International Journal of Education, Modern Management, Applied Science & Social Science (IJEMMASSS)
ISSN : 2581-9925, Impact Factor: 6.340, Volume 04, No. 01(III), January - March, 2022, pp.65-74

IMPACT OF CLIMATE CHANGES: A GEOGRAPHICAL STUDY OF BIKANER DISTRICT

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ABSTRACT

At present, climate change is standing in front of the whole world as a serious problem, Bikaner district has also not remained untouched by this problem. Due to climate change, the situation of divergence in various climatic components is also seen in Bikaner district. The main objective of this paper is to assess the speed and direction of changes in the climatic variables due to climate change in the study area. The researcher has analyzed various climate variables such as temperature, air pressure, humidity, precipitation, and wind speed between the years 1981 to 2020 in this study. Statistical tools like linear regression, standard deviation and Coefficient of variation etc. have been used by the researcher for the analysis of climate variables. Bikaner district is located in the far west of the Indian state of Rajasthan. It is situated between 27°11' to 29°03' north latitude and 71°54' to 74°12' east longitude. Bikaner district is spread across an area of 30,247.90 sq. km. The district is located on the western border of the country; hence the importance of this district increases even more. Bikaner district is a part of the arid region of Rajasthan, thus there are extreme climatic conditions. In the district, high temperature and low humidity prevail for most of the months of the year. The analysis of climatic variables in the study area Bikaner district shows that there has been a decrease in the minimum and highest temperatures, due to which a partial increase in air pressure is reflected here. In the last four decades, there has been an increase in relative humidity here, whose effect is seen on the precipitation here, there has been a partial increase in the amount of precipitation, as well as a partial decrease in the wind speed here in the last four decades. Keeping in view the above circumstances, it can be clearly stated that deviation can be seen in various climatic variables due to climate change in the study area.

Keywords: *Climate Change, Temperature, Relative Humidity, Surface Soil Wetness and Precipitation.*

Introduction

Climate change is the subject of how weather patterns change over decades or longer. Climate change takes place due to natural and human influences. Since the Industrial Revolution (i.e., 1750), humans have contributed to climate change through the emissions of GHGs and aerosols, and through changes in land use, resulting in a rise in global temperatures.[i] There is no denying that climate change is currently the biggest challenge facing global society and tackling it has become a great necessity of the present times. Statistics show that the average earth's surface temperature has risen by about 1.62 degrees Fahrenheit (i.e. about 0.9 degrees Celsius) since the end of the 19th century. In addition, seawater levels have also increased by about 8 inches since the last century. Statistics also show that it is time to seriously consider climate change.[ii]

Bikaner district has also not been unaffected by climate change. If data for more than 30 years of various climate related components are analysed in the Bikaner district, it is clear that there has been a drastic change in the pattern of important climate components like air pressure, rainfall distribution, temperature and humidity in the study area, the impact of which is visible not only on local weather but also it can be seen the serious impact on various aspects of human life.

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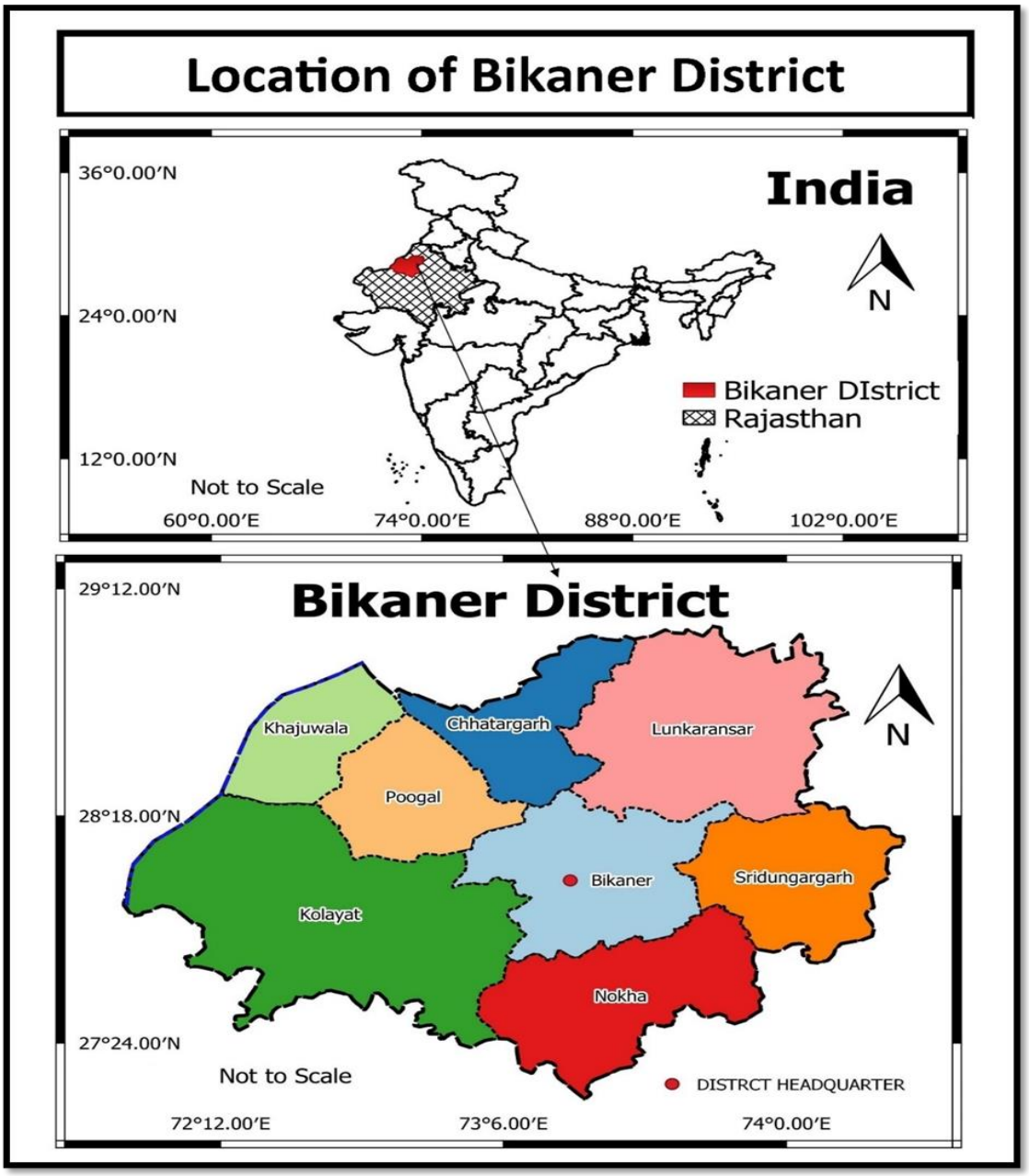
Study Area Profile

Bikaner district is located in the northern-western part of the state. It is located between 27°11' to 29°03' north latitude and between 71°54' to 74°12' east longitude. (District Statistical Outline Bikaner, 2015) Bikaner district is bounded by Sriganganagar district on the north, Churu district on the east, Jodhpur and Nagaur district on the south, Jaisalmer on the south-west and international boundary adjoining Pakistan on the west. Bikaner district is spread over in the area of 30,239 sq. km. (DCHB Bikaner, 2011). Bikaner district has total geographical area is 30,41,753 hectares. In the study area Lunakaransar tehsil is the largest tehsil according to area which is spread over 5,08,273 hectare area and Khajuwala tehsil is smallest in terms of the area it has area an 1,96,788 hectares.

Figure 1



Bikaner district has a total of 951 villages, in which the maximum number from Kolayat tehsil has 245 and the lowest is from Khajuwala tehsil which is only 58 villages. The maximum part of the district is includeed in desolate and dreary regions, which is a part of the Desert of Thar. Bikaner district has no one river system. Near Kolayat few little intermittent water channels can be seen during the rainy season only. The Bikaner district is remarked for the high temperature, high dryness, scarcity of precipitation, that's are the major features of the desert climate. From November to March is found winter season in the district followed by the summer season in the district in April to June. The Monsoon (south-west) season is constituted from July to mid-September, while the period of mid-September to October is counted in the in-between post-monsoon.

Objective and Methodology

The main objective of this study is to analyse various components of climate in the study area Bikaner district to assess the direction and speed of various climate change trends in the study area. In the present research paper, various components of climate such as air pressure, temperature, humidity and rainfall distribution etc were analysed from 1981 to 2020. The research paper is mainly based on secondary climate data. These figures are for the period between 1981 and 1920. All these data have been obtained from Meteorological Department Office in Jaipur, Rajasthan. The study presented uses a variety of statistical tools to identify the trends in various climatic data using Linear Regression, Standard deviation, deviation coefficient, Average, percentage, etc. An attempt has been made to display the findings from the adjective of data by a variety of diagrams.

Review of Literature

Kunkel, K.E. et al. (2013)[iii] in its study studying the regional pattern of climate change in the United States has clarified that climate change has emerged as a serious problem in the United States leading to widespread changes in temperature, rainfall, humidity, etc. Dalton et al. (2013)[iv] In their study, the United States analyzed climate change data in the north western region of the United States, explaining that climate change in the United States has led to regional deviations in components of different climates. Feely et al. (2012)[v] in their study studying climate change on natural resources in the north western states of the United States has clarified that natural resources are continuously shrinking due to climate change.

Discussion

The paper presents point to point analysis of various climatic components like temperature, air pressure, humidity, precipitation and wind etc.

Temperature

Temperature is an important component of climate, which is why if there is partial changes in temperature in the context of the long period of any region, the result is a change in the entire atmospheric conditions of the associated region, which directly and indirectly affects the entire biodiversity, landscape, cultural landscape and all socio-economic activities of the human being. (Bonfils, C., and Coauthors. 2008.) [vi] Therefore, various studies related to climate change have given special importance to temperature. Table 1 represents an annual average, deviation and co-efficient value of minimum temperature in the study area during the period of 1981 to 2020.

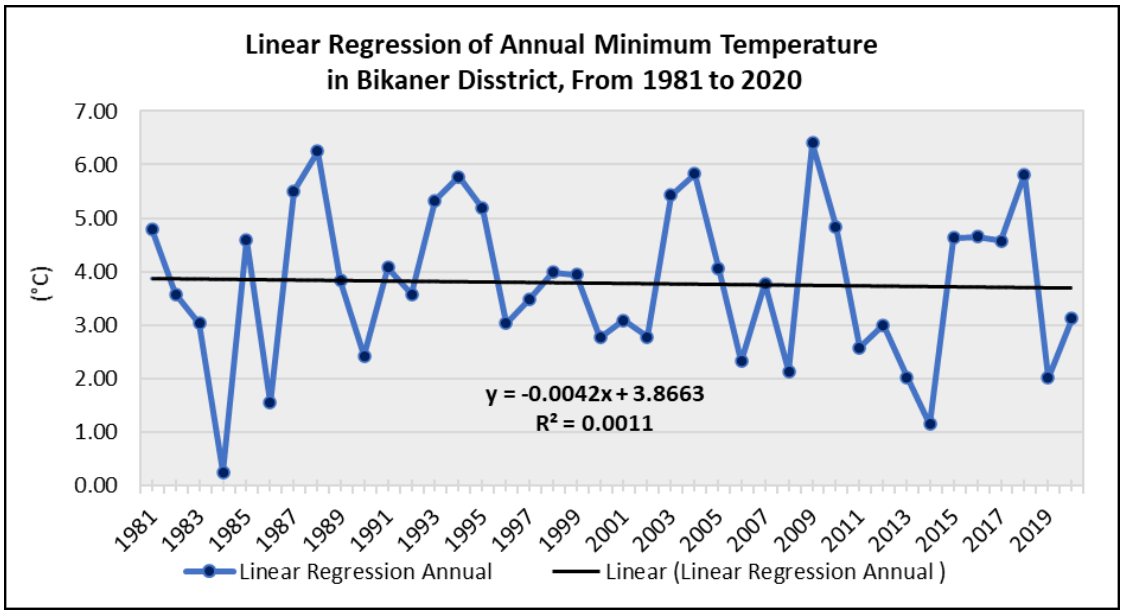
Table 1: Trends of Annual average, SD and CV of Minimum Temperature in study area (1981-2020)

Year	Annual Average	SD	CV (%)	Year	Annual Average	SD	CV (%)
1981	4.8	7.861	61.059	2001	3.09	8.497	36.365
1982	3.58	7.789	45.958	2002	2.78	9.122	30.476
1983	3.03	8.841	34.272	2003	5.43	8.288	65.520
1984	0.25	9.274	2.696	2004	5.83	8.160	71.443
1985	4.6	8.121	56.637	2005	4.06	8.539	47.544
1986	1.55	8.326	18.615	2006	2.32	8.310	27.918
1987	5.51	8.007	68.809	2007	3.78	8.399	45.003
1988	6.25	7.835	79.767	2008	2.14	8.608	24.860
1989	3.83	8.165	46.906	2009	6.4	7.561	84.643
1990	2.43	8.668	28.035	2010	4.84	7.832	61.801
1991	4.08	9.129	44.691	2011	2.58	8.568	30.113
1992	3.58	7.765	46.105	2012	3	9.231	32.499

1993	5.33	7.950	67.044	2013	2.03	8.928	22.736
1994	5.77	7.432	77.637	2014	1.15	8.892	12.933
1995	5.19	8.246	62.936	2015	4.63	7.790	59.435
1996	3.03	7.726	39.219	2016	4.65	7.524	61.804
1997	3.48	8.265	42.103	2017	4.57	8.376	54.560
1998	3.99	7.968	50.076	2018	5.82	7.550	77.085
1999	3.94	8.665	45.471	2019	2.02	9.523	21.212
2000	2.77	8.740	31.694	2020	3.12	8.645	36.089

Source: Meteorological Centre, Jaipur, Rajasthan

Figure 2



Source of Data: Meteorological Centre, Jaipur, Rajasthan

In The study Area Bikaner district, the value of Coefficient of determination of linear regression is 0.0011, the value of y is -0.0042 and the value of X is +3.8663, hence it is clear that there is a declining trend in minimum temperature in the study area during the said period. Similarly, on finding the linear regression of the highest temperature data of Bikaner district from the year 1981 to the year 2020, the value of Coefficient of determination is -0.0058, the value of y is -0.006, and the value of X is +46.362. Thus, the trend of negative growth in the highest temperature is seen in Bikaner district during the said period. Table 2 shows the highest temperature data in Bikaner district for the period 1981 to 2020. From whose observation it is known that in Bikaner district between the year 1981 to the year 2020, the highest annual highest temperature was 47.75 °C in the year 1994 and the lowest annual highest temperature was 43.71 °C in 2008.

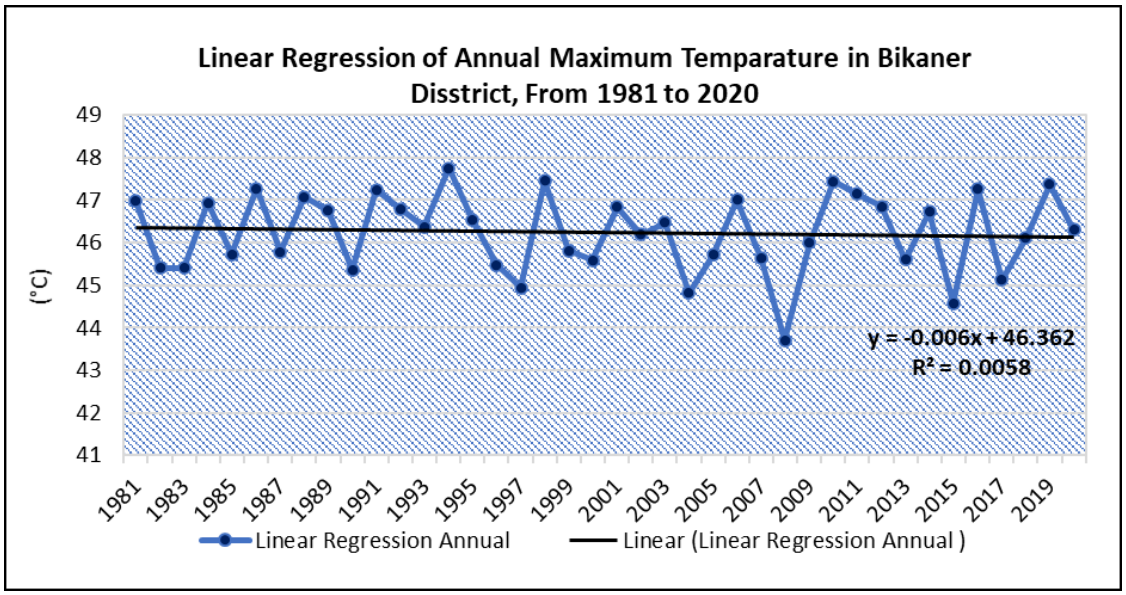
Table 2: Trends of Annual average, SD and CV of Maximum Temperature in Study Area (1981-2020)

Year	Annual Average	SD	CV (%)	Year	Annual Average	SD	CV (%)
1981	46.98	6.978	14.852	2001	46.84	5.610	11.977
1982	45.4	6.448	14.202	2002	46.19	6.274	13.583
1983	45.4	6.663	14.676	2003	46.47	5.460	11.749
1984	46.93	7.074	15.074	2004	44.82	5.688	12.690
1985	45.73	6.307	13.793	2005	45.71	6.799	14.873
1986	47.28	6.980	14.763	2006	47.01	6.149	13.080
1987	45.78	6.163	13.463	2007	45.65	6.381	13.978
1988	47.08	6.313	13.410	2008	43.71	5.217	11.935
1989	46.76	6.597	14.107	2009	46	6.351	13.807

1990	45.37	5.463	12.042	2010	47.44	6.929	14.606
1991	47.24	5.788	12.253	2011	47.14	6.604	14.009
1992	46.79	6.103	13.043	2012	46.85	6.957	14.849
1993	46.37	5.849	12.614	2013	45.61	6.328	13.873
1994	47.75	5.696	11.928	2014	46.73	6.777	14.503
1995	46.53	6.590	14.163	2015	44.58	5.964	13.379
1996	45.48	6.340	13.940	2016	47.26	5.925	12.538
1997	44.94	6.694	14.895	2017	45.12	6.157	13.645
1998	47.45	6.554	13.813	2018	46.11	6.113	13.257
1999	45.81	6.310	13.773	2019	47.37	7.254	15.314
2000	45.59	5.698	12.499	2020	46.3	6.482	13.999

Source: Meteorological Centre, Jaipur, Rajasthan

Figure: 3



Source of Data: Meteorological Centre, Jaipur, Rajasthan

Air Pressure

Atmospheric pressure means the weight of a column of air at a given place and time. It is measured in 'barometer' as force per unit area. As it is known, there is an inverse correlation between temperature and air pressure, that is, when the temperature increases, the air pressure decreases, on the contrary, when the temperature decreases, the air pressure increases. As the temperature in the study area has decreased marginally during the period 1981 to 2020, the study area also sees an increase in the same proportion of air pressure. The value of the Coefficient of determination is 0.0723 when the linear regression of the average annual air pressure data of Bikaner district during the period 1981 to 2020 is obtained, while the value of y is 0.0012 and the value of x is 98.1 80. Bikaner district recorded the highest average annual air pressure between 1981 and 2020 at 98.23 hpa in 1997 and minimum air pressure at 98.2 hpa in 2000. Table 3 displays the distribution of the annual air pressure in Bikaner district.

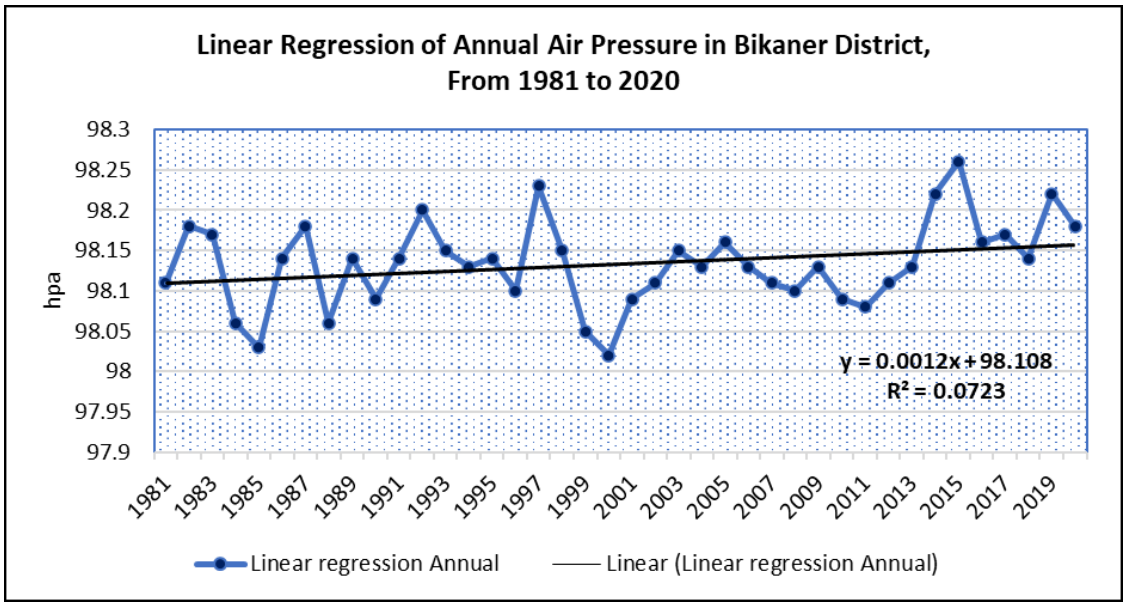
Table 3: Trends of Annual Average, SD and CV of Air Pressure in Study Area (1981-2020)

Year	Annual Average	SD	CV (%)	Year	Annual Average	SD	CV (%)
1981	98.11	0.719	0.733	2001	98.09	0.659	0.672
1982	98.18	0.669	0.681	2002	98.11	0.675	0.688
1983	98.17	0.671	0.683	2003	98.15	0.686	0.699
1984	98.06	0.710	0.724	2004	98.13	0.663	0.676
1985	98.03	0.656	0.669	2005	98.16	0.664	0.677

1986	98.14	0.682	0.695	2006	98.13	0.670	0.682
1987	98.18	0.678	0.691	2007	98.11	0.688	0.702
1988	98.06	0.692	0.705	2008	98.1	0.651	0.664
1989	98.14	0.651	0.663	2009	98.13	0.646	0.659
1990	98.09	0.689	0.703	2010	98.09	0.602	0.614
1991	98.14	0.708	0.721	2011	98.08	0.652	0.665
1992	98.2	0.697	0.710	2012	98.11	0.654	0.667
1993	98.15	0.681	0.694	2013	98.13	0.694	0.707
1994	98.13	0.715	0.729	2014	98.22	0.653	0.665
1995	98.14	0.726	0.740	2015	98.26	0.638	0.649
1996	98.1	0.650	0.663	2016	98.16	0.640	0.652
1997	98.23	0.675	0.688	2017	98.17	0.647	0.659
1998	98.15	0.675	0.688	2018	98.14	0.669	0.682
1999	98.05	0.702	0.716	2019	98.22	0.696	0.709
2000	98.02	0.649	0.662	2020	98.18	0.683	0.696

Source: Meteorological Centre, Jaipur, Rajasthan

Figure 4



Source of Data: Meteorological Centre, Jaipur, Rajasthan

Relative Humidity

The amount of water vapour present in a certain volume of air at a given temperature and the amount of water vapor required to saturate the same air at the same temperature, the ratio of these two quantities is called relative humidity or RH. Relative humidity = pressure of water vapor presented / saturated pressure of water vapor at the same temperature The pressure of water vapor, after finding the dew point, is calculated from Reno's table. (Polley, H. W. et al., 2013.)[vii]

On studying the time lying distribution of relative humidity in the study area, it is clear that there has been a substantial increase in the amount of relative humidity in Bikaner district during the period from 1981 to 2020. The value of the Coefficient of determination is 0.1794, the value of y is 0.1417 and the value of X is 29.34, which shows that the amount of relative humidity in Bikaner district has increased substantially in the last four decades. The highest annual relative humidity in Bikaner district during this period was recorded at 40.75% in 2020, while the minimum annual relative humidity was recorded at 24.56% in 2002.

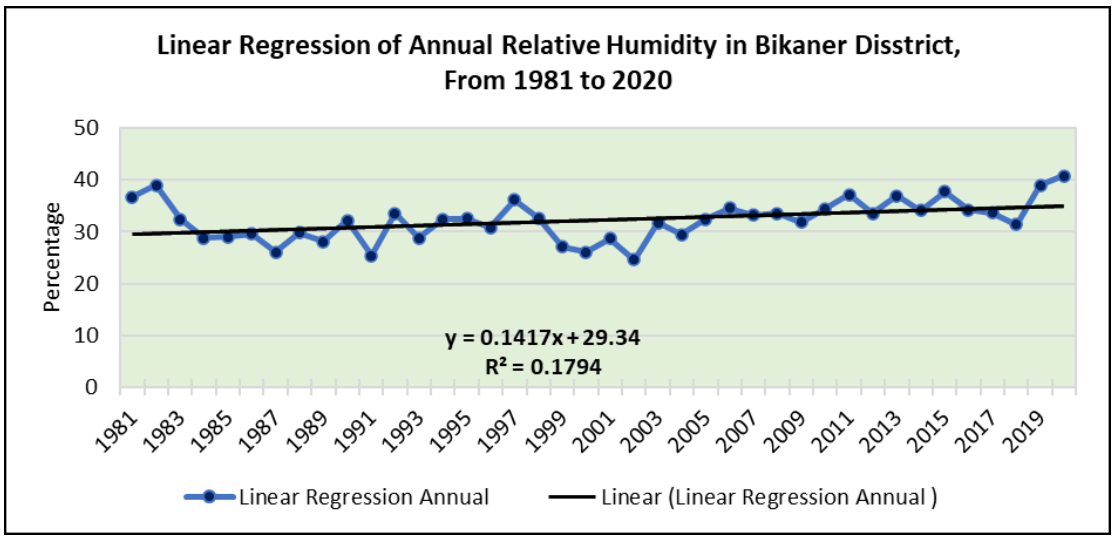
Table 4 Displays the Distribution of Annual Relative Humidity between 1981 and 2020 in Bikaner District

Table 4: Trends of Annual average, SD and CV of Relative Humidity in Study Area (1981-2020)

Year	Annual Average	SD	CV (%)	Year	Annual Average	SD	CV (%)
1981	36.69	12.227	33.324	2001	28.69	11.468	39.973
1982	39	6.845	17.550	2002	24.56	5.870	23.901
1983	32.38	10.602	32.742	2003	31.75	13.227	41.660
1984	28.81	9.839	34.151	2004	29.5	9.478	32.128
1985	29	9.483	32.700	2005	32.44	10.097	31.126
1986	29.62	8.933	30.157	2006	34.5	10.292	29.833
1987	26.06	8.161	31.318	2007	33.19	10.249	30.879
1988	29.81	11.751	39.420	2008	33.56	11.255	33.538
1989	28.06	9.836	35.053	2009	31.88	9.078	28.477
1990	32.12	10.777	33.553	2010	34.44	13.183	38.278
1991	25.38	7.314	28.817	2011	37.12	12.551	33.811
1992	33.5	11.537	34.439	2012	33.56	11.875	35.383
1993	28.81	10.814	37.535	2013	36.94	10.672	28.890
1994	32.44	14.180	43.711	2014	34.12	8.688	25.463
1995	32.56	10.895	33.462	2015	37.69	9.590	25.444
1996	30.81	11.585	37.603	2016	34.19	11.319	33.108
1997	36.12	11.218	31.059	2017	33.62	11.424	33.979
1998	32.62	10.568	32.397	2018	31.38	12.322	39.266
1999	27.06	9.728	35.949	2019	39	10.873	27.880
2000	26.06	9.929	38.102	2020	40.75	9.465	23.226

Source: Meteorological Centre, Jaipur, Rajasthan

Figure: 5



Source of Data: Meteorological Centre, Jaipur, Rajasthan

Precipitation

Precipitation is water released from clouds in the form of rain, freezing rain, sleet, snow, or hail. It is the primary connection in the water cycle that provides for the delivery of atmospheric water to the Earth. Most precipitation falls as rain. (Masson, D., & Cummins, P. F. 2007).[viii] It is known that precipitation is related to the humidity of the atmosphere. If the humidity of the atmosphere increases, it also increases the amount of precipitation. The effect of the increase in the amount of relative humidity in the study area in the last four decades is also seen here on the pattern of precipitation. Bikaner district has seen a substantial increase in the amount of precipitation in the last four decades. In Bikaner district,

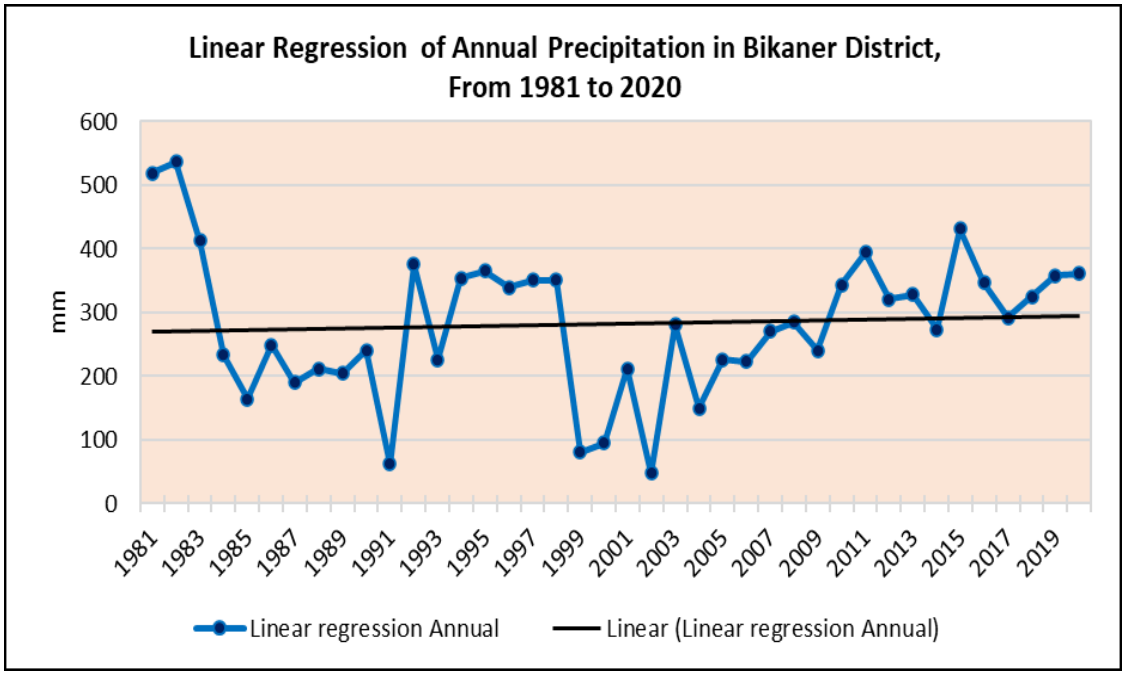
the value of Coefficient of determination is 0.0043, the value of y is 0.6263 and the value of x is 268.85, which shows that the amount of precipitation in Bikaner district has increased. The highest quantity of precipitation in Bikaner district during the period 1981 to 2020 was recorded at 536.55 mm in 1982 while the minimum quantity was recorded at 47.45 mm in 2002. Table 5 displays the annual precipitation volume between 1981 and 2020 in Bikaner district.

Table 5: Trends of Annual Average, SD and CV of Annual Precipitation in Study Area (1981-2020)

Year	Annual Average	SD	CV (%)	Year	Annual Average	SD	CV (%)
1981	3.48	0.807	23.191	2001	3.53	1.034	29.283
1982	3.41	0.730	21.410	2002	3.51	1.103	31.422
1983	3.1	0.623	20.091	2003	3.3	0.770	23.328
1984	3.65	1.101	30.170	2004	3.41	0.972	28.519
1985	3.59	1.083	30.166	2005	3.38	0.882	26.109
1986	3.52	0.704	20.001	2006	3.5	0.808	23.094
1987	3.43	0.772	22.504	2007	3.35	0.965	28.792
1988	3.71	1.011	27.241	2008	3.3	0.812	24.601
1989	3.62	0.905	25.002	2009	3.31	0.586	17.692
1990	3.6	0.923	25.646	2010	3.19	0.611	19.142
1991	3.48	0.855	24.582	2011	3.36	0.800	23.806
1992	3.39	0.705	20.795	2012	3.41	1.062	31.139
1993	3.59	0.963	26.832	2013	3.43	0.958	27.942
1994	3.45	0.770	22.310	2014	3.46	1.001	28.929
1995	3.33	0.726	21.815	2015	3.21	0.519	16.183
1996	3.41	0.715	20.961	2016	3.3	0.784	23.771
1997	3.61	0.785	21.741	2017	3.24	0.756	23.325
1998	3.34	0.857	25.663	2018	3.22	0.787	24.433
1999	3.66	1.199	32.766	2019	3.17	0.701	22.098
2000	3.85	1.200	31.165	2020	3.28	0.645	19.651

Source: Meteorological Centre, Jaipur, Rajasthan

Figure 6



Source of Data: Meteorological Centre, Jaipur, Rajasthan

Wind Speed

Wind speed is a fundamental atmospheric quantity. Air flows from high pressure to low pressure. Different places have different atmospheric pressure, which is due to the difference in temperature. Many functions are affected by wind speed, such as forecasting of weather, operation of aircraft and ships, construction work, development of many plant species and speed of metabolism etc. (C. Michael Hogan. 2010.)[ix] Wind speed has an effect on the weather forecast, aircraft movement, etc. But due to atmospheric pressure, the speed and direction of the wind change many times. Apart from this, due to the weather, there is a change in direction many times. The impact of climate change in the study area is also clearly visible on the speed of the wind. In Bikaner district, the value of Coefficient of determination is 0.246 when the data on the speed of wind is determined by the linear regression of the time period from 1981 to 2020, while the value of y is 0.0069 and the value of x is 3.568. Thus, it is clear that there has been a sharp decrease in the wind speed in Bikaner district in the last four decades. The highest annual wind speed in Bikaner district during the period 1981 to 2020 was recorded at 3.85 m/s in 2000 and minimum wind speed at 3.1 in 1983.

Table 6: Trends of Annual Average, SD and CV of Wind Speed in Study Area (1981-2020)

Year	Annual Average	SD	CV (%)	Year	Annual Average	SD	CV (%)
1981	3.48	0.807	23.191	2001	3.53	1.034	29.283
1982	3.41	0.730	21.410	2002	3.51	1.103	31.422
1983	3.1	0.623	20.091	2003	3.3	0.770	23.328
1984	3.65	1.101	30.170	2004	3.41	0.972	28.519
1985	3.59	1.083	30.166	2005	3.38	0.882	26.109
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1991	3.48	0.855	24.582	2011	3.36	0.800	23.806
1992	3.39	0.705	20.795	2012	3.41	1.062	31.139
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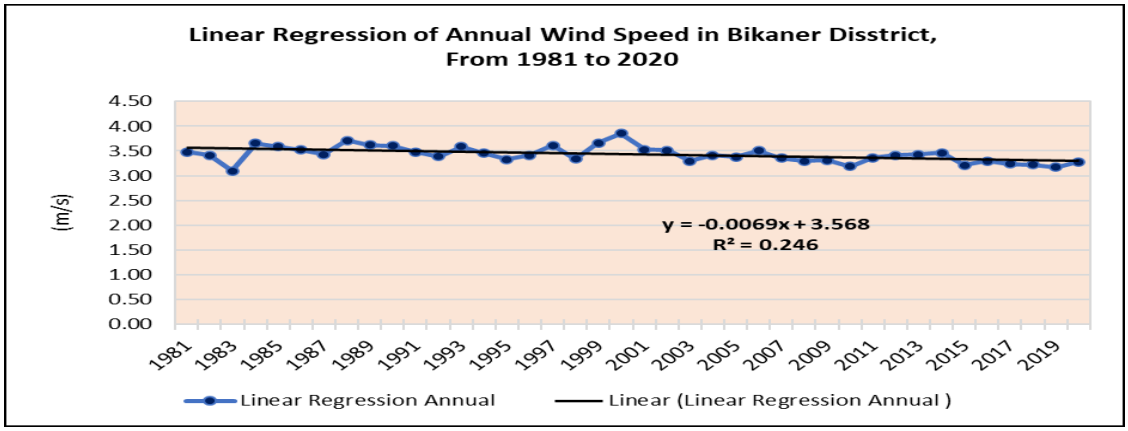
1997	3.61	0.785	21.741	2017	3.24	0.756	23.325
1998	3.34	0.857	25.663	2018	3.22	0.787	24.433
1999	3.66	1.199	32.766	2019	3.17	0.701	22.098
2000	3.85	1.200	31.165	2020	3.28	0.645	19.651

Source: Meteorological Centre, Jaipur, Rajasthan

Figure 7



Source of Data: Meteorological Centre, Jaipur, Rajasthan

Conclusion

Like other parts of the world, Bikaner district is currently undergoing climate change, which is causing a major change in many aquatic elements. While the temperature has decreased in the study area on the one hand, the study area has recorded an increase in the amount of air pressure, humidity and precipitation. Since agriculture is directly related to temperature, rainfall and humidity, it can be clearly stated that the way climate change is changing in Bikaner district will have a clear impact on agriculture.[x] The change in agricultural pattern in Bikaner district is constantly being seen. Where food grains crops were sown prominently in Bikaner district in the past, pulses and oilseeds are now being sown prominently, the changes in the agricultural format due to climate change will have a direct impact on the food security of the people here. Similarly, local biodiversity is also likely to be affected due to changes in climate components in Bikaner district. Climate change is also considered to be a major cause of the decline in the number of migratory birds and large-scale death at many places in Bikaner district. Similarly, due to the way the temperature and wind speed have been reflected in the study area, the development of alternative energy is also expected to be hampered shortly. Because the changes caused by climate change are not suddenly, but these changes are gradually completed. So, we have enough time to understand, address and manage the problem caused by climate change, only lack is the right determination to address climate change.

References

[i] http://www.wmo.int/pages/themes/climate/causes_of_climate_change.php

[ii] https://www.ipcc.ch/srocc/

[iii] Kunkel, K.E. et al. 2013: Regional Climate Trends and Scenarios for the U.S. National Assessment. Part 9. Climate of the Contiguous U.S.

[iv] Dalton et al. 2013: Climate Change in the Northwest: Implications for our Landscapes, Waters, and Communities

[v] Feely et al. 2012: Scientific Summary of Ocean Acidification in WA State Marine Waters

[vi] Bonfils, C., and Coauthors. 2008. Detection and attribution of temperature changes in the mountainous western United States. Journal of Climate, 21, 6404–6424. doi:10.1175/2008JCLI2397.1

[vii] Polley, H. W. et al., 2013. Climate Change and North American Rangelands: Trends, Projections, and Implications. Rangeland Ecology and Management, 66(5), 493-511.

[viii] Masson, D., & Cummins, P. F. (2007). Temperature trends and interannual variability in the Strait of Georgia, British Columbia. Continental shelf research, 27(5), 634-649.

[ix] Mote, P., Petersen, A., Reeder, S., Shipman, H., Whitely Binder, L.C. (2008). Sea level rise in the coastal waters of Washington State. Report prepared by the Climate Impacts Group, Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Oceans, University of Washington, Seattle, Washington and the Washington Department of Ecology, Lacey, Washington.

[x] Symposium, The Economics of Climate Change: The Stern Review and Its Critics, 2 (1) Review of Environmental Economics and Policy 45 (Winter 2008).