STATISTICAL ANALYSIS OF THUNDER-DAYS OVER SRILANKA

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Introduction

Sri Lanka is an island which enjoys tropical monsoonal climate. A *thunder-day* is a standard meteorological parameter that is recorded at synoptic stations around the world. A *thunder-day* is defined as 'an observational day (any 24-hour period) during which thunder is heard at the location' (Kuleshov and Jayaratne, 2004). As thunder is caused by lightning, hearing thunder is the best audible proof of occurrence of lightning.

The *thunder-day* frequency was found to vary considerably with geographical parameters, climate and seasonal conditions such as monsoons (Bandara, 2005). Also lightning activity over Sri Lanka shows peak incidences during two Inter-monsoon seasons. Understanding lightning characteristics over land is vital to achieving optimal advantage in protection of both life and property. This study discusses comprehensively about the *thunder-day* activity and presents a statistical analysis for describing the thunderstorm activity and its variations during all monsoon periods for the regions Colombo, Kurunegala, Nuwara Eliya, Hambanthota, Trincomale, and Anuradhapura

Methodology

Six meteorological regions, Colombo, Kurunegala, Nuwara Eliya, Hambanthota, Trincomalee, and Anuradhapura, were selected for their reliability and availability of *thunder-day* data over sufficiently long periods of observation and to represent a wide geographical distribution across the island. *Thunder-day* data, for the period of 30 years from 1961 to 1990 at six stations were collected from Sri Lanka Meteorological Department and analyzed statistically.

Trends of *thunder-day* incidences in a year over all six regions and all six regions in each monsoon period were examined. And the significant of the trends were tested at $\alpha = 0.05$ level of significance.

The proportions of *thunder-day* incidence among the regions were calculated and bar charts of percentage of monthly proportions of *thunder-days* for each region were constructed. The chi-squared test was used to compare the proportion of *thunder-days* among the regions for a year and for all monsoon periods and significant differences have been found among them. Further pair wise comparison of proportions of *thunder-*

days among the regions was also tested.

Normal approximation to the binomial distribution was used to compute the chance of occurrences (probabilities) of *thunder-days* for each region in all monsoons.

Contour maps were drawn which demonstrate frequencies of lightning activity in all six regions of Sri Lanka in the period 1961–1990.

Results

Trend Analysis of *thunder-days*

The trend of *thunder-days* in Colombo is significant ($p<0.05$) and in the other regions, trends are not significant ($p>0.05$) in a year. In northeast monsoon there is down ward trend in Hambanthota ($p<0.05$) whereas in southwest monsoon there is an upward trend in Colombo ($p<0.05$). In first inter monsoon there is down ward trend in Kurunegala and Nuwara Eliya ($p<0.05$) and no significant trend in *thunder-days* can be seen in second inter monsoon ($p>0.05$).

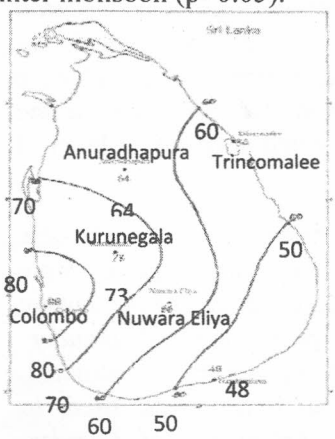

Fig. 1. Contour Plot for a Year

Contour plots of *thunder-days*

Mean number of *thunder-days* of all thirty years were taken for each region for a year and for each monsoon period, and contour plots were drawn in a way such that the same numbers of *thunder-day* areas are covered by a contour line. This process was continued until the same number of *thunder-day* areas in the island are covered by contour lines. A sample contour map for a year is shown in Fig. 1.

Percentage of monthly proportion of the *thunder-days*

Percentages of proportion of *thunder-days* were calculated and the bar charts were drawn for each region. A sample bar chart for Colombo region is shown in Fig. 2.

Comparison of proportions of *thunder-days*

H_0: $p_1 = p_2 = p_3 = p_4 = p_5 = p_6$ or (The proportions are the same in all monsoon periods)

H_1: $p_i \neq p_j$ $i,j = 1, 2, 3, 4, 5, 6$ or (At least two of the proportions are different).

Here the null hypothesis (H_0) is rejected ($p<0.05$).

Computation of probabilities of *thunder-days*

Normal Approximation to Binomial Distribution is shown in Table 1.

The probability of *thunder-days* during a year and monsoon periods. X= Number of *thunder days*

Discussion

Analysis disclosed that the number of *thunder-days* with time in Colombo has significantly increased as p-value is <0.05, but in other regions there is no significant trend in *thunder-days*. It can be noticed clearly that the proportions of *thunder-days* are high in two distinct periods: first inter monsoon and second inter monsoon. The proportions of *thunder-days* are different from region to region

throughout the year and in all monsoon periods ($p<0.05$). The probability of getting *thunder-days* for more than a particular value (60 number of *thunder-days* in a year and 15 number of *thunder-days* in a given monsoon period) is high in Colombo and low in Hambanthota. The highest annual number of *thunder-days* is in Colombo region and lowest in Hambanthota region in Northeast monsoon, first inter monsoon and second inter monsoon. In the southwest monsoon period, the maximum lightning activity has confined to Trincomalee and minimum in Hambanthota.

Conclusions

Annual lightning activity shows considerable variation from year to year. Lightning activity had a significant increasing trend in

Colombo and minimum activity extreme south and south west in Hambanthota (Regional wise).

Maximum lightning activity in Colombo and minimum in Trincomalee in Northeast monsoon, first inter monsoon and second inter monsoon (Monsoonal wise).

In the southwest monsoon period, the maximum lightning activity has confined to Trincomalee and minimum in Hambanthota. (Monsoonal wise).

Proportions of *thunder-days* occurrence is higher in first inter monsoon and second inter monsoon seasons. The highest proportion of the *thunder-days* occurred in the month of April. The probability of getting *thunder-days* is high in Colombo and low in Hambanthota.

References

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Kuleshov, Y. and Jayaratne, E.R. (2004): Estimates of lightning ground flash density in Australia and its relationship to thunder-days. http://*www.bom.gov.au/amm/docs/2004/**kuleshov1**.pdf*

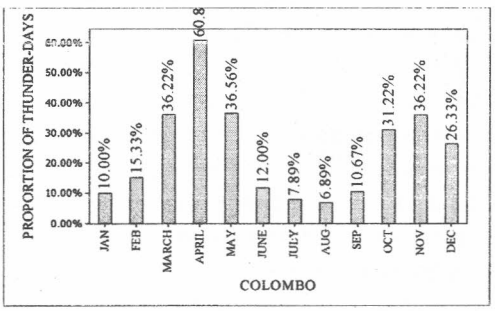

Fig. 2 Percentage of Proportion of *thunder days*

Table 1. Probability of *Thunder-Days*

Regions	Year P(X>60)	Northeast monsoon P(X>15)	Southwest monsoon P(X>15)	First Inter monsoon P(X>15)	Second Inter monsoon P(X>15)
Colombo	1.00	0.50	0.95	1.00	0.84
Kurunegala	0.96	0.01	0.92	0.99	0.80
Nuwara Eliya	0.78	0.00	0.98	0.98	0.32
Hambanthota	0.01	0.01	0.05	0.51	0.45
Trincomalee	0.22	0.00	1.00	0.03	0.35
Anuradhapura	0.78	0.00	0.733	0.97	0.85