

INTER-SEASONAL AND INTRA-SEASONAL TRENDS IN THE RAINFALL OF KANDY

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Introduction

The Central Highlands are an important catchment area for the river systems of Sri Lanka. Hence, the inter-seasonal and long-term trends in rainfall of the Central Hills of Sri Lanka have been studied widely. Malmgren et al. (2003) is such a study in which the monthly average rainfall data of about 130 years between 1870 and 2000 were examined. They concluded that some stations in Central Highlands demonstrate a decrease in the South West Monsoon rainfall (SWM), but no statistically significant upward or downward trend exists for the North East Monsoon (NEM). During the First Inter-Monsoon (FIM) and Second Inter-Monsoon (SIM) the only statistically significant trend in the Central Highlands was the decreasing trend observed in Nuwara Eliya. Other studies using shorter time series also report decreasing trends during SWM rainfall in the Central Highlands (e.g., Rekha & Punyawardana 2003 and Wickramagamage 2015).

The Central Hilly region probably has the most variable and complex regional rainfall pattern in Sri Lanka, so it is difficult to generalize results for this region, unlike the lowland regions. For example, out of the Central Highland stations considered in Malmgren et al. (2003), Kandy and Nuwara Eliya stations show a significant decreasing trend in the SWM, but not Badulla and Diyalalawa stations. In the FIM and SIM seasons, Kandy, Badulla and Diyathalawa do not show an upward or downward trend, but Nuwara Eliya exhibits a decreasing trend. In this study, the longest available total monthly rainfall record of Kandy was examined to identify intra-seasonal, inter-seasonal and long-term changes in rainfall.

Methodology

The data used in the study are the 12 month rainfall totals during a year from 1875 to 2014 obtained from the Katugastota weather station of the

Department of Meteorology¹. The time series of the maximum and minimum monthly rainfall observations were examined to identify intra-seasonal shifts or rearrangements of the highest and lowest rainfall producing months of the year. To identify long-term trends in rainfall, the NEM, FIM, SWM and SIM seasonal rainfall totals were plotted in time series. The Mann-Kendall statistical test was applied to distinguish between significant and non-significant monotonic trends in the seasonal time series. In order to identify periods with anomalous rainfall, a time series of rainfall anomalies was constructed. The anomaly for a particular year was obtained by subtracting the average value of the mean of the total monthly rainfall (time series) from the mean of the total monthly rainfall values of that year.

Results and Discussion

Figure 1 shows the months of the year in which the maximum and minimum monthly rainfall occurred. For the period before 1944, the maximum monthly rainfall of the year occurred 20 times in October and 15 times in November. However, after 1944, October had the highest rainfall only 15 times and November has recorded the highest rainfall 23 times. Fig. 1 suggests changes in SWM period, because June shows fewer maximum annual rainfall occurrences after 1944 than before 1944. Moreover, after the early 1960s, the month of May has not become maximum rainfall producing month, instead, it recorded only minimum annual rainfall events.

¹Note that instead of ‘monthly rainfall totals’, the phrase ‘monthly rainfall’ will be used more often in the paper.

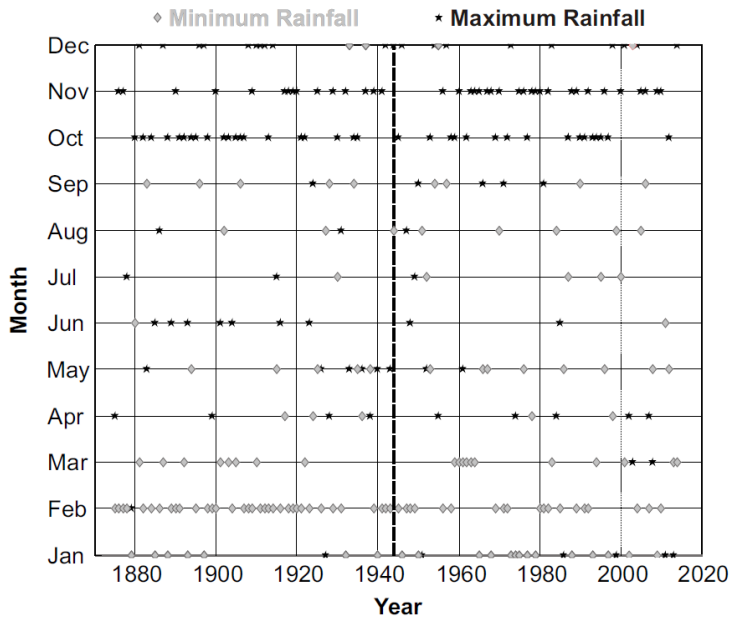


Figure 1: time series of months with maximum and minimum annual rainfall. The vertical black dashed line indicates the midpoint in time (i.e., 1944).

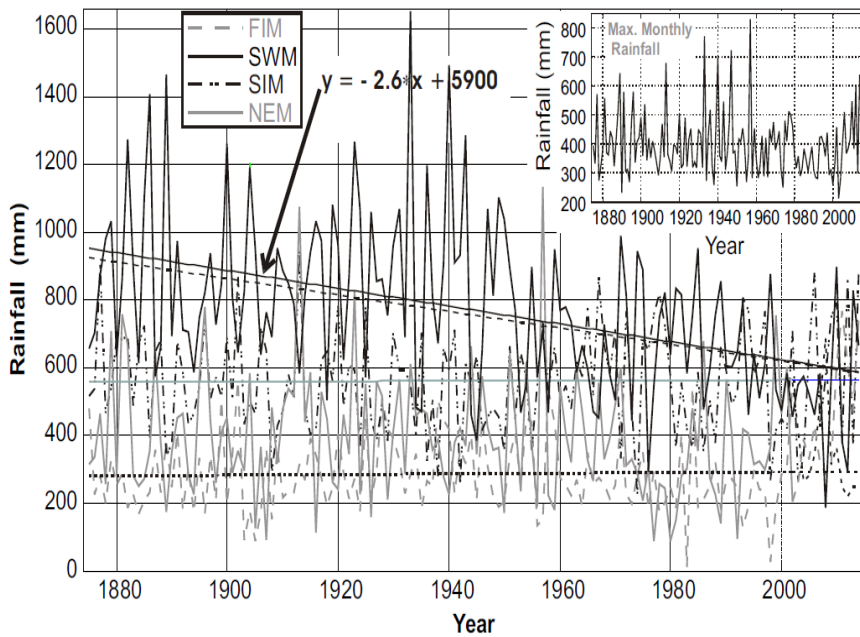


Figure 2: time series of seasonal rainfall and monthly maximum rainfall (top right).

Figure 2 displays the FIM, SWM, SIM and NEM season rainfall totals in grey dashed, black, black dashed and grey colored, respectively. All the seasons demonstrate significant year-to-year variations. However, trend analyses of the rainfall amounts in the FIM, SIM and NEM seasons do not show a monotonic decreasing or increasing trend at the 95% confidence level according to the Mann-Kendall statistical test. In contrast, the SWM rainfall amount demonstrates a decreasing trend at the same level of confidence. The negative slope of the equation of the linear regression line (black line) shows a 2.6 mm drop in the SWM. Even the application of robust regression to minimize the influence of outliers produced a 2.4 mm decrease in SWM rainfall per year (black dashed line). The top figure reveals that, in the last 6 decades, rainfalls in excess of 1000 mm have not occurred unlike in previous decades, which suggests the reduction of maximum rainfall amount during the SWM.

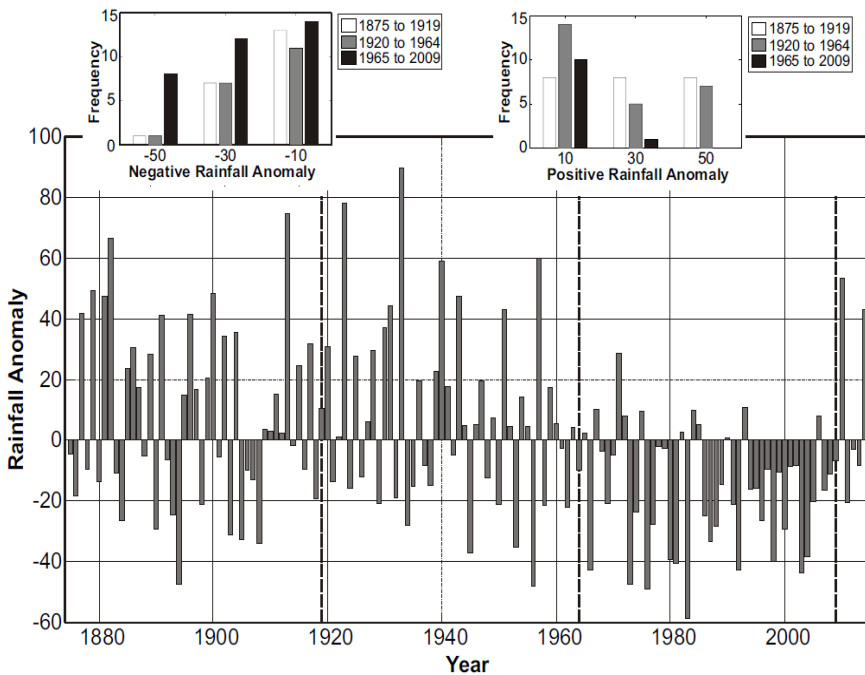


Figure 3: time series of the positive and negative monthly rainfall anomalies and histograms of the negative and positive anomalies (on top)

The black dashed vertical lines in Fig. 3 indicate the years used to divide the time series into three 45-year periods. In the two earlier periods, the positive anomalies were larger in magnitude than the negative anomalies,

but in the later 45 years, the opposite case is true. The positive and negative anomaly histograms summarize the results of the long-term anomaly graph. In the two earlier periods, the positive anomalies were common, indicated by grey and white bars. However, in the latter period the rainfall anomalies are mostly negative.

Conclusion

The FIM, SIM and NEM seasons do not show a significant rainfall trend, but the SWM season rainfall demonstrates a statistically significant decreasing trend. The drop in the SWM season rainfall is 2.4 mm per year. The month of June shows fewer annual maximum rainfall occurrences after 1944 than before 1944. After the 1960s the month of May has not exhibited maximum rainfalls, instead it had only annual minimum rainfall events. The study also reveals that in the last 6 decades, rainfall in excess of 1000 mm has not occurred unlike in previous decades. The recent 45 year period clearly shows that rainfall climate of Kandy has shifted into overall negative anomaly.

Why rainfall is decreasing in Kandy during SWM season cannot be properly understood without a good knowledge about clouds over the Central Highlands. A ground-based cloud observation system is not available in Sri Lanka. Such a system must be established in order to study clouds over Sri Lanka.

References

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