Analysis of extreme climate events in Sri Lanka from 1981-2019: Case study in wet, intermediate and dry zone

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1. Introduction

The occurrence of weather variables beyond the thresholds is known as 'extreme climate events' (Field et al., 2012). The indicated changes in the climate in turn has commuted dynamics in terms of frequency and intensity of these extreme events. Thus, several studies have revealed that the Asian region has undergone significant changes in the trends of climate extremes during the last few decades and those have been characterized by strong variability (Choi et al., 2009; IPCC, 2014). As a result of such cognate changes in the climate, Asian countries are highly vulnerable to extreme climate events. In recent years, Sri Lanka has witnessed numerous extreme climatic events, originated by catastrophic floods, and droughts. Naveendrakumar et al. (2018) has proclaimed that the consequent fluctuation with regard to minimum and maximum temperature are immensely noticeable in Sri Lanka. Despite the temperature rising, the Sri Lanka national report on disaster risk, poverty and human development relationship reveals that drought and floods affect up to 4 million people every year. Similarly, a recent study demonstrated a declining trend in the annual counts of days with heavy rainfall in Southern India and Sri Lanka based on the definitions of extreme climate events. According to the literature, it is clear that the climate of Sri Lanka has changed crucially. Although there are adequate studies on climate variability, there is a lack of information on extreme climate events in Sri Lanka. Therefore, the present study was conducted to analyze the occurrence of extreme climate events and short-term climate variability from 1981-2019 in major Agro-ecological regions of Sri Lanka.

2. Materials and Methods

This study was conducted in seven selected locations covering all three Agro-ecological zones of Sri Lanka including Mahailuppallama, Hambantota, Batalagoda, Monaragala, Nuwara Eliya, Galle and Katugastota (Figure 1).

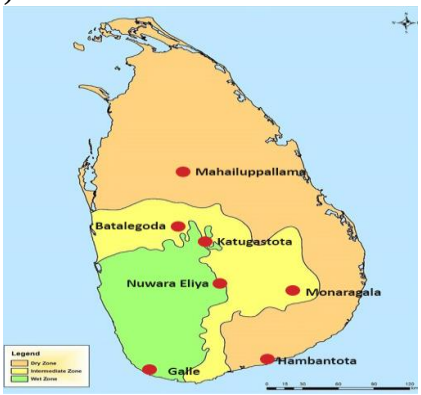

Figure 1. Selected locations

Data on Daily rainfall, minimum and maximum temperature from 1981-2019 were collected from the Department of Meteorology, Sri Lanka. Data quality control was done by using the RClimDex (version 4.0.2.) software. Ten indices were selected for the study as defined by the Expert Team on Climate Change Detection and Indices (ETCCDI) (Table 1). Extreme climatic events were identified for the aforementioned indices from the RClimDEX software package. Annual trends of extreme climatic events were identified by using Non–Parametric Mann Kendal test and regression analysis.

Table 01. Selected Temperature and Precipitation Indices

Index	Definition	Unit
Temperature Indices		
TXn	Annual minimum value of daily maximum temperature	^{o}C
TXx	Annual maximum value of daily maximum temperature	^{o}C
DTR	Annual mean difference between maximum and minimum temperature	^{o}C
TN90p	Annual percentage of days when minimum temperature greater than 90th percentile	%
Precipitation Indices		
CDD	Maximum number of consecutive days with RR < 1mm	days
CWD	Maximum number of consecutive days with RR >= 1mm	days
R95p	Annual total PRCP when precipitation is greater than 95th percentile	mm
R99p	Annual total PRCP when precipitation is greater than 95th percentile	mm
RX5day	Annual maximum of consecutive 5-day precipitation	mm

3. Results and Discussion

The Coldest days (TXn), which are the annual minimum and maximum temperatures, did not show any significant ($p>0.05$) trend in all the selected locations.

Similar to the coldest day, the warmest days (TXx) also did not show any significant ($p>0.05$) trend within the 1981 to 2019 period.

The change in Diurnal Temperature Range (DTR) is rather regional than global (Jayawardena et al. (2018). In this study, no significant ($p>0.05$) trends were observed in Dry zone and Wet zone for the DTR. The intermediate zone showed a significant ($p<0.05$) negative trend in Monaragala and a significant ($p<0.05$) positive trend in Batalagoda.

Accordingly, over 70% of the selected stations in this study showed significant increasing trends in the percentage of warm nights (TN90p). Regarding the warm nights (TN90p) Wet zone showed a significant ($p<0.05$) positive trend for all the selected locations. Similar to the Wet zone, Dry zone also showed a positive trend in Hambantota which was significant ($p<0.05$). thereupon, conspicuous variations could be observed from the locations in the intermediate zone, Batalagoda during the study period. While all the other locations showed a positive trend for warm nights Batalagoda showed a significant ($p<0.05$) negative trend. This result is coinciding with the previous studies done by Jayawardena et al. (2018), as deliberated there, over 60% of the stations showed significant increasing trends in the percentage of warm nights.

In Warm days (TX90p), Dry zone showed a significant positive ($p<0.05$) trend in Hambantota while the Intermediate zone showed a significant ($p<0.05$) negative trend in Monaragala. The wet zone showed no significant ($p>0.05$) trend for warm days within the study period.

When considering the Precipitation Indices, no significant trends were observed for Consecutive Dry Days (CDD) in selected locations in Wet, Dry and Intermediate zones within the study period.

Both positive and negative trends were displayed by all three zones during the study period for Consecutive wet Days (CWD). Nuwaraeliya (in the wet zone) showed a significant ($p<0.05$) negative trend while Hambantota in Dry zone showed a significant ($p<0.05$) positive trend. The intermediate zone showed no significant trends for CWD within the study period.

Very Wet Day precipitation (R95P) in Mahailuppallama, Dry zone showed a significant ($p<0.05$) positive trend, while all the other locations in Wet and Intermediate zones showed no any significant ($p>0.05$) trends.

For extremely wet days (R99P) within the study period, all the zones showed no any significant changes except Mahailuppallama in the dry zone which showed a significant ($p<0.05$) positive trend.

Trends for 5-day precipitation (RX5day) among the selected stations, a significant ($p<0.05$) positive trend was observed in Mahailluppallama in the Dry zone while all the other selected locations showed no any significant ($p>0.05$) trends.

4. Conclusions

In general, a warming trend was observed in temperature indices through this period. DTR in the Intermediate zone showed a significant increasing and decreasing trend. An increasing trend was shown in TN90p for all locations except Batalagoda which showed a significant decreasing trend. An increasing trend showed in Hambantota and a decreasing trend showed in Monaragala for TX90p were found significant. Considering Rainfall indices, a significant positive trend was observed for R95p, R99p and RX5day in Mahailuppallama showing that rainfall intensity in

Mahailuppallama has increased. In general, trend analysis revealed dynamic rainfall trends with both increasing and decreasing patterns in Sri Lanka.

5. References

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Acknowledgement

Sabaragamuwa University of Sri Lanka Research Grant – SUSL/RG/2019/03