Turkish Journal of Computer and Mathematics Education Vol.12 No.13 (2021), 1999-2004

Research Article

On the Analysis of Temperature changes over Kottayam district of Kerala

Anjana Sreeraj[a] and Sreelakshmi Vijayakumar[b]

[a,b]Department of Mathematics, Amrita School of Arts and Sciences, Kochi
Amrita Vishwa Vidyapeetham

Article History: Received: 11 January 2021; Revised: 12 February 2021; Accepted: 27 March 2021; Published online: 4 June 2021

Abstract: It is a well-known fact that the climate change is happening worldwide on global as well as regional scale. Kerala, India is one such state which is affected by climate change in the form of extreme flooding and temperature changes. The pre-monsoon temperature changes are crucial for the coming monsoon period. Hence, in this study, we study pre-monsoon temperature changes over Kottayam district from 1991 to 2014. The dataset has been taken from Kerala Government. The result suggests that there are changes happening in the Kottayam district for both maximum and minimum temperatures with decrease of maximum temperatures and increase of minimum temperature. These changes are indicative of increasing in hot days.

Keywords: Climate change, temperature,kottayam, trend analysis, kerala

1. Introduction

Reasons for Global Climate change are warming of atmosphere and ocean temperature, imbalance in the global water cycle, increasing ice loss, sea-level rise, reducing snow and ice

which is mainly disfigured by human-made activities (Intergovernmental Panel on Climate Change 2013, Stocker et al. 2014.). The main greenhouse gases in the atmosphere are water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ozone (O_3). These gases are raised by human activities such as burning fossil fuels, agricultural activities and land use, and forestry (Mitchell, (1989)). There is an increase of 40% in the CO_2 and 30% of it is in the ocean and results in ocean pollution (Kurihara and Shirayama, (2004)). The IPCC (Intergovernmental Panel on Climate Change's) fifth assessment report firmly specified that surface warming occurs in the world. During 1880-2012, there was an increase of 0.85ºC in the sea temperature (Mastrandrea et al. 2010). During 1971–2010, the greatest warming of the ocean noticed in top 75m of the water by 0.11°C in the global level.

The above literatures are glimpse of climate changes happening around the world. In India also, climate change effects can be visualised in many parts of the country (Singh and Rao 2019). Kerala, is one such place where lot of anomalies from nature can be found. The temperature changes are very crucial since it affects the productivity of crops (Pal and Al-Tabba 2009). Being an agrarian state, the agriculture very much depends on temperature changes in the pre-monsoon period (March, April May). The objective of the study is to analyse the temperature changes over one of the districts of Kerala, which is very famous for the rice productivity. The entire manuscript is arranged in a way such that section 2 presents the Data and Methodology while the results are described in Section3. Section 4 concludes the results of the thesis.

2. Data and Methodology

Kerala is situated at the southwestern Malabar Coast of India (Spread over 38,863 km^2) with an estimated population about 33.4 million and growth rate 4.91% (Census of Kerala, 2011). Kerala's climate is regular and changes little from season to season. All over the year, daily temperatures increase from the low 70 F (low 20 ºC) into the 80 F (27 to 32 °C).

Kottayam is one of the 14 districts in Kerala and it is situated in the South-Central Kerala (spread over 55.40 km^2) with a population of 1,974,551 (Mitra and Singh 2007) (see Figure 1). Kottayam is a land of ideal characteristics. Scenic backwater stretches, opulent paddy fields, hillocks, hills, highlands and broad rubber plantations are the main reason for its ideal landscapes. Kottayam is also known as "Akshara Nagari" which means "Land of letters" because of its inputs to print media and literature. Like the rest of country, Kottayam has a tropical climate with an overwhelming heat during summers i.e. from March to May. Due to low pressure over the Arabian Sea, it gets enough rainfalls during monsoons i.e. from June to September, which is known as the South – West monsoon. The post monsoon season i.e. from October to December which is withdrawing but as the day temperature starts raising it is hot as well as in the summers. Only few studies are there from India about the weather events which are mainly about rainfall events (Kothawale, and Rupa Kumar, K. 2005). Studies about the occurrence of extreme temperature in India are rare. These studies are very significant at regional scale because the influence of annual events is clear and serious at this level. This study is to analyse the trend of maximum and

minimum temperature of Kottayam district of Kerala over the period of 1991 – 2013. The data for conducting the study has been utilized from Kerala Government.

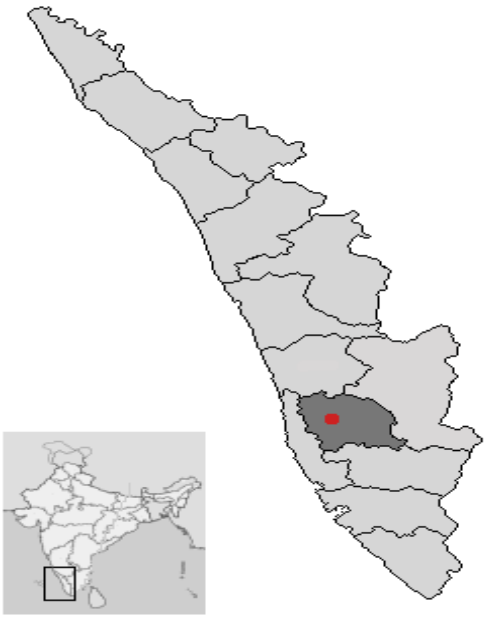


Figure 1: Map showing Kerala and the Kottayam district in dark shade

The following methods are adopted to study the characteristics of temperatures in the considered region:

(a) Mean: $\bar{x} = \sum \frac{x_i}{n}$ (1)

(b) Standard Deviation: $\sigma = \sqrt{\frac{(x_i - \bar{x})^2}{n}}$, where n is the number of observations (2)

(c) Centering and Scaling: $z = \frac{x_i - \bar{x}}{\sigma}$ (3)

(d) Coefficient of variation $C = \frac{\sigma}{\bar{x}}$ (4)

(d) Fitting a line to find the trend:

Trend is the general characteristics of a series over a long period of time which is given by the equation

$$Y = \beta_0 + \beta_1 X \quad (5)$$

The above linear regression model is used to explain the relationship between X and Y, where β_0 and β_1 are found by least square method and X and Y are the temperatures.

3. Results

In the upcoming sections, the seasonal and monthly scale analysis of the temperature over Kottayam district is studied from 1991 to 2013. For this, the daily maximum and minimum temperature has been analysed.

3.1 Daily Maximum and Minimum Temperature changes

The daily maximum and minimum temperature over Kottayam district of Kerala has been shown in Figure 2. The change in daily maximum temperature is shown as the trend line (black dotted line). The trend line shows the daily maximum temperature is decreasing at the rate of 0.03℃/year. The highest temperature is found in the month of March (34.66℃) while the minimum is found in the month of May (31.57℃). The standard deviation in this period for the region is 0.82℃ which indicates a variation of just 2% but in the context of farming, this change is significant.

The daily minimum temperature on the other hand, shows an increasing trend of 0.08℃ /year. The highest minimum temperature is found in the month of April while the least in minimum temperature is found in the

month of March. The standard deviation is less in the daily minimum temperature and a coefficient of variation of 1% indicates that there is not much change in the daily characteristics of temperature.

The decrease of maximum daily temperature and increase in minimum daily temperatures indicates a reduction of diurnal temperature ranges.

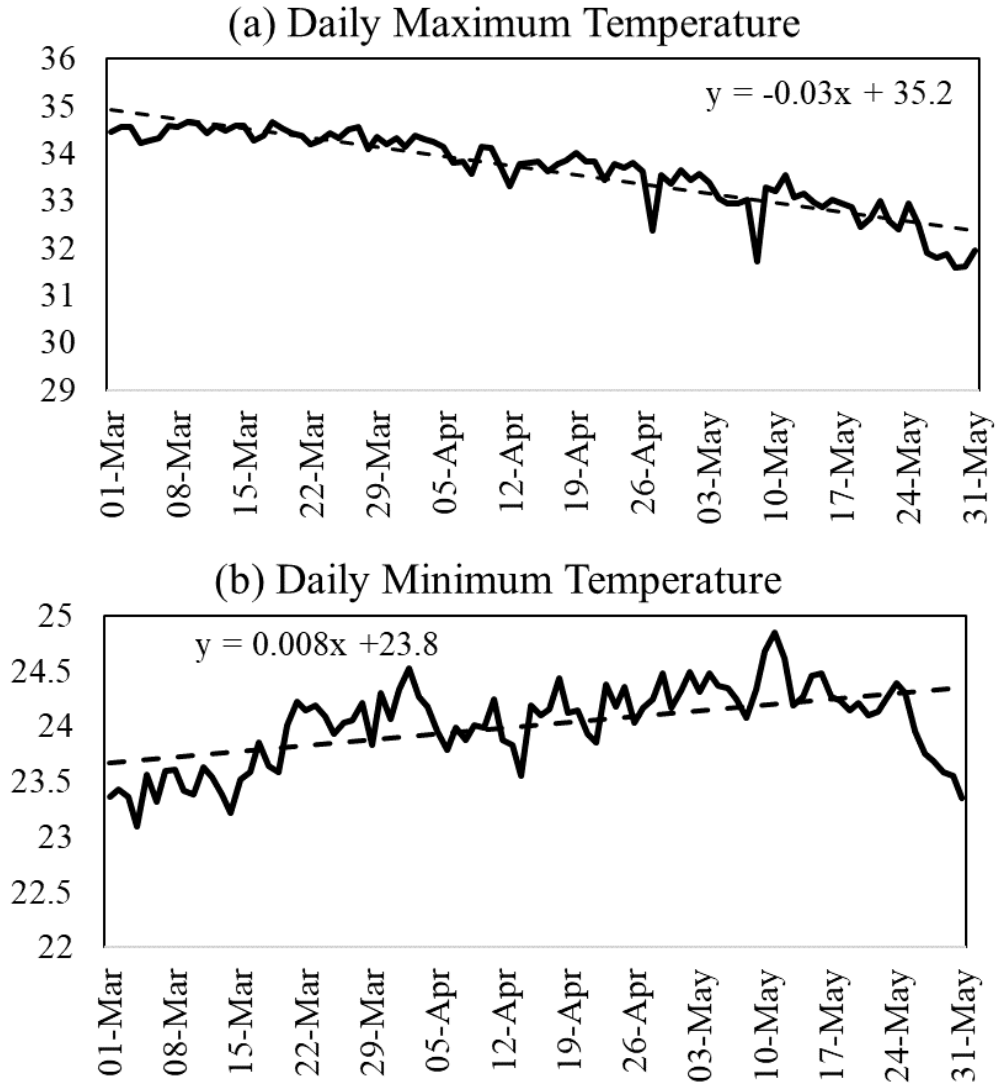


Figure 2: The changes in daily maximum and minimum temperature in the pre-monsoon season (showing Kerala and the Kottayam district in dark shade).

3.2 Seasonal changes in the maximum and minimum temperatures

The seasonal (pre-monsoon) characteristics of maximum and minimum temperature from 1991 to 2013 over Kottayam has been shown in Figure 3. The seasonal maximum temperature ranges from 32℃ to 35℃ with maximum temperature in the year 2010 (35℃) and minimum 1999 (32℃). The mean maximum temperature in this period is found to be 33.64℃ with a standard deviation of 0.61℃. The trend analysis depicts an increase of 0.04℃/year. The seasonal minimum temperature over Kottayam ranges from 23℃ to 24.79℃ with standard deviation of 0.43℃. The variability is found to be 1% indicating very less variability in the minimum temperature ranges. The mean minimum temperature is found to be 24℃ with maximum in the year 2013 and minimum in 2014. The trend as shown in the figure depicts insignificant changes. A small change of 0.003℃/year has been found. A notable inference that can be recorded from the figure is the increasing trend of the diurnal temperature changes which shows an increase of 0.04℃/year, in the seasonal scale.

In view of above, it can be inferred that significant changes are happening on a seasonal scale.

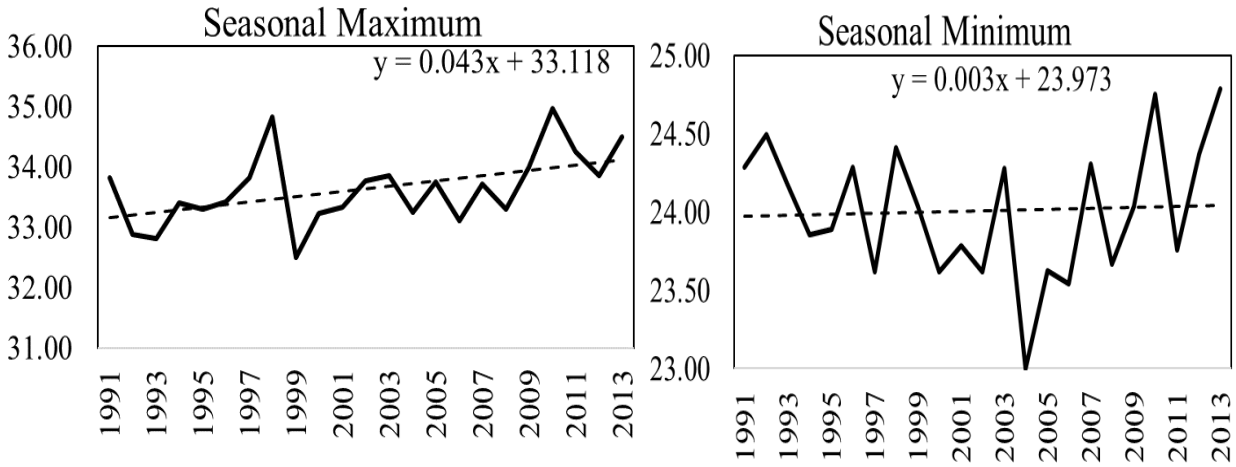


Figure 3: The seasonal maximum and minimum temperature in the pre-monsoon season for Kottaya

3.3 Monthly temperature changes for maximum and minimum temperature changes

The monthly temperature changes for maximum and minimum temperature has been shown in the figure 4 and 5 for March, April and May. The monthly maximum temperature changes for all the months shows a sharp increasing trend in all the months with maximum increase in the month of March (0.063℃) followed by April (0.043℃) and May (0.024℃). The temperatures are of the order of 32℃ to 36℃ in the month of March and April, while in May it ranges from 30℃ to 35℃. The maximum temperature is found in the month of March or April.

The minimum temperature on a monthly scale shows an increasing trend (figure 5) in the month of April and May with 0.006℃/year and 0.037℃/year. On the other hand, in the month of March, there is a decreasing trend of 0.024℃/year, which implies that, the temperature in the month of March is increasing. The minimum temperature in the month of March ranges from 22℃ and 24℃ while in the month of April, it is 23℃ and 25℃. In the month of May, it ranges from 22℃ to 25℃. The mean minimum temperature, in the month of March is 23.7℃, for April 24.12℃ and for May 24.18℃. The standard deviation is found to be highest in the month of March with 0.63℃, the next highest is 0.58℃, while the least deviation is found in the month of April 0.44℃.

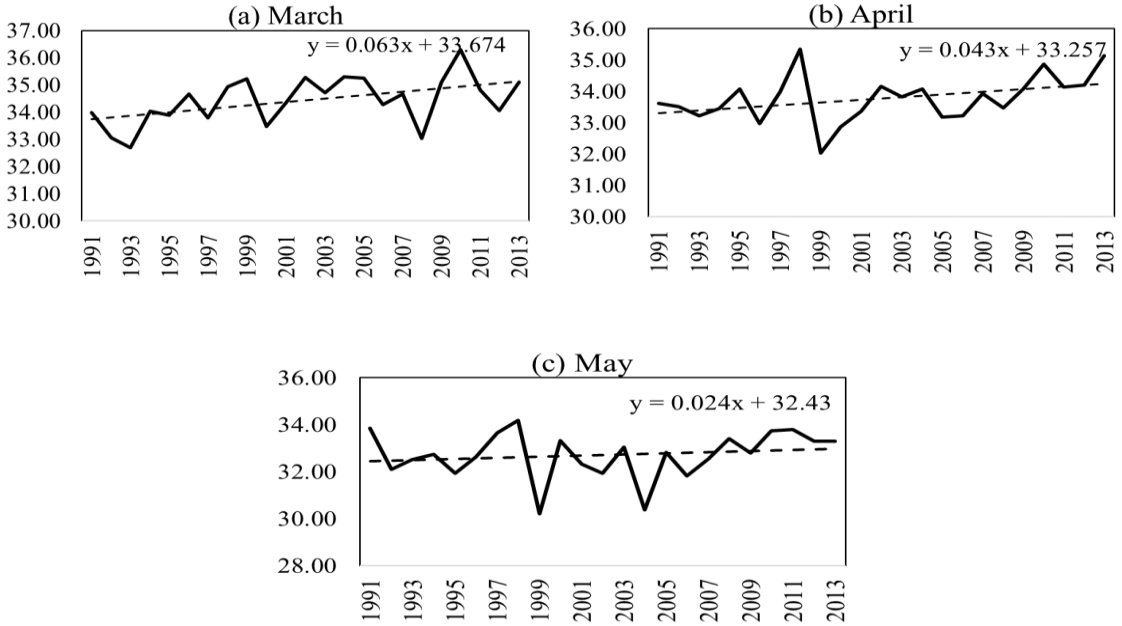


Figure 4: The monthly temperature changes in maximum temperature in the months of (a) March (b) April (c) May

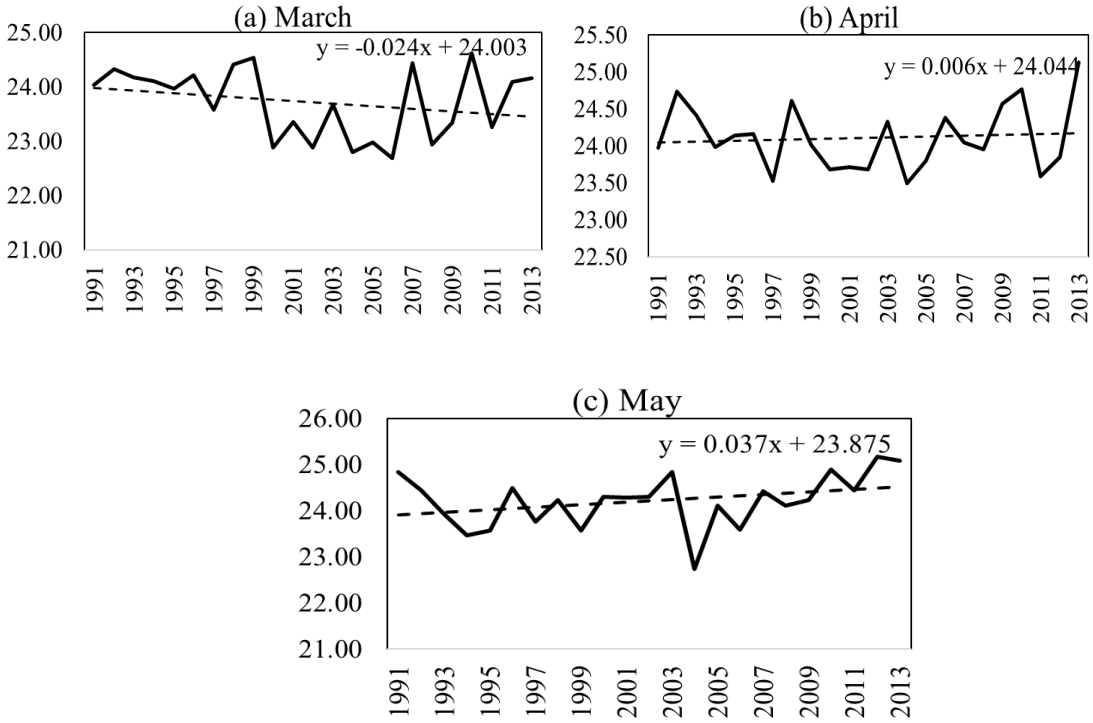
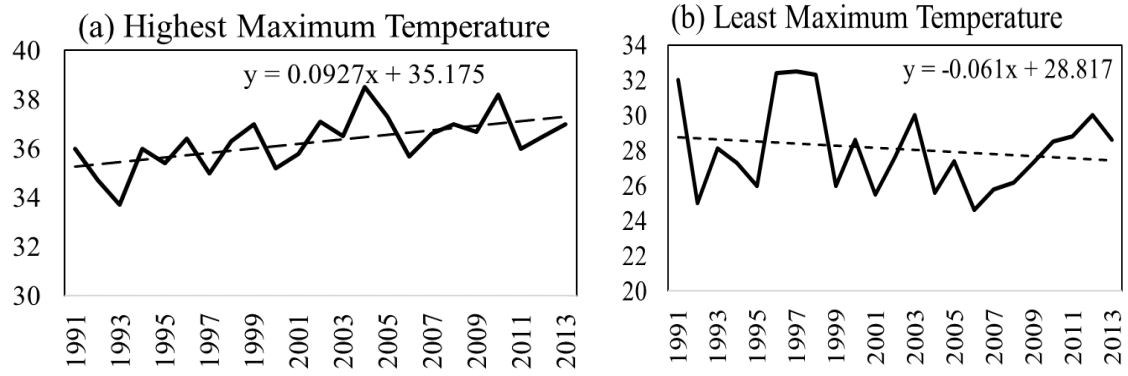


Figure 5: The monthly temperature changes in minimum temperature in the months of (a) March (b) April (c) May

3.4 Trend in the highest and least maximum and minimum temperature

The characteristics of highest and least maximum and minimum trend is shown in Figure 6 and 7 for maximum and minimum temperature respectively. The maximum temperature on a seasonal scale, shows an increasing trend of 0.09℃/year, while the minimum shows a decreasing trend of 0.06℃/year. The highest maximum is temperature is found to be 38.5℃ which is found in the month of March while the least maximum temperature is 24.6℃ which has been observed in the month of May. The highest minimum temperature shows no trend while a small negative trend of 0.012℃ has been found for least minimum temperature. The highest minimum is found to be 29℃ in the month of April while the least minimum temperature is 18.5℃ which is observed in the month of March.

In view of the above, we can observe that even though, the maximum temperatures are decreasing but there is an



increase of minimum temperature, indicating increase in hot days.

Figure 6: The trend in the highest and least maximum temperature on a seasonal scale.

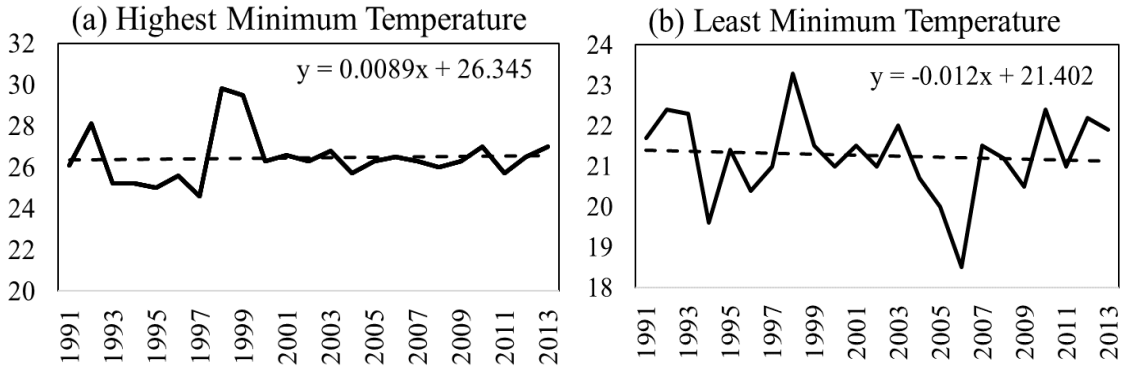


Figure 7: The trend in the highest and least maximum temperature on a seasonal scale.

4. Conclusions

The paper examines the maximum and minimum temperature changes over Kottayam district of Kerala. For the study, daily maximum and minimum temperature datasets have been procured from Kerala Government for the period 1999 to 2013 for the pre-monsoon period (ie. March, April, May). Several statistical characteristics of temperature have been studied such as daily temperature changes and monthly characteristics, highest and least temperature changes in the maximum and minimum temperature. Result suggests that there are changes happening in the Kottayam district for both maximum and minimum temperatures. It is observed that even though, the maximum temperatures are decreasing but there is an increase of minimum temperature, indicating increase in hot days. It is also noted that the diurnal temperature change is decreasing indicating the less prominent relation between hot and cold days.

References

1. Kothawale, D. R., & Rupa Kumar, K. (2005). On the recent changes in surface temperature trends over India. Geophysical Research Letters, 32(18).
2. Kurihara, H., & Shirayama, Y. (2004). Effects of increased atmospheric CO2 on sea urchin early development. Marine Ecology Progress Series, 274, 161-169.
3. Mastrandrea, M. D., Field, C. B., Stocker, T. F., Edenhofer, O., Ebi, K. L., Frame, D. J., ... & Zwiers, F. W. (2010). Guidance note for lead authors of the IPCC fifth assessment report on consistent treatment of uncertainties.
4. Mitchell, J. F. (1989). The “greenhouse” effect and climate change. Reviews of Geophysics, 27(1), 115-139.
5. Mitra, A., & Singh, P. (2007). Human capital attainment and gender empowerment: The Kerala paradox. Social Science Quarterly, 88(5), 1227-1242.
6. Pal, I., & Al-Tabbaa, A. (2009). Trends in seasonal precipitation extremes–An indicator of ‘climate change’in Kerala, India. Journal of Hydrology, 367(1-2), 62-69.
7. Singh, R., & AchutaRao, K. (2019). Quantifying uncertainty in twenty-first century climate change over India. Climate dynamics, 52(7), 3905-3928.
8. Stocker, T., Qin, D., Plattner, G. K., Tignor, M., Allen, S., Boschung, J., ... & Midgley, P. (2014). Summary for policymakers.