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A study of precipitation distribution in the neighbourhood of Mount Everest

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ABSTRACT. In this study the available daily precipitation records of the two raingauge stations nearest to the Everest massif have been studied with a view to examine the distribution of precipitation in the neighbourhood of the highest peak in the world.

1. Introduction

Mount Everest (29,002 ft), the highest mountain in the world is situated (Lat. 27°59′ N, Long. 86°55′E) on the great Himalayan range. A trek of nearly 15 to 20 days through the eastern Nepal from the railhead at Jainagar in north Bihar takes one to the Khumbu glacier (16,000 ft) situated at the foot of the Everest massif. This glacier has its source in the western Cwm, a hidden valley of rock and ice which is enclosed by the lofty wall of the Lhotse (27,890 ft)—Nuptse (25,850 ft) and the western ridge of the Everest (Fig. 1). The summit of the Everest rises in one great continuous sweep through nearly 8000 ft from the bottom of this valley. Before actually reaching the Khumbu glacier from the Indian plains, one has to cross innumerable and almost parallel Himalayan ranges whose average height lies between 5000 ft near the Terai plains and 15,000 ft and above near the great Himalayan range.

2. Past expeditions to the Everest and their weather records

Since 1852, when the height of Mount Everest was first determined, mountaineers all over the world have been attracted by the highest mountain in the world. However regular mountaineering expeditions to this mountain started with the first British Expedition of 1921. Up to 1938 all the Everest expeditions followed the northern route through south Tibet. By this route the final approach to the Summit was along the East Rongbuk glacier which lay at the foot of north face of the Everest. With the closure of the Tibetan route after the Second World War, a new route to the Everest through eastern Nepal was discovered by Shipton in the autumn of 1951. By this route the summit of the Everest could also be reached through South Col (25,850 ft) which lay at the head of western Cwm. Practically, all the Everest expeditions during the last fifteen years have followed the Nepal route and the Summit has successfully been climbed in 1953, 1956 and 1963 by the British, Swiss and American expeditions respectively.

Almost all major expeditions to the Everest either through Tibet or Nepal have recorded the actual weather experienced over and near the mountain during their periods of acclimatization, exploration and climbing. As these observations do not cover a period longer than a few months, the usefulness of these observations is rather limited for any climatological study of this region. Illuminating articles on Himalayan meteorology and weather with special reference to the Everest region have been written by various workers notable among them being Sen and Chatterjee (1934), Burrard *et al.* (1934), and Mason

Fig. 1. The summit of Everest as seen from near about Namche Bazar
A—Nuptse (25,850 ft), B—Summit of Everest (29,002 ft), C—Lhotse (27,890 ft)

(1955). In 1956, Fritz Muller, a member of the successful Swiss expedition to the Everest, stayed behind on Khumbu glacier from April to November to study the behaviour of glaciers and weather in this region. A brief account of his observations has appeared in the Mountain World (1958/1959). In the history of the Everest climbing, for the first time in 1960, a Professional Assistant of the India Meteorological Department accompanied the First Indian Mt. Everest Expedition. He took both instrumental and visual observations of weather experienced at the base camp (18,000 ft) on higher reaches of the Khumbu glacier during the period 13 April to 27 May. A summary of the observations has since been published (*Indian J. Met. Geophys.*, 1961).

During the winter months of 1960-61 a Himalayan Scientific and Mountaineering Expedition led by Edmund Hillary spent nearly eight months at 19,000 ft in the Mingbo valley, an area close to the Everest region. The scientific team of the expedition conducted physiological experiments and also studied meteorology and glaciology of the area during the period December 1960 to May 1961. A resume of the investigations carried out has since been published in the Geographical Journal (Pugh 1962). The weather experienced in this region during this period has been described by Pugh (1961) as follows—

> "Fine weather with clear skies prevailed throughout the autumn and winter. Apart from afternoon mist and a few short storms, the fine weather continued until the end of the April, when the pre-monsoon period of unsettled weather set in. The lowest temperature recorded was —27°C. Winds of 45 knots, gusting to 60 knots were common during the winter....."

On the basis of these weather observations Pugh (1961) has suggested that a safer period for climbing in this region of the Himalayas might be the autumn or early spring months rather than the traditional pre-monsoon months of April and May. The party actually climbed a very difficult Himalayan peak of Ama Dablam (22,494 ft) near Everest on 13 March 1961.

3. Aridity of Everest region

In a recent editorial (*Indian J. Met. Geophys.*, 1960) on Himalayan mountaineering and meteorology the following has been stated—

> "The monsoon current does not penetrate far into the Himalayas from the plains and the annual precipitation on the Khumbu glacier is only about 45 cm at a height of 16,000 ft a.s.l. (5300 metres) and apparently decreases with height. The Everest region apparently is more arid than it was supposed to be."

Fritz Muller (1958/59) recorded a total precipitation of only 39 cm between 12 April to 26 November 1956 of which 33 cm were recorded during the monsoon months. The Himalayan Scientific and Mountaineering Expedition recorded only 13 cm of precipitation during the period December 1960 to May 1961. Of this amount only 7 cm were recorded during the months of December to March and the remaining 6 cm during the two months of April and May. Combining these figures of precipitation with those of Fritz Muller's, Pugh (1962) also estimated annual precipitation of this region to be of the order of 45 cm only. This clearly indicates the semi-arid conditions of this region of the Himalayas.

There are no precipitation recording stations very close to the Everest massif and hence no correct estimates of precipitation in the close proximity of the Everest can be made. However, in this note the available precipitation data of two nearby existing raingauges at Namche Bazar (11,000 ft) and Chaunrikharka (9000 ft) have been examined with a view to find out the distribution of precipitation in the neighbourhood of the Everest.

4. Nearby precipitation recording stations

Two class V hydrometeorological observatories were set up by the India Meteorological Department during 1947-48 in the neighbourhood of Mount Everest at Chaunrikharka (9000 ft) and Namche Bazar (11,000 ft) in the upper reaches of the Dudh Kosi river (Fig. 2) under the Kosi Project Investigation Scheme.

Namche Bazar (11,000 ft) is the last outpost of human habitation on this side of Nepal. It is about 16 miles from the foot of Khumbu glacier in a southwesterly direction and is situated on the southern tip of a mountain ridge which separates the valley of Bhote Kosi from the Dudh Kosi. It is also called the "Gateway to the Everest" as every present day mountaineering expedition to the Everest has to pass through this small horse-shoe shaped village. Rain and snow gauges were installed at this place in April 1948 and a local resident of this village was trained as an observer in recording precipitation daily at the standard hour of 0830 IST. In April 1948, another precipitation recording station was installed at Chaunrikharka (9000 ft) which is about 10 miles due south of Namche Bazar along the Dudh Kosi river. From this place the Everest is about 23 miles as the crow flies. During the last 15 years, both these stations have been inspected by the inspectors of the India Meteorological Department a number of times and the respective local observers have been given necessary training in recording precipitation observations correctly.

5. Precipitation data used

In this study the daily precipitation data of Namche Bazar has been utilised for the period September 1948 to August 1963. The precipitation data of this station for the period January 1956 to April 1957 has not been used as the same was not recorded properly and hence rejected. Apart from this, daily precipitation data of some individual months are also not available. In the case of Chaunrikharka the daily data of precipitation that has been utilized covers a period from January 1949 to December 1962. Daily data earlier to Januray 1949 and of recent months of 1963 are not available and hence

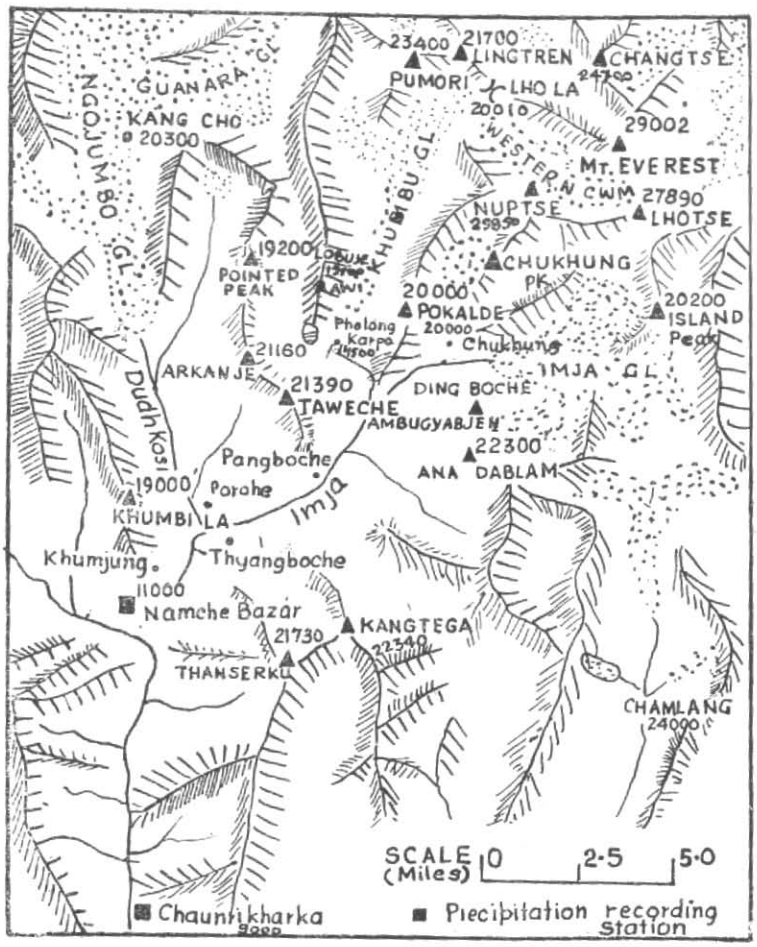

Fig. 2. Everest and neighbourhood

the same could not be considered for this study.

6. Study of precipitation data

The precipitation study carried out in respect of two stations, *viz.*, Chaunrikharka and Namche Bazar has been summarized in Tables 1 to 6. In Tables 1 and 2, mean monthly, annual and seasonal precipitation amounts are given. These tables have been prepared after examining the daily precipitation data of the two stations for the periods mentioned earlier. The highest total monthly precipitation values have been picked up and corresponding percentages with respect to their mean monthly values have been worked out. Percentages of seasonal precipitation to the mean annual have been separately calculated in Table 2. In Table 3 mean daily precipitation has been worked out for all the calendar dates of the year for both the stations. This has been done by taking arithmetic mean of total precipitation recorded on each calendar date during the periods of availability of data. Table 4 gives average number of rainy days and the intensity per rainy day. The intensity was calculated for different months by dividing the mean monthly precipitation with the average number of rainy days in that month. In this study, a rainy day has been taken as that day when precipitation equal to or greater than 0·1 mm is recorded at 0830 IST. The highest precipitation amounts ever recorded for durations of 24,48 and 72 hours at these two stations have been given in Table 5, after being picked up from an examination of the daily data. Table 6 has been prepared to show the total number of occasions of rainy spells of different durations of 1-day, 2-day, 3-day etc during different months. A spell of rain starting in one month and extending into the next month(s) has been counted in the month in which the spell began.

A brief discussion of each of the six tables, mentioned above, is given in the following paras.

(*a*) *Table 1 and Table 2—Mean monthly, seasonal and annual precipitation*

(*i*) *Chaunrikharka* — Mean annual precipitation for this station is of the order of 228 cm. June to September is the principal rainy season during which 86 per cent of the annual precipitation is received. The remaining eight months (October to May) contribute only 14 per cent of the annual precipitation. The pre-monsoon months, March to May contribute 9 per cent of the annual precipitation. During the post monsoon and winter months precipitation is about 9 cm and 3 cm respectively. The highest monthly total rainfall recorded at this station during monsoon months has been 125 cm in the month of July 1957, which is twice the mean monthly rainfall for the month of July.

(*ii*) *Namche Bazar* — Mean annual precipitation of this station is about 94 cm. The monsoon months of June to September is the main rainy season during which 74 per cent of the mean annual precipitation is received. The pre-monsoon season of March to May receives about 10 cm and the remaining two seasons of post-monsoon and winter have almost equal amounts of precipitation, *i.e.*, about 7 cm each. Compared to Chaunrikharka winter precipitation at this station is greater by about 4 cm. The highest monthly total rainfall of 29 cm was recorded in the month of July 1963. This is only slightly more than $1\frac{1}{4}$ times the mean monthly rainfall for this month.

During the winter months precipitation is received at both the stations mostly in the form of snow. Although the local observers have been fully trained by the India Meteorological Department Inspectors in the measurement of water equivalent of snow, it is very likely that the observers may not strictly be following these instructions in view of severe winter conditions prevailing at such far off places in the interior of the Himalayas. As such, measurement of winter precipitation at these two places is subject to error to that extent. This factor of difficulty in measuring winter precipitation may to some extent contribute to the large percentage variations of monthly rainfall to the mean

TABLE 1

Mean monthly and annual rainfall (mm)

	CHAUNRIKHARKA			NAMCHE BAZAR		
	Mean rainfall	Highest (year)	Per cent of annual	Mean rainfall	Highest (year)	Per cent of annual
Jan	8·0	50·7 (1962)	634	34·3	135·3 (1959)	394
Feb	10·8	50·0 (1962)	463	23·5	119·0 (1962)	506
Mar	29·5	66·0 (1961)	224	32·4	80·6 (1963)	249
Apr	48·9	176·2 (1960)	360	27·4	109·5 (1960)	400
May	123·5	380·7 (1960)	308	42·9	150·9 (1953)	352
Jun	376·1	844·6 (1960)	225	138·7	272·0 (1953)	196
Jul	620·8	1248·7 (1957)	201	211·7	289·8 (1963)	137
Aug	615·3	1223·2 (1960)	199	209·5	254·6 (1958)	121
Sep	361·8	1070·0 (1960)	296	139·7	219·5 (1960)	157
Oct	77·6	158·0 (1955)	204	51·1	135·9 (1951)	266
Nov	8·6	43·2 (1956)	502	15·1	68·1 (1952)	451
Dec	7·3	35·1 (1959)	481	13·0	62·5 (1951)	481
Annual	2283·6			939·3		

TABLE 2

Average seasonal total and percentage of annual rainfall

Season	Chaunrikharka		Namche Bazar	
	Average rainfall (mm)	Per cent of annual	Average rainfall (mm)	Per cent of annual
Mar to May	201·9	9	102·7	11
Jun to Sep	1993·5	86	699·6	74
Oct to Nov	86·2	4	66·2	7
Dec to Feb	26·1	1	70·8	8

TABLE 3

Mean daily rainfall (mm)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
						CHAUNRIKHARKA						
1	0·3	2·8	1·9	0·7	0·1	4·1	18·3	24·0	11·0	6·6	3·7	0·0
2	0·0	0·4	0·3	1·1	3·5	7·2	15·2	21·7	10·4	12·0	0·5	0·1
3	0·0	0·0	0·6	0·4	2·7	2·7	19·4	25·1	18·7	3·3	0·7	0·0
4	0·0	0·0	0·4	0·4	3·0	3·4	8·5	12·6	7·5	4·8	0·2	0·0
5	0·0	0·0	0·0	0·0	2·9	3·4	15·0	23·0	20·9	5·7	0·5	0·0
6	0·0	0·0	1·7	0·1	3·4	6·4	15·1	20·9	14·5	5·0	0·8	0·0
7	0·0	0·7	2·8	1·7	2·9	7·0	27·8	12·8	12·1	4·9	1·0	0·0
8	0·0	0·0	1·0	1·9	2·3	16·7	21·4	27·9	23·3	2·3	0·6	2·0
9	0·0	0·0	0·1	1·5	1·9	5·6	25·9	12·5	18·4	1·1	0·0	0·4
10	0·0	0·0	0·3	5·3	0·7	20·5	24·4	14·8	15·4	1·7	0·0	0·4
11	0·1	0·0	0·4	1·8	3·3	14·2	26·7	23·5	11·5	0·0	0·0	0·0
12	0·0	0·2	0·2	4·9	1·1	11·4	13·8	31·5	14·1	2·4	0·0	0·2
13	0·0	0·0	1·4	3·1	0·4	13·7	20·9	18·2	16·9	1·1	0·0	0·5
14	0·0	0·2	0·0	0·5	4·1	13·8	14·1	24·8	21·9	5·0	0·0	0·0
15	0·0	0·5	0·5	0·8	7·9	9·3	17·0	16·0	9·5	4·0	0·0	0·5
16	0·4	0·0	1·3	1·0	2·7	14·8	15·3	22·6	15·9	1·5	0·0	0·4
17	0·0	0·0	0·9	0·3	6·2	14·0	13·1	14·4	11·5	1·0	0·4	0·7
18	0·0	0·7	0·3	0·4	2·7	7·6	13·7	16·7	12·0	3·1	0·0	1·9
19	0·0	0·0	0·0	2·1	6·3	12·5	12·1	38·1	4·1	0·4	0·0	0·0
20	0·1	0·6	0·7	1·3	4·9	9·1	18·9	15·6	6·7	0·2	0·0	0·0
21	0·0	0·0	2·3	2·0	0·5	23·1	19·1	7·2	7·7	1·0	0·0	0·0
22	0·3	0·0	0·2	0·2	2·7	13·7	29·0	21·6	7·6	2·1	0·0	0·0
23	0·3	0·0	0·7	2·9	7·6	12·7	13·2	33·0	5·3	0·8	0·0	0·1
24	0·0	0·2	0·1	1·3	4·6	11·1	19·8	20·7	7·5	0·0	0·1	0·0
25	0·0	3·3	1·7	4·5	2·3	14·1	29·8	14·9	7·0	0·0	0·0	0·0
26	2·0	0·7	1·9	0·2	5·5	19·4	34·4	23·3	12·4	1·4	0·0	0·0
27	2·4	0·2	0·8	1·6	6·4	17·5	18·7	21·0	13·3	0·0	0·2	0·0
28	0·5	0·2	1·9	0·4	10·9	13·3	38·1	16·7	11·9	2·4	0·0	0·0
29	0·0	0·0	1·4	1·3	8·8	15·9	19·7	13·2	3·2	3·9	0·0	0·0
30	1·5		3·2	5·3	7·0	27·5	17·4	20·0	7·7	0·4	0·0	0·0
31	0·0		0·5		2·1		19·1	16·6		0·5		0·0

TABLE 3 (*cont'd*)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
						NAMCHE BAZAR						
1	1·2	0·2	0·8	1·5	0·7	2·7	4·4	4·6	12·1	5·0	0·2	0·0
2	0·1	2·1	0·4	0·2	0·3	3·2	5·0	8·0	4·8	5·2	0·0	0·2
3	0·0	0·3	0·5	0·0	0·3	0·7	5·2	8·5	3·6	6·5	0·0	0·3
4	0·0	1·0	1·1	0·3	3·8	3·6	7·1	3·6	7·4	3·6	0·3	1·3
5	0·2	0·4	1·8	0·8	0·3	2·9	6·3	4·0	7·1	0·6	0·6	0·7
6	0·0	1·7	3·3	2·7	1·0	1·1	4·4	7·3	7·3	1·1	1·0	0·0
7	0·0	0·3	2·0	0·3	0·5	0·9	8·9	6·5	4·4	1·4	0·6	0·0
8	0·3	4·0	0·4	0·3	0·7	3·5	7·1	7·2	5·7	2·1	0·0	0·8
9	0·0	1·7	0·5	5·1	2·0	3·4	6·1	8·0	5·0	0·7	0·0	0·7
10	0·0	0·3	2·8	0·0	0·7	4·5	7·4	8·5	2·7	0·3	0·0	0·5
11	0·0	1·0	2·8	0·0	0·3	10·6	4·7	7·8	5·7	1·3	0·3	0·4
12	0·1	0·3	0·2	0·0	0·9	7·3	9·5	11·2	3·1	0·8	0·0	0·6
13	1·3	0·0	0·0	0·0	0·6	3·8	6·0	8·7	4·6	0·5	0·6	1·2
14	0·0	0·0	0·3	0·0	1·4	5·5	6·4	6·0	4·0	1·0	0·1	1·4
15	0·1	0·6	0·6	0·8	0·3	4·9	9·9	4·4	4·3	1·4	2·1	0·1
16	1·5	0·0	0·4	0·7	0·0	2·5	8·7	7·1	7·5	0·2	0·1	0·0
17	0·4	1·6	0·4	1·8	1·4	2·3	6·1	7·7	2·7	0·4	0·3	1·0
18	0·0	0·1	0·1	0·3	3·5	2·9	4·3	3·9	1·3	0·9	0·3	0·7
19	0·6	3·1	0·2	0·2	2·4	12·4	9·5	6·8	2·2	0·3	0·1	0·3
20	0·5	3·5	2·5	0·0	1·9	4·5	6·7	8·9	1·7	0·4	0·9	0·0
21	1·0	0·0	1·3	0·0	2·6	5·0	8·8	6·3	3·8	2·1	2·4	0·0
22	1·4	0·0	1·6	0·9	1·7	3·4	4·8	5·9	2·9	1·1	0·3	0·0
23	3·5	0·3	1·2	0·0	0·6	3·4	8·6	9·7	2·1	0·5	0·1	0·1
24	0·0	0·0	0·1	0·1	0·9	5·2	6·9	7·0	5·4	0·0	0·0	0·1
25	1·3	0·2	2·4	0·0	0·5	5·8	10·5	5·3	6·8	0·3	0·0	0·5
26	4·4	0·2	0·8	1·7	1·1	5·2	7·0	6·9	5·1	1·2	0·0	0·0
27	2·6	0·1	0·7	0·7	2·1	7·8	7·3	5·0	8·5	0·7	1·6	0·0
28	2·1	0·5	0·0	0·4	1·7	9·5	6·8	4·6	1·5	1·3	2·3	1·4
29	7·8	1·5	1·2	1·3	2·2	7·9	5·0	6·5	3·4	2·0	0·1	0·3
30	2·0		0·3	3·1	2·7	3·9	6·9	5·9	2·6	6·4	0·1	0·3
31	0·5		0·7		0·7		4·8	6·4		0·8		0·0

TABLE 4

Average number of rainy days and mean intensity per rainy day

	Chaunrikharka		Namche Bazar	
	Mean no. of rainy days	Mean intensity per rainy day (mm)	Mean no. of rainy days	Mean intensity per rainy day (mm)
Jan	1·1	7·5	4·3	8·0
Feb	1·4	7·5	3·6	6·5
Mar	4·0	7·4	6·7	4·8
Apr	4·6	10·5	4·1	6·7
May	11·3	10·9	7·4	5·8
Jun	21·0	17·6	17·0	8·1
Jul	27·0	23·0	25·8	8·2
Aug	27·0	22·7	27·0	7·7
Sep	19·6	14·8	21·2	6·6
Oct	6·4	12·1	7·2	7·1
Nov	1·0	8·0	2·4	6·3
Dec	1·2	6·0	2·4	5·4

TABLE 5

Highest 24-hr, 48-hr and 72-hr rainfall amounts (mm)

	CHAUNRIKHARKA Rainfall total in			NAMCHE BAZAR Rainfall total in		
	24 hr	48 hr	72 hr	24 hr	48 hr	72 hr
Jan	34·0	50·2	50·2	63·5	78·7	85·0
Feb	43·8	43·8	43·8	45·0	83·0	85·0
Mar	30·5	35·6	37·2	35·0	41·6	46·8
Apr	58·9	96·0	102·1	66·0	82·8	82·8
May	48·8	94·5	98·1	38·9	49·5	69·9
Jun	98·5	178·8	219·4	86·4	111·0	115·0
Jul	254·8	345·0	391·0	36·1	62·0	70·4
Aug	301·8	336·8	350·6	37·9	50·3	68·8
Sep	111·8	209·2	271·9	76·2	87·6	97·8
Oct	79·3	87·9	90·2	86·9	109·2	111·8
Nov	43·2	45·0	45·0	27·9	45·7	45·7
Dec	27·9	33·0	33·0	17·8	20·3	23·9

for the abnormal months of January, February November and December. Such errors, however, can be avoided if automatic snow rain-recorders are installed at such difficult places.

(*b*) *Table 3 — Mean daily precipitation*

(*i*) *Chaunrikharka*—From an examination of Table 3, it is seen that precipitation occurs continuously on all days during the period 6 April to 10 October. In this period, it is observed that a minimum mean rainfall of 5 mm and above occurred almost daily from 6 June to 6 October. This period may, therefore, be taken as the main rainy season for this station. The highest mean daily rainfall of 38 mm occurred on 28 July and 19 August. During the months November to February there are a good number of dry spells with nil rainfall.

(*ii*) *Namche Bazar* — Excepting for 16 May, rainfall occurs continuously from 26 April to 23 October. A mean daily rainfall of 3 mm and above occurred almost daily from 8 June to

TABLE 6

Frequency of rainy spells of different durations (days)

	Duration (days)																
	1	2	3	4	5	6	7	8	9	10	11-15	16-20	21-25	26-30	31-40	41-50	51-60
CHAUNRIKHARKA																	
Jan	10	1	1														
Feb	16	1															
Mar	33	9	3														
Apr	35	10	2	1													
May	27	16	9	6		3			1		1						
Jun	37	9	10	5	3		2	1	1	2	4	4	2		2		
Jul	10	5	2	3		5	3	1	1	1	4	3	1	3	2		
Aug	5	5	6	3		2	3	1		4	7		3				
Sep	20	17	4	6	2	4	5	3	2	2	2						
Oct	28	13	4	1		2											
Nov	7		1														
Dec	11	3															
NAMCHE BAZAR																	
Jan	13	6	5	2		1											
Feb	17	5	5		1												
Mar	33	11	3	4		1											
Apr	22	7	1	3													
May	29	12	2	1	2	2		1									
Jun	14	9	7	6	1	2		1	2		2	1	3		4		1
Jul	8	8	5	2	1	1	3	2	1	2	1	2	3				2
Aug	2	8	2	2	2	2	1		1		4	2	1		3		
Sep	13	7	6	5	4	4	1	1	3		4	1					
Oct	22	9	4	5			1				1						
Nov	11	7	1		1												
Dec	7	7	2	1													

4 October which may be taken to be the main rainy period for this station. The highest mean daily rainfall of 12 mm occurred on 19 June. There are very few dry spells during the winter months of November to February when there has been no rain at this station.

(c) *Table 4 — Average number of rainy days and mean intensity per rainy day*

(i) *Chaunrikharka*—Average number of rainy days in July and August are the highest. June and September have almost the same number of rainy days, *i.e.*, about 20 days in each month. Least number of average rainy days (*i.e.*, one per month) are in the months of November to February. Average intensity per rainy day is highest in July and August, being about 23 mm per rainy day and it is least in December.

(ii) *Namche Bazar* — Average number of rainy days is highest for the month of August; but the average intensity per rainy day is highest in the months of June, July and January. Least number of rainy days in a month is found to be in the months of November and December although intensity per rainy day is least in the month of March.

(d) *Table 5 — Highest 24-hour, 48-hour and 72-hour precipitation amounts*

The highest 24-hour, 48-hour and 72-hour recorded precipitation values in various months of the year are given in Table 5 for both the stations. The highest values for different durations picked up from this table are given below —

	Chaunrikharka (cm)	Namche Bazar (cm)
24-hour	30·2	8·7
48-hour	34·5	11·1
72-hour	39·1	15·1

It is also seen that higher amounts of precipitation in different durations occur mostly in the monsoon months of June to September in the case of Chaunrikharka. The same is not the case with Namche Bazar where higher amounts have also occurred in post monson seasoon (*i.e.*, in October) for different durations.

(e) *Table 6 — Frequency of rainy spells of different durations*

(i) *Chaunrikharka* — Spells of longer duration, say of 7 days and more, are mostly found in the months of June, July, August and September. Occasionally, there have been such spells in the month of May also. Spells of 16 days and more have been confined to the months of June, July and August only. During the winter months of November to February spells of 1-day duration predominate mostly. The following are the three longest spells experienced at this station—

(1) 40 days from 28 June to 6 August 1949

(2) 34 days from 22 July to 24 August 1962

(3) 32 days from 20 July to 20 August 1952

(ii) *Namche Bazar* — Spells of duration of 7 days and more are generally confined to the months of June, July, August and September but spells of duration more than 21 days are mostly found during the months of June, July and August. During June and July there are one or two spells of duration greater than 51 days but less than 60 days. The following are the three longest spells experienced at this station—

(1) 56 days from 25 July to 18 September 1962

(2) 52 days from 27 June to 17 August 1958

(3) 51 days from 6 July to 25 August 1963

7. Conclusions

1. The principal rainy months in this region are the four months of June to September during which bulk of precipitation is received. This clearly shows that at such

interior locations in the Himalayas, rainfall regime has a pronounced monsoonal character. It is also seen from an examination of daily precipitation records that monsoon usually sets in over this region towards the end of first week of June and withdraws by the middle of the first week of October.

2. The mean annual precipitation at Chaunrikharka (9000 ft) is 228 cm while at Namche Bazar (11,000 ft) it is only 94 cm. The higher value of mean annual precipitation at Chaunrikharka may to some extent be due to the orography of the place as this place is located along a deep valley surrounded by high mountain ridges on three sides. But even taking into consideration the effect of orography it still appears that precipitation in this region decreases quite rapidly as one proceeds to higher altitudes northwards. It is, therefore, quite probable that a place like Khumbu glacier, which is located above 16,000 ft and is further northeast of Namche Bazar, should get an annual precipitation of the order of 45 cm only. This study has shown that the Everest region in the high Himalayas is a semi-arid area, contrary to the popular belief.

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