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Trend of rainfall and temperature change at Umiam, Meghalaya

UDAY S. SAIKIA, K. K. SATAPATHY, B. GOSWAMI, R. K. SINGH and B. K. RAO

Division of Agricultural Engineering, ICAR Research Complex for NEH Region, Umiam 793 103

ABSTRACT

The rainfall and temperature data of Umiam has been studied in relation to its variability and trend over time. In the range of lowest intensity i.e. 0-12.5 mm/day the rainfall frequency has increased significantly over the study period. The frequency distribution on 5-yearly block basis has indicated that in the non-erosive rainfall event range of 0-12.5 mm or more per day, the frequency of occurrence increased from 104.4 (1983-87) to 129.2 (1998-02) during the south west monsoon period. Similarly in the erosive ranges Viz. 37.5-50.0, 50.0-75.0 and 100.0-150.0 mm day^{-1}, respectively, considerable increase in erosive rain events have been observed during 1998-02 as compared to previous block periods.

Key Words: Rainfall variability, temperature, trend

The agriculture in north eastern hill region of India is mainly rainfed in nature and shifting (jhum) cultivation is the main mode of operation. The shifting cultivation is detrimental to both soil and vegetation as it is connected to heavy soil and nutrient losses when practiced in steep slopes. The burning and slashing operations are responsible for reduced floral and faunal diversity in the region.

It is a well known fact that climate is the main driving factor that governs the sustainability of other natural resources such as land, water and vegetation. The NE region gets abundant rainfall to survive crops atleast during the kharif season. The rainfall starts in early March and continues up to the late October. The jhum cultivators follow the rainfall trend and they get their field ready for sowing of seeds by early March itself so that vegetative stage of crops get plenty of rainwater for growth and development.

Due to increased population pressure the hills of NE region are over exploited and the jhum cycle which was earlier 10-12 years has been reduced to 4-5 years now-a-days and it is likely to reduce further (Solanki and Handa, 2003). Hence the soils do not get sufficient time to revitalize the system and may get degraded permanently. Besides the population pressure, it is the climate which takes its toll on the natural resources of the region. Faster decomposition of organic matter is linked with rise in temperature. Gadgil (1996) reported sharp increase of global temperature since 1970's. Though total annual rainfall is increasing over the

Table 1 : Frequency distribution of mean erosive and non-erosive (<12.5 mm day^{-1}) rainfall events in 5-yearly block

Block years	Range (mm)								No. of Erosive events (e12.5 mm)
	0.0-12.5	12.5-25.0	25.0-37.5	37.5-50.0	50.0-75.0	75.0-100.0	100.0-150.0	150.0-225.0	
1983-87	104.4	32.6	14.8	6.8	4.6	2.2	0.4	0	61.4
1988-92	111.2	30.8	12.8	6.4	4.8	3.2	1.2	1.2	60.4
1993-97	114.6	32.6	14.6	7.6	4.8	1.2	0.4	0	61.2
1998-02	129.2	28.0	14.2	8.2	4.6	1.0	1.4	0.0	57.4

years, there is decrease in pre-monsoon rainfall which is vital for commencement of jhum cultivation. The post monsoon season has shown an increase in amount of rainfall over the years and thereby deteriorating the quality of matured grains, delaying the ripening period etc. Overall rainfall amount received in the monsoon period, not much change is noticed which is equal to the total rainfall. But high intensity rainfall events have become more frequent over the moderates.

In this study it is attempted to evaluate the pattern of changing temperature and rainfall in Umiam region of Meghalaya assuming that more or less the whole north eastern hill region has the same pattern.

MATERIALS AND METHODS

The study was conducted at Umiam, Meghalaya located at 25^0 41' N latitude and 91^{0}55' E longitude. Rainfall (1983-2002) and maximum and minimum temperature (1985-2004) data recorded for the given periods were analyzed following standard statistical procedures.

RESULTS AND DISCUSSION

The trend of change in erosive and non erosive 24 hours rainfall events (Table 1) have been studied. It was found that erosive rainfall events (> 12.5 mm) indicate a slight decrease during the study period. But the frequency distribution of erosive events at different levels implies that in the medium intensity ranges of 37.5–50.0 mm, the number of erosive events has shown increasing trend over the years. The increase of non erosive rainfall events (<12.5 mm) might have resulted in reduction in total erosive events in a given period.

The increase of non erosive events have been found significant statistically and have been given in equation 1.

$$y = 1.47\,x - 2814 \qquad (R^2 = 0.44^*) \ldots\ldots (1)$$

(*Significant at 5% level of probability)

Where, y = no. of non erosive events and x = time

Month wise deviation of rainfall in specified block periods has been studied

Table 2: 5-yearly block wise deviation (%) of rainfall from normal at Umiam

Month	1983-87	1988-92	1993-97	1998-02
January	-49.8	18.1	101.3	-41.6
February	3.8	31.5	38.5	-55.4
March	-5.2	3.6	11.6	-20.1
April	-0.9	-10.6	-19.9	18.5
May	-25.4	21.5	5.4	4.0
June	-28.4	8.5	-1.4	9.6
July	0.4	10.7	-23.0	-3.1
August	15.9	-5.6	5.9	-2.3
September	16.2	10.4	-0.9	-16.5
October	-12.4	21.5	-23.9	-9.3
November	-26.8	12.4	3.2	18.4
December	21.3	56.3	-29.2	-82.3
Absolute sum of deviations	206.5	210.7	264.2	281.1
Mean deviation per year	-7.6	14.9	5.6	-15

(Table 2). In the last 10 years since 1993 to 2002, the monsoon rainfall has decreased over previous 10 years. Rainfall during winter period (Dec–Feb) has shown drastic reduction from the normal values. The absolute sum of deviation during the block periods has shown a sharp continuous increase depicting an increase in annual rainfall variability.

As a type of rainfed agriculture jhum cultivation greatly depends on summer rainfall and a decrease in amount of rainfall in this period is going to affect the livelihood of the people by decreasing the growing period of crops during the *kharif* season. On the other hand, reduced rainfall during winter has made cultivation of *rabi* crops almost impossible. Out of four block years, in three, except 1988–92, the mean annual rainfall received was less than the normal value (Table 3). Mean winter rainfall amount has been reduced drastically in 1998–02 as compared to the previous block periods.

It may be observed that out of 20 individual years of rainfall analysis (Fig.1),

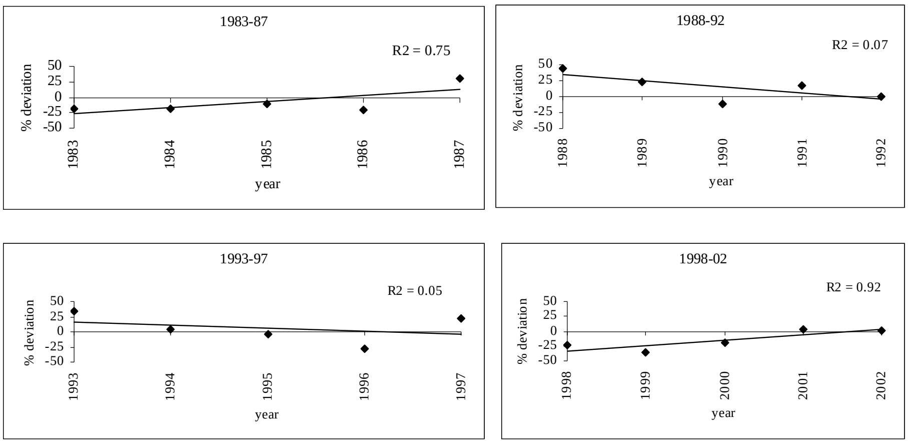

Fig. 1: Mean yearly deviation (%) of rainfall in block of 5 years

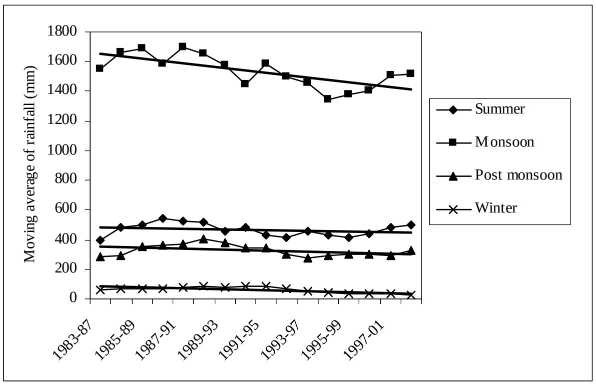

Fig. 2: Trend of rainfall in block of 5 years (moving average) for different seasons

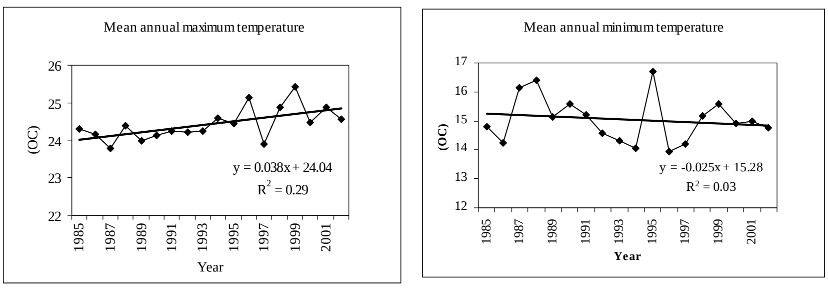

Fig. 3: Trend of change of mean annual maximum and minimum temperature

Table 3 :5 -yearly block wise seasonal and annual distribution of rainfall (mm) at Umiam

Block years	Mean (Yr)	Mean (Summer)	Mean (Monsoon)	Mean (Post Monsoon)	Mean (Winter)	Mean annual rainy days
1983-87	2284.7	398.3	1549.8	286.1	59.8	165.8
1988-92	2645.2	513.7	1653.9	403.9	86.3	171.6
1993-97	2269.3	459.8	1458.2	274.3	56.0	175.8
1998-02	2359.5	499.9	1512.9	323.8	25.2	186.6
Normal	2389.7	467.9	1543.7	322.0	56.8	174.9
Change (%) in 1998-02 over 1983-87	3.3	25.5	-2.4	13.2	-57.9	12.5

Table 4 :Linear trend equations for 5-yearly moving average of rainfall for different seasons

Summer	:	$y = -2.14\ x + 484.58$	$(R^2=0.05)$
Monsoon	:	$y = -16.278\ x + 1671.8$	$(R^2=0.49^*)$
Post monsoon	:	$y = -3.02\ x + 352.99$	$(R^2=0.13)$
Winter	:	$y = -3.07\ x + 87.35$	$(R^2=0.49^*)$

(d.f. = 14) (*=Significant at 5% level of probability)

negative deviation of rainfall was prominent in total 10 years. Only during 1988–92 block periods, the region received fairly good amount of rainfall in excess of normal values. During the period under study, the region observed an increase in total number of rainy days in a year. It increased from 165.8 (1983–87) to 186.6 (1998–02) (Table 3).

The 5-yearly moving average of rainfall was analysed to study the trend of change of rainfall for different seasons (Fig.2). The linear trend equations obtained from the analysis have been presented in Table 4. From the analysis it has been observed that all the trend equations have negative y-intercepts indicating decrease of amount of rainfall over time. The reductions in amount of rainfall in monsoon and winter seasons are statistically significant at 5% level of probability.

During the last 20 years, the region observed a sharp increase in mean annual maximum temperature and slight decrease in mean annual minimum temperature (Fig.3). This implies a higher temperature range with hotter summer and cooler winter, which may influence crop growth and yield in the region.

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