# ASSESSMENT OF DROUGHT IN THE CENTRAL ZONE OF KERALA USING DIFFERENT INDICES


***By***

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**(2017-20-022)**


**THESIS**

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**2024**

## DECLARATION

I, hereby declare that this thesis entitled **"ASSESSMENT OF DROUGHT IN THE CENTRAL ZONE OF KERALA USING DIFFERENT INDICES"** is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Place: Vellanikkara
Date: 27/01/2024

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## CERTIFICATE

Certified that this thesis entitled "**ASSESSMENT OF DROUGHT IN THE CENTRAL ZONE OF KERALA USING DIFFERENT INDICES**" is a bonafide record of research work done independently by **Mr. Sanjay Kumar M. S.** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to him.

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*Sanjay Kumar M. S.*

**CONTENTS**

## LIST OF TABLES

**LIST OF TABLES** (Contd…**)**

## LIST OF TABLES (Contd…)

## LIST OF FIGURES

## LIST OF FIGURES (Contd...)

## LIST OF FIGURES (Contd...)

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# SYMBOLS AND ABBREVIATIONS

| | |
|---|---|
| % | : per cent |
| / | : per |
| AEUs | : Agro Ecological Units |
| A I | : Aridity Index |
| Fig | : Figure |
| IPCC | : Inter-governmental Panel on Climate Change |
| KAU | : Kerala Agricultural University |
| MAI | : Moisture Avalibality Index |
| NDVI | : Normalized Difference Vegitation Index |
| SPI | : Standard Precipitation Index |

# *Introduction*

# 1. INTRODUCTION

Droughts are apparent after a long period with a shortage of precipitation or without any precipitation (Vyshak and Kumar, 2019). Drought can be classified as Meteorological drought, Hydrological drought and Agricultural drought. Meteorological drought defined as the deficiency of precipitation from expected or normal levels over an extended period of time. Meteorological drought usually precedes other kinds of drought. Meteorological drought is said to occur when the seasonal rainfall received over an area is less than 25% of its long term average value. It is further classified as moderate drought if the rainfall deficit is 26-50% severe drought when the deficit exceeds 50% of the normal year. Agricultural drought usually triggered by meteorological drought and hydrological drought, occurs when soil moisture and rainfall are inadequate during the crop growing season causing extreme crop stress and wilting. Plant water demand depends on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth and the physical and biological properties of the soil. In India, it is defined as a period of four consecutive weeks (of severe meteorological drought) with a rainfall deficiency of more than 50% of the long term average (LTA) or with a weekly rainfall of 5 cm or less from mid- May to mid-October (the kharif season) when 80% of India's total crop is planted or six such consecutive weeks during the rest of the year (NIDM, 2009).

India is predominantly an agrarian country, with a substantial portion of its population dependent on agriculture for their livelihoods. Droughts in India can have severe consequences, including crop failure, water scarcity, reduced agricultural productivity, and socio-economic disruptions. Droughts are primarily influenced by variations in monsoon rainfall, which is the lifeline for agriculture in the country.

India experiences two major monsoon seasons: the Southwest Monsoon (June to September) and the Northeast Monsoon (October to December). The Southwest Monsoon is particularly crucial as it brings the majority of the annual rainfall to most parts of the country.

Deviations from normal monsoon rainfall can result in drought conditions, especially in regions that heavily rely on rain-fed agriculture.

The state of Kerala, located in the south-western part of India, is no exception to the detrimental effects of drought. Within Kerala, the Central Zone stands as a crucial area for agriculture and plays a vital role in the state's economy. The Western Ghats mountain range in Kerala acts as a natural barrier, influencing the rainfall patterns in different regions of the state. In recent years, Kerala has faced episodes of drought, primarily due to anomalies in monsoon rainfall. Variations in monsoon patterns, including delayed or deficient rainfall, can lead to water scarcity, affecting agriculture, water supply for domestic and industrial use and overall socio-economic activities. The state's geographical diversity, with coastal areas, hilly regions and plains, contributes to variations in drought vulnerability and impacts across different zones within Kerala

Kerala experienced a severe drought condition in 2012. The Southwest Monsoon, which brings the majority of the annual rainfall, was deficient, resulting in widespread water scarcity and agricultural distress. The deficit rainfall affected crop production, leading to reduced yields and economic losses for farmers. Additionally, water sources such as rivers, lakes and reservoirs experienced depletion, exacerbating the water scarcity situation. The shortage of water supply disrupted daily life activities, including domestic use, industrial operations and tourism.

Kerala witnessed one of the most distressing droughts in the year 2016 which imposed a severe threat to both agriculture and hydrology (Abhilash *et al*., 2018). It is also realized that the frequency of drought years are increasing over Kerala during recent decades. Each deficit rainfall year is unique in the sense that its impact on agriculture, hydrology and socio-economic sector may vary (Abhilash *et al*., 2018). Lack of rainfall so great and long continued to injuriously affect the plant and the animal life of a place and to deplete water supplies both for domestic purposes and for the operation of power plants especially in those regions where rainfall is normally sufficient for such purposes (Krishna *et al*., 2021).

Understanding the spatial and temporal patterns of drought in the central zone of Kerala is crucial for effective drought management, resource allocation, and planning of mitigation strategies. Here we assess the spatial vulnerability to agricultural drought using

drought indices (Krishna *et al*., 2021). Monitoring drought using integrated drought indices enables more accurate drought prediction and can thus assist in the development of more specific drought adaptation strategies (Abbas *et al*., 2014). The drought monitoring indices like Standardized Precipitation index, Aridity index, Normalized difference vegetation Index and Moisture availability index was used for determining drought prone areas.

This study aims to assess drought in the central zone of Kerala by employing multiple drought indices. The chosen indices will provide a more holistic understanding of drought conditions by considering multiple climatic and hydrological variables, including precipitation, temperature, soil moisture, and potential evapotranspiration. Assessment of drought conditions is critical for planning water supplies, irrigation systems, crop and food security programs, hydropower generation, water quality management and waste disposal systems (Recha *et al*., 2017). The drought indices can help in early assessment of drought which in turn can help the decision makers to make timely responses (Krishna *et al*., 2021). By using indices, it can easily monitor and identify the drought-prone areas and take necessary measures by providing local-level support so that the local administrative bodies will be better equipped to help especially the rural farmers and the agricultural sector at grass-root level. In addition to this, district administration can plan for effective drought management options such as application of potash/kaolin spray, mulching, soil and water conservation strategies, alternate wetting and drying, deficit irrigation, adoption of micro irrigation technologies, etc. to sustain the crop production (Abhilash *et al*., 2020).

Overall, this research aims to contribute to the existing knowledge on drought assessment by utilizing multiple indices and focusing on the central zone of Kerala. By providing a comprehensive analysis of drought conditions and their underlying drivers, this study will serve as a foundation for improved drought management practices and sustainable development in the region.

On this context, the present study titled “Assessment of drought in the Central Zone of Kerala using different indices” is aimed:

- Identification and mapping of drought prone areas in the central zone of Kerala using various indices

# Review of literature

## 2. REVIEW OF LITERATURE

Drought is a complex natural hazard characterized by multiple climatological and hydrological parameters. Understanding the relationships between these parameters is crucial for developing measures to mitigate the impacts of droughts. The selection of a threshold level for categorizing drought severity is crucial and requires further research, considering the seasonal characteristics of water demand in different hydroclimatic regions. Efforts are being made to derive more efficient drought indices that can better monitor drought conditions and incorporate economic losses. The selection of a threshold level for categorizing drought severity is crucial and requires further research, considering the seasonal characteristics of water demand in different hydroclimatic regions.

It is observed that most continents around the globe have experienced frequent droughts in the last three decades and this condition is being aggravated due to growing water demands with limited source of water as well as spatio-temporal changes in climatic patterns (Mishra and Singh, 2010).

Many people consider droughts to be hydroclimatic risks. Droughts are, in fact, socio-ecological events that are a result of the interaction of climatic, hydrological, environmental, socioeconomic, and cultural influences. Assessments of the severity and impact of the drought are complicated by its complexity and context-specificity. Researchers, policymakers, stakeholders, and the public can participate in interdisciplinary analyses of drought events and collective assessments to produce information for understanding and managing droughts. Many semiarid, snow-fed, and coastal basins are anticipated to experience worsening droughts because of global warming. Decadal or centenary megadroughts are a possibility, according to research on historical and paleoclimates (Kallis, 2008).

Over the past 64 years, there has been a trend towards more flash droughts across 74% of the global regions recognized by the Intergovernmental Panel on Climate Change Special Report on Extreme Events. Drought intensification rates have

accelerated over sub seasonal time periods. The transition is linked to enhanced evapotranspiration and precipitation deficit abnormalities brought on by human-induced climate change. The change is anticipated to spread to most land regions in the future, with larger increases under higher-emission scenarios. These results highlight the need for rapid drought adaptation in a warmer future (Yuan, *et al*., 2023). There may be repercussions for the enormous stocks of organic carbon stored in soils because of how plants and bacteria react to drought. Soils may lose carbon if bacteria continue to be active during a drought, particularly if plant inputs are reduced. Multiple mechanisms of microbial drought resistance, including toleration and avoidance, have been identified by empirical and theoretical studies. Microbes can adapt to drought within minutes to days thanks to physiological responses. Dispersal and changes in community makeup may both help microbiomes continue to function in the face of drought. Additionally, microbes may evolve to survive in drier environments (Muthuvel, D *et al*.,2023).

## 2.1 Meteorological Drought

Using high resolution gridded data collected over a 60-year period by the Indian Meteorological Department (IMD), the correlation between meteorological droughts and heatwaves is examined in India. When compared to the base era of 1951–1980, significant variations are seen in the concurrent climatic droughts and heatwaves defined at various percentile-based thresholds and durations during the period 1981–2010. The incidence of simultaneous meteorological droughts and heatwaves has significantly increased throughout India (Das, P.K., 2016). Arid and semiarid portions of India's northwest experienced meteorological droughts, with mean annual rainfall varying from 100 to 900 mm. A season or year with rainfall that is less than 75% of the comparable mean at a location is referred to as a drought. The analysis makes use of long-term monthly rainfall records (1901–2013) for 90 districts in north-west India, which are spread over the states of Punjab, Haryana, Rajasthan, and Gujarat. For identifying the beginning, ending, and quantifying the severity of droughts, the percentage deviation of seasonal rainfall from long-term average rainfall has been employed, only four out of the 90 districts had a drought once every five years (Amrit, K., 2018).

Every time the southwest monsoon rainfall across all of India was less than 10% or below average, the SPI for that year was found to be 1 or less. When the total India southwest monsoon rainfall was -15% or less than normal, the composite analysis of SPI for those years, i.e., less than 15% and 20% of normal rainfall years, indicates that during those years more than 30% of the country's territory was under drought conditions. A trend analysis of the monthly SPI for the monsoon months found the districts with a marked rise in the incidence of drought. Over most of the districts in central, northern, and peninsular India, there has been a strong positive association with the meteorological drought, whereas there has been a strong negative correlation over the districts in eastern India (Guhathakurta, P., 2017)

It is not possible to define, monitor, and quantify the severity of drought conditions in a consistent manner. This article discusses the tools that are frequently used in the United States to monitor meteorological drought, their advantages and disadvantages, and which ones are best for doing so. The Standardized Precipitation Index and deciles/percentiles are best for monitoring meteorological drought, according to the literature and the qualitative drought index evaluation (Quiring S.M., 2009).

## 2.2 Agricultural Drought

The propagation period ranges from 5 to 7 months for the drought's beginning, 9 to 15 months for its height, and 10 to 20 months for its end. The internal timeframes required for drought development and recovery range from 3.1 to 6 months. The magnitude of the instantaneous drought development and recovery speed varies between 0.20 and 0.60 for most of the area. Finally, it is noted that the underestimating of agricultural drought propagation features over India results from the absence of physical factors (Das, S., 2023).

A significant area of drought is characterized by a moisture deficit severe enough to harm human beings, animals, and plant life. India has previously undergone 24 major droughts, with the frequency of these events rising from 1891 to 1920, 1965 to 1990, and 1999 to 2012. These events occurred in 1891, 1896, 1899, 1905, 1911, 1915, 1918, 1920, 1941, 1951, 1965, 1966, 1972, 1974, 1979, 1982, 1986, 1987, and

1988. 14 droughts between 1900 and 2012 harmed 1,061 million people and caused $2,441 million in economic losses. Economic, environmental, and societal effects of drought are possible. There are many important ways in which droughts differ significantly from the disasters that garner more media attention, such as earthquakes and tsunamis (Ray, S.S., 2014).

## 2.3 Droughts in India

In India, a drought is a climatic anomaly that is characterized by inadequate water or moisture availability and is brought on by irregular or below-average rainfall, increased water demand, or a combination of these factors. India has had severe droughts that have had a considerable negative impact on agriculture and livestock, causing crop damage and reducing the number of cattle. Droughts in India are thought to have cost the country's economy billions of dollars. The criteria for monitoring and announcing droughts are provided by the present drought management policy in India, although the framework has shortcomings that cause regional droughts to go unnoticed. Planning is needed to increase water use efficiency and save rainwater in India, including discouraging water-intensive crops and utilizing available irrigation capacity.

The recent agricultural droughts in India, are addressing various drought categories, including meteorological, hydrological, agricultural, and socio-economic droughts. It emphasizes the susceptibility of rainfed drylands to drought and highlights instances of monsoon rain deviations from predictions, significantly affecting regions prone to drought. The India Meteorological Department (IMD) assumes a pivotal role in forecasting monsoon conditions for specific states and regions, aiding in preparedness and mitigation efforts. The research, likely discussed in the paper, examines the impacts and potential strategies for mitigating agricultural drought in India while recognizing the essential role of accurate meteorological forecasts in addressing this pressing concern (Gautam *et al*., 2014)

There are several impacts of drought on the structural integrity and economic stats of India which can be evident from the 2002-2003 drought that in Orissa resulted in a significant damage to crop production, with an estimated loss of 85 million tons.

The livestock sector was severely affected by the 1999-2003 droughts, with an estimated impact on 92 million cattle population. The total economic loss to agriculture and livestock during the studied period was estimated at US 31370 million dollars, with US 510 million loss to agriculture and US 30860 million to livestock subsectors. (Pandey and Bhandari.,2009). It was observed that there were higher probabilities of detection in central India, while lower probabilities were found in regions like Rajasthan, Andhra Pradesh, and Karnataka (Bhardwaj and Mishra.,2021).

Drought frequency, severity, and persistence vary across different climatic regions in India, depending on factors such as mean annual precipitation, evapotranspiration, and length of the wet season. Arid and semi-arid regions experience more frequent droughts with an average return period of 3 and 4 years, respectively, while dry-sub-humid, sub-humid, and humid regions have longer return periods of 5-6, 7-8, and 8-15 years, respectively. The current drought management system in India is more focused on relief and crisis management rather than proactive mitigation. The Ministry of Agriculture monitors drought conditions, while the central government provides aid and support. The paper proposes a model drought management plan for different climatic regions in India. Droughts have significant impacts on socio-economy and human well-being, including crop production losses, lack of drinking water, hindered waterborne transport, reduced hydropower production, forest fires, poverty, and regional conflicts. The impacts are likely to increase as water and environmental service demands rise. Drought frequency decreases gradually from dry to wet regions, with arid regions experiencing droughts once every two to three years, semi-arid regions every three to five years, and sub-humid regions every five to nine years. According to research, Bangalore, Chennai, and Surat cities are most at risk for urban drought (Goyal, M.K., *et al*.,2023).

## 2.4 Droughts in Kerala

Due to deforestation, climate change, and development interventions, droughts have grown increasingly frequent in Kerala. Extreme drought conditions have plagued the state for several years, with 2016 ranking as one of the worst drought years. Water stress and drought have been made worse by a decrease in southwest monsoon rainfall

across south Kerala and an increase in post-monsoon rainfall, particularly over that region. Significant effects of these drought occurrences have been seen in the agricultural and water resource industries. The recent floods in Kerala, which were brought on by climate change, have also brought attention to the necessity of risk management and water conservation to deal with the water-related effects of climate change on agriculture. Major soil components required for agricultural productivity have decreased because of rainfall effects and global warming.

Due to the state's ongoing drought circumstances, observed changes in the climate over Kerala have recently drawn increased notice. 2016 was one of Kerala's worst and most severe drought years in recent memory. The combined effect of realized changes in the mean climate state and climate variability may be responsible for this catastrophic drought scenario. Using the standardized precipitation index (SPI), the recent and previous drought occurrences over Kerala are investigated, along with any potential effects they may have on various industries including agriculture and water resources (Krishnakumar, E.K., *et al*., 2019)

According to the trend study, rainfall during the southwest monsoon and on an annual basis has decreased statistically significantly (by up to 63 mm and 55 mm each decade, respectively). There has also been a decline in yearly rainy days, down to 2.8 days each decade. Analysis of temperature trends shows a rising tendency of up to 1.3°C every decade. A declining trend in severe precipitation indexes and an increase in extreme temperature indexes can be seen in Kerala's spatiotemporal variation of extreme climatic indices. While R5 index rose in the center and southern regions of Kerala, R95 and R95p declined in the northern and southern regions. In the state, warm days have grown dramatically while cold days have been trending downward. While cooler evenings are statistically declining in the central and southern regions, warmer nights are statistically increasing. The frequency of droughts in Kerala is increasing, with larger rates over the southern and central regions of the state, according to meteorological data using the Standardized Precipitation Index (SPI) (Vijay, A., *et al*.,2021).

Drought indices (DI) have a tool to quantify the drought nature and express a single digit which is helpful to recognize a drought character. Standardized

Precipitation Index (SPI) is a tool to quantify the drought characteristics, widely used for its simplicity and variable approaches to dignify a drought (Bhunia, P., et al 2020).

Based on the classification of the drought risk, it is possible to determine the daily deviations of NDVI from its long-term mean throughout the same period. High negative NDVI anomalies are prone to drought, and data on land use and land cover can be used to gauge how much each crop is at risk. The drought risk for various crops is determined by superimposing a daily NDVI Anomaly based drought risk map on a land use/land cover map (Sarkar, J., 2011)

The past occurrence of drought and the potential future persistence of drought conditions based on RCP 4.5 and 8.5 scenarios. The state's proclaimed drought years can be compared to the previous drought years. The analysis of the potential future events reveals that the basin will experience drought, ranging from mild to severe circumstances. According to SPEI rather than SPI, there have been more months with moderate and severe droughts, highlighting the significance of temperature in drought studies. (Jincy Rose and Chithra., 2020)

## 2.5 RESEARCH GAP

One of the key research gaps in the assessment of drought in the Central Zone of Kerala is the limited utilization of multiple drought indices. Many studies predominantly rely on a single index, such as the Standardized Precipitation Index (SPI) or the Palmer Drought Severity Index (PDSI), to evaluate drought conditions. However, a more comprehensive understanding of drought in this region could be achieved by incorporating and comparing various indices. Different indices capture different aspects of drought, such as meteorological, agricultural, or hydrological drought, and employing a combination of these indices could provide a more holistic view of drought dynamics. This research gap suggests the need to explore the strengths and weaknesses of different indices and determine how they can be integrated to offer a comprehensive drought assessment tailored to the Central Zone of Kerala's unique climatic conditions

Drought indices are often developed and calibrated for broader regions or climatic zones, and their accuracy can vary significantly when applied to specific

localities. A notable research gap in this context is the absence of studies focusing on the local calibration and validation of drought indices for the Central Zone of Kerala. The region exhibits distinct meteorological and geographical characteristics that may influence drought development and intensity differently than other areas. Therefore, conducting research to adapt and validate existing indices specifically for this region is essential. This gap highlights the necessity of fine-tuning drought assessment tools to accurately represent local conditions, ensuring the reliability of drought monitoring and early warning systems.

While assessing the occurrence and severity of drought is fundamental, understanding its implications and vulnerabilities in the Central Zone of Kerala is another pertinent research gap. Drought can have far-reaching consequences on various sectors, including agriculture, water resources, ecosystems, and human populations. Investigating the direct and indirect impacts of drought events on these sectors and identifying vulnerable areas or populations within the Central Zone of Kerala is vital. Furthermore, understanding the adaptation and mitigation strategies employed by communities and stakeholders in response to drought can help in crafting more effective policies and interventions. By addressing this research gap, your thesis can contribute to a comprehensive understanding of the broader implications of drought in the region and support evidence-based decision-making.

With global concerns about climate change and its potential influence on regional climate patterns, an evident research gap lies in exploring the relationship between climate change and drought in the Central Zone of Kerala. Investigating whether and how climate change is altering the frequency, intensity, and duration of drought events in this region is critical. By assessing the historical data and considering climate projections, your research can offer insights into the future of drought in Kerala. It's crucial to consider the potential compounding effects of climate change and variability, as well as the adaptation measures required to mitigate the adverse impacts of these changing drought patterns.

The Central Zone of Kerala may experience seasonal variations in drought patterns due to its tropical monsoon climate. Consequently, another research gap to be explored is the seasonal variability of drought. Understanding how drought

characteristics vary between different seasons, such as the monsoon and post-monsoon periods, can provide valuable insights into the region's vulnerability and resilience. Additionally, temporal trends in drought occurrences over the years need to be examined to ascertain whether there is a discernible shift in the frequency or severity of drought events. By analyzing spatial and temporal dynamics, your thesis can contribute to a nuanced understanding of the region's drought patterns, thus enabling more targeted and effective drought management strategies

In the domain of drought assessment, the spatial distribution of drought events within the Central Zone of Kerala is an area that warrants further exploration. Identifying specific geographical regions that are more prone to drought can be essential for resource allocation and disaster preparedness. Integrating remote sensing technologies and Geographic Information Systems (GIS) into drought assessment is a research gap that can enhance the accuracy and precision of drought monitoring. By developing spatial models and tools that leverage satellite imagery and GIS data, your research can offer a more detailed and geographically specific analysis of drought occurrence and impacts in the region, potentially aiding in proactive decision-making and resource allocation.

# *Materials and methods*

# 3. MATERIALS AND METHODS

Drought is a recurrent and complex natural hazard that can have profound socio-economic and environmental impacts, particularly in regions heavily reliant on agriculture and water resources. The Central Zone of Kerala, situated in the southwestern part of India, is no exception to the challenges posed by drought. This region, comprising districts like Thrissur, Palakkad and Ernakulam, is vital to Kerala's agricultural productivity and biodiversity.

In this context, understanding and quantifying drought becomes paramount for effective water resource management, disaster preparedness and sustainable land use planning. This thesis focuses on the comprehensive assessment of drought in the Central Zone of Kerala, employing various drought indices to gain a multifaceted understanding of this phenomenon.

The aim of this section is to provide a detailed account of the materials and methods employed in this study. It outlines the data sources, tools and analytical techniques used to assess drought conditions, as well as the specific indices selected for the task. By adopting a rigorous and systematic approach, this research seeks to contribute valuable insights into drought monitoring and mitigation strategies tailored to the unique characteristics of the Central Zone of Kerala.

## 3.1 Study area

This study focuses on the central zone of Kerala, encompassing the districts of Thrissur, Palakkad and Ernakulam, with in this region; there are 13 distinct agro ecological units, each contributing to the overall diversity of the zone (Fig1). The 13 agro ecological units are presented in the Table 3.1.

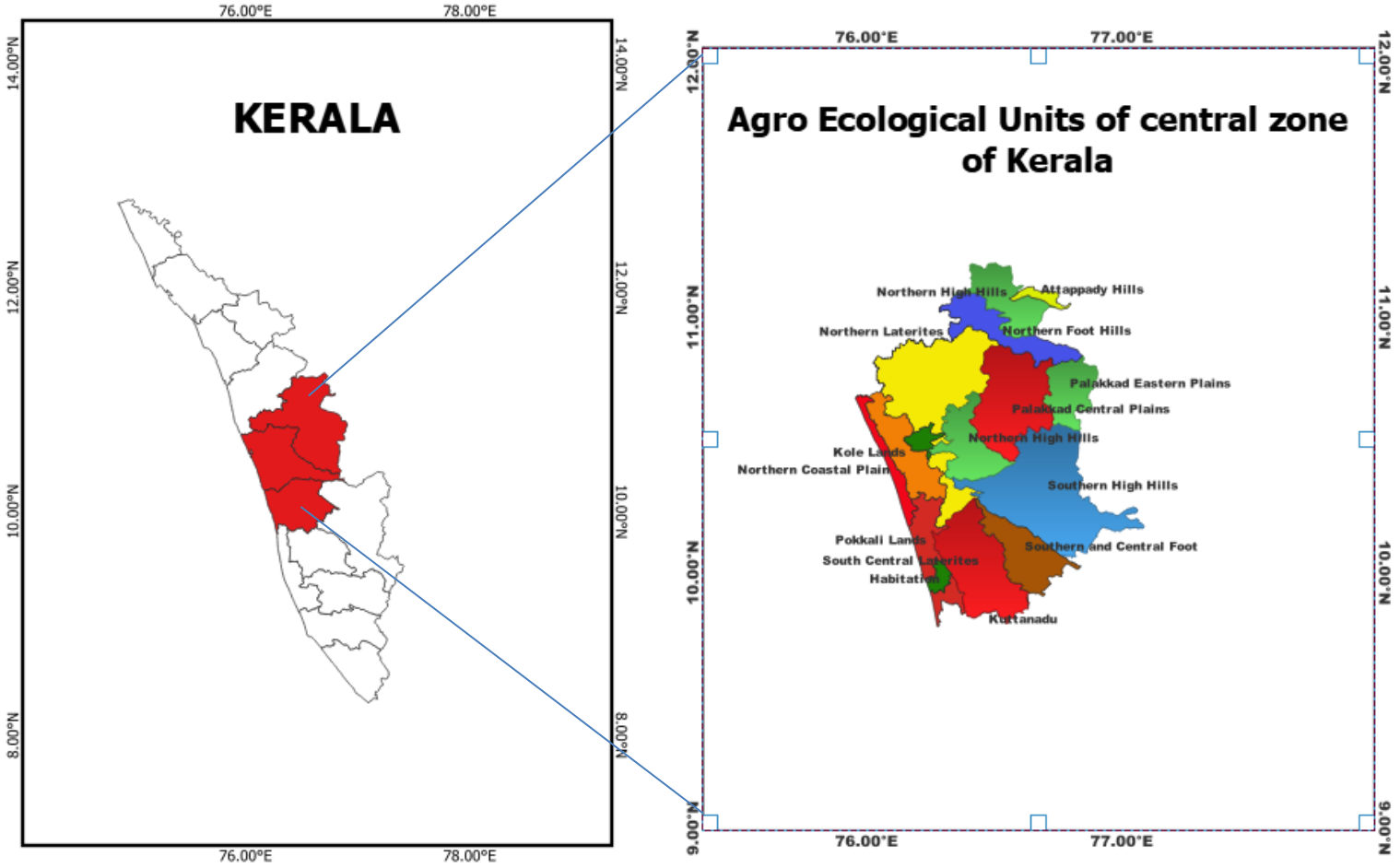



Fig 1 Kerala Map and AEUs of Central Zone of Kerala

Table 3.1 Agro Ecological Units of central zone of Kerala

| District | Latitude | Longitude | AEU |
|---|---|---|---|
| Ernakulam | 10.16 | 76.17 | Pokkali |
| Ernakulam | 9.93 | 76.56 | South Central Laterites |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills |
| Ernakulam | 10.25 | 76.53 | Southern High Hills |
| Thrissur | 10.67 | 75.98 | Northern coastal plains |
| Thrissur | 10.19 | 76.26 | Pokkali |
| Thrissur | 10.78 | 76.45 | Northern Laterities |
| Thrissur | 10.68 | 76.09 | Kole Lands |
| Thrissur | 10.43 | 76.57 | Northern High Hills |
| Thrissur | 10.34 | 76.36 | Southern High Hills |
| Palakkad | 11.23 | 76.69 | Attappady Dry Hills |
| Palakkad | 11.03 | 76.76 | Attappady Hills |
| Palakkad | 11.13 | 76.43 | Northern High Hills |
| Palakkad | 11.03 | 76.30 | Northern Foot Hills |
| Palakkad | 10.73 | 76.09 | North Central Laterites |
| Palakkad | 10.71 | 76.57 | Palakkad Central Plains |
| Palakkad | 10.37 | 76.78 | Southern High Hills |
| Palakkad | 10.83 | 76.75 | Palakkad Eastern Plains |

To comprehensively assess the impact of drought, a set of essential weather parameters will be examined. These parameters consist of rainfall, humidity, sunshine hours, wind speed and minimum and maximum temperature. These data will be sourced from NASA's Power Data Access Viewer (https://power.larc.nasa.gov/data-access-viewer), providing reliable and extensive information for analysis.

Over a 30-year period spanning from 1992 to 2021, meticulous collection of weather data from each of the specified agro ecological units will be conducted. This extended temporal scope will facilitate a thorough understanding of drought patterns and their effects on the various ecosystems and agricultural systems within the central

zone of Kerala. The collected data will form the basis for the subsequent analysis conducted in this study.

In this study utilized six indices to evaluate drought conditions in the central zone of Kerala. It's worth noting that all indices, except for the agriculture drought index, are computed seasonally.

### 3.2 Calculation of Meteorological drought

Meteorological drought is said to occur when the seasonal rainfall received over an area is less than 25% of its long term average value.

Departure of mean rainfall=

$$\frac{(\text{Annual rainfall of year} - \text{mean rainfall})}{mean\ rainfall} * 100$$

The calculation of meteorological drought relies on a 30-years dataset comprising annual rainfall and the mean rainfall of each year for the specified weather parameters. The following table illustrates the classification of rainfall:

Table 3.2 Classification of Rainfall departure

| SL No. | Classification | Rainfall Range Relative to Normal Value |
|---|---|---|
| 1 | < -59 | Large Deficit |
| 2 | -20 to -59 | Deficient |
| 3 | -19 to 19 | Normal |
| 4 | 20 to 59 | Excess |
| 5 | ≥ 60 | Large Excess |

As the values of departure of rainfall vary, meteorological drought can be classified in Table 3.3.

Table.3.3 Classification of Meteorological drought

| Rainfall Departure | Category |
|---|---|
| 0.0 to -25 | No drought condition |
| -26 to -50 | Moderate drought condition |
| >-50 | Severe drought condition |

(Ramya et al., 2017)

### 3.3 Calculation of Agriculture drought

Agricultural drought assessments were performed using the weathercock software. Specifically, the key weather parameter employed for this analysis was the weekly rainfall data.

In the *khari*f season, agricultural drought was determined when a minimum of four consecutive weeks received less than half of the normal rainfall, with each week registering less than 5mm of precipitation (Mavi 1994).

In the *rabi* season, a similar analysis was conducted, although with a slightly more extended timeframe. Agricultural drought in the *rabi* season was identified when there were six consecutive weeks with less than half of the normal rainfall and each of these weeks recorded less than 5mm of precipitation. This methodology allowed for the systematic evaluation of agricultural drought occurrences in both *kharif* and *rabi* seasons.

### 3.4 Moisture Availability Index

The climatic indices are derived based on the Hargreaves (1971) method, which takes into account the Moisture Availability Index (MAI). It is computed as the ratio of 75% dependable rainfall and potential evapotranspiration. Evapotranspiration of individual agro-ecological units are calculated by FAO PenmanMonteith method, using decision support software –CROPWAT 8.0 developed by FAO. The Moisture Availability Index classification can be organized in the following manner:

Table 3.4 Classification of Moisture Availability Index

| SL No. | Moisture Availability Index | Classification |
|---|---|---|
| 1 | 0.00 - 0.33 | Very deficient |
| 2 | 0.34 - 0.67 | Moderately deficient |
| 3 | 0.68 - 1.00 | Deficient |
| 4 | 1.01-1.33 | Adequate moisture |
| 5 | >1.34 | Excessive moisture |

(Kokilavani et al., 2016)

### 3.5 Aridity Index

In this study, the Aridity Index is calculated as the ratio of P/PET, with P representing Precipitation and PET denoting Potential Evapotranspiration (Bannayan et al., 2010). To calculate the Aridity Index, the following procedures were followed.

**1. Precipitation**: Data pertaining to precipitation, which quantifies the amount of rainfall received in the study area, was collected.

**2. Potential Evapotranspiration (PET):** The estimation of Potential Evapotranspiration was carried out using the CROPWAT software. This software utilizes meteorological data to determine the potential evaporation rates within the study region.

The Aridity Index, serving as a fundamental metric for assessing the aridity conditions within the study area, is then obtained by dividing Precipitation (P) by Potential Evapotranspiration (PET). This index plays a crucial role in evaluating the moisture availability for ecological and agricultural processes and serves as a key parameter in our analysis. The classification of the Aridity Index can be structured as follows:

Table 3.5 Classification of Aridity Index

| SL No. | Ranges of Values | Aridity Index |
|---|---|---|
| 1 | Hyper-arid | AI < 0.03 |
| 2 | Arid | 0.03 ≤ AI < 0.20 |
| 3 | Semi-arid | 0.20 ≤ AI < 0.50 |
| 4 | Sub-humid | 0.50 ≤ AI < 0.75 |
| 5 | Humid | AI ≥ 0.75 |

(Mengistu et al., 2020)

### 3.6 Standard Precipitation Index

The Standard Precipitation Index (SPI) is a vital tool used in this study to assess and quantify precipitation anomalies. SPI is calculated as follows:

$$SPI = \frac{Xi - Xm}{\sigma}$$

Here, the components of the SPI equation are defined as follows:

- X (Precipitation): Represents the actual precipitation recorded at the respective weather station under consideration. This is the observed amount of rainfall for a specific period.
- Xm (Mean Precipitation): Xm signifies the long-term average or mean precipitation for the same location and over a comparable time frame. It provides a baseline against which current precipitation levels can be compared.
- σ (Standard deviation): σ represents the standard deviation of precipitation data for the same location and period. It quantifies the degree of variation or dispersion in the historical precipitation data.

The SPI is a dimensionless index that measures how far the observed precipitation (X) deviates from the long-term average (Xm), taking into account the variability of precipitation as indicated by the standard deviation (σ).

By calculating the SPI for a specific time frame and location, this index allows us to categorize and analyse the severity and duration of droughts or wet

spells. A negative SPI value indicates drier-than-normal conditions, while a positive SPI value suggests wetter-than-normal conditions. This methodology provides a valuable tool for assessing and monitoring precipitation anomalies within the study area and is integral to our research on drought patterns and their impacts.

The Standard Precipitation Index (SPI) is typically classified into categories to aid in the interpretation and communication of the severity of precipitation anomalies, as illustrated in the table below.

Table 3.6 Classification of Standard Precipitation Index

| SL No. | SPI Value | Classification |
|---|---|---|
| 1 | ≥ 2.00 | Extreme Wet |
| 2 | 1.5 to 1.99 | Severe Wet |
| 3 | 1.00 to 1.49 | Moderate Wet |
| 4 | -0.99 to 0.99 | Near Normal |
| 5 | -1.00 to -1.49 | Moderate Drought |
| 6 | -1.5 to -1.99 | Severe Drought |
| 7 | ≤ - 2.00 | Extreme Drought |

(Abrha and Hagos, 2019)

### 3.7 Normalized Difference Vegetation Index (NDVI)

#### 3.7.1 Data Acquisition

Landsat 7 and Landsat 8 satellite imagery used in this study were obtained from the United States Geological Survey (USGS). The study area encompasses the central zone of Kerala, India. Landsat 7 and Landsat 8 images provided the necessary data for calculating the Normalized Difference Vegetation Index (NDVI) values for the central zone of Kerala. The study focused on selected overpass dates during the years 2012, 2016 and 2017. These years were chosen due to their significance: 2012 and 2016 were characterized as drought years based on analysis using various drought indices. Consequently, the study aimed to analyse and compare NDVI values between normal

and drought years. Landsat 7 bands 3 and 4 were used for 2012, while Landsat 8 bands 4 and 5 were used for 2016 and 2017.

### 3.7.2 Correction for Landsat 7 Defects

Landsat 7 imagery is susceptible to striping defects, primarily caused by the Scan Line Corrector (SLC)-Off Gap issue. To mitigate this effect and ensure data quality, the following correction method was applied

Gap-Filling: A gap-filling and destriping procedure was implemented to reduce the striping defects present in the Landsat 7 imagery. This step was crucial to obtain accurate and reliable NDVI values for analysis.

- Download GM bands from the USGS data centre.

- Access the menu: Raster Analysis > Fill No Data.

- The data was masked by GM band, removing the strip lines.

### 3.7.3 Mosaicking

Since there were two images covering the central zone of Kerala, a mosaicking process was performed to combine them into a single image

Mosaicking: Landsat images were mosaicked together, aligning them spatially to create a comprehensive and coherent dataset for subsequent analysis.

### 3.7.4 NDVI Calculation

The Normalized Difference Vegetation Index (NDVI) was computed using the following formula:

$$NDVI = (NIR - R) / (NIR + R)$$

For Landsat 8, it is

$$NDVI = (Band\ 5 – Band\ 4) / (Band\ 5 + Band\ 4)$$

For Landsat 7, it is

NDVI = (Band 4 – Band 3) / (Band 4 + Band 3)

Where NIR represents Near-Infrared and R represents Red reflectance values. The NDVI values were extracted from the corrected and mosaicked Landsat imagery for the specific study dates, allowing for vegetation health assessment and comparison between the selected years.

Table 3.7 Classification of NDVI

| SL No. | Classification | Drought |
|---|---|---|
| 1 | < 0 | Extreme Dry |
| 2 | 0 - 0.2 | Dry |
| 3 | 0.2 – 0.4 | Moderate Drought |
| 4 | 0.4 – 0.6 | Wet |
| 5 | ≥ 0.6 | Extremely wet |

(Aziz et al., 2018)

# Results

# 4. RESULTS

## 4.1 Calculation of Meteorological drought

### 4.1.1 Annual Rainfall

#### 4.1.1.1 Palakkad District

Palakkad district comprises eight Agro-Ecological Units (AEUs): Attappady Dry Hills, Attappady Hills, Northern High Hills, Northern Foot Hills, North Central Laterites, Palakkad Central Plains, Southern High Hills and Palakkad Eastern Plains.

The analysis of the meteorological drought for Palakkad district showed that during the years 2012 and 2016, Palakkad district experienced a moderate drought (departure value between -26 and -50). During the year 2000, North Central Laterites were affected by a moderate drought and the remaining AEUs faced a deficiency of rainfall (within the range of -20 to -25%). During 1997, there was an excess of rainfall in the Northern High Hills, the Northern Foot Hills and the North Central Laterites. During 2002, the Attappady Dry Hills, Attappady Hills and Palakkad Eastern Plains experienced a moderate drought. In 2003, there was a deficiency of rainfall in the Attappady Dry Hills, Attappady Hills, Northern High Hills, Northern Foot Hills, and Palakkad Eastern Plains (Table 4.1).

An excess of rainfall was observed in the Northern High Hills, Northern Foot Hills, North Central Laterites, Palakkad Central Plains, and Southern High Hills during 2006 and excess rainfall was experienced by the entire district during the years 2007 and 2021. In 2015, Northern High Hills and Northern Foot Hills faced moderate drought conditions, while a deficiency of rainfall was observed in Attappady Dry Hills, Attappady Hills, North Central Laterites, and Palakkad Eastern Plains.

#### 4.1.1.2 Thrissur District

Thrissur district consists of five Agro-Ecological Units (AEUs): Northern Coastal Plains, Pokkali, Northern Laterites, Kole Lands, Northern High Hills and Southern High Hills.

The analysis of the meteorological drought in Thrissur district showed that during the years 2012 and 2016, Thrissur district experienced a moderate drought (Table 4.1). During the year 2000, moderate drought conditions were observed in the Northern Coastal Plains, Pokkali, Northern Laterites and Kole Lands. In 1997, the district experienced excess rainfall. In 2015, the Northern Laterites experienced a moderate drought. Additionally, excess rainfall was observed in Thrissur district during the years 2006, 2007 and 2021.

#### 4.1.1.3 Ernakulam District

Ernakulum district consists of four Agro-Ecological Units (AEUs): Pokkali, South Central Laterites, Southern and Central Foot Hills, and Southern High Hills.

The analysis of the meteorological drought in Ernakulam district showed that during the years 2000, 2012 and 2016, the district experienced moderate drought, while excess rainfall was observed in the years 1997, 2006 and 2021 (Table 4.1). In 2004, South Central Laterites and Southern and Central Foot Hills received excess rainfall, while the other AEUs also experienced excess rainfall in 2007.

Based on the analysis of meteorological drought using annual data, the years 2012 and 2016 were identified as drought years in the central zone of Kerala, while 2021 exhibited excess rainfall in this region. When examined on a district level, Palakkad district demonstrated a higher incidence of drought conditions.

Table 4.1 Departure of rainfall from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (%)

| District | Latitude | Longitude | AEU | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.17 | Pokkali | -10 | -8 | 12 | -5 | -11 | 24 | -4 | -19 | -31 | 3 |
| Ernakulam | 9.93 | 76.56 | South Central Laterites | -6 | -1 | 14 | -10 | -8 | 21 | -2 | -15 | -29 | 6 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | -6 | -1 | 14 | -10 | -8 | 21 | -2 | -15 | -29 | 6 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | -2 | -9 | 11 | -9 | -6 | 23 | -4 | -16 | -30 | -5 |
| Thrissur | 10.67 | 75.98 | Northern coastal plains | -2 | -9 | 11 | -9 | -6 | 23 | -4 | -16 | -30 | -5 |
| Thrissur | 10.19 | 76.26 | Pokkali | -10 | -8 | 12 | -5 | -11 | 24 | -4 | -19 | -31 | 3 |
| Thrissur | 10.78 | 76.45 | Northern Laterites | 8 | -6 | 14 | -9 | -5 | 25 | 1 | -16 | -25 | -9 |
| Thrissur | 10.68 | 76.09 | Kole Lands | -2 | -9 | 11 | -9 | -6 | 23 | -4 | -16 | -30 | -5 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | -3 | 0 | 14 | -13 | -5 | 16 | -8 | -18 | -25 | -3 |
| Thrissur | 10.34 | 76.36 | Southern High Hills | -3 | 0 | 14 | -13 | -5 | 16 | -8 | -18 | -25 | -3 |
| Palakkad | 11.23 | 76.69 | Attappady Dry Hills | 5 | 2 | 12 | -15 | 2 | 18 | -3 | -15 | -23 | -10 |
| Palakkad | 11.03 | 76.76 | Attappady Hills | 5 | 2 | 12 | -15 | 2 | 18 | -3 | -15 | -23 | -10 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 8 | -6 | 14 | -9 | -5 | 25 | 1 | -16 | -25 | -9 |
| Palakkad | 11.03 | 76.30 | Northern Foot Hills | 8 | -6 | 14 | -9 | -5 | 25 | 1 | -16 | -25 | -9 |
| Palakkad | 10.73 | 76.09 | North Central Laterites | -2 | -9 | 11 | -9 | -6 | 23 | -4 | -16 | -30 | -5 |
| Palakkad | 10.71 | 76.57 | Palakkad Central Plains | -3 | 0 | 14 | -13 | -5 | 16 | -8 | -18 | -25 | -3 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | -3 | 0 | 14 | -13 | -5 | 16 | -8 | -18 | -25 | -3 |
| Palakkad | 10.83 | 76.75 | Palakkad Eastern Plains | 5 | 2 | 12 | -15 | 2 | 18 | -3 | -15 | -23 | -10 |

AEUs - Agro-Ecological Units

Table 4.1 Departure of rainfall from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (%) (Contd..)

| District | Latitude | Longitude | AEU | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.17 | Pokkali | -12 | -5 | 18 | 17 | 33 | 22 | -7 | -1 | 14 | -5 |
| Ernakulam | 9.93 | 76.56 | South Central Laterites | -12 | -4 | 23 | 24 | 33 | 16 | -7 | -5 | 11 | -10 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | -12 | -4 | 23 | 24 | 33 | 16 | -7 | -5 | 11 | -10 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | -17 | -14 | 13 | 8 | 27 | 33 | -3 | 4 | 17 | 0 |
| Thrissur | 10.67 | 75.98 | Northern coastal plains | -17 | -14 | 13 | 8 | 27 | 33 | -3 | 4 | 17 | 0 |
| Thrissur | 10.19 | 76.26 | Pokkali | -12 | -5 | 18 | 17 | 33 | 22 | -7 | -1 | 14 | -5 |
| Thrissur | 10.78 | 76.45 | Northern Laterites | -17 | -23 | 11 | -3 | 28 | 42 | 5 | 7 | 18 | 2 |
| Thrissur | 10.68 | 76.09 | Kole Lands | -17 | -14 | 13 | 8 | 27 | 33 | -3 | 4 | 17 | 0 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | -19 | -10 | 16 | 16 | 20 | 20 | -5 | -4 | 16 | -1 |
| Thrissur | 10.34 | 76.36 | Southern High Hills | -19 | -10 | 16 | 16 | 20 | 20 | -5 | -4 | 16 | -1 |
| Palakkad | 11.23 | 76.69 | Attappady Dry Hills | -27 | -22 | 12 | 14 | 17 | 27 | 2 | -4 | 14 | 1 |
| Palakkad | 11.03 | 76.76 | Attappady Hills | -27 | -22 | 12 | 14 | 17 | 27 | 2 | -4 | 14 | 1 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | -17 | -23 | 11 | -3 | 28 | 42 | 5 | 7 | 18 | 2 |
| Palakkad | 11.03 | 76.30 | Northern Foot Hills | -17 | -23 | 11 | -3 | 28 | 42 | 5 | 7 | 18 | 2 |
| Palakkad | 10.73 | 76.09 | North Central Laterites | -17 | -14 | 13 | 8 | 27 | 33 | -3 | 4 | 17 | 0 |
| Palakkad | 10.71 | 76.57 | Palakkad Central Plains | -19 | -10 | 16 | 16 | 20 | 20 | -5 | -4 | 16 | -1 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | -19 | -10 | 16 | 16 | 20 | 20 | -5 | -4 | 16 | -1 |
| Palakkad | 10.83 | 76.75 | Palakkad Eastern Plains | -27 | -22 | 12 | 14 | 17 | 27 | 2 | -4 | 14 | 1 |

AEUs - Agro-Ecological Units

Table 4.1 Departure of rainfall from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (%) (Contd..)

| District | Latitude | Longitude | AEU | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.17 | Pokkali | -30 | 5 | -4 | -19 | -31 | -5 | 14 | 9 | 7 | 31 |
| Ernakulam | 9.93 | 76.56 | South Central Laterites | -35 | 1 | -8 | -17 | -35 | -4 | 4 | 6 | 9 | 39 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | -35 | 1 | -8 | -17 | -35 | -4 | 4 | 6 | 9 | 39 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | -28 | 2 | 4 | -23 | -35 | -4 | 18 | 14 | 6 | 27 |
| Thrissur | 10.67 | 75.98 | Northern coastal plains | -28 | 2 | 4 | -23 | -35 | -4 | 18 | 14 | 6 | 27 |
| Thrissur | 10.19 | 76.26 | Pokkali | -30 | 5 | -4 | -19 | -31 | -5 | 14 | 9 | 7 | 31 |
| Thrissur | 10.78 | 76.45 | Northern Laterites | -27 | 6 | 12 | -31 | -39 | -11 | 13 | 7 | -1 | 24 |
| Thrissur | 10.68 | 76.09 | Kole Lands | -28 | 2 | 4 | -23 | -35 | -4 | 18 | 14 | 6 | 27 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | -38 | -2 | -3 | -16 | -38 | 0 | 16 | 17 | 17 | 40 |
| Thrissur | 10.34 | 76.36 | Southern High Hills | -38 | -2 | -3 | -16 | -38 | 0 | 16 | 17 | 17 | 40 |
| Palakkad | 11.23 | 76.69 | Attappady Dry Hills | -39 | -7 | 1 | -21 | -42 | 9 | 18 | 21 | 8 | 46 |
| Palakkad | 11.03 | 76.76 | Attappady Hills | -39 | -7 | 1 | -21 | -42 | 9 | 18 | 21 | 8 | 46 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | -27 | 6 | 12 | -31 | -39 | -11 | 13 | 7 | -1 | 24 |
| Palakkad | 11.03 | 76.30 | Northern Foot Hills | -27 | 6 | 12 | -31 | -39 | -11 | 13 | 7 | -1 | 24 |
| Palakkad | 10.73 | 76.09 | North Central Laterites | -28 | 2 | 4 | -23 | -35 | -4 | 18 | 14 | 6 | 27 |
| Palakkad | 10.71 | 76.57 | Palakkad Central Plains | -38 | -2 | -3 | -16 | -38 | 0 | 16 | 17 | 17 | 40 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | -38 | -2 | -3 | -16 | -38 | 0 | 16 | 17 | 17 | 40 |
| Palakkad | 10.83 | 76.75 | Palakkad Eastern Plains | -39 | -7 | 1 | -21 | -42 | 9 | 18 | 21 | 8 | 46 |

AEUs - Agro-Ecological Units

### 4.1.2 Southwest Monsoon Seasonal Rainfall

#### 4.1.2.1 Palakkad District

The analysis of meteorological drought in different AEUs of Palakkad district showed that during the southwest monsoon, the years 1999, 2012, 2015 and 2016 experienced moderate drought conditions, while in 2002, a deficiency of rainfall was observed in Palakkad district (Table 4.2). Conversely, excess rainfall occurred in this region in 1997 and 2007. Excess rainfall was experienced in 1992 in the Attappady Dry Hills, Attappady Hills, and Palakkad Eastern Plains. During 2000, the North Central Laterites experienced moderate drought, while the Southern High Hills, Northern Foot Hills, Palakkad Central Plains, and Northern High Hills encountered a deficiency of rainfall.

During 2003, Attappady Dry Hills, Attappady Hills and Palakkad Eastern Plains were affected by a moderate drought and the remaining AEUs experienced a deficiency of rainfall. During 2006, Northern High Hills and Northern Foot Hills observed excess rainfall, and the same occurred in Northern High Hills in 2013.

From 2018 to 2020, excess rainfall was observed in Palakkad district across all AEUs except for the Northern High Hills and the Northern Foot Hills.

#### 4.1.2.2 Thrissur District

The analysis of meteorological drought in different AEUs of Thrissur district showed that during the years 1999, 2012, 2015 and 2016, moderate drought conditions were experienced, with excess rainfall occurring in 1997 and 2007 (Table 4.2). During 1993, a deficiency of rainfall was observed in the Pokkali region. In 2000, Kole Lands, the Northern Coastal Plains and the Pokkali region experienced moderate drought, while the remaining AEUs saw a deficiency of rainfall. In 2002, Northern Laterites experienced moderate drought, while Kole Lands, Northern

Coastal Plains, Northern High Hills and Southern High Hills faced a deficiency of rainfall. In 2003, a deficiency of rainfall was observed in Thrissur district, except in the Pokkali region. During 2006, both the Pokkali and Northern Laterites regions experienced excess rainfall and in 2013, the Pokkali region observed excess rainfall. For the years 2018, 2019 and 2020, excess rainfall was experienced in Thrissur district, except in the Northern Laterites region.

#### 4.1.2.3 Ernakulum District

The analysis of meteorological drought in different AEUs of Ernakulam district showed that for years 1999, 2012, 2015 and 2016, the district experienced moderate drought conditions, while excess rainfall was observed in 1997 and 2007. During 1993, the Pokkali region faced a deficiency of rainfall (Table 4.2). In 2000, the Southern and Central Foot Hills and South Central Laterites were affected by moderate drought, while the other AEUs in Ernakulum district experienced a deficiency of rainfall. Southern High Hills experienced a deficiency of rainfall in both 2002 and 2003. In 2006, South Central Laterites, Pokkali and the Southern and Central Foot Hills observed excess rainfall. During 2013, the Pokkali region once again experienced excess rainfall. Finally, in the years 2018, 2019 and 2020, both the Southern High Hills and Pokkali regions in Ernakulum district experienced excess rainfall.

The analysis of meteorological drought using southwest monsoon seasonal rainfall data reveals that during the years 1999, 2012, 2015 and 2016 stood out as drought years in the central zone of Kerala. Palakkad district exhibited frequent drought conditions compared to the other two districts.

Table 4.2 Departure of rainfall during the southwest monsoon from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (%)

| District | Latitude | Longitude | AEU | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.17 | Pokkali | 3 | -21 | 10 | -3 | 5 | 46 | 4 | -41 | -29 | -4 |
| Ernakulam | 9.93 | 76.56 | South Central Laterites | 11 | -17 | 12 | -5 | 12 | 46 | 9 | -40 | -24 | 4 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 11 | -17 | 12 | -5 | 12 | 46 | 9 | -40 | -24 | 4 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 8 | -17 | 13 | -4 | 5 | 39 | 6 | -37 | -26 | -12 |
| Thrissur | 10.67 | 75.98 | Northern coastal plains | 8 | -17 | 13 | -4 | 5 | 39 | 6 | -37 | -26 | -12 |
| Thrissur | 10.19 | 76.26 | Pokkali | 3 | -21 | 10 | -3 | 5 | 46 | 4 | -41 | -29 | -4 |
| Thrissur | 10.78 | 76.45 | Northern Laterites | 15 | -13 | 19 | -3 | 7 | 42 | 12 | -32 | -23 | -16 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 8 | -17 | 13 | -4 | 5 | 39 | 6 | -37 | -26 | -12 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 14 | -15 | 9 | -5 | 12 | 31 | 6 | -41 | -25 | -8 |
| Thrissur | 10.34 | 76.36 | Southern High Hills | 14 | -15 | 9 | -5 | 12 | 31 | 6 | -41 | -25 | -8 |
| Palakkad | 11.23 | 76.69 | Attappady Dry Hills | 23 | -11 | 11 | -5 | 18 | 23 | 12 | -39 | -12 | -15 |
| Palakkad | 11.03 | 76.76 | Attappady Hills | 23 | -11 | 11 | -5 | 18 | 23 | 12 | -39 | -12 | -15 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 15 | -13 | 19 | -3 | 7 | 42 | 12 | -32 | -23 | -16 |
| Palakkad | 11.03 | 76.30 | Northern Foot Hills | 15 | -13 | 19 | -3 | 7 | 42 | 12 | -32 | -23 | -16 |
| Palakkad | 10.73 | 76.09 | North Central Laterites | 8 | -17 | 13 | -4 | 5 | 39 | 6 | -37 | -26 | -12 |
| Palakkad | 10.71 | 76.57 | Palakkad Central Plains | 14 | -15 | 9 | -5 | 12 | 31 | 6 | -41 | -20 | -8 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 14 | -15 | 9 | -5 | 12 | 31 | 6 | -41 | -20 | -8 |
| Palakkad | 10.83 | 76.75 | Palakkad Eastern Plains | 23 | -11 | 11 | -5 | 18 | 23 | 12 | -39 | -12 | -15 |

Table 4.2 Departure of rainfall during the southwest monsoon from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (%) (Contd..)

| District | Latitude | Longitude | AEU | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.17 | Pokkali | -18 | -19 | -19 | 9 | 23 | 47 | -8 | 5 | 8 | -1 |
| Ernakulam | 9.93 | 76.56 | South Central Laterites | -17 | -18 | -10 | 10 | 25 | 41 | -11 | 1 | 4 | -8 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | -17 | -18 | -10 | 10 | 25 | 41 | -11 | 1 | 4 | -8 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | -24 | -21 | -17 | 1 | 19 | 52 | -7 | 11 | 9 | 3 |
| Thrissur | 10.67 | 75.98 | Northern coastal plains | -24 | -21 | -17 | 1 | 19 | 52 | -7 | 11 | 9 | 3 |
| Thrissur | 10.19 | 76.26 | Pokkali | -18 | -19 | -19 | 9 | 23 | 47 | -8 | 5 | 8 | -1 |
| Thrissur | 10.78 | 76.45 | Northern Laterites | -29 | -24 | -14 | -6 | 20 | 57 | -5 | 18 | 11 | 8 |
| Thrissur | 10.68 | 76.09 | Kole Lands | -24 | -21 | -17 | 1 | 19 | 52 | -7 | 11 | 9 | 3 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | -24 | -23 | -10 | 0 | 15 | 42 | -11 | 18 | 4 | 7 |
| Thrissur | 10.34 | 76.36 | Southern High Hills | -24 | -23 | -10 | 0 | 15 | 42 | -11 | 18 | 4 | 7 |
| Palakkad | 11.23 | 76.69 | Attappady Dry Hills | -24 | -28 | -4 | -9 | 10 | 45 | -8 | 10 | 8 | -5 |
| Palakkad | 11.03 | 76.76 | Attappady Hills | -24 | -28 | -4 | -9 | 10 | 45 | -8 | 10 | 8 | -5 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | -24 | -24 | -14 | -6 | 20 | 57 | -5 | 18 | 11 | 8 |
| Palakkad | 11.03 | 76.30 | Northern Foot Hills | -24 | -24 | -14 | -6 | 20 | 57 | -5 | 18 | 11 | 8 |
| Palakkad | 10.73 | 76.09 | North Central Laterites | -24 | -21 | -17 | 1 | 19 | 52 | -7 | 11 | 9 | 3 |
| Palakkad | 10.71 | 76.57 | Palakkad Central Plains | -24 | -23 | -10 | 0 | 15 | 42 | -11 | 4 | 7 | -4 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | -24 | -23 | -10 | 0 | 15 | 42 | -11 | 4 | 7 | -4 |
| Palakkad | 10.83 | 76.75 | Palakkad Eastern Plains | -24 | -28 | -4 | -9 | 10 | 45 | -8 | 10 | 8 | -5 |

Table 4.2 Departure of rainfall during the southwest monsoon from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (%) (Contd..)

| District | Latitude | Longitude | AEU | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.17 | Pokkali | -32 | 26 | 8 | -30 | -26 | -1 | 24 | 21 | 20 | -6 |
| Ernakulam | 9.93 | 76.56 | South Central Laterites | -37 | 19 | 2 | -31 | -29 | 5 | 13 | 17 | 16 | 1 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | -37 | 19 | 2 | -42 | -29 | 5 | 13 | 17 | 16 | 1 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | -31 | 19 | 10 | -35 | -26 | 1 | 23 | 23 | 21 | -6 |
| Thrissur | 10.67 | 75.98 | Northern coastal plains | -31 | 19 | 10 | -35 | -26 | 1 | 23 | 23 | 21 | -6 |
| Thrissur | 10.19 | 76.26 | Pokkali | -32 | 26 | 8 | -30 | -26 | -1 | 24 | 21 | 20 | -6 |
| Thrissur | 10.78 | 76.45 | Northern Laterites | -26 | 24 | 18 | -42 | -33 | -7 | 16 | 10 | 9 | -13 |
| Thrissur | 10.68 | 76.09 | Kole Lands | -31 | 19 | 10 | -35 | -26 | 1 | 23 | 23 | 21 | -6 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | -37 | 12 | 5 | -34 | -26 | 15 | 25 | 28 | 26 | 7 |
| Thrissur | 10.34 | 76.36 | Southern High Hills | -37 | 12 | 5 | -34 | -26 | 15 | 25 | 28 | 26 | 7 |
| Palakkad | 11.23 | 76.69 | Attappady Dry Hills | -37 | 10 | 9 | -41 | -32 | 16 | 27 | 27 | 24 | 5 |
| Palakkad | 11.03 | 76.76 | Attappady Hills | -37 | 10 | 9 | -41 | -32 | 16 | 27 | 27 | 24 | 5 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | -26 | 24 | 18 | -42 | -33 | -7 | 16 | 10 | 9 | -13 |
| Palakkad | 11.03 | 76.30 | Northern Foot Hills | -26 | 24 | 18 | -42 | -33 | -7 | 16 | 10 | 9 | -13 |
| Palakkad | 10.73 | 76.09 | North Central Laterites | -31 | 19 | 10 | -35 | -26 | 1 | 23 | 23 | 21 | -6 |
| Palakkad | 10.71 | 76.57 | Palakkad Central Plains | -37 | 13 | 5 | -34 | -26 | 15 | 25 | 28 | 26 | 7 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | -37 | 13 | 5 | -34 | -26 | 15 | 25 | 28 | 26 | 7 |
| Palakkad | 10.83 | 76.75 | Palakkad Eastern Plains | -37 | 10 | 9 | -41 | -32 | 16 | 27 | 27 | 24 | 5 |

### 4.1.3 Northeast Monsoon

#### 4.1.3.1 Palakkad District

The analysis of meteorological drought in different AEUs of Palakkad district showed that the years 1995, 2012, 2016 and 2017 were marked by moderate drought conditions, while the years 1993, 1997, 2005, 2007, 2010, 2019 and 2021 experienced excess rainfall (Table 4.3). During 1992, Attappady Dry Hills, Attappady Hills, and Palakkad Eastern Plains faced moderate drought and deficiency during the years 2003 and 2018. During 2000, Northern Foot Hills and Northern High Hills encountered a deficiency of rainfall, while the remaining AEUs experienced moderate drought conditions. In 2001, the Northern High Hills observed a deficiency of rainfall and a moderate drought in 2003. In 2004, an excess of rainfall was recorded in the North Central Laterites. In 2008, Palakkad Central Plains and Southern High Hills witnessed a deficiency of rainfall, followed by a moderate drought in 2009.

During 2009, Attappady Dry Hills, Attappady Hills, North Central Laterites, and Palakkad Eastern Plains experienced a deficiency of rainfall. In 2011, North Central Laterites encountered a rainfall deficiency. During 2013, Attappady Dry Hills, Attappady Hills, and Palakkad Eastern Plains faced moderate drought, while the remaining AEUs in Palakkad district observed a deficiency of rainfall. Lastly, in 2020, the Southern High Hills and Palakkad Central Plains recorded excess rainfall.

#### 4.1.3.2 Thrissur District

The analysis of meteorological drought in different AEUs of Thrissur district showed that the years of 1995, 2012 and 2016 were marked by moderate drought, while the years 1993, 1997, 2005, 2010, 2019 and 2021 witnessed excess rainfall (Table 4.3). Notably, in 1999, excess rainfall was observed throughout Thrissur district except in Northern Laterites. During 2000, moderate drought affected the entire district except for the AEU Northern Laterites. During 2001, Northern Laterites experienced rainfall deficiency. In 2003, moderate drought conditions were recorded in Northern Laterites. During 2004, excess rainfall was observed in Pokkali, Kole Lands and Northern Coastal Plains.

In 2006, the Pokkali region also experienced excess rainfall. In 2008, moderate drought conditions occurred in Pokkali, with deficiency of rainfall observed in Northern High Hills and Southern High Hills. In 2009, moderate drought was observed in Pokkali, Northern High Hills and Southern High Hills, while deficiency of rainfall was found in Northern Coastal Plains and Kole Lands. In 2011, moderate drought affected the Pokkali region, and deficiency of rainfall was observed in 2014. In the same year, deficiency of rainfall also occurred in Kole Lands and Northern Coastal Plains. In 2017, moderate drought was recorded in Thrissur district, except in Northern High Hills and Southern High Hills, where excess rainfall was observed.

#### 4.1.3.3 Ernakulam District

The analysis of meteorological drought in different AEUs of Ernakulam district showed that for the last three decades, the meteorological conditions in the region have shown variability. The years 1995, 2000, 2012 and 2016 were characterized by moderate drought, while excess rainfall was observed in 1993, 1997, 1999, 2005, 2010, 2019 and 2021. In 2004, South Central Laterites, Southern and Central Foot Hills and the Pokkali region experienced excess rainfall (Table 4.3). In 2006, the Southern and Central Foot Hills and the Pokkali region observed excess rainfall, while in 2008, moderate drought affected South Central Laterites, Southern and Central Foot Hills and the Pokkali region. In 2009, Southern High Hills experienced deficiency of rainfall, while the remaining AEUs faced moderate drought conditions. In 2011, deficiency of rainfall occurred in South Central Laterites and Southern and Central Foot Hills, while the Pokkali region experienced moderate drought. In 2013, deficiency of rainfall was observed in Ernakulam district, and in 2014, the Pokkali region experienced deficiency of rainfall. In 2017, both the Pokkali region and Southern High Hills were affected by moderate drought, while the remaining AEUs experienced deficiency of rainfall.

Based on the analysis of meteorological drought using northeast monsoon seasonal rainfall data reveals that, during the years 1995, 2000, 2012 and 2016 stood out as drought years in the central zone of Kerala. Palakkad district exhibited frequent drought conditions compared to the other two districts.

Table 4.3 Departure of rainfall during the Northeast monsoon from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (%)

| District | Latitude | Longitude | AEU | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.17 | Pokkali | -13 | 46 | 18 | -33 | -6 | 28 | 8 | 23 | -43 | 1 |
| Ernakulam | 9.93 | 76.56 | South Central Laterites | -12 | 48 | 14 | -32 | -9 | 27 | 7 | 23 | -45 | -2 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | -12 | 48 | 14 | -32 | -9 | 27 | 7 | 23 | -45 | -2 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | -5 | 37 | 16 | -38 | -6 | 30 | -1 | 22 | -35 | -10 |
| Thrissur | 10.67 | 75.98 | Northern coastal plains | -5 | 37 | 16 | -38 | -6 | 30 | -1 | 22 | -35 | -10 |
| Thrissur | 10.19 | 76.26 | Pokkali | -13 | 46 | 18 | -33 | -6 | 28 | 8 | 23 | -43 | 1 |
| Thrissur | 10.78 | 76.45 | Northern Laterites | 11 | 32 | 15 | -43 | -7 | 25 | 4 | 19 | -25 | -20 |
| Thrissur | 10.68 | 76.09 | Kole Lands | -5 | 37 | 16 | -38 | -6 | 30 | 3 | 22 | -35 | -10 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | -9 | 40 | 13 | -34 | -9 | 38 | -1 | 26 | -40 | -9 |
| Thrissur | 10.34 | 76.36 | Southern High Hills | -9 | 40 | 13 | -34 | -9 | 38 | -1 | 26 | -40 | -9 |
| Palakkad | 11.23 | 76.69 | Attappady Dry Hills | -37 | 37 | 13 | -37 | -9 | 49 | -1 | 27 | -32 | -16 |
| Palakkad | 11.03 | 76.76 | Attappady Hills | -37 | 37 | 13 | -37 | -9 | 49 | -1 | 27 | -32 | -16 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 11 | 32 | 15 | -43 | -7 | 25 | 4 | 19 | -25 | -20 |
| Palakkad | 11.03 | 76.30 | Northern Foot Hills | 11 | 32 | 15 | -43 | -7 | 25 | 4 | 19 | -25 | -20 |
| Palakkad | 10.73 | 76.09 | North Central Laterites | -5 | 37 | 16 | -38 | -6 | 30 | 3 | 22 | -35 | -10 |
| Palakkad | 10.71 | 76.57 | Palakkad Central Plains | -9 | 40 | 13 | -34 | -9 | 38 | -1 | 26 | -40 | -9 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | -9 | 40 | 13 | -34 | -9 | 38 | -1 | 26 | -40 | -9 |
| Palakkad | 10.83 | 76.75 | Palakkad Eastern Plains | -37 | 37 | 13 | -37 | -9 | 49 | -1 | 27 | -32 | -16 |

Table 4.3 Departure of rainfall during the Northeast monsoon from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (%) (Contd..)

| District | Latitude | Longitude | AEU | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.17 | Pokkali | 3 | 8 | 37 | 35 | 34 | -10 | -31 | -31 | 46 | -31 |
| Ernakulam | 9.93 | 76.56 | South Central Laterites | -3 | 6 | 26 | 42 | 31 | -11 | -30 | -30 | 41 | -24 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | -3 | 6 | 26 | 42 | 31 | -11 | -30 | -30 | 41 | -24 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 7 | -10 | 23 | 28 | 18 | -1 | -15 | -22 | 53 | -23 |
| Thrissur | 10.67 | 75.98 | Northern coastal plains | 7 | -10 | 23 | 28 | 18 | -1 | -15 | -22 | 53 | -23 |
| Thrissur | 10.19 | 76.26 | Pokkali | 3 | 8 | 37 | 35 | 34 | -10 | -31 | -31 | 46 | -31 |
| Thrissur | 10.78 | 76.45 | Northern Laterites | 19 | -26 | 6 | 23 | 7 | 7 | 3 | -8 | 54 | -18 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 7 | -10 | 23 | 28 | 18 | -1 | -15 | -22 | 53 | -23 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | -7 | -9 | 17 | 43 | 15 | 0 | -21 | -26 | 47 | -11 |
| Thrissur | 10.34 | 76.36 | Southern High Hills | -7 | -9 | 17 | 43 | 15 | 0 | -21 | -26 | 47 | -11 |
| Palakkad | 11.23 | 76.69 | Attappady Dry Hills | -6 | -22 | 4 | 49 | 4 | 10 | -8 | -21 | 45 | 3 |
| Palakkad | 11.03 | 76.76 | Attappady Hills | -6 | -22 | 4 | 49 | 4 | 10 | -8 | -21 | 45 | 3 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 19 | -26 | 6 | 22 | 7 | 7 | 3 | -8 | 54 | -13 |
| Palakkad | 11.03 | 76.30 | Northern Foot Hills | 19 | -26 | 6 | 22 | 7 | 7 | 3 | -8 | 54 | -13 |
| Palakkad | 10.73 | 76.09 | North Central Laterites | 7 | -10 | 23 | 28 | 18 | -1 | -15 | -22 | 53 | -23 |
| Palakkad | 10.71 | 76.57 | Palakkad Central Plains | -7 | -9 | 17 | 43 | 15 | 0 | -21 | -26 | 47 | -11 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | -7 | -9 | 17 | 43 | 15 | 0 | -21 | -26 | 47 | -11 |
| Palakkad | 10.83 | 76.75 | Palakkad Eastern Plains | -6 | -22 | 4 | 49 | 4 | 10 | -8 | -21 | 45 | 3 |

Table 4.3 Departure of rainfall during the Northeast monsoon from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (%) (Contd..)

| District | Latitude | Longitude | AEU | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.17 | Pokkali | -40 | -23 | -21 | -1 | -53 | -26 | -8 | 31 | -16 | 71 |
| Ernakulam | 9.93 | 76.56 | South Central Laterites | -43 | -25 | -19 | -2 | -53 | -24 | -13 | 22 | 20 | 68 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | -43 | -25 | -19 | -2 | -53 | -24 | -13 | 22 | 20 | 68 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | -32 | -22 | -9 | -4 | -56 | -30 | -12 | 34 | -13 | 72 |
| Thrissur | 10.67 | 75.98 | Northern coastal plains | -32 | -22 | -9 | -4 | -56 | -30 | -12 | 34 | -13 | 72 |
| Thrissur | 10.19 | 76.26 | Pokkali | -40 | -23 | -21 | -1 | -53 | -26 | -8 | 31 | -16 | 71 |
| Thrissur | 10.78 | 76.45 | Northern Laterites | -29 | -24 | -5 | -11 | -58 | -31 | -18 | 34 | -12 | 78 |
| Thrissur | 10.68 | 76.09 | Kole Lands | -32 | -22 | -9 | -4 | -56 | -30 | -12 | 34 | -13 | 72 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | -37 | -24 | -13 | -4 | -57 | -15 | -15 | 28 | 27 | 61 |
| Thrissur | 10.34 | 76.36 | Southern High Hills | -37 | -24 | -13 | -4 | -57 | -15 | -15 | 28 | 27 | 61 |
| Palakkad | 11.23 | 76.69 | Attappady Dry Hills | -33 | -27 | -13 | -8 | -57 | -27 | -23 | 27 | 12 | 59 |
| Palakkad | 11.03 | 76.76 | Attappady Hills | -33 | -27 | -13 | -8 | -57 | -27 | -23 | 27 | 12 | 59 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | -29 | -24 | -5 | -12 | -58 | -31 | -18 | 34 | -12 | 78 |
| Palakkad | 11.03 | 76.30 | Northern Foot Hills | -29 | -24 | -5 | -12 | -58 | -31 | -18 | 34 | -12 | 78 |
| Palakkad | 10.73 | 76.09 | North Central Laterites | -32 | -22 | -9 | -4 | -56 | -30 | -12 | 34 | -13 | 72 |
| Palakkad | 10.71 | 76.57 | Palakkad Central Plains | -37 | -24 | -13 | -4 | -57 | -28 | -15 | 28 | 27 | 61 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | -37 | -24 | -13 | -4 | -57 | -28 | -15 | 28 | 27 | 61 |
| Palakkad | 10.83 | 76.75 | Palakkad Eastern Plains | -33 | -27 | -13 | -8 | -57 | -27 | -23 | 27 | 12 | 59 |

### 4.1.4 Summer Seasonal Rainfall

#### 4.1.4.1 Palakkad District

The analysis of meteorological drought in different AEUs of Palakkad district showed that the years 1997 and 2000 showed severe drought and the years 1998 and 2013 experienced moderate drought in Palakkad district. During 2001, 2004, 2006, 2008, 2018 and 2021 observed excess rainfall in Palakkad district. During 1993, a moderate drought occurred in the AEUs of the Northern High Hills, North Central Laterites and Northern Foot Hills and a deficiency of rainfall was observed in the Southern High Hills and Palakkad Central Plains.

During 1996, moderate drought was experienced in the Northern High Hills, Southern High Hills, Palakkad Central Plains, Northern Foot Hills and North Central Laterites. During 2002, Attappady Dry Hills, Attappady Hills and Palakkad Eastern Plains experienced moderate drought conditions and excess rainfall in 2017. During 2005, deficiency of rainfall was observed in the Northern Foot Hills and the Northern High Hills. During 2012, moderate drought occurred in Attappady Dry Hills, Attappady Hills and Palakkad Eastern Plains and deficiency of rainfall was observed in Northern Foot Hill and Northern High Hills.

A deficiency of rainfall was observed in the Southern High Hills and Palakkad Central Plains and other AEUs experienced moderate drought conditions in 2016. During 2019, Attappady Dry Hills, Attappady Hills and Palakkad Eastern Plains observed a deficiency of rainfall and the remaining AEUs experienced moderate drought. During 2020, a moderate drought was experienced in the Palakkad district, except for the AEUs North Central Laterites.

#### 4.1.4.2 Thrissur District

The analysis of meteorological drought in different AEUs of Thrissur district showed that the years 1996, 1997, 1998, 2000, 2013 and 2019 had experienced drought in Thrissur district. An excess of rainfall was observed in the years 2004, 2006, 2008 and 2021. During 1992, a moderate drought was experienced in the Thrissur district, except for the AEU Northern Laterites. Northern Laterites

experienced excess rainfall in 1999 and 2001 and deficiency in 2005. During the years 2002 and 2007, a moderate drought occurred in the Southern High Hills and Northern High Hills and there was a deficiency of rainfall in 2010. During 2012, deficiency of rainfall occurred in the Southern High Hills, Northern Laterites, and Northern High Hills. In 2016, a deficiency of rainfall in the Pokkali region and a moderate drought occurred in the remaining AEUs. During 2018, there was an excess of rainfall in Thrissur District, except in the Pokkali region. A moderate drought was experienced in the Southern High Hills, Northern Laterites, and Northern High Hills in 2020.

#### 4.1.4.3 Ernakulam District

The analysis of meteorological drought in different AEUs of Ernakulam district showed that the years 1992, 1993, 1998 and 2013 experienced moderate drought and the years 1996, 1997 and 2000 experienced severe drought in Ernakulum District. An excess of rainfall was observed during the years 2001, 2004, 2006, 2008 and 2021. During 1995, excess rainfall was observed in Pokkali, South Central Laterites and Southern and Central Foot Hills. South Central Laterites, Southern, and Central Foot Hills experienced a deficiency of rainfall in 2007 and an excess of rainfall in 2012. During 2009, excess rainfall occurred in the Pokkali region. During 2016, moderate drought was experienced in the Southern High Hills and the remaining AEUs were affected by a deficiency of rainfall. An excess of rainfall was experienced in the Southern High Hills during 2018. During 2020, South Central Laterites and Southern and Central Foot Hills experienced a deficiency of rainfall.

Based on the analysis of meteorological drought using summer seasonal rainfall data, it was revealed that the years 1997 and 2000 stood out as severe drought years in the central zone of Kerala. Palakkad district exhibited frequent drought conditions compared to the other two districts.

Table 4.4 Departure of rainfall during the summer season from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (%)

| District | Latitude | Longitude | AEU | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.17 | Pokkali | -39 | -31 | -17 | 29 | -63 | -53 | -41 | 11 | -53 | 23 |
| Ernakulam | 9.93 | 76.56 | South Central Laterites | -43 | -29 | -10 | 22 | -55 | -49 | -41 | 10 | -52 | 26 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | -43 | -29 | -10 | 22 | -55 | -49 | -41 | 10 | -52 | 26 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | -28 | -29 | -15 | 14 | -51 | -58 | -43 | 12 | -52 | 32 |
| Thrissur | 10.67 | 75.98 | Northern coastal plains | -28 | -29 | -15 | 14 | -51 | -58 | -43 | 12 | -52 | 32 |
| Thrissur | 10.19 | 76.26 | Pokkali | -39 | -31 | -17 | 29 | -63 | -53 | -41 | 11 | -53 | 23 |
| Thrissur | 10.78 | 76.45 | Northern Laterites | -16 | -31 | -16 | 5 | -43 | -64 | -42 | 21 | -54 | 45 |
| Thirssur | 10.68 | 76.09 | Kole Lands | -28 | -29 | -15 | 14 | -51 | -58 | -43 | 12 | -52 | 32 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | -47 | -33 | -17 | -6 | -46 | -60 | -54 | -14 | -60 | 15 |
| Thrissur | 10.34 | 76.36 | Southern High Hills | -47 | -33 | -17 | -6 | -46 | -60 | -54 | -14 | -60 | 15 |
| Palakkad | 11.23 | 76.69 | Attappady Dry Hills | -34 | -18 | -1 | -2 | -17 | -58 | -49 | -5 | -57 | 50 |
| Palakkad | 11.03 | 76.76 | Attappady Hills | -34 | -18 | -1 | -2 | -17 | -58 | -49 | -5 | -57 | 50 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | -16 | -31 | -16 | 5 | -43 | -64 | -42 | 21 | -54 | 45 |
| Palakkad | 11.03 | 76.30 | Northern Foot Hills | -16 | -31 | -16 | 5 | -43 | -64 | -42 | 21 | -54 | 45 |
| Palakkad | 10.73 | 76.09 | North Central Laterites | -28 | -29 | -15 | 14 | -51 | -58 | -43 | 12 | -52 | 32 |
| Palakkad | 10.71 | 76.57 | Palakkad Central Plains | -38 | -22 | -3 | 10 | -37 | -54 | -47 | 0 | -53 | 35 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | -38 | -22 | -3 | 10 | -37 | -54 | -47 | 0 | -53 | 35 |
| Palakkad | 10.83 | 76.75 | Palakkad Eastern Plains | -34 | -18 | -1 | -2 | -17 | -58 | -49 | -5 | -57 | 50 |

Table 4.4 Departure of rainfall during the summer season from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (%) (Contd..)

| District | Latitude | Longitude | AEU | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.17 | Pokkali | -2 | 9 | 130 | 11 | 73 | -17 | 39 | 26 | 0 | -6 |
| Ernakulam | 9.93 | 76.56 | South Central Laterites | -6 | 12 | 124 | 22 | 62 | -23 | 37 | 16 | -9 | -15 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | -6 | 12 | 124 | 22 | 62 | -23 | 37 | 16 | -9 | -15 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | -6 | 0 | 123 | -5 | 76 | -5 | 49 | 19 | 1 | -3 |
| Thrissur | 10.67 | 75.98 | Northern coastal plains | -6 | 0 | 123 | -5 | 76 | -5 | 49 | 19 | 1 | -3 |
| Thrissur | 10.19 | 76.26 | Pokkali | -2 | 9 | 130 | 11 | 73 | -17 | 39 | 26 | 0 | -6 |
| Thrissur | 10.78 | 76.45 | Northern Laterites | -8 | -14 | 127 | -23 | 86 | 11 | 55 | 0 | 0 | -11 |
| Thirssur | 10.68 | 76.09 | Kole Lands | -6 | 0 | 123 | -5 | 76 | -5 | 49 | 19 | 1 | -3 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | -29 | -6 | 77 | -2 | 35 | -31 | 25 | -3 | -23 | -13 |
| Thrissur | 10.34 | 76.36 | Southern High Hills | -29 | -6 | 77 | -2 | 35 | -31 | 25 | -3 | -23 | -13 |
| Palakkad | 11.23 | 76.69 | Attappady Dry Hills | -28 | 0 | 89 | 8 | 52 | -12 | 52 | -4 | -12 | 9 |
| Palakkad | 11.03 | 76.76 | Attappady Hills | -28 | 0 | 89 | 8 | 52 | -12 | 52 | -4 | -12 | 9 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | -8 | -14 | 127 | -23 | 86 | 11 | 55 | 0 | 0 | -6 |
| Palakkad | 11.03 | 76.30 | Northern Foot Hills | -8 | -14 | 127 | -23 | 86 | 11 | 55 | 0 | 0 | -6 |
| Palakkad | 10.73 | 76.09 | North Central Laterites | -6 | 0 | 123 | -5 | 76 | -5 | 49 | 19 | 1 | -3 |
| Palakkad | 10.71 | 76.57 | Palakkad Central Plains | -17 | 10 | 107 | 14 | 58 | -19 | 46 | 13 | -10 | -6 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | -17 | 10 | 107 | 14 | 58 | -19 | 46 | 13 | -10 | -6 |
| Palakkad | 10.83 | 76.75 | Palakkad Eastern Plains | -28 | 0 | 89 | 8 | 52 | -12 | 52 | -4 | -12 | 9 |

Table 4.4 Departure of rainfall during the summer season from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (%) (Contd..)

| District | Latitude | Longitude | AEU | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.17 | Pokkali | 1 | -36 | -9 | 0 | -21 | 9 | 12 | -56 | -6 | 80 |
| Ernakulam | 9.93 | 76.56 | South Central Laterites | 35 | -37 | -8 | 5 | -20 | 13 | 16 | -46 | -20 | 65 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 35 | -37 | -8 | 5 | -20 | 13 | 16 | -46 | -20 | 65 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | -5 | -39 | 1 | 10 | -31 | 12 | 28 | -48 | -19 | 62 |
| Thrissur | 10.67 | 75.98 | Northern coastal plains | -5 | -39 | 1 | 10 | -31 | 12 | 28 | -48 | -19 | 62 |
| Thrissur | 10.19 | 76.26 | Pokkali | 1 | -36 | -9 | 0 | -21 | 9 | 12 | -56 | -6 | 80 |
| Thrissur | 10.78 | 76.45 | Northern Laterites | -25 | -39 | 19 | 15 | -38 | 4 | 36 | -36 | -30 | 53 |
| Thrissur | 10.68 | 76.09 | Kole Lands | -5 | -39 | 1 | 10 | -31 | 12 | 28 | -48 | -19 | 62 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | -20 | -47 | -15 | 6 | -35 | 4 | 21 | -44 | -38 | 27 |
| Thrissur | 10.34 | 76.36 | Southern High Hills | -20 | -47 | -15 | 6 | -35 | 4 | 21 | -44 | -38 | 27 |
| Palakkad | 11.23 | 76.69 | Attappady Dry Hills | -26 | -38 | 16 | 45 | -30 | 30 | 50 | -21 | -37 | 48 |
| Palakkad | 11.03 | 76.76 | Attappady Hills | -26 | -38 | 16 | 45 | -30 | 30 | 50 | -21 | -37 | 48 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | -25 | -39 | 19 | 15 | -38 | 12 | 36 | -36 | -37 | 53 |
| Palakkad | 11.03 | 76.30 | Northern Foot Hills | -25 | -39 | 19 | 15 | -38 | 12 | 36 | -36 | -37 | 53 |
| Palakkad | 10.73 | 76.09 | North Central Laterites | -5 | -39 | 1 | 10 | -31 | 12 | 28 | -48 | -19 | 62 |
| Palakkad | 10.71 | 76.57 | Palakkad Central Plains | -6 | -38 | -1 | 24 | -24 | 22 | 42 | -34 | -28 | 49 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | -6 | -38 | -1 | 24 | -24 | 22 | 42 | -34 | -28 | 49 |
| Palakkad | 10.83 | 76.75 | Palakkad Eastern Plains | -26 | -38 | 16 | 45 | -30 | 30 | 50 | -21 | -37 | 48 |

### 4.1.5 Winter Seasonal Rainfall

#### 4.1.5.1 Palakkad District

The analysis of meteorological drought in different AEUs of Palakkad district showed that the years 1992, 1996–1999, 2007, 2009, 2010, 2012, 2014, 2015, 2019 and 2020 had experienced severe drought in Palakkad district. Excess rainfall was experienced in the years 1994, 2003, 2005, 2011, 2013 and 2021.

During 1993, deficiency of rainfall occurred in the Northern Foot Hills, Attappady Dry Hills, Attappady Hills, Northern High Hills and Palakkad Eastern Plains. A severe drought was experienced in the Northern Foot Hills and Northern High Hills and excess rainfall was observed in the remaining AEUs in 2000. During the year 2001, an excess of rainfall was observed in North Central Laterites, Northern Foot Hills and Northern High Hills. During 2002, severe drought was experienced in the North Central Laterites, Northern Foot Hills and Northern High Hills and moderate drought was experienced in the remaining AEUs of Palakkad district. In 2004, North Central Laterites, Palakkad Central Plains, and Southern High Hills experienced moderate drought, and the remaining AEUs experienced severe drought. In 2006, a moderate drought occurred in the Attappady Dry Hills, Attappady Hills and Palakkad Central Plains and the remaining AEUs experienced a severe drought.

During 2008, North Central Laterites saw a moderate drought condition, while a deficiency of rainfall was observed in the Palakkad Central Plains and Southern High Hills. In 2016, severe drought was experienced in the Attappady Dry Hills, Attappady Hills and Palakkad Eastern Plains, with moderate drought occurring in the Southern High Hills and Palakkad Central Plains. A deficiency of rainfall was noted

in the Northern High Hills and the Northern Foot Hills. During 2018, a moderate drought occurred in North Central Laterites, followed by a severe drought in 2019. The Northern High Hills, Southern High Hills, Northern Foot Hills and Palakkad Central Plains all experienced moderate drought conditions in 2019.

#### 4.1.5.2 Thrissur District

The analysis of meteorological drought in different AEUs of Thrissur district revealed that, during the years 1992, 1996-99, 2006, 2007, 2009, 2010, 2012, 2014, 2015 and 2019 had experienced severe drought condition. While excess of rainfall observed during the years 1994, 2000, 2003, 2005, 2011, 2013 and 2021.

During 1993, moderate drought was experienced in Northern Laterites. While in 2002, Northern Laterites, Northern coastal plains and Kole Lands experience severe drought and the remaining AEUs had observed moderate drought. In 2004, severe drought was experienced in Northern Laterites and moderate drought was experienced for all other AEUs. During 2008, pokkali region had experienced severe drought, Kole Lands and Northern coastal plains experienced moderate drought and the remaining AEUs were affected by deficiency of rainfall. During 2016, Northern High Hills, Southern High Hills and Northern Laterites had experienced moderate drought and Pokkali region had observed excess of rainfall. During 2017, pokkali region experienced severe drought and Kole Lands and Northern coastal plains had experienced moderate drought condition. While in 2018, Northern coastal plains, Pokkali and Kole Lands had experienced severe drought, remaining AEUs were affected by moderate drought. Northern High Hills and Southern High Hills were

experienced severe drought and the remaining AEUs were affected by moderate drought in 2020.

#### 4.1.5.3 Ernakulam District

The analysis of meteorological drought in different AEUs of Ernakulam district showed that the years 1992, 1996–99, 2006, 2007, 2009, 2010, 2012, 2014, 2015, 2018 and 2019 experienced severe drought, moderate drought in 2004 and excess rainfall observed in 1994, 2000, 2001, 2003, 2005, 2011 and 2021. During 2002, Southern High Hills experienced severe drought and the remaining AEUs experienced moderate drought conditions. In 2008, the Pokkali region experienced a severe drought and the remaining AEUs were affected by a moderate drought. During 2016, South Central Laterite, Southern and Central Foot Hills experienced a deficiency of rainfall and the Pokkali region received an excess of rainfall. While the Pokkali region experienced severe drought in 2017, the southern High Hills were affected by moderate drought and the remaining AEUs were affected by a deficiency of rainfall. During 2020, South Central Laterites, Southern and Central Foot Hills experienced severe drought, and the remaining parts were affected by moderate drought.

Table 4.5 Departure of rainfall during the winter season from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (%)

| District | Latitude | Longitude | AEU | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.17 | Pokkali | -94 | 6 | 273 | -16 | -70 | -98 | -88 | -87 | 322 | 68 |
| Ernakulam | 9.93 | 76.56 | South Central Laterites | -91 | 3 | 268 | -16 | -61 | -93 | -88 | -74 | 326 | 53 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | -91 | 3 | 268 | -16 | -61 | -93 | -88 | -74 | 326 | 53 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | -97 | -6 | 206 | -12 | -71 | -96 | -88 | -90 | 282 | 51 |
| Thrissur | 10.67 | 75.98 | Northern coastal plains | -97 | -6 | 206 | -12 | -71 | -96 | -88 | -90 | 282 | 51 |
| Thrissur | 10.19 | 76.26 | Pokkali | -94 | 6 | 273 | -16 | -70 | -98 | -88 | -87 | 322 | 68 |
| Thrissur | 10.78 | 76.45 | Northern Laterites | -98 | -31 | 103 | -13 | -59 | -91 | -88 | -85 | 214 | 32 |
| Thrissur | 10.68 | 76.09 | Kole Lands | -97 | -6 | 206 | -12 | -71 | -96 | -88 | -90 | 282 | 51 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | -95 | -4 | 199 | 2 | -65 | -91 | -87 | -86 | 314 | 19 |
| Thrissur | 10.34 | 76.36 | Southern High Hills | -95 | -4 | 199 | 2 | -65 | -91 | -87 | -86 | 314 | 19 |
| Palakkad | 11.23 | 76.69 | Attappady Dry Hills | -97 | -20 | 103 | 22 | -57 | -83 | -93 | -85 | 300 | -18 |
| Palakkad | 11.03 | 76.76 | Attappady Hills | -97 | -20 | 103 | 22 | -57 | -83 | -93 | -85 | 300 | -18 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | -98 | -24 | 124 | -4 | -55 | -90 | -84 | -84 | -65 | 46 |
| Palakkad | 11.03 | 76.30 | Northern Foot Hills | -98 | -24 | 124 | -4 | -55 | -90 | -84 | -84 | -65 | 46 |
| Palakkad | 10.73 | 76.09 | North Central Laterites | -97 | -6 | 206 | -12 | -71 | -96 | -88 | -90 | 282 | 51 |
| Palakkad | 10.71 | 76.57 | Palakkad Central Plains | -95 | -4 | 201 | 2 | -65 | -91 | -91 | -86 | 314 | 19 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | -95 | -4 | 201 | 2 | -65 | -91 | -91 | -86 | 314 | 19 |
| Palakkad | 10.83 | 76.75 | Palakkad Eastern Plains | -97 | -20 | 103 | 22 | -57 | -83 | -93 | -85 | 300 | -18 |

Table 4.5 Departure of rainfall during the winter season from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.17 | Pokkali | -44 | 118 | -31 | 80 | -78 | -91 | -51 | -76 | -59 | 166 |
| Ernakulam | 9.93 | 76.56 | South Central Laterites | -28 | 102 | -39 | 61 | -66 | -87 | -43 | -77 | -62 | 144 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | -28 | 102 | -39 | 61 | -66 | -87 | -43 | -77 | -62 | 144 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | -52 | 110 | -41 | 62 | -71 | -84 | -38 | -79 | -60 | 182 |
| Thrissur | 10.67 | 75.98 | Northern coastal plains | -52 | 110 | -41 | 62 | -71 | -84 | -38 | -79 | -60 | 182 |
| Thrissur | 10.19 | 76.26 | Pokkali | -44 | 118 | -31 | 80 | -78 | -91 | -51 | -76 | -59 | 166 |
| Thrissur | 10.78 | 76.45 | Northern Laterites | -67 | 128 | -58 | 34 | -60 | -75 | -24 | -86 | -71 | 126 |
| Thrissur | 10.68 | 76.09 | Kole Lands | -52 | 110 | -41 | 62 | -71 | -84 | -38 | -79 | -60 | 182 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | -28 | 57 | -48 | 42 | -54 | -75 | -23 | -79 | -68 | 157 |
| Thrissur | 10.34 | 76.36 | Southern High Hills | -28 | 57 | -48 | 42 | -54 | -75 | -23 | -79 | -68 | 157 |
| Palakkad | 11.23 | 76.69 | Attappady Dry Hills | -31 | 27 | -64 | 9 | -35 | -61 | -2 | -86 | -79 | 110 |
| Palakkad | 11.03 | 76.76 | Attappady Hills | -31 | 27 | -64 | 9 | -35 | -61 | -2 | -86 | -79 | 110 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | -63 | 152 | -54 | 48 | -56 | -72 | -17 | -85 | -68 | 150 |
| Palakkad | 11.03 | 76.30 | Northern Foot Hills | -63 | 152 | -54 | 48 | -56 | -72 | -17 | -85 | -68 | 150 |
| Palakkad | 10.73 | 76.09 | North Central Laterites | -52 | 110 | -41 | 62 | -71 | -84 | -38 | -79 | -60 | 182 |
| Palakkad | 10.71 | 76.57 | Palakkad Central Plains | -28 | 57 | -48 | 42 | -54 | -75 | -23 | -80 | -68 | 157 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | -28 | 57 | -48 | 42 | -54 | -75 | -23 | -80 | -68 | 157 |
| Palakkad | 10.83 | 76.75 | Palakkad Eastern Plains | -31 | 27 | -64 | 9 | -35 | -61 | -2 | -86 | -79 | 110 |

Table 4.5 Departure of rainfall during the winter season from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (%) (Contd..)

| District | Latitude | Longitude | AEU | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.17 | Pokkali | -54 | 59 | -53 | -87 | 30 | -52 | -73 | -74 | -26 | 182 |
| Ernakulam | 9.93 | 76.56 | South Central Laterites | -63 | 56 | -52 | -86 | -24 | -23 | -64 | -65 | -61 | 252 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | -63 | 56 | -52 | -86 | -24 | -23 | -64 | -65 | -61 | 252 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | -57 | 87 | -72 | -90 | 5 | -39 | -59 | -70 | -26 | 312 |
| Thrissur | 10.67 | 75.98 | Northern coastal plains | -57 | 87 | -72 | -90 | 5 | -39 | -59 | -70 | -26 | 312 |
| Thrissur | 10.19 | 76.26 | Pokkali | -54 | 59 | -53 | -87 | 30 | -52 | -73 | -74 | -26 | 182 |
| Thrissur | 10.78 | 76.45 | Northern Laterites | -67 | 118 | -86 | -94 | -29 | -4 | -39 | -55 | -34 | 560 |
| Thrissur | 10.68 | 76.09 | Kole Lands | -57 | 87 | -72 | -90 | 5 | -39 | -59 | -70 | -26 | 312 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | -69 | 86 | -71 | -88 | -45 | -3 | -37 | -61 | -64 | 367 |
| Thrissur | 10.34 | 76.36 | Southern High Hills | -69 | 86 | -71 | -88 | -45 | -3 | -37 | -61 | -64 | 367 |
| Palakkad | 11.23 | 76.69 | Attappady Dry Hills | -81 | 103 | -86 | -90 | -59 | 19 | -11 | -56 | -61 | 566 |
| Palakkad | 11.03 | 76.76 | Attappady Hills | -81 | 103 | -86 | -90 | -59 | 19 | -11 | -56 | -61 | 566 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | -64 | 141 | -85 | -93 | -21 | 6 | -33 | -50 | -27 | 628 |
| Palakkad | 11.03 | 76.30 | Northern Foot Hills | -64 | 141 | -85 | -93 | -21 | 6 | -33 | -50 | -27 | 628 |
| Palakkad | 10.73 | 76.09 | North Central Laterites | -57 | 87 | -72 | -90 | 5 | -39 | -59 | -70 | -26 | 312 |
| Palakkad | 10.71 | 76.57 | Palakkad Central Plains | -69 | 86 | -71 | -88 | -45 | -3 | -37 | -61 | -64 | 366 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | -69 | 86 | -71 | -88 | -45 | -3 | -37 | -61 | -64 | 366 |
| Palakkad | 10.83 | 76.75 | Palakkad Eastern Plains | -81 | 103 | -86 | -90 | -59 | 19 | -11 | -56 | -61 | 566 |

## 4.2 Agriculture Drought

### 4.2.1 Palakkad District:

The analysis of agricultural drought showed that during the *kharif* seasons of the years 1993, 1999, 2003 and 2016, Palakkad district experienced agricultural drought (Table. 4.6). Additionally, during the $27^{th}$– $30^{th}$ week of 2005, there was an agricultural drought in Southern High Hills and Palakkad Central Plains. Southern High Hills also experienced a drought in the $32^{nd}$ – $35^{th}$ week of 2005 (annexure i).

During *rabi* season, Southern High Hills and Palakkad Central Plains faced agricultural drought during the $45^{th}$– $51^{st}$ week of 1994, while the Northern High Hills experienced it during the $45^{th}$ – $50^{th}$ week of 2003. Northern Central Laterities, Attappady Dry Hills, Attappady Hills, and Palakkad Eastern Plains encountered agricultural drought during the $45^{th}$ – $51^{st}$ week of 2012.

### 4.2.2 Thrissur District

The analysis of agricultural drought showed that during the *kharif* seasons of the years 1993, 1999, 2003 and 2016, Thrissur district experienced agricultural drought (Table 4.7). In 1998, the Pokkali region also experienced drought during the $29^{th}$-$33^{rd}$ week. Agriculture drought was prevalent in Thrissur district in 2000, except for the AEU Northern Laterites. Additionally, the Northern Laterites experienced drought in the $32^{nd}$ – $35^{th}$ week of 2005. The Pokkali region faced agricultural drought in the years 2001, 2002, 2011, 2012 and 2018.

During the *rabi* season, Thrissur district, except for the AEU Northern Laterites, experienced agricultural drought in 1994. In 2003, drought conditions were observed in various regions, including Pokkali, Kole lands, Northern coastal plains, and Northern Laterites. The Pokkali region also experienced drought conditions in

1995 and 2002. It was worth noting that the Pokkali region in Thrissur district was prone to drought.

### 4.2.3 Ernakulam District

The analysis of agriculture drought showed that during *kharif* season, the years of 1993, 1999, 2000, 2003 and 2016 had experienced agriculture drought in Ernakulam district (Table 4.8). During 1998 and 2011, agriculture drought was occurred in Ernakulam district except Southern High Hills. During the years, 2001, 2002, 2012 and 2018, Pokkali region experienced agriculture drought.

During the *rabi* season, Ernakulam District faced agricultural drought at the $46^{th}$ - $60^{th}$ week of 1994 and the $45^{th}$ – $50^{th}$ week of 2003. The Pokkali region also experienced drought conditions during the $45^{th}$ – $50^{th}$ week of 1995.

Compared to the data from the past 30 years, it was evident that the years 2003 and 2016 stand out as the most drought-affected years. The agricultural drought significantly impacted $35^{th}$ – $39^{th}$ week. This period was crucial for rice cultivation in the central zone of Kerala, which predominantly relies on rice as its major cultivated crop. These weeks fall between the transitional phases of *virippu* and *mundakan* seasons, which are critical for rice cultivation. The stages encompass panicle initiation, booting, heading, flowering, and physiological maturity. Notably, the $36^{th}$ – $42^{nd}$ week was particularly vital, encompassing stages such as heading, flowering, milking, physical maturity and harvesting

During the *rabi* season, 2003 also witnessed agricultural drought, affecting the $45^{th}$ – $50^{th}$ week. This time period corresponds to the *mundakan* stage, a crucial phase for rice cultivation. It encompasses activities such as seedling stage, active tillering and panicle initiation.

Table 4.6 Agriculture drought from 1992-2021 (30 years period) in different AEUs of Palakkad district

| **Season** | **Kharif season** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **AEU** | **Attappady Dry Hills** | **Drought Week** | **Attappady Hills** | **Drought Week** | **Palakkad Eastern Plains** | **Drought Week** | **Palakkad Central Plains** | **Drought Week** |
| | 1993 | 31 - 34 | 1993 | 31 - 34 | 1993 | 31 - 34 | 1993 | 31 – 34 |
| | | 36 - 39 | | 36 - 39 | | 36 - 39 | | 36 – 39 |
| | 1999 | 33 - 39 | 1999 | 33 - 39 | 1999 | 33 - 39 | 1999 | 33 – 39 |
| | 2003 | 35 - 39 | 2003 | 35 - 39 | 2003 | 35 - 39 | 2000 | 27 – 30 |
| | 2016 | 36 - 40 | 2016 | 36 - 40 | 2016 | 36 - 40 | 2003 | 35 – 39 |
| | | | | | | | 2016 | 36 – 40 |
| **Season** | **Rabi Season** | | | | | | | |
| | **Year** | **Drought Week** | **Year** | **Drought Week** | **Year** | **Drought Week** | **Year** | **Drought Week** |
| | 2012 | 45 - 51 | 2012 | 45 - 51 | 2012 | 45 - 51 | 1994 | 46 – 51 |

Table 4.6 Agriculture drought from 1992-2021 (30 years period) in different AEUs of Palakkad district (Contd..)

| **Season** | **Kharif Season** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **AEU** | **Northern High Hills** | | **Northern Foot Hills** | | **Southern High Hills** | | **Northern central Laterites** | |
| | **Year** | **Drought Week** | **Year** | **Drought Week** | **Year** | **Drought Week** | **Year** | **Drought Week** |
| | 1993 | 36 - 39 | 1993 | 36 - 39 | 1993 | 31 - 34 | 1993 | 31 – 34 |
| | 1999 | 33 - 39 | 1999 | 33 - 39 | | 36 - 39 | | 36 – 39 |
| | 2003 | 35 - 39 | 2003 | 35 - 39 | 1999 | 33 - 39 | 1999 | 33 – 39 |
| | 2005 | 32 - 35 | 2005 | 32 - 35 | 2000 | 27 - 30 | 2003 | 35 – 39 |
| | 2016 | 36 - 42 | 2016 | 36 - 42 | 2003 | 35 - 39 | 2016 | 36 – 40 |
| | | | | | 2016 | 36 - 40 | | |
| **Season** | **Rabi Season** | | | | | | | |
| | **Year** | **Drought Week** | **Year** | **Drought Week** | **Year** | **Drought Week** | **Year** | **Drought Week** |
| | 2003 | 45 - 50 | 2003 | 45 - 50 | 1994 | 46 - 51 | 2012 | 45 – 51 |

Table 4.7 Agriculture drought from 1992-2021 (30 years period) in different AEUs of Thrissur district

| **Season** | **Kharif season** | | | | | |
|---|---|---|---|---|---|---|
| **AEU** | **Northern Laterites** | | **Northern coastal plains** | | **Northern High Hills** | |
| | **Year** | **Drought Week** | **Year** | **Drought Week** | **Year** | **Drought Week** |
| | 1993 | 36 - 39 | 1993 | 31 – 34 | 1993 | 31 – 34 |
| | 1999 | 33 - 39 | | 36 – 39 | | 36 – 39 |
| | 2003 | 35 - 39 | 1999 | 33 – 39 | 1999 | 33 – 39 |
| | 2005 | 32 - 35 | 2000 | 27 – 30 | 2000 | 27 – 30 |
| | 2016 | 36 - 42 | 2003 | 35 – 39 | 2003 | 35 – 39 |
| | | | 2016 | 36 – 42 | 2016 | 36 – 40 |
| **Season** | **Rabi Season** | | | | | |
| | **Year** | **Drought Week** | **Year** | **Drought Week** | **Year** | **Drought Week** |
| | 2003 | 45 - 50 | 1994 | 46 – 60 | 1994 | 46 – 51 |
| | | | 2003 | 45 – 50 | | |

Table 4.7 Agriculture drought from 1992-2021 (30 years period) in different AEUs of Thrissur district (Contd..)

| **Seasaon** | **Kharif season** | | | | | |
|---|---|---|---|---|---|---|
| **AEU** | **Kole lands** | | **Southern High Hills** | | **Pokkali** | |
| | **Year** | **Drought Week** | **Year** | **Drought Week** | **Year** | **Drought Week** |
| | 1993 | 31 - 34 | 1993 | 31 - 34 | 1993 | 31 – 34 |
| | | 36 - 39 | | 36 - 39 | | 36 – 39 |
| | 1999 | 33 - 39 | 1999 | 33 - 39 | 1998 | 29 – 33 |
| | 2000 | 27 - 30 | 2000 | 27 - 30 | 1999 | 33 – 39 |
| | 2003 | 35 - 39 | 2003 | 35 - 39 | 2000 | 27 – 31 |
| | 2016 | 36 - 42 | 2016 | 36 - 40 | 2001 | 29 – 32 |
| | | | | | 2002 | 37 – 40 |
| | | | | | 2003 | 35 – 39 |
| | | | | | 2011 | 38 – 42 |
| | | | | | 2012 | 38 – 41 |
| | | | | | 2016 | 36 – 41 |
| | | | | | 2018 | 34 – 38 |
| **Season** | **Rabi Season** | | | | | |
| | **Year** | **Drought Week** | **Year** | **Drought Week** | **Year** | **Drought Week** |
| | 1994 | 46 - 60 | 1994 | 46 - 51 | 2012 | 45 – 51 |
| | 2003 | 45 - 50 | | | 1994 | 46 – 60 |
| | | | | | 1995 | 45 – 60 |
| | | | | | 2003 | 45 – 50 |

Table 4.8 Agriculture drought from 1992-2021 (30 years period) in different AEUs of Ernakulam district

| **Season** | **Kharif season** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **AEU** | **South Central Laterites** | | **Southern and Central Foot Hills** | | **Southern High Hills** | | **Pokkali** | |
| | **Year** | **Drought Week** | **Year** | **Drought Week** | **Year** | **Drought Week** | **Year** | **Drought Week** |
| | 1993 | 31 - 34 | 1993 | 31 - 34 | 1993 | 31 - 34 | 1993 | 31 - 34 |
| | | 36 - 39 | | 36 - 39 | | 36 - 39 | | 36 - 39 |
| | 1998 | 30 - 33 | 1998 | 30 - 33 | 1999 | 33 - 39 | 1998 | 29 - 33 |
| | 1999 | 33 - 39 | 1999 | 33 - 39 | 2000 | 27 - 30 | 1999 | 33 - 39 |
| | 2000 | 27 - 31 | 2000 | 27 - 31 | 2003 | 35 - 39 | 2000 | 27 - 31 |
| | 2003 | 35 - 39 | 2003 | 35 - 39 | 2016 | 36 - 42 | 2001 | 29 - 32 |
| | 2011 | 38 - 41 | 2011 | 38 - 41 | | | 2002 | 37 - 40 |
| | 2016 | 36 - 41 | 2016 | 36 - 41 | | | 2003 | 35 - 39 |
| | | | | | | | 2011 | 38 - 42 |
| | | | | | | | 2012 | 38 - 41 |
| | | | | | | | 2016 | 36 - 41 |
| | | | | | | | 2018 | 34 - 38 |
| **Season** | **Rabi Season** | | | | | | | |
| | **Year** | **Drought Week** | **Year** | **Drought Week** | **Year** | **Drought Week** | **Year** | **Drought Week** |
| | 1994 | 46 - 60 | 1994 | 46 - 60 | 1994 | 46 - 60 | 1994 | 46 - 60 |
| | 2003 | 45 - 50 | 2003 | 45 - 50 | 2003 | 45 - 50 | 1995 | 45 - 60 |
| | | | | | | | 2003 | 45 - 50 |

### 4.3 Moisture Availability Index (MAI)

#### 4.3.1 Annual Rainfall

##### 4.3.1.1 Palakkad district

The analysis of the Moisture Availability Index (MAI) showed that in 2016, Palakkad district experienced a severe deficiency of moisture (MAI value between 0-0.3) in the majority of the area. During the years 1992, 1993, 1996, 2008, 2009 and 2017, Palakkad district experienced a moderate deficiency of moisture (MAI value between 0.34-0.67). During the years 1991, 2004, 2014 and 2018, there was a deficiency of moisture (MAI value between 0.68 and 1) in the Northern Foot Hills and North Central Laterites. During the years 1995, 1999–2003 and 2015 experienced severe deficiency of moisture in the regions of Attappady Dry Hills, Attappady Hills and Palakkad Eastern Plains. During the years 1997, 2006, 2007 and 2010, there was a deficiency of moisture in the Northern High Hills, Northern Foot Hills and North Central Laterites and the remaining regions experienced a moderate deficiency of moisture (Table 4.9).

During 1998, a severe deficiency of moisture was experienced in Attappady Hills, and the remaining regions experienced a moderate deficiency of moisture. During the years 2005, 2011 and 2013, the North Central Laterites experienced deficiency and the remaining regions experienced moderate deficiency. In 2021, the Attappady Dry Hills, Attappady Hills, and Palakkad Eastern Plains experienced moderate deficiency, while the remaining regions experienced moderate deficiency.

##### 4.3.1.2 Thrissur District

The analysis of the Moisture Availability Index (MAI) showed that 2016 experienced a severe deficiency of moisture in the Northern High Hills, Northern Laterites and Northern coastal plains and the remaining regions experienced a moderate deficiency. During the years 1992, 1993, 1995, 1998, 2002, 2003, 2008 and 2017 experienced deficiency in the Pokkali region experienced deficiency, and the remaining regions experienced a moderate deficit (Table 4.9).

The analysis of the Moisture Availability Index (MAI) showed that 2016 experienced a severe deficiency of moisture in the Northern High Hills, Northern Laterites and Northern coastal plains and the remaining regions experienced a moderate deficiency. During the years, 1992, 1993, 1995, 1998, 2002, 2003, 2008 and 2017 had experienced deficiency in the Pokkali region and the remaining regions experienced moderate deficiency. During the years 1999–2001 and 2015, had experienced moderate deficiency in Thrissur district.

While 1994, 1997, 2004, 2007, 2010, 2014 and 2018 had experienced moderate deficiency in the Northern High Hills, the remaining regions had experienced deficiency. During 2012, the Northern High Hills experienced a severe deficiency of moisture and the remaining regions experienced a moderate deficiency. While 2009, 2019 and 2020 had experienced moderate deficiency in the Northern Laterites and Northern High Hills, the remaining regions experienced deficiency.

#### 4.3.1.3 Ernakulam District

The analysis of the Moisture Availability Index (MAI) showed that 2016 experienced a very high deficiency of moisture in Ernakulam district, except in the Pokkali region. During the years 1992, 1993, 1995, 1996, 1998, 2002, 2003 and 2008 the Pokkali region experienced deficiency and the remaining areas experienced moderate deficiency. Ernakulam district experienced deficiency in 1994, 1997, 2004, 2005, 2007, 2010, 2013, 2018, 2019 and 2020 (Table 4.9).

During 2001 and 2008, the Southern High Hills experienced moderate deficiency, and the remaining regions experienced deficiency. While 2009, 2011 and 2014 had experienced moderate deficiency in South Central Laterites and Southern and Central Foot Hills, the remaining regions had experienced deficiency.

Analyzing the 30-year annual rainfall data, 2016 experienced more deficiency of moisture over a 30-year period.

Table 4.9 Annual Moisture Availability Index (MAI) from 1992-2021 (30 years period) in different AEUs of central zone of kerala

| District | Latitude | Longitude | AEU | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.69 | 0.71 | 0.86 | 0.72 | 0.69 | 0.94 | 0.74 | 0.62 | 0.53 | 0.84 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.62 | 0.67 | 0.78 | 0.6 | 0.63 | 0.81 | 0.66 | 0.57 | 0.47 | 0.71 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.62 | 0.64 | 0.74 | 0.59 | 0.6 | 0.78 | 0.64 | 0.55 | 0.47 | 0.73 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.64 | 0.60 | 0.72 | 0.59 | 0.62 | 0.8 | 0.63 | 0.55 | 0.46 | 0.66 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.66 | 0.60 | 0.76 | 0.61 | 0.62 | 0.79 | 0.63 | 0.55 | 0.45 | 0.63 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.69 | 0.71 | 0.85 | 0.73 | 0.68 | 0.94 | 0.74 | 0.62 | 0.53 | 0.83 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.66 | 0.57 | 0.69 | 0.55 | 0.58 | 0.75 | 0.61 | 0.50 | 0.45 | 0.58 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.66 | 0.60 | 0.73 | 0.6 | 0.63 | 0.81 | 0.63 | 0.55 | 0.47 | 0.67 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.45 | 0.47 | 0.53 | 0.4 | 0.45 | 0.54 | 0.43 | 0.38 | 0.35 | 0.48 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.66 | 0.60 | 0.73 | 0.60 | 0.63 | 0.81 | 0.63 | 0.55 | 0.47 | 0.67 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.37 | 0.35 | 0.38 | 0.29 | 0.36 | 0.42 | 0.34 | 0.29 | 0.26 | 0.33 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.37 | 0.35 | 0.38 | 0.29 | 0.36 | 0.43 | 0.33 | 0.29 | 0.26 | 0.33 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.61 | 0.53 | 0.39 | 0.52 | 0.54 | 0.71 | 0.57 | 0.47 | 0.42 | 0.54 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.65 | 0.56 | 0.68 | 0.55 | 0.58 | 0.76 | 0.61 | 0.5 | 0.45 | 0.57 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.66 | 0.60 | 0.73 | 0.60 | 0.63 | 0.81 | 0.63 | 0.55 | 0.47 | 0.67 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.47 | 0.48 | 0.54 | 0.42 | 0.46 | 0.55 | 0.44 | 0.39 | 0.36 | 0.49 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.46 | 0.47 | 0.54 | 0.41 | 0.45 | 0.54 | 0.43 | 0.38 | 0.36 | 0.48 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.37 | 0.35 | 0.39 | 0.29 | 0.36 | 0.41 | 0.34 | 0.30 | 0.27 | 0.33 |

Table 4.9 Annual Moisture Availability Index (MAI) from 1992-2021 (30 years period) in different AEUs of central zone of kerala (Contd..)

| District | Latitude | Longitude | AEU | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.70 | 0.74 | 0.94 | 0.93 | 1.07 | 0.98 | 0.74 | 0.78 | 0.91 | 0.76 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.57 | 0.62 | 0.81 | 0.82 | 0.87 | 0.76 | 0.62 | 0.62 | 0.74 | 0.60 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.59 | 0.63 | 0.83 | 0.84 | 0.89 | 0.78 | 0.63 | 0.64 | 0.75 | 0.61 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.56 | 0.56 | 0.76 | 0.74 | 0.86 | 0.90 | 0.66 | 0.70 | 0.80 | 0.68 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.54 | 0.56 | 0.74 | 0.71 | 0.83 | 0.89 | 0.65 | 0.68 | 0.78 | 0.68 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.69 | 0.74 | 0.94 | 0.93 | 1.06 | 0.97 | 0.74 | 0.78 | 0.91 | 0.76 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.52 | 0.47 | 0.69 | 0.61 | 0.80 | 0.89 | 0.66 | 0.66 | 0.74 | 0.64 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.56 | 0.57 | 0.78 | 0.75 | 0.87 | 0.91 | 0.67 | 0.71 | 0.81 | 0.69 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.39 | 0.42 | 0.56 | 0.56 | 0.58 | 0.58 | 0.46 | 0.45 | 0.56 | 0.48 |
| Thirssur | 10.35 | 76.36 | Southern High Hills | 0.56 | 0.57 | 0.77 | 0.74 | 1.04 | 0.91 | 0.67 | 0.71 | 0.80 | 0.69 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.25 | 0.27 | 0.40 | 0.41 | 0.41 | 0.45 | 0.36 | 0.34 | 0.41 | 0.36 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.25 | 0.27 | 0.40 | 0.41 | 0.41 | 0.45 | 0.36 | 0.34 | 0.41 | 0.37 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.48 | 0.44 | 0.65 | 0.57 | 0.75 | 0.83 | 0.62 | 0.62 | 0.69 | 0.60 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.51 | 0.46 | 0.69 | 0.61 | 0.79 | 0.88 | 0.66 | 0.66 | 0.74 | 0.64 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.56 | 0.57 | 0.77 | 0.75 | 0.87 | 0.91 | 0.67 | 0.71 | 0.81 | 0.69 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.40 | 0.44 | 0.58 | 0.58 | 0.59 | 0.60 | 0.47 | 0.47 | 0.58 | 0.50 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.39 | 0.43 | 0.57 | 0.57 | 0.58 | 0.58 | 0.46 | 0.46 | 0.57 | 0.49 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.26 | 0.27 | 0.40 | 0.41 | 0.42 | 0.46 | 0.36 | 0.35 | 0.41 | 0.36 |

Table 4.9 Annual Moisture Availability Index (MAI) from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.55 | 0.85 | 0.77 | 0.63 | 0.34 | 0.73 | 0.89 | 0.83 | 0.81 | 1.05 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.43 | 0.67 | 0.61 | 0.54 | 0.32 | 0.62 | 0.68 | 0.66 | 0.68 | 0.91 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.43 | 0.69 | 0.62 | 0.55 | 0.33 | 0.63 | 0.69 | 0.68 | 0.70 | 0.94 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.48 | 0.70 | 0.70 | 0.51 | 0.33 | 0.63 | 0.79 | 0.74 | 0.69 | 0.86 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.47 | 0.69 | 0.69 | 0.50 | 0.32 | 0.64 | 0.78 | 0.73 | 0.69 | 0.86 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.55 | 0.84 | 0.76 | 0.63 | 0.34 | 0.73 | 0.88 | 0.83 | 0.81 | 1.04 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.45 | 0.68 | 0.70 | 0.41 | 0.33 | 0.54 | 0.70 | 0.64 | 0.59 | 0.77 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.64 | 0.71 | 0.72 | 0.52 | 0.44 | 0.64 | 0.79 | 0.74 | 0.70 | 0.87 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.29 | 0.48 | 0.47 | 0.40 | 0.29 | 0.47 | 0.55 | 0.54 | 0.54 | 0.67 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.42 | 0.71 | 0.71 | 0.52 | 0.44 | 0.64 | 0.79 | 0.74 | 0.70 | 0.87 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.21 | 0.34 | 0.37 | 0.28 | 0.20 | 0.39 | 0.43 | 0.42 | 0.38 | 0.53 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.21 | 0.34 | 0.37 | 0.28 | 0.20 | 0.39 | 0.42 | 0.42 | 0.38 | 0.53 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.42 | 0.63 | 0.66 | 0.40 | 0.33 | 0.52 | 0.66 | 0.60 | 0.56 | 0.74 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.44 | 0.67 | 0.70 | 0.42 | 0.33 | 0.55 | 0.70 | 0.64 | 0.60 | 0.78 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.49 | 0.71 | 0.71 | 0.52 | 0.44 | 0.64 | 0.79 | 0.74 | 0.70 | 0.87 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.30 | 0.49 | 0.48 | 0.41 | 0.30 | 0.48 | 0.57 | 0.56 | 0.56 | 0.69 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.30 | 0.48 | 0.47 | 0.40 | 0.30 | 0.47 | 0.56 | 0.55 | 0.55 | 0.68 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.21 | 0.34 | 0.37 | 0.27 | 0.20 | 0.38 | 0.42 | 0.42 | 0.38 | 0.52 |

### 4.3.2 Southwest Monsoon Rainfall

#### 4.3.2.1 Palakkad District

The analysis of the Moisture Availability Index (MAI) showed that in the years 1999, 2015 and 2016, Attappady Dry Hills, Attappady Hills, North Central Laterites and Palakkad Eastern Plains experienced a very high moisture deficiency and the remaining regions experienced a moderate deficiency (4.10). The years 1993, 2002, 2003, 2000 and 2012 had experienced moderate deficiency in Palakkad district, except in the regions of Northern High Hills and Northern Foot Hills. During 1992, moisture deficiency was experienced in the Palakkad district, except in the regions of Northern Foot Hills and Northern High Hills. During the years 1994, 1995, 1996, 2004, 2005, 2008-11, 2014, 2017 and 2021, experienced moderate deficiency of moisture in the regions Attappady Dry Hills, Attappady Hills, North Central Laterites, Palakkad Eastern Plains and deficiency of moisture experienced in Palakkad Central Plains and Southern High Hills. During 1997, North Central Laterites experienced moderate deficiency in the Attappady Dry Hills, Attappady Hills and Palakkad Eastern Plains. During 1998 and 2006, Attappady Dry Hills, Attappady Hills, North Central Laterites and Palakkad Eastern Plains experienced moderate deficiencies and deficiencies in the Southern High Hills.

During 2001, Attappady Dry Hills, Attappady Hills and Northern Foot Hills experienced moderate deficiencies and deficiencies in Palakkad Central Plains, Southern High Hills and Palakkad Eastern Plains. During the years 2007, 2018, 2019 and 2020 there was a deficiency of moisture in the regions of Attappady Dry Hills, Attappady Hills, North Central Laterites and Palakkad Eastern Plains. During 2013, North Central Laterites experienced moderate drought and the Southern High Hills, Palakkad Eastern Plains, Attappady Dry Hills and Attappady Hills experienced deficiency.

#### 4.3.2.2 Thrissur District

The analysis of the Moisture Availability Index (MAI) showed that 2016 had experienced moderate deficiency in Thrissur district except in the Pokkali region. During the years 1992, 1994, 1995, 1996, 1998, 2001, 2004, 2005, 2008–2011, 2013, 2014, 2017 and 2021 had experienced deficiency in the Northern High Hills and Southern High Hills. During 1993, moderate deficiency was experienced in the Northern High Hills and Southern High Hills. In 1999 and 2015, there was a moderate deficiency in the Northern High Hills and Southern High Hills, with a deficiency observed in the remaining regions. During 1997, deficiency was experienced in the Southern High Hills. During 2000 and 2002, there was a moderate deficiency observed in the Northern High Hills and Southern High Hills, as well as a deficiency noted in the Northern Laterites, Kole Lands, and Northern Coastal Plains. In 2003, Northern High Hills and Southern High Hills experienced moderate deficiency and deficiency in Northern Laterites. During 2012, Northern High Hills and Southern High Hills experienced moderate deficiency and deficiency occurred in the Northern coastal plains, Pokkali and Northern Laterites. During 2015, Northern High Hills and Southern High Hills experienced moderate deficiency and the remaining regions experienced drought (4.10).

#### 4.3.2.3 Ernakulam District

The analysis of the Moisture Availability Index (MAI) showed that 2016 had experienced deficiency in the Pokkali region and the remaining regions had experienced moderate deficiency. During 2012 and 2015, there was a deficiency observed in Ernakulam district. During 1999, South Central Laterites and Southern and Central Foot Hills experienced moderate deficiency and the remaining regions experienced deficiency. During the years 2000 and 2002, there was a deficiency observed in the regions of South Central Laterites, Southern and Central Foot Hills, as well as Southern High Hills (Table 4.10).

Table 4.10 Moisture Availability Index (MAI) Southwest monsoon rainfall from 1992-2021 (30 years period) in different AEUs of central zone of Kerala

| District | Latitude | Longitude | AEU | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 1.53 | 1.10 | 1.63 | 1.42 | 1.54 | 2.07 | 1.55 | 0.83 | 1.04 | 1.49 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 1.31 | 0.99 | 1.33 | 1.10 | 1.40 | 1.71 | 1.27 | 0.66 | 0.88 | 1.17 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 1.28 | 0.91 | 1.28 | 1.08 | 1.27 | 1.61 | 1.26 | 0.66 | 0.87 | 1.25 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 1.42 | 1.02 | 1.48 | 1.23 | 1.36 | 1.74 | 1.39 | 0.78 | 0.96 | 1.20 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 1.49 | 1.05 | 1.53 | 1.27 | 1.39 | 1.74 | 1.37 | 0.76 | 0.92 | 1.12 |
| Thrissur | 10.2 | 76.27 | Pokkali | 1.53 | 1.10 | 1.63 | 1.41 | 1.53 | 2.07 | 1.55 | 0.83 | 1.04 | 1.48 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 1.44 | 1.03 | 1.50 | 1.19 | 1.32 | 1.71 | 1.40 | 0.81 | 0.97 | 1.10 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 1.44 | 1.04 | 1.48 | 1.25 | 1.37 | 1.76 | 1.40 | 0.79 | 0.97 | 1.21 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.92 | 0.65 | 0.88 | 0.76 | 0.90 | 1.02 | 0.86 | 0.45 | 0.64 | 0.78 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.92 | 0.64 | 0.87 | 0.75 | 0.88 | 0.99 | 0.85 | 0.44 | 0.63 | 0.77 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.70 | 0.48 | 0.62 | 0.53 | 0.66 | 0.70 | 0.63 | 0.33 | 0.50 | 0.51 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.69 | 0.48 | 0.62 | 0.52 | 0.66 | 0.70 | 0.62 | 0.33 | 0.50 | 0.51 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 1.32 | 0.95 | 1.35 | 1.09 | 1.22 | 1.62 | 1.27 | 0.74 | 0.89 | 1.02 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 1.45 | 1.02 | 1.43 | 1.16 | 1.29 | 1.71 | 1.35 | 0.79 | 0.94 | 1.08 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.70 | 0.47 | 0.62 | 0.52 | 0.65 | 0.66 | 0.64 | 0.32 | 0.49 | 0.50 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.95 | 0.67 | 0.91 | 0.78 | 0.92 | 1.05 | 1.17 | 0.47 | 0.66 | 0.80 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.93 | 0.66 | 0.90 | 0.77 | 0.91 | 1.03 | 0.87 | 0.46 | 0.65 | 0.79 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.71 | 0.49 | 0.64 | 0.54 | 0.68 | 0.69 | 0.65 | 0.34 | 0.51 | 0.52 |

Table 4.10 Moisture Availability Index (MAI) Southwest monsoon rainfall from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 1.17 | 1.18 | 1.24 | 1.67 | 1.84 | 2.31 | 1.35 | 1.59 | 1.65 | 1.55 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.88 | 0.90 | 1.02 | 1.23 | 1.39 | 1.63 | 0.98 | 1.11 | 1.19 | 1.10 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.92 | 0.92 | 1.06 | 1.29 | 1.44 | 1.70 | 1.02 | 1.17 | 1.23 | 1.13 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.97 | 1.00 | 1.11 | 1.34 | 1.56 | 2.10 | 1.20 | 1.47 | 1.46 | 1.43 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.91 | 1.01 | 1.05 | 1.28 | 1.48 | 2.08 | 1.19 | 1.42 | 1.44 | 1.42 |
| Thrissur | 10.2 | 76.27 | Pokkali | 1.17 | 1.18 | 1.23 | 1.65 | 1.83 | 2.31 | 1.34 | 1.58 | 1.64 | 1.54 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.86 | 0.93 | 1.10 | 1.19 | 1.52 | 2.07 | 1.17 | 1.50 | 1.42 | 1.44 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.98 | 1.01 | 1.12 | 1.36 | 1.58 | 2.13 | 1.22 | 1.48 | 1.47 | 1.44 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.60 | 0.61 | 0.75 | 0.83 | 0.95 | 1.21 | 0.71 | 0.86 | 0.89 | 0.83 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.59 | 0.60 | 0.73 | 0.81 | 1.14 | 1.19 | 0.70 | 0.84 | 0.87 | 0.81 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.38 | 0.40 | 0.56 | 0.54 | 0.64 | 0.89 | 0.52 | 0.67 | 0.64 | 0.58 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.38 | 0.39 | 0.57 | 0.53 | 0.64 | 0.89 | 0.52 | 0.65 | 0.64 | 0.57 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.80 | 0.85 | 1.01 | 1.12 | 1.41 | 1.95 | 1.11 | 1.41 | 1.33 | 1.34 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.85 | 0.91 | 1.08 | 1.19 | 1.49 | 2.07 | 1.18 | 1.49 | 1.41 | 1.43 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.37 | 0.39 | 0.55 | 0.52 | 0.63 | 0.86 | 0.51 | 0.63 | 0.62 | 0.57 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.62 | 0.63 | 0.80 | 0.85 | 1.03 | 1.25 | 0.73 | 0.85 | 0.91 | 0.86 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.61 | 0.62 | 0.76 | 0.84 | 0.96 | 1.23 | 0.72 | 0.87 | 0.89 | 0.84 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.39 | 0.40 | 0.55 | 0.54 | 0.65 | 0.90 | 0.52 | 0.66 | 0.64 | 0.59 |

Table 4.10 Moisture Availability Index (MAI) Southwest monsoon rainfall from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 1.00 | 2.03 | 1.57 | 0.98 | 1.12 | 1.45 | 1.86 | 1.79 | 1.78 | 1.36 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.70 | 1.42 | 1.13 | 0.73 | 0.80 | 1.16 | 1.28 | 1.29 | 1.30 | 1.10 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.73 | 1.47 | 1.16 | 0.75 | 0.83 | 1.06 | 1.32 | 1.34 | 1.33 | 1.14 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.89 | 1.67 | 1.43 | 0.80 | 0.98 | 1.31 | 1.63 | 1.59 | 1.57 | 1.18 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.87 | 1.61 | 1.39 | 0.78 | 0.94 | 1.29 | 1.58 | 1.59 | 1.60 | 1.18 |
| Thrissur | 10.2 | 76.27 | Pokkali | 1.00 | 2.01 | 1.57 | 0.98 | 1.11 | 1.44 | 1.85 | 1.79 | 1.78 | 1.36 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.93 | 1.66 | 1.46 | 0.70 | 0.86 | 1.15 | 1.48 | 1.36 | 1.37 | 1.07 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 1.07 | 1.69 | 1.45 | 0.81 | 0.99 | 1.32 | 1.65 | 1.61 | 1.59 | 1.22 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.50 | 0.98 | 0.84 | 0.50 | 0.61 | 0.93 | 1.04 | 1.03 | 1.02 | 0.86 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.38 | 0.96 | 0.83 | 0.49 | 0.60 | 0.90 | 1.01 | 1.01 | 1.00 | 0.84 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.36 | 0.69 | 0.62 | 0.32 | 0.32 | 0.68 | 0.77 | 0.74 | 0.74 | 0.62 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.36 | 0.69 | 0.63 | 0.32 | 0.32 | 0.68 | 0.77 | 0.74 | 0.74 | 0.62 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.86 | 1.57 | 1.36 | 0.67 | 0.67 | 1.09 | 1.42 | 1.29 | 1.30 | 1.03 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.92 | 1.66 | 1.45 | 0.66 | 0.65 | 1.16 | 1.51 | 1.38 | 1.38 | 1.10 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.35 | 0.66 | 0.61 | 0.32 | 0.31 | 0.65 | 0.72 | 0.71 | 0.70 | 0.58 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.52 | 1.03 | 0.87 | 0.51 | 0.63 | 0.95 | 1.07 | 1.06 | 1.05 | 0.87 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.51 | 1.00 | 0.87 | 0.53 | 0.61 | 0.94 | 1.04 | 1.04 | 1.03 | 0.86 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.36 | 0.69 | 0.63 | 0.32 | 0.32 | 0.67 | 0.75 | 0.73 | 0.73 | 0.60 |

### 4.3.3 Northeast Monsoon

#### 4.3.3.1 Palakkad District

The analysis of the Moisture Availability Index (MAI) showed that 2016 had experienced very deficiency in Palakkad district. While 2012 experienced a very severe deficiency in the Attappady Dry Hills, Attappady Hills, North Central Laterites, Southern High Hills and Palakkad Eastern Plains, the remaining regions experienced a moderate deficiency (Table 4.11). During 1995, Attappady Dry Hills, Attappady Hills, Northern High Hills, North Central Laterites and Palakkad Eastern Plains experienced very deficiency and the remaining regions experienced moderate deficiency. During 1992, the Northern Foot Hills experienced deficiency and the remaining regions experienced moderate deficiency. During the years 1993, 1997, 1999 and 2005, there was a deficiency in Palakkad district. During 1994, the Northern Foot Hills, Palakkad Central Plains and Southern High Hills experienced deficiency and the remaining regions experienced moderate deficiency. During the years 1996, 1998, 2000, 2001, 2003, 2007, 2008, 2009, 2011, 2013–15, 2017 and 2017 had experienced moderate deficiency in Palakkad district. During 2002, deficiency occurred in the Northern High Hills and Northern Foot Hills and the remaining regions experienced moderate deficiency. While 2004 experienced deficiency in the Palakkad Central Plains and Southern High Hills, the remaining regions experienced moderate deficiency. During 2006, the Northern Foot Hills, Palakkad Central Plains and Southern High Hills experienced deficiency, and the remaining regions experienced moderate deficiency.

During 2010, Attappady Dry Hills, Attappady Hills, Northern High Hills, North Central Laterites and Palakkad Eastern Plains experienced deficiency. During 2019, Palakkad Eastern Plains and North Central Laterites experienced moderate deficiency and the remaining regions experienced deficiency. While in 2020, Palakkad Central Plains and Southern High Hills experienced deficiency, the remaining regions experienced moderate deficiency.

#### 4.3.3.2 Thrissur District

The analysis of the Moisture Availability Index (MAI) showed that 2016 had experienced very deficiency in Thrissur district. During 2012, the Southern Hills experienced a very severe deficiency and the remaining regions experienced a

moderate deficiency. During the years 1992, 2007 and 2015, moderate deficiency was experienced in the Northern High Hills and Southern High Hills and the remaining regions experienced deficiency (Table 4.11). During 1993, Northern High Hills and Southern High Hills experienced deficiency. 1994 experienced moderate deficiency in the Southern High Hills and deficiency in Pokkali, the Northern Laterites, Kole Lands and the Northern High Hills. During 1996, 2001 and 2014, Kole Lands, Northern High Hills, and Southern High Hills experienced moderate deficiency, and the remaining regions experienced deficiency.

During 1997, 2004, 2005 and 2006, deficiency occurred in the Northern Laterites, Kole Lands, Northern High Hills, and Southern High Hills. During 1999 and 2019, deficiency was experienced in Kole Lands, the Northern High Hills, and the Southern High Hills. During the years 1995, 2000, 2008, 2009, 2011, 2013 and 2017, Thrissur district experienced moderate deficiency. During 2003 and 2018, the northern coastal plains and Pokkali experienced deficiency and the remaining regions experienced moderate deficiency. While 2020 had experienced moderate deficiency in Kole Lands, the remaining regions had experienced deficiency.

#### 4.3.3.2 Ernakulam District

The analysis of the Moisture Availability Index (MAI) showed that 2016 had experienced very deficiency in Ernakulam district. During the years 1992, 1996, 2001, 2003, 2015 and 2018 experienced moderate deficiency in the Southern High Hills and deficiency in the remaining regions. While 1993, 1997, 1999, 2004, 2005, and 2006 experienced deficiency in Southern High Hills (Table 4.11). During the years 1995, 2000, 2008, 2009, 2011, 2012, 2013 and 2017, Ernakulam district experienced moderate deficiency. While the years 1994, 1998, 2002 and 2007 experienced deficiency in Ernakulam district. During 2014, South Central Laterites and Southern and Central Foot Hills experienced deficiency and the remaining regions experienced moderate deficiency. During 2019, Ernakulam district experienced deficiency except in the Pokkali region. In 2020, Southern High Hills had experienced deficiency.

Table 4.11 Moisture Availability Index (MAI) Northeast monsoon rainfall from 1992-2021 (30 years period) in different AEUs of central zone of Kerala

| District | Latitude | Longitude | AEU | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.74 | 1.27 | 0.93 | 0.53 | 0.79 | 1.02 | 0.96 | 1.04 | 0.48 | 0.86 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.77 | 1.36 | 0.96 | 0.58 | 0.80 | 1.06 | 0.96 | 1.06 | 0.48 | 0.80 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.75 | 1.31 | 0.90 | 0.55 | 0.77 | 1.03 | 0.96 | 1.06 | 0.48 | 0.84 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.66 | 1.00 | 0.76 | 0.41 | 0.64 | 0.86 | 0.76 | 0.86 | 0.46 | 0.63 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.91 | 1.30 | 1.09 | 0.56 | 0.88 | 1.10 | 1.00 | 1.11 | 0.61 | 0.80 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.73 | 1.27 | 0.92 | 0.53 | 0.79 | 1.02 | 0.95 | 1.04 | 0.48 | 0.85 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.94 | 1.16 | 0.91 | 0.45 | 0.78 | 1.00 | 0.92 | 1.01 | 0.63 | 0.68 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.68 | 1.01 | 0.78 | 0.42 | 0.67 | 0.88 | 0.77 | 0.87 | 0.47 | 0.64 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.59 | 0.94 | 0.69 | 0.40 | 0.59 | 0.86 | 0.67 | 0.82 | 0.39 | 0.59 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.57 | 0.91 | 0.66 | 0.39 | 0.57 | 0.83 | 0.65 | 0.79 | 0.38 | 0.57 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.55 | 0.77 | 0.58 | 0.33 | 0.51 | 0.81 | 0.58 | 0.71 | 0.36 | 0.47 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.55 | 0.76 | 0.58 | 0.33 | 0.48 | 0.81 | 0.57 | 0.70 | 0.36 | 0.46 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.66 | 0.80 | 0.64 | 0.32 | 0.57 | 0.73 | 0.65 | 0.72 | 0.44 | 0.48 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.70 | 0.85 | 0.68 | 0.35 | 0.60 | 0.77 | 0.70 | 0.77 | 0.47 | 0.52 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.51 | 0.73 | 0.54 | 0.30 | 0.46 | 0.73 | 0.53 | 0.65 | 0.35 | 0.43 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.61 | 0.98 | 0.71 | 0.42 | 0.61 | 0.89 | 0.70 | 0.85 | 0.40 | 0.61 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.60 | 0.95 | 0.71 | 0.41 | 0.59 | 0.87 | 0.68 | 0.83 | 0.40 | 0.60 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.55 | 0.78 | 0.58 | 0.32 | 0.49 | 0.78 | 0.57 | 0.70 | 0.37 | 0.46 |

Table 4.11 Moisture Availability Index (MAI) Northeast monsoon rainfall from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.90 | 0.90 | 1.13 | 1.15 | 1.13 | 0.76 | 0.59 | 0.57 | 1.31 | 0.57 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.83 | 0.87 | 1.05 | 1.20 | 1.09 | 0.75 | 0.58 | 0.57 | 1.22 | 0.63 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.83 | 0.89 | 1.03 | 1.23 | 1.12 | 0.77 | 0.60 | 0.59 | 1.25 | 0.64 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.76 | 0.62 | 0.84 | 0.92 | 0.82 | 0.70 | 0.60 | 0.53 | 1.12 | 0.53 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 1.02 | 0.82 | 1.09 | 1.21 | 1.07 | 0.92 | 0.78 | 0.69 | 1.44 | 0.70 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.87 | 0.90 | 1.13 | 1.16 | 1.13 | 0.75 | 0.59 | 0.57 | 1.30 | 0.57 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 1.00 | 0.61 | 0.87 | 1.00 | 0.90 | 0.90 | 0.88 | 0.75 | 1.35 | 0.68 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.77 | 0.63 | 0.86 | 0.94 | 0.84 | 0.71 | 0.61 | 0.54 | 1.15 | 0.54 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.60 | 0.57 | 0.75 | 0.95 | 0.75 | 0.65 | 0.52 | 0.46 | 1.00 | 0.56 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.59 | 0.56 | 0.72 | 0.92 | 0.88 | 0.63 | 0.50 | 0.45 | 0.97 | 0.54 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.51 | 0.42 | 0.57 | 0.86 | 0.58 | 0.61 | 0.51 | 0.42 | 0.85 | 0.56 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.51 | 0.41 | 0.56 | 0.86 | 0.57 | 0.61 | 0.51 | 0.42 | 0.85 | 0.57 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.70 | 0.43 | 0.62 | 0.77 | 0.64 | 0.63 | 0.62 | 0.55 | 0.97 | 0.52 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.75 | 0.46 | 0.66 | 0.82 | 0.68 | 0.67 | 0.66 | 0.59 | 1.03 | 0.55 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.49 | 0.39 | 0.52 | 0.79 | 0.53 | 0.57 | 0.48 | 0.39 | 0.78 | 0.52 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.62 | 0.59 | 0.78 | 0.98 | 0.75 | 0.68 | 0.54 | 0.49 | 1.03 | 0.58 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.61 | 0.58 | 0.76 | 0.95 | 0.75 | 0.66 | 0.52 | 0.47 | 1.01 | 0.57 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.51 | 0.41 | 0.54 | 0.83 | 0.57 | 0.60 | 0.51 | 0.44 | 0.83 | 0.56 |

Table 4.11 Moisture Availability Index (MAI) Northeast monsoon rainfall from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.48 | 0.64 | 0.69 | 0.83 | 0.32 | 0.61 | 0.75 | 1.05 | 0.69 | 1.53 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.46 | 0.61 | 0.71 | 0.82 | 0.31 | 0.61 | 0.71 | 0.96 | 0.97 | 1.44 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.46 | 0.63 | 0.72 | 0.84 | 0.34 | 0.64 | 0.73 | 0.99 | 1.01 | 1.50 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.45 | 0.53 | 0.66 | 0.65 | 0.30 | 0.48 | 0.60 | 0.89 | 0.59 | 1.26 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.60 | 0.67 | 0.87 | 0.88 | 0.27 | 0.64 | 0.80 | 1.18 | 0.78 | 1.67 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.48 | 0.64 | 0.69 | 0.83 | 0.32 | 0.61 | 0.75 | 1.05 | 0.69 | 1.52 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.57 | 0.62 | 0.83 | 0.71 | 0.33 | 0.57 | 0.67 | 1.07 | 0.72 | 1.56 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.63 | 0.54 | 0.67 | 0.68 | 0.31 | 0.49 | 0.61 | 0.93 | 0.61 | 1.29 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.38 | 0.48 | 0.58 | 0.62 | 0.28 | 0.45 | 0.54 | 0.79 | 0.81 | 1.09 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.33 | 0.47 | 0.57 | 0.60 | 0.26 | 0.44 | 0.52 | 0.77 | 0.78 | 1.06 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.32 | 0.40 | 0.50 | 0.51 | 0.23 | 0.41 | 0.41 | 0.69 | 0.61 | 1.01 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.33 | 0.39 | 0.50 | 0.51 | 0.23 | 0.41 | 0.41 | 0.69 | 0.62 | 1.07 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.41 | 0.45 | 0.59 | 0.53 | 0.23 | 0.42 | 0.47 | 0.79 | 0.52 | 1.14 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.43 | 0.48 | 0.63 | 0.56 | 0.24 | 0.45 | 0.51 | 0.84 | 0.56 | 1.21 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.33 | 0.37 | 0.46 | 0.47 | 0.22 | 0.36 | 0.38 | 0.62 | 0.56 | 1.05 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.40 | 0.50 | 0.60 | 0.64 | 0.29 | 0.47 | 0.56 | 0.82 | 0.84 | 1.13 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.33 | 0.48 | 0.58 | 0.61 | 0.28 | 0.46 | 0.55 | 0.80 | 0.82 | 1.10 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.32 | 0.39 | 0.49 | 0.50 | 0.23 | 0.39 | 0.41 | 0.66 | 0.60 | 1.09 |

### 4.3.4 Summer Season

#### 4.3.4.1 Palakkad District

The analysis of the Moisture Availability Index (MAI) showed that the years 1992–2000, 2002–2003, 2005–2007, 2009–2013, 2016, 2017, 2019 and 2020 experienced deficiency in Palakkad district. While the years 2001, 2004, 2006, 2008, 2018 and 2021 experienced deficiency in Attappady Dry Hills, Attappady Hills and North Central Laterites, the remaining regions experienced moderate deficiency (Table 4.12). In 2014, Northern Foot Hills experienced moderate deficiency, and the remaining regions experienced deficiency. During 2015, Palakkad Central Plains and Northern Foot Hills experienced moderate deficiency and the remaining regions experienced deficiency.

#### 4.3.4.2 Thrissur District

The analysis of the Moisture Availability Index (MAI) showed that the years 1992, 1993, 1996–1998, 2000, 2013 and 2019 experienced deficiency in Thrissur district. During the years 1995, 1999, 2009, 2015 and 2017, the Northern coastal plains, Pokkali and Kole Lands experienced moderate deficiency and the remaining regions experienced deficiency. During the years 2001, 2008, 2018 and 2021, there was a moderate deficiency in Thrissur district. During 2002, 2005, 2007, 2011 and 2020, the Pokkali region experienced moderate deficiency and the remaining regions experienced deficiency. In 2004, Northern Laterites, Northern High Hills and Southern High Hills experienced moderate deficiency. During 2006, Thrissur district experienced moderate deficiency except in the Pokkali region.

#### 4.3.4.3 Ernakulam District

The analysis of the Moisture Availability Index (MAI) showed that the years 1992, 1993, 1996–98, 2000, 2013, 2016 and 2019 experienced deficiency in Ernakulam district. During 1994, Southern and Central Foot Hills and Southern High Hills experienced deficiency and the remaining regions experienced moderate deficiency. During the years 1995, 1999, 2001, 2003, 2008, 2009, 2014, 2015, 2017 and 2018, Ernakulam district experienced moderate deficiency. During 2002, 2005, 2010 and 2012, experienced deficiency in the Southern High Hills and the remaining regions experienced moderate deficiency. During the years 2007, 2011 and 2020, the Pokkali region experienced moderate drought, and the remaining regions experienced moderate deficiency. In 2006 and 2021, Ernakulam district experienced moderate deficiency, except for the Pokkali region.

Table 4.12. Moisture Availability Index (MAI) during summer monsoon rainfall from 1992-2021 (30 years period) in different AEUs of central zone of Kerala

| District | Latitude | Longitude | AEU | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.25 | 0.29 | 0.34 | 0.55 | 0.15 | 0.20 | 0.23 | 0.46 | 0.19 | 0.55 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.21 | 0.26 | 0.35 | 0.47 | 0.17 | 0.20 | 0.22 | 0.44 | 0.18 | 0.49 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.21 | 0.26 | 0.33 | 0.47 | 0.16 | 0.19 | 0.20 | 0.41 | 0.17 | 0.50 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.23 | 0.23 | 0.27 | 0.37 | 0.16 | 0.14 | 0.17 | 0.36 | 0.15 | 0.46 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.23 | 0.23 | 0.28 | 0.38 | 0.16 | 0.14 | 0.18 | 0.38 | 0.15 | 0.44 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.25 | 0.29 | 0.34 | 0.54 | 0.15 | 0.20 | 0.23 | 0.46 | 0.19 | 0.55 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.23 | 0.19 | 0.23 | 0.30 | 0.16 | 0.10 | 0.15 | 0.34 | 0.12 | 0.43 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.23 | 0.23 | 0.28 | 0.38 | 0.16 | 0.14 | 0.17 | 0.37 | 0.15 | 0.47 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.15 | 0.19 | 0.24 | 0.28 | 0.16 | 0.12 | 0.13 | 0.26 | 0.12 | 0.36 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.15 | 0.19 | 0.23 | 0.27 | 0.15 | 0.11 | 0.12 | 0.25 | 0.11 | 0.35 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.13 | 0.16 | 0.19 | 0.19 | 0.16 | 0.09 | 0.10 | 0.18 | 0.08 | 0.30 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.13 | 0.16 | 0.19 | 0.19 | 0.16 | 0.08 | 0.09 | 0.18 | 0.08 | 0.30 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.22 | 0.18 | 0.22 | 0.28 | 0.15 | 0.10 | 0.14 | 0.31 | 0.12 | 0.39 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.23 | 0.19 | 0.23 | 0.29 | 0.16 | 0.10 | 0.15 | 0.33 | 0.12 | 0.42 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.12 | 0.15 | 0.18 | 0.18 | 0.15 | 0.08 | 0.09 | 0.17 | 0.08 | 0.29 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.16 | 0.20 | 0.25 | 0.29 | 0.16 | 0.12 | 0.13 | 0.26 | 0.12 | 0.37 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.16 | 0.20 | 0.25 | 0.29 | 0.16 | 0.12 | 0.13 | 0.26 | 0.12 | 0.37 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.16 | 0.20 | 0.25 | 0.29 | 0.16 | 0.12 | 0.13 | 0.26 | 0.12 | 0.37 |

Table 4.12. Moisture Availability Index (MAI) during summer monsoon rainfall from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.42 | 0.48 | 1.03 | 0.49 | 0.77 | 0.35 | 0.63 | 0.56 | 0.42 | 0.38 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.35 | 0.43 | 0.87 | 0.46 | 0.63 | 0.28 | 0.56 | 0.45 | 0.34 | 0.32 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.36 | 0.44 | 0.89 | 0.47 | 0.63 | 0.29 | 0.55 | 0.45 | 0.34 | 0.33 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.32 | 0.34 | 0.78 | 0.33 | 0.61 | 0.31 | 0.53 | 0.41 | 0.34 | 0.33 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.31 | 0.33 | 0.76 | 0.31 | 0.59 | 0.31 | 0.52 | 0.40 | 0.33 | 0.32 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.42 | 0.47 | 1.02 | 0.49 | 0.77 | 0.35 | 0.62 | 0.55 | 0.42 | 0.38 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.27 | 0.25 | 0.68 | 0.23 | 0.55 | 0.31 | 0.47 | 0.29 | 0.29 | 0.27 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.32 | 0.34 | 0.78 | 0.33 | 0.61 | 0.32 | 0.53 | 0.41 | 0.34 | 0.33 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.22 | 0.29 | 0.56 | 0.30 | 0.42 | 0.21 | 0.40 | 0.30 | 0.24 | 0.27 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.21 | 0.28 | 0.54 | 0.29 | 0.39 | 0.18 | 0.39 | 0.29 | 0.23 | 0.26 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.14 | 0.20 | 0.40 | 0.22 | 0.30 | 0.17 | 0.31 | 0.19 | 0.17 | 0.22 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.14 | 0.20 | 0.39 | 0.22 | 0.30 | 0.17 | 0.31 | 0.19 | 0.17 | 0.21 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.24 | 0.23 | 0.63 | 0.21 | 0.51 | 0.29 | 0.44 | 0.27 | 0.26 | 0.25 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.26 | 0.24 | 0.66 | 0.22 | 0.52 | 0.30 | 0.45 | 0.28 | 0.28 | 0.27 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.14 | 0.19 | 0.37 | 0.21 | 0.30 | 0.16 | 0.30 | 0.19 | 0.17 | 0.21 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.23 | 0.30 | 0.58 | 0.31 | 0.40 | 0.21 | 0.41 | 0.32 | 0.24 | 0.27 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.22 | 0.29 | 0.57 | 0.31 | 0.43 | 0.21 | 0.40 | 0.30 | 0.24 | 0.27 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.22 | 0.29 | 0.57 | 0.31 | 0.43 | 0.21 | 0.40 | 0.30 | 0.24 | 0.27 |

Table 4.12. Moisture Availability Index (MAI) during summer monsoon rainfall from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.45 | 0.28 | 0.40 | 0.45 | 0.33 | 0.46 | 0.47 | 0.18 | 0.39 | 0.79 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.53 | 0.24 | 0.35 | 0.41 | 0.29 | 0.41 | 0.44 | 0.19 | 0.29 | 0.64 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.53 | 0.25 | 0.35 | 0.42 | 0.30 | 0.43 | 0.44 | 0.19 | 0.29 | 0.64 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.33 | 0.21 | 0.34 | 0.39 | 0.23 | 0.36 | 0.43 | 0.16 | 0.26 | 0.55 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.32 | 0.21 | 0.33 | 0.38 | 0.23 | 0.36 | 0.43 | 0.16 | 0.26 | 0.57 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.45 | 0.28 | 0.39 | 0.45 | 0.33 | 0.45 | 0.47 | 0.18 | 0.38 | 0.79 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.22 | 0.18 | 0.35 | 0.33 | 0.17 | 0.32 | 0.39 | 0.17 | 0.19 | 0.44 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.47 | 0.21 | 0.35 | 0.39 | 0.23 | 0.36 | 0.43 | 0.16 | 0.26 | 0.56 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.25 | 0.17 | 0.27 | 0.34 | 0.20 | 0.31 | 0.37 | 0.16 | 0.18 | 0.39 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.21 | 0.16 | 0.25 | 0.33 | 0.19 | 0.30 | 0.35 | 0.15 | 0.17 | 0.38 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.15 | 0.13 | 0.24 | 0.31 | 0.13 | 0.26 | 0.31 | 0.15 | 0.12 | 0.30 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.15 | 0.13 | 0.24 | 0.30 | 0.13 | 0.26 | 0.31 | 0.15 | 0.12 | 0.30 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.20 | 0.17 | 0.32 | 0.33 | 0.16 | 0.30 | 0.37 | 0.16 | 0.18 | 0.42 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.21 | 0.18 | 0.34 | 0.35 | 0.16 | 0.32 | 0.39 | 0.17 | 0.19 | 0.44 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.14 | 0.12 | 0.22 | 0.29 | 0.13 | 0.24 | 0.28 | 0.14 | 0.11 | 0.28 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.26 | 0.17 | 0.27 | 0.35 | 0.20 | 0.32 | 0.38 | 0.17 | 0.19 | 0.40 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.25 | 0.17 | 0.27 | 0.33 | 0.20 | 0.31 | 0.38 | 0.16 | 0.18 | 0.40 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.25 | 0.17 | 0.27 | 0.33 | 0.20 | 0.31 | 0.38 | 0.16 | 0.18 | 0.40 |

### 4.3.5 Winter Season

#### 4.3.5.1 Palakkad District

The analysis of the Moisture Availability Index (MAI) indicates that over the past 30 years, Palakkad district has consistently experienced severe moisture deficiency, with MAI values ranging between 0.00 and 0.33 (Table 4.13).

#### 4.3.5.2 Thrissur District

The analysis of the Moisture Availability Index (MAI) indicates that over the past 30 years, Thrissur district has consistently experienced severe moisture deficiency except the years 1994 and 2000. While in 1994 and 2000 had experienced moderate deficiency in Pokkali region and the remaining regions had experienced very deficient (Table 4.13).

#### 4.3.5.3 Ernakulam District

The analysis of the Moisture Availability Index (MAI) indicates that over the past 30 years, Ernakulam district has consistently experienced severe moisture deficiency except the years 1994 and 2000. While in 1994 and 2000, deficiency was experienced in the Southern High Hills, the remaining regions had a moderate deficiency (Table 4.13).

Table 4.13. Moisture Availability Index (MAI) during winter season from 1992-2021 (30 years period) in different AEUs of central zone of Kerala

| District | Latitude | Longitude | AEU | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.01 | 0.11 | 0.35 | 0.08 | 0.03 | 0.00 | 0.01 | 0.01 | 0.39 | 0.16 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.01 | 0.10 | 0.36 | 0.08 | 0.04 | 0.01 | 0.01 | 0.02 | 0.40 | 0.15 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.01 | 0.10 | 0.36 | 0.08 | 0.04 | 0.01 | 0.01 | 0.02 | 0.40 | 0.15 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.01 | 0.22 | 0.72 | 0.21 | 0.07 | 0.01 | 0.03 | 0.02 | 0.90 | 0.36 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.00 | 0.06 | 0.20 | 0.06 | 0.02 | 0.00 | 0.01 | 0.01 | 0.23 | 0.09 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.01 | 0.10 | 0.35 | 0.08 | 0.03 | 0.00 | 0.01 | 0.01 | 0.39 | 0.16 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.00 | 0.03 | 0.09 | 0.04 | 0.02 | 0.00 | 0.01 | 0.01 | 0.13 | 0.06 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.00 | 0.06 | 0.20 | 0.06 | 0.02 | 0.00 | 0.01 | 0.01 | 0.24 | 0.10 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.00 | 0.06 | 0.19 | 0.06 | 0.02 | 0.01 | 0.01 | 0.01 | 0.26 | 0.08 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.00 | 0.06 | 0.18 | 0.06 | 0.02 | 0.01 | 0.01 | 0.01 | 0.24 | 0.07 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.00 | 0.04 | 0.09 | 0.06 | 0.02 | 0.01 | 0.00 | 0.01 | 0.18 | 0.04 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.00 | 0.04 | 0.09 | 0.06 | 0.02 | 0.01 | 0.00 | 0.01 | 0.18 | 0.04 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.00 | 0.03 | 0.08 | 0.04 | 0.02 | 0.00 | 0.00 | 0.01 | 0.01 | 0.05 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.00 | 0.04 | 0.11 | 0.05 | 0.02 | 0.00 | 0.01 | 0.01 | 0.02 | 0.08 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.00 | 0.03 | 0.08 | 0.05 | 0.02 | 0.01 | 0.00 | 0.01 | 0.16 | 0.03 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.00 | 0.06 | 0.19 | 0.07 | 0.02 | 0.01 | 0.01 | 0.01 | 0.26 | 0.08 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.00 | 0.06 | 0.20 | 0.07 | 0.02 | 0.01 | 0.01 | 0.01 | 0.26 | 0.08 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.00 | 0.04 | 0.09 | 0.06 | 0.02 | 0.01 | 0.00 | 0.01 | 0.18 | 0.04 |

Table 4.13. Moisture Availability Index (MAI) during winter season from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.06 | 0.20 | 0.06 | 0.17 | 0.02 | 0.01 | 0.05 | 0.02 | 0.04 | 0.26 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.07 | 0.18 | 0.05 | 0.15 | 0.03 | 0.01 | 0.05 | 0.02 | 0.04 | 0.24 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.07 | 0.19 | 0.06 | 0.15 | 0.03 | 0.01 | 0.05 | 0.02 | 0.04 | 0.24 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.11 | 0.50 | 0.14 | 0.38 | 0.07 | 0.04 | 0.15 | 0.05 | 0.09 | 0.67 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.03 | 0.13 | 0.04 | 0.10 | 0.02 | 0.01 | 0.04 | 0.01 | 0.02 | 0.17 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.06 | 0.20 | 0.06 | 0.17 | 0.02 | 0.01 | 0.05 | 0.02 | 0.04 | 0.26 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.01 | 0.09 | 0.02 | 0.06 | 0.02 | 0.01 | 0.03 | 0.01 | 0.01 | 0.10 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.03 | 0.13 | 0.04 | 0.10 | 0.02 | 0.01 | 0.04 | 0.01 | 0.03 | 0.18 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.05 | 0.10 | 0.03 | 0.09 | 0.03 | 0.02 | 0.05 | 0.01 | 0.02 | 0.16 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.05 | 0.09 | 0.03 | 0.08 | 0.03 | 0.02 | 0.05 | 0.01 | 0.02 | 0.16 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.03 | 0.06 | 0.02 | 0.05 | 0.03 | 0.02 | 0.04 | 0.01 | 0.01 | 0.09 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.03 | 0.06 | 0.02 | 0.05 | 0.03 | 0.02 | 0.04 | 0.01 | 0.01 | 0.09 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.01 | 0.09 | 0.02 | 0.05 | 0.02 | 0.01 | 0.03 | 0.01 | 0.01 | 0.09 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.02 | 0.13 | 0.02 | 0.08 | 0.02 | 0.01 | 0.04 | 0.01 | 0.02 | 0.13 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.03 | 0.05 | 0.01 | 0.04 | 0.03 | 0.02 | 0.04 | 0.01 | 0.01 | 0.09 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.05 | 0.10 | 0.03 | 0.09 | 0.03 | 0.02 | 0.05 | 0.01 | 0.02 | 0.17 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.05 | 0.10 | 0.03 | 0.09 | 0.03 | 0.02 | 0.05 | 0.01 | 0.02 | 0.16 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.03 | 0.06 | 0.02 | 0.05 | 0.03 | 0.02 | 0.04 | 0.01 | 0.01 | 0.10 |

Table 4.13. Moisture Availability Index (MAI) during winter season from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.04 | 0.15 | 0.04 | 0.01 | 0.12 | 0.04 | 0.03 | 0.02 | 0.06 | 0.27 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.03 | 0.15 | 0.04 | 0.01 | 0.07 | 0.07 | 0.03 | 0.03 | 0.03 | 0.33 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.04 | 0.15 | 0.05 | 0.01 | 0.07 | 0.10 | 0.03 | 0.03 | 0.03 | 0.34 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.10 | 0.44 | 0.07 | 0.02 | 0.25 | 0.14 | 0.10 | 0.07 | 0.17 | 0.97 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.03 | 0.12 | 0.02 | 0.01 | 0.06 | 0.04 | 0.03 | 0.02 | 0.04 | 0.26 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.04 | 0.15 | 0.04 | 0.01 | 0.12 | 0.05 | 0.03 | 0.02 | 0.06 | 0.27 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.01 | 0.09 | 0.01 | 0.00 | 0.03 | 0.04 | 0.03 | 0.02 | 0.03 | 0.28 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.04 | 0.12 | 0.02 | 0.01 | 0.07 | 0.04 | 0.03 | 0.02 | 0.04 | 0.26 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.02 | 0.12 | 0.02 | 0.01 | 0.03 | 0.06 | 0.04 | 0.02 | 0.02 | 0.30 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.02 | 0.06 | 0.02 | 0.01 | 0.03 | 0.06 | 0.04 | 0.02 | 0.02 | 0.28 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.01 | 0.09 | 0.01 | 0.00 | 0.02 | 0.05 | 0.04 | 0.02 | 0.02 | 0.31 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.01 | 0.09 | 0.01 | 0.00 | 0.02 | 0.05 | 0.04 | 0.02 | 0.02 | 0.31 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.01 | 0.09 | 0.01 | 0.00 | 0.03 | 0.04 | 0.02 | 0.02 | 0.02 | 0.27 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.02 | 0.12 | 0.01 | 0.00 | 0.04 | 0.05 | 0.03 | 0.03 | 0.04 | 0.38 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.01 | 0.08 | 0.01 | 0.00 | 0.02 | 0.05 | 0.04 | 0.02 | 0.02 | 0.28 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.02 | 0.12 | 0.02 | 0.01 | 0.04 | 0.06 | 0.04 | 0.03 | 0.02 | 0.31 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.02 | 0.12 | 0.02 | 0.01 | 0.03 | 0.06 | 0.04 | 0.02 | 0.02 | 0.30 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.01 | 0.09 | 0.01 | 0.00 | 0.02 | 0.05 | 0.04 | 0.02 | 0.02 | 0.30 |

## 4.4 Aridity Index

### 4.4.1 Annual Rainfall

#### 4.4.1.1 Palakkad district

The analysis of the Aridity Index (AI) of Palakkad district showed that the year 2016 has experienced semi-arid conditions in Palakkad district except for the AEU North Central Laterites (Table 4.14). While the years 1992, 1998, 2008, 2009, 2011, 2013 and 2014 experienced semi-arid conditions in the Attappady Dry Hills, Attappady Hills and Palakkad Eastern Plains and sub-humid conditions in the Palakkad Central Plains and Southern High Hills, the remaining years experienced humid conditions. During the years 1993, 1996, and 2001, semi-arid conditions were experienced in the Attappady Dry Hills, Attappady Hills and Palakkad Eastern Plains; humid conditions were experienced in the Northern Foot Hills and North Central Laterites; and the remaining regions experienced sub-humid conditions. During the years 1994 and 1997, experienced humid conditions in the Northern High Hills, Northern Foot Hills and North Central Laterites and the remaining regions experienced sub-humid conditions.

During the years 1995, 2002 and 2003, experienced humid conditions in the North Central Laterites, semi-arid conditions in the Attappady Dry Hills, Attappady Hills and Palakkad Eastern Plains and the remaining regions experienced sub-humid conditions. During 1999, experienced semi-arid conditions in the Attappady Dry Hills, Attappady Hills and Palakkad Eastern Plains and the remaining regions experienced sub-humid conditions. While 2000 and 2012 had experienced sub-humid conditions in the Northern High Hills, Northern Foot Hills and North Central Laterites, the remaining regions experienced semi-arid conditions. During the years 2004, 2005, 2006, 2007, 2010, 2018 and 2021, experienced sub-humid conditions in the Attappady Dry Hills, Attappady Hills and Palakkad Eastern Plains, and the remaining regions experienced humid conditions.

#### 4.4.1.2 Thrissur District

The analysis of the Aridity Index (AI) of Thrissur district showed that the years 2000 and 2016 had experienced semi-arid conditions in the Northern High Hills and the remaining regions had experienced sub-arid conditions (Table 4.14). During the years 1992-94, 1996-98, 2001, 2008, 2009, 2011 and 2018-20, the Northern High Hills experienced sub-humid conditions and the remaining regions experienced humid conditions. While in 1995 and 2003, the Northern Laterites and Northern High Hills experienced sub-humid conditions, the remaining regions experienced humid conditions. While in 2002, the Northern Laterites, Northern coastal plains and Northern High Hills experienced sub-humid conditions, the remaining regions experienced humid conditions. During the years 2004-07, 2010 and 2021 had experienced humid conditions in Thrissur district. During 2012, Kole Lands experienced humid conditions, the Northern High Hills experienced semi-arid conditions and the remaining regions experienced sub-humid conditions.

#### 4.4.1.3 Ernakulam District

The analysis of the Aridity index (AI) of Ernakulam district showed that the years 2000 and 2016 had experienced semi-arid conditions in Ernakulam district (Table 4.14). Ernakulam district experienced humid conditions during the years 1992–1998, 2001, 2003–2011, 2013, 2014 and 2017–2021. During the year 1999 experienced sub-humid conditions in the Southern and Central Foot Hills, Southern High Hills and the remaining regions. During 2012 and 2015, the Pokkali region experienced humid conditions and the remaining regions experienced sub-humid conditions. During 2002, the Southern High Hills experienced sub-humid conditions, and the remaining regions experienced sub-humid conditions.

The analysis of the Aridity Index (AI) showed that Palakkad district showed more dryness compared to other districts.

Table 4.14. Annual Aridity Index from 1992- 2021 (30 years period) in different AEUs of central zone of Kerala

| District | Latitude | Longitude | AEU | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.93 | 0.95 | 1.15 | 0.96 | 0.92 | 1.26 | 0.99 | 0.82 | 0.71 | 1.12 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.83 | 0.89 | 1.04 | 0.80 | 0.85 | 1.08 | 0.88 | 0.75 | 0.62 | 0.94 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.82 | 0.86 | 0.99 | 0.78 | 0.80 | 1.04 | 0.85 | 0.74 | 0.62 | 0.97 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.86 | 0.79 | 0.97 | 0.79 | 0.83 | 1.06 | 0.84 | 0.73 | 0.61 | 0.88 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.88 | 0.80 | 1.01 | 0.81 | 0.83 | 1.05 | 0.83 | 0.73 | 0.60 | 0.84 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.92 | 0.95 | 1.13 | 0.97 | 0.91 | 1.26 | 0.98 | 0.82 | 0.70 | 1.11 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.88 | 0.76 | 0.92 | 0.74 | 0.77 | 1.00 | 0.81 | 0.67 | 0.61 | 0.77 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.87 | 0.80 | 0.98 | 0.80 | 0.84 | 1.08 | 0.84 | 0.74 | 0.62 | 0.89 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.61 | 0.62 | 0.70 | 0.54 | 0.60 | 0.72 | 0.57 | 0.51 | 0.47 | 0.63 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.87 | 0.80 | 0.98 | 0.80 | 0.84 | 1.08 | 0.84 | 0.74 | 0.62 | 0.89 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.49 | 0.47 | 0.51 | 0.39 | 0.48 | 0.55 | 0.45 | 0.39 | 0.35 | 0.44 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.49 | 0.47 | 0.50 | 0.39 | 0.47 | 0.55 | 0.45 | 0.39 | 0.35 | 0.43 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.82 | 0.71 | 0.83 | 0.69 | 0.73 | 0.95 | 0.76 | 0.62 | 0.56 | 0.72 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.87 | 0.75 | 0.90 | 0.73 | 0.77 | 1.01 | 0.81 | 0.66 | 0.60 | 0.76 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.87 | 0.80 | 0.98 | 0.80 | 0.84 | 1.08 | 0.84 | 0.74 | 0.62 | 0.89 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.62 | 0.64 | 0.73 | 0.56 | 0.61 | 0.74 | 0.59 | 0.52 | 0.48 | 0.65 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.61 | 0.63 | 0.73 | 0.55 | 0.60 | 0.72 | 0.58 | 0.51 | 0.47 | 0.64 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.49 | 0.47 | 0.51 | 0.39 | 0.48 | 0.55 | 0.45 | 0.39 | 0.36 | 0.44 |

Table 4.14. Annual Aridity Index from 1992- 2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.93 | 0.99 | 1.25 | 1.24 | 1.42 | 1.30 | 0.99 | 1.04 | 1.22 | 1.01 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.76 | 0.83 | 1.08 | 1.09 | 1.16 | 1.01 | 0.83 | 0.82 | 0.98 | 0.80 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.78 | 0.84 | 1.11 | 1.12 | 1.19 | 1.04 | 0.84 | 0.85 | 1.00 | 0.82 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.74 | 0.75 | 1.02 | 0.98 | 1.15 | 1.20 | 0.88 | 0.93 | 1.06 | 0.91 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.72 | 0.75 | 0.98 | 0.95 | 1.11 | 1.19 | 0.87 | 0.91 | 1.04 | 0.90 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.93 | 0.98 | 1.25 | 1.24 | 1.42 | 1.30 | 0.98 | 1.04 | 1.21 | 1.01 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.69 | 0.62 | 0.92 | 0.81 | 1.07 | 1.19 | 0.88 | 0.88 | 0.99 | 0.86 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.75 | 0.76 | 1.03 | 0.99 | 1.17 | 1.22 | 0.89 | 0.94 | 1.07 | 0.92 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.51 | 0.56 | 0.75 | 0.75 | 0.77 | 0.77 | 0.61 | 0.61 | 0.75 | 0.64 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.75 | 0.76 | 1.03 | 0.99 | 1.39 | 1.21 | 0.89 | 0.94 | 1.07 | 0.92 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.34 | 0.36 | 0.54 | 0.55 | 0.55 | 0.61 | 0.48 | 0.45 | 0.55 | 0.48 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.34 | 0.36 | 0.54 | 0.55 | 0.55 | 0.61 | 0.48 | 0.45 | 0.55 | 0.49 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.64 | 0.58 | 0.86 | 0.76 | 0.99 | 1.11 | 0.82 | 0.83 | 0.92 | 0.80 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.68 | 0.62 | 0.92 | 0.81 | 1.06 | 1.18 | 0.88 | 0.88 | 0.98 | 0.85 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.75 | 0.76 | 1.03 | 0.99 | 1.17 | 1.22 | 0.89 | 0.94 | 1.07 | 0.92 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.53 | 0.58 | 0.77 | 0.77 | 0.79 | 0.79 | 0.63 | 0.63 | 0.77 | 0.66 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.52 | 0.57 | 0.76 | 0.76 | 0.77 | 0.78 | 0.62 | 0.61 | 0.76 | 0.65 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.34 | 0.36 | 0.53 | 0.55 | 0.56 | 0.61 | 0.48 | 0.47 | 0.55 | 0.49 |

Table 4.14. Annual Aridity Index from 1992- 2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.73 | 1.13 | 1.02 | 0.84 | 0.72 | 0.98 | 1.18 | 1.11 | 1.09 | 1.40 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.57 | 0.89 | 0.81 | 0.71 | 0.56 | 0.82 | 0.90 | 0.89 | 0.91 | 1.22 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.58 | 0.92 | 0.83 | 0.73 | 0.57 | 0.85 | 0.92 | 0.91 | 0.94 | 1.25 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.64 | 0.94 | 0.94 | 0.68 | 0.58 | 0.84 | 1.05 | 0.98 | 0.92 | 1.15 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.63 | 0.92 | 0.92 | 0.67 | 0.56 | 0.85 | 1.04 | 0.97 | 0.92 | 1.15 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.73 | 1.12 | 1.02 | 0.84 | 0.72 | 0.98 | 1.18 | 1.10 | 1.08 | 1.39 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.60 | 0.90 | 0.94 | 0.55 | 0.50 | 0.72 | 0.93 | 0.85 | 0.79 | 1.03 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.86 | 0.95 | 0.96 | 0.69 | 0.58 | 0.85 | 1.06 | 0.99 | 0.93 | 1.16 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.39 | 0.64 | 0.62 | 0.53 | 0.39 | 0.62 | 0.74 | 0.72 | 0.72 | 0.90 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.56 | 0.95 | 0.95 | 0.69 | 0.58 | 0.85 | 1.06 | 0.99 | 0.93 | 1.16 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.28 | 0.45 | 0.49 | 0.37 | 0.27 | 0.52 | 0.57 | 0.56 | 0.50 | 0.71 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.28 | 0.45 | 0.49 | 0.37 | 0.27 | 0.52 | 0.57 | 0.56 | 0.50 | 0.71 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.56 | 0.84 | 0.88 | 0.53 | 0.46 | 0.69 | 0.89 | 0.80 | 0.75 | 0.98 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.59 | 0.89 | 0.93 | 0.56 | 0.48 | 0.73 | 0.94 | 0.85 | 0.80 | 1.05 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.65 | 0.95 | 0.95 | 0.69 | 0.58 | 0.85 | 1.06 | 0.99 | 0.93 | 1.16 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.40 | 0.66 | 0.64 | 0.54 | 0.40 | 0.64 | 0.76 | 0.74 | 0.75 | 0.93 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.40 | 0.65 | 0.63 | 0.53 | 0.40 | 0.63 | 0.75 | 0.73 | 0.73 | 0.91 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.28 | 0.45 | 0.49 | 0.37 | 0.27 | 0.51 | 0.56 | 0.56 | 0.50 | 0.70 |

### 4.4.2 Southwest Monsoon

#### 4.4.2.1 Palakkad District

The analysis of the Aridity Index (AI) of Palakkad district during the southwest monsoon season reveals that during the years 1999, 2012 and 2015, the Attappady Dry Hills, Attappady Hills, North Central Laterites, Palakkad Eastern Plains, Palakkad Central Plains and Southern High Hills experienced semi-arid conditions and the remaining regions experienced a humid condition (Table 4.15). During the years 1992, 1994, 1996, 1997, 2006, 2007, 2009, 2010, 2011, 2013, 2014, and 2017–2021, Palakkad district experienced humid conditions. While during 1993, 1995, 2000, 2001, 2002, 2003, 2005, 2008 and 2016 the Attappady Dry Hills, Attappady Hills, North Central Laterites, and Palakkad Eastern Plains experienced sub-humid conditions, the remaining regions experienced humid conditions.

#### 4.4.2.2 Thrissur District

The analysis of the Aridity Index (AI) for Thrissur district during the southwest monsoon season showed that the years 1999, 2012 and 2015 experienced semi-arid conditions in the Northern High Hills, the Southern High Hills experienced sub-humid conditions and the remaining regions experienced humid conditions. The remaining 30-year period (1992–2021) experienced a humid condition in Thrissur district (Table 4.15).

#### 4.4.2.3 Ernakulam District

The analysis of the Aridity Index (AI) for Ernakulam during southwest monsoon season showed that the last 30-year period (1992-2021) experienced a humid condition in Ernakulam District (Table 4.15).

Based on the analysis of southwest monsoon rainfall data, the Aridity Index (AI) reveals that Palakkad District exhibits greater dryness compared to other districts in the case of the southwest monsoon. When analyzing 30 years of data, it was evident that the years 1999, 2012, and 2015 experienced particularly high levels of dryness.

Table 4.15. Aridity Index during southwest monsoon from 1992-2021 (30 years period) in different AEUs of central zone of Kerala

| District | Latitude | Longitude | AEU | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 2.05 | 1.46 | 2.18 | 1.89 | 2.06 | 2.76 | 2.07 | 1.10 | 1.39 | 1.98 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 1.74 | 1.32 | 1.77 | 1.47 | 1.87 | 2.28 | 1.70 | 0.88 | 1.17 | 1.56 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 1.70 | 1.21 | 1.71 | 1.43 | 1.69 | 2.14 | 1.68 | 0.88 | 1.16 | 1.67 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 1.90 | 1.37 | 1.97 | 1.64 | 1.82 | 2.32 | 1.85 | 1.04 | 1.28 | 1.61 |
| Thirssur | 10.68 | 75.98 | Northern coastal plains | 1.98 | 1.39 | 2.04 | 1.70 | 1.86 | 2.32 | 1.82 | 1.01 | 1.23 | 1.50 |
| Thrissur | 10.2 | 76.27 | Pokkali | 2.04 | 1.47 | 2.17 | 1.88 | 2.04 | 2.76 | 2.06 | 1.10 | 1.39 | 1.97 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 1.92 | 1.37 | 2.00 | 1.59 | 1.76 | 2.28 | 1.86 | 1.08 | 1.29 | 1.47 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 1.92 | 1.38 | 1.97 | 1.67 | 1.83 | 2.35 | 1.87 | 1.05 | 1.30 | 1.61 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 1.23 | 0.87 | 1.17 | 1.01 | 1.20 | 1.36 | 1.14 | 0.60 | 0.86 | 1.04 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 1.22 | 0.85 | 1.16 | 0.99 | 1.17 | 1.33 | 1.13 | 0.59 | 0.84 | 1.02 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.93 | 0.65 | 0.82 | 0.70 | 0.89 | 0.93 | 0.84 | 0.44 | 0.67 | 0.68 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.92 | 0.65 | 0.82 | 0.70 | 0.88 | 0.93 | 0.83 | 0.44 | 0.66 | 0.68 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 1.76 | 1.27 | 1.8. | 1.46 | 1.62 | 2.15 | 1.70 | 0.99 | 1.18 | 1.36 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 1.93 | 1.35 | 1.91 | 1.55 | 1.72 | 2.29 | 1.80 | 1.05 | 1.26 | 1.45 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.93 | 0.63 | 0.83 | 0.70 | 0.87 | 0.88 | 0.85 | 0.43 | 0.66 | 0.67 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 1.27 | 0.89 | 1.21 | 1.04 | 1.23 | 1.40 | 1.56 | 0.62 | 0.88 | 1.07 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 1.24 | 0.88 | 1.21 | 1.02 | 1.21 | 1.37 | 1.16 | 0.61 | 0.87 | 1.05 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.95 | 0.65 | 0.86 | 0.72 | 0.90 | 0.92 | 0.86 | 0.45 | 0.68 | 0.69 |

Table 4.15. Aridity Index during southwest monsoon from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 1.57 | 1.58 | 1.65 | 2.22 | 2.45 | 3.08 | 1.79 | 2.12 | 2.20 | 2.06 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 1.17 | 1.20 | 1.36 | 1.65 | 1.86 | 2.17 | 1.31 | 1.49 | 1.58 | 1.46 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 1.23 | 1.22 | 1.41 | 1.72 | 1.92 | 2.27 | 1.36 | 1.56 | 1.64 | 1.51 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 1.29 | 1.34 | 1.48 | 1.79 | 2.08 | 2.80 | 1.61 | 1.96 | 1.94 | 1.90 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 1.22 | 1.34 | 1.40 | 1.71 | 1.97 | 2.78 | 1.58 | 1.89 | 1.91 | 1.90 |
| Thrissur | 10.2 | 76.27 | Pokkali | 1.57 | 1.57 | 1.64 | 2.19 | 2.45 | 3.08 | 1.79 | 2.11 | 2.19 | 2.06 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 1.14 | 1.30 | 1.45 | 1.59 | 2.03 | 2.75 | 1.56 | 2.00 | 1.89 | 1.92 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 1.31 | 1.35 | 1.50 | 1.81 | 2.11 | 2.83 | 1.63 | 1.98 | 1.96 | 1.92 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.81 | 0.82 | 1.00 | 1.10 | 1.26 | 1.62 | 0.95 | 1.15 | 1.18 | 1.11 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.79 | 0.80 | 0.98 | 1.08 | 1.52 | 1.59 | 0.94 | 1.12 | 1.16 | 1.08 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.51 | 0.53 | 0.75 | 0.72 | 0.85 | 1.18 | 0.70 | 0.90 | 0.85 | 0.78 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.51 | 0.53 | 0.76 | 0.71 | 0.85 | 1.18 | 0.70 | 0.86 | 0.85 | 0.77 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 1.07 | 1.14 | 1.35 | 1.49 | 1.87 | 2.60 | 1.48 | 1.87 | 1.78 | 1.79 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 1.13 | 1.21 | 1.44 | 1.58 | 1.99 | 2.76 | 1.57 | 1.99 | 1.89 | 1.90 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.50 | 0.52 | 0.74 | 0.69 | 0.83 | 1.15 | 0.68 | 0.83 | 0.82 | 0.75 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.83 | 0.84 | 1.06 | 1.14 | 1.38 | 1.66 | 0.98 | 1.14 | 1.21 | 1.14 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.81 | 0.83 | 1.01 | 1.12 | 1.28 | 1.63 | 0.96 | 1.16 | 1.19 | 1.12 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.51 | 0.54 | 0.74 | 0.72 | 0.87 | 1.20 | 0.69 | 0.88 | 0.86 | 0.78 |

Table 4.15. Aridity Index during southwest monsoon from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 1.33 | 2.71 | 2.10 | 1.31 | 1.49 | 1.93 | 2.48 | 2.39 | 2.38 | 1.82 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.93 | 1.90 | 1.51 | 0.98 | 1.06 | 1.54 | 1.71 | 1.73 | 1.73 | 1.46 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.97 | 1.96 | 1.54 | 1.00 | 1.11 | 1.41 | 1.76 | 1.79 | 1.78 | 1.52 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 1.19 | 2.23 | 1.90 | 1.07 | 1.31 | 1.74 | 2.17 | 2.13 | 2.10 | 1.57 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 1.16 | 2.15 | 1.85 | 1.05 | 1.25 | 1.73 | 2.11 | 2.12 | 2.13 | 1.58 |
| Thrissur | 10.2 | 76.27 | Pokkali | 1.33 | 2.68 | 2.10 | 1.31 | 1.48 | 1.92 | 2.47 | 2.38 | 2.37 | 1.82 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 1.24 | 2.22 | 1.95 | 0.93 | 1.14 | 1.53 | 1.97 | 1.81 | 1.83 | 1.43 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 1.42 | 2.26 | 1.94 | 1.08 | 1.33 | 1.76 | 2.20 | 2.15 | 2.12 | 1.63 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.67 | 1.30 | 1.13 | 0.67 | 0.81 | 1.24 | 1.39 | 1.38 | 1.36 | 1.14 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.51 | 1.28 | 1.11 | 0.66 | 0.80 | 1.20 | 1.35 | 1.35 | 1.34 | 1.12 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.48 | 0.91 | 0.83 | 0.42 | 0.53 | 0.90 | 1.03 | 0.98 | 0.98 | 0.82 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.48 | 0.91 | 0.83 | 0.43 | 0.53 | 0.91 | 1.03 | 0.98 | 0.98 | 0.82 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 1.15 | 2.09 | 1.82 | 1.09 | 1.07 | 1.46 | 1.89 | 1.72 | 1.73 | 1.37 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 1.22 | 2.21 | 1.93 | 0.90 | 1.13 | 1.55 | 2.01 | 1.84 | 1.84 | 1.46 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.47 | 0.89 | 0.81 | 0.42 | 0.52 | 0.86 | 0.96 | 0.94 | 0.93 | 0.77 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.69 | 1.37 | 1.16 | 0.69 | 0.83 | 1.27 | 1.42 | 1.41 | 1.40 | 1.16 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.68 | 1.33 | 1.16 | 0.71 | 0.82 | 1.25 | 1.39 | 1.39 | 1.38 | 1.15 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.48 | 0.92 | 0.84 | 0.43 | 0.54 | 0.90 | 1.00 | 0.98 | 0.98 | 0.80 |

### 4.4.3 Northeast Monsoon

#### 4.4.3.1 Palakkad District

The analysis of the Aridity Index (AI) for Palakkad district during the northeast monsoon season showed that during the year 2016, the district experienced semi-arid conditions. During 1995, experienced sub-humid conditions in the Palakkad Central Plains and Southern High Hills and the remaining regions experienced semi-arid conditions (Table 4.16). During 2000 and 2012, experienced semi-arid conditions in the Attappady Dry Hills, Attappady Hills, North Central Laterites and Palakkad Eastern Plains and the remaining regions experienced sub-humid conditions. During the years 1992, 1996, 2002 and 2014, sub-humid conditions were experienced in the Attappady Dry Hills, Attappady Hills, North Central Laterites, and Palakkad Eastern Plains and the remaining regions experienced humid conditions. During the years 1993, 1997, 1999, 2005, 2007, 2010, 2019 and 2021, Palakkad district experienced humid conditions. North Central Laterites experienced sub-humid conditions in 1994, 1998, 2004 and 2006, while the remaining regions experienced humid conditions. During 2001 and 2003, the Palakkad Central Plains and Southern High Hills experienced humid conditions, and the remaining regions experienced sub-humid conditions. The Palakkad district experienced sub-humid conditions in 2008, 2013, 2017 and 2018. During 2009 and 2015, experienced humid conditions in the Northern Foot Hills and the remaining regions experienced sub-humid conditions. While 2020 had experienced sub-humid conditions in the Northern High Hills and Northern Foot Hills, the remaining regions had experienced humid conditions.

#### 4.4.3.2 Thrissur District

The analysis of the aridity index (AI) for Thrissur district during the northeast monsoon season showed that during the year 2016, Thrissur district experienced semi-arid conditions except in the regions of Pokkali and Southern High Hills. During the years 1992, 1993, 1996–99, 2001, 2002, 2004–07, 2010, 2014, 2019 and 2021, the

district experienced humid conditions (Table 4.16). During 1994 and 2007, the Southern High Hills experienced sub-humid conditions and the remaining regions experienced humid conditions. During 1995, the Northern Laterites experienced semi-arid conditions and the remaining years experienced sub-humid conditions. During the years 2000 and 2012, the district experienced sub-humid conditions. During the years 2003 and 2020, the Northern Laterites experienced sub-humid conditions and the remaining years experienced humid conditions. During 2008, the Northern High Hills and Southern High Hills experienced humid conditions and the remaining regions experienced humid conditions. During 2009, the Southern High Hills experienced humid conditions and the remaining regions experienced sub-humid conditions. The Pokkali region experienced humid conditions in 2011, 2013 and 2017, while the remaining regions experienced sub-humid conditions. During 2015, the Southern High Hills experienced semi-arid conditions, the Northern Laterites experienced sub-humid condition and the remaining regions experienced humid conditions.

#### 4.4.3.3 Ernakulam District

The analysis of the Aridity Index (AI) for Ernakulam district during the northeast monsoon season showed that during the year 2016, the Southern High Hills experienced semi-arid conditions and the remaining regions experienced sub-humid conditions (Table 4.16). While 2013 and 2017 experienced sub-humid conditions in the Southern High Hills, the remaining regions experienced humid conditions. During the years 1995, 2000 and 2012, Ernakulam district experienced sub-humid conditions and the remaining years experienced humid conditions.

The analysis of the Aridity Index (AI) reveals that Palakkad District exhibits greater dryness compared to other districts in the case of the Northeast Monsoon. When analyzing 30 years of data, it was evident that the year 2016 experienced particularly high levels of dryness.

Table 4.16. Aridity Index during Northeast monsoon rainfall from 1992-2021(30 years period) in different AEUs of central zone of Kerala

| District | Latitude | Longitude | AEU | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.98 | 1.70 | 1.23 | 0.71 | 1.06 | 1.36 | 1.28 | 1.39 | 0.64 | 1.14 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 1.00 | 1.75 | 1.20 | 0.74 | 1.03 | 1.38 | 1.27 | 1.41 | 0.63 | 1.12 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 1.03 | 1.81 | 1.27 | 0.77 | 1.07 | 1.41 | 1.28 | 1.41 | 0.64 | 1.07 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.89 | 1.33 | 1.01 | 0.54 | 0.86 | 1.15 | 1.01 | 1.14 | 0.61 | 0.84 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.91 | 1.30 | 1.09 | 0.56 | 0.88 | 1.10 | 1.00 | 1.11 | 0.61 | 0.80 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.98 | 1.69 | 1.23 | 0.71 | 1.05 | 1.36 | 1.27 | 1.38 | 0.64 | 1.14 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.94 | 1.16 | 0.91 | 0.45 | 0.78 | 1.00 | 0.92 | 1.01 | 0.63 | 0.68 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.91 | 1.35 | 1.03 | 0.56 | 0.89 | 1.17 | 1.03 | 1.16 | 0.62 | 0.86 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.79 | 1.26 | 0.91 | 0.53 | 0.78 | 1.15 | 0.89 | 1.09 | 0.51 | 0.79 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 1.17 | 0.99 | 0.52 | 0.71 | 1.16 | 0.79 | 1.10 | 0.51 | 0.77 | 0.77 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.74 | 1.02 | 0.78 | 0.44 | 0.68 | 1.08 | 0.77 | 0.94 | 0.48 | 0.62 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.73 | 1.01 | 0.77 | 0.44 | 0.64 | 1.07 | 0.77 | 0.94 | 0.49 | 0.62 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.87 | 1.06 | 0.85 | 0.43 | 0.75 | 0.97 | 0.87 | 0.95 | 0.59 | 0.64 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.94 | 1.13 | 0.91 | 0.46 | 0.81 | 1.03 | 0.93 | 1.02 | 0.63 | 0.69 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.68 | 0.97 | 0.72 | 0.41 | 0.62 | 0.97 | 0.71 | 0.87 | 0.46 | 0.57 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.82 | 1.30 | 0.95 | 0.55 | 0.81 | 1.19 | 0.93 | 1.14 | 0.53 | 0.82 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.80 | 1.27 | 0.95 | 0.54 | 0.79 | 1.16 | 0.90 | 1.11 | 0.54 | 0.80 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.73 | 1.04 | 0.77 | 0.43 | 0.66 | 1.04 | 0.76 | 0.93 | 0.49 | 0.61 |

Table 4.16. Aridity Index during Northeast monsoon rainfall from 1992-2021 (30 years period) in different AEUs of central zone of kerala (Contd..)

| District | Latitude | Longitude | AEU | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 1.20 | 1.21 | 1.50 | 1.53 | 1.51 | 1.01 | 0.79 | 0.75 | 1.74 | 0.76 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 1.11 | 1.19 | 1.38 | 1.64 | 1.49 | 1.02 | 0.80 | 0.78 | 1.67 | 0.86 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 1.10 | 1.17 | 1.40 | 1.60 | 1.45 | 1.00 | 0.78 | 0.76 | 1.63 | 0.84 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 1.02 | 0.83 | 1.12 | 1.23 | 1.10 | 0.93 | 0.80 | 0.70 | 1.50 | 0.71 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 1.02 | 0.82 | 1.09 | 1.21 | 1.07 | 0.92 | 0.78 | 0.69 | 1.44 | 0.70 |
| Thrissur | 10.2 | 76.27 | Pokkali | 1.16 | 1.20 | 1.50 | 1.55 | 1.50 | 1.00 | 0.78 | 0.75 | 1.73 | 0.75 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 1.01 | 0.61 | 0.87 | 1.06 | 0.90 | 0.90 | 0.88 | 0.75 | 1.35 | 0.68 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 1.03 | 0.84 | 1.15 | 1.25 | 1.12 | 0.95 | 0.82 | 0.72 | 1.53 | 0.72 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.80 | 0.76 | 1.00 | 1.26 | 0.99 | 0.87 | 0.69 | 0.62 | 1.33 | 0.74 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.77 | 0.96 | 1.18 | 0.99 | 1.02 | 0.67 | 0.63 | 1.19 | 0.78 | 0.51 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.68 | 0.56 | 0.76 | 1.15 | 0.77 | 0.82 | 0.68 | 0.57 | 1.13 | 0.74 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.67 | 0.55 | 0.75 | 1.15 | 0.77 | 0.82 | 0.68 | 0.57 | 1.13 | 0.76 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.94 | 0.58 | 0.82 | 1.02 | 0.86 | 0.84 | 0.83 | 0.73 | 1.29 | 0.69 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 1.00 | 0.62 | 0.88 | 1.09 | 0.91 | 0.92 | 0.88 | 0.78 | 1.38 | 0.74 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.65 | 0.53 | 0.70 | 1.05 | 0.70 | 0.76 | 0.64 | 0.52 | 1.05 | 0.69 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.83 | 0.79 | 1.04 | 1.31 | 1.00 | 0.91 | 0.72 | 0.65 | 1.38 | 0.77 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.81 | 0.77 | 1.01 | 1.27 | 1.00 | 0.88 | 0.70 | 0.62 | 1.35 | 0.75 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 1.20 | 1.21 | 1.50 | 1.53 | 1.51 | 1.01 | 0.79 | 0.75 | 1.74 | 0.76 |

Table 4.16. Aridity Index Northeast monsoon rainfall from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.64 | 0.85 | 0.93 | 1.11 | 0.52 | 0.81 | 1.00 | 1.40 | 0.92 | 2.04 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.62 | 0.83 | 0.96 | 1.12 | 0.53 | 0.86 | 0.97 | 1.33 | 1.34 | 2.01 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.61 | 0.82 | 0.94 | 1.10 | 0.51 | 0.81 | 0.94 | 1.27 | 1.30 | 1.93 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.60 | 0.71 | 0.88 | 0.87 | 0.40 | 0.63 | 0.80 | 1.19 | 0.79 | 1.69 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.60 | 0.71 | 0.87 | 0.88 | 0.40 | 0.64 | 0.80 | 1.18 | 0.78 | 1.67 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.64 | 0.85 | 0.92 | 1.11 | 0.51 | 0.81 | 1.00 | 1.40 | 0.92 | 2.03 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.57 | 0.62 | 0.83 | 0.71 | 0.34 | 0.57 | 0.67 | 1.07 | 0.72 | 1.56 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.85 | 0.73 | 0.90 | 0.91 | 0.41 | 0.65 | 0.82 | 1.24 | 0.81 | 1.72 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.51 | 0.64 | 0.78 | 0.83 | 0.37 | 0.61 | 0.72 | 1.06 | 1.08 | 1.45 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.54 | 0.71 | 0.84 | 0.36 | 0.58 | 0.69 | 1.05 | 1.01 | 1.32 | 0.88 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.46 | 0.53 | 0.66 | 0.68 | 0.30 | 0.55 | 0.55 | 0.92 | 0.82 | 1.25 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.46 | 0.53 | 0.66 | 0.68 | 0.30 | 0.54 | 0.55 | 0.92 | 0.83 | 1.25 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.54 | 0.59 | 0.78 | 0.71 | 0.31 | 0.56 | 0.63 | 1.05 | 0.70 | 1.52 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.58 | 0.63 | 0.84 | 0.75 | 0.32 | 0.59 | 0.67 | 1.12 | 0.74 | 1.62 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.43 | 0.49 | 0.62 | 0.63 | 0.29 | 0.49 | 0.51 | 0.83 | 0.75 | 1.14 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.53 | 0.66 | 0.81 | 0.86 | 0.38 | 0.63 | 0.75 | 1.09 | 1.12 | 1.50 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.52 | 0.65 | 0.78 | 0.82 | 0.37 | 0.61 | 0.73 | 1.07 | 1.09 | 1.46 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.45 | 0.52 | 0.66 | 0.66 | 0.31 | 0.52 | 0.55 | 0.88 | 0.80 | 1.20 |

### 4.4.4 Summer Season

#### 4.4.4.1 Palakkad District

The analysis of the Aridity Index (AI) for Palakkad district during the summer season showed that the years 1997 and 2000 experienced arid conditions in Palakkad district. During 1998, the Northern Foot Hills experienced semi-arid conditions and the remaining regions experienced arid conditions. During the years 1992, 2002, 2013, 2016 and 2020, had experienced arid conditions in the Attappady Dry Hills, Attappady Hills, North Central Laterites, and Palakkad Eastern Plains. During the years 1993–1996, 1999, 2003, 2005, 2007, 2009–11, 2014, 2015, 2017 and 2021, the district experienced semi-arid conditions. In 2001, the Northern High Hills, Northern Foot Hills and Palakkad Central Plains experienced sub-humid conditions, while the remaining regions experienced semi-arid conditions. During 2004, North Central Laterites experienced semi-arid conditions, Palakkad Eastern Plains, Attappady Dry Hills and Attappady Hills experienced sub-humid conditions, and the remaining regions experienced humid conditions. During 2006, the Northern High Hills, Northern Foot Hills, Palakkad Central Plains, and Southern High Hills experienced sub-humid conditions and the remaining regions experienced humid conditions. While 2008 had experienced semi-arid conditions in the North Central Laterites and Palakkad Eastern Plains, the remaining regions had experienced sub-humid conditions. During the years 2012 and 2019, had experienced semi-arid conditions in the North Central Laterites.

#### 4.4.4.2 Thrissur District

The analysis of the Aridity index (AI) for Thrissur district during the summer season showed that during the years 1992–94, 1997, 2007, 2013, 2016 and 2019, semi-arid conditions were experienced in Thrissur District. During the years 1995, 1999, 2009, and 2015, the Northern coastal plains, Pokkali and the remaining regions experienced semi-arid conditions. During the years 1997 and 2000, Pokkali experienced semi-arid conditions and the remaining regions experienced arid conditions. During 1999, the Northern coastal plains and Pokkali region experienced sub-humid conditions and the remaining regions experienced semi-arid conditions.

During 2001, the Northern High Hills and Southern High Hills experienced semi-arid conditions and the remaining regions experienced sub-humid conditions. During the years 2002, 2003, 2005, 2010, 2011, 2017 and 2020, the Pokkali region experienced sub-humid conditions and the remaining regions experienced semi-arid conditions. During 2004, the Southern High Hills experienced sub-humid conditions and the remaining regions experienced humid conditions.

During 2008, Pokkali experienced humid conditions and the remaining regions experienced sub-humid conditions. During 2018, the Southern High Hills experienced semi-arid conditions and the remaining regions experienced humid conditions. In 2021, the Northern Laterites experienced sub-humid conditions, the Northern coastal plains and Pokkali regions experienced humid conditions and the remaining regions experienced semi-arid conditions.

#### 4.4.4.3 Ernkulam District

The analysis of the Aridity Index (AI) for Ernakulam district during the summer season showed that during the years 1992–94, 1996–08, 2000, 2007, 2013, 2016 and 2019, Ernakulam district experienced semi-arid conditions. During the years 1995, 2001, 2009, 2015 and 2018, experienced sub-humid conditions. During the years 1999, 2003, 2012 and 2017, the Southern High Hills experienced semi-arid conditions and the remaining regions experienced sub-humid conditions. During the years 2002, 2010, 2011, 2014 and 2020, the Pokkali region experienced sub-humid conditions and the remaining regions experienced semi-humid conditions. While humid conditions prevailed in 2004 and 2006, the Southern High Hills were semi-arid in 2005 and the remaining regions were humid. During 2008, experienced humid conditions in the Pokkali region and the remaining regions experienced sub-humid conditions. Ernakulam District experienced a humid condition in 2021.

The analysis of the Aridity Index (AI) reveals that Palakkad District exhibits greater dryness compared to other districts in the summer season.

Table 4.17. Aridity Index during summer season from 1992-2021 (30 years period) in different AEUs of central zone of Kerala

| District | Latitude | Longitude | AEU | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.33 | 0.38 | 0.45 | 0.73 | 0.21 | 0.26 | 0.30 | 0.62 | 0.26 | 0.73 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.28 | 0.35 | 0.47 | 0.63 | 0.22 | 0.26 | 0.29 | 0.58 | 0.23 | 0.66 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.28 | 0.35 | 0.44 | 0.62 | 0.22 | 0.25 | 0.27 | 0.54 | 0.23 | 0.66 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.31 | 0.31 | 0.36 | 0.50 | 0.21 | 0.18 | 0.23 | 0.48 | 0.20 | 0.62 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.31 | 0.31 | 0.38 | 0.50 | 0.21 | 0.18 | 0.24 | 0.51 | 0.20 | 0.59 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.33 | 0.38 | 0.45 | 0.72 | 0.21 | 0.26 | 0.30 | 0.62 | 0.26 | 0.73 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.31 | 0.25 | 0.31 | 0.40 | 0.21 | 0.14 | 0.20 | 0.45 | 0.16 | 0.57 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.31 | 0.31 | 0.37 | 0.50 | 0.21 | 0.19 | 0.23 | 0.49 | 0.20 | 0.62 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.21 | 0.26 | 0.32 | 0.38 | 0.21 | 0.16 | 0.17 | 0.34 | 0.15 | 0.48 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.20 | 0.25 | 0.31 | 0.36 | 0.20 | 0.15 | 0.16 | 0.33 | 0.15 | 0.47 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.17 | 0.21 | 0.25 | 0.26 | 0.21 | 0.11 | 0.13 | 0.24 | 0.11 | 0.40 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.17 | 0.21 | 0.25 | 0.26 | 0.22 | 0.11 | 0.13 | 0.24 | 0.11 | 0.40 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.29 | 0.24 | 0.29 | 0.37 | 0.20 | 0.13 | 0.19 | 0.41 | 0.16 | 0.53 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.30 | 0.25 | 0.31 | 0.39 | 0.21 | 0.14 | 0.20 | 0.44 | 0.16 | 0.55 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.16 | 0.20 | 0.24 | 0.24 | 0.20 | 0.10 | 0.11 | 0.23 | 0.10 | 0.39 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.21 | 0.27 | 0.33 | 0.39 | 0.22 | 0.16 | 0.17 | 0.35 | 0.16 | 0.50 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.21 | 0.26 | 0.33 | 0.38 | 0.21 | 0.16 | 0.17 | 0.34 | 0.15 | 0.49 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.17 | 0.21 | 0.25 | 0.26 | 0.22 | 0.11 | 0.12 | 0.25 | 0.11 | 0.42 |

Table 4.17. Aridity Index during summer season from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.56 | 0.64 | 1.37 | 0.65 | 1.03 | 0.47 | 0.84 | 0.74 | 0.57 | 0.51 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.47 | 0.58 | 1.16 | 0.62 | 0.83 | 0.38 | 0.74 | 0.60 | 0.46 | 0.43 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.48 | 0.58 | 1.18 | 0.63 | 0.84 | 0.38 | 0.74 | 0.61 | 0.46 | 0.44 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.42 | 0.46 | 1.04 | 0.43 | 0.81 | 0.42 | 0.70 | 0.54 | 0.45 | 0.44 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.41 | 0.44 | 1.01 | 0.41 | 0.78 | 0.42 | 0.69 | 0.53 | 0.44 | 0.43 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.56 | 0.63 | 1.36 | 0.65 | 1.03 | 0.46 | 0.83 | 0.74 | 0.56 | 0.51 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.36 | 0.33 | 0.90 | 0.30 | 0.73 | 0.41 | 0.62 | 0.39 | 0.38 | 0.36 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.43 | 0.46 | 1.04 | 0.44 | 0.82 | 0.42 | 0.71 | 0.55 | 0.45 | 0.44 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.29 | 0.39 | 0.75 | 0.41 | 0.56 | 0.28 | 0.53 | 0.40 | 0.31 | 0.35 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.28 | 0.37 | 0.72 | 0.39 | 0.52 | 0.24 | 0.52 | 0.39 | 0.30 | 0.34 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.19 | 0.27 | 0.54 | 0.29 | 0.41 | 0.23 | 0.41 | 0.26 | 0.23 | 0.29 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.19 | 0.26 | 0.52 | 0.29 | 0.40 | 0.23 | 0.41 | 0.26 | 0.23 | 0.28 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.32 | 0.31 | 0.84 | 0.28 | 0.67 | 0.38 | 0.59 | 0.36 | 0.35 | 0.34 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.34 | 0.32 | 0.88 | 0.29 | 0.70 | 0.40 | 0.60 | 0.38 | 0.37 | 0.36 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.18 | 0.25 | 0.49 | 0.28 | 0.39 | 0.22 | 0.40 | 0.25 | 0.22 | 0.28 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.30 | 0.40 | 0.77 | 0.42 | 0.54 | 0.28 | 0.55 | 0.43 | 0.32 | 0.36 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.30 | 0.39 | 0.76 | 0.41 | 0.57 | 0.28 | 0.54 | 0.41 | 0.32 | 0.36 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.20 | 0.27 | 0.54 | 0.30 | 0.42 | 0.23 | 0.42 | 0.26 | 0.24 | 0.29 |

Table 4.17. Aridity Index during summer season from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.61 | 0.38 | 0.53 | 0.60 | 0.45 | 0.61 | 0.63 | 0.24 | 0.51 | 1.05 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.71 | 0.32 | 0.46 | 0.55 | 0.39 | 0.55 | 0.58 | 0.26 | 0.38 | 0.85 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.71 | 0.33 | 0.47 | 0.56 | 0.40 | 0.57 | 0.59 | 0.26 | 0.39 | 0.86 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.44 | 0.28 | 0.46 | 0.52 | 0.31 | 0.48 | 0.57 | 0.22 | 0.34 | 0.74 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.43 | 0.28 | 0.44 | 0.50 | 0.30 | 0.49 | 0.57 | 0.21 | 0.35 | 0.76 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.60 | 0.38 | 0.53 | 0.60 | 0.45 | 0.60 | 0.63 | 0.24 | 0.51 | 1.05 |
| Thrissur | 10.78 | 76.46 | Northern Laterities | 0.29 | 0.25 | 0.46 | 0.44 | 0.23 | 0.42 | 0.52 | 0.23 | 0.26 | 0.59 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.63 | 0.29 | 0.46 | 0.52 | 0.31 | 0.48 | 0.57 | 0.22 | 0.35 | 0.74 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.33 | 0.22 | 0.36 | 0.45 | 0.26 | 0.41 | 0.50 | 0.21 | 0.24 | 0.52 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.28 | 0.22 | 0.34 | 0.44 | 0.25 | 0.40 | 0.47 | 0.21 | 0.23 | 0.51 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.20 | 0.17 | 0.32 | 0.41 | 0.18 | 0.34 | 0.41 | 0.20 | 0.16 | 0.39 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.20 | 0.17 | 0.32 | 0.40 | 0.18 | 0.34 | 0.41 | 0.20 | 0.16 | 0.39 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.27 | 0.22 | 0.43 | 0.44 | 0.21 | 0.40 | 0.49 | 0.21 | 0.24 | 0.56 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.28 | 0.24 | 0.46 | 0.46 | 0.22 | 0.42 | 0.52 | 0.22 | 0.25 | 0.59 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.19 | 0.16 | 0.30 | 0.39 | 0.18 | 0.32 | 0.38 | 0.19 | 0.15 | 0.38 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.34 | 0.23 | 0.37 | 0.46 | 0.27 | 0.42 | 0.51 | 0.22 | 0.25 | 0.54 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.34 | 0.22 | 0.36 | 0.43 | 0.26 | 0.42 | 0.50 | 0.22 | 0.25 | 0.53 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.20 | 0.17 | 0.33 | 0.40 | 0.19 | 0.34 | 0.41 | 0.20 | 0.17 | 0.40 |

### 4.4.5 Winter Season

#### 4.4.5.1 Palakkad District

The analysis of the Aridity Index (AI) for Palakkad district during the winter season showed that during the years 1992, 1997–99, 2007, 2009 and 2015, Palakkad district experienced hyper-arid conditions. During the years 1993, 1995, 2001, 2003, 2005, 2006, 2008, 2013, 2017 and 2018, Palakkad district experienced arid conditions. Between 1994 and 2011, the Palakkad Central Plains and Southern High Hills experienced semi-arid conditions while the remaining regions experienced arid conditions. During 1996, Attappady Hills, Northern High Hills, Northern Foot Hills and North Central Laterites experienced hyper-arid conditions and the remaining regions experienced arid conditions. During 2000, North Central Laterites and Attappady Hills experienced arid conditions; Northern High Hills and Northern Foot Hills experienced hyper-arid conditions and the remaining regions experienced semi-arid conditions. During 2002, the Northern High Hills and Northern Foot Hills experienced hyperarid conditions and the remaining regions experienced arid conditions. The Palakkad Central Plains and Southern High Hills experienced arid conditions in 2004, 2010, 2012 and 2014, while the remaining regions experienced hyper arid conditions. During 2016 and 2020, Attappady Dry Hills, Attappady Hills, Palakkad Central Plains and Southern High Hills experienced hyperarid conditions, and the remaining regions experienced arid conditions. During 2021, Palakkad District experienced a semi-arid condition.

#### 4.4.5.2 Thrissur District

The analysis of the Aridity Index (AI) for Thrissur district during the winter season showed that during the years 1992, 1998 and 1999, the district experienced hyper-aridity. During the years 1993, 1995, 2002, 2003, 2005, 2013, 2014, 2017, 2018 and 2020 had experienced arid conditions in this district. During 1994, the Northern Laterites experienced arid conditions and the remaining regions experienced

semi-arid conditions. During 1996, Northern Laterites and Southern High Hills experienced hyperarid conditions and the remaining regions experienced arid conditions. During 1997, 2007, 2009 and 2015, the Pokkali region experienced arid conditions and the remaining regions experienced hyper-arid conditions. During 2000, Pokkali and the Northern Laterites experienced arid conditions and the remaining regions experienced semi-arid conditions. During 2001, the Pokkali region experienced sub-humid conditions and the remaining regions experienced arid conditions. During 2004 and 2012, the Northern Laterites experienced hyperarid conditions, Pokkali experienced semi-arid conditions, and the remaining regions experienced arid conditions. During 2008 and 2016, Pokkali experienced hyper-arid conditions, and the remaining regions experienced arid conditions. Whie, in 2021, had experienced semi-arid conditions in Thrissur district.

#### 4.4.5.3 Ernakulam District

The analysis of the Aridity Index (AI) for Ernakulam district during the winter season showed that during the years 1992, 1997–99, 2007 and 2015, the district experienced hyper-arid conditions. While the years 1993, 1995, 2002, 2004, 2008, 2010, 2016, 2017, 2018 and 2020 experienced arid conditions, the years 1994, 2011, and 2021, experienced semi-arid conditions. During the years 1996, 2006, 2009, 2014 and 2019, the Southern High Hills experienced hyper-arid conditions and the remaining regions experienced arid conditions. During 2000, the Southern High Hills experienced semi-arid conditions and the remaining regions experienced sub-humid conditions. During 2001 and 2012, the Pokkali region and the Southern and Central Foot Hills experienced semi-arid conditions, while the remaining regions experienced arid conditions. During 2021, Ernakulam district experienced semi-arid conditions.

The analysis of the Aridity Index (AI) reveals that Palakkad District exhibits greater dryness compared to other districts in the winter season.

Table 4.18. Aridity Index during winter season from 1992-2021 (30 years Period) in different AEUs of central zone of Kerala

| District | Latitude | Longitude | AEU | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.01 | 0.14 | 0.47 | 0.11 | 0.04 | 0 | 0.01 | 0.02 | 0.52 | 0.22 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.01 | 0.13 | 0.48 | 0.11 | 0.05 | 0.01 | 0.01 | 0.03 | 0.53 | 0.19 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.01 | 0.13 | 0.48 | 0.11 | 0.05 | 0.01 | 0.01 | 0.03 | 0.54 | 0.20 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0 | 0.08 | 0.26 | 0.07 | 0.02 | 0 | 0.01 | 0.01 | 0.31 | 0.13 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0 | 0.08 | 0.26 | 0.07 | 0.03 | 0 | 0.01 | 0.01 | 0.30 | 0.13 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.01 | 0.13 | 0.47 | 0.11 | 0.11 | 0.04 | 0 | 0.01 | 0.02 | 0.54 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0 | 0.04 | 0.11 | 0.05 | 0.02 | 0 | 0.01 | 0.01 | 0.17 | 0.08 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0 | 0.08 | 0.26 | 0.07 | 0.03 | 0 | 0.01 | 0.01 | 0.32 | 0.13 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0 | 0.08 | 0.25 | 0.09 | 0.03 | 0.01 | 0.01 | 0.01 | 0.35 | 0.10 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0 | 0.08 | 0.24 | 0.08 | 0.03 | 0.01 | 0.01 | 0.01 | 0.32 | 0.10 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0 | 0.05 | 0.12 | 0.08 | 0.03 | 0.01 | 0 | 0.01 | 0.23 | 0.05 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0 | 0.04 | 0.09 | 0.06 | 0.02 | 0.01 | 0 | 0.01 | 0.18 | 0.04 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0 | 0.04 | 0.11 | 0.05 | 0.02 | 0 | 0.01 | 0.01 | 0.02 | 0.07 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0 | 0.04 | 0.11 | 0.05 | 0.02 | 0 | 0.01 | 0.01 | 0.02 | 0.08 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0 | 0.03 | 0.08 | 0.05 | 0.02 | 0.01 | 0 | 0.01 | 0.16 | 0.03 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0 | 0.08 | 0.26 | 0.09 | 0.03 | 0.01 | 0.01 | 0.01 | 0.35 | 0.11 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0 | 0.08 | 0.26 | 0.09 | 0.03 | 0.01 | 0.01 | 0.01 | 0.35 | 0.10 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0 | 0.05 | 0.12 | 0.07 | 0.03 | 0.01 | 0 | 0.01 | 0.24 | 0.05 |

Table 4.18. Aridity Index during winter season from 1992-2021 (30 years Period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.07 | 0.27 | 0.09 | 0.23 | 0.03 | 0.01 | 0.06 | 0.03 | 0.05 | 0.34 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.09 | 0.24 | 0.07 | 0.2 | 0.04 | 0.02 | 0.07 | 0.03 | 0.05 | 0.32 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.1 | 0.25 | 0.08 | 0.21 | 0.04 | 0.02 | 0.07 | 0.03 | 0.05 | 0.32 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.04 | 0.17 | 0.05 | 0.13 | 0.02 | 0.01 | 0.05 | 0.02 | 0.03 | 0.24 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.04 | 0.17 | 0.05 | 0.13 | 0.02 | 0.01 | 0.05 | 0.02 | 0.03 | 0.23 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.22 | 0.07 | 0.27 | 0.09 | 0.23 | 0.03 | 0.01 | 0.06 | 0.03 | 0.05 |
| Thrissur | 10.78 | 76.46 | Northern Laterities | 0.02 | 0.13 | 0.02 | 0.08 | 0.02 | 0.01 | 0.04 | 0.01 | 0.02 | 0.13 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.04 | 0.17 | 0.05 | 0.14 | 0.03 | 0.01 | 0.05 | 0.02 | 0.03 | 0.24 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.06 | 0.13 | 0.04 | 0.12 | 0.04 | 0.02 | 0.06 | 0.02 | 0.03 | 0.22 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.06 | 0.12 | 0.04 | 0.11 | 0.04 | 0.02 | 0.06 | 0.02 | 0.03 | 0.21 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.04 | 0.08 | 0.02 | 0.07 | 0.04 | 0.02 | 0.06 | 0.01 | 0.01 | 0.13 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.03 | 0.06 | 0.02 | 0.05 | 0.03 | 0.02 | 0.04 | 0.01 | 0.01 | 0.09 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.02 | 0.12 | 0.02 | 0.07 | 0.02 | 0.01 | 0.04 | 0.01 | 0.02 | 0.12 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.02 | 0.13 | 0.02 | 0.08 | 0.02 | 0.01 | 0.04 | 0.01 | 0.02 | 0.13 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.03 | 0.05 | 0.01 | 0.04 | 0.03 | 0.02 | 0.04 | 0.01 | 0.01 | 0.09 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.07 | 0.13 | 0.04 | 0.12 | 0.04 | 0.02 | 0.07 | 0.02 | 0.03 | 0.23 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.06 | 0.13 | 0.04 | 0.12 | 0.04 | 0.02 | 0.06 | 0.02 | 0.03 | 0.22 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.04 | 0.08 | 0.02 | 0.07 | 0.04 | 0.02 | 0.06 | 0.01 | 0.01 | 0.13 |

Table 4.18. Aridity Index during winter season from 1992-2021 (30 years Period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.06 | 0.2 | 0.06 | 0.02 | 0.16 | 0.06 | 0.03 | 0.03 | 0.09 | 0.36 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.05 | 0.19 | 0.06 | 0.02 | 0.09 | 0.10 | 0.04 | 0.04 | 0.04 | 0.44 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.05 | 0.20 | 0.06 | 0.02 | 0.10 | 0.13 | 0.05 | 0.04 | 0.05 | 0.45 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.04 | 0.15 | 0.02 | 0.01 | 0.09 | 0.05 | 0.03 | 0.02 | 0.06 | 0.34 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.04 | 0.16 | 0.02 | 0.01 | 0.09 | 0.05 | 0.03 | 0.02 | 0.06 | 0.34 |
| Thrissur | 10.2 | 76.27 | Pokkali | 0.33 | 0.06 | 0.2 | 0.06 | 0.02 | 0.16 | 0.06 | 0.03 | 0.03 | 0.09 |
| Thrissur | 10.78 | 76.46 | Northern Laterities | 0.02 | 0.12 | 0.01 | 0 | 0.04 | 0.05 | 0.03 | 0.03 | 0.04 | 0.38 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.05 | 0.16 | 0.02 | 0.01 | 0.09 | 0.05 | 0.03 | 0.03 | 0.06 | 0.35 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.03 | 0.16 | 0.02 | 0.01 | 0.05 | 0.08 | 0.05 | 0.03 | 0.03 | 0.39 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.03 | 0.08 | 0.02 | 0.01 | 0.04 | 0.08 | 0.05 | 0.03 | 0.03 | 0.37 |
| Palakkad | 11.23 | 76.7 | Attappady Dry Hills | 0.01 | 0.12 | 0.01 | 0.01 | 0.02 | 0.07 | 0.05 | 0.03 | 0.02 | 0.41 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.01 | 0.09 | 0.01 | 0 | 0.02 | 0.05 | 0.04 | 0.02 | 0.02 | 0.31 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.02 | 0.12 | 0.01 | 0 | 0.04 | 0.05 | 0.03 | 0.02 | 0.03 | 0.36 |
| Palakkad | 11.04 | 76.3 | Northern Foot Hills | 0.02 | 0.12 | 0.01 | 0 | 0.04 | 0.05 | 0.03 | 0.03 | 0.04 | 0.38 |
| Palakkad | 10.74 | 76.1 | North Central Laterites | 0.01 | 0.08 | 0.01 | 0 | 0.02 | 0.05 | 0.04 | 0.02 | 0.02 | 0.28 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.03 | 0.16 | 0.03 | 0.01 | 0.05 | 0.09 | 0.05 | 0.03 | 0.03 | 0.41 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.03 | 0.16 | 0.03 | 0.01 | 0.05 | 0.08 | 0.05 | 0.03 | 0.03 | 0.40 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.01 | 0.12 | 0.01 | 0.01 | 0.02 | 0.07 | 0.05 | 0.03 | 0.02 | 0.40 |

## 4.5 STANDARD PRECIPITATION INDEX (SPI)

### 4.5.1 Annual Rainfall

#### 4.5.1.1 Palakkad District

The analysis of the Standard Precipitation Index (SPI) showed that in the year 2016, extreme drought was experienced in Palakkad district with a value of ≤ 2.00 (Table 4.19). During 1997, the Northern High Hills, Northern Foot Hills and North Central Laterites experienced moderate wet conditions. During 1999, a moderate drought occurred in the Palakkad Central Plains and Southern High Hills. In 2000, severe drought was experienced in North Central Laterites and moderate drought in the remaining AEUs. During 2002, the Attappady Dry Hills, Attappady Hills, Palakkad Central Plains, Southern High Hills and Palakkad Eastern Plains experienced moderate drought conditions. During 2003, a moderate drought occurred in the regions of Attappady Dry Hills, Attappady Hills, Northern High Hills, Northern Foot Hills and Palakkad Eastern Plains.

During 2006, severely wet conditions were observed in the North Central Laterites and moderate wet conditions in the Northern High Hills, Northern Foot Hills, North Central Laterites and Palakkad Central Plains. While in 2007, Northern High Hills and Northern Foot Hills experienced extreme wetness, severely wet conditions were observed in North Central Laterites and the remaining AEUs experienced moderate wetness. During 2012, Palakkad Central Plains and Southern High Hills experienced extreme drought; Northern High Hills and Northern Foot Hills experienced moderate drought and the remaining AEUs experienced severe drought. In 2015, Northern High Hills and Northern Foot Hills experienced extreme drought and the regions of North Central Laterites, Palakkad Eastern Plains, Attappady Dry Hills and Attappady Hills observed moderate drought conditions. In 2018, North

Central Laterites experienced moderate wetness and in 2019, Palakkad Eastern Plains, Attappady Dry Hills and Attappady Hills experienced moderate wetness.

While 2021 had observed severe wetness in North Central Laterites, moderate wetness in Northern High Hills and Northern Foot Hills and the remaining AEUs had experienced extreme wetness,

#### 4.5.1.2 Thrissur District

The analysis of the Standard Precipitation Index (SPI) showed that in 2016, severe drought was experienced in the Pokkali region and the remaining AEUs had experienced extreme drought conditions (Table 4.19). In 1997, moderate wetness was experienced in the Thrissur district, except in the AEU Northern High Hills. During 1999, the Northern High Hills and Pokkali region experienced moderate drought conditions. In 2000, the Northern High Hills and Northern Laterites experienced moderate drought, while the remaining AEUs experienced severe drought conditions. During 2002, the Northern High Hills experienced moderate drought; in 2003, the Northern Laterites observed moderate drought conditions. During 2004, the Pokkali region experienced moderate wetness. In 2006, Northern Laterites and Northern High Hills observed moderate wetness and the remaining areas experienced severe wet conditions. During 2007, the Northern Laterites experienced extreme wetness, the Northern High Hills and Pokkali region experienced moderate wetness, and the remaining AEUs experienced extreme wetness. During 2012, the Northern High Hills experienced extreme drought, the Northern Laterites experienced moderate drought, and the remaining AEUs experienced severe drought conditions. During 2015, severe drought was experienced in the Northern Laterites and moderate drought in the Northern coastal plains, Pokkali, Kole Lands and Southern High Hills.

In 2018, moderate wetness was observed in the Northern coastal plains, Kole Lands, and Southern High Hills. During 2021, the Northern High Hills experienced extreme wetness, the Northern Laterities experienced moderate wetness and the remaining regions experienced severe wetness.

#### 4.5.1.3 Ernakulam District

The analysis of the Standard Precipitation Index (SPI) showed that the year 2016 had experienced extreme drought and the remaining regions had experienced severe drought (Table 4.19). In 2012, a severe drought was experienced in Ernakulam district. During 1997, moderate wetness was observed in Ernakulam district. In 1999, the Pokkali region experienced moderate drought and in 2000, severe drought was experienced in Ernakulam district. During 2004, moderate wetness was experienced in Pokkali, South Central Laterites, and Southern and Central Foot Hills.

During 2005, South Central Laterites, Southern and Central Foot Hills experienced moderate wetness and in 2006, severe wetness was observed in Ernalulam district. During 2007, severe drought was experienced in the Southern High Hills and moderate drought was experienced in Pokkali. In 2018, Southern Hills experienced moderate wetness. During 2021, South Central Laterites, Southern and Central Foot Hills experienced extreme wetness, and the remaining AEUs experienced severe wetness.

Based on the analysis of annual rainfall data, 2016 was the most drought-affected year in the last 30 years. When compared to other districts, Palakkad district shows more drought conditions and the regions of Attappady Dry and Attappady Hills are the most drought-affected AEUs.

Table 4.19. Annual Standard Precipitation Index (SPI) from 1992-2021 (30 years period) in different AEUs of central zone of Kerala

| District | Latitude | Longitude | AEU | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.163 | 76.178 | Pokkali | -0.60 | -0.45 | 0.67 | -0.30 | -0.66 | 1.41 | -0.20 | -1.11 | -1.81 | 0.17 |
| Ernakulam | 9.933 | 76.565 | South Central Laterites | -0.32 | -0.08 | 0.81 | -0.50 | -0.44 | 1.15 | -0.10 | -0.82 | -1.62 | 0.33 |
| Ernakulam | 10.051 | 76.663 | Southern and Central Foot Hills | -0.32 | -0.08 | 0.81 | -0.50 | -0.44 | 1.15 | -0.10 | -0.82 | -1.62 | 0.33 |
| Ernakulam | 10.252 | 76.534 | Southern High Hills | -0.11 | -0.53 | 0.65 | -0.50 | -0.36 | 1.32 | -0.30 | -0.93 | -1.72 | -0.30 |
| Thrissur | 10.675 | 75.984 | Northern coastal plains | -0.11 | -0.53 | 0.65 | -0.50 | -0.36 | 1.32 | -0.30 | -0.93 | -1.72 | -0.30 |
| Thrissur | 10.199 | 76.266 | Pokkali | -0.60 | -0.45 | 0.67 | -0.30 | -0.66 | 1.41 | -0.20 | -1.11 | -1.81 | 0.17 |
| Thrissur | 10.78 | 76.457 | Northern Laterites | 0.44 | -0.32 | 0.77 | -0.50 | -0.27 | 1.32 | 0.07 | -0.85 | -1.35 | -0.50 |
| Thrissur | 10.682 | 76.094 | Kole Lands | -0.11 | -0.53 | 0.65 | -0.50 | -0.36 | 1.32 | -0.30 | -0.93 | -1.72 | -0.30 |
| Thrissur | 10.43 | 76.573 | Northern High Hills | -0.18 | 0.01 | 0.80 | -0.70 | -0.26 | 0.89 | -0.40 | -1.01 | -1.38 | -0.20 |
| Thrissur | 10.349 | 76.361 | Southern High Hills | -0.11 | -0.53 | 0.65 | -0.50 | -0.36 | 1.32 | -0.30 | -0.93 | -1.72 | -0.30 |
| Palakkad | 11.23 | 76.697 | Attappady Dry Hills | 0.24 | 0.09 | 0.58 | -0.80 | 0.12 | 0.90 | -0.20 | -0.74 | -1.16 | -0.50 |
| Palakkad | 11.036 | 76.765 | Attappady Hills | 0.24 | 0.09 | 0.58 | -0.80 | 0.12 | 0.90 | -0.20 | -0.74 | -1.16 | -0.50 |
| Palakkad | 11.131 | 76.432 | Northern High Hills | 0.44 | -0.32 | 0.77 | -0.50 | -0.27 | 1.32 | 0.07 | -0.85 | -1.35 | -0.50 |
| Palakkad | 11.039 | 76.302 | Northern Foot Hills | 0.44 | -0.32 | 0.77 | -0.50 | -0.27 | 1.32 | 0.07 | -0.85 | -1.35 | -0.50 |
| Palakkad | 10.738 | 76.095 | North Central Laterites | -0.11 | -0.53 | 0.65 | -0.50 | -0.36 | 1.32 | -0.30 | -0.93 | -1.72 | -0.30 |
| Palakkad | 10.711 | 76.577 | Palakkad Central Plains | -0.18 | 0.01 | 0.80 | -0.70 | -0.26 | 0.89 | -0.40 | -1.01 | -1.38 | -0.20 |
| Palakkad | 10.372 | 76.783 | Southern High Hills | -0.18 | 0.01 | 0.80 | -0.70 | -0.26 | 0.89 | -0.40 | -1.01 | -1.38 | -0.20 |
| Palakkad | 10.83 | 76.756 | Palakkad Eastern Plains | 0.24 | 0.09 | 0.58 | -0.80 | 0.12 | 0.90 | -0.20 | -0.74 | -1.16 | -0.50 |

Table 4.19. Annual Standard Precipitation Index (SPI) from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.163 | 76.178 | Pokkali | -0.68 | -0.28 | 1.04 | 0.96 | 1.92 | 1.26 | -0.40 | -0.08 | 0.84 | -0.30 |
| Ernakulam | 9.933 | 76.565 | South Central Laterites | -0.67 | -0.23 | 1.29 | 1.35 | 1.83 | 0.87 | -0.40 | -0.26 | 0.61 | -0.60 |
| Ernakulam | 10.051 | 76.663 | Southern and Central Foot Hills | -0.67 | -0.23 | 1.29 | 1.35 | 1.83 | 0.87 | -0.40 | -0.26 | 0.61 | -0.60 |
| Ernakulam | 10.252 | 76.534 | Southern High Hills | -0.97 | -0.82 | 0.73 | 0.46 | 1.54 | 1.87 | -0.20 | 0.22 | 0.98 | 0.02 |
| Thrissur | 10.675 | 75.984 | Northern coastal plains | -0.97 | -0.82 | 0.73 | 0.46 | 1.54 | 1.87 | -0.20 | 0.22 | 0.98 | 0.02 |
| Thrissur | 10.199 | 76.266 | Pokkali | -0.68 | -0.28 | 1.04 | 0.96 | 1.92 | 1.26 | -0.40 | -0.08 | 0.84 | -0.30 |
| Thrissur | 10.78 | 76.457 | Northern Laterites | -0.88 | -1.23 | 0.57 | -0.20 | 1.48 | 2.22 | 0.26 | 0.36 | 0.96 | 0.12 |
| Thrissur | 10.682 | 76.094 | Kole Lands | -0.97 | -0.82 | 0.73 | 0.46 | 1.54 | 1.87 | -0.20 | 0.22 | 0.98 | 0.02 |
| Thrissur | 10.43 | 76.573 | Northern High Hills | -1.06 | -0.56 | 0.89 | 0.91 | 1.09 | 1.11 | -0.30 | -0.24 | 0.87 | -0.10 |
| Thrissur | 10.349 | 76.361 | Southern High Hills | -0.97 | -0.82 | 0.73 | 0.46 | 1.54 | 1.87 | -0.20 | 0.22 | 0.98 | 0.02 |
| Palakkad | 11.23 | 76.697 | Attappady Dry Hills | -1.38 | -1.14 | 0.61 | 0.73 | 0.85 | 1.34 | 0.12 | -0.20 | 0.73 | 0.07 |
| Palakkad | 11.036 | 76.765 | Attappady Hills | -1.38 | -1.14 | 0.61 | 0.73 | 0.85 | 1.34 | 0.12 | -0.20 | 0.73 | 0.07 |
| Palakkad | 11.131 | 76.432 | Northern High Hills | -0.88 | -1.23 | 0.57 | -0.20 | 1.48 | 2.22 | 0.26 | 0.36 | 0.96 | 0.12 |
| Palakkad | 11.039 | 76.302 | Northern Foot Hills | -0.88 | -1.23 | 0.57 | -0.20 | 1.48 | 2.22 | 0.26 | 0.36 | 0.96 | 0.12 |
| Palakkad | 10.738 | 76.095 | North Central Laterites | -0.97 | -0.82 | 0.73 | 0.46 | 1.54 | 1.87 | -0.20 | 0.22 | 0.98 | 0.02 |
| Palakkad | 10.711 | 76.577 | Palakkad Central Plains | -1.06 | -0.56 | 0.89 | 0.91 | 1.09 | 1.11 | -0.30 | -0.24 | 0.87 | -0.10 |
| Palakkad | 10.372 | 76.783 | Southern High Hills | -1.06 | -0.56 | 0.89 | 0.91 | 1.09 | 1.11 | -0.30 | -0.24 | 0.87 | -0.10 |
| Palakkad | 10.83 | 76.756 | Palakkad Eastern Plains | -1.38 | -1.14 | 0.61 | 0.73 | 0.85 | 1.34 | 0.12 | -0.20 | 0.73 | 0.07 |

Table 4.19. Annual Standard Precipitation Index (SPI) from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.163 | 76.178 | Pokkali | -1.75 | 0.28 | -0.21 | -1.10 | -1.81 | -0.28 | 0.79 | 0.53 | 0.40 | 1.81 |
| Ernakulam | 9.933 | 76.565 | South Central Laterites | -1.93 | 0.04 | -0.42 | -1.00 | -1.96 | -0.20 | 0.23 | 0.35 | 0.48 | 2.20 |
| Ernakulam | 10.051 | 76.663 | Southern and Central Foot Hills | -1.93 | 0.04 | -0.42 | -1.00 | -1.96 | -0.20 | 0.23 | 0.35 | 0.48 | 2.20 |
| Ernakulam | 10.252 | 76.534 | Southern High Hills | -1.63 | 0.11 | 0.24 | -1.40 | -2.01 | -0.25 | 1.02 | 0.79 | 0.33 | 1.58 |
| Thrissur | 10.675 | 75.984 | Northern coastal plains | -1.63 | 0.11 | 0.24 | -1.40 | -2.01 | -0.25 | 1.02 | 0.79 | 0.33 | 1.58 |
| Thrissur | 10.199 | 76.266 | Pokkali | -1.75 | 0.28 | -0.21 | -1.10 | -1.81 | -0.28 | 0.79 | 0.53 | 0.40 | 1.81 |
| Thrissur | 10.78 | 76.457 | Northern Laterites | -1.45 | 0.32 | 0.64 | -1.70 | -2.09 | -0.59 | 0.71 | 0.35 | -0.07 | 1.28 |
| Thrissur | 10.682 | 76.094 | Kole Lands | -1.63 | 0.11 | 0.24 | -1.40 | -2.01 | -0.25 | 1.02 | 0.79 | 0.33 | 1.58 |
| Thrissur | 10.43 | 76.573 | Northern High Hills | -2.10 | -0.10 | -0.18 | -0.90 | -2.10 | -0.01 | 0.91 | 0.97 | 0.95 | 2.25 |
| Thrissur | 10.349 | 76.361 | Southern High Hills | -1.63 | 0.11 | 0.24 | -1.40 | -2.01 | -0.25 | 1.02 | 0.79 | 0.33 | 1.58 |
| Palakkad | 11.23 | 76.697 | Attappady Dry Hills | -1.99 | -0.37 | 0.07 | -1.10 | -2.14 | 0.44 | 0.93 | 1.07 | 0.39 | 2.35 |
| Palakkad | 11.036 | 76.765 | Attappady Hills | -1.99 | -0.37 | 0.07 | -1.10 | -2.14 | 0.44 | 0.93 | 1.07 | 0.39 | 2.35 |
| Palakkad | 11.131 | 76.432 | Northern High Hills | -1.45 | 0.32 | 0.64 | -1.70 | -2.09 | -0.59 | 0.71 | 0.35 | -0.07 | 1.28 |
| Palakkad | 11.039 | 76.302 | Northern Foot Hills | -1.45 | 0.32 | 0.64 | -1.70 | -2.09 | -0.59 | 0.71 | 0.35 | -0.07 | 1.28 |
| Palakkad | 10.738 | 76.095 | North Central Laterites | -1.63 | 0.11 | 0.24 | -1.40 | -2.01 | -0.25 | 1.02 | 0.79 | 0.33 | 1.58 |
| Palakkad | 10.711 | 76.577 | Palakkad Central Plains | -2.10 | -0.10 | -0.18 | -0.90 | -2.10 | -0.01 | 0.91 | 0.97 | 0.95 | 2.25 |
| Palakkad | 10.372 | 76.783 | Southern High Hills | -2.10 | -0.10 | -0.18 | -0.90 | -2.10 | -0.01 | 0.91 | 0.97 | 0.95 | 2.25 |
| Palakkad | 10.83 | 76.756 | Palakkad Eastern Plains | -1.99 | -0.37 | 0.07 | -1.10 | -2.14 | 0.44 | 0.93 | 1.07 | 0.39 | 2.35 |

### 4.5.2 Southwest Monsoon Rainfall

#### 4.5.2.1 Palakkad District

The analysis of the Standard Precipitation Index (SPI) showed that the year 2015 experienced severe drought and the years 2002, 2003 and 2016 experienced moderate drought in Palakkad district (Table 4.20). During 1999, Northern High Hills and Northern Foot Hills experienced moderate drought and the remaining areas were affected by severe drought. In 2012, the Northern High Hills, Northern Foot Hills and North Central Laterites experienced moderate drought, while the remaining areas experienced severe drought.

During 1999, Palakkad Eastern Plains, Attappady Dry Hills and Attappady Hills observed moderate wetness. During 1997, the Northern High Hills, Northern Foot Hills and North Central Laterites experienced severe wetness and the remaining regions experienced moderate wetness. In 2007, Palakkad Central Plains and Southern High Hills experienced severe wetness and the remaining regions experienced extreme wetness. During 2013, Northern High Hills and Northern Foot Hills experienced severe wetness and the remaining regions experienced extreme wetness. During 2018 and 2019, Palakkad district experienced moderate wetness, except for the AEUs Northern High Hills and Northern Foot Hills.

#### 4.5.2.2 Thrissur District

The analysis of the standard precipitation index (SPI) showed that the years 1999, 2015 and 2016 had experienced drought in Thrissur district (Table 4.20). During 1997, the Pokkali region experienced extreme wetness, the Northern High Hills experienced moderate wetness and the remaining areas were affected by severe wetness. In 1999, the Northern Laterites experienced moderate drought and the remaining regions experienced severe drought. During 2000, Thrissur district experienced a moderate drought, except for the AEUs Northern Laterites and Southern High Hills. In 2002, Thrissur district experienced a moderate drought, except in the Pokkali region. During 2003, Northern Laterites and Northern High

Hills experienced moderate drought. In 2006, the Pokkali region had observed moderate wetness.

During 2007, the Northern High Hills experienced severe wetness and the remaining AEUs experienced extreme wetness. During 2013, Pokkali and Northern Laterites experienced moderate wetness. While 2018 experienced moderate wetness, expect Northern Laterites. During 2019, moderate wetness was experienced in the regions of Pokkali and Northern Laterites. In 2002, moderate wetness was experienced in the Northern High Hills.

#### 4.5.2.3 Ernakulam District

The analysis of the Standard Precipitation Index (SPI) showed that the year 1999 experienced severe drought and the years 2000 and 2016 experienced moderate drought in Ernakulam district (Table 4.20). During 1997, the Southern High Hills experienced severe wetness, and the remaining regions experienced extreme wetness. In 2002, the Southern Hills experienced a moderate drought. During 2006, moderate wetness was experienced in Ernakulam district, except in the Southern High Hills. During 2007, South Central Laterites and Southern and Central Foot Hills experienced severe wetness, and the remaining regions experienced extreme wetness.

During 2012, South Central Laterites and Southern and Central Foot Hills experienced severe drought and the remaining regions experienced moderate drought. In 2013 and 2018, moderate wetness occurred in the Pokkali region. During 2015, South Central Laterites and Southern and Central Foot Hills experienced severe drought, while the remaining regions experienced moderate drought.

Analyzing SPI on a southwest monsoon rainfall basis, Palakkad district was the most affected region in the central zone of Kerala.

Table 4.20. Standard Precipitation Index (SPI) during southwest monsoon rainfall from 1992-2021 (30 years period) in different AEUs of central zone Kerala

| District | Latitude | Longitude | AEU | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.163 | 76.178 | Pokkali | 0.12 | -0.94 | 0.46 | -0.20 | 0.22 | 2.08 | 0.18 | -1.87 | -1.33 | -0.20 |
| Ernakulam | 9.933 | 76.565 | South Central Laterites | 0.51 | -0.81 | 0.57 | -0.20 | 0.57 | 2.20 | 0.42 | -1.92 | -1.15 | 0.19 |
| Ernakulam | 10.051 | 76.663 | Southern and Central Foot Hills | 0.51 | -0.81 | 0.57 | -0.20 | 0.57 | 2.20 | 0.42 | -1.92 | -1.15 | 0.19 |
| Ernakulam | 10.252 | 76.534 | Southern High Hills | 0.37 | -0.77 | 0.58 | -0.20 | 0.24 | 1.81 | 0.26 | -1.71 | -1.20 | -0.10 |
| Thrissur | 10.675 | 75.984 | Northern coastal plains | 0.37 | -0.77 | 0.58 | -0.20 | 0.24 | 1.81 | 0.26 | -1.71 | -1.20 | -0.10 |
| Thrissur | 10.199 | 76.266 | Pokkali | 0.12 | -0.94 | 0.46 | -0.20 | 0.22 | 2.08 | 0.18 | -1.87 | -1.33 | -0.20 |
| Thrissur | 10.78 | 76.457 | Northern Laterites | 0.67 | -0.57 | 0.84 | -0.20 | 0.30 | 1.84 | 0.53 | -1.38 | -0.99 | -0.70 |
| Thrissur | 10.682 | 76.094 | Kole Lands | 0.37 | -0.77 | 0.58 | -0.20 | 0.24 | 1.81 | 0.26 | -1.71 | -1.20 | -0.10 |
| Thrissur | 10.43 | 76.573 | Northern High Hills | 0.67 | -0.71 | 0.42 | -0.20 | 0.57 | 1.45 | 0.28 | -1.95 | -0.97 | -0.40 |
| Thrissur | 10.349 | 76.361 | Southern High Hills | 0.37 | -0.77 | 0.58 | -0.20 | 0.24 | 1.81 | 0.26 | -1.71 | -1.20 | -0.10 |
| Palakkad | 11.23 | 76.697 | Attappady Dry Hills | 1.02 | -0.48 | 0.47 | -0.20 | 0.79 | 1.04 | 0.54 | -1.75 | -0.53 | -0.70 |
| Palakkad | 11.036 | 76.765 | Attappady Hills | 1.02 | -0.48 | 0.47 | -0.20 | 0.79 | 1.04 | 0.54 | -1.75 | -0.53 | -0.70 |
| Palakkad | 11.131 | 76.432 | Northern High Hills | 0.67 | -0.57 | 0.84 | -0.10 | 0.30 | 1.84 | 0.53 | -1.38 | -0.99 | -0.70 |
| Palakkad | 11.039 | 76.302 | Northern Foot Hills | 0.67 | -0.57 | 0.84 | -0.10 | 0.30 | 1.84 | 0.53 | -1.38 | -0.99 | -0.70 |
| Palakkad | 10.738 | 76.095 | North Central Laterites | 0.37 | -0.77 | 0.58 | -0.20 | 0.24 | 1.81 | 0.26 | -1.71 | -1.20 | -0.10 |
| Palakkad | 10.711 | 76.577 | Palakkad Central Plains | 0.67 | -0.71 | 0.42 | -0.20 | 0.57 | 1.45 | 0.28 | -1.95 | -0.97 | -0.40 |
| Palakkad | 10.372 | 76.783 | Southern High Hills | 0.67 | -0.71 | 0.42 | -0.20 | 0.57 | 1.45 | 0.28 | -1.95 | -0.97 | -0.40 |
| Palakkad | 10.83 | 76.756 | Palakkad Eastern Plains | 1.02 | -0.48 | 0.47 | -0.20 | 0.79 | 1.04 | 0.54 | -1.75 | -0.53 | -0.70 |

Table 4.20. Standard Precipitation Index (SPI) during southwest monsoon rainfall from 1992-2021 (30 years period) in different AEUs of central zone Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.163 | 76.178 | Pokkali | -0.83 | -0.84 | -0.85 | 0.41 | 1.04 | 2.14 | -0.40 | 0.24 | 0.38 | 0.00 |
| Ernakulam | 9.933 | 76.565 | South Central Laterites | -0.84 | -0.87 | -0.50 | 0.48 | 1.19 | 1.96 | -0.50 | 0.03 | 0.21 | -0.40 |
| Ernakulam | 10.051 | 76.663 | Southern and Central Foot Hills | -0.84 | -0.87 | -0.50 | 0.48 | 1.19 | 1.96 | -0.50 | 0.03 | 0.21 | -0.40 |
| Ernakulam | 10.252 | 76.534 | Southern High Hills | -1.08 | -0.97 | -0.77 | 0.03 | 0.86 | 2.38 | -0.30 | 0.49 | 0.42 | 0.15 |
| Thrissur | 10.675 | 75.984 | Northern coastal plains | -1.08 | -0.97 | -0.77 | 0.03 | 0.86 | 2.38 | -0.30 | 0.49 | 0.42 | 0.15 |
| Thrissur | 10.199 | 76.266 | Pokkali | -0.83 | -0.84 | -0.85 | 0.41 | 1.04 | 2.14 | -0.40 | 0.24 | 0.38 | 0.00 |
| Thrissur | 10.78 | 76.457 | Northern Laterites | -1.27 | -1.03 | -0.62 | -0.30 | 0.86 | 2.47 | -0.20 | 0.76 | 0.49 | 0.34 |
| Thrissur | 10.682 | 76.094 | Kole Lands | -1.08 | -0.97 | -0.77 | 0.03 | 0.86 | 2.38 | -0.30 | 0.49 | 0.42 | 0.15 |
| Thrissur | 10.43 | 76.573 | Northern High Hills | -1.09 | -1.07 | -0.48 | 0.00 | 0.73 | 1.96 | -0.50 | 0.21 | 0.32 | -0.20 |
| Thrissur | 10.349 | 76.361 | Southern High Hills | -1.08 | -0.97 | -0.77 | 0.03 | 0.86 | 2.38 | -0.30 | 0.49 | 0.42 | 0.15 |
| Palakkad | 11.23 | 76.697 | Attappady Dry Hills | -1.39 | -1.26 | -0.17 | -0.40 | 0.46 | 2.01 | -0.40 | 0.43 | 0.35 | -0.20 |
| Palakkad | 11.036 | 76.765 | Attappady Hills | -1.39 | -1.26 | -0.17 | -0.40 | 0.46 | 2.01 | -0.40 | 0.43 | 0.35 | -0.20 |
| Palakkad | 11.131 | 76.432 | Northern High Hills | -1.27 | -1.03 | -0.62 | -0.30 | 0.86 | 2.47 | -0.20 | 0.76 | 0.49 | 0.34 |
| Palakkad | 11.039 | 76.302 | Northern Foot Hills | -1.27 | -1.03 | -0.62 | -0.30 | 0.86 | 2.47 | -0.20 | 0.76 | 0.49 | 0.34 |
| Palakkad | 10.738 | 76.095 | North Central Laterites | -1.08 | -0.97 | -0.77 | 0.03 | 0.86 | 2.38 | -0.30 | 0.49 | 0.42 | 0.15 |
| Palakkad | 10.711 | 76.577 | Palakkad Central Plains | -1.09 | -1.07 | -0.48 | 0.00 | 0.73 | 1.96 | -0.50 | 0.21 | 0.32 | -0.20 |
| Palakkad | 10.372 | 76.783 | Southern High Hills | -1.09 | -1.07 | -0.48 | 0.00 | 0.73 | 1.96 | -0.50 | 0.21 | 0.32 | -0.20 |
| Palakkad | 10.83 | 76.756 | Palakkad Eastern Plains | -1.39 | -1.26 | -0.17 | -0.40 | 0.46 | 2.01 | -0.40 | 0.43 | 0.35 | -0.20 |

Table 4.20. Standard Precipitation Index (SPI) during southwest monsoon rainfall from 1992-2021 (30 years period) in different AEUs of central zone Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.163 | 76.178 | Pokkali | -1.47 | 1.19 | 0.34 | -1.40 | -1.16 | -0.05 | 1.08 | 0.95 | 0.91 | -0.30 |
| Ernakulam | 9.933 | 76.565 | South Central Laterites | -1.75 | 0.93 | 0.09 | -1.50 | -1.40 | 0.22 | 0.62 | 0.82 | 0.76 | 0.06 |
| Ernakulam | 10.051 | 76.663 | Southern and Central Foot Hills | -1.75 | 0.93 | 0.09 | -1.80 | -1.40 | 0.22 | 0.62 | 0.82 | 0.76 | 0.06 |
| Ernakulam | 10.252 | 76.534 | Southern High Hills | -1.44 | 0.87 | 0.47 | -1.60 | -1.17 | 0.07 | 1.07 | 1.04 | 0.94 | -0.30 |
| Thrissur | 10.675 | 75.984 | Northern coastal plains | -1.44 | 0.87 | 0.47 | -1.60 | -1.17 | 0.07 | 1.07 | 1.04 | 0.94 | -0.30 |
| Thrissur | 10.199 | 76.266 | Pokkali | -1.47 | 1.19 | 0.34 | -1.40 | -1.16 | -0.05 | 1.08 | 0.95 | 0.91 | -0.30 |
| Thrissur | 10.78 | 76.457 | Northern Laterites | -1.10 | 1.04 | 0.76 | -1.80 | -1.41 | -0.32 | 0.70 | 0.42 | 0.40 | -0.60 |
| Thrissur | 10.682 | 76.094 | Kole Lands | -1.44 | 0.87 | 0.47 | -1.60 | -1.17 | 0.07 | 1.07 | 1.04 | 0.94 | -0.30 |
| Thrissur | 10.43 | 76.573 | Northern High Hills | -1.77 | 0.62 | 0.24 | -1.60 | -1.24 | 0.71 | 1.20 | 1.32 | 1.22 | 0.33 |
| Thrissur | 10.349 | 76.361 | Southern High Hills | -1.44 | 0.87 | 0.47 | -1.60 | -1.17 | 0.07 | 1.07 | 1.04 | 0.94 | -0.30 |
| Palakkad | 11.23 | 76.697 | Attappady Dry Hills | -1.65 | 0.45 | 0.41 | -1.80 | -1.42 | 0.73 | 1.21 | 1.21 | 1.09 | 0.21 |
| Palakkad | 11.036 | 76.765 | Attappady Hills | -1.65 | 0.45 | 0.41 | -1.80 | -1.42 | 0.73 | 1.21 | 1.21 | 1.09 | 0.21 |
| Palakkad | 11.131 | 76.432 | Northern High Hills | -1.10 | 1.04 | 0.76 | -1.80 | -1.41 | -0.32 | 0.70 | 0.42 | 0.40 | -0.60 |
| Palakkad | 11.039 | 76.302 | Northern Foot Hills | -1.10 | 1.04 | 0.76 | -1.80 | -1.41 | -0.32 | 0.70 | 0.42 | 0.40 | -0.60 |
| Palakkad | 10.738 | 76.095 | North Central Laterites | -1.44 | 0.87 | 0.47 | -1.60 | -1.17 | 0.07 | 1.07 | 1.04 | 0.94 | -0.30 |
| Palakkad | 10.711 | 76.577 | Palakkad Central Plains | -1.77 | 0.62 | 0.24 | -1.60 | -1.24 | 0.71 | 1.20 | 1.32 | 1.22 | 0.33 |
| Palakkad | 10.372 | 76.783 | Southern High Hills | -1.77 | 0.62 | 0.24 | -1.60 | -1.24 | 0.71 | 1.20 | 1.32 | 1.22 | 0.33 |
| Palakkad | 10.83 | 76.756 | Palakkad Eastern Plains | -1.65 | 0.45 | 0.41 | -1.80 | -1.42 | 0.73 | 1.21 | 1.21 | 1.09 | 0.21 |

### 4.5.3 Northeast Monsoon

#### 4.5.3.1 Palakkad District

The analysis of standard precipitation index (SPI) showed that 2016 had experienced extreme drought in Northern High Hills and Northern Foot Hills and the remaining areas had experienced severe drought. Moderate drought occurred in the years 1995 and 2012. During 1993, moderate wetness was experienced in Palakkad district. While 1997, severe wetness was experienced in Palakkad Eastern Plains, Attappady Dry Hills and Attappady Hills and moderate wetness was experienced in North Central Laterites, Palakkad Central Plains and Southern High Hills. During 2000, moderate drought was experienced in Palakkad district except Northern High Hills and Northern Foot Hills. During 2005, severe drought was experienced in Attappady Dry Hills, Attappady Hills and Palakkad Eastern Plains and moderate wetness in Palakkad Central Plains and Southern High Hills.

During 2010, severe wetness was in Palakkad district. While 2017 Northern High Hills, Northern Foot Hills and North Central Laterites had experienced moderate drought and in 2018 had experienced moderate wetness. During 2021, extreme wetness was experienced in Palakkad district.

#### 4.5.3.2 Thrissur District

The analysis of standard precipitation index (SPI) showed that the years, 1995 and 2012 had experienced moderate drought in Palakkad district. During 2016, extreme drought was experienced in Northern Laterites and severe drought was experienced in the remaining regions. While 1993, moderate wet was experienced. During 1997, moderate wetness experienced in Northern coastal plains, Kole Lands, Northern High Hills and Southern High Hills. During 2000, moderate drought was occurred in thrissur district except the region Northern Laterites. During 2004 and

2006, Pokkali experienced moderate wetness and in 2005, Northern High Hills and Northern Laterites experienced moderate wetness.

While 2010, Pokkali region experienced moderate wetness and severe wetness in remaining regions. During 2011, Pokkali region experienced moderate drought condition. Northern coastal plains, Northern Laterites, Kole Lands and Southern High Hills experienced moderate drought in 2017 and moderate wetness in 2019. In 2021, Thrissur district experienced extreme wetness.

#### 4.5.3.3 Ernakulam District

The analysis of the Standard Precipitation Index (SPI) showed that Ernakulam district experienced a severe drought in 2016. The district experienced a moderate drought in 1995, 2000 and 2012. In 1993, severe wetness was experienced in South Central Laterites, Southern and Central Foot Hills, while the remaining regions encountered moderate wetness. During 1997, moderate wetness was experienced in the Southern High Hills. In 2008, the Pokkali region experienced moderate wetness. During 2005 and 2006, moderate wetness was experienced in all areas except the AEU Southern High Hills. In 2008, South Central Laterites, Southern and Central Foot Hills experienced moderate drought conditions. In 2010, severe wetness was experienced in the Southern High Hills, while the remaining areas encountered moderate wetness.

In 2011, the Pokkali region experienced a moderate drought. Southern High Hills experienced moderate drought in 2017 and moderate wetness in 2019. During 2021, Ernakulam district experienced extreme wetness.

Table 4.21. Standard Precipitation Index (SPI) during Northeast monsoon rainfall from 1992-2021 (30 years period) in different AEUs of central zone of Kerala

| District | Latitude | Longitude | AEU | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.163 | 76.178 | Pokkali | -0.42 | 1.47 | 0.56 | -1.10 | -0.20 | 0.88 | 0.25 | 0.73 | -1.39 | 0.04 |
| Ernakulam | 9.933 | 76.565 | South Central Laterites | -0.41 | 1.59 | 0.46 | -1.00 | -0.31 | 0.89 | 0.24 | 0.77 | -1.47 | -0.10 |
| Ernakulam | 10.051 | 76.663 | Southern and Central Foot Hills | -0.41 | 1.59 | 0.46 | -1.00 | -0.31 | 0.89 | 0.24 | 0.77 | -1.47 | -0.10 |
| Ernakulam | 10.252 | 76.534 | Southern High Hills | -0.16 | 1.29 | 0.57 | -1.30 | -0.22 | 1.03 | 0.00 | 0.75 | -1.22 | -0.30 |
| Thrissur | 10.675 | 75.984 | Northern coastal plains | -0.16 | 1.29 | 0.57 | -1.30 | -0.22 | 1.03 | 0.00 | 0.75 | -1.22 | -0.30 |
| Thrissur | 10.199 | 76.266 | Pokkali | -0.42 | 1.47 | 0.56 | -1.10 | -0.20 | 0.88 | 0.25 | 0.73 | -1.39 | 0.04 |
| Thrissur | 10.78 | 76.457 | Northern Laterities | 0.38 | 1.11 | 0.52 | -1.50 | -0.26 | 0.86 | 0.14 | 0.67 | -0.89 | -0.70 |
| Thrissur | 10.682 | 76.094 | Kole Lands | -0.16 | 1.29 | 0.57 | -1.30 | -0.22 | 1.03 | 0.12 | 0.75 | -1.22 | -0.30 |
| Thrissur | 10.43 | 76.573 | Northern High Hills | -0.32 | 1.37 | 0.46 | -1.20 | -0.32 | 1.32 | 0.00 | 0.89 | -1.38 | -0.30 |
| Thrissur | 10.349 | 76.361 | Southern High Hills | -0.16 | 1.29 | 0.57 | -1.30 | -0.22 | 1.03 | 0.00 | 0.75 | -1.22 | -0.30 |
| Palakkad | 11.23 | 76.697 | Attappady Dry Hills | 0.00 | 1.27 | 0.44 | -1.30 | -0.32 | 1.72 | 0.00 | 0.94 | -1.13 | -0.60 |
| Palakkad | 11.036 | 76.765 | Attappady Hills | 0.00 | 1.27 | 0.44 | -1.30 | -0.32 | 1.72 | 0.00 | 0.94 | -1.13 | -0.60 |
| Palakkad | 11.131 | 76.432 | Northern High Hills | 0.38 | 1.11 | 0.52 | -1.50 | -0.26 | 0.86 | 0.14 | 0.67 | -0.89 | -0.70 |
| Palakkad | 11.039 | 76.302 | Northern Foot Hills | 0.38 | 1.11 | 0.52 | -1.50 | -0.26 | 0.86 | 0.14 | 0.67 | -0.89 | -0.70 |
| Palakkad | 10.738 | 76.095 | North Central Laterites | -0.16 | 1.29 | 0.57 | -1.30 | -0.22 | 1.03 | 0.00 | 0.75 | -1.22 | -0.30 |
| Palakkad | 10.711 | 76.577 | Palakkad Central Plains | -0.32 | 1.37 | 0.46 | -1.20 | -0.32 | 1.32 | 0.00 | 0.89 | -1.38 | -0.30 |
| Palakkad | 10.372 | 76.783 | Southern High Hills | -0.32 | 1.37 | 0.46 | -1.20 | -0.32 | 1.32 | 0.00 | 0.89 | -1.38 | -0.30 |
| Palakkad | 10.83 | 76.756 | Palakkad Eastern Plains | 0.00 | 1.27 | 0.44 | -1.30 | -0.32 | 1.72 | 0.00 | 0.94 | -1.13 | -0.60 |

Table 4.21. Standard Precipitation Index (SPI) during Northeast monsoon rainfall from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.163 | 76.178 | Pokkali | 0.09 | 0.27 | 1.18 | 1.12 | 1.08 | -0.34 | -1 | -0.99 | 1.49 | -1 |
| Ernakulam | 9.933 | 76.565 | South Central Laterites | -0.09 | 0.21 | 0.87 | 1.38 | 1.04 | -0.35 | -1 | -0.98 | 1.36 | -0.80 |
| Ernakulam | 10.051 | 76.663 | Southern and Central Foot Hills | -0.09 | 0.21 | 0.87 | 1.38 | 1.04 | -0.35 | -1 | -0.98 | 1.36 | -0.80 |
| Ernakulam | 10.252 | 76.534 | Southern High Hills | 0.26 | -0.34 | 0.8 | 0.98 | 0.63 | -0.02 | -0.50 | -0.76 | 1.83 | -0.80 |
| Thrissur | 10.675 | 75.984 | Northern coastal plains | 0.26 | -0.34 | 0.8 | 0.98 | 0.63 | -0.02 | -0.50 | -0.76 | 1.83 | -0.80 |
| Thrissur | 10.199 | 76.266 | Pokkali | 0.09 | 0.27 | 1.18 | 1.12 | 1.08 | -0.34 | -1 | -0.99 | 1.49 | -1 |
| Thrissur | 10.78 | 76.457 | Northern Laterites | 0.65 | -0.92 | 0.2 | 0.78 | 0.24 | 0.24 | 0.09 | -0.28 | 1.87 | -0.50 |
| Thrissur | 10.682 | 76.094 | Kole Lands | 0.26 | -0.34 | 0.8 | 0.98 | 0.63 | -0.02 | -0.50 | -0.76 | 1.83 | -0.80 |
| Thrissur | 10.43 | 76.573 | Northern High Hills | -0.26 | -0.31 | 0.59 | 1.48 | 0.51 | 0.01 | -0.70 | -0.9 | 1.62 | -0.40 |
| Thrissur | 10.349 | 76.361 | Southern High Hills | 0.26 | -0.34 | 0.8 | 0.98 | 0.63 | -0.02 | -0.50 | -0.76 | 1.83 | -0.80 |
| Palakkad | 11.23 | 76.697 | Attappady Dry Hills | -0.21 | -0.75 | 0.13 | 1.71 | 0.13 | 0.35 | -0.30 | -0.74 | 1.58 | 0.10 |
| Palakkad | 11.036 | 76.765 | Attappady Hills | -0.21 | -0.75 | 0.13 | 1.71 | 0.13 | 0.35 | -0.30 | -0.74 | 1.58 | 0.10 |
| Palakkad | 11.131 | 76.432 | Northern High Hills | 0.65 | -0.92 | 0.2 | 0.78 | 0.24 | 0.24 | 0.09 | -0.28 | 1.87 | -0.50 |
| Palakkad | 11.039 | 76.302 | Northern Foot Hills | 0.65 | -0.92 | 0.2 | 0.78 | 0.24 | 0.24 | 0.09 | -0.28 | 1.87 | -0.50 |
| Palakkad | 10.738 | 76.095 | North Central Laterites | 0.26 | -0.34 | 0.8 | 0.98 | 0.63 | -0.02 | -0.50 | -0.76 | 1.83 | -0.80 |
| Palakkad | 10.711 | 76.577 | Palakkad Central Plains | -0.26 | -0.31 | 0.59 | 1.48 | 0.51 | 0.01 | -0.70 | -0.9 | 1.62 | -0.40 |
| Palakkad | 10.372 | 76.783 | Southern High Hills | -0.26 | -0.31 | 0.59 | 1.48 | 0.51 | 0.01 | -0.70 | -0.9 | 1.62 | -0.40 |
| Palakkad | 10.83 | 76.756 | Palakkad Eastern Plains | -0.21 | -0.75 | 0.13 | 1.71 | 0.13 | 0.35 | -0.30 | -0.74 | 1.58 | 0.10 |

Table 4.21. Standard Precipitation Index (SPI) during Northeast monsoon rainfall from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.163 | 76.178 | Pokkali | -1.29 | -0.74 | -0.67 | -0 | -1.69 | -0.85 | -0.30 | 0.99 | -0.52 | 2.26 |
| Ernakulam | 9.933 | 76.565 | South Central Laterites | -1.41 | -0.81 | -0.63 | -0.10 | -1.76 | -0.80 | -0.40 | 0.72 | 0.66 | 2.24 |
| Ernakulam | 10.051 | 76.663 | Southern and Central Foot Hills | -1.41 | -0.81 | -0.63 | -0.10 | -1.76 | -0.80 | -0.40 | 0.72 | 0.66 | 2.24 |
| Ernakulam | 10.252 | 76.534 | Southern High Hills | -1.13 | -0.77 | -0.32 | -0.10 | -1.94 | -1.06 | -0.40 | 1.18 | -0.44 | 2.51 |
| Thrissur | 10.675 | 75.984 | Northern coastal plains | -1.13 | -0.77 | -0.32 | -0.10 | -1.94 | -1.06 | -0.40 | 1.18 | -0.44 | 2.51 |
| Thrissur | 10.199 | 76.266 | Pokkali | -1.29 | -0.74 | -0.67 | 0 | -1.69 | -0.85 | -0.30 | 0.99 | -0.52 | 2.26 |
| Thrissur | 10.78 | 76.457 | Northern Laterites | -1.01 | -0.85 | -0.19 | -0.40 | -2.04 | -1.08 | -0.60 | 1.18 | -0.43 | 2.72 |
| Thrissur | 10.682 | 76.094 | Kole Lands | -1.13 | -0.77 | -0.32 | -0.10 | -1.94 | -1.06 | -0.40 | 1.18 | -0.44 | 2.51 |
| Thrissur | 10.43 | 76.573 | Northern High Hills | -1.27 | -0.83 | -0.45 | -0.10 | -1.95 | -0.52 | -0.50 | 0.97 | 0.94 | 2.09 |
| Thrissur | 10.349 | 76.361 | Southern High Hills | -1.13 | -0.77 | -0.32 | -0.10 | -1.94 | -1.06 | -0.40 | 1.18 | -0.44 | 2.51 |
| Palakkad | 11.23 | 76.697 | Attappady Dry Hills | -1.16 | -0.93 | -0.44 | -0.30 | -1.97 | -0.93 | -0.80 | 0.94 | 0.41 | 2.07 |
| Palakkad | 11.036 | 76.765 | Attappady Hills | -1.16 | -0.93 | -0.44 | -0.30 | -1.97 | -0.93 | -0.80 | 0.94 | 0.41 | 2.07 |
| Palakkad | 11.131 | 76.432 | Northern High Hills | -1.01 | -0.85 | -0.19 | -0.40 | -2.04 | -1.08 | -0.60 | 1.18 | -0.43 | 2.72 |
| Palakkad | 11.039 | 76.302 | Northern Foot Hills | -1.01 | -0.85 | -0.19 | -0.40 | -2.04 | -1.08 | -0.60 | 1.18 | -0.43 | 2.72 |
| Palakkad | 10.738 | 76.095 | North Central Laterites | -1.13 | -0.77 | -0.32 | -0.10 | -1.94 | -1.06 | -0.40 | 1.18 | -0.44 | 2.51 |
| Palakkad | 10.711 | 76.577 | Palakkad Central Plains | -1.27 | -0.83 | -0.45 | -0.10 | -1.95 | -0.98 | -0.50 | 0.97 | 0.94 | 2.09 |
| Palakkad | 10.372 | 76.783 | Southern High Hills | -1.27 | -0.83 | -0.45 | -0.10 | -1.95 | -0.98 | -0.50 | 0.97 | 0.94 | 2.09 |
| Palakkad | 10.83 | 76.756 | Palakkad Eastern Plains | -1.16 | -0.93 | -0.44 | -0.30 | -1.97 | -0.93 | -0.80 | 0.94 | 0.41 | 2.07 |

### 4.5.4 Summer Season Rainfall

#### 4.5.4.1 Palakkad District

The analysis of the Standard Precipitation Index (SPI) showed that during 1992, the Palakkad Central Plains and Southern High Hills experienced moderate drought conditions. During 1996, moderate drought occurred in the regions of the Northern High Hills, Northern Foot Hills, North Central Laterites, Palakkad Central Plains and Southern High Hills. In 1997, moderate drought was experienced in the North Central Laterites, Palakkad Central Plains and Southern High Hills and the remaining regions experienced severe drought. During 1998, a moderate drought was experienced in Palakkad district except in the AEUs, Northern High Hills and Northern Foot Hills. While 2000 had experienced severe drought in the Attappady Dry Hills, Attappady Hills and Palakkad Eastern Plains, the remaining regions had experienced moderate drought conditions.

During 2001, the Attappady Dry Hills, Attappady Hills, Northern High Hills, Northern Foot Hills and Palakkad Eastern Plains experienced moderate wetness. In 2004, extreme wetness was observed in Palakkad district. In 2006, the Northern High Hills and Northern Foot Hills experienced extreme wetness; the Attappady Dry Hills, Palakkad Eastern Plains and Attappady Hills experienced moderate wetness and the remaining areas experienced severe wetness. While the years 2008 and 2021 experienced moderate wetness. During 2013, Palakkad Central Plains, Southern High Hills, Palakkad Eastern Plains, Attappady Dry Hills and Attappady Hills experienced moderate drought. In 2015, Palakkad Eastern Plains, Attappady Dry Hills, and Attappady Hills experienced moderate wetness. During 2019, moderate drought was experienced in North Central Laterites.

#### 4.5.4.2 Thrissur District

The analysis of the Standard Precipitation Index (SPI) showed that the years 1996 and 2000 experienced moderate drought in Thrissur district. During 1997, the Northern Laterites experienced a severe drought and the remaining AEUs experienced a moderate drought. In 1998, a moderate drought was experienced in the district, except in the regions of Pokkali and Northern Laterites. During 2001, Northern Laterites experienced moderate wetness. In 2004, extreme wetness was observed in the district. During 2006, the Northern Laterites experienced extreme wetness and the remaining areas experienced severe wetness. During 2008, moderate wetness was experienced in the district, except in the Pokkali region. In the Northern High Hills, moderate drought was experienced in 2013 and moderate wetness in 2018. During 2019, moderate drought was experienced in the district, except in the AEU's Northern High Hills and Northern Laterites.

In 2021, the Northern High Hills and Northern Laterites experienced severe wetness, while the remaining regions experienced moderate wetness.

#### 4.5.4.3 Ernakulam District

The analysis of the Standard Precipitation Index (SPI) showed that the years 1996, 1997, 2000 and 2019 had experienced moderate drought in Ernakulam district. During 1992, moderate drought was experienced in South Central Laterites and Southern and Central Foot Hills. In 1998, South Central Laterites, Southern and Central Foot Hills, and Southern High Hills experienced moderate drought conditions.

During 2004, extreme wetness was observed in the district and severe wetness was experienced in this region. Southern High Hills experienced moderate wetness in 2008. In 2021, Ernakulam district experienced a severe drought.

Table 4.22. Standard Precipitation Index (SPI) during summer season rainfall from 1992-2021(30 years period) in different AEUs of central zone of Kerala

| District | Latitude | Longitude | AEU | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.163 | 76.178 | Pokkali | -0.91 | -0.72 | -0.41 | 0.68 | -1.48 | -1.24 | -1.00 | 0.27 | -1.24 | 0.53 |
| Ernakulam | 9.933 | 76.565 | South Central Laterites | -1.07 | -0.72 | -0.25 | 0.56 | -1.38 | -1.22 | -1.00 | 0.24 | -1.30 | 0.65 |
| Ernakulam | 10.051 | 76.663 | Southern and Central Foot Hills | -1.07 | -0.72 | -0.25 | 0.56 | -1.38 | -1.22 | -1.00 | 0.24 | -1.30 | 0.65 |
| Ernakulam | 10.252 | 76.534 | Southern High Hills | -0.69 | -0.71 | -0.36 | 0.34 | -1.27 | -1.43 | -1.10 | 0.29 | -1.29 | 0.79 |
| Thrissur | 10.675 | 75.984 | Northern coastal plains | -0.69 | -0.71 | -0.36 | 0.34 | -1.27 | -1.43 | -1.10 | 0.29 | -1.29 | 0.79 |
| Thrissur | 10.199 | 76.266 | Pokkali | -0.91 | -0.72 | -0.41 | 0.68 | -1.48 | -1.24 | -1.00 | 0.27 | -1.24 | 0.53 |
| Thrissur | 10.78 | 76.457 | Northern Laterites | -0.37 | -0.73 | -0.38 | 0.11 | -1.02 | -1.50 | -1.00 | 0.49 | -1.27 | 1.05 |
| Thrissur | 10.682 | 76.094 | Kole Lands | -0.69 | -0.71 | -0.36 | 0.34 | -1.27 | -1.43 | -1.10 | 0.29 | -1.29 | 0.79 |
| Thrissur | 10.43 | 76.573 | Northern High Hills | -1.03 | -0.59 | -0.09 | 0.28 | -1.00 | -1.45 | -1.30 | 0.00 | -1.43 | 0.95 |
| Thrissur | 10.349 | 76.361 | Southern High Hills | -0.69 | -0.71 | -0.36 | 0.34 | -1.27 | -1.43 | -1.10 | 0.29 | -1.29 | 0.79 |
| Palakkad | 11.23 | 76.697 | Attappady Dry Hills | -0.92 | -0.47 | -0.04 | -0.10 | -0.47 | -1.54 | -1.30 | -0.14 | -1.52 | 1.33 |
| Palakkad | 11.036 | 76.765 | Attappady Hills | -0.92 | -0.47 | -0.04 | -0.10 | -0.47 | -1.54 | -1.30 | -0.14 | -1.52 | 1.33 |
| Palakkad | 11.131 | 76.432 | Northern High Hills | -0.37 | -0.73 | -0.38 | 0.11 | -1.02 | -1.50 | -1.00 | 0.49 | -1.27 | 1.05 |
| Palakkad | 11.039 | 76.302 | Northern Foot Hills | -0.37 | -0.73 | -0.38 | 0.11 | -1.02 | -1.50 | -1.00 | 0.49 | -1.27 | 1.05 |
| Palakkad | 10.738 | 76.095 | North Central Laterites | -0.69 | -0.71 | -0.36 | 0.34 | -1.27 | -1.43 | -1.10 | 0.29 | -1.29 | 0.79 |
| Palakkad | 10.711 | 76.577 | Palakkad Central Plains | -1.03 | -0.59 | -0.09 | 0.28 | -1.00 | -1.45 | -1.30 | 0.00 | -1.43 | 0.95 |
| Palakkad | 10.372 | 76.783 | Southern High Hills | -1.03 | -0.59 | -0.09 | 0.28 | -1.00 | -1.45 | -1.30 | 0.00 | -1.43 | 0.95 |
| Palakkad | 10.83 | 76.756 | Palakkad Eastern Plains | -0.92 | -0.47 | -0.04 | -0.10 | -0.47 | -1.54 | -1.30 | -0.14 | -1.52 | 1.33 |

Table 4.22. Standard Precipitation Index (SPI) during summer season rainfall from 1992-2021(30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.163 | 76.178 | Pokkali | -0.06 | 0.22 | 3.07 | 0.27 | 1.72 | -0.41 | 0.92 | 0.62 | 0.01 | -0.10 |
| Ernakulam | 9.933 | 76.565 | South Central Laterites | -0.15 | 0.29 | 3.09 | 0.55 | 1.56 | -0.58 | 0.91 | 0.40 | -0.23 | -0.40 |
| Ernakulam | 10.051 | 76.663 | Southern and Central Foot Hills | -0.15 | 0.29 | 3.09 | 0.55 | 1.56 | -0.58 | 0.91 | 0.40 | -0.23 | -0.40 |
| Ernakulam | 10.252 | 76.534 | Southern High Hills | -0.15 | 0.01 | 3.03 | -0.10 | 1.87 | -0.11 | 1.22 | 0.47 | 0.03 | -0.10 |
| Thrissur | 10.675 | 75.984 | Northern coastal plains | -0.15 | 0.01 | 3.03 | -0.10 | 1.87 | -0.11 | 1.22 | 0.47 | 0.03 | -0.10 |
| Thrissur | 10.199 | 76.266 | Pokkali | -0.06 | 0.22 | 3.07 | 0.27 | 1.72 | -0.41 | 0.92 | 0.62 | 0.00 | -0.10 |
| Thrissur | 10.78 | 76.457 | Northern Laterites | -0.18 | -0.33 | 2.97 | -0.50 | 2.01 | 0.25 | 1.29 | 0.00 | 0.01 | -0.30 |
| Thrissur | 10.682 | 76.094 | Kole Lands | -0.15 | 0.01 | 3.03 | -0.10 | 1.87 | -0.11 | 1.22 | 0.47 | 0.03 | -0.10 |
| Thrissur | 10.43 | 76.573 | Northern High Hills | -0.45 | 0.27 | 2.88 | 0.38 | 1.56 | -0.51 | 1.24 | 0.35 | -0.26 | -0.10 |
| Thrissur | 10.349 | 76.361 | Southern High Hills | -0.15 | 0.01 | 3.03 | -0.10 | 1.87 | -0.11 | 1.22 | 0.47 | 0.03 | -0.10 |
| Palakkad | 11.23 | 76.697 | Attappady Dry Hills | -0.75 | 0.00 | 2.37 | 0.22 | 1.39 | -0.31 | 1.40 | -0.11 | -0.31 | 0.23 |
| Palakkad | 11.036 | 76.765 | Attappady Hills | -0.75 | 0.00 | 2.37 | 0.22 | 1.39 | -0.31 | 1.40 | -0.11 | -0.31 | 0.23 |
| Palakkad | 11.131 | 76.432 | Northern High Hills | -0.18 | -0.33 | 2.97 | -0.50 | 2.01 | 0.25 | 1.29 | 0.01 | 0.00 | -0.10 |
| Palakkad | 11.039 | 76.302 | Northern Foot Hills | -0.18 | -0.33 | 2.97 | -0.50 | 2.01 | 0.25 | 1.29 | 0.01 | 0.00 | -0.10 |
| Palakkad | 10.738 | 76.095 | North Central Laterites | -0.15 | 0.01 | 3.03 | -0.10 | 1.87 | -0.11 | 1.22 | 0.47 | 0.03 | -0.10 |
| Palakkad | 10.711 | 76.577 | Palakkad Central Plains | -0.45 | 0.27 | 2.88 | 0.38 | 1.56 | -0.51 | 1.24 | 0.35 | -0.26 | -0.10 |
| Palakkad | 10.372 | 76.783 | Southern High Hills | -0.45 | 0.27 | 2.88 | 0.38 | 1.56 | -0.51 | 1.24 | 0.35 | -0.26 | -0.10 |
| Palakkad | 10.83 | 76.756 | Palakkad Eastern Plains | -0.75 | 0.00 | 2.37 | 0.22 | 1.39 | -0.31 | 1.40 | -0.11 | -0.31 | 0.23 |

Table 4.22. Standard Precipitation Index (SPI) during summer season rainfall from 1992-2021(30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.163 | 76.178 | Pokkali | 0.03 | -0.85 | -0.22 | 0.00 | -0.49 | 0.21 | 0.28 | -1.31 | -0.14 | 1.90 |
| Ernakulam | 9.933 | 76.565 | South Central Laterites | 0.87 | -0.92 | -0.21 | 0.12 | -0.51 | 0.32 | 0.39 | -1.15 | -0.49 | 1.63 |
| Ernakulam | 10.051 | 76.663 | Southern and Central Foot Hills | 0.87 | -0.92 | -0.21 | 0.12 | -0.51 | 0.32 | 0.39 | -1.15 | -0.49 | 1.63 |
| Ernakulam | 10.252 | 76.534 | Southern High Hills | -0.12 | -0.97 | 0.02 | 0.24 | -0.76 | 0.29 | 0.68 | -1.19 | -0.48 | 1.54 |
| Thrissur | 10.675 | 75.984 | Northern coastal plains | -0.12 | -0.97 | 0.02 | 0.24 | -0.76 | 0.29 | 0.68 | -1.19 | -0.48 | 1.54 |
| Thrissur | 10.199 | 76.266 | Pokkali | 0.03 | -0.85 | -0.22 | 0.00 | -0.49 | 0.21 | 0.28 | -1.31 | -0.14 | 1.90 |
| Thrissur | 10.78 | 76.457 | Northern Laterites | -0.60 | -0.91 | 0.45 | 0.36 | -0.89 | 0.14 | 0.85 | -0.85 | -0.70 | 1.25 |
| Thrissur | 10.682 | 76.094 | Kole Lands | -0.12 | -0.97 | 0.02 | 0.24 | -0.76 | 0.29 | 0.68 | -1.19 | -0.48 | 1.54 |
| Thrissur | 10.43 | 76.573 | Northern High Hills | -0.18 | -1.03 | -0.02 | 0.65 | -0.64 | 0.60 | 1.12 | -0.93 | -0.75 | 1.32 |
| Thrissur | 10.349 | 76.361 | Southern High Hills | -0.12 | -0.97 | 0.02 | 0.24 | -0.76 | 0.29 | 0.68 | -1.19 | -0.48 | 1.54 |
| Palakkad | 11.23 | 76.697 | Attappady Dry Hills | -0.70 | -1.01 | 0.42 | 1.21 | -0.79 | 0.80 | 1.34 | -0.57 | -0.98 | 1.28 |
| Palakkad | 11.036 | 76.765 | Attappady Hills | -0.70 | -1.01 | 0.42 | 1.21 | -0.79 | 0.80 | 1.34 | -0.57 | -0.98 | 1.28 |
| Palakkad | 11.131 | 76.432 | Northern High Hills | -0.60 | -0.91 | 0.45 | 0.36 | -0.89 | 0.29 | 0.85 | -0.85 | -0.98 | 1.25 |
| Palakkad | 11.039 | 76.302 | Northern Foot Hills | -0.60 | -0.91 | 0.45 | 0.36 | -0.89 | 0.29 | 0.85 | -0.85 | -0.98 | 1.25 |
| Palakkad | 10.738 | 76.095 | North Central Laterites | -0.12 | -0.97 | 0.02 | 0.24 | -0.76 | 0.29 | 0.68 | -1.19 | -0.48 | 1.54 |
| Palakkad | 10.711 | 76.577 | Palakkad Central Plains | -0.18 | -1.03 | -0.02 | 0.65 | -0.64 | 0.60 | 1.12 | -0.93 | -0.75 | 1.32 |
| Palakkad | 10.372 | 76.783 | Southern High Hills | -0.18 | -1.03 | -0.02 | 0.65 | -0.64 | 0.60 | 1.12 | -0.93 | -0.75 | 1.32 |
| Palakkad | 10.83 | 76.756 | Palakkad Eastern Plains | -0.70 | -1.01 | 0.42 | 1.21 | -0.79 | 0.80 | 1.34 | -0.57 | -0.98 | 1.28 |

### 4.5.5 Winter Season Rainfall

#### 4.5.5.1 Palakkad District

The analysis of the Standard Precipitation Index (SPI) showed that the majority of the years experienced a near-normal value of -0.99 to 0.99. During 1994, the North Central Laterites, Palakkad Central Plains and Southern High Hills experienced severe wetness. In 2000, Palakkad district experienced extreme wetness except in the regions of the Northern High Hills and Northern Foot Hills. During 2003, Northern High Hills and Northern Foot Hills experienced moderate wetness. While in 2011, North Central Laterites experienced severe wetness, Northern High Hills, Northern Foot Hills, Palakkad Central Plains and Southern High Hills experienced moderate wetness. During 2021, extreme wetness was experienced in Palakkad district.

#### 4.5.5.2 Thrissur District

The analysis of the Standard Precipitation Index (SPI) showed that the majority of the years experienced a near-normal value of -0.99 to 0.99. During 1994, the Pokkali region experienced extreme wetness, and the Kole Lands, Northern High Hills, Southern High Hills, and Northern coastal plains experienced severe wetness. In 2000, the district experienced extreme wetness, except in the Northern Laterites region. During 2001 and 2005, the Northern High Hills and Southern High Hills experienced moderate wetness. During 2003, the district experienced moderate wetness compared to the northern coastal plains and Kole Lands.

During 2011, Northern High Hills and Southern High Hills experienced extreme wetness, severe drought in Kole Lands and Northern coastal plains, and moderate drought in Pokkali and Northern Laterites. In 2013, Northern High Hills and Southern High Hills experienced severe wetness, and Northern Laterites experienced moderate wetness. During 2021, extreme wetness was experienced in Thrissur district.

#### 4.5.5.3 Ernakulam District

The analysis of the Standard Precipitation Index (SPI) showed that the majority of the years experienced a near-normal value of -0.99 to 0.99. During the years 2000 and 2021, Ernakulam district experienced extreme wetness. In 1994, Southern High Hills experienced severe wetness and the remaining AEUs experienced extreme wetness.

During 2003, the Pokkali region experienced moderate wetness. In 2011, Southern High Hills experienced severe wetness, and the remaining regions experienced moderate wetness.

Table 4.23. Standard Precipitation Index (SPI) during winter season rainfall from 1992-2021 (30 years period) in different AEUs of central zone of Kerala

| District | Latitude | Longitude | AEU | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.163 | 76.178 | Pokkali | -0.84 | 0.05 | 2.44 | -0.10 | -0.63 | -0.87 | -0.80 | -0.78 | 2.88 | 0.61 |
| Ernakulam | 9.933 | 76.565 | South Central Laterites | -0.81 | 0.03 | 2.37 | -0.10 | -0.54 | -0.83 | -0.80 | -0.65 | 2.88 | 0.47 |
| Ernakulam | 10.051 | 76.663 | Southern and Central Foot Hills | -0.81 | 0.03 | 2.37 | -0.10 | -0.54 | -0.83 | -0.80 | -0.65 | 2.88 | 0.47 |
| Ernakulam | 10.252 | 76.534 | Southern High Hills | -0.85 | -0.05 | 1.82 | -0.10 | -0.62 | -0.84 | -0.80 | -0.79 | 2.49 | 0.45 |
| Thrissur | 10.675 | 75.984 | Northern coastal plains | -0.85 | -0.05 | 1.82 | -0.10 | -0.62 | -0.84 | -0.80 | -0.79 | 2.49 | 0.45 |
| Thrissur | 10.199 | 76.266 | Pokkali | -0.84 | 0.05 | 2.44 | -0.10 | -0.63 | -0.87 | -0.80 | -0.78 | 2.88 | 0.61 |
| Thrissur | 10.78 | 76.457 | Northern Laterites | -0.70 | -0.17 | 0.88 | 0.00 | -0.39 | -0.64 | -0.60 | -0.60 | -0.47 | 0.33 |
| Thrissur | 10.682 | 76.094 | Kole Lands | -0.85 | -0.05 | 1.82 | -0.10 | -0.62 | -0.84 | -0.80 | -0.79 | 2.49 | 0.45 |
| Thrissur | 10.43 | 76.573 | Northern High Hills | -0.81 | -0.03 | 1.70 | 0.02 | -0.55 | -0.77 | -0.60 | 0.12 | 3.53 | 1.02 |
| Thrissur | 10.349 | 76.361 | Southern High Hills | -0.81 | -0.03 | 1.70 | 0.02 | -0.55 | -0.77 | -0.60 | 0.12 | 3.53 | 1.02 |
| Palakkad | 11.23 | 76.697 | Attappady Dry Hills | -0.72 | -0.15 | 0.76 | 0.16 | -0.42 | -0.61 | -0.70 | -0.62 | 2.20 | -0.10 |
| Palakkad | 11.036 | 76.765 | Attappady Hills | -0.72 | -0.15 | 0.76 | 0.16 | -0.42 | -0.61 | -0.70 | -0.62 | 2.20 | -0.10 |
| Palakkad | 11.131 | 76.432 | Northern High Hills | -0.70 | -0.17 | 0.88 | 0.00 | -0.39 | -0.64 | -0.60 | -0.60 | -0.47 | 0.33 |
| Palakkad | 11.039 | 76.302 | Northern Foot Hills | -0.70 | -0.17 | 0.88 | 0.00 | -0.39 | -0.64 | -0.60 | -0.60 | -0.47 | 0.33 |
| Palakkad | 10.738 | 76.095 | North Central Laterites | -0.85 | -0.05 | 1.82 | -0.10 | -0.62 | -0.84 | -0.80 | -0.79 | 2.49 | 0.45 |
| Palakkad | 10.711 | 76.577 | Palakkad Central Plains | -0.81 | -0.03 | 1.71 | 0.02 | -0.55 | -0.77 | -0.80 | -0.73 | 2.67 | 0.16 |
| Palakkad | 10.372 | 76.783 | Southern High Hills | -0.81 | -0.03 | 1.71 | 0.02 | -0.55 | -0.77 | -0.80 | -0.73 | 2.67 | 0.16 |
| Palakkad | 10.83 | 76.756 | Palakkad Eastern Plains | -0.72 | -0.15 | 0.76 | 0.16 | -0.42 | -0.61 | -0.70 | -0.62 | 2.20 | -0.10 |

Table 4.23. Standard Precipitation Index (SPI) during winter season rainfall from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.163 | 76.178 | Pokkali | -0.40 | 1.05 | -0.28 | 0.72 | -0.70 | -0.82 | -0.50 | -0.68 | -0.53 | 1.48 |
| Ernakulam | 9.933 | 76.565 | South Central Laterites | -0.25 | 0.90 | -0.34 | 0.54 | -0.59 | -0.77 | -0.40 | -0.69 | -0.55 | 1.28 |
| Ernakulam | 10.051 | 76.663 | Southern and Central Foot Hills | -0.25 | 0.90 | -0.34 | 0.54 | -0.59 | -0.77 | -0.40 | -0.69 | -0.55 | 1.28 |
| Ernakulam | 10.252 | 76.534 | Southern High Hills | -0.46 | 0.97 | -0.36 | 0.55 | -0.63 | -0.74 | -0.30 | -0.69 | -0.53 | 1.61 |
| Thrissur | 10.675 | 75.984 | Northern coastal plains | -0.46 | 0.97 | -0.36 | 0.55 | -0.63 | -0.74 | -0.30 | -0.69 | -0.53 | 1.61 |
| Thrissur | 10.199 | 76.266 | Pokkali | -0.40 | 1.05 | -0.28 | 0.72 | -0.70 | -0.82 | -0.50 | -0.68 | -0.53 | 1.48 |
| Thrissur | 10.78 | 76.457 | Northern Laterites | -0.45 | 1.08 | -0.38 | 0.34 | -0.40 | -0.51 | -0.10 | -0.60 | -0.48 | 1.07 |
| Thrissur | 10.682 | 76.094 | Kole Lands | -0.46 | 0.97 | -0.36 | 0.55 | -0.63 | -0.74 | -0.30 | -0.69 | -0.53 | 1.61 |
| Thrissur | 10.43 | 76.573 | Northern High Hills | 0.62 | 1.34 | 0.44 | 1.21 | 0.39 | 0.21 | 0.65 | 0.17 | 0.27 | 2.19 |
| Thrissur | 10.349 | 76.361 | Southern High Hills | 0.62 | 1.34 | 0.44 | 1.21 | 0.39 | 0.21 | 0.65 | 0.17 | 0.27 | 2.19 |
| Palakkad | 11.23 | 76.697 | Attappady Dry Hills | -0.23 | 0.19 | -0.47 | 0.07 | -0.26 | -0.45 | 0.00 | -0.63 | -0.58 | 0.81 |
| Palakkad | 11.036 | 76.765 | Attappady Hills | -0.23 | 0.19 | -0.47 | 0.07 | -0.26 | -0.45 | 0.00 | -0.63 | -0.58 | 0.81 |
| Palakkad | 11.131 | 76.432 | Northern High Hills | -0.45 | 1.08 | -0.38 | 0.34 | -0.40 | -0.51 | -0.10 | -0.60 | -0.48 | 1.07 |
| Palakkad | 11.039 | 76.302 | Northern Foot Hills | -0.45 | 1.08 | -0.38 | 0.34 | -0.40 | -0.51 | -0.10 | -0.60 | -0.48 | 1.07 |
| Palakkad | 10.738 | 76.095 | North Central Laterites | -0.46 | 0.97 | -0.36 | 0.55 | -0.63 | -0.74 | -0.30 | -0.69 | -0.53 | 1.61 |
| Palakkad | 10.711 | 76.577 | Palakkad Central Plains | -0.24 | 0.48 | -0.41 | 0.36 | -0.46 | -0.64 | -0.20 | -0.68 | -0.58 | 1.33 |
| Palakkad | 10.372 | 76.783 | Southern High Hills | -0.24 | 0.48 | -0.41 | 0.36 | -0.46 | -0.64 | -0.20 | -0.68 | -0.58 | 1.33 |
| Palakkad | 10.83 | 76.756 | Palakkad Eastern Plains | -0.23 | 0.19 | -0.47 | 0.07 | -0.26 | -0.45 | 0.00 | -0.63 | -0.58 | 0.81 |

Table 4.23. Standard Precipitation Index (SPI) during winter season rainfall from 1992-2021 (30 years period) in different AEUs of central zone of Kerala (Contd..)

| District | Latitude | Longitude | AEU | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ernakulam | 10.163 | 76.178 | Pokkali | -0.48 | 0.53 | -0.48 | -0.80 | 0.27 | -0.47 | -0.70 | -0.66 | -0.23 | 1.62 |
| Ernakulam | 9.933 | 76.565 | South Central Laterites | -0.56 | 0.49 | -0.46 | -0.80 | -0.22 | -0.20 | -0.60 | -0.57 | -0.54 | 2.23 |
| Ernakulam | 10.051 | 76.663 | Southern and Central Foot Hills | -0.56 | 0.49 | -0.46 | -0.80 | -0.22 | -0.20 | -0.60 | -0.57 | -0.54 | 2.23 |
| Ernakulam | 10.252 | 76.534 | Southern High Hills | -0.50 | 0.76 | -0.64 | -0.80 | 0.04 | -0.34 | -0.50 | -0.62 | -0.23 | 2.75 |
| Thrissur | 10.675 | 75.984 | Northern coastal plains | -0.50 | 0.76 | -0.64 | -0.80 | 0.04 | -0.34 | -0.50 | -0.62 | -0.23 | 2.75 |
| Thrissur | 10.199 | 76.266 | Pokkali | -0.48 | 0.53 | -0.48 | -0.80 | 0.27 | -0.47 | -0.70 | -0.66 | -0.23 | 1.62 |
| Thrissur | 10.78 | 76.457 | Northern Laterites | -0.45 | 1.00 | -0.61 | -0.70 | -0.15 | 0.04 | -0.20 | -0.36 | -0.19 | 4.47 |
| Thrissur | 10.682 | 76.094 | Kole Lands | -0.50 | 0.76 | -0.64 | -0.80 | 0.04 | -0.34 | -0.50 | -0.62 | -0.23 | 2.75 |
| Thrissur | 10.43 | 76.573 | Northern High Hills | 0.27 | 1.59 | 0.25 | 0.10 | 0.47 | 0.83 | 0.54 | 0.33 | 0.31 | 3.98 |
| Thrissur | 10.349 | 76.361 | Southern High Hills | 0.27 | 1.59 | 0.25 | 0.10 | 0.47 | 0.83 | 0.54 | 0.33 | 0.31 | 3.98 |
| Palakkad | 11.23 | 76.697 | Attappady Dry Hills | -0.59 | 0.76 | -0.63 | -0.70 | -0.43 | 0.14 | -0.10 | -0.41 | -0.45 | 4.16 |
| Palakkad | 11.036 | 76.765 | Attappady Hills | -0.59 | 0.76 | -0.63 | -0.70 | -0.43 | 0.14 | -0.10 | -0.41 | -0.45 | 4.16 |
| Palakkad | 11.131 | 76.432 | Northern High Hills | -0.45 | 1.00 | -0.61 | -0.70 | -0.15 | 0.04 | -0.20 | -0.36 | -0.19 | 4.47 |
| Palakkad | 11.039 | 76.302 | Northern Foot Hills | -0.45 | 1.00 | -0.61 | -0.70 | -0.15 | 0.04 | -0.20 | -0.36 | -0.19 | 4.47 |
| Palakkad | 10.738 | 76.095 | North Central Laterites | -0.50 | 0.76 | -0.64 | -0.80 | 0.04 | -0.34 | -0.50 | -0.62 | -0.23 | 2.75 |
| Palakkad | 10.711 | 76.577 | Palakkad Central Plains | -0.59 | 0.73 | -0.60 | -0.80 | -0.38 | -0.02 | -0.30 | -0.52 | -0.54 | 3.12 |
| Palakkad | 10.372 | 76.783 | Southern High Hills | -0.59 | 0.73 | -0.60 | -0.80 | -0.38 | -0.02 | -0.30 | -0.52 | -0.54 | 3.12 |
| Palakkad | 10.83 | 76.756 | Palakkad Eastern Plains | -0.59 | 0.76 | -0.63 | -0.70 | -0.43 | 0.14 | -0.10 | -0.41 | -0.45 | 4.16 |

## 4.6 Normalized Difference Vegetation Index (NDVI)

### 4.6.1 Southwest Monsoon

#### 4.6.1.1 Palakkad District

The analysis of the Normalized Difference Vegetation Index (NDVI) reveals varying moisture conditions in different regions of the Palakkad district during the study period. In the major part of Palakkad district, the years 2012 and 2016 exhibited dry and moderate drought conditions. Specifically, the Attappady Dry Hills and Palakkad Central Plains showed dry conditions in both 2012 and 2016 (Table 4.24). The Attappady Hills experienced dry conditions in 2012 and moderate drought conditions in 2016. The Northern High Hills and Southern High Hills encountered dry conditions in 2016 and moderate drought conditions in 2012.

Conversely, the North Central Laterites and Palakkad Eastern Plains experienced moderate drought conditions in both 2012 and 2016. The Northern Foot Hills experienced moderate drought conditions in 2016 and wet conditions in 2012 and 2017. During 2017, the Attappady Hills showed moderately dry conditions, while all other regions experienced wet conditions.

#### 4.6.1.2 Thrissur District

The analysis of the Normalized Difference Vegetation Index (NDVI) reveals that the Southern High Hills and Kole Lands experienced extreme dry conditions in 2012. Pokkali and Northern Laterites had experienced moderate drought and the

remaining regions had experienced wet conditions (Table 4.24). During 2016, the Northern High Hills, Southern High Hills and Northern Laterites experienced moderate drought conditions. During 2017, wet conditions were observed in Thrissur district.

#### 4.6.1.3 Ernakulam District

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that Southern and Central Foot Hills experienced extreme dry conditions in 2012, moderate drought conditions in 2016 and wet conditions in 2017 (Table 4.24). South Central Laterites had dry conditions in 2012 and 2016 and moderate drought conditions in 2017. Southern High Hills experienced wet conditions in 2017 and moderate drought conditions in 2012 and 2016.

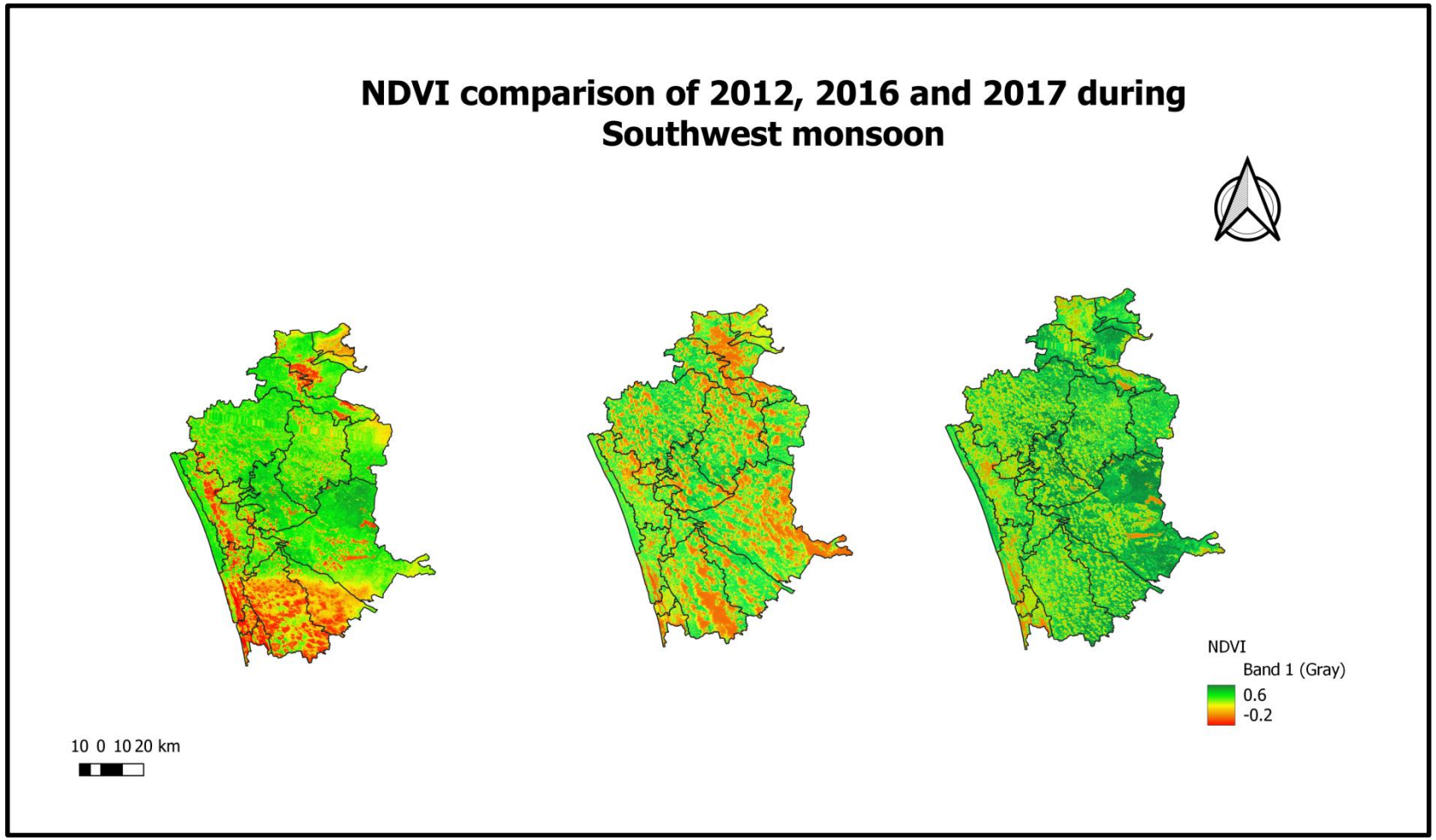



Fig.4.1. NDVI comparison of 2012, 2016 and 2017 during southwest monsoon

Comparing the years 2012, 2016 and 2017, the majority of regions in the central zone of Kerala experienced dry and moderately dry conditions in 2012 and 2016 (Fig 4.1). This indicates that the years 2012 and 2016 witnessed drought conditions in the central zone of Kerala.

Table 4.24. NDVI analysis over 3 years: 2012, 2016 and 2017 during Southwest monsoon

| **District** | **Latitude** | **Longitude** | **AEU** | **2012** | **2016** | **2017** |
|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.32 | 0.29 | 0.25 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.02 | 0.19 | 0.30 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | -0.10 | 0.38 | 0.54 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.34 | 0.25 | 0.46 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.42 | 0.31 | 0.40 |
| Thrissur | 10.20 | 76.27 | Pokkali | 0.38 | 0.34 | 0.43 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.38 | 0.02 | 0.45 |
| Thrissur | 10.68 | 76.09 | Kole Lands | -0.11 | 0.28 | 0.43 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.41 | 0.06 | 0.56 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | -0.05 | 0.12 | 0.50 |
| Palakkad | 11.23 | 76.70 | Attappady Dry Hills | 0.15 | 0.13 | 0.46 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | 0.10 | 0.24 | 0.36 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.33 | 0.07 | 0.49 |
| Palakkad | 11.04 | 76.30 | Northern Foot Hills | 0.42 | 0.34 | 0.52 |
| Palakkad | 10.74 | 76.10 | North Central Laterites | 0.26 | 0.38 | 0.50 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.07 | 0.07 | 0.46 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | 0.20 | 0.06 | 0.56 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.31 | 0.43 | 0.43 |

### 4.6.2 Northeast Monsoon

#### 4.6.2.1 Palakkad District

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that in 2012, Palakkad Central Plains, Southern High Hills and Attappady Hills had experienced extreme dry conditions and the remaining regions had experienced dry conditions. During 2016, Northern Foot Hills and North Central Laterites experienced moderate drought condition and the remaining regions experienced dry conditions. In 2017, the Southern High Hills, Palakkad Eastern Plains and Palakkad Eastern Plains experienced wet conditions, while the remaining regions experienced moderate drought conditions.

#### 4.6.2.2 Thrissur District

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that in 2012, the Northern High Hills experienced extreme dry conditions and the remaining regions experienced dry conditions. During 2016, the Northern coastal plains experienced dry conditions, the southern High Hills experienced wet conditions and the remaining regions experienced moderate drought conditions. During 2017, the Northern High Hills and Southern High Hills experienced wet conditions and the remaining regions experienced moderate drought conditions.

#### 4.6.2.3 Ernakulam District

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that the years 2012 and 2016 Ernakulam district has experienced dry condition. During 2017, Ernakulam district experienced moderate drought conditions.

Comparing the 3 years NDVI data, 2012 had experinced more drought condition in the central Kerala and compared to 2017, 2016 had experinced more dryness (Fig 4.2).

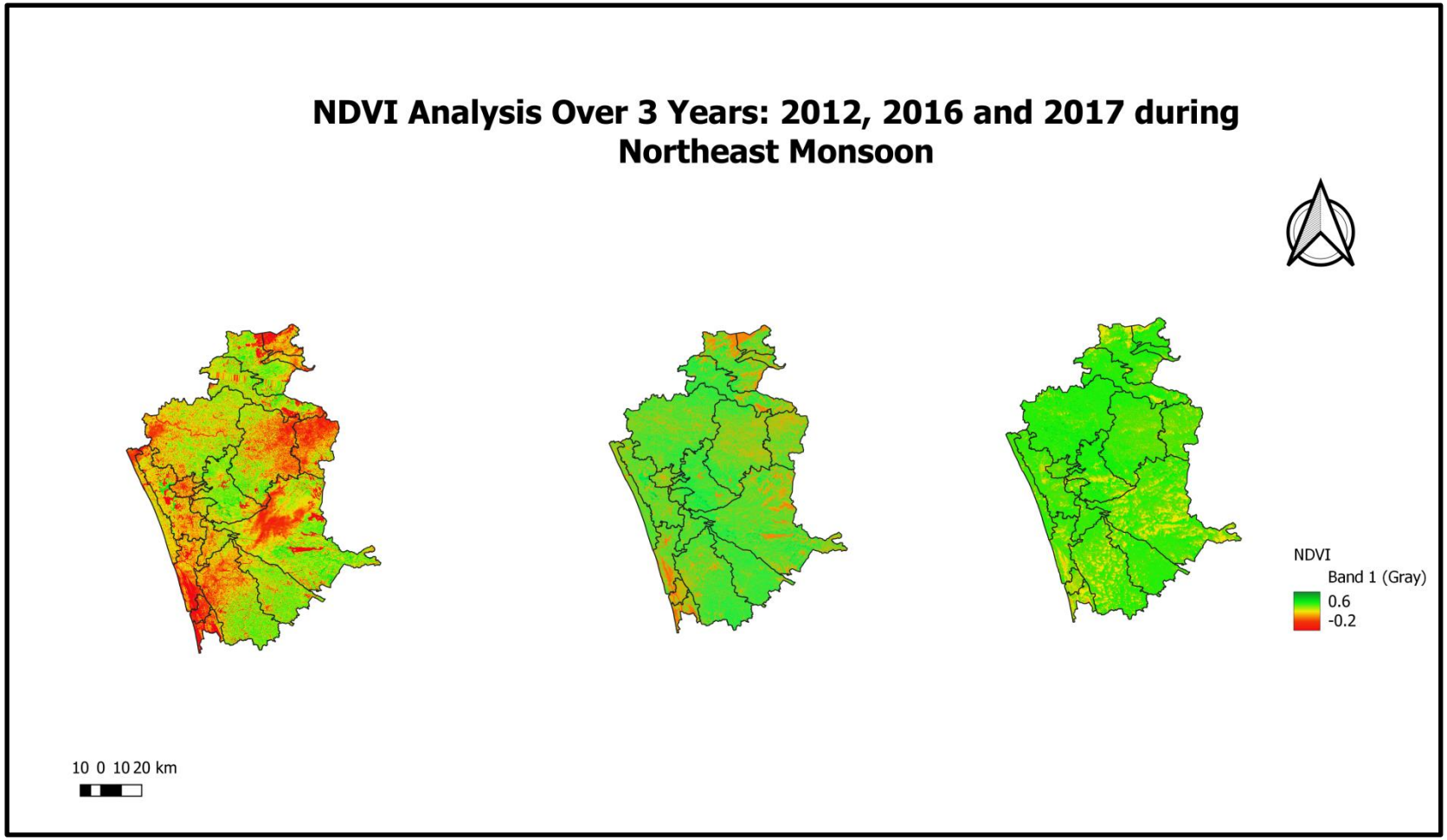



Fig 4.2 NDVI comparison of 2012, 2016 and 2017 during northeast monsoon

Table 4.25. NDVI analysis over 3 years: 2012, 2016 and 2017 during Northest monsoon

| District | Latitude | Longitude | AEU | 2012 | 2016 | 2017 |
|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | 0.01 | 0.16 | 0.24 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.18 | 0.34 | 0.36 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.16 | 0.33 | 0.35 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.13 | 0.34 | 0.24 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | 0.03 | 0.17 | 0.32 |
| Thrissur | 10.20 | 76.27 | Pokkali | 0.09 | 0.32 | 0.38 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | 0.16 | 0.30 | 0.34 |
| Thrissur | 10.68 | 76.09 | Kole Lands | 0.19 | 0.31 | 0.33 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | -0.04 | 0.23 | 0.40 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.11 | 0.41 | 0.40 |
| Palakkad | 11.23 | 76.70 | Attappady Dry Hills | 0.08 | 0.00 | 0.34 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | -0.16 | 0.19 | 0.31 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.16 | 0.01 | 0.42 |
| Palakkad | 11.04 | 76.30 | Northern Foot Hills | 0.19 | 0.34 | 0.35 |
| Palakkad | 10.74 | 76.10 | North Central Laterites | 0.13 | 0.31 | 0.36 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | -0.06 | 0.22 | 0.32 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | -0.38 | 0.11 | 0.40 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | 0.20 | 0.10 | 0.40 |

### 4.6.3 Summer Monsoon

#### 4.6.3.1 Palakkad District

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012, the regions of North Central Laterites, Palakkad Central Plains, Southern High Hills, Palakkad Eastern Plains and Attappady Hills experienced extreme dry conditions. Northern Foot Hills and Attappady Dry Hills had experienced dry conditions and Northern High Hills had experienced moderate drought conditions. During 2016, Attappady Hills, Palakkad Central Plains and Southern High Hills

experienced dry conditions and the remaining regions experienced moderate drought conditions. While in 2017, Attappady Hills experienced dry conditions, Attappady Dry Hills experienced moderate drought conditions, and the remaining regions experienced wet conditions.

#### 4.6.3.2 Thrissur District

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012, the regions of Northern High Hills and Southern High Hills experienced dry conditions and the remaining regions experienced extreme dry conditions. During 2016, Kole Land experienced dry conditions and the remaining regions experienced moderate drought conditions. In 2017, the northern coastal plains, Pokkali, and Kole lands experienced moderate drought conditions, while the remaining regions experienced wet conditions.

#### 4.6.3.3 Ernakulam District

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012, Pokkali experienced extreme dry conditions, Southern and Central Foot Hills experienced dry conditions and the remaining regions experienced moderate drought conditions.

Comparing the 3 years NDVI data, 2012 had experinced more drought condition in the central Kerala and compared to 2017, 2016 had experinced more dryness (Fig 4.3).

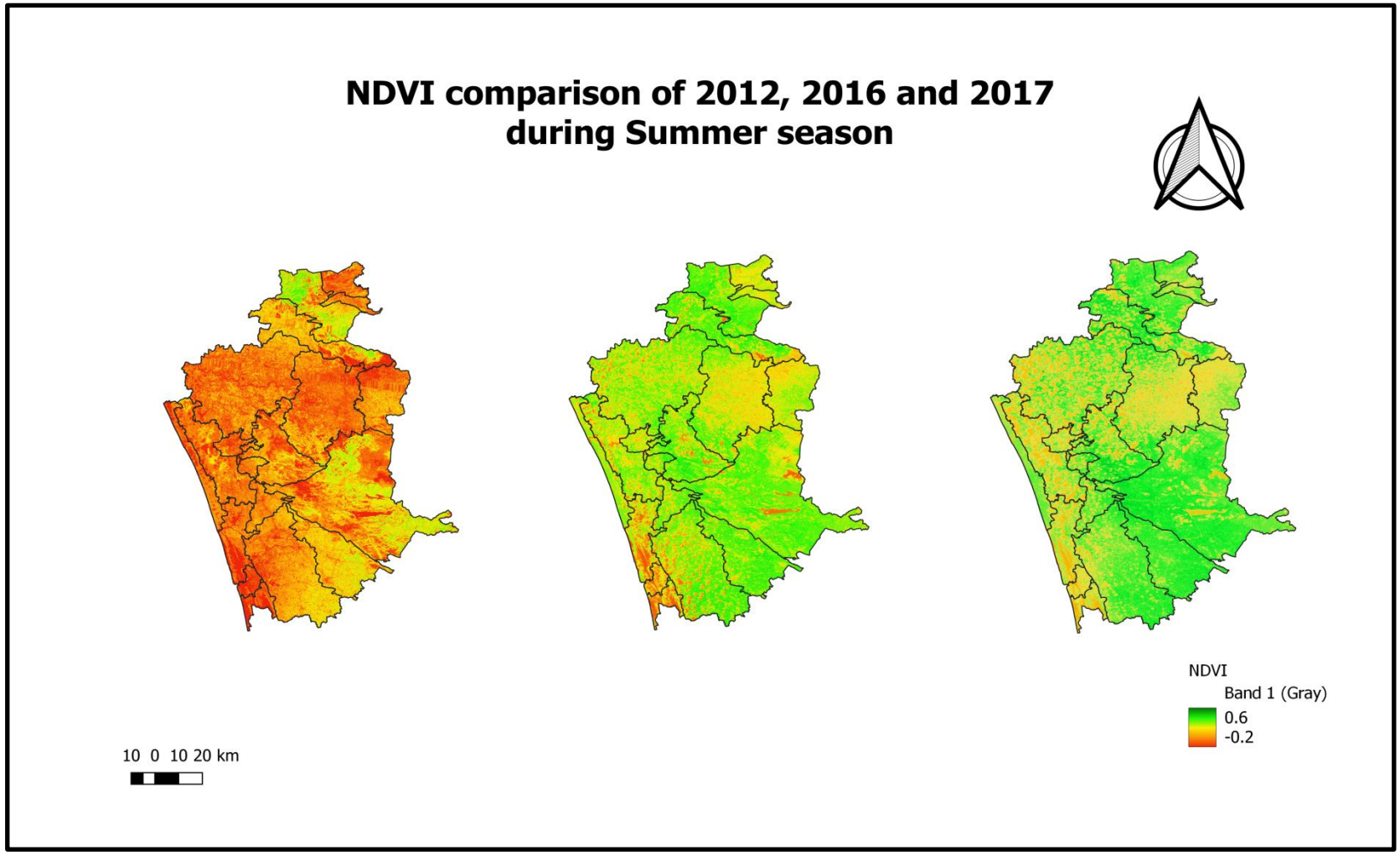



Fig 4.3. NDVI comparison of 2012, 2016 and 2017 during summer season

Table 4.26. NDVI analysis over 3 years: 2012, 2016 and 2017 during Summer Season

| District | Latitude | Longitude | AEU | 2012 | 2016 | 2017 |
|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | -0.04 | 0.24 | 0.24 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.22 | 0.30 | 0.40 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.11 | 0.33 | 0.42 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.23 | 0.44 | 0.43 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | -0.13 | 0.27 | 0.26 |
| Thrissur | 10.20 | 76.27 | Pokkali | -0.01 | 0.24 | 0.31 |
| Thrissur | 10.78 | 76.46 | Northern Laterites | -0.11 | 0.28 | 0.42 |
| Thrissur | 10.68 | 76.09 | Kole Lands | -0.01 | 0.12 | 0.22 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.01 | 0.35 | 0.41 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.13 | 0.39 | 0.41 |
| Palakkad | 11.23 | 76.70 | Attappady Dry Hills | 0.01 | 0.26 | 0.34 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | -0.12 | 0.13 | 0.19 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.33 | 0.39 | 0.41 |
| Palakkad | 11.04 | 76.30 | Northern Foot Hills | 0.16 | 0.37 | 0.42 |
| Palakkad | 10.74 | 76.10 | North Central Laterites | -0.14 | 0.30 | 0.45 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | -0.08 | 0.16 | 0.42 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | -0.40 | 0.02 | 0.42 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | -0.09 | 0.21 | 0.43 |

### 4.6.5 Winter Season

#### 4.6.5.1 Palakkad District

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012, Attappady Hills, North Central Laterites, Southern High Hills, and Palakkad Eastern Plains experienced extreme dry conditions, and the remaining regions experienced dry conditions. During 2016 and 2017, Palakkad district experienced moderate drought conditions.

#### 4.6.5.2 Thrissur District

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012, the regions of the Northern coastal plains, Pokkali, Northern Laterites, and Kole Lands experienced extreme dry conditions in Thrissur district, and the remaining regions experienced dry conditions. During 2016 and 2017, Thrissur district experienced moderate drought conditions.

#### 4.6.5.3 Ernakulam District

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012, the Pokkali region experienced extreme dry conditions, and the remaining regions experienced dry conditions in Ernakulam district. During 2016 and 2017, Ernakulam district experienced moderate drought conditions.

Comparing the 3 years NDVI data, 2012 had experinced more drought condition in the central Kerala and compared to 2017, 2016 had experinced more dryness (Fig 4.4).

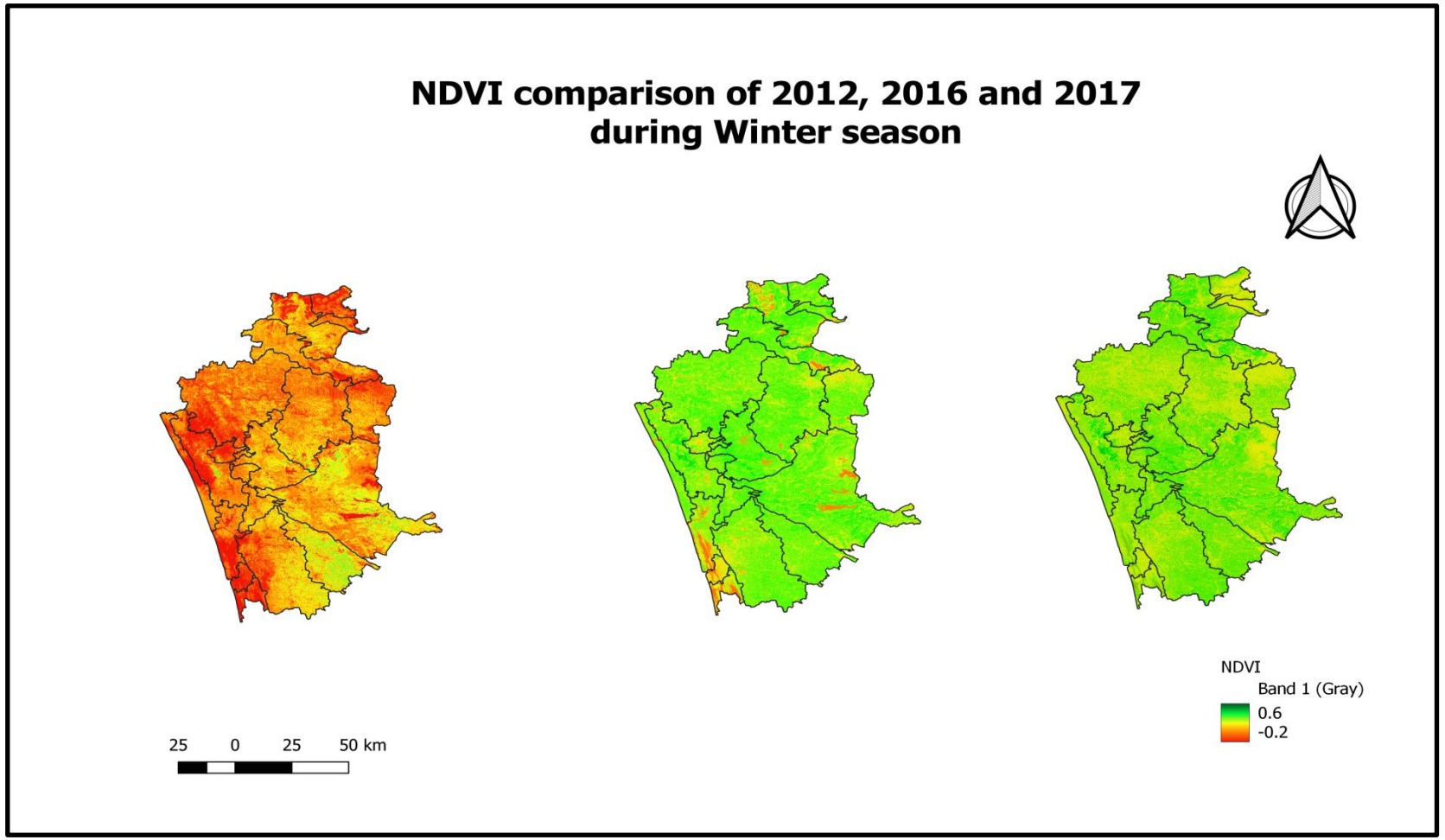



Fig 4.4. NDVI comparison of 2012, 2016 and 2017 during winter season

Table 4.27. NDVI analysis over 3 years: 2012, 2016 and 2017 during Winter Season

| District | Latitude | Longitude | AEU | 2012 | 2016 | 2017 |
|---|---|---|---|---|---|---|
| Ernakulam | 10.16 | 76.18 | Pokkali | -0.09 | 0.22 | 0.21 |
| Ernakulam | 9.93 | 76.57 | South Central Laterites | 0.15 | 0.32 | 0.32 |
| Ernakulam | 10.05 | 76.66 | Southern and Central Foot Hills | 0.18 | 0.33 | 0.35 |
| Ernakulam | 10.25 | 76.53 | Southern High Hills | 0.15 | 0.28 | 0.27 |
| Thrissur | 10.68 | 75.98 | Northern coastal plains | -0.02 | 0.26 | 0.26 |
| Thrissur | 10.20 | 76.27 | Pokkali | -0.05 | 0.31 | 0.32 |
| Thrissur | 10.78 | 76.46 | Northern Laterities | -0.02 | 0.30 | 0.25 |
| Thrissur | 10.68 | 76.09 | Kole Lands | -0.10 | 0.31 | 0.30 |
| Thrissur | 10.43 | 76.57 | Northern High Hills | 0.16 | 0.26 | 0.23 |
| Thrissur | 10.35 | 76.36 | Southern High Hills | 0.19 | 0.36 | 0.36 |
| Palakkad | 11.23 | 76.70 | Attappady Dry Hills | 0.01 | 0.27 | 0.27 |
| Palakkad | 11.04 | 76.77 | Attappady Hills | -0.32 | 0.26 | 0.23 |
| Palakkad | 11.13 | 76.43 | Northern High Hills | 0.06 | 0.37 | 0.35 |
| Palakkad | 11.04 | 76.30 | Northern Foot Hills | 0.16 | 0.31 | 0.29 |
| Palakkad | 10.74 | 76.10 | North Central Laterites | -0.07 | 0.31 | 0.28 |
| Palakkad | 10.71 | 76.58 | Palakkad Central Plains | 0.03 | 0.24 | 0.20 |
| Palakkad | 10.37 | 76.78 | Southern High Hills | -0.31 | 0.22 | 0.28 |
| Palakkad | 10.83 | 76.76 | Palakkad Eastern Plains | -0.04 | 0.27 | 0.28 |

# Discussion

# 5. DISCUSSION

## 5.1 Meterological Drought

### 5.1.1 Annual Rainfall

The analysis of meteorological drought showed that the years 2000, 2012 and 2016 experienced moderate drought conditions in the central zone of Kerala (Fig 5.1). Compared to other regions, Attappady Dry Hills, Attappady Hills and Palakkad Eastren Plains were the most drought-affected regions in central Kerala. During 2002, Palakkad Eastern Plains, Attappady Dry Hills and Attappady Hills experienced a deficiency of rainfall. In 2003, Attappady Dry Hills, Attappady Hills, Northern High Hills of Palakkad district, Palakkad Eastern Plains and Northern Foot Hills experienced a deficiency of rainfall.

During 2021 had experienced excess rainfall in all the AEUs of central Kerala. During 2007 experienced an excess of rainfall in the regions of Northern Laterites, Northern Foot Hills, Southern High Hills, Northern coastal plains, Kole Lands, Attappady Dry Hills, Attappady Hills, Northern High Hills, Northern Foot Hills, North Central Laterites and Palakkad Eastern Plains.

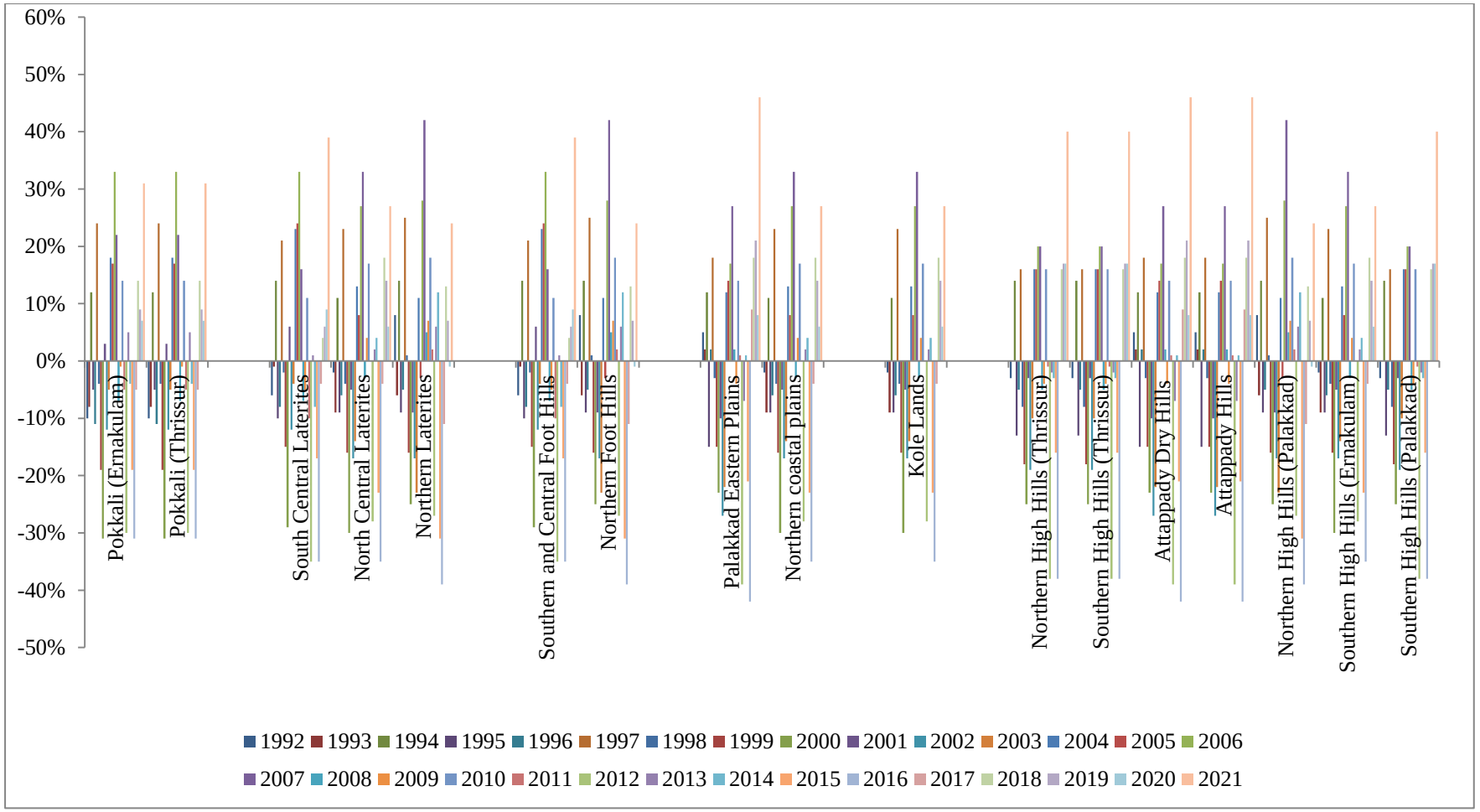


Fig 5.1 Annual Rainfall departure over a 30-year period (1992-2021) of Central zone of Kerala during

#### 5.1.1.1 Hilly Region

The Hilly Region is composed of several distinct areas, including the Northern High Hills, Southern High Hills, Attappady Dry Hills and Attappady Hills.

The analysis of meteorological drought showed that the years 2012 and 2016 experienced moderate drought conditions in the hilly region. Southern High Hills experienced moderate drought conditions in 2000 and the remaining AEUs experienced a deficiency of rainfall. In 2021, excess rainfall occurred in this region.

During 2002, both the Attappady Dry Hills and Attappady Hills witnessed a deficiency in rainfall, indicating a potential challenge for agriculture and water resources in these areas. In 2003, a broader area comprising the Attappady Dry Hills, Attappady Hills and Northern High Hills of Palakkad district encountered a deficiency of rainfall. During 2015; a similar pattern emerged, with the Attappady Dry Hills, Attappady Hills, Northern High Hills of Palakkad district and Southern Hills of Ernakulam district which experienced a deficiency in rainfall.

Analyzing the rainfall over the last 30 years, 2016 was the most drought-affected year (Fig 5.2). From the hilly regions, it becomes evident that the Attappady Dry Hills and Attappady Hills in Palakkad district are particularly prone to drought conditions.

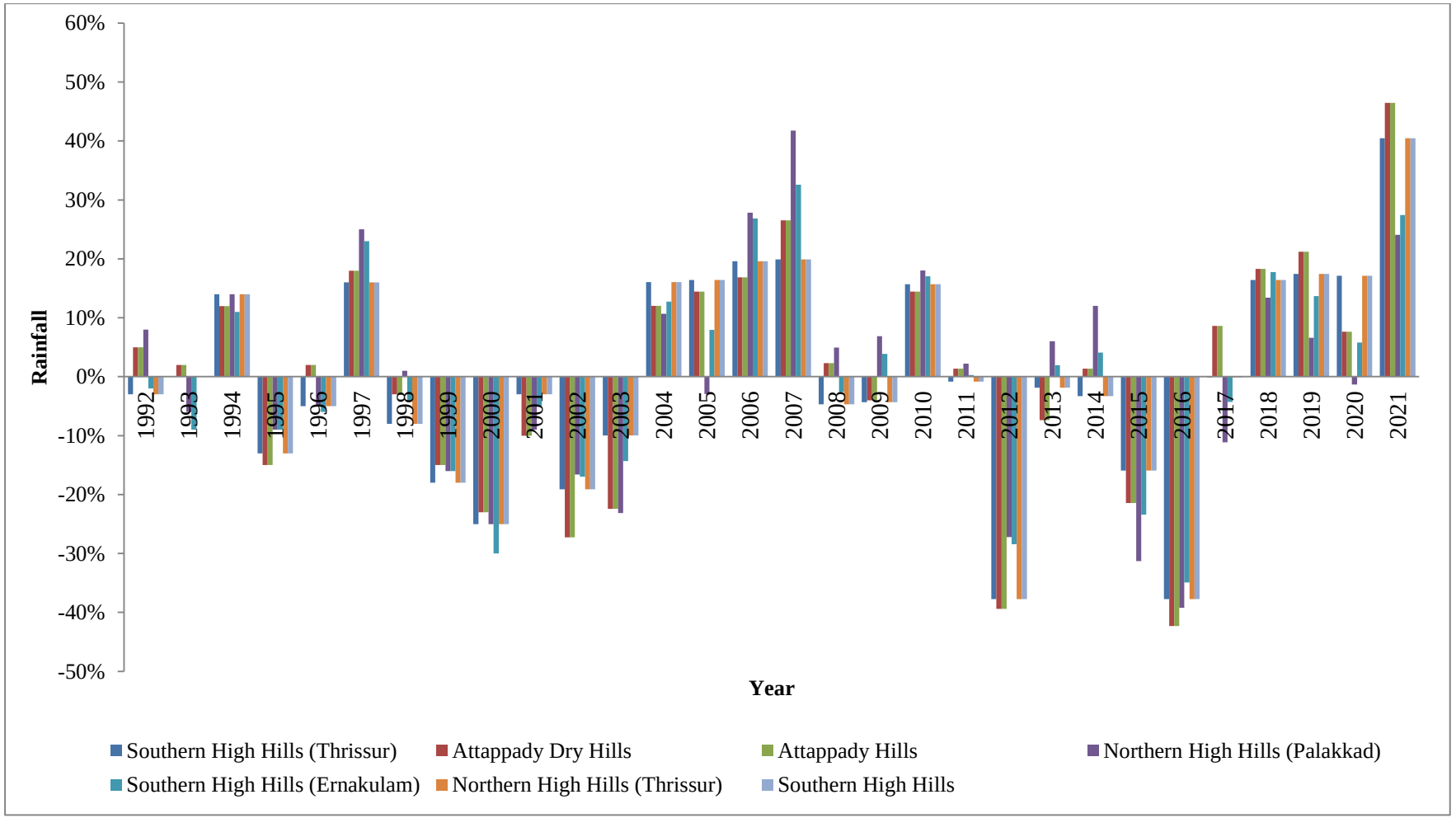



Fig 5.2 Annual rainfall departure over a 30-year period (1992-2021) of Hilly region

### 5.1.1.2 Pokkali Region

The analysis of meteorological drought showed that in the years 1997, 2006, 2007 and 2021, this region experienced an excess of rainfall, which may have posed challenges such as water management and potential flooding. Conversely, during the years 2000, 2012 and 2016, the Pokkali region faced moderate drought conditions.

When analyzing the data for meteorological drought on an annual basis over the last 30 years, it becomes evident that the Pokkali region has generally observed normal conditions for the majority of those years.

When compared to the last 30 years, 2000 and 2016 were the most drought-affected years in the Pokkali region, with a departure rainfall value of -30% (Fig 5.3).

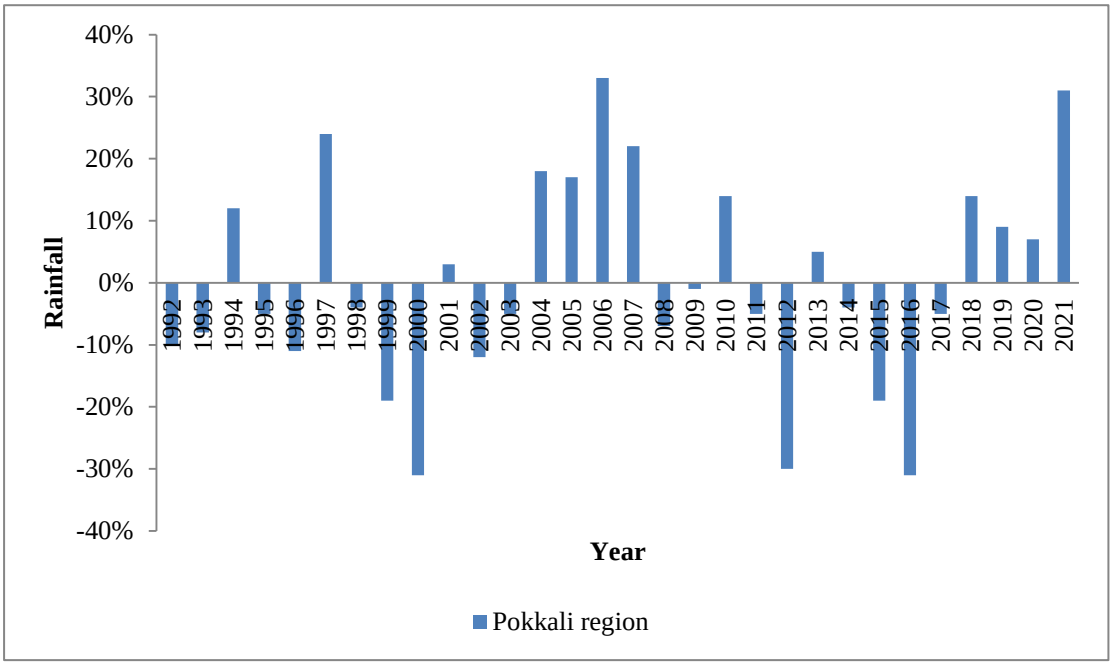



Fig 5.3 Annual rainfall departure over a 30-year period (1992-2021) of Pokkali region

### 5.1.1.3 Plains Region

The Plains region encompasses the Northern Coastal Plains, Palakkad Central Plains and Palakkad Eastern Plains, each having its own distinct climatic patterns. The analysis of meteorological drought showed that the years, 2012 and 2016 experienced

meteorological drought in the Plains region and in 2021, excess of rainfall occurred in this region.

During 2000, Northern Coastal Plains had affected moderate drought. In 1997, the Northern Coastal Plains experienced an excess of rainfall, while the Palakkad Eastern Plains faced a deficiency of rainfall in both 2002 and 2003. In 2006, there was an excess of rainfall observed in both the Northern Coastal Plains and Palakkad Central Plains. A similar pattern emerged in 2007, with all three AEUs within the Plains region experienced an excess of rainfall. In 2015, both the Northern Coastal Plains and Palakkad Eastern Plains observed a deficiency of rainfall. However, in 2019, there was an excess of rainfall occurring in the Palakkad Eastern Plains.

When compared to the last 30 years, 2016 was the most drought-affected year in the plains region (Fig 5.4). Palakkad Eastern Plains were the most affected region of the plains region in 2016, with a departure rainfall value of -42%.

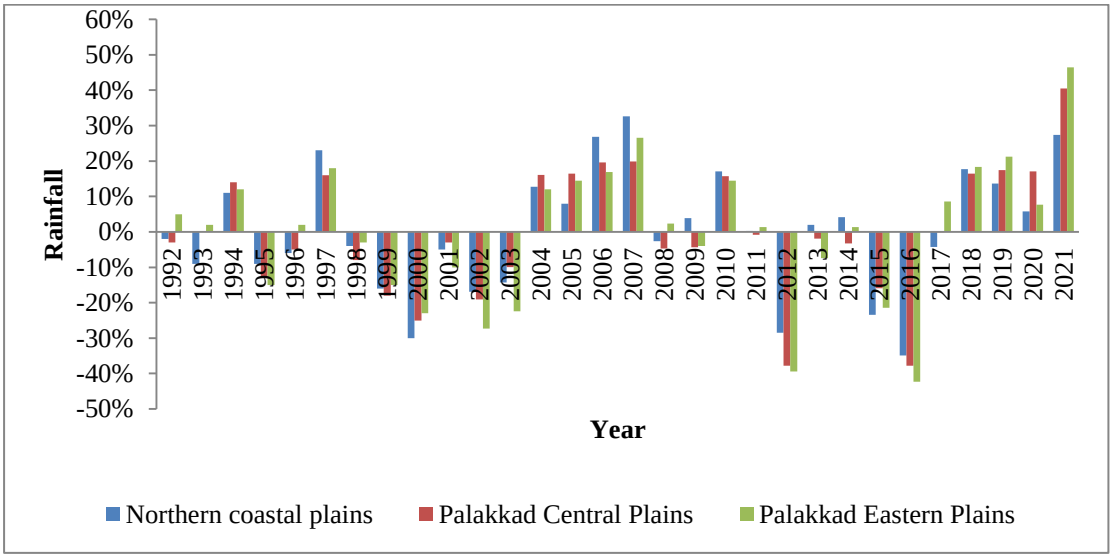



Fig 5.4 Annual rainfall departure over a 30-years period (1992-2021) of Plains region

### 5.1.1.4 Laterites Region

The Laterites region comprises three distinct areas: South Central Laterites, Northern Laterites and North Central Laterites.

The analysis of meteorological drought showed that in the years 1997, 2006, 2007 and 2021, this region experienced excess rainfall. Conversely, during the years 2000, 2012 and 2016, moderate drought conditions were observed in this region. In

2015, the North Central Laterites area faced a deficiency of rainfall, while the Northern Laterites were affected by moderate drought conditions.

When compared to the last 30 years period, 2016 was the most drought-affected year in the Laterite region (Fig 5.5). In 2016, the Northern Laterites were the most drought-affected region in the Laterites region. This study demonstrates that deficiencies in rainfall had a greater impact on Northern Laterites in Thrissur district compared to other AEUs.

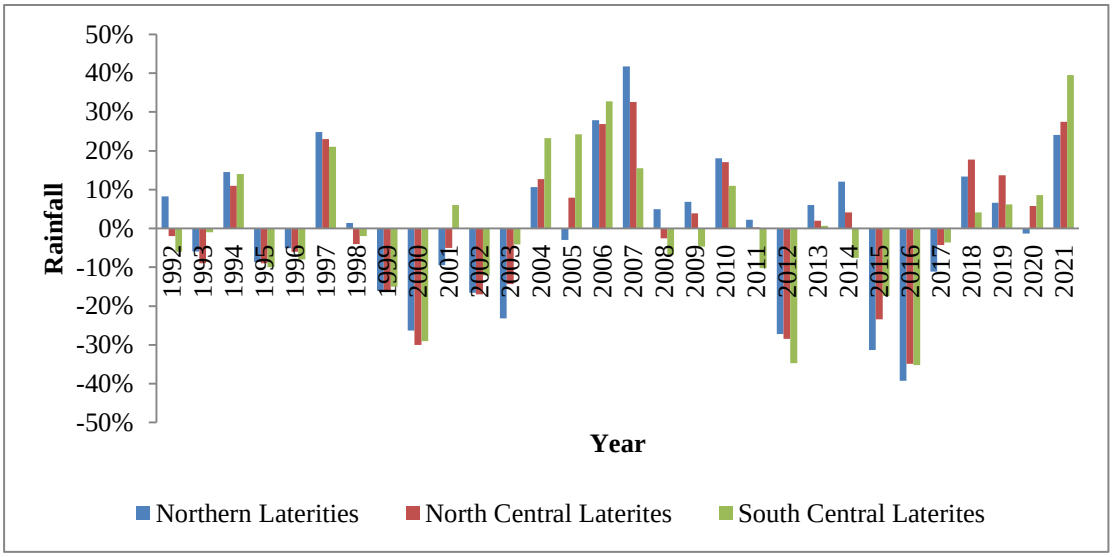



Fig 5.5 Annual rainfall departure over a 30-year period (1992-2021) of Laterites region

### 5.1.1.5 Foot Hills Region

This region includes the 2 AEUs, Southern and Central Foot Hills and Northern Foot Hills.

The analysis of meteorological drought showed that in the years 1997, 2006 and 2021, the Foot Hills Region experienced an excess of rainfall. Conversely, during the years 2012 and 2016, the region faced moderate drought, which could have had adverse effects on agriculture and water resources. In 2000, the Southern and Central Foot Hills faced moderate drought conditions. During 2003, the Northern Foot Hills specifically observed a deficiency of rainfall. On the other hand, the Southern and Central Foot Hills experienced excess rainfall in 2004 and 2005. During 2007, the

Northern Foot Hills region encountered another episode of excess rainfall, whereas in 2015, a deficiency in rainfall was observed.

When compared to the last 30 years, 2016 was the most drought-affected year in the Foot Hills region (Fig 5.6). During 2016, Northern Foot Hills was the most drought-affected region in the Foot Hills region. The Northern Foot Hills experienced a more pronounced deficiency of rainfall compared to the Southern and Central Foot Hills.

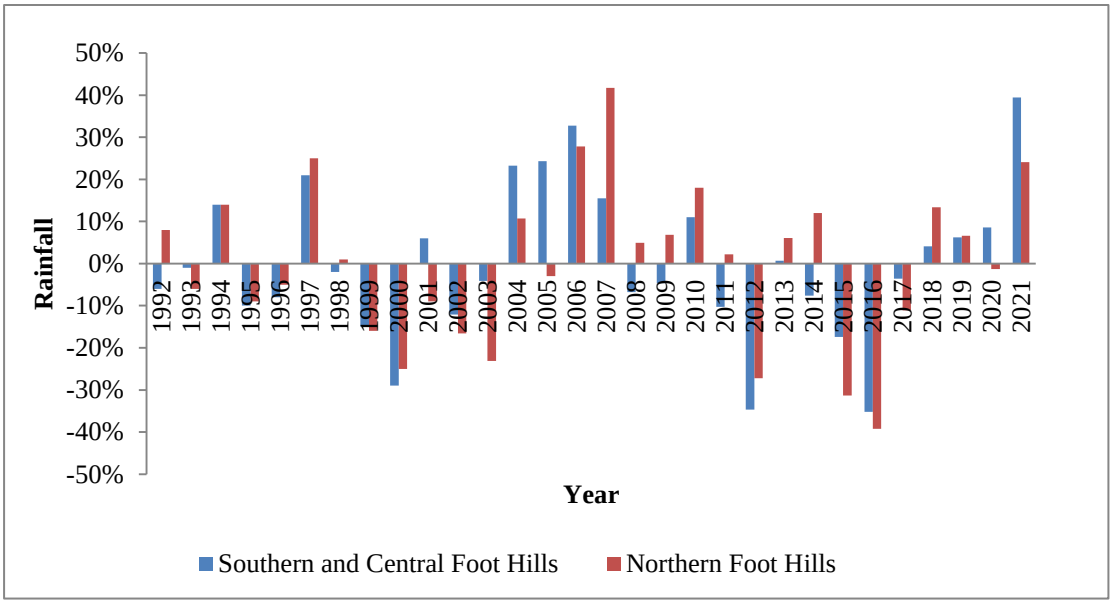
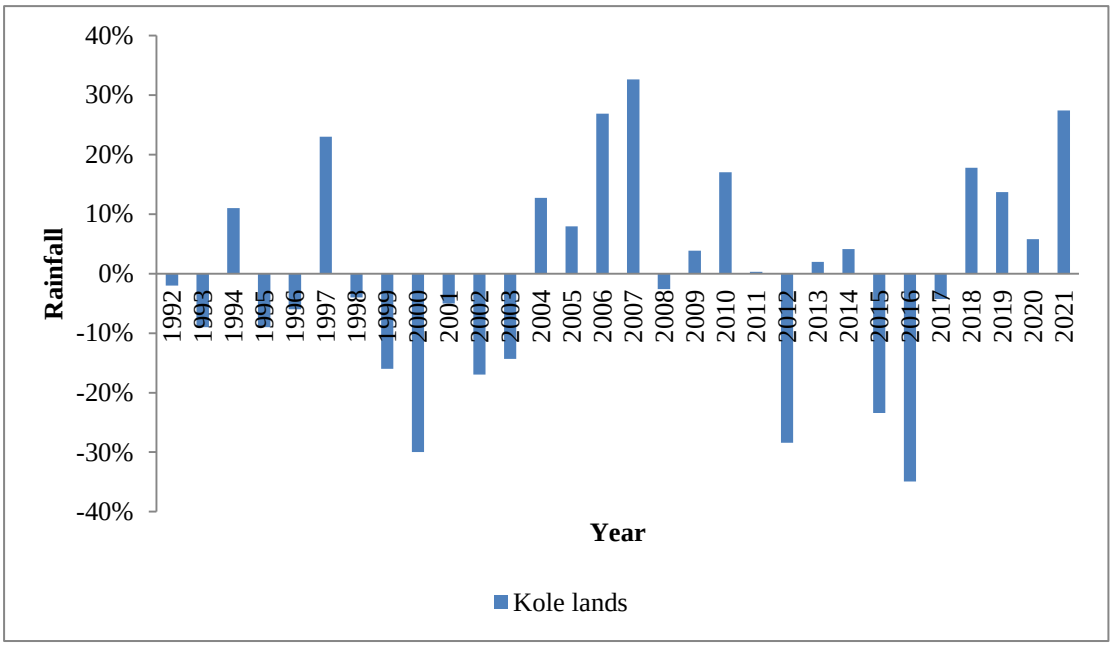



Fig 5.6 Annual rainfall departure over a 30-year period (1992-2021) of Foot Hills region

### 5.1.1.6 Kole lands

The Kole lands, a distinctive geographical feature situated in the Thrissur district, experienced moderate drought conditions in the years 2000, 2012 and 2016. In 2015, a deficiency in rainfall was observed, likely resulting in significant consequences for the region. Conversely, in the years 1997, 2006, 2007 and 2021, there was an excess of rainfall.

Compared to the last 30 years, 2016 was the most drought-affected year in Kole Land, with a departure value of -35% (Fig 5.7).




5.7 Annual rainfall departure over a 30-year period (1992-2021) of Kole lands

### 5.1.2 Southwest Monsoon Seasonal Rainfall

#### 5.1.2.1 Hilly Region

The analysis of meteorological drought showed that the years 1999, 2012, 2015 and 2016 had experienced moderate drought in this region and excess rainfall was observed in 1997 and 2007.

During 1992, both the Attappady Dry Hills and Attappady Hills experienced an excess of rainfall. However, in 2000, the Southern High Hills of Ernakulum district experienced moderate drought and deficiencies in rainfall were observed in the Northern High Hills, Southern High Hills of Palakkad and Thrissur districts. The years 2002 and 2003 also witnessed a deficiency of rainfall in this hilly region. Conversely, in 2006 and 2013, there was an excess of rainfall in the Northern High Hills of the Palakkad district. Notably, during the years 2018, 2019 and 2020, all AEUs recorded an excess of rainfall, except for the Northern High Hills of Palakkad district. Throughout the remaining years within the period 1992–2021, normal rainfall conditions were observed.

When compared to the last 30 years, 2015 was the most drought-affected year in the Hilly region (Fig 5.8). During 2015, Northern High Hills was the most affected region, with a departure value of -42%.

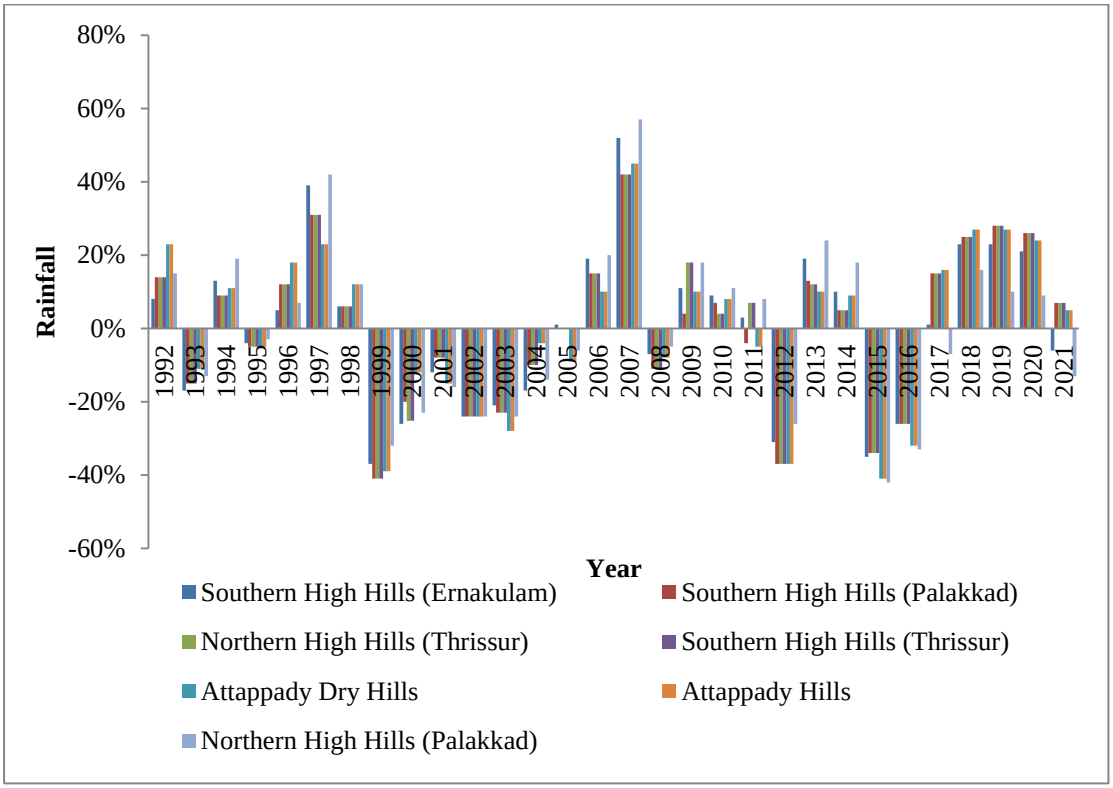



Fig 5.8 Rainfall departure over a 30-year period (1992-2021) of Hilly region during southwest monsoon

### 5.1.2.2 Pokkali Region

The analysis of meteorological drought showed that in the Pokkali region, there were periods of moderate drought conditions in the years 1999, 2000, 2012, 2015 and 2016 and a deficiency of rainfall in 1993. Conversely, the years 1997, 2006, 2007, 2013, 2018, 2019 and 2020 witnessed an excess of rainfall.

When compared to the last 30 years, 1999 was the most drought-affected year in the Pokkali region, with a departure value of -41% (Fig 5.9). Notably, the remaining years within the period 1992–2021 exhibited normal rainfall conditions in the Pokkali region.

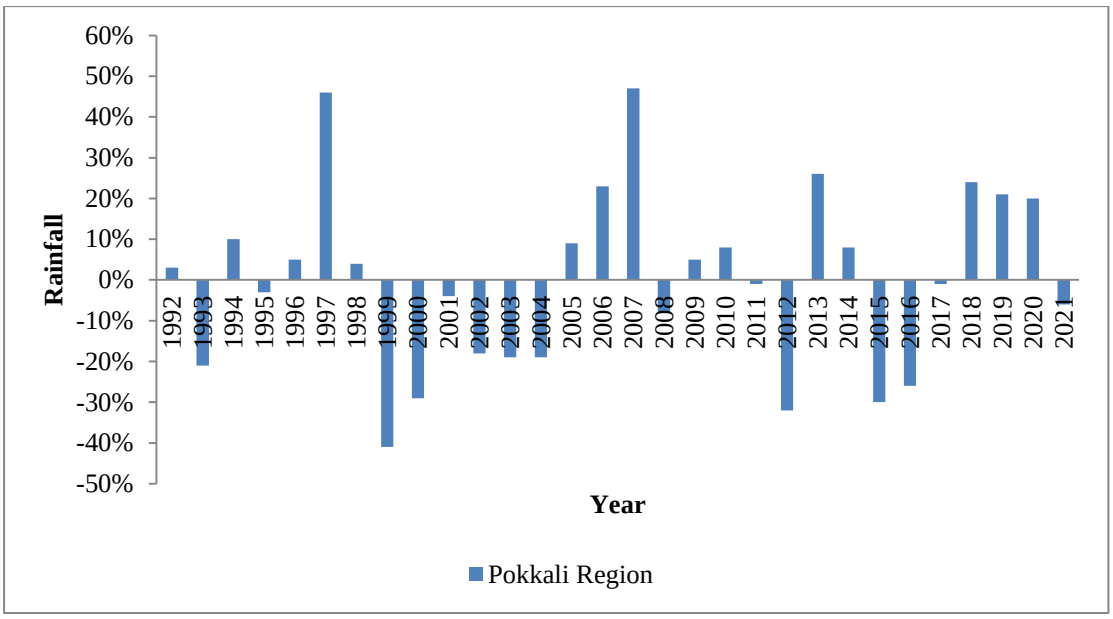



Fig 5.9 Rainfall departure over a 30-year period (1992-2021) of Pokkali region during southwest monsoon

### 5.1.2.3 Plains Region

The analysis of meteorological drought showed that the years 1999, 2012, 2015 and 2016 had experienced moderate drought and excess rainfall was observed in 1997, 2007, 2018, 2019 and 2020 in this region.

In the plains region, specifically in the Palakkad Eastern Plains, there was an excess of rainfall observed in 1992. Conversely, in 2000, deficiencies in rainfall occurred in the Palakkad Central Plains and moderate drought affected the Northern Coastal Plains. During 2002, a deficiency of rainfall was experienced in this region and in 2003, moderate drought was experienced in the Palakkad Eastern Plains and a deficiency of rainfall in the remaining areas.

When compared to the last 30 years, 2015 was the most drought-affected year in the Plains region (Fig 5.10). During 2015, the Palakkad Eastern Plains was the most drought-affected region in the plains region, with a departure value of -41%. Importantly, during the remaining years within the period 1992–2021, normal rainfall conditions prevailed in the plains region.

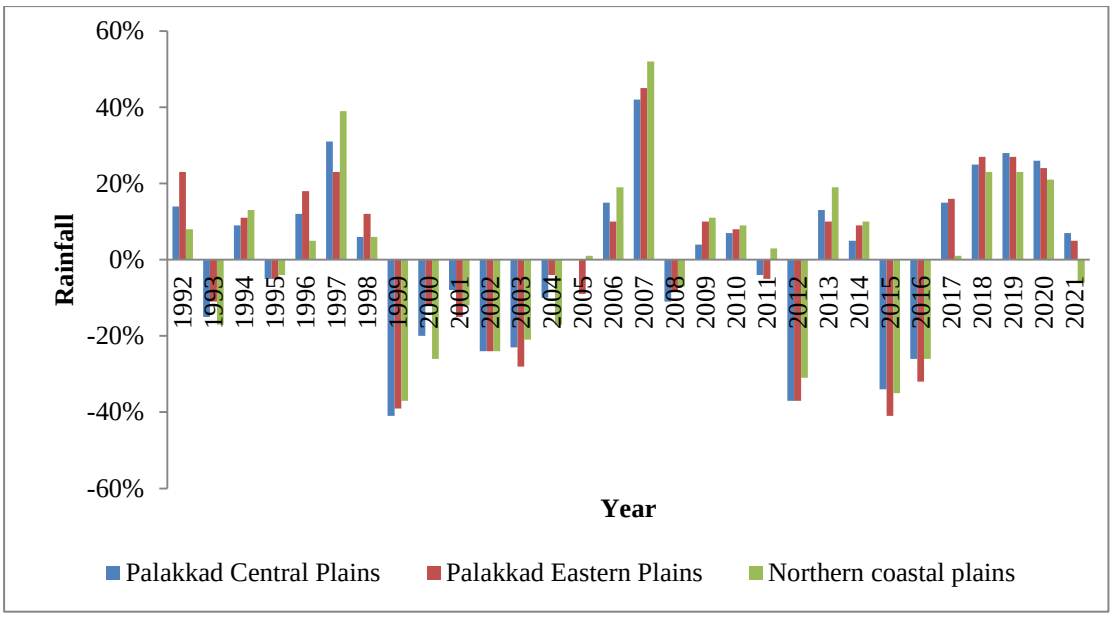



Fig 5.10 Rainfall departure over a 30-year period (1992-2021) of Plains region during southwest monsoon

### 5.1.2.4 Laterites Region

The analysis of meteorological drought showed that the years 1999, 2012, 2015 and 2016 experienced moderate drought in this region and excess rainfall was observed in 1997 and 2007.

During 2000, North Central Laterites experienced moderate drought and deficiency of rainfall in the other AEUs. In 2002, Northern Laterites experienced moderate drought and deficiency in Central Laterites. During 2003, deficiencies in rainfall were observed in the Northern Laterites and North Central Laterites. In contrast, during 2006, excess rainfall was recorded in the South Central Laterites and Northern Laterites. Additionally, in 2013, excess rainfall was observed in the Northern Laterites. Notably, the years 2018, 2019 and 2020 witnessed excess rainfall in North Central Laterites.

When compared to the last 30 years, 2015 was the most drought-affected year in the Laterites region (Fig 5.11). During 2015, the Northern Laterites region was the most drought-affected AEU in the Laterites region, with a departure value of -42%.

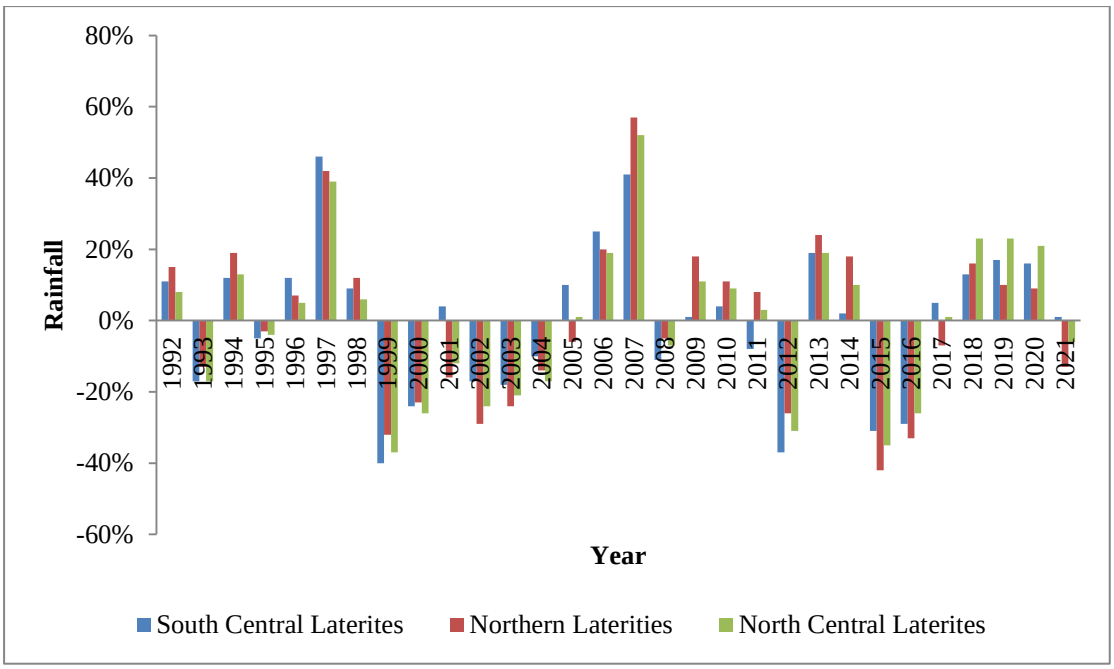



Fig 5.11 Rainfall departure over a 30-year period (1992-2021) of Laterites region during southwest monsoon

### 5.1.2.5 Foot Hills

The analysis of meteorological drought showed that the years 1999, 2012, 2015 and 2016 had experienced moderate drought in this region and excess rainfall was observed in 1997, 2007 and 2013.

During 2000, a deficiency of rainfall occurred in this region. During the years 2002 and 2003, deficiencies in rainfall were observed in the Northern Foot Hills. Importantly, throughout the remaining years of the period 1992–2021, normal rainfall conditions prevailed in this region.

When compared to the last 30 years, 2015 was the most drought-affected year in the Foot Hills region (Fig 5.12).

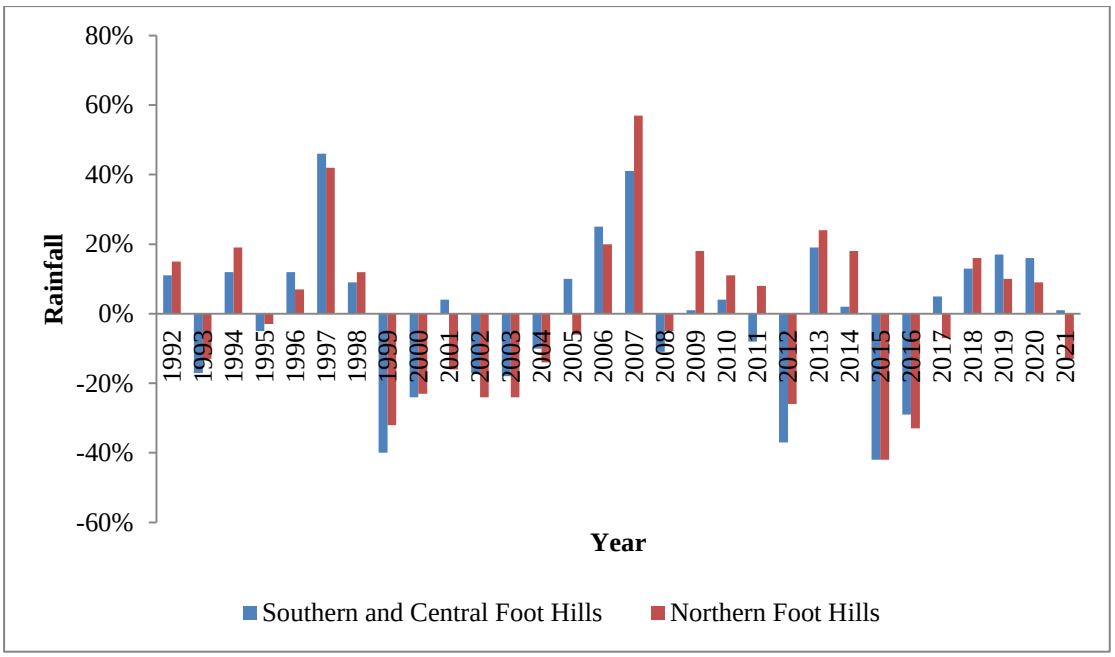



Fig 5.12 Rainfall departure over a 30-year period (1992-2021) of Foot Hills region during southwest monsoon

### 5.1.2.6 Kole Lands

The analysis of meteorological drought showed that in the years 1999, 2000, 2003, 2012, 2015 and 2016, the region experienced moderate drought. Conversely, in 1997, 2007, 2018, 2019 and 2020, there was an excess of rainfall observed. Notably, throughout the remaining years of the period 1992–2021, normal rainfall conditions prevailed in this region.

During the southwest monsoon, the years 1999, 2012, 2015 and 2016 experienced a meteorological drought in the central zone of Kerala. The excess rainfall was observed in 1997 and 2007. Compared to the last 30 years, 2015 was the most drought-affected year in Kole lands, with a departure value of -35% (Fig 5.13).

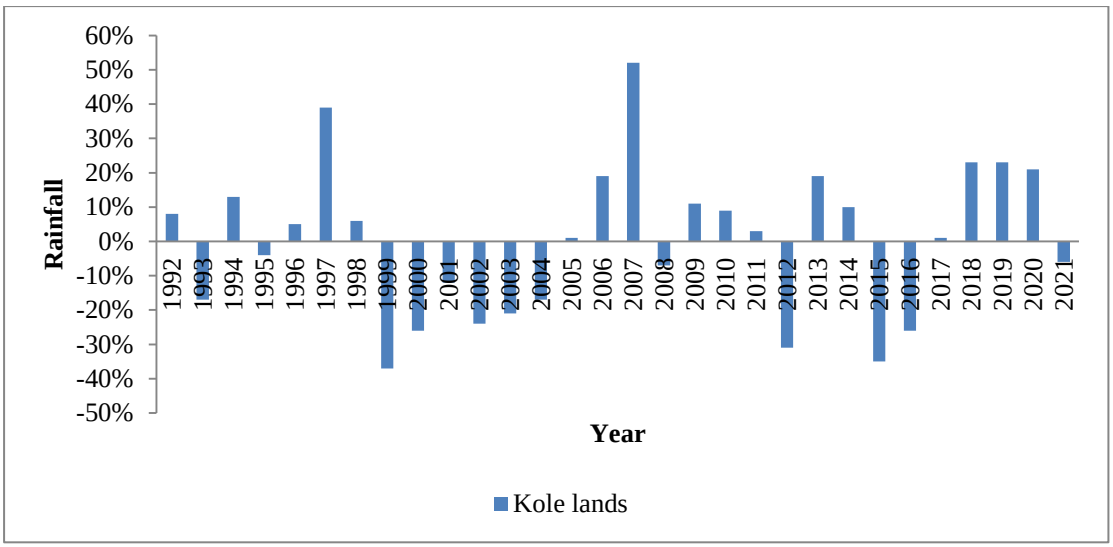



Fig 5.13 Rainfall departure over a 30-year period (1992-2021) of Kole lands during southwest monsoon

### 5.1.3 Northeast Monsoon

#### 5.1.3.1 Hilly Region

The analysis of meteorological drought showed that moderate drought was observed in Attappady Dry Hills and Attappady Hills in 1992. Similarly, in the years 1995, 2012 and 2016, the hilly region experienced moderate drought. Conversely, excess rainfall was observed in 1993, 1997, 2005, 2010, 2019 and 2021 in this region. In 1999, there was excess rainfall, except in the Northern High Hills of Palakkad district.

During 2000, a deficiency of rainfall was observed in the Northern High Hills, while the remaining AEUs experienced moderate drought conditions. However, in 2001, the Northern High Hills experienced a deficiency of rainfall. During 2003, Attappady Dry Hills and Attappady Hills faced a deficiency of rainfall, while the Northern High Hills experienced moderate drought. During 2008, deficiencies in rainfall were observed in the Southern High Hills of Palakkad and Thrissur districts, as well as in the Northern High Hills of Thrissur district, with excess rainfall observed in 2020.

Additionally, in 2009, the Northern High Hills of Thrissur district, Southern High Hills of Palakkad and Thrissur districts experienced moderate drought, while

Attappady Dry Hills, Attappady Hills and the Southern High Hills of Ernakulam district observed deficiencies in rainfall. During 2013, Attappady Dry Hills and Attappady Hills experienced moderate drought, while the remaining AEUs faced deficiencies in rainfall. In 2017, moderate drought was observed in this region, except in the Northern and Southern High Hills of Thrissur district. Finally, in 2018, Attappady Dry Hills and Attappady Hills experienced a deficiency of rainfall. In this hilly region, Attappady Dry Hills and Attappady Hills are the most drought-prone areas.

When compared to the last 30 years, 2016 was the most drought-affected year in the hilly region (Fig 5.14).

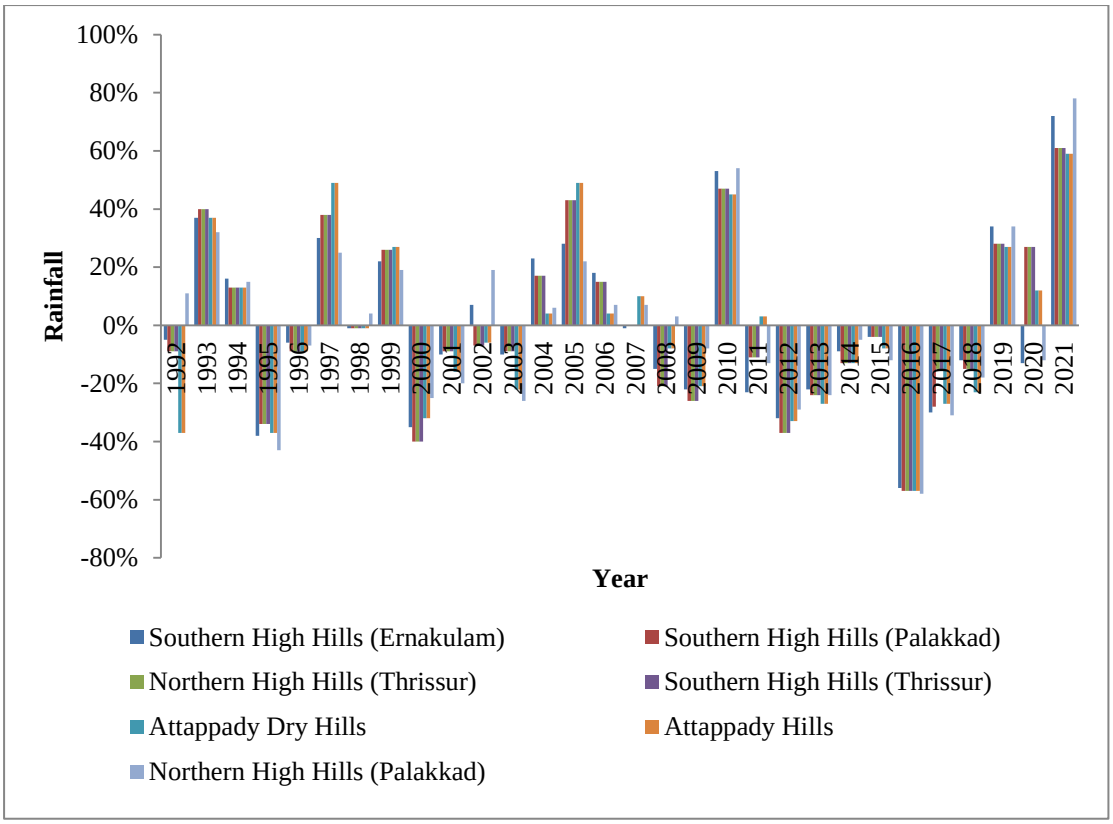



Fig 5.14 Rainfall departure over a 30-year period (1992-2021) of Hilly region during Northeast monsoon

### 5.1.3.2 Pokkali Region

The analysis of meteorological drought showed that the years 1995, 2000, 2008, 2009, 20011, 2012, 2016 and 2017 experienced moderate drought and deficiency of rainfall were affected in 2013 and 2014. Conversely, excess rainfall was observed in the years 1993, 1997, 1999, 2004–2006, 2010, 2019 and 2021 in this region.

In the Pokkali region, 2016 was the worst drought year, with a departure value of -53% (Fig ure 5.15).

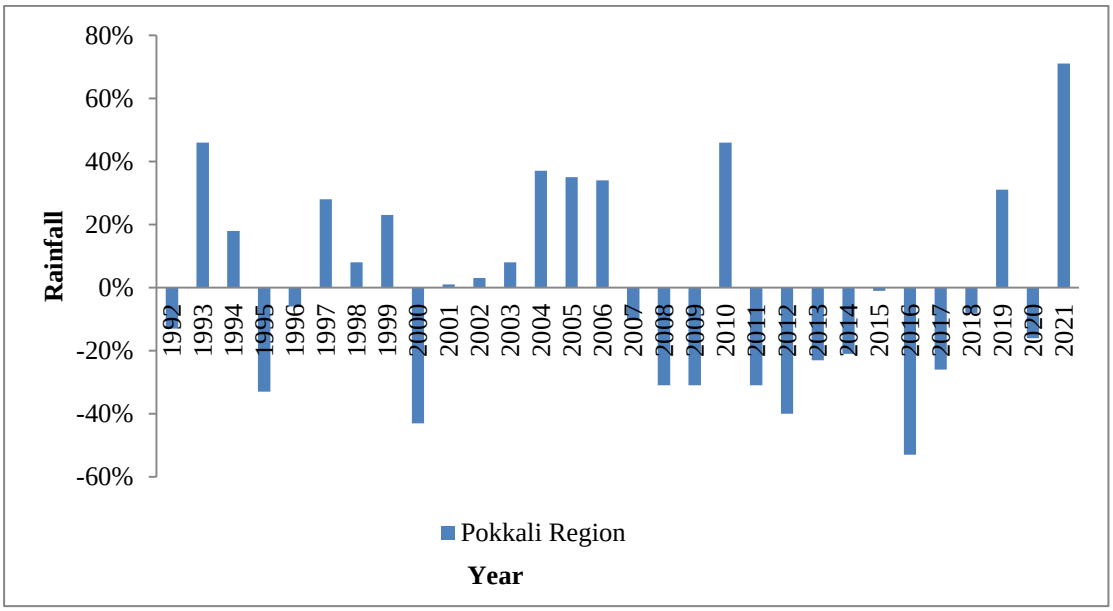



Fig 5.15 Rainfall departure over a 30-year period (1992-2021) of Pokkali region during Northeast monsoon

### 5.1.3.3 Plains Region

The analysis of meteorological drought showed that the years 1995, 2000, 2012, 2016 and 2017 experienced moderate drought. Conversely, in the years 1993, 1997, 1999, 2005, 2010, 2019 and 2021, excess rainfall was observed in this plains region. Palakkad Eastern Plains experienced moderate drought in 1992 and deficiencies of rainfall in 2003. During 2004, the Northern Coastal Plains witnessed excess rainfall, while 2011 saw a deficiency of rainfall. During 2008, the Palakkad Central Plains experienced a deficiency of rainfall and in 2020, they encountered

excess rainfall. In 2009, the Palakkad Central Plains experienced moderate drought and the remaining areas oobserved adeficiency of rainfall.

During 2013, the Palakkad Eastern Plains experienced moderate drought and the remaining areas experienced a deficiency of rainfall.

When compared to the last 30 years, 2016 was the most drought-affected year in the plains region (Fig 5.16).

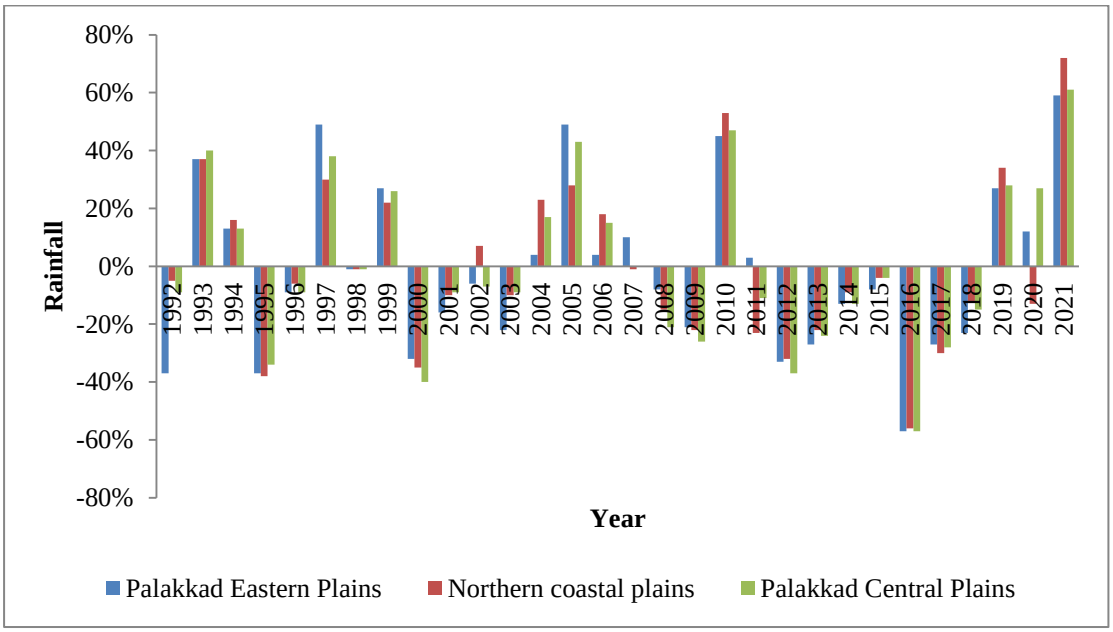



Fig 5.16 Rainfall departure over a 30-year period (1992-2021) of Plains region during Northeast monsoon

### 5.1.3.4 Laterites Region

The analysis of meteorological drought showed that the years 1995, 2012, 2016 experienced moderate drought and a deficiency of rainfall was observed in the year 2013. During 1993, 1997, 2005, 2010, 2019 and 2021, excess rainfall was observed in this region. In 1999 and 2004, both South Central Laterites and North Central Laterites witnessed excess rainfall. During 2000, Northern Laterites observed deficiency and the remaining AEUs experienced moderate drought conditions. While in 2001 deficiency of rainfall and during 2003 moderate drought were experienced in Northern Laterites. During 2008, moderate drought occurred in South Central Laterites and in 2020, excess rainfall was experienced. Additionally, in 2009,

moderate drought was experienced in South Central Laterites and deficiency occurred in North Central Laterites. In 2011, South Central Laterites and North Central Laterites encountered deficiencies in rainfall.During 2017, South Central Laterites observed deficiency and the remaining AEUs experienced moderate drought. Notably, throughout the remaining years of the period 1992–2021, normal rainfall conditions prevailed in this region.

When compared to the last 30 years, 2016 was the most drought-affected year in the Laterites region (Fig 5.17). During the 2016 drought year, North Central Laterites was the most affected region in the Laterites region.

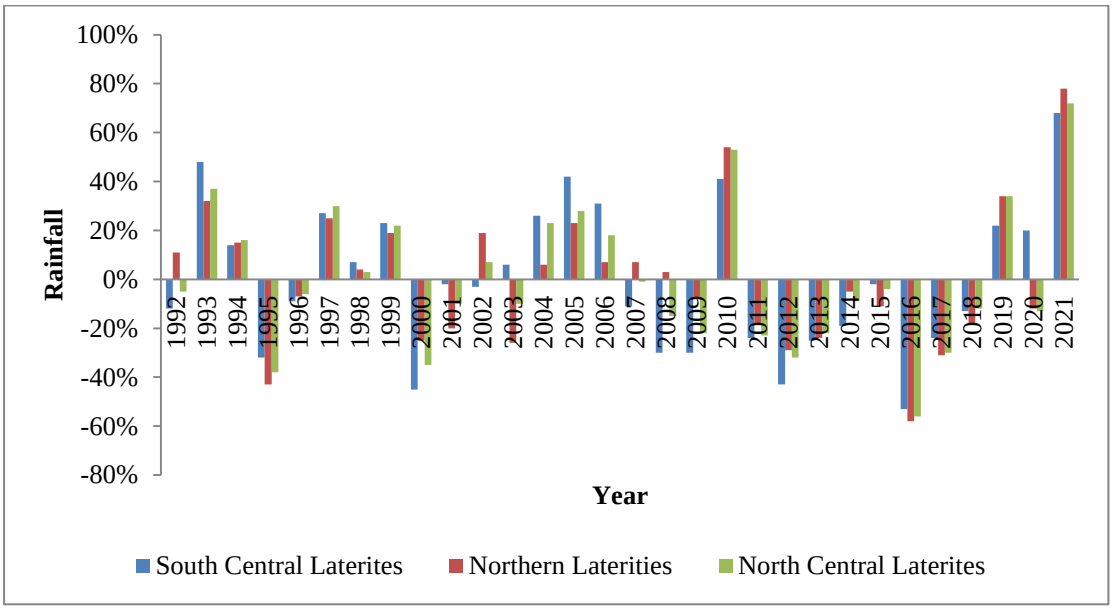



Fig 5.17 Rainfall departure over a 30-year period (1992-2021) of Laterites region during Northeast monsoon

**5.1.3.5 Foot Hills**

The analysis of meteorological drought showed that in the years 1995, 2012, 2013 and 2016, this region experienced moderate drought, while in the years 1993, 1997, 2005, 2010, 2019 and 2021, excess rainfall was observed. During 2000, the Southern and Central Foot Hills experienced moderate drought and the Northern Foot Hills observed a deficiency of rainfall. Specifically, the Southern and Central Foot Hills faced moderate droughts in 2008 and 2009. During 2011, deficiency of rainfall was observed in the Southern and Central Foot Hills and in the years 1999, 2004 and

2006, they encountered excess rainfall. A deficiency of rainfall was found in this region in 2013. During 2017, Northern Foot Hills experienced moderate drought and Southern and Central Foot Hills experienced deficiency.

When compared to the last 30 years, 2016 was the most drought-affected year in the Foot Hills region (Fig 5.18).

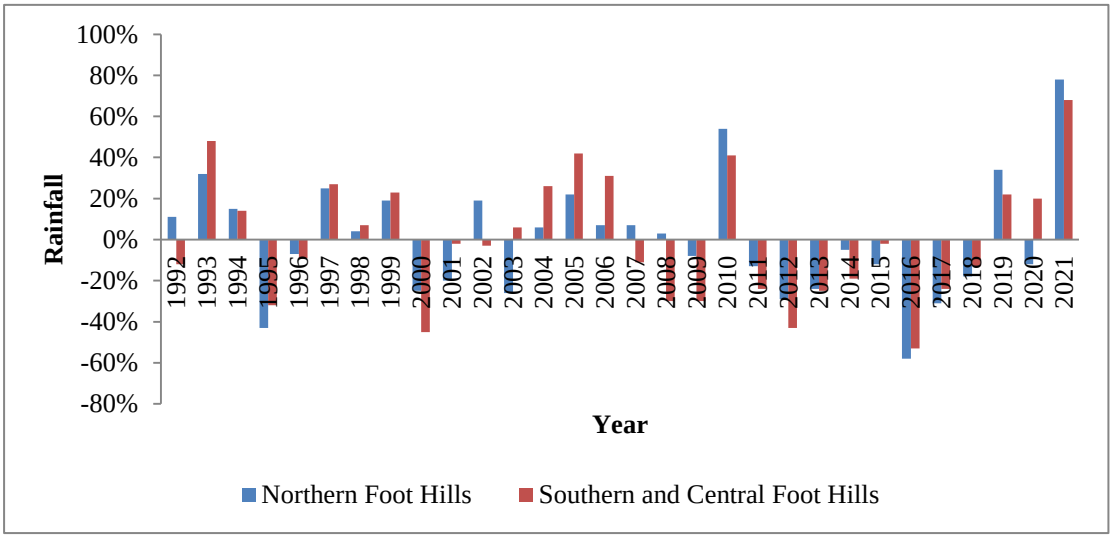



Fig 5.18 Rainfall departure over a 30-year period (1992-2021) of Foot Hills region during Northeast monsoon

**5.1.1.3.6 Kole Lands**

The analysis of meteorological drought showed that in the years 1995, 2000, 2012, 2016 and 2017, the region faced moderate drought conditions, while in the years 1997, 1999, 2004–2005, 2010, 2019 and 2021, excess rainfall was observed. Throughout the remaining years, normal rainfall conditions prevailed. During the years 2009, 2011 and 2013, there was a moderate drought in this region.

During the year 2016, the worst drought affected in Kole lands, with a departure value of -56% (Fig 5.19). During the northeast monsoon, the Pokkali region

was highly susceptible to drought conditions.

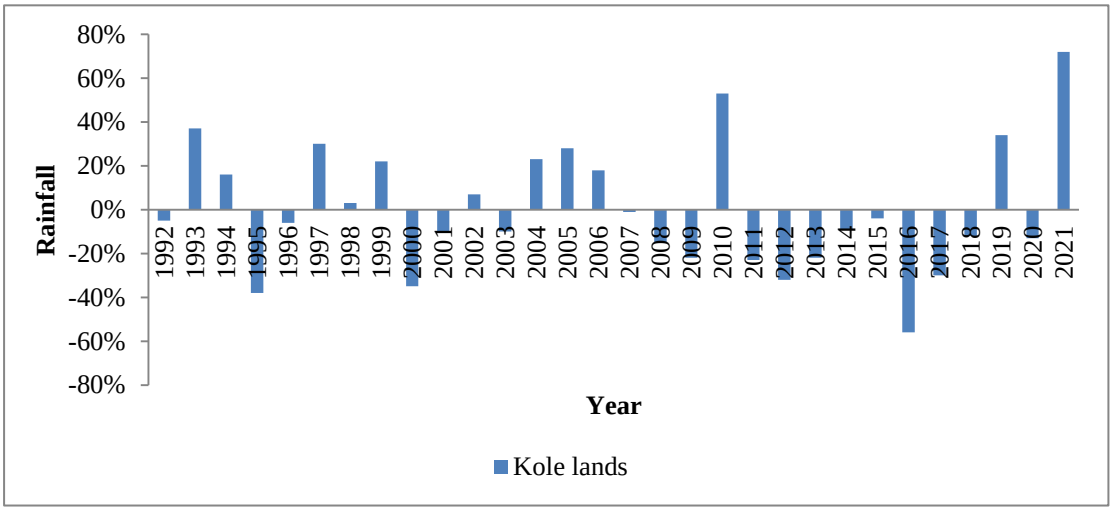



Fig 5.19 Rainfall departure over a 30-year period (1992-2021) of Kole lands during Northeast monsoon

### 5.1.4 Summer Seasonal Rainfall

#### 5.1.4.1 Hilly Region

The analysis of meteorological drought showed that the years 1997, 1998, 2000, 2013 and 2016 witnessed drought in this region. During 2004, 2006, 2008, 2018 and 2021, the region experienced excess rainfall. During 1992, moderate drought was affected in the entire region except for the Northern High Hills of Palakkad district. During 1993, a moderate drought occurred in the Southern High Hills of Palakkad district and a deficiency of rainfall affected the Northern High Hills, Southern High Hills of Ernakulum and Thrissur districts. During 1996, moderate drought was experienced in the region, except in the Attappady Dry Hills and Attappady Hills. Conversely, in 2001, excess rainfall was observed across the region, except in the Northern High Hills and Southern High Hills of Thrissur district. In 2002, moderate drought was experienced in the Attappady Dry Hills, Attappady Hills, Northern High Hills and Southern High Hills of Thrissur district.

During 2005, a rainfall deficiency occurred in the Northern High Hills of Palakkad district. Additionally, in 2007, a moderate drought occurred and in 2010, there were instances of rainfall deficiency in the Northern High Hills and Southern

High Hills of Thrissur district. During 2012, Attappady Dry Hills and Attappady Hills experienced moderate drought and the Northern High Hills and Southern High Hills of Palakkad district observed a deficiency of rainfall. During 2017, excess rainfall was recorded in the Attappady Dry Hills and Attappady Hills. In 2019, Attappady Dry Hills and Attappady Hills experienced moderate drought and the remaining part of the region was affected by a deficiency of rainfall.

During 2020, a deficiency of rainfall affected the region, except for the Southern High Hills of Ernakulum district. When compared to the last 30 years, 1997 was the most drought-affected year in the hilly region (Fig 5.20).

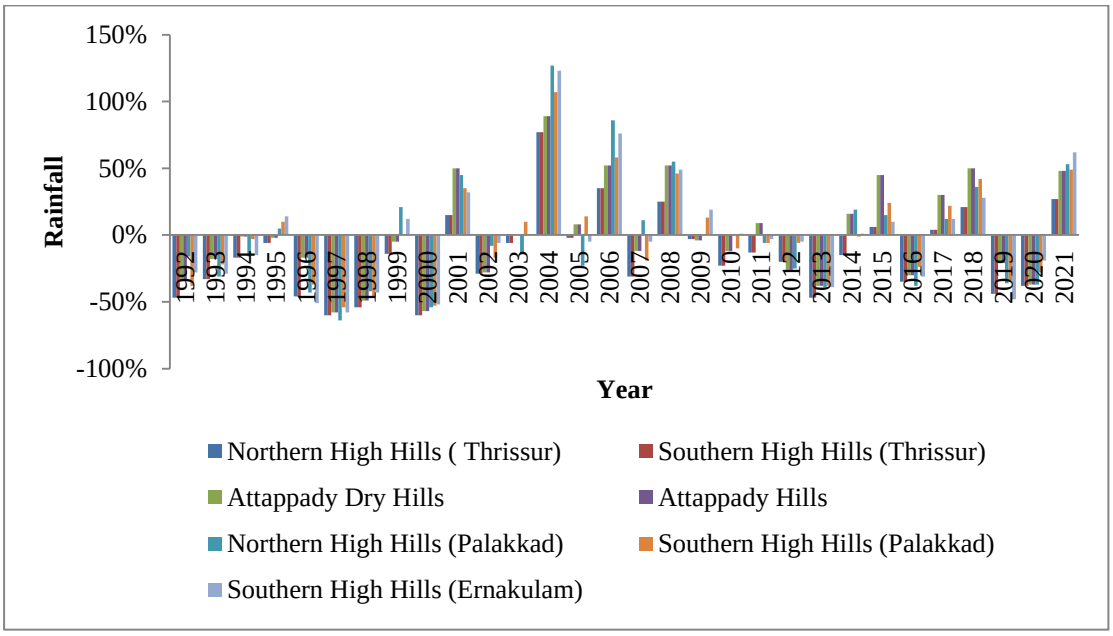



Fig 5.20 Rainfall departure over a 30-year period (1992-2021) of Hilly region during summer season

### 5.1.4.2 Pokkali Region

The analysis of meteorological drought showed that the years 1992, 1993, 1996, 1997, 1998, 2000, 2013 and 2019 experienced drought in this region, while excess rainfall was recorded in 1995, 2001, 2004, 2006, 2008, 2009 and 2021. During 2016 experienced a deficiency of rainfall in the Pokkali region.

When compared to the last 30 years, 1999 are the most drought-affected years in the Pokkali region, with a departure value of -63% (Fig 5.21).

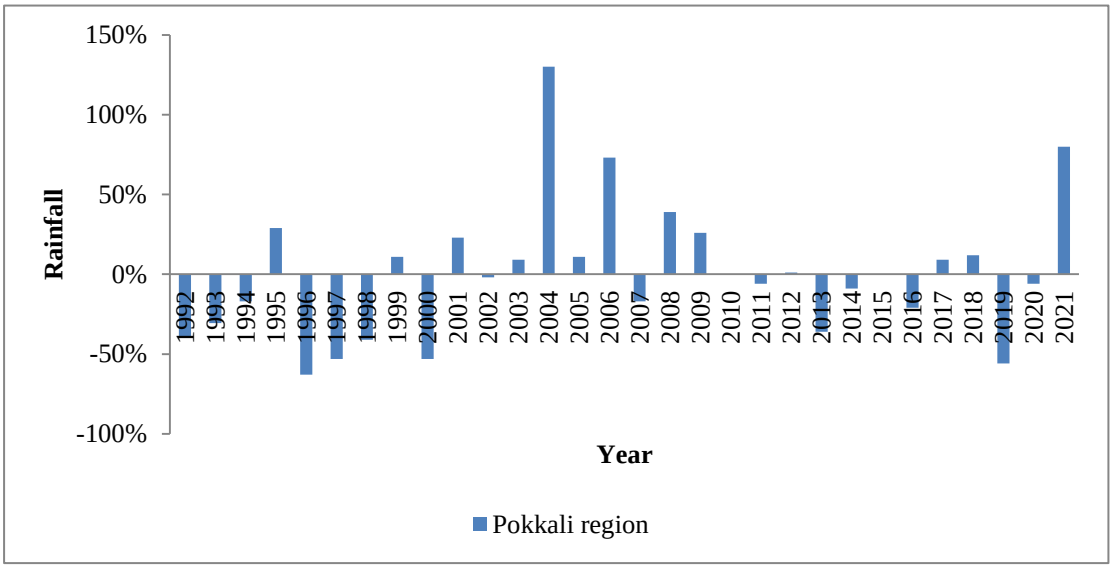



Fig 5.21 Rainfall departure Over a 30-year period (1992-2021) of Pokkali region during summer season

### 5.1.4.3 Plains Region

The analysis of meteorological drought showed that in the years 1992, 1997, 1998, 2000, 2013 and 2019, drought was experienced in this region, while excess rainfall was recorded in 2001, 2004, 2006, 2008, 2018 and 2021. Additionally, in 1993, moderate drought was experienced in the Northern Coastal Plains and a deficiency of rainfall was observed in the Palakkad Central Plains. During 1996, there were instances of moderate drought in the Northern Coastal Plains and Palakkad Central Plains. During 2002 and 2012, the Palakkad Eastern Plains experienced moderate drought, with excess rainfall observed in 2017. In 2016, a deficiency of rainfall occurred in the Palakkad Central Plains, while the remaining areas experienced moderate drought. Furthermore, in 2020, both the Palakkad Eastern Plains and the Palakkad Central Plains faced moderate drought conditions.

When compared to the last 30 years, 1997 was the most drought-affected year in the Plains region (Fig 5.22).

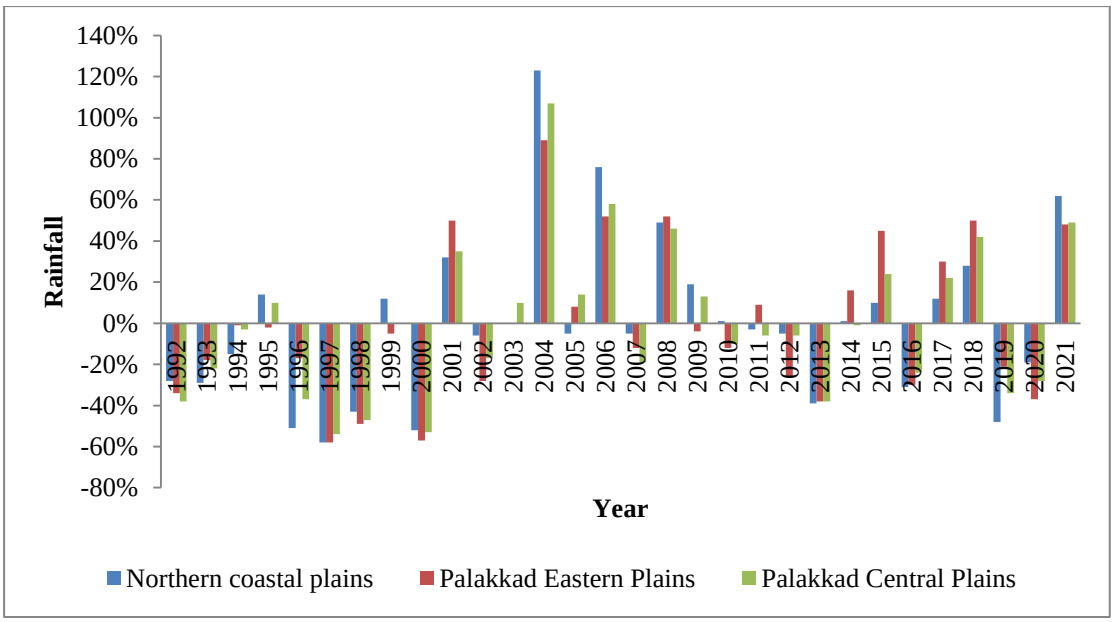



Fig 5.22 Rainfall departure over a 30-year period (1992-2021) of Plains region during summer monsoon

### 5.1.4.4 Laterites Region

The analysis of meteorological drought showed that in the years 1993, 1996-1998, 2000, 2013 and 2019, this region experienced drought conditions, while excess rainfall was observed in 2001, 2004, 2006, 2008 and 2021. During 1992, both South Central Laterites and North Central Laterites recorded moderate drought conditions. South Central Laterites experienced excess rainfall in 1995 and 2005 but recorded a deficiency in 2007. During 1999, South Central Laterites had excess rainfall, while deficiencies were recorded in 2005 and 2012. During 2016, South Central Laterites observed a deficiency of rainfall, while the remaining AEUs experienced moderate drought conditions. In 2020, both South Central Laterites and Northern Laterites experienced a moderate drought.

Compared to the last 30 years, 1997 was the most drought-affected year in the Laterite region (Fig 5.23).

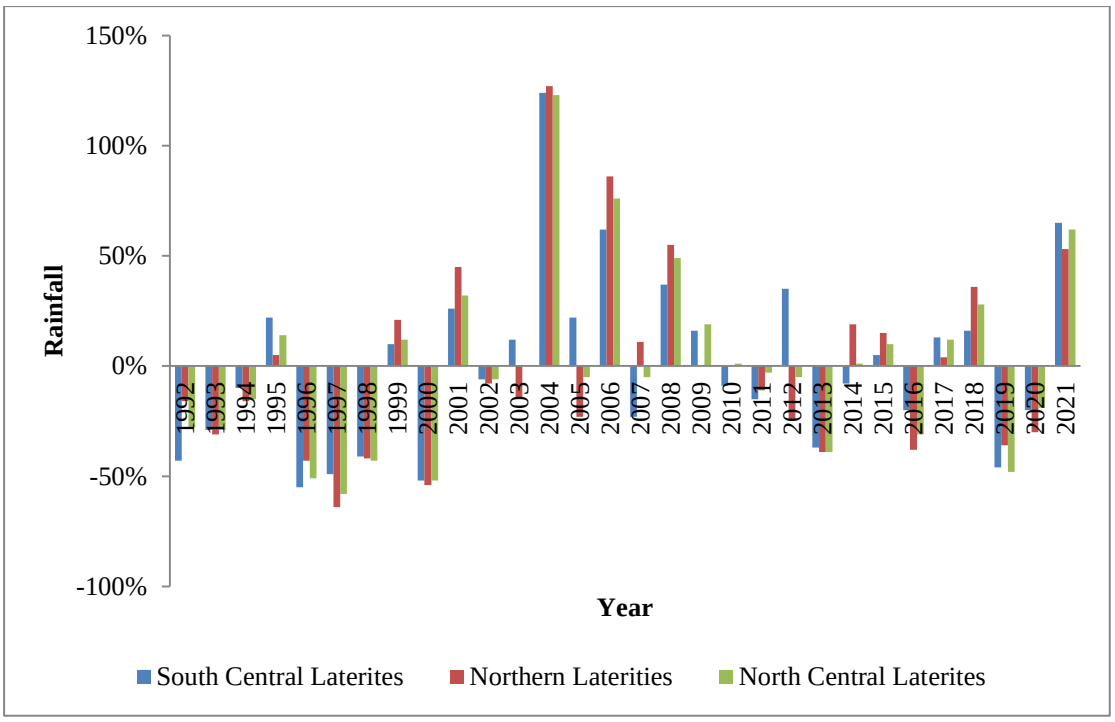



Fig 5.23 Rainfall departure over a 30-year period (1992-2021) of Laterites region during summer season

**5.1.4.5 Foot Hills**

The analysis of meteorological drought showed that the years 1993, 1996-1998, 2000, 2013 and 2019 experienced drought conditions. Excess rainfall was recorded in 2001, 2004, 2006, 2008 and 2021. During 1992, moderate drought was experienced in Southern and Central Foot Hills and in 2007, there were deficiencies in rainfall, while in 1995 and 2005, excess rainfall was observed in Southern and Central Foot Hills. Northern Foot Hills encountered a deficiency in rainfall in 2005 and excess rainfall in 2018. During 2016 and 2020, moderate drought was experienced in the Northern Foot Hills and deficiency of rainfall in the Southern and Central Foot Hills.

When compared to the last 30 years, 1997 was the most drought-affected year in the Foot Hills region (Fig 5.24).

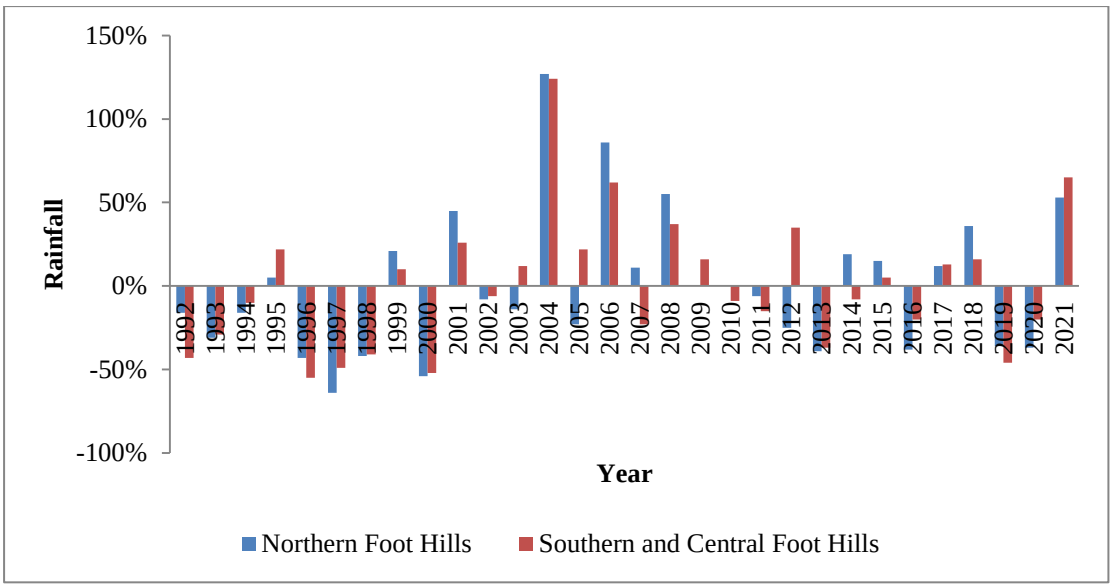



Fig 5.24 Rainfall departure over a 30-year period (1992-2021) of Foot Hills during summer season

### 5.1.4.6 Kole Lands

The analysis of meteorological drought showed that the years 1992, 1993, 1996–1998, 2000, 2013, 2016 and 2019 had experienced drought in kole lands and excess rainfall was recorded in 2001, 2004, 2006, 2008, 2018 and 2021.

When compared to the last 30 years, 1997 was the most drought-affected year in Kole lands (Fig 5.25).

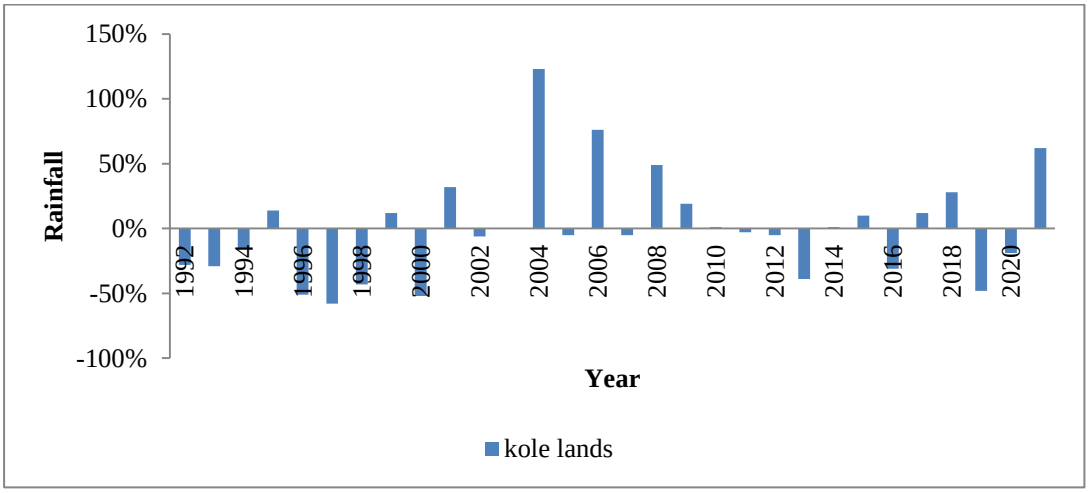



Fig 5.25 Rainfall departure over a 30-year period (1992-2021) of Kole lands during summer season

### 5.1.5 Winter Seasonal Rainfall

#### 5.1.5.1 Hilly Region

The analysis of meteorological drought showed that 1992, 1996, 1997, 1998, 1999, 2007, 2009, 2010, 2012, 2014, 2015 and 2019 experienced severe drought in hilly regions. Conversely, excess rainfall was observed in 1994, 2003, 2005, 2011, 2013 and 2021.

During 1993, Attappady Dry Hills, Attappady Hills, and Northern High Hills experienced rainfall deficiency. In 2000, the Northern High Hills experienced a severe drought, while other AEUs experienced excess rainfall. In 2001, the Southern High Hills of Ernakulum and the Northern High Hills of Palakkad district observed excess rainfall.

During 2002, the Northern High Hills of Palakkad district and the Southern High Hills of Palakkad district experienced severe drought and the remaining areas experienced moderate drought. During 2004, Attappady Dry Hills, Attappady Hills and the Northern High Hills of Palakkad district experienced severe drought and the remaining AEUs experienced moderate drought conditions. While in 2006, Attappady Dry Hills and Attappady Hills experienced moderate drought, the remaining areas observed severe drought conditions. During 2008, the Southern High Hills of Ernakulum district experienced moderate drought and the Northern High Hills, Southern High Hills of Thrissur and Palakkad districts observed rainfall deficiency. During 2016, Attappady Dry Hills and Attappady Hills experienced severe drought, while the Northern High Hills and Southern High Hills of Thrissur and Palakkad districts experienced moderate drought and deficiency in the Northern High Hills of Palakkad district. In 2017, a moderate drought occurred in the Southern High Hills of Ernakulum.

During 2018, the Southern High Hills of Ernakulum district experienced severe drought and the Northern High Hills and Southern High Hills of Palakkad and Thrissur districts had moderate drought conditions. While in 2020, the Northern High

Hills of Palakkad district and the Southern High Hills of Ernakulum had experienced moderate drought, the remaining AEUs had experienced severe drought conditions.

When compared to the last 30 years, 1992 was the most drought-affected year in the Hilly region (Fig 5.26).

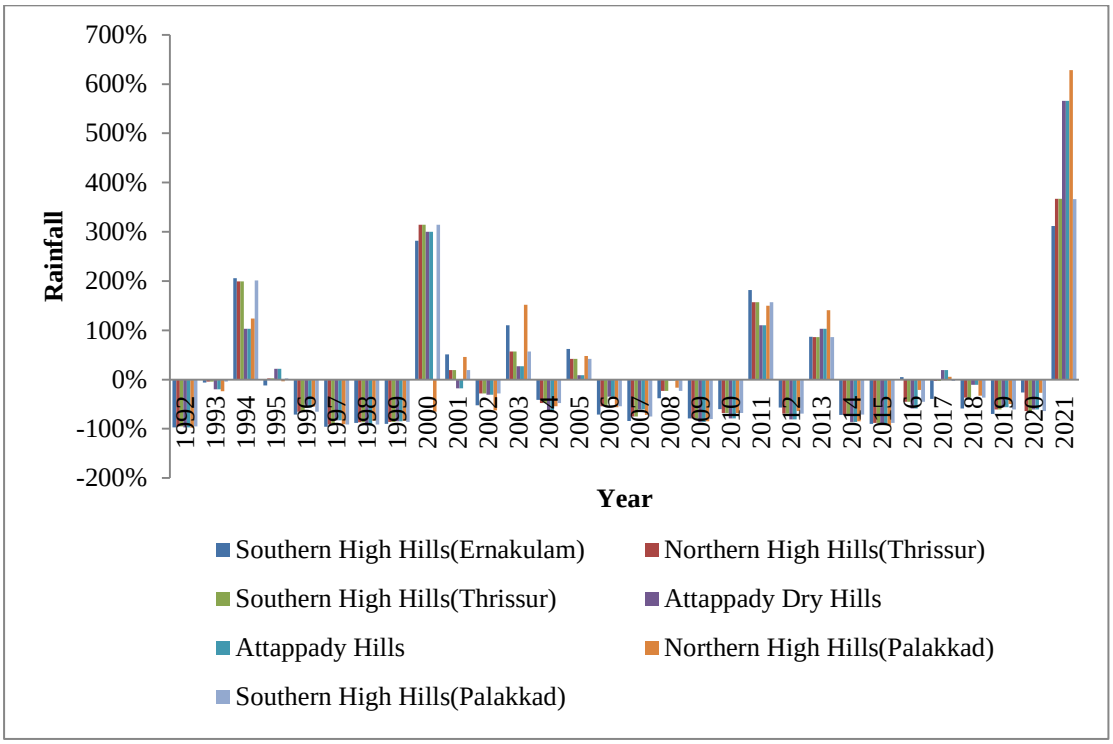



Fig 5.26 Rainfall departure over a 30-year period (1992-2021) of Hilly region during winter season

### 5.1.5.2 Pokkali Region

The analysis of meteorological drought showed that the years 1992, 1996-1999, 2006-2010, 2012, 2014, 2015, 2017, 2018 and 2019 had experienced severe drought conditions and moderate drought in 2002, 2004 and 2020, while excess rainfall was observed in 1994, 2000, 2001, 2003, 2005, 2011, 2013 and 2016. The year 1997 was the most drought-affected year in the Pokkali region compared to the last 30 years (Fig 5.27).

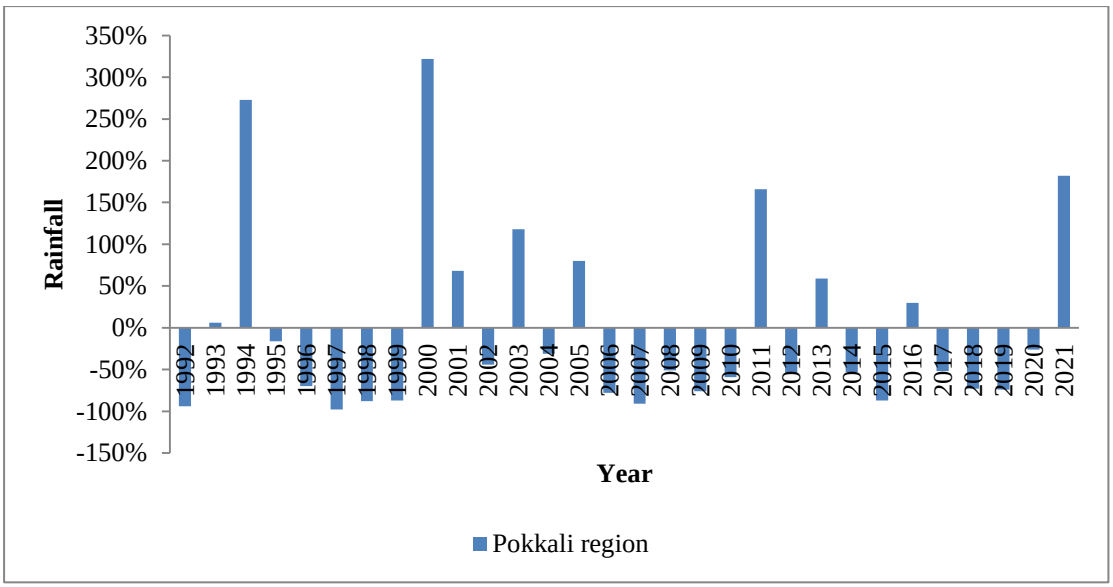



Fig 5.27 Rainfall departure over a 30-year period (1992-2021) of Pokkali region during winter season

### 5.1.5.3 Plains Region

The analysis of meteorological drought showed that the years 1992, 1996-1999, 2006, 2007, 2009, 2010, 2012, 2014, 2015 and 2019 had experienced severe drought in the plains region, while excess rainfall was recorded in the years 1994, 2000, 2003, 2005, 2011, 2013 and 2021. In 1993, the Palakkad Eastern Plains experienced a deficiency in rainfall and in 2001 the Northern Coastal Plains observed excess rainfall.

During 2002, the Northern coastal plains experienced severe drought and the remaining areas experienced moderate drought conditions. During 2004, the Palakkad Eastern Plains experienced severe drought and the remaining areas experienced moderate drought conditions. In 2006, the Palakkad Eastern Plains experienced moderate drought and the remaining areas experienced severe drought conditions. During 2008, the Northern coastal plains experienced moderate drought and the Palakkad Central Plains observed deficiency. During 2016, Palakkad Eastern Plains experienced severe drought and moderate drought in Palakkad Central Plains. In 2017, a moderate drought was observed in the Northern coastal plains. During 2018, the Palakkad Central Plains experienced moderate drought and the Northern coastal plains experienced severe drought. During 2020, the Northern coastal plains

experienced moderate drought and the remaining AEUs will experience severe drought.

When compared to the last 30 years, 1992 was the most drought-affected year in the plains region (Fig 5.28).

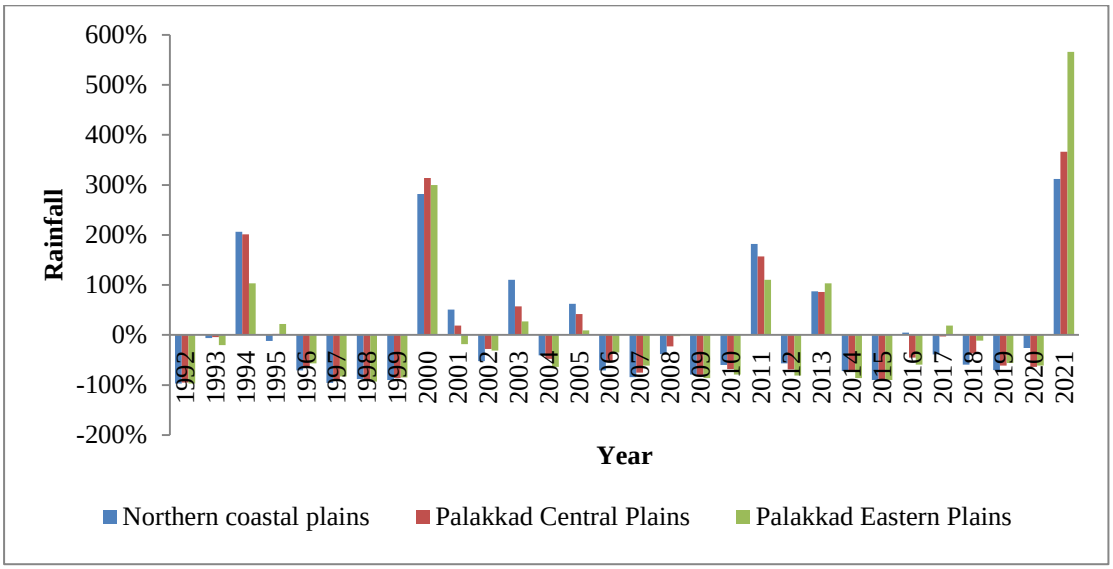



Fig 5.28 Rainfall departure over a 30-year period (1992-2021) of Plains region during winter season

### 5.1.5.4 Laterites Region

The analysis of meteorological drought showed that the years 1992, 1996-1999, 2006, 2007, 2009, 2010, 2012, 2014, 2015 and 2019 experienced severe drought, while excess rainfall was recorded in the years 1994, 2000-2001, 2003, 2005, 2011, 2013 and 2021. During 1993, a moderate drought was experienced in the Northern Laterites. During 2002, South Central Laterites had experienced moderate drought and the remaining AEUs experienced severe drought condition. During 2004, Northern Laterites experienced severe drought and the remaining areas were affected by moderate drought conditions.

During 2008, Northern Laterites experienced a deficiency of rainfall and the remaining areas experienced a moderate drought. In 2016, Northern Laterites experienced moderate drought and South Central Laterites experienced deficiency of rainfall. During 2017, North Central Laterites experienced moderate drought and

South Central Laterites experienced deficiency of rainfall. During 2018, Northern Laterites experienced moderate drought and the remaining areas experienced severe drought. In 2020, South Central Laterite experienced severe drought and the remaining areas observed moderate drought conditions.

When compared to the last 30 years, 1992 was the most drought-affected year in the Laterite region (Fig 5.29).

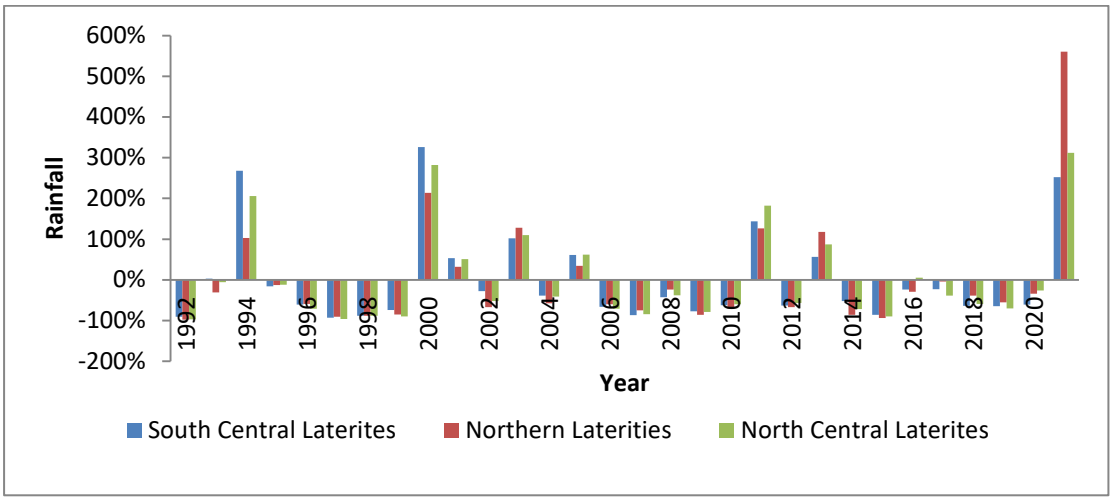



Fig 5.29 Rainfall departure over a 30-year period (1992-2021) of Laterities region during winter season

**5.1.5.5 Foot Hills**

The analysis of meteorological drought showed that the years 1996-1999, 2006-2007, 2009, 2010, 2012, 2014, 2015 and 2019 had experienced severe drought in Foot Hills region. Conversely, excess rainfall was observed in the years 1994, 2001, 2003, 2005, 2011, 2013 and 2021.

Additionally, in 1993 and 2000, the Northern Foot Hills experienced rainfall deficiencies, while the Southern and Central Foot Hills had excess rainfall in 2000 and deficiencies in 2017. When compare to last 30 years, 1992 was the most drought affected year in Foot Hills region (Fig 5.30).

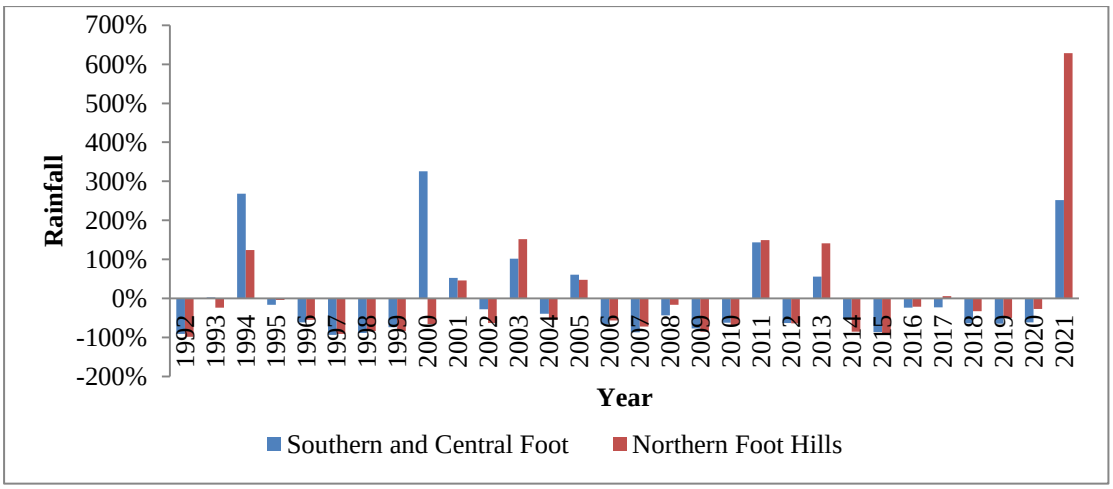



Fig 5.30 Rainfall departure over a 30-year period (1992-2021) of Foot Hills during winter season

### 5.1.5.6 Kole Lands

The analysis of meteorological drought showed that the years 1992, 1996-1999, 2002, 2007, 2009-2010, 2012, 2014-2015, 2018 and 2019 had experienced severe drought and the years 2004, 2008, 2017 and 2020 had affected by moderate drought, while excess rainfall was observed in 1994, 2000-2001, 2003, 2005, 2011, 2013 and 2021.

When compared to the last 30 years, 1992 was the most drought-affected year in Kole lands.

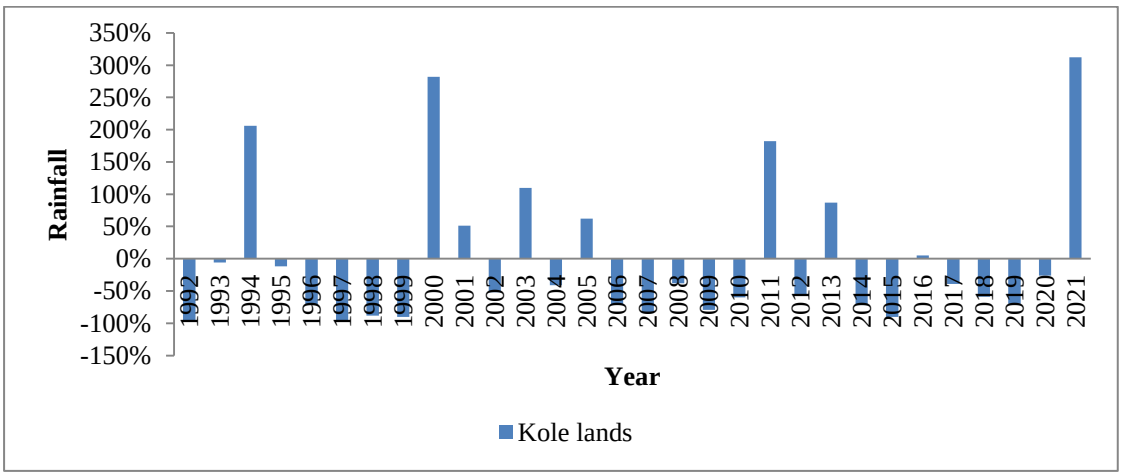



Fig 5.31 Rainfall departure over a 30-year period (1992-2021) of Kole lands during winter season

## 5.2 Agricultural Drought

### 5.2.1 Hilly Region

In the analysis of agricultural drought during the *kharif* season, the years 1993, 1999, 2003 and 2016 experienced agricultural drought in the Hilly region. Notably, the Southern High Hills and Northern High Hills of Thrissur District encountered agricultural drought during the $27^{th}$-$30^{th}$ weeks of 2000. Furthermore, in 2005, the Northern High Hills of Palakkad District experienced agricultural drought during the 32nd–35th week.

Turning to the *rabi* season, it was observed that both the Southern High Hills and Northern High Hills of Thrissur District faced agricultural drought in 1994. Additionally, in 2003, the Southern High Hills of Ernakulam District experienced an agricultural drought during the $45^{th}$-$50^{th}$ week. Moreover, the Attappady Dry Hills and Attappady Hills regions encountered agricultural drought during the $45^{th}$-51st weeks of 2012.

### 5.2.2 Pokkali region

In the analysis of agricultural drought during the *kharif* season, the following weeks in various years experienced agricultural drought: $31^{st}$ – $34^{th}$ week of 1993, $29^{th}$ – $33^{rd}$ week of 1998, $33^{rd}$ – $39^{th}$ week of 1999, $27^{th}$ – $31^{st}$ week of 2000, $29^{th}$ – $32^{nd}$ week of 2001, $37^{th}$– $40^{th}$ week of 2002, $35^{th}$ – $39^{th}$ week of 2003, $38^{th}$ – $42^{nd}$ week of 2011, $38^{th}$ – $41^{st}$ week of 2012, $36^{th}$ – $41^{st}$ week of 2016, and $34^{th}$ – $38^{th}$ week of 2018.

During the *rabi* season, agricultural drought was observed in the following weeks: $46^{th}$ -60tth week of 1994, $45^{th}$ – $60^{th}$ week of 1995, $45^{th}$ – $50^{th}$ week of 2003, and $45^{th}$ – $51^{st}$ week of 2012.

### 5.2.3 Plains Region

In the plains region, the analysis of agricultural drought during the *kharif* season revealed the following periods when drought occurred: $31^{st}$-$34^{th}$ and $36^{th}$-$39^{th}$ weeks of 1993, $33^{rd}$-$39^{th}$ week of 1999, and $35^{th}$– $39^{th}$ week of 2003. Furthermore,

during the 27th– 30th weeks of 2000, agricultural drought was observed in the Northern coastal plains and Palakkad central plains. In 2016, drought conditions were prevalent during the 36th– 40th week in the Palakkad Eastern Plains and Palakkad Central Plains, and the 36th– 42nd week in Northern coastal plains.

During the *rabi* season, the year 1994 witnessed drought conditions in the 46th – 60th week in the Northern coastal plains and the 46th– 51st week in Palakkad Central Plains. During 2012, the Palakkad Eastern Plains faced drought during the 45th – 51st weeks.

### 5.2.4 Laterites Region

During the *kharif* season, the Laterites region experienced drought in the 33rd– 39th week of 1999 and the 35th– 39th week of 2003. Additionally, in 1993, the South Central Laterites and Northern Central Laterites encountered drought during the 31st – 34th and 36th– 39th weeks. Northern Laterites also experienced drought in the 36th – 39th weeks of 1993. In 1998, the South Central Laterites faced drought during the 30th– 33rd week, and in 2000, during the 27th– 31st week.

In 2005, the Northern Laterites region experienced drought during the 32nd– 35th week. Furthermore, in 2016, agricultural drought was observed in the Laterites region.

Shifting to the *rabi* season, the South Central Laterites experienced drought in the 46th– 60th weeks of 1994. In 2003, both the South Central Laterites and Northern Central Laterites faced drought during the 45th– 50th week. Additionally, the Northern Central Laterites region experienced drought in the 45th– 51st week.

### 5.2.5 Foot Hills

During the *kharif* season, agricultural drought occurred in the Foot Hills region during the 33rd– 39th week of 1999 and the 35th– 39th week of 2003. In 1993, the Northern Foot Hills experienced drought during the 36th – 39th week, while the Southern Central Foot Hills encountered agricultural drought in the 31st– 34th and

$36^{th}$– $39^{th}$ weeks. In 1998, both Southern and Central Foot Hills faced drought during the $30^{th}$– $33^{rd}$ week, and in 2000, it occurred during the $27^{th}$– $31^{st}$ week. The $32^{nd}$– $35^{th}$ week saw drought in the Northern Foot Hills. In 2016, the Northern Foot Hills experienced drought in the $36^{th}$ – $42^{nd}$ week, while the Southern and Central Foot Hills faced drought in the $36^{th}$ – $41^{st}$ week.

During the *rabi* season, the Foot Hills region encountered drought during the $45^{th}$– $50^{th}$ week of 2003 and the Southern and Central Foot Hills experienced drought in the $46^{th}$- $60^{th}$ week of 1994.

### 5.2.6 Kole Land

During the *kharif* season, an agricultural drought occurred in this region during the following periods: $31^{st}$ -$34^{th}$ and $36^{th}$ -$39^{th}$ weeks of 1993, $33^{rd}$ -$39^{th}$ weeks of 1999, $27^{th}$ -$30^{th}$ weeks of 2000, $35^{th}$ -$39^{th}$ weeks of 2003, and $36^{th}$ -$42^{nd}$ weeks of 2016.

In the *rabi* season, agricultural drought was observed in Kole lands during the $46^{th}$ -$60^{th}$ weeks of 1994 and the $45^{th}$ -$50^{th}$ week of 2003.

## 5.3 Moisture Availability Index (MAI)

### 5.3.1 Annual Rainfall

The analysis of the Moisture Availability Index (MAI) showed that during the years 1992, 1993, 1996, 2008 and 2017 there was a moderate deficiency of moisture experienced in the central zone of Kerala. Compared to other AEUs Attappady Dry Hills and Attappady Hills are the most moisture-deficient regions in the central zone of Kerala. The analysis also showed that 2016 was the most deficient year in the last 30 years (1992–2021).

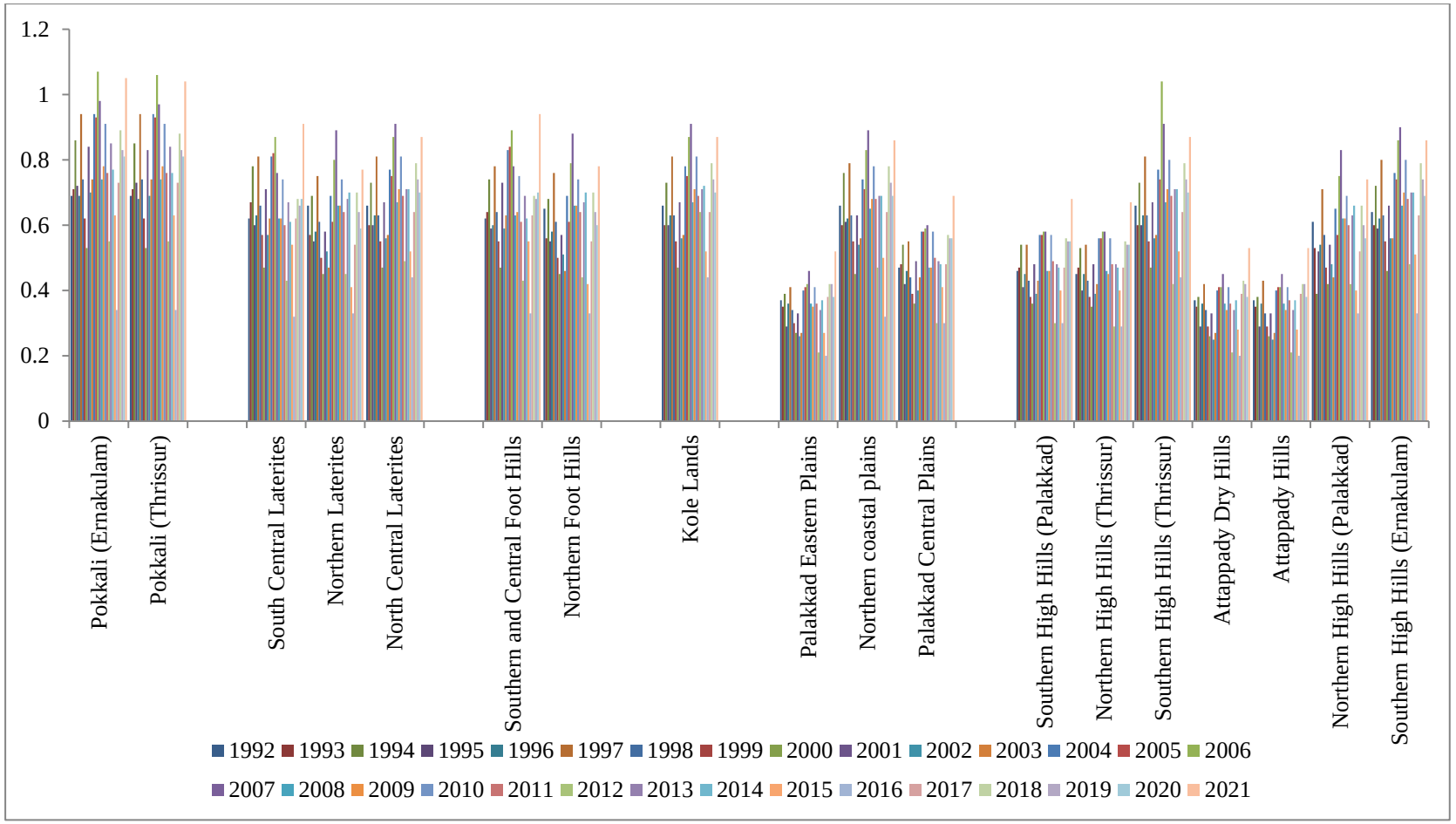



Fig 5.32 Annual Moisture Availability Index (MAI) from 1992-2021 (30 years period) in different AEUs of central zone of Kerala

#### 5.3.1.1 Hilly Region

The analysis of the Moisture Availability Index (MAI) showed that during 2016 there was a very deficiency of moisture in the hilly region except in the Southern High Hills of Thrissur district. During the years 1992, 1993, 1996, 2008 and 2017 there was a moderate deficiency of moisture in the hilly region. In 1994, 2004, 2005, 2009, 2011, 2014, 2018, 2019 and 2020 there was a deficiency of moisture in the Southern High Hills of Thrissur and Ernakulam. During the years 1995, 1999 and 2003, there was a very high deficiency of moisture in the Attappady Dry Hills and Attappady Hills and the remaining regions experienced a moderate deficiency. During 1998, Attappady Hills experienced a very severe deficiency and the remaining regions experienced a moderate deficiency.

During the years 1997, 2006, 2007 and 2010 had experienced deficiencies in the Northern High Hills and Southern High Hills of Ernakulam and Palakkad districts. During 2012, the Northern High Hills and Southern High Hills of Ernakulam and Palakkad districts experienced moderate deficiency and the remaining regions experienced very deficiency. During 2015, Attappady Dry Hills and Attappady Hills experienced very deficiency and the remaining regions experienced moderate deficiency.

Compared to other regions, Attappady Dry Hills and Attappady Hills are the most moisture-deficient regions (Fig 5.33).

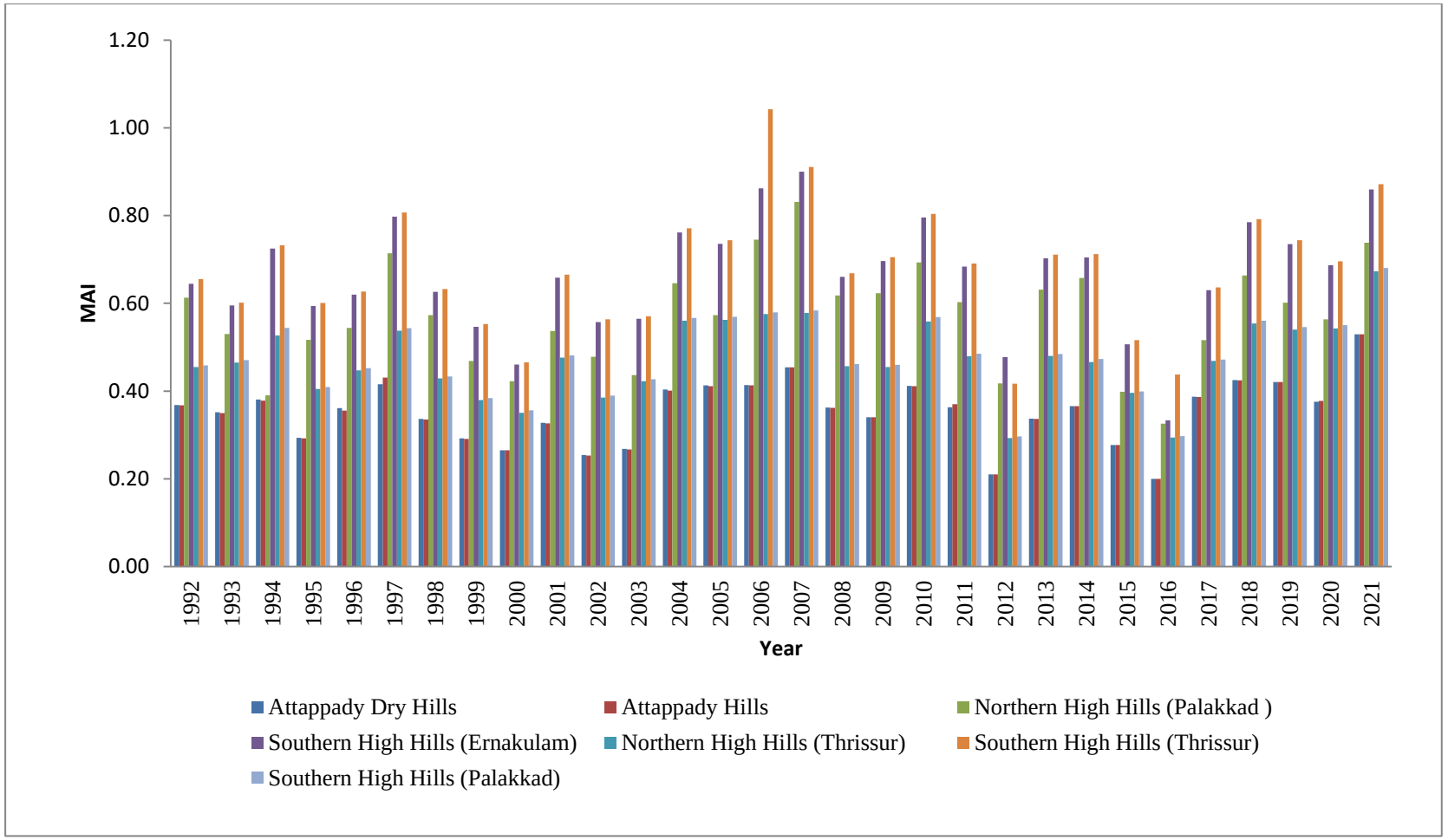



Fig 5.33 Annual Moisture Avalibality Index from 1992-2021 (30 years period) of Hilly region

### 5.3.1.2 Pokkali Region

The analysis of the Moisture Availability Index (MAI) showed that during the years 1992–98, 2001–05, 2007–11, 2013, 2014 and 2017–20, deficiency was experienced, and in the years 1999, 2000, 2012, 2015 and 2016, moderate deficiency was experienced in the Pokkali region.

Over the 30-year study, 2016 was the year that experienced the most moisture deficiency (Fig 5.34).

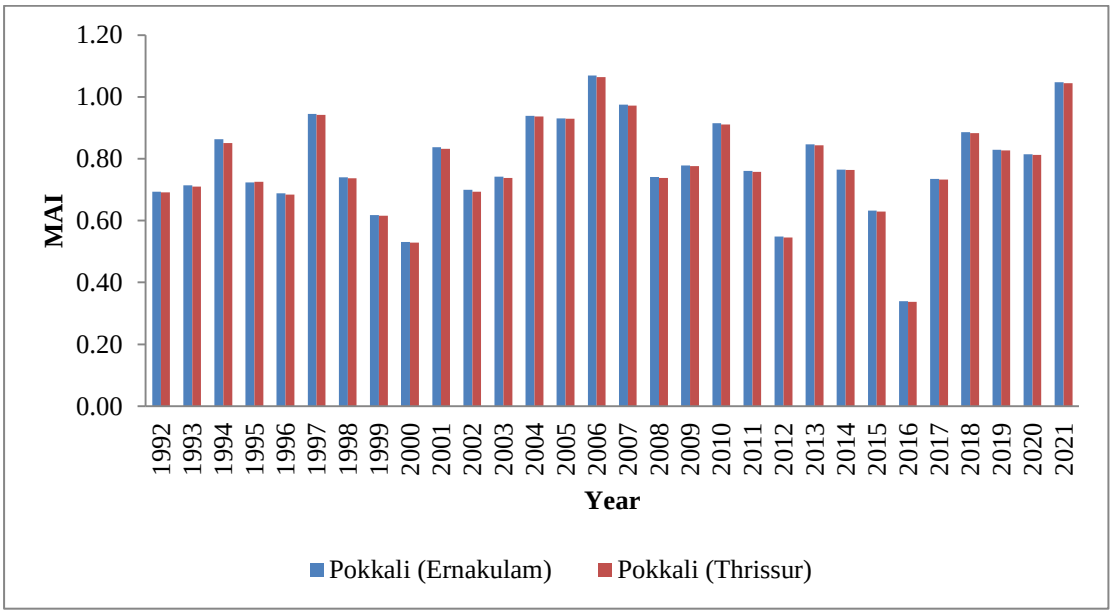



Fig 5.34 Annual Moisture Avalibality Index from 1992-2021 (30 years period) of Pokkali region

### 5.3.1.3 Plains Region

The analysis of the Moisture Availability Index (MAI) showed that in 2016, there was a very high deficiency and in 1992, 1993, 1995, 1998–03, 2008, 2015 and 2017, there was a moderate deficiency in the plains region.While the years 1994, 1997, 2004–07, 2009–11, 2013–14 and 2018–2020 experienced deficiency in the Northern coastal plains and moderate deficiency in the remaining regions. During 2020, moderate deficiency occurred in the Northern coastal plains and the remaining

regions experienced very deficiency. During 2021, the Plains region experienced deficiency.

Over the 30-year study, 2012 and 2016 were the years that experienced the most moisture deficiency (Fig 5.35).

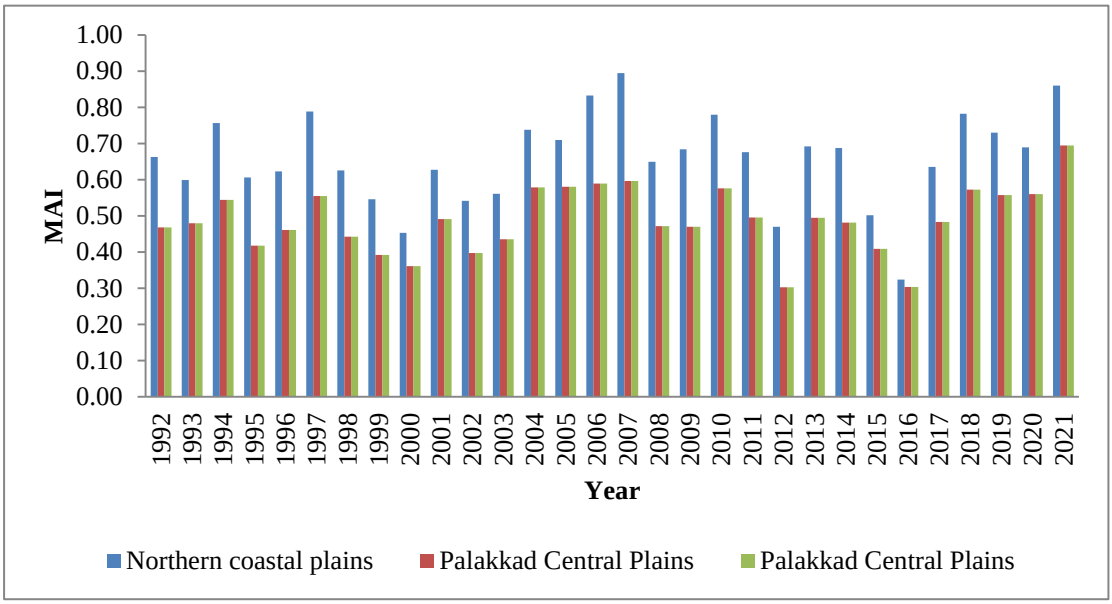



Fig 5.35 Annual Moisture Avalibality Index from 1992-2021 (30 years period) of Plains

### 5.3.1.4 Laterites Region

The analysis of the Moisture Availability Index (MAI) showed that during 2016 experinced very high deficiency of moisture in the Laterites region, except in the North Central Laterites region. During the years 1992, 1993, 1995, 1996, 1998-2000, 2002, 2008, 2009, 2012, 2015 and 2017, the Laterites region experienced moderate deficiency. During the years 1994, 1997, 2004–2007, 2010, 2013, 2018 and 2021 experienced deficiency in this region. During 2001, South Central Laterites experienced deficiency and the remaining regions experienced moderate deficiency. During 2011, North Central Laterites experienced deficiency and the remaining regions experienced moderate deficiency.

Over the 30-year study, 2016 was the year that experienced the most moisture deficiency (Fig 5.36).

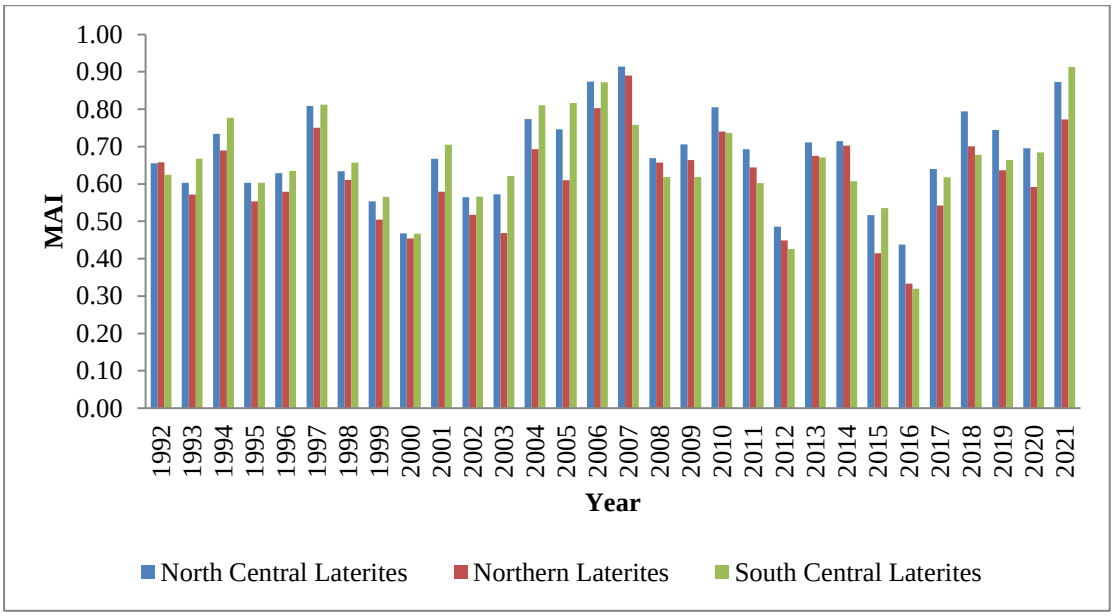



Fig 5.36 Annual Moisture Avalibality Index from 1992-2021 (30 years period) of Laterites region

**5.3.1.5 Foot Hills**

The analysis of the Moisture Availability Index (MAI) showed that in 2016, there was a very high deficiency of moisture. During the years 1992, 1993, 1995, 1996, 1998–2000, 2002, 2003, 2008, 2009, 2011, 2012, 2015 and 2017 experienced moderate deficiency of moisture. While 1994, 1997, 2004, 2006, 2007, 2010, 2018 and 2021 experienced deficiencies, during the years 2001, 2005, 2013, 2019 and 2020 experienced deficiencies in the Southern and Central Foot Hills and moderate deficiencies in the Northern Foot Hills.

Over the 30-year study, 2016 was the year that experienced the most moisture deficiency (Fig 5.37).

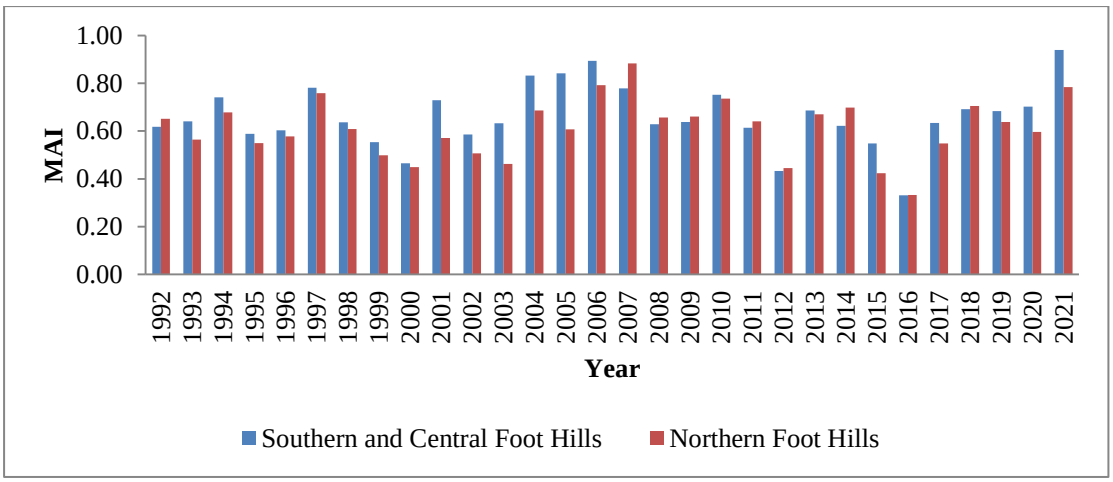



Fig 5.37 Annual Moisture Availability Index from 1992 -2021 (30 years period) of Foot Hills region

### 5.3.1.6 Kole Lands

The analysis of the Moisture Availability Index (MAI) showed that during the years 1992, 1993, 1995, 1996, 1998–03, 2008, 2011, 2012, 2015 and 2015-17 had experienced moderate deficiency and the remaining years had experienced deficiency in kole lands.

Over the 30-year study, 2012 and 2016 were the years that experienced the most moisture deficiency (Fig 5.38).

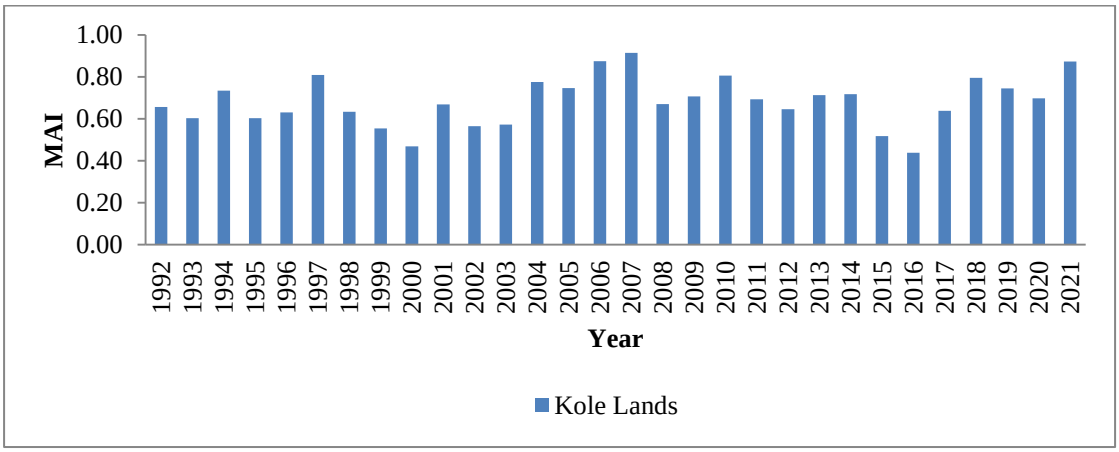



Fig 5.38 Annual Moisture Availability Index from 1992-2021 (30 years period) of Kole lands region

### 5.3.2 Southwest Monsoon

#### 5.3.2.1 Hilly Region

The analysis of the Moisture Availability Index (MAI) showed that the years 1999, 2015 and 2016 were very deficientey of moisture in Attappady Dry Hills and Attappady Hills. While the years 1993, 2000, 2002, 2003 and 2012 had experienced moderate deficiency in Attappady Dry Hills, Attappady Hills, Southern High Hills, Northern High Hills and Southern High Hills. During the years 1994, 1995, 1996, 1998, 2001, 2004, 2005, 2008–11, 2014, 2017 and 2021 experienced moderate deficiency in Attappady Dry Hills and Attappady Hills and deficiency in the Southern High Hills of Thrissur and Palakkad and the Northern High Hills of Thrissur. During 1992 and 2013, deficiency occurred in all hilly regions except the Northern High Hills of Palakkad and the Southern High Hills of Ernakulam.

During the years 2007, 2018, 2019 and 2020, Attappady Dry Hills and Attappady Hills experienced deficiency of moisture. During 1997, Attappady Dry Hills, Attappady Hills and the Southern High Hills of Thrissur experienced deficiency. During 2012, Attappady Dry Hills and Attappady Hills experienced moderate deficiency and the Southern High Hills of Palakkad and the Northern High Hills of Thrissur experienced deficiency.

Compared to other regions, Attappady Dry Hills and Attappady Hills are the most moisture-deficient regions (Fig 5.39).

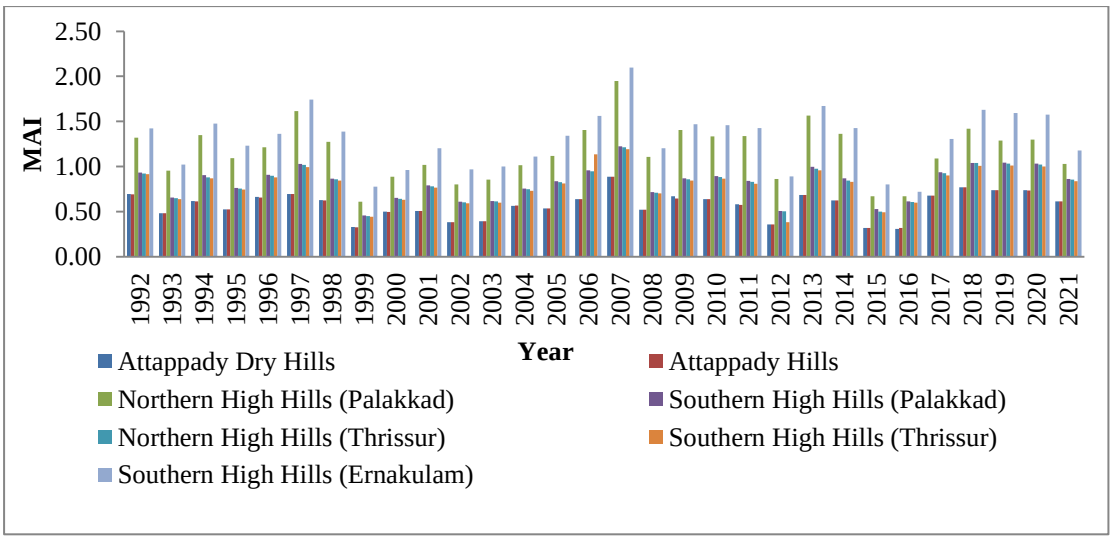



Fig 5.39 Moisture Avalibality Index during southwest monsoon from 1992-2021 (30 years period) of Hilly region

### 5.3.2.2 Pokkali Region

The analysis of the Moisture Availability Index (MAI) showed that the years 1999, 2012, 2015 and 2016 had experienced deficiency in the Pokkali region. Over the 30-year study, 1999 and 2016 were the years that experienced the most moisture deficiency (Fig 5.40).

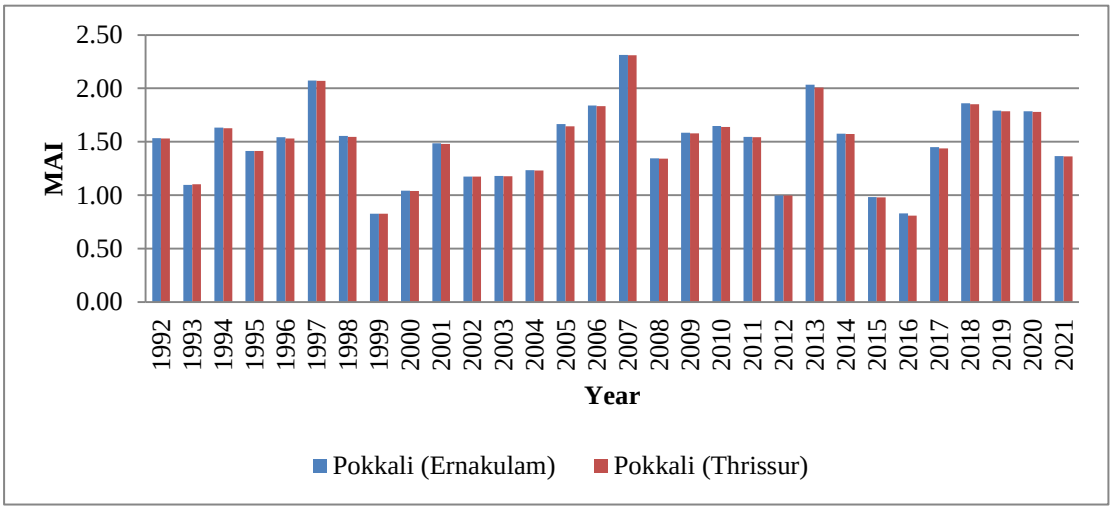



Fig 5.40 Moisture Avalibality Index during southwest monsoon from 1992-2021 (30 years period) of Pokkali region

### 5.3.2.3 Plains Region

The analysis of the Moisture Availability Index (MAI) showed that the years 2015 and 2016 experienced very deficiency in the Palakkad Eastern Plains, moderate deficiency in the Palakkad Central Plains and deficiency in the Northern coastal plains. During the years 1992 and 2001 experienced deficiency in Palakkad Central Plains and Palakkad Eastern Plains. During the years 1993 and 2003 had experienced moderate deficiency in the Palakkad Central Plains and Palakkad Eastern Plains. During 1994-96, 2004, 2005, 2008–11, 2014, 2017 and 2021 had experienced moderate deficiency in the Palakkad Eastern Plains and deficiency in the Palakkad Central Plains. During the years 1997, 2007, 2013, 2018, 2019 and 2020 had experienced deficiency in the Palakkad Eastern Plains. During the years 1998 and 2006 had experienced moderate deficiency in the Palakkad Eastern Plains. During the years 2000, 2002 and 2012 experienced moderate deficiency in the Palakkad Central Plains and Palakkad Eastern Plains and deficiency in the Northern coastal plains.

Compared to other regions, the Palakkad Eastern Plains are the most moisture-deficient regions (Fig 5.41).

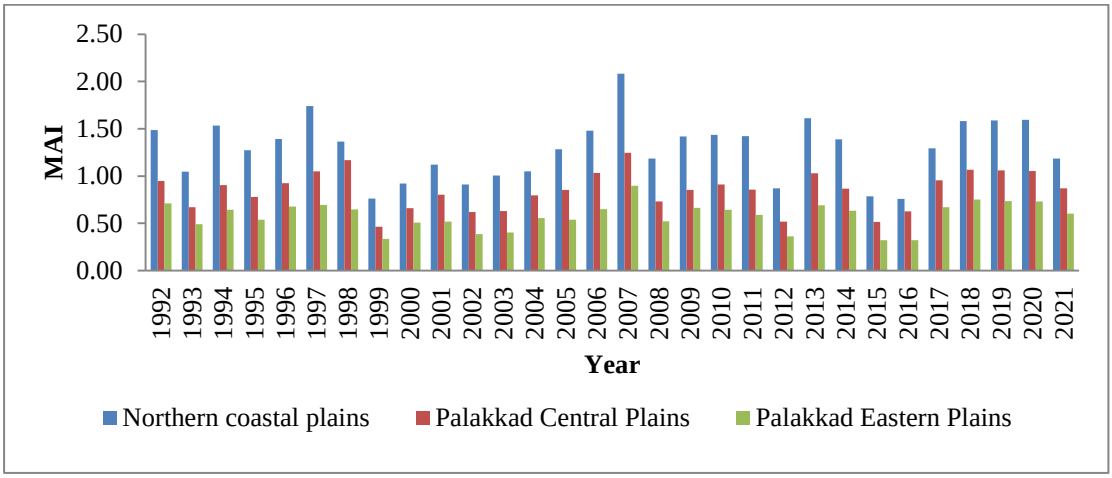



Fig 5.41 Moisture Availability Index during southwest monsoon from 1992-2021 (30 years period) of Plains region

### 5.3.2.4 Laterites Region

The analysis of the Moisture Availability Index (MAI) showed that the years 1992, 2007, 2018, 2019 and 2020 had experienced deficiency in North Central Laterites. During the years 1993 and 2008 had experienced moderate deficiency in North Central Laterites and deficiency in South Central Laterites. While in the years 1994–98, 2001, 2004–2006, 2009–11, 2013, 2014, 2017 and 2021 had experienced moderate deficiency in North Central Laterites.

During the years 2000, 2002, 2003, 2012 and 2015 had experienced moderate deficiency in the North Central Laterites and deficiency in the remaining regions. While in 2015, North Central Laterites experienced very deficiency and the remaining regions experienced deficiency. During 2016, North Central Laterites experienced very deficiency and the remaining regions experienced moderate deficiency.

Compared to other regions, the Northern Central Plains are the most moisture-deficient regions (Fig 5.42).

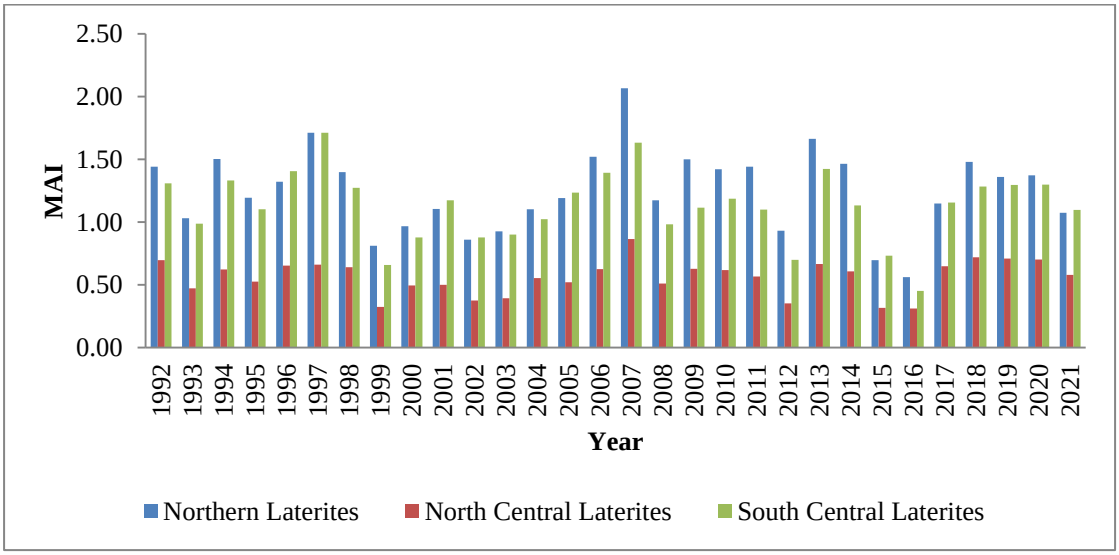



Fig 5.42 Moisture Avalibality Index during southwest monsoon from 1992-2021 (30 years period) of Laterites region

### 5.3.2.5 Foot Hills

The analysis of the Moisture Availability Index (MAI) showed that the years 1999 and 2016 experienced moderate deficiency in the Foothills region. During 1993, Southern and Central Foot Hills experienced deficiency. During the years 2000, 2002, 2003 and 2015, this region experienced deficiencies. In 2015, moderate deficiency was experienced in the Northern Foot Hills and deficiency was experienced in the Southern and Central Foot Hills. Over the 30-year study, 1999 and 2016 were the years that experienced the most moisture deficiency (Fig 5.43).

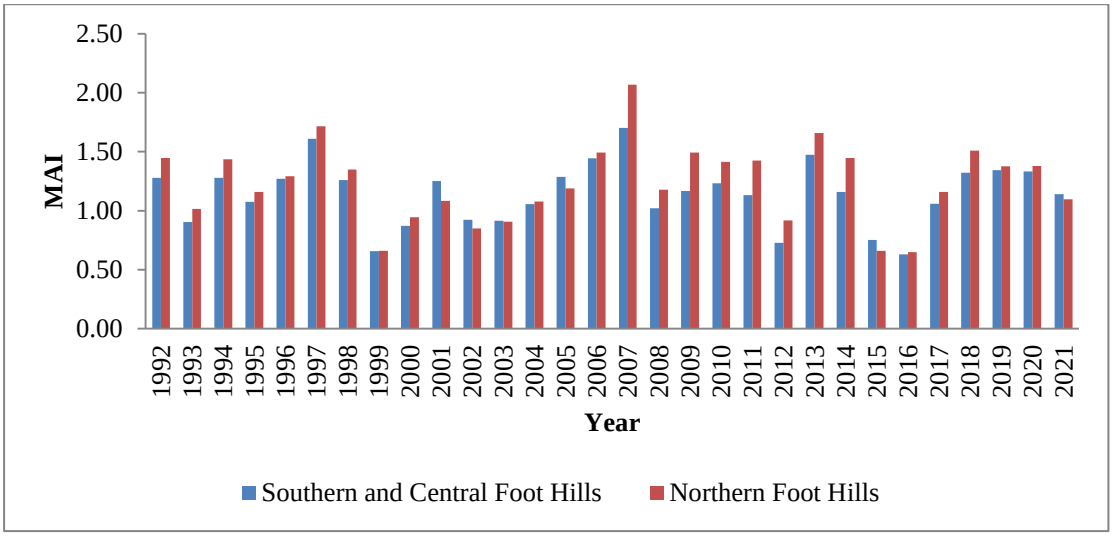



Fig 5.43 Moisture Avalibality Index during southwest monsoon from 1992-2021 (30 years period) of Foot Hills region

### 5.3.2.6 Kole Lands

The analysis of the Moisture Availability Index (MAI) showed that during the year 2016, there was moderate deficiency and in the years 1999, 2000, 2002 and 2015, there was deficiency.

Over the 30-year study, 1999 and 2016 were the years that experienced the most moisture deficiency (Fig 5.44).

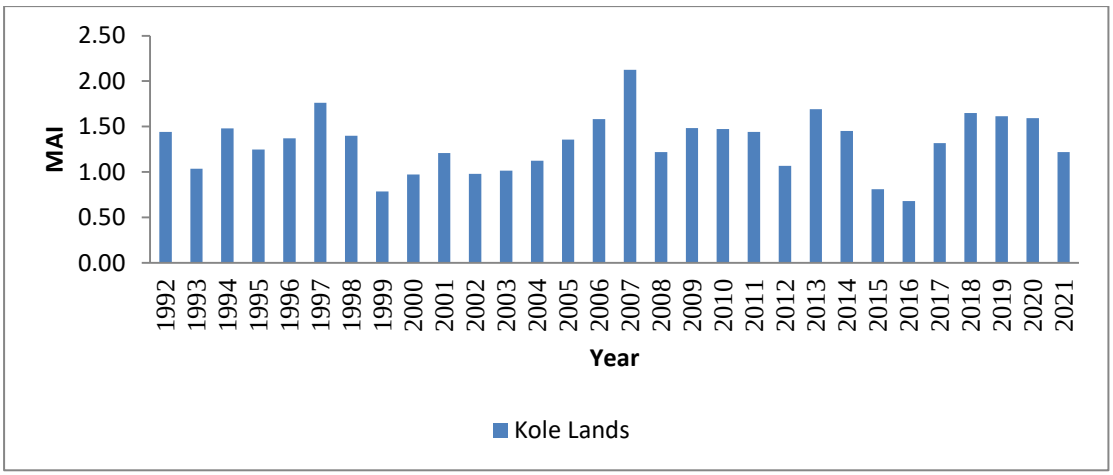



Fig 5.44 Moisture Avalibality Index during southwest monsoon from 1992-2021 (30 years period) of Kole lands region

### 5.3.3 Northeast Monsoon

#### 5.3.3.1 Hilly Region

The analysis of the Moisture Availability Index (MAI) showed that during the year 2016 had experienced very deficiency of moisture. During the years 1992, 1996, 2000, 2001, 2003, 2008, 2009, 2011, 2013, 2014, 2015, 2017 and 2018 had experienced moderate deficiency in hilly regions. While the years 1993, 1997, 1999, 2005 and 2019 had experienced deficiencies in this region. During 1994, the Southern High Hills of Palakkad and Ernakulam and the Northern High Hills of Thrissur experienced deficiency and the remaining regions experienced moderate deficiency. While in 1995, Attappady Dry Hills, Attappady Hills and the Northern High Hills of Palakkad district experienced very deficiency, the remaining regions experienced moderate deficiency.

During 1996, the Southern Hills of Ernakulam district experienced deficiency and the remaining regions experienced moderate deficiency. During 1998 and 2007 had experienced deficiency in the Southern High Hills of Ernakulam. During 2002, the Southern High Hills of Ernakulam and the Northern High Hills of Palakkad experienced deficiency and the remaining regions experienced moderate deficiency.

During 2004 and 2006, the Attappady Dry Hills, Attappady Hills and Northern High Hills of Palakkad district experienced moderate deficiency and the remaining regions experienced deficiency. In 2010, there was a deficiency in the hilly region except for the AEU's Southern High Hills of Ernakulam and Palakkad. During 2012, very high deficiency occurred in the Attappady Dry Hills, Attappady Hills and Southern High Hills of Palakkad and Thrissur and the remaining regions experienced moderate deficiency. While in 2020, the Southern High Hills of Palakkad and Thrissur and the Northern High Hills had experienced deficiency, the remaining regions had experienced moderate deficiency.

Compared to other regions, Attappady Dry Hills and Attappady Hills are the most moisture-deficient regions (Fig 5.45).

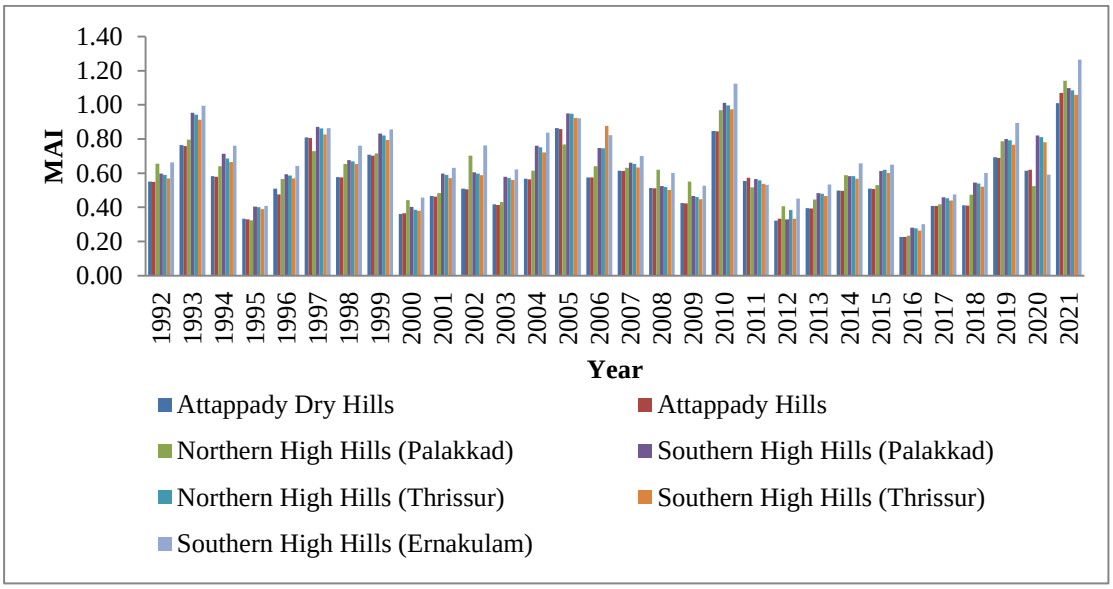



Fig 5.45 Moisture Avalibality Index during northeast monsoon from 1992-2021 (30 years period) of Hilly region

### 5.3.3.2 Pokkali Region

The analysis of the Moisture Availability Index (MAI) showed that during the year 2016, there was a high level of deficiency in the Pokkali region. The Pokkali region experienced deficiency during the years 1992, 1994, 1996, 2001–03, 2007, 2015,

2018, and 2020. While in 1995, 2000, 2008, 2009, 2011–13, 2017 had experienced moderate deficiency in the Pokkali region.

Over the 30-year study, 2016 was the year that experienced the most moisture deficiency (Fig 5.46).

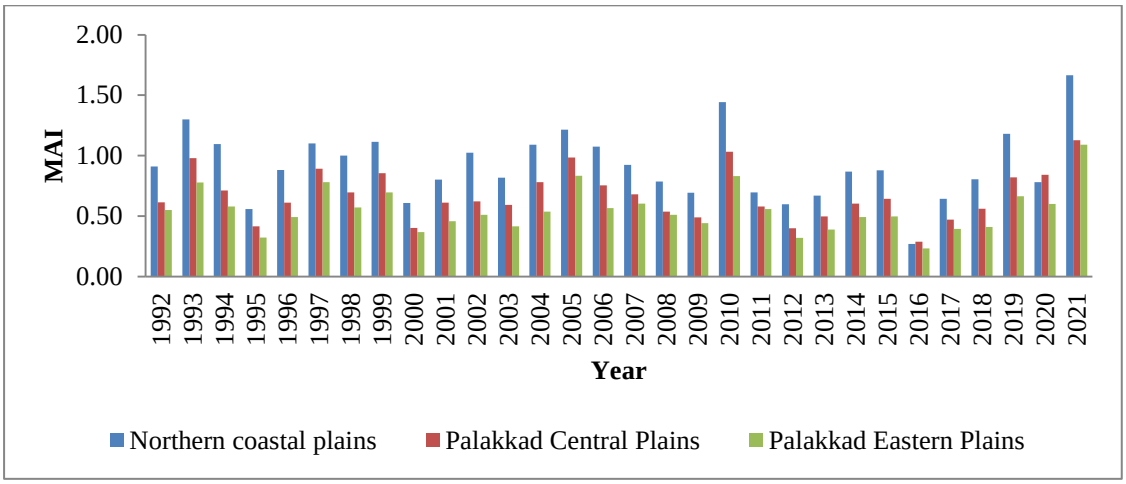



Fig 5.46 Moisture Availability Index during northeast monsoon from 1992-2021 (30 years period of Plains region

### 5.3.3.3. Plains Region

The analysis of the Moisture Availability Index (MAI) showed that during the year 2016 there was a very high deficiency in the plains region. During the years 1992, 1996, 2001, 2003, 2007, 2014, 2015 and 2018 experienced deficiency in the Northern coastal plains and moderate deficiency in the Palakkad Central Plains and Palakkad Eastern Plains. Palakkad Central Plains and Palakkad Eastern Plains had experienced deficiency in the years 1993, 1997 and 1999. During the years 1994, 2004, 2007, 2019 and 2020 had experienced moderate deficiency in the Palakkad Central Plains and moderate deficiency in the Palakkad Eastern Plains. During the years 1995 and 2012 had experienced a very high deficiency in the Palakkad Eastern Plains and a moderate deficiency in the remaining regions. During the years 1997, 1999 and 2005 experienced deficiencies in the Palakkad Central Plains and Palakkad

Eastern Plains. During the years 1998 and 2002 had experienced moderate deficiency in the Palakkad Central Plains and Palakkad Eastern Plains.

Compared to other regions, the Palakkad Eastern Plains are the most moisture-deficient regions (Fig 5.47).

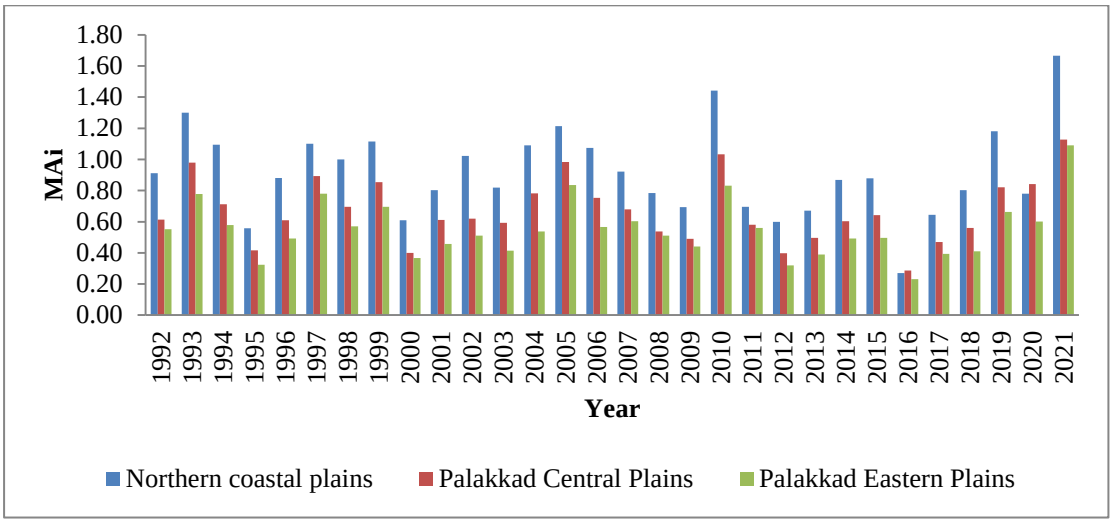



Fig 5.47 Moisture Avalibality Index of Plains region over a 30 years period during northeast monsoon rainfall

### 5.3.3.4 Laterites Region

The analysis of the Moisture Availability Index (MAI) showed that during the year 2016, there was a very high deficiency in the Laterites region. During the years 1992, 1996, 1998, 2001, 2002, 2007, 2014, 2015 and 2020, North Central Laterites experienced moderate deficiency and the remaining regions experienced deficiency. During the years 1993 and 2010, North Central Laterites experienced deficiency. While 1995, North Central Laterites had experienced very deficiency and the remaining regions experienced moderate deficiency. During the years 2000, 2008, 2009, 2011, 2013 and 2017 experienced moderate deficiency in the Laterites region.

Compared to other regions, the Northern Central Plains are the most moisture-deficient region (Fig 5.48).

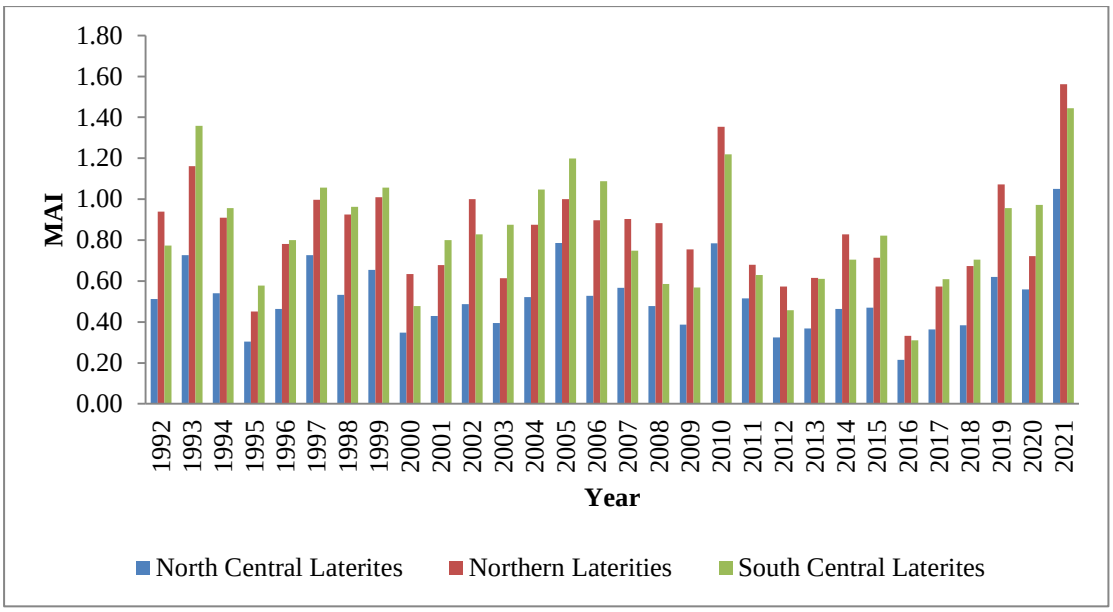



Fig 5.48 Moisture Availability Index during northeast monsoon from 1992-2021 (30 years period) of Laterities region

**5.3.3.5 Foot Hills**

The analysis of the Moisture Availability Index (MAI) showed that during the year 2016, Foot Hills experienced a very high level of deficiency. During the years 1992, 1993, 2002 and 2019 experienced a deficiency of moisture. During the years 1995, 2000, 2008, 2009, 2011, 2012, 2013 and 2017 this region experienced moderate deficiency. During the years 1996, 1999, 2001, 2003, 2007, 2014, 2015 and 2018, there was a moderate deficiency of moisture in the Northern Foot Hills and a deficiency in the Southern and Central Foot Hills. While the years 1997, 1999, 2005 and 2006 had experienced deficiency in the Northern Foot Hills.

Compared to Southern and Central Foot Hills, Northern Foot Hills are the most moisture-deficient regions (Fig 5.49).

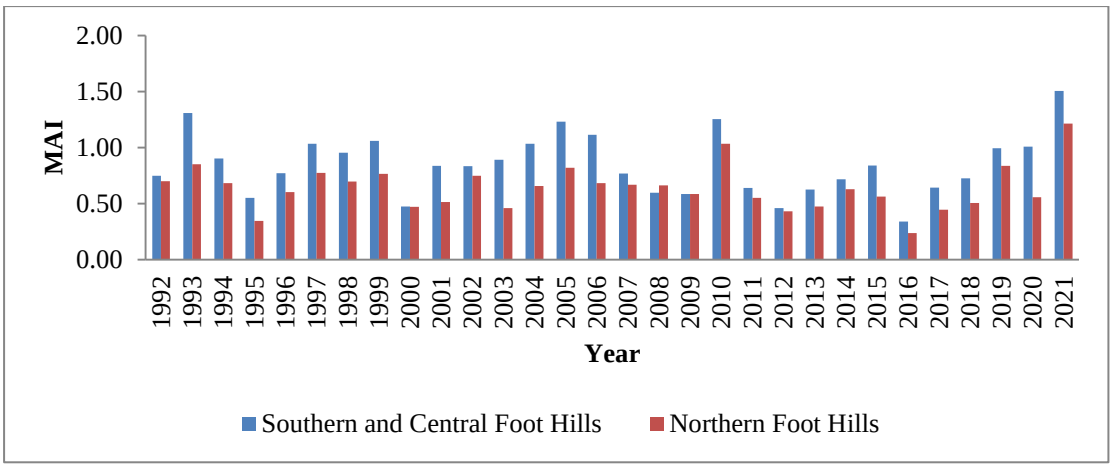



Fig 5.49 Moisture Availability Index during northeast monsoon from 1992-2021 (30 years period) of Foot Hills region

### 5.3.3.6 Kole Lands

The analysis of the Moisture Availability Index (MAI) showed that during the year 2016, Kole Lands experienced a very high deficiency of moisture. During the years 1992, 1993, 1997, 1998, 1999, 2004–07, 2015 and 2019 experienced deficiency in Kole lands. While the years 1995, 1996, 2000, 2001, 2003, 2008, 2009, 2011–14, 2017, 2018 and 2020 experienced moderate deficiency. Over the 30 years study, 2016 was the year that experienced the most moisture deficiency (Fig 5.50).

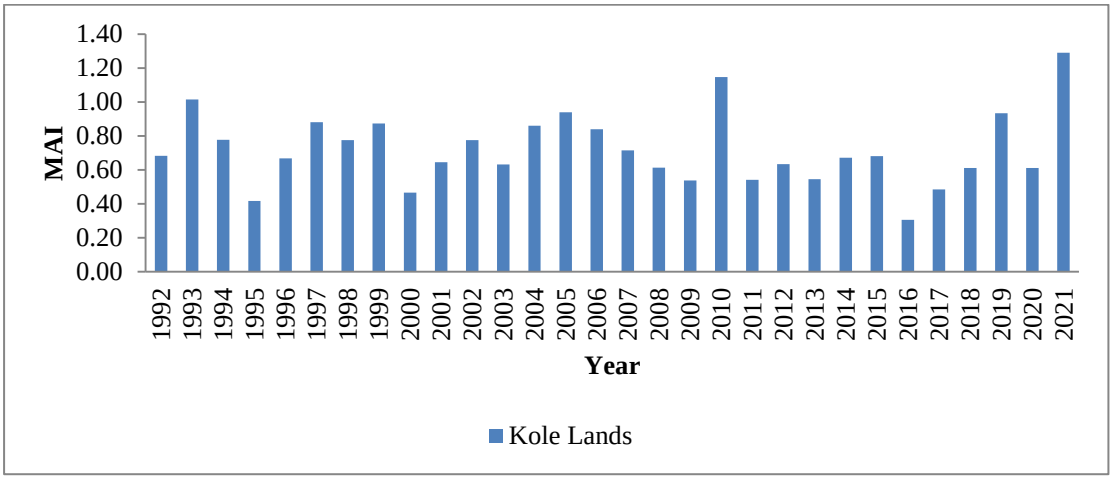



Fig 5.50 Moisture Availability Index during northeast monsoon from 1992-2021 (30 years period) of Kole lands region

### 5.3.4 Summer Season

#### 5.3.4.1 Hilly Region

The analysis of the Moisture Availability Index (MAI) showed that during the years 1992–94, 1996–98, 2000–2002, 2005–2007, 2010–13, 2016, 2019 and 2020, there was a very high deficiency of moisture in hilly regions. During the years 1995, 1999, 2003, 2009, 2014, 2015 and 2017 there was a moderate deficiency of moisture in the Southern High Hills of Ernakulam and the remaining regions experienced a deficiency. During the years 2001, 2006, 2008, 2018 and 2021, there was a very high deficiency in Attappady Dry Hills and Attappady Hills and the remaining regions experienced a moderate deficiency.

Compared to other regions, Attappady Dry Hills and Attappady Hills are the most moisture-deficient regions (Fig 5.51).

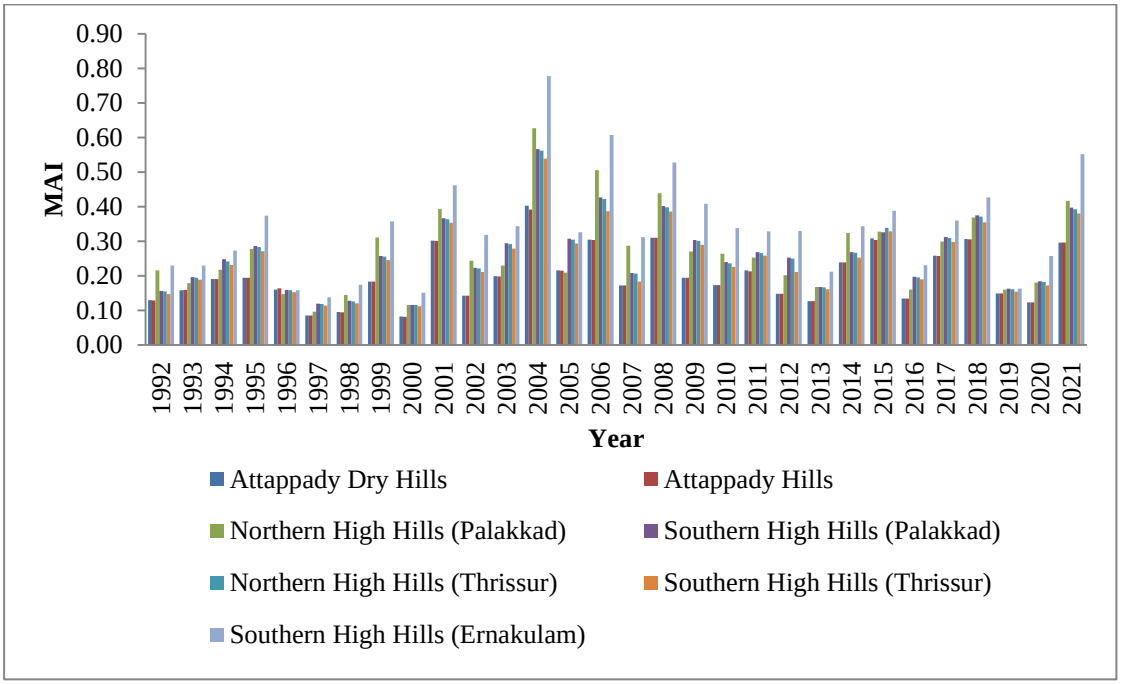



Fig 5.51 Moisture Avalibality Index during summer season from 1992-2021 (30 years period) of Hilly region

### 5.3.4.2 Pokkali Region

The analysis of the Moisture Availability Index (MAI) showed that during the years 1992, 1993, 1996–08, 2000, 2013, 2016 and 2019 had experienced deficiency and the years 1994, 1995, 1999, 2001-03, 2005, 2007, 2008-12, 2014, 2015, 2017, 2018 and 2020 experienced moderate deficiency

Over the 30-year study, 1996 was the year that experienced the most moisture deficiency (Fig 5.52).

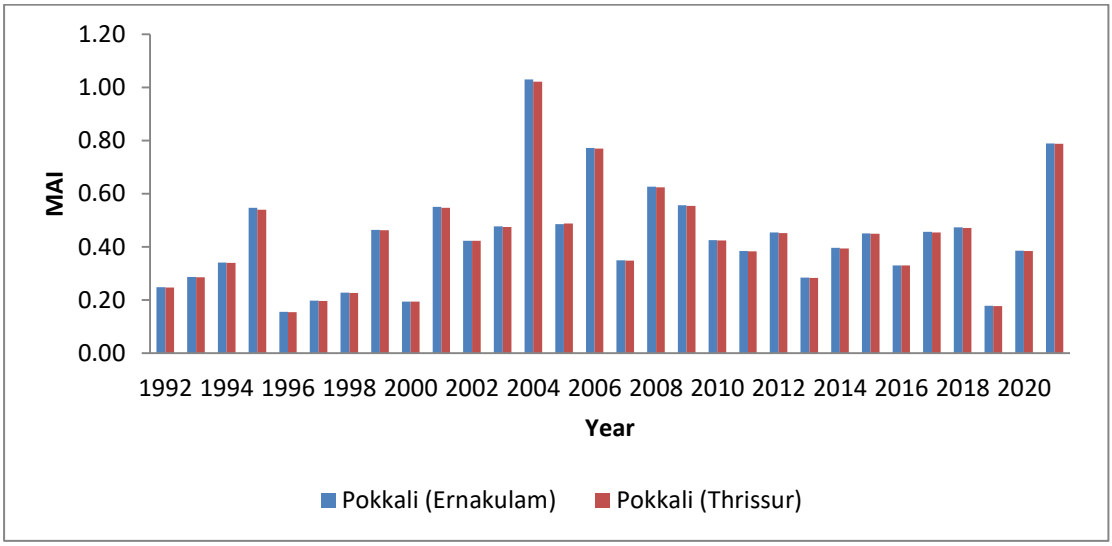



Fig 5.52 Moisture Avalibality Index during summer monsoon from 1992-2021 (30 years period) of Pokkali region

The analysis of the Moisture Availability Index (MAI) showed that during the years 1992, 1993, 1994, 1996–98, 2000, 2002, 2003, 2005, 2007, 2010–13, 2016, 2019 and 2020 had experienced very deficiency in plains regions. While 1995, 1999, 2009, 2014 and 2017 experienced moderate deficiency in the Northern coastal plains and very deficiency in the remaining regions, 2001, 2006, 2008, 2018 and 2021 experienced moderate drought in this region. In 2004, the Northern coastal plains experienced deficiency and the remaining regions experienced moderate drought. During 2015, very high deficiency was experienced in the Palakkad Eastern Plains and the remaining regions experienced moderate deficiency.

Over the 30-year study, 2000 was the year that experienced the most moisture deficiency (Fig 5.53).

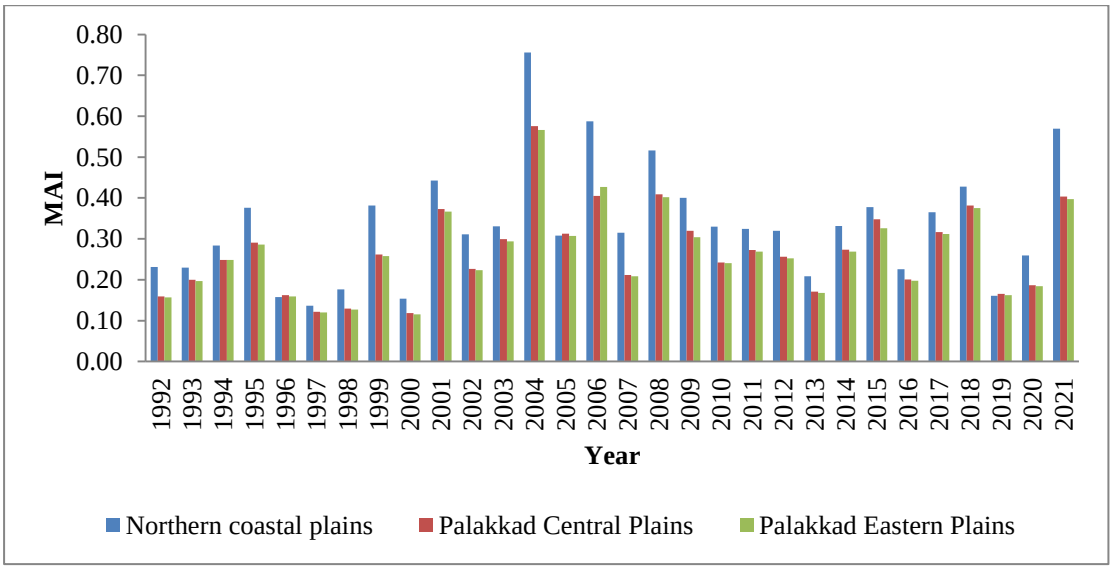



Fig 5.53 Moisture Avalibality Index during summer season from 1992-2021 (30 years period) of Plains region

### 5.3.4.4 Laterites Region

The analysis of the Moisture Availability Index (MAI) showed that during the years 1992, 1993, 1996–98, 2000, 2007, 2011, 2013, 2016, 2019 and 2020, the region experienced a very deficiency of moisture. While the years 1994, 1995, 1999, 2003, 2005, 2009, 2010, 2012, 2015 and 2017 experienced a moderate deficiency in South Central Laterites, the remaining regions had experienced a very deficiency.

During the years 2001, 2006, 2008, 2014, 2018, and 2021, there was a very high deficiency of moisture in North Central Laterites and a moderate deficiency in the remaining regions. While 2004 deficiency was experienced in South Central Laterites, the remaining regions had experienced moderate deficiency.

Compared to other regions, the Northern Central Plains are the most moisture-deficient region (Fig 5.54).

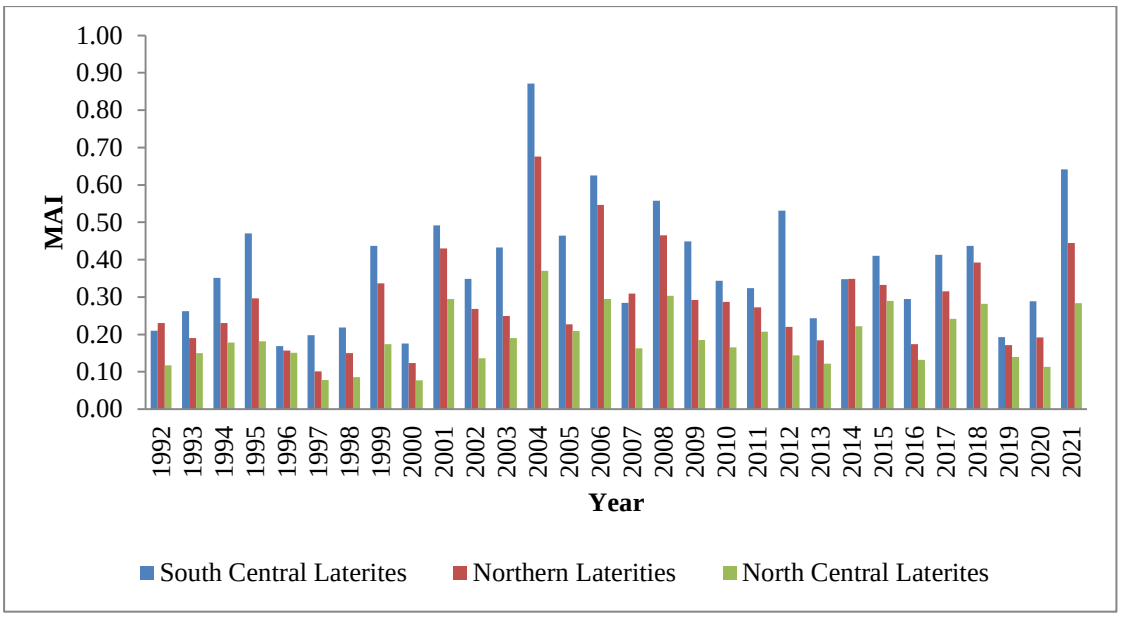



Fig 5.54 Moisture Avalibality Index during summer season from 1992-2021 (30 years period) of Laterities region

### 5.3.3.5 Foot Hills

The analysis of the Moisture Availability Index (MAI) showed that during the years 1992, 1993, 1994, 1996–98, 2000, 2007, 2011, 2013, 2016, 2019 and 2020, there was a very deficiency of moisture in the Foot Hills region. While 1995, 1999, 2002, 2003, 2005, 2009, 2010, 2012, and 2017 had experienced moderate deficiency in the Southern and Central Foot Hills, the remaining regions had experienced very deficiency. During the years 2001, 2006, 2008, 2014, 2015 and 2021, experienced a moderate deficiency of moisture in this region. While 2004 deficiency was experienced in the Southern and Central Foot Hills, the remaining region experienced a moderate deficiency.

Compared to Southern and Central Foot Hills, Northern Foot Hills are the most moisture-deficient regions (Fig 5.55).

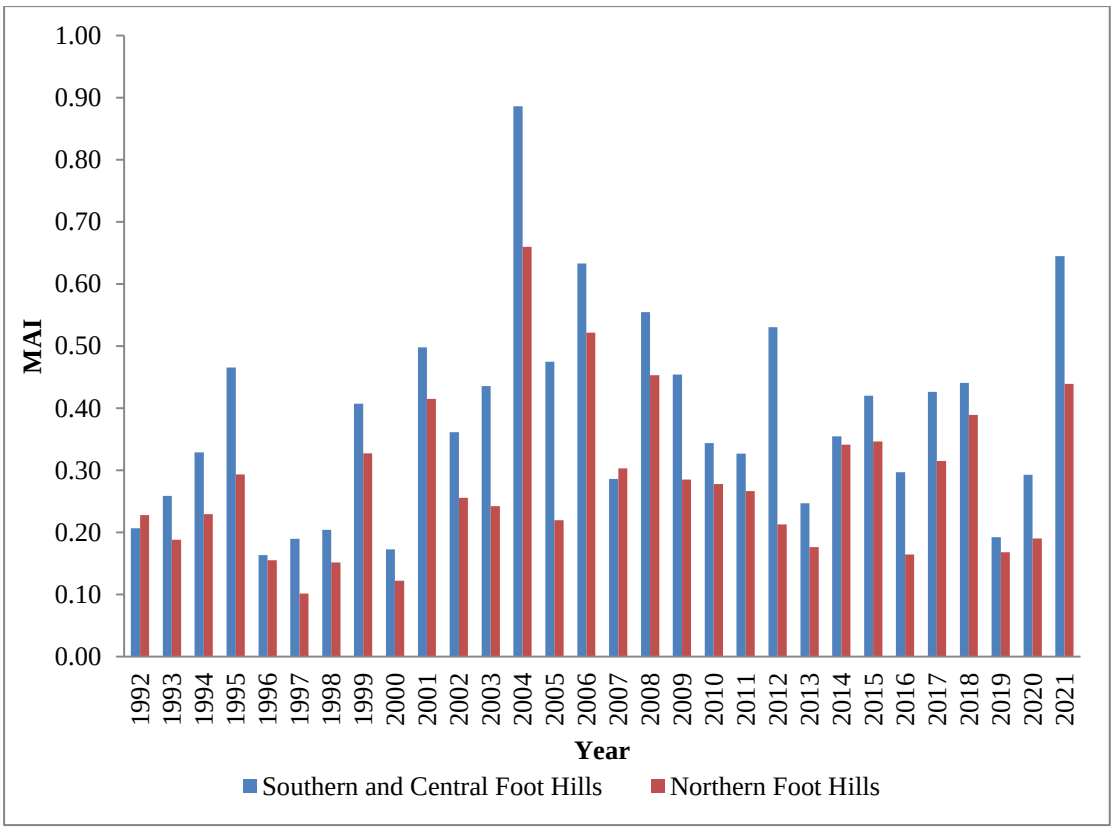



Fig 5.55 Moisture Avalibality Index during summer season from 1992-2021 (30 years period) of Foot Hills region

### 5.3.4.6 Kole Lands

The analysis of the Moisture Availability Index (MAI) showed that during the years 1992, 1993, 1994, 1996–98, 2000, 2002, 2005, 2007, 2011, 2013, 2016, 2019 and 2020, Kole lands experienced very deficiency. While in the years 1995, 1999, 2001, 2003, 2006, 2008–10, 2012, 2014, 2015, 2017, 2018 and 2021 had experienced moderate deficiency. During 2004, Kole Land experienced a deficiency of moisture.

Over the 30-year study, 1997 was the year that experienced the most moisture deficiency (Fig 5.56).

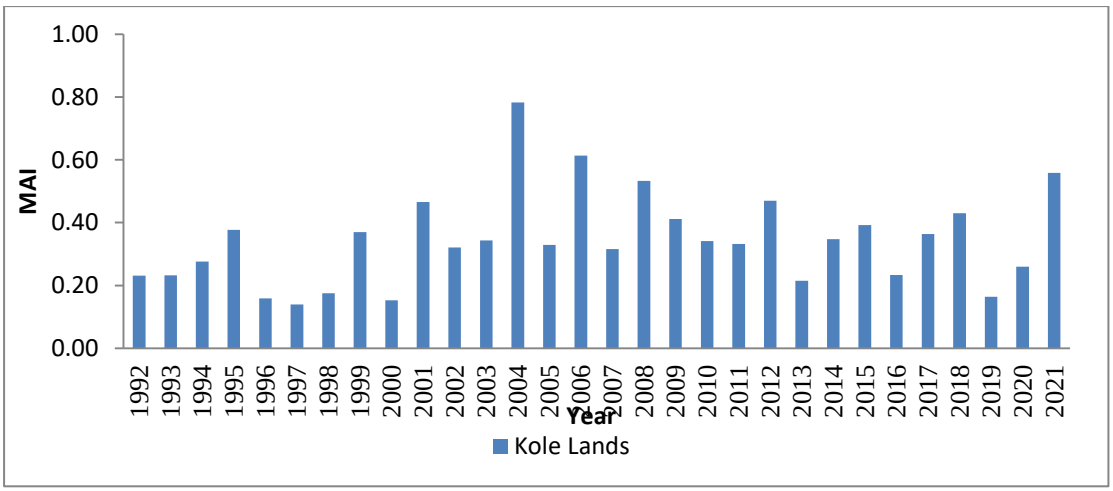



Fig 5.56 Moisture Avalibality Index during summer season from 1992-2021 (30 years period) of Kole lands region

### 5.3.5 Winter Season

#### 5.3.5.1 Hilly Region

The analysis of the Moisture Availability Index (MAI) indicates that over the past 30 years, the hilly region has consistently experienced severe moisture deficiency, except in 1994 and 2000. In 1994 and 2000, the Southern High Hills of Ernakulam experienced deficiency and the remaining regions experienced very deficiency.

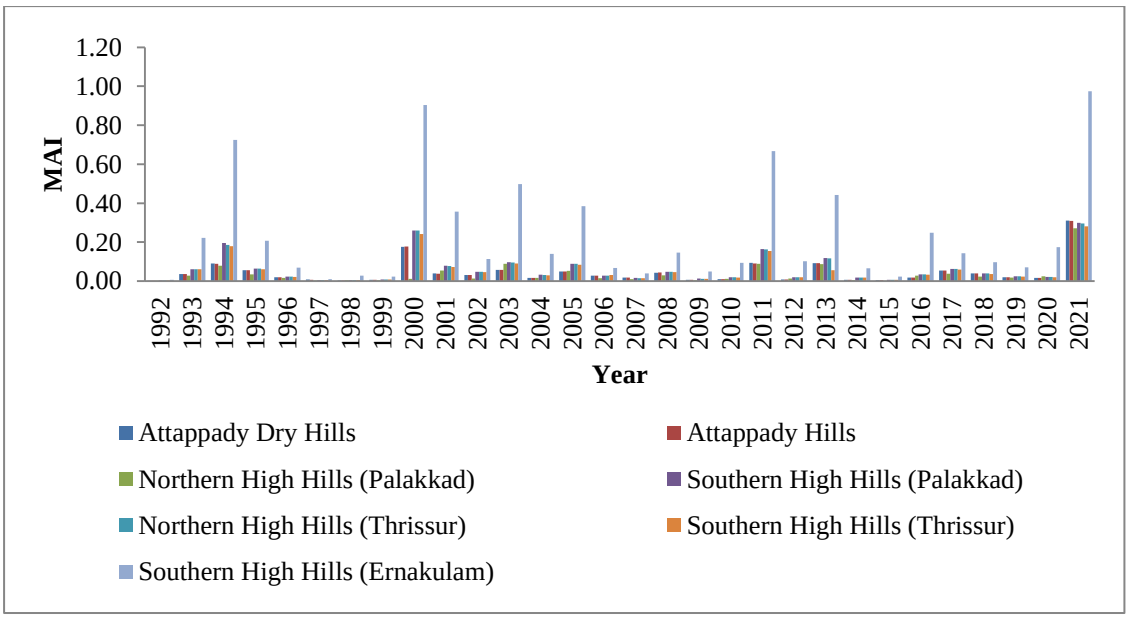



Fig 5.57 Moisture Avalibality Index during winter season from 1992-2021 (30 years period) of Hilly region

### 5.3.5.2 Pokkali Region

The analysis of the Moisture Availability Index (MAI) indicates that over the past 30 years, the Pokkali region had consistently experienced severe moisture deficiency, except in 1994 and 2000. In 1994 and 2000, the Pokkali region experienced moderate deficiency. Over the 30-year study, 1997 was the year that experienced the most moisture deficiency (Fig 5.58).

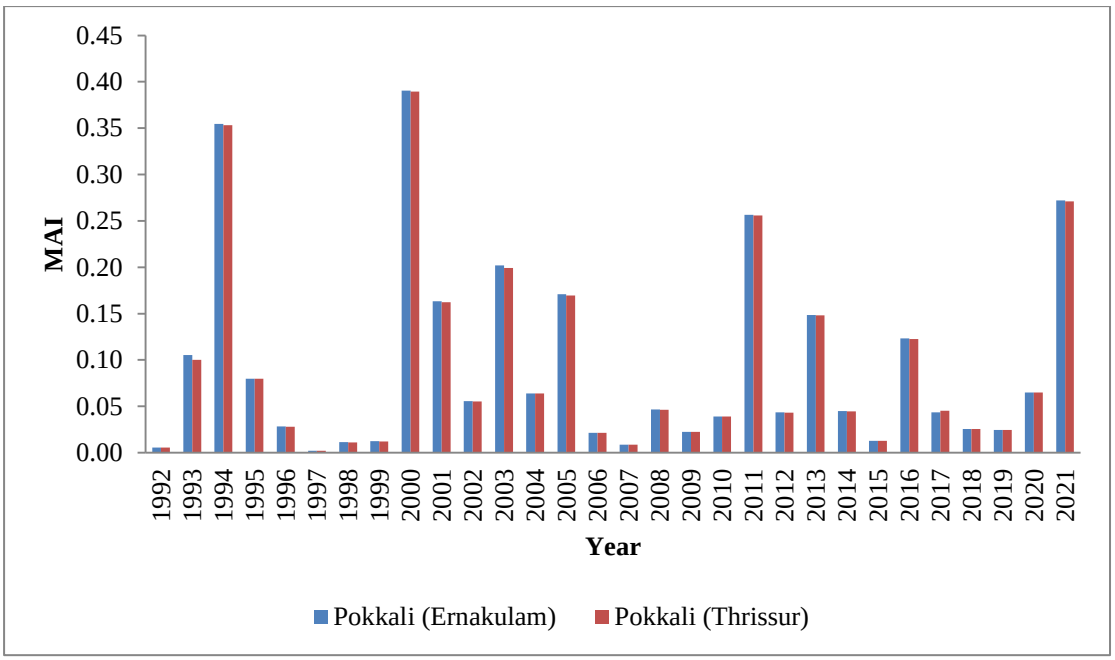



Fig 5.58 Moisture Avalibality Index during winter season from 1992-2021 (30 years period) of Pokkali region

### 5.3.5.3 Plains Region

The analysis of the Moisture Availability Index (MAI) indicates that over the past 30 years, the plains region has experienced very deficiency.

Compared to other regions, the Palakkad Eastern Plains are the most moisture-deficient regions (Fig 5.59).

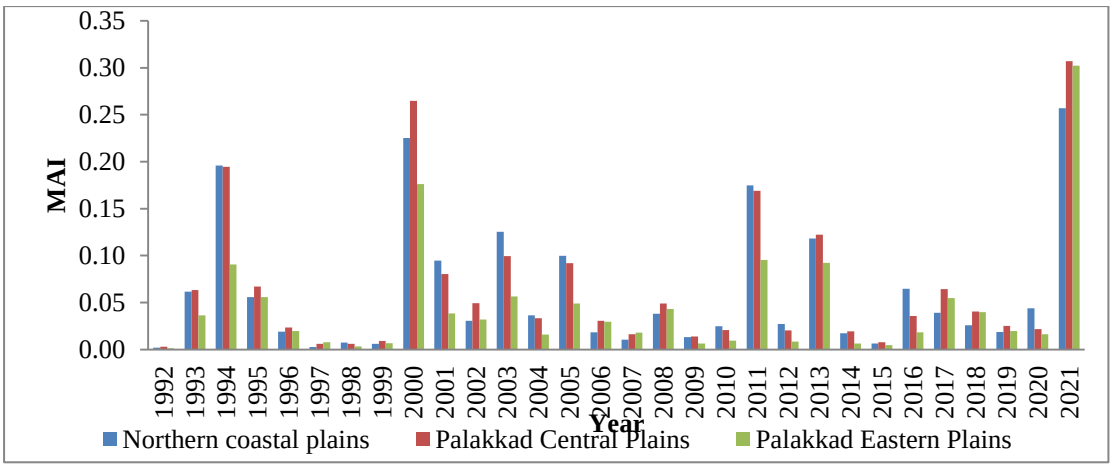



Fig 5.59 Moisture Availability Index during winter season from 1992-2021 (30 years period) of Pokkali region

### 5.3.5.4 Laterites Region

The analysis of the Moisture Availability Index (MAI) indicates that over the past 30 years, the plains region has consistently experienced severe moisture deficiency, except in 1994 and 2000. In 1994 and 2000, South Central Laterites experienced moderate deficiency, and the remaining regions experienced very deficiency.Over the 30-year study, 1993 was the year that experienced the most moisture deficiency (Fig 5.60).

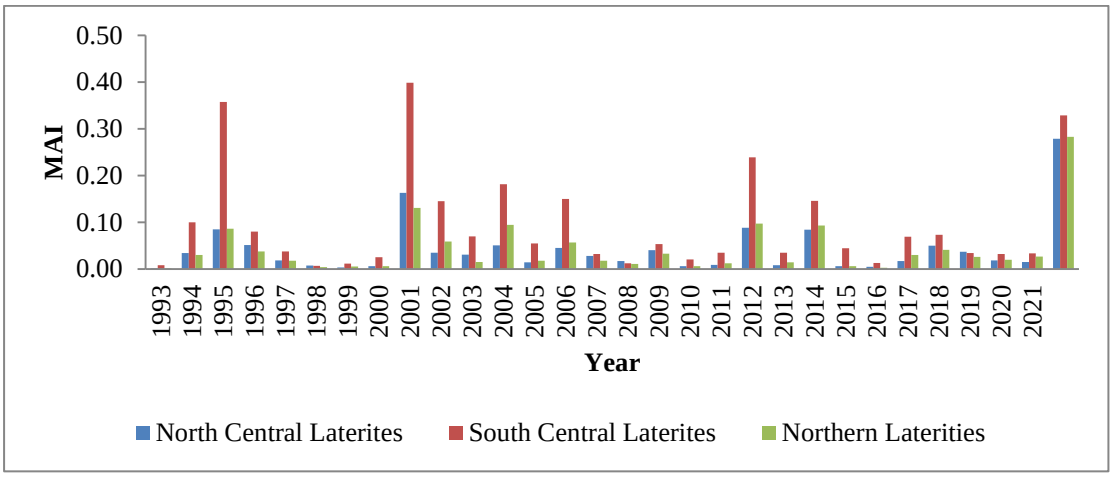



Fig 5.60 Moisture Availability Index during winter season from 1992-2021 (30 years period) of Laterites region

### 5.3.4.5 Foot Hills

The analysis of the Moisture Availability Index (MAI) indicates that over the past 30 years, the Foothills region has consistently experienced severe moisture deficiency, except in 1994 and 2000. In 1994 and 2000, Southern and Central Foot Hills experienced moderate deficiency and the remaining regions hexperiencedvery deficiency.

Compared to the Southern and Central Foot Hills, the Northern Foot Hills are the most moisture-deficient regions (Fig 5.61).

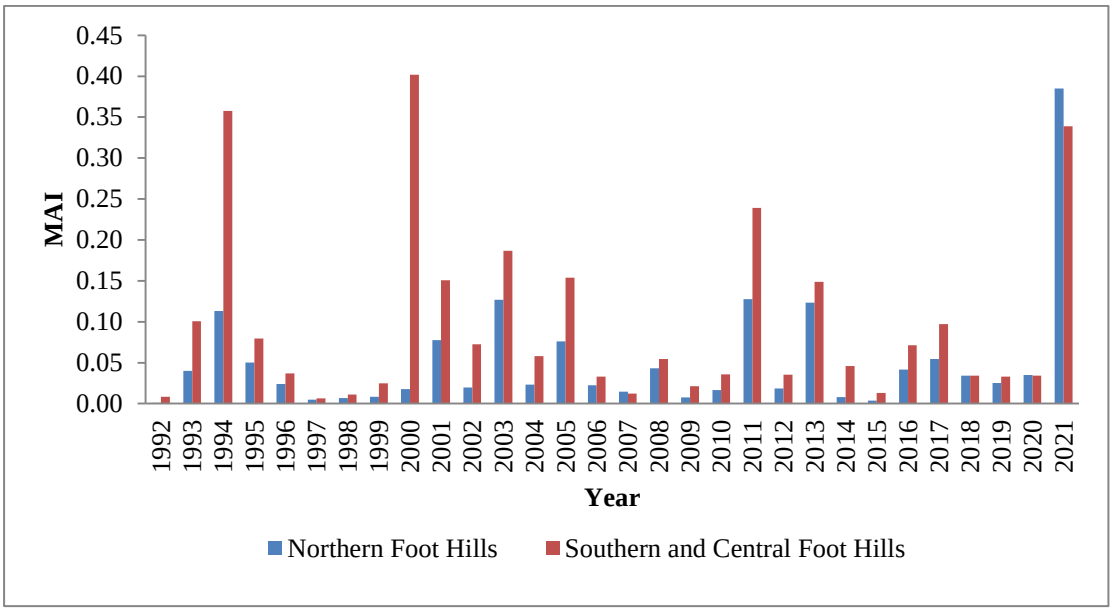



Fig 5.61 Moisture Avalibality Index during winter season from 1992-2021 (30 years period) of Foot Hills region

### 5.3.4.6 Kole Lands

The analysis of the Moisture Availability Index (MAI) indicates that over the past 30 years, Kole Lands experienced a very deficiency of moisture. Over the 30-year study, 1992 and 1997 were the years that experienced the most moisture deficiency (Fig 5.62).

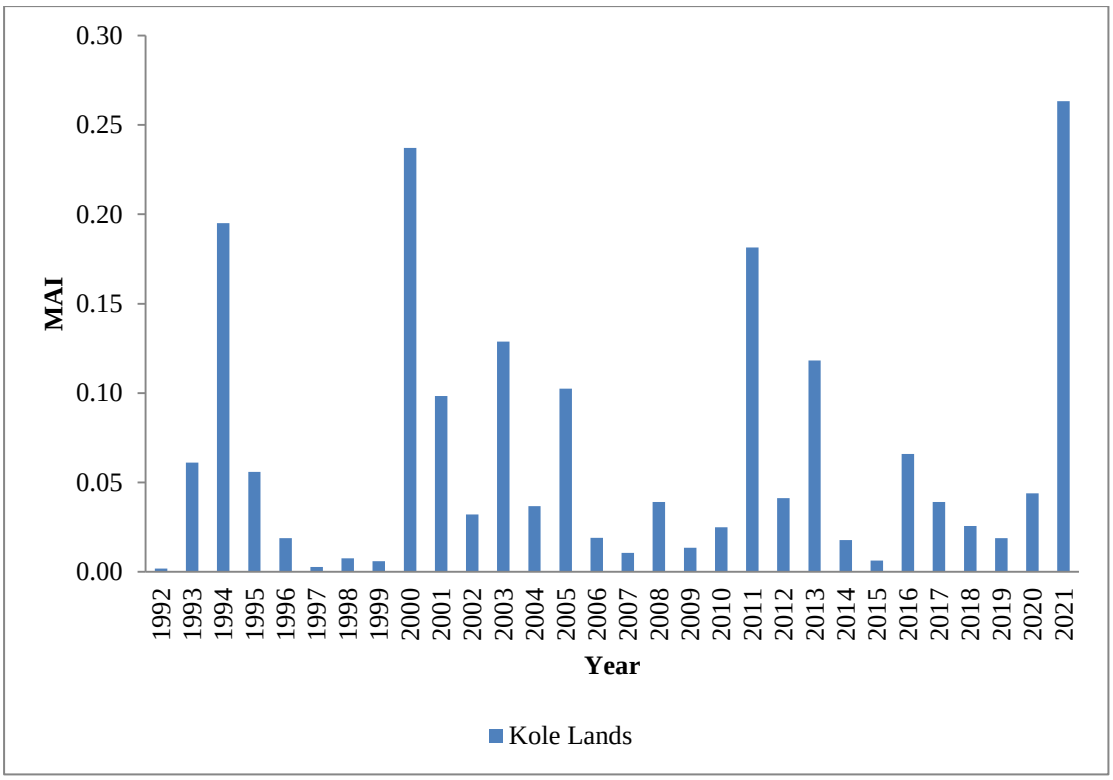



Fig 5.62 Moisture Avalibality Index during winter season from 1992-2021 (30 years period) of Kole lands region

## 5.4 Aridity Index (AI)

### 5.4.1 Annual Rainfall

The analysis of the Aridity Index (AI) for the central zone of Kerala showed that during the years 1992, 1998, 2008, 2009, 2011, 2013 and 2014, semi-arid conditions were experienced in the Palakkad Eastern Plains, Attappady Dry Hills and Attappady Hills. Compared to other regions, the Palakkad Eastern Plains, Attappady Dry Hills and Attappady Hills are the most dryness affected regions in the central zone of Kerala.

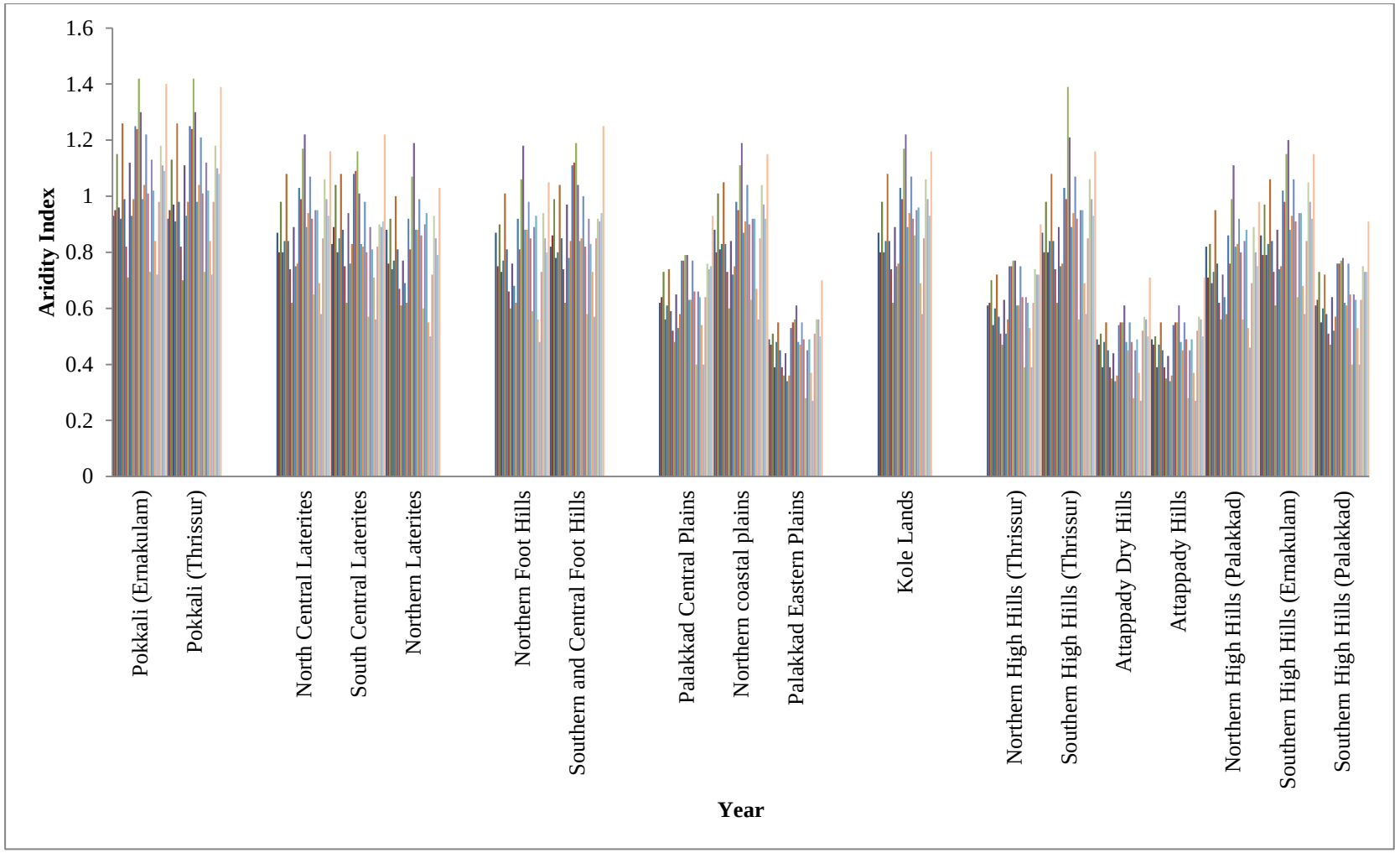


Fig 5.63 Annual Aridity Index from 1992-2021 (30 years period) in different AEUs of central zone of Kerala

#### 5.4.1.1 Hilly Region

The analysis of the Aridity Index (AI) for the Hilly region showed that during the years 1992, 1998, 2008, 2009, 2011, 2013 and 2014, semi-arid conditions were experienced in the Attappady Dry Hills and Attappady Hills; the Northern High Hills of Thrissur experienced sub-humid conditions and the remaining regions experienced humid conditions. During the years 1993, 1995, 1996, 2001, 2002 and 2003, Attappady Dry Hills and Attappady Hills experienced semi-arid conditions; the Northern High Hills of Palakkad and Thrissur and the Southern High Hills of Palakkad experienced sub-humid conditions; and the remaining regions experienced humid conditions. While the years 1994, 1997 and 1998–20 had experienced sub-humid conditions in the Attappady Dry Hills and Attappady Hills, the Southern High Hills of Palakkad and the Northern High Hills of Thrissur and the remaining regions had experienced humid conditions.

During the years 1999 and 2015, the Attappady Dry Hills and Attappady Hills experienced semi-arid conditions, and the remaining regions experienced sub-humid conditions. During the years 2000 and 2012 had experienced a semi-arid condition in the Attappady Dry Hills, Attappady Hills, Southern High Hills of Palakkad and the Northern High Hills of Thrissur. During the years 2004, 2005, 2006, 2007, 2010 and 2021, Attappady Dry Hills and Attappady Hills experienced sub-humid conditions, and the remaining regions experienced humid condition.

When compared to other regions, Attappady Dry Hills and Attappady Hills coming from the Palakkad district had experienced more dryness in the hilly region (Fig 5.64).

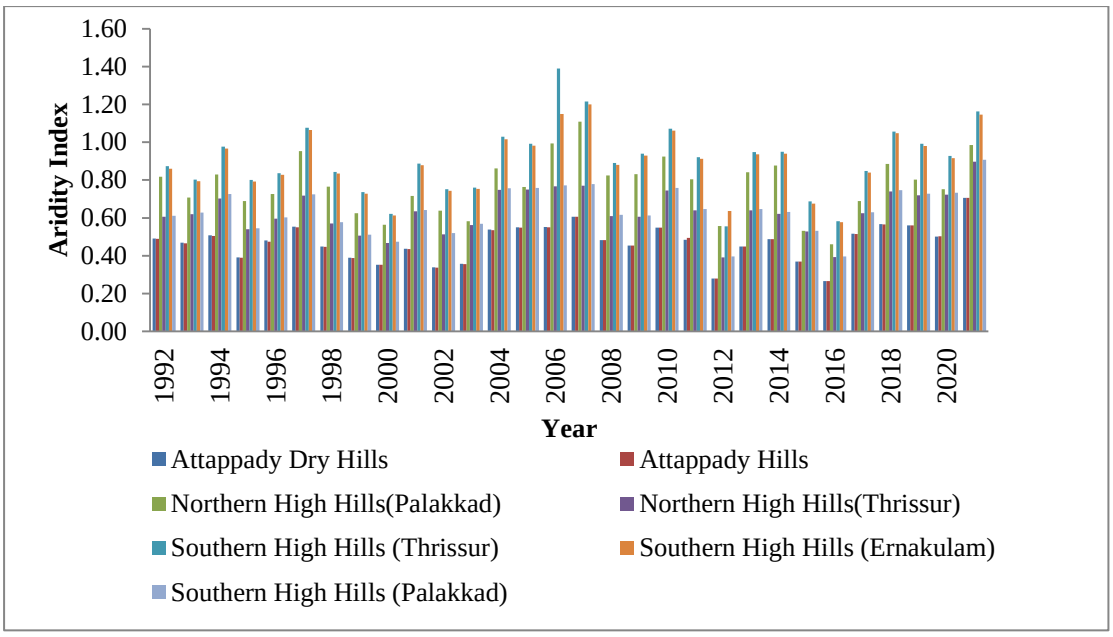



Fig 5.64 Annual Aridity Index from 1992-2021 (30 years period) of Hilly region

### 5.4.1.2 Pokkali Region

The analysis of the Aridity Index (AI) in the Pokkali region showed that during the years 1992–99, 2001–11, 2013, 2015 and 2017–2021, the region experienced humid conditions and in the years 2000, 2012 and 2016, it experienced sub-humid conditions.

The Pokkali region experienced more dryness in the years 2000, 2012 and 2016 over the last 30 years (Fig 5.65).

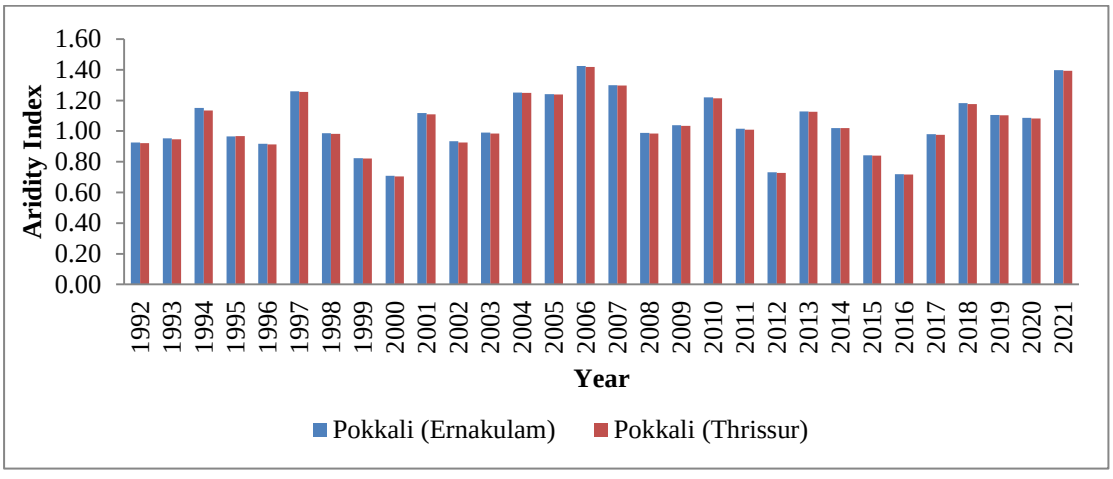



Fig 5.65 Annual Aridity Index from 1992-2021 (30 years period) of Pokkali region

### 5.4.1.3 Plains Region

The analysis of the Aridity Index (AI) for the Plains region showed that during the years 1992, 1993, 1995, 1996, 1998, 2001, 2008, 2009, 2011, 2013 and 2014, the Palakkad Eastern Plains experienced semi-arid conditions, the Palakkad Central Plains experienced sub-humid conditions and the remaining regions experienced humid conditions. During the years 1994, 1997, 2017 and 2019, the northern coastal plains experienced humid conditions, and the remaining regions experienced sub-humid conditions. While the years 1999, 2002 and 2015 had experienced semi-arid conditions in the Palakkad Eastern Plains, the remaining regions had experienced sub-humid conditions. During the years 2000, 2012 and 2016, sub-humid conditions in the Northern coastal plains and the remaining regions experienced semi-arid conditions.

When compared to other regions, the Palakkad Eastern Plains had experienced more dryness in the plains region (Fig 5.66).

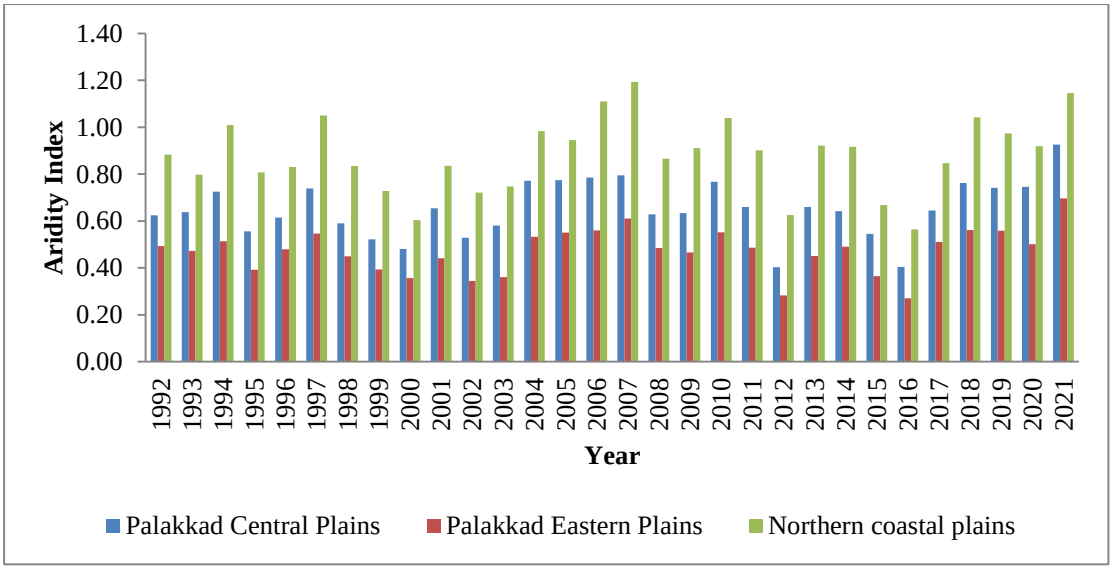



Fig 5.66 Annual Aridity Index from 1992-2021 (30 years period) of Plains region

### 5.4.1.4 Laterites Region

The analysis of the Aridity Index (AI) in the Laterites region showed that during the years 1992–1994, 1996–98, 2001, 2004–2011, 2013, 2014 and 2018–2021,

humid conditions were experienced and in the years 2000, 2012, 2015 and 2016 were experienced in sub-humid conditions. While the years 1995, 2002, 2003 and 2017 had experienced sub-humid conditions in the Northern Laterites, the remaining regions had experienced humid conditions. During 1999, South Central Laterites experienced humid conditions, and the remaining regions experienced sub-humid conditions.

When compared to other regions, the Northern Laterites had experienced more dryness in the Laterites region (Fig 5.67).

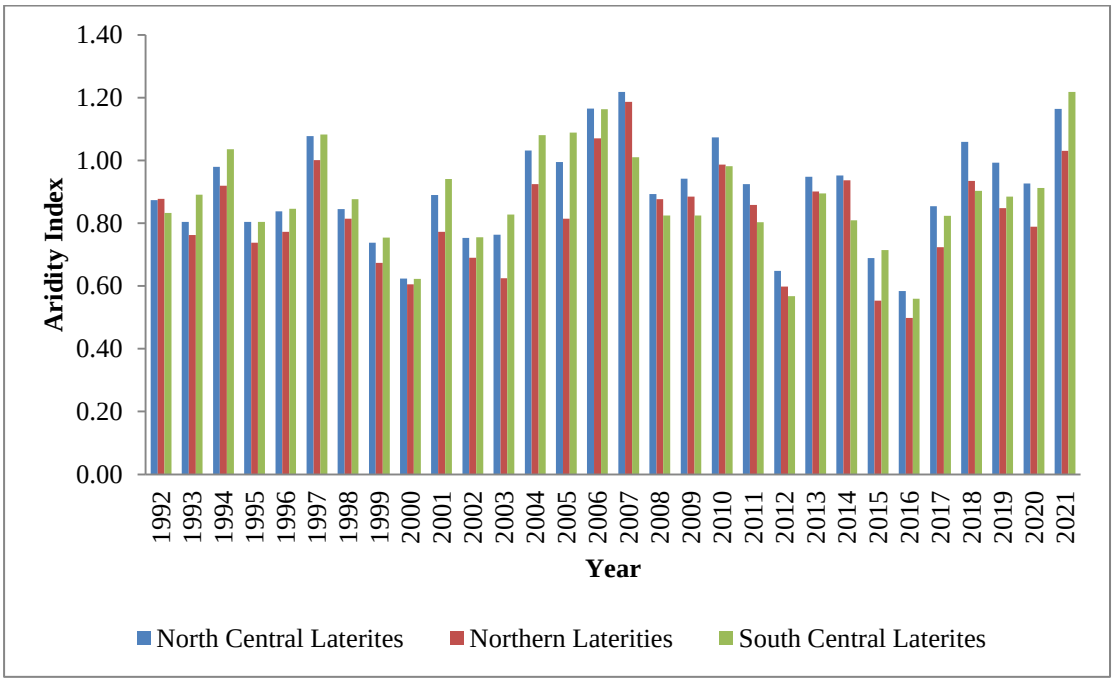



Fig 5.67 Annual Aridity Index from 1992-2021 (30 years period) of Laterities region

### 5.4.1.5 Foot Hills

The analysis of the Aridity Index (AI) in the Foot Hills region showed that during the years 1992–94, 1996–98, 2001, 2004–11, 2013, 2014 and 2018–2021, humid conditions were experienced. During the years 1999, 2000, 2012 and 2015, the region experienced sub-humid conditions. During the years 1994, 2002, 2003 and 2017, sub-humid conditions were experienced in the Northern Foot Hills and the remaining regions experienced humid conditions. During 2016, the Northern Foot

Hills experienced semi-arid conditions, and the remaining regions experienced sub-humid conditions.

When compared to South and Central Foot Hills, Foot Hills has experienced more dryness in the Foot Hills region (Fig 5.68).

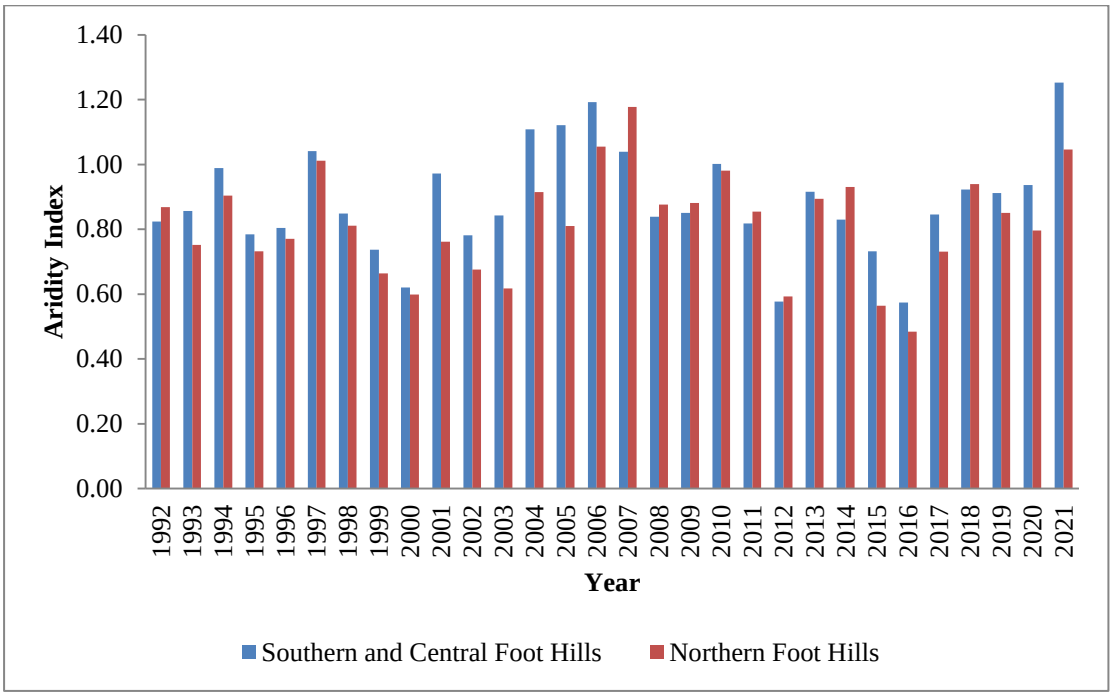



Fig 5.68 Annual Aridity Index from 1992-2021 (30 years period) of Foot Hills region

### 5.4.1.6 Kole Lands

Aridity Index (AI) analysis in Kole lands revealed that the years 1992–1998, 2001–2014 and 2017–2021 experienced humid conditions, while the years 1999, 2000, 2015, and 2016 experienced sub-humid conditions.

The years 1999, 2000, 2015 and 2016 showed more dryness over the last 30 years (Fig 5.69).

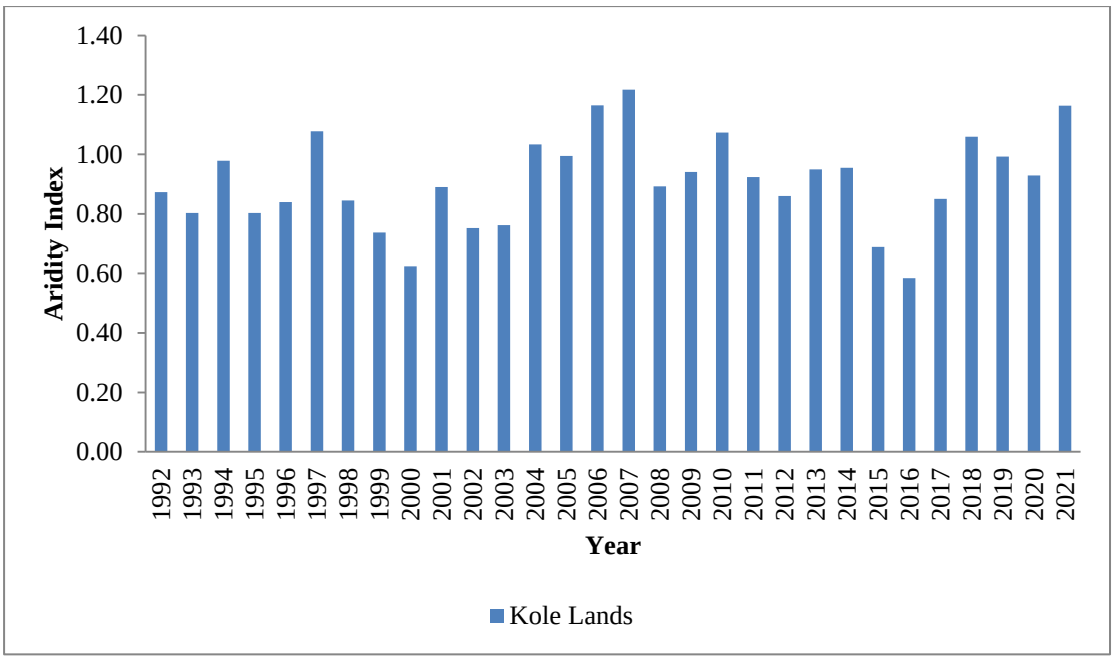



Fig 5.69 Annual Aridity Index from 1992-2021 (30 years period) of Kole lands region

### 5.4.2 Southwest Monsoon

#### 5.4.2.1 Hilly Region

The analysis of the Aridity index (AI) for the hilly region during the southwest monsoon season showed that during the years 1992, 1994, 1996, 1997, 2004, 2006, 2007, 2009-11, 2013, 2014 and 2017-2021, the hilly region experienced humid conditions. During the years 1993, 1995, 2000–03, 2005, 2008 and 2016, the Attappady Dry Hills and Attappady Hills and the remaining regions experienced humid conditions. During the years 1999, 2012 and 2015, Attappady Dry Hills and Attappady Hills experienced semi-arid conditions; the Northern High Hills of Palakkad and the Southern High Hills of Ernakulam experienced humid conditions; and the remaining regions experienced sub-humid conditions.

When compared to other regions, the Attappady Dry Hills and Attappady Hills in Palakkad district had experienced higher levels of dryness in the hilly region (Fig 5.70).

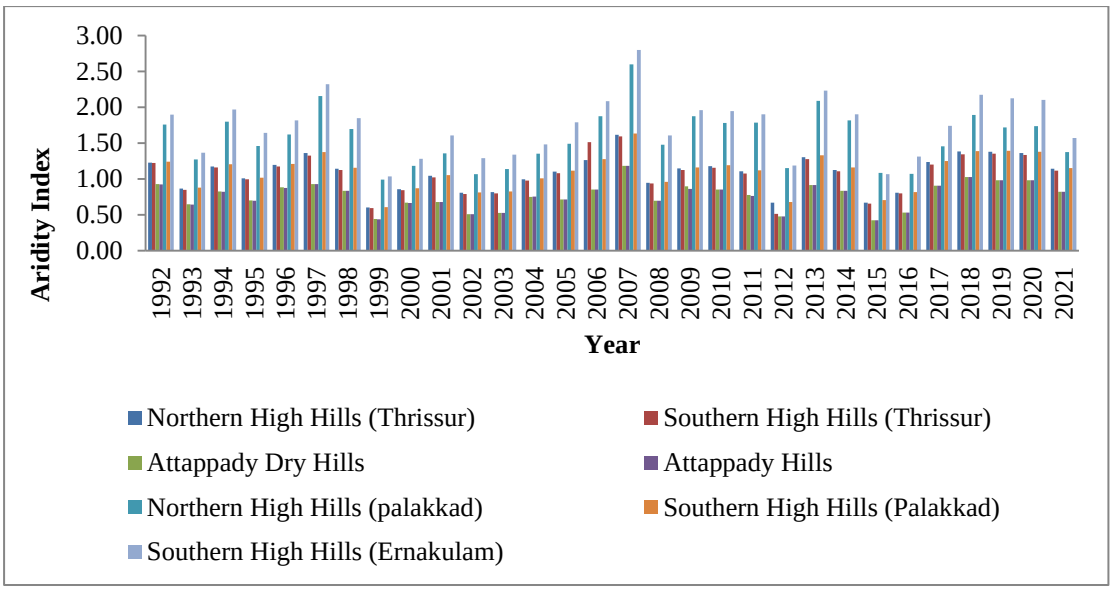



Fig 5.70 Aridity Index during southwest monsoon from 1992-2021 (30 years period) of Hilly region

### 5.4.2.1 Pokkali Region

The analysis of the Aridity Index (AI) for the Pokkali region showed that the region experienced humid conditions over the last 30 years (1992–2021) (Fig 5.71).

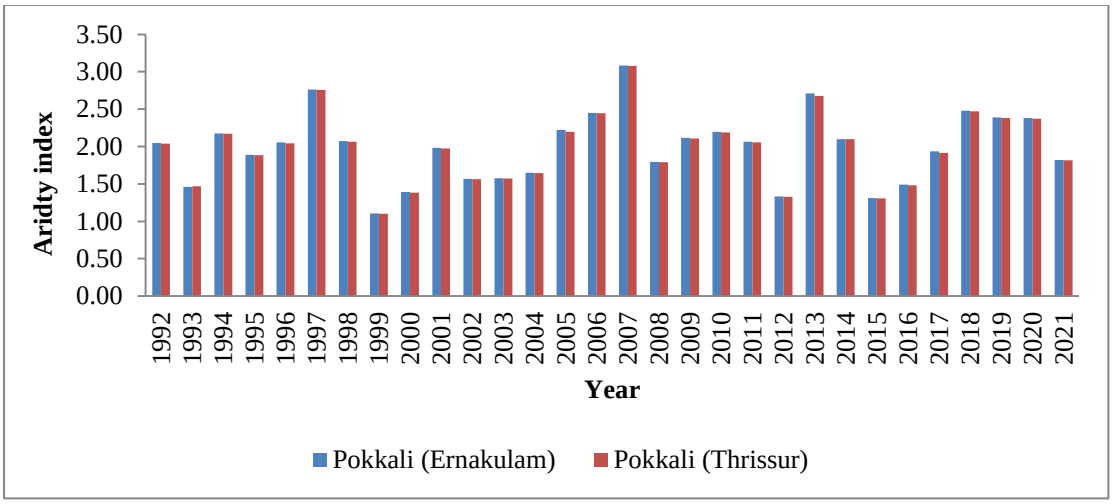



Fig 5.71 Aridity Index during southwest monsoon from 1992-2021 (30 years period of Pokkali region

### 5.4.2.3 Plains Region

The analysis of the Aridity Index (AI) for the plains region showed that during the years 1992, 1994, 1996–98, 2006, 2007, 2009–2011, 2013, 2014, 2017 and 2018–2021, the region experienced humid conditions. During the years 1993, 1995, 2000–2005, 2008 and 2016 had experienced sub-humid conditions in the Palakkad Eastern Plains. While the years 1999, 2012 and 2016 experienced semi-arid conditions in the Palakkad Eastern Plains, sub-humid conditions in the Palakkad Central Plains and the remaining regions experienced humid conditions.

When compared to other regions, the Palakkad Eastern Plains experienced more dryness in the hilly region (Fig 5.72).

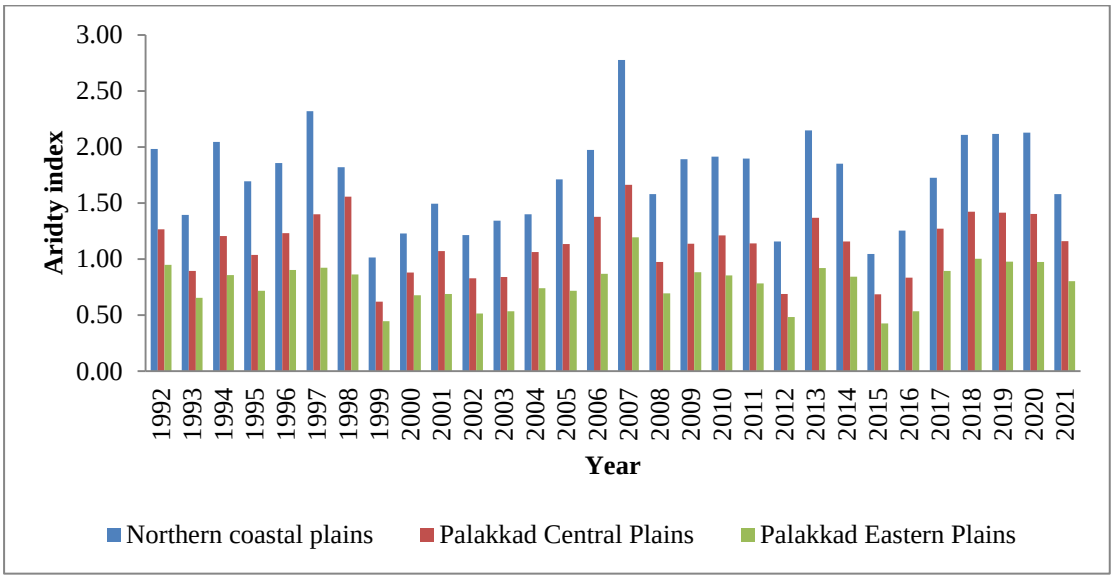



Fig 5.72 Aridity Index during southwest monsoon from 1992-2021 (30 years period) of Plains region

### 5.4.2.4 Laterites Region

The analysis of the Aridity Index (AI) for the Laterites region showed that during the years 1992, 1994, 1996–98, 2006, 2007, 2009–2011, 2013, 2014 and 2017–21, the region experienced humid conditions. During the years 1993, 1995, 2000–05, 2008 and 2016, sub-humid conditions were experienced in the North

Central Laterites and the remaining regions experienced humid conditions. While in 1999, 2012 and 2015 experienced semi-arid conditions.

When compared to other regions, Northern Laterites had experienced more dryness in the hilly region (Fig 5.73).

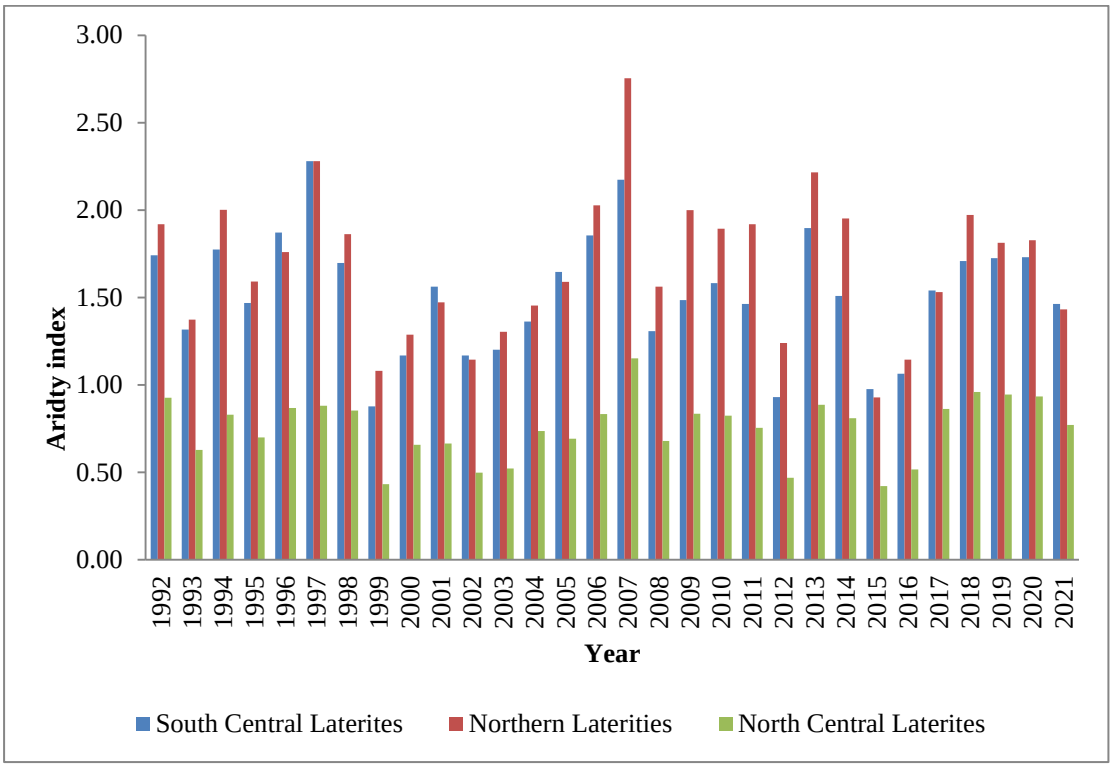



Fig 5.73 Aridity Index during southwest monsoon from 1992-2021 (30 years period) of Laterities region

### 5.4.2.5 Foot Hills

The analysis of the Aridity index (AI) for the Foot Hills region showed that the Foot Hills region experienced humid conditions in the last 30 years (1992–2021). When compared to the Northern Foot Hills, the South and Central Foot Hills had experienced more dryness in the hilly region (Fig 5.74).

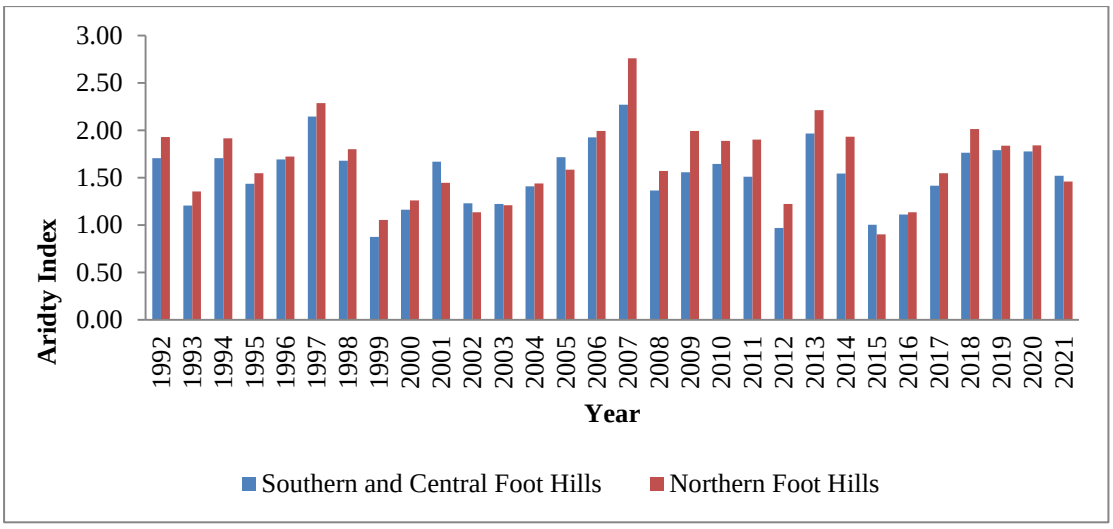



Fig 5.74 Aridity Index during southwest monsoon from 1992-2021 (30 years period) of Foot Hills region

### 5.4.2.6 Kole lands

The analysis of the Aridity Index (AI) for Kole lands showed that the Kole lands region experienced humid conditions in the last 30 years (1992–2021).The years 1999 and 2016 showed more dryness over the last 30 years (Fig 5.75).

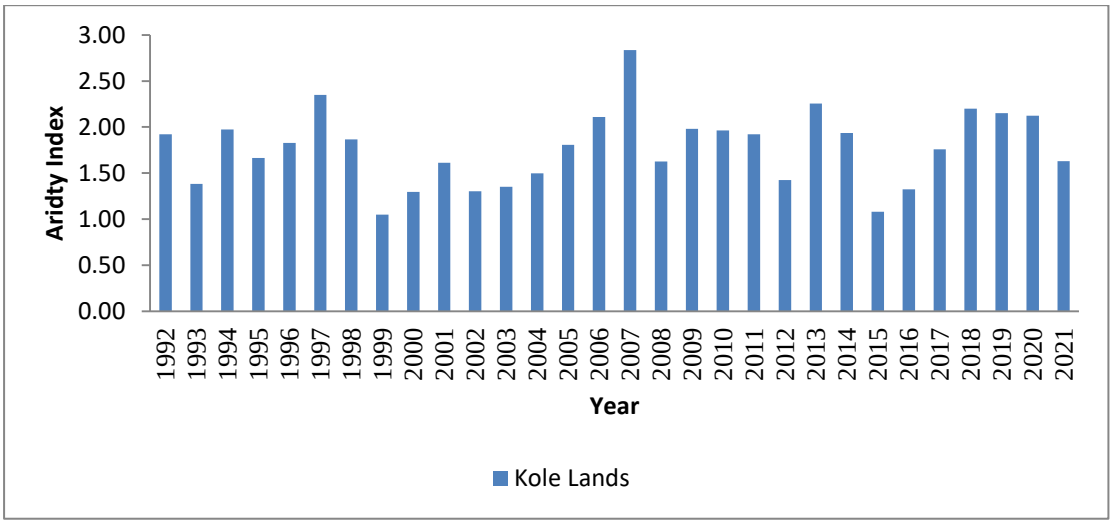



Fig 5.75 Aridity Index during southwest monsoon from 1992-2021 (30 years period) of Kole lands region

### 5.4.4 Northeast Monsoon

#### 5.4.4.1 Hilly Region

According to the Aridity Index (AI) for the hilly region, the Southern High Hills of Thrissur experienced sub-humid conditions in 2016, while the remaining regions experienced semi-arid conditions. During the years 1992, 1996, 2002 and 2014, sub-humid conditions were experienced in Attappady Dry Hills and Attappady Hills. While in 1999, the Southern High Hills of Thrissur experienced sub-humid conditions, the remaining regions experienced humid conditions. During 1999, the Attappady Dry Hills, Attappady Hills and Northern High Hills of Palakkad district experienced semi-arid conditions, and the remaining regions experienced sub-humid conditions. While in 2000 and 2003, Attappady Dry Hills, Attappady Hills and the Northern High Hills of Palakkad experienced sub-humid conditions, the remaining regions experienced humid conditions. While in 2008, the Southern High Hills of Ernakulam experienced humid conditions, the remaining regions experienced sub-humid conditions. During 2009 and 2018, the Southern High Hills of Thrissur and Ernakulam experienced humid conditions, and the remaining regions experienced sub-humid conditions. In 2011 Attappady Hills and the Southern High Hills of Palakkad and Ernakulam experienced humid conditions and the remaining regions experienced sub-humid conditions.

During 2012, Attappady Dry Hills and Attappady Hills experienced semi-arid conditions, and the remaining regions experienced sub-humid conditions. During 2015, the Southern High Hills of Thrissur experienced semi-arid conditions; the Attappady Dry Hills, Attappady Hills, and Northern High Hills of Palakkad experienced sub-humid regions; and the remaining regions experienced humid conditions.

When compared to other regions, Attappady Dry Hills and Attappady Hills had experienced more dryness in the hilly region (Fig 5.76).

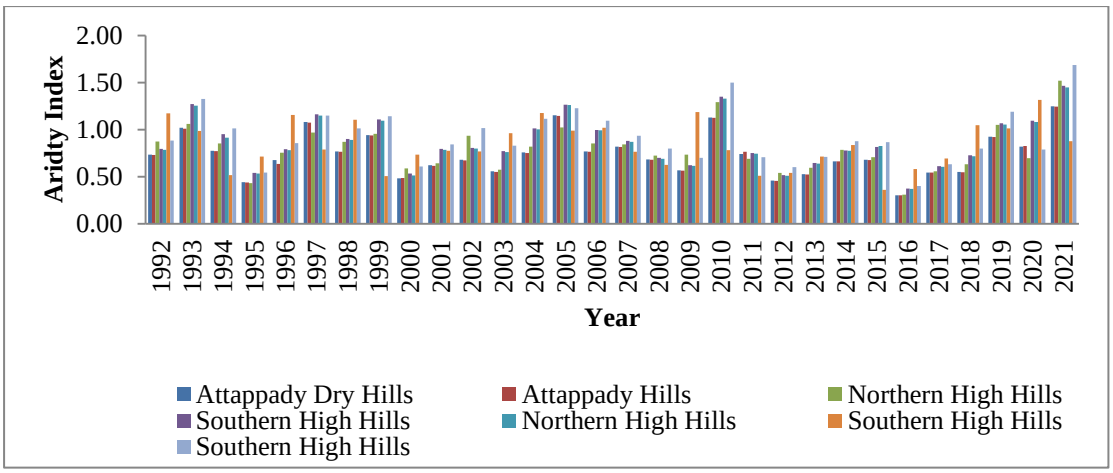



Fig 5.76 Aridity Index during northeast monsoon from 1992-2021 (30 years period) of Hilly region during

### 5.4.4.2 Pokkali Region

The analysis of the Aridity Index (AI) for the Pokkali region showed that during the years 1995, 2000, 2012 and 2016, the region experienced sub-humid conditions, and the remaining years experienced humid conditions in the Pokkali region.The Pokkali region experienced more dryness in the years 2000, 2012 and 2016 over the last 30 years (Fig 5.77).

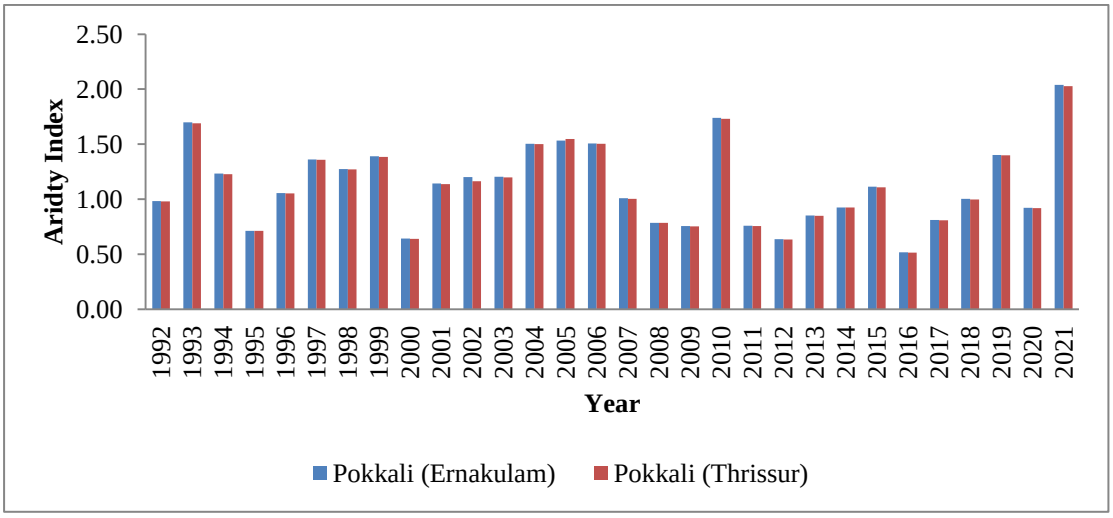



Fig 5.77 Aridity Index during northeast monsoon from 1992-2021 (30 years period) of Pokkali region

### 5.4.4.3 Plains Region

The analysis of the Aridity Index (AI) for the Plains region showed that during 2016, the region experienced semi-arid conditions. During the years 1992, 1996, 2002–04, 2014 and 2016, had experienced sub-humid conditions in the Palakkad Eastern Plains. While 1995, 2000 and 2012 experienced semi-arid conditions in the Palakkad Eastern Plains, the remaining regions experienced sub-humid conditions. While 2008 and 2018 experienced humid conditions in the Northern coastal plains, the remaining regions had experienced sub-humid conditions. In 2011 had experienced sub-humid conditions in the Northern coastal plains and the remaining regions had experienced humid conditions. The remaining years had experienced humid conditions in the plains region.

When compared to other regions, the Palakkad Eastern Plains had experienced more dryness in the plains region (Fig 5.78).

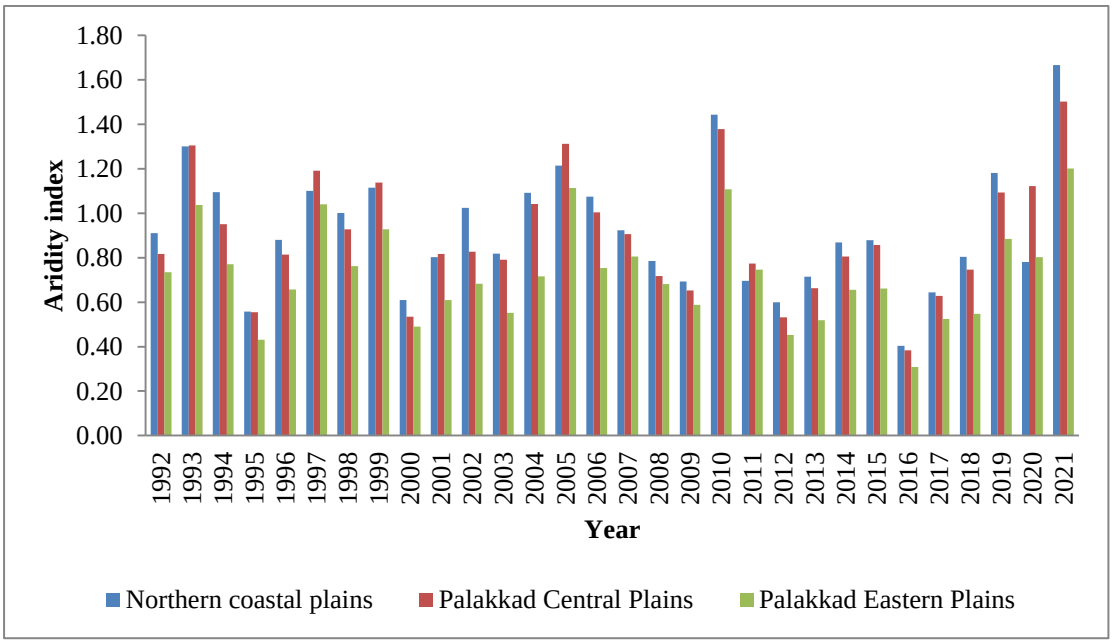



Fig 5.78 Aridity Index during northeast monsoon from 1992-2021 (30 years period) of Pokkali region

### 5.4.3.4 Laterites Region

The analysis of the Aridity Index (AI) for the Laterites region showed that during the years 1995 and 2016, semi-arid conditions were experienced in the Northern Laterites and North Central Laterites and the remaining regions experienced sub-humid conditions. During the years 1992, 1994, 1996, 1998, 2001, 2002, 2004, 2006, 2008 and 2014, the North Central Laterites experienced sub-humid conditions, and the remaining regions experienced humid conditions. During the years 2003, 2009, 2011, 2013, 2015, 2017 and 2018, the South Central Laterites experienced humid conditions, and the remaining regions experienced sub-humid conditions. During 2020, the Northern Laterites experienced sub-humid conditions, and the remaining regions experienced humid conditions. The remaining years had experienced humid conditions in the Laterite region.

When compared to other regions, the Northern Central Laterites had experienced more dryness in the Laterites region (Fig 5.79).

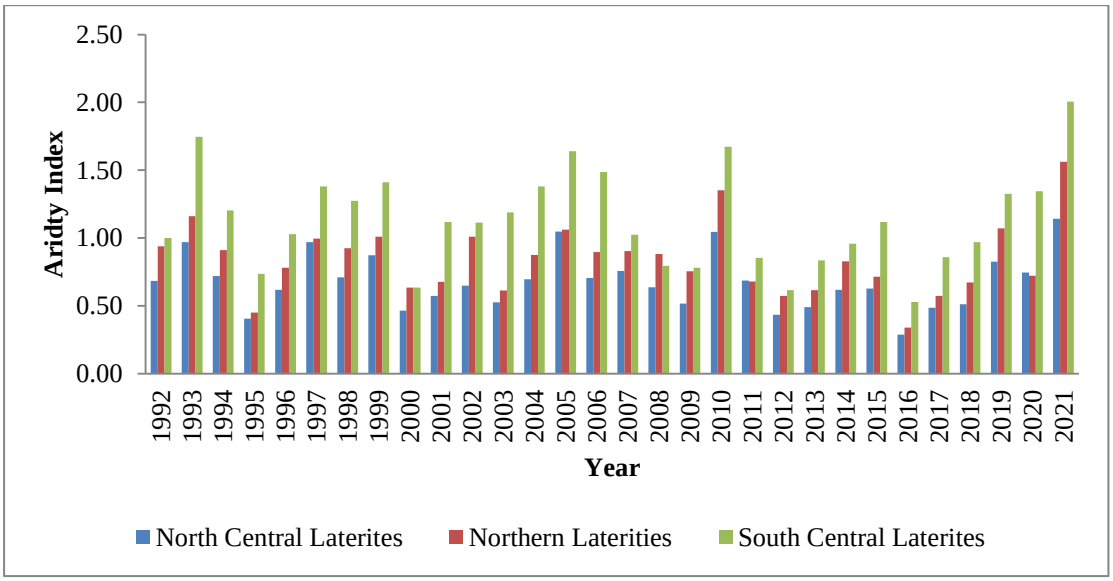



Fig 5.79 Aridity Index during northeast monsoon from 1992-2021 (30 years period) of Laterities region

### 5.4.3.5 Foot Hills

The analysis of the Aridity Index (AI) for the Foot Hills region showed that during the years 1995 and 2016, the Northern Foot Hills experienced semi-arid conditions and the Southern and Central Foot Hills experienced sub-humid conditions. During the years 2000 and 2012, Foot Hills experienced sub-humid conditions. The remaining years had experienced humid conditions in this region.

When compared to the South and Central Foot Hills, the Northern Foot Hills had experienced more dryness in the Foot Hills region (Fig 5.80).

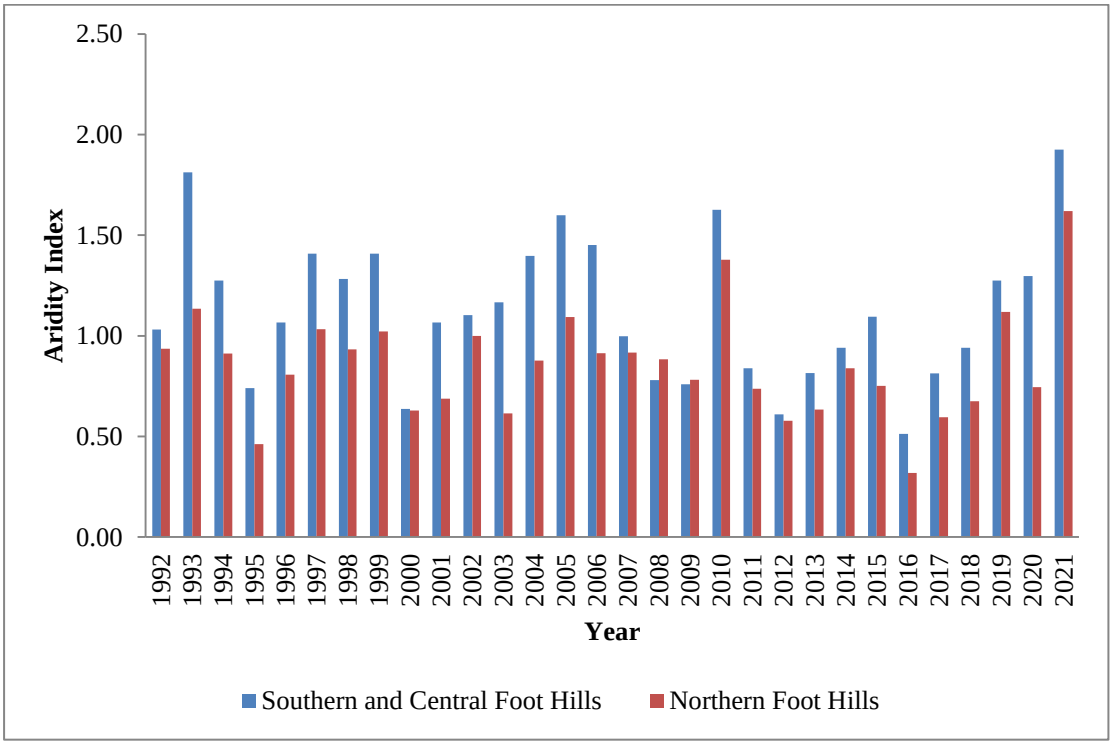



Fig 5.80 Aridity Index during northeast monsoon from 1992-2021 (30 years period) of Foot Hills region

### 5.4.3.6 Kole Lands

The analysis of Aridity Index (AI) for Kole lands showed that during the years 2016 had experienced semi-arid condition in Kole lands. During the years 1995, 2000, 2009, 2011, 2012, 2013 and 2017 had experienced sub humid condition and the remaining years had experienced humid condition in this region. The year 2016 showed more dryness over the last 30 years period (Fig 5.81).

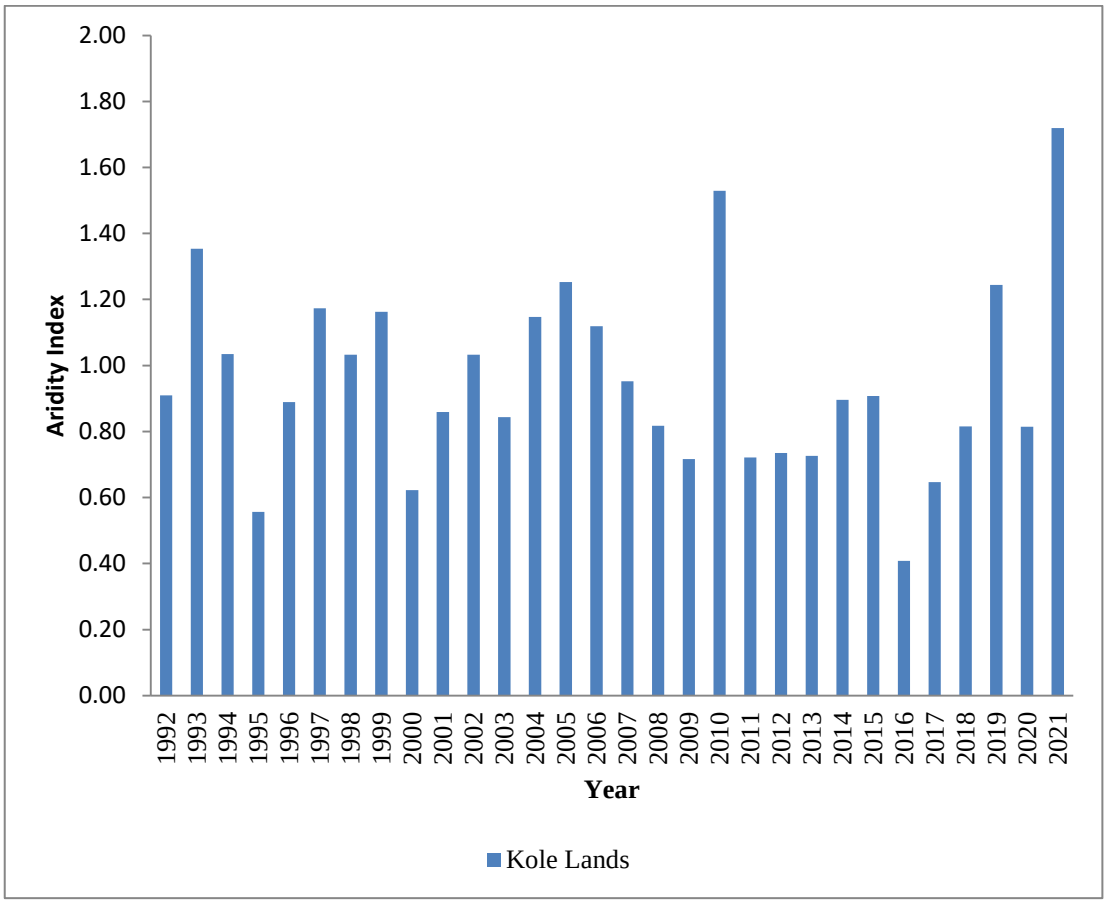



Fig 5.81 Aridity Index of Kole lands region during Northeast monsoon rainfall

### 5.4.4 Summer Season

#### 5.4.4.1 Hilly Region

The analysis of the Aridity Index (AI) for the hilly region showed that during the year 1997, the region experienced arid conditions. During the years 1993, 1994, 1996, 1999, 2003, 2005, 2007, 2010-12, 2014, 2017 and 2019, had experienced semi-arid conditions in hilly regions. During the years 1992, 2002, 2013, 2016 and 2020, semi-arid conditions were experienced in the Attappady Dry Hills and Attappady Hills, and the remaining regions experienced semi-arid conditions. During the years 1995, 2009 and 2015, had experienced sub-humid in the hilly region.

During the years 1999, 2003, 2012 and 2017, the Southern High Hills experienced semi-arid conditions, and the remaining regions experienced sub-humid conditions. During the years 2002, 2010, 2011, and 2020, the Pokkali region experienced a sub-humid condition, while the remaining region experienced a semi-arid condition. In 2004, 2006, and 2021, the hilly region experienced a humid condition. During 2005, the Southern High Hills experienced semi-arid conditions, and the remaining regions experienced humid conditions. During 2008, the Pokkali region experienced humid conditions, and the remaining regions experienced sub-humid conditions.

When compared to other regions, Attappady Dry Hills and Attappady Hills had experienced more dryness in the hilly region (Fig 5.82).

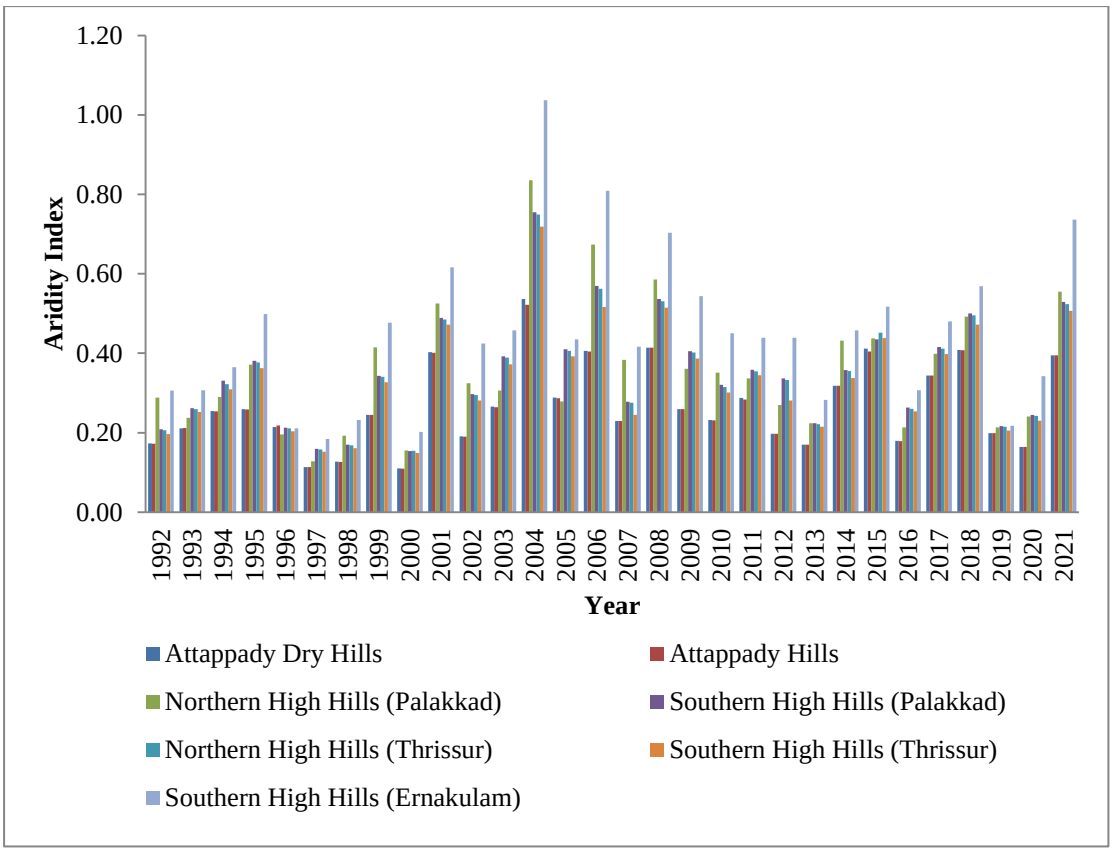



Fig 5.82 Aridity Index during summer season from 1992-2021 (30 years period) of Hilly region

### 5.4.4.2 Pokkali region

The analysis of the Aridity Index (AI) for the Pokkali region showed that during the years 1992–94, 1996–98, 2000, 2007, 2013, 2016 and 2019, the region experienced semi-arid conditions. During the years 1995, 1999, 2001, 2002, 2003, 2005, 2009–12, 2014, 2015, 2017, 2018 and 2020 experienced sub-humid conditions, and the years 2004, 2006, 2008 and 2021 experienced humid conditions in the Pokkali region.

The Pokkali region experienced more dryness in the years 1995, 2000 and 2019 over the last 30 years (Fig 5.83).

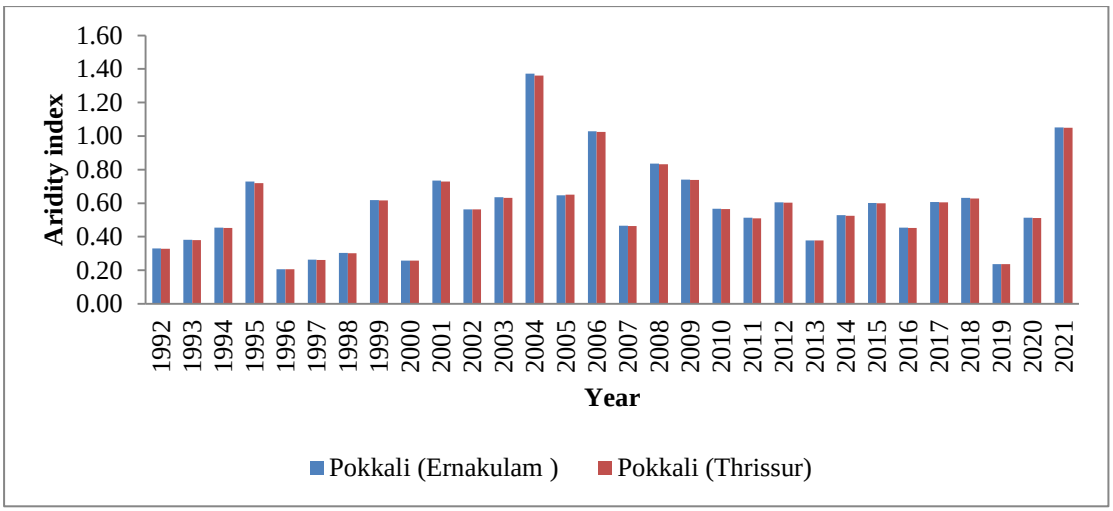



Fig 5.83 Aridity Index during summer season from 1992-2021 (30 years period) of Pokkali region

### 5.4.4.3 Plains Region

The analysis of the Aridity Index (AI) for the Plains region shows that during the years 1997 and 2000, the region experienced arid conditions. During the years 1992, 2002, 2013, 2016 and 2020, arid conditions were experienced in the Palakkad Eastern Plains and the remaining regions experienced semi-arid conditions. During the years 1993, 1994, 1996, 2003, 2005, 2007, 2010–12, 2014, 2017 and 2019, had experienced semi-arid conditions in the plains region. During 1998, the region experienced semi-arid conditions, and the remaining regions experienced arid conditions. During 2001, 2008 and 2018 experienced semi-arid condition in Palakkad Eastern Plains and the remaining region has experienced sub humid condition. During 2004, the Palakkad Eastern Plains experienced sub-humid conditions, and the remaining regions experienced humid conditions. While in 2006 and 2021, Palakkad Eastern Plains experienced semi-arid conditions, Palakkad Central Plains experienced sub-humid conditions, and the remaining AEU experienced humid conditions.

When compared to other regions, the Palakkad Eastern Plains experienced more dryness in the Plains region (Fig 5.84).

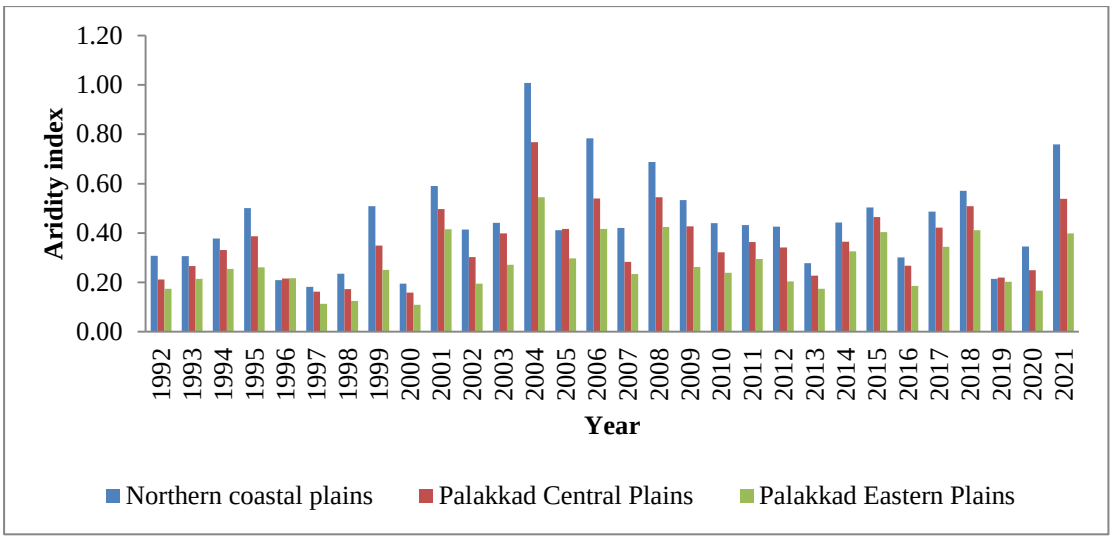



Fig 5.84 Aridity Index during summer season from 1992-2021 (30 years period) of Plains region

### 5.4.4.4 Laterites Region

The analysis of Aridity Index (AI) for Laterites region shows that during the years 1992, 1998, 2002, 2012, 2013, 2016, 2019 and 2020, North Central Laterites experienced arid condition and the remaining regions had experienced semi-arid condition. During the years 1993, 1994, 1996, 1999, 2007, 2010, 2011 and 2014 experienced semi-arid condition. While 1995, 1999, 2003, 2009, 2015 and 2017 had experienced sub humid in South Central Laterites and the remaining regions experienced semi-arid condition. During the years 1997 and 2000, had experienced semi-arid condition in South Central Laterites and arid condition experienced in the remaining regions. During the years 2001, 2008 and 2018 experienced semi-arid condition North Central Laterites and the remaining regions experienced sub humid condition.

During 2004, North Central Laterites had experienced semi-arid condition and the remaining regions had experienced humid condition. During 2005 and 2006, South Central Laterites had experienced humid condition and the remaining regions had experienced semi-arid condition. During 2012, North Central Laterites had

experienced arid condition, Northern Laterites had experienced semi-arid condition and the remaining region had experienced sub humid condition. During 2021, North Central Laterites had experienced semi-arid condition, Northern Laterites experienced sub humid condition and the remaining region experienced humid condition.

When compared to other regions, Northern Central Laterites experienced more dryness in Laterites region (Fig 5.85).

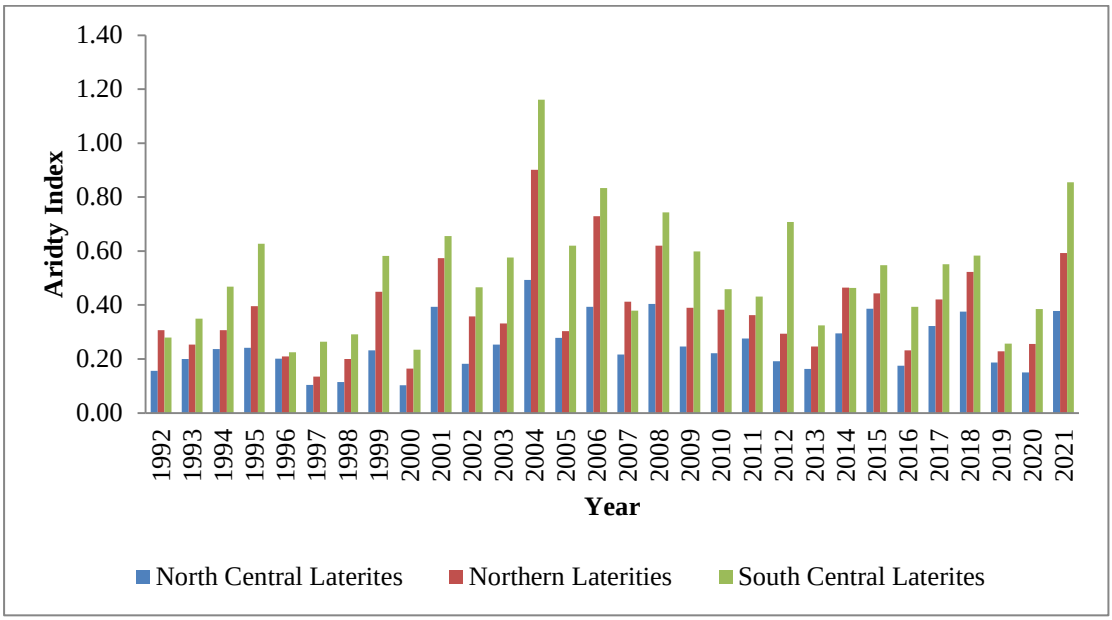



Fig 5.85 Aridity Index during summer season from 1992-2021 (30 years period) of Laterities region

### 5.4.4.5 Foot Hills

The analysis of the Aridity Index (AI) for the Foot Hills region showed that during the years 1992–94, 1996–98, 2002–2007, 2010, 2011, 2012, 2014–2016, 2019 and 2020, semi-arid conditions were experienced in the Foot Hills region. During the years 1995, 1999, 2003, 2009, 2012, 2015 and 2017, the Northern Foot Hills experienced semi-arid conditions, and the remaining regions experienced sub-humid conditions. During 1997 and 2000, the Northern Foot Hills experienced semi-arid conditions, and the remaining regions experienced the Southern and Central Foot

Hills. In 2004, the Plains region experienced a humid condition. During 2005 and 2021, the Southern and Central Foot Hills experienced humid conditions, and the remaining region experienced semi-arid conditions. During 2006, Southern and Central Foot Hills experienced humid conditions, and the remaining region experienced sub-humid conditions.

When compared to the South and Central Foot Hills, the Northern Foot Hills had experienced more dryness in the Foot Hills region (Fig 5.86).

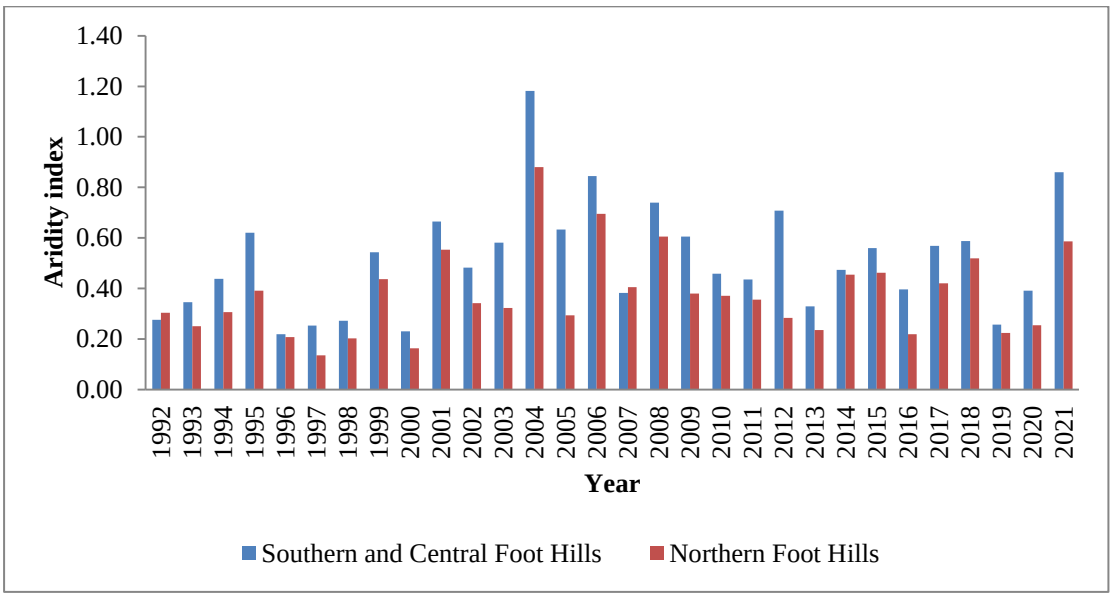



Fig 5.86 Aridity Index during summer season from 1992-2021 from 1992-2021 (30 years period) of Foot Hills

### 5.4.4.6 Kole Lands

The analysis of the Aridity Index (AI) for Kole Lands showed that during the years 1997 and 2000, Kole Lands experienced arid conditions. During the years 2001, 2008, 2012, 2015 and 2018, sub-humid conditions were experienced in 2004 and 2006. The remaining years had experienced semi-arid conditions in Kole lands.

The years 1997, 2000, and 2019 showed more dryness over the last 30 years (Fig 5.87).

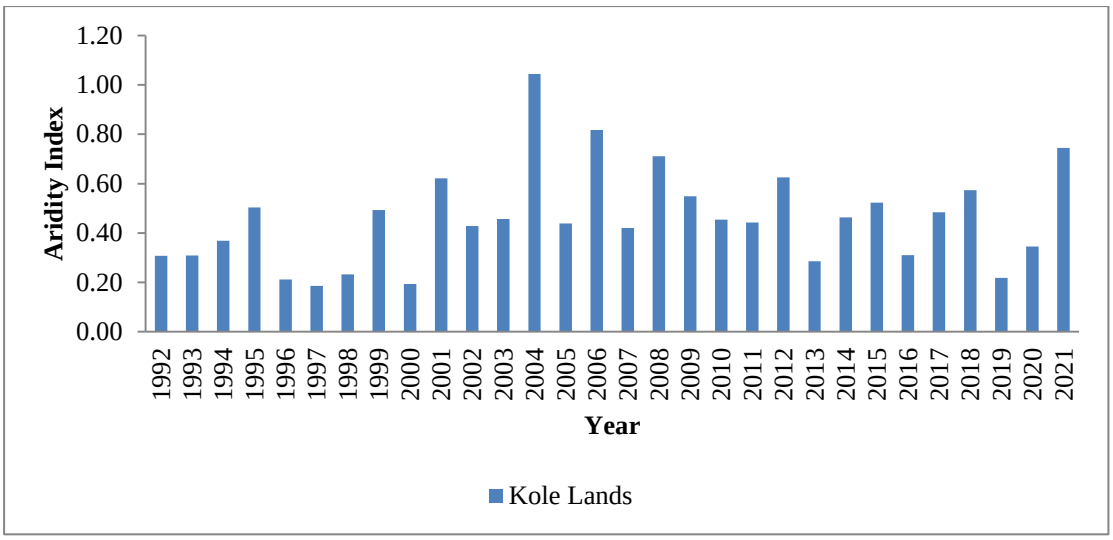



Fig 5.87 Aridity Index during summer monsoon from 1992-2021 (30 years period) of Kole lands

### 5.4.5 Winter Season

#### 5.4.5.1 Hilly Region

The analysis of the Aridity Index (AI) for the hilly region showed that during the years 1992, 1997, 1998, 1999, 2007, 2009 and 2015, the region experienced hyper arid in the hilly region. During the years 1993, 2001, 2003, 2005, 2008, 2013, 2017 and 2018, the region experienced arid conditions. During 1994, Attappady Dry Hills, Attappady Hills and the Northern High Hills of Palakkad experienced arid conditions, and the remaining regions experienced semi-arid conditions. During 1996, Attappady Hills, the Northern High Hills of Palakkad district, and the Southern High Hills of Ernakulam experienced hyperarid conditions and the remaining regions experienced hyperarid conditions. While during 2000, the Northern High Hills of Palakkad district experienced hyper-arid conditions, the Attappady Hills experienced arid conditions, and the remaining regions experienced semi-arid conditions. During 2002, the Northern High Hills of Palakkad experienced hyper conditions, and the remaining regions experienced arid conditions.

During the years 2004, 2010 and 2012, Attappady Dry Hills, Attappady Hills and the Northern High Hills of Palakkad experienced hyper-conditions and the remaining regions experienced arid conditions. During the year 2011, Attappady Dry Hills, Attappady Hills and the Northern High Hills of Palakkad experienced arid conditions, and the remaining regions experienced semi-arid conditions. During 2021, the hilly region experienced a semi-arid condition.

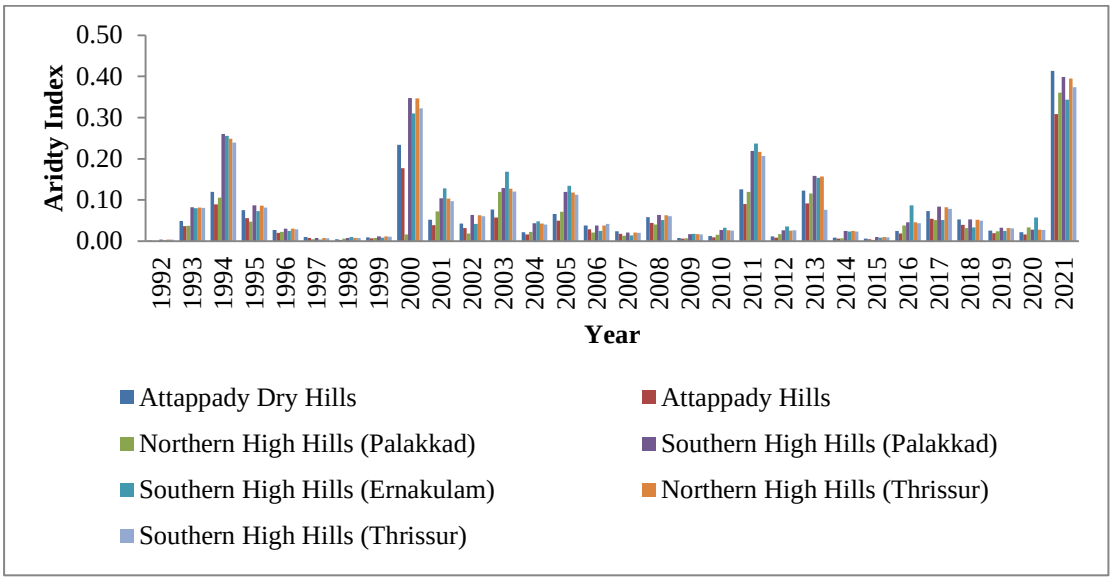



Fig 5.88 Aridity Index during winter season from 1992-2021 (30 years period) of Hilly region

### 5.4.5.2 Pokkali Region

The analysis of the Aridity Index (AI) of the Pokkali region showed that during the years 1992, 1998 and 1999, hyperarid conditions were experienced and in the years 1993, 1995, 1996, 2002, 2009, 2010 and 2017–20, arid conditions were experienced in this region. During the years 1994 and 2021 experienced semi-arid conditions. During the years 1997, 2007 and 2015, Pokkali in Thrissur district experienced arid conditions and Pokkali in Ernakulam district experienced hyper-arid conditions. During 2000, Pokkali in Thrissur district experienced arid conditions, and Pokkali in Ernakulam district experienced sub-humid conditions. During 2001, Pokkali in Thrissur district experienced a sub-humid condition and Pokkali in

Ernakulam district experienced a semi-arid condition. During the years 2003, 2005, 2011 and 2013, Pokkali in Thrissur district experienced arid conditions and Pokkali in Ernakulam district experienced semi-arid conditions. During the years 2004, 2006, and 2012, Pokkali in Thrissur district experienced semi-arid conditions, and Pokkali in Ernakulam district experienced arid conditions.

When compared to pokkali in Ernakulam district, pokkali in Thrissur district showed more dryness (Fig 5.89).

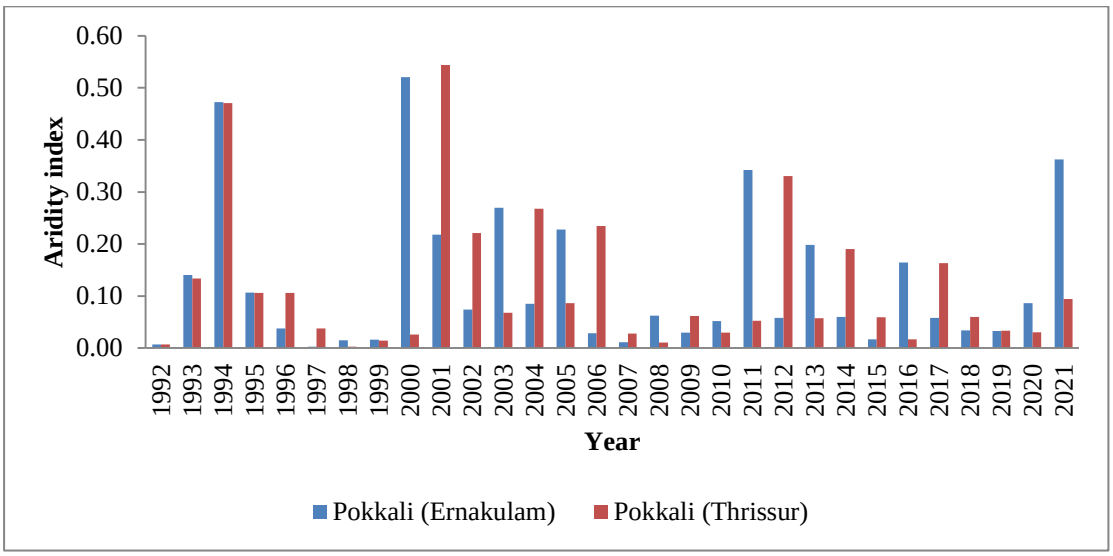



Fig 5.89 Aridity Index during winter season from 1992-2021 (30 years period) of Pokkali region

### 5.4.5.3 Plains Regions

The analysis of the Aridity Index (AI) for the Plains region showed that during the years 1997, 1998, 1999, 2007, 2009 and 2015, the region experienced hyper-arid conditions. During the years 1993, 1995, 1996, 2001, 2003, 2005, 2006, 2008, 2013 2017 and 2019 had experienced arid condition in this region. During 1994 and 2011, the Palakkad Eastern Plains experienced arid conditions, and the remaining regions experienced semi-arid conditions. During 2000 and 2001, semi-arid conditions were experienced in this region. While in the years 2004, 2010, 2012, 2014, 2016, and

2020, the Palakkad Eastern Plains experienced hyperarid conditions, arid conditions occurred in the remaining regions.

During 2011, the Palakkad Eastern Plains experienced arid conditions, and the remaining regions experienced semi-arid conditions. When compared to other regions, the Palakkad Eastern Plains had experienced more dryness in the Plains region (Fig 5.90).

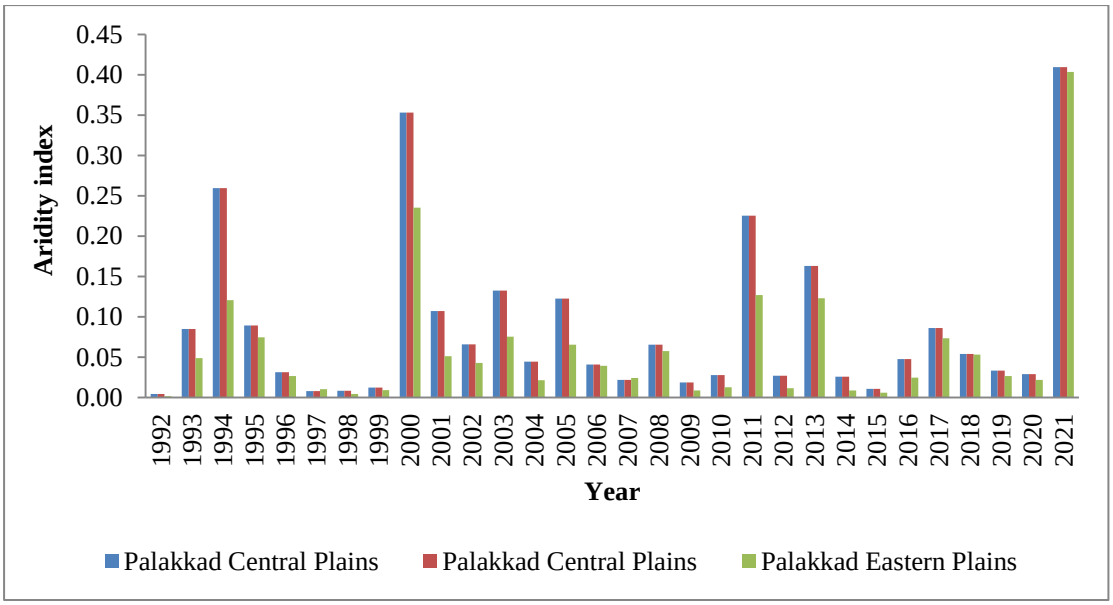



Fig 5.90 Aridity Index during winter season from 1992-2021 (30 years period) of Plains region

### 5.4.5.4 Laterites Region

The analysis of the aridity index (AI) for the Laterite region showed that during the years 1992, 1997–99, 2007 and 2015, the region experienced hyperarid conditions. During the years 1993, 1995, 2001, 2002, 2008, 2013, 2017 and 2018 experienced arid conditions. During the years 1994, 2003, 2005 and 2011, South Central Laterites had experienced semi-arid conditions, and the remaining regions had experienced arid conditions. During the years 1996, 2004, 2009, 2010, 2012 and 2014, arid conditions were experienced in the South Central Laterites, and the remaining regions experienced hyperarid conditions. During 2006, the Northern

Laterites experienced hyperarid conditions, and the remaining regions experienced arid conditions. During the years 2016, 2019 and 2020, North Central Laterites experienced hyperarid conditions.

When compared to other regions, the Northern Central Laterites experienced more dryness in the Laterites region (Fig 5.91).

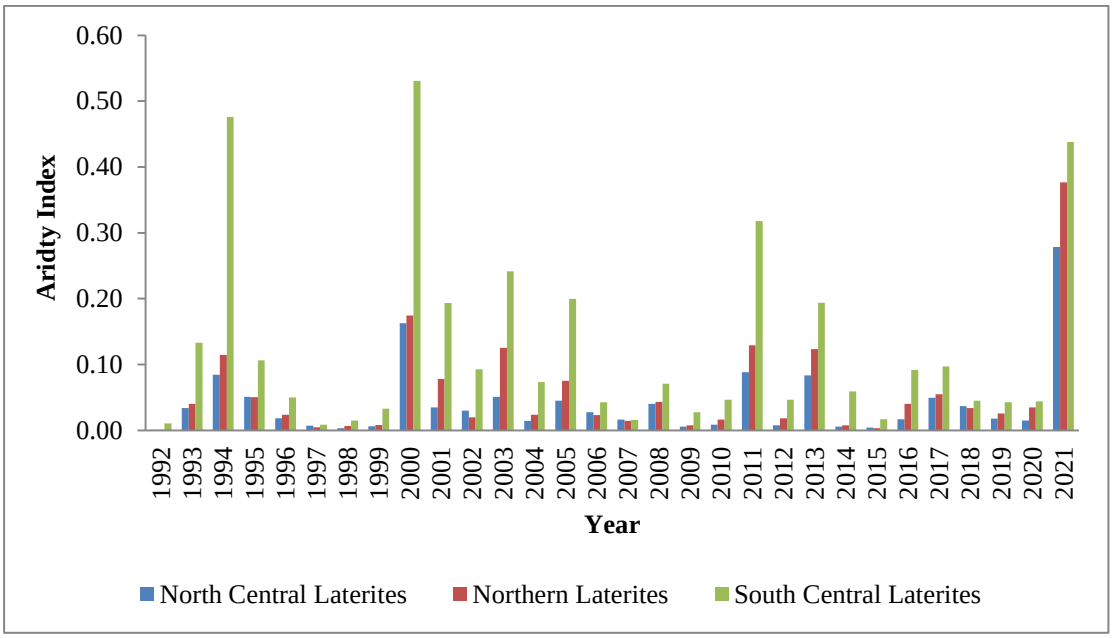



Fig 5.91 Aridity Index during winter season from 1992-2021 (30 years period) of Laterites region

### 5.4.5.5 Foot Hills

The analysis of the Aridity Index (AI) in the Foothills region showed that during the years 1992, 1997–99, 2007 and 2015, hyperarid conditions were experienced. During the years 1993, 1995, 2006, 2008, 2016–2019 and 2020, this region experienced arid conditions. During the years 1994, 2001, 2003, 2005, 2011 and 2013, had experienced semi-arid in the Southern and Central Foot Hills and arid in the Northern Foot Hills. During the years 1996, 2002, 2004, 2009, 2010, 2012 and 2014, had experienced hyper arid in the Southern and Central Foot Hills and arid in the Northern Foot Hills. While during 2000, the Southern and Central Foot Hills

experienced sub-humid conditions, the remaining regions experienced hyper-arid conditions. During 2021, this region experienced a semi-arid condition.

Compared to the South and Central Foot Hills, the Northern Foot Hills experienced more dryness in the hilly region (Fig 5.92).

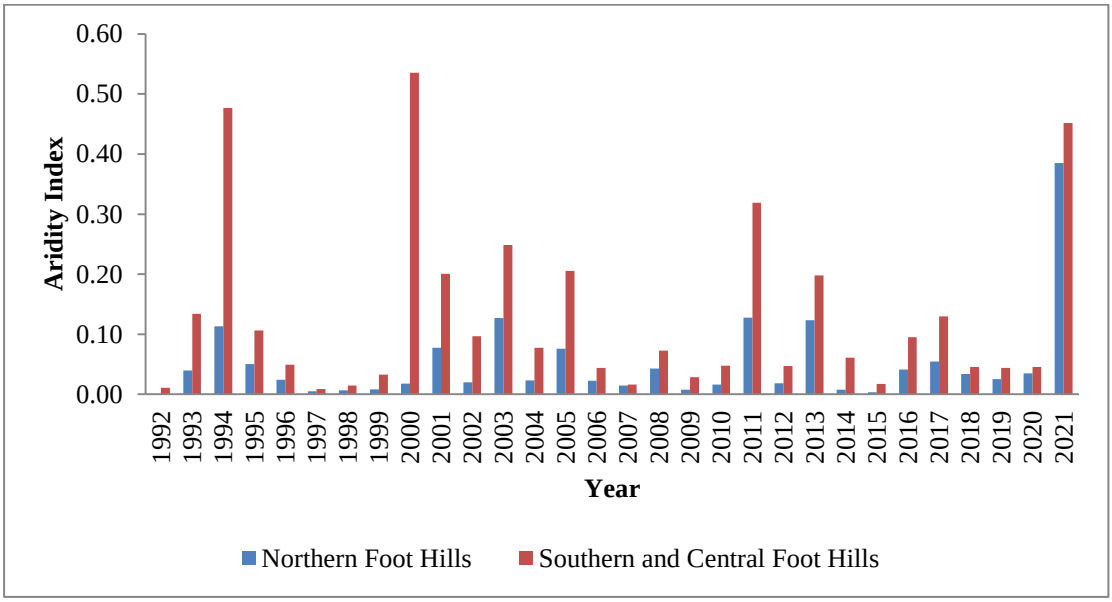



Fig 5.92 Aridity Index during winter season from 1992-2021 (30 years period) of Laterites region

### 5.4.5.6 Kole Lands

The analysis of the Aridity Index (AI) for Kole lands showed that during the years 1992, 1997–99, 2007, 2009, 2014 and 2015, hyper-arid conditions were experienced, and in the years 1993, 1995, 1996, 2001–06, 2008, 2010, 2012, 2013, and 2016–2020, arid conditions were experienced. While the years 1994, 2000, 2011 and 2021 experienced semi-arid conditions in this region.

The years 1997, 1999 and 2015 showed more dryness over the last 30 years (Fig 5.93).

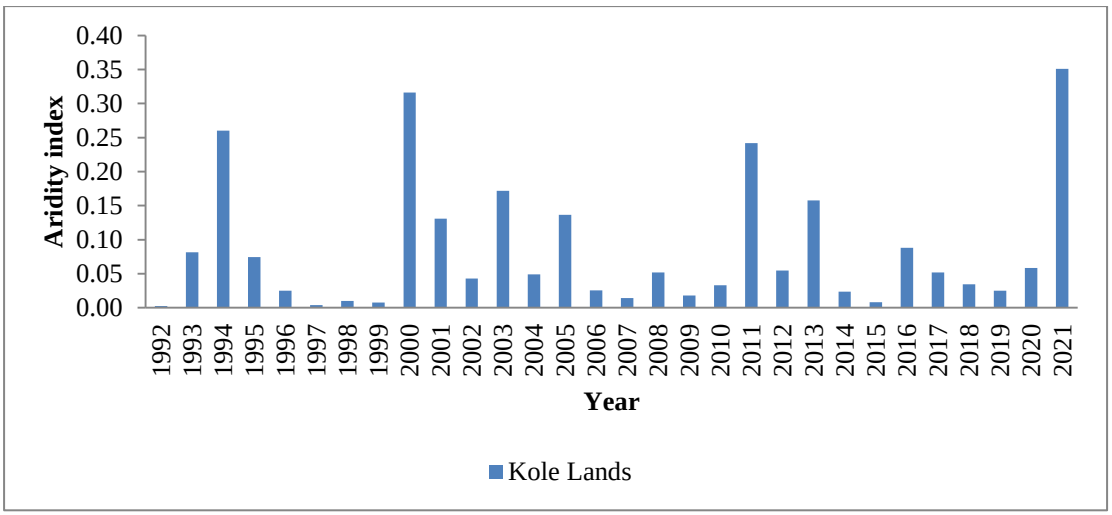



Fig 5.93 Aridity Index during winter season from 1992-2021 (30 years period) of Laterites region

## 5.5 Standard Precipitation Index (SPI)

### 5.5.1 Annual Rainfall

The analysis of the Standard Precipitation Index (SPI) showed that during 2016 central zone of Kerala experienced extreme drought condition except the AEUs Kole lands and South Central Laterites. During 2012, Southern High Hills of Palakkad district and Palakkad Central Plains had experienced extreme drought condition and the remaining regions experienced severe drought condition. During 2000, Pokkali, Northern coastal plains, South Central Laterites, Southern and Central Foot Hills, Kole lands, Northern Central Laterites, Southern High Hills of Palakkad and Thrissur districts experienced severe drought, and the remaining regions were affected by moderate drought.

During 2021, extreme wetness was experienced in the regions Southern and Central Foot Hills, Northern Foot Hills, Palakkad Central Plains, Palakkad Eastern Plains, Northern High Hills, Attappady Dry Hills, Attappady Hills, Southern High Hills of Palakkad, Northern and Southern High Hills of Thrissur district and the remaining regions had experienced severe wetness.

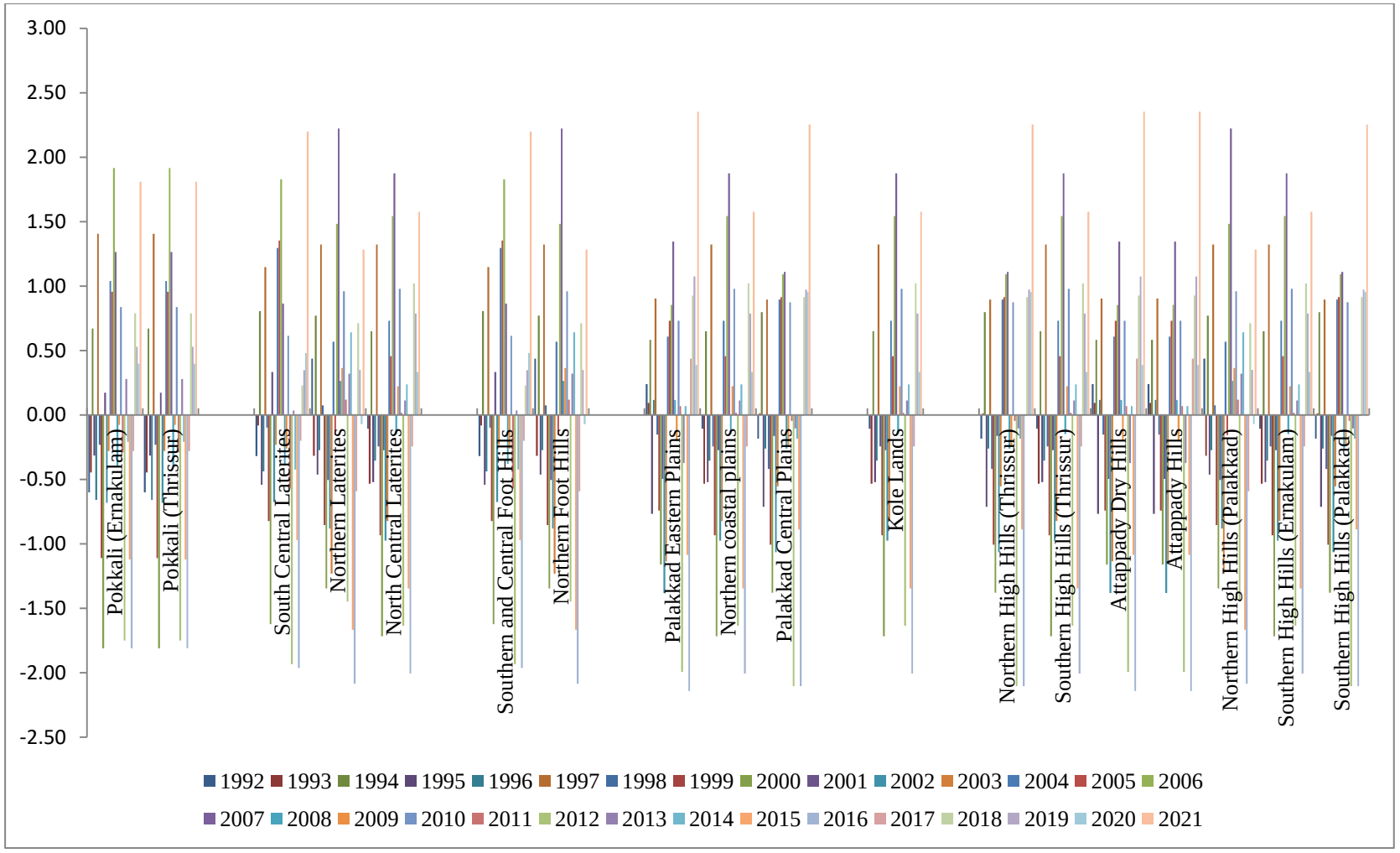



Fig 5.94 Annual Standard Precipitation Index (SPI) from 1992-2021 (30 years period) of different AEUs in central zone of Kerala

#### 5.5.1.1 Hilly Region

The analysis of the Standard Precipitation Index (SPI) showed that during 2016, the hilly region experienced extreme drought conditions. While in 2012, the Southern High Hills of Palakkad and the Northern High Hills of Thrissur district experienced extreme drought, the Northern High Hills of Palakkad district experienced moderate drought and the remaining AEUs experienced severe drought. During 1997, the Northern High Hills and Southern High Hills of Ernakulam district experienced moderate wetness. During 1999, the Southern High Hills of Palakkad and the Northern High Hills of Thrissur district experienced moderate drought. During 2000, the Southern High Hills of Palakkad and Thrissur districts experienced severe drought, and the remaining regions were affected by moderate drought.

During 2002, Attappady Dry Hills, Attappady Hills, Northern High Hills of Thrissur, and Southern High Hills of Palakkad district experienced moderate drought. Since 2003, the Attappady Dry Hills, Attappady Hills, and Northern High Hills of Palakkad district had experienced moderate drought conditions. Severe wetness and moderate wetness were experienced in the Southern High Hills of Ernakulam and Thrissur districts during 2006. During 2015, the Northern High Hills of Palakkad district experienced severe drought and the Southern High Hills of Thrissur and Ernakulam districts, Attappady Dry Hills and Attappady Hills experienced moderate drought.

During 2018, the Southern High Hills of Ernakulam and Thrissur districts experienced moderate wetness. During 2019, Attappady Dry Hills and Attappady Hills experienced moderate wetness. In 2021, the Northern High Hills of Palakkad district experienced moderate wetness, the Southern High Hills of Ernakulam and Thrissur districts experienced severe wetness, and the remaining regions experienced extreme wetness.

When compared to the last 30 years SPI value, 2016 was the most drought-affected year (Fig 5.95).

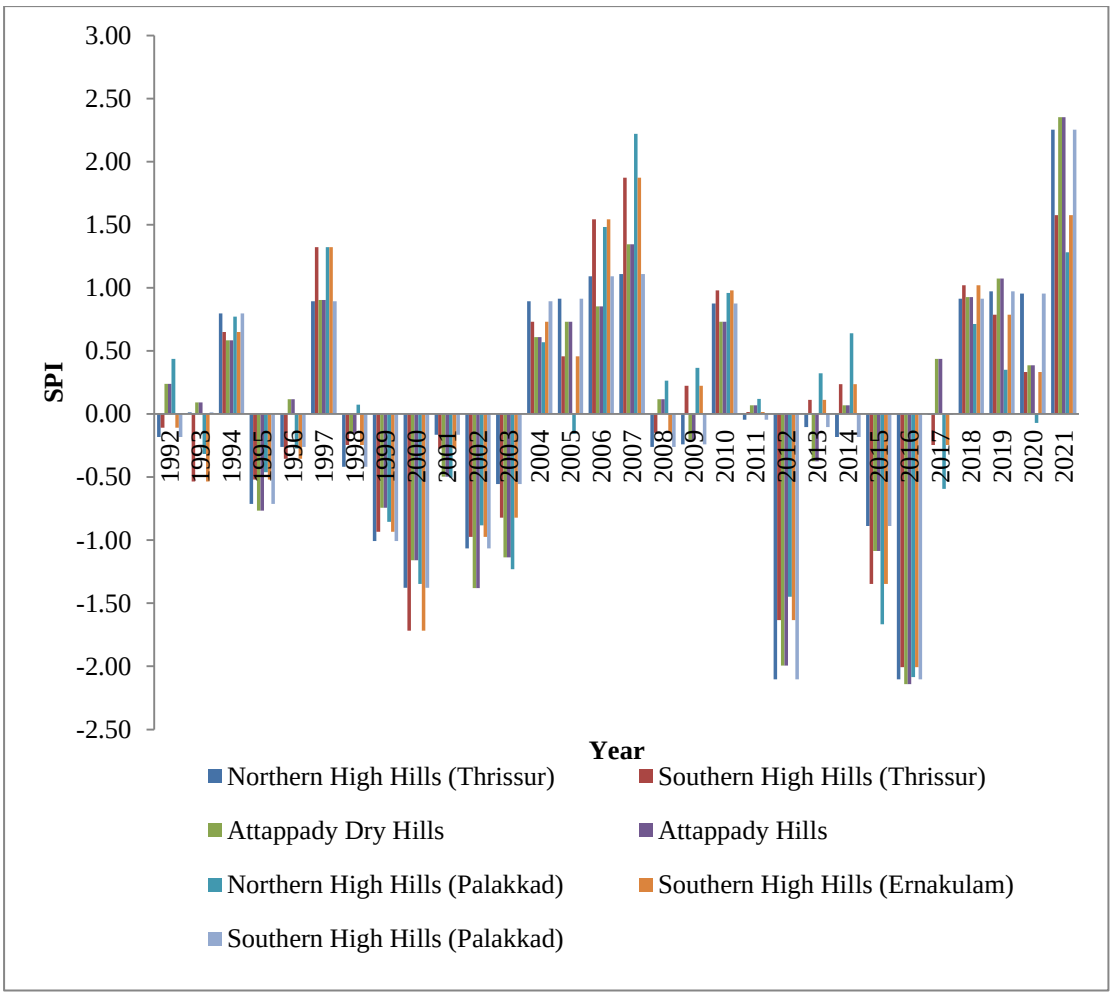



Fig 5.95 Annual Standard Precipitation Index (SPI) from 1992-2021 (30 years period) of Hilly region

### 5.5.1.2 Pokkali Region

The analysis of the Standard Precipitation Index (SPI) showed that during those years, 2016, 2012, and 2000, there was severe drought in the Pokkali region and moderate drought in 1999 and 2015. Moderate wetness was experienced in 1997, 2004, and 2005, while severe wetness occurred in 2006 and 2021.

When compared to the last 30 years SPI values, 2000 and 2016 were the most drought-affected years (Fig 5.96).

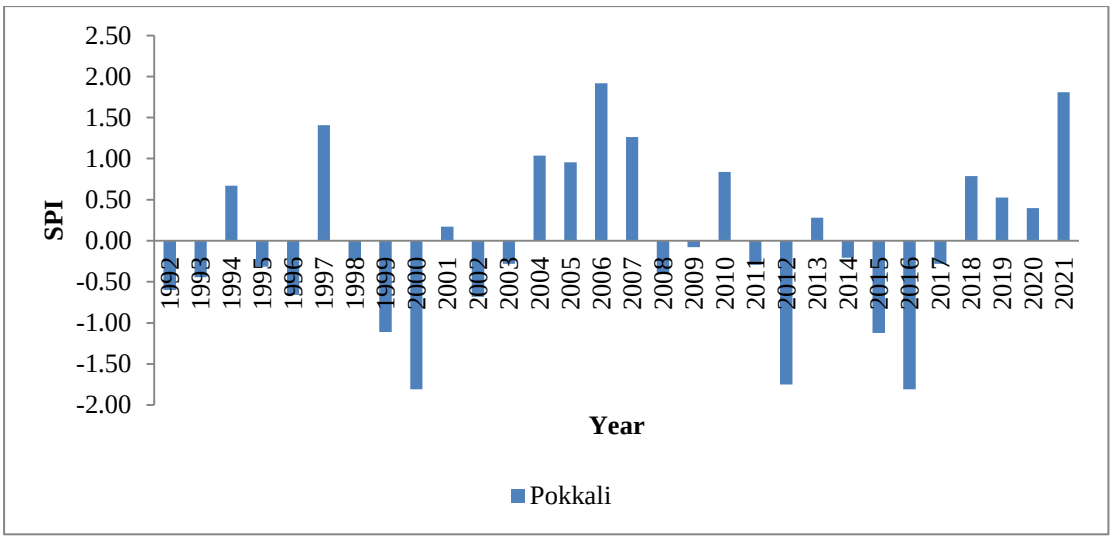



Fig 5.96 Annual Standard Precipitation Index (SPI) from 1992-2021 (30 years period) of Pokkali region

### 5.5.1.3 Plains Region

The analysis of the Standard Precipitation Index (SPI) showed that in 2016, the plains region experienced extreme drought. In 1997, Northern Coastal Plains experienced moderate wetness. During 1999, the Palakkad Central Plains experienced moderate drought conditions. During 2000, the Northern coastal plains experienced severe drought, and the remaining regions experienced moderate drought. In 2002, Palakkad Central Plains and Palakkad Eastern Plains experienced moderate drought, and in 2003, Palakkad Eastern Plains were affected by moderate drought. During 2006, Northern Coastal Plains experienced severe wetness, and the Palakkad Central Plains experienced moderate wetness. During 2007, the Northern Coastal Plains experienced severe wetness, and the Palakkad Central Plains and Palakkad Central Plains experienced moderate wetness.

During 2012, the Palakkad Central Plains experienced extreme drought and the remaining regions were affected by severe drought. While 2001–2005 had experienced moderate drought in the Palakkad Eastern Plains and Northern coastal plains, in 2018, the Northern Coastal Plains experienced moderate wetness and in 2019, the Palakkad Eastern Plains experienced moderate wetness. During 2021, the

Northern Coastal Plains experienced severe wetness, and the remaining regions experienced extreme wetness.

When compared to the last 30 years SPI value, 2016 was the most drought-affected year (Fig 5.97).

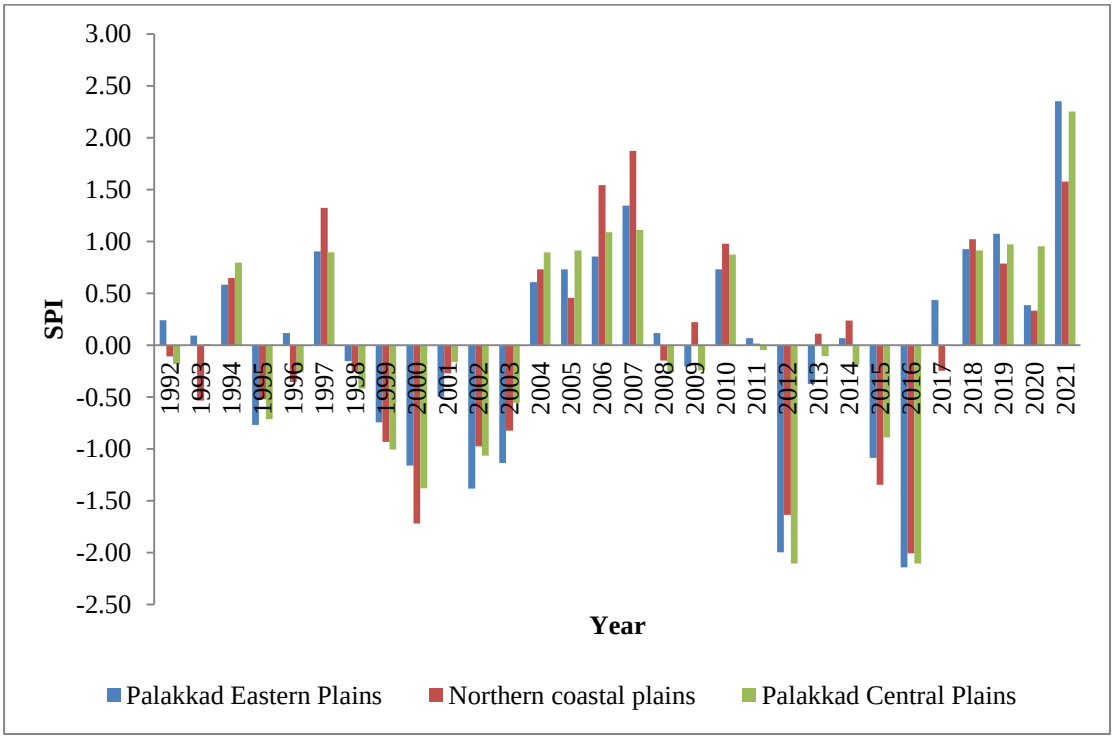



Fig 5.97 Annual Standard Precipitation Index (SPI) from 1992-2021 (30 years period) of Plains region

### 5.5.1.4 Laterites Regions

The analysis of the Standard Precipitation Index (SPI) shows that during 2016, there were an extreme drought in Northern Laterites and North Central Laterites and a severe drought in South Central Laterites. During 1997 had experienced moderate wetness in the Laterite region. While in 2000, the Northern Laterites experienced moderate drought conditions, the remaining regions experienced severe drought. In 2003, a moderate drought was experienced in the Northern Laterites. South Central Laterites experienced moderate wetness in 2004 and 2005. While in 2006, the

Northern Laterites experienced moderate wetness, the remaining regions experienced severe wetness. During 2007, the Northern Laterites experienced extreme drought, and the North Central Laterites experienced severe wetness.

During 2012, the Northern Laterites experienced moderate drought, and the remaining regions experienced severe drought. During 2015, a severe drought occurred in the Northern Laterites and a moderate drought occurred in the North Central Laterites. During 2018, North Central Laterites experienced moderate wetness. In 2021, South Central Laterites experienced extreme wetness, North Central Laterites experienced severe wetness, and Northern Laterites experienced moderate wetness.

When compared to the last 30 years, 2016 was the most drought-affected year (Fig 5.98).

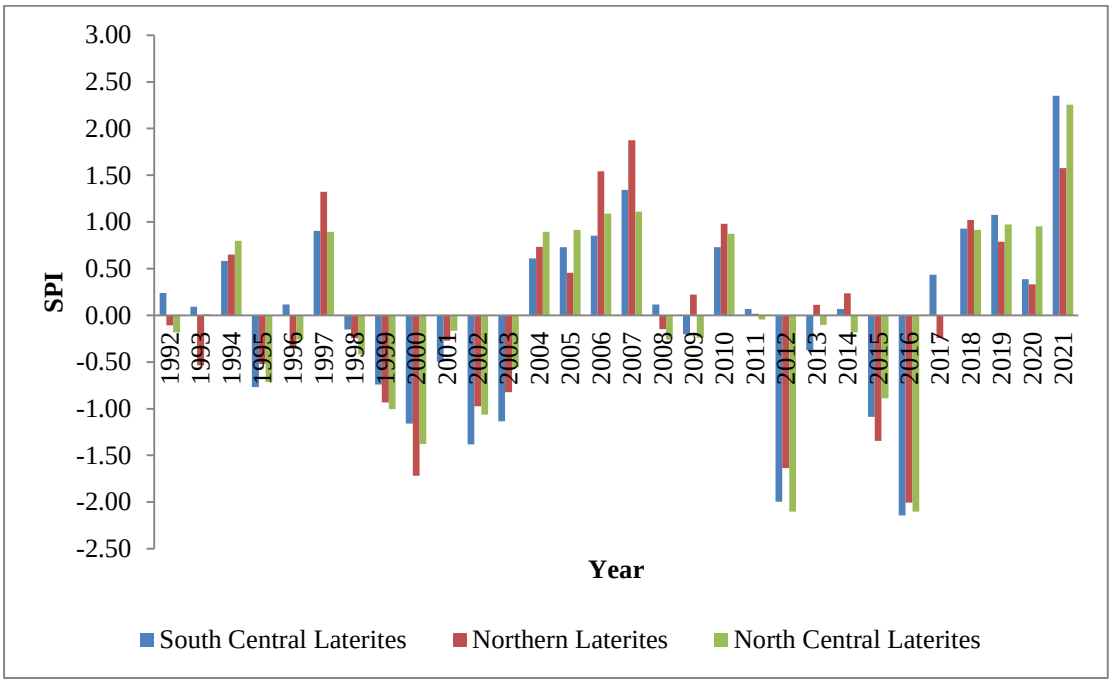



Fig 5.98 Annual Standard Precipitation Index (SPI) from 1992-2021 (30 years period) of Laterites region

#### 5.5.1.5 Foot Hills

The analysis of the Standard Precipitation Index (SPI) showed that during 2016, Northern Foot Hills experienced extreme drought and Southern and Central Foot Hills experienced severe drought. During 1997 experienced moderate wetness in the Foot Hills region. During 2000, Southern and Central Foot Hills experienced severe drought, and Northern Foot Hills experienced moderate drought. While 2003, the Southern and Central Foot Hills experienced a moderate drought. During the years 2004 and 2005, moderate wetness was experienced in the Southern and Central Foot Hills. During 2006, Southern and Central Foot Hills experienced severe wetness, and Northern Foot Hills experienced moderate wetness. During 2007, the Northern Foot Hills experienced extreme wetness. During 2012, Southern and Central Foot Hills experienced severe drought and Northern Foot Hills experienced moderate drought. In 2015, a severe drought occurred in the Northern Foot Hills. During 2021, Southern and Central Foot Hills experienced extreme wetness and Northern Foot Hills experienced moderate wetness.

When compared to the last 30 years SPI value, 2016 was the most drought-affected year (Fig 5.99).

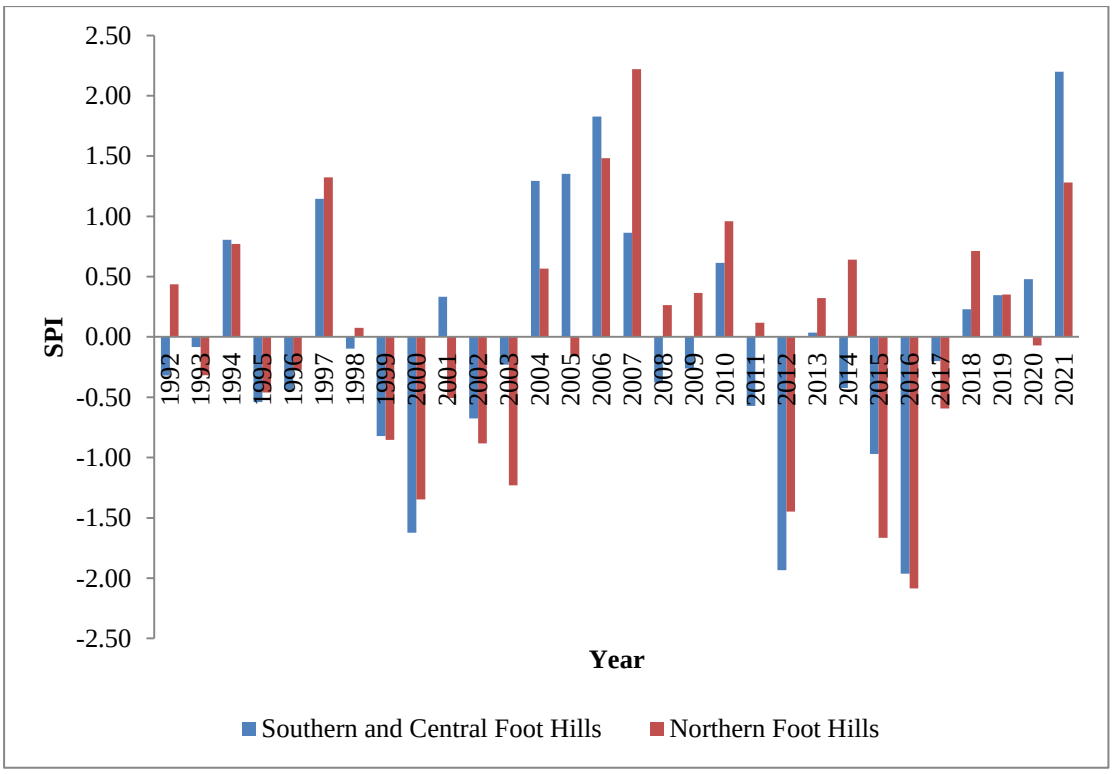



Fig 5.99 Annual Standard Precipitation Index (SPI) from 1992-2021 (30 years period) of Foot Hills region

### 5.5.1.6 Kole Lands

The analysis of the Standard Precipitation Index (SPI) showed that during 2016, the Pokkali region experienced extreme drought. The Pokkali region experienced severe drought in 2000 and 2012. While 2015 experienced moderate drought, moderate wetness occurred in the years 1997, 2006 and 2018, and severe wetness was experienced in 2007 and 2021.

When compared to the last 30 years SPI value, 2016 was the most drought-affected year (Fig 5.100).

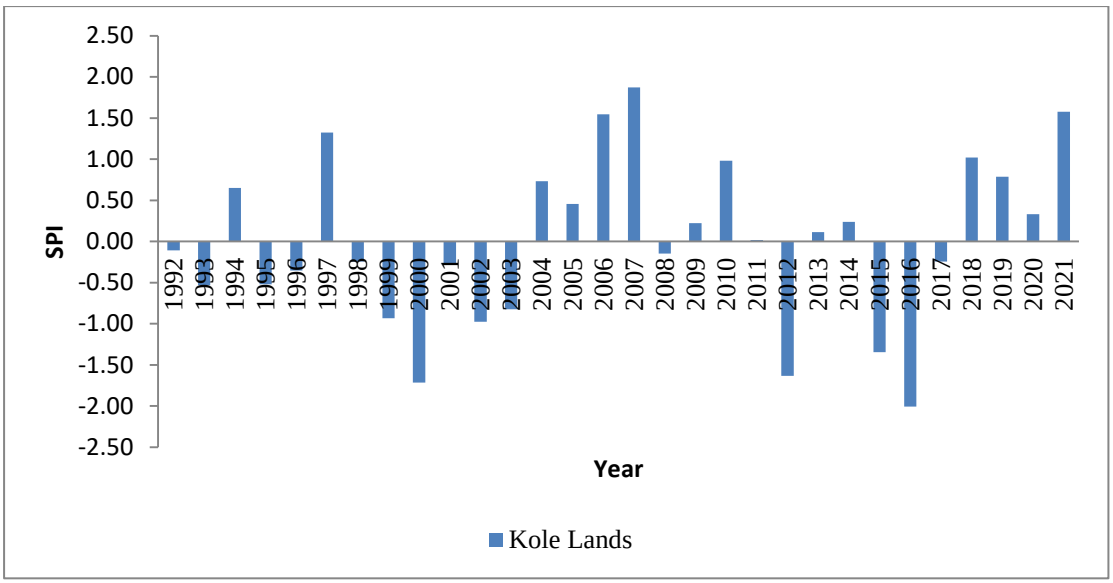



Fig 5.100 Annual Standard Precipitation Index (SPI) from 1992-2021 (30 years period) of Kole lands region

### 5.5.2 Southwest Monsoon Rainfall

#### 5.5.2.1 Hilly Region

The analysis of the Standard Precipitation Index (SPI) showed that during 2015, the hilly region experienced severe drought and moderate drought occurred in the hilly region in the years 2002 and 2016. During 1992, Attappady Dry Hills and Attappady Hills experienced moderate wetness. During 1997, the Northern High Hills of Palakkad and the Southern High Hills of Thrissur and Palakkad districts experienced severe wetness and the remaining regions experienced moderate wetness. During 1999, the Northern High Hills of Palakkad district experienced moderate drought, and the remaining regions experienced severe drought. While in 2000, the Southern High Hills of Ernakulam and Thrissur district experienced moderate drought. During 2003, moderate drought was experienced in the hilly region except in the southern high hills of Ernakulam and Thrissur.

During 2018 and 2019, moderate wetness occurred in hilly regions except the Northern High Hills of Palakkad. In 2020, moderate wetness occurred in the Northern

High Hills of Thrissur, the Southern High Hills of Palakkad, the Attappady Dry Hills, and the Attappady Hills.

When compared to the last 30 years SPI value, 1999 was the most drought-affected year (Fig 5.101).

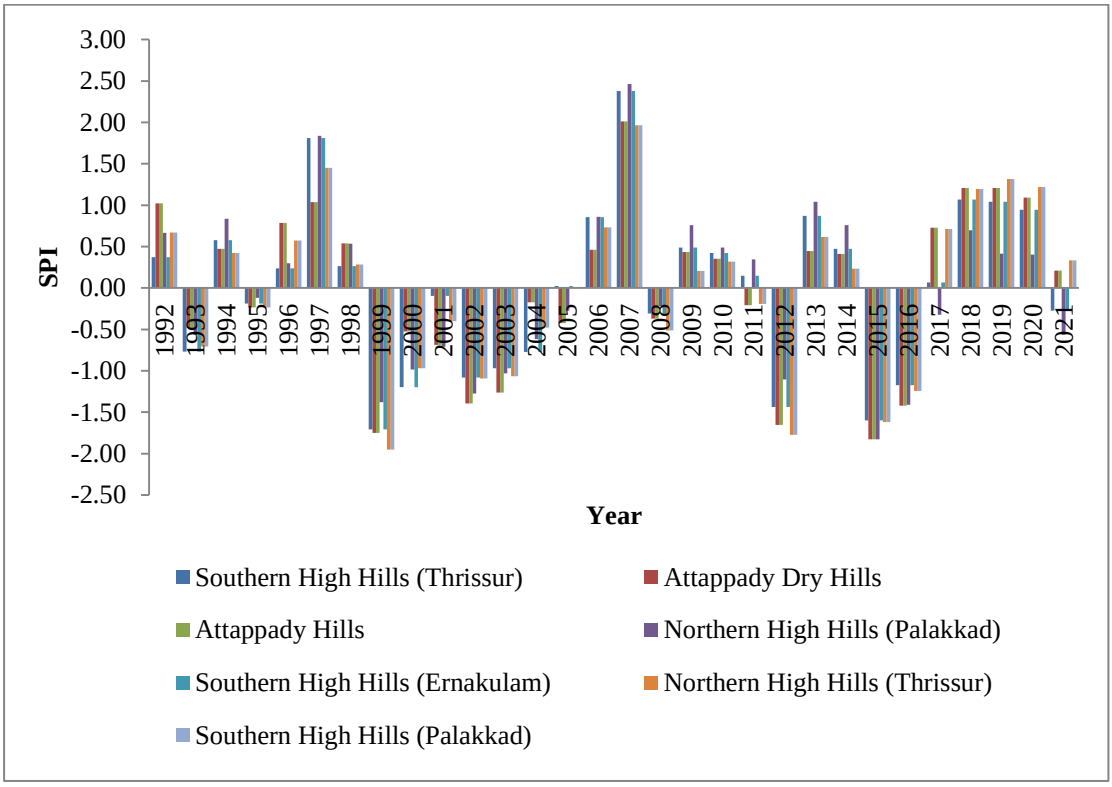



Fig 5.101 Standard Precipitation Index (SPI) during southwest monsoon from 1992-2021 (30 years period) of Hilly region

### 5.5.2.2 Pokkali Region

The analysis of the Standard Precipitation Index (SPI) showed that during the years 2000, 2012, 2015 and 2016, there was moderate drought, and in 1999, there experienced severe drought in hilly regions. While 2007, 2013, and 2018 experienced moderate wetness and extreme wetness in 1997 and 2007.Compared to the last 30 years SPI value, 1999 was the most drought-affected year (Fig 5.102).

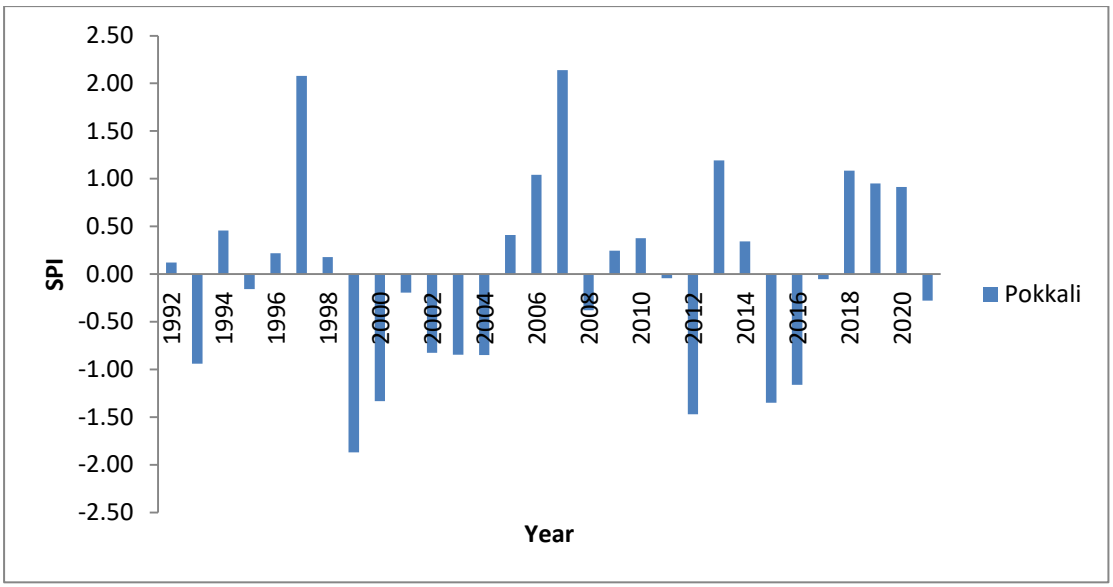



Fig 5.102 Standard Precipitation Index (SPI) during southwest monsoon from 1992-2021(30 years period) of Pokkali region

**5.5.2.3 Plains Regions**

The analysis of the Standard Precipitation Index (SPI) showed that during the years 1999 and 2015 had experienced severe drought in 1999 and 2015 and moderate drought in 2002 and 2016. While moderate wetness was experienced in 2018 and 2019. During 1992, the Palakkad Eastern Plains experienced moderate wetness. During 1997, severe wetness experienced in the Northern Coastal Plains and the remaining regions experienced moderate wetness. During 2000, the Northern coastal plains experienced moderate drought conditions. In 2003, a moderate drought was experienced in the Palakkad Central Plains and Palakkad Eastern Plains.

During 2007, severe wetness was experienced in the Palakkad Central Plains, while extreme wetness was observed in the remaining areas. In 2012, the Northern coastal plains experienced severe drought and the remaining regions experienced moderate drought. During 2020, the Palakkad Central Plains and Palakkad Eastern Plains will experience moderate wetness.

When compared to the SPI values of the last 30 years, 1999 was the most drought-affected year (Fig 5.103).

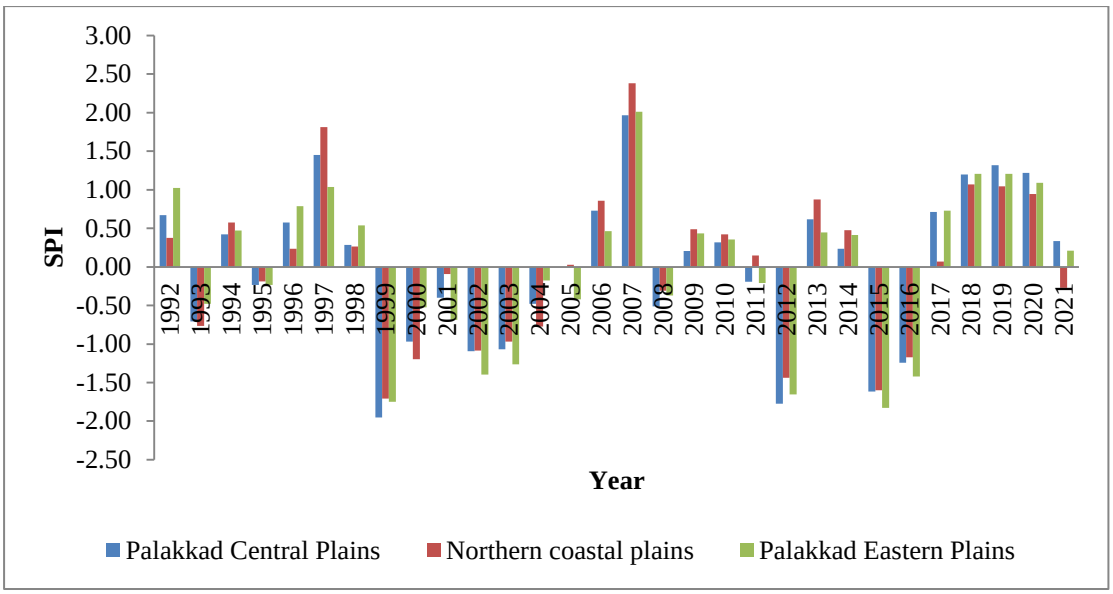



Fig 5.103 Standard Precipitation Index (SPI) during southwest monsoon from 1992-2021 (30 years period) of Plains region

### 5.5.2.4 Laterites Region

The analysis of the Standard Precipitation Index (SPI) shows that the year 2016 experienced moderate drought in the Laterites region. During 1997, South Central Laterites experienced extreme wetness and the remaining regions experienced severe wetness. In 1999, moderate drought was experienced in the Northern Laterites, while severe drought occurred in the remaining areas. During 2000, moderate drought was experienced in South Central Laterites and North Central Laterites. During 2002, moderate drought was experienced in North Central Laterites and Northern Laterites. During 2003, a moderate drought was experienced in the Northern Laterites. South Central Laterites experienced moderate wetness in 2006, and in 2007, South Central Laterites experienced severe wetness and the remaining areas experienced extreme wetness.

During 2012, severe drought was experienced in South Central Laterites and the remaining areas experienced moderate drought. During 2013, moderate wetness was experienced in the Northern Laterites. During 2015, moderate drought was

experienced in South Central Laterites and the remaining areas experienced severe drought. North Central Laterites had experienced moderate wetness in 2018 and 2019.

When compared to the last 30 years SPI value, 1999 was the most drought-affected year (Fig 5.104).

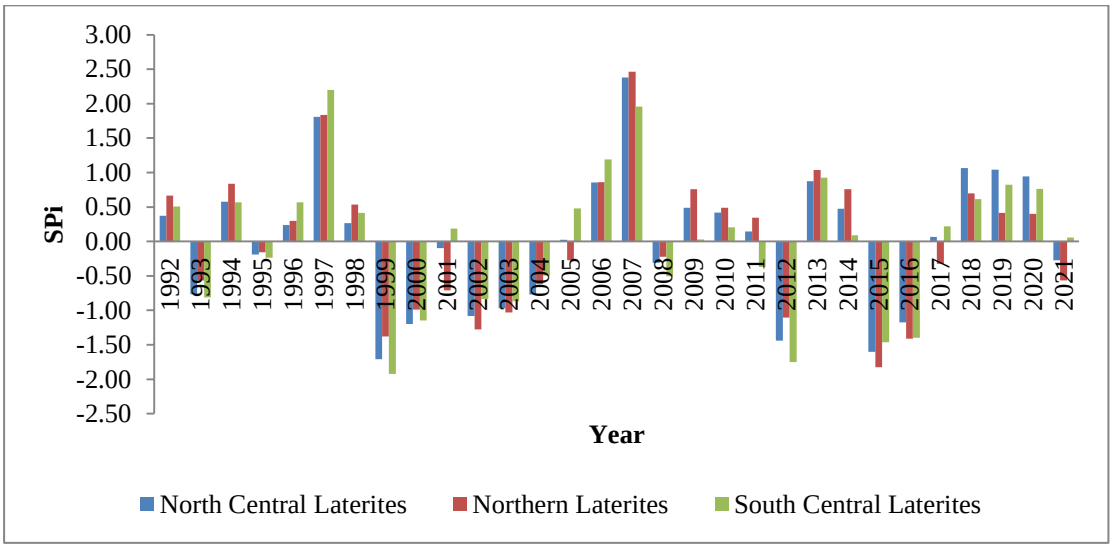



Fig 5.104 Standard Precipitation Index (SPI) during southwest monsoon from 1992-2021 (30 years period) of Laterites region

### 5.5.2.5 Foot Hills

The analysis of the Standard Precipitation Index (SPI) showed that during the year 2015, there was severe drought, and in 2016, there was moderate drought in the Foot hills region. During 1997, extreme wetness was experienced in the Southern and Central Foot Hills and severe wetness was experienced in the Northern Foot Hills. During 1999, severe drought was experienced in the Southern and Central Foot Hills and moderate drought was experienced in the Northern Foot Hills. Southern and Central Foot Hills experienced moderate drought in 2000. The Northern Foot Hills experienced moderate drought in 2003 and 2004. While Southern and Central Foot Hills experienced moderate wetness, during 2007, Northern Foot Hills experienced extreme wetness and Southern and Central Foot Hills experienced severe wetness. During 2012, Northern Foot Hills experienced moderate drought, and Southern and

Central Foot Hills experienced severe drought. During 2013, Northern Foot Hills experienced moderate wetness. When compared to the last 30 years, 1999 was the most drought-affected year (Fig 5.105).

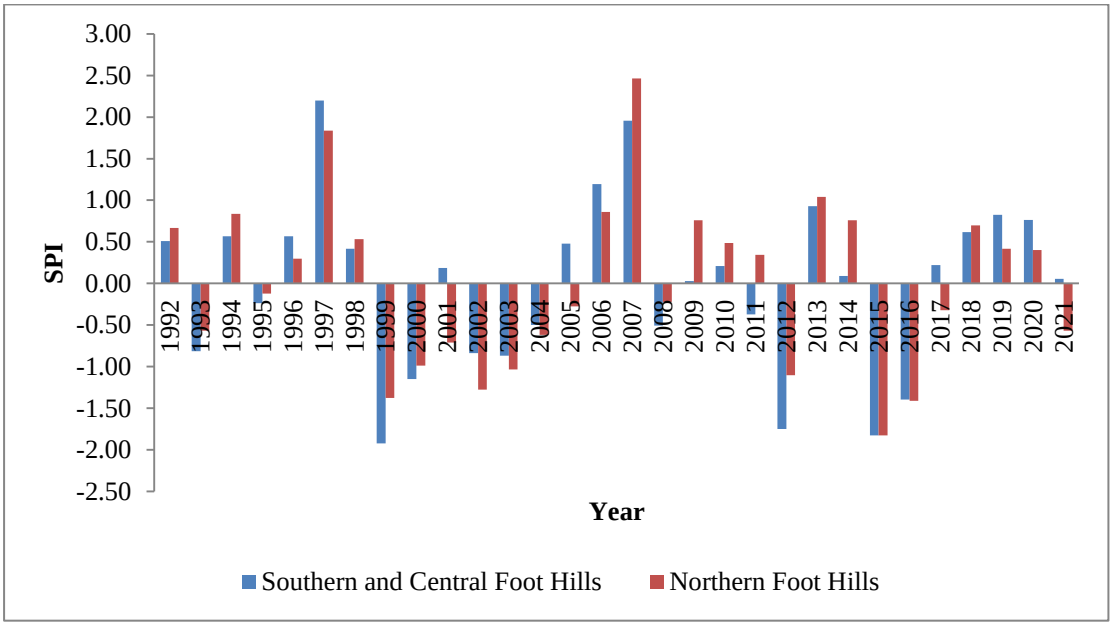



Fig 5.105 Standard Precipitation Index (SPI) during southwest monsoon from 1992-2021 (30 years period) of Foot Hills region

### 5.5.2.6 Kole lands

The analysis of the Standard Precipitation Index (SPI) shows that during the years 1999 and 2015, severe and moderate droughts were experienced in 2000, 2002, 2012 and 2016. During the years 2018 and 2019 experienced moderate wetness, severe wetness in 1997 and extreme wetness in 1997.

When compared to the last 30 years SPI value, 1999 was the most drought-affected year (Fig 5.106).

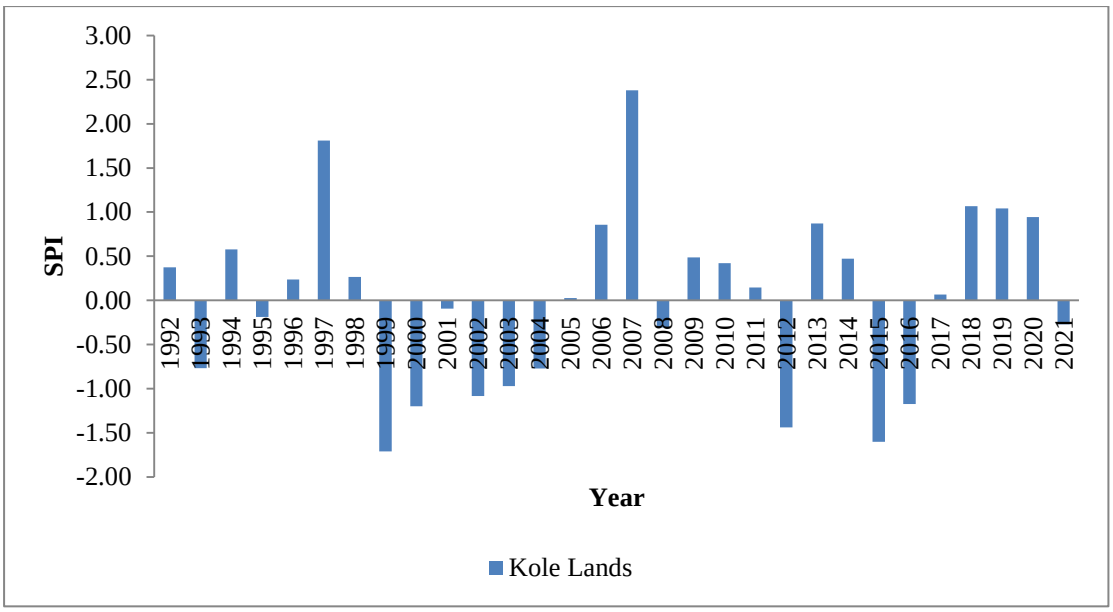



Fig 5.106 Standard Precipitation Index (SPI) during southwest monsoon from 1992-2021 (30 years period) of Kole lands region

### 5.5.3 Northeast Monsoon Rainfall

#### 5.5.3.1 Hilly Region

The analysis of the Standard Precipitation Index (SPI) showed that during the years 1995 and 2012, the Hilly region experienced moderate drought. While in 2021 we experienced extreme wetness, severe wetness was observed in 2010 and moderate wetness was experienced in 1993. During 1997, Attappady Dry Hills and Attappady Hills experienced severe wetness and moderate wetness in the Northern High Hills of Thirssur and the Southern High Hills. During 2000, moderate drought was experienced in the hilly region except in the Northern High Hills of Palakkad district. During 2005, the Southern High Hills of Palakkad and the Northern High Hills of Thrissur experienced moderate wetness, while the Attappady Dry Hills and Attappady Hills experienced severe wetness. During 2016, the Northern High Hills of Palakkad district experienced extreme drought, and the remaining regions experienced moderate drought. The Southern High Hills of Thrissur and Ernakulam and the

Northern High Hills had experienced moderate drought in 2017 and moderate wetness in 2019.

When compared to the last 30 years SPI value, 2016 was the most drought-affected year (5.107).

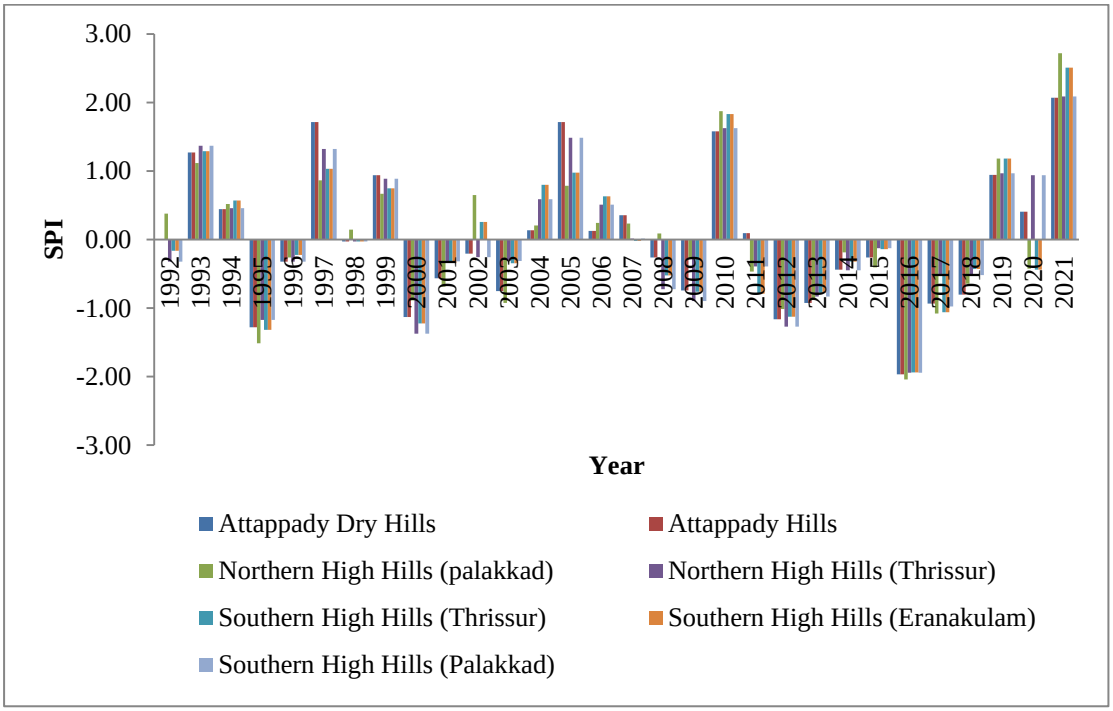



Fig 5.107 Standard Precipitation Index (SPI) during northeast monsoon from 1992-2021 (30 years period) of Hilly region

### 5.5.3.2 Pokkali Region

The analysis of the Standard Precipitation Index (SPI) shows that during the years 1995, 2000, 2011 and 2012, experienced moderate drought and severe drought in 2016. Moderate drought was experienced in the years 1993, 2004, 2005, 2006, and 2010, and extreme wetness was experienced in 2021.

When compared to the last 30 years, 2016 was the most drought-affected year (Fig 5.108).

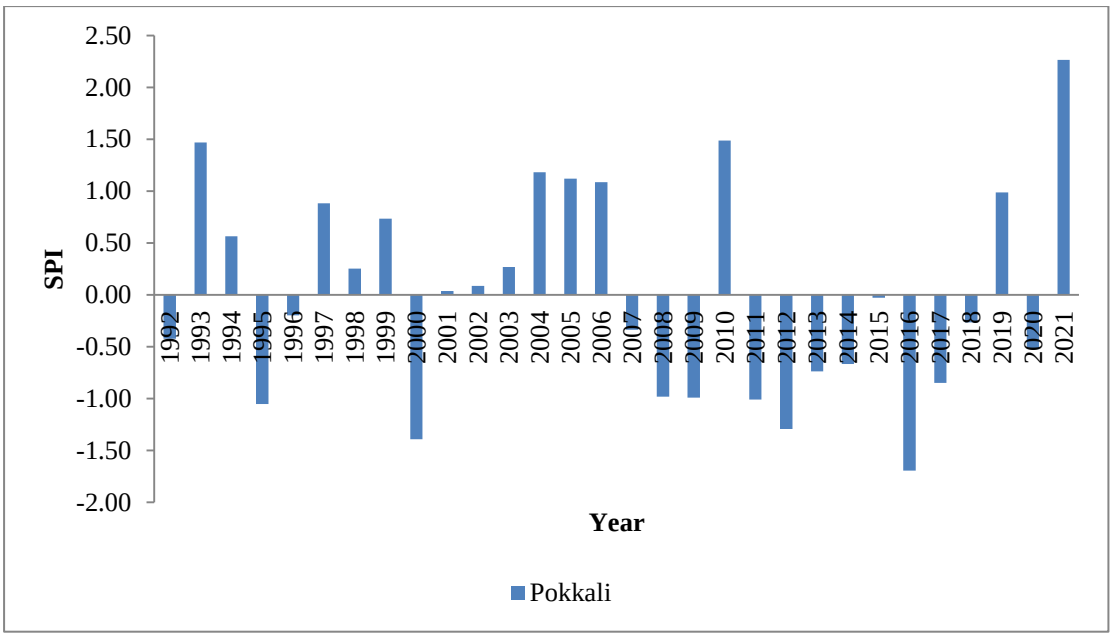



Fig 5.108 Standard Precipitation Index (SPI) during northeast monsoon from 1992-2021 (30 years period) of Pokkali region

### 5.5.4.2 Plains Regions

The analysis of the Standard Precipitation Index (SPI) shows that in 2016, there was a severe drought, and in 1995, 2000, and 2012, there were moderate drought conditions in plains regions. During 2021, extreme wetness was experienced, severe wetness was experienced in 2010, and moderate wetness was experienced in 1993. The Palakkad Eastern Plains experienced severe wetness, and the remaining regions experienced moderate wetness. During 2005, the Palakkad Eastern Plains experienced severe drought and moderate drought in the Palakkad Central Plains. The Northern coastal plains experienced moderate drought in 2017 and moderate wetness in 2019.

When compared to the last 30 years, 2016 was the most drought-affected year (Fig 5.109).

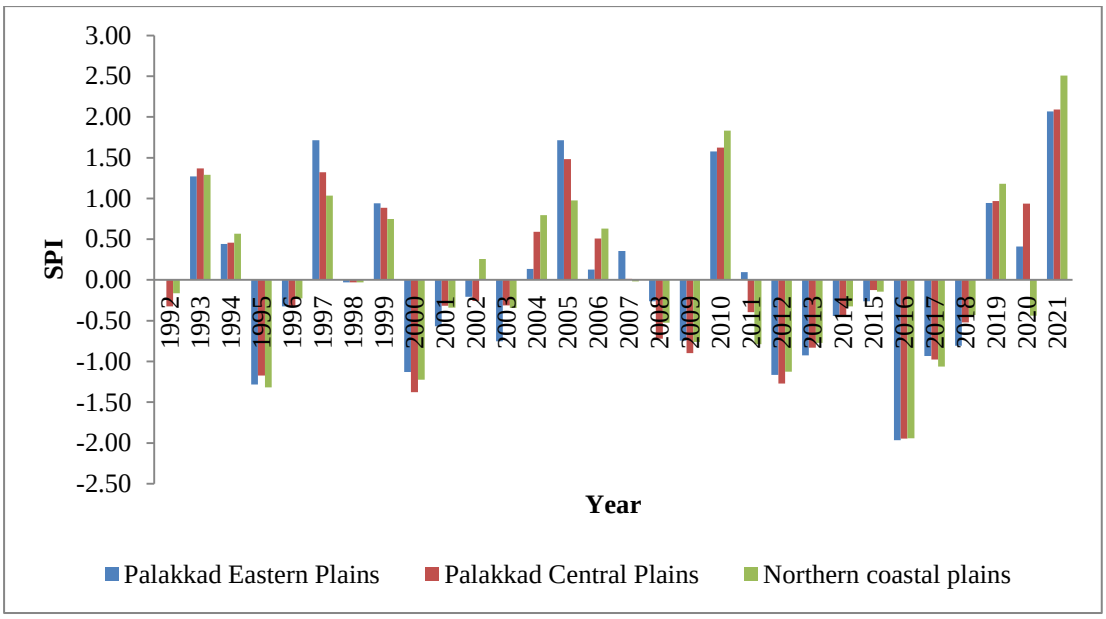



Fig 5.109 Standard Precipitation Index (SPI) during northeast monsoon from 1992-2021 (30 years period) of Plains region

### 5.5.4.3 Laterites Region

The analysis of the Standard Precipitation Index (SPI) showed that during the years 1995 and 2012, experienced moderate droughts. During 2021, extreme wetness was experienced in this region. During 1992, South Central Laterites experienced severe and moderate wetness in the remaining regions. North Central Laterites experienced moderate wetness in 1997. During 2000, South Central Laterites and North Central Laterites experienced moderate drought. South Central Laterites experienced moderate wetness in 2004 and 2005 and a moderate drought in 2008. During 2010, moderate wetness was experienced in South Central Laterites and the remaining regions experienced severe wetness. During 2016, the Northern Laterites experienced extreme drought, and the remaining regions experienced severe drought. Northern Laterites and North Central Laterites experienced moderate drought in 2017 and moderate wetness in 2019.

When compared to the last 30 years, 2016 was the most drought-affected year (Fig 5.110).

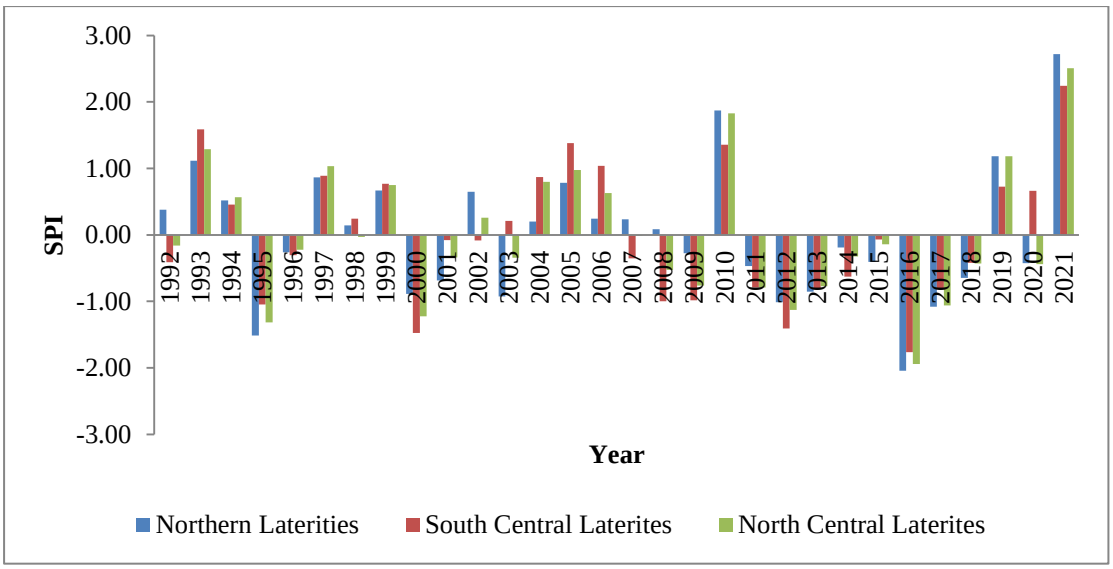



Fig 5.110 Standard Precipitation Index (SPI) during northeast monsoon from 1992-2021 (30 years period) of Laterites region

**5.5.3.5 Foot Hills**

The analysis of the Standard Precipitation Index (SPI) showed that during the years 1995 and 2012, there was a moderate drought in the Laterites region during northeast monsoon rainfall in the Foot Hills. During 2021, extreme wetness was experienced in the foothills region. During 1993, the Southern and Central Foot Hills experienced severe wetness and moderate wetness in the Northern Foot Hills. Southern and Central Foot Hills had experienced moderate drought in 2000 and 2008 and moderate wetness in 2005 and 2006. During 2016, extreme drought was experienced in the Northern Foot Hills and severe drought was experienced in the Southern and Central Foot Hills. Northern Foot Hills had experienced moderate drought in 2017 and moderate wetness in 2019.

When compared to the last 30 years, 2016 was the most drought-affected year (Fig 5.111).

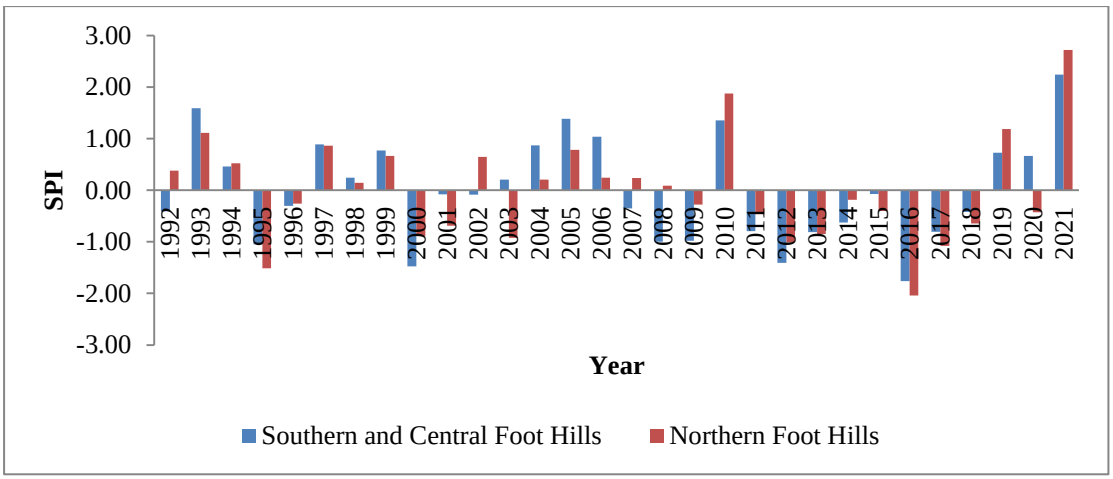



Fig 5.111 Standard Precipitation Index (SPI) during northeast monsoon from 1992-2021 (30 years period) of Foot Hills region during

### 5.5.3.6 Kole Lands

The analysis of the Standard Precipitation Index (SPI) shows that during the years 1995, 2000, 2012 and 2017, experienced moderate drought and severe drought in 2016. During 2021 experienced extreme wetness, severe wetness in 2010 and moderate drought occurred in the years 1993, 1997 and 2019. When compared to the last 30 years, 2016 was the most drought-affected year (5.112).

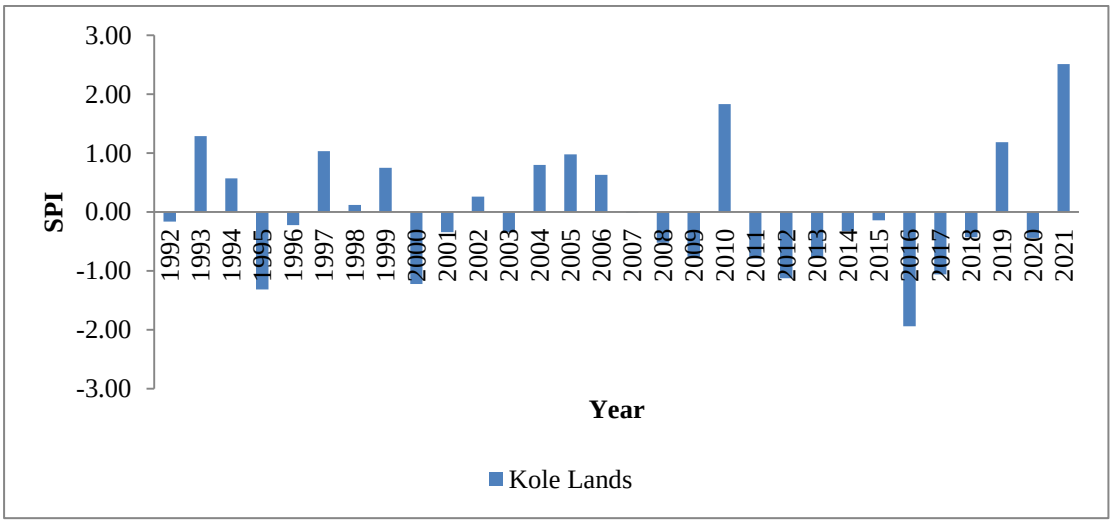



Fig 5.112 Standard Precipitation Index (SPI) during northeast monsoon from 1992-2021 (30 years period) of Kole lands region

### 5.5.4 Summer Season Rainfall

#### 5.5.4.1 Hilly Region

The analysis of the Standard Precipitation Index (SPI) shows that during the year 2000, severe drought was experienced in Attappady Dry Hills and Attappady Hills and the remaining regions experienced moderate drought. During 2004, extreme wetness was experienced in hilly regions and moderate wetness was experienced in 2008. During 1992, the Southern High Hills of Palakkad and the Northern High Hills of Thirissur experienced moderate drought. During 1996, moderate drought was experienced in the hilly region except for the Attappady Dry Hills and Attappady Hills. During 1997, Attappady Dry Hills, Attappady Hills, and the Northern High Hills of Palakkad district experienced severe drought and the remaining areas experienced moderate drought. In 1998, a moderate drought was experienced in the hilly region except for the Northern High Hills of Palakkad district. During 2001, Attappady Dry Hills, Attappady Hills, and the Northern High Hills of Palakkad district experienced moderate wetness.

During 2013, Attappady Dry Hills, Attappady Hills, the Northern High Hills of Thirissur, and the Southern High Hills of Palakkad district experienced moderate drought. During 2015, moderate wetness was experienced in Attappady Dry Hills and Attappady Hills. During 2018, moderate wetness was experienced in Attappady Dry Hills, Attappady Hills, the Southern High Hills of Palakkad, and the Northern High Hills of Thrissur district. In 2019, the Southern High Hills of Eranakulam and Thrissur experienced moderate drought. During 2021, the southern high hills of Eranakulam and Thrissur experienced severe wetness, and the remaining areas experienced moderate wetness.

When compared to the last 30 years, 1997 was the most drought-affected year (5.113).

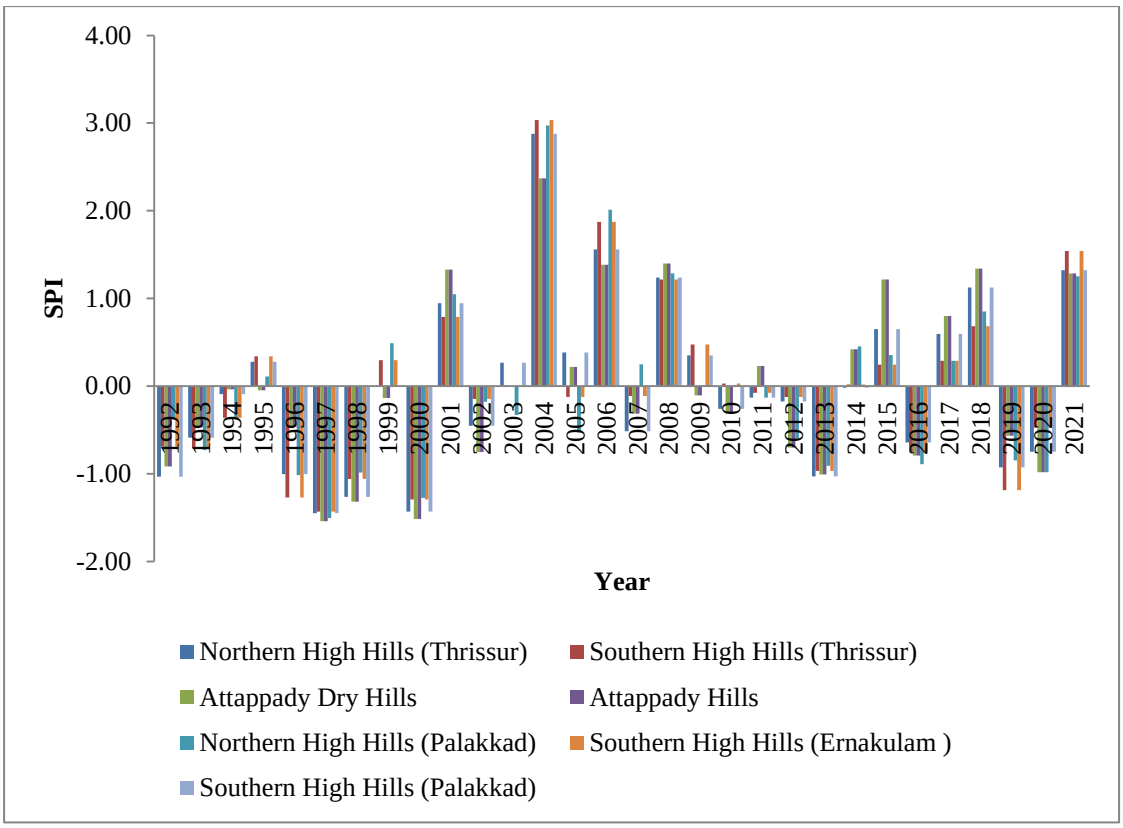



Fig 5.113 Standard Precipitation Index (SPI) during summer monsoon from 1992-2021 (30 years period) of Hilly region

### 5.5.4.2 Pokkali Region

The analysis of the Standard Precipitation Index (SPI) shows that during the years 1996, 1997, 2000 and 2019, the Pokkali region experienced moderate drought. Extreme wetness was experienced in 2004 and severe wetness was experienced in 2006 and 2021. The remaining years experienced normal condition.

When compared to the last 30 years, 1997 was the most drought-affected year (5.114).

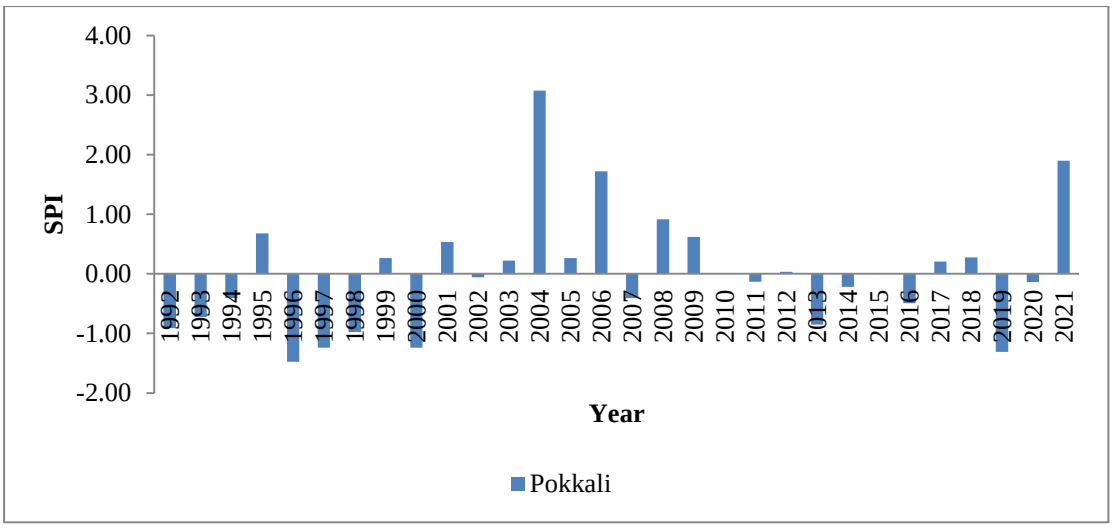



Fig 5.114 Standard Precipitation Index (SPI) during summer season from 1992-2021 (30 years period) of Pokkali region

### 5.5.4.3 Plains Region

The analysis of the Standard Precipitation Index (SPI) shows that during the year 1998, there was moderate drought in the plains region. Extreme wetness was experienced in 2004 and moderate wetness was experienced in 2008. During 1992, the Palakkad Central Plains experienced a moderate drought. During 1996 had experienced moderate drought in the Palakkad Central Plains and Northern coastal plains. During 1997 and 2000, the Palakkad Eastern Plains experienced severe drought, and the remaining areas experienced moderate drought. During 2001 and 2015, the Palakkad Eastern Plains experienced moderate wetness. During 2006, the Palakkad Eastern Plains experienced moderate wetness, and the remaining regions experienced severe wetness.

During 2013, the Palakkad Central Plains and Palakkad Eastern Plains experienced moderate drought conditions. During 2019, the northern coastal plains experienced a moderate drought. In 2021, severe wetness was experienced in the northern coastal plains, and the remaining regions experienced moderate wetness.

When compared to the last 30 years SPI value, 1997 was the most drought-affected year (Fig 5.115).

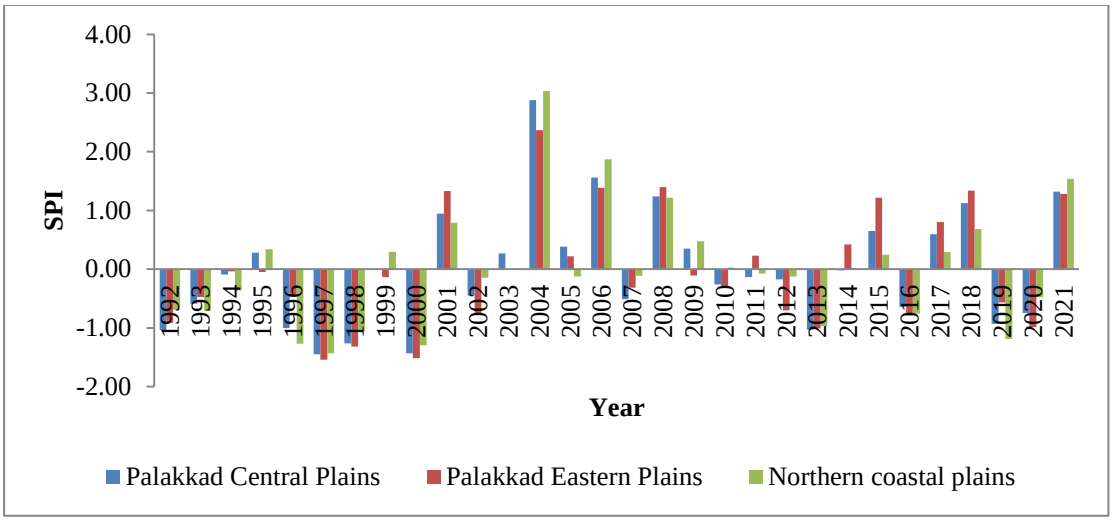



Fig 5.115 Standard Precipitation Index (SPI) during summer season from 1992-2021 (30 years period) of Plains region

### 5.5.4.4 Laterites Region

The analysis of the Standard Precipitation Index (SPI) shows that during the years 1996 and 2000, the Laterites region experienced moderate drought. During 2004, extreme wetness was experienced in this region and severe wetness was experienced in 2021. South Central Laterites experienced a moderate drought in 1992. During 1997, Northern Laterites experienced severe drought and moderate drought in the remaining areas. During 1998, moderate drought was experienced in North Central Laterites and South Central Laterites. In 2001, moderate wetness was experienced in the Northern Laterites. During 2006, extreme wetness was experienced in the Northern Laterites, and the remaining regions had experienced severe wetness.

During 2008, the Northern Laterites and North Central Laterites experienced moderate drought conditions. While in 2019, moderate drought was experienced in North Central Laterites and South Central Laterites. During 2021, South Central Laterites experienced severe wetness, and the remaining areas experienced moderate wetness.

When compared to the last 30 years SPI value, 1997 was the most drought-affected year (Fig 5.116).

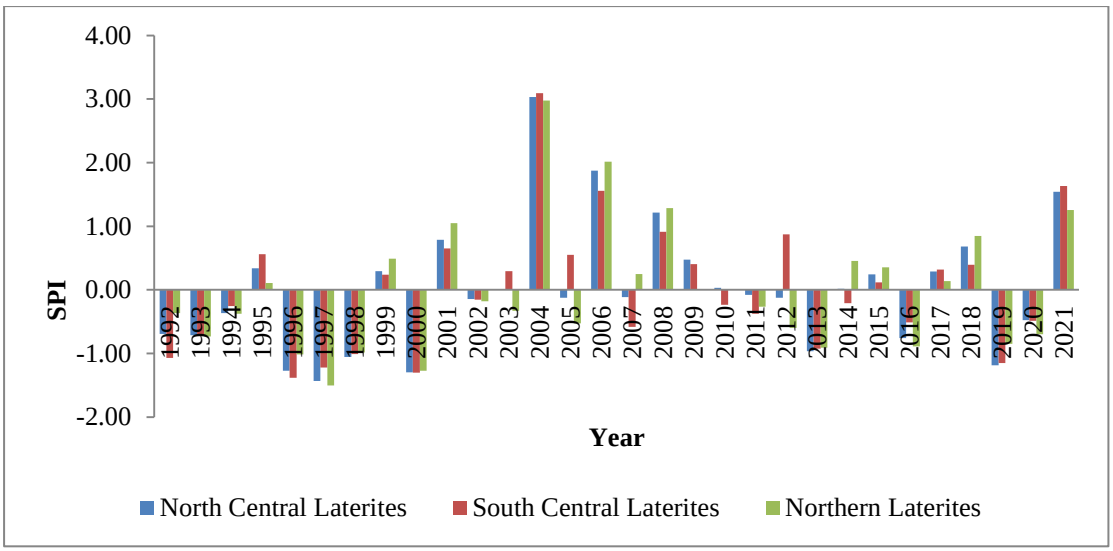



Fig 5.116 Standard Precipitation Index (SPI) during summer monsoon from 1992-2021 (30 years period) of Plains region

**5.5.4.5 Foot Hills**

The analysis of the Standard Precipitation Index (SPI) shows that during the years 1996 and 2000, Foot hills region experienced moderate drought. In 2004, extreme wetness occurred in this region. During the years 1992, 1998 and 2019, had experienced moderate drought conditions. During 1997, severe drought was experienced in the Northern Foot Hills and moderate drought was experienced in the Southern and Central Foot Hills. Northern Foot Hills experienced moderate wetness in 2001 and 2008. During 2006, the Northern Foot Hills experienced extreme wetness and severe wetness in the Southern and Central Foot Hills. During 2021, Southern and Central Foot Hills had experienced severe wetness, and Northern Foot Hills had experienced severe wetness.

When compared to the last 30 years SPI value, 1997 was the most drought-affected year (5.117).

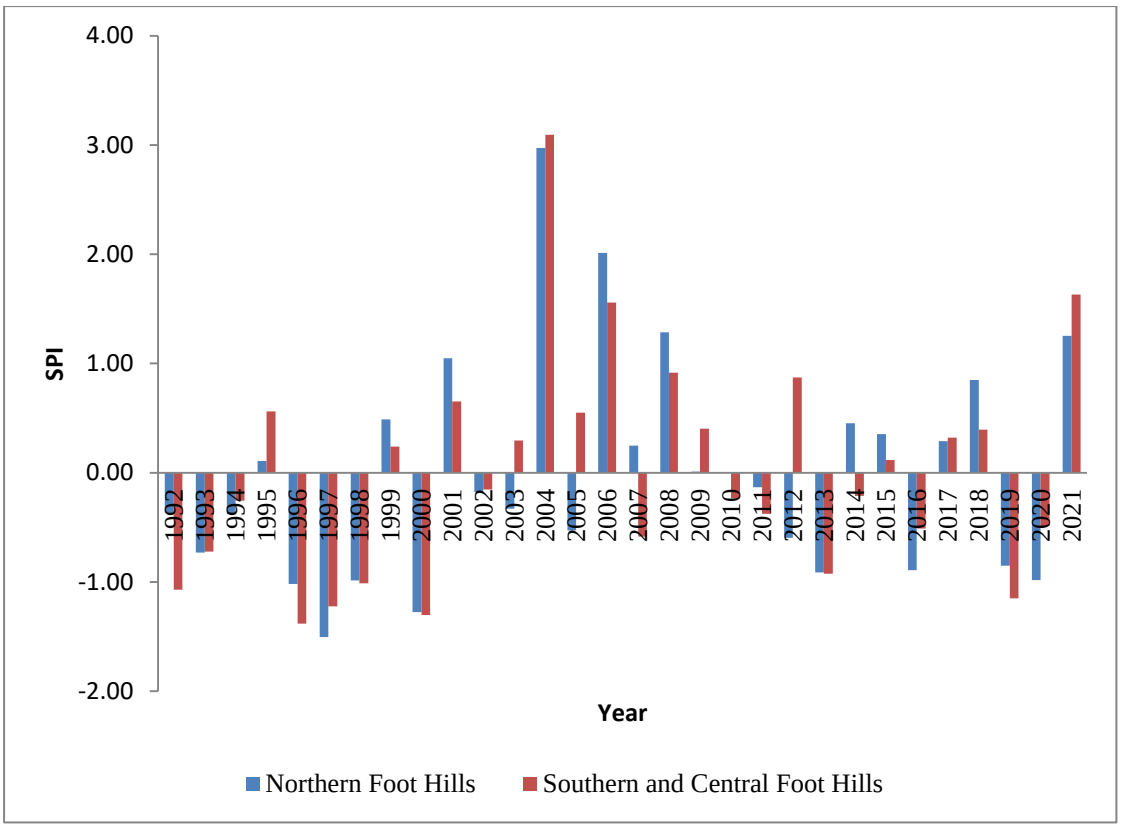



Fig 5.117 Standard Precipitation Index (SPI) during summer monsoon from 1992-2021 (30 years period) of Plains region

### 5.5.4.6 Kole lands

The analysis of the Standard Precipitation Index (SPI) shows that during the years 1996–2000 and 2019, Kole lands experienced moderate drought. Extreme wetness was experienced in 2004 and moderate wetness was experienced in 2006 and 2008. During 2021 experienced severe wetness.

When compared to the last 30 years, 1997 was the most drought-affected year (Fig 5.118).

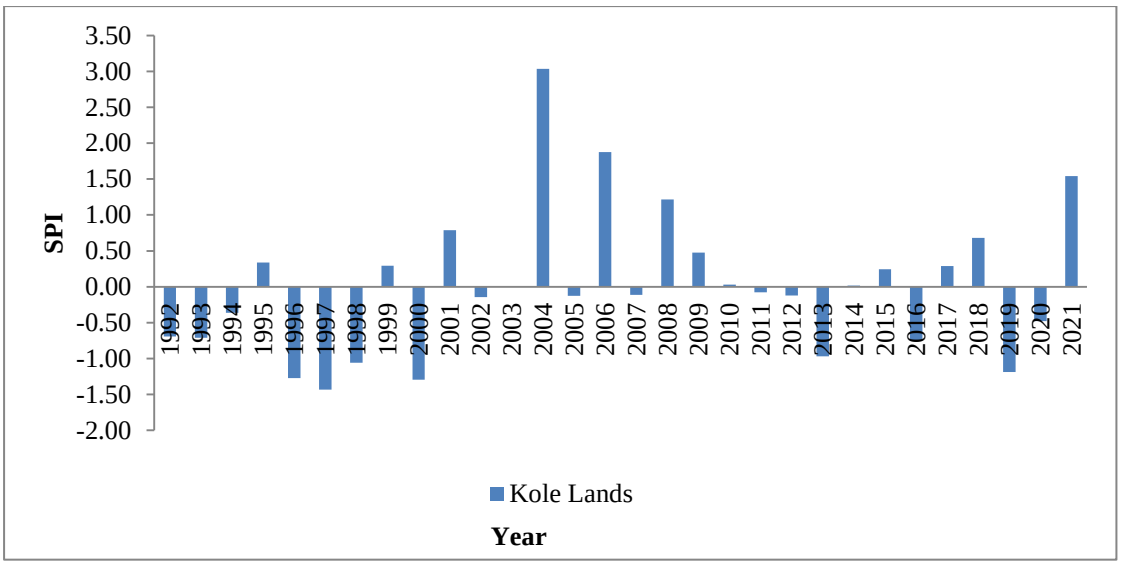



Fig 5.118 Standard Precipitation Index (SPI) during summer monsoon from 1992-2021 (30 years period) of Kole Lands region

### 5.5.5 Winter Season Rainfall

#### 5.5.5.1 Hilly Region

The analysis of the Standard Precipitation Index (SPI) showed that the majority of years had a near-normal value of -0.99 to 0.99. During 2021, extreme wetness was experienced in the hilly region. During 1994, the Northern High Hills of Thrissur and the Southern High Hills experienced severe wetness. During 2000, extreme wetness was experienced in all hilly regions except the AEU Northern High Hills of Palakkad district. The Northern High Hills and Southern High Hills of Thrissur experienced moderate wetness in 2001 and 2005, and severe wetness was experienced in 2013. During 2003, the Northern High Hills and Southern High Hills of Thrissur experienced moderate wetness.

During 2011, the Southern High Hills of Ernakulam experienced severe wetness, the Northern High Hills and Southern High Hills of Thrissur experienced

extreme wetness, and the Southern High Hills and Northern High Hills of Palakkad experienced moderate wetness.

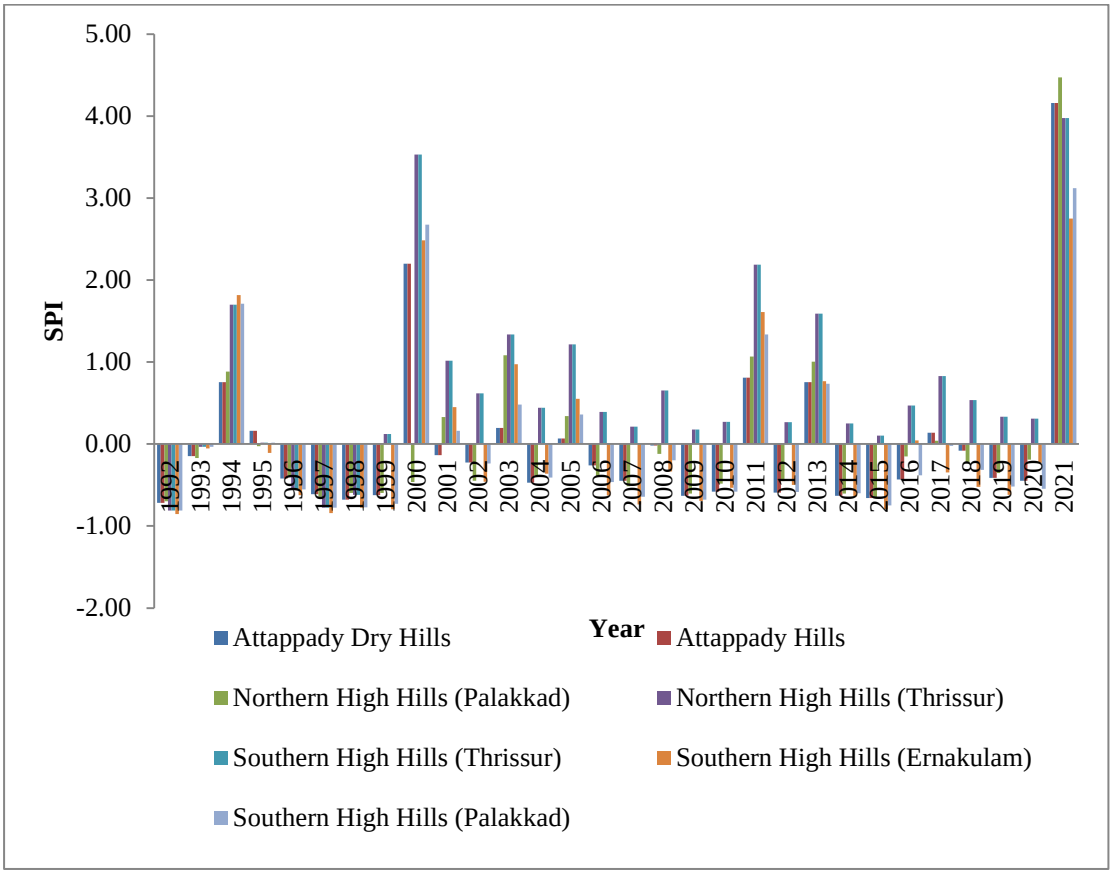



Fig 5.119 Standard Precipitation Index (SPI) during winter season from 1992-2021 (30 years period) of Hilly region

### 5.5.5.2 Pokkali Region

The analysis of the Standard Precipitation Index (SPI) showed that the majority of years experienced a near-normal value of -0.99 to 0.99. During the years 1994, 2000, and 2021, extreme wetness and moderate wetness were experienced in 2003 and 2011.

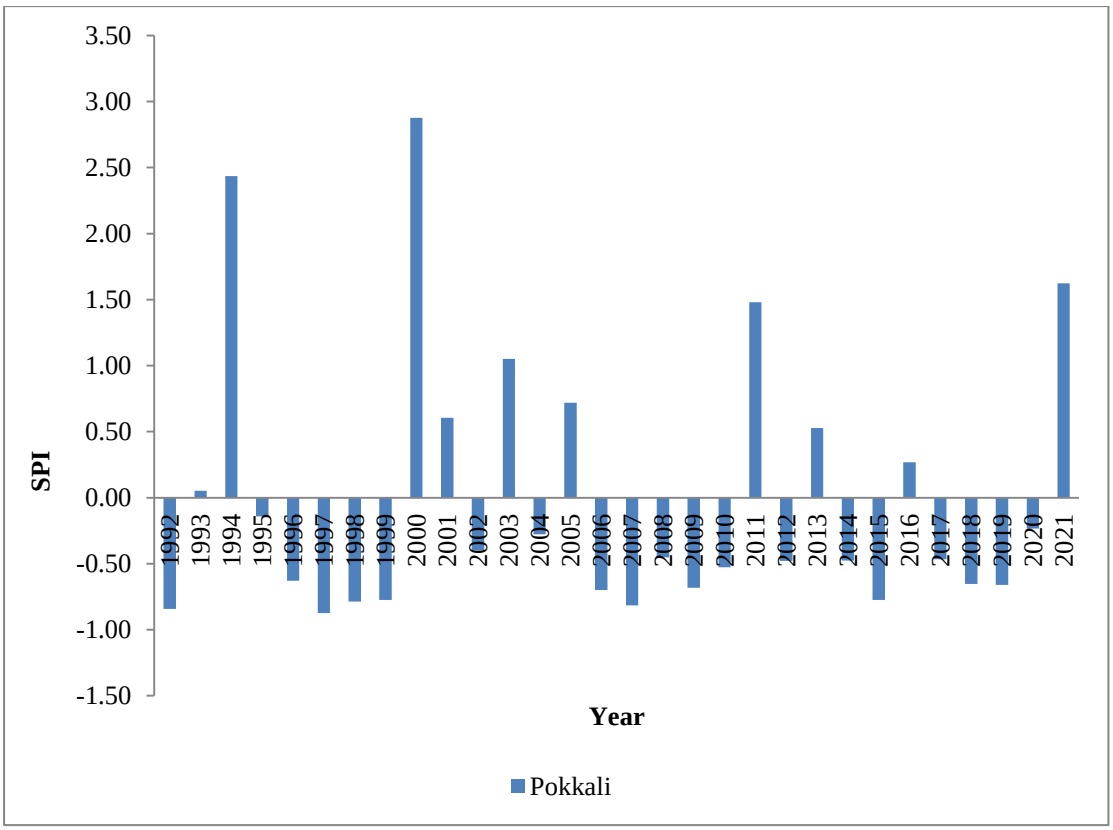



Fig 5.120 Standard Precipitation Index (SPI) during winter season from 1992-2021 (30 years period) of Pokkali region

### 5.5.5.3 Plains Region

The analysis of the Standard Precipitation Index (SPI) showed that the majority of the years experienced a near-normal value of -0.99 to 0.99. During the years 2000 and 2021 had experienced extreme wetness in the plains region. Palakkad Central Plains and Northern coastal plains experienced severe wetness in 1994. During 2011, the Northern coastal plains experienced severe wetness, and the Palakkad Central Plains experienced moderate wetness.

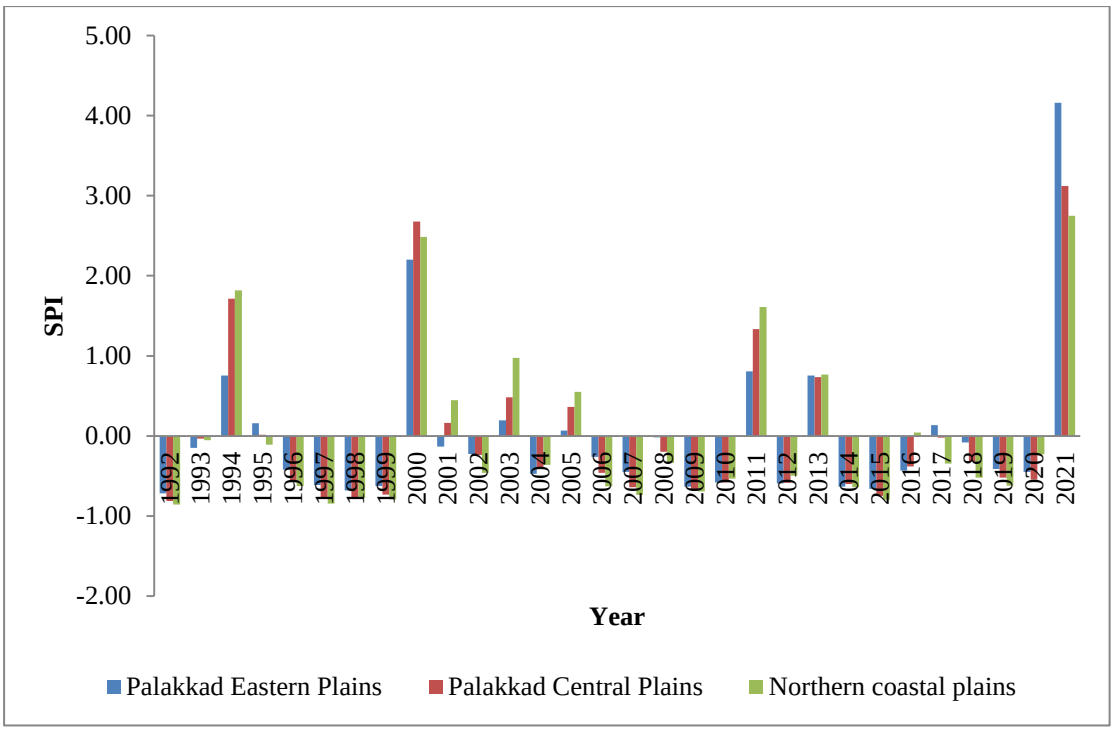



Fig 5.121 Standard Precipitation Index (SPI) during winter season from 1992-2021 (30 years period) of Plains region

### 5.5.5.4 Laterites Region

The analysis of the Standard Precipitation Index (SPI) showed that the majority of years experienced a near-normal value of -0.99 to 0.99. During the year 2021, we experienced extreme wetness in this region. During 1994, South Central Laterites experienced extreme wetness and North Central Laterites experienced severe wetness. During 2000, extreme wetness was experienced in the South Central Laterites and North Central Laterites. Northern Laterites experienced moderate drought in the years 2003 and 2013. During 2011, North Central Laterites experienced severe wetness and the remaining regions experienced moderate wetness.

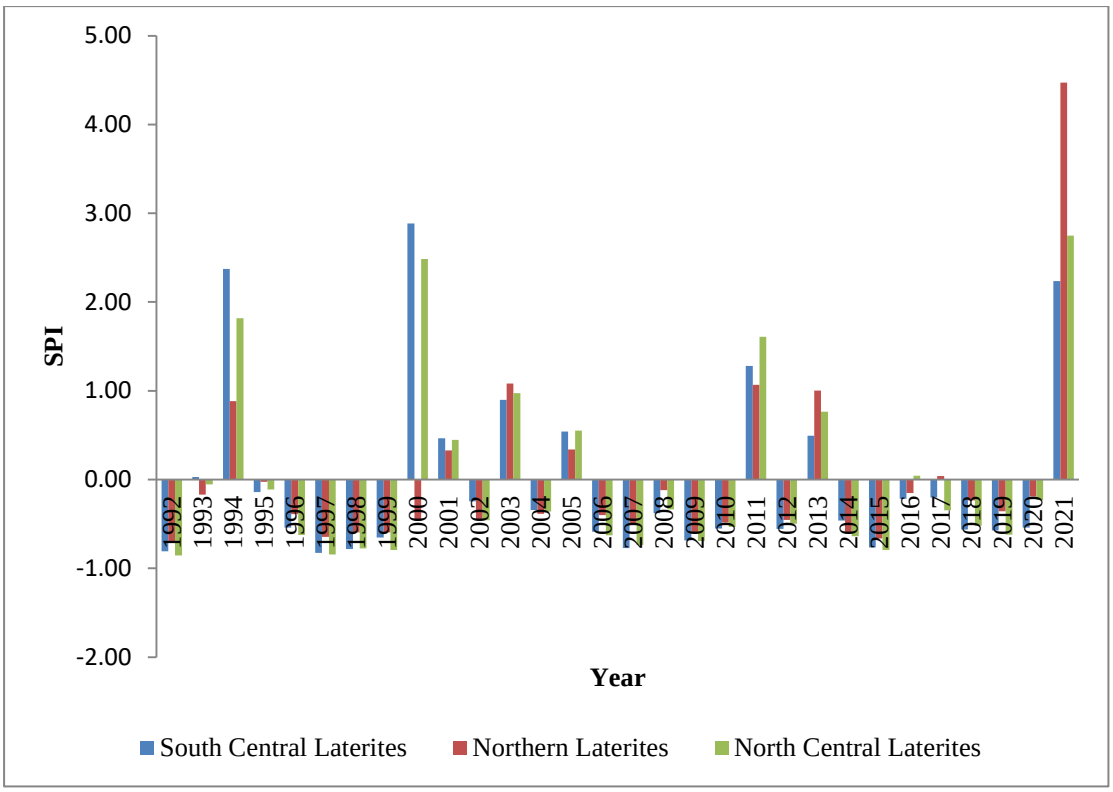



Fig 5.122 Standard Precipitation Index (SPI) during winter season from 1992-2021 (30 years period) of Laterites region

### 5.5.5.5 Foot Hills

The analysis of the Standard Precipitation Index (SPI) shows that majority of years experienced a near-normal value of -0.99 to 0.99. During the year 2021had experienced extreme wetness and moderate wetness in 2011. Southern and Central Foot Hills experienced severe droughts in 1994 and 2000. Northern Foot Hills experienced a moderate drought condition in 2003.

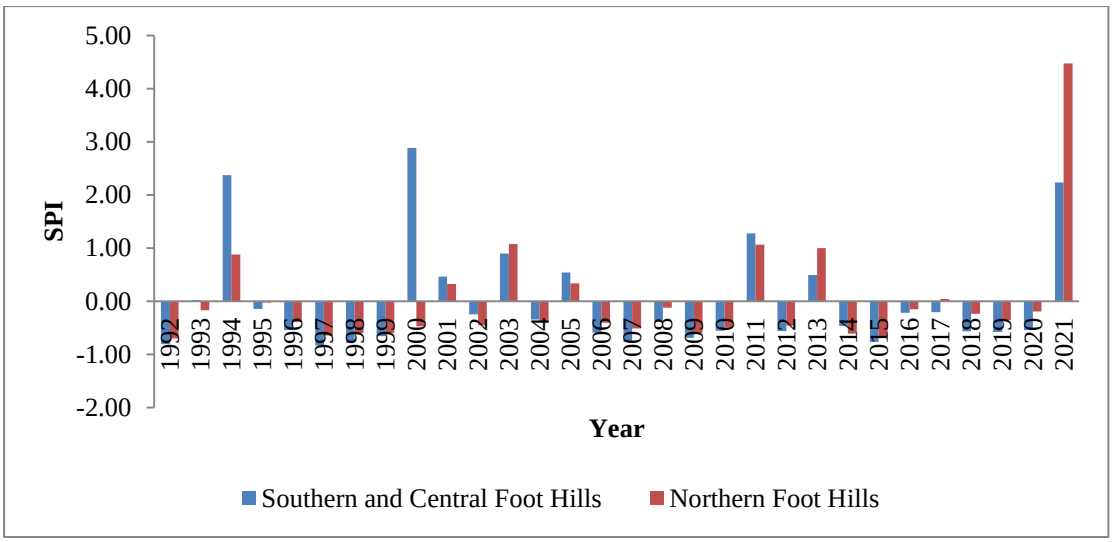



Fig 5.123 Standard Precipitation Index (SPI) during winter season from 1992-2021 (30 years period) of Foot Hills region

### 5.5.5.6 Kole lands

The analysis of the Standard Precipitation Index (SPI) shows that the majority of the yeras experienced a near-normal value of -0.99 to 0.99. Kole lands experienced severe wetness in 2011 and extreme wetness in the years 2000 and 2021.

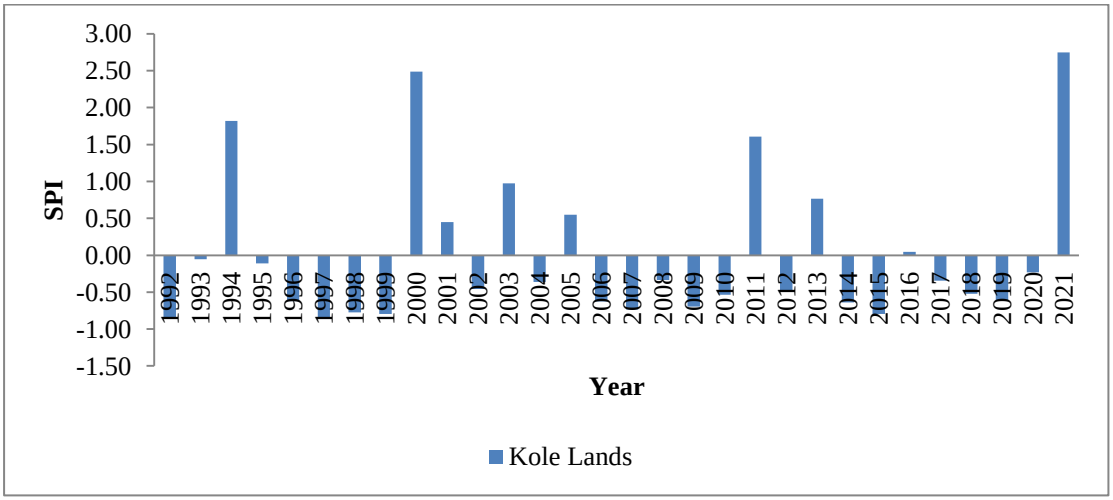



Fig 5.124 Standard Precipitation Index (SPI) during winter season from 1992-2021 (30 years period) of Kole lands

## 5.6 Normalized Difference Vegetation Index (NDVI)

### 5.6.1 Southwest Monsoon

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012 experienced extreme dry conditions in the Southern High Hills of Thrissur district, the Southern and Central Foot Hills and Kole lands. During 2016 Northern Laterites, Palakkad Central Plains, Northern High Hills, Southern High Hills and Pokkali regions had experinced moderate drought condition. During 2017, NDVI showed wet conditions in the central zone of kerala. Compared to 2017, the analysis showed that 2012 experienced extreme drought conditions in the central zone of Kerala while 2016 also experienced dry conditions in this region.

By analysising Normalized Difference Vegetation Index, In 2012 Kole lands and Southern High Hills regions had experinced extreme drought condition in Central zone of kerala compared to last 30 years. While 2016 had also experinced drought conditions in central zone of kerala.

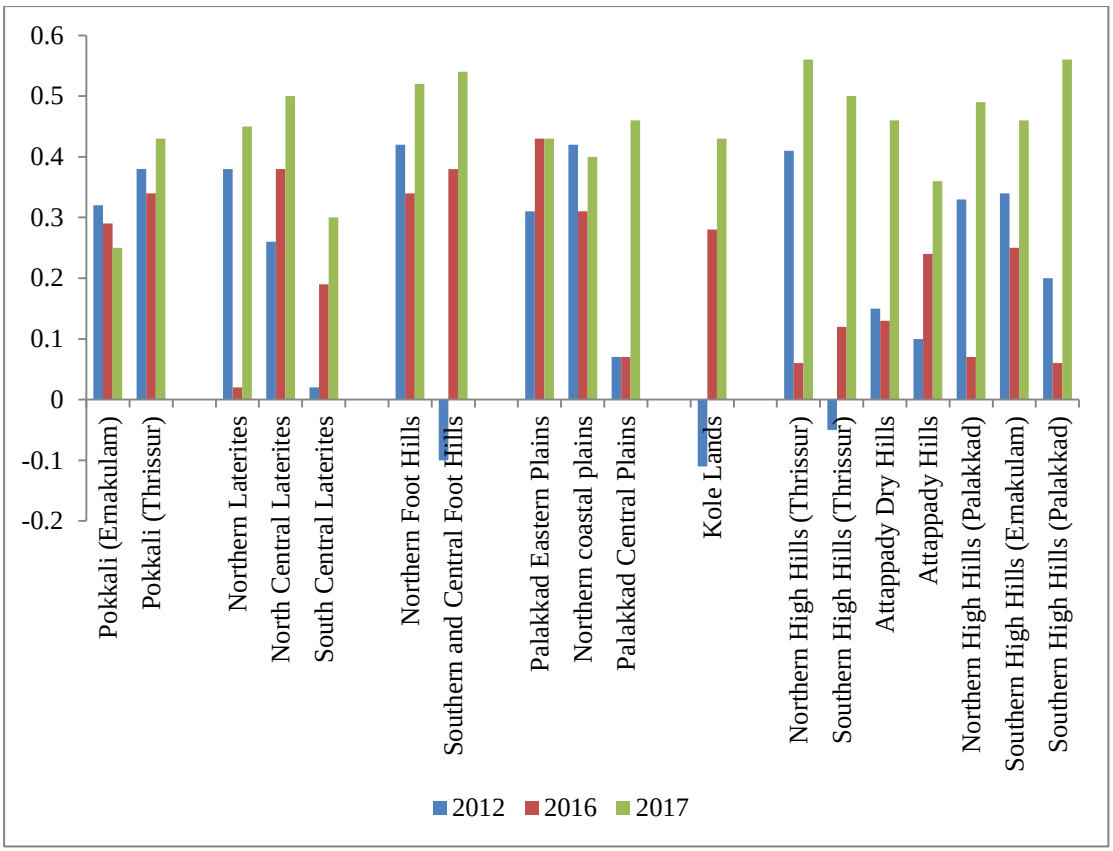



Fig 5.125 NDVI during southwest monsoon of different AEUs in central zone of Kerala

### 5.6.1.1 Hilly Region

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012, the Southern High Hills of Thrissur district experienced extreme dry conditions and the Attappady Dry Hills and Attappady Hills experienced dry conditions. While the Northern High Hills of Thrissur experienced wet conditions, the remaining regions experienced moderate dry conditions. During 2016, Attappady Hills and the Southern High Hills of Ernakulam district experienced moderate dry conditions and the remaining regions experienced dry conditions. During 2017, Attappady Hills experienced moderate dry conditions, and the remaining regions experienced wet conditions.

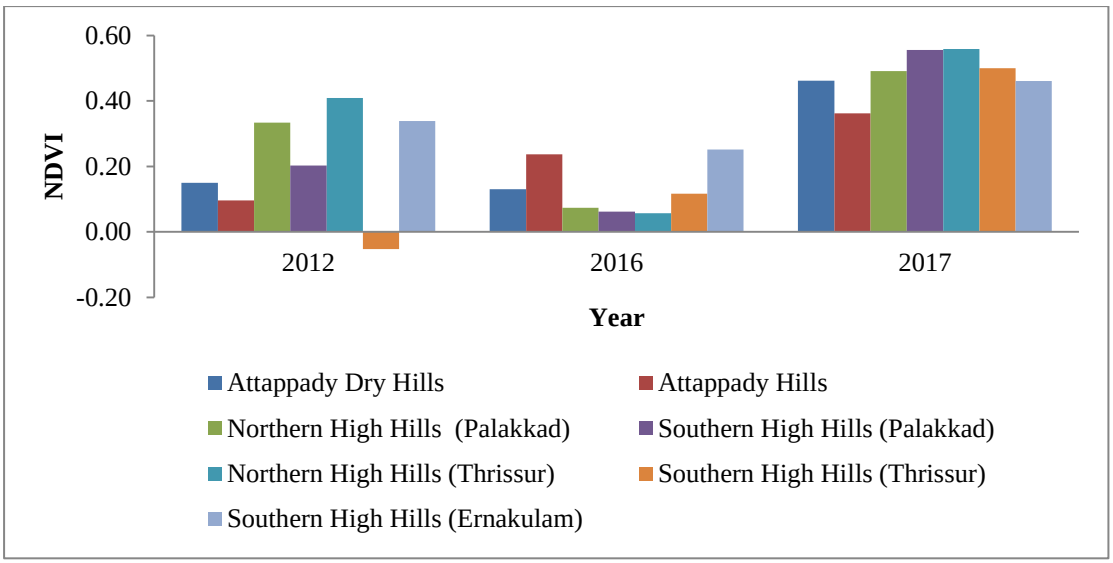



Fig 5.126 NDVI comparison of 2012, 2016 and 2017 during southwest monsoon of Hilly region

### 5.6.1.2 Pokkali Region

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012 and 2016, had experienced moderate dry conditions in the Pokkali region and during 2017, moderate dry conditions occurred in Ernakulam and wet conditions in Thrissur.

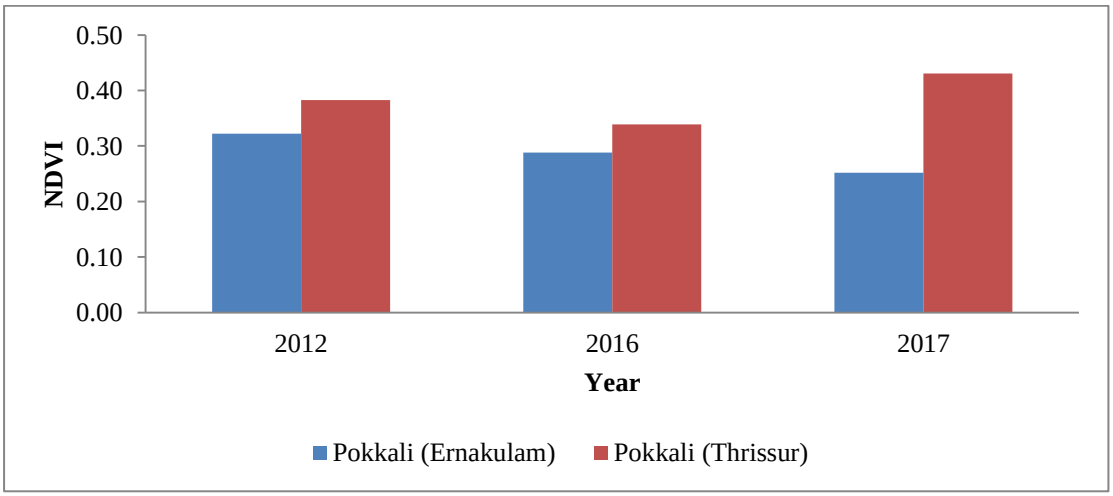



Fig 5.127 NDVI comparison of 2012, 2016 and 2017 during southwest monsoon of Pokkali region

### 5.6.1.3 Plains Region

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012, Palakkad Central Plains experienced dry conditions, Palakkad Eastern Plains experienced moderate dry conditions and Northern coastal plains experienced wet conditions. In 2016, the Palakkad Central Plains experienced dry conditions and the remaining regions experienced moderate dry conditions. During 2017, wet conditions were experienced in the Plains region.

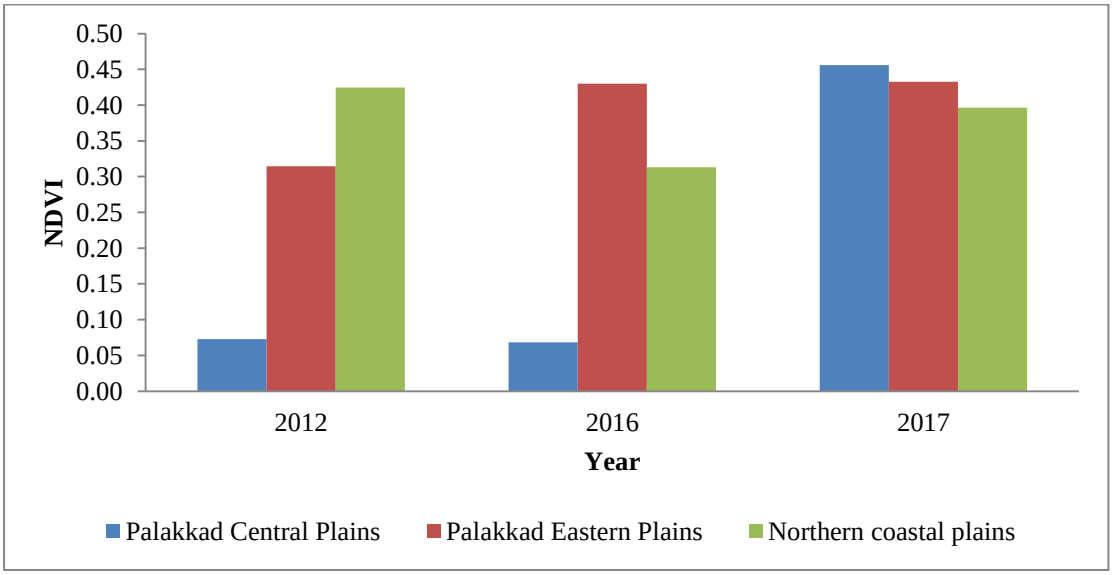



Fig 5.128 NDVI comparison of 2012, 2016 and 2017 during southwest monsoon of Plains region

### 5.6.1.4 Laterites Region

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that in 2012, South Central Laterites experienced dry conditions and the remaining regions experienced moderate dry conditions. During 2016, dry conditions occurred in Northern Laterites and South Central Laterites and moderate dry conditions in North Central Laterites. While in 2017, South Central Laterites experienced moderate dry conditions, the remaining regions experienced wet conditions.

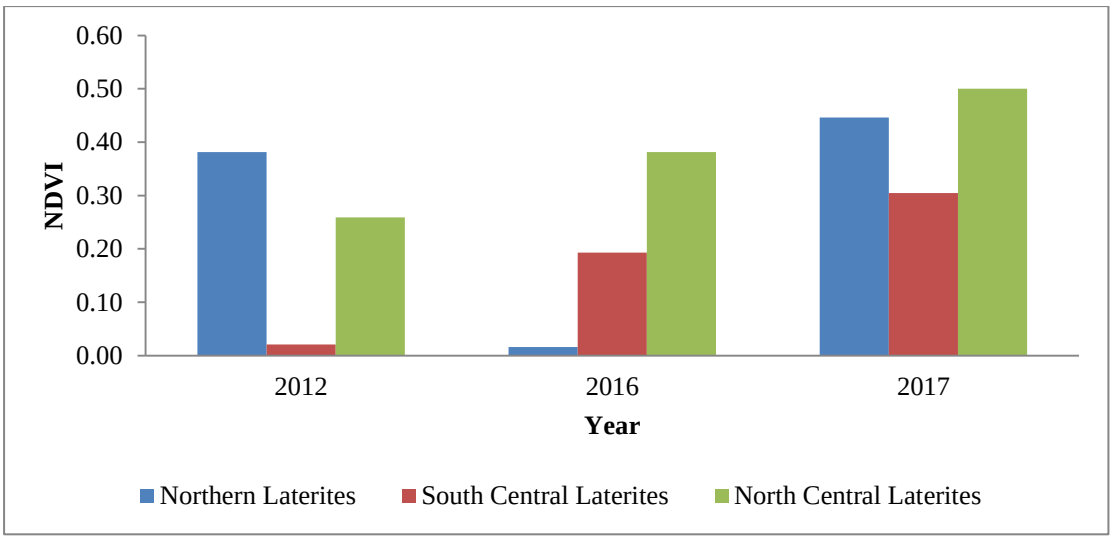



Fig 5.129 NDVI comparison of 2012, 2016 and 2017 during southwest monsoon of Laterites region

### 5.6.1.5 Foot Hills

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012, extreme dry conditions occurred in the Southern and Central Foot Hills and wet conditions in the Northern Foot Hills. While the Foothills region experienced moderate dry conditions in 2016 and wet conditions in 2017.

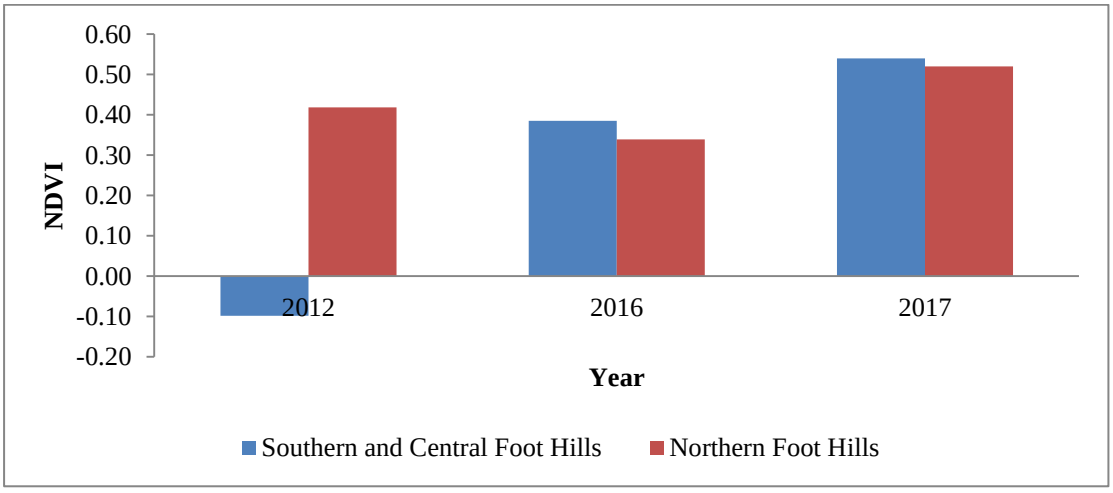



Fig 5.130 NDVI comparison of 2012, 2016 and 2017 during southwest monsoon of Foot Hills region

### 5.6.1.6 Kole Lands

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012, extreme dry conditions were experienced in Kole lands. A moderate dry condition was experienced in 2016 and a wet condition in 2017.

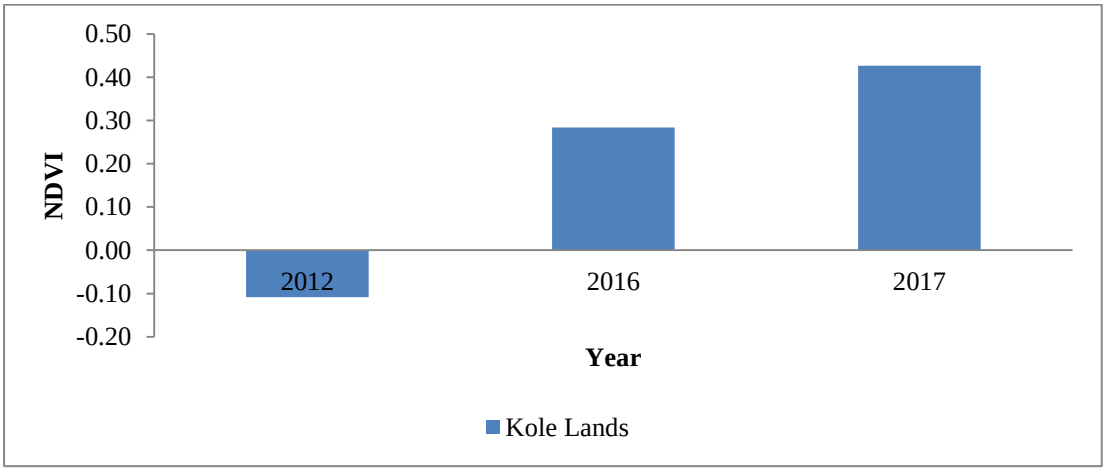



Fig 5.131 NDVI comparison of 2012, 2016 and 2017 during southwest monsoon of Kole lands region

### 5.6.2 Northeast Monsoon

### 5.6.2.1 Hilly Region

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012, the Northern High Hills of Thrissur, Attappady Hills and Southern High Hills of Palakkad district experienced extreme dry conditions and the remaining regions experienced dry conditions. While in 2016, a dry condition occurred in the Southern High Hills and Northern High Hills of Palakkad, the Attappady Hills and Attappady Dry Hills, the Southern High Hills of Thrissur, and the remaining regions experienced moderate dry conditions. While in 2017, Attappady Dry Hills, Attappady Hills, and the Southern High Hills of Ernakulam district experienced moderate dry conditions, the remaining regions experienced wet conditions.

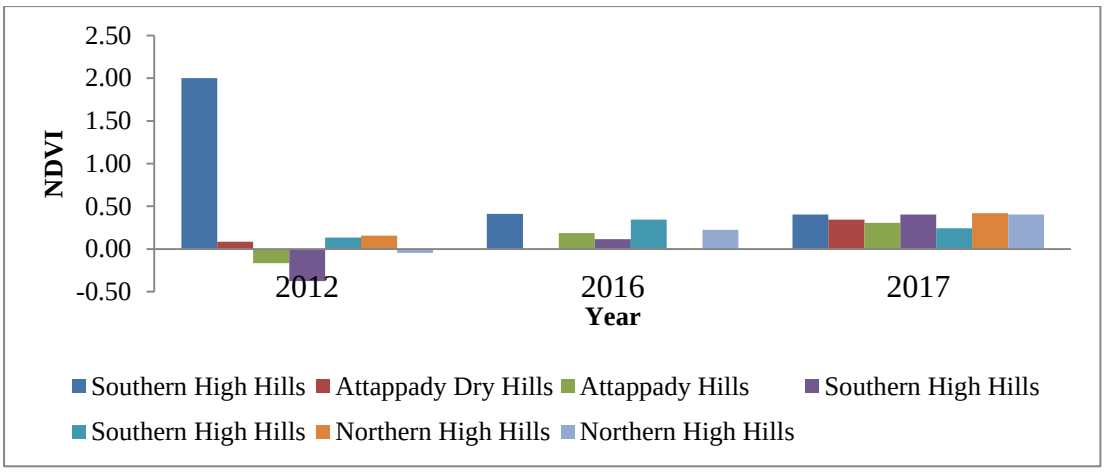



Fig 5.132 NDVI comparison of 2012, 2016 and 2017 during northeast monsoon of Hilly region

### 5.6.2.2 Pokkali Region

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that the years 2012 and 2016 experienced dry condition and 2017 experienced moderate dry conditions.

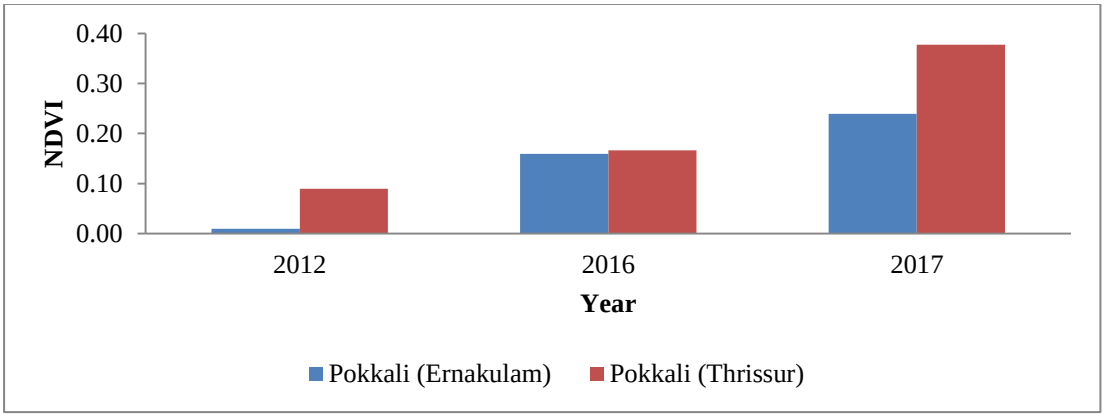



Fig 5.133 NDVI comparison of 2012, 2016 and 2017 during northeast monsoon of Pokkali region

### 5.6.2.3 Plains Region

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012, Palakkad Central Plains experienced extreme dry conditions and the remaining regions experienced dry conditions. In 2016, the Palakkad Eastern Plains

and Northern coastal plains experienced dry conditions, while the Palakkad Central Plains experienced moderate dry conditions. During 2017, the Palakkad Eastern Plains experienced wet conditions, and the remaining regions experienced moderate dry conditions.

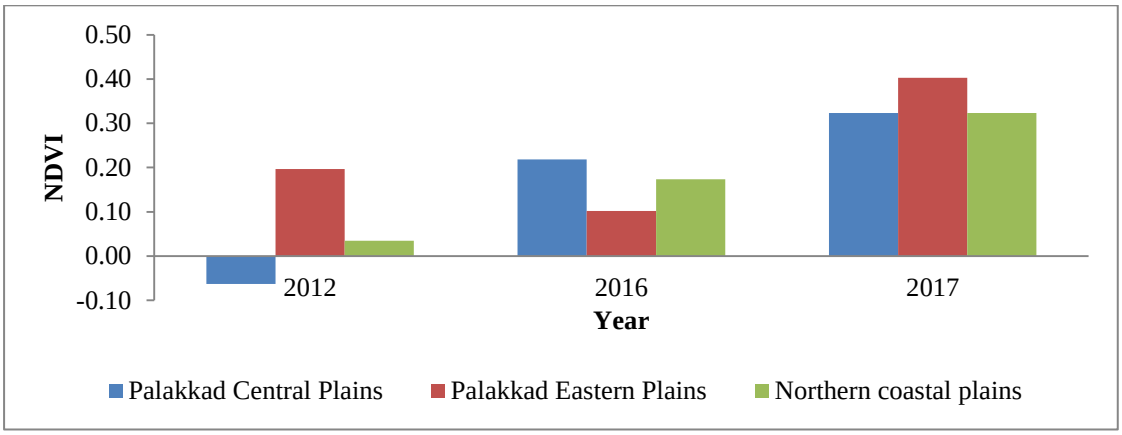



Fig 5.134 NDVI comparison of 2012, 2016 and 2017 during northeast monsoon of Plains region

### 5.6.2.4 Laterites Region

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during the year 2012, this region experienced a dry condition. In contrast, 2016 and 2017 witnessed a moderate dry condition in the Laterites region.

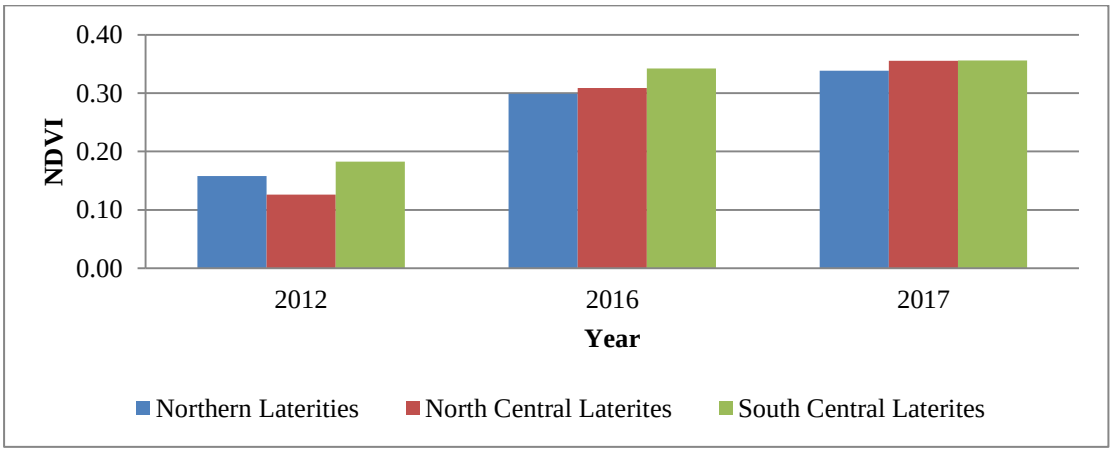



Fig 5.135 NDVI comparison of 2012, 2016 and 2017 during northeast monsoon of Laterites region

### 5.6.2.5 Foot Hills

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during the year 2012, this region experienced a dry condition, while in 2016 and 2017 the Foot Hills region experienced a moderate dry condition.

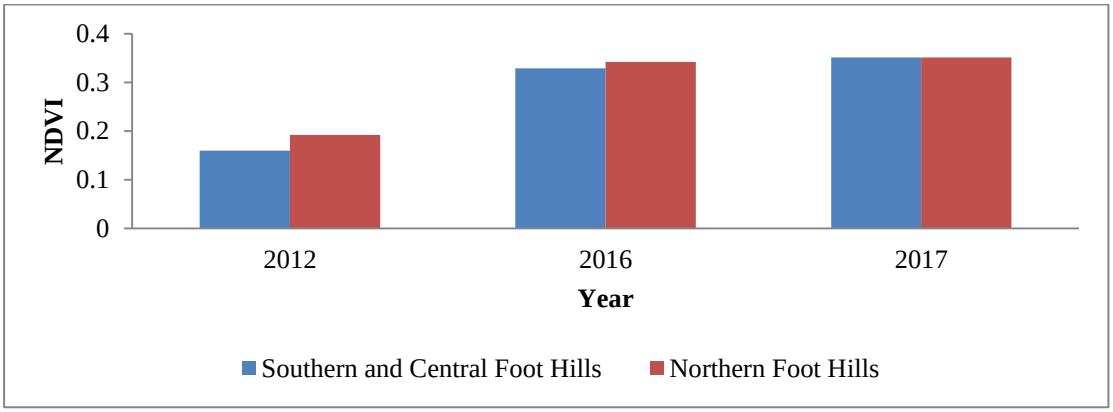



Fig 5.136 NDVI comparison of 2012, 2016 and 2017 during northeast monsoon of Foot Hills region

### 5.6.2.6 Kole Lands

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during the year 2012, this region experienced a dry condition, while in 2016 and 2017; the Kole Lands experienced a moderate dry condition.

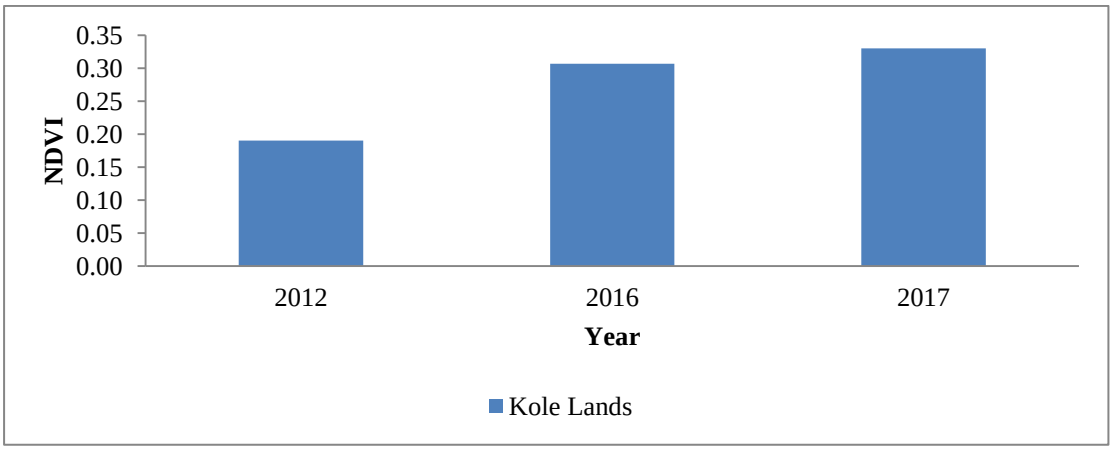



Fig 5.137 NDVI comparison of 2012, 2016 and 2017 during northeast monsoon of Kole lands region

### 5.6.3 Summer Season

#### 5.6.3.1 Hilly Region

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012, Attappady Hills and the Southern High Hills of Palakkad district experienced extreme dryness, while the Southern High Hills of Ernakulam and the Northern Hills of Palakkad experienced moderate dryness, and the remaining regions experienced dry conditions. During 2016, the Southern High Hills of Ernakulam district experienced wet conditions, the Attappady Hills and the Southern High Hills of Palakkad district experienced dry conditions and the remaining regions experienced moderate dry conditions. During 2017, Attappady Hills experienced dry conditions, Attappady Dry Hills experienced moderate dry conditions, and the remaining regions experienced wet conditions.

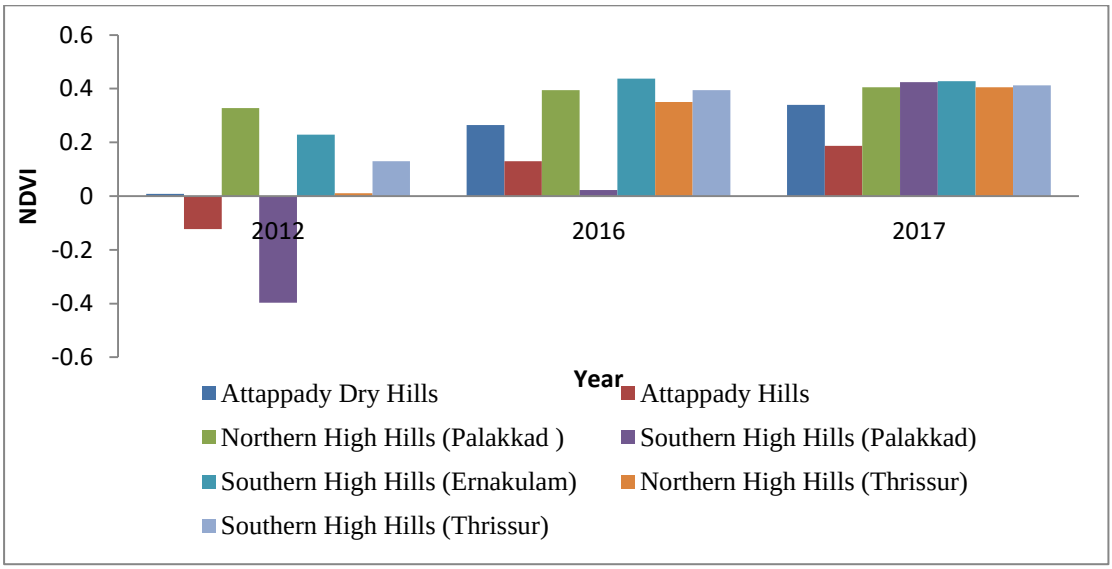



Fig 5.138 NDVI comparison of 2012, 2016 and 2017 during northeast monsoon of Hilly region

### 5.6.3.2 Pokkali Region

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012, the Pokkali region experienced an extreme dry condition, while in 2016 and 2017 Pokkali region experienced a moderate dry condition.

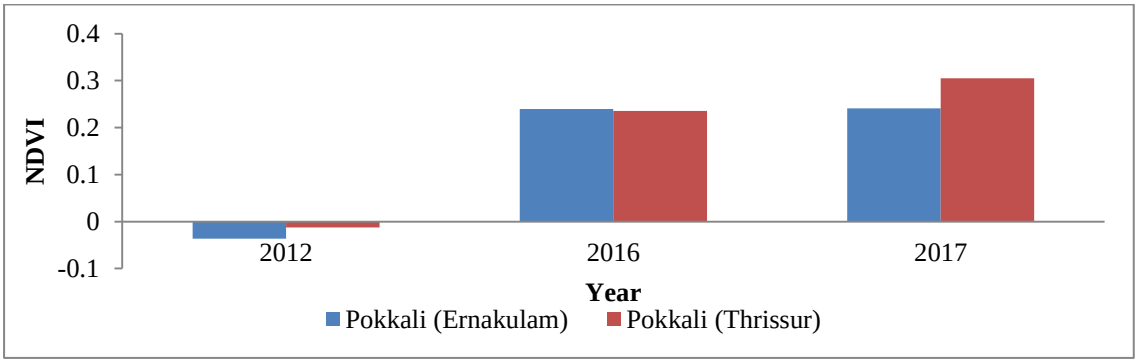



Fig 5.139 NDVI comparison of 2012, 2016 and 2017 during northeast monsoon of Pokkali region

### 5.6.3.3 Plains Region

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012, extreme dry conditions occurred in the plains region. In 2016, Palakkad Central Plains experienced dry conditions and the remaining regions experienced moderate dry conditions. During 2017, the Northern coastal plains experienced moderate dry conditions and the remaining regions experienced wet conditions.

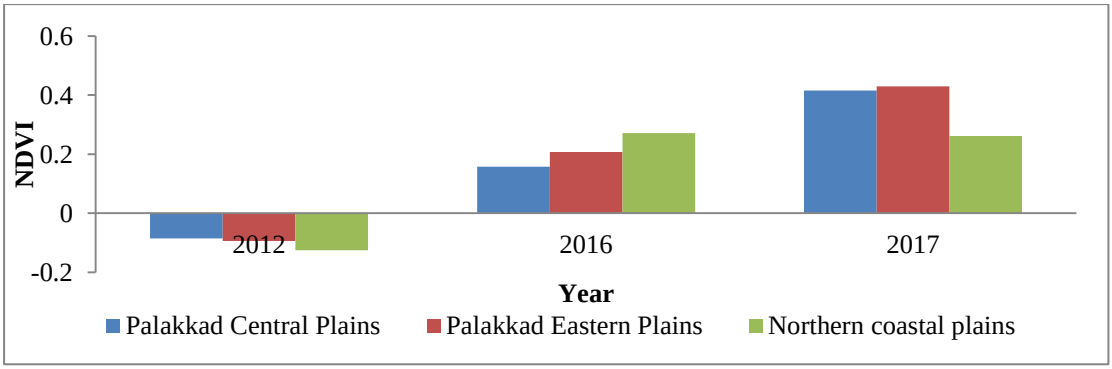



Fig 5.140 NDVI comparison of 2012, 2016 and 2017 during northeast monsoon of Plains region

### 5.6.3.4 Laterites Region

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during the year 2012, Northern Laterites and North Central Laterites experienced extreme dry conditions and South Central Laterites experienced moderate dry conditions. While 2016 experienced moderate dry conditions, the entire region experienced wet conditions in 2017.

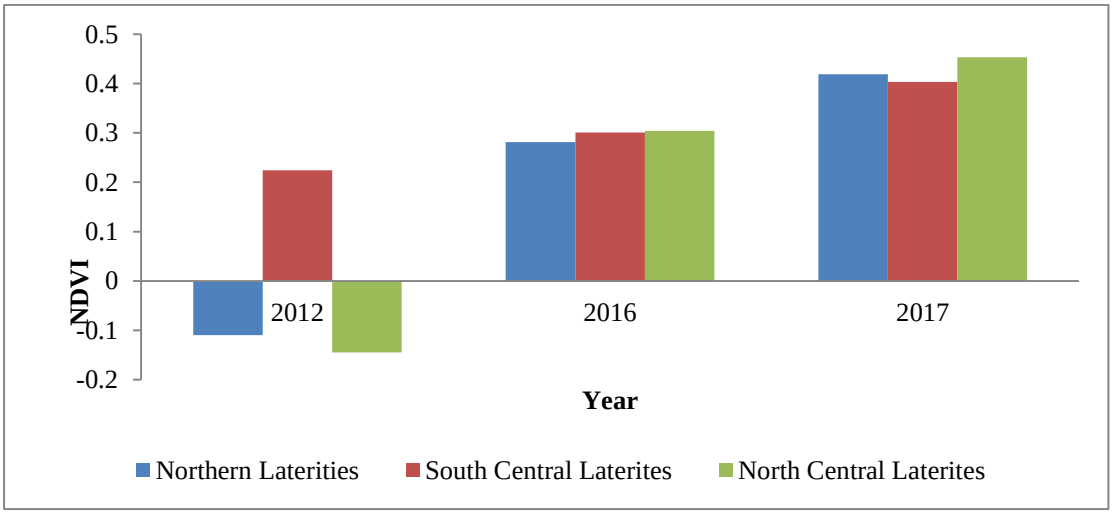



Fig 5.141 NDVI comparison of 2012, 2016 and 2017 during northeast monsoon of Laterites region

### 5.6.3.5 Foot Hills

The analysis of the Normalized Difference Vegetation Index (NDVI) shows that during the year 2012, this region experienced a dry condition, while in 2016, had experienced a moderate dry condition. In 2017, wet conditions were experienced.

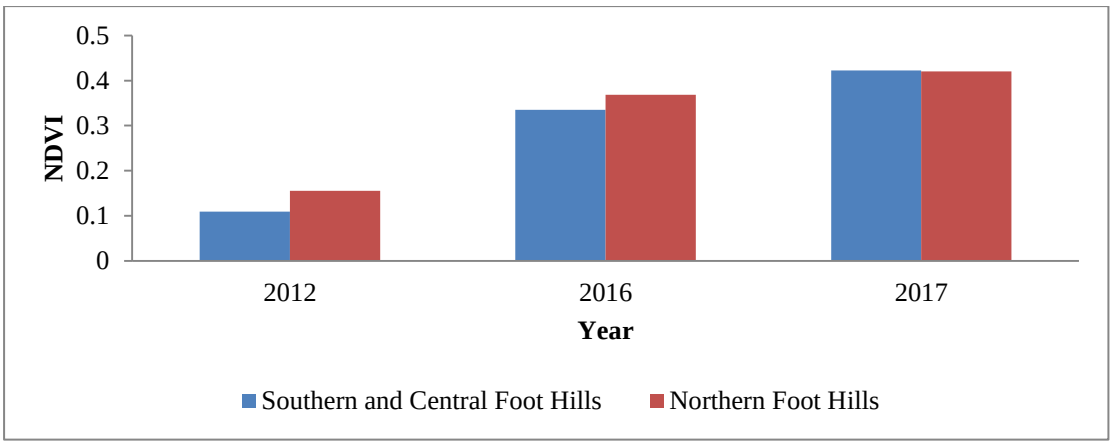



Fig 5.142 NDVI comparison of 2012, 2016 and 2017 during northeast monsoon of Foot Hills region

#### 5.6.3.6 Kole Lands

The analysis of the Normalized Difference Vegetation Index (NDVI) showed thatduring the year 2012 had experienced extreme drought condition, 2016 experienced dry condition and 2017 had experienced moderate dry condition.

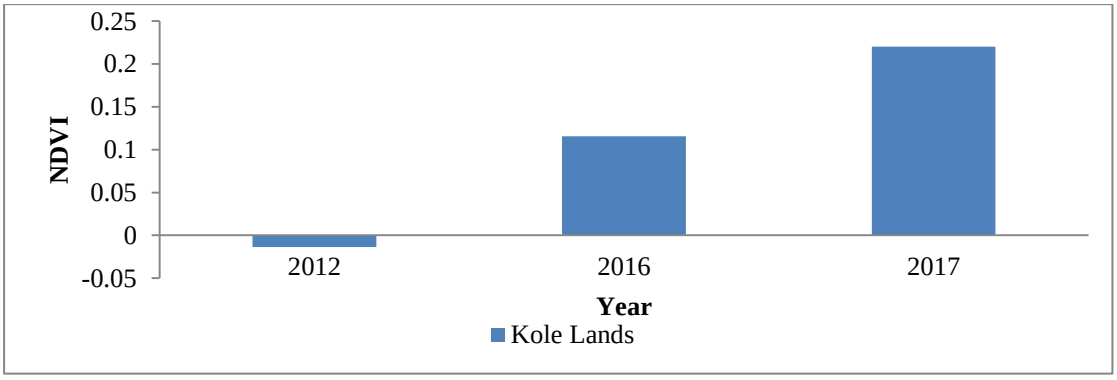



Fig 5.143 NDVI comparison of 2012, 2016 and 2017 during northeast monsoon of Kole lands region

### 5.6.4 Winter Season

#### 5.6.4.1 Hilly Region

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012, Attappady Hills and Southern High Hills of Palakkad district experienced extreme dry condition and the remaining regions experienced dry

condition. During 2016 and 2017, the hilly region experienced moderate dry conditions.

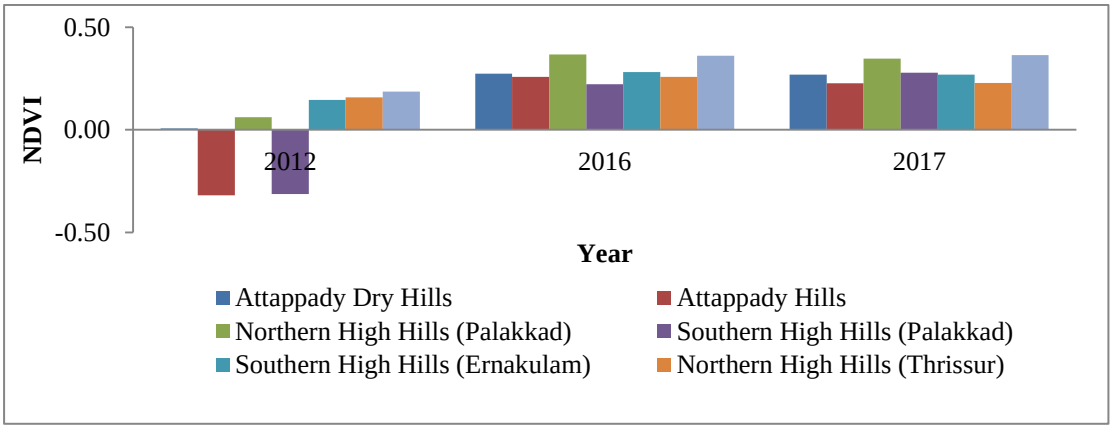



Fig 5.144 NDVI comparison of 2012, 2016 and 2017 during winter season of Hilly region

### 5.6.4.2 Pokkali Region

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012, Pokkali region experienced dry condition and the years 2016 and 2017 had experienced moderate dry condition.

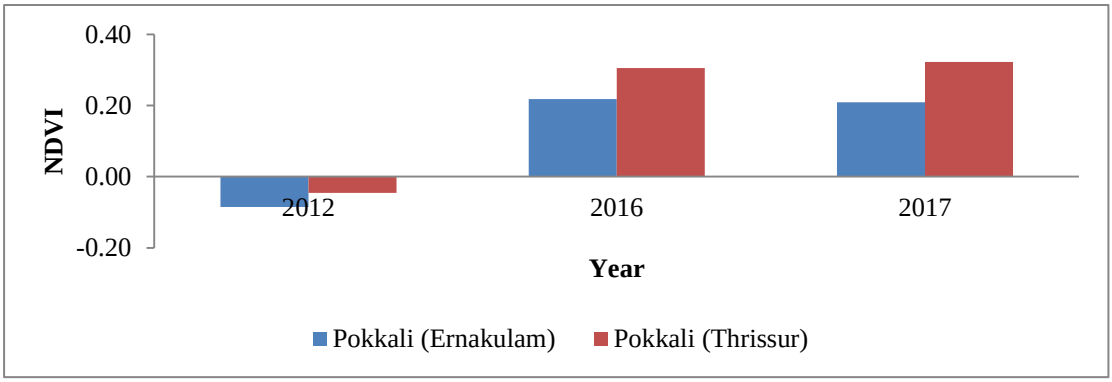



Fig 5.145 NDVI comparison of 2012, 2016 and 2017 during winter season of Pokkali region

### 5.6.4.3 Plains Region

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012, Northern coastal plains and Palakkad Eastern Plains experienced

extreme dry condition and Palakkad Central Plains had experienced dry condition. During 2016 and 2017, there was a moderate dry condition.

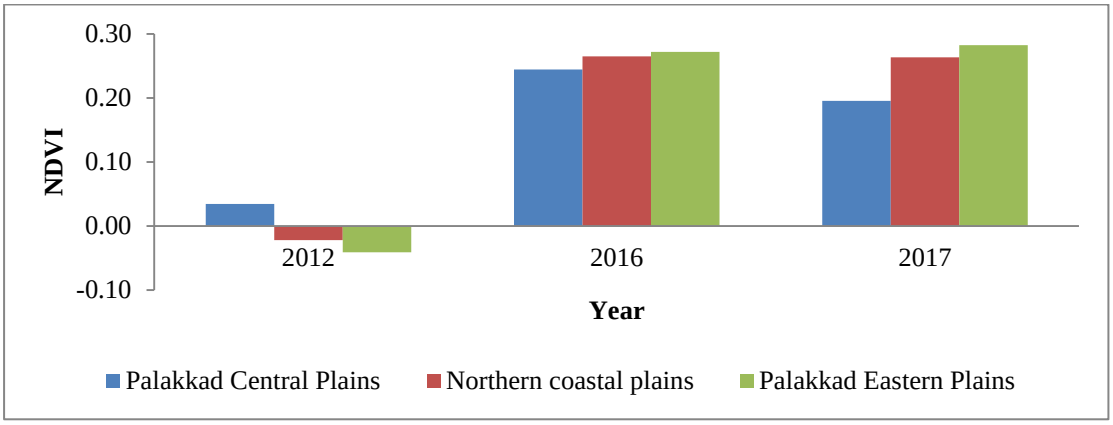



Fig 5.146 NDVI comparison of 2012, 2016 and 2017 during winter season of Plains region

### 5.6.4.4 Laterites Region

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012, Northern Laterites and North Central Laterites experienced extreme dry conditions, and South Central Laterites experienced dry conditions. During 2016 and 2017, there was a moderate dry condition.

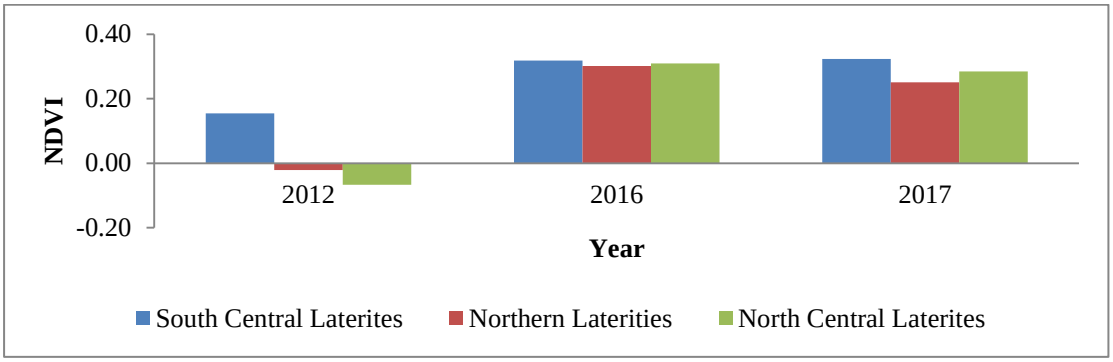



Fig 5.147 NDVI comparison of 2012, 2016 and 2017 during winter season of Laterites region

### 5.6.4.5 Foot Hills

The analysis of the Normalized Difference Vegetation Index (NDVI) showed that during 2012, Northern Foot Hills and Southern and Central Foot Hills

experienced dry condition. During 2016 and 2017, there was a moderate dry condition.

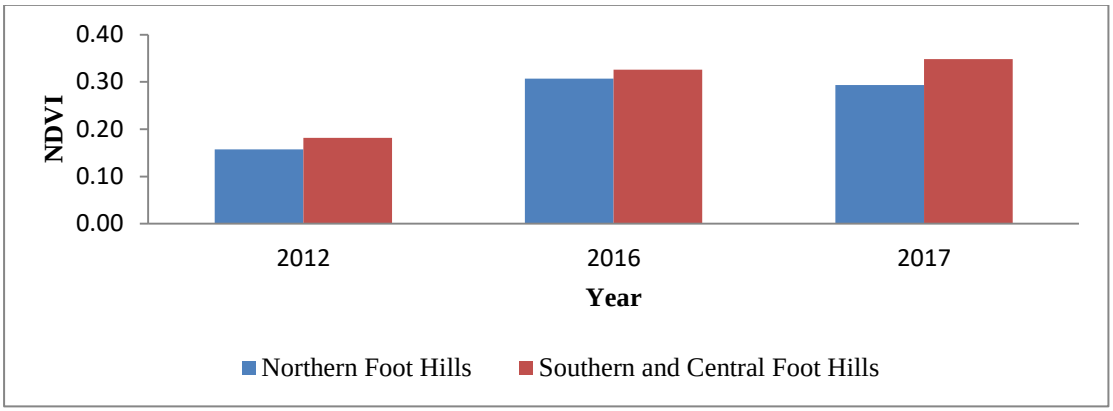



Fig 5.148 NDVI comparison of 2012, 2016 and 2017 during winter season of Foot Hills region

### 5.6.4.6 Kole Lands

The analysis of the Normalized Difference Vegetation Index (NDVI) indicates that in 2012, an extreme dry condition occurred, while in 2016 and 2017, there was a moderate dry condition experienced in Kole Lands.

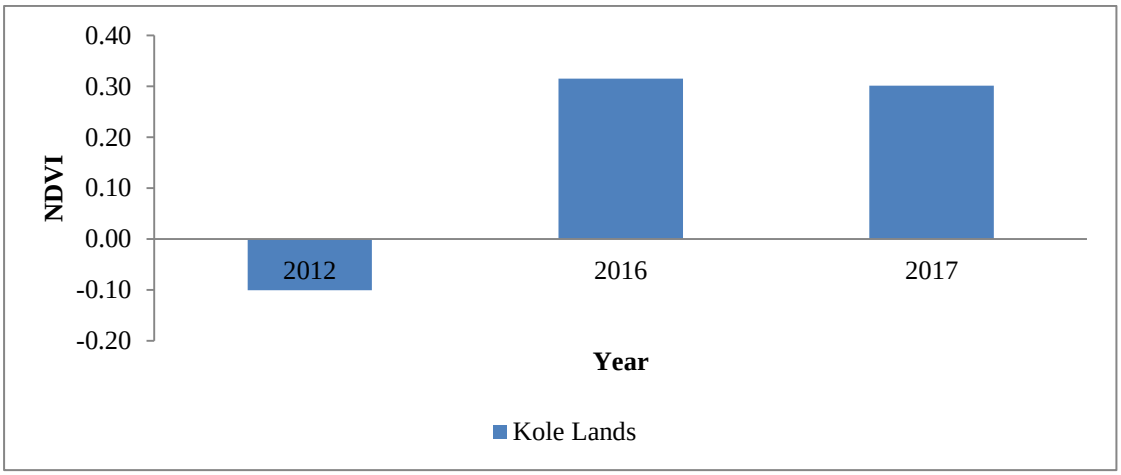



Fig 5.149 NDVI comparison of 2012, 2016 and 2017 during winter season of Kole lands region

In the context of my study on the southwest monsoon, it is crucial to highlight that numerous years, including 2000, 2012, and 2016, were characterized by drought conditions in the central zone of Kerala. This observation aligns with the findings of Vyshak and Kumar (2019), who conducted an analysis of the Standardized Precipitation Index (SPI) for the southwest monsoon over a 35-year period (1983-2017) at Vellanikkara (Thrissur). Their analysis revealed that, out of these 35 years, the SPI values indicated negative (indicating dry conditions) for the southwest monsoon in 20 years and positive (indicating wet conditions) in 15 years. Specifically, there were five notable drought events (SPI ≤ -1.00) during the southwest monsoon at Vellanikkara, namely 1999 (moderately dry), 2001 (moderately dry), 2002 (moderately dry), 2003 (moderately dry), and 2016 (severely dry). Additionally, the year 2016 experienced meteorological drought. The similar study conducted by Abhilash S et al 2018 also found that the year 2016 was the highest extreme annual drough year in the history.

Furthermore, Abhilash et al. (2018) reported that during 2016, SPI values at time scales of 3 to 12 months displayed large negative values of less than −2 throughout the state of Kerala, indicating the severity of the drought conditions prevailing in the region.

By analysising agriculture drought 2012 and 2016 had also experienced drought condition. The similar study conducted by Aswathi, K.P et al., 2022 highest number of *kharif* drought weeks were experienced in the year 2012 followed by 2016. Whereas, *rabi* drought weeks were highest in the year 2016. The frequency of drought years are increasing and decreasing the rainy days of kerala Central Kerala has witnessed the most substantial decline in the annual number of rainy days compared to other zones. This reduction is particularly pronounced during the south-west monsoon throughout the entire state. Incidents affecting human lives due to these factors have been reported in central Kerala in recent years (Vijay, A., *et al*.,2021). This additional analysis underscores the gravity of the drought situation during that particular years.

# *SUMMARY*

# 5. SUMMARY

In the analysis of drought conditions over the last 30 years (1992–2021) in the central zone of Kerala, utilizing various indices such as the Standard Precipitation Index (SPI), Moisture Availability Index (MAI), Aridity Index (AI) and Normalized Difference Vegetation Index (NDVI), several key trends and findings emerged. In terms of meteorological drought, the years 2012 and 2016 stood out as drought years in the central zone of Kerala, with Palakkad district experiencing a higher incidence of drought conditions compared to the other two districts. While the southwest monsoon season showed variations in drought occurrences across different Agro-Ecological Units (AEUs), the years 1999, 2012, 2015 and 2016 were marked by moderate drought conditions in Palakkad. Thrissur and Ernakulam districts also experienced drought in various years, with notable excess rainfall events.

In terms of agricultural drought, Palakkad, Thrissur and Ernakulam districts experienced drought during the years 2003 and 2016 in both *kharif* and *rabi* seasons. Compared to other AEUs, the Pokkali region was affected by agricultural drought in the majority of years that impact rice cultivation, which is a major crop in the central zone of Kerala.

The analysis of the Moisture Availability Index (MAI) further reinforced the presence of deficiencies in rainfall, with 2016 stood out as a year marked by very deficient moisture availability in the regions. In the analysis of the moisture availability index for different districts in Kerala during the southwest monsoon, northeast monsoon, summer season and winter season, several trends and variations are observed. Palakkad district consistently experiences greater dryness compared to Thrissur and Ernakulam districts. The years 1999, 2012 and 2015 stood out with higher levels of dryness in Palakkad, particularly during the southwest monsoon. In contrast, Thrissur and Ernakulam districts generally maintain a humid or sub-humid

condition. During the Northeast Monsoon, Palakkad and Thrissur districts both experience varying levels of dryness, with Palakkad exhibiting semi-arid conditions in 2016, while Thrissur remains largely humid. Ernakulam district maintains a more stable condition during this season. In the summer season, Palakkad experiences periods of both deficiency and moderate deficiency in moisture availability. Thrissur district also shows variations in moisture availability, while Ernakulam remains predominantly humid. In the winter season, Palakkad and Thrissur districts consistently face severe moisture deficiency, with occasional years of moderate deficiency. Overall, these indices provide insights into the varying climatic conditions in these districts, with Palakkad typically being the driest of the three.

The analysis of the Aridity Index (AI) in Palakkad, Thrissur and Ernakulam districts reveals variations in climatic conditions over the years. Palakkad district experienced semi-arid conditions in 2016, while in other years; it ranged from semi-arid to humid conditions in different regions within the district. Thrissur district had semi-arid conditions in 2000 and 2016, while other years were marked by sub-humid and humid conditions. Ernakulam district had semi-arid conditions in 2000 and 2016, with various humidity levels in other years. Overall, Palakkad district consistently showed higher dryness compared to the other districts. In southwest monsoon, Palakkad district, during specific years like 1999, 2012 and 2015, some regions experienced semi-arid conditions, while other years were generally humid. In Thrissur district, the southwest monsoon season was predominantly humid, with only a few years of semi-arid conditions. Ernakulam district consistently experienced a humid climate during the entire 30-year period. Coming to northeast monsoon, Palakkad district experienced a mix of semi-arid, sub-humid and humid conditions during different years. In contrast, Thrissur district mostly had humid conditions, with sporadic instances of semi-arid and sub-humid conditions. Ernakulam district exhibited a pattern of sub-humid and humid conditions.

In the summer season, Palakkad district generally experienced arid and semi-arid conditions, with a focus on dryness compared to other districts. In the winter season, Palakkad district faced hyper-arid and arid conditions, indicats extreme dryness. During the winter season in Palakkad, Thrissur and Ernakulam districts demonstrates varying degrees of dryness and arid conditions over the years. Palakkad district experienced hyper-arid, arid, semi-arid and semi-arid conditions in different years. Thrissur district had hyper-arid, arid, semi-arid and semi-arid conditions and Ernakulam district exhibited hyper-arid, arid, semi-arid and semi-arid conditions in various years.

The analysis of the Standard Precipitation Index (SPI) showed that the central zone of Kerala highlighted varying drought and wetness conditions over the years, with severe drought in Palakkad in 2016 and significant wetness in Thrissur in 2021. The analysis showed 2016 was the most drought-affected year in this region. Palakkad district consistently showed more drought conditions compared to other districts, with Attappady Dry and Attappady Hills being the most affected areas. The analysis based on annual and northeast rainfall data showed that 2016 experienced severe droughts in all the regions. Coming to the Southwest monsoon, Palakkad district experienced a severe drought in 2015 and the years 2002, 2003 and 2016 experienced a moderate drought. In Thrissur district, drought was experienced during the years 1999, 2015 and 2016. Ernakulam district experienced drought in the years 1999, 2000 and 2016.

The analysis of the Normalized Difference Vegetation Index (NDVI) reveals varying moisture conditions in different regions. In the southwest monsoon season, the Attappady Dry Hills, South Central Laterites and Palakkad Central Plains experienced dry conditions in 2012 and 2016 and the Attappady Hills experienced dry conditions in 2012 and moderately dry conditions in 2016. The northeast monsoon showed that in 2012, the Northern High Hills, Palakkad Central Plains, Southern High

Hills and Attappady Hills experienced extreme dry conditions, while the remaining regions experienced dry conditions. The analysis based on the summer season, the NDVI showed that during 2012, the regions of North Central Laterites, Pokkali, Palakkad Central Plains, Southern High Hills, Palakkad Eastern Plains and Attappady Hills experienced extreme dry conditions and the remaining regions experienced dry conditions.

Based on the winter season of 2012, the AEUs Attappady Hills, Northern coastal plains, Pokkali, Northern Laterites, Kole Lands, North Central Laterites, Southern High Hills and Palakkad Eastern Plains experienced extreme dry conditions and the remaining regions experienced dry conditions.

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# *Annexure*

# Annexure.i

## Standard Meteorological Weeks

| Week No. | Dates | Week No. | Dates |
|---|---|---|---|
| 1 | 01 Jan - 07 Jan | 27 | 02 Jul - 08 Jul |
| 2 | 08 Jan - 14 Jan | 28 | 09 Jul - 15 Jul |
| 3 | 15 Jan - 21 Jan | 29 | 16 Jul - 22 Jul |
| 4 | 22 Jan - 28 Jan | 30 | 23 Jul - 29 Jul |
| 5 | 29 Jan - 04 Feb | 31 | 30 Jul - 05 Aug |
| 6 | 05 Feb - 11 Feb | 32 | 06 Aug - 12 Aug |
| 7 | 12 Feb - 18 Feb | 33 | 13 Aug - 19 Aug |
| 8 | 19 Feb - 25 Feb | 34 | 20 Aug - 26 Aug |
| 9 | 26 Feb - 04 Mar | 35 | 27 Aug - 02 Sep |
| 10 | 05 Mar - 11 Mar | 36 | 03 Sep - 09 Sep |
| 11 | 12 Mar - 18 Mar | 37 | 10 Sep - 16 Sep |
| 12 | 19 Mar - 25 Mar | 38 | 17 Sep - 23 Sep |
| 13 | 26 Mar - 01 Apr | 39 | 24 Sep - 30 Sep |
| 14 | 02 Apr - 08 Apr | 40 | 01 Oct - 07 Oct |
| 15 | 09 Apr - 15 Apr | 41 | 08 Oct - 14 Oct |
| 16 | 16 Apr - 22 Apr | 42 | 15 Oct - 21 Oct |
| 17 | 23 Apr - 29 Apr | 43 | 22 Oct - 28 Oct |
| 18 | 30 Apr - 06 May | 44 | 29 Oct - 04 Nov |
| 19 | 07 May - 13 May | 45 | 05 Nov - 11 Nov |
| 20 | 14 May - 20 May | 46 | 12 Nov - 18 Nov |
| 21 | 21 May - 27 May | 47 | 19 Nov - 25 Nov |
| 22 | 28 May - 03 Jun | 48 | 26 Nov - 02 Dec |
| 23 | 04 Jun - 10 Jun | 49 | 03 Dec - 09 Dec |
| 24 | 11 Jun - 17 Jun | 50 | 10 Dec - 16 Dec |
| 25 | 18 Jun - 24 Jun | 51 | 17 Dec - 23 Dec |
| 26 | 25 Jun - 01 Jul | 52 | 24 Dec - 31 Dec |

# ASSESSMENT OF DROUGHT IN THE CENTRAL ZONE OF KERALA USING DIFFERENT INDICES

*By*

**SANJAY KUMAR M S**

**(2017-20-022)**

**ABSTRACT OF THE THESIS**

**THESIS**

**Submitted in partial fulfilment of the requirements for the degree of**

**BSc-MSc (Integrated) Climate Change Adaptation**

**FACULTY OF AGRICULTURE**

**Kerala Agricultural University**

**COLLEGE OF CLIMATE CHANGE AND ENVIRONMENTAL SCIENCE**

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**2024**

# ABSTRACT

Drought is a prolonged and extended period of abnormally low precipitation or moisture levels, typically resulting in water shortages, reduced soil moisture and adverse impacts on ecosystems, agriculture, water supply and various sectors of human life. Hence this study presents a comprehensive analysis of drought conditions over the last 30 years (1992-2021) in the central zone of Kerala, utilizing various indices such as the Standard Precipitation Index (SPI), Moisture Availability index (MAI), Aridity index (AI) and Normalized Difference Vegetation Index (NDVI). Additionally, Meteorological drought and Agricultural drought were calculated using weather parameters. The study area is the central zone of Kerala which comprises three districts: Thrissur, Palakkad, and Ernakulam. Within this region, there are 13 Agro Ecological Units (AEUs) which are the Northern Coastal Plains, Pokkali Lands, Kole Lands, Southern Central Laterites, Northern Central Laterites, Southern and Central Foot Hills, Northern Foot Hills, Southern High Hills, Northern High Hills, Attappady Hills, Attappady Dry Hills, Palakkad Central Plains, and Palakkad Eastern Plains.

From the analysis of meteorological drought it was revealed that the prevalence of drought conditions in the years 2012, 2015, and 2016, affecting various regions in different seasons in the central zone of Kerala. Attappady Hills and Attappady Dry Hills in Palakkad District are identified as the most meteorological drought-prone areas in central Kerala.

The occurrence of agricultural drought was analysed. It was found that years 2016 and 2003 were found to be agricultural drought years in all AEUs. Compared to other AEUs, the Pokkali region was affected by agricultural drought in the majority of years. It has wide-ranging and severe effects on both crop and livestock farming. Rice was a significant crop in this region, and its cultivation significantly influences crop production and food security in central Kerala. The impacts of agricultural drought

include crop failure, increased operating costs, and it leads to an increase in food prices.

The Moisture Availability Index (MAI) analysis reaffirmed the presence of deficient rainfall, particularly in 2016, and revealed extreme dryness in the central zone of Kerala. Additionally, the study assessed the aridity index in these districts during different seasons, highlighting Palakkad's consistent dryness compared to Thrissur and Ernakulam. The analysis of the Standard Precipitation Index (SPI) revealed occurrence of both drought and wet spells during the southwest and northeast monsoon seasons. It was observed that Palakkad district faced severe drought in 2016 followed by Thrissur and Ernakulam.

The analysis of weather data from the last 30 years (1992-2021), using various indices, shows that Palakkad district is the most drought-affected region in the central zone of Kerala. Regarding the AEUs, the Attappady Hills and Attappady Dry Hills in Palakkad district are identified as the most drought-affected regions. Compared to the last 30 years, 2016 was a major drought-affected year in the central zone of Kerala. Therefore, this study is useful in identifying the drought prone areas of central zone. This aids in guiding the development of necessary actions for drought management and adaptation strategies to reduce the impacts of meteorological and agricultural drought. The ability to identify and predict drought conditions in advance is of paramount importance for implementing timely mitigation and adaptation measures.