Variations in Rainfall Patterns of Batticaloa (DL_{2b}) in Terms of Severity and Frequency of Occurrence of Wet and Dry Events

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Abstract

Variations in climatic patterns are known to influence the availability and sustainability of water resources in Sri Lanka, thereby influencing the agriculture based livelihoods and economy. Hence, due attention is required to be paid on the variations of climate patterns, while focusing on the changes in rainfall patterns that directly denote the changes in climate. Standardized Precipitation Index (SPI) remains as one of the widely used approaches in evaluation and prediction of variations in rainfall patterns, due to its simplicity and effectiveness. Periodic variations of such climate extremes in Batticaloa (DL_{2b} agro-ecological zone) were studied, to evaluate the trends and severity of climate extremes using the Standardized Precipitation Index (SPI). Monthly cumulative rainfall data from January, 1900 to December, 2014 of the Batticaloa rain gauging station were used in this study. The collected monthly accumulated rainfalls were arranged into two major time periods, ranging from 1900-1956 (past years) and 1957-2014 (recent years) to be used as the input to the SPI calculation in Mat Lab R2007b (version 7.5). The identified events (both wet and dry) were ranked into five classes based on the magnitude (severity) of each event as normal, mild, moderate, severe and extreme. The variations in rainfall patterns (with respect to SPI) were evaluated by using the Paired Chi-Square test. The dry events of Batticaloa in the recent years (1957-2014) indicate a significant reduction of the severity of drought events ($p<0.05$ at 95% level of confidence), as the occurrence frequency of extreme and severe droughts decrease with increments in mild and moderate drought events. On the other hand wet events indicate notable increments in mild, moderate, severe and extreme wet events within the recent years, which is not significant in terms of Paired Chi-square statistics ($p>0.05$). Hence, a significant reduction of the dryness along with a notable increment in wetness, in terms of severity and frequency of occurrence, could be predicted for Batticaloa, in accordance with results of SPI.

Keywords: *climate change, wetness, dryness, severity, frequency, SPI*

Introduction

Sustainable planning and management of water resources, which in turn immensely contribute to the agricultural productivity of Sri Lanka, is respected as a vital requirement in achieving self-sufficiency in agriculture. Hence, planning and management of water resources based on the variations in climate to ensure sustainable development, has been one of the highest priorities of the agricultural sector. Therefore, severity and occurrence frequency of dry and wet events should

be focused in planning and management of water resources, at either regional or national scales, regardless of focusing on overall patterns and trends in dry and wet events (Udayanga and Najim, 2013 and 2014).

Numerous methods and empirical formulae such as Effective Drought Index, Palmer Drought Severity Index, Surface Water Supply Index, Standardized Precipitation Index [SPI] (McKee *et al.*, 1993)are being utilized to analyze and predict the variations in wetness and dryness along with other extreme weather conditions.SPI has maintained its reputation as one of the most widely used methods of predicting weather extremes, due to its simplicity, flexibility, effectiveness and capability of being used as an objective measurement of meteorological droughts effectively in dry regions (Udayanga and Najim, 2014).A proper understanding and identification of climate patterns, its trends and shifts are vital for well-coordinated planning and management of water resources to withstand unfavorable weather extremes such as drought events (Udayanga and Najim, 2013). Therefore, SPI based analysis of climatic patterns, was done to analyze the trends in dryness and wetness in terms of severity and frequency of occurrence in Batticaloa District Secretariat Division (DSD) of the dry zone.

Methodology

Batticaloa that lie under DL_{2b} agro-ecological zone, was selected as the study area. Monthly Cumulative rainfall data from January, 1900 to December, 2014 of Batticaloa rain gauging station were obtained from the Department of Meteorology. Two major data sheets including monthly cumulative rainfall data ranging from 1900-1956 (past years) and 1957-2014 (recent years) were prepared and SPI values for each month of the above two time intervals were calculated, as the difference between precipitation on a time scale (x_i) and the mean value ($\bar{x}$), divided by the standard deviation(s), as given in the equation 1 (McKee *et al.*, 1993).

$$SPI=\frac{Xi-\bar{x}}{SD} \quad \text{Eq. 1}$$

Based on SPI range, drought periods were classified into five classes as normally dry (< -0.49), mild drought (-0.50 to -0.99), moderate drought (-1.00 to -1.49), severe drought (-1.50 to -1.99), extreme drought (-2.00 or lesser) events (Liu *et al.*, 2011)while the anomalously wet events were also classified into five similar classes as normally wet (0 to 0.49), mild wet events (0.50 to 0.99), moderate wet events (1.00 to 1.49), severe wet events (1.50 to 1.99) and extreme wet (2.00 or higher) events (Liu *et al.*, 2011).The total number of events in both the periods were calculated and percentage occurrence of each class of events were calculated, separately. The significance in variation of the percentage occurrence of the above identified events (in each class) during the respected periods, were statistically assessed in accordance with the Paired-Chi-square test.

Results and Discussions

Temporal variations of the SPI values in past and recent years of Batticaloa (Figure 1), facilitate the accurate, effective comparison and interpretation of the variations in climatic patterns within the time periods of consideration. The percentage of

climatic events belonging to each class that occurred within considered time periods are tabulated in Table 1, along with results of the Paired Chi-square test, which was performed to evaluate the significance of the alterations in climate patterns (in terms of dryness and wetness).The dry events of Batticaloa in the recent years (1957-2014) indicate a decrease in the occurrence frequency of normal, severe and extreme drought events (Table 1) than the past (1900-1956). This indicates, that the severity of drought events is being reduced significantly ($p<0.05$ at 95% level of confidence), as the occurrence frequency of extreme and severe droughts decrease with increments in mild and moderate drought events. On the other hand wet events indicate increments in mild, moderate, severe and extreme wet events (Table 1) within the recent years, which is not significant in terms of Paired Chi-square statistics ($p>0.05$).

Figure 1:Temporal variation of SPI (1900-1956 and 1957-2014) in Batticaloa.

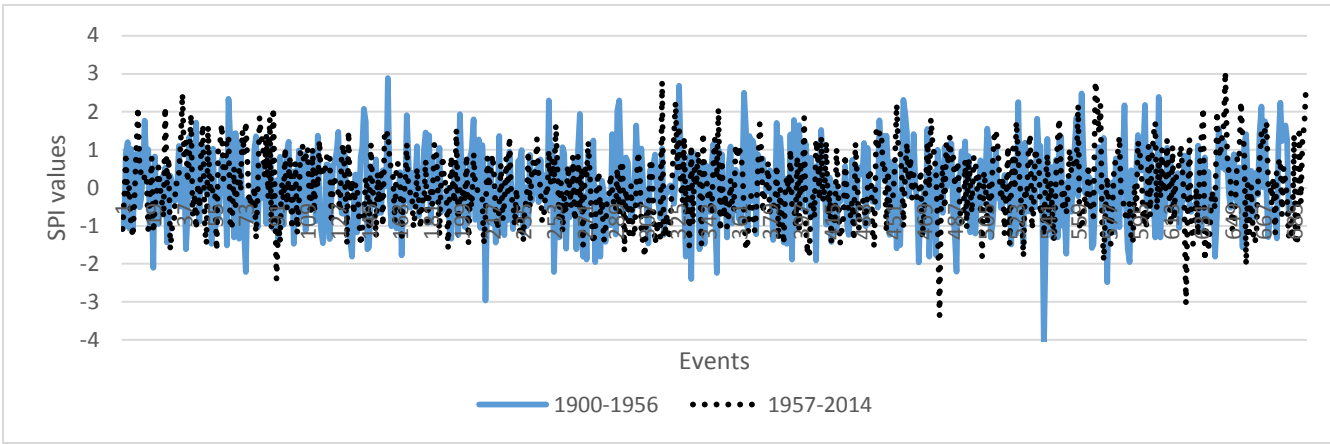

Table 1: Percentage occurrence of drought and wet events in past and recent years in accordance with different classes of drought and wet events in Batticaloa

Events	SPI Value	Category of the Events	Percentage of Wet and Dry Events (%)		Results of the Paired Chi-square test
			1900-1956	1957-2014	
Droughts	0 to -0.49	Normal Dry Events	37.76	37.32	P<0.05 at 95% level of Confidence
	-0.50 to -0.99	Mild Drought Events	27.43	30.20	
	-1.00 to -1.49	Moderate Drought Events	23.60	27.07	
	-1.50 to -1.99	Severe Drought Events	8.55	3.99	
	≤ -2.00	Extreme Drought Events	2.65	0.85	
Wet Events	0 to 0.49	Normal Wet Events	35.47	32.60	P>0.05 at 95% level of Confidence
	0.50 to 0.99	Mild Wet Events	32.27	32.79	
	1.00 to 1.49	Moderate Wet Events	21.22	23.17	
	1.50 to 1.99	Severe Wet Events	6.40	6.45	
	≥ 2.00	Extreme Wet Events	4.65	4.99	

Conclusions

The results of this study suggest a significant decrease in severity and occurrence frequency of dry events (severe and extreme droughts) along with an increase in wet events (except for normal wet events) in the recent years (1957-2014) compared to the past (1900-1956) within Batticaloa in terms of SPI. Therefore, planning and management of the water resources in the Batticaloa should be done properly based on the observed present and expected future trends in climate patterns.

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