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Determination of Tendency of Rainfall in India Described by Number of Rainy Days

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Abstract – A study has been carried out on the tendency of rainfall, described by number of rainy days, in India on the basis of data on number of rainy days at 42 location / stations covering India and by the application of the formulation / method of determining tendency of non-negative integral valued numerical data. This article is based on the findings of this study.

Keywords: Tendency of rainfall, number of rainy days, rainfall in India, determination of tendency.

1. INTRODUCTION

Rainfall is one of the prime factors that determine the climate of a location. It is also a vital factor of the existence not only of all the livings but also the nature itself. Agriculture, horticulture, fishery, animal property, forestry etc. all depend upon rainfall. Thus rainfall is vitally important for the nature as well as for the world of the living organism. At the same time, it is to be noted that over rainfall may also create problem just like no rainfall and/or shortage of rainfall create problem. Accordingly, it is necessary to know the tendency of rainfall at location/region. There had been a number of studies on trend of rainfall as well as forecasting on rainfall [1 , 2 , 4 , 9 , 16 , 29 , 31 , 32 , 33 , 35 , 36 , 37 , 38]. However, it is yet to develop formulation/method of determining tendency of rainfall at a location and/or in a geographical region. A study has here been carried out on the tendency of rainfall in India. Tendency of rainfall has, in this study, been described by number of rainy days at a location during a period. The study has been made on the basis of data on number of rainy days at 42 location / stations covering India and by the application of the formulation / method of determining tendency of non-negative integral valued numerical data [26].

2. A BRIEF DESCRIPTION OF LITERATURE

A basic characteristic of data, most widely used in statistics, is central tendency which means the tendency of data to cluster around some central value [3 , 4 , 13 , 20 , 31]. Lot of research had already been done on measures of central tendency of data. The measures, developed so far, are of two types namely mathematical measures and positional measures. Arithmetic Mean [7 , 8 , 20 , 21], Geometric Mean [7 , 8 , 20 , 21] and Harmonic Mean [7 , 8 , 20 , 21] are the three pioneer measures of central tendency of data These three are also known as Pythagorean Means [7 , 8]. Median and Mode are two positional measures of central tendency [34 , 40]. Some more mathematical measures of central tendency, recently developed, are Arithmetic-Geometric Mean [3 , 10 , 17 , 20 , 21, 23 , 30], Arithmetic-Harmonic Mean [11 , 12 , 17 , 18 , 19 , 20 , 21 , 23 , 28], Geometric-Harmonic Mean [13 , 17 , 20 , 21 , 23] and Arithmetic-Geometric-Harmonic Mean [14 , 15 , 17 , 20 , 21 , 23] have been developed in some recent studies.

Each of the measures of central tendency, as mentioned above, results in value which lies in the middle part or central part of the associated data. However, tendency of data may not always be towards the central portion of the data in reality. In many cases, the tendency of data is not towards the central / middle portion

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of the data set but towards one end point of the data set. As an example, suppose that a region/location normally remains completely drought (i.e. without rainfall i.e. with zero rainy day) during a particular time period. But, due to some irregular/accidental/random factor/cause there may be rainfall (though rare of very small) during that time period. As a result, if data on number of rainy days are collected and tendency is calculated by the existing measures then the value obtained will be different from 0 and > 0. But, the real / actual tendency of number of rainy days in this case is 0. Moreover, there are situation(s) where data set consists of integral valued numbers so that the tendency of the data set is also an integral valued number (for example, number of rainy days as mentioned above). In such situation(s), the above mathematical measures may fail to provide the value, which is a valid one, of the tendency of data since the values provided by them are not bound to be integers. The mathematical measures may suit the continuous data. Positional measures may suit ordinal data. Thus there is necessity of some formulation/method of determining tendency of data in such situation. For this reason, formulation/method has been developed for determining the tendency of integral valued numerical data [22 , 26]. Number of rainy days is a variable which assumes non-negative integral values. Formulation/method has also been developed for determining tendency of non-negative integral valued data [26]. This formulation/method has already been applied in determining the tendency of rainfall at Delhi and Mumbai [25 , 26]. In the current study, the same has been applied in determining the tendency of rainfall at 42 location/stations covering India.

2.1. Formulation/Method Used:

Let

$$x_1 , x_2 , \ldots\ldots\ldots , x_N$$

be N observed values, which are non-negative integral values, observed on a non-negative integral valued random variable X.

Since the observations are non-negative integral valued, the tendency of the observations or equivalently the tendency of the random variable X is also a non-negative integral value.

Then the formulation / method of determining the tendency of the observations, developed recently [26] can be summarized as follows:

Let

I = Integer just below the Arithmetic Mean of $x_1 , x_2 , \ldots\ldots , x_N$

& M = Mode of $x_1 , x_2 , \ldots\ldots , x_N$

(1) If I = M ,

then the common value is the value of central tendency of X.

(2) If I and M of the observations are found to be different then identify the outlier(s) in the data set and repeat the process to obtain identical value of I and M. This common value is the value of central tendency of X.

(3) If mode is found not to be unique and/or if mode is found not to be identifiable, I is the value of central tendency of X.

3. TENDENCY OF RAINFALL IN INDIA

In order to obtain a picture of tendency of rainfall in India, the 42 locations/stations namely Agartala , Ahmadabad , Allahabad , Amritsar , Bangalore , Bhopal , Bhubaneswar , Bhunter , Chennai , Mumbai , Chandigarh(A) , Chandigarh , Dehra Dun , Dhubri , Dibrugarh , Guwahati , Hisar , Hyderbad , Imphal , Jaipur , Jammu(A) , Kohima , Kolkata , Lucknow , Nagpur , New Delhi , Palam (A) , Panjim , Patiala , Patna (A) , Pondicherry , Port Blair , Pune , Shilong (A) , Shilong / C.S.O. , Silchar , Simla , Srinagar (A) , Tezpur, Trivandrum, Udaipur , Varanasi have been selected for study since these 42 locations more or less cover the entire India and since Indian Meteorological Department has established stations at these locations for collecting & further processing meteorological data.

Data on number of rainy days (month-wise) at these stations have been collected from the year 1969 onwards. In order to determine the tendency of number of rainy days in each of the 12 months at each of the stations, the formulation/method as mentioned above has been applied to these data.

The tendencies of number of rainy days obtained for the 12 months at the stations have been summarized in Table - 5.1. It is to be mentioned that due to the lake of sufficient data, it has not been possible to determine the tendency of rainy days at Kohima.

In the next step, periods of no-rain tendency (i.e. tendency of zero rainy days) at the stations have been identified and have been summarized in Table - 5.2.

4. CONCLUSIONS

The following two facts are observed in this study:

The method / formulation, as mentioned in section 2.1, of determining the tendency of data it fulfills the criterion that the tendency of data is not always towards the middle / central portion of the data set while the other measures do not fulfill this criterion and (2) it yields integral value as the value of tendency of integral valued data which is not yielded by the other measures while logically the tendency of integral valued data is to be an integral value. In view of these two facts, the method / formulation / measure, as mentioned in section 2.1, of determining the tendency of data can be regarded as more accurate than its other measures. It is to be noted that the tendency of data is not always towards the middle / central portion of the data set but the central tendency of data is always towards the middle / central portion of the data set. It can be concluded that the value of central tendency of a data set containing non-negative integral valued numbers is the common value of the mode and the integer just below the arithmetic mean of the data set if exists and simply the integer just below the arithmetic mean if does not exist. When the common value does not exist, the presence of outlier(s) in the data set is to be examined and necessary rectification of calculation is to be worked out if the presence of outlier is found in the data set. Thus, tendency can be regarded as a basic characteristic of data so that central tendency is a special case of this characteristic.

5. TABLES OF FINDINGS

Table -5. 1: (Tendency of Rainfall in terms of Number of Rainy Days at various stations in India)

Station	Tendency of Number of Rainy Days in the month											
	Jan	Feb	Mar	April	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Agartala	0	0	3	8	13	15	15	15	11	6	1	0
Ahmadabad	0	0	0	0	0	4	11	10	4	0	0	0
Allahabad	1	1	0	0	1	4	11	11	8	1	0	0
Amritsar	2	3	3	3	3	3	9	7	3	1	0	1
Bangalore	0	0	0	2	6	6	7	10	9	8	3	1
Bhopal	1	1	0	0	0	7	14	14	7	1	1	0
Bhubaneswar	0	1	1	2	3	10	15	15	11	7	1	0
Bhunter	5	6	8	5	6	4	8	8	4	1	1	2
Chennai	1	0	0	0	1	4	6	8	7	10	10	5
Chandigarh(A)	2	2	3	1	2	6	11	11	5	1	0	1
Chandigarh	3	2	1	0	2	6	10	10	5	1	0	0
Dehra Dun	3	3	3	2	3	9	19	20	11	2	0	1
Dhubri	0	0	2	8	13	16	17	13	11	4	1	0
Dibrugarh	3	5	8	13	13	17	22	16	14	7	2	2
Guwahati	1	2	4	9	12	14	17	12	10	4	1	0
Hisar	1	1	1	1	1	3	7	6	3	0	0	0
Hyderbad	0	0	0	1	2	7	9	10	7	5	1	0
Imphal	1	3	6	9	10	15	15	12	9	6	3	1
Jaipur	0	1	0	0	1	3×	10	9	3	1	0	0
Jammu(A)	1	1	2	1	1	2	2	2	2	1	1	1
Kohima	×	×	×	×	×	×	×	×	×	×	×	×
Kolkata	1	1	2	2	6	12	17	16	13	6	1	0
Lucknow	1	1	0	0	1	4	11	11	8	1	0	0
Mumbai	0	0	0	0	0	13	22	21	13	3	1	0
Nagpur	1	1	1	1	1	8	13	13	8	3	1	0
New Delhi	1	1	1	1	1	4	10	9	4	1	0	0
Palam(A)	1	1	1	1	1	3	9	9	4	1	0	0

Panjim	0	0	0	0	3	21	26	24	12	5	2	0
Patiala	2	2	2	0	2	3	9	8	4	0	0	1
Patna(A)	1	1	0	1	2	6	14	12	10	3	0	0
Pondicherry	1	0	0	0	1	2	4	6	6	9	11	6
Port Blair	1	1	1	4	15	18	18	18	17	14	12	4
Pune	0	0	0	0	2	9	12	9	7	4	1	0
Shilong (A)	1	1	3	9	16	19	20	15	15	9	2	0
Shilong / C.S.O.	1	2	3	8	15	18	18	15	16	8	2	1
Silchar	1	3	6	12	14	20	21	17	15	8	2	1
Simla	4	4	5	4	5	10	17	16	9	2	1	1
Srinagar(A)	4	4	7	6	5	3	5	4	2	2	2	3
Tezpur	1	1	3	10	12	15	16	13	11	5	1	1
Trivandrum	1	1	2	6	9	16	13	10	8	11	9	4
Udaipur	0	0	0	0	1	4	8	9	5	1	0	0
Varanasi	1	1	0	0	1	4	13	12	9	1	0	0

Table -5.2: (Period of No-Rain Tendency at Various Stations in India)

Station	Period of No-Rain Tendency
Agartala	December – February
Ahmadabad	October – May
Allahabad	March – April & November – December
Amritsar	November
Bangalore	January – March
Bhopal	March – May & December
Bhubaneswar	December – January
Bhunter	Nil
Chennai	February – April
Chandigarh(A)	November
Chandigarh	November – December & April
Dehra Dun	November

Dhubri	December – February
Dibrugarh	Nil
Guwahati	December
Hisar	October – December
Hyderbad	December – March
Imphal	Nil
Jaipur	November – January & March – April
Jammu(A)	Nil
Kohima	×
Kolkata	December
Lucknow	November – December & March – April
Mumbai	December – May
Nagpur	December
New Delhi	November – December
Palam(A)	November – December
Panjim	December – April
Patiala	October – November & April
Patna(A)	November – December & March
Pondicherry	February – April
Port Blair	Nil
Pune	December – April
Shilong(A)	December
Shillong/C.S.O.	Nil
Silchar	Nil
Simla	Nil
Srinagar(A)	Nil
Tezpur	Nil
Trivandrum	Nil
Udaipur	November – April
Varanasi	November – December & March – April

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