ASSESSMENT AND COMPARISON OF CLIMATIC PATTERNS IN THANAMALVILA AND BINGIRIYA (DL_{1b} and IL_{1a}) REGIONS OF SRI LANKA

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Introduction

Proper planning and management of water resources within the dry and intermediate zones, which contribute immensely to the agricultural production of the country play a vital role in achieving self-sufficiency. Hence, planning and management of water resources based on the climate has been one of the highest priorities of the agricultural sector. Due consideration needs to be given to dry and wet events as these are characterized by both severity and frequency of occurrence. Locality or region based planning and management of water resources is crucial than focusing on overall patterns and trends of dry and wet events.

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) have been developed to analyze and predict the wetness and dryness and other weather extremes. SPI has maintained its reputation as the most widely used method of weather extreme prediction due to its simplicity, flexibility, effectiveness and capability of being used as an objective measurement of meteorological droughts effectively in dry regions (Sternberg *et al.*, 2011). Nandintsetseg and Shinoda (2011) have used SPI to assess the frequency, duration, severity and impacts of drought on pasture production in Mongolia while bivariate frequency of droughts in Guangdong has been analyzed by Lee *et al.* (2013).

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. As both dry and intermediate zones are intensively contributing to agricultural production of Sri Lanka, an analysis of the shifts, variations and trends of the climate patterns at recent times with respect to the past, especially focusing on dry and wet events of both zones is highly significant to assist the planning and management of the water resources. 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 both the localities in the

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dry and intermediate zones. An attempt was made to identify any significant climatic variations among the selected localities while evaluating the effectiveness and applicability of the SPI.

Methodology

Study area

Thanamalvila (mean annual rainfall of 900 to 1750 mm) and Bingiriya (mean annual rainfall of 1750 to 2500 mm) District Secretariat divisions that lie under DL_{1b} and IL_{1a} agro-ecological zones, respectively were selected as the study areas. Daily rainfall data from January 1961 to March 2011 of Thanamalvila and Rathmalagara rain gauging station were obtained from the Department of Meteorology and the collected data were compared with nearby stations to identify extreme outliers, transcription errors, and calibration errors while the error bound data were corrected. Monthly precipitation was computed based on the aggregated daily rainfall values from January 1961 to March 2011 for both the rain gauging stations. Two major data sheets including monthly cumulative rainfall data ranging from 1961-1985 and 1986-2011 were prepared for each station. SPI values for each month for the time intervals 1961-1985 and 1986-2011 in each locality 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).

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

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 too were 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 the percentage of each class of events (drought and wet events of different classes) were calculated separately and were compared with respect to the classes of the events recorded during 1961-1985 and 1986-2011. The overall patterns of climate variations (monthly) in the time intervals (1961-1985 and 1986-2011) were plotted against time on a monthly basis and the observable patterns were compared with each other to identify any similarities, variations and shifts of climate from 1961-1985 and 1986-2011 in each locality. Finally the overall climatic trends in both localities were compared with respect to dry and wet events predicted by the SPI analysis.

Results and Discussions

The variations of SPI (Figure 1) with time in both periods (from 1961-1985 and 1986-2011) of both localities can be analyzed to assess the prevailing trends and also to predict expected trends. When only the magnitude of the SPI values of Thanamalvila is considered, totally 128 events (deviations from standardized value) have been recorded within the period 1961-1985 while only 114 events are recorded with the period 1986-2011 (Table 1). On the other hand, 100 and 139 events have been recorded within 1961-1985 and 1986-2011 (Table 1) respectively within the IL_{1a} zone.

Thus, the dry events of the DL_{1b} zone recorded in the recent years (1986-2011) indicate a significant decrease in the number of dry or drought events of moderate, severe and extreme drought classes (Table 1) than the past (1961-1985) symbolizing a significant decreasing trend of major drought events (except the number of events of the mild drought class). On the other hand when the dry events of IL_{1a} zone are considered, a significant decrease in all the drought classes during the recent years than in the past is evident (Table 1). Wijeratne *et al.* (2007) suggests a possible reduction in monthly rainfall by 100 mm for Sri Lanka. Also a possible increase of the mean temperature and a possible reduction in the quantity and spatial distribution of rainfall of Sri Lanka by 2050 compared to that of 1961-1990 has been predicted (De Silva et al., 2007). The wet events of DL_{1b} zone indicate a significant increase in mild, severe and extreme wet events (Table 1) within the recent years (1986-2011) than in 1961-1985 except the moderate drought class. Hence a significant increasing trend of major wet events (except the number of wet events of the moderately wet class) in the recent years than in the past is symbolized.

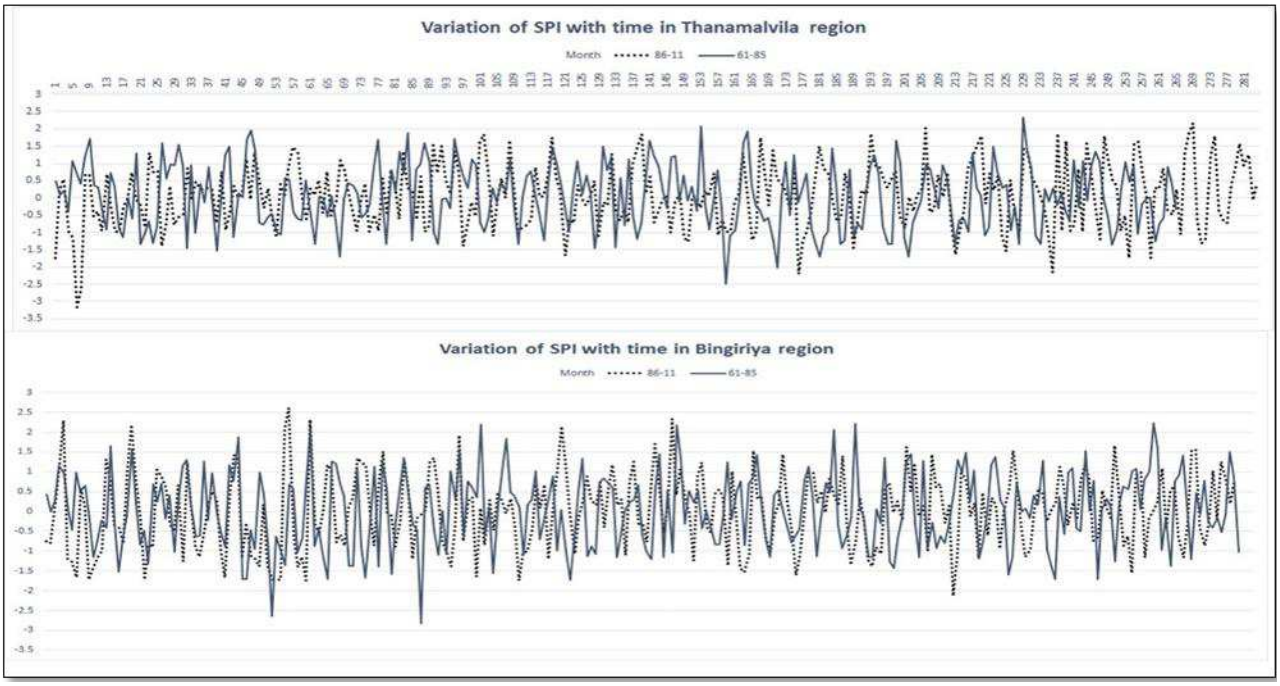

Figure 1: Variation of SPI with time in Thanamalvila and Bingiriya region

Table 1: Number of drought and wet events in accordance with different classes of drought and wet events in Thanamalvila and Bingiriya

Event	SPI Value	Category	Number of Events (Percentage)			
			Thanamalvila		Bingiriya	
			1961-1985	1986-2011	1961-1985	1986-2011
Droughts	0 to -0.49	normally dry	14 (17.9%)	10 (8.8%)	13(9.4%)	8(8.0%)
	-0.50 to -0.99	mild droughts	11 (8.6%)	23 (20.2%)	19(13.7%)	18(18.0%)
	-1.00 to -1.49	moderate droughts	16 (12.5%)	12 (10.5%)	24(17.3%)	18(18.0%)
	-1.50 to -1.99	severe droughts	20 (15.6%)	4 (3.5%)	10(7.2%)	9(9.0%)
	≤ -2.00	extreme droughts	5 (3.9%)	3 (2.6%)	2(1.4%)	1(1.0%)
Wet	0 to 0.49	Normal wet events	17 (13.3%)	13 (11.4%)	13(9.4%)	9(9.0%)
	0.50 to 0.99	mild wet events	23 (18.0%)	22 (19.3%)	20(14.4%)	11(11.0%)
	1.00 to 1.49	moderate wet events	16 (12.5%)	12 (10.5%)	24(17.3%)	15(15.0%)
	1.50 to 1.99	severe wet events	8 (6.3%)	17 (14.9%)	8(5.8%)	4(4.0%)
	≥ 2.00	extreme wet events	2 (1.6%)	2 (1.8%)	6(4.3%)	7(7.0%)

The wet events of IL_{1a} zone exhibit a significant decrease in all the wet event classes (except in the extreme wet event class) during the recent years compared to the past (Table 1). De Silva, (2006) has suggested an increase in average annual rainfall in intermediate zones while the average annual rainfall of the dry zone areas such as Jaffna, Mannar, Puttlam and Hambantota is also predicted to increase when rainfall is predicted to decrease in other dry zone areas such as Anuradhapura, Batticaloa and Trincomalee while Batticaloa is expected to produce the highest decrease of annual rainfall.

Conclusions

The results of this study suggest a significant decrease in dry events (9.2%, 2.0%, 12.1% and 1.3% reduction of normal dry events, moderate droughts, severe droughts and exceptional droughts respectively) and a significant increase in wet events (1.3%, 8.7 % and 0.2% increase of mild wet, severe wet and exceptionally wet events) in the recent years (1986-2011) compared to the past (1961 to 1985) within the DL_{1b} zone. A significant reduction of wet and dry events (in all respected classes) in both severity and frequency of occurrence could be suggested in the recent years than in the past within the IL_{1a} zone.

The planning and management of the water resources in the DL_{1b} and IL_{1a} agro-ecological zones should be done properly based on the observed present and expected future trends in climate patterns. Thus, repairing and maintaining the tank systems to store more water is essential in both the regions (especially in IL_{1a} zone since hindered climate pattern is expected). Also, the dam and the other related structures of water holding and conveyance facilities should be properly maintained to avoid sudden catastrophic breakouts due to overloading of water within the DL_{1b} zone.

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