15 –ാം കേരള നിയമസഭ

6 –ാം സമ്മേളനം

നക്ഷത്രചിഹ്നമിട്ട ചോദ്യം നം. 10 **23-08-2022 - ൽ മറുപടിയ്ക്ക്**

കാലാവസ്ഥ വ്യതിയാനം ഉയർത്തുന്ന വെല്ലുവിളികൾ നേരിടാൻ പദ്ധതി

ചോദ്യം		ഉത്തരം	
ശ്രീ. സെബാസ്റ്റ്യൻ കുളത്തുങ്കൽ, ഡോ. എൻ. ജയരാജ്, ശ്രീ പ്രമോദ് നാരായൺ, ശ്രീ. ജോബ് മൈക്കിൾ		**ശ്രീ. പിണറായി വിജയൻ (മുഖ്യമന്ത്രി)**	
(എ)	കാലാവസ്ഥയിൽ ഉണ്ടായിട്ടുള്ള വലിയ വ്യതിയാനം സംസ്ഥാനത്തിന്റെ സാമൂഹിക സാമ്പത്തിക വികസനത്തിനും സുസ്ഥിരതയ്ക്കും വെല്ലുവിളി ഉയർത്തുന്നതായി വിശകലനം ചെയ്തിട്ടുണ്ടോ; ഇത് സംബന്ധിച്ച പഠന റിപ്പോർട്ടുകൾ ലഭ്യമാണോ;	(എ)	വിശകലനം ചെയ്തിട്ടുണ്ട്. ഇത് സംബന്ധിച്ച് 2014-ൽ സംസ്ഥാന കാലാവസ്ഥാ വ്യതിയാന കർമ്മ പരിപ്രേക്ഷ്യം SAPCC കേന്ദ്ര സംസ്ഥാന സർക്കാരുകൾ അംഗീകരിച്ച് പുറത്തിറക്കിയിട്ടുണ്ട്. കേന്ദ്ര വനം പരിസ്ഥിതി മന്ത്രാലയത്തിന്റെ പുതിയ മാർഗ്ഗനിർദ്ദേശങ്ങളുടെ അടിസ്ഥാനത്തിൽ ആയത് പരിഷ്കരിക്കുന്നതിനുള്ള നടപടികൾ സ്വീകരിച്ചിട്ടുണ്ട്. കൂടാതെ കേരള സംസ്ഥാന ശാസ്ത്ര സാങ്കേതിക പരിസ്ഥിതി കൗൺസിലിന് കീഴിലുള്ള കാലാവസ്ഥ വ്യതിയാന പഠന കേന്ദ്രത്തിൽ (ICCS) കാലാവസ്ഥയെ കുറിച്ചുള്ള വാർഷിക പ്രസ്താവന പ്രസിദ്ധീകരിക്കുന്നുണ്ട്. 2021-വർഷത്തെ കാലാവസ്ഥ പ്രസ്താവന റിപ്പോർട്ട് അനുബന്ധമായി ചേർത്തിരിക്കുന്നു. കാലാവസ്ഥ വ്യതിയാനം മൂലം സംസ്ഥാനത്തിലെ പെരിയാർ, പമ്പ, ചാലിയാർ, ഭാരതപ്പുഴ എന്നീ നദീ തടങ്ങളിൽ ഉണ്ടായിട്ടുള്ള മാറ്റങ്ങളെക്കുറിച്ചുള്ള പഠനവും കാലാവസ്ഥ വ്യതിയാന പഠന കേന്ദ്രം ആരംഭിച്ചിട്ടുണ്ട്.
(ബി)	കാലാവസ്ഥ വ്യതിയാനം നേരിട്ട് ബാധിക്കുന്ന മേഖലകൾ ഏതൊക്കെയെന്ന് വ്യക്തമാക്കാമോ;	(ബി)	1.കാർഷിക മേഖല, 2. മൃഗസംരക്ഷണം, 3.വനം, വന്യജീവി ജൈവവൈവിധ്യം 4.ആരോഗ്യം, 5. ജലവിഭവം, 6. ഫിഷറീസ്, തീരദേശം 7.വിനോദസഞ്ചാരം മുതലായവയാണ് കാലാവസ്ഥ വ്യതിയാനം നേരിട്ട് ബാധിക്കുന്ന മേഖലകളായി വിലയിരുത്തിയിട്ടുള്ളത്.
(സി)	കാലാവസ്ഥ വ്യതിയാനവുമായി ബന്ധപ്പെട്ട് തദ്ദേശ സ്ഥാപനങ്ങളുടെ തലത്തിൽ അനുയോജ്യമായ പദ്ധതികൾ തയ്യാറാക്കി ലോക്കൽ ആക്ഷൻ പ്ലാൻ	(സി)	യു.എൻ.ഇ.പി, യു.എൻ ഗ്രിഡ്, ചിമ ഫൗണ്ടേഷൻ ഇറ്റലി എന്നിവരുടെ സഹായത്തോടെ 10വർഷ പ്രളയ ആവർത്തന സാധ്യത, 25വർഷ പ്രളയ ആവർത്തന സാധ്യത, 50വർഷ പ്രളയ ആവർത്തന

	നടപ്പാക്കാൻ ഉദ്ദേശിക്കുന്നുണ്ടോ; വിശദാംശം ലഭ്യമാക്കാമോ;		സാധ്യത, 100വർഷ പ്രളയ ആവർത്തന സാധ്യത, 200വർഷ പ്രളയ ആവർത്തന സാധ്യത, 500വർഷ പ്രളയ ആവർത്തന സാധ്യത പ്രദേശങ്ങളുടെ സൂക്ഷ്മ ഭൂപടങ്ങൾ തയ്യാറാക്കി പ്രസിദ്ധീകരിച്ചിട്ടുണ്ട്. ഓരോ തദ്ദേശ സ്ഥാപനത്തിലെയും പ്രളയ സാധ്യതാ പ്രദേശം, അതാത് പ്രളയ സാധ്യതാ പ്രദേശത്ത് ഉണ്ടാകാവുന്ന പ്രളയ ജല ഉയരം എന്നിവ പൊതു ജനങ്ങൾക്കായി പ്രസിദ്ധീകരിച്ചിട്ടുണ്ട്. കേന്ദ്ര ദുരന്ത ലഘൂകരണ പദ്ധതി 2019 പ്രകാരം പ്രളയ സാധ്യതാ പ്രദേശങ്ങളുടെ സൂക്ഷ്മ ഭൂപടങ്ങൾ കേരളം തന്നെ മുൻകൈ എടുത്ത് തയ്യാറാക്കിയിട്ടുണ്ട്. തദ്ദേശ സ്ഥാപനങ്ങൾക്കും, വകുപ്പുകൾക്കും ദുരന്ത സാധ്യത പരിഗണിച്ചുള്ള തയ്യാറെടുപ്പുകൾക്കായി ഈ ഭൂപടങ്ങൾ ഉപയോഗിക്കുവാൻ കഴിയും. ഭൂപടത്തിൽ ഓരോ പ്രളയ ആവർത്തന സാധ്യതാ പ്രദേശത്തും ഉള്ള സ്കൂളുകൾ, ആശുപത്രികൾ എന്നിവ ഉൾപ്പെടുത്തിയിട്ടുണ്ട്. ഇവ പ്രാദേശിക സൂചകങ്ങളായി ഉപയോഗിക്കുവാൻ കഴിയും
(ഡി)	കാലാവസ്ഥ വ്യതിയാന സംബന്ധിയായ പ്രവർത്തനങ്ങളെ ഏകോപിപ്പിക്കുന്നതിന് പരിസ്ഥിതി- കാലാവസ്ഥ വ്യതിയാന വകുപ്പ് രൂപീകരിക്കുന്നതിന് നടപടി സ്വീകരിക്കാമോ?	(ഡി)	2010 മുതൽ സംസ്ഥാന പരിസ്ഥിതി വകുപ്പിനു കീഴിൽ പരിസ്ഥിതി കാലാവസ്ഥാ വ്യതിയാന ഡയറക്ടറേറ്റ് നിലവിലുണ്ട്. കാലാവസ്ഥാ വ്യതിയാന സംബന്ധമായ വിഷയങ്ങളിൽ സംസ്ഥാന തല നോഡൽ ഏജൻസി ആയി ഡയറക്ടറേറ്റ് പ്രവർത്തിച്ചു വരുന്നു.

സെക്ഷൻ ഓഫീസർ

STATEMENT ON CLIMATE FOR THE STATE OF KERALA: 2021

institute for climate change studies

INSTITUTE FOR CLIMATE CHANGE STUDIES

A Research Organization under Kerala State Council for Science Technology and Environment (KSCSTE), Govt. of Kerala

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STATEMENT ON CLIMATE FOR THE STATE OF KERALA: 2021

HIGHLIGHTS

The Kerala State averaged annual mean land surface air temperature during 2021 was +0.40^{0}C warmer than average (1971-2020) making 2021, the eighth warmest year for Kerala on record since 1901. The warmest year for Kerala on record prior to 2021 was 2016 (+0.97^{0}C) followed by 2019 (+0.88^{0}C). The warmer than normal annual mean temperature was mainly contributed by the above average mean temperature during the southwest monsoon season (0.73^{0}C). The 8 of the 10 warmest years in record were pertaining to the recent decade (2012-2021) and therefore the annual mean temperature of Kerala during the past decade (2011-2020/ 2012-2021) was also the warmest decade on record with the decadal averaged annual mean temperature anomaly of 0.51^{0}C /0.55^{0}C.

The annual maximum and minimum temperatures averaged over the state during the year 2021 were also warmer than average with anomalies of 0.39^{0}C (9th warmest) & 0.42^{0}C (6th warmest).

The observed warming trend in the Kerala averaged temperatures is in line with the observed warming trends in the Global mean surface temperature and in the all India averaged annual mean temperature.

Kerala experienced seasonal rainfall of 10.4% below its Long Period Average (LPA) value for the period 1971-2020 during the southwest monsoon season and 114.8% above its LPA during the northeast monsoon season, which are the main rainy seasons of the state. The northeast monsoon season rainfall during 2021 was highest ever recorded since 1901. Kerala also experienced highest ever winter season rainfall (401% above its LPA) during 2021.

Introduction

The Institute for Climate Change Studies (ICCS) is an autonomous research institution under Kerala State Council for Science Technology and Environment (KSCSTE), Government of Kerala. The Centre is envisioned for integrated research, technical support and capacity building in all aspects of Climate change issues and integrate development policies, plans and programs at State level. Now as part of its state level climate monitoring activities, ICCS has decided to issue statement of annual climate for the State of Kerala in line with the annual statement issued by India Meteorological Department (IMD) for the country. As a first attempt ICCS has decided to issue annual climate statement for the previous year 2021. From next year onwards, the climate statement for the previous year will be issued in the month of January. The present statement contains, important information about the monthly, seasonal and annual State averaged temperature and rainfall for the year 2021 vis a vis the same during the last 120 years. This statement also includes State specific information related to various extreme weather and climate events experienced during 2021. The rainfall and temperature data and extreme weather events information used for the preparation of this report was provided by IMD.

Temperatures

The monthly and seasonal maximum, minimum and mean temperature anomalies averaged over the State of Kerala is given in the **Fig.1**. The anomalies were computed based on the Long Period Average (LPA) for the period 1971-2020. The State averaged monthly maximum temperature was warmer than average during most of the months of 2021 (except January, May and November) with June recording highest monthly maximum temperature anomaly (1.37^{o}C).The State averaged monthly minimum temperature was warmer than the average during all months except in May with highest anomaly recorded in January (1.48^{o}C).The State averaged mean monthly temperature was warmer than average during all the months of the year except in May and November. Among the months, the highest State averaged monthly mean temperature anomaly was recorded in June (0.87^{0}C, fourth warmest since 1901), followed by July (0.76^{0}C, sixth warmest since 1901). Season wise, the monsoon season (June to September) recorded the highest season averaged maximum temperature anomaly (1.06^{o}C, second warmest since 1901) and mean temperature anomaly (0.73^{o}C, third warmest since 1901). However, winter season (January to February) recorded the highest season averaged minimum temperature anomaly (0.87^{o}C, fourth warmest since 1901).

During the year 2021, the annual mean land surface air temperature of Kerala was +0.40^{0}C warmer than average (1971-2020) making 2021, the eighth warmest year for Kerala on record since 1901 (**Fig.2**). The seven warmest years on record prior to 2021 on ascending order are: 2014 (0.42^{0}C), 1987(0.45^{0}C), 2015 (0.66^{0}C), 2017 (0.71^{0}C), 2020 (+0.81^{0}C), 2019 (+0.88^{0}C), 2016 (+0.97^{0}C). It is also important to note that 8 of the 10 warmest years in record were pertaining to the recent decade (2012-2021). As a result, the annual mean temperature of Kerala during the past decade (2011-2020/ 2012-2021) was also the warmest decade on record with the decadal averaged annual mean temperature anomaly of 0.51^{0}C /0.55^{0}C. A significant increasing trend of 1.05^{0}C/100 years is observed in the State averaged annual mean temperature during 1901-2021 (**Fig.2**).

The annual maximum and minimum temperatures averaged over the state during the year 2021 were also warmer than average with anomalies of 0.39^{0}C (9th warmest) & 0.42^{0}C (6th warmest) (**Fig.2**). During the period 1901-2021, the State averaged maximum temperature showed a significant increasing trend (1.67^{0}C/100 years) and the State averaged minimum temperature a relatively lower increasing trend (0.42^{0}C/100 years). As seen in the **Fig.2,** the anomalies of annual maximum temperature were more negative than that of annual minimum temperatures till late 1980's. Thereafter, the role was reversed. This is mainly because of the observed higher increasing trend in the maximum temperature compared to that in the minimum temperature. This has also resulted in the increased annual State averaged diurnal variation (not shown here) in recent decades.

The district averaged trends in the maximum, minimum and mean temperatures for the period 1901-2021 is shown in the **Figures 3a**, **3b** and **3c** respectively. There are significant increasing trends in the district averaged maximum and mean temperatures for all the 14 districts of the State. However, in the case of minimum temperature, significant increasing trends were observed in9 out of the 14 districts. Among the remaining five districts, Kannur and Pathanamthitta showed increasing but non-significant trends, Kasaragod, the northern most district showed significant decreasing trend and Kollam and Thiruvananthapuram, the two southern most districts showed decreasing but insignificant trends.

Rainfall

Kerala most of its annual rainfall during two monsoon seasons; Southwest monsoon season (June to September) and Northeast monsoon season (October to December). During 2021, the State received the southwest monsoon season rainfall within the normal range but 10.4% below its long-period average (LPA)(**Fig.4**). On the other hand, the season averaged rainfall received during the Northeast monsoon season was exceptionally high (114.8% above LPA) (**Fig.5**). It may be mentioned that the State averaged season rainfall in both the seasons during the past 121 years (1901-2021) have shown a decreasing trend of about 10% of LPA/100 years. In the case of southwest monsoon season,

Kerala has received State averaged season rainfall less than that received during 2021 in 26 years of the period 1901-2020 with lowest in 1981 (43.4% below LPA). The highest ever State averaged season rainfall over Kerala was received in 1924 (79.9% above LPA). In case of Northeast monsoon season, the State averaged season rainfall received during 2021 was highest ever in record since 1901. This was followed by 2010 (72.4% from LPA) and 1977 (69.9% from LPA).

During 2021 southwest monsoon season, 12 of the 14 districts received less than LPA rainfall with Palakkad and Idukki recorded lowest (27.2% below LPA) and highest (-4.6% below LPA) season rainfall among these 12 districts. The other two districts which received above LPA rainfall were Kottayam (16.2% above LPA) and Pathanamthitta (9.6% above LPA). On the other hand, during northeast monsoon season, all the districts got exceptionally above LPA rainfall with Pathanamthitta (174% above LPA) recording the highest followed by Kasaragod ((145% above LPA).

The trend map in the district averaged southwest monsoon season rainfall during the period 1901-2021 (**Fig.6a**), shows decreasing trends in the rainfall in all the districts except in Idukki, where increasing but in significant trend is seen. Among the districts showing decreasing trends, rainfall trends over 3districts from south (Alappuzha, Kollam and Pathnamthitta) and 4 districts from north (Kannur, Wayanad, Malappuram and Palakkad) were significant. In case of Northeast monsoon season (**Fig.6b**) also decreasing trends in seasonal rainfall was seen in all the districts except in Kasaragod, with significant decreasing trends in Palakkad and Kottayam. Kasaragod showed increasing but non-significant trend was observed.

In 2021, Kerala also experienced relatively increased rainfall activity during the winter (January to February) and, pre-monsoon (March to May) seasons with rainfall of 401% above LPA (highest ever since 1901) and 116% above LPA respectively. Among the three months of the pre-monsoon season, May month received the highest rainfall of 569.57 mm against the LPA of 206.35, due to the formation of one cyclone each in the Arabian Sea and Bay of Bengal.

Extreme Weather Events:

Table1 shows the highest maximum and minimum temperatures and highest rainfall recorded in the 12 IMD met observatories across Kerala along with the dates during 2021. It is seen that, among these stations, Palakkad reported the highest maximum temperature of 38.7^{o}C (on 8th April and 8th May) followed by Vellanikkara in Thrissur district (38.5^{o}C on 26th March). Lowest minimum temperature was recorded by Punalur in Kollam district (16.0^{o}C on 28th January, 28th and 30th December) followed by Vellanikkara (18.1^{o}C on 26th January). Highest one day rainfall was recorded by Karipur airport (254.9mm) followed by Kozhikode city (216mm) both the events recorded on 12th October.Among these observatories, highest number of daily heavy rainfall events (>64.5mm) were recorded by Kozhikode (16 days) followed by Kottayam & CIAL Kochi (13 days each). **Fig.7** shows the locations of extreme rainfall of various intensities occurred during the southwest and northeast monsoon seasons based on rainfall data available from all the stations including the 12 IMD stations given in the Table-1.

The year 2021 witnessed many extreme weather events like heavy rainfall, floods, landslide, lightning, thunderstorms, etc over most of the districts of Kerala. A few of such events caused loss of life, which are listed in table 2. The causalities mentioned here are based on the media and government reports of disaster Management Authorities. Major Extreme Weather Events & associated loss of life occurred during 2021 over the Kerala states is given in **Fig.8**.

Table 1: Highest maximum and minimum temperatures and highest rainfall recorded in the 12 IMD meteorological observatories across Kerala along with the dates during 2021.

IMD Stations	Highest of Maximum Temperature ^{0}C (Date)	Lowest of Maximum Temperature ^{0}C (Date)	Highest of Minimum Temperature ^{0}C (Date)	Lowest of Minimum Temperature ^{0}C (Date)	Max Rainfall mm (Date)	Frequency of Heavy Rainfall Events (>64.5 mm)
Kannur	36.6 (02-02-2021)	24.9 (19-07-2021)	28.0 (31-03-2021)	21.4 (29-12-2021)	166.2 (12-10-2021)	7
Kozhikode city	35.8 (28-03-2021)	25.8 (19-07-2021)	28.2 (08-04-2021)	21.8 (27-05-2021)	216.0 (12-10-2021)	10
Karipur A. P	35.9 (05-03-2021)	24.7 (28-09-2021)	34.1 (25-04-2021)	20.2 (12-02-2021, 29-12-2021)	254.9 (12-10-2021)	16
Palakkad	38.7 (08-04-2021, 08-05-2021)	25.4 (15-06-2021, 28-09-2021, 13-10-2021)	27.9 (31-03-2021)	20.0 (25-12-2021)	123.7 (17-10-2021)	4
Vellanikkara	38.5 (26-03-2021)	24.5 (28-09-2021)	25.7 (01-04-2021)	18.1 (26-01-2021)	111.3 (15-05-2021)	9
Kochi A.P (Nedumbassery)	36.6 (25-03-2021, 31-03-2021)	24.5 (11-07-2021)	26.2 (01-04-2021, 29-04-2021)	19.0 (11-02-2021)	189.9 (14-11-2021)	13
Kochi (NAS)	33.8 (31-03-2021, 01-05-2021, 07-05-2021)	25.2 (17-10-2021)	29.2 (02-08-2021)	21.4 (26-01-2021)	209.0 (15-05-2021)	8
Alappuzha	37.2 (07-03-2021)	25.2 (13-06-2021)	28.0 (06-04-2021)	21.6 (11-02-2021)	157.2 (15-05-2021)	13
Kottayam	38.4 (16-03-2021)	25.5 (28-09-2021)	25.8 (01-04-2021)	19.0 (11-02-2021)	151.8 (10-07-2021)	12
Punalur	37.2 (10-03-2021	26.0 (27-05-2021)	24.0 (01-04-2021, 11-07-2021)	16.0 (28-01-2021, 28-12-2021, 30-12-2021)	135.8 (12-10-2021)	11
Trivandrum AP	34.9 (06-04-2021)	25.7 (26-11-2021)	26.6 (25-05-2021)	20.0 (29-12-2021)	165.2 (26-05-2021)	6
Trivandrum city	36.3 (31-03-2021)	25.0 (26-11-2021)	26.9 (01-04-2021)	20.4 (11-02-2021, 12-02-2021)	155.8 (12-05-2021)	8

Table 2: Extreme Weather Events during 2021 and associated loss of human Lives.

Impacted weather Events, 2021 Kerala			
Event	**Number of casualties & Date**	**season**	**Affected districts**
Floods and Heavy Rain	90 (23 to 25 May; 14 & 15 Jul.; 11 to 19 Oct.; 10 to 15 Nov.)	Pre monsoon (March to May) Monsoon (June to September) and Post monsoon (October to December)	Alapuzha, Ernakulam, Idukki, Kannur, Kollam, Kottayam, Kozhikode, Malappuram, Palakkad, Pathanamthitta Thiruvananthapuram, Thrissur, Wayanad
Lightning	12 (11 & 15 Apr, 9 & 12 May)	Pre- Monsoon (March to May)	Ernakulam, Thiruvananthapuram
Heavy rainfall and strong winds associated with the Extremely Severe Cyclonic Storm "TAUKTAE"	9 (14 to 19 May)	Pre-monsoon (March to May)	Ernakulam, Idukki, Kozhikode, Pathanamthitta and parts of Kerala

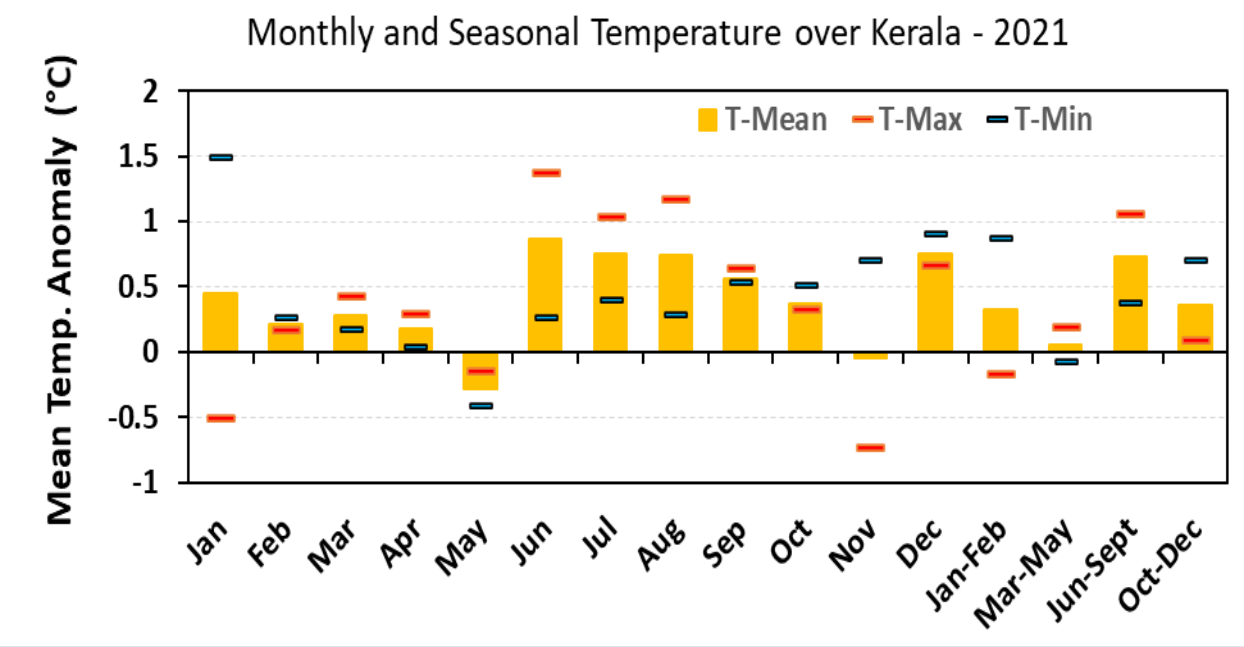

Fig.1. Monthly and Seasonal Maximum, Minimum and Mean Temperature anomalies averaged over Kerala during 2021.The anomalies were computed from long period average for the base period of 1971-2020.

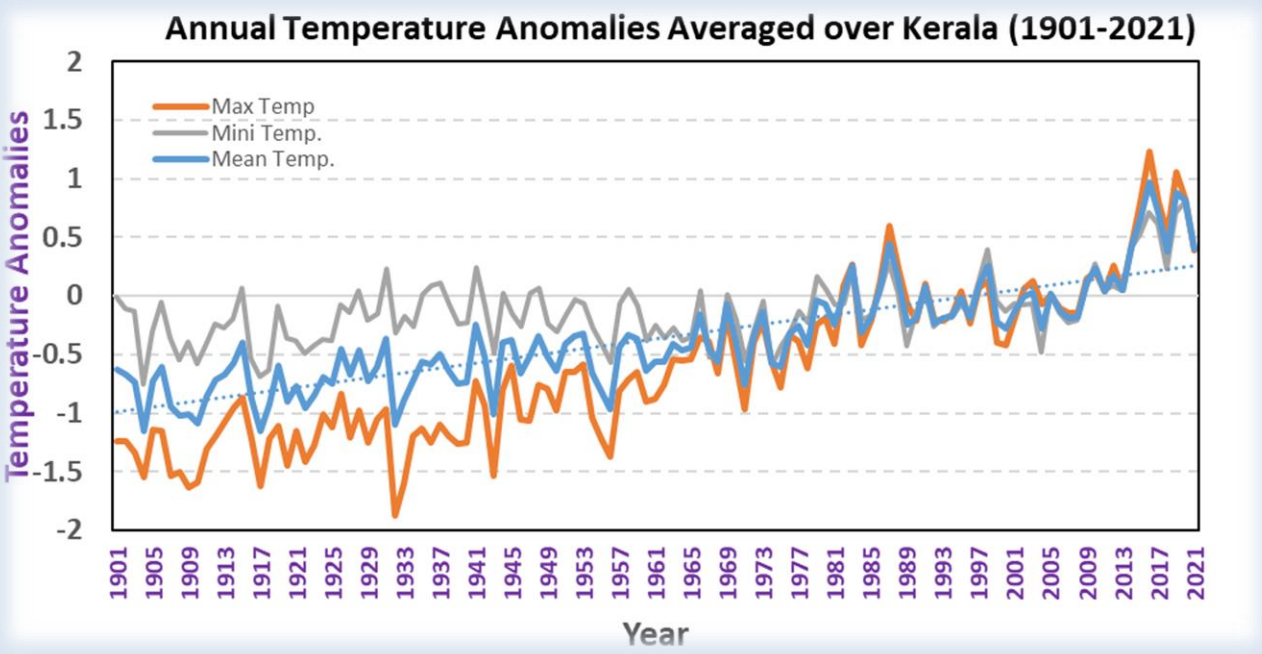

Fig.2: Annual maximum, minimum and mean land surface air temperature anomalies averaged over the State of Kerala for the period 1901-2021.The anomalies were computed with respect to the base period of 1971-2020. The dotted line indicates the linear trend in the annual mean temperature time series.

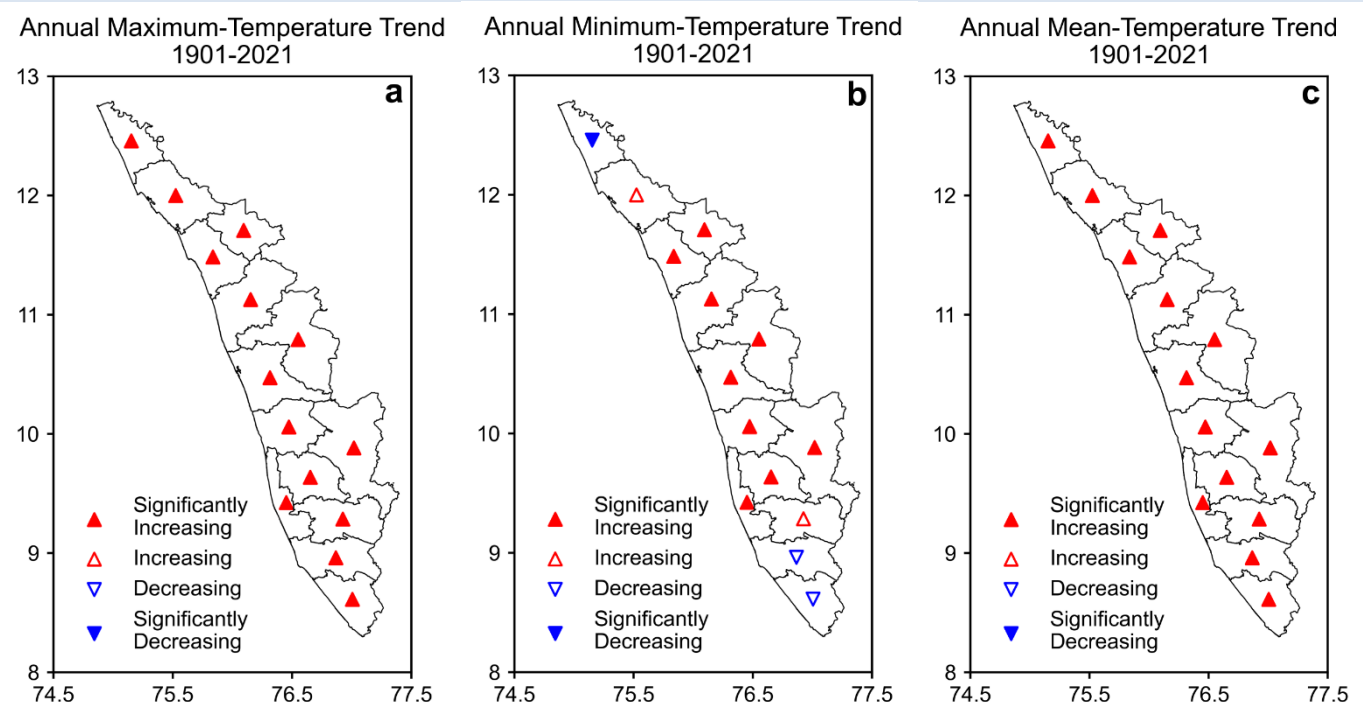

Fig.3: Trends in district averaged **a)** maximum, **b)** minimum, and **c)** mean land surface air temperatures for the period 1901-2021.

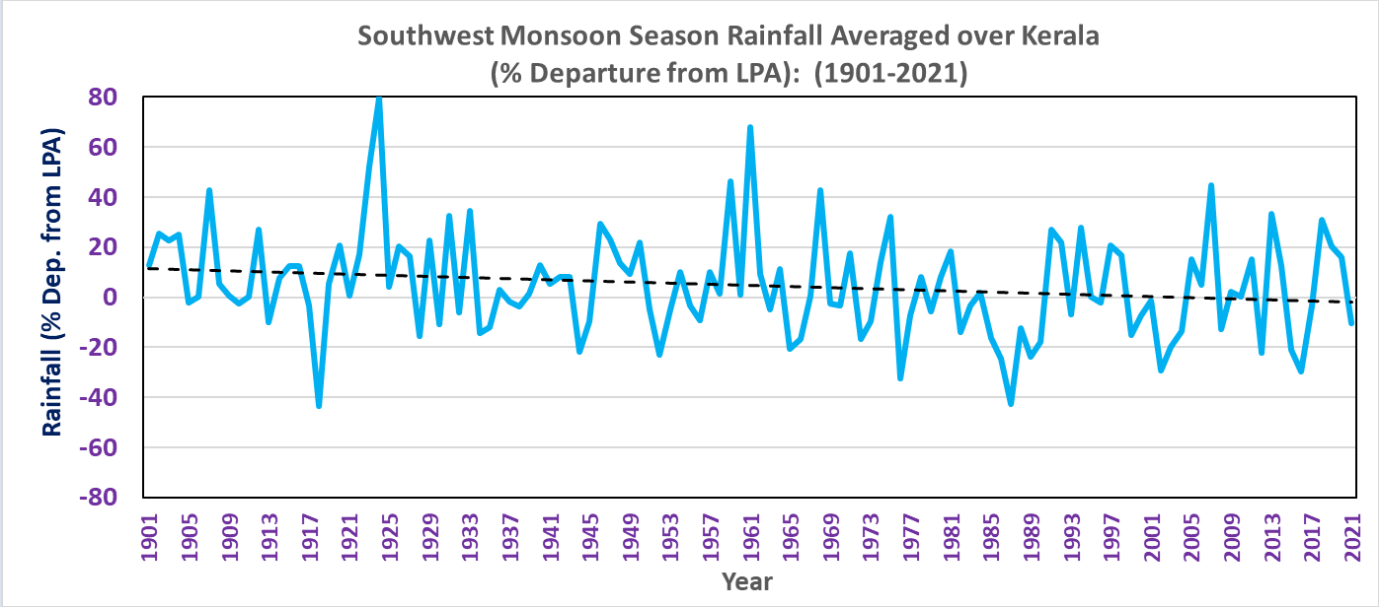

Fig.4: Seasonal departure of southwest monsoon rainfall averaged over Kerala as percentage from LPA for the period 1901-2021.

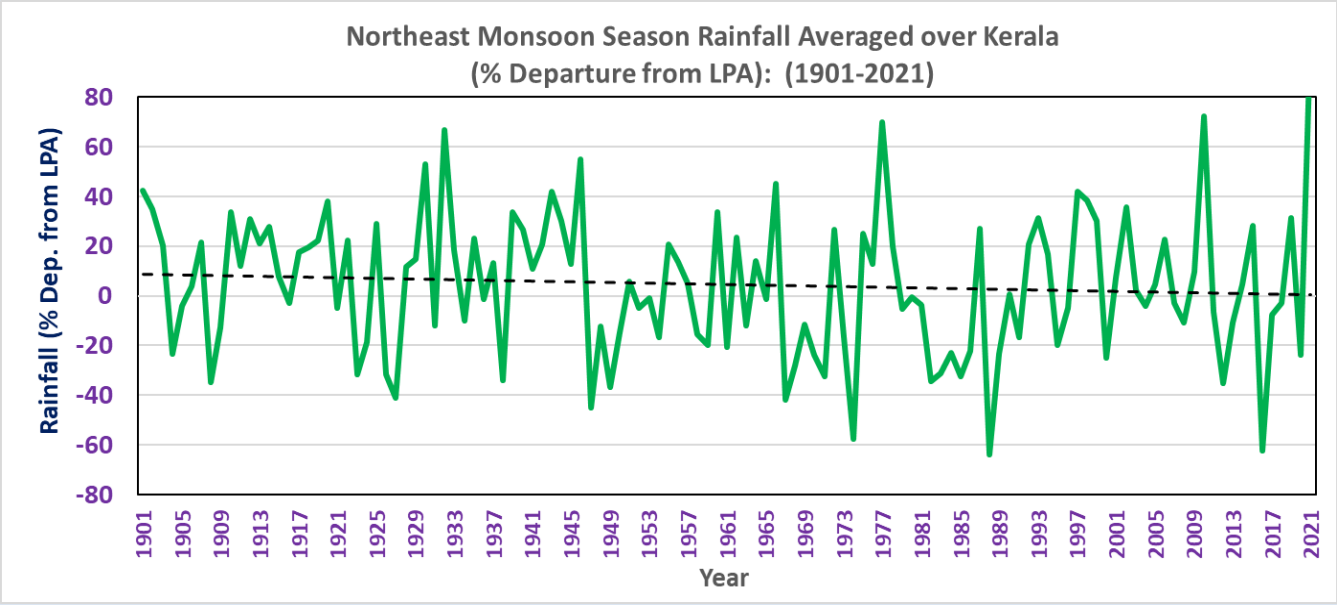

Fig.5: Seasonal departure of northeast monsoon rainfall averaged over Kerala as percentage from LPA for the period 1901-2021.

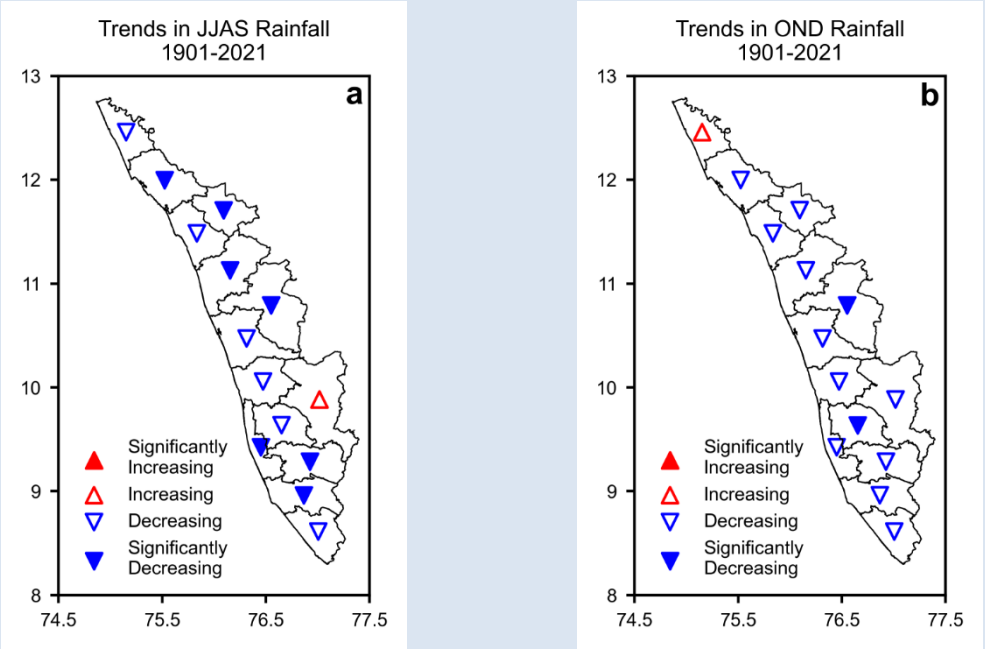

Fig.6: Trends in district averaged **a)** southwest monsoon (JJAS), and **b)** northeast monsoon (OND) for the period 1901-2021.

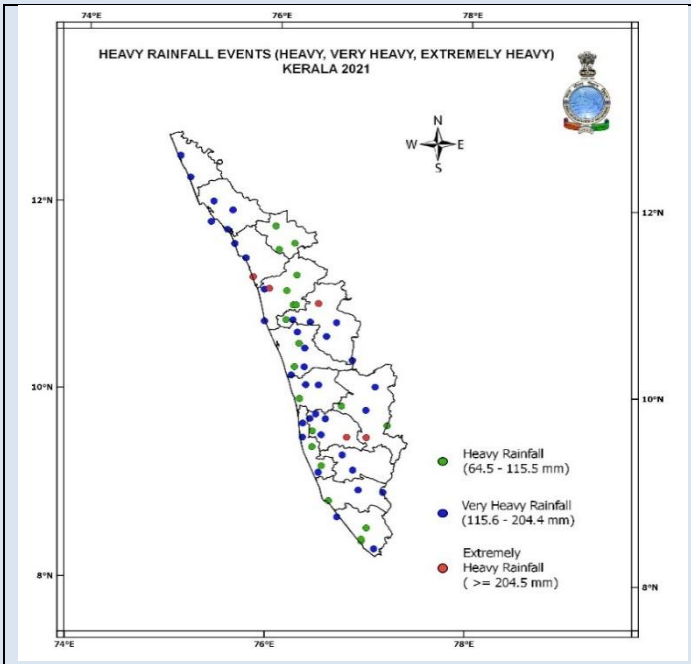

Fig.7: Location of Heavy Rainfall (64.5-115.5mm), Very Heavy Rainfall (115.6-204.4 mm) and Extremely Heavy Rainfall (more than 204.5 mm) reported stations over Kerala during the period June to December 2021.

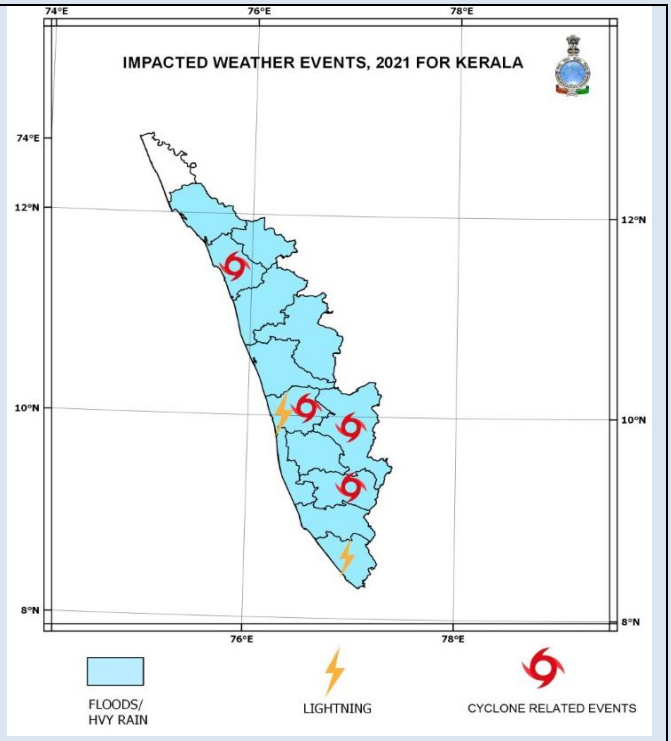

Fig.8: Locations of impact occurred associated with Major Extreme Weather Events occurred during 2021 causing loss of life (details provided in the Table 2). The 3 extreme weather events considered are; floods/heavy rainfall, lightning and cyclone related heavy rainfall and strong winds.