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Analysis of 20 Years Rainfall Data from 1999 to 2018 in Badulla District: A Case Study

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Abstract:

The Climate in Sri Lanka is tropical and consists of very characteristic in dry and wet seasons. As compared with the land area of Sri Lanka, Badulla district covers 4.4 %. Badulla district is a capital city of Uva province and it consists of 15 AGA divisions and 1960 villages. Badulla district is an agricultural district where vegetables, tea, fruits, and paddy are cultivated. The district has been separated into two portions as Upper region and Lower region considering the climatic and geographical features. The upper region of the district is eminent for tea plantation and vegetable cultivation while the lower region is famous for paddy agriculture. Changing climate is an uncountable cause of worry for all over the world especially rain-fed developing country. The fluctuated rainfall pattern harmfully affects their crops. The attempt was made to study the variation of monthly, seasonal and annual rainfall over Badulla district of Sri Lanka during twenty years' period from 1999 to 2018. Annual rainfall trends over the Badulla District showed the increasing trends of about 15.8 mm/Year. Near about 12 years (60 %) shows annual rainfall less than that of mean annual rainfall and 08 years (40 %) show annual rainfall more that of mean annual rainfall. First Inter-Monsoon Season (March-April), Southwest-monsoon Season (May-September) and Second Inter-Monsoon Season (October-November) rainfall trends show the decreasing rainfall trends while Northeast-Monsoon Season (December-February) rainfall trends shows the increasing rainfall trend.

Keywords **—Rainfall, Annual, Seasonal, Monthly, Rainfall trends**

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I. INTRODUCTION

Water is one of the most important substances on the Earth. It is vigorous for life process of while it is a basis of power for living being. There is no substitute for it. Beyond above, water serves many other useful purposes for domestic consumption, agriculture, industry and so on. The main vital source of water in World is the rain which has a dramatic consequence mainly on agriculture. Vegetations get their water supply from natural sources as well as through the irrigation. The yield of crops in rainfed areas depends mainly on the rainfall pattern. The studying of these patterns is very important. It makes significant to predict the probability of amount of rainfall based on the past records of hydrological data using statistical analysis. By appropriating a frequency distribution to the set of rainfall data, the probability of incidences of random parameter can be calculated.

II. STUDY AREA

The present study is carried out at Badulla district (Fig.1) located in Uva province. The region has a latitude and longitude of 6.9934° N and 81.0550° E, respectively and Elevation is 670 m. Agriculture is the main occupation in this area and almost encircled by the BaduluOya River. This area is surrounded by tea plantations and also includes paddy, rubber, banana and vegetables. In Badulla district, it receives rainfall from Inter, northeast and southwest Monsoons. The daily rainfall data is collected from the Meteorological Department of Sri Lanka, for a period of 20 years from 1999 to 2018. These data is used for the Annual, Monthly and Seasonal Rainfall data analysis.

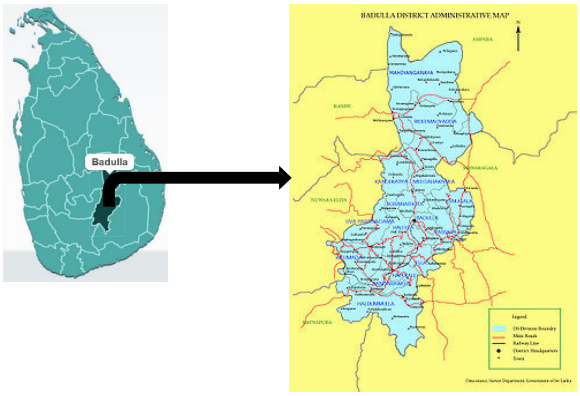

Fig. 1Location map of the study area

III. DATA AND METHODOLOGY

The daily rainfall measured in millimetre (mm) of Badulla district for a period of twenty years from 1999 to 2018 was collected from Metrological Department of Sri Lanka because this study was performed separately for annual, seasonal and monthly rainfall. The monthly rainfall was calculated by taking the total of daily rainfall of the particular month while seasonal and annual rainfall were calculated by taking the total of monthly rainfalls of the particular season and seasonal rainfalls for the particular year, respectively. And finally, average values of each three parameters for the said period were calculated. First Inter-Monsoon Season (March-April), Southwest-Monsoon Season (May-September), Second Inter-Monsoon Season (October-November) and Northeast-Monsoon Season (December-February) time series of all parameters under study rainfall are prepared and analyzing of data were done using Minitab software.

The Mean, Standard Deviation (St. Dev), Variance, Coefficient of Variation (Coef. Var), Minimum, Maximum, Mean of the Squared Successive Differences (MSSD) of the monthly, seasonal and annual rainfall contributed for the entire period of study (1969-2010) is computed.

IV. RAINFALL FEATURES

Rainfall characteristics of Badulla district are shown in table 1. Annual rainfall over Badulla district from 1999 to 2018 is 1823.9 mm with a standard deviation 385.5 mm. The coefficient of variation of annual rainfall for Badulla is 21.13%. The seasonal rainfall for First Inter-Monsoon Season (March-April), Southwest-Monsoon Season (May- September), Second Inter-Monsoon Season (October-November), and Northeast-Monsoon Season (December-February) are 313.7mm, 378.0 mm, 544.7 mm, and 583.2 mm, respectively. Maximum rainfall was observed in Northeast-Monsoon Season which contributes near about 32.22%. First Inter-Monsoon Season, Southwest-Monsoon Season, Second Inter-Monsoon Season contribute nearly 17.2 %, 20.73 % and 29.86 % respectively to annual rainfall.

The Maximum coefficient of variation was observed in February and it is 101.64 % which mean rainfall is more variable in February. The Minimum coefficient of variation is observed in November and it is 34.59% which means that rainfall is more November. Maximum monthly rainfall was observed in November, December, October, January, and April are 286.00 mm, 269.85mm, 258.66 mm, 201.34 mm and 201.21 mm respectively. November contributes highest in monthly rainfall and it is 15.68% to the annual rainfall. Rainfall in July (47.46 mm) is least and contributes only 2.60 % to the annual rainfall.

TABLE I

RAINFALL CHARACTERISTICS IN MILLIMETERS (mm) OF BADULLA DISTRICT

Variable	Mean	St.Dev	Variance	Coef. Var	Minimum	Maximum	MSSD
January	201.3	132.5	17562.3	65.82	24.7	579.7	20812.2
February	116.3	117.5	13800.3	100.97	17.4	538	14747.7
March	112.5	84.8	7182.9	75.32	3.4	355.1	7503.9
April	201.2	103.1	10633.3	51.25	35.7	406.4	10843
May	114.4	86	7395.9	75.2	0.4	309.4	6703.9
June	47.6	47.9	2295.6	100.61	2.7	188.8	3022.3
July	47.46	35.68	1273.18	75.18	10.3	162.6	1750.72
August	69.9	49.1	2408.3	70.24	3	186.7	2401.6
September	98.7	60.7	3690.3	61.55	0.5	229.6	4272.9
October	258.7	142.5	20310.2	55.1	60.1	508.5	20433.6
November	286	98.9	9786.3	34.59	137.1	470	11867.1
December	269.9	144.4	20861	53.52	65	669.5	25388.2
First Inter-Monsoon Season	555.9	178.4	31825	32.09	241.7	947.9	34845.7
Southwest - monsoon Season	1748	472	222397	26.97	1048	2815	235065
Second Inter-Monsoon Season	2304	642	411769	27.85	1290	3763	443872
Northeast - Monsoon Season	4608	1283	1647075	27.85	2579	7526	1775489
Annual	1823.9	385.5	148590.9	21.13	1034.7	2525.1	176877.5

A. Analysis of Annual Rainfall Trends

Annual rainfall trends over the Badulla District showed the increasing trends of about 15.8 mm/Year. Near about 12 years (60 %) shows annual rainfall less than that of mean annual rainfall and 08 years (40 %) show annual rainfall more that of mean annual rainfall. The maximum rainfall was observed in 2001 and it is 2525.1 mm. The minimum rainfall was observed in 2010 and it was 1034.7 mm. As considered with the departure of annual rainfall from normal over Badulla, maximum negative departure was shown in 2016 which was -789.225 mm/year. The maximum positive departure was shown in 2011 and it was 701.175 mm/year. The minimum departure was 3.975 mm/year and it was shown in 2018. Annual rainfall shows 21.13 mm/year coefficient of variation from 1999 to 2018.

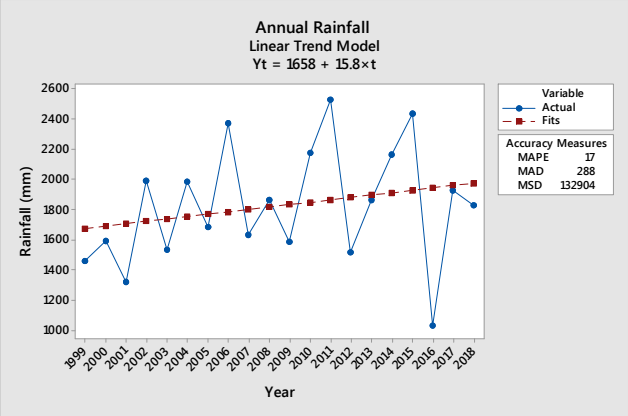

Fig. 2 Annual Rainfall Trend

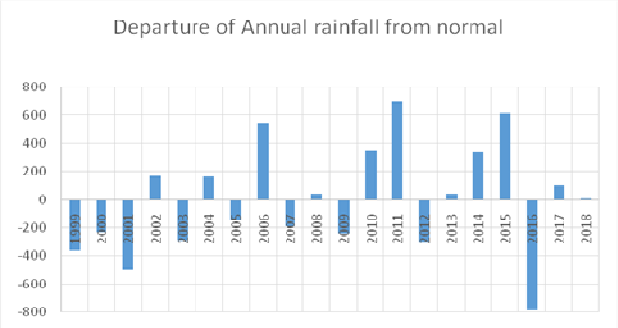

Fig. 3 Departure of Annual Rainfall from normal

B. Seasonal Rainfall Trends

During the past 20 years, seasonal rainfall has been considerably changed. Considering with coefficient of variation in seasons First Inter-Monsoon season, it shows the highest variation as 32.09 mm/year and Southwest-Monsoon Season, Second Inter-Monsoon Season, Northeast - Monsoon Season shows 26.97 mm/year, 27.85 mm/year, 27.85 mm/year coefficient of variation respectively.

First Inter-Monsoon season rainfall shows a small increasing trend of 0.15 mm/year. The minimum First Inter-Monsoon seasonal rainfall was shown in 2014 and maximum First Inter-Monsoon seasonal rainfall was shown in 2016. The respective values are 241.7 mm/year and 947.9 mm/year. In May to September (Southwest-monsoon Season) shows a comparatively high increasing trend of 14.8 mm/year. 1047.9 mm/year and 2815.3 mm/year were shown as a minimum and maximum

Southwest -Monsoon Seasonal rainfalls in the year 2016 and year 2014 respectively. Long term Second Inter-Monsoon Seasonal rainfall shows 15.1 mm/year increasing trend with a maximum in 2014 and minimum in 1016 as 4155.25 mm/year and 947.44 mm/year respectively. Northeast -Monsoon Season in December to February shows a comparatively very high increasing trend with 45.0 mm/year rainfall. The maximum Northeast -Monsoon Seasonal rainfall was shown in 2014 as 9377.43 mm/ year and the minimum was shown in 2016 as 1250.42 mm/year.

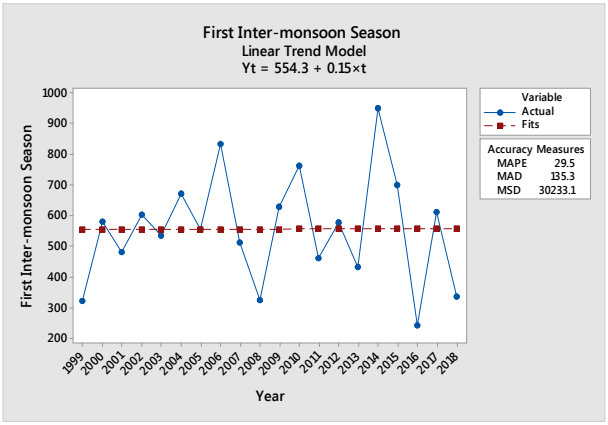

Fig. 4 FirstInter-Monsoon Season Rainfall Trend

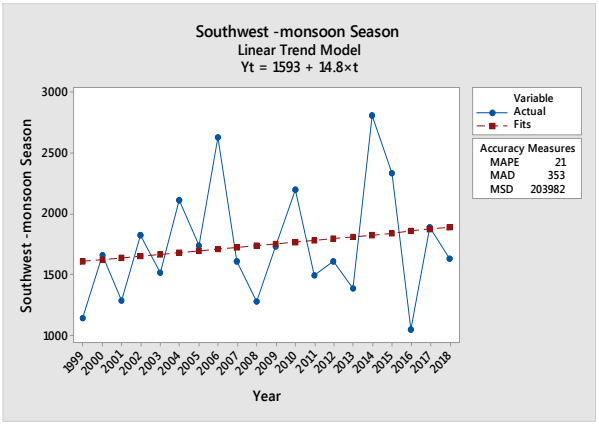

Fig. 5 Southwest -Monsoon Season Rainfalls

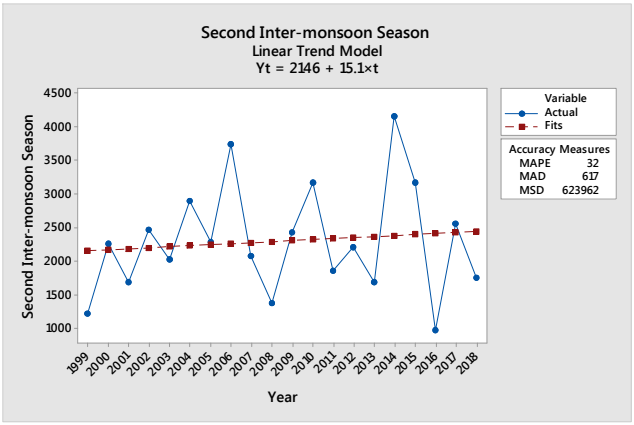

Fig. 6 Second Inter-Monsoon Season Rainfall

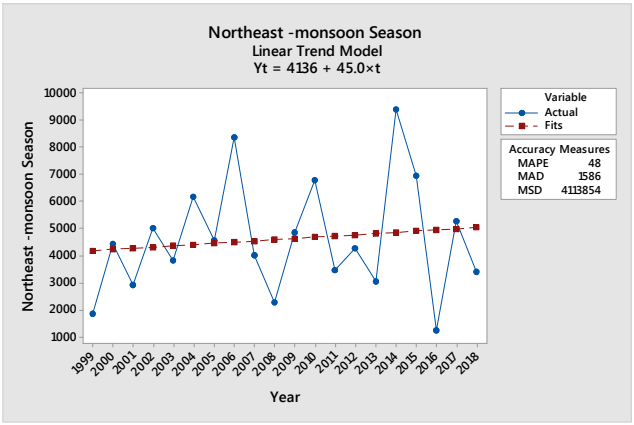

Fig. 7 Northeast -Monsoon Season Rainfall Trend

C. Monthly Rainfall Trends

Characteristics of monthly rainfall over Badulla have been calculated for individual months by fitting them to the linear trends. Maximum monthly rainfall was observed for November, December and October and they were 5173.1 mm, 5397 mm and 5720.1 mm respectively. The minimum monthly rainfall was observed in July, June and August and they were 949.2 mm, 952.4 mm and 1397.3 mm correspondingly.

Analysing the fitted linear trends, four months (33.33%) shows the decreasing monthly rainfall trend and eight months (66.66%) shows the increasing monthly rainfall trends. The negative maximum monthly rainfall trends were shown in

January and November. The minimum negative rainfall trend was shown in September and it was -0.66. Within the other Eight months May and October shows maximum positive monthly rainfall trends, respectively given by 8.15 mm and 6.35 mm.

For monthly rainfall, maximum coefficient of variation was observed for February and June and they were 100.97 % and 100.61 % respectively and minimum coefficient of variation was observed for November and it was 34.59 %. This means that monthly rainfall was more variable in February and June it is more stable in November.

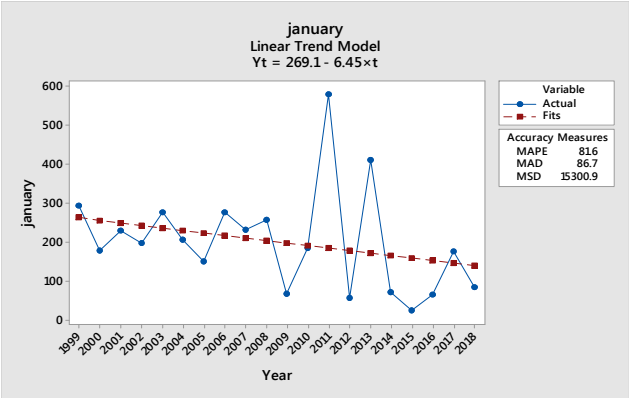

Fig. 8 January Rainfall Trend

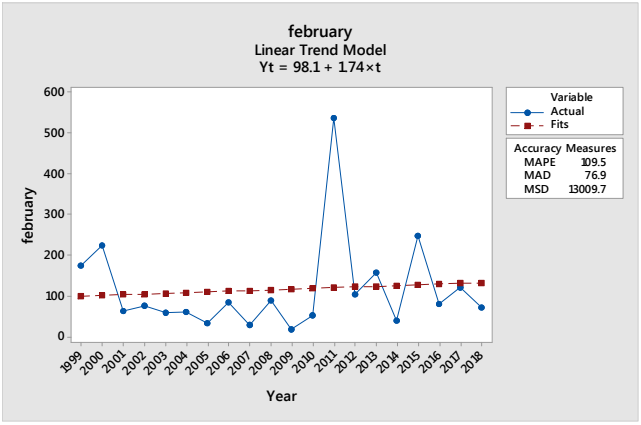

Fig. 9 February Rainfall Trend

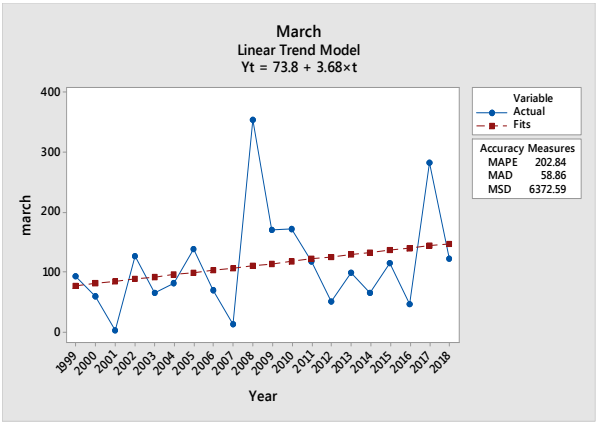

Fig. 10MarchRainfall Trend

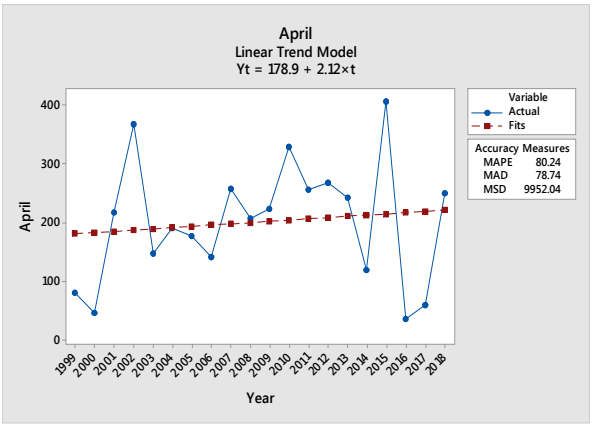

Fig. 11AprilRainfall Trend

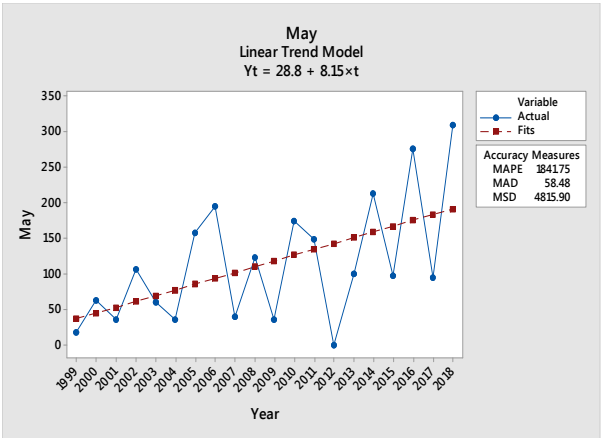

Fig. 12 MayRainfall Trend

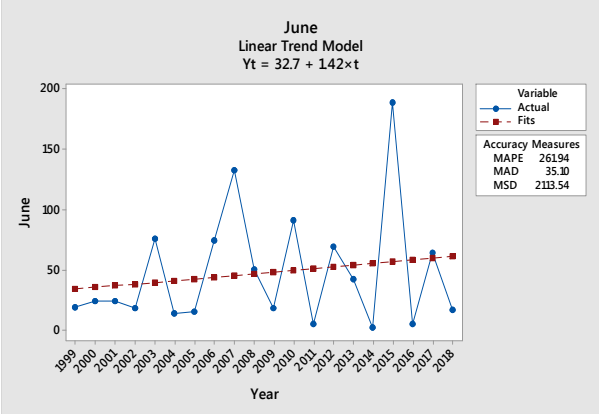

Fig. 13 JuneRainfall Trend

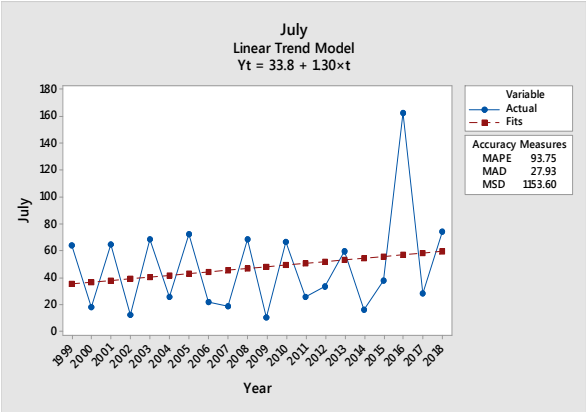

Fig. 14 JulyRainfall Trend

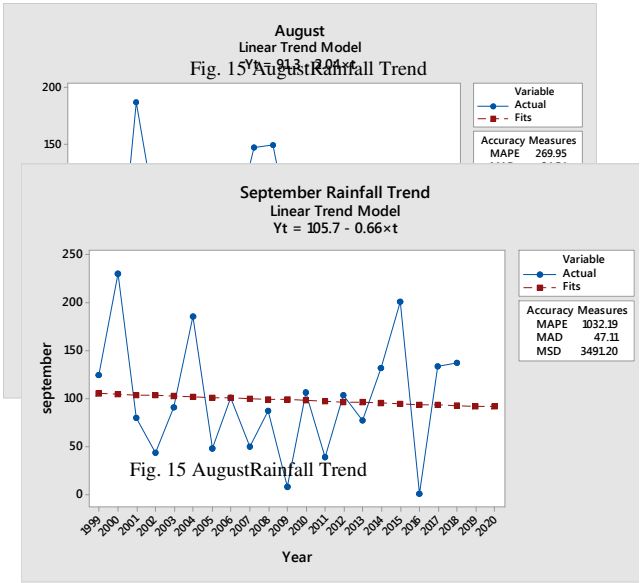

Fig. 15 AugustRainfall Trend

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Fig. 16September Rainfall Trend

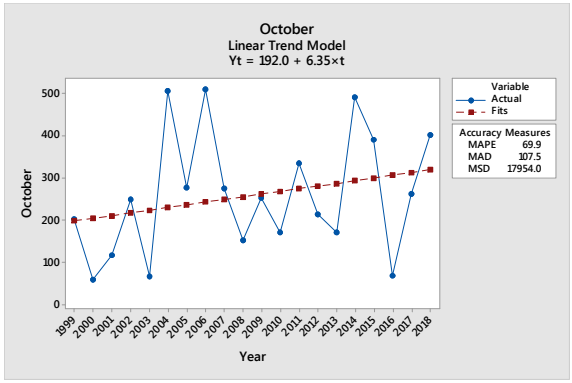

Fig. 17October Rainfall Trend

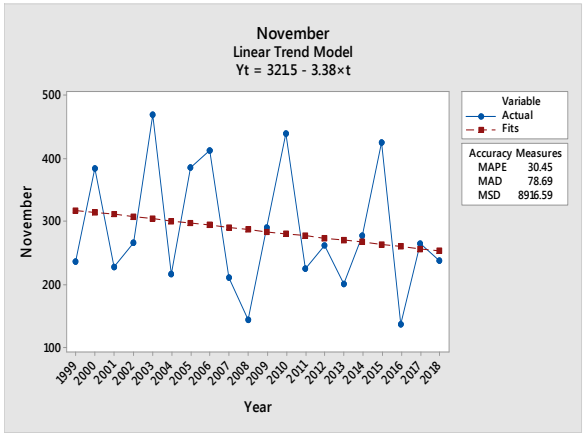

Fig. 18 November Rainfall Trend

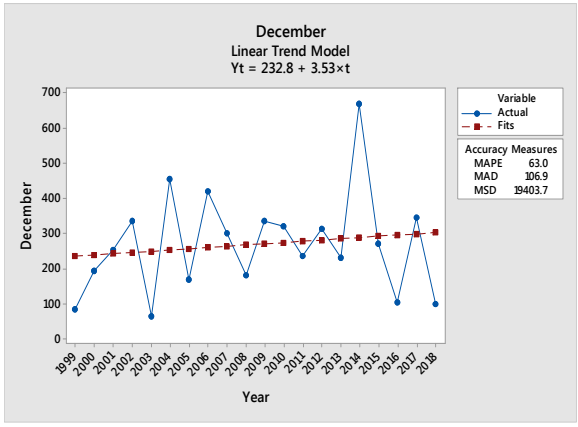

Fig. 19 DecemberRainfall Trend

V. CONCLUSIONS

The aim of the present study was to identify rainfall trends for the period of 1999 to 2018 over Badulla district. Annual rainfall trends showed a significantly increasing trend of about 15.8 mm/Year. Near about 12 years (60 %) shows annual rainfall less than that of mean annual rainfall and 08 years (40 %) show annual rainfall more that of mean annual rainfall. The maximum rainfall was observed in 2001 and it is 2525.1 mm and minimum rainfall was observed in 2010 and it was 1034.7 mm.

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