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Climate Change and Temporal Analysis of Temperature and Rainfall Variability in Kerala

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Abstract
Growing temperatures have a broader effect on environmental resources, including forests and ground cover, which increases the frequency and intensity of natural disasters and degrades the environment more broadly. Due to a combination of factors, including geography, land-use change, urbanisation, development activities, and the state's high population density, Kerala is one of the Indian states experiencing a severe change in climate. Kerala has an average of 3,000 mm of rainfall each year, yet the risk for drought is still very real. In 2017, the state was hit by a drought. Summer droughts typically occur in central Kerala (Palakkad) from February to May. By 2050, it is expected that the average temperature in Kerala's atmosphere will rise by 2 degrees Celsius. Thus, the purpose of this study is to examine the changes in the state's climate and precipitation over the preceding thirty years. Thiruvananthapuram and Palakkad are the two districts included in the study regions. The study employed primarily secondary data approaches, which were sourced from the state's meteorological department. Mapping software like ArcGIS, ERDAS, and QGIS helped in the production of the maps. Furthermore, location-related and other pertinent data related to the research region were obtained by using Google Earth, Google Maps, and other comparable programmes. The findings indicate a rise in the frequency of hot days and heat waves in all of Palakkad's terrestrial zones. The past ten years have been difficult for the people living in the Palakkad area because of the rising temperatures; some have even suffered from serious sunburns. Due to changes in the global climate, the rate of rainfall during the monsoon season varies from district to district in the state. In the Thiruvananthapuram district, the amount of rainfall has been declining over the previous ten years, resulting in a severe drought. Both local and regional levels need to address these problems.

Keywords: Climate Change, drought, environmental degradation, Hot waves, Rainfall,

Introduction
The weather conditions prevailing in an area in general, or over a long period, are known as the Climate. According to Oxford dictionary, climate change is the change in the earth's weather, including changes in temperature, wind patterns, and rainfall, especially the increase in the temperature of the Earth's atmosphere that is caused by the increase of particular gases, especially Carbon dioxide, over a long period. According to the 2021 Global Climate Report from NOAA National Centre for Environmental Information, every month of 2021 was warmer than average, despite the cooling influence from the' La Nina' climate pattern in the tropical Pacific. The

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"coolest" month was February, which was 1.15 ˚F warmer than average; the rest of the year temperatures were more than 1.4 ˚F warmer than average. The year ended as the sixth warmest on record, 0.84°C (1.51°F) above the 20th-century average. Among the ten warmest years on record are 2013–2021. The 45th year since 1977 in which global temperatures were above the 20th century average was 2021. Note that 2005, the first year in the 21st century to set a new global temperature record, is tied with 2013 as the 10th warmest year on record and 2010 as the ninth.

According to UNICEF (2020), in India, extreme weather events such as cyclones threaten human lives and destroy infrastructure critical to their well-being. Severe droughts lead to crop failures and rising food prices, which for the poor mean food insecurity and nutritional deprivations that can have lifelong impacts. The wider impact of temperature rise is eroding environmental assets such as ground cover, forest etc., leading to increased frequency and magnitude of natural disasters and wider environmental degradation. According to the IPCC Assessment Report (2022), India's sea level is projected to increase substantially by 2050. The rate of sea-level rise in the North Indian Ocean (NIO) was 1.06–1.75 mm per year from 1874 to 2004, and it has increased to 3.3 mm per year in the last 25 years (1993–2017). Kerala is one of the states in India facing drastic climate change due to the combined effect of geography, land-use change, urbanisation, development activities and population density of the state. While Kerala receives an annual average rainfall of 3,000 mm, the possibility of drought also looms large. The state experienced drought in 2017. The central Kerala (Palakkad) generally experiences summer droughts (February to May) (Kerala State Land Use Board, 2013).

A recent study by Vijay et al. (2022) has found a considerable decline in both yearly and southwest monsoon rainfall in Kerala. The study reveals a large increase in warm days, whereas cold days show a declining tendency throughout the state. The rise in nocturnal temperatures is statistically significant, but colder evenings are declining in central and southern areas. The analysis of meteorological drought using the Standardised Precipitation Index (SPI) indicates a growing prevalence of droughts in Kerala, particularly in the southern and central regions, with greater frequency.

Another study was done by Aysha Jennath and Saikat Paul in 2022 in the coastal areas of five districts in the southern state of Kerala, India (Jennath and Paul, 2022). The districts included Thiruvananthapuram, Alappuzha, Ernakulam, Thrissur, and Malappuram. The purpose of the study was to investigate the relationship between climate or environmental factors and population migration. Coastal households were surveyed regarding their encounter with unfavourable climate events and whether it resulted in migration. The climate stress parameters for the region were obtained by analysing satellite altimetry and reanalysis datasets. Coastal locations experience a wide range of stress-inducing occurrences, particularly as climate change becomes more pronounced. The main coastal phenomena that impact the local population are storm surge and the resulting floods, coastal erosion, and inundation caused by rising sea levels. The heavily populated areas of the world are at risk of coastal flooding caused by rising sea levels, more powerful waves, and increasing storms. This can result in the destruction of property and infrastructure. Individuals who have directly encountered the consequences but have chosen to remain in the climate-affected area have attributed their decision to financial constraints as the primary factor preventing them from leaving.

Statement of the Problem

As per the State Action Plan on Climate Change (SAPCC, 2023), Kerala is facing a significant

threat from climate change. It is predicted that the average temperature in the atmosphere of Kerala will increase by 2 degrees Celsius by the year 2050. In addition, a recent study conducted by RMSI, an IT consultancy firm based in Noida, on the reports of the Intergovernmental Panel on Climate Change (IPCC) reveals that by 2050, a substantial portion of the population, property, and infrastructure in Thiruvananthapuram, as well as five other cities including Kochi, Mumbai, Chennai, Vizag, and Mangalore, will be submerged due to the rising sea levels. Thiruvananthapuram is considered to be highly susceptible to various risks and hazards, as it has shown moderate levels in relation to all the indicators. RMSI reports that the State capital city is expected to be affected by the potential new coastline and coastline with high tide, resulting in the potential impact on 349 and 387 buildings, respectively. The section of Star Road, airport – Valiyathura road, and Kovalam beach road is at risk of being flooded due to the projected rise in sea levels. Palakkad has been designated as one of the most susceptible districts in Kerala according to the State Action Plan on Climate Change (SAPCC). This classification is based on factors such as a significant portion of the population depending on agriculture, a low ranking in the human development index, and greater levels of socioeconomic hardship. The purpose of this study is to illustrate the variations over time in temperature and rainfall patterns in the Thiruvananthapuram and Palakkad districts of Kerala, with a focus on the dynamics of climatic conditions in the state.

Objectives of the Study

The major objectives of the study are:

- To compare and analyse the Rainfall of Thiruvananthapuram and Palakkad districts in Kerala
- To compare and analyse the Temperature of Thiruvananthapuram and Palakkad districts
- To study the climatic variability of Thiruvananthapuram and Palakkad districts in Kerala

Materials and Methods

For the most part, the approaches that were utilised for the study were secondary data, which were generally obtained from the meteorological department of the state. The literature review was conducted in a comprehensive manner, taking into account all of the research that was necessary for the production of the study. The compilation of maps was accomplished with the assistance of mapping tools such as ArcGIS, ERDAS, and QGIS. Additionally, Google Earth, Google Maps, and other similar applications were utilised in order to obtain locational and other relevant information about the research area.

Results and Discussion

Location of Study Area

This study was undertaken in two districts in Kerala, specifically Thiruvananthapuram and Palakkad. Thiruvananthapuram serves as the capital city of Kerala. The area, situated in the southwestern corner of India, is recognised for its internationally acclaimed beaches, extensive backwater stretches, and its abundant cultural legacy and ancient landmarks. Thiru-anantha-puram, also known as the city of the holy Anantha, derives its name from Ananthan. The cosmic serpent, adorned with a thousand heads, upon whose coils Lord Mahavishnu resides. The economy of the Trivandrum district mostly relies on sectors such as tourism, information technology, leisure, and education. The Thiruvananthapuram district encompasses an area of 2192 square kilometres in the state of Kerala. The district's industries encompass mineral processing, sugar milling, textile production, and handicrafts. The production of rice, coconut, and coastal fishing

are providing significant economic advantages for the population.

Palakkad, also known as Palghat, is one of the fourteen revenue districts of the state of Kerala. The district is located in the central part of the state. The district encompasses a geographical feature known as the Palakkad gap, which serves as the gateway to Kerala from the north. This gap is a 40 km break in the mountain range. This pass serves as a thoroughfare connecting Kerala and Tamil Nādu. The region possesses a rich historical foundation, strategic geographical position, predominantly rural nature, significant tourism attractions, and a diverse range of developmental activities. The extensive Western Ghats range is likely the primary determinant of the distinctive attributes of the districts. The Bharathapuzha, which is the longest river in Kerala, rises from the highland and flows across the entire district of Palakkad. The majority of individuals, accounting for almost 65%, are engaged in the occupation of agriculture (Department of Mining and Geology, 2006). Palakkad is an expansive expanse of lush flatland dotted with hills.

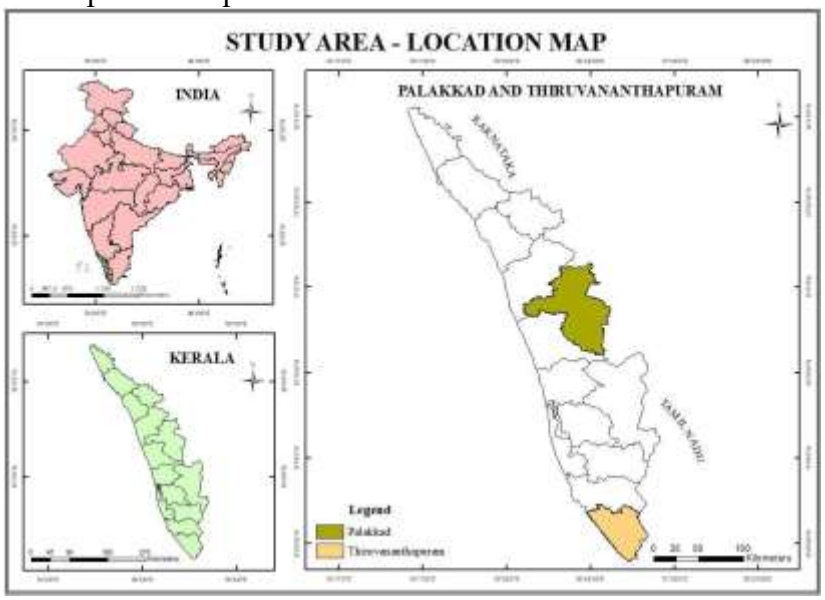

Fig.1, Study Area- Location Map (Palakkad and Thiruvananthapuram)
Source: Compiled by the researchers, 2022

The Thiruvananthapuram district is located between the north latitudes of 8º17’ and 8º51’, and its longitudinal extension ranges from 76º 41’ to 77º 17’ east. Palakkad district is located within the latitudes of 10º20’ and 11º14’ north, and the longitudes of 76º20’ and 76º54’ east. Figure 1 illustrates the geographical boundaries of the Thiruvananthapuram and Palakkad districts in the state of Kerala.

The Trivandrum district spans approximately 78 kilometres of coastal areas, but the Palakkad district does not have any coastline territory. Trivandrum district is situated between the Arabian Sea to its west and the Western Ghats to its east. In contrast, Palakkad district is surrounded by Malappuram district to the west and the Western Ghats and Coimbatore district of Tamil Nadu to the east.

The climate in the Trivandrum district is predominantly hot and tropical. The mountain ranges typically have cold weather, while the lower areas have invigorating weather, and the seaside parts are normally hot. The average minimum temperature is 35ºC and the average maximum

temperature is 20ºC. The yearly average rainfall in the district is approximately 1500 mm per year. The south-western monsoon, occurring from June to September, is the primary period of rainfall. The second rainy season is the north- east monsoon, which occurs from October to November. The average temperature throughout December to February drops to 20ºC, which is typically classified as the winter season. The summer season commences in February and extends until May. The average temperature during this period reaches 35ºC.

It is a tropical wet and dry climate that prevails in the Palakkad district environment. With the exception of the months of March and April, the temperature is consistently maintained at a moderate level throughout the year. There is a minimum temperature of 19.4 degrees Celsius, which is most commonly experienced in December, and the highest temperature that is observed here is 37 degrees Celsius, which occurs throughout the month of May. The hottest temperature ever recorded during the summer in the Palakkad district was +40 degrees Celsius at Mundoor (2019). On the same day last year, the temperature was measured at 3 degrees Celsius higher than it is today. It rains 2212 millimetres on average in the Palakkad region. As a result of the hot breeze coming from the Tamil Nādu area, the temperature in the Palakkad district continues to rise.

The Neyyar, Karamana, and Vamanapuram rivers are considered to be the most significant rivers in the Thiruvananthapuram district. It is the Neyyar river that is the most southerly river in the state of Kerala. Agasthya Hills is the starting point for it. This river is 56 kilometres long, and its drainage basin covers a total area of 497 square kilometres. The Chemmunji Mottai and the Agasthyamala are the places where the Karamana River first begins its journey. In total, the river is 68 kilometres long. The Vamanapuram River has a total length of 88 kilometres, and it starts from the same region as the Karamana River. Veli, Akkulam Lake, and Vellayani Lake are the majority of the backwaters that can be found in the district. A representation of the geomorphology and drainage of the Thiruvananthapuram district may be found in Figure 2.

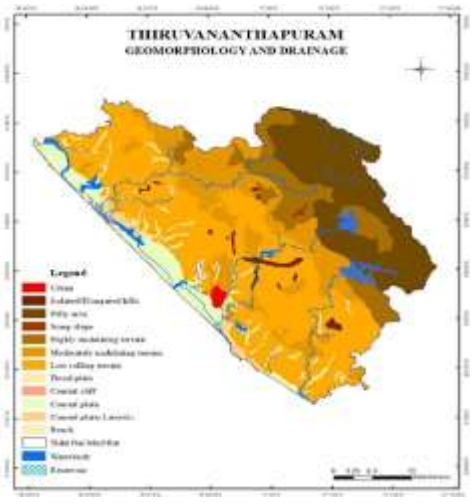

Figure 2, Geomorphology and Drainage- Thiruvananthapuram Source: Compiled by the researchers, 2022

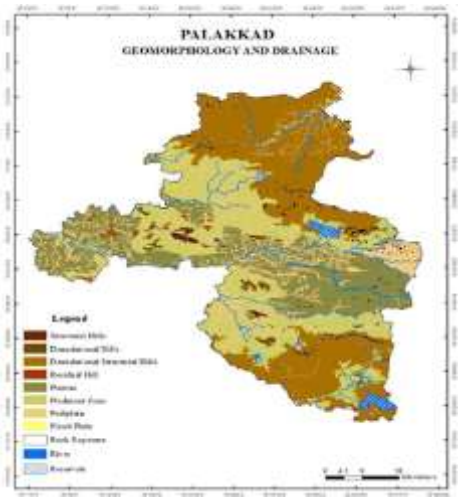

Figure 3, Geomorphology and Drainage- Palakkad Source: Compiled by the researchers, 2022

Two rivers, the Bharathapuzha and the Bhavani, are the primary sources of drainage for the Palakkad district. It is the Bhavani River that flows to the east. Nila, Kuttippuram River, and Ponnani River are some of the other names for the Bharathapuzha River. Gayathripuzha, Kannadipuzha, Kalpathy puzha, and Thuthapuzha are the four primary tributaries that make up this river. A total of fifty watersheds and two hundred and ninety-nine smaller watersheds make up the Bharathapuzha basin. Gayathripuzha, Kannadipuzha, Kalpathy puzha, and Thuthapuzha are the four primary tributaries that make up this river. The geomorphology and drainage map of the Palakkad district is provided in Figure 3.

Importance of Climatic Status

One of the most important aspects that will determine the total impact of climate change is going to be the amount of rainfall and other types of precipitation that change in the future. Although the ability to accurately forecast rainfall is significantly more challenging than predicting temperature, there are certain statements that scientists can make with certainty regarding the future. At this point, it is not possible to differentiate between natural changes and any impact that climate change may have had on regional rainfall in general. There are, however, a few particular instances in which a signal is beginning to emerge. According to the findings of a recent study, the likelihood of severe floods occurring in England and Wales in the autumn of 2000 was significantly raised as a result of climate change caused by human activity. According to the current understanding, it is possible that increases in the amount of heavy rainfall that occurs throughout the winter months in the United Kingdom may begin to become more noticeable in the 2020s. The weather is a manifestation of the energy that is travelling through the climatic system of the Earth, and it varies depending on the time and geographic scale. A region's climate is comprised of both the long-term averages of the weather and the variability of the weather in that region. The term "internal variability" refers to the phenomenon that occurs when natural processes that are inherent to the various components of the climate system modify the distribution of energy (Kunkel et al, 2022). During this work, the authors have made an effort to explain the climatic fluctuations that have occurred in the districts of Palakkad and Trivandrum, as well as the variations in rainfall that have occurred in these areas during the past thirty years (1991-2020). The present Climatic Status of Kerala is given in Table 1.

Table 1, Present Climatic Status of Kerala in 2022

Sl. No.	Seasons	Maximum Temperature	Minimum Temperature	Average Rainfall
1	Winter	28	18	25
2	Summer	36	32	135
3	S-W Monsoon	30	19	2500
4	N-E Monsoon	35	29	500

Source: ENVIS Hub, 2022

During the period from 1991 to 2000, there were no significant fluctuations in temperature in the Thiruvananthapuram district. The temperature saw a minor alteration. The minimum temperature recorded was 19.3ºC, while the maximum temperature was 36.7ºC. The maximum temperature

difference observed over the decade was 0.8ºC, while the minimum difference was 1ºC. The highest temperature recorded occurred in 1998, while the lowest temperature was recorded in 1999. However, in the district of Palakkad, according to the provided table, the highest temperature for the year 1992 (41.4º C) was recorded in the decade 1991-2000. The lowest minimum temperature of 16.8ºC was recorded in 1994. The temperature fluctuation within a specific decade reached a maximum of 3.6ºC, while the minimum was 3ºC.

Based on data from the 2001-2010 decade, the highest temperature variation observed in the warmest year in Thiruvananthapuram district was 2.9ºC, while the lowest temperature variation observed throughout the decade was 2.3ºC. The temperature range is 19.9º C. The years 2001, 2007, and 2010 experienced the highest temperatures throughout this decade. In the year 2007, the maximum temperature recorded in Palakkad district was 40.4º C. The lowest minimum temperature of 17.8ºC was recorded in 2006. The largest temperature variation between the decades was 4.2ºC, while the minimum variation was 1.4ºC.

Table 2. Climatic Variabilities of Thiruvananthapuram & Palakkad Districts (1991-2020)

Sl. No	Year	Thiruvananthapuram		Palakkad	
		Max T	Min T	Max T	Min T
1	1991	35.2	19.7	40.4	18
2	1992	35.1	19.4	41.4	19.8
3	1993	35.6	19.4	40.6	17.2
4	1994	35.2	19.4	39.4	16.8
5	1995	35.3	19.9	39.4	18.6
6	1996	35	20	39.2	19
7	1997	35.5	20.3	37.8	19.4
8	1998	36.7	19.5	40.6	19.4
9	1999	35.8	19.3	38.8	17.8
10	2000	35.1	20	38.6	18.8
11	2001	38.4	19.6	37.9	19.2
12	2002	36.1	19.1	38.3	18.6
13	2003	36.9	18.5	38.6	18.3
14	2004	36.5	19.1	36.2	18
15	2005	36.4	20.1	37.9	18.9
16	2006	35.5	19.6	37.8	17.8
17	2007	38	19.6	40.4	18
18	2008	35.8	19.2	No Data	No Data
19	2009	36.5	18.5	No Data	No Data
20	2010	37.5	20.8	No Data	No Data
21	2011	35.5	19.1	No Data	No Data

22	2012	36	18.6	37.5	19.5
23	2013	36.4	19.8	40.4	19.5
24	2014	36.6	20	40.2	20.8
25	2015	36.4	19.8	37.2	20.5
26	2016	36.5	21	41.9	19.5
27	2017	37.2	20.5	39.8	20.2
28	2018	35.9	20.6	39.1	20.1
29	2019	38.2	18.9	41.1	18.8
30	2020	36	21.4	39.4	20

Source: Compiled by the Researchers from various sources, 2022

According to data from the 2011-2020 decade, the temperature in the Thiruvananthapuram district exhibits significant variations. The largest temperature differential observed throughout this decade was 2.7ºC, while the minimum temperature fluctuation recorded was 2.8ºC. The years 2017 and 2019 experienced the highest temperatures of the decade, while in the Palakkad district, the highest temperature recorded in 2016 was 41.9º C. The lowest minimum temperature recorded in 2019 was 18.8ºC. The highest temperature differential between the decades is 4.4 degrees Celsius. The districts of Thiruvananthapuram and Palakkad exhibit significant disparities in terms of temperature and rainfall variability. The rainfall variability between the two districts is shown in Table 3.

Table 3. Decadal Rainfall Variability of Thiruvananthapuram & Palakkad Districts (1991-2020)

Sl. No	Year	Thiruvananthapuram	Palakkad
1	1991	2022.4	2021.6
2	1992	1978.6	2127.8
3	1993	1944.8	1495.2
4	1994	1817.1	1984.5
5	1995	1573.4	1710.1
6	1996	1629	1786.3
7	1997	1904.6	1446.8
8	1998	2290	1925.2
9	1999	1865.8	1852.7
10	2000	1395	1758.2
11	2001	2136.4	1984
12	2002	1469	1893
13	2003	1405	1785
14	2004	1912.4	1645.2
15	2005	1954	1465.9
16	2006	2135.2	1748.6
17	2007	2006.2	1963.1
18	2008	2025.1	No Data
19	2009	1495	No Data
20	2010	1906.1	No Data
21	2011	1605.2	No Data

22	2012	1173.2	1884.7
23	2013	1855.4	2796.7
24	2014	1977.5	2342.4
25	2015	2119.5	1514.2
26	2016	1193	1454
27	2017	1843.3	1817.5
28	2018	2164.3	3443.2
29	2019	1956.1	2954.9
30	2020	2407	2241.1

Source: Compiled by the Researchers from various sources, 2022

The Thiruvananthapuram district received varying amounts of rainfall during the decade 1991-2000. The highest decadal rainfall of 2290cm was recorded in the year 1998, while the lowest decadal rainfall of 1395cm was recorded in 2000. In the Palakkad district, the highest rainfall of the decade was recorded in 1992, measuring 2127.8cm. The lowest rainfall of the decade in Palakkad was recorded in 1993, measuring 1495.2cm. In Thiruvananthapuram, during the 2001-2010 decade receive the highest rainfall in the year 2001(2136cm) and the lowest received the year 2003(1405cm), and in Palakkad district the highest rainfall was recorded in the year 2001 (1984 cm), and the lowest of the decade was recorded during the year 2005 (1465.9 cm). The decade 2011-2020 of Thiruvananthapuram district received the highest rainfall in the year 2020(2407cm) and the lowest in the year 2012(1173cm) but in Palakkad receive highest rainfall was recorded in the year 2018 (3443.2 cm), and the lowest of the decade was recorded during the year 2016 (1454 cm). The decadal highest rainfall recording in the years 2013,2018, and 2019. Compared to Thiruvananthapuram district, the decadal rainfall of the Palakkad district was Low.

Results from Decadal Analysis

Over the previous three decades (1991-2020), the temperature, weather patterns, and rainfall in both Thiruvananthapuram and Palakkad districts have seen significant changes. The initial decade under consideration for investigation is the period from 1991 to 2000. There has been no discernible alteration in the weather pattern of the Thiruvananthapuram and Palakkad district during this decade. Palakkad has consistently recorded higher temperatures than Trivandrum during the past few decades. During the 1991-2000 decade, Thiruvananthapuram experienced a highest temperature fluctuation of 0.8ºC, with a minimum change of 1ºC. In contrast, Palakkad had a maximum temperature variation of 3.6ºC, with a minimum variance of 2.6ºC. The difference in maximum temperature between Thiruvananthapuram and Palakkad during a period of ten years is 4.7ºC. In 1992, the temperature in Palakkad reached a peak of 41.4ºC, whereas in 1998, Thiruvananthapuram experienced a maximum temperature of 36.7ºC. The district that received the largest amount of rainfall during the decade was Thiruvananthapuram, with a total of 2290cm in the year 1998. In 1992, Palakkad district recorded its highest rainfall of 2127.8cm. Palakkad saw the highest temperature, while Thiruvananthapuram received the largest amount of rainfall in this decade.

The weather pattern of the decade from 2001 to 2010 had a small alteration. In 2001, the hottest temperature recorded in Thiruvananthapuram was 38.4ºC, whereas in 2007, Palakkad experienced a temperature of 40.4ºC. The largest temperature difference between Thiruvananthapuram and Palakkad district was 1.6ºC. The temperature in Palakkad district was 1.6ºC higher than the temperature in Thiruvananthapuram. The highest recorded rainfall in Thiruvananthapuram

occurred in 2001, measuring 2136 cm, while the lowest rainfall of the decade was reported in 2003, measuring 1405 cm. However, Palakkad experienced the most amount of rainfall in the year 2001, with a total of 1984 cm. Conversely, the lowest amount of rainfall in the decade occurred in 2005, with a recorded measurement of 1465.9 cm. Thiruvananthapuram district received the most amount of rainfall during this decade, whereas Palakkad district experienced the highest temperature.

From 2011 to 2020, the temperature in the Thiruvananthapuram district had a significant increase. The decade of Trivandrum experiences a maximum temperature variance of 2.7ºC, whereas the Palakkad district has a decadal maximum fluctuation of 4.4ºC. The temperature difference between the two areas was 0.3ºC, which was the greatest deviation observed. In 2019, the maximum temperature recorded in Thiruvananthapuram was 38.2ºC, while in 2016, Palakkad experienced a temperature of 41.9ºC. There was a significant fluctuation in rainfall throughout the last ten years in Palakkad. In Thiruvananthapuram, the maximum recorded rainfall was 2407cm in the year 2020, whereas in Palakkad it reached 3443cm in 2018. The decadal volatility of rainfall in the last decade (2011-2020) is higher compared to previous decades. The district of Palakkad is credited as having the highest temperature and the largest amount of rainfall.

In Thiruvananthapuram district, the temperature increased by around 0.8ºC between the first decade (1999-2000) to the second decade (2001-2010), and by roughly 0.7ºC from the second decade (2001-2010) to the third decade (2011-2020). The cumulative rise in temperature over the past thirty years was 1.5ºC. In Palakkad, the temperature variation throughout the first and second decades is 1ºC. In the second decade, there was a decrease in temperature of 1ºC. From the second decade to the third decade (2011-2020), the temperature increased by around 0.2ºC. The decadal temperature variation amounted to 1.2ºC.

The rainfall variability in Thiruvananthapuram district throughout the first two decades (1991-2000) and (2001-2010) was 153.7cm. However, in the second decade, there was a drop in rainfall. The increase in height from the second decade (2001-2010) to the third decade (2011-2020) was 271cm. The difference in total rainfall between the decades was 424.7cm. In Palakkad, the rainfall variability over the first two decades was 143cm, whereas between the second decade to third decade, it increased significantly to 1,459.2cm. The cumulative difference in rainfall over a period of ten years was 1,602.2cm.

According to the data, there were no noticeable fluctuations in temperature in both the Thiruvananthapuram and Palakkad districts over the first decade (1991-2000). The largest temperature difference between the two districts in the first decade was 4.7ºC. According to the report, the Palakkad district saw the greatest temperature throughout the first ten years. In the first decade (1991-2000), Thiruvananthapuram had the most amount of rainfall, measuring 2290cm, while Palakkad received 2127.8 cm. Thiruvananthapuram received the maximum amount of rainfall in this decade. Between 2000 and 2010, there were noticeable fluctuations in the temperature of both districts. The temperature disparity between Thiruvananthapuram and Palakkad district was 1.6ºC. In Thiruvananthapuram, the largest amount of rainfall ever recorded was 2136cm, whereas in Palakkad it was 1984cm.Thiruvananthapuram received the most amount of rainfall during the decade. According to the data from the 2011 to 2020 decade, there were no significant fluctuations in temperature in any area. The temperature difference between the two regions reached a maximum of 3.4ºC. Palakkad had the highest recorded temperature of 41.6ºC in

the district over the past decade. During the same decade, the district that received the maximum amount of rainfall was Palakkad. Palakkad recorded a precipitation of 3443.2 centimetres in 2018, while Thiruvananthapuram experienced 2407 centimetres of rainfall in 2020. The climate and rainfall patterns in Thiruvananthapuram and Palakkad districts have seen changes during the past 30 years. From 1991 to 2000 and 2001 to 2010, Palakkad district experienced the highest recorded maximum temperature, while Thiruvananthapuram district received the greatest recorded rainfall. The Palakkad district had a significant transformation between 2011 and 2020, with the highest temperatures and rainfall levels being attributed to this area. From 2011 to 2020, there was an increase in the variability of rainfall and temperature in Palakkad district. However, there have been no significant fluctuations in temperature and rainfall patterns in the Thiruvananthapuram district. Based on the provided data, Thiruvananthapuram experienced a total temperature increase of 1.5ºC during the past three decades, and there was a difference of 424.7cm in rainfall variability between these decades. The temperature in Palakkad district has varied by 1.2ºC over the previous three decades, while the rainfall has varied by 1,602.2cm.

Conclusion

The climatic fluctuations result in numerous disruptions worldwide. It is a pressing issue that affects humans, animals, and the environment. The impacts of climate change encompass severe meteorological events, heightened occurrences of aridity, biodiversity loss, catastrophic incidents, insufficient food supply, amplified health hazards, and increased poverty rates. This study aims to analyze the climatic and rainfall variations during the previous three decades. The study regions encompass two districts in the state of Kerala: Thiruvananthapuram and Palakkad. It is well-established that as the concentration of greenhouse gases increases, there is a corresponding increase in global surface temperature. From 2011 to 2020, the world had the warmest decade on record. According to the world record, the temperature at the local level increased by a few degrees. Each successive decade has exhibited higher temperatures than the preceding one, both locally and globally. Furthermore, there is an increase in the occurrence of hot days and heat waves throughout all terrestrial regions. The elevated temperature exacerbated heat-related illnesses and rendered outdoor work more arduous for individuals (Clark et al, 2020). The inhabitants of Palakkad area have had numerous challenges in the previous decade due to the increase in temperature and had even experienced severe sunburn. Studying the effects of climate change and proposing ways to reduce its impact is crucial. The objective of space-based global change observation, in conjunction with other observations and studies, is to establish a robust scientific foundation for formulating national and international policies pertaining to both natural and human-induced alterations in the Earth system (Kikstra et al, 2022).

As the climate change tightens its grip, devastating droughts are caused by the rise in the average temperature of the planet. In the Thiruvananthapuram district, the amount of rainfall has been decreasing over the course of the last ten years, leading to a severe drought. The rate of rainfall during the monsoon season varies from district to district in the state, as a result of changes occurring at the global level. There is, therefore, a significant possibility that this district in Kerala may experience a drought that is quite destructive. Additionally, because of the spike in temperature, sunburn, heat waves, and tornadoes have occurred in both districts, particularly in the Palakkad area. There was a little tornado that occurred near the Vellayil coast of Kozhikode on July 15, 2022, and it lasted for ten minutes. This micro tornado sent shockwaves across the fisherman and local residents in the north of Kerala. It is all due to the shift in the climate on a worldwide scale, which is reflections on a local scale. These issues have to be addressed in a local

as well as regional levels. At first, the global community is focusing on these effects of climate change, hoping for a new dawn having reduced impacts of the same.

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