PERSISTENCE EFFECTS ON THE OCCURRENCES OF DROUGHT MONTHS IN SRI LANKA

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Introduction

Droughts and drought hazards studies have received very important attention in meteorology and climatology and in the other related disciplines. Various investigations have been with different aims and approaches have derived and used different definition based on quite different Criteria. (Subramaniyam 1975, Thomas 1962 & 1965, Thornthwaite 1963, Thornthwaite and Mather 1955, Gibbs and Maher 1967, Hemamalini 1981, Jutta Dikshit 1983, Saarinen 1976 etc.) The studies which deal with drought in Sri Lanka also have taken place. The south west monsoon drought (Jameson 1931) the liability of drought at Colombo (Jameson 1932) had studied long ago. Wikkramatileka did a study on drought in the south east of Sri Lanka (1955). Farmer analyzed the incidence of rain less months (1956). Dry zone climatology was discussed by Thambyahpillay (1965). By employing Thornthwaite's water balance technique the incidence of drought had been analyzed by Sri nanda (1975 & 1984). Domros studied aridity and drought in Sri lanka (1978). The rainfall fluctuation in Sri Lanka in terms of space and time has been analysed by Suppiah and Yoshino (1984 a & b). An assessment of the occurrence drought months have studied by Balachandiran (1975, 1986/87 & 1995) recently.

Droughts definition

Summarizing drought definitions it can be said that "drought as a meteorologic phenomenon and this occurs during a period when precipitation is less than the long term average, and when this deficiency is great enough and continues long enough to hurt mankind. Drought is thus measured interms of the duration and magnitude of the departure from the average climate in the area " (Thomas 1962) 'Climatological occurrence such as droughts are negative depature from the normal. But these are seldom affected by presence of persistence. So it is necessary to study whether the persistence effects the occurrences of drought months in Sri Lanka. To find out these, the frequency, probability and the runs of drought months have calculated.

Methodology

For this the monthly rainfall data for 30 stations through out Sri Lanka for the period of 23 years (1948 - 1970) was utilized (Table 1) Altogether 276 months (23 X12) observation has utilized.

In defining drought, the immediate problem is whether the 23 year average rainfall could regarded as a longterm average and whether the 23 year distribution could be treated as a normal distribution. To solve these problems a chi squard lest for normality was carried out for a few selected stations. From this test it seemed the 23 year rainfall should be treated as a normal ditribution. According to the definition, drought should be defined interms of long period average. So the 23 year average was compared with a thirty year average (1931 - 60). From this comparison it can be assumed that no significant deferences exist between them. This is also confirmed by a comparative study of two thirty year periods of rainfall (1911-40 and 1931-60) for Sri Lanka by De Mel (1971)

Identification of drought months interms of negative departure from the normal of monthly averages for 276 months has been carried out. In this manner the magnitude, frequency and probability of drought months have been considered and the magnitude has been selected as follows.

Crtegories of Drought

		Received		of the mean		Negative. Dep.
A	Slight drought	.	76% to 89%	"	"	11% - 15%
B.	Moderate drought	"	51% to 75%	"	"	26% - 50%
C.	Severe drought	"	26% to 50%	"	"	51% - 75%
D.	Extreme drought	"	≤ 25%	"	"	> 75%
E.	Far extreme drought	"	No rain at all	"	"	100%

In particular the first three divisions i-e. A,B,& C have followed the categories of Banerai and chgbra (1963) while the other two divisions (C & D) have been created, because it seemed necessary for a fine identification in a Sri lankan context, For example, out of 276 months (23 x12) 151 months experienced drought in Hambantota. the categories of drought such as A,B,C,D & E have occurred for 19,51,43,33,35 months respectively in the same station. For all thirty station the frequency of drought month have calculated. Further the probabilities of having drought month following relative frequency method have calculated. For example, in Hambantota 151 months were identified as drought out of 276 months, thus the probability of having drought month in Hambantota is 0.55.

So, we can say that there is more than equal chance to have a drought month. The probability to have a slight, moderate, severe, extreme and for extreme is 0.07, 0.18, 0.16, 0.12 and 0.02 respectively. We denote these as P_1, P_2, P_3, P_4 and P_5 respectively.

So $P_1 + P_2 + P_3 + P_3 + P_4 + P_5 = P$ (0.55)

and $P + Q = 1$ or

$P_1 + P_2 + P_3 + P_4 + P_5 + Q = 1$

Where Q is the chances of a rainy month $(1 - 0.55 = 0.45)$

Thus if there is a drought month we are certain to have one of these five categories and so it can be identified which occurs more frequently.

Theory of runs and persistence

'When we are dealing with events which either can or cannot occur, the term run is taken to mean an unbroken succession of occurrences (or non-occurrences). In order to appreciate the effect of persistence, we must first consider the number of runs of different lengths expected in a series in which there is no persistence. In such a series both the probability that an event will occur and the probability that it will no occur are independent" (Brooks and Carruthers 1953)

Following Brooks and Carruthers the chance of a given month being a drought month is P. If there is no persistence, the chance that the following month is normal is Q. Hence the chance that a month begins a run of drought month is QP. The chance of the following month being drought is P and so the probability of a run of at least two drought months is QP^2. Similary the chance of at least three consecutive drought months is QP^3. and so on. The total number of months is N(276 months). So the expected number of runs at least one, atleast two, at least three, at least n drought months are

$NQP, NQP^2, NQP^3 \ldots\ldots\ldots\ldots\ldots\ldots\ldots NQP^n$

provided that there is no persistence.

For example, if we take one station eg. Anuradhapura, the probability of having a slight drought month is P = 0.09, Q = 0.91 and N= 275; thus NPQ = 23, this is the total number of runs expected. The expected number of runs of two or more drought months is 23P =2 and so on. In this way the runs of drought months have

been calculated for all thirty stations, and the runs of n or more months (assuming no persistence) are given in the first line. The differences between successive values in this line give the expected number of runs of exactly the months (n = 1,2,3) which are given in the second line. the observed values are counted from the frequency table and given in the third line, this being preparted for every catecory of drought (see example). It is obvious that short runs are much less frequent, and long runs are more frequent, than would be expected on the hypothesis of independence i.e. of no persistence (Brooks and Carruthers).

To know the persistence effects one needs the average length of both observed and expected runs, persistence ratio, and significance level. these are calculated for the various values of P. As defined (Brooks and Carruthers 1953, Maher 1967) in the literature, the average length of a run is:

1.
$$\frac{(NPQ - NP^2Q) + 2(NP^2Q - NP^3Q) + \dots\dots\dots\dots\dots\dots}{NPQ}$$

$$= \quad 1(1 - P) + 2(P - P^2) \dots\dots\dots\dots\dots\dots\dots\dots$$

$$= \quad \frac{1}{(1-p)}$$

Therefore the average runs of observed can be calculated by:

$$\frac{\text{total runs of n or more months}}{\text{total runs of observed}}$$

And the average runs of expected can be calculated by : $\quad \dfrac{1}{(1 - P)}$

The persistence ratio is calculated as follows

$$\frac{\text{average length of runs observed}}{\text{average length of runs expected}}$$

With the null hypothesis of no persistence the expected value of this ratio is unity. The 95 percent confidence limit of the persistence ratio for a series of samples of size N from a random (non - persistence) series is

$$\frac{1}{1 + 1.96\sqrt{(P/NQ)}}$$

These three statistics are defined for all categories of drought at each of the all stations mentioned previously. If the persistence ratio does not agree with the one of either side of 1.00, persistence is present.

Persistence Level

The probability for the occurrences of drought months has calculated. In terms of these probabilities the expected runs were calculated for all stations, together with observed runs as in the example.

Using the same probabilities the average length of both observed and expected runs, persistence ratio and confidence level and the persistence whether it was present or not were calculated for all drought catagories. The catagories of drought are tabulated as follows:-

P_1 = Slight
P_2 = Moderate
P_3 = Severe
P_4 = Extreme
P_5 = Far extreme

Thus, one can simply judge the persistence levels from the following Box for Anuradhapura & Badulla

Examples:-
Runs of Observed and expected

	Slight drought	Anuradhapura 'n' Months			Badulla 'n' Months		
		1	2	3	1	2	3
(1)	Runs of n or more months assuming no persistence	23	2	-	25	2	-
(2)	Difference, runs of 'n' months	21	2	-	23	2	-
(3)	Observed runs	20	3	-	27	-	-

Persistence level in various stations

Table 1   Persistence in Anuradhapura (N = 275)

Various Values	Average observed	length of runds Expected	persistence ratio	confidence limit 1.0	Persistence
P_1 0.09	1.09	1.10	0.99	$\pm$ 0.04	not present
P_2 0.17	1.21	1.20	1.01	$\pm$ 0.05	not present
P_3 0.13	1.09	1.15	0.95	$\pm$ 0.05	not present
P_4 0.14	1.22	1.16	1.05	$\pm$ 0.05	not present
P_5 0.04	1.10	1.04	1.06	$\pm$ 0.02	present

The first four categories of drought in anuradhapura show that there was no persistence in their drought period, in other words both the observed and expected runs of drought are in close agreement. But in the case of far extreme drought (P_5) the persistence ratio is 1.06, and the confidence limits are 0.98 and 1.02. So the persistence ratio shows the excess amount. In view of this, it can be said that the persistence was present in Anuradhapura in the case of far extreme drought.

Table 2.   Persistence in Badulla (N = 276)

Various values of P	Average Observed	length of runs Expected	Persistence ratio	Confidence Limit 1.00	Persistence
P_1 0.10	1.00	1.11	0.90	$\pm$ 0.04	present
P_2 0.17	1.26	1.20	1.05	$\pm$ 0.05	not present
P_3 0.14	1.18	1.16	1.02	$\pm$ 0.05	not present
P_4 0.07	1.00	1.08	0.93	$\pm$ 0.03	present

In the case of far extreme drought (P_5) in Badulla, there was only one such occasion observed and for 276 months as N this one occasion cannot give any chance. Badulla shows a different picture of persistence than Anuradhapura. The persistence was present in the occurrences of slight(P_1) and extreme (P_4) drought. This can be seen from the values of the persistence ratio and the confidence limits. There was no persistence in moderate (P_2) or severe (3) occurrences.

Table 3   Persistence in Batticaloa (N = 275)

Various Values	Average length of runs Observed	Expected	Persistence Ratio	Confidence Limit 1.00	Persistence
P_1 0.09	1.00	1.10	0.91	± 0.04	present
P_2 0.15	1.11	1.18	0.94	± 0.05	present
P_3 0.16	1.19	1.19	1.00	± 0.05	not present
P_4 0.11	1.11	1.12	0.99	± 0.04	not present
P_5 0.03	1.00	1.03	0.97	± 0.02	present

The persistence was present in the occurrences of slight (P_1), moderate (P_2)droughts in Batticaloa as can be seen from table 5.3. the other two categories of drought occurrences are in close agreement with expected runs and in particular severe drought (P_3) was at unity.

Table 4   Persistence in Chilaw (N = 260)

Various Values of P	Average length of runs Observed	Expected	Persistence Ratio	Confidence Limit 1.00	Persistence
P_1 0.05	1.00	1.05	0.95	± 0.03	present
P_2 0.13	1.17	1.15	1.02	± 0.02	not present
P_3 0.14	1.06	1.16	0.91	± 0.05	present
P_4 0.17	1.22	1.20	1.02	± 0.06	not present
P_5 0.02	1.25	1.02	1.23	± 0.02	present

In Chilaw the persistence was present in the occurrences of slight (P_1), severe (P_3), and far extreme (P_5) drought. In the case of moderate (P_2) and extreme (P_4) drought months it was not present. These occurrences are in close agreement with expected runs.

Table 5   *Persistence in Colombo (N = 276)*

Various Values	Average length of runs Observed	Expected	Persistence Ratio	Confidence Limit 1.00	Persistence
P_1 0.09	1.29	1.10	1.17	± 0.04	present
P_2 0.16	1.13	1.19	0.95	± 0.05	not Present
P_3 0.15	1.03	1.18	0.87	± 0.05	present
P_4 0.08	1.16	1.09	1.06	± 0.03	present

The persistence was present in the occurrences of slight (P_1), severe (P_3) and extreme (P_4) drought months in Colombo. Only the occurrences of moderate (P_2) drought months are in close agreement and far extreme (P_5) drought months are not observed there.

Table 6   *Persistence in Diyatalawa (N = 275)*

Various Values of P	Average length of runs Observed	Expected	Persistence ratio	Confidence limit 1.00	Persistence
P_1 0.13	1.13	1.15	0.98	± 0.05	not present
P_2 0.21	1.21	1.27	0.95	± 0.06	not present
P_3 0.11	1.15	1.12	1.03	± 0.04	not present
P_4 0.07	1.00	1.08	0.93	± 0.03	present

In Diyatalawa the case has a different picture. The first three categories of drought months namely slight (P_1), moderate (P_2) and severe (P_3) are in close agreement with expected runs. But for extreme (P_4) the persistence was present. The fifth category is not expected there.

Table 7   *Persistence in Galgamuwa (N = 263)*

Various Values of P	Average length of runs Observed	Average length of runs Expected	Persistence ratio	Confidence limit 1.00	Persistence
P_1 0.07	1.00	1.08	0.93	± 0.03	present
P_2 0.16	1.02	1.19	0.86	± 0.05	present
P_3 0.16	1.14	1.19	0.96	± 0.05	not present
P_4 0.06	1.07	1.06	1.01	± 0.03	not present
P_5 0.11	1.12	1.12	1.00	± 0.04	not present

The persistence was present in the occurrences of slight (P_1) and moderate (P_2) drought months in Galgamuwa. The other three categories are in close agreement with expected runs and in particular far extreme drought (P_5) was at unity.

Table 8   *Persistence in Galle (N = 275)*

Various Values of P	Average length of runs Observed	Average length of runs Expected	Persistence Ratio	Confidence Limit 1.00	Persistence
P_1 0.13	1.13	1.15	0.98	± 0.05	not present
P_2 0.18	1.32	1.22	1.08	± 0.06	present
P_3 0.13	1.16	1.15	1.01	± 0.05	not present
P_4 0.05	1.08	1.05	1.03	± 0.03	not present

Only for the occurrences of moderate (P_2) drought months the persistence was present in Galle and for others such as slight (P_1), severe (P_3) and extreme (P_4) are in close agreement with expected runs and no chance for extreme (P_5) drought months there.

Table 9.   *Persistence in Hambantota (N = 276)*

Various Values of P	Average length of runs		Persistence Ratio	Confidence Limit 1.00	Persistence
	Observed	Expected			
P_1 0.07	1.19	1.08	1.10	$\pm$ 0.03	present
P_2 0.18	1.20	1.22	0.98	$\pm$ 0.05	not present
P_3 0.16	1.33	1.19	1.12	$\pm$ 0.05	present
P_4 0.12	1.14	1.14	1.00	$\pm$ 0.04	not present
P_5 0.02	1.00	0.98	0.98	$\pm$ 0.02	not present

In Hambantota the persistence was present in the occurrences of slight (P_1) and severe (P_3) drought months. In the case of extreme drought (P_4) it shows unity. Generally the three i.e moderate (P_2), extreme (P_4) and far extreme (P_5) occurrences are in close agreement.

Table 10   *Persistence in Jaffna (N = 275)*

Various Values of P	Average Length of runs		Persistence Ratio	Confidence limit 1.00	Persistence
	Observed	Expected			
P_1 0.06	1.06	1.06	1.00	$\pm$ 0.03	not present
P_2 0.12	1.18	1.14	1.04	$\pm$ 0.04	not present
P_3 0.10	1.07	1.11	0.96	$\pm$ 0.04	not present
P_4 0.18	1.29	1.22	1.06	$\pm$ 0.06	not present
P_5 0.10	1.08	1.11	0.97	$\pm$ 0.04	not present

Extraordinarily, in Jaffna the expected and observed runs of drought months are in close agreement and no persistence existed.

Table 11   *Persistence in Kalmunai (N = 261)*

Various Values of P	Average length of runs observed	Expected	Persistence ratio	Confidence limit 1.00	Persistence
P_1 0.07	1.00	1.08	0.93	± 0.03	Present
P_2 0.14	1.13	1.16	0.97	± 0.05	Not Present
P_3 0.17	1.07	1.21	0.88	± 0.06	Present
P_4 0.07	1.13	1.08	1.05	± 0.03	Present
P_5 0.07	1.06	1.08	0.98	± 0.03	Not Present

In Kalmunai the persistence was present for the occurrences of slsight drought (P_1), severe derought (P_3) and extreme drought (P_4) months and for the other cases such as moderate drought (P_1) and far extreme drought (P_5) the occurrences are in close agreement with expected runs.

Table 12   *Persistence in Kalutara (N = 272)*

Various values of P	Average length of runs Observed	Expected	Persistence ratio	Confidence limit 1.00	Persistence
P_1 0.08	1.10	1.09	1.01	± 0.04	not present
P_2 0.20	1.15	1.25	0.92	± 0.06	present
P_3 0.15	1.14	1.18	0.97	± 0.05	not present
P_4 0.05	1.17	1.05	1.11	± 0.03	present

For Kalutara the occurrences of slight drought (P_1) and severe drought (P_3) months are in close agreement with expected runs. but the persistence was present in the occurrences of moderate drought (P_2) and extreme drought (P_4) months and there was no chance for far extreme (P_5) drought months there.

Table 13   *Persistence in Kandy (N = 273)*

Various values of P	Average length of runs		Persistence Ratio	Confidence Limit 1.00	Persistence
	Observed	Expected			
P_1 0.10	1.27	1.11	1.14	± 0.04	present
P_2 0.22	1.34	1.28	1.05	± 0.06	not present
P_3 0.11	1.00	1.12	0.89	± 0.04	present
P_4 0.07	1.00	1.08	0.93	± 0.03	present
P_5 -	-	-	-	-	-

In Kandy persistence was there for the occurrences of three cases such as slight drought (P_1), severe drought (P_3) and extreme drought (P_4) months. The occurrences of moderate drought (P_2) months are in close agreement with expected. It there is no chance for far extreme drought (P_5) month.

Table 14   *Persistence in Kantalai (N = 254)*

Various values of P.	Average length of runs		Persistence ratio	Confidence Limit 1.00	Persistence
	Observed	Expected			
P_1 0.08	1.00	1.09	0.92	± 0.04	present
P_2 0.18	1.12	1.22	0.92	± 0.06	present
P_3 0.11	1.04	1.12	0.93	± 0.04	present
P_4 0.09	1.15	1.10	1.05	± 0.04	present
P_5 0.08	1.11	1.09	1.01	± 0. 01	not present

The persistence was present in the occurrences of slight drought (P1), moderate drought (P_2) severe drought (P_3); and extreme drought (P_4) months. Only for, the occurrences of far extreme drought (P_5) months it was not present and It is in close agreement with expected.

Table 15   *Persistence in Kankesanthurai (N= 263)*

Various values of P	Average length of runs		Persistence ratio	Confidence limit 1.00	Persistence
	Observed	Expected			
P_1 0.08	1.05	1.09	0.96	± 0.04	not present
P_2 0.15	1.18	1.18	1.00	± 0.05	not present
P_3 0.12	1.15	1.14	1.01	± 0.05	not present
P_4 0.09	1.00	1.10	0.91	± 0.04	presnt
P_5 0.15	1.43	1.18	1.21	± 0.05	present

During the occurrences of slight drought (P_1), moderate drought (P_2) and severe drought (P_3) months the persistence was not present and these are in close agreement with expected runs and in particular P_2 was at unity in Kankesanthurai. For the other two occurrences (P_4 and P_5) the persistence was present there.

Table 16   *Persistence in Kurunegala (N = 275)*

Various values of P	Average length of runs		Persistence ratio	Confidence limit 1.00	Persistence
	Observed	Expected			
P_1 0.09	1.00	1.10	0.91	± 0.04	present
P_2 0.13	1.03	1.15	0.90	± 0.05	present
P_3 0.16	1.22	1.19	1.03	± 0.05	not present
P_4 0.09	1.14	1.10	1.04	± 0.04	not present
P_5	-	-	-	-	-

In Kurunegal a for the occurrences of slight drought (P_1) and moderate drought (P_2), the persistence was present. It was not present for the severe drought (P_3) and extreme drought (P_4) months and there is close agreement with expected. The chance for extremen(P_5) dorught month is not there.

Table 17   *Persistence in Mah Oya (N = 237)*

Various Values of P	Average length of runs Observed	Expected	Persistence ratio	Confidence Limit 1.00	Persistence
P_1 0.04	0.90	1.04	0.87	± 0.03	present
P_2 0.22	1.16	1.28	0.91	± 0.07	present
P_3 0.11	1.13	1.12	1.01	± 0.05	not present
P_4 0.10	1.21	1.11	1.09	± 0.04	present
P_5 0.02	1.00	1.02	0.98	± 0.02	not present

The persistence was there in the occurrences of slight drought (P_1), moderate drought (P_2) and extreme drought drought (P_4) months in Maha Oya. But for the other two (P_3 and P_5), they are in close agreement with expected runs.

Table 18   *Persistence in Mannar (N = 224)*

Various values of P	Average length of runs Observed	Expected	Persistence Ratio	Confidence Limit 1.00	Persistence
P_1 0.05	0.80	1.05	0.76	± 0.03	present
P_2 0.05	0.97	1.18	0.82	± 0.06	present
P_3 0.11	0.96	1.12	0.86	± 0.05	present
P_4 0.15	0.92	1.28	0.78	± 0.06	present
P_5 0.18	0.18	1.22	0.97	± 0.06	not present

In Mannar, it was present in the occurences of first four categories namely slight drought (P_1), moderate drought (P_2), severe drought (P_3), and extreme drought (P_4) months and only far extreme drought (P_5) months it was not there and it is in close agreement with expected.

Table 19   ***Persistence in Marichchudaddi (N = 254)***

Various Values of P	Average length of runs Observed	Expected	Persistence ratio	Confidence Limit 1.00	Persistence
P_1 0.05	1.30	1.05	1.24	± 0.03	present
P_2 0.13	1.17	1.15	1.02	± 0.05	not present
P_3 0.11	1.04	1.12	0.93	± 0.04	present
P_4 0.97	1.00	1.08	0.93	± 0.03	present
P_5 0.28	1.73	1.39	1.25	± 0.08	present

In this place only the moderate drought (P_2) months occurences have close agreement with expected runs. The occurences of slight drought (P_1), severe drought (P_3), extreme drought (P_4) and far extreme drought (P_5) months were the effect of the persistence.

Table 20   ***Persistence in Moneragala (N = 263)***

Various values of P	Average length of runs Observed	Expected	Persistence ratio	Confidence limit 1.00	Persistence
P_1 0.11	0.97	1.12	0.87	± 0.04	present
P_2 0.21	1.25	1.27	0.98	± 0.06	not present
P_3 0.12	1.00	1.14	0.88	± 0.05	present
P_4 0.04	0.91	1.04	0.88	± 0.03	present
P_5 0.01	1.00	1.01	0.99	± 0.01	not present

The persistence was present in the occurrences of slight (P_1), severe (P_3) and extreme (P_4) drought months in Moneragala. But the occurrences of moderate (P_2) and far extreme (P_5) months are in agreement with expected runs.

Table 21   *Persistence in Mullaitivu (N = 248)*

Various values of P	Average length of runs Observed	Expected	Persistence Ratio	Confidence Limit	Persistence
P₁ 0.08	1.00	1.09	0.92	± 0.04	present
P₂ 0.15	1.31	1.18	1.11	± 0.05	present
P₃ 0.10	1.04	1.11	0.94	± 0.04	present
P₄ 0.12	1.04	1.14	0.91	± 0.05	present
P₅ 0.12	1.12	1.14	0.98	± 0.05	not present

This station gives the same picture which was existed in Mannar. The occurrences of far extreme (P_5) drought months are in close agreement with expected runs. For the other categories of drought (P_1, P_2, P_3, & P_4) the persistence was present.

Table 22   *Persistence in Nuwara Eliya (N = 275)*

Various Values of P	Average length of runs Observed	Expected	Persistence Ratio	Confidence Limit 1.00	Persistence
P₁ 0.15	1.17	1.18	0.99	± 0.05	Not Present
P₂ 0.19	1.13	1.24	0.91	± 0.06	Present
P₃ 0.10	1.17	1.11	1.05	± 0.04	Present
P₄ 0.04	0.92	1.04	0.89	± 0.02	Present

In Nuwara Eliya there is no chance for the occurrences of far extreme drought (P_5) months. Here the occurrences of slight (P_1) are in close agreement with expected runs. The persistence was present in the occurrences of Moderate (P_2), severe (P_3) and extreme (P_4) drought months.

Table 23   *Persistence in Paranthan (N = 271)*

Various Values of P	Average length of runs		Persistence Ratio	Confidence Limit 1.00	Persistence
	Observed	Expected			
P_1 0.07	1.00	1.08 ·	0.93	± 0.03	present
P_2 0.14	1.30	1.16	1.12	± 0.05	present
P_3 0.13	1.06	1.15	0.92	± 0.05	present
P_4 0.14	1.22	1.16	1.05	± 0.05	not present
P_5 0.10	1.04	1.11	0.94	± 0.04	present

In Paranthan also the persistence gave more effect. For the occurrences of slight (P_1), moderate (P_2), severe (P_3) and far extreme (P_5) drought months it was there but not for the occurrences of extreme (P_4) drought months.

Table 24   *Persistence in Puttalam (N = 276)*

Various Values of P	Average length of runs		Persistence Ratio	Confidence Limit 1.00	Persistence
	Observed	Expected			
P_1 0.04	0.92	1.04	0.89	± 0.02	present
P_2 0.16	1.13	1.19	0.95	± 0.05	not present
P_3 0.11	1.20	1.12	1.07	± 0.04	present
P_4 0.16	1.26	1.19	1.06	± 0.05	present
P_5 0.05	1.00	1.05	0.95	± 0.03	present

The persistence was present in the occurrences of four categories of drought such as P_1, P_3, P_4 and P_5 (slight, severe, extreme and far extreme drought months). The P_2 is in close agreement with expected runs.

Table 25   **_Persistence in Ratnapura (N = 275)_**

Various values of P.	Average length of runs Observed	Expected	Persistence Ratio	Confidence Limit 1.00	Persistence
P_1 0.17	1.09	1.21	0.90	± 0.05	present
P_2 0.20	1.20	1.25	0.96	± 0.06	not present
P_3 0.08	1.05	1.09	0.96	± 0.04	not present
P_4 0.02	1.00	1.02	0.98	± 0.02	not present

For the occurrences of slight (P_1) drought months the persistence was present and there is no chance for far extreme (P_5) drought months in Ratnapura. Here the occurrences of P_2, P_3, and P_4 are in close agreement with expected, runs.

Table 26   **_Persistence in Rasagalla Estate (N = 263)_**

Various Values of P.	Average length of runs Observed	Expected	Persistence Ratio	Confidence Limit 1.00	Persistence
P_1 0.14	1.12	1.16	0.97	± 0.05	not present
P_2 0.23	1.39	1.30	0.96	± 0.07	not present
P_3 0.08	1.05	1.09	0.96	± 0.04	not present
P_4 0.03	1.14	1.03	1.11	± 0.02	present

Here the picture was the other way round if it is compared with Ratnapura. The occurrences of extreme (P_4) drought months only show the presence of persistence. The occurrences of P_1, P_2, and P_3 drought months are in close agreement with expected runs and no chance for P_5 drought months in Rasagalla Estate.

Table 27   ***Persistence in Tissamaharama (N = 256)***

Various Values of P	Average length of runs		Persistence Ratio	Confidence Limit 1.00	Persistence
	Observed	Expected			
P_1 0.04	1.00	1.04	0.96	± 0.03	present
P_2 0.15	1.18	1.18	1.00	± 0.05	not present
P_3 0.15	1.11	1.18	0.94	± 0.05	present
P_4 0.10	1.04	1.11	0.94	± 0.04	present
P_5 0.07	1.20	1.08	1.11	± 0.03	present

Except the occurrences of moderate (P_2) drought months which are in close agreement with expected runs, the occurrences of others (P_1, P_3, P_4 and P_5) had the effect of persistence.

Table 28   ***Persistence in Topawewa (N = 257)***

Various Values of P	Average length of runs		Persistence Ratio	Confidence Limit 1.00	Persistence
	Observed	Expected			
P_1 0.06	1.00	1.06	0.94	± 0.03	present
P_2 0.17	1.13	1.21	0.93	± 0.06	present
P_3 0.12	1.20	1.24	1.05	± 0.05	not present
P_4 0.08	1.05	1.09	0.96	± 0.04	not present
P_5 0.11	1.17	1.12	1.05	± 0.04	present

In Topawewa the occurrences of slight drought (P_1), moderate drought (P_2) and far extreme drought (P_5) had the effect of persistence. The occurrences of severe drought (P_3) and extreme drought (P_5) are in close agreement with expected runs.

Table 29   _Persistence in Trincomalee (N = 275)_

Various Values of P	Average length of runs Observed	Expected	Persistence Ratio	Confidence Limit 1.00	Persistence
P_1 0.08	1.05	1.09	0.96	± 0.04	not present
P_2 0.13	1.13	1.15	0.98	± 0.05	not present
P_3 0.13	1.09	1.15	0.95	± 0.05	not present
P_4 0.13	1.16	1.15	1.01	± 0.05	not present
P_5 0.06	1.13	1.06	1.07	± 0.03	present

In Trincomalee the occurrences of the first four drought months (P_1, P_2. P_3, P_4) are in close agreement with expected runs. There was no persistence. The occurrences of far extreme drought (P_5) months showed the effect of persistence.

Table 30   _Persistence in Vavuniya (N = 263)_

Various Values of P	Average length of runs Observed	Expected	Persistence Ratio	Confidence Limit 1.00	Persistence
P_1 0.08	1.11	1.09	1.02	± 0.04	not present
P_2 0.13	1.21	1.15	1.05	± 0.05	not present
P_3 0.18	1.12	1.22	0.92	± 0.06	present
P_4 0.10	1.08	1.11	0.97	± 0.04	not present
P_5 0.08	1.05	1.09	0.96	± 0.04	not present

During the occurrences of severe drought (P_3) months the persistence was there. But for other categories of drought months (P_1, P_2, P_4 & P_5) it was not there and these occurrences are in close agreement with expected runs.

Conclusion

In Conclusion, it could be said that the effect was produced to some extent by the presence of persistence in the occurrences of drought months in all over the Island. During the occurreimces of slight drught months (P_1) it was present in twenty stations out of thirty. During the occurrences of moderate drought months it was present in twelve stations out of thirty. During the occurrences of severe drought months (P_3) it was present in fifteen stations out of thirty. During the occurrences of extreme drought months (F_4) it was present in seventeen station out of thirty. And during the occurrences of far extreme drought months (P_5) it was present in ten stations out of twenty. This category was not observed in another ten station.

The only place which was not influenced by persistence is Jaffna. The places which were influenced by persistence at least for one kind of drought month, are Anuradhapura, Diyatalawa, Galle, Rasagalla, Trincomalee and Vavuniya. Likewise the presence of persistence is given in table 31. The effect was produced by the occurrences of drought months in one half of the country. This means that the occurrences of drought months are in close agreement in terms of observed and expected occurrences in the other half of the country. As pointed out by Maher (1967) it might be true in the areas affected by persistence that the greater average length of run is the result of persistence reducing the number of short runs and increasing the number of long runs as well as reducing the total number of runs.

Persistence effect studied on global basis. Namias (1972), Lamb (1924) Winstanley(1973) have published theories based on zonal and global circulation systems. Charney et al (1975) have reported a biogeophysical feedback mechanism interms of albedo, plants and rainfall inrelation Sahel Zone. The persistence of Southern Oscillation in the occurence of drought had been explained (Stringer 1972). Further, a study on precipitation fluctuation in Monsoon Asia during last hundred years shows that these fluctuations were paralled with the Southern Oscillation. Recently it is analysed that EL Nino also produces persistence effect on cylons floods and droughts (Shannon and Laura 1977)

Table 31

Stations	Presence of Persistence				
	P1	P2	P3	P4	P5
Anuradhapura					*
Badulla					*
Batticaloa	*	*			*
Chilaw	*		*		*
Colombo	*		*	*	-
Diyatalawa				*	-
Galgamuwa	*	*			
Galle		*			-
Hambantota	*		*		
Jaffna					
Kalmunai	*		*	*	
Kalutara		*		*	-
Kandy	*		*	*	-
Kantalai	*	*	*	*	
Kankesanturai				*	*
Kurunegala	*	*			-
Maha Oya	*	*		*	
Marichchukaddi	*		*	*	*
Moneragala	*		*	*	
Mullaitivu	*	*	*	*	
Nuwara Eliya		*	*	*	-
Paranthan	*	*	*		*
Puttalam	*		*	*	*
Ratnapura	*				-
Rasagalla Estate				*	-
Tissamaharama	*		*	*	*
Topawewa	*	*			*
Trincomalee					*
Vavuniya			*		

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