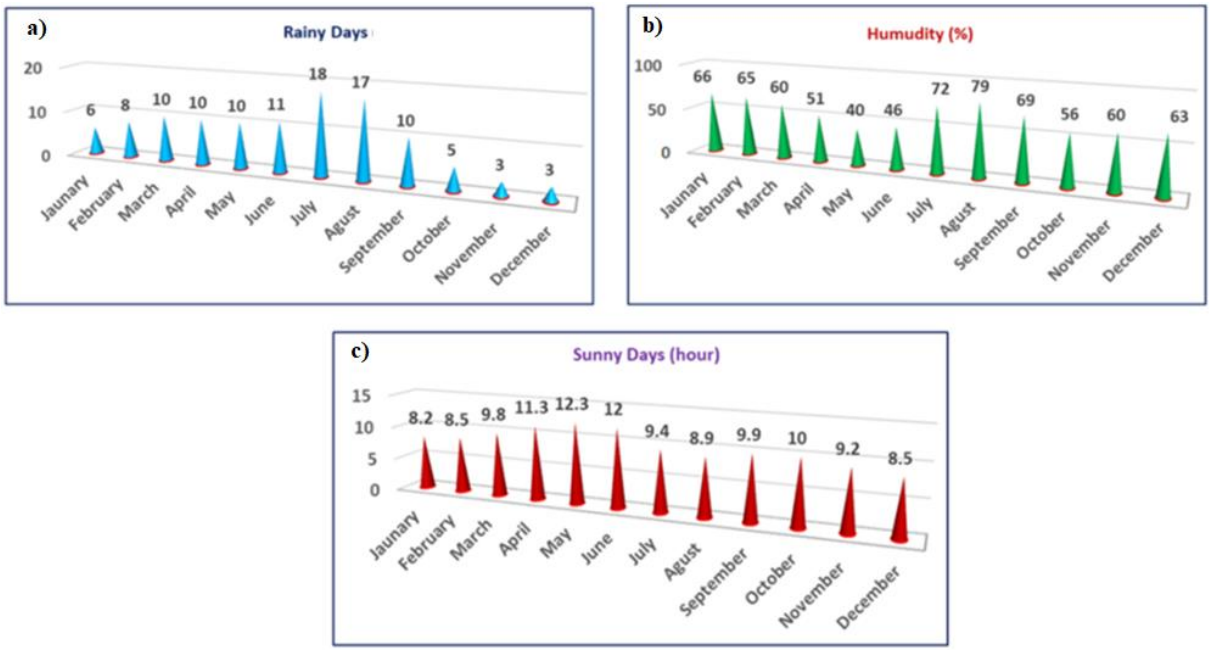


Figure 2. Distributions of Temperature and Precipitation (1992-2021)
(a; Min temperature, b; Max. Temperature, c; Average Temperature, d; Precipitation)

The average highest minimum temperature for many years is seen in July as 23.6 ºC. The lowest minimum temperature was seen in January as 3.5 ºC. When looking at the maximum temperature values, it was seen that the highest temperature was in June as 35.8 ºC. The lowest maximum temperature was recorded in January as 16.2 ºC. When looking at the temperature averages for many years, it was seen in June as 29.8 ºC. The lowest average temperature was recorded in January as 9.3 ºC. When looking at the total precipitation values, it was seen that the highest precipitation was in July as 258 mm. The lowest total precipitation was recorded in November as 34 mm. As well as , the months with the most and least precipitation totals were respectively July and November. From January to July, the lowest temperature fluctuated. As well as , the months with the highest and lowest average temperatures were June and January, respectively (the average of 1992-2021 years).

The year's high temperature was in June, while the lowest recorded maximum temperature occurred in January Figure 2. Climate models, in particular, predict temperature rises in the

Asian region of between 0.5-2°C by 2030 and 1-7°C by 2070. In Pakistan's arid north, temperatures are anticipated to increase more quickly. [29,30,31].



Figures 3. Distributions of Rainy days (a) , Humudity (b) and Sunny days (c) (1999-2019)

Meanwhile, sunny days (8.2 hour) has lower values as compared to all other variables of rainy days (3 day) and humidity (40%) which means these variables has very less variability betwen 1999 to 2019 years. According figures 3. The year's longest days of sunlight were recorded in May (12.3 hour), while the fewest were recorded in January (8.2 hour). July shows the most rain days (18 day), while November and December shows the least. May recorded the lowest humidity (40%), while August (79%) experienced the highest.

Table 1. Some statistical values of climate paremeter

Climate Parameters	Average and Total Values	R^2	SD
Average Temperature (°C)	**20.3**	**0.031**	**7.288**
Min. Temperature (°C)	**14.2**	**0.0420**	**7.404**
Max. Temperature (°C)	**26.7**	**0.0406**	**6.650**
Precipitation (mm) (Total)	**1377**	**0.0686**	**70.923**
Humidity (%)	**61**	**0.0210**	**11.057**
Rainy Days (Total)	**111**	**0.0505**	**4.770**
Sunny Hours (hour)	**9.8**	**0.0066**	**1.370**
Temperature and Precipitation (1991-2021); Humudity, Rainy days, Sunny days (1999-2019)			

The values of all climatic variable data explained by doing statistical analysis between months and climatic change paremeters. It was found that average precipitation 1377 mm ± 70.923 has total precipitation in annually followed by total rainy days 111 day ± 4.770, average min. temperature 14.2 ^{o}C ± 7.404, average max. temperature 26.7 ^{o}C ± 6.650, annually average temperature 20.3 ^{o}C ± 7.288 and average humidity 61% ± 11.057 while average sunny hours 9.8 hour ± 1.370 has total and average values. Agriculture play a significant role in economic livelihoods and the most significant factor affecting agricultural production is the climate [32].

Most researches stated that, Pakistan is listed as one of the top 8 nations that are most impacted by climatic changes which can be favorable and unfavourable [33,34].

As stated by researcher the relationship between rice output in Pakistan and carbon dioxide (CO_2) emissions, average temperature, planted area, and fertilizer use was explored. The most useful finding of this study is that carbon dioxide (CO_2) emissions have a favorable long- and short-term impact on rice production in Pakistan [35].

It was evaluated the effects of climate change on a region in Pakistan using the Ordinary Least Square approach. They looked into whether a temperature increase of up to 3 ^{0}C would shorten the growth season length (GSL) of this country's wheat production.

Their findings demonstrated that Chitral district would benefit from rising temperatures because of its high altitude locations that cause rising temperature have positive effects on wheat crop [36].

In addition, climat change have nagative impact on grains yield. According to the Global Climate Change Vulnerability Index (CCVI) study Pakistan was the 29th most vulnerable region between 2009 and 2010 and the 16th most vulnerable region between 2010 and 2011 [37,38]. Therefore, agriculture sector is more vulnerable to the effects of climate change because crops production in these parts of the world is low technology based.

It was reported that the temperature rise during the growing season had a detrimental effect on the output of maize production. According to a study, climate change would reduce Pakistan's agricultural productivity by 8-10% through 2040, with wheat being one of the biggest losers [5].

According to a different study given by Khan et al. 2020, wheat and rice (particularly Basmati rice) crops will experience the harshest effects of climate change in the upcoming years [39].

4. CONCLUSION

Climate change explains changes in the parameters of the atmosphere over time scales ranging from ten years to billions of light years. Therefore, these parameters have been important to the lifestyle during these time periods. Impact of climate change on agricultural productivity is a widely studied topic.

Climate change is posing a serious threat to all economic sectors around the world, particularly the agricultural sector because of its high dependency.

Crop seasons are predicted by the global change ımpact study centre to be shifting and getting shorter as a result of climate change. In the future, it will have a significant impact on crop productivity.

One of the main assets in the country's economy is the contribution of agriculture. Therefore, the issue that people are concerned about is the impact of climate change on agriculture. According to studies, Pakistan, which is highly vulnerable to weather, has been ranked as the 8th most badly impacted country by climate change due to its implications on agriculture and livelihoods. Meanwhlie. it has been reported, these climat change impacts can be positive and negative during the years. By they way, If governments and climate activists want to quickly achieve environmental reforms, they must improve communication and provide greater support.

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