August 2010 ISSN : 0974 - 7451 Volume 5 Issue 4

Trade Science Inc.

Environmental Science
An Indian Journal
Current Research Papers

ESAIJ, 5(4), 2010 [226-231]

Trends of some climatic parameters under climate change scenario in intermontane Imphal valley, Manipur, North Eastern Himalaya

Md.Abdullah Khan, Sarfaraz Ahmad*, Shadab Khursheed
Department of Geology, Aligarh Muslim University, Aligarh, U.P., (INDIA)
E-mail : sarf71@gmail.com
Received: 12th May, 2010 ; Accepted: 22nd May, 2010

ABSTRACT

Trend analyses of climatic parameters in the Imphal valley show an overall increasing in trend of atmospheric temperature. The rate of increasing is more pronounced for the minimum temperature unlike that of the all India and north-east India in Imphal basin. Rainfall trend exhibited increasing trend compared with decreasing trends of regional and national trends. The frequency analysis indicated the decreasing in low intensity rainfall events and increasing high intensity rainfall events in last three decades. Rate of increasing trend for rainfall, minimum, maximum and mean atmospheric temperature observed before the 1981 and afterwards period suggests two different growth periods. While the trends of the daily evaporation and daily sunshine hour show decreasing trend. Observed trends for the various climatic parameters indicated the local effect of global warming phenomenon on local climate in remote North Eastern Himalaya, India.

KEYWORDS

Global warming;
North East Himalaya;
Regional climate change;
Local climate change.

INTRODUCTION

Climate change phenomenon is a relevant global concern nowadays because its impacts will be felt all over the world in varying degrees and in various forms and will affect all organisms on earth. India is home to 16.2% of the world's total population with only about 2.4% of the earths total land surface. It has different landforms with different regional climatic conditions. Therefore, there will be profound practical implications of the changes in climate in India on many aspects. It is the accepted view all over the world that the main driving factor for the global climate change is the rise in the mean global temperature since1901. This rise in global temperature is largely contributed by the humans because the life style of mankind have contributed enormous amount of green house gases in the atmosphere. These gases along with natural sources like water vapor and aerosols produced by volcanic eruptions etc. present in the atmosphere trapped the heat that is reflected from the earth's surface and redirected it towards the earth. The accumulation of higher concentration of the green house gases results in the increase of the temperature of the earth. The immediate consequence of global warming is the drastic and destructive changes in the climatic conditions in different regions of the world. The increasing temperature affect the precipitation patterns and disrupt and cause damaging floods and draughts in different parts of the globe. The effects of climate change in agriculture and on human health caused by the increasing temperature as re-

sponse to the global warming phenomenon are likely to be very serious, and very significant across the regions of India. The studies conducted by various researches[1,3,4,6,7] indicated that the climate is changing in Indian subcontinent and its impact is very tremendous especially in urbanized area.

Most of the data set for climate studies is from urban surroundings or cities because few studies have been conducted for the remote area because of non-availability of the weather data in those places. The data set of the urban area is not only governed by local atmosphere, sometimes it is affected by urban pollution. Therefore, there is need to conduct climatic change studies in low level urbanized, pristine areas to evaluate the impact of climate change on local level. Hence, some important climatic parameters from the study area i,e. the Imphal valley were analyzed and discussed below.

DATA AND METHODOLOGY

The area is characterized by cool summer and chilly winter. The average rainfall in the area is more than in the central region, the Cherapunji area in the region receives maximum rainfall in the world. The North-East monsoon is the predominant feature in region. The location map of the imphal valley in Eastern Himalaya is shown in Figure 1.

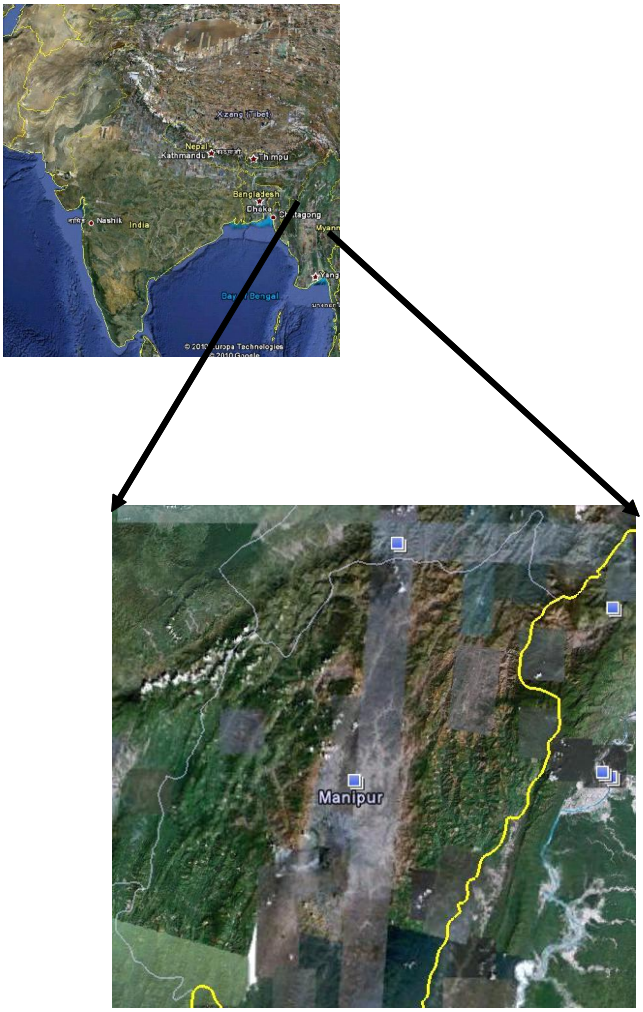

Figure 1 : Location showing study area Imphal valley, Manipur

The study based on data set of a large area may not represent the true picture of climatic change in the study area. Therefore, it is necessary to evaluate the climatic trends at local level to find out whether the climatic condition in the study area is being influenced by the global change phenomena. Hence, the daily weather data for the Imphal valley available with the Indian Meteorological Department (IMD), Pune, for the period, 1968-1998 was obtained for the study. Comparative studies of two time periods, 1969-1980 and 1981-1998 were taken up to find out the changing patterns of the meteorological parameters.

Trends of temperature change in Imphal valley

The trend line for the daily maximum temperature for the period, 1969-98 shows a very feeble increase with the rate of $7*10^{-5}$ °C/day with R^2 value of 0.0036. However, on monthly basis the negative trends were also observed for daily maximum temperature for the months of March, (pre-monsoon), and May (summer) due to development of the cloud and the subsequent rainfall (Figure 2a). The trend in the daily maximum temperature for 1969-1980 suggests non significant trends for various months (Figure 2b). However in the March, May, September and October show negative trends. But the rate of increase in daily maximum temperature for the period 1981-1998 shows positive trends for all the months (Figure 2c). The rates of increase in maximum temperature for the periods of 1969-1998, 1969-1981 and 1981 -1998 indicate that the rate of increase is much higher than the other periods (2d). It indicates that after 1981, the warming phenomenon might have started to intensify in full swing.

Minimum daily temperature of the atmosphere in Imphal valley indicates an increasing trend with 0.0001°C/day with R^2 value of 0.0042 for the period of 1969-1998 (Figure 3a). But for the months of October and November the trend lines show negative trends. This may be due to the overcast condition prevailed during the

retreating monsoon. For the period of 1969-1980, all the months other than February, March and April show negative trends (Figure 3b). However, for the period of 1981-1998, trend for all the months are positive and the values are also greater than the average increase observed during the period, 1969-1998 (Figure 3c & 3d). This is in contrast to the findings for all Indian trend, where warming is caused by mainly due to the increase in maximum temperature[8]. The warming in Imphal valley is mainly due to the increase in minimum temperature and it conform to other studies in both Northern and Southern Hemispheric landmasses[2,5]. The increase in minimum

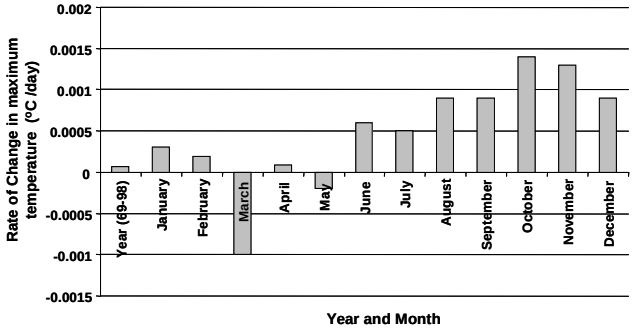

Figure 2a : Rate of change in daily maximum temperature for the period, (1969-1998) and in various months for the same period.

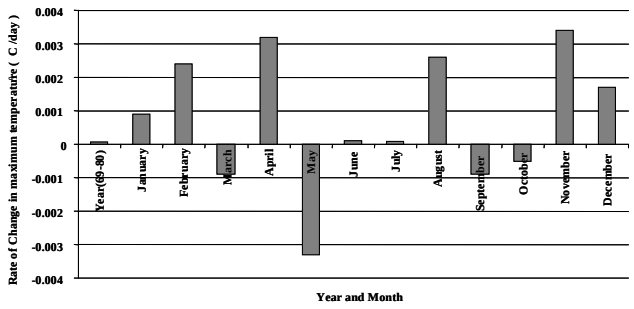

Figure 2b : Rate of change in daily maximum temperature for the period, (1969-1980) and in various months for the same period.

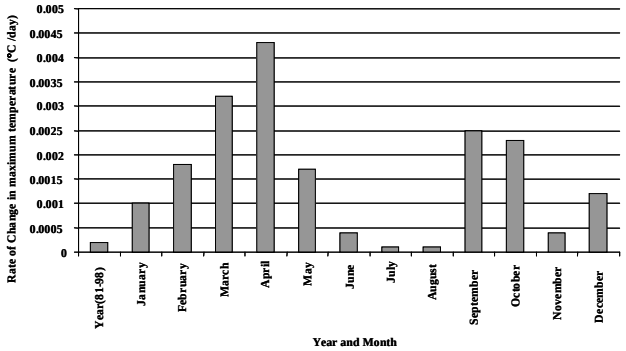

Figure 2c : Rate of change in daily maximum temperature for the period, (1981-1998) and in various months for the same period.

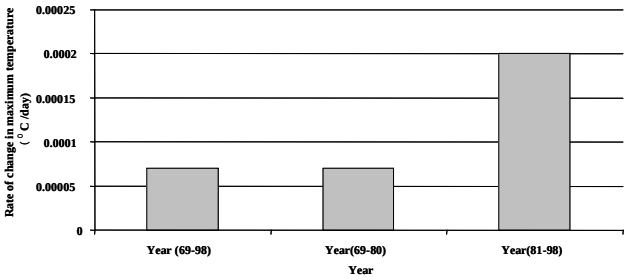

Figure 2d : Rate of change in daily maximum temperature in different time periods.

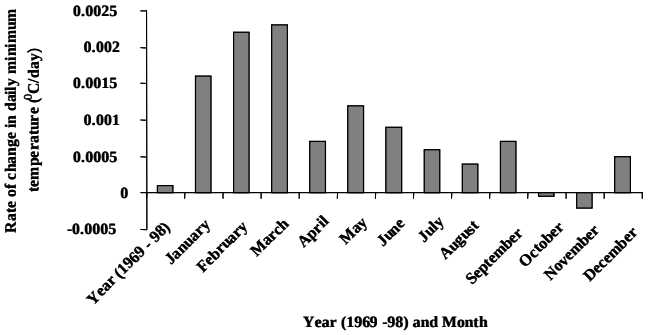

Figure 3a : Rate of change in daily minimum temperature for the period, (1969-1998) and in various months for the same period.

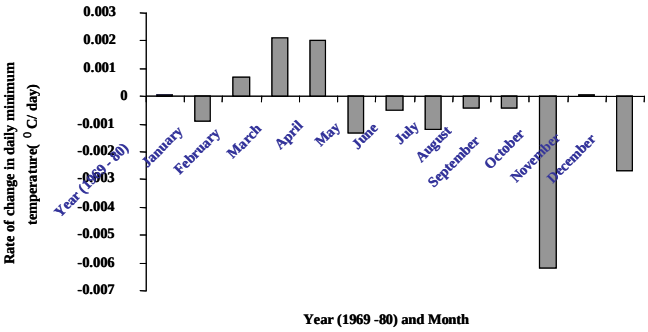

Figure 3b : Rate of change in daily minimum temperature for the period, (1969-1980) and in various months for the same period.

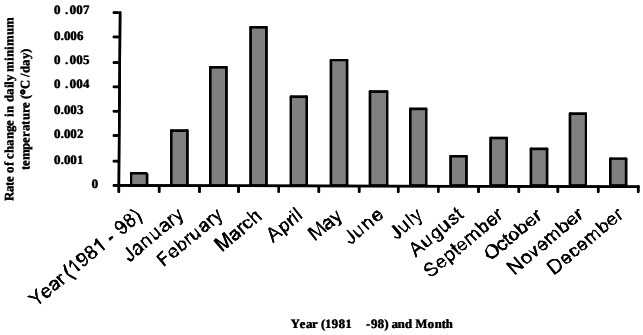

Figure 3c : Rate of change in daily minimum temperature for the period, (1981-1998) and in various months for the same period.

temperature is mainly due to the increase in cloud cover including the low clouds.

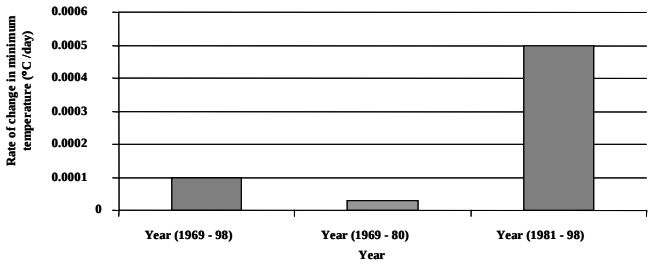

Figure 3d : Rate of change in daily minimum temperature in different time periods.

Trends of rainfall change in Imphal valley

The trend observed for rainfall during 1969-1998 shows increase in the rainfall at the rate of 0.0003mm / day with R^2 value of 0.0037. In all the months except November show positive rainfall trend (Figure 4a). It indicates that the winter rainfall and retreating monsoon rainfall is decreasing in the Imphal valley.

For the period of 1969-1980, there is no definite trend for rainfall in various months (Figure 4b). While for the period of 1981-1998, most of the months show positive trends except January and April (Figure 4c). The comparative rate of increase in rainfall in most of the months of this period is probably due to the effect

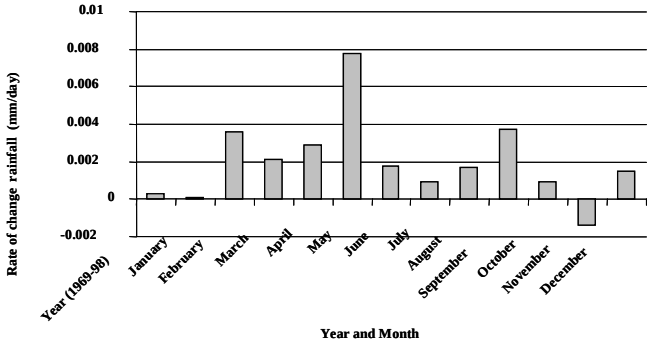

Figure 4a : Rate of change in daily rainfall (in mm) for the period, (1969-1998) and in various months for the same period.

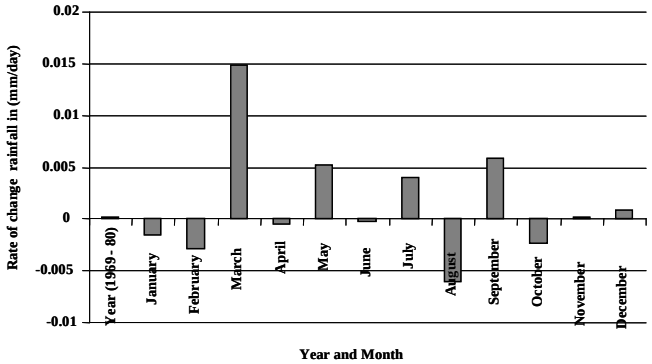

Figure 4b : Rate of change in daily rainfall (in mm) for the period, (1969-1980) and in various months for the same period.

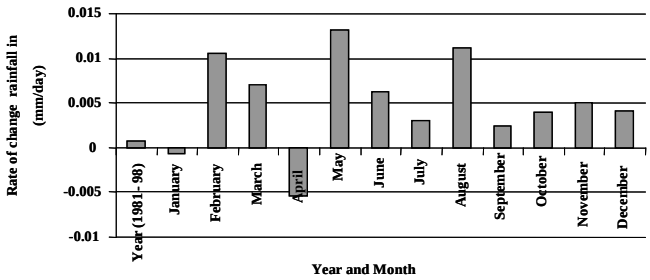

Figure 4c : Rate of change in daily rainfall (in mm) for the period, (1981-1998) and in various months for the same period.

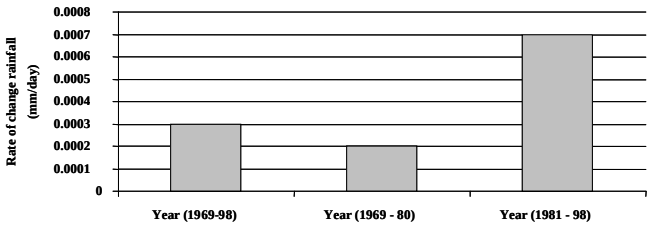

Figure 4d : Rate of change in daily rainfall (in mm) in different time periods.

of global climate change phenomenon, which has been established through world climatic observations after 1980s. The comparative rate of increase in rainfall per

TABLE 1 : Frequency analysis of the rainfall events in Imphal valley for two distinct periods.

Rainfall intensity class (in mm)	Period of 1969-1980	Period of 1981-1998	% Pre-1980	% Post-1980	% of change
0-5	3525	3884	81.48	76.37	5.12
5-10	313	445	7.24	8.75	-1.51
10-15	164	274	3.79	5.39	-1.60
15-20	120	146	2.77	2.87	-0.10
20-25	55	105	1.27	2.06	-0.79
25-30	44	63	1.02	1.24	-0.22
30-35	32	41	0.74	0.81	-0.07
35-40	24	41	0.55	0.81	-0.25
40-45	13	25	0.30	0.49	-0.19
45-50	10	10	0.23	0.20	0.03
50-55	4	13	0.09	0.26	-0.16
55-60	3	13	0.07	0.26	-0.19
60-65	4	5	0.09	0.10	-0.01
65-70	3	6	0.07	0.12	-0.05
70-75	4	2	0.09	0.04	0.05
75-80	1	2	0.02	0.04	-0.02
80-85	3	4	0.07	0.08	-0.01
85-90	0	2	0.00	0.04	-0.04
90-95	1	1	0.02	0.02	0.00
95-100	1	1	0.02	0.02	0.00
100-105	2	3	0.05	0.06	-0.01

day for the period of 1969-98, 1969-81 and 1981 - 1998 show a distinct change in rate of increase of slope of trend line after 1981 (4d), which suggests that global warming phenomena started giving responses.

The frequency analysis of daily rainfall was carried out for two period, 1969-80 and 1981-1998 (TABLE 1). It is found that lower intensity rainfall (<5mm/day) contributed 81.48% of the total rainfall events in the Imphal valley during the period 1969-1980. However, this frequency class of rainfall decreases to 76.37% for the period 1981-1998. The decrease in the lower intensity rainfall event is mainly affected by the warming of the atmosphere as a result of the rise in minimum temperature. The increasing temperature prevents the convective cloud over the valley from turning into light rains.

The study also shows that higher intensity rainfalls have increased in the Imphal valley in recent years (TABLE 1). These higher intensity rainfall events cause sudden and higher runoffs in the study area which in turn result in flash floods. Our study is verified by the occurrence of greater frequency of flash floods in the study area.

Trends of Sunshine hours change in Imphal valley

The trend of daily sunshine hour in the Imphal valley is analyzed for the period 1969-1998. It indicates that the sunshine hours are decreasing at the rate of 0.0001 hour per day with R^2 value of 0.0025. For the period, 1969-1980 the trend line of the sunshine hour indicate a decrease in sun shine hours at the rate of 0.000003 hour per day with R^2 value of 0.000001.

The trends of sunshine hour in various months for the period of 1969-80 show negative trends in May and September (Figure 5a). However, for the period of 1981-98, except for the months of January, April and September, rest of the months show negative trends (Figure 5b). The comparative rate of change of sunshine hour for the periods, 1969-80 and 1981-98 show a drastic decrease in the rate of sunshine hour after 1981 (Figure 5c).

Comparative analysis of the trends showed in 5c graphs indicated that, the rate of sunshine hours dramatically decreased after 1980 and onwards. It is a clear indication of climate change become active in this time.

Trends of evaporation change in Imphal valley

The temporal variation trend of evaporation in the

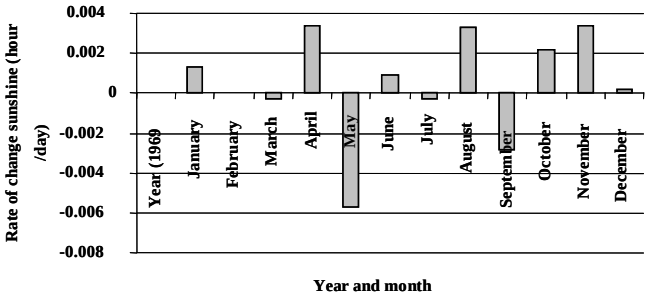

Figure 5a : Rate of change in daily sunshine hour for period, (1969-1980) and in various months for the same period.

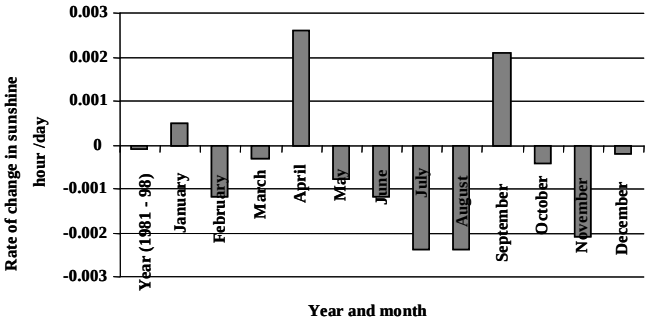

Figure 5b : Rate of change in daily sunshine hour for the period, (1969-1980) and in various months for the same period.

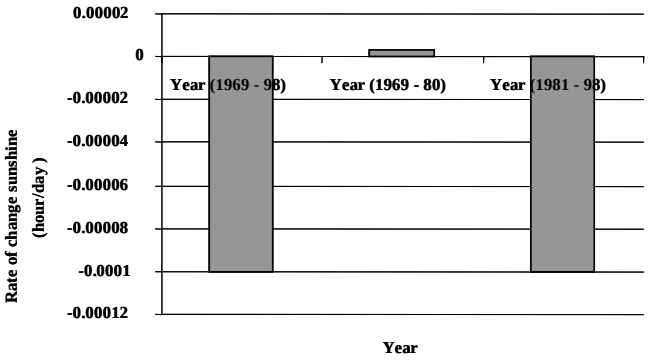

Figure 5c : Rate of change in daily sunshine hour in different time periods.

Imphal valley indicates that, evaporation is decreasing at the rate of $7*10^{-5}$ mm/day with R^2 value of 0.0087mm for the period, 1969-1998. In all the months except January, the evaporation shows negative trends with varying rates (Figure 6a). The decrease in the rate of evaporation is probably due to the greater cloudiness and lesser sunshine hour observed in the study area for the same period. For the period 1969-1980, in the months of May, July and September show negative trends of sunshine, indicating lesser evaporation rates than that of the rest of the months (Figure 6b). However for the period 1981-1998, all of the months show negative trend except January and March (Figure 6c).

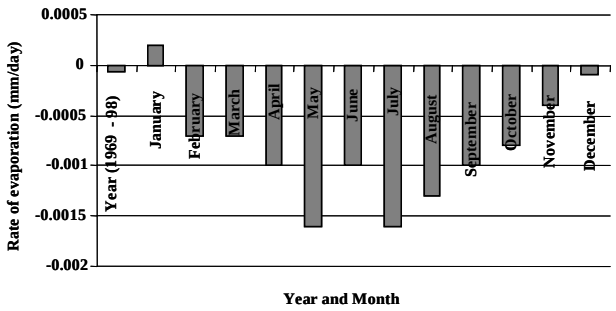

Figure 6a : Rate of change in daily evaporation for the period, (1969-1998) and in various months for the same period.

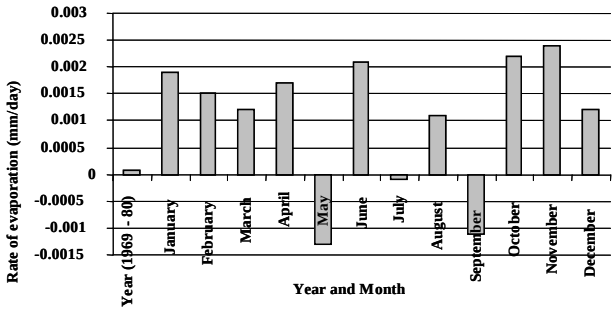

Figure 6b : Rate of change in daily evaporation for the period, (1969-1980) and in various months for the same period.

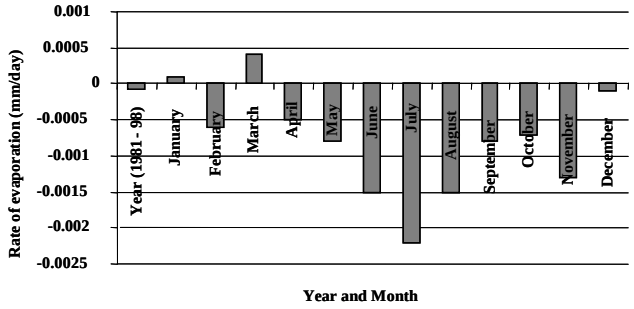

Figure 6c : Rate of change in daily evaporation for the period, (1969-1980) and in different months for the same period.

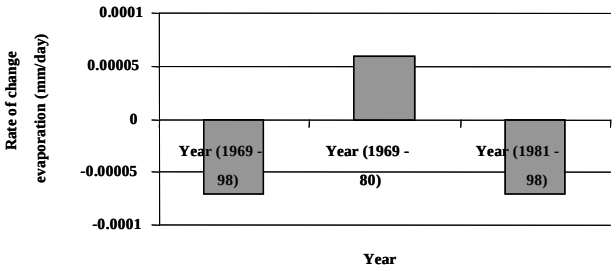

Figure 6d : Rate of change in daily evaporation in different time periods.

The rate of change in daily evaporation for the period of 1969-1980 and 1981-1998 clearly indicate a positive relationship with the decreasing trend in the sunshine hour. The comparative trends of the daily evaporation for the period 1969 – 80 and 1981- 1998 indicate that the after 1980 the daily evaporation is decreasing since that time.

CONCLUSIONS

Observed trends for the various climatic parameters indicated the local effect of global warming phenomenon in remote Eastern Himalaya**.**

It is evident from the trend analysis that the rate of increase in temperature in the Imphal valley is more pronounced in the minimunm temperature. Overall rainfall shows increasing trend along with increase in contribution of high intensity rainfall which is concentrated in shorter period. The low intensity rainfall which is spread over longer period shows a decreasing trend. Daily evaporation and sunshine hours show decreasing trends. The trends of climatic parameters in different periods indicated that the intensity of the climate change processes has been changed with intensity after 1980. Afterwards the climatic parameters started responding with different intensity.

ACKNOWLEDGEMENTS

The authors would like to express their thanks to Chairman, Department of Geology, Aligarh Muslim University for providing the laboratory and library facilities. They also appreciate the financial assistance provided by, Department of Science and Technology, New Delhi, Government of India to conduct the present research work.

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