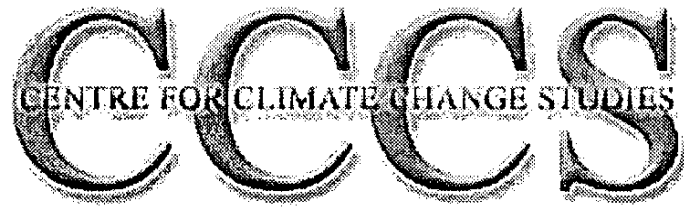


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REPORTS
OF
RESEARCH STUDIES
CONDUCTED
BY THE
CENTRE FOR CLIMATE CHANGE STUDIES

**UNDER THE BLOCK GRANT- RG/BG/2000/05 OF THE
NATIONAL SCIENCE FOUNDATION**

SEPTEMBER 2002

CENTRE FOR CLIMATE CHANGE STUDIES

DEPARTMENT OF METEOROLOGY

383, BAUDDHALOKA MAWATHA

COLOMBO 7, SRI LANKA

TEL./FAX. 941-676259

**Research Studies funded by the Centre of Climate Change Studies
under National Science Foundation Block Grant RG/BG/2000/05**

1. Effect of Climate Change on Rubber Plantations in Sri Lanka by W. Wijesuriya¹
2. A Comparative Study of the Ambient Air Temperature Trends at Anuradhapura and Maha Iluppallama by T.K. Fernando² and B.R.S.B. Basnayake³
3. A Study of the Variation of Thunderstorm Activity over Sri Lanka by K.R. Abhayasinghe Bandara³
4. Impact of Climate Change on Coconut Production in LCWIR and LCWR regions of Sri Lanka by T.S.G. Peiris⁴
5. Assessment of Evidence, Causes and Implications of Change in Daily Temperature Regimes in Sri Lanka by B. Marambe⁵, B.R.S.B. Basnayake³, B.V.R. Punyawardena⁶, K.R. Dinuka⁵ and G.D. Thambawita⁵
6. Variations of Air Temperature and Rainfall during the Yala and Maha Agricultural Seasons by B.R.S.B. Basnayake³ and T.K. Fernando²
7. Development of a Database on Climate and Climate Change Studies by B.R.S.B. Basnayake¹ and G. Gunasekera

1 Rubber Research Institute, Agalawatte

2 Ministry of Environment and Natural Resources, Battaramulla

3 Department of Meteorology, Colombo 7

4 Coconut Research Institute, Lunuwila

5 Faculty of Agriculture, University of Peradeniya, Peradeniya

6 Natural Resource Management Centre, Department of Agriculture, Peradeniya

Effect of Climate Change on Rubber Plantations in Sri

Lanka

by

W. Wijesuriya

Rubber Research Institute

Agalawatte

Title: Effects of Climate Change on Rubber Plantations in Sri Lanka

Research Institute: Rubber Research Institute of Sri Lanka

Period of contract: 01st June to 30th November 2001

Scientific background and scope/objectives of the study:

This study was focused on finding any changes in the rainfall; temporal and seasonal together with other important meteorological factors, in major rubber growing areas. Special focus was made on finding the risks of dry spells, onset and cease of rains in a rainy season and to relate them with management practices in rubber plantations to suggest a crop calendar with possible improvements.

Experimental method:

Daily data on rainfall in 15 stations covering the rubber growing areas of Sri Lanka were collected from the Meteorological Department. The time frame covered was 1941 to 2000. Data on other meteorological factors were also collected from 6 AGROMET stations

The statistical methods involved in analyses were;

- Descriptive analyses consisting of; computation of average, minimum, maximum, coefficient of variation (CV%) and quartiles for yearly and monthly data
- Time series techniques to identify any trends, seasonal effects or cycles for yearly and monthly data,
- Probability analyses *viz.* incidence of a wet week, a wet week after a wet week (W/W) for weekly rainfall totals; 20 mm, 30 mm, 40 mm and 50 mm,
- Regression analysis to identify the significance of the trend in yearly and monthly data, and

Identification of start and end dates for the 2 major rainy seasons.

Results obtained:

Long term annual rainfall values showed significant declining trends in Peradeniya, Aranayake, Matara, Nalanda, Ambanpitiya, Galle, Avissawella Matale and Okkampitiya. Random fluctuations were observed in Agalawatta, Badulla, Kalutara, Ratnapura, Kurunegala and Hanwella with no significant trends. Analysis of annual rainfall under different scenarios suggested that during the period 1981 to 2000, majority of the locations indicated negative deviations indicating decreased rainfall during this period. Significant declining trends were observed in March for Avissawella, Agalawatta, Ratnapura, Galle, Ambanpitiya, Aranayake and Matale. Declining behaviour in Rainfall was observed for December in Ambanpitiya, Aranayake, Peradeniya, Nalanda and Kurunegala. No significant trends were identified in Hanwella, Kalutara and Badulla for any of the months. Although, significant declining trends were observed, the magnitude was small.

At Avissawella after 1994, a late start and an early end was observed for the 1st rain spell. In the Ambanpitiya area, the start of the first rain spell was found to be fairly late during the last 4 years. Moreover, the length of the first spell seemed to be narrowing towards the year 2000. Any marked shift was not identified in other locations.

Conclusions:

Any marked variations were not observed for rainfall in rubber growing areas. However, it is important to note any departures from the normal

trend as these will be useful to find out adaptation measures with respect to the productivity of a certain crop.

Based on probabilities associated with wet weeks and dry spells, this study identified suitable periods for different farming operations; namely, clearing, holing, planting, fertilizer application, disease control and other operations such as; rain guarding in rubber plantations located in different agro-ecological regions in Sri Lanka.

FINAL REPORT

**EFFECTS OF CLIMATE CHANGE ON RUBBER
PLANTATIONS IN SRI LANKA**

(CCCS/RP/09)

**BIOMETRY SECTION
RUBBER RESEARCH INSTITUTE OF SRI LANKA**

2002

1. DETAILS OF THE PROJECT

- (A) Research Proposal No. : *CCCS/RP/09*
- (B) Title of the study : *Effects of climate change on rubber plantations in Sri Lanka*
- (C) Institute where research was carried out :
Rubber Research Institute, Agalawatta
- (D) Name/Address of the Principal Investigator:
Wasana Wijesuriya
Biometry section
Rubber Research Institute
Agalawatta
- (E) Name/Address of co-investigator:
Keminda Herath
Biometry section
Rubber Research Institute
Agalawatta
- (F) Date of award of the grant :
01-06-2001
- (G) Date of completion of the research:
31-05-2001
- (H) Total allocation :
Rs, 37,000.00
- (I) Total spent (Grantee's estimate) :
Rs. 36921.00
- (J) No. of Technical Assistants and period of service:
01 (one)
01st June to 30th November
- (K) Whether RA has registered or obtained post-graduate degree
Not applicable

2. DESCRIPTION OF THE RESEARCH CARRIED OUT

2.1 INTRODUCTION

Climate changes interfere with the biological phenomena causing different impacts on plant growth and hence productivity. Rubber production depends on good management practices and on factors mostly related to the weather, over which the planter has no control. All these management practices in a planting cycle are linked with the weather pattern.

Rubber (*Hevea brasiliensis* Muell Arg.) cultivation is mainly limited to the wet south-west corner of Sri Lanka because the rubber plant grows well only in areas where moisture is not a limiting factor. Rainfall is of great concern to the rubber grower as it affects the tree at all stages of growth from planting through felling. Hence, any changes in the seasonal pattern may have adverse impact on the application of recommended agronomic practices in rubber plantations. Some important events of interest on this regard are; start, end and length of the rainy seasons, amount of rainfall in different seasons and risk of dry spells. Findings of initial research work on these aspects have been reported by Liyanage *et. al.*, (1984), for the Raigama area and recommended the optimum times for carrying out various cultural operations involved in rubber cultivation, namely; clearing, burning, holing, planting, fertilizer application and disease control.

Apart from the management practices, disease incidence, flowering, pod set and pod ripening are closely linked with seasonal pattern of weather factors. Recent studies conducted by the Rubber Research Institute revealed low seed production in most of the rubber growing areas in the wet zone (Seneviratne *et. al.*, 1999). This has become a major threat in production of quality planting materials through budding techniques. During the past few years, several leaf diseases also appeared as epidemics due to the conducive weather pattern for initiation and spreading of leaf diseases (Annual Reviews of RRISL; 1997, 1998 and 1999).

Rubber yield is seasonal in nature. A steady drop in yield is observed during February to April (wintering period) and, during May to July the trees recover (post-wintering period). Fairly high yields are observed during August to October (High yielding period) and followed by 'peak yielding period' during November to January (Wijesuriya *et. al.*, 1997). It is an accepted fact that the total number of tapping days determines the economic yield of rubber, which depends on number of rainy days. Temperature, relative humidity, sun shine hours, wind velocity and evapo-transpiration also have combined influence on growth, disease incidence and yield of rubber (Sethuraj and Mathew, 1992). Therefore, any changes in the seasonal pattern in environmental factors can have direct impact on rubber production.

The influence of rainfall on yield of rubber has been studied by Senanayake (1978) and confirmed that there is a positive non-significant relationship exist between them. A well spread-out rainfall

is needed especially during the immature stages of rubber to assure a vigorous and uniform growth. Several studies were reported in India, Malaysia and Sri Lanka, where rainfall is considered as a major factor influencing land productivity of rubber plantations (Anon, 1998; Devakumar *et. al.*, 1998 and Samrappuli, 1998). However, number of rainy days during the latter part of the year can have adverse impact on profitability of plantations because the number of tapping days are reduced during the peak yielding period of rubber. Attempts have been made to relate weather parameters to rubber yield by Sailajadevi *et. al.* (1998). However, in general very little information is available on impact of meteorological factors on productivity of rubber lands. Moreover, no quantitative analyses were done except visual observations on effect of weather factors on disease incidence in rubber plantations.

This study was focussed on finding any changes in the rainfall; temporal and seasonal together with other important meteorological factors, in major rubber growing areas. Special focus was made on finding the risks of dry spells, onset and cease of rains in a rainy season and to relate them with management practices in rubber plantations to suggest a crop calendar with possible improvements.

2.2 MATERIALS AND METHODS

2.2.1 DATA

Daily data on rainfall in 15 stations covering the rubber growing areas of Sri Lanka were collected from the Meteorological Department.

The time frame covered was 1941 to 2000. Rainfall records of the Dartonfield estate were also employed in analyses, but the data availability was limited to the period 1964 to 2000. Table 1 describes these areas and the respective agro-ecological regions (AER's).

Table 1. Selected rainfall stations in rubber growing areas and their agro-ecological regions (AER's)

AER	LOCATION
WL-1	Agalawatta Ratnapura Avissawella
WL-2	Ambanpitiya
WL-3 and WL-4	Galle Kalutara Hanwella Matara
WM-2 and WM-3	Peradeniya Matale Aranayake
IL-1	Kurunegala
IL-2	Okkampitiya
IM-3	Nalanda
IU-2	Badulla

Data on other meteorological factors were also collected from AGROMET stations. The data availability and the stations from which the data were collected are given in Table 2. The data availability was limited to a shorter period and therefore, it was not possible to carryout analyses to identify any long-term deviations in these meteorological factors.

Table 2. Selected AGROMET stations in rubber growing areas, data availability and their agro-ecological regions (AER's)

AER	Location	Data availability (years)
WL-1	Ratnapura	1976-2000
WL-2	Kottawa	1978-2000
WL-3 and WL-4	Bombuwala Katunayake	1976-2000 1990-2000
WM-2 and WM-3	Peradeniya	1977-2000
IL-1	Batalagoda	1976-2000
IL-2	Monaragala	1998-2000

2.2.2 METHOD

ANALYSIS OF RAINFALL DATA

Data Management

Data collected in text format were reformatted in EXCEL for easy data management and exploration.. Daily data were summarized into yearly, monthly and standard week bases for all the stations.

Data Analysis

The methods involved were;

- Descriptive analyses consisting of; computation of average, minimum, maximum, coefficient of variation (CV%) and quartiles for yearly and monthly data
- Time series techniques to identify any trends, seasonal effects or cycles for yearly and monthly data
- Probability analyses *viz.* incidence of a wet week, a wet week after a wet week (W/W) for weekly rainfall totals; 20 mm, 30 mm, 40 mm and 50 mm. Similarly, the probability of

incidence of a dry week after a dry week (D/D), was also computed.

- Regression analysis to identify the significance of the trend in yearly and monthly data

Criteria for determination of onset and cease of rains

a) Onset of rains

Defining the onset of rains is difficult due to the wide variability of the specific nature of the rainfall pattern in Sri Lanka. Such a definition depends on the particular purpose as well. A rainy day is defined as having a rainfall greater than 0.5mm although an agricultural rain is defined as; having a rainfall greater than 0.3mm per day. The start of rains is defined using three specific components as follows.

- a.) The onset of rains is considered, after a stated date; 1st March and 1st August for South West (SW) rains and North East (NE) rains, respectively.
- b.) A potential start date will be the first occurrence of at least 30mm of rain summed over 3 consecutive days. At least two out of 3 days should be rainy.
- c.) The potential beginning could be a false start if there is a seven-day dry spell within next twenty days after potential start.

b) Cease of rains

The date of the end of rains is also difficult to decide due to the intermittent and patchy nature of rains in the Island. The definition of the cease of rains also depends on the particular application. The components that define the cease of rains are termed as follows.

- a.) The end date of rains is considered on a stated date; 1st July and 15th January for SW and NE rains, respectively.
- b.) The first 3-day dry spell is considered as a potential end of rains.
- c.) This day is a false one if the total rainfall over next 20 days exceeds 100mm.

Although the start and end dates were specified, certain difficulties were encountered during the analysis. In several locations, deviations were observed in start and end dates. These deviations are discussed under results obtained.

ANALYSIS OF OTHER METEOROLOGICAL FACTORS

Data on; air temperature, relative humidity, sun shine hours and wind velocity were available only for 24 years in most of the selected areas. Therefore, it was not possible to carryout analyses to identify any long-term deviations in these meteorological factors. However, time series plots were prepared for the selected locations.

3. RESULTS OBTAINED

3.1 DESCRIPTIVE STATISTICS OF ANNUAL RAINFALL

The long-term mean of the rainfall is useful in comparing different locations to assess the potential of agricultural crops. The ideal annual rainfall for rubber should fall within the range of 1650 – 3000 mm and be reasonably uniformly distributed throughout the year. It was reported that, in general the tree performance will be severely affected if rainfall over a six month period is less than 500 mm, especially when it is not uniformly distributed.

Table 3 depicts the descriptive statistics of rainfall for different regions studied. The Q_{25} and Q_{75} values were computed using relative frequency occurrence by ranking the data series (Q_{25} = 75% expected probability and Q_{75} = 25% expected probability). Favourable values of rainfall for successful rubber cultivation were observed in all locations except in Matara. Rainfall values reported in the station at Matara is comparatively low as it is monitored in the coastal zone. The average values are fairly large in the areas where rubber is grown. As reported by Katulande (1985), WL-1 and WL-2 areas in the Matara district receive more than 2540 mm and 1905 mm, respectively. Further, the 75% expected values are also greater than the lower limit for rubber cultivation (1650 mm) except for Okkampitiya, Nalanda, Badulla and

Matara. The coefficient of variability (CV) varied from 11.2% to 25.7% in the locations studied. The CV % is generally high in areas where the total annual rainfall is low.

Table 3. Descriptive statistics of annual rainfall data from 15 different locations

Area	Location	Average (mm)	Min. (mm)	Max. (mm)	CV%	Q25 (mm)	Q75 (mm)
Low Country Wet Zone	Avissawella	3562	1963	4703	16.2	3132	3821
	Agalawatta	4211	3188	5057	12.7	3755	4717
	Ratnapura	3504	2684	4720	14.0	3068	3892
	Ambanpitiya	2453	1098	3342	20.0	2050	2741
	Matara	1547	570	2735	25.7	1330	1754
	Galle	2423	1550	3859	16.5	2180	2599
	Kalutara	2142	1400	3940	20.5	1828	2435
Mid Country Wet Zone	Hanwella	3178	1797	4561	17.2	2820	3645
	Peradeniya	2130	1346	2883	17.5	1920	2365
	Aranayake	2293	1158	3299	20.0	1943	2608
Low Country Inter-mediate Zone	Matale	3767	2486	5349	11.2	3603	3970
	Kurunegala	2053	1474	2923	16.6	1797	2245
Mid Country Intermediate Zone	Okkampitiya	1669	1065	2734	21.2	1420	1907
	Nalanda	1801	1048	2798	21.1	1520	1994
Up Country Intermediate Zone	Badulla	1743	1175	2607	18.4	1541	1933

CV= Coefficient of variation Q25 = 75% expected value Q75 = 25% expected value

TEMPORAL VARIATION IN ANNUAL RAINFALL

In some areas, long-term annual rainfall values showed declining trends while some others had random fluctuations. The regression coefficients, t-values and the significance probability values are presented in Table 4. Annual rainfall values at Agalawatta,

Badulla, Kalutara, Ratnapura, Kurunegala and Hanwella had no significant declining trends. However, Peradeniya, Aranayake, Matara, Nalanda, Ambanpitiya, Galle, Avissawella, Matale and Okkampitiya data indicated significant negative trends.

Table 4. Results of linear regression analysis of annual rainfall values in different districts

Locations with significant negative trends

Area	Location	Regression coefficient	t-value	Significance probability
WM2&3	Peradeniya	-14.690	-3.690	0.000
WM2&3	Aranayake	-16.802	-3.860	0.000
WL3&4	Matara	-10.410	-3.690	0.000
IM3	Nalanda	-10.119	-4.150	0.000
WL2	Ambanpitiya	-10.365	-2.810	0.007
WL3&4	Galle	-7.667	-2.700	0.009
WL1	Avissawella	-13.536	-2.610	0.012
WM2&3	Matale	-7.684	-2.200	0.032
IL2	Okkanpitiya	-6.261	-2.200	0.032

Locations with non-significant negative trends

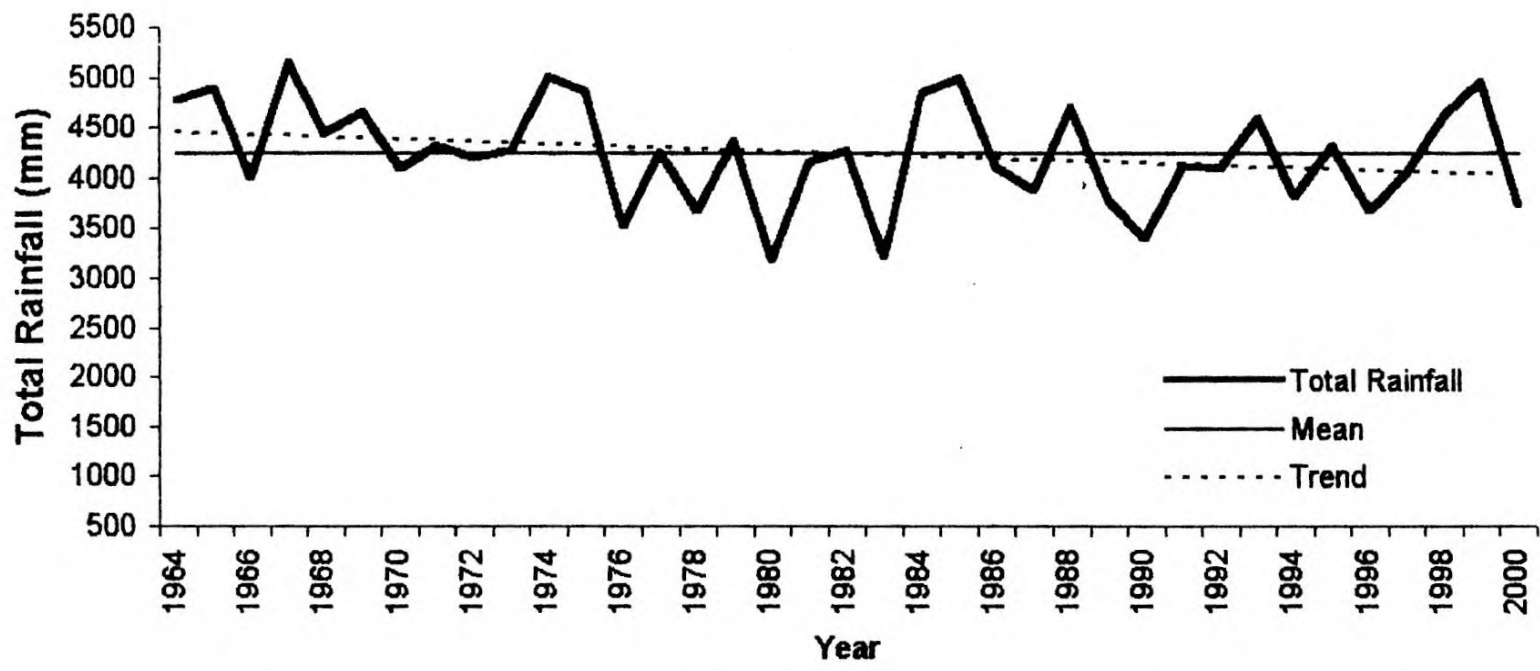
Area	Location	Regression coefficient	t-value	Significance probability
WL1	Agalawatta	-14.225	-1.774	0.085
IU2	Badulla	-2.708	-1.137	0.260
WL3&4	Kalutara	-3.181	-0.790	0.434
WL1	Ratnapura	-2.562	-0.695	0.490
IL1	Kurunegala	-1.583	-0.621	0.537
WL3&4	Hanwella	-2.197	-0.260	0.799

The temporal variation in annual rainfall in the selected 15 locations are depicted in figures 1 to 5. The plots of auto-correlations suggest that no cyclic patterns in annual rainfall except in the Agalawatta area (Fig. 6). In all other areas, a random variation was observed.

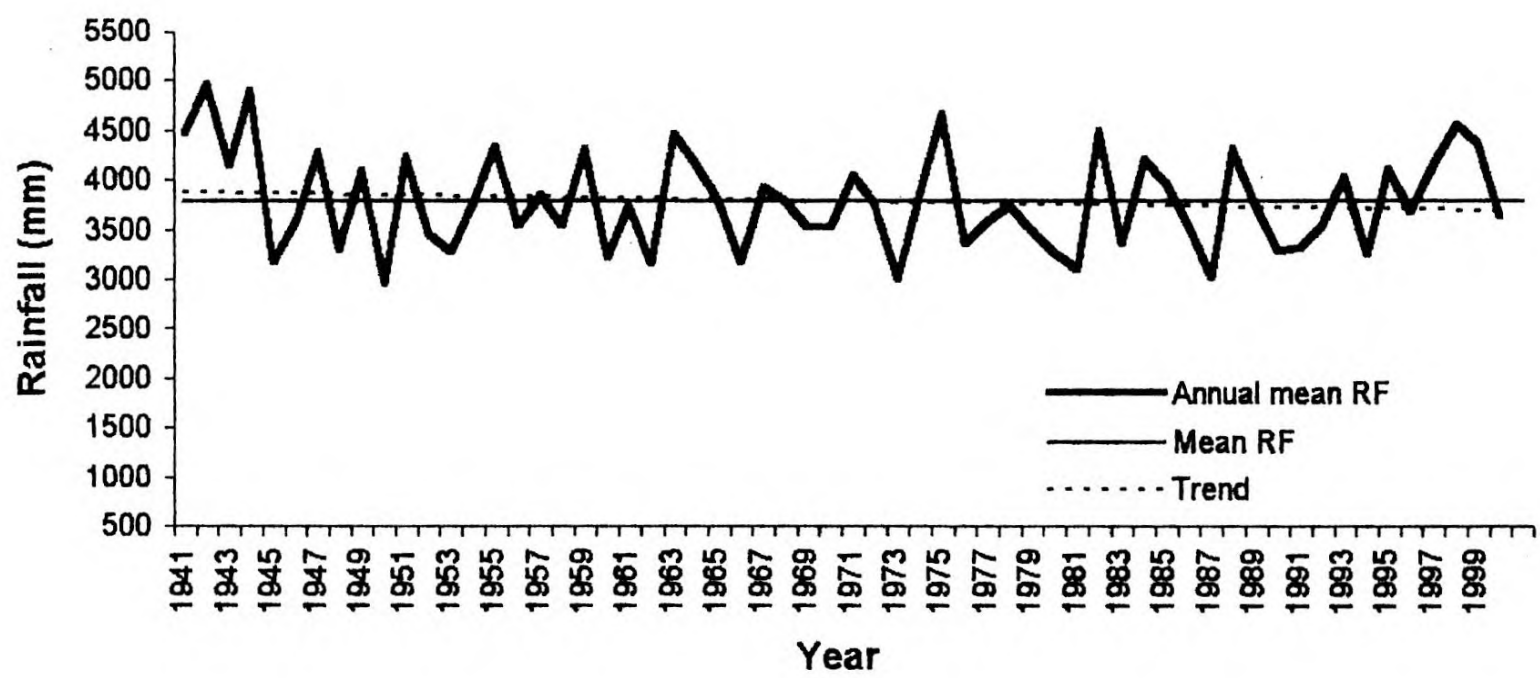
VARIATION IN ANNUAL RAINFALL UNDER DIFFERENT SCENARIOS

The mean annual rainfall for different scenarios; 1941-1960, 1961-1980 and 1981-2000 and the % deviation in annual rainfall with respect to the long-term average are presented in Table 5. During the

Agalawatta



Ratnapura



Avissawella

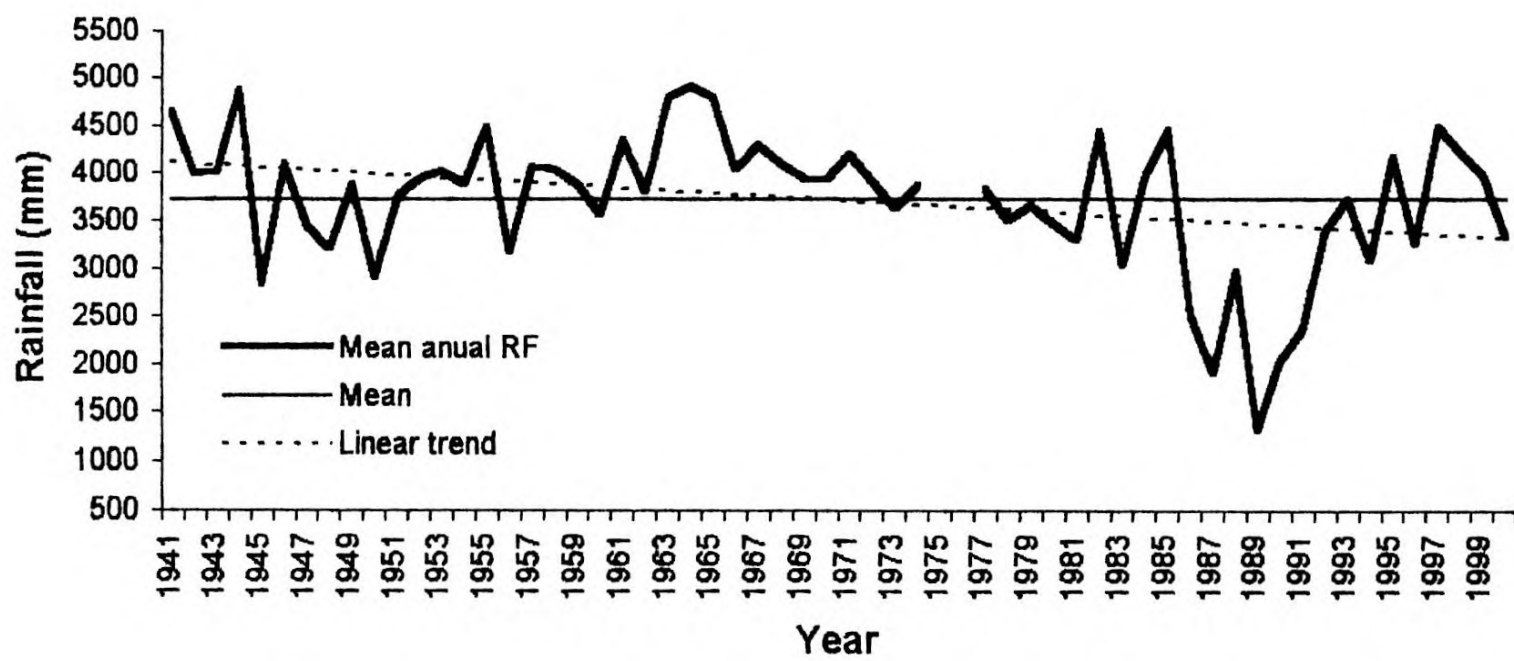
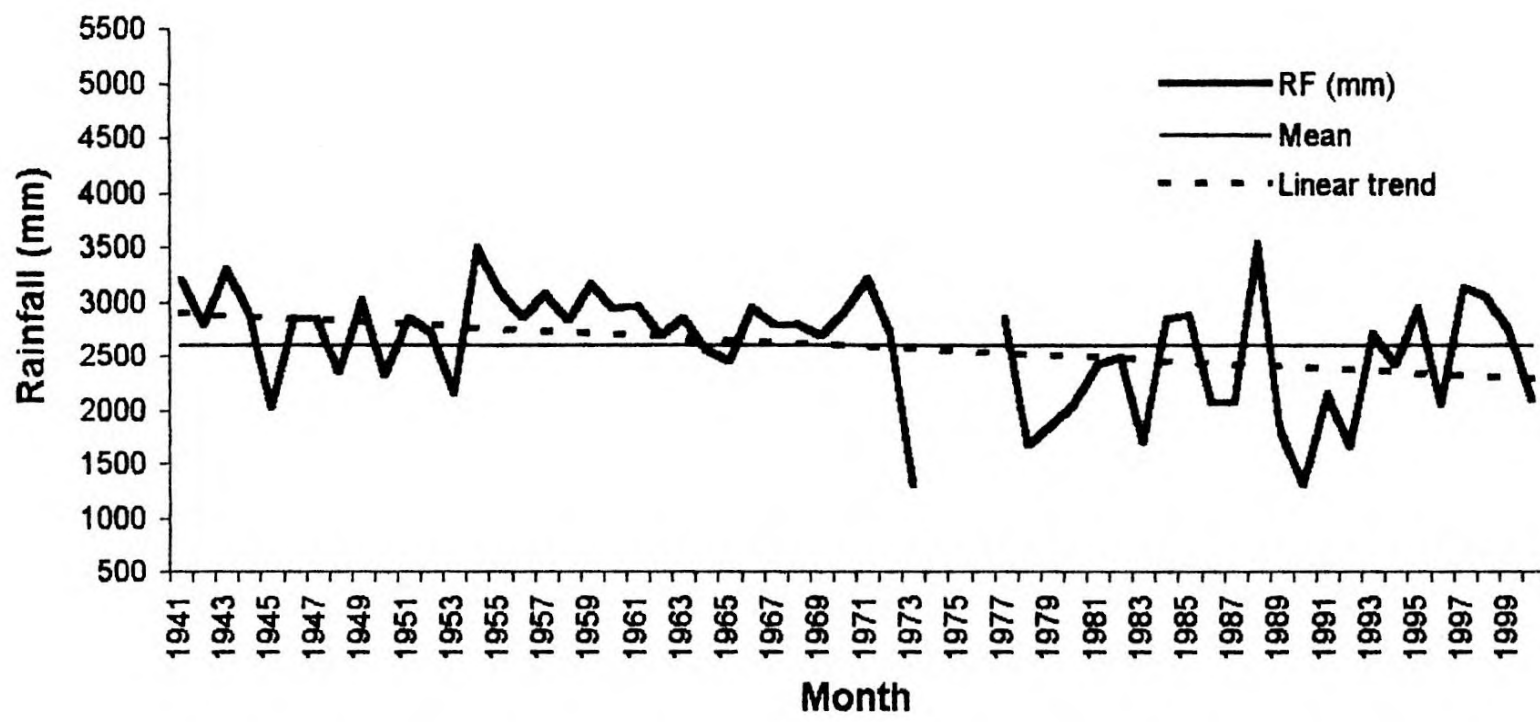
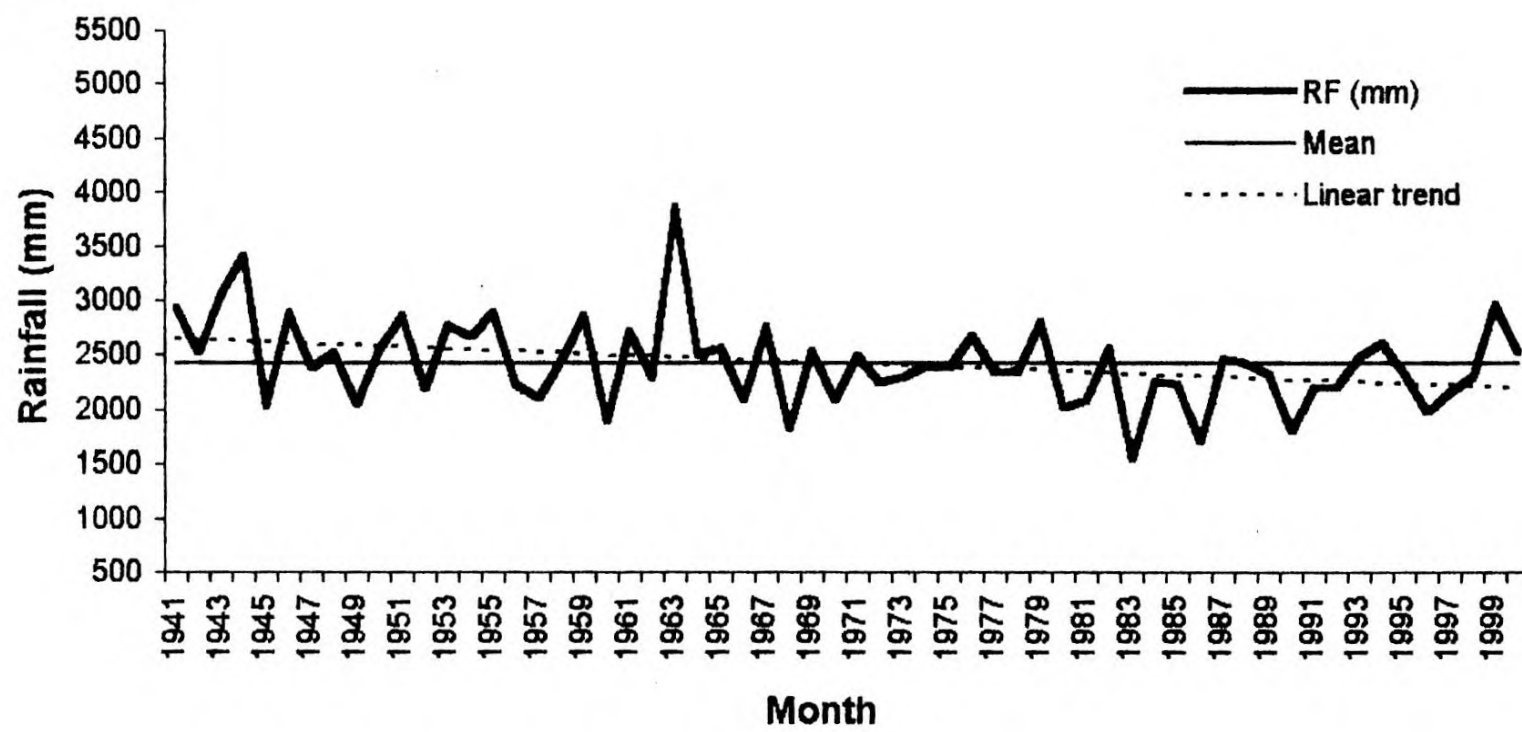


Fig. 1 Temporal variation in rainfall for Agalawatta Ratnapura and Avissawella

Ambanitiya



Galle



Kalutara

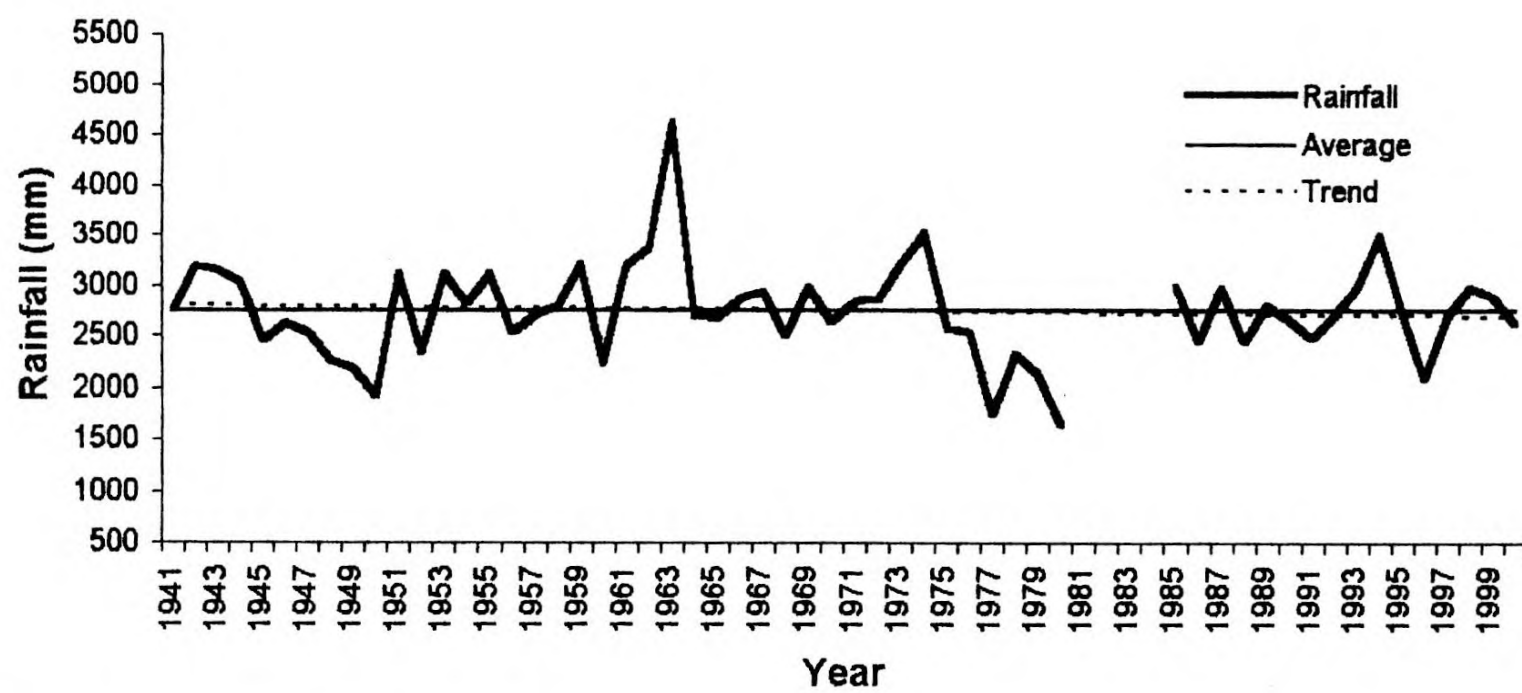
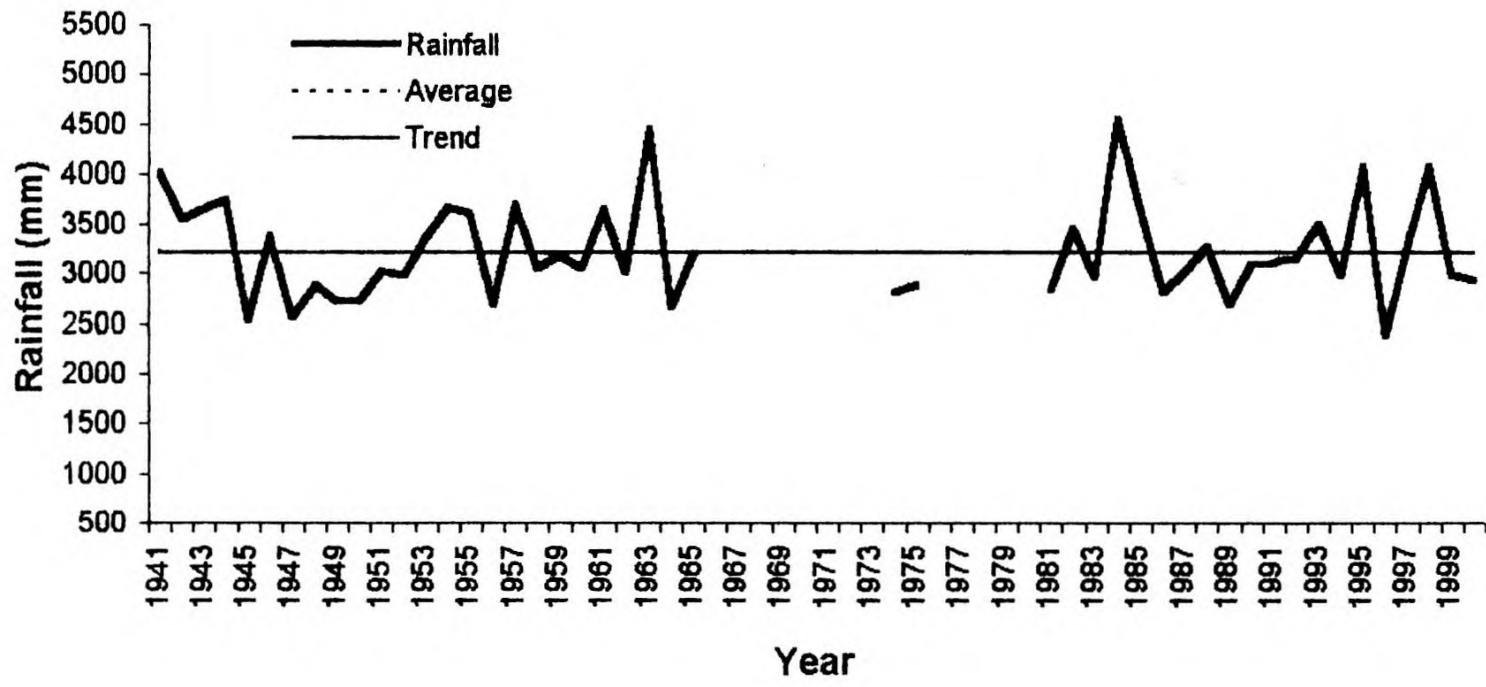
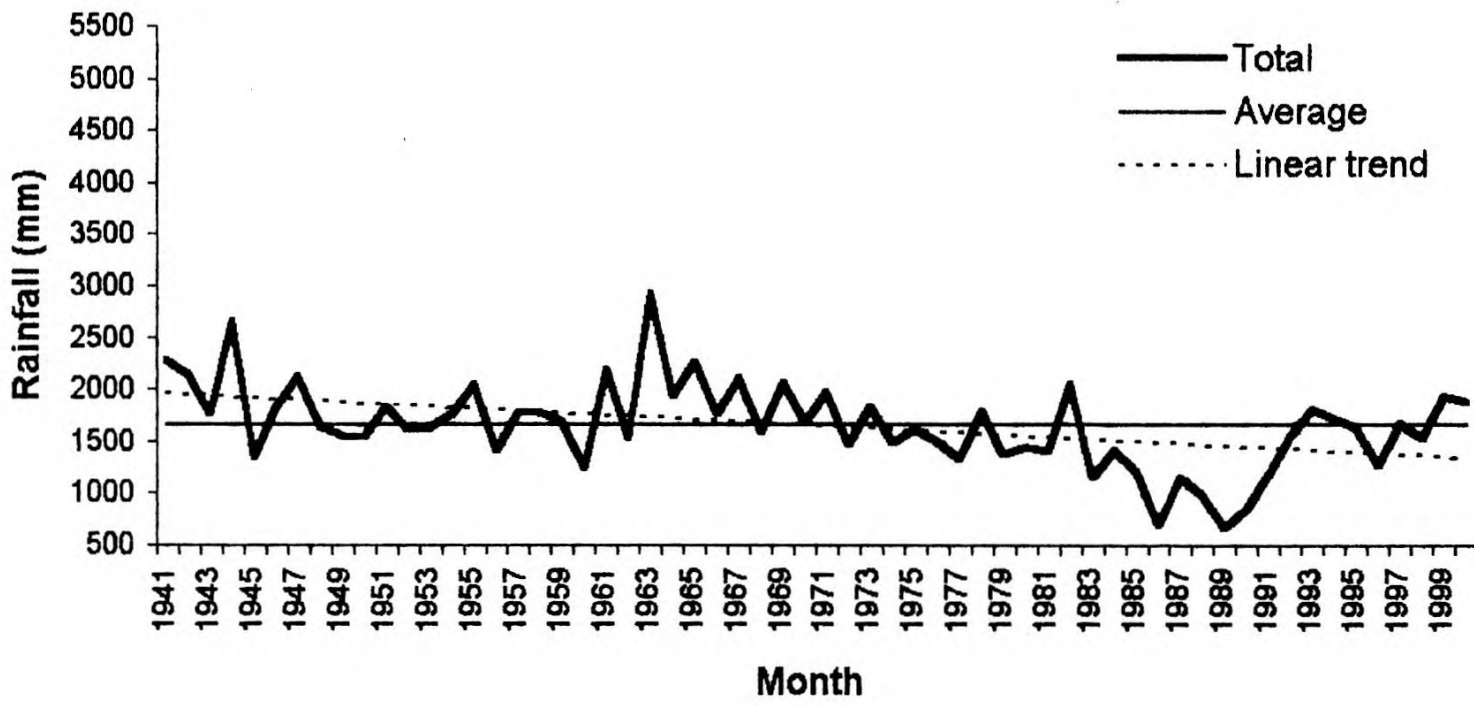


Fig. 2 Temporal variation in rainfall for Ambanpitiya, Galle and Kalutara

Hanwella



Matara



Peradeniya

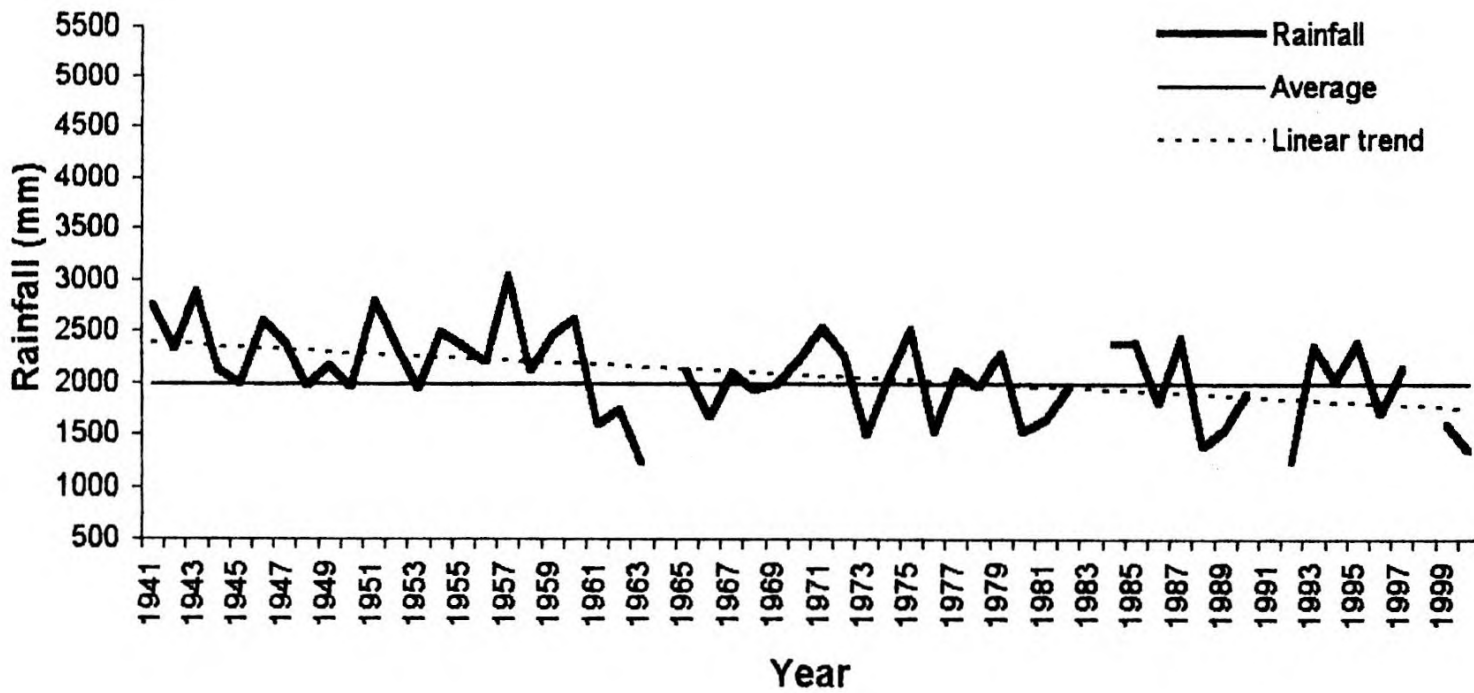
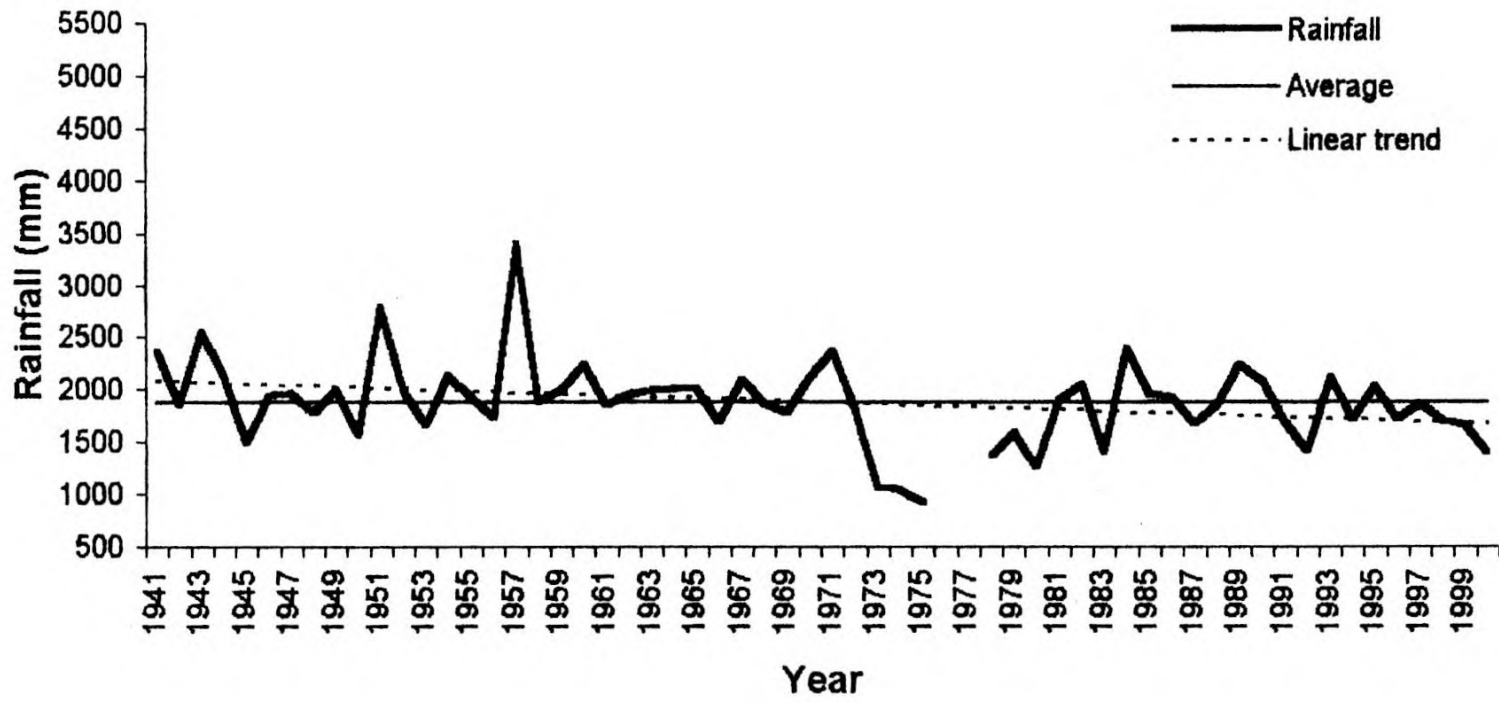
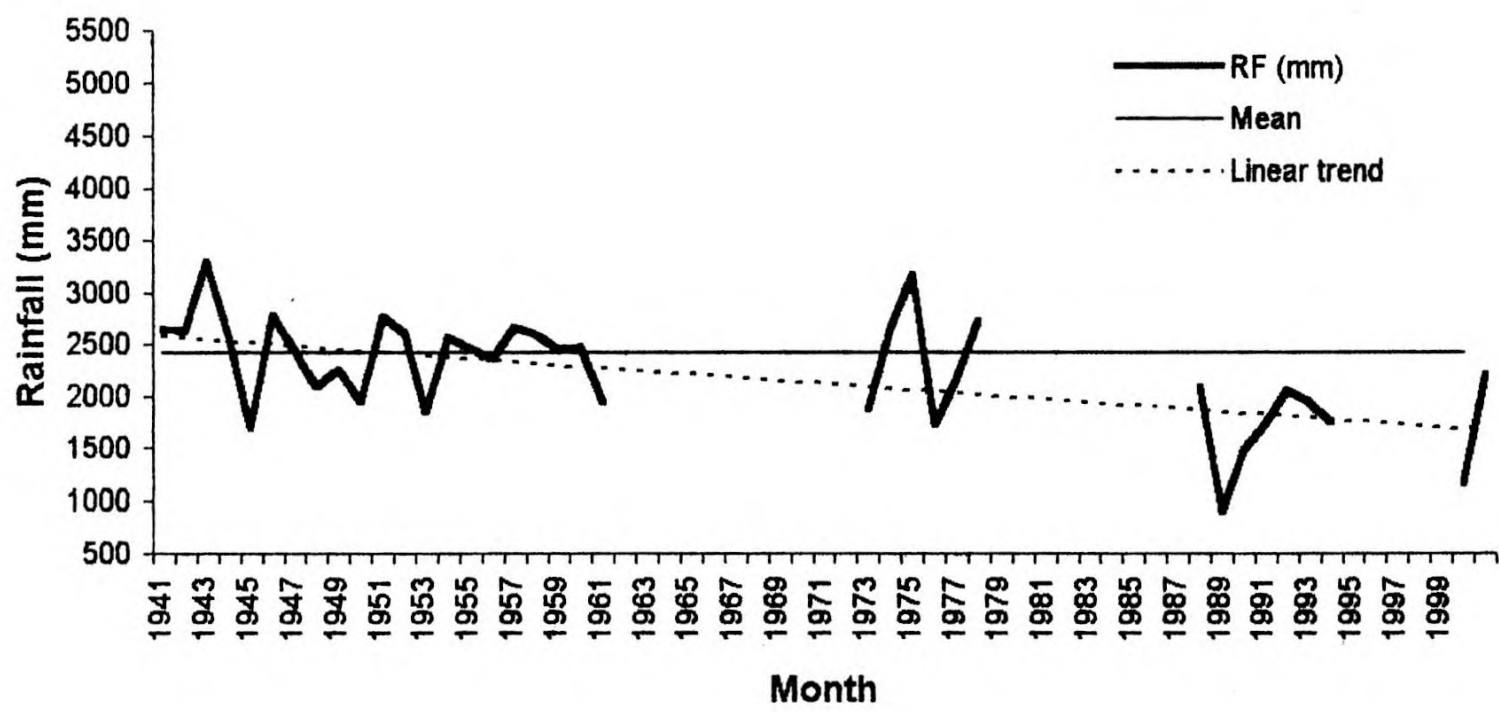


Fig. 3 Temporal variation in rainfall for Hanwella, Matara and Peradeniya

Matale



Aranayake



Kurunegala

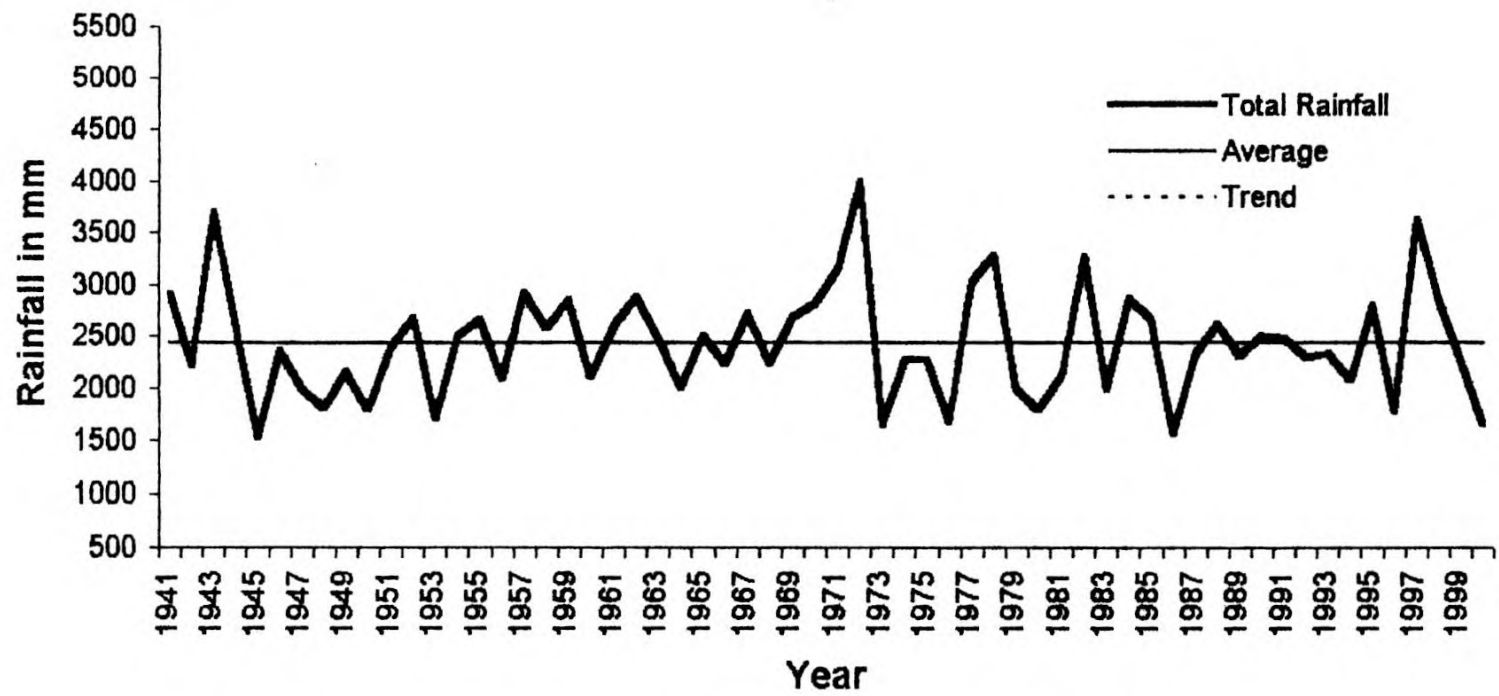
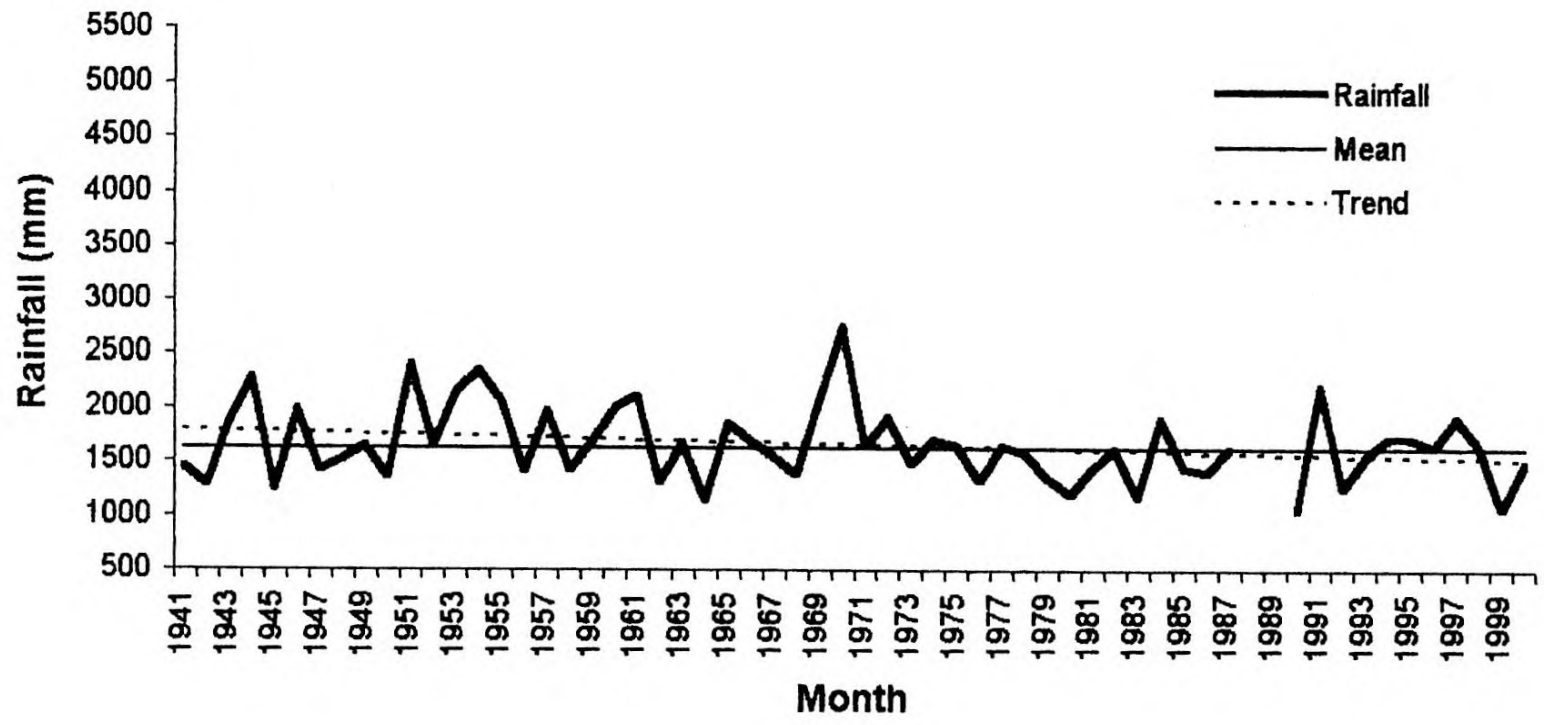
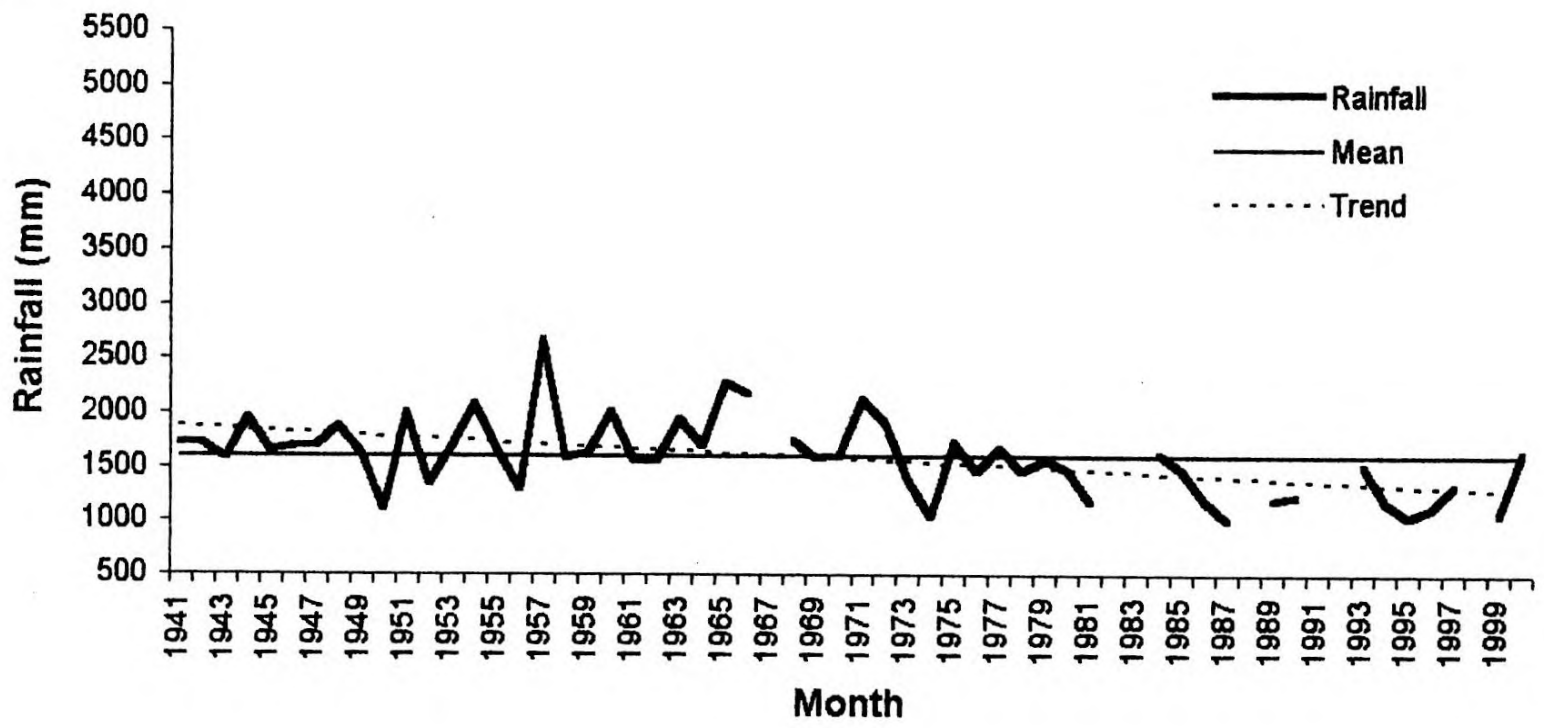


Fig. 4 Temporal variation in rainfall for Matale, Aranayake and Kurunegala

Okkampitiya



Nalanda



Badulla

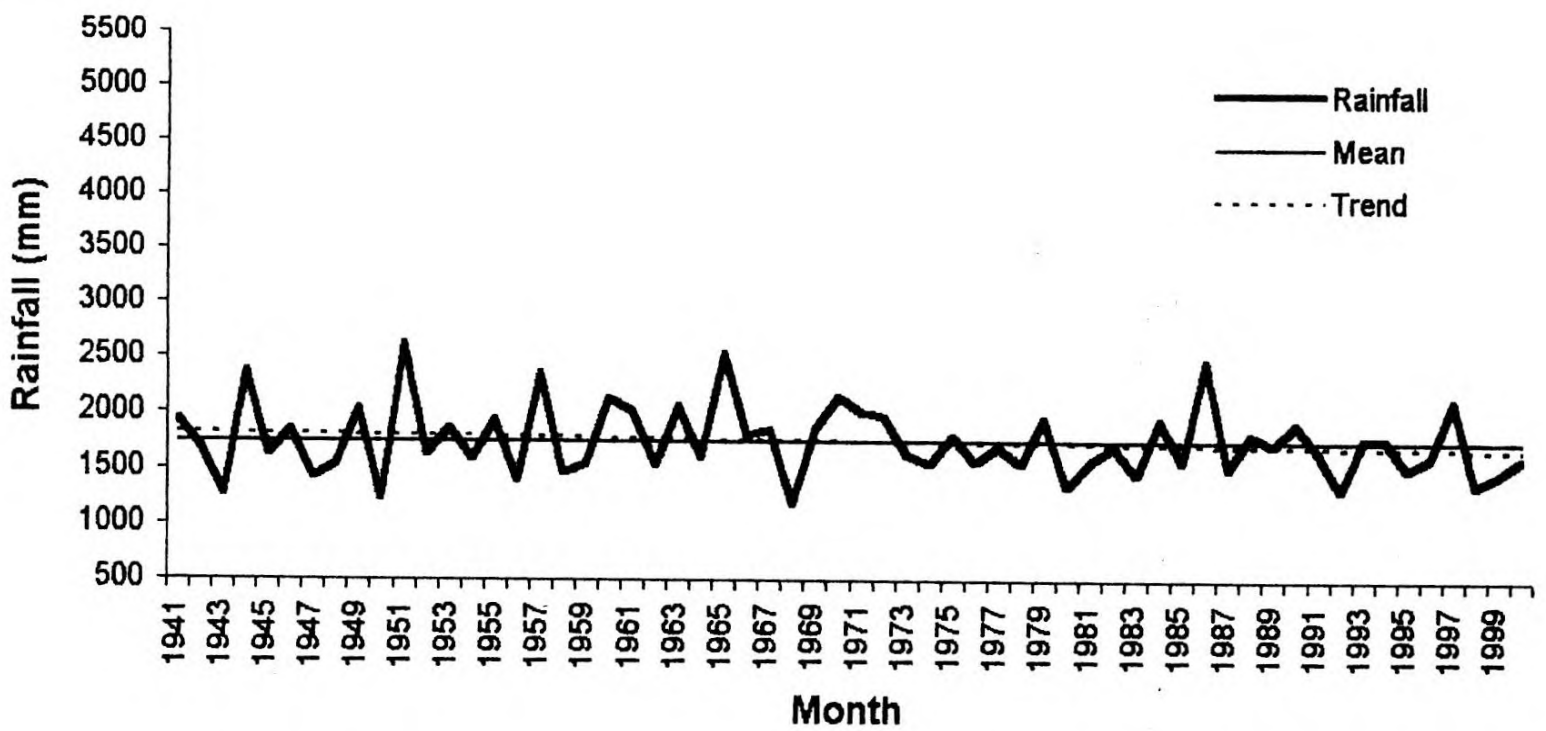


Fig. 5 Temporal variation in rainfall for Okkampitiya, Nalanda and Badulla

Autocorrelations: DARTONFIELD - Agalawatta

Lag	Auto- Stand.											Box-Ljung	Prob.
	Corr.	Err.	-1	-.75	-.5	-.25	0	.25	.5	.75	1		
1	-.023	.158					*					.021	.885
2	-.009	.156					*					.024	.988
3	.158	.153					I***					1.078	.782
4	.156	.151					I***					2.142	.710
5	-.160	.149					***I					3.292	.655
6	-.062	.147					*I					3.470	.748
7	.172	.144					I***					4.899	.672
8	-.172	.142					***I					6.367	.606
9	-.091	.139					**I					6.792	.659
10	.328	.137					I****	**				12.530	.251
11	.094	.134					I**					13.016	.292
12	-.199	.132					****I					15.306	.225
13	.009	.129					*					15.311	.288
14	.196	.126					I****					17.714	.220
15	-.122	.123					**I					18.684	.228
16	-.222	.121					****I					22.066	.141

Autocorrelations: GALLE

Lag	Auto- Stand.											Box-Ljung	Prob.
	Corr.	Err.	-1	-.75	-.5	-.25	0	.25	.5	.75	1		
1	-.049	.126					*I					.152	.697
2	.219	.125					I****					3.227	.199
3	-.006	.124					*					3.230	.358
4	.168	.123					I***					5.102	.277
5	-.027	.122					*I					5.153	.398
6	.069	.120					I*					5.481	.484
7	-.046	.119					*I					5.629	.584
8	.173	.118					I***					7.768	.456
9	-.004	.117					*					7.770	.558
10	.144	.116					I***					9.302	.504
11	.030	.115					I*					9.370	.588
12	.193	.114					I****					12.255	.425
13	.063	.112					I*					12.573	.481
14	-.106	.111					**I					13.473	.490
15	.120	.110					I**					14.659	.476
16	-.040	.109					*I					14.791	.540

Autocorrelations: RATNAPURA

Lag	Auto- Stand.											Box-Ljung	Prob.
	Corr.	Err.	-1	-.75	-.5	-.25	0	.25	.5	.75	1		
1	-.098	.126					**I					.610	.435
2	.083	.125					I**					1.054	.590
3	-.066	.124					*I					1.342	.719
4	.094	.123					I**					1.935	.748
5	-.053	.122					*I					2.123	.832
6	-.087	.120					**I					2.644	.852
7	.010	.119					*					2.650	.915
8	.070	.118					I*					2.997	.935
9	-.195	.117					****I					5.761	.764
10	.101	.116					I**					6.520	.770
11	-.084	.115					**I					7.062	.794
12	-.091	.114					**I					7.705	.808
13	.020	.112					*					7.737	.860
14	.024	.111					*					7.785	.900
15	-.028	.110					*I					7.848	.930
16	-.073	.109					*I					8.298	.939

Fig. 6. Auto-correlations for annual rainfall for Agalawatta, Galle and Ratnapura

period, 1941 to 1960, the deviations from the long-term average were positive except for Kurunegala and Kalutara. Fairly large deviations (> 10%) were observed in Peradeniya, Matale and Aranayake, which are in the mid country wet zone and also had significant negative trends in annual rainfall for the period 1941 to 2000.

During the next 20 year period commencing from 1961, the largest deviation was observed in Hanwella, which was 23.5% less when compared to the long-term average. Matale also recorded a negative deviation of 13.8%. Several other locations; Ambanpitiya, Ratnapura, Peradeniya and Aranayake also showed negative deviations. Rest of the locations had positive deviations.

During the next 20 year period; from 1981 to 2000, majority of the locations indicated negative deviations. The two locations which had positive deviations were Hanwella and Matara. The largest deviation was observed in Aranayake (-25.7%) followed by Nalanda (-19.6) and Matara (16%). There were some locations which had relatively low deviations throughout. They are Agalawatta, Kalutara, Kurunegala and Badulla. This analysis suggest that there is some indication of decreased rainfall during the period 1981 to 2000.

3.2 SEASONAL VARIATION IN RAINFALL DESCRIPTIVE STATISTICS

Monthly rainfall values provide a better guide to identify the seasonal pattern of rainfall within year. The mean rainfall, 75% expected values of rainfall and CV were computed on a monthly basis for all the locations. The 75% expected values for the selected 15 locations are presented in Figures, 7 and 8.

The typical bimodal pattern was observed in WL-1 areas (Agalawatta, Ratnapura and Avissawella) with sufficient amount of rainfall throughout the year. However, January and February are comparatively dry, and hence, attention should be paid on moisture conservation measures, especially during the initial stages of rubber. The WL-2 area selected (Ambanpitiya) had three months, which have 75% expected values less than 50 mm. Therefore, special attention

Table 5. Mean annual rainfall in different location under different seasons and their deviation with respect to the long-term average.

Location	1941-1960	1961-1980	1981-2000
Agalawatta	-	4333.1 (2.1)	4165.0 (-1.8)
Ambanpitiya	2836.9 (9.2)	2543.9 (-2.0)	2385.5 (-8.1)
Ratnapura	3870.7 (2.3)	3701.0 (-2.2)	3759.1 (-6.9)
Avisawella	3835.1 (3.2)	4054.6 (9.1)	3301.3 (-11.1)
Galle	2559.7 (5.6)	2456.9 (1.4)	2240.6 (-7.5)
Kalutara	2701.0 (-1.5)	2790.3 (1.7)	2671.8 (-2.6)
Hanwella	3204.7 (8.7)	2255.2 (-23.5)	3170.6 (7.5)
Matara	1778.6 (7.7)	1790.2 (8.4)	1385.9 (16.0)
Peradeniya	2371.0 (19.8)	1873.3 (-5.3)	1682.8 (-14.9)
Matale	2066.8 (13.1)	1573.7 (-13.8)	1812.1 (-0.8)
Aranayake	2458.4 (11.6)	2140.4 (-2.8)	1637.6 (-25.7)
Kurunegala	2380.5 (-2.3)	2510.9 (3.1)	2386.7 (-2.0)
Nalanda	1726.9 (8.8)	1679.9 (5.8)	1277.2 (-19.6)
Badulla	1771.1 (1.6)	1773.7 (1.8)	1667.2 (-4.3)
Okkampitiya	1751.6 (8.4)	1643.9 (1.7)	1452.8 (-10.1)

(Figures in parentheses are the deviations from the long-term average)

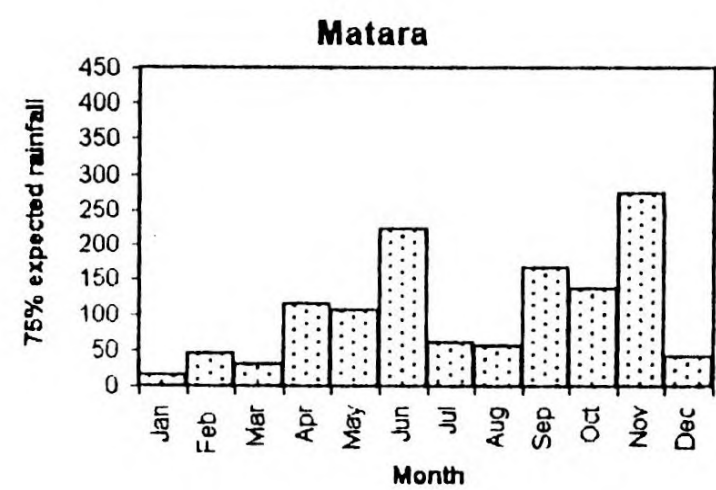
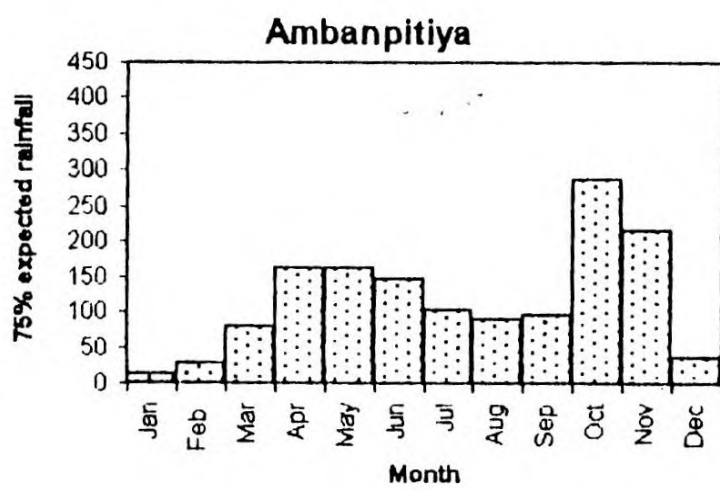
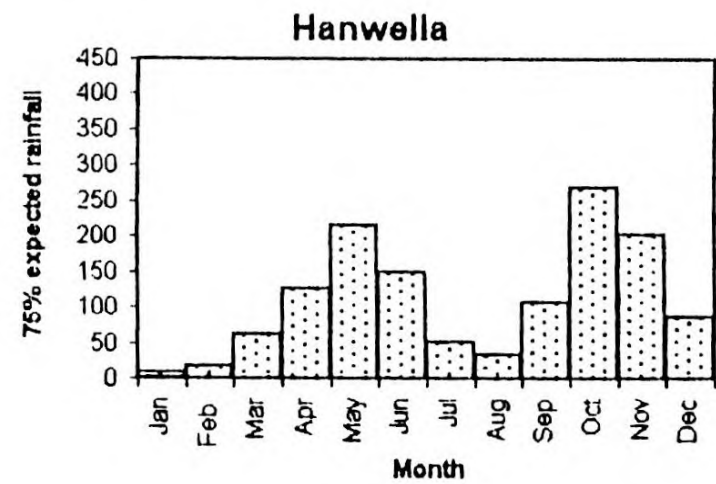
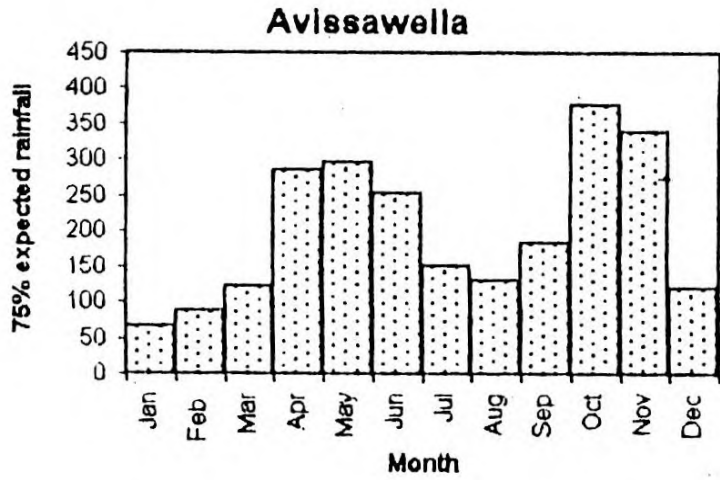
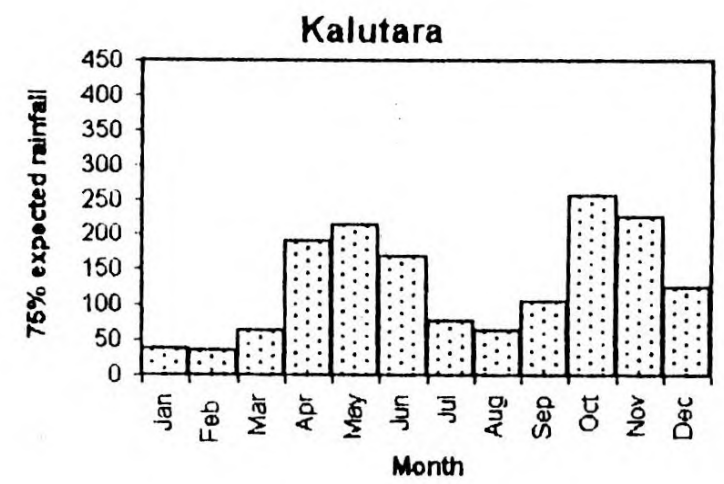
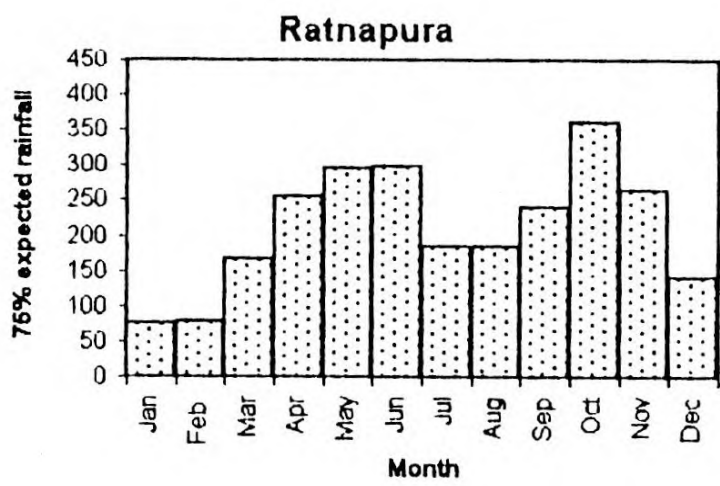
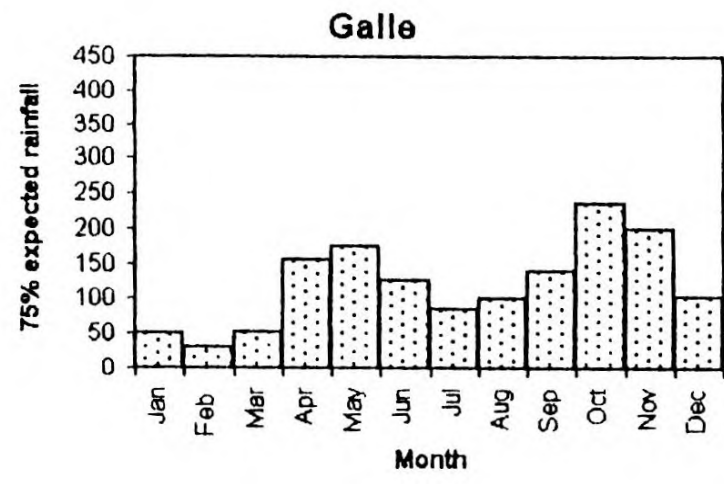
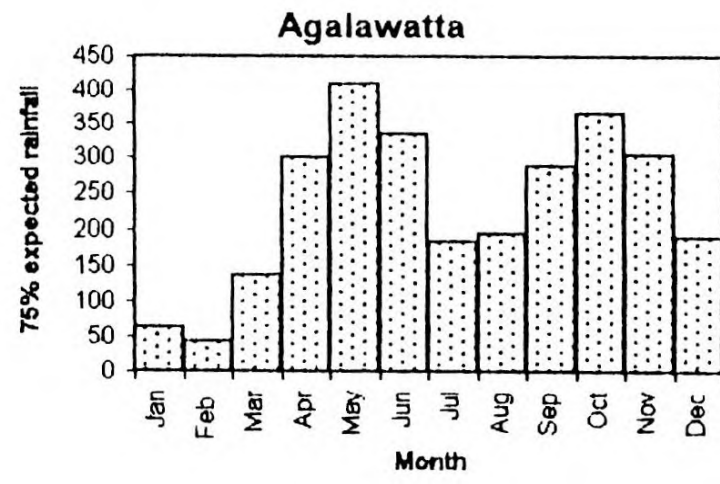


Fig. 7 75% expected rainfall values in low country wet zone areas

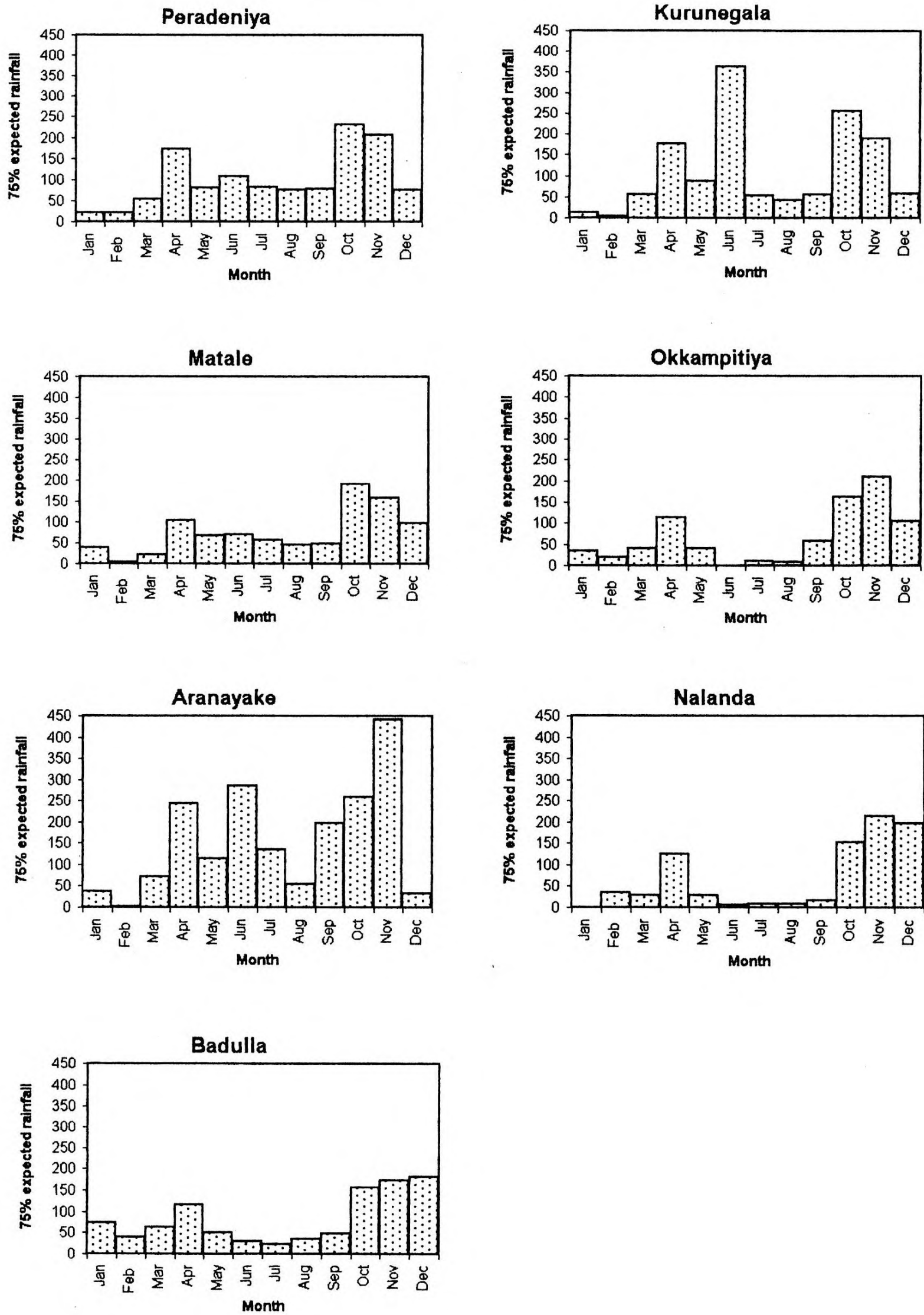


Fig. 8 75% expected rainfall values in low country intermediate zone, mid country intermediate zone, mid country wet zone and up country intermediate zone areas

should be paid to the rubber clearings planted in the October/November period and they may be adversely affected during the period December to March. The WL-3 and WL-4 areas (Galle, Kalutara, Hanwella and Matara) also had the same problem. Hanwella and Matara data indicated that there is a tendency to have more dry months during the early part of the year and during July and August.

In Peradeniya and Matale areas there is a dry spell during the early part of the year and comparatively the rainfall in the April/May period is low. The pattern observed for the rest of the year is similar for these two stations. However, Aranayake had somewhat different behaviour with the highest expected rainfall observed in November, but the expected rainfall experienced in December is less than 50 mm.

TEMPORAL VARIATION IN DIFFERENT MONTHS

The results of the regression analysis for different stations are presented below together with the regression coefficients and associated probabilities. In several areas, temporal variation in March showed significant declining trends. The temporal variation in rainfall in March for Ambanpitiya, Aranayake, Matale and Avissawella is shown in Fig. 9 and Figures, 10, 11, and 12 illustrates the variations in April, August, November and December.

Low Country Wet Zone

Location	Month	Regression coefficient	t-value	Significance Probability
Ambanpitiya	March	-2.487	-3.509	0.0009
	December	-3.057	-2.972	0.0044
Avissawella	March	-2.956	-2.912	0.0053
Hanwella	-	-	-	-
Agalawatta	March	-4.465	-2.377	0.0230
Ratnapura	March	-1.290	-2.416	0.0189
Kalutara	-	-	-	-

Matara	October	-2.966	-3.234	0.0021
	November	-3.158	-2.252	0.0285
Galle	February	-1.204	-2.334	0.0231
	March	-1.368	-2.713	0.0088

Mid Country Wet Zone

Aranayake	March	-2.444	-3.214	0.0028
	April	-4.216	-3.366	0.0019
	December	-3.609	-2.760	0.0091
Matale	March	-1.179	-2.952	0.0046
Peradeniya	April	-1.935	-2.457	0.0177
	August	-2.107	-2.120	0.0394
	December	-3.305	-3.040	0.0039

Mid Country Intermediate Zone

Nalanda	November	-3.803	-3.389	0.0014
	December	-5.229	-3.655	0.0008

Low Country Intermediate Zone

Kurunegala	December	-1.659	-2.029	0.047
Okkampitiya	April	-2.561	-3.428	0.0011
	August	-0.732	-2.044	0.0455

Up Country Intermediate Zone

Badulla	-	-	-	-
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The trends in temporal variation in different months is a good indication of seasonal shifts. However, further analyses are recommended for different segments of time periods.

START AND END OF THE RAINY SEASONS IN THE RUBBER GROWING AREAS

First rainy season - start

The first rainy season appears due to the combined effect of inter monsoons and the south west monsoonal influence. The mean dates of onset and end of rains in the first rainy season for different locations are listed in Table 6, together with the standard errors. The earliest start date ranged from 23rd February to 24th April in the low country wet zone (LCWZ) areas. The earliest start date was observed in Ratnapura. The start dates of selected locations in the mid country areas ranged from 09th April to 13th May. An early start was observed

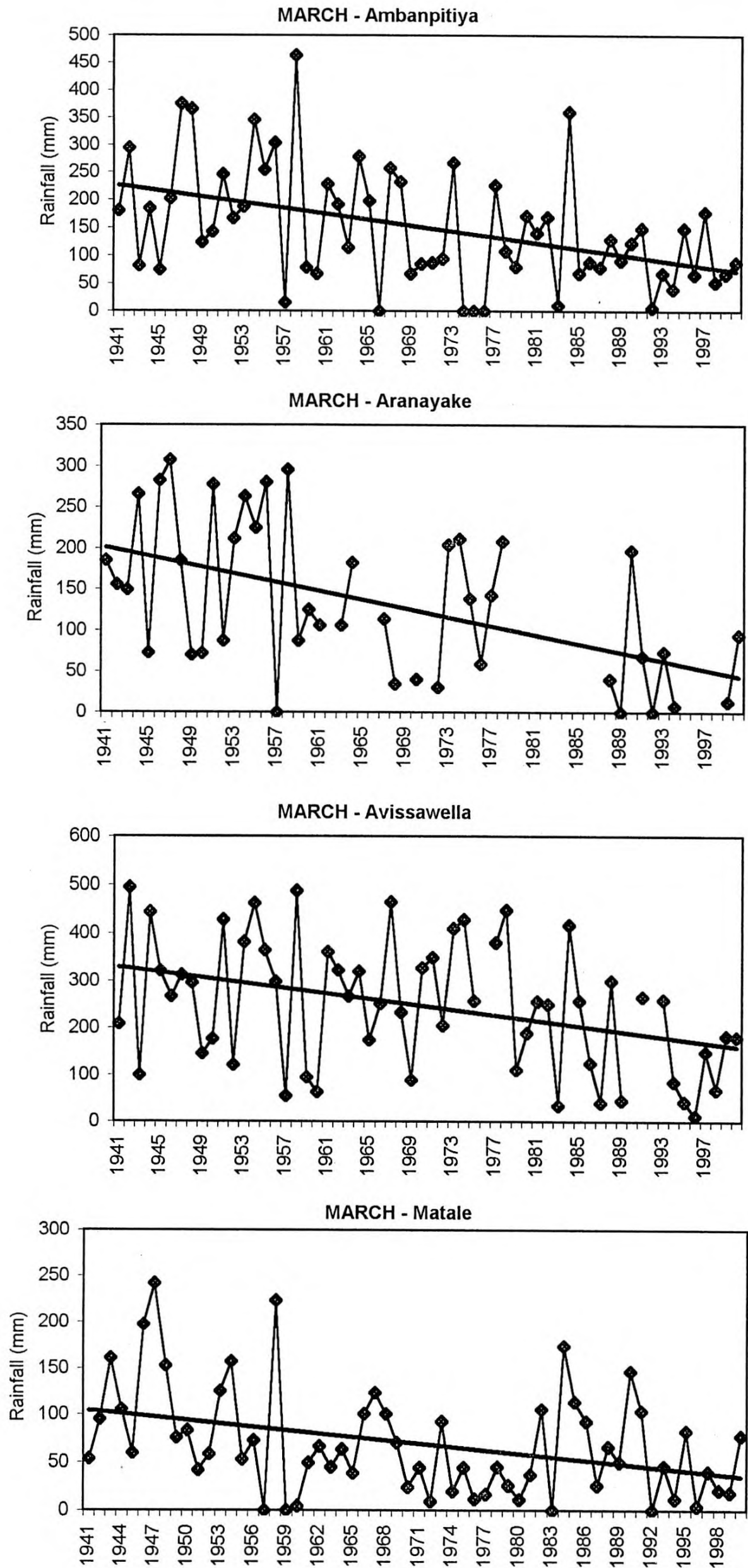


Fig.09: Temporal variation of rainfall in March

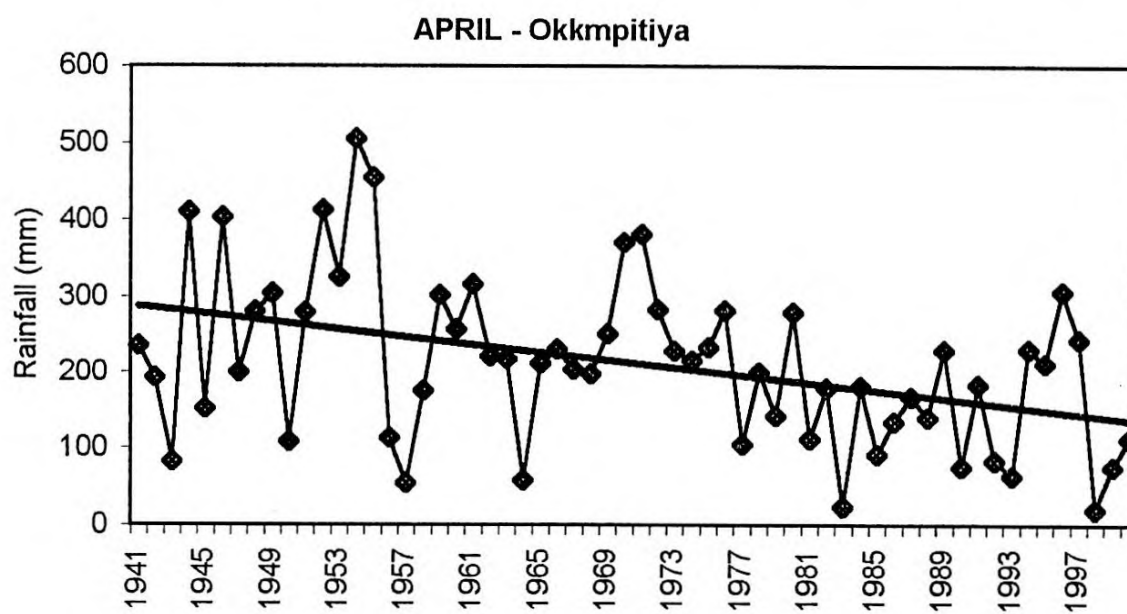
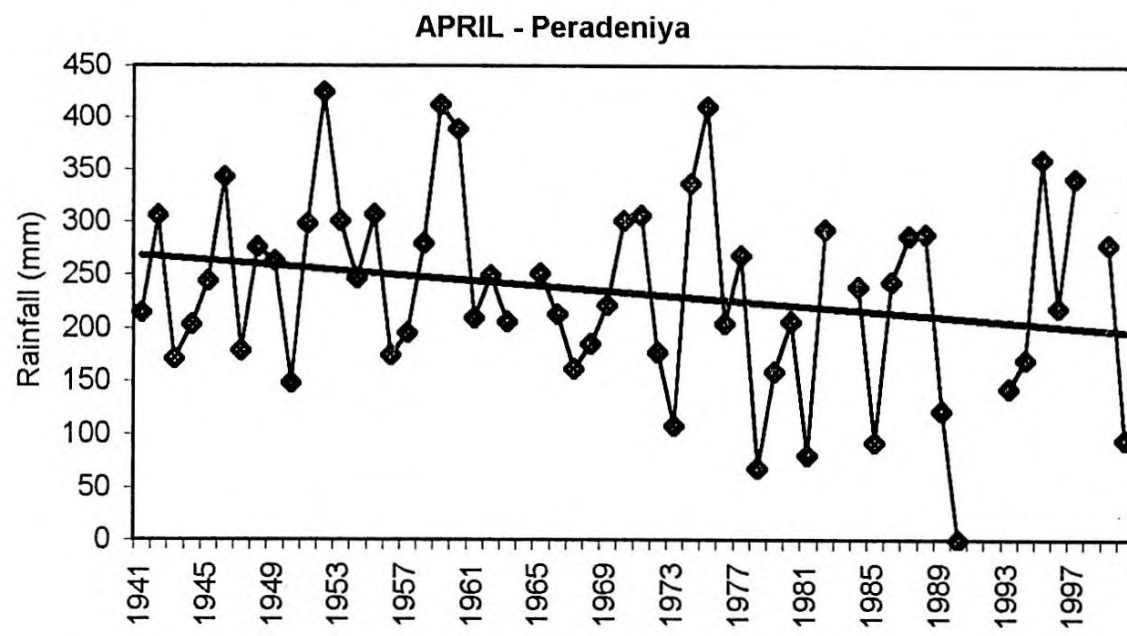
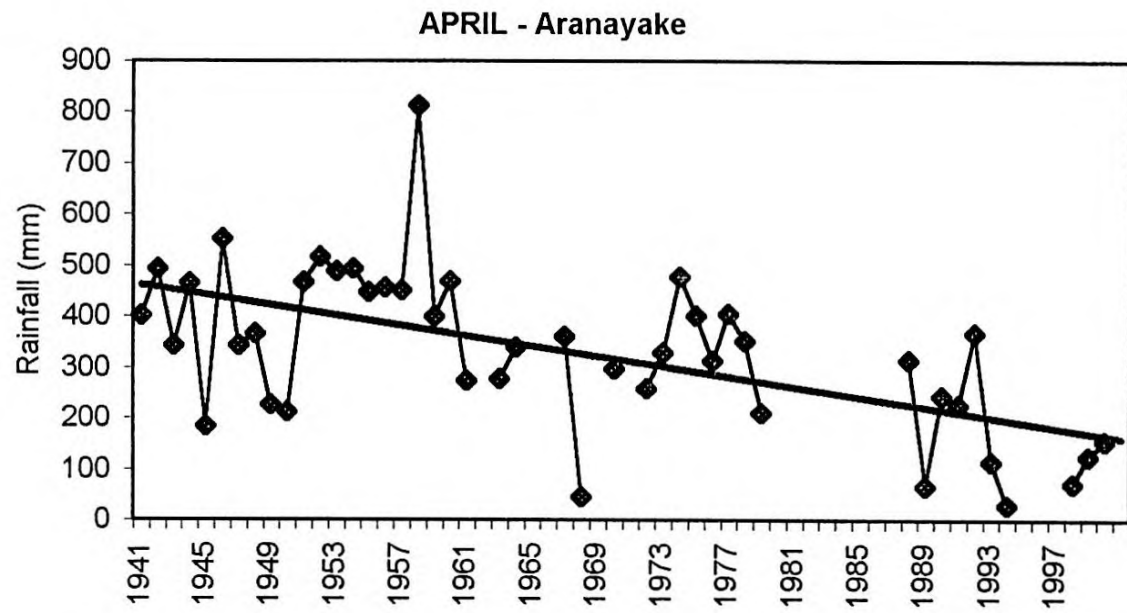


Fig.10: Temporal variation of rainfall in April

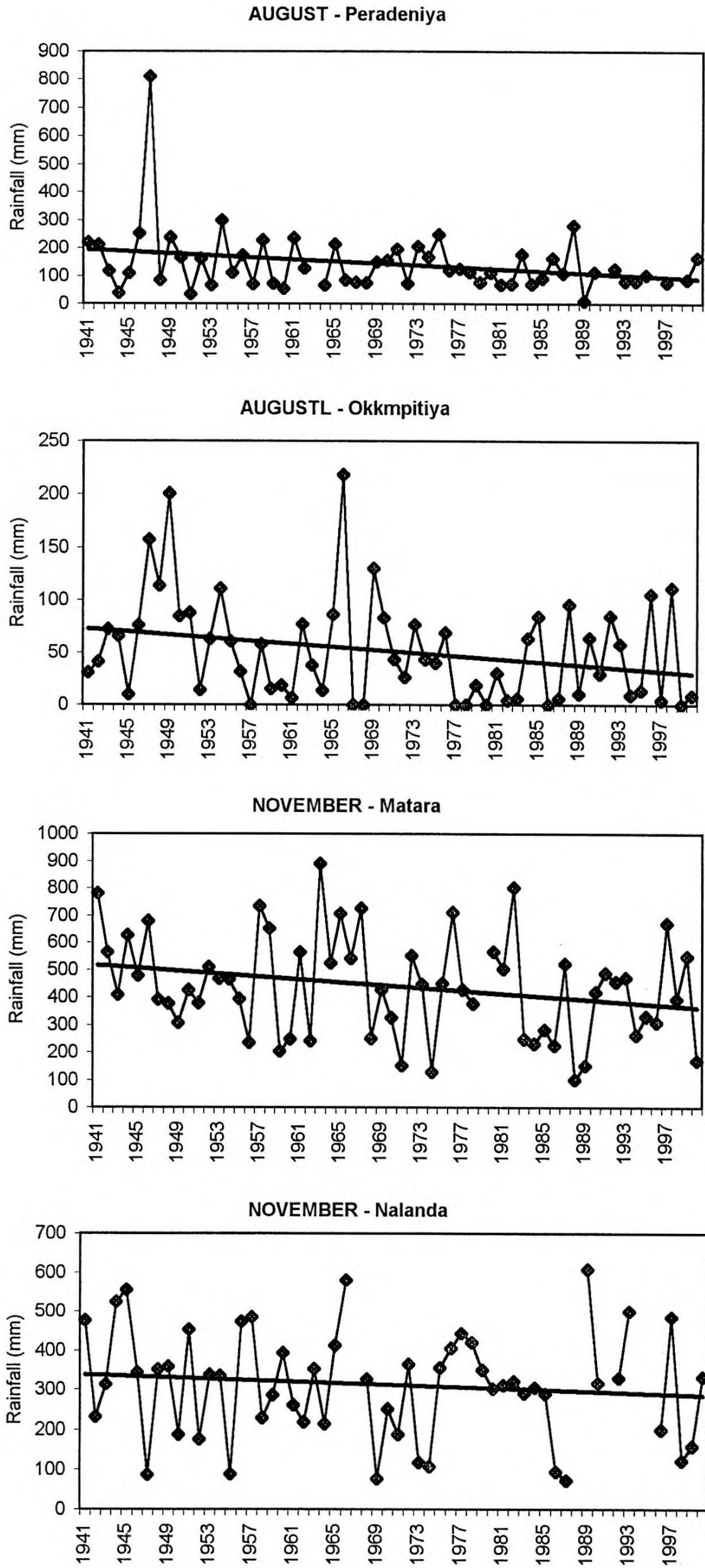


Fig.11: Temporal variation of rainfall in August and November

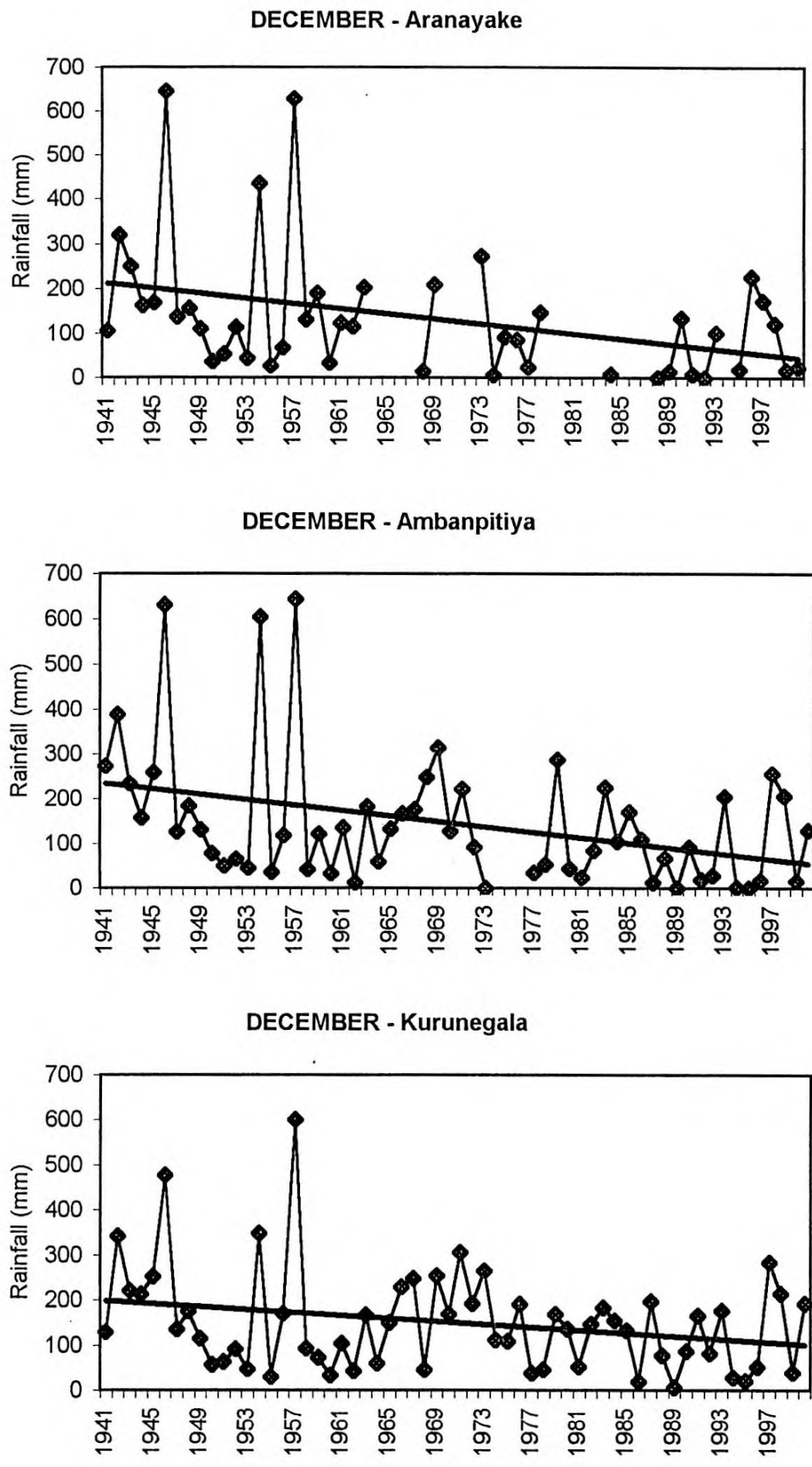


Fig.12: Temporal variation of rainfall in December

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