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Rainfall Variability on Climate Changes in Eastern Province in Sri Lanka

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Abstract: Rainfall extremes have adverse impacts on the society and environment of Sri Lanka. The objective of this paper is to seek evidence spatio-temporal trends for rainfall variability on climate change in Eastern Province of Sri Lanka by analyzing long-term monthly data of rainfall received during the four rainy seasons - i.e. the Northeast monsoon, the first inter-monsoon and the second inter-monsoon during the period 1980-2010, from meteorological stations of the Department of Meteorology. Five stations of Eastern Province have observed either flooding in rapid sequence in recent years. Some studies attribute such extreme events to rainfall variability on climate changed induced by global warming. However, there is a dearth of climatological studies addressing the spatio-temporal trends in rainfall over Sri Lanka in support of such attribution. Using daily rainfall data collected at the 5 stations from Eastern Province of the Department of Meteorology, It interprets rainfall trends using different GIS techniques, so that the practical implications of rainfall variability on climate change in recent decades are clearly identifiable. The study finds that the number of rainy days has declined at all the rainfall stations except for the Trincomalee station.

Keywords: Climatology and Spatio-temporal

Introduction

Precipitation varies from year to year and over decades, and changes in amount, intensity, frequency, and type (e.g. snow vs. rain) affect the environment and society. Steady moderate rains soak into the soil and benefit plants, while the same amounts of rainfall in a short period of time may cause local flooding and runoff, leaving soils much drier at the end of the day. Snow may remain on the ground for some months before it melts and runs off. Even with identical amounts, the climate can be very different if the frequency and intensity of rainfall differ, highlight the fact to the characteristics of rainfall are just as vital as the amount, in terms of the effects on the soil moisture and stream flow.

Rainfall is of primary importance to the both physical and cultural landscape of any region. Of all the standard climatic parameters, rainfall is the most variable parameter in time and space. Rainfall received across Sri Lanka varies dramatically from year to year, ranging from dry periods that can persist for months, to periods of intense downpours, storms and flooding. The temporal and spatial diversities associated with rainfall have provided the basis for dividing the climate year in Sri Lanka into four seasons: two Monsoon periods and two Inter-Monsoon periods. The Southwest Monsoon (Summer Monsoon) prevails from May to September while the Northeast Monsoon (winter Monsoon) lasts from December to February. In between these two monsoon periods, two Inter-Monsoon periods exist: March to April - first Inter-Monsoon period and October and November - second Inter-Monsoon (National Atlas of Sri Lanka, 1988). Westerly winds prevail during the Southwest Monsoon and North-easterly winds prevail during the Northeast Monsoon. The seasonal variations of wind direction and rainfall have a marked influence on human activities.

Climate change has become a major concern to human society because of its potentially deleterious impact worldwide. It poses especially significant threats to sustainable development in developing countries, which have fewer resources and are more vulnerable (Munasinghe, 2001). Impacts on developing countries remain poorly understood because few

studies have successfully measured the effects of climate on developing country economies. Nonetheless, it is likely that a developing country will be more vulnerable because a greater fraction of its economy is in climate sensitive sectors (for example, agriculture), it is already in a hot climatic zone, and the economy relies on labor-intensive technologies with fewer adaptation opportunities (Mendelsohn *et al.*, 2001).

Rainfall is a key determinant of the growing seasons and the types of agriculture practised. Rainfall plays an important role in agriculture as any shortages or excesses of rainfall gives way to a reduction in yields. For instance, rice is the main crop in Sri Lanka and is highly susceptible to rainfall variability. Other crops such as the plantation crops of tea and rubber are also dependant on the amount of rainfall received.

The number of rainy days in a season is of particular importance for tea and rubber crops. Yield decreases can be attributed to an increase in the frequency of droughts and reduction of the number of rainy days. Therefore, examining trends in the variability of the number of rainy days is vital as it is a decisive factor in agriculture. The number of rainy days is also important for industrial activities such as salt production.

Given the importance of agriculture the number of rainy days affects growing patterns and yields. Therefore, it is important to investigate the factors determining the variability of rainfall. There is a dearth of studies on rainfall variability in Sri Lanka. Such studies are essential to evaluate the impact of climate change on agriculture.

Since late-1980s, there appear to have been changes in weather patterns in Sri Lanka with an apparent reduction in rainfall received and more intense dry spells. This study aims to assess the magnitude and significance of rainfall variability and change over time using statistical analysis techniques and spatial analysis techniques in Geographical Information Systems (GIS).

Objectives

The goal of this study is to obtain evidence of rainfall variability on climate change in Eastern Province in Sri Lanka over the last three decades. Although there are several climatic variables that could be included in a study of climate change, only rainfall has been selected for the current analysis from the 5 stations in Eastern Province in Sri Lanka. The study has the following specific objectives:

- To observe trends in annual rainfall in Eastern Province.
- To observe trends in the number of rainy days.
- To observe trends in the number of rainy days by rainy seasons

Materials and Method

This study is utterly based on secondary data available from the Department of Meteorology. Daily rainfall data were collected for the period from 1980 to 2010 for 5 rainfall stations from Eastern Province climate in Sri Lanka the minimum 30-year period required for climatological analyses. The 5 rainfall stations are well distributed over the entire Province by elevation and climatic regions, the stations under study, their elevations and the period.

Statistical analysis such as linear regression and time series analyses were utilized to examine periodic rainfall changes in both annual and seasonal contexts. GIS spatial analysis techniques such as Surface Interpolation, zonal statistics were utilized.

Results and Discussions

The result of trends in the number of rainy days, the annual number of rainy days was obtained from the original daily rainfall record at each station. Regression analysis was performed on the number of rainy days at each station (Table 01) for results.

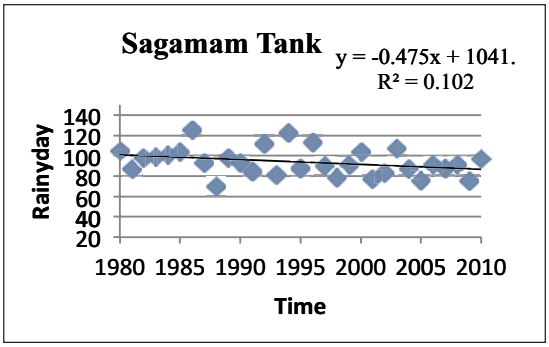
Table 1:
Number of Rainy Days period from 1980 to 2010

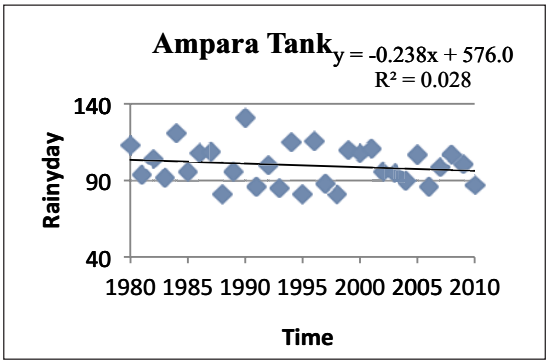
Station	Slope (m)	Intercept	R^2
Batticaloa	-0.020	128.2	0.000
Kantalai Tank	-0.054	202.6	0.001
Trincomalee	-0.166	425.7	0.013
Ampara Tank	-0.238	576.0	0.028
Sagamam Tank	-0.475	1041	0.102

It is observable that all the stations have a decreasing number of rainy days. It is shown that three stations have had a marked negative trend and it is more pronounced in the Eastern Province Sagamam Tank and Potuvil have recorded as having the notable decreasing trend while Trincomalee and Amparar Tank in the Eastern Province have shown a moderate decline in the number of rainy days received during the study period. Observations like Kantalai Tank and Batticaloa have slightly less decreasing trends. There is no station with the positive trends in the number of rainy days. These aspects can be clearly displayed in graphical form.

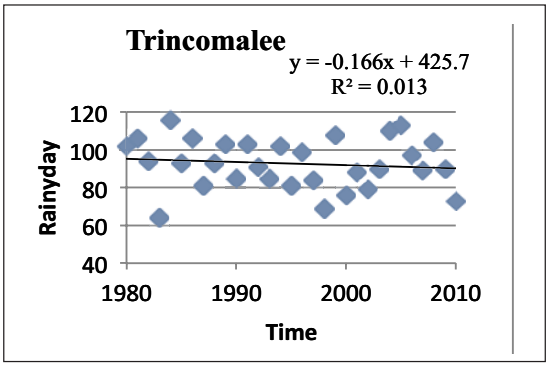
In the Eastern Province, the highest decline is recorded in Sagamam Tank at -0.474. The lowest decline is recorded in Batticaloa and Kantalai Tank as -0.000 and -0.001 respectively. Figure 01 to 03 demonstrates the decrease in the number of rainy days in Ampara Tank and Trincomalee, situated in the eastern part of the island, records a low decline of -0.013 and 0.0.28 respectively in number of rainy days. In both station, there has been a steady decline apart from few deviations between certain years. In both stations, the number of rainy days has not exceeded 140 days since the 1980s.

Figure 1:
Stations with significant negative trends in the number of rainy days





(a)



(b)

Figure 2:
Stations with moderate negative trends in the number of rainy days (a) & (b):

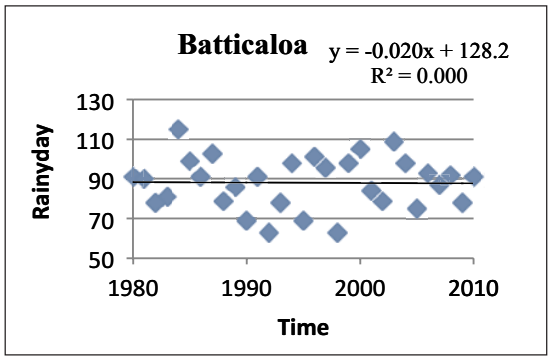


Figure 3:
Stations with low negative trends in the number of rainy days

Trends Analysis in the number of rainy days by NEMS

With regard to the number of rainy days received in each season, the Northeast Monsoon Season (NEMS) has witnessed a negative trend in all the meteorological stations under study. Potuvil has depicted a remarkable decline in all seasons except in the Second Inter Monsoon Season (SIMS). In the NEMS the decline has been more pronounced in the Central to Eastern parts of the country. Out of the NEMS Inter-monsoon seasons, the FIMS has a comparatively higher rate of decline in the number of rainy days. In the NEMS the same phenomenon has correlated between the amount of rainfall and the frequency of the rainfall except in the station Sagamam Tank. All stations under study have negative trends in the amount of rainfall that received during a particular season. Despite the reduction in the number of rainy days at all stations during the NEMS, the total rainfall received at Batticaloa and Kantalai Tank has increased.

The annual rainfall of the eastern province is predictably considered as ranging between 1000mm to 5000mm. There is a marked spatial pattern associated with the mean annual rainfall over particular station in eastern part of Sri Lanka. Seasonally greatly varying distribution of rainfall throughout the year can be derived for the entire island. Monthly rainfall at each meteorological station was used to compute annual rainfall totals.

Table 2:
Simple regression - Annual rainfall

Station	Slope (m)	Intercept	R^2
Batticaloa	18.22	- 34761	0.122
Ampara Tank	12.49	- 23292	0.088
Trincomalee	12.07	- 22617	0.075
Kantalai Tank	19.82	- 38030	0.298
Sagamam Tank	-2.778	6802	0.003

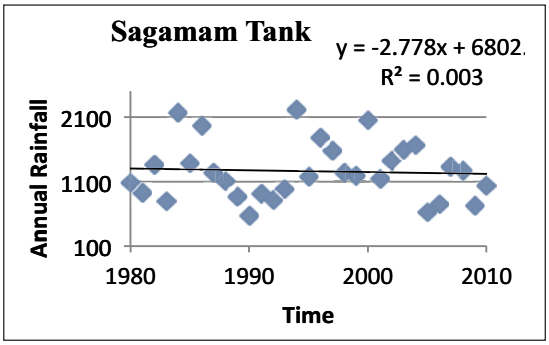
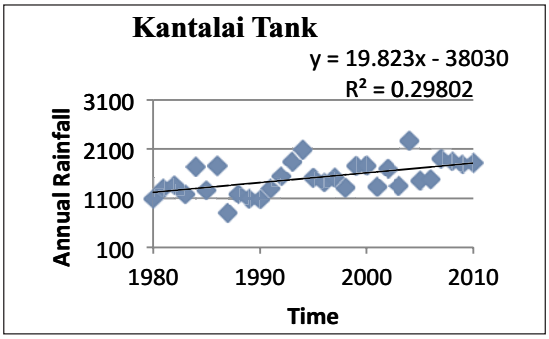
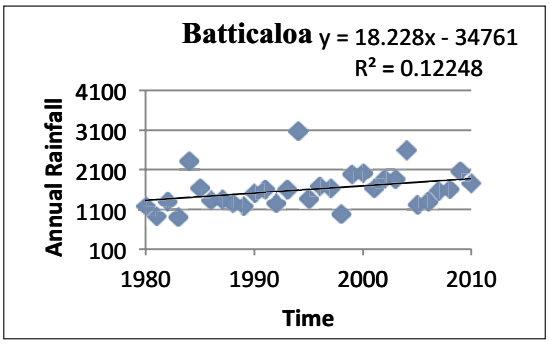


Figure 4:
Annual Rainfall Negative Trends Analysis



(a)



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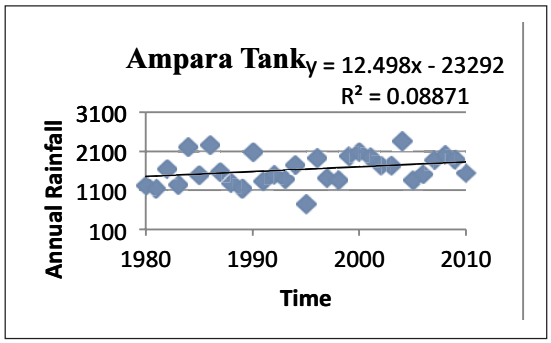
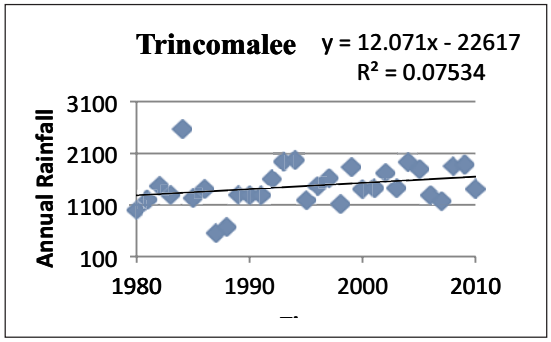


(c)



(d)

Figure 5:
Annual Rainfall Positive Trends Analysis (a), (b), (c) & (d)

The above graphical format clearly shows that almost all the stations under study have recorded positive trends in annual rainfall over time. Only Sagamam Tank has shown a negative trend but it is not a significant relationship as the R^2 record for about 0.003. The positive trend is more remarkable in stations such as Ampara Tank, Batticaloa, Trincomalee and Kantalai Tank. It is seen that both Batticaloa and Kantalai Tank have demonstrated remarkable positive trends in the annual rainfall pattern just as in the number of rainy days (Figure 05). From these results it can be concluded that both these stations have experienced a boost in the amount of annual rainfall received. It is notable that Ampara Tank and Trincomalee have a moderate enhance in the number of rainy days but when it comes to the annual rainfall both stations are having remarkable enhance.

Conclusion

The study finds that although the number of rainy days has decreased except rainfall station included in the analysis. The total annual rainfall has not decreased in the all stations. This could indicate that the intensity of rainfall events may have increased together with increased durations of dry spells. The apparent increased incidence of flooding and droughts in the recent past could probably be attributed to such changes in the temporal pattern of rainfall distribution. Further studies are needed to investigate the relationship between the number of rainy days and total rainfall within a season. These studies should also establish the relationship between local rainfall and global drivers of climate variability and change. Such studies could provide invaluable guidance to decision making in agriculture and water resources management.

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