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Standardized Precipitation Index for Metrological Drought Analysis In Kashmir Valley Of Jammu And Kashmir

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Abstract: The term "drought" is multifaceted, with varying interpretations based on personal experiences. It is a natural disaster that is distinguished by a severe and ongoing precipitation deficit. The planning and management of freshwater resources as well as the forecasting of the arrival and intensity of droughts depend heavily on drought monitoring. A number of indices have been put forth over time to track and measure data related to droughts. The Standardized Precipitation index (SPI), which is based on the idea of probability, is the most commonly used index. The current study examines the possibility of analysing the temporal pattern and severity of drought in the Kashmir Valley (Jammu and Kashmir) using precipitation-based SPI. Utilizing the "DrinC" software application, the Indices were calculated. SPI values were calculated using monthly precipitation data for the IMD Srinagar 2003 to 2022. SPI series computations were carried out for short, moderate, and long time scales. Based on the data, the Kashmir region experienced four periods of moderate drought in the years 2007, 2009, 2012, and 2016. Additionally, there was no significant drought from 2003 to 2022. 2007 had the maximum intensity with an SPI value of -1.37 for a moderate drought.
Keywords: Temporal pattern, Standardized Precipitation Index, Drought indexes, Complex Environment

I. INTRODUCTION

A complex environmental phenomenon known as drought is commonly described as a period of time during which there is less water available than usual and a negative impact on the local economy, ecology, human population, animals, and social and cultural life. [Zarei Sirdas, 2003; et al., 2016]. Different drought indices have been created as drought indicators. tools for observation and evaluation across the globe. Indexes of drought are quantifiable measurements that combine one to assess the degree and intensity of the drought or more data factors, like evapotranspiration and precipitation, into a single The term "drought" is ambiguous and can mean different things to different people. For example, farmers may define it as "a shortage of rainfall or a long period of time without any rainfall," or they may define it as below-average rainfall or a protracted dry spell that could harm plants. The northeaster states of India are home to many struggling farmers. Whole rice crops have been lost by some. Some have postponed planting. In UP and Jharkhand, the monsoon of 2022 has not produced much precipitation thus far. As of August 16, Uttar Pradesh had gotten 44% less rain than usual. With an average of almost 30% less rainfall than typical, the circumstances in Bihar, Jharkhand, and West Bengal all appear dire. Approximately 42% of India's land area faces statistics from the week ending March 26, 2019 (Drought Early Warning System -DEWS) indicate the spatial extent of the drought that occurred last year.

Drought	State Affected
Disastrous	Western Rajasthan and small portion of Karnataka (Bellary)
Severe	Karnataka, Tamil Nadu, large portion of U.P. and small part of Maharashtra (North-Western part)
Large	U.P., Central M.P. Maharashtra, Punjab and Haryana
Moderate	Orrisa, Bihar, W.B, half of M.P. part of Maharashtra, A.P. and Tamil Nadu.

Table 1 Drought affected areas of India

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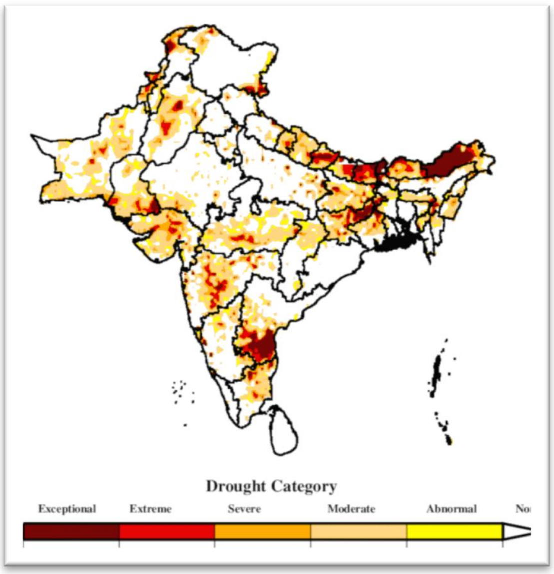
India's states of Rajasthan, Uttar Pradesh, Karnataka, and Odisha are among those that are most vulnerable to drought (Gupta et al., 2011). India's drought-affected regions are shown in Table above. The nation is experiencing more regional droughts, with a general trend towards agriculturally significant areas such as the central Maharashtra region, the coastal south of India, and the Indo-Gangetic plains (Malliya et al., 2016).



Regarding the UT of Jammu and Kashmir, there are notable differences in the climate of each area. But the Kashmir Valley does not frequently experience droughts.

During the winter of 2017–18 it was found that it was one of the driest winters in recent year's. Kashmir witnessed a roughly ninety percent decrease in precipitation in January, a typically snowy month in the Valley. 3.2 millimetres of rain and snow fall in the Valley throughout the month, compared to an average of 65.3 millimetres. The Jhelum River's water levels in the Valley were lowered to two and half feet over the dry months that followed.

One of the main economic sectors in the state of Jammu and Kashmir is agriculture.

The biggest problem affecting crop productivity is frequently the lack of water. Drought, both short-term and long-term, negatively affects agriculture. While the majority of the nation receives adequate rainfall annually, several areas start to lose their resilience to droughts throughout the dry season. Since rainfall data are frequently more readily available than other meteorological or remote sensing data in many places, a drought study based solely on rainfall data is frequently conducted. The goal of the current study is to examine the drought conditions during a 20-year period in the Kashmir valley of Jammu and Kashmir. Precipitation Index (SPI) standardization with DrinC software assistance

In the current study, DrinC software was utilized to help with cropping seasons and at various timelines.

Two Sources and Techniques

Study region and information

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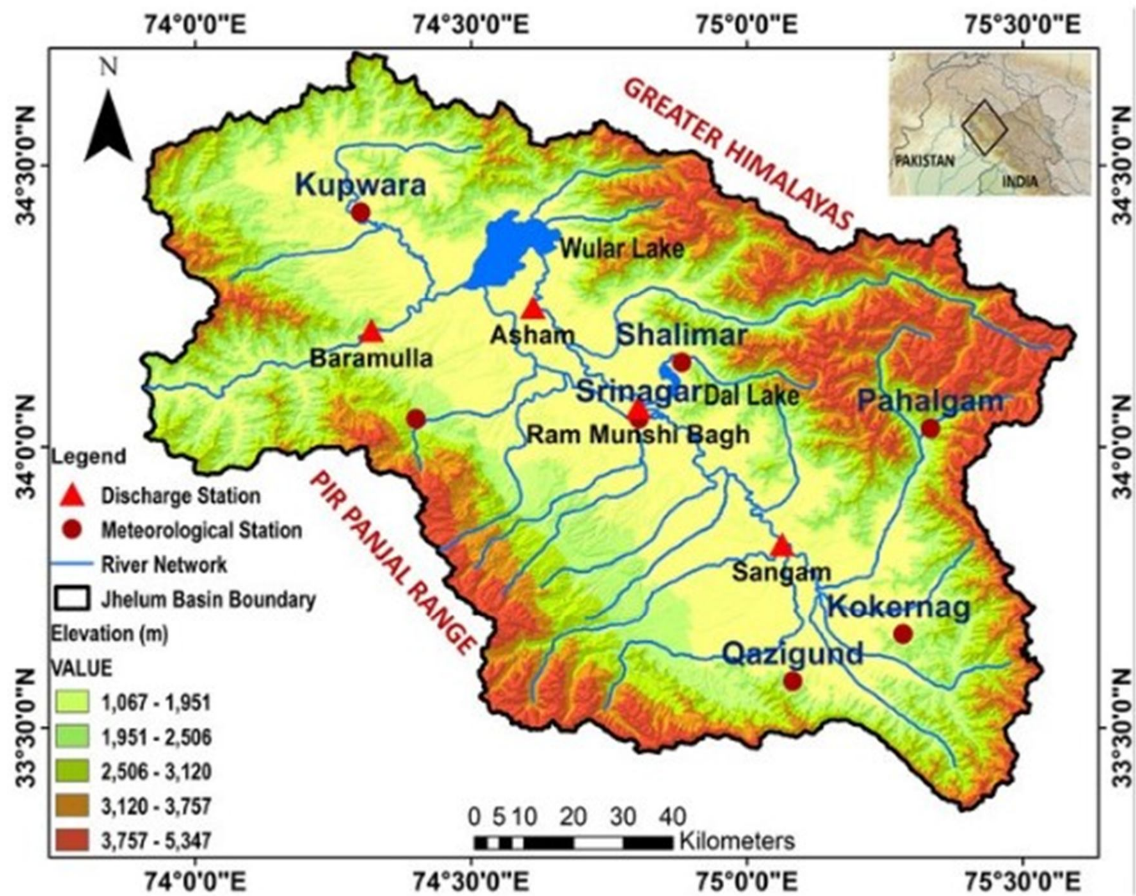
II. METHODOLOGY

The Kashmir valley lies between latitude 33^0 and 35^0 N and longitude 73^0 and 76^0 E. The valley is 100 km (62mi) wide and covers 15,520,3 km^2 (5,992.4 sq. mi) in area. It is bounded by sub-ranges of the Western Himalayas. The great Himalayas bound it in the northeast and separate it from the Tibetan Plateau whereas the Pir-Panjal Range in the Lesser Himalayas bounds it on the west and south, and separate it from the Punjab Plains. The Kashmir Valley has a moderate climate, which is largely defined by its geographic location, with the towering Karakoram Range in the north, Pir Panjal Range in the south and west, and Zanaskar Range in the east. It can be generally described as cool in the spring and autumn, mild in the summer and cold in the winter. As a large valley with significant differences in geo-location among various districts, the weather is often cooler in the hilly areas compared to the flat lower parts. Summer is usually mild and fairly dry, but relative humidity is generally high and the nights are cool. Precipitation occurs throughout the year and no month is particularly dry. The hottest month is July (mean minimum temperature 16 °C, mean maximum temperature 32 °C) and the coldest are December–January (mean minimum temperature −15 °C, mean maximum temperature 0 °C).The Kashmir Valley enjoys a moderate climate but weather conditions are unpredictable. The record high temperature is 37.8°C and the record low is −18 °C. On 5 and 6 January 2012, after years of relatively little snow, a wave of heavy snow and low temperatures (winter storm) shocked the valley covering it in a thick layer of snow and ice. The Valley has seen an increase in relative humidity and annual precipitation in the last few years. This is most likely because of the commercial afforestation projects which also include expanding parks and green cover.



The computation is carried out in the long run. A drought event is defined as an SPI that is consistently negative, intensifies to an SPI of -1.0, and ends when it turns positive. The following classification was used to define the SPI-related drought intensities (see table below).

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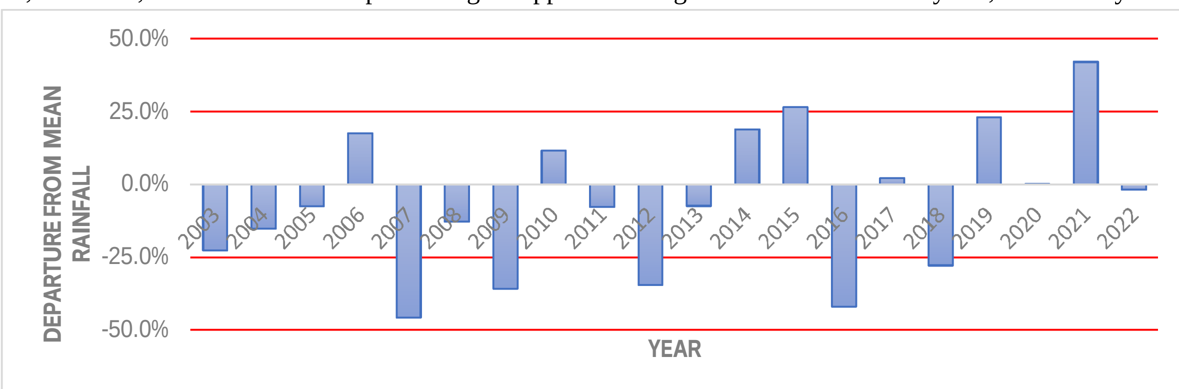
SPI VALUES	DROUGHT CATEGORY
2.00 +	Extremely Wet
1.50 to 1.99	Very Wet
1.0 to 1.49	Moderately Wet
-0.99 to 0.99	Near Normal
-1.0 to - 1.49	Moderate Drought
-1.50 to - 1.99	Severe Drought
-2.0 and less	Extreme Drought

III. EXPERIMENTAL FINDINGS

The severity and frequency of drought on various timelines in the Kashmir Valley, were calculated using the monthly SPI data. The report also evaluated the state of the drought during India's primary cropping seasons, emphasizing the crucial years for the Rabi, Zaid, and Kharif seasons. All things considered, this thorough analysis offers insightful information about the patterns of drought in the Kashmir valley between 2003 and 2022, which can help with drought preparedness and prediction

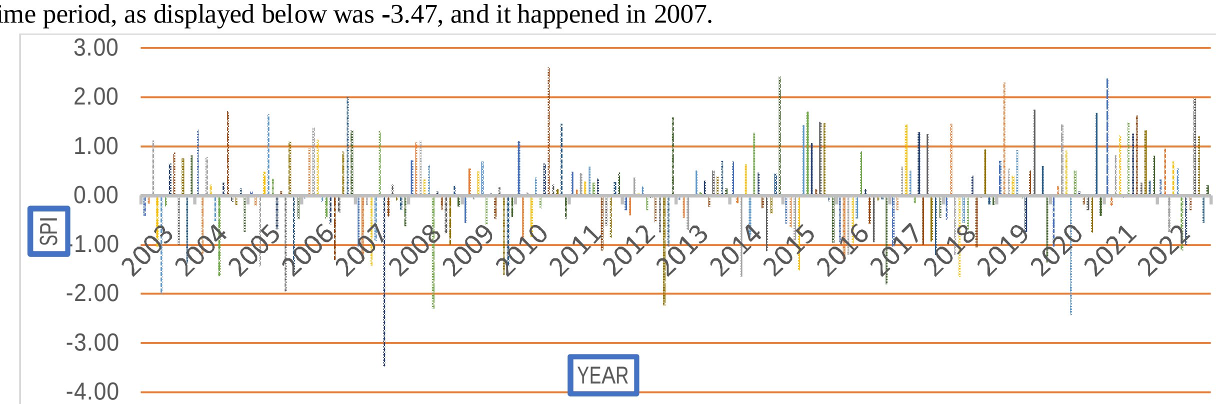
Kashmir valley is bearing the brunt of climate change. Annual Difference in Rainfall departure analysis has been done to determine drought years and the amount of annual rainfall deficit. If an area experiences a deficiency in annual rainfall of greater than -25% of its average, the year is deemed a drought year. According to the analysis, Kashmir valley experienced a mild drought in 2007, 2009, 2012, 2016, and 2018, however no catastrophic drought happened during the course of these 20 years, as is clearly seen below.



The above figure displays the proportion of annual rainfall deviations for the area between 2003 and 2022.

It was noted that the drought intensities are very varied and frequently fall below -1.0 and rise over 1.0 on smaller scales like the SPI -1 and SPI -3 series. On the other hand, SPI-6, SPI-9, and SPI-12 drought intensities decline over longer periods.

The 1-month SPI is a measure of short-term circumstances and has a strong correlation with the drought in the weather. It is helpful in determining crop stress and soil moisture, especially when the crops are growing. The Kashmir Valley's lowest SPI on a one-month time period, as displayed below was -3.47, and it happened in 2007.



The figure displays SPI volatility on a monthly basis over a twenty-year period

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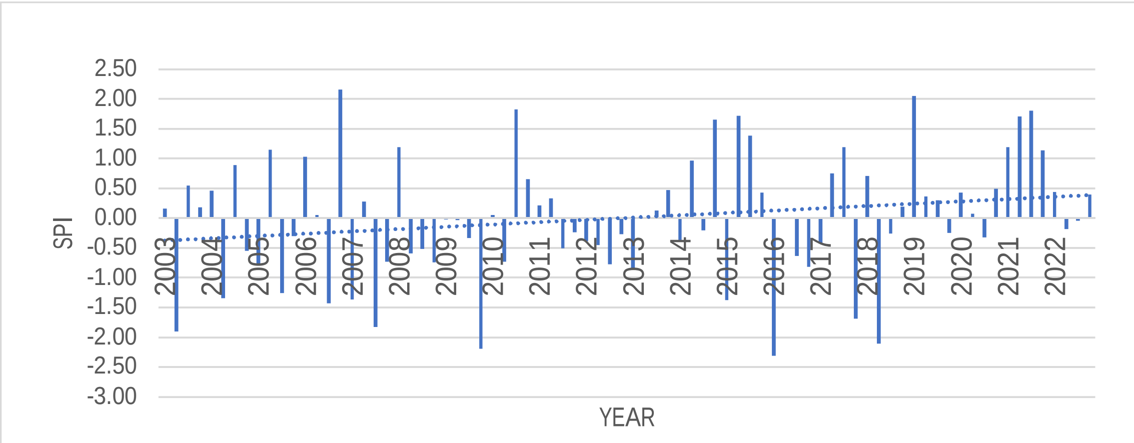
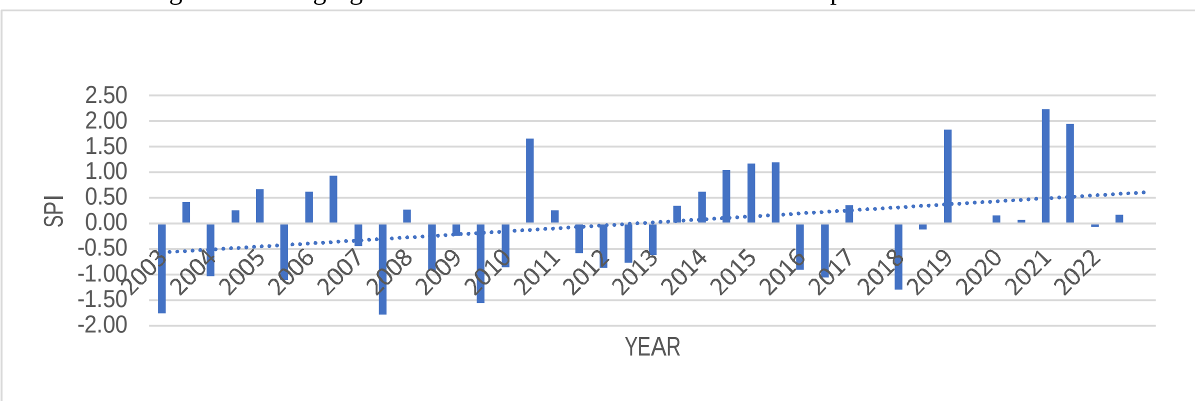
The 3-month SPI provides an estimate of seasonal precipitation as well as short- and medium-term moisture conditions. Compared to many other hydrological indicators, the 3-month SPI is more useful in highlighting the current moisture conditions of the main agricultural regions. According to following Figure, the lowest SPI for the Kashmir valley on a 3-month period was -2.31, and it happened in 2016.

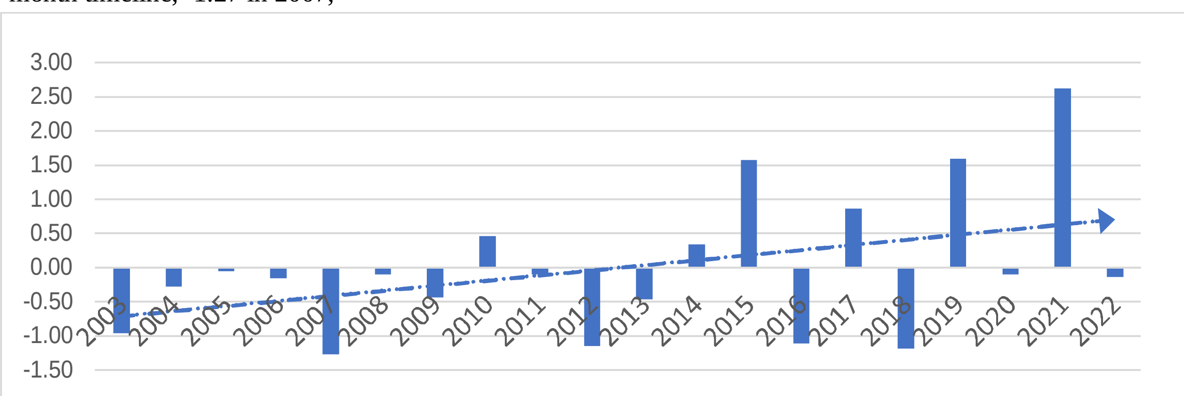


The figure displays SPI fluctuation over a twenty-year timeframe on a quarterly basis

The 6-month SPI is highly effective at displaying the precipitation over many seasons and identifies seasonal to medium-term trends in precipitation. According to following figure. which shows lowest SPI for a 6-month period was -1.76 in 2003.



Above figure shows SPI variation on a half-yearly basis throughout a twenty-year period time span of medium intervals, the 9-month SPI offers insight into intersessional precipitation trends. Droughts typically take a season or longer to develop. The lowest SPI on a 9-month timeline, -1.27 in 2007,



The above figure shows the variation in SPI on a trimester basis throughout a twenty-year period The 12-month SPI values are typically associated with reservoir levels, stream flows, and even groundwater levels over extended periods of time. The lowest SPI for the Kashmir Valley was in 2007 -1.37 on a 12-month time period, as shown in following figure.

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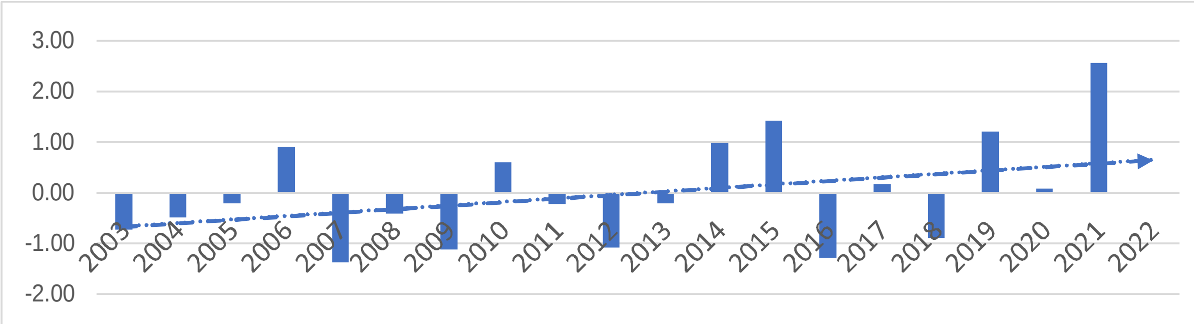
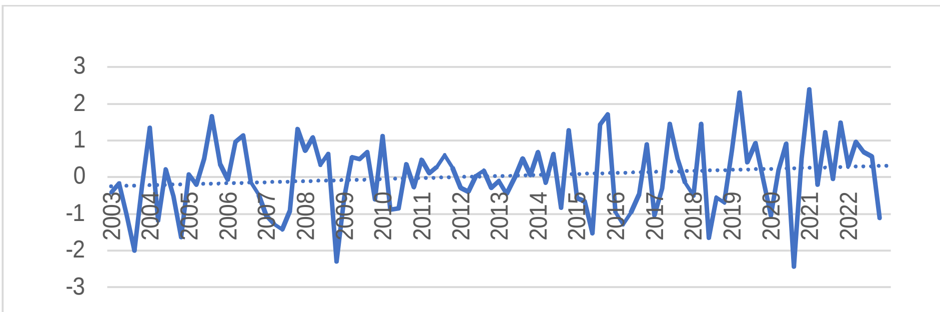
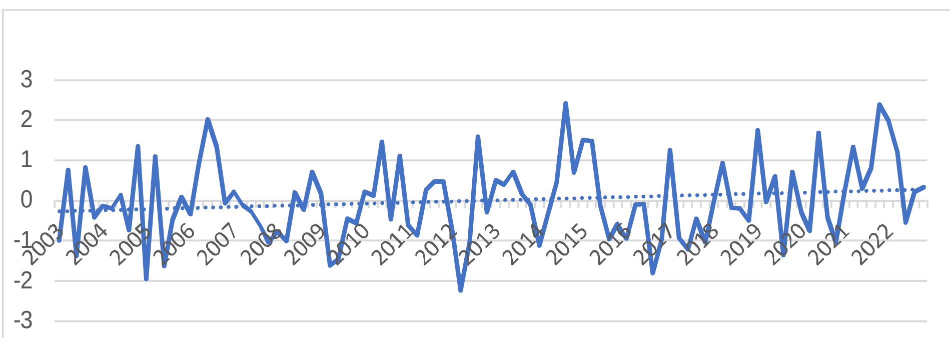


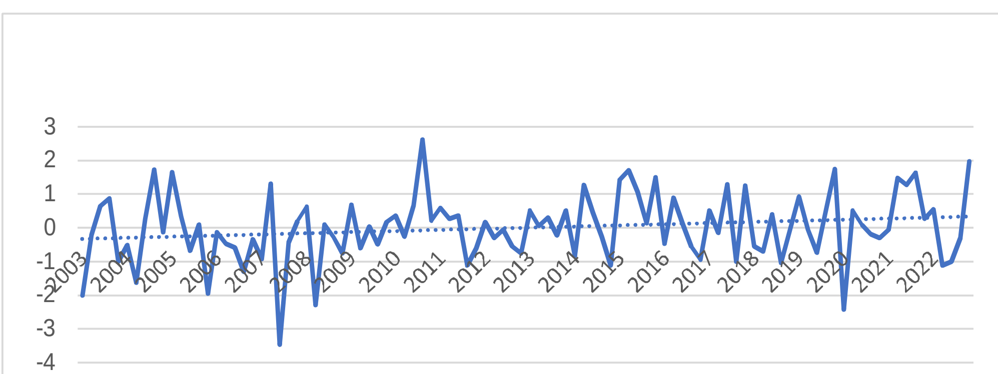
SPI fluctuation on an annual basis throughout a twenty-year period
Study using various farming seasons as a basis
SPI values for the season of Kharief



SPI values for the season of Rabi



SPI values for the season of Zaid



India has three main farming seasons: Zaid, Rabi, and Kharif. Therefore, it is critical to analyse the wet and dry conditions that occur during these seasons in order to predict droughts and be prepared for them. However, the Kharif season, which runs from June to October and is mostly dependent on rainfall, is the primary agricultural season in Kashmir. During this season, paddy, maize, soybeans and vegetables are the principal crops grown. Since June is the month when seed sowing peaks, June rainfall is crucial to causing seed to sprout. Crops enter their active growing season in August and enter their maximal vegetative phase, or early reproductive phase, The months of September. October and November are the busiest months for harvesting.

IV. CONCLUSION

This study's primary goal was to evaluate droughts identified in the Kashmir valley's historical rainfall records using the Standardized Precipitation Index criterion. After looking at temporal patterns of drought, numerous fascinating findings on the variation in drought occurrence in the area were found. Given the rainfall data, a growing trend was seen in Kashmir valley, suggesting that the areas under examination \are not susceptible to drought. It was discovered that the "DrinC" software, when used with SPI, is an effective tool for determining the frequency and severity of droughts. \The study's findings are pertinent to research on climate change in order to \comprehend past trends and create drought scenarios for the future.

Over the research period of 2003–2022, there hasn't been a single year of severe drought. Just four moderate droughts occurred in the Kashmir valley during the research period (the previous 20 years) in the years 2007, 2009, 2012, and 2016. Furthermore, the SPI trend lines indicate that the SPI is growing across all sizes. This suggests that the area is experiencing fewer droughts on a regular basis. During the year 2007, there was a moderate drought with a high SPI value (-1.37).

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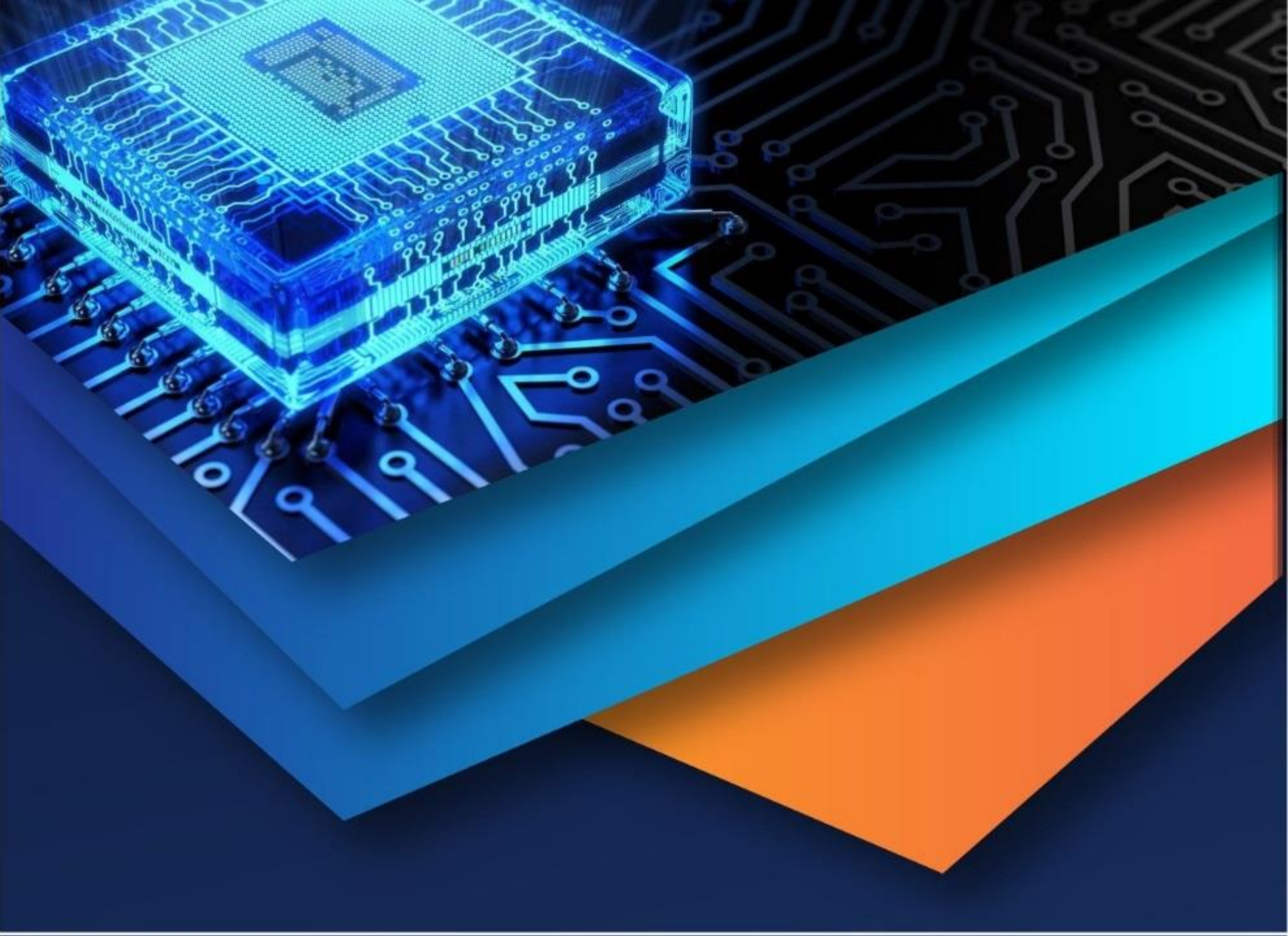

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