Indian J. Met. Hydrol. Geophys. 1976, 27,4, 385-390

551.553.21 (664)

Monsoon in Sierra Leone

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(Received 22 October 1975)

ABSTRACT. General characteristic of monsoon in Sierra Leone is discussed in this paper. The months July, August, September may be considered as monsoon months in Sierra Leone. Most of the rain in this country occurs in these three months. Rainfall data for the period 1954 to 1973 were analysed. It was found that rainfall gradually decreases from west to east and from south to north. Though the rainfall increases in monsoon, there is considerable reduction in thunderstorm activity. The diurnal variation of rainfall indicates that the rainfall is maximum in early morning and minimum in the evening. A comparison of rainfall characteristic has been made with those over west coast of India.

1. Introduction

Sierra Leone is a country in West Africa with area about 28,000 sq. miles and with undulated topography. The country lies between latitudes 6° 55′N and 10°00′N and longitudes 10° 15′ W and 13° 16′ W. It is in the northern limit of equatorial rain forest zone. The months July, August and September are considered as monsoon months in Sierra Leone. In the present paper, an attempt has been made to understand the behaviour of monsoon in Sierra Leone. A comparison has also been made with the monsoon in West coast of India.

2. Data

Rainfall data for the period 1954 to 1973 were analysed for daily, monthly and seasonal rainfalls. Lungi (Freetown Airport) is the only observatory with round the clock watch. Weather diaries of this station were carefully examined. Pilot Balloon ascent data for afternoon (1800Z) were analysed for the period 1955-1964. Self recording raingauge charts for the same period were also analysed for studying hourly rainfall.

3. Analysis

Table 1 gives the rainfall at places in Sierra Leone during premonsoon (April to June), monsoon (July to September) and post monsoon (October and November) seasons. The percentage contribution of seasons rainfall to annual total is also presented. It will be seen that the main contribution of rainfall to the country is during monsoon. Table 2 gives the monthly rainfall at these places.

Fig. 1 gives the location of stations. To determine the zonal and meridional variation of rainfall, stations falling within 8° 00′N and 8° 30′ N and those within 11° 30′W and 12° 00′ W were chosen. Rainfall data were plotted against longitude in former case and against latitude in the latter. They are reproduced in Figs. 2 and 3.

It will be seen from Table 2 that the maximum rainfall occurs in different months at different places. It will be seen that a part of the coast gets the highest rain in July. Most part of the country gets it in August. In fact August, can be taken as the typical monsoon month for that country.

Increase in rainfall is not the only criterion for monsoon. With the advent of monsoon there is a marked change in weather pattern. Thus, the frequency of thunderstorms decreases considerably. This is shown in Fig. 4. Conversely, the monsoon rainfall is not associated with thunder. Percentage of days with rain without thunder is shown in solid line in the same figure. Again, in June rain occurs at any time of the day except a few hours around noon, whereas in July most of the rain occurs in early morning and least in the late afternoon and early evening (Fig. 5).

With the advent of monsoon, an abrupt increase in rainfall is expected. Five day normal rainfalls were plotted for Lungi for this purpose, but no abrupt change was noticed. 10 day average rainfalls were then plotted (Fig. 6) and it was found that onset of monsoon occurs in the beginning of

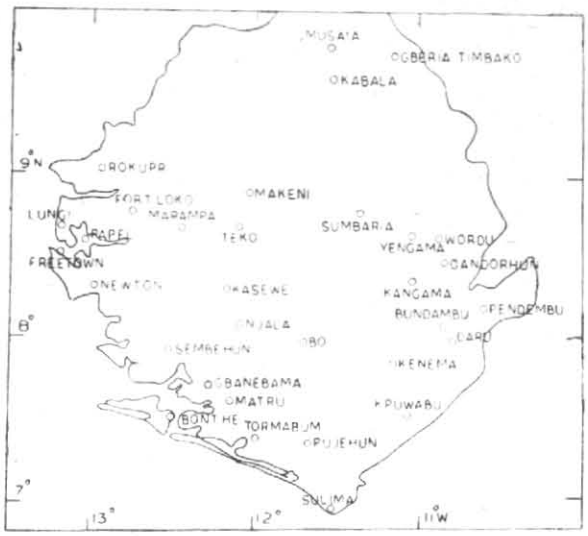
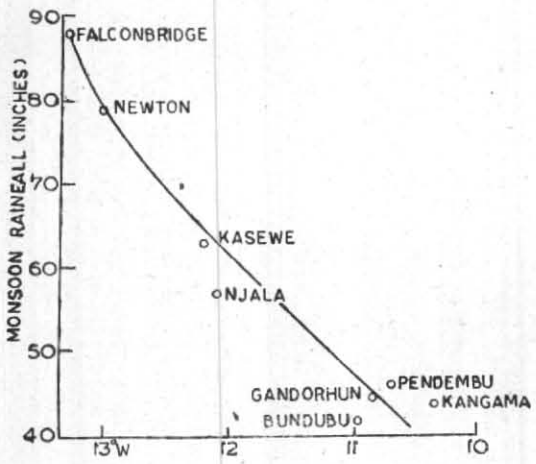


Fig. 1. Positions of stations in Sierra Leone for which rainfall data has been analysed

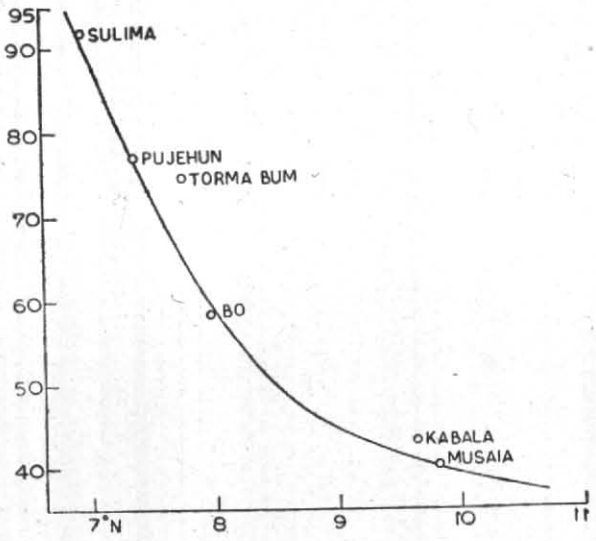
TABLE 1

Seasonal rainfall at different places in Sierra Leone

Station	Lat. (°N)	Long. (°W)	Rainfall (inches)				Percentage contribution of annual rainfall		
			Pre-monsoon	Monsoon	Post-monsoon	Annual	Pre-monsoon	Monsoon	Post-monsoon
Bo	07°58′	11°45′	30·86	58·05	21·22	114·20	27	51	19
Bonthe	07 32	12 30	40·02	84·33	20·81	148·45	27	57	14
Bunumbu	08 10	10 58	33·57	41·54	20·63	98·97	34	42	21
Daru	07 59	10 52	33·78	45·27	20·13	100·79	34	45	20
Falcornbridge	08 30	13 14	22·72	87·85	15·34	128·19	18	69	12
Gandorhun	08 26	10 52	30·68	44·64	20·44	99·29	31	45	21
Gberia Timbako	09 45	11 11	18·90	37·35	14·15	71·79	26	52	20
Gbangrama	07 42	12 18	31·83	69·50	16·40	120·20	27	58	14
Kabala	09 35	11 33	26·17	42·61	17·65	87·93	30	48	20
Kangama	08 21	10 23	34·03	43·81	20·93	102·20	33	43	20
Kasewe	08 20	12 12	30·95	62·98	23·42	120·24	26	52	20
Kenema	07 33	11 11	31·66	53·86	21·89	111·63	28	49	20
Kpuwabu	07 30	11 05	34·37	50·46	23·59	112·03	31	45	21
Lungi	08 37	13 12	26·03	83·00	17·40	128·50	20	65	14
Makeni	08 53	12 03	29·74	66·80	24·19	121·44	25	56	20
Marampa	08 41	12 31	24·75	57·62	22·70	106·70	23	55	21
Mattru	07 37	12 11	32·46	59·56	18·22	112·52	29	53	16
Musaia	09 45	11 34	22·98	39·87	16·58	79·81	29	50	21
Newton	08 20	13 00	26·26	78·91	18·52	125·85	21	63	15
Njala	08 06	12 06	32·02	56·73	20·06	109·52	28	50	17
Pendembu	08 07	10 42	32·86	45·96	19·19	102·27	32	45	19
Port Loko	08 46	12 47	25·19	60·78	19·33	106·88	24	58	18
Pujehun	07 21	11 43	35·41	76·89	21·17	138·61	26	56	15
Rokupr	09 01	12 57	24·53	72·32	30·08	118·48	21	61	17
Sembehun	07 57	12 32	29·54	67·18	18·33	117·36	25	57	16
Sulima	06 58	11 37	52·59	91·55	34·84	173·76	30	47	22
Sumbaria	08 50	11 20	31·61	50·20	23·24	107·66	30	47	22
Teko	08 49	12 02	28·24	65·30	21·08	116·28	24	56	18
Torma Bum	07 25	12 00	33·82	75·66	19·72	133·89	25	57	15
Wordo	08 37	10 57	31·75	40·08	16·01	98·80	32	46	17
Yengema	08 37	11 03	30·80	45·00	18·72	97·63	32	47	19



Longitude West
Fig. 2



Latitude North
Fig. 3

July. No date or period could be fixed for withdrawal of monsoon. Probably we can take it to be end of September.

4. Discussions

Weather over West Africa is explained by the march of I.T.C.Z. with its associated weather zones (Walker, 1958). The seasonal march of the zones is shown in Fig. 7. Zone D is the monsoon weather zone. Zone E is relatively dry. It will be seen that this zone comes over southern parts of Sierra Leone. In confirmation to this Sulima can be seen to have a relatively dry period in August.

It will be seen that heaviest rainfall occurs in July on the coast south of 8° N and in August along coast north of this latitude. This is explained by the seasonal march of weather zones.

Monsoon in Sierra Leone is due to a south-westerly current. Upper winds at Freetown were analysed and it was found that in general there is a westerly component of wind near the ground throughout the year. In March and in monsoon months (July, August and September) the south-westerlies are quite prominent. In March, the hottest month, the sea breeze is very prominent (Mukherjee and Moore 1973). With the onset of monsoon the southwesterlies set in prominently upto about 5000 ft. (1·5 km.). In the pre-monsoon the easterlies are prominent from 3000 ft and attain speed of 20 kt at 9000 ft. With the advent of monsoon the prominent easterlies move up and on an average there is a regime of variable wind from 5000 ft to 11,000 ft. It must be stated here that there may be a bias towards easterlies in the upper air analysis. It is the experience of the author that whenever the westerlies are prominent during the monsoon the coverages by low clouds are more and as such high pilot balloon ascents are not possible.

When the monsoon withdraws, the easterlies come down and components of 20 kt easterlies are found as low as 6000 ft. The abrupt change in upper winds explains abrupt change in rainfall intensity in July and thus helps us to find out the time of onset of monsoon. Similarly gradual decrease in south-westerlies indicate that withdrawal of monsoon should be a comparatively gradual process.

Southwesterly winds are expected to cause more rainfall to the western side of the country and there should be gradual decrease of rainfall towards east. This explains Fig. 2. The north-south variation of rainfall is due to the march of I.T.C.Z. The amount of rainfall depends on the period of time a place is traversed by zones C and D. This explains Fig. 3.

Since the rain bearing wind is from southwest or more correctly from south southwest, we should expect higher amount of rainfall on the coast due to coastal convergence. To test this ratio of rainfalls at Bo (an inland station) and Lungi were plotted (Fig. 8). In premonsoon the wind is from east or northeast and as such there is a sort of divergence along the coast. During moonsoon the wind is from west and hence coastal convergence plays substancial part in giving increased amount of rain. This explains the nature of the curve in the above figure.

5. Comparison with west coast of India

Sierra Leone and west coast of India are similarly situated. Both get rain mainly from southwest

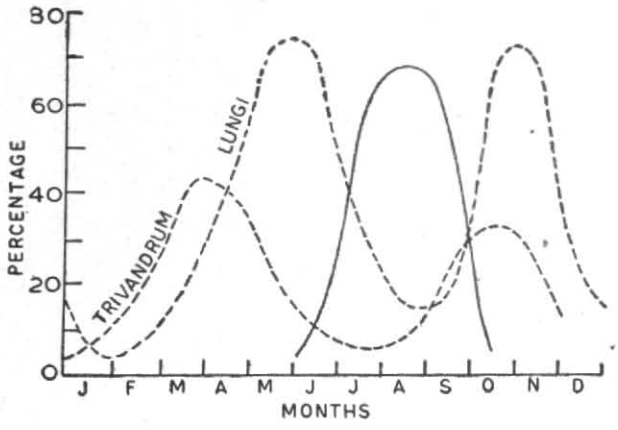


Fig. 4
Solid line : % days with rain but without thunder and dashed line : % days with thunder

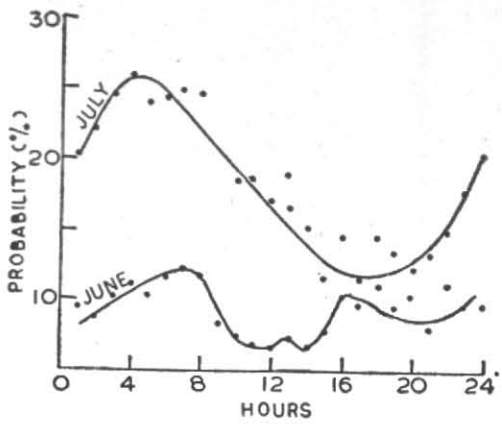


Fig. 5
Diurnal variation of rainfall probability.

TABLE 2

Average monthly rainfall (inches) at different places in Sierra Leone

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bo	0·42	0·97	2·70	5·28	10·8	13·80	17·77	20·97	19·31	14·05	7·17	1·68
Bonthe	0·41	0·74	1·73	4·43	10·95	22·91	31·96	28·62	23·75	14·00	6·81	2·14
Bunumbu	0·34	1·47	4·71	7·38	8·84	12·64	12·35	14·17	15 01	13·03	7·60	1·62
Daru	0·34	1·38	4·00	6·94	10·73	12·11	12·38	14·37	16·52	12·57	7·56	1·89
Falconbridge	0·35	0·32	0·70	2·21	6·37	13·44	32·88	33·26	21·71	10·63	4·71	1·61
Gandorhun	0·43	2·03	4·75	6·57	7·72	11·64	13·26	14·47	16·91	13·15	7·29	1·07
Grangbama	0·19	1·23	1·38	3·92	9·86	16·65	21·55	26·00	21·95	10·57	5·83	1·07
Gberia Timbako	0·01	0·78	1·39	2·49	6·10	8·92	11·05	11·26	15·03	11·26	2·89	0·60
Kabala	0·29	0·49	1·82	3·98	7·81	12·56	12·33	14·66	15·62	13·04	4·61	0·72
Kangama	0·77	1·14	3·60	6·93	11·55	11·91	13·10	14·50	16·15	12·55	8·38	0·58
Kasewe	0·33	0·95	2·57	4·08	10·23	14·07	20·59	20·08	20·31	15·34	8·14	1·55
Kenema	0·63	1·52	3·97	5·60	10·17	11·92	15·62	20·13	18·11	13·84	8·05	2·07
Kpuwabu	0·71	1·98	3·20	7·70	11·49	12·61	16·21	17·03	17·22	15·23	8·36	0·93
Lungi	0·33	0·16	0·85	2·27	8·22	14·69	29·02	32·30	21·68	11·64	5·85	1·45
Makeni	0·23	0·29	1·31	3·84	8·65	14·91	19·54	25·31	21·95	16·13	8·06	1·19
Marampa	0·19	0·17	1·26	3·07	8·14	11·88	17·24	22·05	18·33	14·95	7·75	1·06
Mattru	0·38	0·58	2·47	4·92	9·57	15·50	18·40	19·72	21·48	10·36	7·86	1·27
Musaia	0·40	0·50	1·60	3·02	7·13	10·23	12·33	12·83	14·71	11·70	4·88	0·88
Newton	0·36	0·39	0·97	2·70	7·93	14·66	28·49	30·42	20·00	12·61	5·91	1·39
Njala	0·46	0·82	2·99	4·95	9·72	14·36	16·71	20·70	17·32	14·10	6·96	1·44
Pendembu	0·50	1·58	4·46	6·25	10·65	11·50	13·56	16·75	15·65	12·85	6·84	2·18
Port Loko	0·23	0·22	1·07	2·54	7·34	14·24	19·87	24·56	16·15	13·65	5·08	1·15
Pujehun	0·06	0·88	1·99	5·50	11·20	16·72	27·78	27·08	24·08	13·30	7·87	1·66
Rokupr	0·17	0·04	0·41	2·03	7·26	14·83	22·90	29·12	20·30	14·55	6·13	0·74
Sembehun	0·17	0·56	1·53	4·38	9·24	14·39	23·19	23·96	20·09	1·92	6·41	1·56
Sulima	1·08	0·89	2·30	4·57	15·57	30·57	38·00	25·98	27·57	16·32	8·52	2·82
Sumbaria	0·44	0·86	3·41	5·07	10·36	12·77	15·41	17·00	17·71	15·43	17·81	1·31
Teko	0·30	0·35	1·48	3·75	8·66	14·35	20·32	23·98	21·00	14·80	6·28	0·94
Torma Bum	0·51	1·27	2·11	4·75	10·60	16·36	26·73	26·33	25·70	12·31	7·41	1·81
Wordo	0·23	2·35	4·68	5·40	9·45	12·22	14·12	16·07	14·87	11·65	0·30	1·38
Yengema	0·45	1·23	3·86	6·19	9·21	11·52	12·74	15·05	17·21	12·13	6·59	1·44

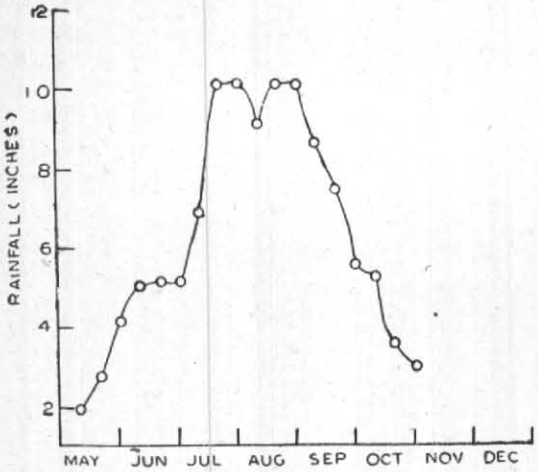


Fig. 6. 10-day average rainfall of Lungi

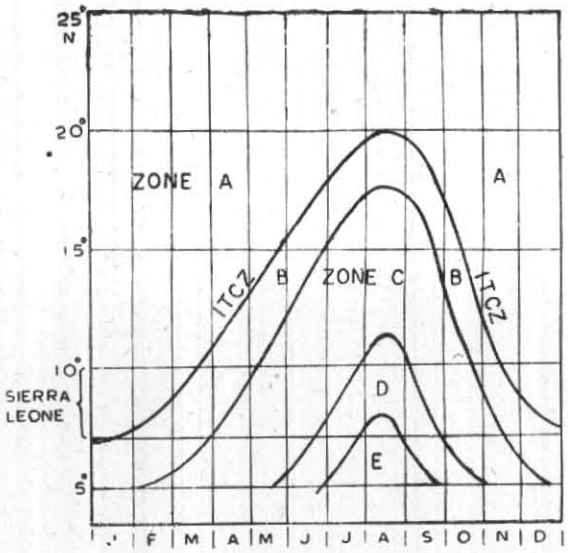


Fig. 7 Weather zones associated with ITCZ

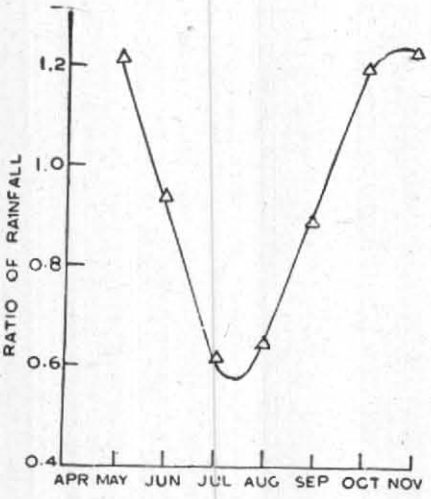


Fig. 8. Rainfall at Bo/Lungi

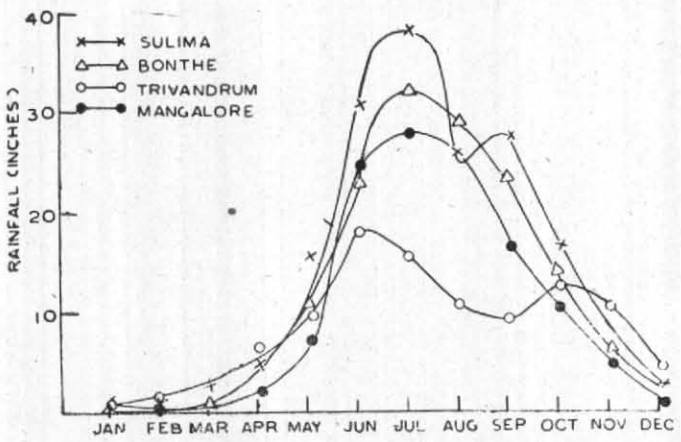


Fig. 9. Monthly rainfall at Sulima, Bonthe, Trivandrum and Manglore

monsoon. So it was decided to compare the points of similarity of monsoon at these two places.

(a) *Rainfall and Thunderstorm*

It has already been stated that with advent of monsoon, rainfall at Sierra Leone increases whereas thunderstorm activity decreases. To check this phenomena in the west coast of India, monthly frequency of thunder storm days at Trivandrum has been plotted. It will be seen that at Trivandrum thunderstorm activity decreases sharply in June and attains minimum in August. There are two maxima one in April, before onset of monsoon and another in November. The time of second maximum corresponds to second maximum for Lungi. First maxima for the frequency of thunderstorm days for Lungi comes in June. That also is just before the onset of monsoon at that place.

(b) *Diurnal variation of Rainfall*

It will be seen from fig. 5 that during monsoon rainfall is maximum in early morning and minimum inlate afternoon and early evening at Lungi. Jagannathan. (1963) found that for whole of West coast of India the same type of diurnal variation exists.

(e) *Occurrence of Double Maxima*

It has been mentioned that the southern most part of Sierra Leone experiences a double maximum of rainfall. To see such an occurrence in west

coast of India rainfall along west coast were examined. It was found that Trivandrum also has a double maxima (Fig. 9). Examining the monthly rainfall data for Sierra Leone it was found that the double maxima appears upto 7°N, North of which only a single maximum is obtained. Over west coast of India double maxima is found upto 12°N.

Acknowledgement

The author worked in Sierra Leone Meteorological Service for three years where the data presented in this paper was collected. Thanks are due to Mr. H. G. Moore, Director, Sierra Leone Meteorological Service for permitting the author to use the data.

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