The Himalayan Review
Nepal Geographical Society

Vol. XX-XXIII
1989 - 92

Temperature Variation in Nepal

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INTRODUCTION

Temperature is a measure of intensity or degree of hotness in a body (Oliver and Hidore 1984). It is the fundamental element of climate and is influenced by factors such as altitude, aspect, topography, prevailing winds, distance from the sea and snowfields etc. In Nepal the distribution of temperature is influenced mainly by altitude. It varies considerably from south to north as well as east to west depending on topography and effect of local winds.

The purpose of this paper is to analyse the variation in the distribution of temperature in Nepal. The data from 92 different meteorological stations have been used. But only 72 stations have time series data for 20 years (1961-80). Generalisation is made on the basis of limited stations and their limited records.

Altitudinal Variation of Temperature

Standard distribution is appropriate to show the annual variation of temperature with altitudes (Conrad and Pollak 1950). Out of 92 stations having partial or full records of temperature, 20 percent stations were randomly selected. The mean temperature of the year 1980 is considered as the standard temperature. This shows the variation of average temperature with increasing height above the Tarai belt of Nepal. The mean temperature and elevation is shown in Table 1.

Fig. 1 shows the variation of mean temperature with increasing height. The shape of this curve is represented by means of a parabola having an equation of the form :

$$t = a + bh + ch^2$$

Where, 't' is temperature

'h' is altitude.

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Table 1 : Variation of Temperature 't' with Elevation 'h' in Nepal (1980)

S.No.	Sector/ Region	Stations	h (hm)	tobs (°c)	test (°c)	Difference
1	ET	Biratnagar Airport	0.72	24.7	18.7	6.0
2	CT	Simara Airport	1.30	23.9	18.8	5.1
3	WT	Nepalgunj	1.44	25.0	18.9	6.1
4	WT	Mahendranagar	1.76	23.4	18.9	4.5
5	CT	Rampur	2.56	24.0	19.0	5.0
6	ET	Dharan British Camp	4.44	25.0	19.2	5.8
7	WH	Surkhet	7.20	22.0	19.3	2.7
8	WH	Tulsipur	7.25	22.6	19.3	3.3
9	CH	Khudi Bazar	8.23	20.3	19.3	1.0
10	CH	Pokhara Airport	8.27	20.8	19.3	1.5
11	EH	Illam Tea Estate	13.00	18.9	18.6	0.3
12	WH	Chainpur (West)	13.04	18.8	18.6	0.2
13	EH	Bhojpur	15.24	16.6	18.1	-1.5
14	EH	Okhaldhunga	17.20	16.7	17.5	-0.8
15	WH	Dadeldhura	18.65	16.0	17.0	-1.0
16	WM	Jumla	23.00	10.0	15.0	-5.0
17	EM	Chialsa	27.70	12.4	12.2	0.2
18	CM	Mustang	37.05	6.5	4.5	2.0

Note : 1 hm(hectometer)=100 Metres
CM= Central Mountain
CT=Central Tarai
WM =Western Mountain
CH =Central Hills
EM= Eastern Mountain
ET= Eastern Tarai
WT=Western Tarai
EH= Eastern Hills
WH =Western Hills

The method of least squares yields the most probable results. The equation representing the average temperature which is the function of altitude, above the Tarai belt of Nepal is:

$$t = 18.59 + 0.213\ h - 0.016\ h^2$$

From this equation the maximum turning point of the curve is

$$(h)\ t\ max = \frac{0.213}{0.016 \times 2} = 6.656\ (hm)\ \text{i.e.}\ 665.6\ m.$$

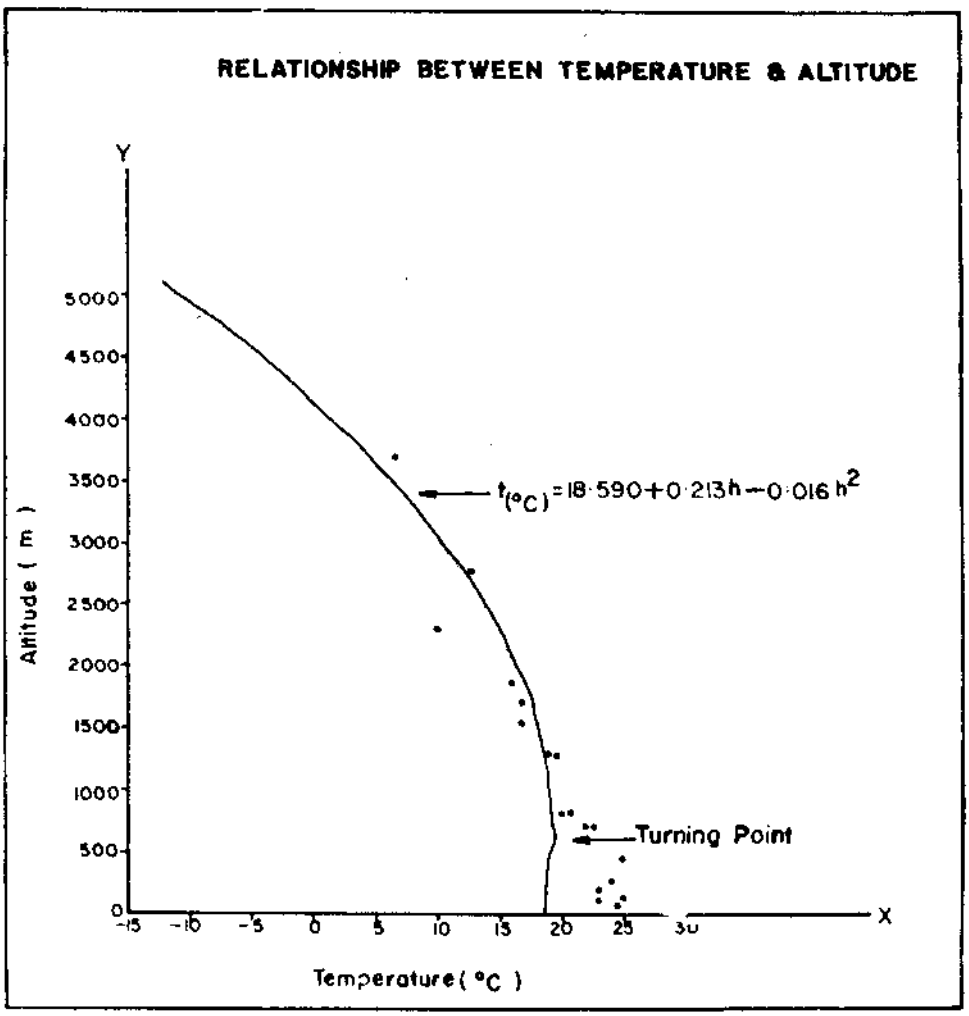
RELATIONSHIP BETWEEN TEMPERATURE & ALTITUDE
Y
X
Altitude (m)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-15
-10
-5
0
5
10
15
20
25
30
$t_{(°C)} = 18{\cdot}590 + 0{\cdot}213h - 0{\cdot}016\,h^2$
Turning Point
Temperature (°C)

FIG-1

Through this equation,we can estimate the temperature at different altitudes where there are no meteorological stations in Nepal. The normal lapse rate of temperature is 0.68°c/100 m. Since the atmosphere is mainly heated from below, it is clear that temperature should be highest at low altitude and should decrease with height (Hau 1953). Upto 665.6 m. altitude the temperature increases by 0.02°c/100m.This is the highest turning point. The temperature decreases slowly at the beginning and is followed by increasing rate of decrement.

The estimated value of temperature is comparable with the actual value. But during inversion of temperature, actual value differs highly from the estimated value of temperatures. Table 1 indicates that there is higher difference of temperature upto 665.6 m. altitude. Beyound 1500m the difference between observed and estimated values is negative. This is mainly because of the altitude, orientation of the mountain ranges and slope of the mountains. Thus, there is a great variation in the vertical distribution of temperature in Nepal.

Regional Variation of the Temperature

Regional variation of temperature is distinct in Nepal. Temperature differs from place to place due to altitudinal variations. Fig.2 shows that the Tarai and Inner Tarai regions are very hot. Mean annual temperature is above 20°c. In the mid-hill region, temperature ranges from 15° to 20°c, but in the river valleys like Pokhara and Trisuli it remains above 20°c At higher altitudes it is below 15°c. The mean annual temperature remains below 10°c in the Himalayan region. The mean annual temperature in the Trans-himalayan region and the eastern sector of the Himalayan range is below 5°c.

Intra Regional Variation

Local winds, altitude, slope and aspect of the mountain ranges affect the intra-regional distribution of temperature. Pokhara and Trisuli valleys have over 20°c mean annual temperature because of the lower altitude and the southern aspect. In the same way Paklihawa in Tarai has over 28.3°c mean annual temperature, which is higher than the general temperature of the Tarai region. Paklihawa lies at an altitude of 100m, and falls under the influence of "Rake" * wind in the summer season, which blows from the Thar desert of India .In the eastern part of the country the isotherm lines bend southward because of the effect of "Seratoo"** in the winter season.

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* "Rake" refers to the hot wind blowing from the Thar Desert of India and is caused by depression in summer sunshine in west.

** "Seratoo" refers to the cold wind blowing from the High Himalaya which is of local importance.

Seasonal Variation of Temperature

The seasonal distribution of temperature is caused by earth's revolution in relation to the sun. Broadly there are two distinct seasons in Nepal.

Summer season:

Summer season (April to September) is very hot and rainy. The beginning of the season is characterised by hot, dry, dusty and hazy atmospheric conditions. In summer, Tarai and Inner Tarai regions have over 25°c mean summer temperature (Fig.3). Within this belt, the western part has higher temperature than the eastern part because of the effect of 'Rake' wind in the west. The isotherm line bends northward in this season. In the mid-hills the mean summer temperature ranges from 20°c to 25°c in the south and 15°c to 20°c in the north. In the Himalayan region the mean summer temperature decreases gradually with height. On the whole the hilly region experiences mild temperatures in this season.

Winter season

Winter season is characterised by very cold conditions in the hills and mountain and mild temperatures in the Tarai and Inner Tarai regions. This season is more or less dry with clear skies. Lowest minimum temperature occurs in the month of January throughout the country.

The mean winter temperature ranges from below 0°c to 19.5°c. Tarai region gets over 20°c mean winter temperature. The mid-hills record 15°c to 20°c with the exception of Kathmandu Valley. Kathmandu Valley records the lowest temperature due to excessive night time radiation. On the whole, the winter is very cold in the hills and mountains. Tarai has mild temperature conditions (Fig.4).

In terms of the atmospheric circulation in lower and upper troposphere, four distinct seasons can be recognised in Nepal (Nayava 1980):

(1) Pre-monsoon season (March to May)
(2) Summer monsoon season (June to September)
(3) Post-monsoon season (October) and
(4) Winter season (November to February)

Pre-monsoon season lasts from March to May . The highest mean monthly temperature of the year occurs in this season. But there is considerable variation from place to place. For example, Sallyan and Barahaksetra have recorded the highest mean temperature in May. But at Kathmandu, Gorkha, Okhaldhunga, Chainpur (East) and Taplethok, the highest temperature is recorded in the month of June. At Bhojpur and Namche Bazar it is recorded in the month of August. Thus highest temperature occurs from May to August all over the country. In general, May is the hottest month of the year.

The seasonal distribution of temperature as shown in Table 2 indicates that the highest mean temperature occurs during the monsoons. In this season Tarai and Inner Tarai record over 25°c. Hills record 20°c and Mountains record below 20°c mean seasonal temperature. After September, the post-monsoon season is characterised by decreasing temperatures. This decrement is continued upto winter season. Winter season is the coldest season in Nepal. In this period Tarai and Inner Tarai record 15°c to 20°c, Hills records 10°c to 15°c and Mountains record below 10°c mean seasonal temperature. After winter, temperature tends to rise slowly in pre-monsoon season. This season is hot in Tarai, warm in hills and cold in mountain. Again as the spring advances the temperature tends to increase slowly upto post-monsoon season.

Table 2 : Mean Seasonal Temperature Distribution in Nepal (1961- 1980)

S.No.	Geographic Region	Stations	Seasons			
			Pre-Monsoon t (°c)	Summer Monsoon t (°c)	Post-Monsoon t (°c)	Winter t (°c)
1.	Tarai	Biratnagar Airport	26.0	28.2	25.5	18.2
2.	"	Simara Airport	26.2	28.7	25.2	17.3
3.	"	Nepalgunj (Reg. off.).	28.1	29.6	26.6	18.5
4.	"	Mahendranagar	25.4	28.9	24.8	16.6
5.	"	Dharan British Camp	26.5	28.0	25.3	19.5
6.	"	Rampur	25.9	28.2	24.6	19.5
7.	Hills	Tulsipur	24.6	26.2	22.5	15.9
8.	"	Surkhet	23.8	26.4	22.0	13.9
9.	"	Illam Tea Estate	20.1	21.7	20.0	14.3
10.	"	Bhojpur	18.0	20.6	17.8	11.8
11.	"	Okhaldhunga	17.6	20.1	17.4	11.3
12.	"	Khudi Bazar	22.0	24.2	20.4	14.4
13.	"	Pokhara Airport	22.0	25.0	21.1	14.7
14.	"	Chainpur West	20.3	23.5	18.7	12.8
15.	"	Dadeldhura	17.1	20.1	16.5	10.0
16.	Mountain	Chialsa	10.0	14.4	10.4	4.1
17.	"	Mustang	5.4	13.0	7.6	-1.2
18.	"	Jumla	12.2	18.8	12.8	5.6

Table 3 : The Range Between Mean Summer and Winter Temperature by Sector & Geographic Region (1961-1980)

Serial No.	Sector/ Geographic Region	Stations	Summer Temperature (°c)	Winter Temperature (°c)	Range (°c)
1.	ET	Biratnagar Airport	28.2	18.2	10.0
2.	CT	Simara Airport	28.7	17.3	11.4
3.	WT	Nepalgunj (Reg. off.)	29.6	18.5	11.1
4.	WT	Mahendranagar	28.9	16.6	12.3
5.	ET	Dharan British Camp	28.0	19.5	8.5
6.	CT	Rampur	28.2	16.9	11.3
7.	WH	Tulsipur	26.2	15.9	10.3
8.	WH	Surkhet	26.4	13.9	12.5
9.	EH	Illam Tea Estate	21.7	14.3	7.4
10.	EH	Bhojpur	20.6	11.8	8.8
11.	Eh	Okhaldhunga	20.1	11.3	8.8
12.	CH	Khudi Bazar	24.2	14.4	9.8
13.	CH	Pokhara Airport	25.0	14.7	10.3
14.	WH	Chainpur West	23.5	12.8	10.7
15.	WH	Dadeldhura	20.1	10.0	10.1
16.	EM	Chialsa	14.4	4.1	10.3
17.	CM	Mustang	13.0	-1.2	14.2
18.	WM	Jumla	18.8	5.6	13.2

Range of Temperature

In Nepal the range between mean summer and winter temperature increases from east to northwest and west (Table 3). South to north differences are also noticeable but it is irregular. For example, the range of temperature at Biratnagar, Okhaldhunga and Chialsa are 10.0°c. 8.8°c and 10.3°c respectively. The range of temperature decreases from Tarai to mid-

hills followed by higher range of temperature in the Mountain. Higher range in mountains is mainly due to "Seratoo". Due to valley air drainage the range of temperature is also higher in the midland valleys like Kathmandu and Pokhara.

Annual Variation of Temperature

The annual cycle of temperature is expressed by the tabulated values of the twelve monthly means. The differences between the highest and the lowest of the twelve monthly means are the mean annual ranges (Table 4).

Table 4 : Mean Annual Range of Temperature (1961-1980)

S.No.	Stations (°c)	Maximum (°c)	Minimum (°c)	Range
1.	Salyan	23.6	10.8	12.8
2.	Gorkha	25.4	12.6	12.8
3.	Kathmandu	25.3	10.4	14.9
4.	Okhaldhunga	20.6	9.4	11.2
5.	Bhojpur	20.8	10.1	10.7
6.	Chainpur (East)	25.4	13.4	12.0
7.	Barahshetra	29.2	17.0	12.2
8.	Taplethok	24.6	12.4	12.2

The mean annual range of temperature varies considerably in Nepal. At Kathmandu the mean annual range of temperature is 14.9°c. The range of temperature is higher in most of the stations.

Conclusion

The distribution of temperature in Nepal shows that there is a great disparity in the horizontal and vertical distribution of temperature. Temperature varies from south to north as well as from east to west. Altitude is not the only factor in controlling this variations. Slope aspect and local winds are relatively important factors. It appears that the seasonal contrast

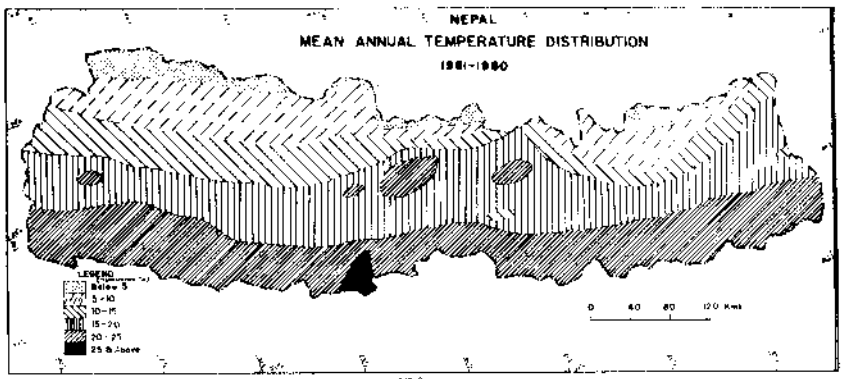

NEPAL
MEAN ANNUAL TEMPERATURE DISTRIBUTION
1961-1980
LEGEND
Below 5
5 - 10
10 - 15
15 - 20
20 - 25
25 & Above
0 40 80 120 Kms

FIG 2

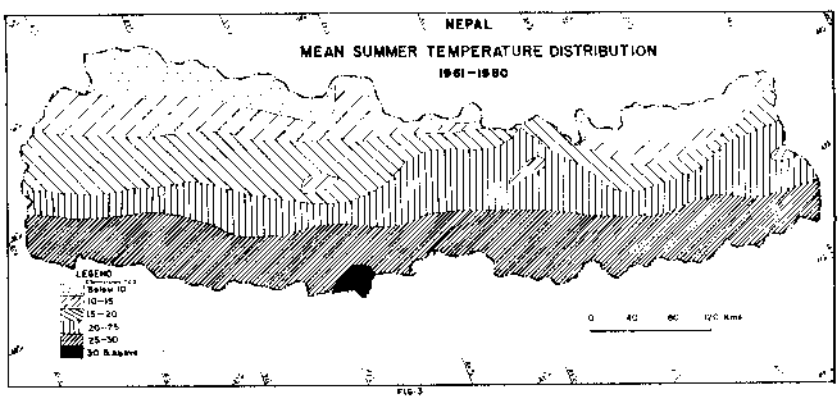
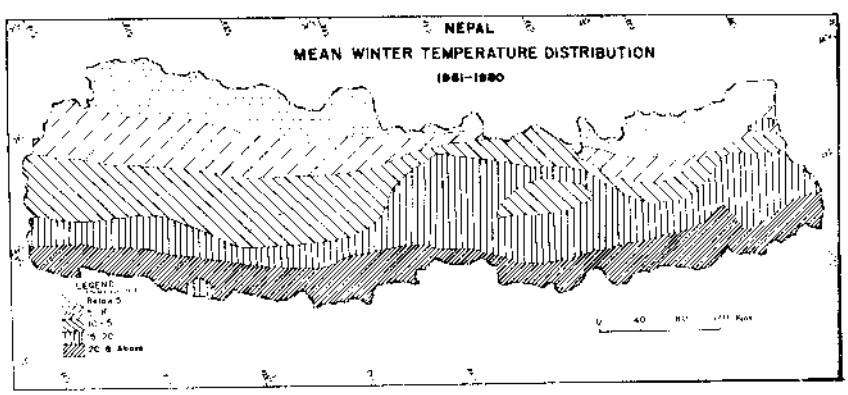

NEPAL
MEAN SUMMER TEMPERATURE DISTRIBUTION
1961-1980
LEGEND
Below 10
10-15
15-20
20-25
25-30
30 & Above
0 40 80 120 Kms

FIG-3


NEPAL
MEAN WINTER TEMPERATURE DISTRIBUTION
1961-1980

in temperature is increasing in Nepal. This aspect, and the factors contributing to it, require further investigations.

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