

Temporal Changes in Drought Pattern of Different Agro-Ecological Regions in Sri Lanka

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Abstract

Protracted period of deficient precipitation is called as a drought which affects the environment, economy and social status of human beings. Rainfall data is the main factor to analyze and identify drought pattern in a particular area. Due to climate changes, it is possible that drought patterns have gradually changed. According to annual variation in the rainfall, climate in Sri Lanka categorized into four seasons, viz.: first inter monsoon, Southwest monsoon, second inter monsoon and Northeast monsoon. Sri Lankans are affected by several natural disasters such as floods, droughts, landslides etc. To find out feasible and possible solutions, it is very important to analyze the changes of rainfall patterns and drought patterns. The objective of this study was to study the changes in the rainfall pattern in 3 selected meteorological stations (Anuradhapura, Hambanthota and Nuwara Eliya) from 1901 to 1930 and 1971 to 2000 (two 30 year periods of time of at the beginning and end of twentieth century). Monthly rainfall data of these two time periods were collected from meteorological department of Sri Lanka. Rainfall trend was analyzed using Microsoft Excel and frequency analysis was done by using Minitab statistical package. Standard Precipitation Index (SPI) was used to identify and analyze strength of drought months during considered two 30 year periods, which was done by monthly and seasonally for selected stations. The SPI analysis revealed the severity of droughts and illustrated the changes of drought patterns in selected areas with time. The results indicated that trend of rainfall was decreased during 1971-2000 period compared to 1901-1930 period in all three stations. The highest total rainfall has occurred during 1901-1930. Number of droughts occurred during the two 30 year time periods were very much similar and it was statistically proven by the Wilcoxon signed rank test. The number of droughts occurred seasonally was comparatively differed in first and last three decades in the twentieth century.

Keywords: Drought, Rainfall, Standard Precipitation Index, Drought Indices

Introduction

Rainfall data is the main factor that can be used to analyse and identify the drought patterns in a particular region or a country. Due to climate changes, it is possible that drought patterns have gradually changed. Sri Lanka is located very close to the equator and the climate of the island is characterized as tropical (Jayamaha, 1975). The central part and the southern half of the island are mountainous with heights more than 2.5 km. The central mountainous area consists of many complex topographical features such as ridges, peaks, plateaus,

basins, valleys and escarpments. Complexity of topography affects the spatial patterns of winds, seasonal rainfall, temperature, relative humidity and other climatic elements, particularly during the monsoon season. The mean annual rainfall varies from under 900 mm in the driest parts to over 5000 mm in the wettest parts in Sri Lanka. An annual bi-modal rainfall pattern is found in Sri Lanka. According to annual variations in the rainfall the climate in Sri Lanka is categorized into four seasons as First inter monsoon, South-west monsoon, Second inter monsoon and

North-east monsoon (Department of Meteorology, 2012).

People in Sri Lanka are affected by several natural disasters such as floods, droughts, landslides etc (Manawadu, 2008). Due to climate change, the rainfall pattern has changed abnormally and it has badly affected the environment as well as human beings. Due to timely importance of disaster management, this study is mainly focused on analysis of the changes of rainfall pattern and drought patterns in different agro-ecological regions in Sri Lanka.

There are several indices that are used to measure the strength of a drought, such as Standard Precipitation Index, Palmer Drought Severity Index, Palmer Hydrological Drought Index, Crop Moisture Index, Surface Water Supply Index and etc (Tsegaye, 2007). Standard Precipitation Index is suitable to measure droughts by analysis of only rainfall data (Lana and Serra, 2001). This study will help to identify the changes of drought pattern over time and also it will help to suggest drought adaptation methodologies for required areas.

Methodology

The study was conducted for 3 main meteorological stations in Sri Lanka viz.: Anuradhapura, Hambantota and Nuwara Eliya. Anuradhapura and Hambantota meteorological stations were in the low country dry zone. Nuwara Eliya was in the wet zone and it is one of the main agricultural production areas in Sri Lanka. Monthly rainfall data were collected from above stations for the analysis. Quantitative data were collected to analyze rainfall patterns and drought patterns in selected stations. Monthly rainfall data were considered as quantitative data for this study. Microsoft Excel 2007 package and Minitab statistical software were used for analysis of rainfall data. Trend analysis was done after

creating bar graphs for annual rainfalls by using MS Excel. Histograms and box plots were created by using Minitab to analyze the variations in rainfall distribution in selected two periods of times. Finally, average annual rainfalls were compared among different stations.

Percentages of different categories according to SPI were developed by using pie charts. Pie charts developed for two 30 year periods were compared and analyzed. SPI variations were analyzed by using Wilcoxon signed rank test.

Results and Discussion

There was a decrement found in trend analysis of rainfall in 1971-2000 when comparing with 1901-1930. Frequency analysis of rainfall values of the selected stations are shown in Table 1. According to histograms means and confidential intervals, rainfall values of 1901-1930 is greater than 1971-2000 period of time. The minimum rainfall is same and is equal to zero. The maximum rainfall value is lower in 1971-2000 compared to 1901-1930 except in Hambantota. It can be concluded that more rainfall occurred during 1901-1930 when compared to 1971-2000 period. There was a reduction in rainfall trend analysis during 1971-2000 when compared to 1901-1930 period.

According to SPI analysis, number of drought months in those selected two 30 years of periods were almost identical in three selected stations (Figure 2). There was no significant difference of drought months in the two time periods and South west monsoon at Nuwara Eliya and second inter monsoon at Anuradhapura (Table 2). However, there were no statistically significant differences were found in percentages of droughts months in the selected two 30 year periods in each monsoon season for selected 3 stations.

Table . Comparison of Monthly Rainfall in 1901- 1930 and 1971 - 2000

Criteria	Anuradhapura		Meteorological Station Hambanthota		Nuwara-eliya		Conclusion
	Period		Period		Period		
	1901 – 1930	1971 – 2000	1901– 1930	1971- 2000	1901– 1930	1971– 2000	
Mean	116.31	100.56	84.79	81.45	193.51	160.54	
Confidence Intervals	104.15 128.48	89.29 111.82	76.796 92.80	73.47 89.43	180.50 206.52	149.65 171.42	More rainfall in 1901-1930
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	
Maximum	593.60	527.50	417.06	469.00	723.65	558.0	
P Value	0.005	0.005	0.005	0.005	0.005	0.005	
	Does not follow Normal distribution		Does not follow Normal distribution		Does not follow Normal distribution		

It is evident that monthly rainfall values were not following the normal distribution during two 30 year time periods. In addition, all three stations reported

higher average annual rainfall values during 1901 – 1930 compared to 1971 – 2000 (Figure 1).

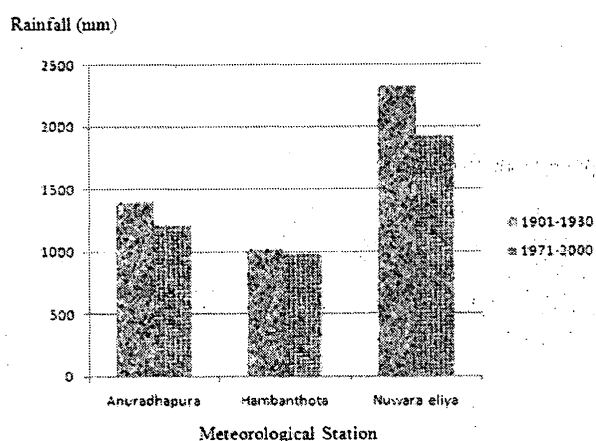


Figure. Changes of average annual rainfall (mm)

Conclusions

The trend of rainfall pattern decreased at the selected 3

stations during 1971-2000 when compared with 1901-1930 periods. Frequency analysis of monthly rainfall explained that more rainfall occurred during 1901-1930 period compared with 1971-2000 period. In addition, more annual rainfall events were occurred during 1901-1930 period at selected 3 stations. Percentages of droughts were increased only during first inter monsoon and south west monsoon of Nuwara Eliya, and second inter monsoon of Anuradhapura.

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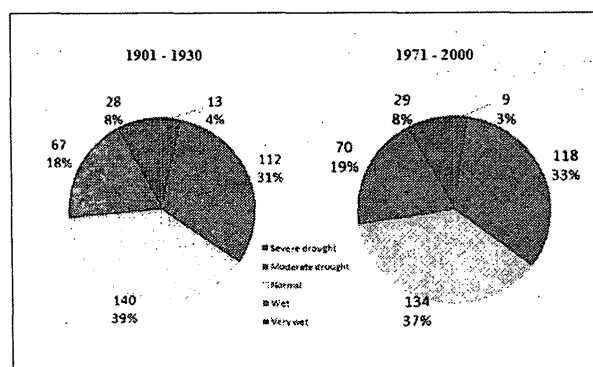


Figure. Comparison of number of drought months in Anuradhapura from 1901 to 1930 and from 1971 to 2000

Table. Comparison of percentages of droughts in selected two 30 years periods

Monsoon	Meteorological station	1901-1930	1971-2000	Droughts – Increment/Decrement
First inter monsoon	Anuradhapura	30%	27%	↓
	Hambanthota	37%	33%	↓
	Nuwara eliya	37%	43%	↑
South west monsoon	Anuradhapura	30%	27%	↓
	Hambanthota	30%	26%	↓
	Nuwara eliya	30%	33%	↑
Second inter monsoon	Anuradhapura	30%	43%	↑
	Hambanthota	46%	30%	↓
	Nuwara eliya	39%	36%	↓
North east monsoon	Anuradhapura	38%	31%	↓
	Hambanthota	35%	31%	↓
	Nuwara eliya	34%	31%	↓

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