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Effect of lunar cycle on rainfall

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सार — केरल के तीन पश्चिमी तटीय केंद्रों के दक्षिण-पश्चिम मानसून अवधि की वर्षा के 1931 के आगे के 50 साल के आंकड़ों का विश्लेषण किया गया। उक्त अवधि को दो भागों में बांटा गया है। पहले भाग में अपेक्षाकृत अधिक वर्षा अर्थात् जून-जुलाई में हुई वर्षा के आंकड़े हैं और दूसरे भाग में अपेक्षाकृत कम वर्षा अर्थात् अगस्त-सितम्बर में हुई वर्षा के आंकड़े हैं। इस अध्ययन के लिए केवल >6.25 सें० मी० प्रति दिन की वर्षा मात्रा वाले वर्षा दिवसों का उपयोग किया गया है। चंद्र चक्र में 29.53 दिन हैं और उसे दस अवस्थाओं में बांटा गया है। प्रत्येक अवस्था में लगभग तीन दिन हैं। सौर सक्रियता के प्रभाव पर विचार करने के लिए अवधि को सक्रिय और निश्चेष्ट सूर्य प्रक्रिया में विभाजित किया गया है। अवधि का यह विभाजन उन वर्षों के निर्धारण से किया गया जिनमें क्रमशः सूर्य धब्बों की संख्या उच्च चतुर्थक से अधिक रही और जिनमें सूर्यधब्बों की संख्या निम्न चतुर्थक से कम रही। आंकड़ों का विश्लेषण χ^2 परीक्षण के उपयोग से किया गया। इससे सिद्धांत और वास्तविक प्रेक्षण के बीच असंगता की मात्रा का पता चलता है।

विश्लेषण से ज्ञात हुआ कि भारी वर्षा और चंद्र चक्र के बीच कुछ सार्थक सांख्यिकीय संबंध है। सक्रिय सूर्य प्रक्रिया अवधि में प्रभाव अधिक सार्थक होता है जिससे सौर सक्रियता के प्रभाव का भी पता चलता है।

ABSTRACT. Rainfall data for a period of 50 years from 1931 onwards have been analysed for three west coast stations in Kerala for the southwest monsoon period. The period is divided into two halves, the first half, *i.e.*, June-July, providing comparatively more rainfall and the second half, *i.e.*, August-September, providing comparatively lesser rainfall. Rainy days, having rain amounts >6.25 cm/day, have only been utilised for this study. The lunar cycle, which is having 29.53 days, is divided into ten phases, each phase constituting of around three days. To consider the effect of solar activity, the period is divided into active and quiet sun by considering those years with sunspot number greater than the upper quartile and those with sunspot number less than the lower quartile respectively. The data were analysed using χ^2 test. It describes the magnitude of the discrepancy between theory and observation.

Analysis has shown that there is some statistical significance between heavy rainfall and lunar cycle. The effect is more significant in active sun period which shows the effect of solar activity also.

Key words — Lunar cycle, Sunspot number, Rainfall, Quiet sun, Active sun.

1. Introduction

In recent years some workers have carried out studies on rainfall in relation to lunar activities. Manchly (1954) found a significant tendency for a reduction in rainfall on approximately 2 to 3 days prior to new moon. Adderley and Bowen (1962) and Bradley *et al.* (1962) found a marked tendency for extreme precipitation to occur near the middle of the first and third week of synodic month, especially on the third to fifth days after the new and full moon. Visagre (1966), from studies of the winter rain in South Africa, inferred that the winter rain is modulated by the moon. He found a reduced solar influence and increased lunar influence in the winter rains which is not of a convective nature. He also found that only the first and third harmonics of the lunar daily variation in rainfall at South African stations were significant. Berson and Deacon (1965), while analysing the effect of lunar cycle in rainfall, found that the effect is only during the months of heavy rainfall and that only when the sunspot number is below the median value. Only tentative conclusions could be drawn from their studies. The controversial nature of the results of studies has led to the present work.

Here, three coastal stations, namely, Thiruvananthapuram, Cochin and Calicut having heavy rainfall during southwest monsoon season were selected for the present study. These stations are along the west coast of Kerala. Rainfall data of these stations were collected for a period of 50 years.

2. Data and analysis

The daily rainfall data of Thiruvananthapuram, Cochin and Calicut were collected from Indian Daily Weather Report (IDWR) for 50 years from 1931-50 and 1961-89. Useful indications might

TABLE 1

Frequencies of rainy days with rainfall exceeding 6.25 cm/day in ten divisions of lunar synodic period (1931-1950, 1961-1989) for Kerala

Period	Phase in lunar synodic decimals										Total	χ^2	P
	1	2	3	4	5	6	7	8	9	10			
							Jun-Jul						
Quiet sun	19	15	17	23	16	17	7	11	13	13	157	14.78	0.098
Active sun	14	12	9	9	10	11	9	11	7	6	98	5.06	0.826
All years	33	27	26	32	33	27	16	22	20	19	255	13.12	0.164
							Aug-Sep						
Quiet sun	13	8	7	3	2	3	2	6	5	7	56	18.64	0.031
Active sun	—	—	3	2	—	8	5	3	3	7	31	23.52	0.007
All years	13	8	10	5	2	11	7	9	8	14	87	13.34	0.16

TABLE 2

Values of rainfall exceeding 6.25 cm/day for active (A) and quiet (Q) sun period for Cochin

Phases	Q						A		
	31	32	33	34	43	44	47	48	49
1	108.8	58.4	—	116.45	69.4	—	90.7	67.8	—
2	—	—	—	—	62.0	90.2	—	67.1	—
3	81.8	—	124.0	111.8	78.5	—	—	66.8	68.8
4	100.3	—	100.5	—	322.5	—	75.7	154.9	78.2
5	67.55	—	—	70.1	113.2	103.9	—	75.7	—
6	—	80.5	—	—	64.3	—	—	63.8	—
7	70.4	—	—	—	—	—	—	—	79.25
8	69.2	—	—	—	—	—	81.48	66.8	—
9	82.6	—	—	71.9	—	—	62.7	108.7	65.0
10	—	87.6	87.1	117.1	—	—	128.5	—	—

emerge only if the rainfall of these stations are high. Southwest monsoon season has been selected as it provides more than 80% of the annual rainfall.

This season has also been divided into two halves; first half providing more rainfall, *i.e.*, June-July and the second half providing comparatively less rainfall, *i.e.*, August-September. Only rainfall amounts greater than or equal to 6.25 cm are considered. To find the effect of lunar cycle on rainfall, the lunar cycle which is having 29.53 days is divided into ten phases, each constituting of around three days. The full moon comes between phases 5 and 6 and the new moon between 10 and 1. Ananthakrishnan and Parthasarathy (1984) have found that there is some association between sunspot cycle and

TABLE 3

Percentage deviation of heavy rainfall from mean

Phases	Mean Q	Mean A	% deviation from mean	
			Q	A
1	88.26	79.25	−3.33	−3.03
2	76.1	67.1	−16.65	−17.9
3	99.03	67.8	−8.47	−17.04
4	174.4	102.93	91.1	25.94
5	88.69	75.7	−2.86	−7.38
6	72.4	63.8	−20.7	−21.94
7	70.4	79.25	−22.89	−3.03
8	69.2	74.14	−24.21	−9.29
9	77.25	78.8	−15.39	−3.59
10	97.27	128.5	6.54	57.23

Indian rainfall. To incorporate this idea also, the effect of solar activity in the strength of lunar cycle variations was taken into account. For this we separated the study period into years of greatest and least solar activity. In the present study the data were divided into two parts. One part (denoted active sun) was for years of sunspot relative number greater than the upper quartile and the second part (denoted quiet sun) was for years of sunspot relative number less than the lower quartile.

3. Results and discussion

To gain some idea of the statistical significance of the variations of heavy rainfall in the lunar cycle, the frequencies of occurrence were studied. For this, number of rainy days with rainfall amount greater than or equal to 6.25 cm have been tabulated against each phase of lunar cycle for Kerala coast in Table 1. Values of rainfall exceeding 6.25 cm/day for active (A) and quiet (Q) sun period for Cochin are given in Table 2.

In Table 3, percentage deviation of heavy rainfall from mean is calculated separately for active and quiet sun period. It showed two maxima both in active and quiet sun period, one before the full moon and another in the new moon phase. With a well-marked one in the new moon phase in active sun period and two phases before the full moon in quiet sun period.

From the frequencies given in Table 1 the values of χ^2 for departure from uniformity were calculated. It is one of the simplest and most widely used non-parametric tests in statistical work. It describes the magnitude of discrepancy between theory and observation. The values of significance level P for each value of χ^2 is found out from standard tables. These are appropriate if effects of persistence may be neglected.

For June-July, under quiet sun only, the hypothesis of random distribution of heavy rainfall over the different phases of the moon is contradicted at 10% level, suggesting some influence of the lunar cycle on rainfall. For August-September, under quiet sun, the hypothesis of random distribution of heavy rainfall over the different phases of the moon is contradicted at 5% level, indicating influence of the lunar cycle on rainfall. However, for August-September under active sun, reliable inference cannot be drawn from the computed Chi-square value in view of the small cell frequency (3.1) on the basis of the hypothesis of random distribution.

4. Conclusions

On the basis of the data of a few coastal stations in Kerala, it becomes possible to conclude tentatively that there is some effect of lunar cycle on rainfall over coastal Kerala under quiet sun conditions.

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