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Comprehensive Study of Climate Change in Parbhani District, India

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Abstract

Climate change is one of the most critical Global challenges out of times. The climate change impacts will range from affecting agriculture to sea level rise and increasing intensity of natural disaster. The issue of Climate Change and its impact on water resources is of immense importance and that is why it requires an initiative against it. This analysis focuses on the climate change analysis of the Parbhani district of Marathwada. This study analyses climatological data, including rainfall, temperature, pan evaporation, bright sunshine hours, relative humidity, and UV index, over a period of 32 years (1988–2019). The normal and decadal trends from 30 years of data (1987–2017) were compared with the conditions in 2018 and 2019. The 30-year average annual rainfall was 841.87 mm, with occasional winter showers. The monsoon typically starts in June and ends in September. The maximum and average peak temperatures were recorded in May, while the minimum temperatures fell to their lowest in January. Pan evaporation displayed a rising trend from January to May, and then declined from June to December. The relative humidity fell from January to April and subsequently rose until September before dropping again by December. Bright sunshine hours show a steady increase from January to May, while the UV index remained fairly consistent with the 30-year average. This comparative analysis helps illuminate climate variability and seasonal patterns in the region.

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Keywords

Climate change, Rainfall, Evaporation, Temperature, UV Index.

Introduction

One of the biggest environmental issues the world is now experiencing is climate change. Numerous negative effects on agriculture, water resources, forests and biodiversity, health, coastal management, and temperature rise are linked to it. The primary effect of climate change in India is a decline in agricultural productivity (Balasubramanian and Birundha, 2012). India's average temperature has already increased by around 0.7^0C during the 1901 – 2018 periods due to greenhouse gas emissions and by the end of 2100 it is expected to rise by approximately 4.4^0C. The impact of climate change is projected to have different effects within and between countries (Arora *et al.,* 2005). Information about such changes is required at global, regional and basin scale for a variety of purpose. An investigation was carried out to identify trends in temperature time series of 125 stations distributed over the whole India and it was observed that annual mean temperature, mean maximum temperature and mean minimum temperature have increased at the rate of 0.42^0C, 0.92^0C and 0.09^0C per 100 year respectively (Arora *et al.,* 2005).

Inter Government panel on climate change is forecasting increasing frequency of droughts and flood cautioning about the water, food, health and environmental security. Availability of fresh water per capita is dwindling world over and threatening the availability of quality drinking water for the developing nations (Qiu *et al.,* 2023). Foods prices have already shouted up for various reasons, the chief among them are near stagnation of productivity of irrigated soils and diversion of agricultural lands to other uses. With the advent of the climate change, it has become imperative to adopt our in various gamut's of activities of sustainable development. Water and environment are the most important sector of life directly or indirectly affect the climate change. Still, many of the times questions are asked, whether the climate change is due to anthropogenic reason is really responsible for natural disaster or not. Irrespective of this debate, it has been observed in the world over that the change in catchment hydrology has been accelerated and quite often runoff from the catchment has been decreasing due to upstream development affecting the Commitments. There has been a global concern on the issue of runoff generation at catchment scale in this changing world (Gupta *et al.,* 2015 and Wu *et al.,* 2017).

Inconsistency in runoff generation due to climate change brings difficulties in its prediction. Any sustainable hydrological response to climate warming would highlight the resilience of that catchment. Therefore, one has to learn to live with the lesser and lesser water than before by Improving water conservation Technology while tremendous care has to be taken to achieve Water, food and environmental security. The impact of Climate Change was found to be more prominent on seasonal rather than annual water availability. Due to predicted climate change, it is accepted that the availability of water would be significantly affected in time and space. Accordingly, in long run, cropping pattern and order land use are likely to change (Konpala *et al.,* 2020). Thus, the revised assessment of water for irrigation has to be made in view of this changes. The long-term planning for the development of irrigation system (surface water and ground water) should considered the variation in the availability of surface water and groundwater resources under change climatic scenarios. In India 75% population depends on agriculture and the climatic change will have effect on agriculture. Agriculture, being heavily influenced by climate, faces significant jeopardy from climate change. The climate serves as the foremost factor determining agricultural productivity, with climate change exacerbating the vulnerability of climate-dependent crop production. The global average surface temperature has increased by approximately 0.6ºC over the past century, and further, it will be increased by 1.4–5.8ºC (IPCC) over the end of 21 century. It has manifested in terms of events like melting glaciers, rising sea-level, extreme weather and floods (Ninan & Bedamatta, 2012; Rattani, 2018). Human actions have been identified as the primary cause of the predominant warming trend (0.1°C per decade) witnessed over the last five decades.

In India more than 90% of the annual rainfall is received during the period of four months (June to September) the distribution of rainfall in highly non-uniform and significantly varies in space (Karmakar *et al.*, 2023). The available water resources are subjected to the movement of water through the different components of hydraulic cycle depending upon their interactions. In Hydraulic cycle three-phase are identified it which are evaporation face, precipitation phase and runoff face. Temp and rainfall may significantly affect the hydrological cycle and hence available water resources. The climate change resulting due to anthropogenic as well as natural causes effects the hydrologic cycle R & D efforts are being made by many researchers' world over to study the impact of Climate Change on water resources at bison sub-basin scale (Yang *et al.,* 2021) Such studies are needed to project the further water demand. India needs to first adapted to climate change and secondly to further enhance the ecological sustainability of India's development path. In India presently more than 45% of the average annual rainfall including snowfall in the country is wasted by natural runoff to the sea. Rain water harvesting schemes are now implemented in

the country to minimize this runoff to increase ground water level. For the success of this scheme, it is necessary that how the possible climate changes will affect the intensity, special and temporal variability of the rainfall, evaporation rates and temperature in different Agro climatic region and river basin of India. The predictions made on the future scenario through the region level downscaling are used for researchers to quantify the impacts of water resources. With this view an exercise has been made to study the climate change in the Parthian district.

Materials and Methods

Description of the study area

Parbhani district lies in 18° 45' and 20° 01' N latitude and between 76° 13 and 77° 26' E longitude. With an area of 6155 sq km and 409 meters above mean sea level (MSL) in division of Marathwada. The climate of the study area is characterized as semi-arid and tropical with an average annual rainfall of 947.5 mm. The soil of the study region is medium deep black clay. The mean minimum and maximum temperature of the study area is 21.8 0 C and 44.6 0 C respectively. The mean relative humidity ranges from 30 to 98 per cent (Tarate *et al.,* 2017). Location map of the study area is shown in figure 1. The region experiences wide variability in inter and Intra District variability in rainfall stations. The agriculture production in Parbhani region of Maharashtra state is limited, primary for erratic nature of the monsoon rains. The dry land farmers and through him majority of population in Parbhani region have a very constraint condition as far as agriculture production is concerned because of varieties of monsoon.

Data collection

The daily rainfall maximum temperature, minimum temperature, relative humidity, evaporation, bright sunshine hours, wind speed, data for the 30 years (1978 to 2019) were collected from Agricultural Meteorology Observatory, Vasantrao Naik Marathawada Krishi Vidyapeeth, Parbhani, Maharashtra.

Data analysis

Rainfall The daily rainfall data during the 1988 to 2017 was collected and analysed the sum of the rainfall data for from January to December was group and the average of some of the data from 1988 to 2017 was determined and compared with the sum of the rainfall data of the Year 2018 and 2019.

Maximum temperature

The daily maximum temperature data during the 1988 to 2017 was collected and analyzed the sum of the maximum temperature data form from January to December was group and the average of the from 1988 to 2017 was determined and compared with every data of the maximum temperature of the Year 2018 and 2019.

Relative humidity

The daily relative humidity data during the 1988 to 2017 was collected and analyzed the sum of the RH data for the from January to December was grouped and the average of the from 1988 to 2017 were determined and the compared with the average of the average for the year 2018 and 2019.

Evaporation

The daily evaporation data during the 1988 to 2017 was collected and analyzed the sum of the evaporation data for each month from January to December was grouped and the average of data from 1988 to 2017 was determined and compared with the average of the evaporation of the Year 2018 and 2019.

Bright sunshine hours

The daily bread bright sunshine hour's data during the 1988 to 2017 was collected and analysed. The sum of the bright sunshine hours data for each from January to December was group and the average of the fourth night are from 1988 to 2017 was determined and compared with the average of the bright sunshine hours for the year 2018 2019.

UV Index

The daily UV index data during the 1988 to 2017 was collected and analyzed the sum of the data for each month from January to December was group and the average of the 1988 to 2017 determined and compared with the average of the year 2018 and 2019.

All the average 30 years data with respect to rainfall, maximum temperature, minimum temperature, evaporation, relative humidity, wind speed, Bright Sunshine hours and UV-Index from January to December we are compared with the current data the year 2018 and 2019 to observe deviations and to notice the change related to climate change.

Results and Discussion

Study on climate change of Parbhani district was carried out during the year 1988 to 2017, 2018 and 2019. In the present study all the climatological data since, 1988 to 2017 and it was compared with the climate data of year 2018 and 2019. Results of the present study have been discussed in the chapter.

Rainfall Analysis

The daily rainfall data during years 1988 to 2017 was collected and analyzed. Rainfall data from January to December was grouped and the averages of the 30 years from 1988 to 2017 were worked out.

The data on the average rainfall of 30 years and the rainfall of the years 2018 and 2019 are presented in the Table No.1. revealed that, from January to March, 30 years average shows that there was an occurrence of some winter showers, but when we compared with the rainfall data of 30 years average with the year 2018 and 2019, it was observed that, there is decreasing trend of rainfall from 2018 to 2019 during January to March month. From June to August, unevenness in rainfall pattern were observed. Thus, climatic variation with respect to rainfall pattern was observed during unevenness in rainfall pattern were observed in case of monsoon season. However, in the post monsoon season (Oct to Dec) variability in rainfall was observed.

The Graphical representation of changes in Rainfall of 30 years with the rainfall of year 2018 and 2019 shown in fig.2.

Maximum Temperature

The data on the average maximum temperature of 2018 and 2019 are presented in the Table No.2. From Table No.2, it was observed that analysis of the temperature data during January to May, there was a continuous rise in maximum temperature in the year 2018 and 2019. The graphical representation of maximum temperature is shown in the fig.3.

Minimum temperature

The 30-year average minimum temperature and the minimum temperature of the year 2018 and 2019 were presented in the Table No.3. According to Table 4.3, the minimum temperature from January to May increased in 2018 and 2019, and the average minimum temperature for the previous 30 years also increased. In case of monsoon season, there was deviation in the minimum temperature during the season. The graphical representation of minimum temperature is shown in the fig.4.

Evaporation

The data of the daily evaporation during the year 1988 to 2017 was collected and analyzed. The data on the average evaporation and evaporation for the year 2018 and 2019 are presented in the Table No. 4. On the basis of Table No. 4 the evaporation data revealed that during January to May there was continuous increase in evaporation rate was observed.

Table.1 Comparison of 30 years average rainfall with rainfall of year 2018 and 2019.

Month	30 Years	2018	2019
January	5.79	0	**0.83**
February	5.19	2.46	**0.4**
March	12.78	2.72	**0.71**
April	10.03	3.45	**3.52**
May	24.20	13.63	**0.78**
June	146.53	170.52	**66.76**
July	193.34	116.92	**138.4**
August	182.96	236.13	**90.37**
September	168.17	27.99	**147.72**
October	70.83	3.94	**137.23**
November	17.31	2.9	**1.76**
December	**4.66**	**2.8**	**4.37**

Table.2 Comparison of 30 years average maximum temperature with temperature of year 2018 and 2019**.**

Month	30 Years	2018	2019
January	31.29	31.37	**30.59**
February	34.36	34.17	**34.11**
March	37.97	38.18	**38.65**
April	40.91	41.46	**42.46**
May	41.77	42.69	**43.07**
June	35.20	34.04	**38.00**
July	31.22	30.75	**32.37**
August	30.03	30.75	**31.35**
September	29.84	31.77	**30.28**
October	30.14	34.81	**29.36**
November	29.86	33.74	**29.21**
December	**29.82**	**30.00**	**28.66**

Table.3 Comparison of 30 years average minimum temperature with the minimum temperature of the year 2018 and 2019.

Month	30 Years	2018	2019
January	14.00	13.94	**12.32**
February	16.56	17.63	**16.41**
March	20.39	21.71	**20.09**
April	24.47	24.96	**25.14**
May	26.88	28.22	**27.13**
June	24.83	24.50	**27.42**
July	22.92	22.55	**23.74**
August	22.26	22.13	**22.90**
September	21.70	20.99	**22.69**
October	19.37	19.94	**20.83**
November	16.14	18.31	**17.20**
December	**13.65**	**13.96**	**15.99**

Table.4 The comparison of 30 years average evaporation with evaporation of the year 2018 and 2019.

Month	30 Year	2018	2019
January	4.6	4.1	**4.8**
February	6.1	5.8	**6.2**
March	8.35	7.3	**8.6**
April	10.8	10.2	**12.2**
May	12.5	12.9	**13.15**
June	8.15	7.85	**10.1**
July	5.3	5.35	**5.25**
August	5.6	3.9	**4.25**
September	5	4	**5.3**
October	5.5	5.75	**4.65**
November	5.1	5.2	**3.9**
December	**4.15**	**4.3**	**3.8**

Table.5 Comparison of 30 years average relative humidity of with relative humidity of the Year 2018 and 2019.

Month	30 Year	2018	2019
January	36.27	24.91	**27.21**
February	25.92	26.04	**26.23**
March	22.56	20.43	**18.66**
April	21.37	19.53	**17.26**
May	27.90	23.21	**20.56**
June	58.90	65.67	**47.48**
July	74.76	76.11	**71.34**
August	79.92	76.35	**76.35**
September	80.88	71.50	**81.74**
October	72.66	47.20	**80.84**
November	61.84	36.28	**73.86**
December	**45.97**	**35.89**	**65.37**

Table.6 Comparison of 30 years average bright sunshine hour with bright sunshine hours of year 2018 and 2019.

Month	BSH 30 Year	BSH 2018	BSH 2019
January	9.8	9.43	**9.24**
February	10.55	9.75	**9.94**
March	10.7	9.85	**10**
April	10.85	10.43	**10.3**
May	10.55	12.5	**12.5**
June	7.2	11.16	**10.3**
July	4.8	7.08	**5.935**
August	4.65	6.354	**4.6**
September	6.7	9.31	**4.06**
October	9.2	8.53	**5.41**
November	9.5	7.5	**6.8**
December	**9.7**	**7.5**	**6.96**

Table.7 Comparison of 30 years average UV index with 2018 and 2019 UV-Index.

Month	UV Index 30	UV 20018	UV 2019
January	6.3	6	**6**
February	7.1	8	**7**
March	8.2	8	**9**
April	8.7	9	**10**
May	8.7	9	**10**
June	7.1	8	**6**
July	6.3	7	**6**
August	6.4	7	**6**
September	6.8	7	**6**
October	6.1	6	**6**
November	6	6	**7**
December	**6.1**	**5**	**5**

Figure.1 Location Map of the Study Area

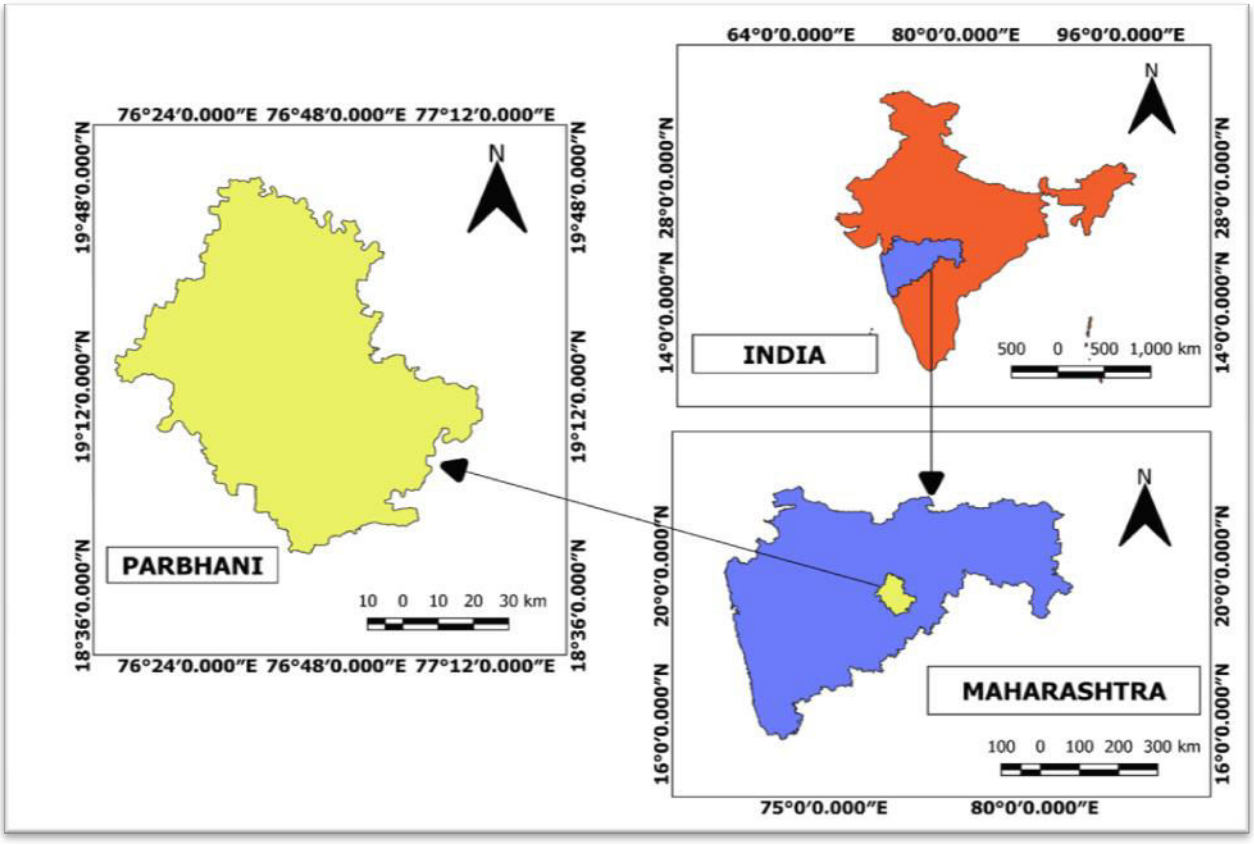


Figure.2 The Graphical representation of changes in Rainfall of 30 years with the rainfall of year 2018 and 2019

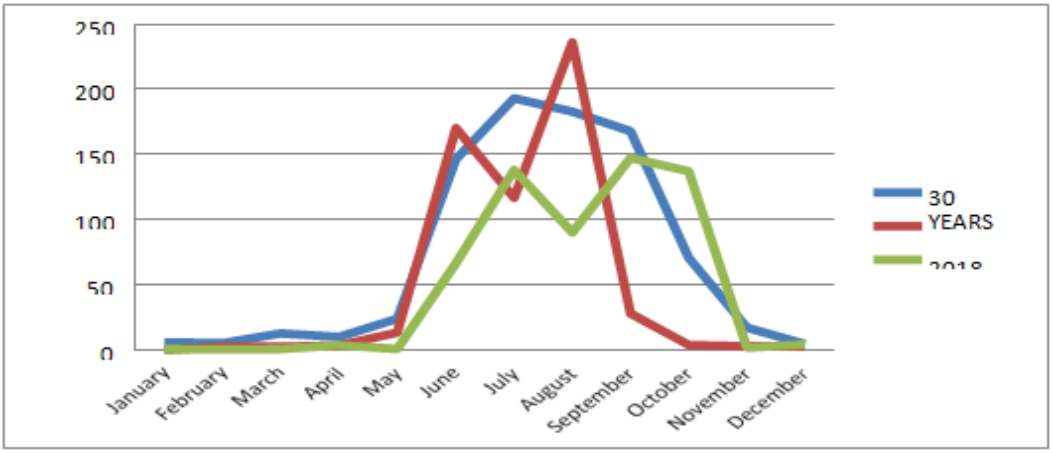


Figure.3 The Graphical representation of changes in maximum temperature of 30 years with the maximum temperature of year 2018 and 2019

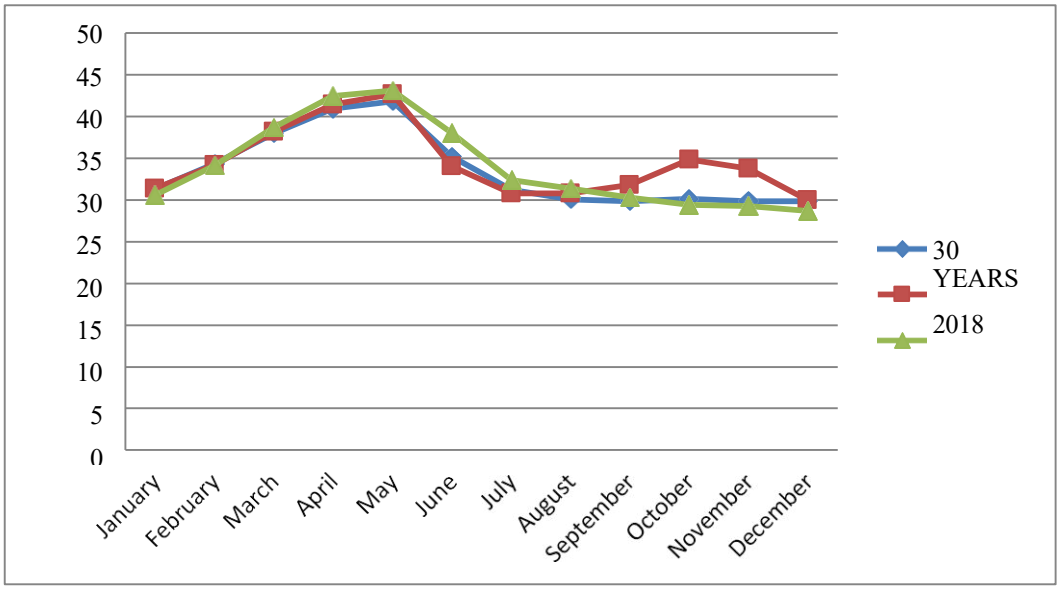


Figure.4 The graphical representation of changes in average minimum temperature of 30 years with the average minimum temperature of year 2018 and 2019.

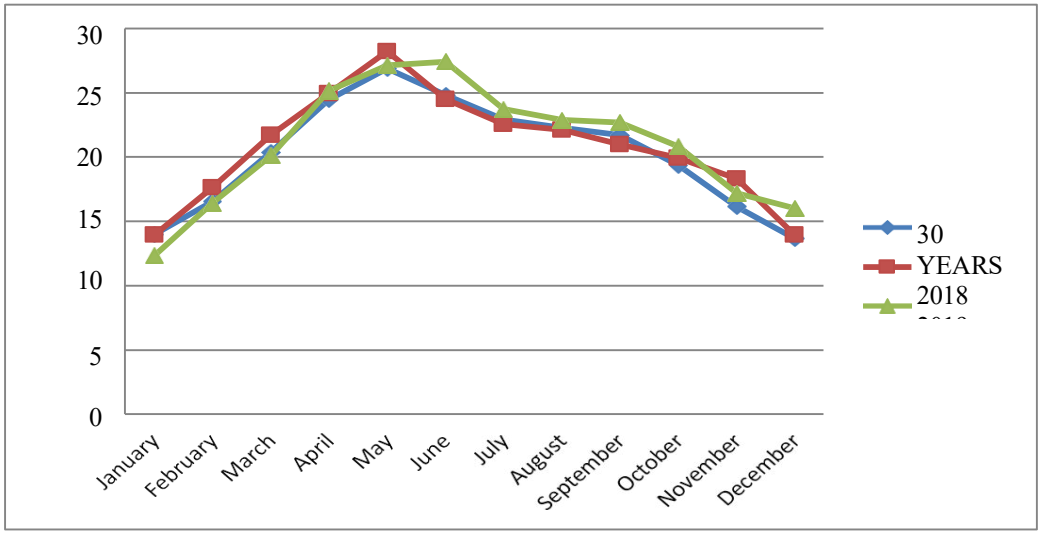


Figure.5 Graphical representation of changes in minimum temperature of 30 years with the minimum temperature of year 2018 and 2019.

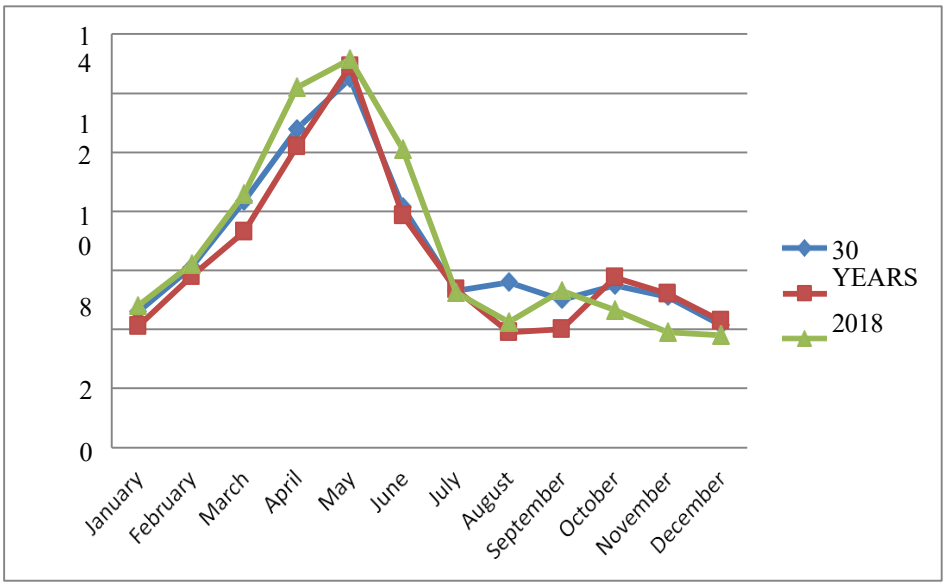


Figure.6 Graphical representation of changes in Relative Humidity of 30 years with the Relative Humidity of year 2018 and 2019.

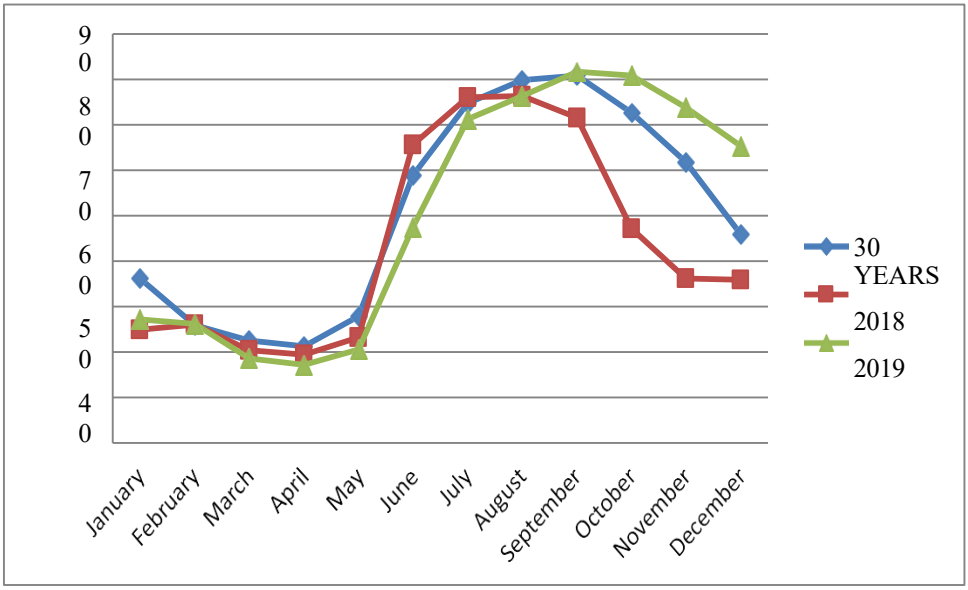


Figure.7 The Graphical representation of changes in Bright Sunshine Hours of 30 years with the Bright Sunshine Hours of the year 2018 and 2019.

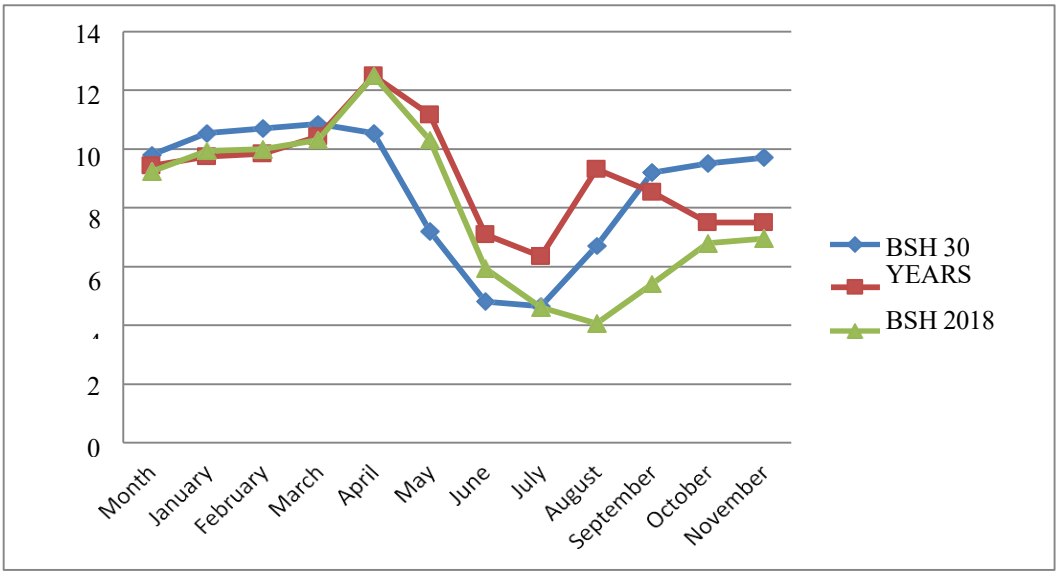
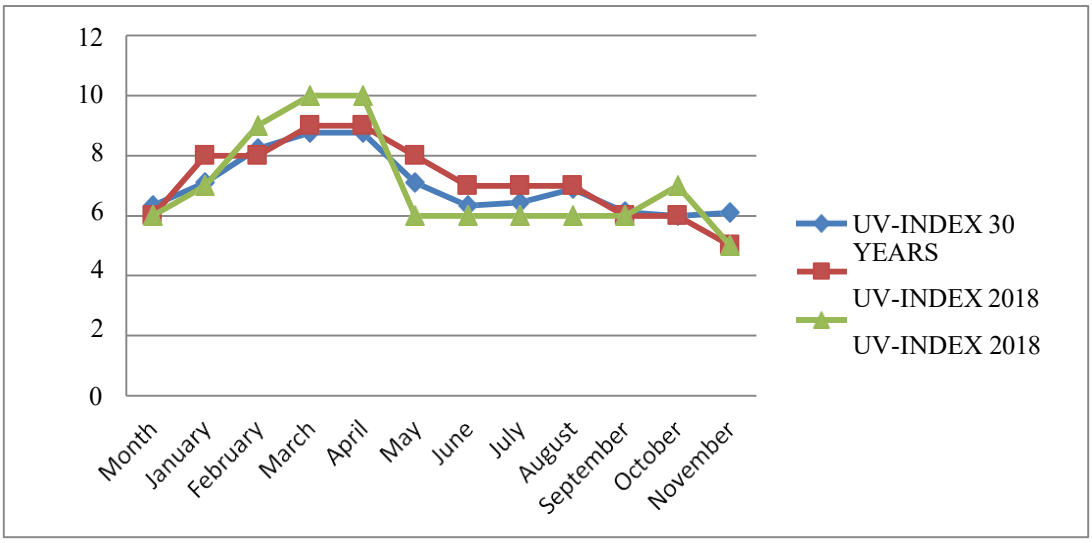


Figure.8 Graphical representation of changes in UV-Index of 30 years with the UV-Index of the year 2018 and 2019.



The continuous increasing evaporation rate may lead to take various ways to control water evaporation rate and dams also increase in evaporation rate may increase the water requirement of the various crops. Variations in the range of evaporation rate were overserved in monsoon as well as in post monsoon season. The graphical representation of evaporation rate shows in the figure 5.

Relative Humidity (RH)

The data of the daily relative humidity during y the year 1988 to 2019 was grouped and the averages of the 30 years from 1988 -2017 were worked out. The data on average relative humidity (RH) of 2018 and 2019 are presented in Table no.5.Table no.5 indicates that, From January to May, there was continuous decrease in relative humidity was observed. During monsoon season the relative humidity was increases significantly.

Variability in values of relative humidity was observed in post monsoon season (from Sept to Dec). The deviation in relative humidity may be due to increase or decrease in the maximum temperature throughout the year. The graphical representation of RH shown in the figure 6.

Bright Sunshine Hours

The data on the average Bright sunshine hours (30 years) and Bright sunshine hours 2018 and 2019 are represented in table no.6.Table no 4.6 revealed that the continuous increase in Bright sunshine Hours during the January to May, was observed in the year 2018 and 2019. Whereas variability was observed in the results of BSH in case of monsoon season (from June to Sept). During the post monsoon season (Sept to Dec) there was decrease in the Bright sunshine hours were observed. The graphical representation is shown in the figure no.7.

UV-Index

The daily UV index data during the 1988 to 2017 was collected and analyzed. The sum of the data for each month from January to December was group and the average of the 1988 to 2017 determined and compared with the average of the year 2018 and 2019. And the 30 years data with 2018 and 2019 is shown in table no.7. Table no.7 revealed that during January to May, there was continuous increase in the UV-Index, in the year 2018 and 2019. from Jun month the decrease in UV index was observed upto December month. The graphical representation is shown in the figure no. 8.

Conclusion

The climatological data i.e. rainfall, temperature, pan evaporation, Bright Sunshine Hours, Relative Humidity and UV-Index of last 32 years from 1988 to 2019 was collected. The normal and decadal analysis of this data of last 30 year were undertaken and was compared with the data of the year 2018 and 2019.

The rainfall data of last 30 years 1987 to 2017 was analyzed and found that the total average annual rainfall for 30 years was 841.87 mm. Some winter showers observed during 30 years average rainfall, also some winter shower was observed in 2018 and 2019 year. The monsoon starts from June month and it ended in September month.

The temperature data for 30 years indicates that, the maximum and average peak temperature was recorded in the month of May, whereas, the lowest maximum average temperature was recorded during December in 2019. Whereas, May month was the peak point for the minimum temperature in all the data (30 years average, 2018 and 2019). And lower temperature was recorded as during January month in the 2019 year.

The average increase in evaporation rate was observed during the month of January to month of May. Then again, this evaporation rate was fallen from June to December.

The comparison of 30 years average relative humidity with the relative humidity of the year 2018 and 2019 shows that, there was continuous decreasing trend was observed from January month to April month. And then again continuous increase in relative humidity was observed from May to September month.

After that again it falls back from October to December month. The Bright Sunshine Hours data shows that increasing trend from January to May month. The UV index in all most all month was found to be slight variation as compared to 30 years of average.

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