AN ANALYSIS OF DROUGHTS IN SRI LANKA

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The occurrence of dry spells and droughts would not normally be expected to be a feature of the weather of a tropical island. However, prolonged periods of dry or, at least relatively dry weather are not uncommon in Sri Lanka. A particularly long spell was experienced during the period of 99 days from 31st December 1971 to 7th April 1972. The significant features of the weather and rainfall over the Island during this period are discussed in this article. A few details of two other spells are also discussed briefly.

INTRODUCTION

Upto the present time no organised study of droughts in Sri Lanka has been undertaken and published literature on the subject is not available. However, information and statistical data on droughts are given in the "*Annual Report of the Colombo Observatory*" which is published annually by the Department of Meteorology. These reports contain: (*a*) brief description of drought conditions in the "Weather Summary"; (*b*) monthly rainfall totals and either their standard averages or the departures from these averages; (*c*) number of rain days and their departures from average; (*d*) periods of "Absolute Droughts", "Partial Droughts" and "Dry Spells"; and (*e*) maps showing the rainfall totals and either their standard averages or the departures from their averages.

There are four important geographical and topographical features in Sri Lanka which considerably influence the rainfall over the island. The first is the fact that Sri Lanka is a small island situated in the warm tropical Indian Ocean. The second is its proximity to the equator. The next is the existence of a large mass of hills at the centre of the island. The other factor is the presence of the vast landmass of the Indian Subcontinent to the immediate north and northwest of Sri Lanka.

The warm sea surface around the Island generally gives tropical maritime air masses over the country. These air masses are usually warm and moist and often unstable. Being close to the equator, the island is favourably placed with respect to the equatorial convergence zone. These two factors are both conducive to the production of precipitation. If these two were the only predominant factors, occurrence of droughts and dry spells should be a rare feature.

The third factor, namely the central hills, provides orographic trigger action for the production of rain on the windward side. On the other hand, they have a sheltering effect on the opposite side causing a reduction of rainfall along the leeward slopes and beyond. The effect of this sheltering is liable to cause occasional dry spells in the eastern and northern regions of the island during the period of the south-west monsoon from May to September.

The effect of the neighbouring landmass is to inhibit the input of moisture into airstreams passing over it. Airstreams travelling southwards from the subtropical

TABLE I

Mean number of days of absolute drought (A) and partial drought (P), and days in dry spells

	Jan.		Feb.		March		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Mean No. of days per year in dry spells
	A	*P*	*A*	*P*	*A*	*P*	*A*	*P*	*A*	*P*	*A*	*P*	*A*	*P*	*A*	*P*	*A*	*P*	*A*	*P*	*A*	*P*	*A*	*P*	
Anuradhapura	3	5	8	11	3	8	3	3	10	18	21	29	24	22	18	15	21	17	1	1	0	0	0	0	156
Badulla	0	0	2	0	8	3	1	2	6	12	7	15	7	6	7	1	8	0	2	0	0	0	0	0	75
Batticaloa	0	0	3	2	11	8	12	13	18	20	12	20	8	16	7	10	11	19	4	4	0	0	0	0	153
Colombo	4	4	8	6	3	6	1	0	0	0	0	0	5	6	4	7	0	4	2	0	0	0	5	0	55
Diyatalawa	2	2	1	2	4	3	1	0	2	1	5	9	4	6	7	6	2	2	0	0	0	0	0	0	64
Galle	2	3	5	3	4	3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	28
Hambanteta	6	4	8	13	12	11	6	3	11	5	4	10	12	14	12	22	10	10	5	1	0	1	0	8	149
Jaffna	16	18	19	25	15	21	5	12	18	20	27	30	26	26	17	21	21	19	2	3	0	0	0	6	226
Kandy	4	4	6	9	5	8	1	1	3	3	0	0	0	0	0	0	0	3	0	0	0	0	0	0	48
Kurunegala	5	10	9	14	6	9	2	1	3	3	0	0	0	1	3	3	1	0	0	0	0	0	2	4	70
Mannar	5	8	18	19	12	20	10	18	21	27	26	30	26	30	25	31	26	25	6	6	0	0	2	0	232
Nuwara Eliya	3	2	4	4	6	6	1	1	4	3	0	0	0	0	0	0	0	0	2	0	0	0	0	0	32
Puttalam	4	4	6	8	8	7	2	4	7	12	12	24	25	29	24	30	15	21	2	6	0	0	0	0	171
Ratnapura	1	0	6	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	15
Trincomalee	3	2	12	12	18	18	12	14	15	16	26	26	18	11	9	8	8	4	0	4	0	0	0	0	172

Note: These figures are for the 10-year period 1949–1958.

anticyclonic ridge of the Northern Hemisphere have a larger proportion of their trajectories over India and are therefore unable to collect much moisture. If this effect predominates it will lead to dry conditions throughout the entire island during the northeast monsoon months of December to February.

Distribution of Droughts

Table I gives the mean number of days of "Absolute Drought" and "Partial Droughts" at 15 representative stations in Sri Lanka taken over a period of 10 years from 1949 to 1958. The terms "Absolute Drought" and "Partial Drought" could be defined as follows:—

(1) *An absolute drought is one during which 0.01 inch of rain or more is not recorded on any day during a period of at least 15 consecutive days.*

(2) *A partial drought is one which extends over a period of at least 29 consecutive days the mean daily rainfall of which does not exceed 0.01 inch.*

The Table also shows (in the last column) the mean number of days included in dry spells during the year. A "Dry Spell" consists of any period of at least 15 consecutive days to none of which is credited with 0.04 inch of rain or more. The figures in this column include the days listed under all three categories. (These are the definitions in general use in the Sri Lanka Meteorological Service.)

The period 1949 to 1958 was selected at random from among the years with extracted data. From this Table it will be seen that most droughts occur during the southwest monsoon period from May to September. These spells are generally restricted to the northern and eastern regions of the country. The period least liable to drought conditions is October to December, particularly the month of November. Incidentally, the period October to December is the main storm season in Sri Lanka.

The annual distribution given in the last column of the table is represented in Fig. 1, which shows the regions most prone to droughts as the northern half of the island and the extreme eastern and southeastern areas. These are the two regions with the lowest annual rainfall totals, the totals generally falling below 1,500 mm. Maximum drought conditions are experienced in the extreme northwestern region consisting of the Mannar and Jaffna Districts. Minimum values are recorded in the inland lowland areas of the southwest quarter of the island and along the lower southwestern slopes of the central hills. The annual rainfall totals in this region generally exceed 4,000 mm.

Recent Droughts in the Southwest Monsoon Season

A few details regarding two droughts experienced during the southwest monsoon period in recent years are given below. One of these occurred in 1966 and was spread out from the beginning of May to late August and in certain areas even to the second half of September. The other was recorded in 1967 from mid-May to late September. During the entire period of the five months of the southwest monsoon (May to September) over Sri Lanka most of the stations in the northern and eastern regions of the country do not receive more than 300 mm of rainfall each. Of these, several stations in the extreme northern, northwestern and southeastern

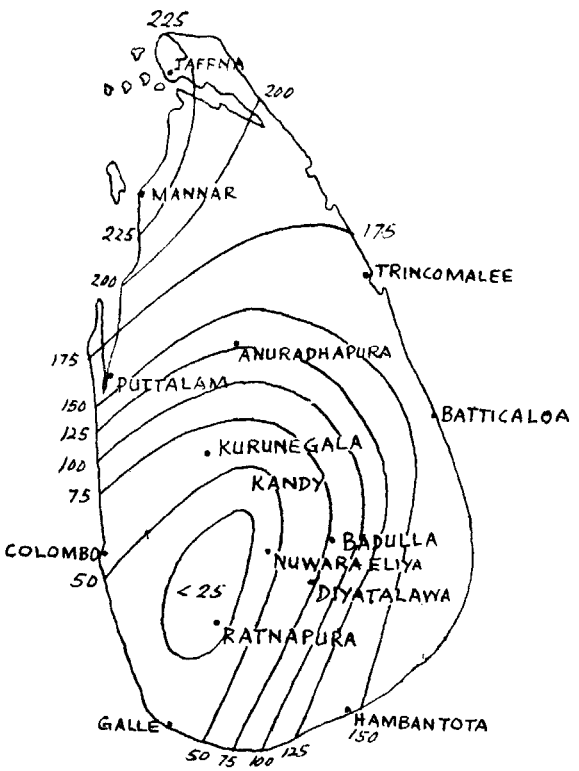

FIG. 1. The distribution of dry spell days over the island.

areas record less than 200 mm during this season. Hence even comparatively small deficits of rainfall over fairly long periods of time give rise to drought conditions in these regions.

The drought of 1966 was experienced in the northern half of the island and in the extreme southeastern region. Mannar, for example, had a 118-day spell of partial drought from 1st May to 26th August. Then, after a break of one day on the 27th, there followed another partial drought which lasted 32 days from 28th August to 28th September. During these two periods there were three spells of absolute drought at the station, namely, 79 days from 3rd May, 24 days from 22nd July and 25 days from 28th August. Mannar recorded only 58 mm of rainfall during these five months against an average of 101 mm. Conditions were particularly severe during the first three months of the spell (May to July) when only 4 mm of rainfall were recorded against an average of 61 mm. During the same season Puttalam had a partial drought lasting 143 days from 2nd May while Jaffna had a partial drought of 111 days from 1st May, which included a spell of 68 days of absolute drought beginning on the 2nd, and Anuradhapura had a spell of 110 days of partial drought commencing on 2nd May of which the first 69 days comprised a period of absolute drought. Puttalam experienced only 32 mm of rainfall during the four months from May to August while its average for the 4-month period is 160 mm. During the same period Jaffna recorded

only 4 mm against an average of 95 mm, and Anuradhapura 27 mm against an average of 146 mm. In the East, Trincomalee recorded a 100-day spell of partial drought from 3rd May to 10th August. This was followed by another spell of 36 days from 16th August. The total rainfall recorded from May to August at this station in 1966 was 65 mm while the average value for the period is 243 mm. Rainfall was more scarce during the first three months, the total recorded being only 14 mm against an average of 140 mm. In the southeast, Hambantota experienced a 75-day spell of partial drought from 11th July. The total rainfall recorded during these 75 days at this station was only 18 mm of which 3 mm were recorded on the last day (23rd September). The rain on the 23rd was followed by more precipitation during the next few days. The rain spell which commenced about this time was widespread over Sri Lanka. This was caused by active convergence from the 22nd to 24th, resulting from the presence of the Intertropical Convergence Zone lying across the island between latitudes 07°N and 08°N. This was followed on the 25th by a cyclonic circulation, centered around 11°N 86°E in Southwest Bay of Bengal, which caused the strengthening and deepening of the moist westerly airstream over the island, and the dry spell was broken.

The 1967 drought affected only the northwestern and northcentral regions of the island. Mannar recorded a partial drought of 149 days from 18th May. Absolute drought conditions were experienced at this station from 18th May to 26th August, a spell of 101 days. This was followed by 0.3 mm of rain on the following day and another period of 44 days of absolute drought from the 28th. Thus Mannar experienced a continuous spell of 146 days during which the total rainfall was only 0.3 mm. The average rainfall at this station for the period June to September is 52 mm. Hence, a rainfall deficit of nearly 52 mm was recorded at this station for this four-month period in 1967. Anuradhapura recorded a spell of 130 days of partial drought from 18th May. The rainfall recorded from June to September at this station totalled only 39 mm while the average for the four months is 165 mm. This shows a departure from normal amounting to as much as 124 mm. During this same season Jaffna had partial drought conditions which were restricted to three shorter periods—36 days from 13th May to 17th June, 48 days from 19th June to 5th August and 32 days from 27th August to 28th September.

A trough of low pressure in Southwest Bay of Bengal gave rise to a spell of moderate rain, which was fairly widespread over the Island, from the 18th to 21st September 1967. With this rainfall, the dry spell ended in most areas, the September rainfall totals at Hambantota and Trincomalee (for example) being very near their average values while at Puttalam the average was exceeded appreciably. However, dry conditions continued in the extreme northern and northcentral regions with Jaffna and Anuradhapura recording large deficits for September while Mannar had no rain at all during the entire month. The drought conditions in these regions finally ended under the influence of a depression which formed in the Arabian Sea to the west of Sri Lanka. The depression deepened into a cyclonic storm on the 20th October 1967 morning, moved slowly in an easterly direction and struck the west coast of the island (near Madampe) on 20th evening. The storm resulted in very heavy rainfall which was widespread over the entire country.

Analysis of the Dry Spell of January to April 1972

This dry spell commenced on 31st December 1971 with the trough of low pressure which had persisted in Southwest Bay of Bengal moving away towards the extreme South Bay by the 29th. Until the 31st, December was a wet month as will be seen from Table II. Most stations recorded rainfall totals far in excess of their normals, particularly Trincomalee (797 mm), Jaffna (600 mm), Anuradhapura (489 mm) and Mannar (424 mm). The only station which recorded a rainfall deficit during this month was Diyatalawa. The dry spell continued up to 7th April 1972, with the periods 31st December to 16th January and 31st January to 5th March being particularly severe.

Until 16th January the airstream over the island was coming over the Indian landmass from a high pressure cell. This subsident air with a continental track was very dry upto considerable heights. The air temperature at 1000 mb rose from 24.6°C on 26th December to 27.4°C on the 31st and remained at about this value for several weeks. At 700 mb the temperature increased from 8.2°C on the 30th to 11.6°C on 3rd January. Thereafter, the temperature varied between 8°C and 9°C for a few weeks. The dew-point temperatures remained below average at 1000 mb until 17th January. The dew-points at 700 mb were well below normal during the period, the lowest value recorded being −23.4°C on the 3rd while the normal was around 0°C.

On 17th January an easterly wave was observed to be moving across the Bay of Bengal and by the 18th it was found to move across Tamil Nadu. This wave brought in some moisture from the Bay and, with convergence taking place over the island between this airstream and the subsident air from the northwest, there was a temporary break in the dry conditions. On the 17th and 18th, most areas in the northern half of the island and the hill areas received rain. The maximum effect of the convergence was experienced along the northeast coastal area where Trincomalee recorded 3 and 13 mm, respectively, on the two days. This gave a total of 16 mm for the two days which was somewhat greater than half the rainfall received at this station during the entire month of January.

By 19th January the easterly wave moved across the Indian landmass, the supply of moisture was arrested and the air became somewhat drier again. The dew-point at 1000 mb which dropped to 3°C below normal on the 21st began to rise and was somewhat above normal by the 28th. The dew-point temperature at 700 mb exceeded its normal value by a few degrees for some days but fell below average by the 28th. Thereafter, it recovered and was about 4°C above normal by the 31st. These increases in the dew-point temperatures between the 29th and 31st were not accompanied by any rise in the air temperatures. In fact, the air temperatures showed slight decrease from the 28th to 31st. There were two distinct changes in the upper air structure from the 28th to 31st. One difference was in the temperature profile. On the 28th there was a shallow low level inversion from 975 to 950 mb and a second inversion at a higher level from 720 to 690 mb. These inversions had collapsed by the 31st, thereby presenting more favourable conditions for convective instability. The second difference was in the moisture content of the air. The upper air sounding on the 28th showed moist conditions up to 800 mb or so, gradually becoming drier up to 550 mb and very dry beyond 550 mb. On the 31st the air was fairly moist all the way up to 300 mb with the layer between 550 and 450 mb being almost saturated. Fig. 2 shows

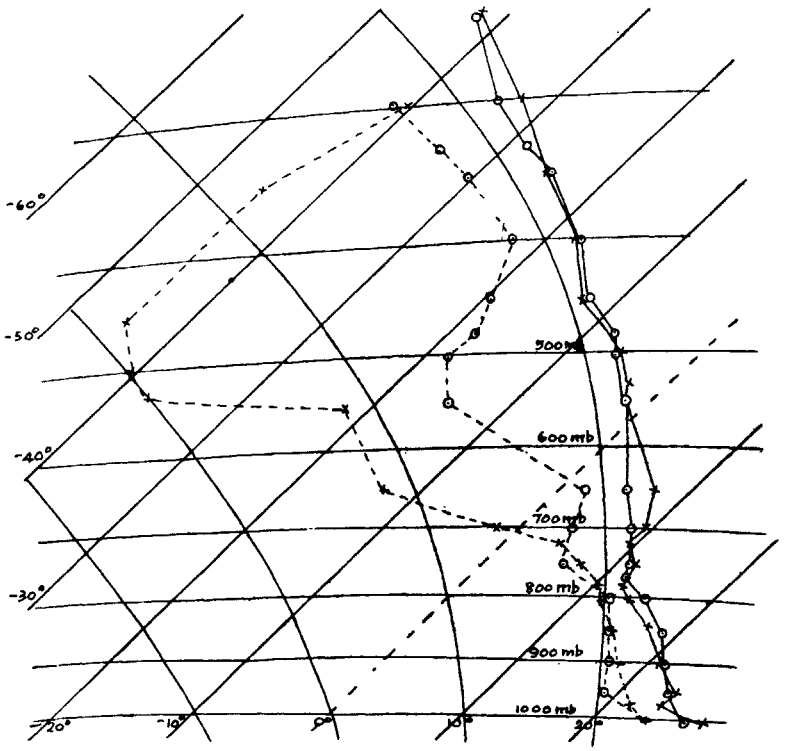

FIG. 2. The upper air temperatures and dew points on 28th and 31st January 1972

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the upper air temperatures and dew-points obtained from the radiosonde ascents made at Colombo on the 28th and 31st of January.

As a result of these changed conditions there was a welcome short spell of rain from 29th to 31st January, particularly among the hills and in other inland areas. Nuwara Eliya (at an elevation of 1.9 km) recorded 26 mm on the 29th, 38 mm on the 30th and 13 mm on the 31st, making a total of 77 mm for the 3 days. This amounted to over 80 per cent of the total rainfall recorded at this station during the month. Badulla (at an elevation of 680 m) and Diyatalawa (at 1.3 km) recorded totals of 53 and 28 mm respectively for this period of 3 days. These totals were approximately 45 per cent of their monthly totals. Kandy (at 480 m) and Kurunegala (at 120 m) recorded 14 and 7 mm respectively for this period, the figures representing almost their monthly totals.

A high pressure cell centred about 15°N 60°E in the Arabian Sea began to take control of the weather over the island from the beginning of February and its influence became the major factor until 7th April. With this warm and dry subsident air the weather over the island remained very dry during most of this period. February was a particularly dry month with several stations recording no precipitation at all

The air temperatures at 1000 and 700 mb remained generally around their mean values except on 31st March when the 700 mb value showed a deficit of 3°C. Dew-points at 1000 mb were less than their means until 24th March but increased slightly thereafter. The values at 700 mb which were somewhat above normal dropped well below normal on 18th February and remained so except for a few days around 17th March.

The rise in the 700 mb dew-point on 17th March was due to moisture brought in as a result of a feeble low pressure area which developed over the island on this date. This low pressure persisted on the 18th and 19th. The presence of this feeble low modified the influence of the high pressure cell in the Arabian Sea and a fair amount of rainfall was experienced in the southwestern lowlands. This low was, however, too weak to induce precipitation over a wider region. By the 20th, the low began to move away and gradually fill up, and the island again came directly under the influence of the high pressure system in the Arabian Sea.

In the meantime another high pressure area began to build up around 15°N 85°E in the Bay of Bengal from about 10th March. The surface synoptic situation at 1200 GMT on 11th March with these two high pressure cells is shown in Fig. 3. Another feeble trough developed on the 22nd in the Eastcentral Arabian Sea area along and off the west coast of India. This persisted until the 26th and was the cause of the increase in dew-point temperature at 1000 mb from the 25th. This resulted in a fair amount of precipitation mainly in the southwest quarter of the island on the 26th and 27th. This trough became unimportant by the 28th and the weather once more came under the direct influence of the Arabian Sea high pressure cell and dry conditions were again predominant.

This general synoptic pattern persisted over the Sri Lanka region until 7th April. A low pressure area which was observed over the South Andaman Sea and adjoining Southeast Bay of Bengal from 3rd April developed into a well marked low pressure

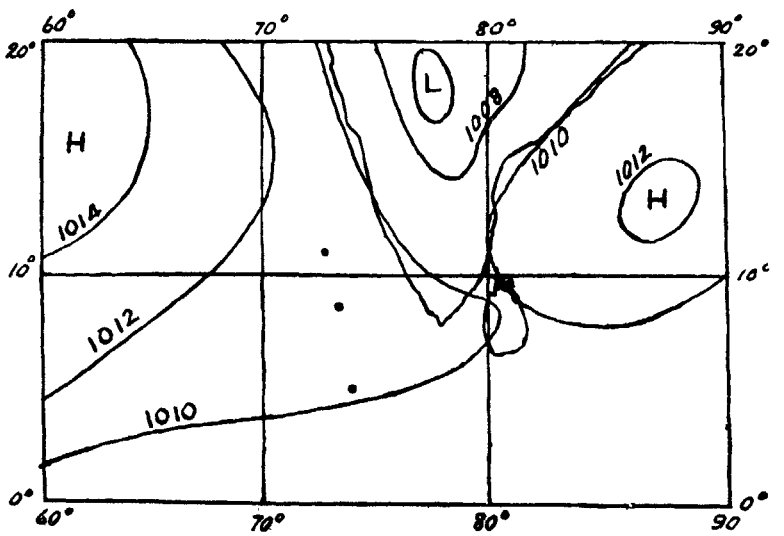

FIG. 3. The Surface Chart at 1200 GMT on 11-3-72. The two high pressure cells dominate the situation.

on the 7th. Fig. 4 gives the surface synoptic chart at 1200 GMT on 7th April. This shows the deepening of the low pressure into a depression. As a result of this, the high pressure cell in the Bay was pushed northwards and began to distintegrate. On the 8th this low pressure system concentrated into a depression and was centred at about 10°N 90°E. This is seen in Fig. 5 which gives the surface situation 24 hours after that in Fig. 4. It deepened further into a cyclonic storm by the following day and gradually moved in a northerly to northeasterly direction. With this depression the

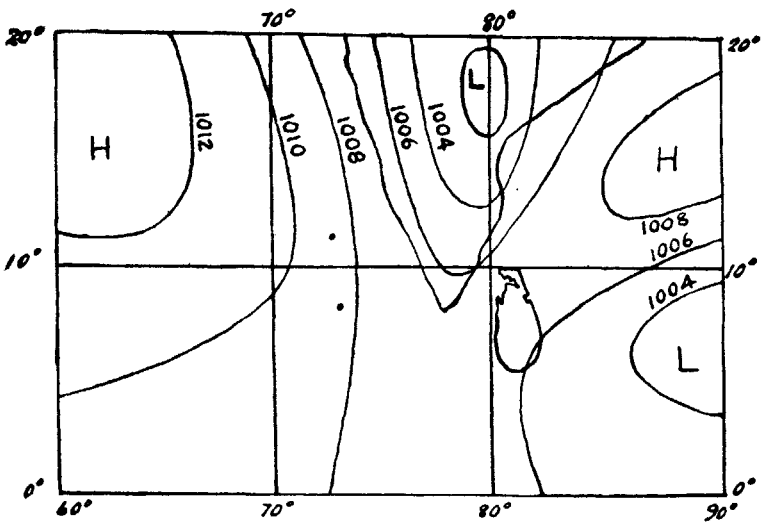

FIG. 4. The Surface Chart at 1200 GMT on 7-4-72. The low pressure is deepening into a depression.

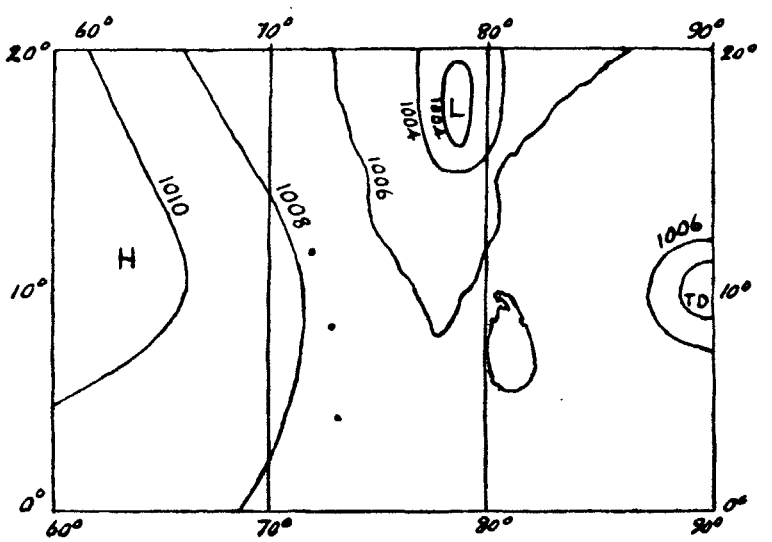

FIG. 5. The Surface Chart at 1200 GMT on 8-4-72 showing the Tropical Depression in the Bay.

TABLE II

Number of days of absolute and partial drought periods during the spell of 1972

Station	Jan. 1972		Feb. 1972		Mar. 1972	
	Absolute	Partial	Absolute	Partial	Absolute	Partial
Anuradhapura	17	31	29	29	21	31
Badulla	0	0	28	29	4	5
Batticaloa	0	0	17	0	25	25
Colombo	24	0	29	29	4	18
Diyatalawa	0	0	0	7	0	25
Galle	0	0	17	11	22	28
Hambantota	20	20	29	29	22	31
Jaffna	15	13	29	29	31	31
Kandy	0	0	29	29	5	18
Kurunegala	19	31	14	29	0	18
Mannar	30	31	29	29	31	31
Nuwara Eliya	0	0	28	29	27	30
Puttalam	18	20	29	29	27	29
Ratnapura	0	0	0	0	0	0
Trincomalee	16	0	11	11	19	31

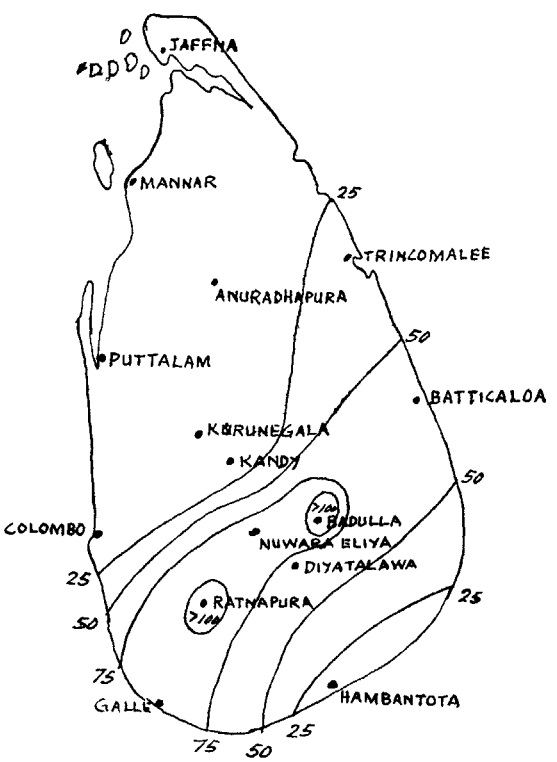

FIG. 6. Rainfall totals for January 1972.

TABLE III

Rainfall totals and departures from average (in mm)

Station	December 1971		January 1972		February 1972		March 1972		April 1972	
	Total	Departure	Total	Departure	Total	Departure	Total	Departure	Total	Departure
Anuradhapura	489	+247	12	—111	0	—54	1	—98	139	—48
Badulla	371	+96	121	—108	0	—121	38	—72	163	—33
Batticaloa	501	+71	66	—213	61	—117	37	—18	13	—55
Colombo	181	+6	16	—72	0	—96	68	—50	157	—103
Diyatalawa	166	—37	59	—93	33	—53	70	—51	155	—55
Galle	186	0	80	—33	12	—104	54	—63	87	—165
Hambantota	147	+26	8	—93	0	—58	5	—61	112	+3
Jaffna	600	+333	7	—89	0	—37	0	—30	24	—46
Kandy	393	+182	18	—100	0	—83	27	—93	201	+13
Kurunegala	306	+130	7	—91	0	—60	92	—78	411	+148
Mannar	424	+222	1	—86	0	—34	0	—44	63	—25
Nuwara Eliya	285	+95	94	—51	2	—74	20	—76	174	+20
Puttalam	176	+23	12	—61	0	—46	31	—45	152	+14
Ratnapura	228	+14	125	—26	61	—120	174	—70	326	—11
Trincomalee	797	+423	30	—181	16	—79	3	—45	5	—71

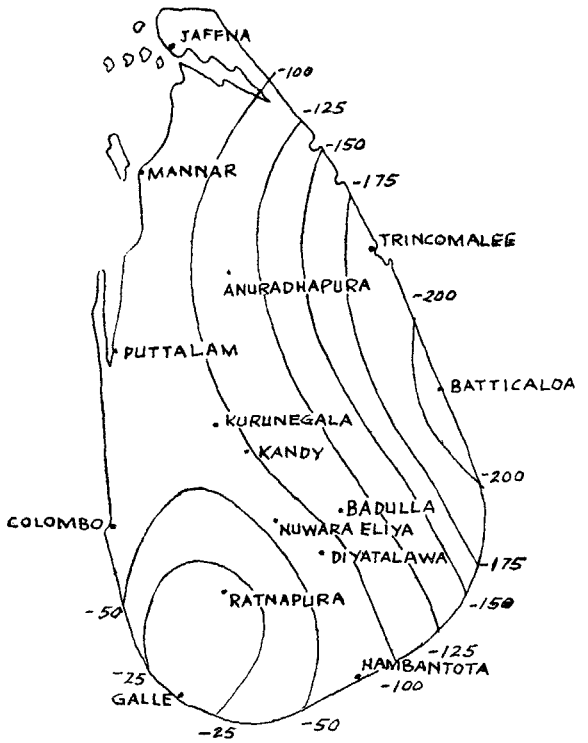

FIG. 7. Departures from normal for January 1972 (in mm).

long spell of drought conditions over the Island was broken on 8th April. Kurunegala, for instance, received 30 mm of rainfall on this day and again 46 mm on the following day. Colombo had 31 mm on the 8th while on the 9th Kandy recorded 64 mm, Hambantota 48 mm and Badulla 45 mm.

Table II gives the number of days of absolute and partial droughts during the 3 months, January to March. This shows the period February–March as the worst affected. Table III gives the monthly rainfall totals and their departures from the standard averages from December to April. January, February and March show rainfall deficits throughout the entire Island.

The isopleths of monthly rainfall totals for January, February and March are shown in Figs. 6, 8 and 10, respectively, while their departures from average are shown in Figs. 7, 9 and 11, respectively. The upper air data for Colombo obtained on 13th and 17th March are plotted in Fig. 12. These two ascents demonstrate the extreme dry conditions that prevailed during this period. Taking all these factors into consideration the drought which occurred during the first few months of 1972 appears to be one of the most severe spells experienced in Sri Lanka.

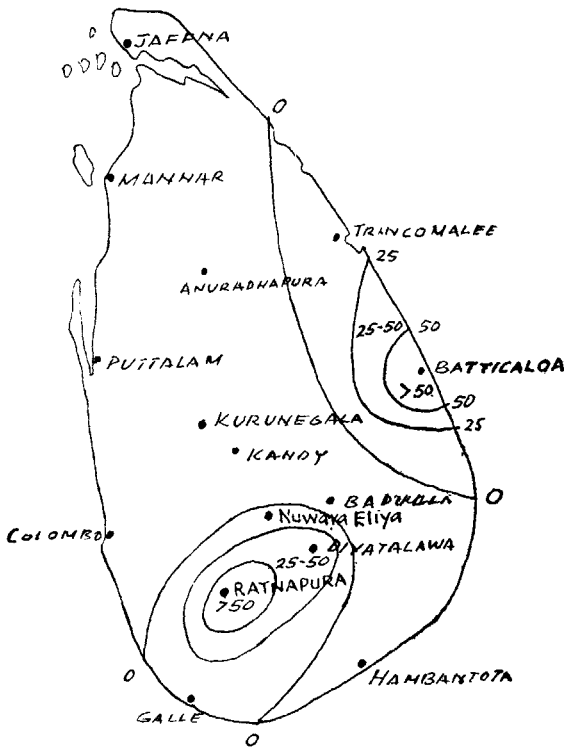

FIG. 8. Rainfall totals for February 1972 (in mm).

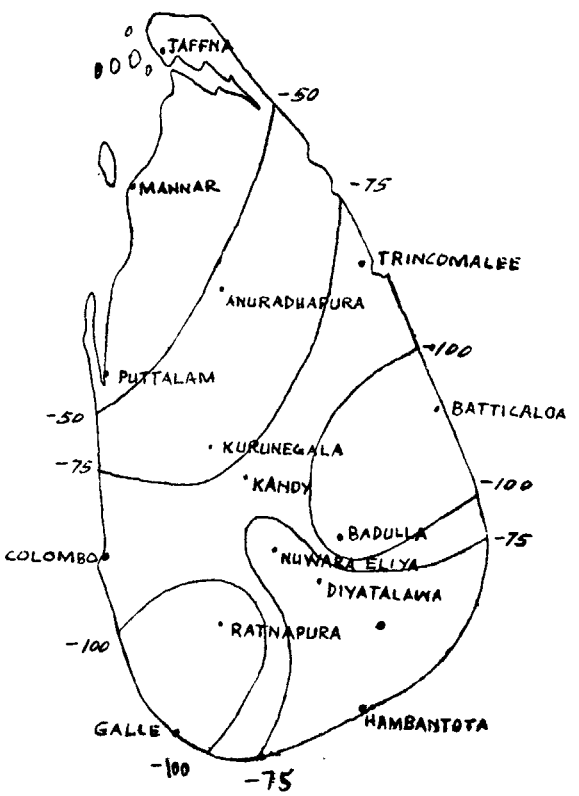

FIG. 9. Departures from normal for February 1972 (in mm).

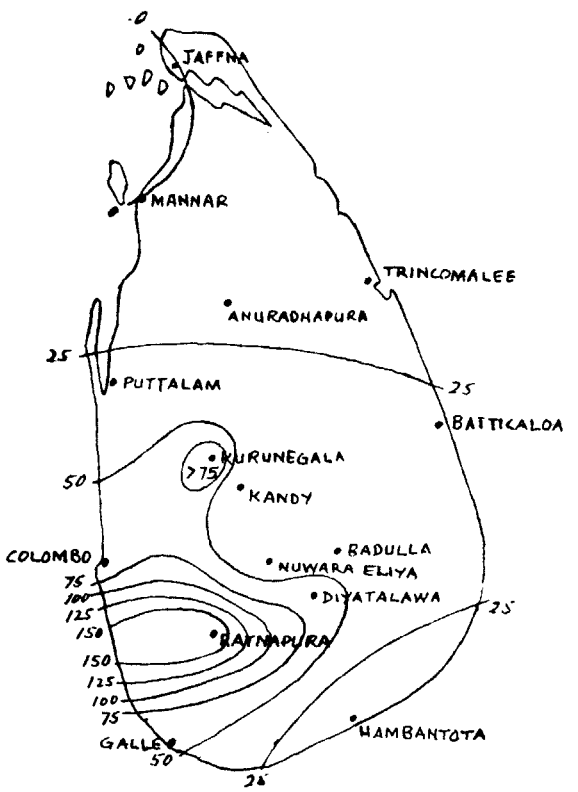

FIG. 10. Rainfall totals for March 1972 (in mm).

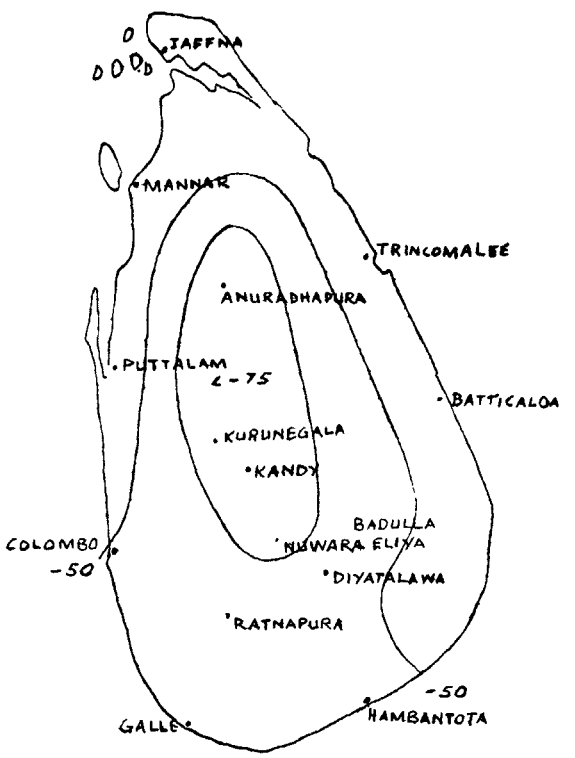

FIG. 11. Departures from normal for March 1972 (in mm).

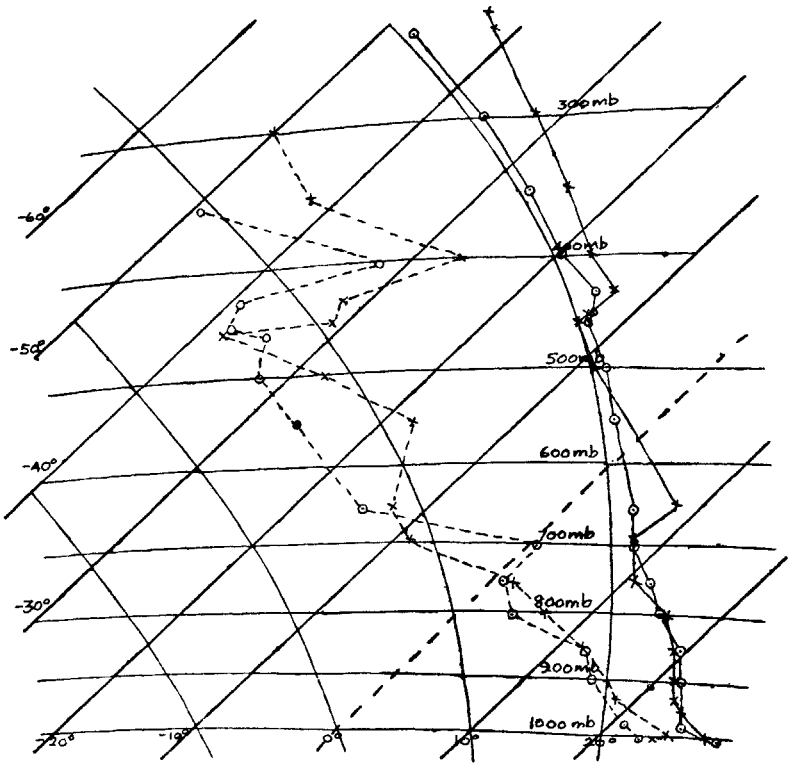

FIG. 12. The upper air temperatures and dew points on 13th and 17th March 1972

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CONCLUSION

Droughts and dry weather periods are experienced in Sri Lanka under two conditions. One situation arises when the airstream over the island comes from a Northern Hemisphere high pressure system and travels over the dry mainland of India immediately before reaching Sri Lanka. Such a situation can occur during the northeast monsoon months of December to February and can extend into the subsequent winter monsoon season. Such droughts and dry spells can occur over most parts of the island.

The second situation can occur during the southwest monsoon months of May to September when the prevailing airstream of the monsoon is relatively dry. Under such dry monsoon conditions dry spells are liable to occur mainly in areas which are shielded by the hills.

The drought of early 1972 comes under the former category while those of 1966 and 1967 are of the second type.

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